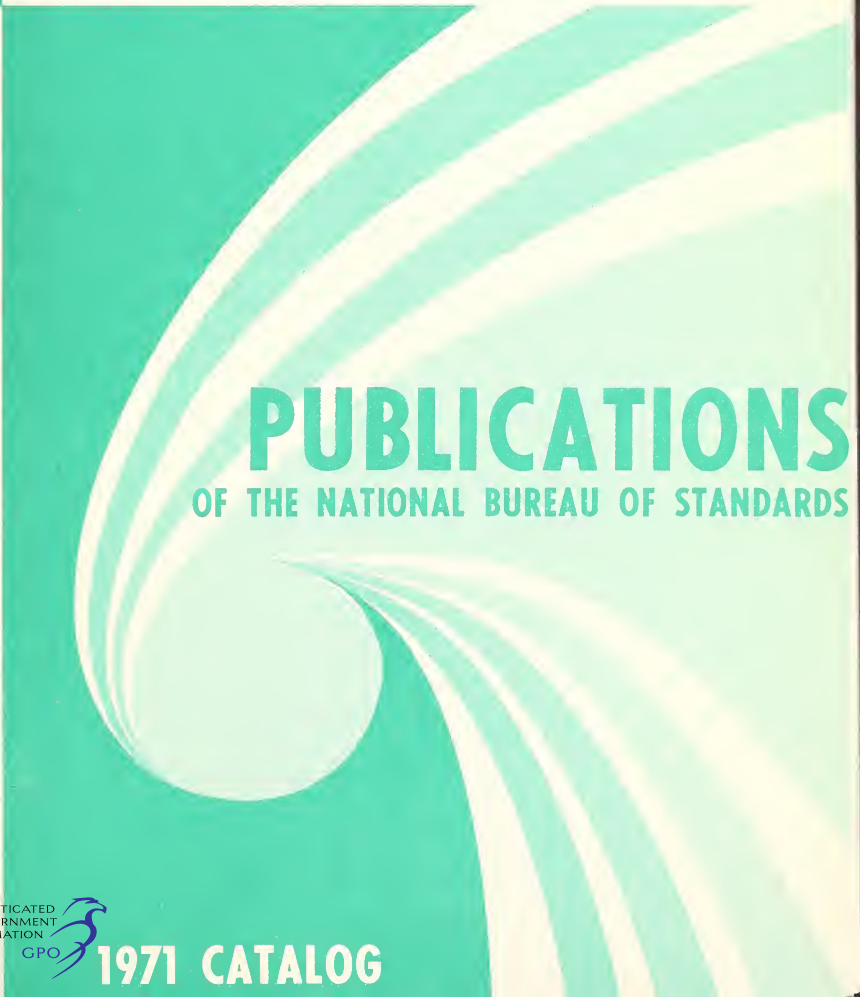
A UNITED STATES
DEPARTMENT OF
COMMERCE
PUBLICATION

NBS SPECIAL PUBLICATION 305
SUPPLEMENT 3



PUBLICATIONS
OF THE NATIONAL BUREAU OF STANDARDS

U.S.
PARTMENT
OF
OMMERCE

1971 CATALOG

NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards[1] was established by an act of Congress March 3, 1901. The Bureau's overall goal is to strengthen and advance the Nation's science and technology and facilitate their effective application for public benefit. To this end, the Bureau conducts research and provides: (1) a basis for the Nation's physical measurement system, (2) scientific and technological services for industry and government, (3) a technical basis for equity in trade, and (4) technical services to promote public safety. The Bureau consists of the Institute for Basic Standards, the Institute for Materials Research, the Institute for Applied Technology, the Center for Computer Sciences and Technology, and the Office for Information Programs.

THE INSTITUTE FOR BASIC STANDARDS provides the central basis within the United States of a complete and consistent system of physical measurement; coordinates that system with measurement systems of other nations; and furnishes essential services leading to accurate and uniform physical measurements throughout the Nation's scientific community, industry, and commerce. The Institute consists of a Center for Radiation Research, an Office of Measurement Services and the following divisions:

Applied Mathematics—Electricity—Heat—Mechanics—Optical Physics—Linac Radiation[2]—Nuclear Radiation[2]—Applied Radiation[2]—Quantum Electronics[3]—Electromagnetics[3]—Time and Frequency[3]—Laboratory Astrophysics[3]—Cryogenics[3].

THE INSTITUTE FOR MATERIALS RESEARCH conducts materials research leading to improved methods of measurement, standards, and data on the properties of well-characterized materials needed by industry, commerce, educational institutions, and Government; provides advisory and research services to other Government agencies; and develops, produces, and distributes standard reference materials. The Institute consists of the Office of Standard Reference Materials and the following divisions:

Analytical Chemistry—Polymers—Metallurgy—Inorganic Materials—Reactor Radiation—Physical Chemistry.

THE INSTITUTE FOR APPLIED TECHNOLOGY provides technical services to promote the use of available technology and to facilitate technological innovation in industry and Government; cooperates with public and private organizations leading to the development of technological standards (including mandatory safety standards), codes and methods of test; and provides technical advice and services to Government agencies upon request. The Institute also monitors NBS engineering standards activities and provides liaison between NBS and national and international engineering standards bodies. The Institute consists of the following divisions and offices:

Engineering Standards Services—Weights and Measures—Invention and Innovation—Product Evaluation Technology—Building Research—Electronic Technology—Technical Analysis—Measurement Engineering—Office of Fire Programs.

THE CENTER FOR COMPUTER SCIENCES AND TECHNOLOGY conducts research and provides technical services designed to aid Government agencies in improving cost effectiveness in the conduct of their programs through the selection, acquisition, and effective utilization of automatic data processing equipment; and serves as the principal focus within the executive branch for the development of Federal standards for automatic data processing equipment, techniques, and computer languages. The Center consists of the following offices and divisions:

Information Processing Standards—Computer Information—Computer Services—Systems Development—Information Processing Technology.

THE OFFICE FOR INFORMATION PROGRAMS promotes optimum dissemination and accessibility of scientific information generated within NBS and other agencies of the Federal Government; promotes the development of the National Standard Reference Data System and a system of information analysis centers dealing with the broader aspects of the National Measurement System; provides appropriate services to ensure that the NBS staff has optimum accessibility to the scientific information of the world, and directs the public information activities of the Bureau. The Office consists of the following organizational units:

Office of Standard Reference Data—Office of Technical Information and Publications—Library—Office of International Relations.

---

[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.

[2] Part of the Center for Radiation Research.

[3] Located at Boulder, Colorado 80302.

UNITED STATES DEPARTMENT OF COMMERCE
PETER G. PETERSON, *Secretary*
NATIONAL BUREAU OF STANDARDS • Lawrence M. Kushner, *Acting Director*

Publications of the National Bureau of Standards 1971 Catalog

A Compilation of Abstracts and Key Word and Author Indexes

Betty L. Oberholtzer

t.

National Bureau of Standards Special Publication 305 Supplement 3

To Accompany National Bureau of Standards Circular 460; its Supplement, Miscellaneous Publication 240; its Supplement, Special Publication 305; and its Supplements 1 and 2

Nat. Bur. Stand. (U.S.), Spec. Publ. 305 Suppl. 3, 342 pages (July 1972)
CODEN: XNBSA

Issued July 1972

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
(Order by SD Catalog No. C13.10:305 Suppl. 3) - Price $3
Stock Number 0303-1014

PREFACE

This annual supplement to the Bureau's publication catalog provides, in one source, complete citation information on all NBS papers published during 1971 in NBS and non-NBS media. As in previous years, slightly more than one-fourth of NBS-authored papers appeared in the Bureau's own journals and other publication series. The remaining three-fourths were published in those various professional and technical journals and books best suited to communicate the results of NBS research to its primary audiences. Past catalogs of NBS publications are listed in Section 2.3.

NBS publications are issued through the Government Printing Office and are listed herein by their respective subject series, as indicated in the Table of Contents. A separate numerical sequence is employed to organize NBS-authored papers published in non-NBS publications. For all NBS papers, whatever the publication media, the citations herein include title, author(s), place of publication, key words, and abstract. Features designed to facilitate the catalog's use, and to enhance its reference value, include permuted author and key-word indexes. In the latter, each key-word entry appears in alphabetical order, trailed by the other key words for that particular paper. Helpful collateral information on document availability and points of purchase is also included. An edge index on the rear cover permits ready reference to specific areas of interest.

As in the past, the Bureau's computer-assisted photocomposition capability has facilitated the prompt issuance of this 1971 catalog. Publication data are encoded throughout the year into a time-shared computer system, making it possible to produce periodic internal management reports on the status of Bureau publications, as well as to produce this annual photocomposed catalog at lower cost.

Significant technical advances achieved during the year in these electronic-printing techniques not only contributed to this supplement, but also make possible the photocomposition and publication of a larger number of NBS research papers of greater technical complexity.

W. R. TILLEY, *Chief*
Office of Technical Information
and Publications

Contents

1. NBS PUBLICATION PROGRAM

1.1. INTRODUCTION

For many years, the National Bureau of Standards formal publication program has provided a principal and effective means of communicating the results of the Bureau's research, development, and service activities to the scientific and technical community. Publications thus constitute a major end product of the Bureau's efforts, totalling about 900 items per year. These take the form of the Bureau's four periodicals, its ten nonperiodical publications, and articles in the journals of professional organizations and technological associations.

This book, Publications of the National Bureau of Standards, lists those publications representing the results of the Bureau's in-house programs; these publications are as follows:

1.2. PERIODICALS

1.2.1. JOURNAL OF RESEARCH

The *Journal of Research* reports research and development in physics, mathematics, chemistry, and engineering. Comprehensive scientific papers give complete details of the work, including laboratory data, experimental procedures, and theoretical and mathematical analyses. The *Journal* also presents review articles by recognized authorities and compilations of information on subjects closely related to the Bureau's technical program. The *Journal of Research* is issued in three separate sections as follows:

A. Physics and Chemistry

This section presents papers of interest primarily to scientists working in these fields. It covers a broad range of physical and chemical research, with major emphasis on standards of physical measurements, fundamental constants and properties of matter. Issued six times a year.

Editor: C. W. Beckett
Associate Editor: D. D. Wagman

B. Mathematical Sciences

This section presents studies and compilations designed mainly for the mathematician and theoretical physicist. Topics in mathematical statistics, theory of experiment design, numerical analysis, theoretical physics and chemistry, logical design and programming of computers and computer systems are covered, together with short numerical tables. Issued quarterly.

Editor: M. Newman
Associate Editor: F. W. Olver

C. Engineering and Instrumentation

This section reports results of interest chiefly to the engineer and the applied scientist. It includes many of the new developments in instrumentation resulting from the Bureau's work in physical measurement, data processing, and development of test methods. It also covers some of the work in acoustics, applied mechanics, building research, and cryogenic engineering. Issued quarterly.

Effective spring of 1972 it is planned to discontinue this Section of the Journal and to utilize appropriate NBS and non-NBS publication media for papers carried in this Section.

Editor: M. Greenspan
Associate Editors: G. F. Montgomery and
A. F. Schmidt

1.2.2. TECHNICAL NEWS BULLETIN

Reports results of Bureau's programs in measurement standards and techniques, properties of matter and materials, engineering standards and services, instrumentation, and automatic data processing.

The best single source of information concerning the Bureau's research, developmental, cooperative and publication activities, this monthly publication is designed for the industry-oriented individual whose daily work involves intimate contact with science and technology—engineers, chemists, physicists, research managers, product-development managers, and company executives. Readers use the *TNB* to learn of new developments with practical applications, to fill in background, to get ideas for further investigations, and for information on NBS services and publications. Issued monthly.

1.3. NONPERIODICALS

Ten categories of nonperiodical publications, described as follows, are listed in this catalog:

MONOGRAPHS—major contributions to the technical literature on various subjects related to the Bureau's scientific and technical activities.

HANDBOOKS—recommended codes of engineering and industrial practice (including safety codes) developed in cooperation with interested industries, professional organizations, and regulatory bodies.

SPECIAL PUBLICATIONS—provides material of a particular nature and quality. Includes proceedings of high-level national and international conferences sponsored by NBS, precision measurement and calibration volumes, NBS Research Highlights, and other special publications appropriate to this grouping. This series had previously been designated Miscellaneous Publications.

APPLIED MATHEMATICS SERIES—mathematical tables, manuals, and studies.

NATIONAL STANDARD REFERENCE DATA SERIES—provides quantitative data on the physical and chemical properties of materials, compiled from the world's literature and critically evaluated. Developed under a world-wide program coordinated by NBS.

BUILDING SCIENCE SERIES—research results, test methods, and performance criteria of building materials, components, systems, and structures.

TECHNICAL NOTES—designed to supplement the Bureau's regular publications program. Communications and reports of data of limited or transitory interest. Often serve as final reports on work sponsored at NBS by other Government agencies.

PRODUCT STANDARDS—developed cooperatively with interested Government and industry groups, and used voluntarily. The term *Product Standards* is now being used to identify all new standards as well as all revisions of existing standards. Existing standards will continue to be referred to as *Commercial Standards or Simplified Practice Recommendations* until such time as they are revised.

FEDERAL INFORMATION PROCESSING STANDARDS PUBLICATIONS—publications in this series collectively constitute the Federal Information Processing Standards Register. The purpose of the Register is to serve as the official source of information in the Federal Government regarding (1) uniform Federal information processing standards resulting from provisions of Public Law 89-306 (the Brooks Bill), and (2) data elements and codes standards in data systems developed under the provisions of Bureau of the Budget Circular No. A-86. FIPS PUBS will include approved Federal information processing standards information of general interest, and a complete index of relevant standards publications.

CONSUMER INFORMATION SERIES—practical information, based on NBS research and experience, covering areas of interest to the consumer. Easily understandable language and illustrations provide useful background knowledge for shopping in today's technological marketplace.

1.4. NBS BIBLIOGRAPHIC SUBSCRIPTION SERVICES

The Cryogenic Data Center and the Electromagnetics Division of the National Bureau of Standards, Boulder, Colorado have developed specialized bibliographic issuances designed to provide interested audiences with information on latest developments in certain specialized fields. These issuances, together with subscription information, are listed below:

Cryogenic Data Center Current Awareness Service (Publications and Reports of Interest in Cryogenics). A literature survey issued weekly. Annual subscription: Domestic, $15.00; Foreign, $20.00.

Liquefied Natural Gas. A literature survey issued quarterly. Annual subscription: $15.00.

Superconducting Devices and Materials. A literature survey issued quarterly. Annual subscription: $15.00.

For the above services, send subscription orders and remittances, made payable to the Dept. Comm./NBS to the Cryogenic Data Center, Room 2022, Cryogenics Building, National Bureau of Standards, Boulder, Colorado 80302.

Electromagnetic Metrology Current Awareness Service (Abstracts of Selected Articles on Measurement Techniques and Standards of Electromagnetic Quantities from D-C to Millimeter-Wave Frequencies). Issued monthly. Annual subscription: $100.00 (Special rates for multi-subscriptions). Send subscription order and remittance made payable to the Dept. Comm./NBS to the Electromagnetic Metrology Information Center, Electromagnetics Division, National Bureau of Standards, Boulder, Colorado 80302.

1.5. PAPERS PUBLISHED BY OTHERS

Many significant contributions by NBS authors are published in other journals. Up-to-date listings of these articles are carried regularly in the Technical News Bulletin, as well as in each section of the Journal of Research, along with selected abstracts.

1.6. OSRDB BIBLIOGRAPHY SERIES

Under the National Standard Reference Data System's program administered by the NBS Office of Standard Reference Data (OSRD) each NSRDS data center or compilation project builds up a comprehensive bibliographic file covering its area of interest. This information provides a basis for evaluation and preparation of standard reference data. It also provides the basis for the OSRDB bibliography series which was inaugurated to make listings of these extensive files available to the technical community. Papers in this bibliographic series are available by purchase from the National Technical Information Service, Springfield, Virginia 22151, see Section 4.1 for a list of these papers.

2. PURCHASE PROCEDURES AND DOCUMENT AVAILABILITY

2.1. PURCHASE PROCEDURES

The publications of the Bureau are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, at the prices listed in this publication. You may also order through the U.S. Department of Commerce Field Office nearest you (see page 337 for list of Field Offices of the U.S. Department of Commerce). Nonperiodicals (only) may also be ordered through the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22151

This section includes price lists of available publications, plus instructions on how to acquire reprints of articles by NBS authors, and how to get out-of-print material.

How to Make Remittances. Remittances for publications for which individual sales or subscription prices are shown should be mailed to Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, by coupon, postal money order, express money order, or check. Postage stamps will not be accepted. Publications cannot be mailed before remittances are received. *Foreign remittances should be made either by international money order or draft on an American bank.*

The letter symbol, publication number, and full title of the publication must be given when ordering. The Superintendent of Documents allows a discount of 25 percent on orders of 100 or more copies of one publication.

For the convenience of the general public, coupons in the denomination of five cents may be purchased from the Superintendent of Documents. These may be exchanged for Government publications sold by the Superintendent's office. Address order to Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Persons who make frequent purchases from the Superintendent of Documents may find a deposit account convenient. Deposits of $25 or more are accepted against which orders may be placed without making individual remittances or first obtaining quotations. Order blanks are furnished for this purpose. After the order has been processed, the order itself is returned, showing the publications supplied, explanations regarding those not sent, the amount of charge, and the balance on deposit.

No charge is made for postage on documents sent to points in the United States and possessions, or to Canada, Mexico, Newfoundland (including Labrador), and certain Central and South American countries. To other countries the regular rate of postage is charged, and remittances must cover such postage. In computing foreign postage, add one-fourth of the price of the publication.

Orders for publications purchased from the National Technical Information Service (NTIS) must be accompanied by postal money order, express money order, or check made out to the NTIS and covering total cost of the publications order. Information concerning NTIS coupons can be obtained directly from NTIS. All inquiries or orders should be addressed to: National Technical Information Service, Springfield, Virginia 22151.

2.2. ANNOUNCEMENTS OF NBS PUBLICATIONS

The National Bureau of Standards and the agencies mentioned below regularly issue the following official announcements dealing with NBS publications.

Technical News Bulletin. Issued monthly by the National Bureau of Standards. In addition to publishing technical news of the Bureau, the Bulletin announces all new publications by members of the staff whether published in an NBS series or in a non-NBS publication. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Annual subscription, $3.00; $4.00 foreign. Single copies, 15 cents each.

Monthly Catalog of United States Government Publications. Issued monthly by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Annual subscription, with consolidated annual index, $7.00; $8.75 foreign.

Price Lists. These consist of lists of publications prepared by the Superintendent of Documents on special subjects. Single copies sent on request without charge provided you state the subject matter field in which you desire information. For a complete list and order form for subject price lists, request a copy of **How to Keep in Touch with United States Government Publications** from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

List of Selected Government Publications. Issued semimonthly by the Superintendent of Documents. Each list is arranged alphabetically by subjects, with annotations and prices. May be obtained free from that office.

Business Service Check List. Weekly announcement of publications of the Department of Commerce. Lists titles and prices of National Bureau of Standards Publications, as well as those of other offices of the Department of Commerce. Available from the Superintendent of Documents. Annual subscription, $2.50; $4.00 foreign.

2.3. CATALOGS OF NBS PUBLICATIONS

Previous catalogs, plus this publication, constitute a complete list of the titles of the Bureau's publications through December 31, 1971. Where the price is given, the catalog is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Otherwise, it may be consulted in a library which maintains sets of National Bureau of Standards publications.

Circular 460: Publications of the National Bureau of Standards 1901 to June 30, 1947. 375 pages, including subject and author indexes. Brief abstracts are included for the period January 1, 1941 to June 30, 1947	$1.25
Supplement to circular 460: Publications of the National Bureau of Standards, July 1, 1947 to June 30, 1957. 373 pages, including subject and author indexes	$1.50
Miscellaneous Publication 240: Publications of the National Bureau of Standards July 1, 1957 to June 30, 1960. First NBS Catalog to Include Titles of Papers Published in Outside Journals 1950 to 1959. 391 pages, including subject and author indexes	$3.50
Supplement to Miscellaneous Publication 240: Publications of the National Bureau of Standards published by NBS, July 1960 through June 1966; published by others, 1960 through 1965. 740 pages, including subject and author indexes	$4.00
Special Publication 305: Publications of the National Bureau of Standards published by NBS, July 1966 through December 1967; published by others, 1966-1967. 223 pages, a citation of titles and abstracts, with key words and author indexes	$2.00
Supplement 1 to Special Publication 305: Publications of the National Bureau of Standards, 1968 through 1969. 497 pages, a citation of titles and abstracts, with key words and author indexes	$4.50
Supplement 2 to Special Publication 305: Publications of the National Bureau of Standards, 1970. 378 pages, a citation of titles and abstracts, with key words and author indexes	$3.25
Supplement 3 to Special Publication 305: Publications of the National Bureau of Standards, 1971. 342 pages, a citation of titles and abstracts, with key words and author indexes	$3.00

2.4. FUNCTIONS OF DEPOSITORY LIBRARIES IN THE UNITED STATES

The Superintendent of Documents, United States Government Printing Office, is authorized by law to furnish Government publications to designated depository libraries. The libraries listed in Appendix A are now receiving selected publication series of the National Bureau of Standards for general reference use. Whether a given library has a copy of a particular publication can be determined by inquiring at the library.

2.5. FUNCTIONS OF U.S. DEPARTMENT OF COMMERCE FIELD OFFICES

Department of Commerce Field Offices are maintained in the cities listed in Appendix B. Their purpose is to provide ready access, at the local level, to the services of the Department of Commerce as well as to its reports, publications, statistical statements, and surveys. Each Field Office serves as an official sales agent of the Superintendent of Documents, U.S. Government Printing Office, making available for purchase locally a wide range of Government publications. The reference library maintained by each Field Office contains many Government and private publications, periodicals, directories, reports, and other reference materials.

2.6. AVAILABILITY OF NBS PUBLICATIONS

A. PERIODICAL SUBSCRIPTION RATES

Periodical	Domestic[1]	Foreign[2]
Journal of Research of the National Bureau of Standards:		
Section A. Physics and Chemistry, issued six times a year, paper covers (4)	9.50	11.75
Bound volume (1 volume per year), blue buckram	(3)	(3)
Section B. Mathematical Sciences, issued quarterly, paper covers (4)	5.00	6.25
Bound volume (1 volume per year), green buckram (4)	(3)	(3)
Technical News Bulletin, 12 monthly issues (4)	3.00	4.00

NOTE.—Send order, with remittance, to Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

[1] United States and its possessions, Canada, Mexico, Newfoundland (including Labrador), and certain Central and South American Countries.

[2] Foreign price includes the cost of the publication and postage.

[3] Prices of the bound volumes vary. The Superintendent of Documents will furnish prices on request.

[4] These monthly periodicals may be obtained on a 1-, 2-, or 3-year subscription basis (although at no reduction in rates).

B. PRICE LISTS FOR NONPERIODICALS

The following lists give the numbers and prices of all NBS publications issued from 1901 through 1971 which are still in print. Those items in **boldface** denote the 1971 publications cited in this supplement. The prices shown herein supersede prices quoted in previous catalogs of NBS publications. Publications may be ordered from the Superintendent of Documents, U.S. Government Printing Office or from the U.S. Department of Commerce Field Office nearest you. Some NBS publications may be purchased from the National Technical Information Service. (See Section 2.1.)

When an item refers to "see—", the original item has been superseded by the item referenced, and the price shown is the sales price for the superseding publication. If "OP" is listed instead of a price, that publication is out of print. In such cases, your nearest depository library may still have a copy of the out-of-print item. (See Section 2.4 and Appendix A.)

CIRCULARS (Discontinued Series)

No.	Price
3 see C547, Sec. 1, in part	OP
8 see Mono. 90	$0.25
9 see C602	OP
10 see C425	OP
12 see C440	OP
16 see C555	OP
17 see Mono. 47	.30
25 see M260	.45
29 see C60	OP
31 see H100	.50
32 see C405	OP
35 see M183	OP
40 see C381	OP
44 see C440	OP
47 see M233	OP
49 see H8	OP
51 see C432	OP
52 see C387	OP
54 see H3 & H4	OP
57 see C410	*
61 see H29	OP
62 see C424	OP
65 see C417	OP
75 see C397	OP
76 see C346	OP
82 see C361	OP
83 see C333	OP
95 see C426	OP
100 see C592	OP
101 see C447	OP
131 see C385	OP
138 see C385	OP
139 see C390	OP
154 see H71	*
239 see C363	OP
257 see C365	OP
280 see C406	OP
294 see C407	OP
300 see C418	OP
319 see C378	OP
322 see C360	OP
328 see Mono. 15	OP
330 see C362	OP
332 see Mono. 15	OP
339 see C363	OP
371 see C378	OP
375 see C457	OP
380 see C418	OP
383 see C424	OP
390 see H71	*
392 see C432	OP
396 see C418	OP
398 see M260	$0.45
399 see C406	OP
400 see C426	OP
402	.05
410	*
413 see C426	OP
414 see H71	*
415 see Mono. 47	.30
428 see C533	2.50
434 see C602	OP
425 see H71	*
438	*
450 see C579	*
454 (PB192338)	**
456 see Mono. 47	.30
460	1.25
460 Suppl.	1.50
462 see Mono. 80, in part	2.75
464	*
465 see H90	.40
466 see H71	*
470	.30
474 see C576	*
477 see C555	OP
478 see Mono. 104	.35
482 see C509	OP
485 see C592	OP
488 Sect. 1 & 2	1.25
488 Sect. 3, 4, & 5	1.50
495 see Mono. 88	.35
499	*
500 Pt. I see TN270–3	$1.25
500 Pt. II see TN270–3	1.25
506 see C576	*
508 see C561	OP
510 (PB192339)	**
510 Suppl. 1 (PB192340)	**
510 Suppl. 2 (PB192341)	**
518 see Mono. 70, Vol. I in part	2.00
Vol. II in part	3.00
533	2.50
536	.20
537 see NSRDS–NBS 10	.40
539 Vol. 1 to 10 are now PB178902 through PB178911	**
542 (PB188806)	**
552 see M260	.45
553	2.00
556 (PB172004)	**
559 see H71	*
563 & 563 Suppl. 1, see M274	.50
564	*
567 see M271	1.25
571 (PB175659)	**
572 see Mono. 15	OP
576	*
577 & 577 Suppl.	*
579 (PB168350)	*
580 see M251	OP
582	3.25
589 (PB188296)	**
592 see Mono. 106	1.25
593	.45
596 (PB172059)	**
600 see Mono. 90	.25
601	.30

---

*See page 21 for additional information.

**Now available from the National Technical Information Service; order by PB number.

MONOGRAPHS

No.	Price
2 (PB187752)	*
3 Vol. I	$6.00
3 Vol. II	6.00
4 (PB174987)	*
8 (PB186237)	*
10	.20
11	.20
12	1.50
13 (PB172156)	*
14	.15
17	.65
18 see Mono. 88	.35
20	2.75
22	2.00
23 (PB183992)	*
24	.20
25 Sect. 1 (PB178429)	*
25 Sect. 2 (PB178430)	*
25 Sect. 3 (PB178431)	*
25 Sect. 4	.55
25 Sect. 5	.55
25 Sect. 6	.60
25 Sect. 7	1.50
25 Sect. 8	1.50
25	1.25
26	.20
27 Suppl. incl. in Suppl. 2	.35
27 Suppl. 2	.35
28 see BSS17	.40
29 (PB172178)	*
30 (PB193908)	*
31	.35
32 Suppl. to Parts I & II	.30
33	.55
34 Vol. 1 (COM–71–00631	*
34 Vol. 2	2.00
35	.60
35 Suppl. 1	.65
36	.30
38	.70
40	$0.50
41 (PB191728)	*
42	.75
43 Vol. I	6.50
43 Vol. II	6.25
44	.15
45 (PB186433)	*
46 (PB176590)	*
47	.30
50 see M278	.55
& M278 Suppl	.30
51	.30
52	1.00
54	.25
55	.20
56	.30
57 see M274	.50
58 (PB193909)	*
59	1.75
60	.25
61	4.00
62	.15
63	.35
64	.15
65	.15
66	.35
67 (PB186426)	*
68	.25
69	.30
70 Vol. I (PB168072)	*
70 Vol. II (PB189714)	*
70 Vol. III	4.25
70 Vol. IV	5.50
70 Vol. V	4.75
71	2.00
72 (PB186427)	*
73 (PB186432)	*
74 (PB195213)	*
75	.40
76	$0.20
77* (PB180646)	**
78	.20
79	.35
80	2.75
81	3.25
82 (PB189659)	*
83	.55
85	.70
86	.35
87	.40
88	.35
89 (AD700466)	*
90	.25
91	2.25
92	2.75
93	.75
94	.75
95	.45
96	1.25
97	.25
98	.55
99	.70
100	4.50
101	2.75
102	.25
103	.20
104	.35
105	2.25
106	1.25
107	1.75
108	.45
109	.55
110	.30
111	2.00
112	.35
113 Vol. I	1.50
113 Vol. II	1.25
113 Vol. III	1.25
114	.60
115	.55
116	1.50
117	.35
118	.50
119	3.25
120	.50
121	.30

*Now available from the National Technical Information Service; order by PB, Com., or AD number.
**Consolidated supplement to BMS144 and supersedes supplements 1 & 2 of BMS144.

APPLIED MATHEMATICS SERIES

No.	Price	No.	Price	No.	Price
1 see AMS25	$0.45	27	$4.00	50 (PB176520)	*
2 (PB194385)	*	28 (AD695952)	*	51	$4.50
5	.50	29 (AD695953)	*	53 (PB186430)	*
6	2.25	30 (PB175817)	*	54	.30
8	.30	31	4.75	55	6.50
9	1.75	32	2.25	56 (PB190608)	*
10	2.00	33 (PB175818)	*	57	.35
11	.70	34	2.00	58	.40
12 (PB184887)	*	35	2.00	59	3.25
13	.40	36	4.00	60	.60
14	5.50	40 (PB186428)	*	61	.70
17	2.00	41 (PB176521)	*		
19 (PB175815)	*	42 (PB175819)	*		
20	1.75	43 (PB176127)	*		
21 (PB178392)	*	44 (AD695954)	*		
22 (PB192337)	*	45	.55		
23 (PB175967)	*	46 (PB186429)	*		
24 (PB175816)	*	47	.45		
25	.45	48 (PB176119)	*		
26 (PB178415)	*	49	.50		

*Now available at the National Technical Information Service; order by PB or AD number.

BUILDING MATERIALS AND STRUCTURES REPORTS
(Discontinued Series)

No.	Price	No.	Price	No.	Price
17 see BMS144	OP	19 see BMS116	OP	144 & Suppl. 1 & 2, see Mono. 77 (PB180647)	*
17 Suppl. 1 & 2, see Mono. 77 (PB180647)	*	64 (PB177986)	*	151 (PB177987)	*
		66	$0.60		

*Now available at the National Technical Information Service; order by PB number.

CONSUMER INFORMATION SERIES

No.	Price	No.	Price	No.	Price
1	$0.65	3	$0.40	4	**$0.60**
2	.65				

MISCELLANEOUS PUBLICATIONS
(Superseded by Special Publication Series)

No.	Price	No.	Price	No.	Price
3 see M232	$0.50	174 see M211	$0.20	262-1	$0.60
39 see M234	.10	179	*	262-2	4.25
54 see BH5	OP	187	*	265	3.00
64 see M247	.40	203 see M243	OP	266	3.75
65 see M178	OP	211	.20	267	2.00
78 see M82	OP	214 see M286	2.25	268 (6.25 for 100)	.10
85 see H29	OP	230 see M288	2.00	269	2.75
89 H28, Part I	2.00	232	.50	271	1.25
H28, Part II	.75	233 see M286	2.25	273	2.50
H28, Part III	.60	234	.10	274	.50
H28, Suppl.	.70	236 see SP236	.25	275	5.25
90 see M187	*	240	3.50	276	2.00
92 see H46	*	240 Suppl.	4.00	277	**
93 see M160	OP	241 see M260	.45	277 see SP322	.75
94 see M163	OP	247	.40	277 Suppl. 1, seeSP322	.75
95 see H13	OP	250 see SP250	1.75	278 see SP320	1.25
100 see CS8-61	.40	253 see SP344 (6.25 for 100)	.10	278 Suppl.	.30
111 see M155	OP			279	.65
114 (PB192894)	*	257	1.75	280	1.50
121 see M233	OP	258	1.25	281	2.00
125 see M187	*	259	.05	283	.60
126 see M183	OP	260 see SP260	.50	284	1.25
130 see M178	OP	260-1	.30	285	1.75
134 see M160	OP	260-2	.35	286	2.25
141 see H28, Part I	2.00	260-5	.25	287	2.50
H28, Part II	.75	260-6	.45	288	2.00
H28, Part III	.60	260-7	.60	289	.50
H28, Suppl.	.70	260-8	.55	290	1.00
143 see M146	OP	260-9	.15	291	1.00
144 see M154	OP	260-10	.30	292	.40
152 see M163	OP	260-11	.25	294	.25
153 see M160	OP	260-12	.20		
169 see M230	OP	260-13	.40		
171 see M187	*	260-14	.30		
172 see M243	OP	260-15	.20		

*See page 21 for additional information.

**Now available from the National Technical Information Service.

SPECIAL PUBLICATIONS

No.	Price	No.	Price	No.	Price
236, 1971 Ed	$0.25	306–3	.50	340	1.50
250, 1970 Ed	2.00	306–4	.55	341	1.25
260, 1970 Ed	.75	307	3.00	342	1.75
260–16	.35	309	5.00	343	6.00
260–17	.65	310	1.25	344 ($6.25 for 100)	.10
260–18	.50	311	1.25	345	2.25
260–19	.30	312 (2 Vols)	8.50	345–1	1.25
260–21	.35	313	1.50	345–2	2.25
260–22	.35	314	3.50	345–3	1.00
260–23	.25	315	.70	345–4	1.25
260–25	30	315–1	.75	345–5	1.50
260–26	.50	315–2	.75	345–6	1.75
260–27	1.25	315–3	1.00	345–7	1.25
260–28	1.00	315–4	.75	345–8	1.50
260–29	.60	315–5	$0.75	345–9	1.25
260–30	1.00	317	8.25	345–10	2.25
260–31	.35	SP318	1.50	345–11	2.00
295	1.25	SP319	1.00	345–12	1.50
296	3.00	320	1.25	346	2.50
297	1.25	320 Suppl. 1	.65	347	1.25
299 (2 Vols.)	10.50	321	5.75	350	.55
300 Vol. I	5.50	322	.75	352	5.50
300 Vol. II	4.75	324	7.00	353	1.75
300 Vol. IV	5.50	326	4.50	355	.30
300 Vol. VI	5.00	327	4.00		
300 Vol. VII	7.00	329	9.00		
301	4.00	331	1.25		
302	6.25	332	1.75		
303	4.25	333	.70		
304	.50	334	.75		
305	2.00	335	1.50		
305 Suppl. 1	4.50	336	5.25		
305 Suppl. 2	3.25	337	5.50		
306	1.00	339	4.75		
306–2	.60	338	1.00		

HANDBOOKS

No.	Price	No.	Price	No.	Price
1 see H82	$1.75	46	*	85	1.50
2 see H24	OP	47 see H84 to H89	—	86	.65
3 see H30#		48	.20	87	.70
(PB189052)	**	49	*	88	.40
7 see H33	OP	51	.30	89	*
8 see H34	OP	52 see H69	.50	90 (PB188654)	**
9 sec H35	OP	53	.15	91	6.50
10 see H35#	OP	54 see H73	.30	92	.55
11 see H82	1.75	55	.35	93	.35
12 see H46	*	56 see H65	OP	94	3.00
14 see H29	OP	57	$0.15	95	.25
15 see H76	*	58	*	96	.25
17 see H46	*	59	*	97	*
20 see H76	*	60 see H76	*	98	.35
21 see H46	*	62 see H84 to H89	—	99	.35
22 see H44, Third Ed.	$2.00	63	*	100	$0.50
23 see H73	.30	64	.30	101	3.00
25 see H28, Part I	2.00	65	*	102	*
H28, Part II	.75	68 see H104	1.25	103	1.25
H28, Part III	.60	69	.50	104	1-25
H28, Suppl.	.70	70 see H104	1.25	105–1	.25
26 see H82	1.75	71	*	105–2	.25
28 1969 (Part I)	2.00	72	.35	105–3	.25
28 1957 (Part II)	1.25	73	*	106	2.75
28 1957 (Part III)	.60	74	*	107	.30
28 1963 Supplement	.70	75	*	108	3.25
29 see H44, Third Ed.	2.00	76	*		
30# (PB189052)	**	77 Part II	6.75		
32 see H81	2.50	78 see H84 to H89	—		
37 see H94	3.00	80	1.00		
40 see H46	*	81#	$2.50		
41 see H76	*	81 Suppl. 2	.05		
42 see H92	$0.55	82	1.75		
43#	OP	83 see H103	1.25		
44 (4th Ed.) Looseleaf	2.00	84	*		

#H81 amends in part: Part 2, Definitions and the Grounding Rules of these Handbooks.
*See pages 21 and 22 for additional information.
**Now available from the National Technical Information Service; order by PB number.

BUILDING SCIENCE SERIES

No.	Price	No.	Price	No.	Price
0	$0.60	16	.40	32	1.50
1	2.75	17	.40	33	.40
3	.15	18 (PB193736)	*	34	.70
4	.20	19	.30	35	1.25
5, Part 2	.35	20	.75	36, Part 6	1.25
6	.20	21	.55	37	.75
7	2.50	22	.70	38	.25
8, Part 3	.55	23	.25	40	3.00
9 (PB193907)	*	24	.30		
10	.25	25	1.25		
11	$0.25	26	.25		
12	.15	27	.30		
13	.15	28	.25		
14	.15	30	1.75		
15, Part 4	.75	31	.25		

*Now available from the National Technical Information Service; order by PB number.

NATIONAL STANDARD REFERENCE DATA SERIES

No.	Price	No.	Price	No.	Price
1	$0.15	13	1.00	28	2.75
2	.45	14	.40	29	.75
3, Sect. 1	.35	15	3.00	30	.45
3, Sect. 2	.20	16, Part 2	2.00	31	.55
3, Sect. 3	1.00	17 see NSRDS–39	7.75	32	.70
3, Sect. 4	.55	18	.40	33	.50
4, Vol. I	2.50	19	.20	34	.75
5	.70	20	.45	36	3.75
6 see NSRDS–39	7.75	21	7.00	37	9.75
7	.35	22, Vol. II	4.50	38	1.00
8 (PB189698)	*	23	.55	39	7.75
9	2.00	24	4.25		
10	.40	25	2.00		
11 see NSRDS–39	7.75	26	4.00		
12	.60	27	1-25		

*Now available from the National Technical Information Service; order by PB number.

PRODUCT STANDARDS

No.	Price	No.	Price	No.	Price
0–70	$0.60	20–70	.35	40–70	.10
1–66	.20	21–70	.15	41–70	.10
2–66	.10	22–70	.20	42–70	.40
3–66	.10	23–70	.10	43–71	.10
4–66	.10	24–70	.10	44–71	.15
5–66	.15	25–70	.10	46–71	.10
6–66	.10	26–70	.10	49–71	.15
7–66	.15	27–70	.25	50–71	.25
8–67	.15	28–70	.25		
9–68	.10	29–70	.15		
10–69	.15	30–70	.15		
11–69	.15	31–70	.15		
12–69	.15	32–70	.30		
13–69	.10	33–70	.10		
14–69	.10	34–70	.10		
15–69	.20	35–70	.10		
16–69	.10	36–70	.35		
17–69	.15	37–70	.10		
18–69	.15	38–70	.15		
19–69	.15	39–70	.15		

COMMERCIAL STANDARDS
(Discontinued Series)

No.	Price	No.	Price	No.	Price
5–65	$0.15	236–66	.20	272–65	.20
8–61	.40	248–64	.10	273–65	.10
46–65	.15	256–63	.10		
142–65	.10	259–63 see PS1–66	.20		
150–63	.10	261–63	.10		
163–64	.15	263–64	.10		
188–66	.40	264–64	.10		
190–64	.10	267–65	.10		
205–64	.10	268–65	.10		
227–59	.15	271–65	.10		

453-313 O - 72 - 2

FEDERAL INFORMATION PROCESSING STANDARDS PUBLICATIONS

No.	Price	No.	Price	No.	Price
0	$0.20	7	.25	14	.10
1	.10	8-1	.10		
2	.10	9	.10	15	.25
3	.10			16	.10
4	.20	10	.35	17	.10
		11	.15	18	.10
5-1	.20	12	1.50	19	.20
6-1	.45	13	.10		

SIMPLIFIED PRACTICE RECOMMENDATIONS
(Discontinued Series)

No.	Price	No.	Price	No.	Price
174-65	$0.10	229-63	$0.10	267-65	$0.10
179-63	.10	265-63	.05		

PURCHASE OF TECHNICAL NOTES

The following is a list of the National Bureau of Standards Technical Notes available only by purchase from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22151. The "PB" number in parenthesis is to be used when ordering this series. Reproduced hard copy and microfische copies of these Technical Notes are available from NTIS. Prices should be determined by inquiry to NTIS.

No.
1 (PB151360)
2 (PB151361)
2– (PB151361–2)
3 (PB151362)
4 (PB151363)
5 (PB151364)
6 (PB151365)
7 (PB151366)
8 (PB151367)
9 (PB151368)
10 (PB151369)
11 (PB151370)
12 (PB151371)
13 (PB151372)
14 (PB151373)
15 (PB151374)
16 (PB151375)
18 (PB151377)
18–2 (PB151377–2)
18–3 (PB151377–3)
18–4 (PB151377–4)
18–5 (PB151377–5)
18–6 (PB151377–6)
18–7 (PB151377–7)
18–8 (PB151377–8)
18–9 (PB151377–9)
18–10 (PB151377–10)
18–11 (PB151377–11)
18–12 (PB151377–12)
18–13 (PB151377–13)
19 (PB151378)
20 (PB151379)
21 (PB151380)
22 (PB151381)
23 (PB151382)
24 (PB151383)
25 (PB151384)
26 (PB151385)
27 (PB151386)
28 (PB151387)
29 (PB151388)
30 (PB151389)
31 (PB151390)
33 (PB151392)
34 (PB151393)
35 (PB151394)
36 see NSRDS-40 (In press)
37 (PB151396)
38 (PB151397)
39 (PB151398)
40–1 (PB151399–1)
40–2 (PB151399–2)
40–3 (PB151399–3)
40–4 (PB151399–4)
40–5 (PB151399–5)
40–6 (PB151399–6)
40–7 (PB151399–7)
40–13 (PB151399–13)
41 (PB151400)
42 (PB151401)
43 (PB151402)
44 (PB151403)
45 (PB151404)
46 (PB151405)
47 (PB151406)
48 (PB151407)
49 (PB151408)
50 (PB151409)
51 (PB161552)
52 (PB161553)
53 (PB161554)
54 (PB161555)
55 (PB161556)
56 (PB161557)
57 (PB161558)
58 (PB161559)
59 (PB161560)
60 (PB161561)
61 (PB161562)
62 (PB161563)
63 (PB161564)
64 (PB161565)
66 (PB161567)
67 (PB161568)
68 (PB161569)
69 (PB161570)
70 (PB161571)
71 (PB161572)
72 (PB161573)
73 (PB161574)
74 (PB161575)
75 (PB161576)
76 (PB161577)
77 (PB161578)
78 (PB161579)
79 (PB161580)
80 (PB161581)
81 (PB161582)
82 (PB161583)
83 (PB161584)
84 (PB161585)
85 (PB161586)
86 (PB161587)
87 (PB161588)
88 (PB161589)
89 (PB161590)
90 (PB161591)
91 (PB161592)
92 (PB161593)
93 (PB161594)
94 (PB161595)
95 (PB161596)
96 (PB161597)
97 (PB161598)
102 (PB161603)
106 (PB161607)
107 (PB161608)
108 (PB161609)
109 (PB161610)
110 (PB161611)

No.	No.	No.
111 (PB161612)	122 (PB161623)	134 (PB161635)
112 (PB161613)	123 (PB161624)	135 (PB161636)
113 (PB161614)	124 (PB161625)	136 (PB161637)
114 (PB161615)	125 (PB161626)	137 (PB161638)
115 (PB161616)	128 (PB161629)	138 (PB161639)
116 (PB161617)	129 (PB161630)	139 (PB161640)
117 (PB161618)	130 (PB161631)	140 (PB161641)
118 (PB161619)	131 (PB161632)	142 (PB161643)
119 (PB161620)	132 (PB161633)	143 (PB161644)
121 (PB161622)	133 (PB161634)	146 (PB161647)
		147 (PB161648)
		148 (PB161649)

The following Technical Notes and all subsequent issuances in this series may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, at the prices indicated.

No.	Price	No.	Price	No.	Price
18–14	$0.50	120 (PB161621)	*	179 (PB190610)	*
18–15 (PB195215)	*	120A (PB190611)	*	180	$0.15
18–16 (PB195216)	*	129A	$1.00	181	.50
18–17 (PB195217)	*	141 (PB191729)	*	182	.15
18–18 (PB168058)	*			183	.25
		145	.60		
18–19 (PB195218)	*	151 (PB191732)	*	184	.20
18–20 (PB168044)	*	154 (PB172217)	*	185	.40
18–21 (PB195219)	*	154A (PB182435)	*	186 Superseded by TN441	.55
18–22 (N6613994)	*	155	.25		
18–23	.50			187 (PB188807)	*
		157	1.25		
18–24	.50	159	.25	188	.20
18–25	.40	160	.15	190	.40
18–26	.45	161	.15	191 (PB182538)	*
40–8 (PB189932)	*	162	.50	192	.25
40–9 (PB189933)	*			193	1.00
		163	.25		
40–10 (PB189934)	*	164 (N6314864)	*	194 see NSRDS 1	.15
40–11 (PB189935)	*	165 (AD401044)	*	196	.20
40–12 (PB189936)	*	166 (PB181454)	*	197	.30
98 (PB186280)	*	169	.25	198	.35
99 (PB186431)	*	171	2.00	199 (AD683408)	*
100	1.50	172 (PB193915)	*	200	.25
100–A	.20	173	.25	201 (PB182539)	*
101 Vol. 1 (AD687820)	*	174	.25	202	.60
101 Vol. 2 (AD687821)	*	177	.75	203	.30
103	1.00	178 (PB190917)	*	204 (PB184118)	*
				205	.25

*Now available from the National Technical Information Service; order by PB or AD number.

TECHNICAL NOTES–Continued

No.	Price	No.	Price	No.	Price
206–1 & 2	$0.25	262	$1.00	307	.40
206–3	.25	262A	.50	308	0.50
206–4	.25	263	.25	309	.60
206–5	.30	264	.50	310	.30
207	1.50	265 see TN441	.55	311	.30
209 (PB168043)	*	266 (PB195214)	*	313	.45
210 (PB189930)	*	267	.45	314	.55
211 Vol. I	.50	270–1 see TN270–3	2.00	315	.25
211 Vol. II	.45	270–2 see TN270–3	2.00	316	.35
211 Vol. III	.60	270–3	2.00	318	.55
211 Vol. IV	.65	270–4	1.25	319	.55
211 Vol. V	.60	270–5	.55	321	.15
211 Vol. VI	.60	270–6	1.25	322	.20
214 (PB189931)	*	271	.60	323	.25
215 (PB188808)	*	272	.50	324	.30
216	.20	273	.50	325	.30
217 (PB189103)	*	274	.60	326	.60
218 (PB188809)	*	275	.50	327	.20
219 (PB186279)	*	276	1.00	328	.25
221	.20	279	.30	329	.35
222	.30	280	.25	330	.30
223 (PB168051)	*	281	.50	331	.20
224	.20	283	.35	332	.60
225 (AD614056)	*	284	.15	333	.25
226 (PB195214)	*	285	.25	334 (PB173291)	*
227 (PB184473)	*	286	.25	335	.25
228 (PB191731)	*	287 (PB182436)	*	336	.30
229 (PB188805)	*	288	.30	339	.50
230	.40	289	.50	341	.25
231	.25	290	.25	342	.40
233	.20	291	.30	343	.15
236 (AD437308)	*	292	.50	344	.20
237	.15	294 (PB176289)	*	345	.35
242 see TN479	.75	295	.25	346 (PB194282)	*
243	.10	296	.60	347	.25
244	.20	297 (PB188657)	*	348	.40
245 (PB184177)	*	298 (PB186238)	*	349	.25
246	.40	299	.25	350	.25
247	.40	300 (PB168048)	*	351	.30
249	.40	301	.55	352	.25
252	.40	302	.60	353	.10
253 (PB184176)	*	303	.25	355	.20
255	.45	304 (AD615936)	*	356	.25
260	.50	305	.60	357	.30
261	**	306	.75	358	.20
				359	.25

---

*Now available from the National Technical Information Service; order by PB number.

**Technical Note 261 has been superseded by the Journal of Research, Section A. Physics and Chemistry, 69A5, 385–395 (Sept.-Oct. 1965).

TECHNICAL NOTES—Continued

No.	Price	No.	Price	No.	Price
360	$0.50	412	.15	463	1.25
361	.50	413	.30	464	1.25
362	.70	414 (PB176109)	*	465	.60
363	.50	415	.50	466	.20
364	.30	416	0.30	467	5.50
365	.60	417	.25	467, Parts 1 & 2	8.50
366	1.25	418	.15	469	.30
367	.60	419 (PB179432)	*	470	.75
368	.25	420	.15	472	.50
369	.50	421	.50	473	.25
370 (AD688697)	*	423	.50	474	.30
371	.30	424	.55	475	.45
372	.35	425	.50	476	.30
373	1.00	426	.40	477	.35
374	.35	427	.45	478 (PB190609)	*
375	.50	428	.55	479	.75
377	.65	431	.30	480	.25
378	.50	432	.65	481	.30
379	.35	433	.25	483	.30
381	.65	434	.20	484	.60
383	1.25	435	.15	485	.35
384	1.00	436	.30	486	.35
385	1.00	438	.70	487	.30
386	.35	439	.45	488	.50
387	.30	440	.40	489	.60
390	.50	441 see TN526	1.25	490	.30
392	1.50	442	.20	491	.25
393	.30	443	.25	492	.40
394	.60	444	.40	494	.35
395	.50	445	.35	495	.50
396	.40	446	.55	496	.60
397	1.00	447	.20	497	.30
398	.25	448	.70	498	.40
399	.60	449	.30	498-1	.30
400	.55	451	1.25	498-2	.45
401	.55	452	1.00	499	.65
402	.50	453	.55	500	.60
403	.50	454	.55	501	1.25
404	1.25	455	1.25	502	1.00
405	.60	456	.55	503	1.00
406	.70	457	1.25	504	1.00
407	.40	458	1.00	505	1.25
408 see TN482	1.25	459	.60	506	.55
409	.40	461	.50	507	1.25
410	.25	462	.65		

*Now available from the National Technical Information Service; order by PB or AD number.

TECHNICAL NOTES—Continued

No.	Price	No.	Price	No.	Price
508	1.25	544	1.25	584	1.50
509	.70	545	1.25	589	.60
510	.50	546	1.25	590	.35
511	.30	547	1.25	591	.50
512	.25	548	1.25	592	.70
513	$0.30	549	.75	595	.65
514	1.00	550	.50	596	.65
515	.35	551	1.50	597	.50
516	.25	552	2.00	598	.55
517	.35	553	.70	599	.65
518	.65	554	1.50	600	.40
519	.50	555	.65	602	.30
520	.65	556	.30	603	1.00
521	.30	557	.35	604	.35
522	.30	558	.50	605	1.25
523	.50	559	1.50	606	.45
524	.75	560	.60	607	.65
525	.75	562	.30	608	.35
526 see TN441	1.25	563	.70	609	.75
527	.60	564	1.00	611	.35
528	$0.60	565	.75	613	.40
529	.30	566	.20	702	.50
530	1.25	567	.70	703	.50
531	.70	568	.70	705	.70
532	.45	569	.70	708	.75
533	1.00	570	.25		
534	.50	571	.60		
535	1.75	572	.35		
536	.35	573	.35		
537	.30	574	.50		
538	.40	575	.45		
539	.30	576	.45		
541	.65	577	.55		
542	1.25	578	.35		
543	1.00	579	.20		

BOUND VOLUMES OF THE JOURNAL OF RESEARCH

Vol.	Price	Vol.	Price
65A (Jan.–Dec. 1961)	$5.25	69A (Jan.–Dec. 1965)	$5.50
65B (Jan.–Dec. 1961)	3.25	69B (Jan.–Dec. 1965)	3.75
65C (Jan.–Dec. 1961)	3.25	69C (Jan.–Dec. 1965)	3.75
65D (Jan.–Dec. 1961)	6.00	69D (Jan.–Dec. 1965)	10.00
66A (Jan.–Dec. 1962)	5.50	71A (Jan.–Dec. 1967)	7.75
66B (Jan.–Dec. 1962)	3.00	71B (Jan.–Dec. 1967)	4.50
66C (Jan.–Dec. 1962)	4.00	71C (Jan.–Dec. 1967)	4.25
66D (Jan.–Dec. 1962)	7.00	72A (Jan.–Dec. 1968)	9.50
67A (Jan.–Dec. 1963)	6.00	72B (Jan.–Dec. 1968)	5.25
67B (Jan.–Dec. 1963)	3.25	72C (Jan.–Dec. 1968)	4.50
67C (Jan.–Dec. 1963)	3.75	73A (Jan.–Dec. 1969)	8.25
67D (Jan.–Dec. 1963)	7.00	73B (Jan.–Dec. 1969)	5.50
68A (Jan.–Dec. 1964)	6.25	73C (Jan.–Dec. 1969)	3.00
68B (Jan.–Dec. 1964)	2.50	**74A (Jan.–Dec. 1970)**	**9.75**
68C (Jan.–Dec. 1964)	3.50	**74B (Jan.–Dec. 1970)**	**5.50**
68D (Jan.–Dec. 1964)	9.50	**74C (Jan.–Dec. 1970)**	**3.50**

SOURCES FOR REPRINTS OF NBS PAPERS IN PERIODICALS

SOURCES	TYPE OF PAPER		
	NBS Journal Research Papers [1] Prior July 1959	NBS Journal Research Papers July 1959 to Present	NBS-Authored Papers non-NBS Media
Superintendent of Documents, GPO		See Footnote [3]	
National Technical Information Service (NTIS)[2]	See Footnote [5]		
Author		X	X
Federal Depository Libraries [4]	X	X	
Library of Congress [6]	X	X	X
Original Media			X

---

[1] RESEARCH PAPERS were reprints of individual articles that appeared in Volumes 1–62 of the monthly Journal of Research. These papers were published, numbered, and made available separately. In 1959 NBS began publishing the Journal of Research in separate sections, and RESEARCH PAPERS were discontinued.

[2] Address: National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22151.

[3] Bound volumes or (when available) the individual Journals may be purchased. See price list above.

[4] Primarily for reference; some libraries are equipped to reproduce copies for a fee. See Appendix A for list.

[5] Hard copy available and microfische copies also available. See Footnote (2) for address.

[6] Photoduplication Service, Library of Congress, Washington, D.C. 20540.

OUT-OF-PRINT MATERIAL

Those NBS Publications not listed in the Price Lists, are out of print and are not available from the Superintendent of Documents. Many can be consulted at libraries. Also, in many cases, photoduplicated copies can be purchased from the Library of Congress. For full information concerning this service, write to the Photoduplication Service, Library of Congress, Washington, D.C. 20540.

Certain NBS publications are out of print because they have been replaced, or partially replaced, by material issued by other organizations. In this connection, NBS is able to offer the following information:

Circular 410, National Standard Petroleum Oil Tables. Information in this Circular has been incorporated in the ASTM-IP Petroleum Measurement Tables issued by the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103. Available at $8.75 ($6.50 to ASTM members). Tables 5 and 7 of the ASTM-IP Tables may also be purchased from the ASTM in separate reprint form at $1.50 a copy for the two tables.

Circular 438, Static Electricity. The National Fire Protection Association, 60 Batterymarch Street, Boston, Mass. 02110, has issued a publication by the same title, available from them as NFPA Publication 77M, at $1.00.

Circular 464, Gas Calorimeter Tables. The American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103, has issued a publication on this subject. Listed as ASTM D900–55, it can be ordered at 75 cents per copy.

Circular 499, Nuclear Data. The publication of nuclear data is being continued in a new journal entitled *Nuclear Data*, published by Academic Press, 111 Fifth Avenue, New York, N.Y. 10003.

Circular 564, Tables of Thermal Properties of Gases. A reprinted edition is available from Pergamon Press of London and New York, at $20.00. Microfische of this Circular is available from Cryogenic Data Center, National Bureau of Standards, Boulder, Colorado 80302 for $4.50.

Circular 576, Automotive Antifreezes. For information on this subject consult American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

Circular 577 and Supplement, Energy Loss and Range of Electrons and Positrons. These have been superseded by NASA Special Publication 3012, available from the National Technical Information Service, Springfield, Va. 22151, at $3.00 hardcopy and $.65 microfische Number N65–12506.

Miscellaneous Publication 179, American Standard Building Code Requirements for Minimum Design Loads in Buildings and Other Structures. The American National Standards Institute, 1430 Broadway, New York, N.Y. 10018, has issued a publication on this subject. Available from them as A58.1–1955, at $2.50.

Miscellaneous Publication 187, Directory of Commercial and College Laboratories. A new Directory of College and Commercial Testing Laboratories is published by the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103, at $3.50.

Handbook 46, Code for Protection Against Lightning. A United States of America Standards Institute Code for Protection Against Lightning (NFPA–78–1969) is available from the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018, at $1.25.

Handbook 49, Recommendations for Waste Disposal of Phosphorus-32 and Iodine-131 for Medical Users. Reprints of this Handbook can be purchased as NCRP Report 9 at $1.00 from NCRP Publications, Post Office Box 30175, Washington, D.C. 20014.

Handbook 58, Radioactive Waste Disposal in the Ocean. Reprints of this Handbook can be purchased as NCRP Report 16 at $1.00 from NCRP Publications, Post Office Box 30175, Washington, D.C. 20014.

Handbook 59, Permissible Dose from External Sources of Ionizing Radiations. Reprints of this Handbook can be purchased as NCRP Report 39 at $2.00 per copy from NCRP Publications, Post Office Box 30175, Washington, D.C. 20014.

Handbook 63, Protection Against Neutron Radiation up to 30 MeV. Reprints of this Handbook can be purchased as NCRP Report 20 at $1.00 per copy from NCRP Publications, Post Office Box 30175, Washington, D.C. 20014.

Handbook 65, Safe Handling of Bodies Containing Radioactive Isotopes. Reprints of this Handbook can be purchased as NCRP Report 21 at $1.00 per copy from NCRP Publications, Post Office Box 30175, Washington, D.C. 20014

Handbook 71, Specifications for Dry Cells and Batteries. For more information on this Handbook, write to American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

Handbook 73, Protection Against Radiations from Sealed Gamma Sources. For more information on this Handbook, write to NCRP Publications, Post Office Box 30175, Washington D.C. 20014.

Handbook 74, Building Code Requirements for Reinforced Masonry. The American National Standards Institute, 1430 Broadway, New York, N.Y. 10018 has issued a publication on this subject. Available from them as A41.2–1960 (R1970), at $2.75.

Handbook 75, Measurement of Absorbed Dose of Neutrons and of Mixtures of Neutrons and Gamma Rays, has been superseded by NCRP Report 25 at $1.00 per copy from NCRP Publications, Post Office Box 30175, Washington, D.C. 20014.

Handbook 76, Medical X-ray Protection Up to Three Million Volts. For more information on this Handbook, write to NCRP Publications, Post office Box 30175, Washington, D.C. 20014.

Handbook 84, Radiation Quantities and Units, has been superseded by ICRU Report 11 at $1.00 per copy from ICRU Publications, Post Office Box 30165, Washington, D.C. 20014.

Handbook 89, Methods of Evaluating Radiological Equipment and Materials. Reprints of this Handbook can be purchased as NCRP Report 10F at $1.25 per copy from NCRP Publications, Post Office Box 30175, Washington, D.C. 20014.

Handbook 97, Shielding for High-Energy Electron Accelerator Installations. Reprints of this Handbook can be purchased as NCRP Report 31 at $1.00 per copy from NCRP Publications, Post Office Box 30175, Washington, D.C. 20014.

Handbook 102, ASTM Metric Practice Guide. American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103, has issued a publication as Document E380–70, at $1.50.

3. TITLES AND ABSTRACTS OF NBS PUBLICATIONS, 1971

3.1. PAPERS FROM THE JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, SECTION A. PHYSICS AND CHEMISTRY, VOLUME 75A, JANUARY-DECEMBER 1971

January-February 1971

High-speed (subsecond) measurement of heat capacity, electrical resistivity, and thermal radiation properties of tantalum in the range 1900 to 3200 K, A. Cezairliyan, J. L. McClure, and C. W. Beckett, *J. Res. Nat. Bur. Stand. (U.S.),* 75A (Phys. and Chem.), No. 1, 1-13 (Jan.-Feb. 1971).

> Key words: Electrical resistivity; emittance; heat capacity; high-speed measurements; high temperature; tantalum; thermal radiation properties; thermodynamics.

Measurements of heat capacity, electrical resistivity, hemispherical total and normal spectral emittances of tantalum above 1900 K by a pulse heating technique are described. Duration of an individual experiment, in which the specimen is heated from room temperature to near its melting point, is less than one second. Temperature measurements are made with a photoelectric pyrometer. Experimental quantities are recorded with a digital data acquisition system. Time resolution of the entire system is 0.4 ms. Results on the above properties of tantalum in the range 1900 to 3200 K are reported and are compared with those in the literature. Estimated inaccuracy of measured properties in the above temperature range is 2 to 3 percent for heat capacity, 0.5 percent for electrical resistivity, 3 percent for hemispherical total emittance, and 2 percent for normal spectral emittance.

Thermophysical properties of methane: orthobaric densities and some thermal properties, R. D. Goodwin, *J. Res. Nat. Bur. Stand. (U.S.),* 75A (Phys. and Chem.), No. 1, 15-21 (Jan.-Feb. 1971).

> Key words: Heats of vaporization; methane; orthobaric densities; specific heats of the saturated liquid; thermofunctions for ideal gas states; thermophysical properties.

For use in the computation of thermodynamic functions, analytical descriptions are given for the following properties: the orthobaric densities and saturation temperatures; the heats of vaporization; the specific heats of saturated liquid; and the thermodynamic functions for ideal gas states.

The infrared spectrum of matrix isolated BaO_2, S. Abramowitz and N. Acquista, *J. Res. Nat. Bur. Stand. (U.S.),* 75A (Phys. and Chem.), No. 1, 23-25 (Jan.-Feb. 1971).

> Key words: Barium; barium oxides; high temperature; infrared; matrix isolations.

The infrared spectra of matrix isolated BaO_2 have been observed and assigned. Ba atoms were allowed to react with an argon oxygen mixture and condensed on a liquid hydrogen cooled surface. Spectra observed using $^{18}O_2$ and $^{16}O^{18}O$ confirm this assignment.

Refinement of the crystal structure of the aragonite phase of $CaCO_3$, B. Dickens and J. S. Bowen, *J. Res. Nat. Bur. Stand. (U.S.),* 75A (Phys. and Chem.), No. 1, 27-32 (Jan.-Feb. 1971).

> Key words: Calcium carbonates; carbonates; crystal structure; single crystal x-ray diffraction.

Aragonite ($CaCO_3$) crystallizes in the unit cell $a = 4.9598(5)$ Å, $b = 7.9641(9)$ Å, and $c = 5.7379(6)$ Å at 25 °C with four formula weights in space-group *Pmcn*. The structure has been refined to $R_w = 0.024$, $R = 0.040$ using 765 x-ray reflections from a single crystal. The Ca ion is coordinated to nine oxygens with Ca . . . O distances in the range 2.414(2) Å to 2.653(1) Å. The two unique C – O distances in the CO_3 group are 1.288(2) Å (on the mirror plane) and 1.283(1) Å. The two unique O – C – O angles are 119.6(2)° (across the mirror plane) and 120.13(8)°. The distances and angles in the CO_3 group are not significantly different at the 95 percent confidence level.

Simple shearing flows in polyisobutylene solutions, L. J. Zapas and J. C. Phillips, *J. Res. Nat. Bur. Stand. (U.S.),* 75A (Phys. and Chem.), No. 1, 33-40 (Jan.-Feb. 1971).

> Key words: BKZ fluid; nonlinear behavior; polyisobutylene; stress relaxation; viscosity.

Measurements of shear stress for various shearing flow histories at 25 °C are correlated through the BKZ elastic fluid theory. The data are on 10 percent PIB solution in cetane. The histories include single step stress relaxation, suddenly applied steady shear, steady shearing flow, stress relaxation after steady shear.

Synthesis of fluorodienes, J. E. Fearn, *J. Res. Nat. Bur. Stand. (U.S.),* 75A (Phys. and Chem.), No. 1, 41-56 (Jan.-Feb. 1971).

> Key words: Cyclic inter-intramolecular mechanism; diene polymerization; fluorodienes; intermediates; polymerization; purity; synthesis; telomerization.

In a comprehensive study of the cyclic, inter-intramolecular mechanism in diene polymerization, all of the completely fluorinated dienes from C_5 to C_8 have been prepared with a high degree of purity. Also prepared were 4-chloroperfluoro-1,6-heptadiene and perfluoro-1,11-dodecadiene, the latter inadvertently. The successful syntheses involved, in most cases, a telomerization which utilized, as the starting material, I_2, ICl, CF_2CFCl, or CF_2CF_2. From these telomers, not only the dienes but many new intermediate compounds were prepared; they were then purified and characterized. The chemistry of these compounds, especially that relating to their polymerization, is briefly discussed.

Quantum corrections to the second virial coefficient for the Lennard-Jones (*m*-6) potential, M. E. Boyd, *J. Res. Nat. Bur. Stand. (U.S.),* 75A (Phys. and Chem.), No. 1, 57-89 (Jan.-Feb. 1971).

> Key words: Lennard-Jones gas; (*m*-6) intermolecular potential; quantum corrections; second virial coefficient; statistical mechanics; thermodynamics.

Tables are presented for the second virial coefficient of a Lennard-Jones (*m*-6) gas in reduced variables for seven values of *m*.

---

[1] The various NBS publications series are grouped under subheadings within this section. The several volumes of the Journal of Research are presented consecutively within their appropriate subheadings. If a particular publications series is sought, consult the table of contents or the edge index on the back cover.

A wide range of reduced temperatures, in a mesh chosen for ease of interpolation, is covered. Values are given for the classical term and three quantum corrections as well as the first two temperature derivatives of each of these terms. A discussion of the variation of behavior with m, especially at the limits $m=6$ and $m=\infty$, is included.

March-April 1971

Tentative set of key values for thermodynamics—Part 1. Report of the ICSU-CODATA Task Group on key values for thermodynamics, October, 1970, S. Sunner, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 2, 97-101 (Mar.-Apr. 1971).

Key words: CODATA; key values; thermodynamics.

This paper is a preliminary report from the Task Group on Key Values for Thermodynamics of the Committee on Data for Science and Technology (CODATA) of the International Council of Scientific Unions (ICSU). It gives values agreed upon by the Committee for enthalpies of formation and entropies of 32 atoms, molecules, and ionic species. Sources of the data are also tabulated.

Expanded formulation of thermodynamic scaling in the critical region, M. J. Cooper, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 2, 103-107 (Mar.-Apr. 1971).

Key words: Critical region; equation of state; liquid-gas transition; phase boundary; phase transition; thermodynamic scaling.

A description of the thermodynamic properties in the critical region of a physical system is obtained from a scaled expression for the free-energy $F(\rho, T)$. In general, a nonsymmetric coexistence curve is predicted, with the symmetric case (e.g., magnets) included as a special example. For fluids, deviations from symmetry give rise to an expression for the average density below the critical point nonlinear in the temperature near T_c (in contrast to the usual "law of rectilinear diameter"); these asymmetries also contribute to the discontinuity in the specific heat along the critical isochore. To lowest order, the formulation reduces to Widom's homogeneous scaling; the classical equations of state of the van der Waals type are incorporated as a special case.

Table of spin-orbit energies for *p*-electrons in neutral atomic (core) *np* configurations, W. C. Martin, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 2, 109-111 (Mar.-Apr. 1971).

Key words: Atomic spectra; atomic theory; spin-orbit interaction.

Data are given in support of the recently proposed formula $\zeta_{np}n^{*3}=0.450Z^{2.33}$ cm^{-1} ($Z \geqslant 5$). The table includes evaluations of this formula, which are probably accurate to ~ 15 percent for all atoms $Z=10$ to 90. For many (core) np configurations. the accuracy of ζ_{np} from the formula is greater than that to be expected from fitting the observed levels to intermediate coupling theory.

Heat capacities of *cis*-1,4-polyisoprene from 2 to 360 K, S. S. Chang and A. B. Bestul, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 2, 113-120 (Mar.-Apr. 1971).

Key words: Annealed and quenched glass; calorimetry; *cis*-1,4-polyisoprene; glass transformation; heat capacity; natural rubber; normal and supercooled liquid; rubber, natural; thermal diffusivity; thermodynamic properties.

Heat capacities of amorphous synthetic *cis*-1,4-polyisoprene have been determined for the quenched and annealed glasses from 2 to T_g (around 200 K) and for the liquid from T_g to 360 K, with a precision of better than 0.05 percent above 15 K. T_g, as determined from H versus T plots, is 203 K for the quenched glass and 198 K for the annealed glass. For the glasses the heat capacity values from this research are about 1 percent higher than that reported in 1935 for natural rubber hydrocarbon. For the liquid the result from this research agrees better (within 1 percent) with recently (1967) proposed values than those from the earlier experiment cited. Effects of crystallization and melting, stark rubber crystals, and additives (antioxidants and stabilizers) were also studied.

Combined low-pressure and high-pressure measurements of density and bulk modulus of aviation instrument oil and 2-methylbutane and their mixtures, J. C. Houck and P. L. M. Heydemann, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 2, 121-127 (Mar.-Apr. 1971).

Key words: Bulk modulus; compressibility; density; dilatometric measurements; high pressure; liquids; ultrasonics; 2-methylbutane.

Dilatometric measurements were made on mixtures of aviation instrument oil and 2-methylbutane at low pressures. These results are combined with previous dilatometric and ultrasonic measurements at high pressures to give density, relative volume, and isothermal bulk modulus of the mixtures to pressures of 20 kilobars. The ratio of the adiabatic bulk modulus to isothermal bulk modulus for 2-methylbutane is also given.

Crystal structure of $Ca_2Na_2(CO_3)_3$ (shortite), B. Dickens, A. Hyman, and W. E. Brown, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 2, 129-135 (Mar.-Apr. 1971).

Key words: Calcium sodium carbonate; crystal structure; shortite; single-crystal x-ray diffraction.

$Ca_2Na_2(CO_3)_3$ crystallizes in the orthorhombic unit cell $a=4.947(1)$ Å, $b=11.032(2)$ Å, and $c=7.108(1)$ Å at 25 °C with two formula weights in space-group Amm2. The structure has been redetermined, corrected, and refined to $R_w=0.025$, $R=0.020$ using 684 "observed" x-ray reflections from a single crystal. Corrections were made for absorption and isotropic extinction. In the extinction refinements, r refined to 0.00017(1) cm. The structure consists of Ca_2NaCO_3 layers interleaved with $Na(CO_3)_2$ layers. The Ca ion is coordinated strongly to nine oxygens, including three CO_3 edges, with Ca . . . O distances varying from 2.401(2) Å to 2.576(2) Å. One Na ion is coordinated strongly to eight oxygens, including two CO_3 edges, with Na . . . O distances from 2.429(2) Å to 2.605(1) Å. The other Na ion is coordinated strongly to six oxygens, including one CO_3 edge, at 2.296(1) Å to 2.414 Å, and weakly to a seventh at 3.050(3) Å. One CO_3 group is coordinated to seven cations, the other is coordinated to eight. The CO_3 groups have seemingly maximized their edge sharing with Ca ions rather than Na ions.

May-June 1971

The solid phase photolysis and radiolysis of ethylene at 20 to 77 K, R. Gorden, Jr., and P. Ausloos, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 3, 141-146 (May-June 1971).

Key words: Ethylene; free radical reactions; ion-molecule reactions; photolysis; polymerization; radiolysis.

Films of ethylene condensed onto a cold finger maintained at 20 K were irradiated with photons whose energy ranged from 8.4 to 21.2 eV. At the higher photon energies the relative yields of products compare well with those seen in the radiolysis of solid ethylene. Experiments on CH_2CD_2 demonstrate that in the photolysis hydrogen is mainly formed by the elimination processes $CH_2CD_2^* \rightarrow H_2(D_2)+C_2D_2(C_2H_2)$ and $CH_2CD_2^* \rightarrow HD+C_2HD$. The relative probabilities of these three processes are independent of the energy of the incident photons from 8.4 to 11.6 eV and are within experimental error identical to those observed in earlier gas phase photolysis experiments. Relative to acetylene, cyclobutane is a minor product at 8.4 eV but increases by an order of magnitude at higher energies where ions play a role. Cyclobutane, 1-butene and methylcyclopropane formed upon irradiation of frozen $C_2H_4-C_2D_4$ mixtures consisted mainly of C_4D_8, $C_4D_4H_4$, and C_4H_8. Plausible mechanisms which may account for the formation of the latter products are examined. In the solid phase as in the gas phase the relative importance of H-atom production is seen to increase with increasing photon energy. Cyclopropane, apparently formed by insertion of CH_2 into C_2H_4, is observed as a product at all wavelengths in the photolysis, and in the radiolysis.

Kinetic mass spectrometric investigation of the ion-molecule reactions occurring in C_4 and C_5 alkanes following photoionization at 106.7 and 104.8 nm, L. W. Sieck, S. K. Searles, and P. Ausloos, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 3, 147-153 (May-June 1971).

Key words: Gas phase; hydrocarbons; ion-molecule reactions; mass spectrometry; photoionization; rate constants.

The photoionization of C_4 and C_5 alkanes has been investigated at 106.7 and 104.8 nm in a mass spectrometer specifically designed for the investigation of ion-molecule reactions occurring at thermal kinetic energies. Absolute rate constants are reported for the reactions of various fragment ions with the corresponding parent molecule.

The rate constants found for reactions of *sec*-$C_3H_7^+$ ions with *i*-C_4H_{10}, *n*-C_4H_{10}, *i*-C_5H_{12}, and *n*-C_5H_{12} were found to be 3.3, 4.4, 4.7, and 5.2×10^{-10} cm^3/molecule-second respectively. The $C_4H_9^+$ ions were also found to be highly reactive, exhibiting rate constants of 3.6 and 3.8×10^{-10} cm^3/molecule-second in reactions with *i*-C_5H_{12} and *n*-C_5H_{12}. The rate constants for reaction of $C_3H_6^+$ with *i*-C_4H_{10}, *n*-C_4H_{10}, *i*-C_5H_{12}, and *n*-C_5H_{12} were found to be 4.9, 4.9. 7.6, and 7.9×10^{-10} cm^3/molecule-second, respectively. Butene ions are less reactive by an order of magnitude. The results are compared with complementary data derived from electron impact experiments, and the relationship between the structure and reactivity of the various ions is discussed.

An alumina standard reference material for resonance frequency and dynamic elastic moduli measurement. I. For use at 25 °C, R. W. Dickson and J. B. Wachtman, Jr., *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 3, 155-162 (May-June 1971).

Key words: Alumina; elastic modulus; resonance frequency; shear modulus; standard reference material; Young's modulus.

Bars of sintered polycrystalline alumina were machined to nominal dimensions of 12.7 by 1.27 by 0.32 cm. Surfaces were machined flat and parallel. The mass, dimensions, and resonance frequencies (flexural and torsional) were measured at 25 °C. The exact frequency is specified for each bar and is typically about 2030 Hz for flexural resonance and 11250 Hz for torsional resonance. The effect of suspension loading on resonance frequency was determined and a correction made. Each bar can be used as a frequency standard with an uncertainty for values measured in air of about ±0.03 Hz for flexure and ±0.08 Hz for torsion. The effect of atmosphere on resonance frequency was determined and a correction was made for this effect. The uncertainty for resonance frequencies in vacuum is about ±0.06 Hz for flexure and ±0.18 Hz for torsion. Each bar can also be used as a dynamic elasticity standard with an uncertainty estimated to be about 0.2 percent for the shear modulus and 0.4 percent for Young's modulus.

Optical and mechanical properties of some neodymium-doped laser glasses, R. M. Waxler, G. W. Cleek, I. H. Malitson, M. J. Dodge, and T. A. Hahn, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 3, 163-174 (May-June 1971).

Key words: Chemical composition; density; glasses; hardness; laser; optical homogeneity; photoelasticity; refractive index; thermal conductivity; thermo-optic properties; transmittance.

Studies have been made to evaluate thermo-optic and piezo-optic properties of five laser glasses. Measurements were made at the Cd red line, $\lambda=0.6438$ μm, over a wide range of temperatures and pressures using interferometric and polarimetric techniques. The refractive index-temperature data show both positive and negative values and small changes with temperature. The changes in index with applied compressive stress are positive in value. Other optical properties evaluated were homogeneity, transmittance, and refractive index as a function of wavelength. An ultrasonic pulse-echo technique was used to determine the elastic constants, Young's modulus, shear modulus, bulk modulus, and Poisson's ratio. Data for thermal expansion, thermal conductivity, density, hardness and chemical composition are also given. Calculations were made of the thermal change of refractive index at constant volume. These data can be used to calculate corrections for the distortions of the wavefront of light generated in lasers.

Effect of environment on viscous flow in inorganic oxide glasses, J. H. Simmons and P. B. Macedo, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 3, 175-184 (May-June 1971).

Key words: Critical point theories; immiscibility; phase transitions; structural relaxation; transport phenomena; viscous flow.

Results from viscosity and shear structural relaxation measurements conducted above the liquid-liquid phase transition of a series of immiscible inorganic oxide glasses are analyzed. A model is proposed which relates the temperature dependence of the complex modulus and viscosity to the behavior of microstructure in the glass resulting from supercritical fluctuations in composition. It is suggested that the critical microstructure induces differences in local environment in the glass which in turn cause the appearance of distributions of relaxation times. The model is formulated using elementary fluctuation theory and the resulting equations are successfully compared to the data.

Phase relations in the SrO-IrO$_2$-Ir system in air, C. L. McDaniel and S. J. Schneider, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 3, 185-196 (May-June 1971).

Key words: Dissociation; equilibrium; phase relations; SrO:IrO$_2$ compounds; SrO-IrO$_2$-Ir system.

The equilibrium phase relations for the SrO-IrO$_2$-Ir system were determined in an air environment at atmospheric pressure. A ternary equilibrium phase diagram was constructed indicating selected oxygen reaction lines and tie lines. A binary representation is given for the ternary system in air. Of the nine phases detected in this study, three are stable and six are probably metastable under atmospheric conditions. The stable compounds, $4SrO\cdot IrO_2$, $2SrO\cdot IrO_2$, and $SrO\cdot IrO_2$ dissociate at 1540, 1445, and 1205 °C, respectively. The metastable phases include low-$4SrO\cdot IrO_2$, $2SrO\cdot 3IrO_2$, $xSrO\cdot IrO_2(x>2)$, $ySrO\cdot IrO_2(4>y>2)$, $zSrO\cdot IrO_2(2>z>1)$, and $3SrO\cdot 2IrO_2$. The specific composition of the metastable phases could not be ascertained with certainty. The x-ray patterns of all phases detected in this study were indexed with the exception of that of the $zSrO\cdot IrO_2(2>z>1)$ compound. A summary of x-ray data is given for all known phases occurring in the system.

The crystal structure of BaCa(CO$_3$)$_2$ (barytocalcite), B. Dickens and J. S. Bowen, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 3, 197-203 (May-June 1971).

Key words: Aragonite; barium calcium carbonate; calcium carbonate; crystal structure; single crystal x-ray diffraction.

The barytocalcite phase of $BaCa(CO_3)_2$ crystallizes in the monoclinic unit cell $a=8.092(1)$ Å, $b=5.2344(6)$ Å, $c=6.544(1)$ Å, $\beta=106.05(1)°$ at 25 °C with cell contents of $2[BaCa(CO_3)_2]$. The structure previously reported by Alm is correct in its coarse details but has been redetermined here and refined to $R_w=0.028$, $R=0.023$ in space-group $P2_1/m$ using 1652 observed reflections. Corrections were made for absorption, isotropic extinction, and anomalous dispersion.

The structure of barytocalcite has an ... ABCABC ... stacking of cation layers and repeat every 3 layers. The calcite phase of $CaCO_3$ has an ABC cation layer sequence and repeats every 6 layers. The orientations of the CO_3 groups in barytocalcite are like the CO_3 group orientation in the aragonite phase of $CaCO_3$, and are rotated about 30° from the CO_3 group orientation in calcite. The cation layer sequence in aragonite is ... ABAB ... and the structure repeats every 2 layers.

The Ca ion in barytocalcite is coordinated to seven oxygens, including an edge of a CO_3 group, with Ca . . . O distances in the range 2.305(2) Å to 2.518(2) Å. The Ba ion is coordinated to five edges and one apex of the CO_3 groups with Ba . . . O distances ranging from 2.729(3) Å to 3.140(2) Å. The distances of the C atoms in the CO_3 groups from the planes of the O atoms are 0.025(5) Å and 0.022(4) Å for C(1) and C(2), respectively.

Ionization of hydrofluoric acid at 25 °C, P. R. Patel, E. C. Moreno, and J. M. Patel, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 3, 205-211 (May-June 1971).

Key words: Hydrofluoric acid; ionization constant; lanthanum fluoride electrode; least squares procedure; potentiometric measurements.

The ionization constant, K_1, for the reaction $HF \rightleftarrows H^+ + F^-$ was calculated on the basis of potentiometric measurements in the cell Ag; AgCl, Cl^-, $F^-||LaF_3||NaF$, HCl, $H_2O|KCl(Satd.)$, Hg_2Cl_2; Hg at 25 °C. A least squares procedure was applied to the experimental data yielding a best estimate for K_1 of 5.85×10^{-4} with a standard error of 0.03×10^{-4}.

Vapor pressure equation for water in the range 0 to 100 °C, A. Wexler and L. Greenspan, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 3, 213-230 (May-June 1971).

Key words: Clausius-Clapeyron equation; saturation vapor pressure over water; steam; vapor pressure; vapor pressure of water; virial coefficients; water vapor.

Some precise measurements of the vapor pressure of liquid water at seven temperatures in the range 25 to 100 °C were reported recently by H. F. Stimson of NBS. These measurements have an estimated standard deviation of 20 ppm or less, except at 25 °C where the estimated standard deviation is 44 ppm. We have derived a formula which yields computed values of vapor pressure agreeing with Stimson's measurements to within 7 ppm.

We integrated the Clausius-Clapeyron equation using the accurate calorimetric data of Osborne, Stimson, and Ginnings and the Goff and Gratch formulations for the virial coefficients of water vapor to obtain an equation that has a rational basis. This equation was then adjusted to bring it into closer accord with Stimson's pressure measurements. Two tables are given of the vapor pressure, expressed in pascals, as a function of temperature at 0.1-deg intervals over the range 0 to 100 °C, one on the International Practical Temperature Scale of 1948 and the other on the International Practical Temperature Scale of 1968.

July-August 1971

Inclusions in laser materials, H. S. Bennett, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 4, 247-260 (July-Aug. 1971).

Key words: Antimony; heat conduction; laser materials; Nd-doped glass; platinum; stress components; thermoelastic theory.

One of the severe problems encountered in high-power-solid-state laser systems is the thermal damage to laser rods and optical elements. One such type of damage is thought to arise from metallic or dielectric inclusions; i.e., impurities with physical and optical properties which differ substantially from those of the host material. Such inclusions may absorb an appreciable amount of the incident radiation and thereby may undergo thermal expansion. This produces major stresses within the host material. Estimating such thermal properties requires the consideration of solutions to the heat diffusion equation and to the thermal stress equations with appropriate boundary conditions. The optical path length change for a probing light ray passing near the inclusion, the radial and tangential stress components, and the changes of the refractive index for radially polarized and tangentially polarized light due to the thermal stress field are computed. The dependence of the maximum value of the tensile stress upon the size of the inclusion and upon the physical properties of the host is examined. The feasibility of using optical techniques to detect metallic and dielectric inclusions in laser materials before they cause damage also is studied. The computations suggest that the use of laser pulse widths of the order of microseconds or longer may be more promising for the detection of small incipient absorbing centers than the use of nanosecond pulse widths.

Heat diffusion near absorbing centers in laser materials, H. S. Bennett, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 4, 261-268 (July-Aug. 1971).

Key words: Absorbing center; complementary error function; heat diffusion; laser host.

The solutions to the heat diffusion equation for spherical absorbing centers in laser materials are presented. The ratio of the volume specific heats for the absorbing center and the laser host is found to determine three regions of behavior. Series expansions for small times and for very large times also are given in each of the three regions. Rapidly converging representations for the complementary error function of complex arguments are developed in order to evaluate numerically the region for which the volume specific heat ratio is greater than three fourths.

Thermal conductivity, electrical resistivity, and thermopower of aerospace alloys from 4 to 300 K, J. G. Hust, D. H. Weitzel, and R. L. Powell, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 4, 269-277 (July-Aug. 1971).

Key words: Aluminum alloy; cryogenics; electrical resistivity; Lorenz ratio; nickel alloys; Seebeck effect; thermal conductivity; titanium alloy; transport properties.

Thermal conductivity, electrical resistivity, and thermopower have been measured for several aerospace alloys: titanium alloy A110–AT, aluminum alloy 7039, Inconel 718, and Hastelloy X. Tables and graphs of the measured properties and Lorenz ratio are presented over the range 4 to 300 K. Comparisons to other measurements and theoretical analysis of the data are included. The uncertainties of the property data are estimated as (1) 0.7 to 2.5 percent for thermal conductivity, (2) 0.25 percent in electrical resistivity, and (3) about $0.1 \mu V/K$ in thermopower.

Refractive indices of fused silica at low temperatures, R. M. Waxler and G. W. Cleek, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 4, 279-281 (July-Aug. 1971).

Key words: Fused silica; glasses; interferometry; optics; refractive index.

The refractive indices of a commercial fused silica specimen were determined at ten wavelengths from 404.7 to 667.8 nm over the temperature range from − 200 to + 20 °C. The data are needed for the design of optical systems for space applications where the extremes of temperature are encountered. Values of the thermal coefficient of refractive index were found to be positive and varied from about 9×10^{-6}/°C at room temperature to 3×10^{-6}/°C at liquid nitrogen temperature. The data also showed that there is an increase in dispersion with increasing temperature. These results bear out the predictions of the theory for the thermo-optic behavior of solids.

High-speed (subsecond) measurement of heat capacity, electrical resistivity, and thermal radiation properties of tungsten in the range 2000 to 3600 K, A. Cezairliyan and J. L. McClure, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 4, 283-290 (July-Aug. 1971).

Key words: Electrical resistivity; emittance; heat capacity; high-speed measurements; high temperature; thermal radiation properties; thermodynamics; tungsten.

Measurements of heat capacity, electrical resistivity, hemispherical total emittance, and normal spectral emittance of tungsten above 2000 K by a pulse heating technique are described. Duration of an individual experiment, in which the specimen is heated from room temperature to near its melting point, is less than one second. Temperature measurements are made with a photoelectric pyrometer. Experimental quantities are recorded with a digital data acquisition system, which has a full-scale signal resolution of one part in 8000. Time resolution of the entire system is 0.4 ms. Results on the above properties of tungsten in the range 2000 to 3600 K are reported and are compared with those in the literature. Estimated inaccuracy of measured properties in the above temperature range is: 2 to 3 percent for heat capacity, 1 percent for electrical resistivity, 3 percent for hemispherical total and normal spectral emittances.

The calculated continuous emission of a LTE hydrogen plasma, J. R. Roberts and P. A. Voigt, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 4, 291-333 (July-Aug. 1971).

Key words: Emission coefficient; hydrogen; hydrogen continuum; LTE; spectral radiance standard; Stark-broadening.

The total continuous emission coefficient for a LTE hydrogen plasma at one atmosphere is calculated for a temperature range from 8000 to 16000 K and a wavelength range from 400 to 15000 Å. Contributions involving the species H, H_2^+, H^-, and H_2, as well as the wings of Stark-broadened hydrogen lines are included. This calculation will permit the radiation emitted from a laboratory hydrogen plasma to be used as a high intensity spectral radiance calibration standard.

The second spectrum of nickel (Ni II) (addenda and errata), A. G. Shenstone, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 4, 335-336 (July-Aug. 1971).

Key words: Energy levels; ionization potential; nickel; spectral series; spectroscopy; wavelength.

This paper provides additional information which came to light too late for the original publication [J. Res. Nat. Bur. Stand. (U.S.) **74A**, 801 (1970)].

Tables of second virial coefficients and their first and second derivatives for the Stockmayer (*m*, 6, 3) potential function, J. S. Gallagher and M. Klein, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 4, 337-385 (July-Aug. 1971).

Key words: Dipole; gas; intermolecular potential function; polar; second virial coefficient; Stockmayer.

Expressions are developed for the second virial coefficient and its first two temperature derivatives for polar molecules on the Stockmayer model of a dipole imbedded in a spherical core. In the case considered, the core molecules interact according to an (m, 6) intermolecular potential function. Terms describing the dependence of these quantities on the polarizability of the dipole are also included. Tables are given for the cases $m = 9$, 12, 18, 24, 36, and 60. These tables can be used to calculate the first density corrections to all of the thermodynamic properties of a fluid of polar molecules. The adequacy and accuracy of the tables are discussed in some detail.

September-October 1971

Measurement of the relative enthalpy of pure α-Al_2O_3 (NBS heat capacity and enthalpy standard reference material No. 720) from 273 to 1173 K, D. A. Ditmars and T. B. Douglas, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 5, 401-420 (Sept.-Oct. 1971).

Key words: Alumina; aluminum oxide; corundum; drop calorimetry; enthalpy; heat capacity standard; specific heat; standard reference material; synthetic sapphire; thermodynamic functions.

The relative enthalpy of NBS Standard Reference Material No. 720 (99.98 percent pure, single-crystal α-Al_2O_3, a calorimetric heat-capacity standard) was measured over the range 273 to 1173 K by the drop method using a highly precise Bunsen ice calorimeter. Enthalpy data over the same temperature interval were obtained also on the Calorimetry Conference Sample of this substance. These results are believed to be more accurate than similar NBS results on the latter sample published in 1956, and show no significant discontinuity with the NBS data on the same substance that covered the ranges 13 to 380 K and 1173 to 2257 K. The average deviation from the mean for all enthalpy measurements on the SRM 720 sample was 0.017 percent, and the smooth enthalpy values derived from the data were estimated to be accurate to 0.1 percent. The precautions observed in order to minimize measuring errors are described in detail. The data are compared with many sets of the most reliable published data available and new recommended values for the thermodynamic functions of α-Al_2O_3 are presented for the interval 0 to 1200 K.

High-precision coulometric titrations of boric acid, G. Marinenko and C. E. Champion, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 5, 421-428 (Sept.-Oct. 1971).

Key words: Accurate analysis; boric acid; coulometric titration; high-precision acidimetry; high-precision coulometry.

An absolute method was developed for the determination of boric acid by coulometric titrimetry. The precision of the method, expressed as the standard deviation of a single determination is 0.0033 percent. Changes in the investigated titration parameters produced no significant effects on the titration results. Indications are that within the uncertainty of measurements the method is bias free.

Determination of trace elements in ruby laser crystals by neutron activation analysis, B. A. Thompson and E. C. Miller, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 5, 429-433 (Sept.-Oct. 1971).

Key words: Activation analysis; Al_2O_3; interfering reactions; laser; nondestructive analysis; ruby; trace elements.

Methods are described by which concentration levels have been determined for up to ten different trace elements and upper limits established for over 40 additional elements at the parts per million level or below in ruby crystals using neutron activation analysis. This information is required to determine the effect of trace element levels on laser performance. With conventional analytical methods difficulties arise because of both the refractory and insulating properties of the material. Because the crystals cannot be readily dissolved, the activation analysis was carried out nondestructively, irradiating the samples with highly thermalized neutrons to minimize formation of ^{24}Na and ^{27}Mg from (n, α) and (n, p) reactions on the Al_2O_3 matrix, and using a 47-cm³ Ge(Li) detector.

Crystallography of some double sulfates and chromates, H. F. McMurdie, M. C. Morris, J. deGroot, and H. E. Swanson, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 5, 435-439 (Sept.-Oct. 1971).

Key words: Chromates; langbeinites; lattice constants; sulfates; Tutton salts.

New information is given on cell parameters, density and methods of preparation of 50 compounds of the langbeinite and Tutton salt groups. The langbeinites have the general formula $(A^+)_2(B^{2+})_2(XO_4)_3$ and the Tutton salts the general formula $(A^+)_2(B^{2+})(XO_4)_2 \cdot 6H_2O$, where A is K, Rb, (NH_4), Tl or Cs; B is Mg, Ni, Cu, Co, or Zn; and X is S or Cr. A comprehensive list of references on the crystallography of the compounds is included.

Discrimination between equations of state, J. R. Macdonald and D. R. Powell, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 5, 441-453 (Sept.-Oct. 1971).

Key words: Curve fitting; data analysis; equations of state; model discrimination; surface fitting.

Eight isothermal equations of state are analyzed to yield quantitative measures of the degrees to which equation pairs can be discriminated for real data, data of limited span and precision. Calculated curves allow one to assess the span and precision necessary in *P-V* data to allow unambiguous discrimination of various pairs. Some discussion is presented of bias and systematic error which may arise in least squares fitting. Using exact synthetic data, we also illustrate for seven equation pairs the very large relative systematic errors in parameter and standard deviation estimates which arise from such fitting of data of limited span with an incorrect but "close" equation model. General conclusions following from these results are discussed. Although the present work is principally concerned with discrimination between equations of state, its results are pertinent to the more general problem of choosing a "best" analytical model (linear or nonlinear) to represent experimental results.

New absorption bands and isotopic studies of known transitions in CO, J. D. Simmons and S. G. Tilford, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 5, 455-467 (Sept.-Oct. 1971).

Key words: Absorption spectrum; CO; electronic transitions; rotational analysis; vibrational analysis; vibrational and rotational constants.

Several new absorption bands of the $a'\,{}^3\Sigma^+ - X^1\Sigma^+$ and $e\,{}^3\Sigma^- - X^1\Sigma^+$ transitions in CO have been observed and analyzed. Vibrational levels of both the $a'\,{}^3\Sigma^+$ and $e\,{}^3\Sigma^-$ states are now known to within 0.4 eV of their dissociation limits. Isotopic bands of $^{13}C^{16}O$ in natural abundance have been analyzed for both transitions. The vibrational numbering of the $e\,{}^3\Sigma^-$ state must be increased by one unit. New bands of the $I^1\Sigma^- - X^1\Sigma^+$ and $D^1\Delta - X^1\Sigma^+$ transitions are also reported.

A study of line shape of CO infrared emission lines, J. A. Dowling, S. Silverman, W. S. Benedict, and J. W. Quinn, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 5, 469-479 (Sept.-Oct. 1971).

Key words: Carbon monoxide; collision parameters; equivalent width; flame spectra; line shapes.

The shape of several vibration-rotation lines of CO emitted by a C_2H_2-O_2 flame was investigated. An equivalent width measurement was made using an absorption cell of room temperature CO as an analyzer. Analysis of the data showed that line shapes could be fitted to a Voigt function with shape parameters *a* between 1.0 and 1.5.

The collision widths of the flame lines, as determined by the shape parameters, are in essential agreement with earlier room temperature measurements. The extrapolation of the widths measured at room temperature to high temperature has been shown to be reliable within the uncertainty of this experiment (± 15%).

Ionization quantum yields and absorption coefficients of selected compounds at 58.4 and 73.6-74.4 nm, R. E. Rebbert and P. Ausloos, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 5, 481-485 (Sept.-Oct. 1971).

Key words: Absorption coefficient; helium resonance radiation; hydrocarbons; inorganic molecules; ionization efficiency; ionization quantum yield; neon resonance radiation.

The ionization quantum yields and the extinction coefficients of a number of compounds have been determined at the wavelengths of the helium (58.4 nm) and neon (73.6-74.4 nm) resonance lamps. These are lamps with thin aluminum windows (100-200 nm) which we inserted in a glass cell backed by a second cell. Both cells are provided with parallel plate electrodes and separated from each other by an aluminum window. The ionization quantum yields are based on ionization efficiency of argon which is unity. Hydrogen, which has an ionization quantum yield of 0.94 and 1.00 at 73.6-74.4 and 58.4 nm respectively, was used as a secondary standard because it yielded better defined saturation ion current plateaus. The extinction coefficients were determined in both a double cell and a single cell arrangement. The agreement between the two measurements was excellent. In general an inert diluent was added to the gas of interest in order to improve the plateau of the saturation ion current. These results are compared with the literature values, which were mainly determined in windowless systems with monochromators.

Kinetic mass spectrometric investigation of the reactions of t-$C_4H_9^+$ ions with some simple polar molecules at thermal energies, L. Hellner and L. W. Sieck, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 5, 487-493 (Sept.-Oct. 1971).

Key words: Ion molecule reactions; mass spectrometry; neopentane; photoionization; proton affinity; rate constants.

The interactions of t-$C_4H_9^+$ ions from neopentane with some simple polar molecules have been investigated in a high pressure photoionization mass spectrometer at thermal kinetic energies. Proton transfer was found to occur from t-$C_4H_9^+$ to acetone, ammonia, and the various methylamines, but not to molecules having estimated proton affinities < 195 kcal/mol (815 kJ/mol). Macroscopic thermal rate coefficients are reported for the various proton transfer reactions, all of which are on the order of 10^{-9} cm³/molecule · second. The reaction

$$t\text{-}C_4H_9^+ + 2CH_3OH \rightarrow (CH_3OH)_2H^+ + C_4H_8$$

was found to occur, but not the analogous reaction with H_2O. On the basis of supplementary experiments, new limits are reported for the proton affinity of acetone. These are 203 ± 2 kcal/mol < proton affinity of acetone < 207 kcal/mol.

Energy levels, wave functions, dipole and quadrupole transitions of trivalent gadolinium ions in sapphire, P. H. E. Meijer, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 5, 493-523 (Sept.-Oct. 1971).

Key words: Corundum; energy levels of Gd^{+++} in Al_2O_3; quadrupole transitions; spin Hamiltonian; transition probabilities; ultrasonic (paramagnetic) resonance; ultrasonic transition probabilities; wave functions of Gd^{+++}.

A computation is made of energy levels, wave functions and transition matrix elements of the Gd^{3+} ion in Al_2O_3. The crystal field parameters are taken from Geschwind and Remeika's paramagnetic resonance experiments. The transition probabilities are given for dipole radiation in three polarization directions. For ultrasonic work we give the real and imaginary parts of the five matrix elements of the quadrupole transition. From these one can easily deduce the transition probabilities in any given direction.

The magnetic field directions are described by the angles θ and ϕ, the polar and azimuthal angles with respect to the crystalline c axis. The values of θ go from 0 to $\pi/2$ in six steps and two values of π are chosen, 0 and $2\pi/3$ for which the variation is largest. The magnetic field strengths are from 0 to 0.6 tesla (6000 gauss); beyond this value the spin can be considered as "free." Some consideration is given to the analytical behavior of the energy versus field diagram for the direction $\theta = \phi = 0$.

November-December 1971

The accuracy of measurements of viscosity of liquids, R. S. Marvin, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 6, 535-540 (Nov.-Dec. 1971).

Key words: Absolute measurement of viscosity; accuracy of viscosity measurement; calibration of viscometers; viscosity; uncertainty of viscosity measurements.

Most absolute measurements of viscosity have utilized capillary flow, and required semiempirical corrections amounting to several times their precision and estimated accuracy. The range of values found from these measurements and the possibility of unrecognized systematic errors make it impossible to base a realistic estimate of accuracy on the results of only one type of measurement. The results of two independent absolute measurements involving different types of flow, reported in the two accompanying papers, are summarized here. The estimated accuracy in each case is about 0.1 percent. The two results differ by 0.5 percent. It is suggested that we continue to base the calibration of relative viscometers on the value of 1.002 centipoise (cP) for the viscosity of water at 20 °C and one atmosphere. This provides a generally accepted base which limits comparability only by the precision of the measurements. However, whenever the true values of viscosity are required the limits of uncertainty including an estimate of systematic error should be taken as no better than ±0.25 percent.

An absolute determination of viscosity using a torsional pendulum, H. S. White and E. A. Kearsley, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 6, 541-551 (Nov.-Dec. 1971).

Key words: Absolute measurement; calibration; standard; torsional pendulum; viscosity.

An absolute measurement of the viscosity of di(2-ethylhexyl) sebacate with a torsional pendulum viscometer. The apparatus and calibration procedures are discussed and a detailed study of errors is made. The systematic error was estimated to be less than ±0.07 percent and the variability was shown to be less than ±0.07 percent. There is an unexplained difference of 0.3 to 0.4 percent between these measurements and measurements with a capillary instrument.

An absolute determination of viscosity using channel flow, R. W. Penn and E. A. Kearsley, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 6, 553-560 (Nov.-Dec. 1971).

Key words: Absolute measurement; calculation of bounds; calibration; Poiseuille flow; standard; viscosity; viscous flow.

The viscosity of a sample of di(2-ethylhexyl) sebacate has been determined by measuring the pressure at taps along a closed channel containing the flowing liquid. By means of relative viscosity measurements in conventional capillary viscometers, we are able to express our results in terms of the viscosity of water at 20 °C. We find a value of 0.010008 poise. An appendix outlines the calculation of upper and lower bounds for the geometrical flow constant.

A new determination of the atomic weight of zinc, G. Marinenko, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 6, 561-564 (Nov.-Dec. 1971).

Key words: Atomic weight; coulometry; zinc, atomic weight.

The atomic weight of zinc determined coulometrically for 5 metallic reference samples is 65.377±0.003 where the uncertainty figure is the 95 percent confidence interval for the mean plus an allowance for the mean plus an allowance for known possible sources of systematic error.

High-speed (subsecond) measurement of heat capacity, electrical resistivity, and thermal radiation properties of niobium in the range 1500 to 2700 K, A. Cezairliyan, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 6, 565-571 (Nov.-Dec. 1971).

Key words: Electrical resistivity; emittance; heat capacity; high-speed measurements; high temperature; niobium; thermal radiation properties; thermodynamics.

Measurements of heat capacity, electrical resistivity, hemispherical total emittance, and normal spectral emittance of niobium in the temperature range 1500 to 2700 K by a subsecond duration pulse heating technique are described. Results obtained on the above properties are reported and are compared with those in the literature. A sharp increase in heat capacity above 2000 K was observed. Electrical resistivity showed a negative departure from linearity in the curve of electrical resistivity against temperature. Estimated inaccuracy of measured properties is: 2 percent for heat capacity, 0.5 percent for electrical resistivity, and 3 percent for hemispherical total and normal spectral emittances.

Stable radical-anions derived from glyoxal *bis*(phenylhydrazones), A. J. Fatiadi, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 6, 573-577 (Nov.-Dec. 1971).

Key words: Bis(phenylhydrazone); e.s.r.; glyoxal; methyl sulfoxide; oxygen; radical-anion.

A series of resonance-stabilized, hydrazyl radical-anions has been observed for the first time; they were prepared by an electron-transfer reaction involving treatment of glyoxal bis(phenylhydrazones) in methyl sulfoxide with a base and a trace of oxygen. The stability of these radical-anions appears to be dependent on the nature of the *para* substituents on the phenylhydrazine moiety.

Temperature dependence of photocurrents produced by x and gamma rays in silicon radiation detectors, K. Scharf and R. K. Mohr, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 6, 579-589 (Nov.-Dec. 1971).

Key words: Gamma rays; photocurrents; radiation; radiation detector; radiation dosimetry; silicon radiation detector; temperature dependence; x rays.

The temperature dependence of dc photocurrents produced by x and gamma rays in silicon radiation detectors of the *n-p*, *p-i-n*, and surface-barrier type was investigated in a temperature range between 20 and 50 °C. Photodiode photocurrents, assumed as being equal to the *generated* currents I_g, showed a positive temperature dependence in all detectors investigated. Their temperature coefficient at 25 °C varied between +0.004 per °C and +0.002 per °C. The temperature dependence of short-circuit currents I_{sc} measured by a compensation method, was positive and nearly linear for *n-p* type detectors but nonlinear and negative for *p-i-n* and surface-barrier type detectors. It is shown, that this different behavior of individual detectors is due to the influence of the strongly temperature-dependent junction current I_j which under the short-circuit mode is drained off the generated current I_g. The junction current is a function of the internal series resistance R_s and the junction resistance R_j of the irradiated detector ($I_j = I_{sc}\ R_s/R_j$). With increasing resistance ratio R_s/R_j, the current ratio I_j/I_g increases and the temperature coefficient α_{sc} of the short-circuit current decreases. Temperature coefficients $(\alpha_{sc})_{25}$ measured in the different detectors at 25 °C and a current density 6×10^{-7} A/cm^2 decreased with increasing resistance ratio from +0.004 per °C to − 0.005 per °C. Resistance ratios R_s/R_j of the detectors investigated ranged between 0.01 and 0.24 approximately. Thus, $(\alpha_{sc})_{25}$ measured in an individual detector can be changed by changing its *effective* series resistance. A decrease of $(\alpha_{sc})_{25}$ with increasing I_{sc} was observed in detectors with larger resistance ratios. This was apparently due to the voltage dependence of R_j at higher junction voltages produced by larger short-circuit currents.

Isomerization processes in ions of the empirical formula $C_4H_8^+$, S. G. Lias, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 6, 591-605 (Nov.-Dec. 1971).

Key words: Butene; cyclobutane; ion structure; isomerization; methylcyclopropane; photoionization; photolysis; radiolysis.

Ions of the formula $C_4H_8^+$ have been generated with different initial energies by ionizing ethylene ($C_2H_4^+ + C_2H_4 \rightarrow C_4H_8^+$, where the $C_4H_8^+$ ion is formed with an initial energy of > 11.51 eV), cyclobutane (initial energy of $C_4H_8^+$,> 10.84 eV), methylcyclopropane (> 10.15 eV), 1-C_4H_8 (> 9.58 eV), and *i*-C_4H_8 (> 9.06 eV) with 11.6-11.8 eV photons, and in some cases also with 10 eV photons and with gamma radiation. The structures of the ions have been determined from the structures of the C_4H_8 products formed in charge transfer reaction between the ions and charge acceptors such as dimethylamine and nitric oxide, as well as from the structures of the butanes formed in D_2^- transfer reactions with methylcyclopentane-d_{12} ($C_4H_8^+ + C_6D_{12} \rightarrow C_4H_8D_2 + C_6D_{10}^+$).

At low pressures the $C_4H_8^+$ ions initially formed in ethylene, cyclobutane, and methylcyclopropane isomerize to the thermodynamically most stable configurations, *i*-$C_4H_8^+$ and 2-$C_4H_8^+$. The 2-$C_4H_8^+$ structure predominates in all the experiments. As the pressure is raised, the *i*-$C_4H_8^+$ ion yield diminishes as that of 2-$C_4H_8^+$ increases, indicating that when the precursor of the *i*-$C_4H_8^+$ ion is collisionally deactivated, it ends up as 2-$C_4H_8^+$. At high pressures, 1-$C_4H_8^+$ ions are intercepted; their yield increases with increasing pressure, indicating that 1-$C_4H_8^+$ is an intermediate which isomerizes further unless it is collisionally deactivated. The 1-$C_4H_8^+$ ion formed in methylcyclopropane (initial energy > 10.15 eV) is more easily deactivated than that formed in cyclobutane (initial energy > 10.84 eV). That the isomerization of the 1-$C_4H_8^+$ ion to lower energy structures such as *i*-$C_4H_8^+$ and 2-$C_4H_8^+$ requires excess internal energy is demonstrated by the fact that in the photolysis with 10 eV photons, a negligible amount of isomerization is observed, but with 11.6-11.8 eV photons, more than half of the 1-$C_4H_8^+$ ions isomerize to the 2-$C_4H_8^+$ structure at a pressure of 2 torr. Isomerization of the low energy *i*-$C_4H_8^+$ ions formed in the photolysis of *i*-C_4H_8 to other structures is relatively unimportant at 11.6-11.8 eV.

Taking the ratio *i*-$C_4H_8^+$/2-$C_4H_8^+$ as an indicator of the amount of energy removed by collisions from the intermediate $C_4H_8^+$ species under conditions where only *i*- and 2-$C_4H_8^+$ ions are intercepted, it is shown that the efficiency of energy transfer from the ions to helium, hydrogen, neon, krypton, xenon, nitrogen, and carbon dioxide is related to the polarizability of the added deactivator.

The photochemistry of propane at high photon energies (8.4-21.2 eV), R. E. Rebbert, S. G. Lias, and P. Ausloos, *J. Res. Nat. Bur. Stand. (U.S.),* **75A** (Phys. and Chem.), No. 6, 607-612 (Nov.-Dec. 1971).

Key words: Ion-molecule reaction; photoionization; propane; quantum yields; rare-gas resonance radiation; unimolecular dissociation.

Neon and helium resonance lamps, which deliver photons of 16.7-16.8 eV and 21.2 eV energy, respectively, have been used to photolyze C_3H_8, C_3D_8, C_3H_8-C_3D_8 (1:1) mixtures, and $CD_3CH_2CD_3$ and the results obtained at the two energies are compared. In particular, it is noted that although the quantum yield of ionization in propane is unity at 16.7-16.8 eV, when the energy is raised still further to 21.2 eV, the probability of ionization apparently diminishes to 0.93, an observation which suggests that at 21.2 eV, superexcited states may be reached whose dissociation into neutral fragments competes with ionization.

The quantum yields of the lower hydrocarbon products formed in the presence of a radical scavenger in C_3H_8 and C_3D_8 are reported, and are compared with quantum yields of products formed in the vacuum ultraviolet photolysis at lower energies. (Quantum yields of products formed at 8.4 eV and 10.0 eV are reported here for the first time.) Acetylene is formed as a product in the decomposition of the neutral excited propane molecule, and its yield increases in importance with increasing energy; at 16.7-16.8 eV, where all product formation can be traced to ionic processes, acetylene is formed in negligible yields. It is concluded that ionic processes in propane do not lead to the formation of acetylene, and the observation of this product in radiolytic systems may be a reliable indicator of the relative importance of neutral excited molecule decomposition processes.

From the results obtained with the C_3H_8-C_3D_8 (1:1) mixture, and with $CD_3CH_2CD_3$, details of the ion-molecule reaction mechanisms and the unimolecular decomposition of the propane ion are derived.

3.2. PAPERS FROM THE JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, SECTION B. MATHEMATICAL SCIENCES, VOLUME 75B, JANUARY-DECEMBER 1971

January-June 1971

Bounds to truncation errors in biorthogonal polynomial approximations, with illustrative applications to gamma-ray transport distributions, L. V. Spencer, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 1 and 2, 1-16 (Jan.-June 1971).

Key words: Biorthogonal polynomials; gamma-ray transport; moment method; neutron transport; polynomial truncation errors; Sievert function.

Problems of gamma-ray and neutron penetration in infinite, homogeneous media can be solved in terms of infinite sums of a certain type of biorthogonal polynomial system. Many calculations have used a few terms, perhaps 4 to 8, successfully due to good apparent convergence. This paper develops expressions for bounds to the truncation error of these finite sums. Examples and applications are given of the functions used to obtain the error bounds.

A theorem on matrix commutators, J. M. Smith, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 1 and 2, 17-21 (Jan.-June 1971).

Key words: Commutator; matrix; orthogonal; skew-symmetric.

Let $P = I_p + (-I_q)$, the direct sum of the $p \times p$ identity matrix and the negative of the $q \times q$ identity matrix. The following theorem is proved.

THEOREM: *If the matrices* A *and* B *are* P*-orthogonal (orthogonal with respect to* P*) and* P*-skew-symmetric (skew-symmetric with respect to* P*) then* $[A.B] = AB - BA$ *may be expressed as the difference,* $C - D$, *of matrices which are* P*-orthogonal,* P*-skew-symmetric.*

Explicit expressions for the matrices C and D are given.

A special permutation matrix decomposition for combinatorial design incidence matrices, E. C. Johnsen and T. F. Storer, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 1 and 2, 23-30 (Jan.-June 1971).

Key words: Block design; combinatorial analysis; configurations; König's theorem; matrices; matrix equations; permutation matrix decompositions; 0, 1 matrices.

By a well-known theorem of König, every 0,1 matrix A of order v with all row and column sums equal to $k > 0$ can be decomposed into a sum of k permutation matrices of order v. Here we consider whether A, trace $A = 0$ or v, can have a special permutation matrix decomposition called a *special König decomposition*. The question is answered more or less satisfactorily using certain graph factorization theorems of Petersen and Tutte. Symmetric counterexamples are given to show that not all such matrices have special König decompositions; however, it is shown that symmetric incidence matrices *for* $\langle v, k, \lambda \rangle$ designs always have special König decompositions.

The Casimir check for the algebraic matrices of the configuration $(d+s)^n p$, C. Roth, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 1 and 2, 31-47 (Jan.-June 1971).

Key words: Casimir operator; checking parameters; $(d+s)^n p$, SU_3.

By using the eigenvalues of the Casimir operator for the group SU_3, checking parameters were obtained for 12 electrostatic interaction matrices of the configuration $(d+s)^n p$.

Convex homotopy, W. A. Horn, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 1 and 2, 49-61 (Jan.-June 1971).

Key words: Convex functions; convex sets; homotopy.

Given any two continuous, convex functions f and g on a compact, convex set with certain properties ("regular" convexity), it is shown that an infinite number of homotopies of f and g exist which are also convex. One such homotopy in particular (the "basic" homotopy) is shown to have nice monotonicity properties and can be used as a basis for constructing other homotopies. A method of constructing the basic homotopy is given for the case where the domain of f and g is a line segment. (Theorems are for normed linear spaces only.)

The powers of a connected graph are highly hamiltonian, V. N. Bhat and S. F. Kapoor, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 1 and 2, 63-66 (Jan.-June 1971).

Key words: Graph; hamiltonian; power of a graph.

Let G be a connected graph on p points. It is proved that if any k points are deleted from the graph G^{m+2}, $1 \leq m \leq p - 3$ and $0 \leq k \leq m$, then the resulting graph is hamiltonian.

Exact solutions of linear equations with rational coefficients, A. S. Fraenkel and D. Loewenthal, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 1 and 2, 69-75 (Jan.-June 1971).

Key words: Congruences; exact solutions; linear equations; modular arithmetic.

Improvements of a congruential method for finding the exact solutions of systems of linear equations with rational coefficients are described. Typical execution times on the CDC 1604-A are given, as well as the Fortran program.

An improvement of the Fischer inequality, R. Merris, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 1 and 2, 77-80 (Jan.-June 1971).

Key words: Fischer inequality; Hadamard determinant theorem; permanent; positive definite hermitian matrix.

An improvement of the classical Fischer inequality for the determinant of a positive definite hermitian matrix is proved. It is used to analyze the Hadamard determinant theorem.

On the Smith normal form, M. Newman, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 1 and 2, 81-84 (Jan.-June 1971).

Key words: Invariant factors; principal ideal rings; Smith normal form.

An elementary proof is given of the fact that if A, B are nonsingular $n \times n$ matrices over a principal ideal ring R, then the kth invariant factor of AB is divisible by the kth invariant factor of A and by the kth invariant factor of B, $1 \leq k \leq n$. Some consequences are drawn.

On certain optimal quadrature formulas, S. Haber, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 1 and 2, 85-88 (Jan.-June 1971).

Key words: Analytical functions; approximation; Gaussian quadrature; integration; optimal quadrature; quadrature.

A class of optimal quadrature formulas defined by V. L. N. Sarma in a probabilistic context is shown to be identical with a class of formulas defined previously, in a different manner, by P. J. Davis. As a result a contrast is drawn between the maximum of the error of a quadrature formula over the unit sphere in a certain function space, and its average—in Sarma's sense—over that sphere.

July-December 1971

Some elementary formulas in "matrix calculus" and their applications, J. T. Fong, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 3 and 4, 97-107 (July-Dec. 1971).

Key words: Chain rule; continuum mechanics; gradient; matrices; matrix calculus; partial differentiation; product rule; tensor function; trace.

A collection of elementary formulas for calculating the gradients of scalar- and matrix-valued functions of one matrix argument is presented. Using some of the well-known properties of the operator "trace" on square matrices, alternative definitions of gradients and simple examples of calculating them using the product rule and the chain rule for differentiation are treated in an expository fashion in both component and matrix notations with emphasis on the latter. Two examples in continuum mechanics are presented to illustrate the application of the so-called "matrix calculus" of differentiable functions.

Linear transformations on matrices, M. Marcus, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 3 and 4, 109-115 (July-Dec. 1971).

Key words: Determinant; generalized matrix function; invariants; matrices; rank.

Let K be a field and let $M_n(K)$ denote the vector space of all $n \times n$ matrices over K. Suppose $I(X)$ is an invariant defined on a subset $\mathscr{U}$ of $M_n(K)$. This paper surveys certain results concerning the following problem. Describe the set $\mathscr{L}(I, \mathscr{U})$ of all linear transformations $T: \mathscr{U} \rightarrow \mathscr{U}$ that hold the invariant I fixed:

$$I(T(X)) = I(X), \qquad X \epsilon \mathscr{U}$$

Eigenvalues of sums of Hermitian matrices. III., R. C. Thompson and L. F. Garbanati, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 3 and 4, 117-124 (July-Dec. 1971).

Key words: Eigenvalues; linear inequalities; singular values.

Two classes of nonlinear inequalities for the eigenvalues of sums of Hermitian matrices are obtained. These nonlinear inequalities are shown to follow from linear inequalities established in parts I and II of this series. A new inequality for the singular values of matrix products is also obtained.

A new type of boundary value coupling for second order Sturm-Liouville systems, J. Geist, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 3 and 4, 125-138 (July-Dec. 1971).

Key words: Boundary value problems; coupled equations; differential equations; self-adjoint equations; Sturm-Liouville systems.

A natural generalization of the familiar second order Sturm-Liouville system is presented. This generalization consists of considering a number of differential equations defined on different intervals, instead of just one equation on one interval. The self-adjoint character of the differential equations is retained in the generalization, but the boundary conditions are relaxed considerably. The most general boundary conditions which can be accommodated by this sort of generalization of Sturm-Liouville theory are discussed. The existence of eigenvalues is proved, and a generalized orthogonality and a weak eigenfunction expansion theorem are derived.

An ergodic source which is not a function of any finite Markov process, R. D. Traub, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 3 and 4, 139-148 (July-Dec. 1971).

Key words: Information theory; Markov process; probability theory; ring theory; stochastic process.

The problem of deciding when a stationary stochastic process is a function of a finite Markov process has been considered by several authors, leading to an elegant necessary and sufficient condition. Taking a different approach, this note uses elementary ring theory to prove that a certain explicitly constructed stationary ergodic process is not a function of any finite Markov process.

On entire functions of exponential type, S. M. Shah and W. C. Sisarcick, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 3 and 4, 149-156 (July-Dec. 1971).

Key words: Bounded index; entire function; exponential type; maximum modulus.

Let f be an entire function and let $p \geqslant 1$ and

$$I(l, r) = \left\{ \int_0^{2\pi} |f^{(l)}(re^{i\theta})|^p d\theta \right\}^{1/p}.$$

Let $C > 0$. If there exists a positive integer N such that for $k = 0, 1, \ldots, N$,

$$\sum_{j=0}^{N} \frac{I(k+j, r)}{j!} \geqslant C \sum_{j=N+1}^{\infty} \frac{I(k+j, r)}{j!},$$

for all sufficiently large r, then f is of exponential type not exceeding $\{2 \log (1(1/c)) + 1 + \log (2N)!\}$. If this condition is replaced by related conditions, then also is of exponential type.

A table of integrals of the error function. II. Additions and corrections, M. Geller and E. W. Ng, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math Sci.), Nos. 3 and 4, 157-178 (July-Dec. 1971).

Key words: Error functions; indefinite integrals; special functions.

This is an extension of a compendium of indefinite and definite integrals of products of the error function with elementary or transcendental functions recently published by the authors.

A note on the time dependence of the effective axis and angle of a rotation, H. Gelman, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 3 and 4, 179-186 (July-Dec. 1971).

Key words: Angular velocity; effective axis and angle of rotation; intrinsic vector; kinematics of a rigid body; rotation group; spatial rotation.

The time dependent rotation of one orthogonal coordinate system with respect to a fixed one is considered in the parametrization based on the effective axis and angle of the rotation, a parametrization which has recently been used to discuss the irreducible representations of the rotation group. The method of the intrinsic vector is used to derive the equations of motion for the instantaneous effective axis and angle. A new representation of the angular velocity is obtained in a rotating orthogonal coordinate system generated by a unit vector along the effective axis, and a new geometrical interpretation of the effective angle is given.

A numerical solution of integral equation of the first kind applied to slit correction in small-angle x-ray scattering, J. Mazur, *J. Res. Nat. Bur. Stand. (U.S.),* **75B** (Math. Sci.), Nos. 3 and 4, 187-207 (July-Dec. 1971).

Key words: Conditions for convergence of solutions; integral equation of first kind; shifting operators; slit correction; slit weighting-function; small-angle x-ray scattering; strong numerical instability.

A novel approach to the problem of the slit correction in small-angle x-ray scattering is presented, based on a matrix inversion method. The integral equation for the slit correction is written as a Volterra equation of the first kind. This equation is reduced to a system of simultaneous equations, expressed in matrix form. The order of the matrix is equal to the number of experimentally determined points. To obtain these equations, one has to expand the unknown functions in Taylor series around each point to be subsequently determined. There is, however, a difficulty inherent in this method due to the fact that most of the series expansions of the function to be determined lead to a strong numerical instability. However, a general method is developed, which enables us to find shifting operators leading to numerically stable systems of equations. The "unsmearing" of the experimental data is then performed by standard matrix inversion procedures.

3.3. PAPERS FROM THE JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, SECTION C. ENGINEERING AND INSTRUMENTATION, VOLUME 75C, JANUARY-DECEMBER 1971

January-March 1971

Rotary-vane attenuator with an optical readout, W. E. Little, W. Larson, and B. J. Kinder, *J. Res. Nat. Bur. Stand. (U.S.)*, **75C** (Eng. and Instr.), No. 1, 1-5 (Jan.-Mar. 1971).

Key words: Attenuator; microwave; precision; rotary vane.

A precision x-band rotary-vane attenuator has been developed that follows its theoretical cosine squared law of attenuation to within 0.002 dB to a value of 20 dB. The best available attenuation measurement techniques verify this relationship to within the accuracy of the measurements. From 20 to 50 dB, the deviation from the theoretical value slowly increases and is frequency dependent. At present, three attenuators of this type have been constructed by NBS. Two of these attenuators have excellent attenuation versus frequency characteristics in the 20 to 50 dB range (0.08 dB deviation at 50 dB) while the third has a marked degree of frequency sensitivity (0.21 dB at 50 dB).

Design and operational characteristics of a high-speed (millisecond) system for the measurement of thermophysical properties at high temperatures, A. Cezairliyan, *J. Res. Nat. Bur. Stand. (U.S.)*, **75C** (Eng. and Instr.), No. 1, 7-18 (Jan.-Mar. 1971).

Key words: High-speed measurements; high temperatures; thermodynamics; thermophysical properties.

Design and constructional details of a high-speed system for the measurement of selected thermophysical properties of electrical conductors at temperatures above 2000 K in experiments of subsecond duration are described. Operational characteristics of such a system are given. Various phenomena that affect the design and successful operation of the system are discussed and, whenever possible, quantitative results are given. Certain experimental checks to assess the operation of the system are also described.

A new method of determining residual thiosulfate in processed photographic film, C. I. Pope, *J. Res. Nat. Bur. Stand. (U.S.)*, **75C** (Eng. and Instr.), No. 1, 19-22 (Jan.-Mar. 1971).

Key words: Archival film; hypo; microfilm; permanent record film.

Chromatographic paper, saturated with ammonia, is used to extract the residual thiosulfate from the gelatin layer of processed film. The paper is treated in a silver nitrate solution and fixed in an ammonia-sodium chloride solution. Thiosulfate, if present, forms silver sulfide and the thiosulfate is determined by measuring the transmission density of the paper darkened by silver sulfide. The paper extraction method is simple, rapid, requires only a densitometer as special equipment, and is very sensitive especially when the transmission density is measured for two layers of the paper. No filters are required. The test readily reveals the uneven distribution of residual thiosulfate on the film. By selective removal of thiosulfate from the image silver by ammonia and potassium bromide solutions, it was shown that a small amount of thiosulfate was absorbed on the image silver immediately after processing.

Scanning densitometer for continuous recording of spectral transmission density at low spatial contrast, W. L. McLaughlin, M. Rosenstein, E. K. Hussmann, and J. J. Lantz, Jr., *J. Res. Nat. Bur. Stand. (U.S.)*, **75C** (Eng. and Instr.), No. 1, 23-27 (Jan.-Mar. 1971).

Key words: Densitometer; microdensitometer; radiochromic dye films; spectral transmission density.

A simple photoelectric transmission densitometer can be converted in the laboratory into an instrument for measuring spatial variations in spectral density of small areas of thin, nonturbid films. This is accomplished by adding relatively inexpensive components that are readily available and easily assembled. The basic instrument can be one of a number of commercial densitometers, consisting of stabilized electronics, an adjustable light source, and a photosensitive probe which has a wide range and measures spectral transmission density. For continuous scanning of relatively small sample areas, the following additions are needed: (1) narrow-bandpass filters; (2) interchangeable field illuminating slits; (3) a short-focal-length illuminating-condenser lens which compromises between a relatively large numerical aperture and a reasonable depth of focus; (4) a motor-driven stage with adjustable speeds; (5) a light diffuser and light guide; and (6) a continuous, relatively fast-response data-recording system (such as a fast-response strip-chart recorder). This instrument has been assembled and tested especially for measuring spatial variations of spectral density produced in irradiated photochromic films; and also for calibrating a train of irradiated film samples, in terms of transmission density at a given wavelength as a function of irradiance, radiation absorbed dose, or photochemical reactivity.

Rotating optical attenuator for the generation of subsecond duration sawtooth shape radiance pulses, A. Cezairliyan, *J. Res. Nat. Bur. Stand. (U.S.)*, **75C** (Eng. and Instr.), No. 1, 29-32 (Jan.-Mar. 1971).

Key words: High-speed methods; light attenuator; photometry; radiance modulation; radiation.

A rotating attenuator for the generation of subsecond duration sawtooth shape radiance pulses is described. The attenuator disk is in the form of a cam. The geometry of the opening of a diaphragm used as the aperture stop determines the shape of the radiance pulses. Radiance is determined from the measurements with a high-speed photoelectric pyrometer. Recording of signals is made with a high-speed digital data acquisition system. The combined measuring and recording systems have a full-scale signal resolution of approximately one part in 8000 and a time resolution of 0.4 ms. Two different diaphragms are used in this study yielding radiance pulses (20 to 150 ms long) with linear and quadratic rise. The standard deviation of the experimental points from the pertinent functions describing the radiance variation is less than 0.5 percent.

Sound speed measurements in solids: absolute accuracy of an improved transient pulse method, T. M. Proctor, Jr., *J. Res. Nat. Bur. Stand. (U.S.)*, **75C** (Eng. and Instr.), No. 1, 33-40 (Jan.-Mar. 1971).

Key words: Acoustical pulse; longitudinal and shear sound waves; solids sound speed accuracy; speed of sound; transient pulse-acoustical.

A modified transient pulse technique for measuring shear and longitudinal sound speeds in solids has been devised. The technique is described and evaluated for both precision and accuracy on a variety of solids. This evaluation has been done by experiments in which the constancy of sound speed with path length is used as the prime test for accuracy. A number of variables such as transducer frequency, transducer size, choice of different coincidence points, etc., have been examined. The transducer bond problem is examined and overcome by the use of a time delay bond. Indicated accuracy of the method is found to be better than one part in 10^4. Advantageous sample geometries for accuracy testing are discussed.

Seismic response of infrasonic microphones, A. J. Bedard, Jr., *J. Res. Nat. Bur. Stand. (U.S.),* **75C** (Eng. and Instr.), No. 1, 41-45 (Jan-Mar. 1971).

Key words: Compensation; ground motion; infrasonic microphones; seismic response.

Factors affecting the (unwanted) seismic response of infrasonic microphones are indicated. Past measurements of ground motion deduced from the radiated atmospheric sound measured with infrasonic microphones are reviewed, and such measurements are compared with seismometer measurements of ground motion. Seismic motions caused by the Japanese earthquake of May 1968 are used in this example. The seismic response of the infrasonic microphone used for this measurement was experimentally determined and the results are presented. A simple method of compensating for interfering seismic effects on microphones is described.

April-June 1971

Heated air adiabatic saturation psychrometer, L. Greenspan, *J. Res. Nat. Bur. Stand. (U.S.),* **75C** (Eng. and Instr.), No. 2, 69-78 (Apr.-June 1971).

Key words: Adiabatic saturation; dew point temperature; humidity; hygrometer; mixing ratio; moist gas; psychrometer; vapor pressure.

A portable self-contained heated-air adiabatic saturation psychrometer intended as a field and laboratory instrument has been developed and constructed. The instrument measures the humidity of air in the range from 0 to 50 grams of water vapor per kilogram of dry air over an ambient temperature range of − 5 to 40 °C. It samples a test gas at the rate of 4 liters per minute.

The psychrometer was compared with the NBS pressure humidity generator over the mixing ratio range of 2.5 to 19 grams of water per kilogram of dry air (equivalent to a dew-point range of − 5.4 to 24 °C at atmospheric pressure). The mixing ratio indicated by the psychrometer was higher than that produced by the generator by $0.025 \text{ g/kg} + 0.24$ percent of the reading with a standard deviation of 0.024 g/kg; that is, it was higher by 1.24 percent to 0.37 percent of the reading as the measured mixing ratio increased from 2.5 to 19 g/kg. In equivalent terms of dew point, the psychrometer reading was higher by 0.16 deg C to 0.06 deg C as the measured dew point increased from − 5.4 to 24.0 °C. The results are approximately those which would be expected based on an analysis of estimated errors in individual measurements.

Computation of the temperature distribution in cylindrical high-pressure furnaces, M. Waxman and J. R. Hastings, *J. Res. Nat. Bur. Stand. (U.S.),* **75C** (Eng. and Instr.), No. 2, 79-83 (Apr.-June 1971).

Key words: Analytic solutions; boundary conditions; computation, temperature distribution; furnaces, high-pressure; high-pressure furnaces; high-temperature, high-pressure research; power dissipation; temperature distribution, steady-state; temperature gradients; temperature irregularities; temperature variation; thermal conductivity.

The steady-state temperature distribution in typical cylindrical high-pressure furnaces has been computed from analytic solutions for various boundary conditions. Either the temperature variation along the cylindrical heater or the power dissipation per unit length is prescribed. The results are tabulated and discussed as an aid in the design of high-pressure furnaces and in the estimation of temperature gradients. Topics considered include: (1) the reduction of temperature gradients around the center of the furnace, (2) the effect of temperature irregularities along the heater, and (3) the effect of the relative thermal conductivity of neighboring components.

Rotating adjustable transmission optical step attenuator, A. Cezairliyan, *J. Res. Nat. Bur. Stand. (U.S.),* **75C** (Eng. and Instr.), No. 2, 85-88 (Apr.-June 1971).

Key words: High-speed measurements; optical attenuator; photometry; radiance.

A rotating wavelength-independent optical attenuator is described that generates four radiance steps. Radiance ratios between the steps can be continuously varied. Experiments are performed to assess the operational characteristics of the attenuator. Radiance is determined from measurements with a high-speed photoelectric pyrometer. Recording of signals is made with a high-speed digital data acquisition system. The combined measuring and recording systems have a full-scale signal resolution of approximately one part in 8000 and a time resolution of 0.4 ms. The results of several experiments on radiance ratio measurements are found to be in agreement within one part in 1000.

An improved method for microwave power calibration, with application to the evaluation of connectors, G. E. Engen, *J. Res. Nat. Bur. Stand. (U.S.),* **75C** (Eng. and Instr.), No. 2, 89-93 (Apr.-June 1971).

Key words: Calibration; connectors; mismatch; power equation; power measurement.

In the procedures for microwave power calibration, which are well documented, the subject of mismatch errors (or corrections) plays a major role. In particular, the evaluation of mismatch corrections requires the measurement of complex reflection coefficients; and the accuracy of this measurement is limited, in part, by connector imperfections.

The application of recently developed "power equation" methods to this problem provides both a simplified determination of the mismatch correction (M_{gm}) and improved accuracy. In particular, the intermediate step of measuring the reflection coefficients is eliminated, and the precision connector requirement is greatly relaxed. If this new method were adopted at each level of the usual calibration hierarchy, the accuracy of disseminating measurements referenced to the primary standards at NBS would be greatly improved.

The accuracy potential was demonstrated in a series of experiments involving the Type N, GPC-7, and waveguide flange connectors. The outcome of this experimental evaluation, in which the "ordinary" Type N performed on a par with GPC-7, raises some rather serious questions relative to current trends in connector development.

Apparatus for impact-fatigue testing, R. E. Schramm, R. L. Durcholz, and R. P. Reed, *J. Res. Nat. Bur. Stand. (U.S.),* **75C** (Eng. and Instr.), No. 2, 95-98 (Apr.-June 1971).

Key words: Cryostat; fatigue; impact; low temperature; mechanical property equipment; stainless steel.

A standard impact machine was extensively modified to allow the measurement of the response of specimens to repeated, controlled impact pulses. This equipment enables one to vary the temperature (76-297 K), specimen geometry (uniaxial, biaxial, triaxial stress systems), and load levels. At stress levels in the neighborhood of the yield stress, on the order of 10,000 impact cycles are needed to fatigue specimens to fracture. Strain rates achieved are moderately high, of the order of 1000 min^{-1}, which conveniently form intermediate data between tensile (max. of about 100 min^{-1}) and explosive straining data (about 6000 min^{-1}). Contrasted to standard fatigue tests, no constraint is placed on specimen elongation and only unidirectional stresses are imposed. Typical impact-fatigue results for AISI 310 stainless steel are presented.

A program in refractory metal thermocouple research, G. W. Burns and W. S. Hurst, *J. Res. Nat. Bur. Stand. (U.S.),* **75C** (Eng. and Instr.), No. 2, 99-106 (Apr.-June 1971).

Key words: EMF-temperature relationship; furnace; high temperature; refractory metals; thermocouple; thermoelements; sensor; ultra high vacuum; W-Re alloys.

A refractory metal thermocouple research program, directed towards establishing the parameters that are necessary to achieve reliable, long term, high temperature thermocouple performance, is outlined. A description of special apparatus for exposing bare-wire thermoelements to high temperatures in vacuum and in high purity gaseous environments is given, and the design and performance of an ultra-high-vacuum, high-temperature furnace system are described. Bare-wire W-3 percent Re and W-25 percent Re thermoelements were exposed at 2400 K in argon, hydrogen or vacuum, and experienced a shift in their emf-temperature relationship upon initial exposure. After the initial shift, the thermoelements exposed in the gaseous environments experienced no significant further change in their emf-temperature relationship for periods up to 1000 hours. The thermoelements exposed in vacuum continually drifted in their emf-temperature relationship as a result of the preferential loss of Re by evaporation.

Polarization measurements as related to corrosion of underground steel piling, W. J. Schwerdtfeger, *J. Res. Nat. Bur. Stand. (U.S.),* **75C** (Eng. and Instr.), No. 2, 107-121 (Apr.-June 1971).

Key words: Corrosion; corrosion rate; disturbed soil; instantaneous rate; pit depth; pitting factor; polarization; steel piling; undisturbed soil; weight loss.

Most of this paper is devoted to the author's evaluation of polarization measurements made by the Corps of Engineers (Lower Mississippi Valley Division) on steel pipe specimens exposed to the soil at four dam sites as related to the corrosion of steel piling (underground) observed at the sites. As the polarization measurements were made periodically on weighed specimens for periods as long as seven years, the Corps' data offered an excellent opportunity for evaluating the accuracy and practicability of a polarization technique for measuring corrosion rates. Reasonable agreement between calculated and actual corrosion on the specimens made it possible to estimate maximum anticipated corrosion on the piling after 50 years of exposure.

Confidence gained in the value of polarization measurements made on short length pipe specimens led the author to make measurements on actual piling. Instantaneous corrosion rates were measured on two driven pipe piles, 72 ft (22 m) and 19 ft (5.8 m) in length, both of which had been exposed for 12 years. One month later, the short pile was extracted and examined. Relatively low corrosion rates calculated from the polarization data were verified by the appearance of the pile and by the limited extent of the pitting.

July-December 1971

Thermal voltage converters and comparator for very accurate AC voltage measurements, E. S. Williams, *J. Res. Nat. Bur. Stand. (U.S.),* **75C** (Eng. and Instr.), Nos. 3 and 4, 145-153 (July-Dec. 1971).

Key words: AC-DC difference; comparator; thermoelement; transfer voltmeter, voltage measurements.

A new fourteen-range set of thermal voltage converters and a thermoelement comparator are used to measure ac-dc difference, and a-c voltages relative to external d-c standards, with 20 ppm (parts-per-million) accuracy at audio frequencies. The imprecision is less than 2 ppm. Corrections relative to the very stable middle ranges can be redetermined for every range by a seven-step intercomparison of certain adjacent ranges.

Formulation and experimental verification of an axisymmetric finite-element structural analysis, R. A. Mitchell, R. M. Woolley, and C. R. Fisher, *J. Res. Nat. Bur. Stand. (U.S.),* **75C** (Eng. and Instr.), Nos. 3 and 4, 155-161 (July-Dec. 1971).

Key words: Axisymmetric; elastic; experiment; finite-element analysis; force transducer; stiffness matrix; structural analysis.

A finite-element structural analysis is described for application to problems in which geometry and loading are axisymmetric and material properties are isotropic elastic. An attempt to minimize restrictions imposed on the shape and orientation of the triangular finite-elements has been largely successful. This facilitates use of the analysis, with automatic finite-element mesh generation, in parameter or optimization studies. A series of laboratory tests to verify the analysis are described in which the magnitude and distribution of boundary loading was known within narrow limits.

A Burnett apparatus for the accurate determination of gas compressibility factors and second virial coefficients, and an evaluation of its capability based on some results for argon and carbon dioxide, M. Waxman and J. R. Hastings, *J. Res. Nat. Bur. Stand. (U.S.),* **75C** (Eng. and Instr.), Nos. 3 and 4, 163-172 (July-Dec. 1971).

Key words: Adsorption, gas on metal; argon, compressibility factor of; Burnett data reduction; carbon dioxide, second virial coefficient of; compressibility factor; gas; gas, compressibility factor of; gas, *PVT* properties of; measurements; second virial coefficient.

A Burnett apparatus has been developed for the determination of the compressibility factor of gases, including corrosive halogenic gases, to an accuracy of 0.1 percent to 0.01 percent at temperatures from 0 to 225 °C and for pressures up to 250 bars. The apparatus has been used throughout this temperature and pressure range and at temperatures within 15 °C of the critical temperature of the sample gas. The apparatus features a rugged yet highly sensitive and reproducible null-type pressure transducer to isolate the sample gas without introducing a pressure uncertainty greater than the precision of the pressure measurements, which is better than 1 part in 50,000. The pressure measurements are accurate to at least 1 part in 20,000. The reduction of the data is discussed extensively. The capability of the apparatus has been evaluated in terms of the compressibility factor represented by a finite pressure or density virial expansion and derived from argon data at 25 °C and pressures up to 250 bars and in terms of the second virial coefficient of carbon dioxide based on data at 50 °C and pressures below 35 bars. The value obtained for this second virial coefficient, -102.2 ± 0.5 cm^3/mol, compares favorably with the value of -102.5 cm^3/mol obtained from a recent correlation and is in substantial disagreement with the value of -100.7 ± 0.4 cm^3/mol determined by Dadson and co-workers from the Burnett method and the piezometer method.

An extension to the sliding short method of connector and adaptor

evaluation, G. F. Engen, *J. Res. Nat. Bur. Stand. (U.S.),* **75C** (Eng. and Instr.), Nos. 3 and 4, 173-180 (July-Dec. 1971).

Key words: Adaptor; connector; efficiency; sliding short.

Sliding short methods represent a measurement tool of substantial potential for the measurement of small losses such as are associated with waveguide connectors or adaptors. Until recently, however, the use of these methods has been inhibited by the uncertainty of the error contribution due to non-ideal short behavior.

A recent analysis by Almassy has shown that by the use of proper techniques, the error contribution from this source is usually negligible, provided that the adaptor (or connector) is "well matched."

It is the purpose of this paper to eliminate this latter restriction, develop additional measurement methods, and describe further applications.

Accurate microwave high power measurements using a cascaded coupler method, K. E. Bramall, *J. Res. Nat. Bur. Stand. (U.S.),* **75C** (Eng. and Instr.), Nos. 3 and 4, 181-186 (July-Dec. 1971).

Key words: Accurate; calibration; directional coupler; high power; measurement; microwave.

The use of directional couplers to extend the range of low-level power meters is a well established technique. Calibration of bolometer-coupler units up to 20 dB is routine at NBS and other laboratories and allows power measurement to the 1 W level. For higher coupling ratios, however, the problems in calibration using conventional techniques becomes more difficult. This paper describes a cascade method which allows calibration of low power meter-coupler combinations for measurement up to the megawatt range.

The technique is based upon system linearity and the uncertainty limits are shown to be 1 percent to 1.5 percent using NBS low power standards. By using the NBS calibration services and commercially available equipment, the above power levels can be measured with uncertainty limits less than 2.7 percent. The method can also be adapted to measurement of large coupling ratios (20-80 dB).

Results are given for power (200 watts in WR-90 waveguide) and coupling ratio (40 dB coaxial coupler) measurements.

3.4. MONOGRAPHS

Major contributions to the technical literature on various subjects related to the Bureau's scientific and technical activities.

Monogr. 25, Section 9. **Standard x-ray diffraction powder patterns. Section 9.—Data for 63 substances,** H. E. Swanson, H. F. McMurdie, M. C. Morris, E. H. Evans, and B. Paretzkin, Nat. Bur. Stand. (U.S.), Monogr. 25—Sec. 9, 128 pages (Dec. 1971).

Key words: Crystal structure; integrated intensities; lattice constants; peak intensities; powder patterns; reference intensities; standard; x-ray diffraction.

Standard x-ray diffraction patterns are presented for 63 substances. Forty of these patterns represent experimental data and 23 are calculated. The experimental x-ray powder diffraction patterns were obtained with an x-ray diffractometer. All *d*-values were assigned Miller indices determined by comparison with computer interplanar spacings consistent with space group extinctions. The densities and lattice constants were calculated, and the refractive indices were measured whenever possible. The calculated x-ray powder diffraction patterns were computed from published crystal structure data. Both peak height and integrated intensities are reported for the calculated patterns.

Monogr. 119. **A high-dispersion spectral analysis of the Ba II star HD 204075 (ζ Capricorni),** J. L. Tech, Nat. Bur. Stand. (U.S.), Monogr. 119, 174 pages (Mar. 1971).

Key words: Abundances of elements in stars; Ba II stars (ζ Capricorni); curve of growth; equivalent widths; identification of spectral lines; ionization in stars; oscillator strengths; temperature in stars; turbulence in stars.

A double differential curve of growth analysis, using both the sun and ϵ Virginis (G9 II-III) as comparison stars, has been performed for the Ba II star ζ Capricorni. The observational material consists of equivalent widths, central depths, and half-widths for 1100 spectral lines measured on direct-intensity tracings of plates obtained by J. L. Greenstein at the coudé focus of the 200-in telescope. The plates cover the spectral regions 3880-4825 Å and 5100-6720 Å at reciprocal dispersions of 2.3 and 3.4 Å/mm, respectively. Line identifications given in earlier lists for barium stars have been critically re-examined. Three lines have been attributed with reasonable certainty to dysprosium, which has not previously been observed in barium stars.

The atmospheric parameters derived for ζ Cap are:

θ_{exc} : 1.13 $[P_e]_{\zeta-\odot}$: -1.28
θ_{ion} : 0.99 $[P_e]_{\zeta-\epsilon}$: $+0.13$
$\log 2\alpha$: -2.5 $[k]_{\zeta-\odot}$: -1.10
v_{micro} : 3.5 km/s $[k]_{\zeta-\epsilon}$: -0.03
v_{macro} : 5.5 km/s

Atmospheric abundances have been derived for 37 elements. The results obtained with respect to the two comparison stars are in good agreement. The barium star exhibits essentially solar abundances for most elements lighter than germanium, but overabundances by factors of about two are indicated for carbon and lithium. With the exception of europium, all observed elements heavier than germanium are found to be overabundant in ζ Cap. Improved NBS *gf*-values, converted to the system of line strengths in ϵ Vir, have yielded exceptionally well-defined curves of growth for several rare earths. Overabundances by factors of about eight or nine have been found for the *s*-processed rare earths, as well as for dysprosium, which is generally considered to be *r*-processed. The abundances derived for the rare earths are greater by about a factor of three than those derived for the same star by Warner (Mon. Not. Roy. Astron. Soc. **129,** 263 (1965)).

Monogr. 120. **Unified theory calculations of Stark broadened hydrogen lines including lower state interactions,** C. R. Vidal, J. Cooper, and E. W. Smith, Nat. Bur. Stand. (U.S.), Monogr. 120, 45 pages (Jan. 1971).

Key words: Classical path; hydrogen lines; line wings; Stark broadening; unified theory.

Recently published calculations of hydrogen Stark broadening on the basis of the unified classical path theory have been extended to include lower state interactions in the final line profile. A detailed comparison with experiments in the density range 10^{13}-10^{17} cm^{-3} is given

Monogr. 121. **The effect of time ordering on the Lyman α profile,** J. T. Godfrey, C. R. Vidal, E. W. Smith, and J. Cooper, Nat. Bur. Stand. (U.S.), Monogr. 121, 14 pages (June 1971).

Key words: Lyman-α; Stark-broadening; time-ordering; unified theory.

Using a unified theory of spectral line broadening previously developed, the effects of time-ordering over the complete line profile are investigated. The behavior of the time-ordered thermal average and un-time-ordered thermal average are compared. The Fourier transform of the thermal average is obtained analytically. Calculations for the line profile of the Lyman-α line of hydrogen are presented and are representative in that the full thermal average is replaced by the thermal average with the electron velocity distribution approximated by $f(v)=\delta v-v_{\mathrm{av}})$ where v_{av} is the thermal velocity for the plasma in question.

3.5. HANDBOOKS

Recommended codes of engineering and industrial practice (including safety codes) developed in cooperation with interested industries, professional organizations, and regulatory bodies. In many cases recommended requirements are given official status through their incorporation in local ordinances by State and municipal regulatory bodies.

H44. **Specifications, tolerances, and other technical requirements for commercial weighing and measuring devices,** H. F. Wollin, Compiler and Editor, Nat. Bur. Stand. (U.S.), Handb. 44, Fourth Edition, 222 pages (Dec. 1971).

Key words: Commercial weighing and measuring devices; specifications; technical requirements; tolerances.

NBS Handbook 44, Fourth Edition, "Specifications, Tolerances, and Other Technical Requirements for Commercial Weighing and Measuring Devices," is a revision of the Third Edition of Handbook 44. This Fourth Edition adopted by the National Conference on Weights and Measures is given legal status in practically every state in the United States. (Supersedes NBS Handbook 44 – 3rd Edition.)

H105-2. **Specifications and tolerances for reference standards and field standard weights and measures. 2. Specifications and tolerances for field standard measuring flasks,** B. C. Keysar, Nat. Bur. Stand. (U.S.), Handb. 105-2, 6 pages (Jan. 1971).

Key words: Accurate measurements of volume of liquids; field standard measuring flasks; specification; tolerances; weights and measures inspection.

These specifications and tolerances are recommended as minimum requirements for standards used in the field by State and local weights and measures officials in quantity determinations of liquid commodities.

H105-3. **Specifications and tolerances for reference standards and field standard weights and measures. 3. Specifications and tolerances for metal volumetric field standards,** B. C. Keysar, Nat. Bur. Stand. (U.S.), Handb. 105-3, 8 pages (May 1971).

Key words: Accurate measurements of volumes; field standard; metal volumetric field standards; provers; specifications; test measures; tolerances; weights and measures inspection.

These specifications and tolerances are recommended as minimum requirements for standards used in the field by State and local weights and measures officials in quantity determinations of liquid commodities.

H108. **Weights and measures labeling handbook,** D. E. Edgerly, Nat. Bur. Stand. (U.S.), Handb. 108, 406 pages (May 1971)

Key words: Consumer package; exemption; fluid measure; labeling; net quantity; principal display panel; regulations; weights and measures.

The Weights and Measures Labeling Handbook has been prepared for use by State weights and measures officials in the enforcement of State laws and regulations pertaining to the packaging and labeling of commodities. The Handbook provides a cross indexed compilation of the requirements of the Model State Packaging and Labeling Regulation, U. S. Department of Agriculture regulations, and regulations of the Food and Drug Administration and Federal Trade Commission issued pursuant to the Fair Packaging and Labeling Act.

3.6. SPECIAL PUBLICATIONS

This series includes proceedings of high-level national and international conferences sponsored by NBS, precision measurement and calibration volumes, NBS Research Highlights, and other special publications appropriate to this grouping, such as administrative pamphlets, wall charts and bibliographies.

SP236, 1971 Edition. **NBS frequency and time broadcast services. Radio stations WWV, WWVH, WWVB, and WWVL,** P. P. Viezbicke, Editor, Nat. Bur. Stand. (U.S.), Spec. Publ. 236, 1971 Edition, 15 pages (July 1971).

Key words: Broadcast of standard frequencies; high frequency; low frequency; standard frequencies; time signals; very low frequency.

Detailed descriptions are given of the technical services provided by the National Bureau of Standards radio stations WWV, WWVH, WWVB, and WWVL. These services are: 1. Standard radio frequencies; 2. Standard audio frequencies; 3. Standard musical pitch; 4. Standard time intervals; 5. Time signals; 6. UT corrections; and 7. Official announcements. In order to provide users with the best possible services, occasional changes in broadcasting schedules are required. This publication shows the schedules in effect on July 1, 1971. Annual revisions will be made. Current data relating to standard frequencies and time signals are available monthly in the Time and Frequency Services Bulletin. Advance notices of changes occurring between revisions will be sent to users of NBS broadcast services who request such notice on the basis of need. Supersedes NBS Special Publication 236, 1970 and previous issues.

SP250, 1970 Edition. **Calibration and test services of the National Bureau of Standards,** Nat. Bur. Stand. (U.S.), Spec. Publ. 250, 1970 Edition, 353 pages (Dec. 1971).

Key words: Calibration services; fees for testing; test fee schedule; test procedures.

This publication contains a descriptive listing, item by item, of most of the test and calibration work done at the National Bureau of Standards with the respective fees. The content is fully indexed providing easy access to data on specific measurement services. Included also is information about the Bureau's organization and statutory functions, the procedures for requesting tests, and the reports issued thereon. Throughout the text are mentioned various other publications which form a bibliography in measurement techniques. This publication supersedes Special Publication 250, 1968 Edition and the supplementary material in Measurement Users Bulletins Numbers 1 through 11. Supersedes Miscellaneous Publication 250, 1968 Edition.

SP260-21. **Analysis of interlaboratory measurements on the vapor pressures of cadmium and silver. (Certification of Standard Reference Materials 746 and 748),** R. C. Paule and J. Mandel, Nat. Bur. Stand. (U.S.), Spec. Publ. 260-21, 30 pages (Jan. 1971).

Key words: Cadmium; components of error (within- and between-laboratory); heats of sublimation (second and third law); interlaboratory measurements; silver; standard errors; standard reference materials; vapor pressure.

Detailed statistical analyses have been made of results obtained from a series of interlaboratory measurements on the vapor pressures of cadmium and silver. Standard Reference Materials 746 (cadmium) and 748 (silver) which were used for the measurements have been certified over the respective pressure ranges $10^{-11}-10^{-4}$ atm and $10^{-12}-10^{-3}$ atm. The temperature ranges corresponding to these pressures are 350-594 K for cadmium and 800-1600 K for silver. The heats of sublimation at 298 K and the associated two standard error limits for cadmium and silver are 26660 ± 150 cal/mol and 68010 ± 300 cal/mol, respectively. Estimates of uncertainty have been calculated for the certified temperature-pressure values as well as for the uncertainties expected from a typical single laboratory's measurements. The statistical analysis has also been made for both the second and third law methods, and for the within- and between-laboratory components of error. The uncertainty limits are observed as functions of both the heat of sublimation and the temperature.

SP260-22. **Homogeneity characterization of Fe-3Si Alloy,** H. Yakowitz, C. E. Fiori, and R. E. Michaelis, Nat. Bur. Stand. (U.S.), Spec. Publ. 260-22, 30 pages (Feb. 1971).

Key words: Fe-3Si alloy; homogeneity testing; metallography; microprobe analysis; spectrometric analysis; Standard Reference Materials.

An alloy of iron-3.22 wt. pct. silicon (Fe-3Si) was characterized with regard to chemical homogeneity of iron and silicon at the micrometer level of spatial resolution. This alloy is satisfactory for use as a homogeneous standard for electron probe microanalysis. The samples were cut from coarse-grained sheet stock to a final size of about 3 mm × 3 mm × 0.28 mm thick. Homogeneity was checked by means of quantitative raster scanning in which a square matrix (1.1 mm × 1.1 mm) of individual points is analyzed by the microprobe. Each matrix represents 400 separate analyses. Usually, the same matrix was rerun so that each point was sampled twice. The coefficient of variation for both the iron and silicon is less than one percent. Quantitative microprobe analysis was also carried out on this alloy giving a silicon content of 3.14% and an iron content of 96.9%.

SP260-25. **A standard reference material containing nominally four percent austenite,** G. E. Hicho, H. Yakowitz, S. D. Rasberry, and R. E. Michaelis, Nat. Bur. Stand. (U.S.), Spec. Publ. 260-25, 22 pages (Feb. 1971).

Key words: Austenite in ferrite; electron microprobe; powder metallurgy; quantitative microscopy; SRM; x-ray fluorescence analysis.

This standard was produced by powder metallurgical techniques using known amounts of austenite. Using these techniques, 134 specimens were prepared. Because these standards are expected to be used primarily for the calibration of x-ray diffraction equipment, only one surface of each standard is certified, and these surfaces range from 3.1 percent to 5.2 percent in austenite content. To make the specimens, 310 stainless steel powder (austenitic) was blended with 430 stainless steel powder (ferritic) to make a mixture of 5 percent austenite in ferrite. The material was compacted, sintered, polished and etched so the austenite appears white and the ferrite, a deep brown. Then quantitative microscopy methods were used to determine the percentage of austenite near the surface. Furthermore, the 310 powder contains 20 percent of nickel while the 430 powder contains virtually no nickel. Therefore, after establishing a meaningful calibration curve, x-ray fluorescence analysis for the nickel content was also used as a direct measurement of the amount of austenite on the surface of the compact. Both procedures were carried out on fifteen specimens statistically selected from the total number of compacts produced. Agreement, within experimental error limits, was obtained between the x-ray fluorescence results and quantitative microscopy results.

The x-ray fluorescence method was used to characterize all additional compacts. X-ray diffraction determinations of austenite content are in good agreement with the x-ray fluorescence and quantitative microscopy results. The compacts may be used as x-ray diffraction standards for austenite or in special cases as x-ray fluorescence standards for nickel content.

SP260-26. **Standard reference materials: National Bureau of Standards—U.S. Steel Corporation joint program for determining oxygen and nitrogen in steel,** J. F. Martin, Nat. Bur. Stand. (U.S.), Spec. Publ. 260-26, 40 pages (Feb. 1971).

Key words: Inert gas fusion; one ppm of oxygen and nitrogen in steel; Research Associate Program; simultaneous determination of oxygen and nitrogen; Standard Reference Material for oxygen.

Because of a need for a method for the rapid, simultaneous determination of small concentrations of oxygen and nitrogen in steel, a joint project under the Industrial Fellowship Program of U.S. Steel and the Research Associate Program of the National Bureau of Standards (NBS) was established. After investigation of various techniques, an analytical apparatus was constructed with excellent sensitivity for both elements. This apparatus consists of an inert gas fusion system coupled to a gas chromatograph. Recommended modifications have been completed on this equipment, and simultaneous determinations of oxygen and nitrogen in steel are presently being made. The detection limit is < 1 ppm for both oxygen and nitrogen, and the analysis time is about 5 minutes.

A direct result of this program has been the issuance by NBS of a new Standard Reference Material (SRM), a maraging steel, for oxygen. This SRM has the lowest oxygen concentration (4.5 ppm) of any steel standard yet issued by NBS.

SP260-27. **Uranium isotopic standard reference materials,** E. L. Garner, L. A. Machlan, and W. R. Shields, Nat. Bur. Stand. (U.S.), Spec. Publ. 260-27, 162 pages (Apr. 1971).

Key words: Absolute isotopic abundance; ignition procedure; isotopic standards, mass spectrometry; stoichiometry; uranium.

An ignition procedure has been developed that will yield reproducible stoichiometry for U_3O_8. The effects of temperature, length of ignition, rate of cooling, pressure and type of atmosphere were investigated. This ignition procedure has been used for the blending of high purity ^{235}U and ^{238}U separated isotopes to prepare calibration standards for the determination of bias effects in the thermal emission mass spectrometry of uranium. Weight aliquoting was used to prepare calibration mixes with $^{235}U/^{238}U$ ratios of more than 10 and less than 0.1 and to add a ^{233}U spike for the determination of minor isotope abundances in the uranium isotopic standards by the isotope dilution technique.

A description of the unique features of the mass spectrometer instrumentation including the source, NBS collector and expanded scale recorder are given. Two specific analytical procedures were used for the isotopic analysis of uranium and are adaptable, within a general framework, to fit the particular ion current intensity requirements of a wide range of isotopic distributions. Mass discrimination due to evaporation and ionization on the filaments, and other parameters such as temperature, time, sample size, sample mounting, total sample composition, acidity, filament material, pressure, non-ohmic response, R-C response and source memory were studied as part of the development effort to establish sound analytical procedures.

The absolute isotopic abundances of 18 uranium SRMs were determined by thermal emission mass spectrometry. The general approach was to determine absolute $^{235}U/^{238}U$ ratios by using calibration mixes to correct for filament bias. Then the absolute ^{234}U and ^{236}U were determined by ^{233}U isotope dilution. For SRM U-0002, isotope dilution was the only practical means of determining the low abundance of ^{235}U as well as the ^{234}U. The limits given for the isotopic composition of the uranium SRMs are at least as large as the 95 percent confidence limits for a single determination and include terms for inhomogeneities of the material as well as analytical error.

SP260-28. **Standard reference materials: Preparation and evaluation of SRM's 481 and 482 gold-silver and gold-copper alloys for microanalysis,** K. F. J. Heinrich, R. L. Myklebust, S. D. Rasberry, and R. E. Michaelis, Nat. Bur. Stand. (U.S.), Spec. Publ. 260-28, 100 pages (Aug. 1971).

Key words: Alloys; corrections; electron probe; homogeneity; matrix scanner; microanalysis; quantitative analysis; standard reference materials; x-ray emission.

The reasoning behind the choice of the systems Au-Ag and Au-Cu for SRM's, and their suggested uses are described. We also report on the preparations of the materials, their chemical analysis, the tests performed to ascertain macroscopic and microscopic homogeneity, and on relative x-ray intensity measurements at various x-ray lines and voltages. A description of the instrumentation (matrix scanner), techniques, and programs employed in the homogeneity studies, as well as tables and graphs of the x-ray intensity measurements, are appended.

SP260-29. **Calibration of NBS secondary standard magnetic tape (computer amplitude reference) SRM 3200 using the reference tape amplitude measurement "Process A" Model II,** S. B. Geller, Nat. Bur. Stand. (U.S.), Spec. Publ. 260-29, 57 pages (June 1971).

Key words: Average signal peak level; computer amplitude reference; magnetic tape; master standard; saturation curves; secondary standard; signal level calibration; standard reference materials; unrecorded reference.

This publication describes the design, operation and calibration of the NBS signal amplitude measuring system (Process A—Model II) that is used for calibrating unrecorded Secondary Standard Magnetic Tapes (Computer Amplitude Reference) SRM 3200. This system supersedes the measurement system that was described in the NBS Special Publication 260-18 (November 1969). The signal level calibration is made with respect to a reference signal level derived from the NBS Master Standard Magnetic Tape (Computer Amplitude Reference) that is kept in repository at NBS. The techniques for measuring and recording the data that accompany each Secondary Standard Magnetic Tape in the form of strip chart recordings and saturation curves are described.

SP260-30. **Standard reference materials: standard samples issued in the USSR,** R. S. Gorozhanina, A. Y. Freedman, and A. B. Shaievitch, All-Union Scientific Research Institute of Metrology Sverdlovsk Branch, All-Union Scientific Research Center of the State Service for Standard Samples, translated from the Russian by M. C. Selby, Nat. Bur. Stand. (U.S.), Spec. Publ. 260-30, 86 pages (June 1971).

Key words: Standard reference materials; standard samples; standards in Russia; USSR standards.

This reference handbook contains information on standard samples of properties and composition of substances and materials including areas of their application, nomenclature, certified characteristics, and values of the certified quantities.

The handbook was prepared for personnel of metrological establishments, for laboratories of ferrous and non-ferrous metallurgy, for all branches of industry employing metals and alloys, for the mining industry, geological research service, oil refining industry, scientific research organizations, and institutes of higher education.

SP260-31. **Thermal conductivity of electrolytic iron, SRM 734, from 4 to 300 K,** J. G. Hust and L. L. Sparks, Nat. Bur. Stand. (U.S.), Spec. Publ. 260-31, 19 pages (Nov. 1971).

Key words: Cryogenics; electrical resistivity; electrolytic iron; Lorenz ratio; Seebeck effect; thermal conductivity; transport properties.

Thermal conductivity data are reported for a specimen of electrolytic iron, SRM 734, for temperatures from 4 to 300 K. Variability of this iron was studied by means of electrical residual resistivity ratio measurements on 63 specimens. This study showed that with a two-hour anneal at 1000 °C one can obtain a thermal conductivity Standard Reference Material that has variability of less than 1 percent in thermal conductivity.

SP300. Volume 7. **Precision measurement and calibration. Radiometry and photometry,** H. K. Hammond, III, and H. L. Mason, Editors, Nat. Bur. Stand. (U.S.), Spec. Publ. 300, Vol. 7, 685 pages (Nov. 1971).

Key words: Emissivity; flashing light; flux measurement; irradiance; material properties; photometry; projectors; radiance; radiometry; reflectometry.

This volume is one of an extended series which brings together some of the previously published papers, monographs, abstracts and bibliographies by NBS authors dealing with the precision measurement of specific physical quantities and the calibration of the related metrology equipment. The contents have been selected as being useful to the standards laboratories of the United States in tracing to NBS standards the accuracies of measurement needed for research work, factory production, or field evaluation.

Volume 7 contains reprints of more than 60 items on radiometry and photometry published between 1957 and 1970. The material has been placed in groups according to the following subjects: general radiometry, emissivity standards, emissivity measurements and techniques, material properties, irradiance standards, radiometric measurement techniques, radiance standards, flux measurement, reflectometry, general photometry, projectors, flashing lights, and chronological bibliography of publications by NBS staff.

SP305. Supplement 1. **Publications of the National Bureau of Standards 1968-1969. A compilation of abstracts and key word and author indexes,** B. L. Oberholtzer, Nat. Bur. Stand. (U.S.), Spec. Publ. 305 Suppl. 1, 497 pages (Dec. 1970).

Key words: Articles; publications.

This Supplement lists the publications of the NBS from January 1968 to December 1969. A brief abstract for each publication is given. It also includes abstracts of those papers by Bureau authors that have appeared in non-NBS media. Subject and author indexes are included and general publication information is furnished. This catalog and previous lists give reference to the publications printed by the Bureau during the period 1901 to December 1969. To accompany NBS Circular 460, its Supplement, Miscellaneous Publication 240, its Supplement, and Special Publication 305.

SP305. Supplement 2. **Publications of the National Bureau of Standards 1970. A compilation of abstracts and key word and author indexes,** B. L. Oberholtzer, Nat. Bur. Stand. (U.S.), Spec. Publ. 305 Suppl. 2, 378 pages (July 1971).

Key words: Abstracts, NBS publications; key words; publications.

This Supplement to Special Publication 305 Supplement 1 of the National Bureau of Standards lists the publications of the Bureau issued between January 1, 1970 and December 31, 1970. It includes an abstract of each publication (plus some earlier papers omitted from Special Publication 305 Supplement 1), key word and author indexes, and general information and instructions about NBS publications. Previous catalogs of NBS publications referenced in Special Publication 305, Supplement 1 remain in effect. To accompany National Bureau of Standards Circular 460, its Supplement, Miscellaneous Publication 240, its Supplement, Special Publication 305 and its Supplement 1.

SP317. Volumes I and II. **Fundamental aspects of dislocation theory.** Proceedings of a conference held at the National Bureau of Standards, Gaithersburg, Md., April 21-25, 1969. J. A. Simmons, R. deWit, and R. Bullough, Editors, Nat. Bur. Stand. (U.S.), Spec. Publ. 317, Vol. 1, 752 pages, Vol. II, 624 pages (Dec. 1970).

Key words: Conference; continuum mechanics; crystal physics, disclinations; dislocations; elasticity; electron-dislocation interactions; lattice defects; phonon-dislocation interactions; solid-state; theoretical physics; thermally activated processes; twinning.

These Proceedings contain research papers, discussions thereon, and panel discussions for the conference on "Fundamental Aspects of Dislocation Theory," held under the auspices of the Institute for Materials Research, April 21-25, 1969, at the laboratories of the National Bureau of Standards, Gaithersburg, Maryland. Approximately 75 contributed papers and two panel discussions are included. Topics covered are Discrete Dislocations in Continuum Elasticity, Lattice Theories, Dislocation-Phonon Interactions, Applications of the Geometry of Dislocations, Intrinsic Properties of Dislocations, Dislocation Field Theories, Thermally Activated Processes and Statistical Theories, Dislocation-Electron Interactions, and Future Directions for Dislocation Theory. *These proceedings include the following papers (indented):*

Discrete dislocations in continuum elasticity, A. K. Head, *SP317*, pp. 5-9 (Dec. 1970).

Key words: Dislocation observations; dislocation theory; status and problems.

As a framework in which to survey some of the current questions in this long-established part of dislocation theory, the problem of the experimental determination of stacking fault energy is considered. Attention is restricted to those methods which observe and measure in the electron microscope a simple dislocation-stacking fault configuration. It is assumed that the configuration is in equilibrium with the forces between the dislocation balancing the surface tension of the stacking fault. The stacking fault energy then follows if these dislocation forces are known from theory for the observed dimensions of the configuration.

Experimental techniques have improved to the point where a reproducibility of 1 to 5 percent standard deviation is claimed. This calls for theory which has at least a similar standard of accuracy. It is doubtful if the theory which is in current use has this accuracy and this is surveyed under the following headings: (a) The treatment of the core; (b) Elastic anisotropy; (c) Zig-zag instabilities; (d) The effect of the stacking fault; (e) The observation of dislocations by electron microscopy.

The image force on dislocations at free surfaces—comments on the concept of line tension, J. Lothe, *SP317*, pp. 11-22 (Dec. 1970).

Key words: Dislocation nodes; dislocations-image series; dislocation-surface interactions; line tension of dislocations.

It is shown that a straight dislocation emerging at a planar free surface is acted upon by a force distributed according to the law $dF=\lambda^{-1}(-E \text{ cotan } \theta+\partial E/\partial\theta)d\lambda$. Here θ is angle of inclination to surface. E is dislocation energy factor, and λ is distance from surface along the dislocation. The proof involves use of a slightly generalized version of the energy flow theorem for straight dislocations (Lothe, Phil. Mag. **15**, 9 (1967)). The above formula is the exact linear elasticity law corresponding to the usual approximate line tension result. According to this law there are certain angles of incidence for which the forces vanish so that the dislocation can be straight. Similarly, when only elastic terms are considered, there are certain node orientations for which the forces on the branches vanish so that the branches can be truly straight (Indenbom and Dubnova, Sovj. Phys. (Solid State) **9**, 915 (1967)). In this paper a discussion is given of how core energy terms may modify the results. It is concluded that also for nodes in the characteristic orientation for no elastic forces on the branches, some branch curvature will be present near the node.

Stability and some characteristics of uniformly moving dislocations, K. Malén, *SP317*, pp. 23-33 (Dec. 1970).

Key words: Anisotropic elasticity; Cerenkov waves; dislocation dynamics; dislocation stability.

The stability of uniformly moving dislocations has been studied in the case of elastic anisotropy using computer. The velocity for instability to occur for a screw dislocation in an isotropic medium is so high, 0.98 C_t, with C_t the transverse sound velocity, that it may well be unattainable. Inclusion of anisotropy gives the possibility of more reasonable instability velocities. Some data showing this for Fe, Li and Cr are given.

The stress field around a uniformly moving dislocation has been studied. Increasing the velocity of a dislocation corresponds to some extent to a change in the anisotropy of the crystal.

In uniform motion above the lowest velocity of sound in the direction of motion one can have associated with the moving dislocation 2, 4 or 6 Çerenkov waves, above the next sound velocity 4 or 6 and above the highest sound velocity 6 waves.

The formula developed earlier for the stress field around a uniformly moving planar dislocation loop can be generalized directly to three dimensions using the theorems of Indenbom and Orlov for the fields from three-dimensional sources using data for two-dimensional sources.

The generalization can also be made using the fact that the choice of cut surface is arbitrary.

The dislocation in a semi-infinite isotropic medium, D. J. Bacon and P. P. Groves, *SP317*, pp. 35-45 (Dec. 1970).

Key words: Dislocation loops; elasticity; finite bodies.

The displacement associated with an infinitesimal dislocation loop (displacement dipole) of arbitrary orientation in an isotropic, semi-infinite elastic medium has been obtained, and on integration this yields the displacement associated with a finite dislocation loop. The solution for the infinitesimal loop has been obtained by finding the relationship between point forces and displacement dipoles in an infinite medium, and using the same relations with Mindlin's solution for the point force in an elastic half-space. This approach leads to a rather simpler analysis than that of Steketee, and the expressions for the displacements of all the infinitesimal loops near a free surface are presented here for the first time. The solution is being used to study the stability of a prismatic dislocation loop on a glide prism of square cross-section near a free surface. Preliminary results are presented for the forces on the loop sides and changes in loop energy on rotation for the situation in which the Burgers vector is normal to the surface.

Theoretical considerations on the extension of 1/2⟨110⟩, {111} dislocations in isotropic fcc metals into Shockley partials, Doris Kuhlmann-Wilsdorf and T. R. Duncan, *SP317*, pp. 47-55 (Dec. 1970).

Key words: Dislocation geometry; Shockley partials; stacking faults.

The energy changes and equilibrium separations associated with the extension of 1/2 ⟨110⟩, {111} dislocations in fcc metals into Shockley partials have been calculated and were found considerably smaller than the previous corresponding values due to Seeger and Schöck. The new results may be shown to be credible on the basis of the following simple estimates:

The theoretical shear fracture strength of a crystal may be written as $\tau_{crit} = G/q$, with G the appropriate shear modulus, and the numerical parameter q near 30 for {111} planes in fcc metals. The resolved shear stress required to force the Shockley partials into coincidence at vanishing stacking fault energy, $(\tau_{eq})_{Max}$, must approach but cannot exceed τ_{crit} so that $(\tau_{eq})_{Max} \leqslant G/30$, i.e. much smaller than the value of $\sqrt{6}G/8\pi \simeq G/9$ previously assumed. Similarly, the stacking fault energy cannot exceed the value of $\gamma_{crit} = Ga/\sqrt{6}q$ with a the lattice constant, and the dislocation core energy must be in the order of $E_c \simeq 2r_0\,\gamma_{crit} \simeq 1/4E_D$ where E_D is the total dislocation energy, and the core radius, r_0, is taken to be that distance from the dislocation axis at which the resolved shear stress on the slip plane would become equal to τ_{crit} in linear elastic behavior. Lastly, D_0, the actual equilibrium separation between the partials must be considerably smaller than $D_0{}^*$, the separation calculated from linear elastic theory, as long as $D_0{}^* < 2r_0$. One finds easily that $D_0{}^* \leqslant 2r_0$ for $\gamma \geqslant \gamma_{crit}/6$ and $\gamma \geqslant \gamma_{crit}/10$ for edge and screw dislocations, respectively, depending somewhat on Poisson's ratio, so that only in silver will edge dislocations have an equilibrium separation a little larger than $2r_0$, but much less than $2r_0$ in the other common pure fcc metals. For $D_0 = 2r_0$, when the core energy is reduced by about 1/3 according to the rule of the square of the Burgers vectors but the elastic energy is virtually unaffected, and remembering that work $2r_0\gamma$ with $\gamma \simeq \gamma_{crit}/6$ must be done to spread out the stacking fault, the relative energy gain due to the extension of edge dislocations is simply estimated as $(\Delta E/E_D)\perp \simeq [1/3E_c/4E_c - 1/6\gamma_{crit}/4\gamma_{crit}] \simeq 4\%$ which may be compared to the calculated value of 4.6% in silver.

Screw dislocations in inhomogeneous solids, G. P. Sendeckyj, *SP317*, pp. 57-69 (Dec. 1970).

Key words: Dislocations-elasticity; dislocation surface interactions; finite elasticity; inhomogeneities.

The problem of screw dislocations interacting with free surfaces and inhomogeneities is reconsidered and a general method is presented for solving a large class of screw dislocation problems. The method is based on knowledge of certain general solutions in the theory of antiplane deformation of elastic solids. It can be shown that all the known screw dislocation solutions for solids undergoing antiplane deformation can be found by using this approach.

As an illustration of the method, three new solutions for screw dislocations near inhomogeneities are given. These are the screw dislocation near (1) an elastic elliptic cylindrical inclusion, (2) two circular cylindrical inclusions, and (3) a *curvilinear* cavity or rigid inclusion. The interaction energy between the dislocation and the inhomogeneities is also computed.

Subsonic, supersonic, and transonic dislocations moving on an interface separating two media of differing elastic properties, H. M. Berg, J. E. Bloom, H. Ishii, R. H. Marion, D. E. Pease, D.

T. Spreng, J. B. Vander Sande, and J. Weertman, *SP317*, pp. 71-82 (Dec. 1970).

Key words: Dislocation dynamics; interface dislocations; supersonic dislocation.

This paper examines the problem of a dislocation moving on an interface separating two isotropic elastic media that have differing elastic constants and densities. This problem has application to the phenomenon of diffusionless transformations. Solutions are found for moving screw dislocations, gliding edge dislocations, and climbing edge dislocations. It is assumed that the dislocation velocity lies in either the subsonic, the transonic, or the supersonic velocity region. We have generalized the analysis that was used in a study of the elastic displacements and stress field of subsonic, transonic, and supersonic dislocations moving in an ordinary elastic medium. The results given in the present paper are formally identical to those obtained in that simpler analysis.

Internal stress and the incompatibility problem in infinite anisotropic elasticity, J. A. Simmons and R. Bullough, *SP317*, pp. 89-124 (Dec. 1970).

Key words: Anisotropic elasticity; dislocations; Green's tensor; incompatibility; internal stress; source kernels; stress functions.

Using the language of integral projection operators, the linear elastic distortion field of an infinite anisotropic body is decomposed into its internal and external components. The kernel of the external projection operator is identified as the elastic field due to force dipoles while that of the internal field corresponds to internal distortion fields due to displacement dipoles.

By integration of the projection operator for the internal distortion field, an alternative description for internal distortion fields in terms of dislocations is given. The Mura-Willis formula as well as the distortion field due to a rational dislocation element (in the sense of Eshelby and Laub) for an anisotropic body are then obtained as integrals of the basic displacement dipole kernel for internal distortions.

Further integration of the displacement dipole kernel provides a description of the internal distortion field due to a rational incompatibility element. The general formula for the stress function due to an incompatibility distribution in a general infinite anisotropic body is then given and shown to reduce to the formulation of Kröner for isotropic bodies.

Finally, explicit methods to compute kernels for internal distortions due to incompatibilities are given and discussed.

Series representations of the elastic Green's tensor for cubic media, D. M. Barnett, *SP317*, pp. 125-134 (Dec. 1970).

Key words: Anisotropy; cubic materials; elasticity; Green's tensor.

Two representations for the cubic Green's tensor components as power series in the anisotropy factor $\omega = 1 - (c_{11} - c_{12})2c_{44}$ are developed, and first order corrections of anisotropy to the Green's tensor and to the interaction energy between two "mechanical" point defects are calculated. It is shown that the best successive approximation scheme is that which constructs the zeroth order (isotropic) approximation to the Green's tensor by identifying the Lamé constants λ and μ as $\lambda = c_{12}, \mu = c_{44}$.

Some problems involving linear dislocation arrays, N. Louat, *SP317*, pp. 135-146 (Dec. 1970).

Key words: Dislocation pileups; dislocations-elasticity; phase boundaries.

Muskhelishvili's inversion formulae for singular integral equations are shown to be special cases of a more general result which is then employed to deal with two types of problems. In the first we consider the distribution of dislocations in a double periodic array of screw pile-ups in an arbitrary stress field. The second type is concerned with screw pile-ups terminating at phase boundaries, again for arbitrary stress fields.

Some recent results on dislocation pileups, J. C. M. Li, *SP317*, pp. 147-150 (Dec. 1970).

Key words: Dislocation pileups; Moutier cycle; stress concentrations.

A few results intended to illustrate the usefulness of orthogonal polynomials and singular integral equations for the problem of dislocation pileups are described. A simple method of solving a few special integral equations is suggested. The usefulness of a Moutier cycle for the calculation of stress concentration is shown.

The behavior of an elastic solid containing distributions of free and fixed dislocations, E. Smith, *SP317*, pp. 151-162 (Dec. 1970).

Key words: Crack nucleation; dislocations-elasticity; internal stresses.

There are many situations in metal physics where the stresses acting on fixed dislocations have an important bearing on a physical phenomenon, and the paper derives a general expression relating these stresses when fixed edge dislocations are contained within an infinite elastic solid in which there are also free edge dislocations that occupy equilibrium positions.

Special cases are considered in detail, particular attention being given to the situation where all the dislocations are of the same type, the free ones having identical Burgers vectors b while there are two fixed dislocations with Burgers vectors pb and qb; all the dislocations lie in the same plane within an infinite solid. This is the most general model for which the stresses on each dislocation and also the equilibrium positions of the free dislocations may be determined analytically. It is indicated how the model degenerates into all the others that have been discussed analytically in terms of classic polynomial functions.

The results are briefly discussed in relation to the problem of cleavage crack nucleation in crystalline solids.

The elastic interaction between grain boundaries and screw dislocation pile-ups, M. O. Tucker, *SP317*, pp. 163-171 (Dec. 1970).

Key words: Anisotropic elasticity; dislocation pileups; dislocations-elasticity; grain boundaries.

The configuration of an array of parallel infinitive straight screw dislocations, in equilibrium under a constant applied stress, and piled-up on a plane inclined to a grain boundary at an arbitrary angle is considered. The model used for the grain boundary is the plane interface between two elastically anisotropic half-spaces welded together. Using this approximation of a continuous distribution of infintesimal dislocations the integral equation expressing the equilibrium conditions is solved using a Wiener-Hopf technique and approximate expressions are presented for the stresses near to the tip of the array when the dislocations are parallel to orthotropic symmetry axes in each half-crystal.

One-electron theories of cohesion on ion-pair potentials in metals, N. W. Ashcroft, *SP317*, pp. 179-200 (Dec. 1970).

Key words: Band structure; cohesion; core-core interactions; electron density; inter-atomie; one-electron potentials; pseudopotentials.

The single particle picture of cohesion in metals is briefly reviewed in the light of modern knowledge of their band structures. Periodic components in the electron density distributions (intimately connected with the same band structures) are important in the determination of the effective potential between ions.

In simple metals, defined to be those with tightly bound core states, the net binding of the metallic state is basically a remnant of a competition between kinetic (Pauli principle) and Madelung energies of ostensibly free conduction electrons. Various corrections (for correlation, for exchange, etc.) must be included, and the Madelung energy (which is normally appropriate to a uniform electron gas in a Coulomb lattice of point ions) can be modified as necessary for departures from Coulomb's law. Terms in the total energy also arise from periodic variations in conduction electron density; for perfect lattices these are naturally dependent on the ionic arrangement and will vary in importance from crystal structure to crystal structure. Electronic density variations arising from disorder (e.g. distributions of defects) also introduce corrections into total energy.

The structurally dependent terms in the total energy can be evaluated to second order in the pseudopotential: to this same order the *total* energy may be written as a sum over pair potentials between ions whose form is quite straight forward to evaluate. As with many inter-atomic potentials, the ion-ion potentials demonstrate "hard-core" effects at small separation, and are rather weak at large distances.

Extending the simple theory to transition metals or metals exhibiting additional band structure more akin to itinerant narrow-band behavior, can be carried through by incorporating Born-Mayer interactions between tight binding atomic states. This procedure is, of course, only valid in situations where the Block method itself is applicable. While the core-core exchange term approximated by the Born-Mayer interaction is quite small in the simple metals it is appreciable for metals like Cu, Ag and Au, and in fact is basically responsible for fixing the equilibrium density. Its addition to the otherwise "simple-metal" like ion pair potentials modifies the behavior at short range.

Localized vibration modes associated with screw dislocations, A. A. Maradudin, *SP317,* pp. 205-217 (Dec. 1970).

Key words: Dislocation-phonon interactions; dispersion relations; lattice of dynamics; localized modes.

The dispersion relation for the one-dimensional continuum of localized modes associated with a screw dislocation is obtained in the long wavelength limit, as a function of the wave vector parallel to the dislocation line. The result has the form $\omega^2(q)=s^2q^2-\omega_0^2 \exp(-\text{const.}/q)$ where s is the speed of sound for transverse acoustic waves, and ω_0 is a typical Brillouin zone boundary frequency.

The method of lattice statics, J. W. Flocken and J. R. Hardy, *SP317,* pp. 219-245 (Dec. 1970).

Key words: Computer simulation; Kansaki method; lattice statics; point defects; Schottky pairs.

The formalism of the method of lattice statics for treating the lattice distortions and the formation and interaction energies associated with a defect in a crystal is presented in detail. This approach is based on the Fourier transformation of the set of direct space equilibrium equations to reciprocal space. This results in a set of decoupled equations which can be explicitly solved for the Fourier amplitudes of the displacement field which can then be found by Fourier inversion. A similar approach is used to obtain Fourier transformed expressions for the relaxation and interaction energies associated with the defect.

The solution of the equations of lattice statics for the Fourier amplitudes in the limit of small wave vectors gives expressions for the displacement field identical to those obtained from the theory of continuum elasticity.

Results are presented of recent applications of the method of lattice statics to find the formation energies of Schottky pairs in certain alkali halides. Strain field displacements, relaxation energies and interaction energies associated with vacancies in Na and K are given.

Lattice statics in its asymptotic form has been used to find the displacement field far from cubic point defects and double force defects in a number of metals. Displacement profiles about vacancies in Na and K and about a double force defect in Cu are shown. A comparison of the exact lattice statics results to asymptotic results along a ⟨111⟩ direction in K shows that the elastic limit is only attained at about the 19th or 20th neighbor position from the defect.

Effect of zero-point motion on Peierls stress, H. Suzuki, *SP317,* pp. 253-272 (Dec. 1970).

Key words: Anharmonicity; dislocations in lattices; Peierls stress; zero point motion.

Calculations of the Peierls stress hitherto made are criticized and the following conclusions are obtained. The significant difference in Peierls stress between different materials arises mainly from the difference in crystal structures. The Peierls stress is necessarily high in a rectangular lattice where atoms just above and below the slip plane face each other, while in the lattices where the atoms face alternately along the slip plane it is of the order of one percent of that in the rectangular lattice. The Peierls stress in the body-centered cubic crystal is, however, rather high for a screw dislocation owing to the screw structure of this crystal with the axes parallel to [111] direction. The calculated Peierls stresses are several times of those expected from experiments. The zero-point motion decreases the calculated Peierls stress through two mechanisms. The one is the difference in frequency spectrum of a dislocation line at the bottom of the potential valley and at the top of the potential hill. The other is due to the change in spring constants of atom pairs around the dislocation through anharmonicity.

Point defects and dislocations in copper, A. Englert, H. Tompa, and R. Bullough, *SP317,* pp. 273-283 (Dec. 1970).

Key words: Computer simulation; copper; dislocation structure; pair-potential; point defects.

A new pair potential for copper has been constructed from a set of ten interpolated cubic polynomials. The form of the potential is such that at short range it agrees with the usual Born-Mayer repulsive potential and is in satisfactory agreement with the available phonon dispersion data and the observed stacking fault energy and vacancy formation energy for copper. The potential has been used to study the atomic configuration associated with various point and line defects in copper. In particular, because of its fit to the stacking fault energy, it provides a consistent result for the degree and nature of the dissociation to be expected for an edge dislocation in copper.

Atomistic calculations of dislocations in solid krypton, M. Doyama and R. M. J. Cotterill, *SP317,* pp. 285-289 (Dec. 1970).

Key words: Atomic calculation; interatomic potential; krypton.

The elastic continuum theory treatment usually fails near the core of dislocations. Atomic calculations of edge and screw dislocations in solid krypton were carried out using a pairwise potential. In rare gases, the electron redistribution of the electron density is small, thus, this method is useful in studying the properties of dislocation cores.

A lattice theory model for Peierls-energy calculations, A. Hölzler and R. Siems, *SP317,* pp. 291-298 (Dec. 1970).

Key words: Computer simulation; Green's tensors; interatomic potential; lattice studies; Peierl's energy; screw dislocation.

A lattice theory model for a screw dislocation is discussed which is similar to that of Maradudin. For the forces between neighbouring rows of atoms, however, a sinusoidal, not a linear, dependence of their relative displacements is assumed throughout the whole lattice. The displacements are expanded about the elastic theory values. The conditions of equilibrium then yield a system of linear equations for the deviations of the displacements from the elastic theory values, which is solved by an iteration procedure making use of Green's Function for a plane square lattice. For a number of points in the vicinity of the source point and for points in certain symmetry directions simple exact analytical expressions for the latter are derived, for points at larger distances an asymptotic expansion is given. The displacements thus obtained are then used to calculate the energies of the dislocation at the position of minimum energy and at the saddle point and their difference, the Peierls energy, by direct summation of the interaction energies of neighbouring pairs of atoms.

The interaction between a screw dislocation and carbon in body-centered cubic iron according to an atomic model, R. Chang, *SP317,* pp. 299-303 (Dec. 1970).

Key words: Carbon in iron; computer simulation; dislocation-interstitial interaction; interatomic potentials; lattice defects.

The interaction energy between carbon and a screw dislocation in body-centered cubic iron near the core regions of the dislocation was calculated atomistically using a pairwise interatomic potential matching the elastic properties of the material. In order to avoid the use of the iron-carbon potential, it was assumed that the iron-carbon octahedron of the Johnson configuration (2 iron atoms separated by 1.225 a_0 in the [100] direction and 4 iron atoms separated by 0.958 a_0 in the (100) plane, a_0 being the lattice parameter) remains undistorted whether it is present in a perfect or a defective lattice. Our first calculations yield, depending on site location, binding energies varying from 0.04 to 0.55 eV.

The structure of the $\langle 111\rangle$ screw dislocation in iron, P. C. Gehlen, G. T. Hahn, and A. R. Rosenfield, *SP317,* pp. 305–308 (Dec. 1970).

Key words: Computer simulation; dislocation core structure; interatomic potentials; iron.

The concept of a dissociated $a/2\ \langle 111\rangle$ screw dislocation has been invoked to explain the slip behavior in b.c.c. materials and particularly the asymmetry of the critical resolved shear stress. No direct experimental evidence of dissociation has been obtained, but the idea has received some albeit conflicting support from discrete lattice calculations of the atomic positions in the core. Chang, using isotropic elasticity for α-iron, found that the dislocation core has three very narrow intrinsic faults. These three faults are symmetric with respect to the screw axis. Bullough and Perrin, on the other hand, found that the screw is split with faults on two $\{112\}$ planes belonging to the zone of the screw axis. The misfit is spread over a distance of about $3b$. On the third $\{112\}$ plane no splitting was found to occur.

In view of these discrepancies, the calculations were repeated for anisotropic and isotropic elastic boundary conditions and with different interatomic potentials. Excellent agreement was found with Chang's configuration even though a volume expansion term was added to the displacements associated with the dislocation.

It was shown that the final configuration is strongly dependent on the position of the dislocation line with respect to the lattice and at least two metastable positions were found. Even though the atomic arrangement is quite different, their energy is not more than 0.1 eV larger than the energy of the stable one.

Using the Johnson potential unmodified for long-range electronic effects, the dislocation was found to have the following characteristics: core radius, 4-5.5 A; core energy, 0.20-0.25 eV per atomic plane; and an effective hole radius of 1.35 Å.

It was shown that the final configurations are rather insensitive to the model size and to the boundary conditions used.

Eigenfrequencies in a dislocated crystal, T. Ninomiya, *SP317,* pp. 315-357 (Dec. 1970).

Key words: Dislocation-phonon interactions; dislocation vibration; internal friction; localized modes.

Dynamical theories of dislocation vibration and interactions with phonons are surveyed. Eigenfrequencies of lattice vibrations in a crystal containing a straight dislocation are calculated by using Lagrangian formalism. It is found that there is one eigenfrequency of dislocation vibration (wave number κ) in each of the intervals of the normal mode frequencies of $k_z=\kappa$ in a perfect lattice. It is also found that there is a band of localized dislocation vibration below the phonon band. The mean squared amplitude of the dislocation vibration is determined by the localized mode for an edge dislocation and by the resonance modes for a screw dislocation. Phonon scattering by the fluttering mechanism is next treated by using the above results and the conditions of resonance scattering is given. Finally, the effect of the Peierls potential and the vibration of a dislocation dipole are discussed. In the Appendices the problem of quantization of dislocation vibration and the extension of the above theories to a case of translational motion are briefly described.

Phonon scattering by dislocations and its influence on the lattice thermal conductivity and on the dislocation mobility at low temperatures, P. P. Gruner, *SP317,* pp. 363-389 (Dec. 1970).

Key words: Dislocation mobility; dislocation-phonon interactions; nonlinear elasticity; phonons; thermal conductivity.

On account of the large strains associated with dislocations, the superposition principle is violated. The resulting scattering of phonons limits the lattice thermal conductivity and leads to a friction force which acts on moving dislocations. The phonon-dislocation interaction is treated with nonlinear continuum theory. Terms up to the third order in the strains are retained in the Taylor expansion of the elastic energy density. These third order terms contain the phonon-dislocation interaction and the normal three-phonon interactions. In the case of thermal conductivity, the transport problem is solved with the variational method which leads to a system of linear equations for the phonon occupation numbers. The coefficients of this system of equations contain all the information on the scattering mechanisms. The influence on the thermal conductivity of special dislocation configurations such as piled-up dislocations and dislocation dipoles will be discussed.

It will be shown that the friction force which acts on moving dislocations on account of the anharmonicity can be obtained from quantities that are known from the calculations of the phonon conductivity. A one to one correspondence between friction force and thermal resistance exists, however, only if the dislocation velocity is small compared with the sound velocity and if all parts of the dislocation move with the same velocity.

Phonon scattering by Cottrell atmospheres, P. G. Klemens, *SP317*, pp. 391-394 (Dec. 1970).

Key words: Cottrell atmospheres; mechanical properties; phonon scattering; thermal resistivity.

The formation of Cottrell atmospheres can change the scattering of phonons by dislocations and in some cases substantially enhance the lattice thermal resistivity due to dislocations. The strength of the atmospheres can be changed by annealing. This changes thermal conductivity values at high temperatures first, since diffusion through shorter distances is involved. The diffusion coefficient can be determined by means of such annealing studies.

Dragging forces on moving defects by strain-field phonon scattering, A. Seeger and H. Engelke, *SP317*, pp. 397-401 (Dec. 1970).

Key words: Dislocation drag; dislocation-phonon interactions; electroresistivity; kink motion; phonon scattering.

An expression for the dragging force on a uniformly moving defect by scattering of phonons at its strain-field has been derived using nonlinear elasticity theory. The quantization procedures and the formulation of the master equation for the phonon distribution follow the techniques developed in the theory of heat conductivity. Numerical calculations have been performed for kinks in screw dislocations in copper. A comparison with numerical results obtained in the theory of heat conductivity shows quite good agreement. The formalism developed should prove useful also for calculations of the electron drag on dislocations in metals.

Thermal energy trapping by moving dislocations, J. H. Weiner, *SP317*, pp. 403-414 (Dec. 1970).

Key words: Computer simulation; dislocation-phonon interaction; Frenkel-Kontorowa model.

The steady motion of a dislocation along a piece-wise harmonic Frenkel-Kontorowa model is considered For suitable model parameters there is one localized mode associated with either the stable or unstable dislocation configuration and the remaining modes are nonlocalized or extended. Because of the piece-wise harmonic character of the model, the set of normal modes of the system changes at discrete instants of time, referred to as transition times, as the dislocation moves along the chain. In particular, the localized modes must move along with the dislocation position and we refer to the localized mode momentum and energy as the dislocation momentum and energy respectively. The particle momentum and energy due to the sum of the extended modes is termed thermal.

At the transition times, it is necessary to expand atomic velocities in terms of the new set of modes appropriate to the forthcoming state of the crystal. It is found that a coordination effect exists between the transition times and the thermal motion such that on the average over many transitions, thermal momentum in the direction of the dislocation motion is transferred to the dislocation momentum.

Dislocation resonance, J. A. Garber and A. V. Granato, *SP317*, pp. 419-421 (Dec. 1970).

Key words: Dislocation damping; dislocation resonance; internal friction.

At low temperatures in insulators and superconductors, only reradiation of elastic waves should limit dislocation resonance. This effect has been calculated using Eshelby's expression for the reradiation. It is found that the resonance is very sharp, and still persists even when a random distribution of dislocation segment lengths is assumed.

Dislocation radiation, R. O. Schwenker and A. V. Granato, *SP317*, pp. 423-426 (Dec. 1970).

Key words: Dislocation radiation; dispersion relations; internal friction.

Thin walls of mobile dislocations have been produced. These can be excited to emit macroscopic plane sound waves. Calculations have been made to predict the properties of the reradiated waves on the basis of a vibrating string model which neglects dislocation interactions. Measurements of the relative modulus change $\Delta G/G$ and the decrement Δ (real and imaginary part of the response) as a function of frequency permit a check of the Kramers-Kronig dispersion relations. In addition, measurements of the amplitude of the reradiated wave provide another check since the amplitude is proportional to $[(\Delta G/G)^2+(\Delta/\pi)^2]^{1/2}$.

The anharmonic properties of vibrating dislocations, C. Elbaum and A. Hikata, *SP317*, pp. 427-445 (Dec. 1970).

Key words: Anharmonic properties; dislocation dynamics; ultrasonics.

The anharmonic properties of vibrating dislocations are discussed in terms of the nonlinear stress-strain relation and of the higher harmonics of an ultrasonic wave generated when an initially sinusoidal wave propagates in a solid containing (mobile) dislocations. The treatment takes account of both lattice and dislocation contributions to the anharmonic behavior of the solid.

Estimates of the amplitude of the harmonics (these estimates have been confirmed experimentally) indicate that the lattice and dislocation components are comparable for the second harmonic and that the dislocation component is much larger than the lattice component for the third harmonic. Therefore, by investigating the third harmonic, it is possible to obtain detailed information on dislocation dynamics, without the complications of the lattice contribution.

A source of dissipation that produces an internal friction independent of the frequency, W. P. Mason, *SP317*, pp. 447-458 (Dec. 1970).

Key words: Internal friction; kink motion; Peierl's stress.

Many measurements of the internal friction of metals and other materials such as the earth's crust show that there is a component at low frequencies which produces a value independent of the frequency. It has been shown that this component is associated with dislocation motion.

Using a model for which dislocation motion results from the motion of kinks, it is shown that such a loss can be associated with the energy dissipated when kinks cross Peierls barriers. Theoretical calculations have shown that the energy dissipated in mechanical vibrations requires a dissipative force equal to from 0.01 to 0.1 of the Peierls stress to replace the energy lost. At the low stresses used in internal friction measurements, it requires a thermal activation to cause motions of the kinks. The lag of the motion behind the applied stress produces a drag coefficient B proportional to the temperature. The energy due to kink dissipation produces an internal friction to modulus change ratio β, equal to the ratio of the dynamic to the static kink stress. Measurements in copper and in the alloy Ti-6Al-4V indicate that this ratio is about 0.03, in agreement with calculations.

The meaning of dislocations in crystalline interfaces, W. Bollmann, *SP317,* pp. 465-477 (Dec. 1970).

Key words: Dislocations; grain boundaries; interfaces; twinning.

The extension of the dislocation concept to arbitrary crystalline interfaces is discussed. It is shown that invariance and continuity of the Burgers vector can be conserved and that in high angle boundaries the function of the standard or primary dislocation is the delimitation of ranges of coordination between the two crystals. In certain relative orientations where the superposition of the two crystals forms a highly periodic pattern (which is energetically favorable such that the crystal tends to conserve it) a slight deviation from that optimum pattern is corrected by a network of secondary dislocations. There is complete balance between the Burgers vectors of primary as well as secondary dislocations.

Structural and elastic properties of zonal twin dislocations in anisotropic crystals, M. H. Yoo and B. T. M. Loh, *SP317,* pp. 479-493 (Dec. 1970).

Key words: Dislocation geometry; twinning; zonal dislocations.

A descriptive definition of zonal twin dislocations for compound twin systems is given based on the well established rational crystallographic elements. Geometric characteristics of zonal twin dislocations in double lattice structures are thoroughly discussed. Equilibrium shapes of an incoherent twin boundary have been analyzed by using the anisotropic elastic properties of edge dislocations. Short-ranged structural properties of zonal twin dislocations are discussed based on a Peierls-Nabarro model. It is found that the "anisotropic parameter," K_eS_{66}, correctly predicts the active mode of crystallographically nonequivalent conjugate twin systems.

Non-planar dissociations of dislocations, S. Mendelson, *SP317,* pp. 495-529 (Dec. 1970).

Key words: Dislocation dissociation; lattice shuffling; partial dislocations; twinning; zonal dislocations.

Non-planar dissociations of dislocations are studied in hcp, fcc, bcc, diamond lattice, tetragonal and orthorhombic crystal structures. The geometric and energetic conditions are shown to be favorable for various dissociations in each crystal structure. A general equation is formulated for dissociations into partials which are glissile on various twin planes of a common zone. The Burgers vector of the twinning dislocations are expressed in terms of orthogonal unit vectors which lie in the "plane of shear" of the twin mode. The twinning dislocations are generally of the "zonal" type, chosen to be consistent with minimum shear-strain and simple atomic shuffling criteria for twinning, and applied in derivations of the twinning elements and shear-strains for various twin modes. The sign of the shear-strain determines the "stress sense" characteristics for dislocation resistance and twinning and are shown to be consistent with behavior in various hcp and bcc metals. The maximum repulsive force on the twinning partials γ_m is computed using anisotropic elasticity, and compared with evaluations of twin lamella energies γ. In many cases it is found that $\gamma_m/\gamma > 1$, leading to an increase in dislocation resistance, locking, or twinning at lower temperatures. In the cases where $0 < \gamma_m/\gamma < 1$ the partialized dislocation model reduces to the "modified pseudo-Peierls-Nabarro model" for dislocation resistance.

Among various effects, the dissociations account for all twin modes in hcp metals and for the extreme difference in the flow behavior of Cd and Zn on one hand and Ti and Zr on the other. The stress dependent activation energies for motion of dissociated 60° dislocations in germanium are computed and compare favorably with the data of Kabler. A "lock" for kinks on 60° dislocations is described which can account for dragging points in the model of Celli et al.

Propagation of glide through internal boundaries, M. J. Marcinkowski, *SP317,* pp. 531-545 (Dec. 1970).

Key words: Boundary dislocations; glide propagation; grain boundaries; virtual dislocations.

It has been shown that when an internal boundary such as a grain boundary is cut by a crystal glide dislocation, a disturbance is left at the boundary. This disturbance closely resembles that about a crystal dislocation with the exception that (a) there is no extra half plane associated with the dislocation and (b) the Burgers vector associated with this disturbance is a variable which depends on the nature of the internal boundary. These boundary dislocations have been termed virtual dislocations.

The nature of the virtual boundary dislocations has been treated in detail for the symmetrical tilt boundary. Both homogeneous and heterogeneous type glide across these boundaries have in turn been applied to grain boundary crack formation and propagation, grain boundary rotation, preferred orientation, etc.

Kinks, vacancies, and screw dislocations, R. M. Thomson, *SP317,* pp. 563-576 (Dec. 1970).

Key words: Dislocation geometry; dislocations; kinks; pipe diffusion; vacancies in dislocations.

A vacancy on a nonsplit pure screw dislocation can dissociate into a set of kinks. This dissociation is demonstrated geometrically for the NaCl lattice, showing that no geometrical constraints are violated by the dissociation. The kinks thus generated also splinter and spread the charge of the vacancy along the line. The effective vacancy association energy on the line is thus much higher than has been supposed hitherto, and is partly due to the delocalization of the charge singularity of the point defect and partly due to the delocalization of elastic singularity. When the Peierls energy is low, the vacancy will always dissociate, while if it is high, the dissociation will occur only when the total kink energy is less than the vacancy energy. Vacancy contributions to both climb and pipe diffusion are discussed in terms of the kink dissociation process. Results are that interstitial pipe diffusion is entirely symmetric to vacancy pipe diffusion, no motion energy is needed, and the formation energy for diffusion is related to the Peierls energy.

Topological restriction on the distribution of defects in surface crystals and possible biophysical application, W. F. Harris, *SP317,* pp. 579-592 (Dec. 1970).

Key words: Dislocations in biophysics; protein structure; surface crystals; surface dislocations.

Many thin biological structures such as some plasma membranes and virus capsids appear to be made up of units packed in two-dimensional lattices. Such structures are termed *surface crystals.* Dislocations and disclinations are observable in some of these crystals. The perfect surface crystal is described by a *pair* of basis vectors and the conventional crystal by a *triplet* of basis vectors; both are regarded as embedded in three-dimensional space. This difference allows the existence of defects which have no counterpart in conventional crystals. The various defects are classified as local or global, intrinsic or extrinsic. Surface crystals that form closed surfaces are considered and it is shown that the sum of the rotations of intrinsic (screw) disclinations in them must equal $2\pi X$ where X is the Euler-Poincaré characteristic of the surface. The biophysical consequences are discussed briefly.

Disclinations in surfaces, F. R. N. Nabarro, *SP317,* pp. 593-606 (Dec. 1970).

Key words: Crystal surface imperfections; disclinations; screw disclinations.

The screw disclination is essentially a 2-dimensional object. Screw disclinations provide a convenient classification of star polygons. By considering the disclinations in vector fields lying on surfaces, it is possible to relate Euler's theorem for polyhedra inscribed on a sphere (faces − edges + corners = 2) to the fixed-point theorem for continuously-varying small displacements of points on a sphere. The changes in the Euler characteristic produced by the addition of holes, handles and cross caps are related to the disclinations which these singularities introduce into vector fields lying on the surface. These disclinations may be localized into the neighbourhood of their corresponding singularities.

Application of dislocation theory to liquid crystals, J. Friedel and M. Kléman, *SP317,* pp. 607-636 (Dec. 1970).

Key words: Cholesteric crystals; faulted ribbon; liquid crystals; nematic crystals; smectic crystals.

After an introduction which recalls some of the properties of liquid crystals, a general theory of dislocations in a mesomorphic medium is outlined. On the basis of their symmetry properties, and of viscosity relaxation, it is first shown that perfect disclinations in nematic crystals may take any shape, are restricted to straight lines in smectic crystals, and that both types exist in cholesteric crystals, where there are two possible axes of rotation. The second part is specialized to the case of cholesteric crystals for which a mechanism of pairing of dislocations is proposed which allows a multiple disclination to take any shape, at the expense of a small increase of energy in the faulted ribbon.

Nonmetric connexions, quasidislocations and quasidisclinations. A contribution to the theory of nonmechanical stresses in crystals, K. H. Anthony, *SP317,* pp. 637-649 (Dec. 1970).

Key words: Affine connexions; continuum mechanics; curvature tensor; disclination; internal stresses; quasidisclination.

Nonmechanical stresses produced, for instance, by a temperature gradient or by an internal magnetic field are related to an affine lattice connexion, which is nonmetric with respect to the elastic metric. The covariant derivative of the elastic metric with respect to the lattice connexion is regarded as source-function for this kind of internal stresses. It may easily be determined from experimental data. The calculation of mechanical stresses is based on this quantity.

Instead of describing nonmechanical stresses by a nonmetric lattice connexion we alternatively may use an elastic connexion which is metric with respect to the elastic metric. In the elastic connexion are involved the tensors of quasiplastic torsion and of quasidisclination-density, which are regarded as source functions of nonmechanical stresses. Both tensors are intimately connected. They are a natural generalization of the quasidislocation tensor of the linear theory of nonmechanical stresses.

From the theory of quasidisclinations we obtain the following statement: In general, nonmechanical stresses cannot be eliminated solely by a dislocation movement. An additional distribution of crystal disclinations is necessary.

Linear theory of static disclinations, R. deWit, *SP317,* pp. 651-673 (Dec. 1970).

Key words: Burgers vector; compatibility; continuum; contortion; Cosserat; couple-stress; defect; deformation; disclination; dislocation; dualism; elasticity; incompatibility; motor calculus; plasticity.

A brief review of compatible and incompatible elasticity theory is given. It is shown how dislocation theory was developed from classical compatible elasticity. Then disclination theory is developed from dislocation theory in an analogous way. The disclination and dislocation density tensors are defined from the plastic deformation. The total deformation satisfies the classical condition of compatibility. By combining these two concepts the geometric basic laws or field equations are found, which relate the elastic deformation to the defect content. The contortion or Nye curvature tensor is found to be a useful equivalent for the dislocation density. Weingarten's theorem motivates the generalization of the Burgers vector and the definition of the analogous rotation vector of disclinations. Finally the dualism between the geometry of disclination theory and the statics of couple-stress theory, as well as the relation of disclination theory to "motor calculus" are pointed out.

Introduction to the panel discussion "intrinsic properties of dislocations," J. P. Hirth, *SP317,* pp. 683-685 (Dec. 1970).

The problem of non-locality in the mechanics of solids: review on present status, E. Kröner, *SP317,* pp. 729-736 (Dec. 1970).

Key words: Dilatation centers; lattice statics; non-local theories; solid mechanics; wave propagation.

The concept of non-locality, in particular with reference to the mechanics of solids, is discussed. A brief report is given on the derivation of the non-local theory of elasticity from atomic lattice theory. In addition some simple solutions of this theory, concerning the interaction of dilatation centers and wave propagation, are quoted. A generalization of the theory which would include dislocations is indicated.

Non-local theory of elasticity for a finite inhomogeneous medium — a derivation from lattice theory, E. Kröner and B. K. Datta, *SP317,* pp. 737-746 (Dec. 1970).

Key words: Green's tensor; Hooke's elasticity; non-local elasticity; solid mechanics.

In the linear theory of non-local elasticity the strain energy can be written as a double volume integral summing up the interactions of pairs of mass elements. The properties of the material, in this case, are described by a two-point-tensor function $c_{ijkl}(\mathbf{r},\mathbf{r}')$. It is found that for finite bodies $c_{ijkl}(\mathbf{r},\mathbf{r}')$ does not have the symmetries of the (Hooke's) elasticity tensor C_{ijkl} of the local theory. However, the symmetries of this tensor function are sufficient to exclude the rotations from the strain energy expression. It is shown that with the help of the elastic Green's function one can express $c_{ijkl}(\mathbf{r},\mathbf{r}')$ in terms of force constants of the lattice. It is also shown that an infinite homogeneous body is not a suitable model either for the non-local or for the local theory, because in this case $c_{ijkl}(\mathbf{r},\mathbf{r}')$ as well as C_{ijkl} obey the Cauchy relations.

On problems of the non-local theory of elasticity, I. A. Kunin and A. M. Waisman, *SP317,* pp. 747-759 (Dec. 1970).

Key words: Green's tensor; non-local elasticity; solid mechanics; surface waves.

The paper contains new results concerning the linear theory of an elastic medium with non-local interactions:

I. *The structure of the general solution of the equations of motion.* The dependence of the general solution on the distribution of energy operator zeroes. Specific effects of the non-locality: new types of damped and undamped waves, the existence of a maximum frequency for the latter ones, the space dispersion. The Green's function.

II. *Approximate models.* Two types of approximate models: the long-wave approximations and the first zeroes approximations. Domains of their applicability.

III. *Boundary value problems.* The replacing of the boundary by a boundary layer of width of the interaction radius. Generalized Green's formula. Fundamental boundary value problems, their correct formulation for first zeroes approximations. The comparison with couple-stress theories. Examples of exact and approximate solutions. The existence of new types of surface waves different from Rayleigh waves.

A non-Riemannian construction of variational criteria for plastic manifolds with special reference to the theory of yielding, K. Kondo, *SP317*, pp. 761-784 (Dec. 1970).

Key words: Continuum mechanics; non-Riemannian theories; plasticity; yielding.

The variational formalism is viewed not as an independent assumption but as a natural consequence following from a more fundamental penetration into the recognition of nature and this is shown in regard to the static aspects of plasticity. The energy is defined as the necessary quantity for the geometrical construction. With the Riemannian and non-Riemannian picture, a bridge is sought between the theory of yielding and the theory of dislocations, as also between the theory of dual yielding and theory of couple stresses. The standpoint of the theory of yielding and dual yielding is explained constitutively with a statistical construction to reconfirm the formulae which have been proposed. The meaning of the plastic constants involved in the theory is clarified by the construction.

Derivation of a continuum theory of dislocations on the basis of an estimative analysis of crystal lattices, M. Mişicu, *SP317*, pp. 785-816 (Dec. 1970).

Key words: Continuum mechanics; dislocation field theory; statistical methods.

Starting from the non-primitive crystal lattice model, a continuum theory is derived by means of an interpolation procedure which takes into account the variability of kinematic and dynamic fields. The non-holonomy of the fields of displacements, energy and entropy is considered in order to elaborate the analysis of dislocation and irreversible effects.

The elastic generalized Cosserat continuum with incompatible strains, R. Stojanović, *SP317*, pp. 817-829 (Dec. 1970).

Key words: Continuum mechanics; Cosserat continua; dislocation field theory; oriented media.

Considered is a continuum with deformable directors. Dislocations are regarded as sources of incompatibilities and internal strains. Established are the relations between the dislocation density tensor and the gradients of directors. The conservation law for dislocations (i.e. the law that the dislocation lines cannot end inside a body) appears as the integrability condition for the dislocation density—gradients of directors relation. In a linearly connected space L_3 in which the directors of a dislocated medium represent fields of absolutely parallel vectors the equality of the dislocation density tensor with the torsion tensor of the space L_3 follows as an immediate consequence. It is also proved that the geometry of L_3 is equivalent to the geometry of the linearly connected space L_3 which is defined in terms of the distorsions, introduced in the theories based on the non-oriented continuum models. From the principle of virtual work are derived the general (non-linear) relations for stress and hyperstress. The stress tensor is not symmetric. In the appendix are presented the modified divergence theorem and the expressions for the variations of the gradients of directors in the absence of a displacement field, i.e., in the case when the compatibility conditions for the strain tensor are not satisfied.

A dynamic theory of dislocations and its applications to the theory of the elastic-plastic continuum, C. Teodosiu, *SP317*, pp. 837-876 (Dec. 1970).

Key words: Anisotropic elasticity; anisotropic plasticity dislocations; constitutive relations; dislocation dynamics; non-linear elasticity.

The starting point of this study is a paper by Kröner (J. Math. Phys. 42, p. 27, 1963), who proposed the replacement of the loading history variables in the yield criterion and in the work-hardening equation by state variables, such as the dislocation density and the density of dislocation loops.

The first part of the work summarizes the formulation recently given by the author for the dynamic non-linear theory of dislocations in anisotropic media. The relations connecting the continuum kinematic quantities to the discrete dislocation arrangement and to the dislocation velocities are emphasized.

To construct a theory of the elasto-plasticity, the system of kinematic equations is completed by postulating a yield condition and a work-hardening equation, which contain as independent variables the stress, the dislocation density, the density of dislocation loops, and the temperature.

Making constitutive assumptions for the free energy, the specific entropy, and the heat conduction vector, and using the principle of material indifference and the thermodynamical restrictions, a definite theory of the elastic-plastic continuum is obtained.

Non-linear dynamic problems for anisotropic elastic bodies in the continuum theory of dislocations, C. Teodosiu and A. Seeger, *SP317*, pp. 877-905 (Dec. 1970).

Key words: Anisotropic elasticity; dislocation dynamics; dislocation; elasticity; non-linear elasticity.

The non-linear continuum theory of dislocations has been used to solve a number of problems for isotropic materials, including the determination of stresses produced by dislocations, the scattering of elastic waves by straight dislocations and kinks, and the small-angle scattering of x-rays by dislocation lines and rings. For the application of these results it is necessary to know the elastic constants of third or higher order entering the constitutive equations. Third-order elastic constants have recently become available for a large class of single crystals with an accuracy that exceeds considerably the earlier polycrystalline data. It appears therefore desirable to develop a formulation of the theory that may be applied to anisotropic materials.

The present work aims at developing approximate methods for solving non-linear problems such as the determination of the strains produced by stationary or uniformly moving dislocations in anisotropic media and of their effects on a superimposed infinitesimal motion.

The non-linear problems are solved by reduction to a series of linear problems using expansions in terms of small parameters. Three such parameters appear naturally: the magnitude of the distortion produced by dislocations, the magnitude of the deformation gradient of the superimposed motion, and the ratio between the dislocation and sound velocities. To obtain definite approximation algorithms, hypotheses concerning the relative order of magnitude of these three parameters are introduced.

On the thermodynamics of inhomogeneous bodies, C. C. Wang, *SP317,* pp. 907-924 (Dec. 1970).

Key words: Constitutive relations; continuum mechanics; dislocations; inhomogeneous elastic bodies.

This paper concerns the thermodynamics of inhomogeneous elastic bodies. I adopt the constitutive equations for thermoelastic materials given by Coleman & Noll (1963) and develop a theory for bodies made up of such materials. The general scheme of this theory is based on my paper on Generalized Simple Bodies (1969). The main result is the explicit field equations for the deformation and the temperature on a thermoelastic body.

Elastic-plastic plane bending of a single crystal, C. S. Hartley and M. A. Eisenberg, *SP317,* pp. 925-941 (Dec. 1970).

Key words: Dislocation distributions; mechanical properties; plane blending.

The elastic-plastic bending of a single crystal beam which deforms by single slip on a plane containing the axis of bending and in a direction normal to the axis of bending is analyzed. Both continuum plasticity and dislocation approaches are used to obtain stresses and/or displacements in the elastic and plastic regions. The relation between the applied bending moment and the curvature of the neutral axis is also obtained. The approaches are compared and correspondences between the two theories are discussed.

Generalized stress and non-Riemannian geometry, S. I. Ben-Abraham, *SP317,* pp. 943-962 (Dec. 1970).

Key words: Affine connection; continuum mechanics; non-Riemannian geometry; stress.

The general non-Riemannian approach to the geometry of a solid with lattice defects is briefly discussed. Non-Riemannian geometry is applied to the treatment of statics. The "stress" curvature tensor has the meaning of a generalized stress tensor with 27 components, while the associated Einstein tensor represents the classical stress tensor. The "stress" connexion expresses the generalized moment stress having 27 components. Its torsion tensor is the classical couple stress tensor.

The identities of the curvature tensors are identified with the static equilibrium conditions. Using a stress function density instead of a metric tensor, it is shown that the equilibrium conditions can always be identically fulfilled. A consistent theory involving lattice defects must necessarily involve also generalized moment stresses and generalized stresses.

The elastic field of moving dislocations and disclinations, T. Mura, *SP317,* pp. 977-996 (Dec. 1970).

Key words: Anisotropic elasticity; dislocation dynamics; dislocations; Green's tensors.

The previous work and the present state of study on the elastic field of moving dislocations and disclinations are reviewed. Emphasis will be placed upon the general method and approach using Green's tensor functions and Fourier integrals. The previous solutions for individual problems are reviewed as examples of this unified approach.

Kinematics of continuously distributed dislocations, S. I. Ben-Abraham, *SP317,* pp. 999-1020 (Dec. 1970).

Key words: Affine connection; continuum mechanics; kinematics; non-Riemannian geometry.

The general non-Riemannian approach to the geometry of a solid with lattice defects is extended to include the kinematics. The treatment is valid for both the motion of old defects and the creation of new ones. The change in a geometric quantity is described by a corresponding rate. The main quantities dealt with are distortion rates, stretching tensors and connexion rates, and new quantities called fluxions are introduced. In terms of these a fundamental kinematic law and continuity equations for the defect currents are set up and are found to be consistent with earlier results valid in special cases.

A micromorphic approach to dislocation theory and its relation to several existing theories, A. C. Eringen and W. D. Claus, Jr., *SP317,* pp. 1023-1040 (Dec. 1970).

Key words: Continuum mechanics; dislocation distributions; micromorphic dislocations; micropolar dislocations.

Two separate continuum dislocation theories are presented; one dealing with static, incompatible, micropolar dislocations and disclinations, as encountered in initial stress problems, and the other with a dynamical theory of micromorphic solids, containing continuous distributions of dislocations.

Relationships between several continuum dislocation theories and micromorphic mechanics are established by providing extensions and new interpretations of the micromorphic theory. First both micromorphic and micropolar theories of elastic solids are summarized, and then the theories of Kröner, Fox, and Berdichevskii and Sedov are discussed in some detail within this framework. In the last section, by use of micromorphic kinematics, dislocation density, strain, and microstrain tensors are introduced and constitutive equations are constructed. Together with the balance laws this constitutes a complete dynamical theory. The theory is intended for predictions of motions and micromotions of a solid containing dislocations undergoing elastic deformations. From the micromotion, the dislocation density and first stress moments can be calculated.

On the continuum theory of dislocations, N. Fox, *SP317,* pp. 1041-1052 (Dec. 1970).

Key words: Constitutive relations; continuum mechanics; dislocation kinematics; dislocations; oriented media; thermodynamics and dislocation motion.

The kinematics of an oriented medium are discussed with reference to the continuum theory of dislocations. The concepts of dislocation density dislocation flux and slip velocity are introduced and a corresponding constitutive theory is developed.

Dislocation dynamics in the presence of a multiple spectrum of thermally surmountable barriers, W. Frank, *SP317,* pp. 1065-1076 (Dec. 1970).

Key words: Arrhenius rate theory; dislocation dynamics; statistical theory of dislocation; thermal acceleration.

A theoretical treatment is given of the thermally activated motion of dislocations in the presence of dislocation barriers with different heights. The height of a barrier is allowed to depend on an arbitrary number of characteristic parameters (multiple obstacle spectrum). Under the assumptions which are usually made for the derivation of an Arrhenius equation for the slip rate $\dot{a}$ in the case of a uniform array of dislocation barriers, $\dot{a}$ is calculated for a multiple spectrum of barriers.

It is found that even under these conditions the validity of an Arrhenius equation $\dot{a} = \dot{a}_0 \exp(-\Delta\bar{G}/kT)$ (a_0=const., $\Delta\bar{G}$ = mean free enthalpy of activation) is preserved. An application of the "spectrum theory" is discussed.

Flow and the Arrhenius equation in the statistical framework, U. F. Kocks, *SP317*, pp. 1077-1082 (Dec. 1970).

Key words: Arrhenius law; mechanical properties; precipitation hardening; thermal activation.

The rate equation of plastic flow and a general work-hardening law are combined into a single equation of flow. It degenerates into the Arrhenius law only under certain specified conditions. A single Arrhenius term with temperature insensitive pre-exponential (and entropy) terms adequately describes the rate dependence of dislocation motion through a slip plane studded with obstacles of any spectrum of strengths and spacings. In this case, the mobile dislocation density in the slip plane generally does not enter the flow equation; only the density of slip plane does.

Movement of a dislocation through random arrays of point and parallel line obstacles, A. J. E. Foreman, P. B. Hirsch, and F. J. Humphreys, *SP317*, pp. 1083-1098 (Dec. 1970).

Key words: Computer simulation; dislocation motion; mechanical properties; precipitation hardening.

The motion of a dislocation through random arrays of impenetrable point and parallel line obstacles is considered. For impenetrable point obstacles the difference in line tension for edges and screws, and the elliptical equilibrium shape of the bowing-out loop are taken into account, and the yield stress for screws and edges is found to be the same. The results of a calculation of the effect of interaction between neighboring segments of the dislocation on the critical breaking angle and on the yield stress are presented. Computer calculations on the motion of dislocations through random arrays of parallel line obstacles show that the dislocations move by the generation and motion of large "kinks." The yield stress is found to increase approximately linearly with the obstacle length. These calculations are relevant to and are compared with the hardening in the early stages of the work hardening curve of dispersion hardened alloys containing small particles, in which rows of prismatic loops are formed at the particles, which act as linear obstacles to the gliding dislocations.

Strain rates in dislocation dynamics, W. de Rosset and A. V. Granato, *SP317*, pp. 1099-1106 (Dec. 1970).

Key words: Dislocation kinetics; mobile dislocations, stress rates.

Since the success by Johnston and Gilman in relating yield phenomena in LiF to direct measurements of dislocation velocities and densities, the Λbv expression for the strain rate has been used almost exclusively, where Λ is the mobile dislocation density, b the Burgers vector, and v is the average dislocation velocity. We note that there are cases for which the strain rate is independent of dislocation velocity. When the velocity is large enough the strain rate is given in a simplified model by $\dot{\Lambda} b\bar{x}$, where $\bar{x}$ is the average distance traveled by a dislocation. The strain rate is eventually determined, then, by the rate at which new dislocations are created and not necessarily by the rate at which old dislocations expand or by the dislocation velocity.

On the mechanism of cross-slip of dislocations at particles, M. S. Duesbery and P. B. Hirsch, *SP317*, pp. 1115-1134 (Dec. 1970).

Key words: Activation energy; cross slip; mechanical properties; misfit strain; precipitation hardening.

The effect of the misfit strain field upon the mechanism of cross-slip of dislocations at impenetrable particles in two-phase alloys is considered. The strain field is found to have a profound effect of the activation energy for cross-slip.

Theories of thermally activated processes and their application to dislocation motions in crystals, H. Engelke, *SP317*, pp. 1137-1156 (Dec. 1970).

Key words: Bordoni-peaks; dislocation motion; kink relaxation; mechanical properties; thermal activation.

Thermally activated processes involving dislocations are usually treated by applying the theory of absolute reaction rates and the string approximation of dislocations. In the first part of this paper the limits of validity of these treatments are discussed. A paper of T. Geszti is briefly reviewed in which it is shown that in processes involving *point defects* deviations from the rate theory must be expected if the energy exchange between defect and lattice waves is slow compared with the average time between jumps, e.g. if localized or quasi-local vibrations contribute essentially to the defect motion. It is pointed out that the localized modes of dislocations may also lead to deviations from the rate theory.

In the second part a treatment of the double kink relaxation (Bordoni relaxation) based on the Kramers-Brinkman diffusion theory of chemical reactions is given. After showing that in f.c.c. metals the influence of the Peierls potential is so small that on dislocation loops only one kink pair must be considered explicitly whereas the remaining parts of the loops may be described by the string approximations, diffusion equations for the loop motion are derived. Under certain conditions these equations are equivalent to a system of reaction rate equations. Exact solutions of this system are not yet available. However, the behaviour of dislocation loops in the amplitude independent region of internal friction measurements may be extrapolated combining results of two limiting cases: a double well model and a simplified multi-well model.

The relaxation strength and the preexponential factor of the relaxation time calculated have the same orders of magnitude as in measurements of the Bordoni peak. The loop length dependence of the damping peak is in good agreement with neutron-irradiation measurements. The characteristic half-width of the Bordoni peak may partly be explained using loop length and stress distributions.

Slightly dissociated dislocations, R. Hobart, *SP317*, pp. 1157-1161 (Dec. 1970).

Key words: Dislocation stacking faults; Peierls-Nabarro model.

A modified Peierls-Nabarro model is used to calculate the relation between the separation of partials and stacking fault energy for an idealized dislocation dissociated into two equal pure screw partials. The resulting expression agrees with the inverse dependence obtained by equating the elastic repulsion of the partials to the attraction of the stacking fault, but unlike that result does not break down at zero separation. Also an argument is given that the width of such a dissociated dislocation should be considered as a complex quantity, with the imaginary part corresponding to the separation of the partials.

The broadening of resonance lines by dislocations, A. M. Stoneham, *SP317*, pp. 1169-1173 (Dec. 1970).

Key words: Line broadening; optical zero phonon line; spin resonance; statistical methods for dislocations.

Dislocations and other defects in solids broaden sharp resonance lines in solids, such as spin resonance and optical zero phonon lines. The broadening is a result of the random strain fields produced, and the shape of the resonance line is a measure of the distribution of internal strains. Measurement of line shapes can give information which is different from that given by the more usual mechanical and transport studies of dislocations. We calculate the shapes of the resonance lines in terms of the properties of the individual defects which cause broadening, their density and their statistical distribution. The theory is applied to straight dislocations, infinitesimal loops, dislocation dipoles and to point defects.

Dislocation pair interaction in a finite body, R. O. Scattergood and U. F. Kocks, *SP317,* pp. 1179-1189 (Dec. 1970).

Key words: Dislocation surface; dislocations; elastic interactions; finite elasticity; interactions.

The elastic interaction between dislocations in a finite body shows important features not found in an infinite body. For example, two like dislocations parallel to the axis of a cylinder repel each other only when they are close, but attract each other when their distance is comparable to the cylinder radius. Contours of the pair interaction energy are given for both screw and edge dislocations in a circular cylinder.

These new features appear not only when free surface conditions are demanded on the entire body, but even when approximate stress fields are used that demand some surface tractions, so long as no torques are transmitted through the body.

The relevant torques (bending moments) associated with an edge dislocation in a circular cylinder, which vanish when the mantle is traction free, may be made to vanish in general by a simple modification of the stress field of the edge dislocation.

The mean square stresses $\langle\sigma^2\rangle$ for a completely random and a restrictedly random distribution of dislocations in a cylindrical body, M. Wilkens, *SP317,* pp. 1191-1193 (Dec. 1970).

Key words: Dislocations; elasticity; statistical methods.

The paper gives a full proof of the author's earlier statement according to which the elastic interaction energy of completely randomly distributed dislocations vanishes. As a consequence the outer cut-off radius in the logarithmic factor of the elastic energy coincides with the external cylinder radius rather than with the mean dislocation spacing. The proof takes into account the elastomechanical boundary conditions which were neglected in the earlier paper. Further it is shown that for a restrictedly random distribution the outer cut-off radius is equivalent to the radius of the areas small compared with the cylinder cross-section, each of which contains the same number of dislocations randomly distributed over the corresponding area. In the special case that each area contains only one dislocation with arbitrary inside the area the outer cut-off radius degenerates to the mean dislocation spacing.

Theoretical aspects of kinematical x-ray diffraction profiles from crystals containing dislocation distributions, M. Wilkens, *SP317,* pp. 1195-1221 (Dec. 1970).

Key words: Diffraction profiles; dislocation diffraction; kinematic x-ray diffraction; statistical methods for dislocations.

The paper deals with a theoretical study of the Fourier transform of the x-ray diffraction line profiles from crystals containing dislocation distributions. The theory is based mainly on a calculation of spatial averages of powers of the strains ϵ_n, where ϵ_n means the differential strain perpendicular to the reflecting planes averaged over a certain length n(n = variable of the Fourier transform). The second power average $\langle\epsilon_n^2\rangle$ is calculated in a closed form for a restrictedly random dislocation distribution. However, the result is approximately valid also for other distributions. The contributions of the averages of higher powers of ϵ_n are taken into account in an approximate manner. The expression derived for the Fourier transform depends on the two parameters ρ and R_e, where ρ is the dislocation density. R_e is equivalent to the effective outer cut-off radius which appears for instance in the logarithmic factor of the elastically stored energy. The result which is applicable for $R_e \geqslant \rho^{-1/2}$ is discussed in comparison with the theory of Krivoglaz and Ryaboshapka, in which a completely random dislocation distribution is assumed, and with the theory of diffraction from distorted crystals mainly developed by Warren and Averbach.

Thermodynamic properties of solids containing dislocations, J. Holder and A. V. Granato, *SP317,* pp. 1223-1225 (Dec. 1970).

Key words: Bulk modulus; dislocations and thermodynamics; entropy; specific heat; thermal expansion; thermodynamics and expansions.

Using thermodynamics and elasticity theory, a unified treatment of the changes in the thermodynamic properties of solids containing dislocations is given. The results are expressed in terms of temperature and pressure derivatives of the formation energy of the dislocations. The required pressure and temperature dependence of the energy is given by the measured pressure and temperature dependence of the elastic constants appearing in the energy expression found at zero pressure and temperature. The method is not restricted to calculations of volume changes, or to isotropic, static or even elastic systems at zero pressure. Changes in entropy, specific heat, thermal expansion and bulk modulus due to dislocations are easily calculated.

Charged dislocations in the diamond structure, P. Haasen and W. Schröter, *SP317,* pp. 1231-1253 (Dec. 1970).

Key words: Band structures; charged dislocations; diamond lattice; dislocation-electron interactions; semiconductors.

The electronic states at dislocations in elemental semiconductors are reviewed in the light of new experimental and theoretical work. Evidence is produced for the existence of a one-dimensional energy band along edge as well as screw dislocations. This explains quantitatively their ability to act as donors as well as acceptors depending on temperature, doping, and dislocation density. The degree of charging has been recalculated from the free energy of a system of charged dislocations screened by free carriers. The dislocation charge limits the Hall mobility in addition to the strain field of the dislocation. Measurements of photoconductivity of deformed semiconductors support the above model of the charged dislocation. The dislocation charge influences the Peierls force and thus the mobility of dislocations in the diamond structure. The occupation limit of the neutral dislocation, measured from the valence band edge, lies at 0.09 eV in germanium, and at 0.3 eV in silicon.

Electronic effects associated with stacking faults in normal metals, C. Nourtier and G. Saada, *SP317,* pp. 1259-1277 (Dec. 1970).

Key words: Dislocation-electron interactions; interatomic potentials; stacking faults.

The authors use a simple pair interaction model to make the following calculations. (1) Stacking fault energy of simple metals. (2) Interaction energy between a stacking fault and an impurity atom or a vacancy, and application to the study of segregation effects. (3) Interaction energy of parallel stacking faults.

Numerical results are given. Consequences of the long range interaction between defects are discussed.

Theory of surface states on stacking faults, R. M. Thomson, *SP317*, pp. 1279-1288 (Dec. 1970).

Key words: Dislocation-electron interactions; Slater-Koster method; stacking fault.

The Slater-Koster method in the Bloch representation is applied to a model for a stacking fault in an idealized crystal leading to a type of Shockley surface state. A series expansion is obtained for the energy which is worked out for the simplified case of a constant matrix element, with the result that for a tight binding nonoverlapping band, there are surface waves which split off from both the top and bottom of the band. Contrary to Shockley's results for external surfaces, and to the Slater-Koster theory of the localized impurity, localized states occur on the stacking fault for a single nonoverlapping band and for arbitrary potential values. A constant matrix approximation is worked out for the case of the simple metals.

Interactions of dislocations with electrons in metals, C. Elbaum and A. Hikata, *SP317*, pp. 1291-1292 (Dec. 1970).

Key words: Dislocation dynamics; dislocation-electron interactions; phonons.

Physical arguments are given to show that the interaction of moving (vibrating) dislocations with conduction electrons in metals is independent of temperature. Calculations based on the assumption that the Fourier components of the displacement field of a moving dislocation can be treated as pseudo-phonons give the same result. These conclusions were confirmed by the results of recent experiments.

Electronic energy states of dislocations; the case of covalent-ionic solids, C. Elbaum and R. R. Holmes, *SP317*, pp. 1293-1302 (Dec. 1970).

Key words: Band structure; covalent-ionic solids; dislocation-electron interactions; Fermi energy; semiconductors.

It is shown that electronic energy bands are associated with dislocations in wide-band-gap, compound semiconductors. The eigenvalue problem for the dislocation band edge is solved for CdS-type crystals, and the occupation of the band is calculated. The Fermi energy is then determined for crystals containing many deep-lying discrete levels as well as dislocation bands. It is predicted that when a crystal is illuminated with light of appropriate wavelength and increasing intensity, the thermal activation energy governing the electrical conductivity passes through a series of energy plateaus which are equal to the energy of the discrete levels. In a dislocation-free crystal, these plateaus are connected by step changes, while in a crystal with dislocations they are connected by broad transition regions. The above predictions have been verified experimentally.

Interactions between electrons and moving dislocations, G. P. Huffman and N. Louat, *SP317*, pp. 1303-1322 (Dec. 1970).

Key words: Dislocation damping; dislocation-electron interactions; electroresistivity.

A moving dislocation in a metal induces an electric field which causes currents in the conduction electron gas. The energy dissipation associated with these fields and currents is calculated from the Boltzmann equation in a manner analogous to theories of acoustical attenuation. It is found that the applied stress required for steady motion is proportional to the dislocation velocity divided by the electrical resistivity, in good agreement with low temperature yield and flow stress measurements on bcc metals. The concept of a large electronic component of drag which increases with decreasing temperature is used to give a qualitative explanation of the observed mechanical properties of b.c.c. metals. When one considers electronically damped dislocations impeded by pinning points, it is found that: (1) the dislocation velocity depends only on the mean strength of the pinning obstacles; (2) the stress required to overcome an obstacle dynamically is less than that required statically and is, in fact, the electronic drag stress; and (3) the apparent dislocation velocity should vary rapidly with applied stress. The displacement field of a dislocation is significantly wider and more gradual in a f.c.c. than in a b.c.c. lattice, and this feature can be incorporated into the calculation by assuming that the electronic screening of the positive charge shift of the dislocation is essentially perfect in a f.c.c. lattice. The Boltzmann formation then gives a temperature independent stress or drag coefficient in agreement with experiment and with Holstein's scattering calculation. The problem of a dislocation moving in an applied magnetic field directed along its length and perpendicular to its direction of motion is also treated. Under suitable conditions it is found that the stress or drag coefficients exhibit oscillations of the cyclotron resonance type which could be as large as 10 to 30% of the zero field values.

SP320. Supplement 1. **Bibliography on atomic transition probabilities, July 1969 through June 1971,** J. R. Fuhr and W. L. Wiese, Nat. Bur. Stand. (U.S.), Spec. Publ. 320, Suppl. 1, 67 pages (Sept. 1971).

Key words: Allowed; atomic; discrete; forbidden; transition probability.

This is the first supplement to the NBS Special Publication 320, "Bibliography on Atomic Transition Probabilities," and it covers the most recent literature on the subject from July 1969 through June 1971. The papers are arranged according to elements and stages of ionization, and the method employed and classification of transitions are indicated for each reference. Only articles on discrete transitions, both allowed and forbidden, are listed. Papers containing data for many elements within isoelectronic sequences are collected separately in front of the list in order to keep this bibliography to a reasonable size. Also included is a selected list of new papers dealing with the subject of atomic transition probabilities from a general point of view.

SP324. **The NBS Alloy Data Center: permuted materials index,** G. C. Carter, D. J. Kahan, L. H. Bennett, J. R. Cuthill, and R. C. Dobbyn, Nat. Bur. Stand. (U.S.), Spec. Publ. 324, 683 pages (Mar. 1971).

Key words: Alloy data; bibliography; index; information; Knight shifts; NMR; soft x ray.

This Index contains literature references to ~ 10,000 research papers on physical properties of metals and alloys. The Index contains all NMR Knight shift papers and soft x-ray emission papers. It also contains many soft x-ray absorption papers and a number of papers on generally related topics such as susceptibilities, specific heats, hyperfine fields, and band structures. The papers are annotated in depth and the coded information put onto a magnetic tape. The Permuted Materials Index was created from this tape, listing alloys under each of their constituent components (i.e., CuNi appears under CuNi and under NiCu alloys).

SP326. **Accurate characterization of the high-pressure environment.** Proceedings of a Symposium held at the National Bureau of Standards, Gaithersburg, Md., October 14-18, 1968, E. C. Lloyd, Editor, Nat. Bur. Stand. (U.S.), Spec. Publ. 326, 343 pages (Mar. 1971).

Key words: Accurate measurement; equation-of-state; fixed points; high pressure; high-pressure equipment; instrumentation; pressure scale; shock wave technique; temperature.

The volume contains 38 papers prepared for the Symposium on Accurate Characterization of the High-Pressure Environment held on October 14-18, 1968, at Gaithersburg, Maryland, under the sponsorship of the National Bureau of Standards and the Geophysical Laboratory at the Carnegie Institution of Washington. The papers are presented with the discussions that occurred during the sessions. The book also includes reports of several informal committees of the conferees on choices of reference pressure materials and on other matters relevant to improved measurement and calibration. The Symposium was intended to provide an authoritative survey of problems and techniques presently in use or proposed for precise high-pressure measurement and for temperature measurement at high pressure. *These proceedings include the following papers (indented):*

Hydrostatic pressures of 50 kbar in a piston-cylinder device: measurement of pressure and characterization of the pressure medium, A. Jayaraman and R. G. Maines, *SP326*, pp. 5-8 (Mar. 1971).

A method suited for making resistivity and other electrical measurements to 50 kbar hydrostatic pressure, using a conventional piston-cylinder device, is described. In this method a Teflon cell is used to contain the pressure medium, which is a 1:1 mixture of *n*-pentane and isoamyl alcohol. After the fluid mixture freezes (at about 46 kbar), further advance of the piston results in uniaxial stress. However, this can be readily relaxed by heating the medium to 70 °C. The resultant isotropic pressure distribution stays when the pressure medium is cooled back to room temperature. The technique of probing the pressure distribution inside the cell, as well as pressure calibration procedure, is described.

Ultrasonic and dilatometric measurements at very high pressures, P. L. M. Heydemann and J. C. Houck, *SP326*, pp. 11-22 (Mar. 1971).

Key words: Bulk modulus; density; dilatometric measurements; high pressure; liquids; solids; ultrasonics.

A short-cylinder and piston assembly and its use for dilatometric and ultrasonic measurements on solids and liquids at pressures up to 40 kbar are described. All necessary corrections for the evaluation of measurements are discussed and the systematic uncertainties are given. It is demonstrated that ultrasonic methods can significantly reduce the uncertainties in the determination of density and bulk modulus of both solids and liquids.

Characterization of the bismuth I-II and barium I-II points under hydrostatic pressure, R. J. Zeto, H. B. Vanfleet, E. Hryckowian, and C. D. Bosco, *SP326*, pp. 25-33 (Mar. 1971).

Hydrostatic pressure experiments were made which have new and important relevance to high-pressure calibration in both liquid and solid pressure systems for the bismuth I-II and barium I-II points on the high-pressure scale. The bismuth I-II transformations were characterized and the mechanism of the solid-state reactions was related to pressure calibration. The strain hysteresis commonly associated with the bismuth I-II point was shown to be invalid and was alternatively explained on the basis of a thermally activated nucleation and growth mechanism which was demonstrated to govern these transformations. With hydrostatic pressure, initiation of the bismuth I-II transformation was observed as a function of kinetic times as long as 15 hours while pressure and temperature were maintained constant. The transformation behavior was a function also of the microstructure, purity, and thickness of the sample. The bismuth I-II transformation was not necessarily sharp with respect to kinetic time. As long as 42 hours were observed for completion of the transformation with very thin samples. Under hydrostatic pressure the bismuth I-II equilibrium point was not midway between the initiation of the I-II and II-I transformations but was located appreciably closer to the former transformation. The bismuth I-II calibration point was correlated between liquid and solid pressure systems. For solid systems it was shown that the "apparent" hysteresis was completely one-sided toward the low-pressure side and that the equilibrium point coincided with the initiation of the I-II transformation which should be employed as the pressure calibration point. The bismuth I-II region of indifference was characterized with respect to nature of the sample and manner of measurement. An experimental technique was indicated by which the center of the region of indifference was reproducible within ±5 bars. The barium I-II point was measured at 56.27 kbar on the basis of a manganin gage under hydrostatic pressure.

The upper bismuth pressure calibration point, J. C. Haygarth, H. D. Luedemann, I. C. Getting, and G. C. Kennedy, *SP326*, pp. 35-37 (Mar. 1971).

The Bi III-V and IV-V equilibrium boundaries were studied by monitoring electrical resistance changes. Extrapolation of the III-V data to 25 °C yields an equilibrium transition pressure of 77.5 ± 1.0 kilobar (kbar). The extrapolation also agrees within experimental error with the pressure of 78.2 kbar determined in a separate experiment at 22 °C. The use of the transition as a calibration point is discussed, and a procedure for estimating the compression-stroke transition pressure from the equilibrium transition pressure is proposed.

Optical interferometry at high pressures, K. Vedam, *SP326*, pp. 39-43 (Mar. 1971).

After a brief review of the present status of optical interferometry at high pressures, the experimental technique of measuring the variation of refractive index with pressure to 7 and 14 kbars with one- and two-stage optical pressure vessels respectively, is described along with some typical results obtained. The need for such measurements on liquids and gases which are used as fluid pressure media is emphasized.

Equipment for generating pressures up to 800 kilobars, N. Kawai, *SP326*, pp. 45-47 (Mar. 1971).

A type of high-pressure apparatus has been developed which extends considerably the range of attainable very high static pressure. It consists basically of a sphere segmented into tapering truncated pistons. Hydrostatic pressures in the sample chamber in the centre of the sphere have reached 800,000 bars (11,600,000 psi). Pressures of over one million bars should be possible with the present technology. Some new and interesting results from high-pressure studies are described.

Manganin resistance gages as accurate instruments for high-pressure measurements, Yu. A. Atanov and E. M. Ivanova, *SP326*, pp. 49-51 (Mar. 1971).

The rapid development of modern science and technology foretells the wide application of high hydrostatic pressures from 20 to 40 kbar in the near future. The measurement of pressures in this range is usually carried out by manganin resistance gages. Many authors, however, report different metrological characteristics of individual manganin gages and present widely differing values of pressure coefficient, reproducibility, stability, nonlinearity, etc. There is no common basis for the selection of interpolation and extrapolation equations relating the change of resistance of a manganin gage with the measured pressure.

In this work an attempt is made to investigate the scatter of metrological characteristics of a large group of identical manganin gages by means of an absolute free piston gage, to find the best extrapolation equation and to evaluate possible errors of pressure measurements over 15 kbar.

A critical review of the effect of pressure on thermocouple emf's, R. E. Hanneman, H. M. Strong, and F. P. Bundy, *SP326*, pp. 53-61 (Mar. 1971).

The effects of high pressure on the emf's of thermocouples are critically reviewed and best currently available thermocouple corrections are presented. The important factors affecting these thermocouple corrections are discussed, including pressure-temperature gradients, contamination, and deformation. A novel method for simultaneous and continuous *in situ* measurement of pressure and temperature within a high-pressure cell through use of dual thermocouples is briefly described.

The effect of pressure on the thermal emf of the platinum/platinum 10 percent rhodium thermocouple, P. M. Bell, F. R. Boyd, Jr., and J. L. England, *SP326*, pp. 63-65 (Mar. 1971).

Pressure dependence of the thermoelectric power of thermocouple materials, P. J. Freud and P. N. La Mori, *SP326*, pp. 67-75 (Mar. 1971).

Single-wire measurements of the pressure dependence of the thermoelectric power were made hydrostatically to 8 kbar for chromel, alumel, copper, and constantan and in a piston cylinder apparatus to 40 kbar for chromel, alumel, platinum, and platinum 10 percent rhodium. The temperature interval covered for the hydrostatic measurements was − 195 to 290 °C and for the piston cylinder measurements it was 30 to 380 °C. A detailed discussion is given of the pressure-temperature distribution within the piston cylinder cell. Pressure emf values are presented with an uncertainty of ± 7 percent.

The effect of pressure on the E.M.F. of thermocouples, I. C. Getting and G. C. Kennedy, *SP326*, pp. 77-80 (Mar. 1971).

Temperature measurement by thermal noise at high pressures, R. H. Wentorf, Jr., *SP326*, pp. 81-89 (Mar. 1971).

The temperature of a small carbon resistor (700 to 3,000 Ω) in a high-pressure cell next to a Pt-Pt10 percent Rh thermocouple was measured by thermal noise. Runs were made at 40 and 50 kbar to temperatures of about 1,400 K. The results suggest that at the highest temperatures the thermocouple indicated temperatures from 40 to 60 K too low, in fairly good agreement with estimates made by other methods.

Equations of state for sodium and aluminum, D. J. Pastine and M. J. Carroll, *SP326*, pp. 91-103 (Mar. 1971).

Equations of state are calculated for sodium and aluminum. In each case this is done by first calculating the 0 K isotherm and then adding the thermal contributions to the pressure. The calculations in both cases are theoretical and very few experimental data are used. Comparisons of theoretical prediction and experimental data are very favorable.

An atomistic theory of shock compression of a perfect crystalline solid, D. H. Tsai, *SP326*, pp. 105-122 (Mar. 1971).

Key words: Equation of state of solids; lattice dynamics; shock compression; shock wave; thermal relaxation.

Lattice dynamical calculations have been employed to study the process of compression of a perfect, two-dimensional, fcc lattice by a strong shock wave. The interaction energy between the lattice points is assumed to be the Morse-type potential function, and the interaction is assumed to extend to the fourth nearest neighbors. The formulation of the dynamical problem is described. The details of the computation of the shock wave stress and density profiles, shock velocity, energy density profile, local energy distribution, velocity distribution, and the components of the Grueneisen parameter are discussed. Of special interest is the thermal relaxation process behind the shock front. It is found that the relaxation time is not constant, and that the steady, relaxed region in the shock profile trails farther behind the shock front with increasing time. The implications of these results on the calculation of the high-pressure equation of state of a crystalline solid are examined.

Effect of 2024 aluminum alloy strength on high-pressure shock measurements, M. van Thiel and A. Kusubov, *SP326*, pp. 125-130 (Mar. 1971).

A shock wave technique is described by which wave profiles may be determined in metals. Piezo-resistance manganin gages were used to determine these profiles to 130 kbars in 2024 aluminum alloy. The data are consistent with the assumption that the Hugoniot is the hydrostat. A maximum of 28 kbars is obtained for the maximum yield strength on the release wave following the strongest shock. The derived loading-unloading curves in the pressure volume and pressure mass velocity planes indicate that errors of about 2 percent are produced by use of purely hydrostatic release paths.

Calculation of equation of state from high-pressure sound velocity data, A. C. Holt and R. Grover, *SP326*, pp. 131-135 (Mar. 1971).

We describe a method for calculating the Mie-Grüneisen equation-of-state parameters for simple metals from shock Hugoniot data and a knowledge of the volume variation of longitudinal sound velocity at high pressure. The theory is applied to the calculation of the equation of state of aluminum.

Shock temperature calculations for silicone fluid, M. Cowperthwaite and J. H. Blackburn, *SP326*, pp. 137-145 (Mar. 1971).

The problem of calculating shock temperature indirectly from experimental data without assuming thermodynamic properties is formulated and solved theoretically. In principle, the $(e-p-v)$ and $(T-p-v)$ equations of state can be constructed in an overlapping domain of the $(p-v)$ plane from a family of Hugoniot curves centered at points of known energy and temperature.

Experiments were performed in an attempt to construct these equations of state for silicone fluid 210. Shock and free surface velocities were measured to determine Hugoniot curves in the 300-kbar regime, and energies and densities were measured from − 30 to + 260 °C along the atmospheric isobar to determine the initial states of the shock wave experiments. In practice, it was necessary to assume a form for the $(e-p-v)$ equation of state, since the differences in volumes between states on Hugoniot curves at the same pressure above 40 kbar were found to be comparable with the experimental error in measuring the volumes of each of these states. The data were fitted to a Mie-Grüneisen type $(e-p-v)$ equation of state with variable C_v and $(\partial p/\partial T)_v$, since Hugoniot point indicated a linear dependence of energy on pressure along an isochore, and C_v varied along the atmospheric isobar. Shock temperatures on the 25 °C Hugoniot were calculated at points of intersection with isentropes and by integrating with constant atmospheric pressure values of C_v. The position of the 296 °C isentrope limits the temperature calculation with isentropes to values below 522 °C and 58 kbar, and the values around 50 kbar are 8 percent lower than those calculated with the 25

°C value of C_v, since C_v increases along the Hugoniot curve. Temperature calculations above 58 kbar assumed the 296 °C value of C_v. Considerably more experimental work would be required over the entire pressure range to permit determining equations of state of silicone 210 without making assumptions.

The equation of state of selected materials for high-pressure references, W. J. Carter, S. P. Marsh, J. N. Fritz, and R. G. McQueen, *SP326,* pp. 147-158 (Mar. 1971).

Effect of pressure on the lattice parameters of lead chalcogenides and nickel arsenide-type compounds, S. Minomura, H. Nagasaki, and I. Wakabayashi, *SP326,* pp. 159-165 (Mar. 1971).

The compressibility and thermal expansion of LiF to 60 kbar and 600 °C as determined by x-ray diffraction: report of progress, L. C. Carrison and C. B. Sclar, *SP326,* pp. 167-171 (Mar. 1971).

Measurements were made of the compressibility of LiF to 60 kbars over the temperature range 25 to 600 °C by high-pressure high-temperature x-ray powder diffraction methods. Pressures were determined by using NaCl as an internal calibrant. These results also provide data on the thermal expansion of LiF between 25 and 600 °C at pressures of 38 and 57 kbar. This paper demonstrates the feasibility of determining the unit-cell volume of crystalline solids under concomitant high pressure and high temperature by *in situ* x-ray methods.

Ultrasonic and static equation of state for cesium halides, G. R. Barsch and Z. P. Chang, *SP326,* pp. 173-186 (Mar. 1971).

Calculation of the *P-V* relation for sodium chloride up to 300 kilobars at 25 °C, J. S. Weaver, T. Takahashi, and W. A. Bassett, *SP326,* pp. 189-199 (Mar. 1971).

The *P-V* relation for the Bl phase of NaCl was calculated up to 300 kilobars at 25 °C by means of the Hildebrand and Mie-Grüneisen equations. The effect of (1) the uncertainty in the parameters used, (2) the functional form for the temperature-dependent part of internal energy, (3) the anharmonic contribution, and (4) the second nearest neighbor repulsion on the calculated *P-V* relation is discussed. It was found that the calculated *P-V* relation for NaCl is sensitive to the value chosen for Bt_0, and that the effect of (2), (3), and (4) on the calculated *P-V* relation is small. The precision for the present calculation has been estimated to be ±2.5 percent. The calculated *P-V* relation is in agreement within experimental uncertainties with the fixed points on the absolute pressure scale, with that determined by Bridgman up to 100 kilobars, and that obtained by Fritz from shock wave data up to 260 kilobars. Simultaneous determinations of the effect of pressure on the volumes of NaCl and MgO were made by x-ray diffraction on an intimate mixture of these two materials. It was found that the pressure values calculated from the volume of NaCl using the calculated *P-V* relation are in agreement with those calculated from the volume of MgO using the *P-V* relation calculated from the values of Bt_0 and Bt_0' with the Murnaghan equation. This agreement verifies not only the calculated *P-V* relation for NaCl, but also establishes the validity of the internal standard method for pressure determination.

The Hugoniot equation of state of sodium chloride in the sodium chloride structure, J. N. Fritz, S. P. Marsh, W. J. Carter, and R. G. McQueen, *SP326,* pp. 201-208 (Mar. 1971).

The Hugoniot equation of state of NaCl has been obtained by measuring the shock velocity through NaCl on copper and 2024 aluminum base plates. Shock velocities through the base plates and standard impedance-matching were used to obtain the Hugoniot curves for both single-crystal (in various orientations) and pressed-powder samples. The smooth behavior of the resulting shock locus up to 230 kbar indicates that NaCl exists in the sodium chloride structure up to this pressure. In the shock-particle velocity plane the best linear fit to the data reported here is u_s(km/s) $=(3.528\pm.012)+(1.343\pm.009)u_p$. A quadratic fit, which gives a large weight to the measured bulk sound speed in NaCl, is $u_s=3.403+1.5422u_p-0.07345u_p^2$. Isotherms at 293 K, using different forms for the Grüneisen parameter and a simple Debye model for the specific heat, are calculated from the Hugoniots and are presented here. They should prove useful when NaCl is used as an internal standard in high-pressure x-ray devices.

Consistency in the high-temperature equation of state of solids, L. Thomsen and O. L. Anderson, *SP326,* pp. 209-217 (Mar. 1971).

Four equations of state for solids are examined theoretically for mutual consistency in the high-temperature regime. It is found that neither the Birch-Murnaghan nor the Murnaghan equation can be shown to be consistent with either the Mie-Grüneisen or the Hildebrand equation. An expression is derived for the volume dependence of the Grüneisen parameter $\gamma(\rho)$. A recent theoretical treatment of NaCl, proposed for use as a pressure standard, is neither internally consistent, nor is it sufficiently precise for such a purpose.

The solid-liquid phase line in Cu, R. G. McQueen, W. J. Carter, J. N. Fritz, and S. P. Marsh, *SP326,* pp. 219-227 (Mar. 1971).

Shear strength effects on phase transition "pressures" determined from shock-compression experiments, O. E. Jones and R. A. Graham, *SP326,* pp. 229-237 (Mar. 1971).

Plane-wave shock compression experiments provide an independent, and often unique, method for establishing pressures at which phase transitions occur in solids. The transition stress which is measured in a shock experiment consists of two components: a mean isotropic pressure, and a deviatoric shear stress which is related to the yield strength, i.e., the Hugoniot elastic limit (HEL), of the solid when subjected to shock compression. The effects of the nonzero shear strength of a solid on the measured shock transition stress are discussed, and methods outlined for calculating the isotropic pressure component needed for comparison with hydrostatic results. Comparison requires that the compression to initiate the transition be independent of shear distortion. The shock propagation characteristics of a solid which are necessary for establishing a reliable equilibrium transition pressure are considered. Existing HEL data are collected in an Appendix and permit the importance of shear strength to be assessed for various materials. Shock compression data for phase transitions in Bi, Fe, Ge, CdS, and InSb are analyzed and shear strength corrections applied to obtain transition pressures.

Study of phase transitions in insulators by the dielectric constant technique, G. A. Samara and W. L. Chrisman, *SP326,* pp. 243-249 (Mar. 1971).

This paper proposes the measurement of the dielectric constant and dielectric loss as a probe for detecting and studying the properties of pressure-induced phase transformations in insulators. The measurement is very sensitive, relatively simple, and can be adapted for use in many types of high pressure apparatus. To illustrate the general usefulness of the technique, results on a variety of substances (solids and liquids) obtained from measurements in three different pressure apparatus will be presented and discussed. The substances investigated include a number of alkali and thallous halides, strontium titanate, and water.

Experimental determination of Curie points of ferromagnets up to 90 kilobars—possible use for calibration of high pressure, J. M. Leger, C. Susse, and B. Vodar, *SP326*, pp. 251-256 (Mar. 1971).

Second-order phase transformations which occur without volume discontinuity and theoretically without any hysteresis are suggested as secondary pressure gauges and for interpolation under high pressure in different temperature ranges. Results are presented concerning the shifts of Curie temperatures of some ferromagnets up to 90 kbar. The pressure effect is generally small but may be accurately determined.

Fixed points on the high-pressure scale identified by phase transitions in ammonium fluoride, R. Kaneda, S. Yamamoto, and K. Nishibata, *SP326*, pp. 257-262 (Mar. 1971).

The I-II and II-III transitions in NH_4F, as fixed points on the high-pressure scale, have been investigated under purely hydrostatic conditions at the temperatures of 0, 25 and 50 °C. By means of manganin resistance gages, the transition pressures at 25 °C have been determined to be 3605 ± 10 bar for the I-II and 11531 ± 23 bar for the II-III. Their respective dependences on temperature are +2.5 bar/°C and +20.7 bar/°C. The realization of both transition points is easy at and above room temperature, but at low temperatures the II-III transition is very sluggish.

A review of resistance-jump phase changes useful for high-pressure calibration, F. P. Bundy, *SP326*, pp. 263-270 (Mar. 1971).

The coesite-stishovite transition, S. Akimoto and Y. Syono, *SP326*, pp. 273-277 (Mar. 1971).

The coesite-stishovite transition curve has been determined over the temperature range 550 to 1,200 °C in the pressure range 82.0 to 98.0 kbar by means of a tetrahedral-anvil type of high-pressure apparatus. Amorphous anhydrous silica, α-quartz, coesite, and stishovite were used as starting materials. The transition curve was fitted by the linear equation $P(\text{kbar}) = 69 + 0.024\ T(°\text{C})$ using pressure scale proposed by Jeffery et al. This determination was found to be in a reasonable agreement with the previous data, if the common pressure scale is used. Experimental information for the coesite-stishovite transition was also compared with the stability relation derived from enthalpies and entropies of coesite and stishovite. It was suggested that the pressure scale proposed by Jeffery et al. was underestimated considerably around 100 kbar.

The use of solid-solid transitions at high temperatures for high-pressure calibration, P. N. La Mori, *SP326*, pp. 279-282 (Mar. 1971).

Transition pressures have been determined for bismuth 1 → 2 and bismuth 2 → 3 to the melting point (183 °C). The transitions parameters of thallium 2 → 1, 1 → 3 and 2 → 3 have been measured to 40 kbar and 220 °C. The thallium 1 → 2 → 3 triple point has been determined as 114 ± 1 °C and 37.4 ± 0.4 kbar. The use of the determined transition parameters as high-pressure, high-temperature fixed points is discussed.

The use of iron and gold for calibration of higher pressure and temperature points, H. M. Strong and F. P. Bundy, *SP326*, pp. 283-290 (Mar. 1971).

Transition pressures of Bi 3-5, Sn, and Fe, M. Contré, *SP326*, pp. 291-296 (Mar. 1971).

Making use of "X type anvil," the change in resistance of two reference metals in each run was simultaneously recorded in order to compare their transition pressures. A linear extrapolation through the well-known points below 60 kbar showed inconsistencies in the most commonly used high pressure scales. The recording of the pistons displacements lead to an exponential extrapolation which gave transition pressures of 78 ± 2 kbar for Bi 3–5, of 102 ± 4 kbar for Sn and of 140 ± 15 kbar for Fe.

On application of mercury melting curve for accurate high-pressure measurements, V. S. Bogdanov, Yu. L. Levin, S. S. Sekoyan, and Yu. I. Shmin, *SP326*, pp. 297-301 (Mar. 1971).

High-pressure scale as determined by x-ray diffraction techniques up to approximately 100 kbar, H. T. Hall, *SP326*, pp. 303-305 (Mar. 1971).

Pressure inhomogeneity: a possible source of error in using internal standards for pressure gages, J. C. Jamieson and B. Olinger, *SP326*, pp. 321-323 (Mar. 1971).

Studies have been made on two intimate mechanical mixtures of NaCl and Nb having different composition at high "pressures" using x-ray diffraction. A plot of V_p/V_o for Nb versus V_p/V_o for NaCl showed a different curve for each of the two mixtures. Our analysis and the consequences of this apparent violation of the criteria for an internal pressure gage are discussed.

Comparison of four proposed *P-V* relations for NaCl, J. S. Weaver, *SP326*, pp. 325-329 (Mar. 1971).

Some comparisons among four *P-V* relations for the Bl phase of NaCl discussed at this symposium are presented. The two scales (Models III and V) proposed by Weaver et al. (this volume) and a 1968 revision of Decker's *P-V* relation (D_{68}) are shown to agree closely. The three models yield zero-pressure thermal expansion curves in reasonable agreement with experiment, but give values for B_{to}' smaller than the measured value. This appears to be due, in part, to the form used for the lattice energy. The three models yield pressures about 2.5 percent smaller than those calculated from the pressure scale (F_{68}) based on Hugoniot data proposed by Fritz et al. (this volume). Comparison of Models III, V, and F_{68} in the $u_s - u_p$ plane suggests that part of this difference must result from either the form chosen for the lattice energy in Models III and V or from the Hugoniot data upon which F_{68} is based. Omission of part of the data used in F_{68} improves the agreement of this model with the sonic value of B_{to}' and partially removes the discrepancy between F_{68} and Models III and V. Suggestions for additional studies which may be useful in choosing a *P-V* relation for NaCl for pressure calibration purposes are presented. It is concluded that, since the differences among these scales are comparable to the experimental uncertainties involved in applying them, and since there is no compelling reason to choose one over the others, any of these scales may be used for the present.

SP329. **An index of U.S. voluntary engineering standards,** W. J. Slattery, Editor, Nat. Bur. Stand. (U.S.), Spec. Publ. 329, 1,000 pages (Mar. 1971).

Key words: Engineering standards, index of; index of standards, recommended practices, specifications, and test methods; Key-Word-In-Context index of voluntary standards; standards, voluntary, index of.

This computer-produced Index contains the permuted titles of more than 19,000 voluntary engineering and related standards, specifications, test methods, and recommended practices, in effect as of December 31, 1969, published by some 360 U.S. technical societies, professional organizations, and trade associations. The title of each standard can be found under all the significant key words which it contains. These key words are arranged alphabetically down the center of each page together with their surrounding context. The date of publication or last revision, the standard number, and an acronym designating the standards-issuing organization appear as part of each entry. A list of these acronyms and the names and addresses of the organizations which they represent are found at the beginning of the Index.

SP330. **The International System of Units (SI),** C. H. Page and P. Vigoureux, Editors, Nat. Bur. Stand. (U.S.), Spec. Publ. 330, 42 pages (Jan. 1971).

Key words: General Conference of Weights and Measures; International Committee of Weights and Measures; International System of Units; SI; Système International d'Unités; units of measurement.

This translation from the French "Le Système International d'Unités", (SI) published originally by the International Bureau of Weights and Measures (BIPM) has been prepared jointly by the National Physical Laboratory, UK, and the National Bureau of Standards, USA. Included are Resolutions and Recommendations of the General Conference of Weights and Measures (CGPM) on the International System of Units, together with relevant extracts from the International Organization for Standardization (ISO) for the practical use of the system.

Appendix I gives in chronological order the decisions promulgated since 1889 by CGPM and the International Committee of Weights and Measures (CIPM) on units of measurement and on SI. Appendix II outlines the measurements, consistent with the theoretical definitions given in this document, which metrological laboratories can make to realize the units and to calibrate precision material standards.

SP334. **Industrialized building in the Soviet Union, (a report of the U.S. Delegation to the U.S.S.R.),** J. R. Wright, Editor, Nat. Bur. Stand. (U.S.), Spec. Publ. 334, 81 pages (Dec. 1970).

Key words: Building economics; building systems; construction industry; housing; precast concrete; production capacity; production management; production methods; standardization; United Soviet Socialist Republics.

The 1969 Exchange delegation to the USSR reports the status of Soviet building industrialization, with emphasis on Soviet housing. The report describes the State management hierarchy, production of precast concrete components and housing construction procedures. The loadbearing panel system, the mainstay of Soviet prefabricated housing, is compared with the newer three-dimensional box system. Detailed analysis is made of the cost of a nine-story panel prefabricated apartment building in the USSR, and the cost of the same building if constructed in the U.S.

SP335. **Innovative metrology—key to progress.** Proceedings of the 1970 Standards Laboratory Conference held at the National Bureau of Standards, June 15-17, 1970, H. L. Mason, Editor, Nat. Bur. Stand. (U.S.), Spec. Publ. 335, 132 pages (Mar. 1971).

Key words: Metrology management; National Conference of Standards Laboratories; physical measurement; Proceedings NCSL.

The biennial Standards Laboratory Conference of the National Conference of Standards Laboratories convened at the Gaithersburg facilities of the National Bureau of Standards June 15-17, 1970. The theme of the meeting, Innovative Metrology—Key to Progress, was amplified by 23 papers presented at technical sessions devoted to new technologies and applications, laboratory management and operations, new methods of optimizing calibration intervals, new ways of managing, and new international developments. *These proceedings include the following papers (indented):*

The evolution of a radiological mensuration technique, H. Bardach and S. Wisnieff, *SP335*, pp. 11-21 (Mar. 1971).

Key words: Attenuation of betas; beta-transmission phenomenology; counting geometry; mass absorption coefficient derivation; strontium 90 wall-thickness measurement gage; thin-wall mensuration.

A radiological mensuration technique was devised to measure the minimum wall thickness anchoring from interior corner points of small castings invested with internal cavities. The factors involved in the development of the mensuration technique which culminated in the manufacture of a semi-automatic machine tooled with a strontium 90 gage were examined in detail. These factors included the phenomenology of beta transmission through plural media, the subtleties of counting geometry, and the characteristics of the beta spectrum, all of which contributed in some measure to the efficacy and uniqueness of the beta emitter as a mensuration tool.

The technique involved the positioning of an encapsulated strontium 90 point source contiguous with the interior points at which the minimum wall thicknesses were to be measured and determining these thicknesses by referencing the observed beta transmission counting rates to a calibration curve.

An automated time domain instrument test console, L. S. Kreyer, *SP335*, pp. 23-28 (Mar. 1971).

Key words: Automatic measuring devices; automatic performance test; computer control systems; instrument calibration procedures; instrument performance testing; pulse technology; time domain testing.

This paper describes a computer-controlled system which automatically tests the performance of oscilloscopes and other time domain instruments. The system utilizes advances in pulse technology to speed up the calibration process by replacing frequency domain test methods with time domain test methods. Cost effectiveness of this system in terms of reduced man hours to calibrate an instrument, reduction of systematic errors due to operator bias, and consistent reporting of test results are described.

Standards laboratory applications of a computer-automated system, F. B. Seeley, *SP335*, pp. 29-33 (Mar. 1971).

Key words: Computer automation; resistance thermometers; resistor intercomparison; standard cell surveillance.

A computer-automated calibration system whose accuracy and precision make it suitable for standards laboratory applications is described. The system has been applied to electrical, radio-frequency, electro-optical, and electromechanical measurements. Results are summarized that include saturated standard cell, standard resistor, resistance thermometer, micropotentiometer, and attenuator calibrations. Additional topics include the experience in computer programming, reliability, and systems operation.

Cost reduction in calibrating bolometer mounts, W. F. Dentinger and L. dePian, *SP335*, pp. 35-37 (Mar. 1971).

Key words: Automated dc substitution; bolometer calibration; radiofrequency power measurement; self-balancing Wheatstone bridge.

Ordinarily a great deal of time is spent in calibrating bolometer mounts. Manual bridges require considerable care for proper balances, bias adjustments, and calibration procedures. New instruments have been designed to automate many of the manual operations. These instruments are self-balancing and maintain precise power levels with minimum adjustments. Due to the fact that in previous setups a series of measurements had to be made in order to average out errors caused by temperature changes, the new automated system described in this paper can save about 90 percent in measurement time. In addition, a less skilled operator can perform the measurement with the same accuracy.

Measurement comparison programs, H. S. Ingraham, Jr., *SP335*, pp. 39-40 (Mar. 1971).

Key words: Accelerometer round robin; computer program for Youden diagrams; correlation effect; end standard of length.

The measurement comparison program of 1965 circulated unknowns in pairs, allowing use of Youden diagrams to distinguish systematic from random error. In 1969, two pairs were sent out several months apart, allowing check of the correlation effect; a round robin was started on acceleration; a 24-inch end standard was included in the physical package.

Report on the 1968-69 mass measurement agreement comparison round robin, L. B. Macurdy, *SP335*, pp. 41-45 (Mar. 1971).

Key words: Between-group variance; mass comparisons of 1969; systematic and random weighing errors; within-group variance.

Seventeen laboratories took part in the round robin measurements of the NCSL Mass Comparison packages during 1968 and 1969. In order to speed up the measurements the laboratories were divided into two groups. The weights were calibrated by the NBS Mass Laboratory at the beginning and again at the end, and Mettler Instrument Corporation measured all sets near the middle of the series. Two sets of weights were sent to each laboratory at times separated by two months or more in order to provide data on errors made on the same day (within-group variance) and on errors between measurements at longer intervals (between-group variance). Each set of weights consisted of four pairs of one-piece stainless steel weights of 100 g, 25 g, 10 g, and 1 g. Data include weighing errors of the various laboratories and Youden plots of the measurements. Some errors proved to be larger than had been expected. The results illustrate the need for verifying the accuracy of measurement on some rational basis.

NCSL specification presentation, F. J. Dyce, *SP335*, pp. 47-50 (Mar. 1971).

Key words: Calibration records; calibration system specification; intervals; procedures; recall; reliability; traceability.

This paper describes in summary the requirements of the National Conference of Standards Laboratories "Calibration System Specification." It indicates how the specification was written by members of the NCSL Specifications Committee in answer to a DOD request. The specification contains the minimum essential requirements of a calibration system. The paper discusses the steps required to approve the specification as a recommended practice and to obtain Government approval and adoption.

Cost visibility exchange program—a new approach to cooperative savings, R. J. Barra, *SP335*, pp. 51-55 (Mar. 1971).

Key words: Calibration and maintenance manhours; digital counters; digital voltmeters; exchange program on costs; oscilloscopes.

A preliminary survey by the Calibration Systems Management Committee indicates 600,000 manhours per year spent on 9 types of instruments, including oscilloscopes. Member organizations are asked to contribute cost data with the objective of saving one million dollars in calibration and maintenance costs by 1972.

Keys to optimum calibration intervals, R. B. F. Schumacher, *SP335*, pp. 57-64 (Mar. 1971).

Key words: Calibration intervals; economy in adjusting quality level; measurement uncertainty; reliability of working instruments.

The search for optimum calibration intervals or for methods to obtain them can be frustrating. Our theories concerning the behavior of measuring instruments are deficient, and as a result, so are all theoretical models attempting to establish optimum intervals. Nor can we hope to determine empirically what optimum intervals should look like. The many variables in calibration control systems, affecting quality and behavior and performance evaluation of measuring instruments, forbid us to compare the meaning and merit of calibration intervals achieved in one calibration control system with those achieved in another such system. Time does not permit us to experiment in one system until we achieve calibration intervals which are even near optimum. We must be modest and practical. We must lower our sights.

This paper attempts to show the main sources of our ignorance about instrument behavior and about the influence of a calibration control system on instrument behavior and on our evaluation of this behavior. It offers seven keys to the establishment of an efficient method for calibration interval adjustment. Emphasis is on efficiency, practicability, economy. The purpose of adjusting calibration intervals is to maintain a given level of instrument quality level at the lowest cost. Having found a satisfactory calibration interval adjustment method, one should look to other components of the entire calibration control system for opportunities to lower costs.

Intervals by exception, J. Glassman, *SP335*, pp. 65-72 (Mar. 1971).

Key words: Calibration intervals; exponential distribution; reliability, systems effectiveness, tradeoffs.

"Intervals by exception" is a new approach devised at the Navy Metrology Engineering Center to control the evaluation and adjustment of calibration intervals for the Navy Calibration program. It furnishes management with a powerful tool with which to monitor calibration intervals and assure reliability of equipment.

What are some of the interesting features of this new technique?

(1) It enables management to concentrate on problem equipment by pinpointing "dogs" and "gems," i.e., statistically poor and statistically good equipments.

(2) It allows management to select "optimum" intervals based on automatically derived reliability tradeoffs.

(3) It motivates laboratory personnel by providing an information feedback loop for problem instruments.

(4) It lowers operating costs by funneling analysis and engineering effort into the areas of greatest needs and most promising returns.

(5) It lowers costs by lengthening intervals on family types and stabilizing reliability levels.

(6) It provides automatic computer monitoring of all decisions (cause-effect feedback).

This system is presented with charts that illustrate its operation, outputs, and management-oriented controls. The presentation includes data analyses, adjusting of intervals, detection of "dogs" and "gems," resultant changes in system operating characteristics, underlying mathematical assumptions, and mathematical models.

Optimizing calibration intervals, D. J. Greb, *SP335*, pp. 73-79 (Mar. 1971).

Key words: Data support; fixed calibration interval; instrument reliability; statistical validitv; two-method optimization.

This paper describes a two-method system for using simple attributes calibration data to adjust and optimize calibration intervals. Each method is used only where its superior characteristics predominate; the combination of methods produces a total system which exploits the advantages of each without having to suffer with the disadvantages. The "fixed interval through data" method is employed where there are at least 27 bits of data, the application being unique in that the data is treated as a random sample from an infinite population, sampling variations are accounted for, and all decisions to extend calibration intervals are characterized by statistical validity. When there are only from 5 to 26 bits of data, statistical validity is not possible and the "fixed interval through engineering intuition" method is utilized. However, intuition and judgment are applied only to a set of decision rules, and strong, specific data support is required. The system has not been extended to less than 5 bits of data, although there would seem to be no problem in so doing. Net results in the first 18 months of use are 495 changes involving 34,200 units, with annual savings of 24,100 technician hours, and with no noticeable deterioration in overall instrument reliability.

Optimum cycles determined with confidence, P. A. Seamans, *SP335*, pp. 81-84 (Mar. 1971).

Key words: Calibration histories; equal likelihood; oscilloscopes; RX meters; vacuum-tube voltmeters.

The calibration history of a family of instruments provides data on how often the instruments were recertified and whether each was in calibration when recertified. These data permit the calculation of the optimum calibration interval for a desired level of confidence in the instrument readings. Three case histories (oscilloscope, RX meter, VTVM) show this method is effective. The histories of a family of oscilloscopes over a thirteen-year period show that calibration cost tends to be roughly constant with time and thus does not seem to follow the "bathtub curve." All instruments investigated seem to have equal likelihood of failure in all intervals, and thus the bathtub curve does not seem to hold in general.

Breakthrough techniques for metrology work, L. B. Wilson, *SP335*, pp. 85-88 (Mar. 1971).

Key words: Managerial breakthrough techniques; personnel selection for metrology; steady control versus sudden change.

Metrology work involves the conflicting and diametrically opposed problems of control versus breakthrough. Controls are vital to assure accuracy and reliability. However, breakthroughs are necessary to provide improved accuracies, ranges, and types of measurements. The dichotomy of this situation comes principally from the differences in attitudes involved. Ideally, control and breakthrough should be carried out by two different types of people because of these differences.

Breakthrough techniques, coupled with proper attitudes and a systematic method for establishing objectives and evaluating alternatives, provide a powerful set of new tools for improvement. Examples are given showing the possibilities for applying these tools to reduce costs and provide needed measurement and calibration services.

Data system for improving instrument reliability, F. J. Dyce, *SP335*, pp. 99-104 (Mar. 1971).

Key words: Calibration data system; calibration interval adjustment method; instrument reliability; instrument standardization.

This paper discusses the importance of monitoring and control of instrument reliability. It suggests that a minimum reliability level be set as a goal. It discusses the interval adjustment scheme used at Martin Marietta wherein individual instrument performance determines calibration interval as well as repair and surplus. A thorough explanation is given of the computerized data system used at Martin Marietta to monitor instrument reliability and to isolate repetitive problem areas. Several examples are given of reliability problems which were solved through use of the system.

A unique standardization committee is discussed which justifies the company's sole-source purchase of general-purpose, reliable electronic test equipment.

The paper concludes that striving towards a reliability goal will result in improved reliability and reduced cost.

The importance of visibility and control in laboratory management systems, J. L. King, *SP335*, pp. 95-98 (Mar. 1971).

Key words: Data for decision; standards laboratory management; test equipment records; use, storage, or surplus.

The Test Equipment Control Engineering Section has overall responsibility for 2719 different models of 40,000 items, from purchase to final disposition. Computerized system shows decision-makers the history of costs, locations, and interface with operations; yields savings of $800,000 per year.

The new state standards program, R. Mills, *SP335*, pp. 89-94 (Mar. 1971).

Key words: Length measurements; mass measurements; metrology; standards; state laboratories; volume measurements.

In 1965, Congress appropriated funds for new state standards and instruments in mass, length, and volume. The laboratories receiving this package are, in most cases, under the administration of state offices of weights and measures. These labs not only check the accuracy of field standards used by weights and measures inspectors, but also serve as local measurement centers to perform industrial tests. The equipment and training given to laboratory personnel are described in this paper, as well as some of the administrative details and the utilization we foresee for the state laboratories.

New U.S. Air Force audit program, L. W. Root, *SP335*, pp. 105-109 (Mar. 1971).

Key words: Audit examinations; audit package; Precision Measurement Equipment Laboratories (PMEL); technician skills; U.S. Air Force.

This paper describes a unique quality assurance audit program used for testing worldwide Precision Measurement Equipment Laboratories (PMEL's). Conventional methods utilized during previous audits are examined briefly and disadvantages noted. The advent of highly sophisticated systems and test equipment has placed increased emphasis on the experience and skill level of the technicians who provide calibration support at PMEL's. Specific configuration of a unique package designed to evaluate this skill level is discussed in some detail and results obtained during the past year are presented.

NPL work on the determination of $2e/h$ by the ac Josephson effect, B. W. Petley and K. Morris, *SP335*, pp. 111-115 (Mar. 1971).

Key words: Inductive ratio divider; Josephson effect; NPL of UK; potential-divider resistor; quantum standard of voltage; solder-drop Josephson junctions; superconductivity.

The a-c Josephson effect in superconductivity appears to be an exciting possibility for use as a quantum method of maintaining the volt as an SI unit, through the relations $2\ eV = h\nu$. A potential-divider resistor was devised for precise comparison of a Wesson-cadmium cell with millivolt outputs from various solder-drop junctions excited at 36.8 GHz. The value found for $2\ e/h$ is 483.5941 ± 0.0010 $MHz/\mu V_{69NPL}$.

The impact of advanced electronic technology on measurements, R. F. Clark, *SP335*, pp. 117-119 (Mar. 1971).

Key words: Attenuation measurement; automatic data correction; auxiliary receiver for microwave measurements; dual admittance Woods bridge; Engen microcalorimeter; rf coaxial impedance standards.

Advances in electronic technology have made possible significant improvements in both accuracy and precision of measurements. Some comments will be made on the increase in accuracy through automatic application of data corrections (which were previously too difficult to be practicable) and the elimination of many "human" errors. Better precision coming from increased speed of measurement and improved control of the environment of the measurement will be discussed.

Design and development through metrology, P. Prakash, *SP335*, pp. 121-124 (Mar. 1971).

Key words: Designing to specification; fabrication of balances; legal metrology; mass standards; NPL of India.

The National Physical Laboratory of India, in implementing the 1956 Standards of Weights and Measures Act, adjusted and calibrated mass standards of 50 to 10^{-6} kg for 250 State Laboratories. Most of the 5000 balances needed by Inspectors were designed and fabricated by four commercial manufacturers in India, with specifications, technician training, and performance testing supplied by NPL. With this experience, two manufacturers designed and fabricated the higher precision balances for District-level laboratories. The technique is recommended to developing countries faced with similar projects.

Telecommunication measurements for automatic production and maintenance, H. Fleischer, *SP335*, pp. 125-127 (Mar. 1971).

Key words: Automatic noise-level recorders; calibration of carrier-frequency filters; microwave transmission lines; Siemens-Halske AEG; Wandel & Goltermann.

Automatic recorders with uncertainties no greater than 0.1 dB up to 18 MHz are used in one channel of a microwave link to measure effective equivalence and noise level to provide production calibration control for filters and attenuators. Details of two German-made systems are described.

Present status of electrical standards and their traceability in Japan, M. Kanno, *SP335*, pp. 129-132 (Mar. 1971).

Key words: Absolute measurements; basic electrical standards; quantum electric standards; radio-frequency standards.

The national electrical standards for Japan described herein are established and maintained in the Electrotechnical Laboratory. Dissemination is by two public agencies. Committees on traceability and on measuring techniques are active in the Institute of Electrical Engineers.

SP336. **Space simulation.** Proceedings of a Conference held at NBS, Gaithersburg, Maryland, September 14-16, 1970, J. E. Richmond, Editor, Nat. Bur. Stand. (U.S.), Spec. Publ. 336, 985 pages (Oct. 1970).

Key words: Ablation; particulate radiation; re-entry; space simulation; thermal radiation; vacuum; weightlessness.

This volume contains all of the papers presented at the Fifth Space Simulation Conference held at the National Bureau of Standards September 14-16, 1970, that were available for publication. The general scope of the conference was the effect of the space environment on materials, components, structures, and man. The range of topics is too wide to permit a simple classification, but contamination, ablation, degradation of materials by the space environment and predictive testing account for approximately half of the papers presented. Other topics range from purely laboratory problems such as radiometry standards, calibration of vacuum gages, cryopumping and operation of space simulation facilities to gravity simulation, with neutral buoyancy for zero gravity and a man-rated centrifuge for high gravity, use of a drifting submarine to study the psychological aspects of long-duration missions in a space station, and simulation of (1) atmospheric balloon environments, (2) radiation from nuclear power sources, (3) solar wind, (4) micro-meteoroid bombardment, (5) soil friction on the moon, and (6) the Martian atmosphere. *These proceedings include the following papers (indented):*

Molecular contamination in environmental testing at Goddard Space Flight Center, J. C. Goldsmith and E. R. Nelson, *SP336*, pp. 1-24 (Oct. 1970).

Key words: Chemical analysis; contamination; organic residues; outgassing; polymeric materials; residual gas analysis; test facility; vacuum.

A discussion of the various techniques used to detect and analyze materials outgassing from a spacecraft during the environmental test is presented. In addition, a number of compounds that have been detected and their parent outgassing sources are listed. The two major methods for reducing the threat of contamination (i.e., proper choice of spacecraft materials and proper operation of the test facility) are also discussed.

Contamination measurement in space environment simulation chambers, C. M. Wolff and M. L. Ritter, *SP336*, pp. 25-49 (Oct. 1970).

Key words: Contamination collection units; gas-liquid chromatography; infrared spectrometry; mass spectrometry; quartz crystal oscillator mass monitors; radiometry; reflectometry; space environment simulation chambers.

Contamination measurement is classified according to the requirements; i.e., the identity, sources, and effects of contamination by active and passive sampling. The chemical nature of the most common contaminants found in space environment simulation is discussed. Qualitative and quantitative techniques for contaminants analyses are described and evaluated. These techniques include mass spectrometry, quartz crystal oscillator mass monitors, infrared spectrometry, and gas-liquid chromatography. Also, the uses of optical surfaces and thermal control coatings as contaminants effects monitors are described.

Contamination studies in a space simulated environment, D. L. Enlow, *SP336,* pp. 51-77 (Oct. 1970).

Key words: Absorption; condensation; contamination control; evaluation; far infrared; fluid dynamic force; microorganisms; optical properties; planetary quarantine; polymers; shock force; space simulation; testing; volatile products.

Biological and optical contamination problems can be best investigated experimentally. Studying the dynamics of microorganisms in a vacuum environment showed that shock forces in the order of a 1000 g's will liberate 20 percent of the previously bound particles and the effect of simulated attitude control gas jet firing will remove more than 50 percent of the bound particles.

A potential source for optical degradation to infrared systems is identified as the absorption phenomena of condensed volatile products from certain polymeric materials. The effects of this condensation were analyzed by a combination of surface photography and IR spectroscopy. These preliminary investigations point out the need for proper materials selection for far infrared space-borne optical systems.

External spacecraft contamination modeling and countermeasures, T. Baurer, M. H. Bortner, I. M. Pikus, and A. M. Cooper, *SP336,* pp. 79-103 (Oct. 1970).

Key words: Contamination; mass transfer; spacecraft.

The problem of spacecraft external contamination is a function of both the spacecraft and the receptors, in relation to the natures and quantities of contaminants involved, i.e., the problem depends on both design and mission. The relevant phenomenology may be conceptualized in a model which assumes that a mass-transfer mechanism is operative, including sources, transport modes, and sinks. Typical sources include engine debris, jettisoned wastes, outgassing, and cabin leakage. Gaseous contaminant transport is based on the complex interaction of gas-surface interaction potentials and hydrodynamic, electrostatic, and magnetic fields. Condensed-phase materials are subject to hydrodynamic coupling, induced polarization, and electrostatic field effects. The sink or deposition mechanism assumes differential charge development on conducting (e.g., vehicle skin) and dielectric (e.g., windows, lenses) external surfaces, such as to cause preferential attraction to the latter. The net electrostatic potentials at the dielectric surfaces cause charge neutralization of impinging ions, followed by bonding, scattering, and desorption. Impacting particulates adhere or scatter at the dielectric surface depending on the relative magnitudes *of local surface potential,* strength of induced dipoles, and particle velocity vectors normal to the surface. Flowing and adhering contaminants continually cover the surface, preserving its dielectric nature. This model suggests the applicability of at least three complementary approaches to the problem of counteracting contamination, viz., passive prevention of the appearance of contaminants, active removal measures during the transport of contaminants which do appear, and means of counteracting or discounting the effects of contaminants which complete their transit to sensitive surfaces.

Particulate contaminant measurement by quartz crystal microbalance, R. L. Chuan, *SP336,* pp. 105-111 (Oct. 1970).

Key words: Particulate sampling; quartz crystal microbalance; spacecraft contamination.

A piezo-electric crystal executing vibrations in a shear mode can be used as a mass balance with very high sensitivity. Various methods have been used by investigators in diverse fields to bring the mass to be measured to such a balance. Some of these are: absorption of a gas into the surface of the crystal; condensation of a gas onto a cooled crystal; chemical reaction with material bonded to the crystal surface; and impaction of particulate matter onto the crystal surface. The present paper deals with this last mass-accretion mechanism as applied to the measurement of contamination in the form of particulate matter present in space environment (actual and simulated).

The QCM (quartz crystal microbalance) responds to a mass change on its surface typically in the following manner: $\Delta f = -Cf^2\Delta m$, where Δf is the change in the crystal resonant frequency f due to the addition of mass Δm, and C is a constant whose magnitude is about 10^6. For a nominal frequency of 10^7 Hz the sensitivity, $\Delta f/\Delta m$, is of the order of 10^8 Hz/gm, from which it is seen that the mass resolution of the QCM depends directly on frequency resolution. Frequency resolution, in any given oscillator, depends on the characteristic time within which measurements are taken – the resolution generally degrading as the time increases. Thus for small mass change occurring in a long time (by which we mean seconds or tens of seconds) the frequency resolution is commonly not better than about 0.1 to 1 Hz for a 10^7 Hz oscillator. However, if the characteristic measurement time is less than, say, 10^{-2} sec, the frequency resolution can be quite good – being of the order of 10^{-2} Hz or better. This consideration lends itself to the sensitive and accurate measurement of discrete particulate mass, because when such a mass is deposited on the crystal there is an almost instantaneous, though small, frequency shift. By utilizing this very high rate of frequency shift it is possible to measure particulate mass down to the order of 10^{-11} gm. This is equivalent to a single particulate of 2 micron diameter with mass density 2 gm cm^{-3}.

In addition to measuring the mass of particulate matter, the technique also provides information on whether the material is volatile. If subsequent to its impaction onto the crystal surface, with an accompanying frequency shift, the particulate material evaporates, there will not only be a loss of mass but, more importantly, there will be cooling of the crystal. The crystal can be chosen so as to exhibit a frequency change of a sign opposite to that caused by mass addition. Then the instantaneous frequency change caused by the impaction of particulate will be followed closely by an opposite frequency change due to evaporation.

Experimental data will be presented showing the response of the QCM to nonvolatile and volatile particulate matters.

Space measurements of the contamination of surfaces by OGO-6 outgassing and their cleaning by sputtering and desorption, D. McKeown and W. E. Corbin, Jr., *SP336,* pp. 113-127 (Oct. 1970).

Key words: Cleaning; desorption; ions; outgassing; quartz crystal microbalance; solar panels; space; sputtering; surface contamination.

Results of the contamination of surfaces by outgassing of the OGO-6 satellite and the rates at which these surfaces are now being cleaned by sputtering and desorption after being in space for five months are given. The contamination measurements are being made with a quartz crystal microbalance to define the conditions of Al and Au surfaces used in an experiment to measure gas-surface energy transfer. It was found that the primary source of outgassing on the satellite was its two solar panels baking out in the sun. The time constant for the exponential decay of the outgassing is 1,000 hours. The maximum amount of contamination adsorbed by the surfaces exposed to the outgassing was reached after five months in orbit and is 96 mg/m^2 for the Al surface and 52 mg/m^2 for the Au surface. The contamination has a desorption activation energy of 26 kcal/g mol which falls into the energy range of materials, such as, epoxies and vacuum oils. The surfaces are now undergoing cleaning by desorption at 1.2×10^{-9}g/m^{2}s and sputtering by upper atmospheric neutral impacts at 2.3×10^{-9}g/m^{2}s. A method to greatly increase the cleaning rate by removal of the contamination by sputtering with upper atmospheric ions is discussed.

Simulation of radiation from RTG power sources, P. A. Newman, Jr., *SP336*, pp. 129-140 (Oct. 1970).

Key words: Evaluation; MOSFETS; neutrons; Pu^{239}-Be; radiation simulation; RTG; test.

The recent interest in Radioisotope Thermoelectric Generator (RTG) power systems for deep space missions and the ever increasing use of the radiation sensitive MOSFET in spacecraft electronics has made it essential that an assessment of the radiation effects for this combined application be determined. An RTG with its continuous flux of neutrons and gamma photons provides a long term hostile environment for electronic components. This paper deals with a radiation source (Pu^{239}-Be) selected to simulate, for the most part, the neutron effects of the RTG. Preliminary experiments with this source have indicated that for most electronic applications the neutron contributions of the RTG over a five year mission in present spacecraft configurations will not be a major problem. An analysis of the data from several experiments indicate that predictions of the radiation effects can be made for "hotter" configurations with a reasonable degree of confidence.

In situ vacuum gauge calibration by the reference transfer method, L. D. Blado and R. H. Lilienkamp, *SP336*, pp. 141-150 (Oct. 1970).

Key words: Reference transfer method; vacuum gauge calibration.

Application of the Reference Transfer Method to in situ calibration of ionization gauges was evaluated in order to ascertain the effectiveness of the method when applied in a manner determined both by the commercial availability of equipment and by the restraints of an operating space environment simulation facility. A prototype Reference Transfer Calibrator (RTC) was assembled from standard vacuum components. Transfer ratio determinations were made in the range 10^{-4} to 10^{-8} torr. These experimental measurements were then compared with theoretical calculations, thereby verifying the feasibility of the technique.

Methods of determining residual gas composition from residual gas analyzer data, R. H. Lilienkamp, *SP336*, pp. 151-164 (Oct. 1970).

Key words: Mass spectrometry; residual gas analysis computer simulation; residual gas analysis data reduction; space vacuum system gas.

Three methods of determining residual gas composition from Residual Gas Analyzer (RGA) data are compared using a computer simulation of an RGA to generate the data for analysis. Typical vacuum system gas mixtures and errors from shot noise were simulated. Errors were also introduced into the calibration data used to interpret the RGA data. The first method is an iteration technique which proved to be inferior to the other methods. The second is a matrix inversion method which worked well for the gases used in this study but which must be evaluated for each gas mixture. The third method is a multiple regression analysis giving least squares fit to the data. This method uses all of the data from the RGA and is usable with any mixture of gases. The effect of the calculation of the residual gas composition is also shown.

Spectral absolute reflectance measurements of CO_2 frosts in the 0.5 to 12.0 micron region, B. E. Wood, A. M. Smith, B. A. Seiber, and J. A. Roux, *SP336*, pp. 165-183 (Oct. 1970).

Key words: Absorbing; anomalous dispersion; carbon dioxide; cryodeposit; cryogenics; frost; infrared; integrating sphere; Mars; reflectance; scattering; simulation; spectral.

In situ absolute reflectance measurements have been made for carbon dioxide frosts formed on liquid-nitrogen cooled substrates. Data were obtained spectrally in the wavelength range from 0.5 to 12.0μ using an infrared integrating sphere. CO_2 frosts were found to exhibit an anomalous dispersion reflectance peak at 4.3 microns which was shown to be a very sensitive indication of the presence of solid CO_2. Also CO_2 frosts scatter short wavelength radiation ($\Lambda < 1.0\mu$) significantly and is semi-transparent for much of the wavelength range between 2.0 and 12.0. The application of these results to problems associated with cryogenically cooled surfaces is discussed.

NBS radiometric standards—present and future, H. J. Kostkowski, *SP336*, pp. 185-187 (Oct. 1970).

Key words: Irradiance; radiometric standards; radiometry; spectral irradiance; spectral radiance.

One of the primary functions of the National Bureau of Standards is to realize, maintain and disseminate national standards of measurement. In radiometry, the currently available standards consist of various types of tungsten lamps or blackbodies that have been calibrated in terms of spectral irradiance, or total irradiance.

The standards of spectral radiance are either tungsten strip lamps or blackbodies, have temperatures from 500 to 3000 K, and are calibrated, depending on the temperature and source, from 0.2 to 15 μm. Their uncertainty varies from about 0.1 to 5% depending on the temperature and wavelength. Two additional, useful standards that do not require calibration and are available commercially are the graphite arc and the copper-point blackbody.

At present, there are two standards of spectral irradiance. The first is a 1000-watt coiled coil tungsten filament quartz-halogen lamp and the second consists of this lamp mounted in a ceramic reflector. Their spectral irradiances at a wavelength of 0.9 μm and working distances of 50 and 40 cm are about 25 and 105 μw cm^{-2} nm^{-1} respectively, and they both vary with wavelength roughly as a 3200 K blackbody. These standards are uncertain by values ranging from 3% at 2.5 μm to 8% at 0.25 μm. However, a research effort is now under way which is expected to reduce these uncertainties within a year by a factor of about 3.

The standards of total irradiance consist of the same lamps used for spectral irradiance standards and in addition 100, 500, and 1000 watt projection lamps. They have irradiances varying from about 0.5 to 135 mw cm^{-2} at working distances from 100 to 40 cm. The uncertainty of these sources has been estimated to be about 1%.

Radiometric detectors that can be calibrated electrically are becoming commercially available and appear useful in replacing irradiance source standards for some applications, particularly at the upper levels of approximately 100 mw cm^{-2}. Such absolute or calorimetric detectors, as they are sometimes referred to, are being developed and extensively evaluated at NBS. An uncertainty and reproducibility of a few tenths of a percent is anticipated for some models of these detectors.

A description of the standards, of how they are realized, of current attempts and limitations in extending their range or reducing their uncertainties, and the present NBS policy for their dissemination will be included in the verbal presentation.

Apparatus for laboratory simulation of ionospheric flow over on-board instruments of an AES, E. N. Evlanov, V. B. Leonas, and S. V. Umansky, *SP336*, pp. 189-196 (Oct. 1970).

Key words: Apparatus; beam diagnostic; ion source; ion transportation; laboratory space simulation; vacuum system.

An apparatus for a simulation of ionospheric plasma flow over on-board instruments of an artificial earth satellite (AES) is described. The simulated fluxes of nitrogen, hydrogen, and other ions have energies in the range of 5 -10^2 eV, current density of $1 \cdot 10^{-8}$ A/cm and provide good simulation of the natural working conditions of on-board instruments. A description of diagnostic means which are used for analysis of the flow parameters is given.

Thermal conductivity measurements of a candidate Viking heat-shield material after sterilization, and during exposure to vacuum, and to a simulated Martian atmosphere, L. R. Greenwood and R. M. Fleming, *SP336*, pp. 197-208 (Oct. 1970).

Key words: Ablation material; thermal conductivity; vacuum effect.

An experimental program has been conducted to measure the thermal conductivity of the proposed Viking heat-shield material, Martin SLA-561, after sterilization (60 hours at 276 °F) and during exposure to vacuum and to a simulated Martian atmosphere (74.4 percent CO_2, 12.8 percent N_2, 12.8 percent Ar). In situ thermal conductivity measurements were made at 75 °F using the line-source technique. The thermal conductivity of SLA-561 was measured to be 0.0298 Btu/ft-hr-°F at atmospheric pressure. In the first environmental sequence consisting of atmosphere, vacuum, and simulated Martian atmosphere exposure, a 60-percent reduction in thermal conductivity was measured in vacuum. After a 4-hour exposure to a 7-torr pressure in the simulated Martian atmosphere, the thermal conductivity increased 67 percent from the value measured in vacuum. The second environmental sequence consisted of measurements in the atmosphere, after sterilization and during exposure to vacuum and the simulated Martian atmosphere. The results of these measurements showed that sterilization had no effect on the thermal conductivity measured at atmospheric pressure nor on the changes measured in vacuum and in the simulated Martian atmosphere. Thermal conductivity was measured at varying pressures during both environmental sequences and the results showed the thermal conductivity to be essentially independent of pressure below 10^{-4} torr with the transition from molecular to continuum flow occurring in the 10^{-2} to 10 torr pressure range.

Method for rock property determination in ultrahigh vacuum, E. R. Podnieks and P. G. Chamberlain, *SP336*, pp. 209-223 (Oct. 1970).

Key words: Anisotropy; compression tests; mass spectroscopy; mechanical properties; outgassing; pressure measurements; rock mechanics; space environment simulation; ultrahigh vacuum.

A special ultrahigh vacuum system was designed for determining deformational and strength properties of simulated lunar rocks. The system provides a vacuum of 10^{-9} to 10^{-10} torr (10^{-7} to 10^{-9} N/m^2) depending on the specimen size and rock type. The vacuum was measured by various types of gages and also by ion pump current measurements. The partial pressure measurements of the various gas components were obtained by a quadrupole residual gas analyzer. The vacuum chamber has two stainless steel bellow-type feedthroughs for loading and a spring mechanism to compensate for the atmospheric pressure effect on the rock specimen. The uniaxial load was applied to the specimen by a servo-controlled hydraulic testing machine. Specimens of tholeiitic basalt, dacite, and semiwelded tuff were used. Special procedures in specimen preparation and preconditioning were developed. During the pumpdown period, prolonged roughing and an initial bakeout produced significantly low final pressures in the chamber. Test data presented include a typical load-deformation curve from rock specimen in ultrahigh vacuum, outgassing characteristics during loading in terms of pressure variation, and changes in the composition of gases being released by the specimen.

Friction between solids and simulated lunar soils in ultrahigh vacuum and its significance for the design of lunar roving vehicles, L. L. Karafiath, *SP336*, pp. 225-244 (Oct. 1970).

Key words: Adhesion; basalt; fiberglass; friction; steel; titanium; ultrahigh vacuum.

The initial and kinetic friction between various solids and ground basalt, simulating the lunar soil, was measured in ultrahigh vacuum with a rotating disk-type apparatus designed for this purpose. Pressures below $p = 10^{-9}$ torr have been routinely reached with the vacuum system consisting of a turbomolecular, a getter-ion and a liquid-N_2-cooled titanium sublimation pump. The testing program included tests with steel, titanium, and fiber-glass disks and ground basalt in two particle size ranges, coarse (250-500μ) and fine (38-62μ). The experimental results show that both the initial and kinetic friction invariably increase in ultrahigh vacuum. For the range of normal stresses applied in the experiments, the total kinetic friction was highest for fiberglass followed by titanium and steel; the total initial friction was highest for fiberglass followed by steel and titanium.

Real time simulation of atmospheric balloon environment, A. J. Paillous and M. Roussel, *SP336*, pp. 245-259 (Oct. 1970).

Key words: Atmospheric environment; balloon; computer; ozone; plastic material; simulation; solar ultraviolet radiation.

A simulation chamber was designed in order to study the behaviour of several balloon materials during long time flights. Solar ultraviolet radiation, pressure, temperature and atmospheric composition are the simulated constituents of the atmospheric balloon environment. Samples are irradiated without mechanical strain. A computer program, taking the values of different parameters (of the environment and of the material) against wavelength into account, gives the information for conducting the simulation. Experiments are performed in real-time. Exact ultraviolet energy doses, in each spectral wavelength interval, between 300 and 410 nm, are delivered every day to samples. A night-day cycle is simultaneously achieved with a thermal cycle.

Analysis of the simulation of the solar wind, D. E. Zuccaro, *SP336*, pp. 261-277 (Oct. 1970).

Key words: Charge exchange; charge neutralization; ion optics; mass separators; proton sources; solar wind; sputtering; ultrahigh vacuum systems.

This analysis surveys the properties of the solar wind, establishes a set of requirements for solar wind simulation, and develops a conceptual design of a simulator system. The significant features of the design are the following. The protons are formed in an r-f excited plasma discharge ion source. A 20° deflection magnetic mass separator is used to purify the proton beam of other ions, energetic charge exchange neutrals, and Lyman alpha photons. The use of a small diameter beam permits differential pumping of the ion source and the sample chamber. The proton beam either can be expanded to flood the sample, or it can be scanned over the sample.

Solar wind simulator, H. J. King, *SP336*, pp. 279-296 (Oct. 1970).

Key words: Ion beam deflection; ion optics; mass separator; proton source; solar wind simulator.

It is necessary to expose samples of thermal control coating materials to a proton flux in the laboratory in order to estimate the stability of their reflective and absorptive properties when exposed to the solar wind. The choice of the ion source, mass separator, and beam transport system which make up an experimental apparatus to perform these tests is discussed. A final system design is presented which is capable of irradiating 10 standard samples 2 cm in diameter with a proton beam ranging in energy from 0.5 to 3.0 KeV and in intensity from 1 to 1000 times that of the nominal solar wind.

Laboratory experiment on solar wind interaction with geomagnetic field, E. M. Dubinin, G. G. Managadze, and I. M. Podgorny, *SP336*, p. 297 (Oct. 1970).

Key words: Earth magnetic field; earth tail; magnetosphere; plasma theory; shock wave; solar wind.

It is impossible to reproduce in a laboratory all phenomena which exist at the interaction of the solar wind and the Earth magnetic field. In previous works it was shown that choice of experimental conditions permits one to simulate some of the most interesting effects, for example, the collisionless shock near the Earth magnetosphere. According to the principle of limited simulation, to reproduce the magnetosphere and the collisionless shock the parameters of the artificial solar wind should be: plasma density—n $= 10^{13}$ cm^{-3}, electron temperature—$T_e = 15-20$ eV, embedded magnetic field—B ~ 40 Oe, ion temperature—T_i· ~ 5 eV, stream velocity—$V = 3 \cdot 10^7$ cm/sec.

At these conditions the plasma flux compressed the dipole magnetic field on the day side and formed a configuration of the magnetic field similar to the magnetic field of the Earth tail. Between the artificial magnetosphere and the plasma flow the collisionless shock is displayed. The thickness of the shock is in agreement with plasma theory and has the same order of magnitude in dimensionless expression as in space measurements. In the shock high level magnetic field microfluctuation was discovered. The dimension of the fluctuations is about that of the Larmour radium of ions. The microfluctuations were predicted in plasma theory as a result of Alfven and magnetosound instability.

In addition to the shock investigations, measurements of the plasma density, velocity and magnetic field strength were carried out before and behind the shock.

Effect of photodegradation on organic coatings, P. J. Hearst, *SP336*, pp. 299-312 (Oct. 1970).

Key words: Atmospheric exposure; ATR spectroscopy; clear and pigmented films; infrared analysis; internal reflection spectroscopy; mercury-arc irradiation; organic coatings; photodegradation; surface degradation; volatile degradation products; xenon-arc irradiation.

Clear and pigmented coating films were irradiated with a mercury arc, a xenon arc, and sunlight. Strips of the free films, consisting chiefly of alkyd, vinyl, and epoxy coatings, were exposed in a quartz chamber. The major volatile product, as determined by infrared spectroscopy, was carbon dioxide, but the products varied depending on the irradiation, the pigmentation, and the type of coating. Internal reflection spectra indicated primarily the formation of carbonyl groups, and the greatest changes were obtained for coatings that did not have high initial carbonyl absorption.

Relation between dose rate effects and laboratory simulation of space radiation damage, A. Roizès and R. Schuttler, *SP336*, pp. 313-321 (Oct. 1970).

Key words: Defect annealing; impurities; silicon; space simulation.

The experimental simulation of space radiation damage is usually done on a much shorter time scale than the satellite lifetime. The defect annealing in the semiconductor may lead to an overestimation of the real space degradation; indeed the irradiation time may be of the same magnitude order than the annealing time constant. Cleland's experiments on germanium show that for a sufficient dose the defect number electron induced may be half as much in the long irradiation case than in the shorter one.

The higher density of punctual defects introduced by a greater flux rate enhances the production of multiple defects as reducing the production of vacancy-impurity complexes.

Different factors that can influence the defect center distribution are analysed in the range − 100 to + 100 °C.

It is shown that to improve the device hardness against radiation, we must study the production rate of defects in the bulk material coming from different growing methods and makers, as we know that the damage depends on impurity constant.

Moreover a second improvement can be reached by annealing enhancement. Thus we must choose a material whose defect annealing temperature is as near as possible than the device temperature operation. A combination of these two requirements can help to select an optimal crystal for devices in space environment.

It is shown that with a better knowledge of the recovery process it will be possible to simulate long irradiation time with reasonable operation time of a particle accelerator by irradiating devices at a controlled temperature higher than the usual temperature operation.

For example, calculations made on the E center defect (vacancy—phosphorous association) show that one year irradiation at 300 K can be simulated with the same dose, in one hour irradiation at 400 K.

We deduced that in a room temperature simulation the number of defects, in this case, is overestimated by about 50% approximately.

Some problems concerning the simulation of plastic films degradations by ionizing radiations, A. J. Paillous and Ph. Fayet, *SP336*, pp. 323-344 (Oct. 1970).

Key words: Electron damage; electron energy; electron spin resonance; evaluation; gel; mechanical properties; optical properties; plastic films; poly(ethylene terephtalate); proton damage; proton energy; radiation effect; radiation intensity; recovery; solubility; space simulation; temperature effect; tests; viscosity.

Simulation in the laboratory, of the action of polyenergetic proton- and electron-fluxes encountered in Space is necessary for a convenient estimate of polymeric film materials. In order to select the best simulation conditions, the following points were experimentally investigated on poly(ethylene terephtalate) films, irradiated in vacuum by 1.5 MeV-protons and by 0.35-, 0.6-, 2.0 MeV-electrons: a) dose rate effects; b) effects of interruptions during irradiation (samples being kept in vacuum); c) recovery during post-irradiation exposures to air or to vacuum; d) effect of the sample temperature during irradiation; e) effect of particles' energy; and f) effect of the particles' nature.

It appears that accelerated tests in a vacuum can be used to predict the damage created during missions in Space which are of a longer duration than that of the tests themselves. Electron damage in Space can be simulated by a monoenergetic electron irradiation which introduces into the sample the same absorbed energy dose than the computed dose which would be absorbed in Space. For plastic films there is no practical equivalence in the effects of proton- and electron-irradiation, except for the optical transmission properties. The need for an in situ testing of mechanical and optical properties is outlined.

Ultraviolet and charged particle degradation of aluminum and silver coated FEP teflon second surface mirrors, F. G. Cunningham, B. L. Bean, and S. G. Park, *SP336*, pp. 345-358 (Oct. 1970).

Key words: Aluminum coated teflon; electron degradation; proton degradation; silver coated teflon; teflon film; ultraviolet degradation.

An experimental program has been undertaken in which bare FEP Teflon films were subjected to ultraviolet irradiation and charged particle bombardment, and in which five mil aluminum and silver coated FEP Teflon films were: i) ultraviolet irradiation in vacuum and oxygen; ii) irradiated with 5, 10 and 25 or 30 KeV electrons and protons; and iii) exposed to simultaneous ultraviolet-proton and ultraviolet-electron bombardment.

The charged particle irradiations indicate that a measurable change occurs in the spectral reflectance of both silver and aluminum backed material at a dose of about 1×10^{15} particles/cm^2, and that this degradation increases as the total dose is increased. This spectral reflectance change appears first and is the most pronounced in the ultraviolet for a given total dose. At a total dose of 1×10^{16} particles/cm^2 the surfaces generally look cloudy and oftimes mottled. Upon closer examination this mottling is found to be due to the presence of Litchenberg figures within the teflon—especially in the case of electron irradiation—which are caused by charge storage and subsequent electric discharge. The calculated changes in integrated solar absorptance generally agree with those reported by other observers. The ultraviolet results confirm that silver coated teflon is stable when irradiated in vacuum and indicate that aluminum coated material undergoes a small decrease in integrated solar absorptance (i.e., an improvement) when so irradiated.

The interaction of low energy electrons with polymeric perfluorinated ethylenepropylene (FEP), J. B. Schutt, *SP336*, pp. 359-382 (Oct. 1970).

Key words: Degradation mechanising; electron bombardment; electron degradation; polymeric perfluorinated ethylenepropylene; proton bombardment; thermal control coatings.

Photomicrographs are presented showing the effects of 30 KeV electrons on FEP. Depicted are Lichtenberg patterns, bubbles and a buckling effect. The attempt to explain these observations is derived from a theoretical analysis based on a diffusion mechanism for charge flow using beam current as a source term. The solution is used to demonstrate that charge is stored centrosymmetrically with respect to ground. These effects are discussed in terms of an "electrolysis" mechanism resulting from charge storage and beam energy thermalization. Explicit expressions are given for surface charge storage and voltage across the sample resulting from such charge accumulation. Buckling is treated from a thermodynamic basis using the Helmholtz free energy and assuming the distortion develops isothermally. "Electrolysis" is postulated via a mechanism selecting the tertiary carbon as the active site for mobile moiety generation.

The usefulness of optical data for purposes of thermal design taken from samples irradiated with low energy electrons in the laboratory is questioned. Because FEP is an electrical insulator, these experiments must, therefore, be carried out in a neutral laboratory environment, or be characterized in the space environment from carefully designed electrical experiments.

The degradation of Alzak by short wavelength ultraviolet radiation, M. J. Donohoe, R. McIntosh, Jr., and J. H. Henniger, *SP336*, pp. 383-392 (Oct. 1970).

Key words: Alzak; thermal control coatings; ultraviolet degradation; vacuum UV.

Experimental evidence is presented to further support earlier findings on the UV induced degradation of Alzak, which was found to be inversely proportional to wavelength between 220 and 300nm. UV and vacuum UV exposures at selected wavelengths between 123.6 and 300nm indicate degradation to be inversely proportional to wavelength down to 185nm. Equivalent exposure to 123.6nm radiation however, produced less degradation indicating a change in the damage dependency below 185nm. Degradation of up to 12% change in reflectance at 295nm is reported for Alzak exposed to less than 50 equivalent sun hours of vacuum UV radiation.

The photo-response at an alkaline paint interface with aluminum, W. A. Wappaus, *SP336*, pp. 373-402 (Oct. 1970).

Key words: Alkaline paint; conduction of paints during ultraviolet exposure; electrode potential of paints; photo degradation; thermal control coatings; ultraviolet degradation.

When a spacecraft coating comprised of aluminum oxide and potassium silicate is applied to an aluminum alloy (6061) substrate and subsequently partially coated with evaporated gold electrodes, a measurable potential is developed between the substrate and the gold electrodes. This effect is observed when the coating is in darkness and in vacuum. A dark current is also observed. Prior to observation, the specimen is heated in vacuum to 150 °C for 24 hours.

When the coating is irradiated in situ with UV shorter in wavelength than 3600 Angstroms, the current and voltage is found to increase. Upon exposure to prolonged irradiation this current level decays exponentially with time. The voltage similarly decays with time in an exponential manner indicating that photo-degradation of the electronic transport properties is occurring.

The transport mechanism proposed to account for this behavior is a migration of protons toward the aluminum substrate and negative hydroxyl ions toward the gold electrodes resulting in the electrolysis of water in the coating! In the presence of UV this process is accelerated resulting in an increased current flow of three orders of magnitude. Since the current flow during UV radiation decays exponentially, this suggests a diffusion limited process.

Plans and status of NMAB ad hoc committee on testing for prediction of material performance in structures and components, R. S. Shane, *SP336*, pp. 403-404 (Oct. 1970).

Key words: Combined environments; components; material performance; predictive testing; structures.

National Materials Advisory Board—National Research Council—National Academy of Sciences—*ad hoc* Committee on "Testing for Prediction of Material Performance in Structures and Components"—Interim Report.

At the request of the Office of the Director of Defense Research and Engineering, the National Materials Advisory

Board of the National Academy of Sciences has undertaken to review "Testing for Prediction of Material Performance in Structures and Components."

The basic purposes of the study have been identified as: (a) make a selective survey of the needs for new and/or improved predictive (including accelerated) testing techniques; (b) consider predictive methods for forecasting the performance of materials in structures and components under combined stresses in service; (c) identify the factors of predictive testing and explore approaches for development of methods and techniques of predictive testing; (d) appraise the benefits of predictive testing as well as the risks of predictive testing; (e) provide guidance in establishing a policy for Government and/or Industry interaction; (f) recommend mechanisms for implementing this policy.

An *ad hoc* Committee has been appointed and convened. The principal problem areas appear to be (a) interaction phenomena, (b) design of multi-factor tests which forecast definitively the behavior of structures and components in the presence of known or foreseeable failure modes, involving materials (c) lack of systematic accumulation of existing information so that gaps in needed knowledge become apparent and remedial action can be taken before design choices are irrevocably made, (d) peripheral failure modes are frequently overlooked.

NMAB plans to co-sponsor the ASTM National Symposium on Predictive Testing, Anaheim, California, April 21-23, 1971.

Monitoring service testing by nondestructive testing, R. W. McClung, *SP336*, p. 405 (Oct. 1970).

Key words: Compaction density; eddy current measurements; fuel rods; impregnation density; monitor tests; neutron radiography; ultrasonics; x rays.

Applications of nondestructive testing techniques to monitor tests include the use of x rays with both film and television detection to monitor thermal cycling of fuel rods, neutron radiography on irradiation experiments, eddy-current measurement of space interval between components, and interim monitoring by ultrasonics of the wall thickness of a vessel in a reactor experiment. Studies during fabrication development include multiple interim measurements of compaction density of fuel rods and impregnation density of graphite using quantitative gamma and x-ray attenuation as well as use of eddy-currents to monitor changes in quality of sodium bonding in a fuel rod. Recommended approaches include the use of eddy-current methods to monitor changes in electrical properties, dimensions or flaw character, ultrasonics to measure changes in elastic properties, dimensions of flaw character, penetrating radiation to observe or measure changes in density, or dimensions and other forms of energy for similar applications.

Signature analysis—nonintrusive techniques for incipient failure identification application to bearings and gears, B. Weichbrodt and K. A. Smith, *SP336*, pp. 407-448 (Oct. 1970).

Key words: Bearings; diagnostics; gears; reliability; signature analysis; vibration.

This paper describes how acoustic and vibration signals generated by operating machinery can be used to diagnose its internal condition without using internal sensors which might perturb the system of interest.

It is shown how characteristic "signatures" can be electronically extracted from the overall noise and vibration signals. By interpreting these signatures in the light of engineering knowledge of the machinery under study, it is often possible to identify incipient failure modes long before final failure. This technology opens up many new possibilities to avoid unscheduled maintenance, improve product quality and reduce testing time.

The paper discusses in detail specific applications to bearing and gear diagnostics and shows how the diagnostic process can be electronically implemented and automated. Several other application areas are briefly discussed.

A major part of the work which is reported in this paper was sponsored by the Condition Monitoring Engineering Operation of General Electric's Aircraft Engine Group, for development of jet engine diagnostic systems.

Measurement methods for microcircuits, W. M. Bullis, *SP336*, pp. 449-455 (Oct. 1970).

Key words: Device fabrication; environmental testing; integrated circuits; measurement methods; microcircuits; silicon.

One of the problems encountered with testing in either simulated or real environments is associated with the necessity of demonstrating that the failures observed are, in fact, due to the environment rather than random effects which would occur even in the absence of the environmental stimulus. This problem is particularly acute in the case of high-reliability electronic components such as silicon monolithic integrated circuits. For these parts, desired levels of reliability can be achieved only if all process steps in their manufacture can be carried out in a controlled and reproducible fashion. This paper surveys the status and availability of standard test methods suitable for making the measurements which are necessary to achieve such control. Consideration is given to standard measurement methods appropriate for thin film integrated circuits and hybrid microcircuits as well as those for silicon monolithic integrated circuits fabricated by the epitaxial, planar process.

Life testing using continuous acceleration, E. Rabinowicz and B. Shiralkar, *SP336*, pp. 457-471 (Oct. 1970).

Key words: Accelerated testing; cumulative damage; failure; life testing; mechanical reliability.

One method of carrying out accelerated tests consists of increasing the stress at a uniform rate with time until failure. It is shown that from such tests the life under normal stress conditions can be predicted by plotting the results on a stress-time curve on which the stress axis has been modified so that area represents amount of damage. Tests with electric light bulbs, whose failure obeys a cumulative damage criterion, give good agreement between predicted and measured life. The danger of the continuous acceleration procedure is that the stress may become so high that new failure modes are introduced.

Establishment of an optimum duration for spacecraft component thermal vacuum tests, W. L. Harvey, *SP336*, pp. 473-485 (Oct. 1970).

Key words: Absorption; adsorption; "bake out"; components; decomposition; degassing; environment; evaporation; outgassing; simulation; sublimation; thermal conduction; thermal vacuum tests; volatile constituents; volatilization.

The duration of planetary space missions precludes performing component thermal vacuum tests which simulate the mission time period. Many arbitrary approaches have been taken to establish adequate durations for these tests. This paper outlines an approach which considers the probable effects of the thermal vacuum environment on the components and their constituent materials. In general these effects are found to be related to outgassing rate which is time and temperature dependent. A test cycle is proposed which considers this situation and utilizes any prior "bake out" heat exposure to reduce the test duration to a reasonable period.

Equipment to study high velocity dislocations in materials, V. R. Parameswaran and J. Weertman, *SP336,* pp. 487-508 (Oct. 1970).

Key words: Dislocation velocity; high speed dislocations; impact stress pulse; piezoelectric stress gauge; quartz; slip bands.

The microstructural and physical properties of a material deformed under high strain rates are quite different from those of the slowly deformed material. This is attributed to the motion of a shock front consisting of an array of high speed dislocations through the shock loaded material. An equipment was constructed to shock load single crystals of metals by shooting small steel pellets using a gas gun. The slip bands generated on the surface of the crystals by the stress pulses give a measure of the dislocation mobility in the material. In this paper the equipment used to produce the stress pulses and that used to measure and record the stress pulses are described.

Some effects of equalization on acceleration response and fatigue life expectancy, R. M. Mains, *SP336,* pp. 509-524 (Oct. 1970).

Key words: Acceleration response; evaluation; fatigue life; lumped parameter system; mechanical impedance; random vibration; test; transfer impedance; transmissivity equalization; vibration.

A set of calculations is reported for various transmissibilities of a 10-mass system, intended to be representative of an exciter, fixture, test article arrangement. The difficulties of achieving equalization at some coordinate when it has a transmissibility range of 10^6 or more are noted. By comparison of r.m.s. responses to a level power spectral density input, it is shown that factors of 5 to 10 or more difference in acceleration response result from equalization at different coordinate locations. These differences in r.m.s. response would produce corresponding differences in predicted realtime behavior. The differences in r.m.s. spring stress responses were smaller for various equalization locations, but still large enough that predictions of fatigue life expectancy (for the system used) would be much affected by the choice of equalization location.

Charged particle track implications for accelerated testing, T. M. Flanagan and V. A. J. van Lint, *SP336,* pp. 525-534 (Oct. 1970).

Key words: Radiation damage; radiation testing.

This work considers the ionization effects produced by the passage of energetic particles through material, emphasizing the fact that the ionization is formed along particle tracks rather than being uniformly distributed throughout the material. Thus, the particle track through a material can be visualized as a cylinder centered on the particle path disturbed by ionization and carrier trapping. The dimension of the disturbed region is related to the range of the electron ejected by the ionization event, while the density of carriers within the disturbance depends on the ejected electron range and on the ionization efficiency of the energetic particle. The disturbed regions then relax with characteristic times ranging from the very short to the very long. The dose-rate dependence arises from the relationship of the characteristic relaxation times and the average time for two particles to disturb the same volume. At low doses, each particle track traverses primarily unirradiated material, and the effects are additive. At higher doses, nonlinearities are expected, since particles penetrating a previously disturbed region may find the carrier traps in a different charge state than in virgin material. Another source of nonlinearities is the density of ionization which will vary with particle type and energy. The size of the disturbance around a track varies from 100 to about 2000 Å, depending on the material. This quantity can be used to calculate the average overlap time for a given dose rate. The dose which must accumulate before nonlinearities are apparent can be estimated from the trap density of the material. Each of these factors must be taken into account when planning on assessing simulation of radiation effects.

A simulation to validate future space missions, T. P. Foley, A. W. Metz, and A. W. Yonda, *SP336,* pp. 535-547 (Oct. 1970).

Key words: Simulation; space systems; system test bed.

A simulation tailored to be responsive to the needs of aerospace systems analysts has been developed. The simulation is written in FORTRAN so that it can easily be transferred between different computers. The simulation is modularly structured so that new functions can be simulated and easily added. The level of detail of the simulation of model elements can vary widely. When macroscopic system aspects have been studied and optimal configurations established, then sub-systems of interest can be modeled in greater detail and embedded in the macroscopic simulation for more detailed study. Thus, design engineers can study the performance of their design in a total system environment before hardware is fabricated.

The parameters of the simulation permit the configuration of models rapidly. These can be run against a scenario of input parameters which when varied provide information on system performance. Thus, many different projected system configurations can be quickly exercised and discarded until only a few feasible system configurations remain. These then can be exercised with model elements being more detailed enabling a more comprehensive analysis. Provision is made for entry of errors into the system so that performance characteristics of the system in a degraded state can be studied. The exercising of Executive Program strategies is provided for. Thus, a tool which is oriented toward supporting the systems analysis requirements for studying dynamic system performance has been developed.

General purpose centralized automatic testing for improvement of shipboard system performance, F. J. Zupan, *SP336,* pp. 549-568 (Oct. 1970).

Key words: Data acquisition; data dissemination; data processing; maintenance; operational readiness; performance monitoring; testing.

Increased operational effectiveness of Navy shipboard systems is the primary goal of the Navy automatic testing program. This paper discusses the rationale and techniques utilized in developing an experimental model which will help update and modernize traditional methods and approaches to systems monitoring and maintenance. Developments in acquisition, processing and dissemination of information as related to a centralized on-line performance monitoring system are covered. Both laboratory and shipboard functional tests were performed, with a laboratory model system monitoring typical Navy electronic and non-electronic systems. Test results, a discussion of problem areas, and a prediction of the impact of centralized testing on the shipboard maintenance and operating organization are included.

Explosive oxidations initiated by simulated meteoroid penetration into spacecraft atmospheres, W. H. Carden, *SP336,* pp. 569-585 (Oct. 1970).

Key words: Blast over-pressure; combustion front; hypervelocity impact; meteoroid penetration; oxidative detonation; oxidative flash; oxygen atmosphere; spacecraft.

Hypervelocity impact tests were conducted in an evacuated range on target samples which simulated a NASA S-IVB wall configuration since this stage is planned as the primary structure in the NASA Orbiting Workshop program. The samples formed part of the wall of a large tank which contained an oxygen-rich atmosphere. The explosive oxidations which occurred inside the tank as a result of perforation were observed and the results were analyzed. The bare thermal insulation on the inside of the wall further enhanced the otherwise severe reaction which occurs with a metallic wall in the presence of enriched oxygen.

The dynamic environment simulator—a multienvironmental man-rated centrifuge, D. B. Rogers, M. McCally, and K. L. Cappel, *SP336*, pp. 587-598 (Oct. 1970).

Key words: Combined environmental stress; dynamic environment simulator; man-machine system; man-rated centrifuge; simulation research.

The U.S. Air Force Dynamic Environment Simulator is a man-rated centrifuge with multiple environment simulation capabilities. This facility can generate combinations, either simultaneous or sequential, of acceleration, vibration, temperature, barometric pressure, gas composition, noise and related environmental stresses. Simulation of a broad variety of aerospace flight mission environments is now possible using this facility. The man rating of this facility was carried out in the last six months of 1969 and resulted in the first manned run in December of that year. Although presently programmed to meet Air Force data requirements for the design of planned and proposed aircraft systems, the Dynamic Environment Simulator represents a national research capability capable of supporting the requirements of many R & D programs including manned space flight, high speed surface transportation and other systems or functions where man is exposed to physical environmental stresses in combination.

Use of the BEN FRANKLIN submersible as a space station simulator, M. J. Ferguson and C. B. May, *SP336*, pp. 599-621 (Oct. 1970).

Key words: Closed ecological system; habitability; maintainability prediction; microbiology; microflora shift; physiology; psychology; space station simulator; submersible.

This paper presents the NASA-sponsored effort using the Ben Franklin submersible as a space station analog during the 30-day drift mission in the Gulf Stream, starting 14 July and ending 14 August 1969. The areas of investigation include: (1) Psychological and physiological measurements during the pre-mission, mission, and post-mission phases were related to observed crew behavior. The results reveal that detailed consideration must be given early in the design to those aspects which could cause crew annoyance and frustration, and which could be further aggravated by long confinement. Selection of crew pairs for compatibility of personality will help reduce stress in small closed systems. (2) Habitability in a closed ecosystem was investigated. The objective was to determine the suitability of BEN FRANKLIN submersible habitability data for providing guidelines for future spacecraft design. These include provision for privacy, control of temperature and humidity, and adequate facilities for personal hygiene. (3) Microbiological investigation as a study of the effect of total biological isolation upon the flora of the crew, environmental and life support subsystems. The continuing shift and simplification of microbial flora on the 30-day mission indicates a need for investigation of the problem in association with longer space missions. (4) The maintainability experiment objective was to obtain detailed information on the frequency, duration, type, and complications of onboard maintenance during the mission.

Development of an open circuit cryogenic life support system for use in neutral buoyancy space simulation, C. M. McClure and C. W. Williams, *SP336*, pp. 623-649 (Oct. 1970).

Key words: Cryogenics; liquid air; liquid nitrogen; liquid oxygen; neutral buoyancy; space simulation.

Marshall Space Flight Center has a need for a self contained underwater life support system which can supply a breathing mixture to the neutral buoyancy test subject, without the need for a surface tethered supply line. A prototype system has been developed which utilizes a mixture of liquid oxygen and liquid nitrogen contained in a single supply tank. Development and testing has shown that this system will supply the quantity and quality of gas required under completely controlled and predictable conditions to depths of at least 60 feet.

Advanced diving techniques applicable to extended mission neutral buoyancy space simulation. J. B. MacInnis and C. M. McClure, *SP336*, pp. 651-659 (Oct. 1970).

Key words: Diving; hyperbaric; neutral buoyancy; simulation; space.

Diving methodology is reviewed. Nonsaturated diving is recognized as the basis for almost all neutral buoyancy testing to date. Saturated diving methodology is reviewed and its possible special adaptation for extended duration mission neutral buoyancy simulation is proposed. The advantages of using the new closed circuit rebreather SCUBA gear is also reviewed and proposed as an aid to extended mission simulation.

A method to obtain an ultraclean environment, M. S. Cridlin and J. W. O'Connor, *SP336*, pp. 661-668 (Oct. 1970).

Key words: Anti-migration traps; cold shrouding; contamination; environment; ion pumping; low pressure; low temperature; pumping; ultraclean; vacuum.

The Goddard Space Flight Center has designed and fabricated a system which offers an effective approach toward solving the problems usually encountered in creating an ultra high vacuum. The vacuum techniques described find application in an Auger Spectrometry System.

This ionization pumped system is unconventional in that: (1) Interior chamber cryogenic shrouding is eliminated. In lieu of the internal shrouds the method is to submerge the entire chamber exterior in a dewar of liquid nitrogen. Eliminating the shrouds within the chamber eliminates sources of contamination and the exposing of the wall exterior to the cryogenics eliminates the typical ambient temperatures that chamber walls normally experience, (2) The ionization pump is located within the ultrahigh vacuum chamber, rather than outside. This eliminates the gate valve typically associated with an externally mounted pump and permits greatly increased realization of the conductance pump capacity. The pump is protected by use of gas purging when pressures are increased to atmospheric.

The method of precleaning, prior to bakeout, involving high temperature gas purging is described as well as the entire systems operation. Pressures in the order of 7×10^{-13} torr have been observed.

A programmable dynamic thermal vacuum system for solar array component testing, J. W. Fairbanks and M. B. Eck, *SP336*, pp. 669-682 (Oct. 1970).

Key words: Gaseous nitrogen heater; gas stream blower; GN temperature conditioning; solar array; solar cell; thermal cycle vacuum testing; thermal shroud.

The Programmable Dynamic Thermal Vacuum System (PDTVS) was designed to provide long-term laboratory evaluation of solar array components undergoing thermal cyclic effects anticipated for specific missions. This system is capable of duplicating the temperature excursions, including rate-of-change of temperature, for practically all missions currently under consideration at NASA. The equipment can obtain test specimen temperatures between +150 °C to −120 °C with a rate-of-change of at least 6 °C/min. The PDTVS can accommodate thirty-six 6 in × 6 in test specimen holders and position each one in front of a illumination port for periodic in situ electrical measurements with a solar simulator.

Basically, the facility consists of an ion-pump vacuum system with 2 bell jars, thermal conditioning equipment, a 3 stage blower, a programmable control unit and an LN_2 storage tank. The novel developments in this system include a high-energy low-mass heater which employs radiative-convective coupling of a gas stream to an IR source. The test carrousel shaft is used for specimen positioning and as an instrumentation penetration. Initial difficulties required modification of the blower bearings, shaft and housing to accommodate the wide range of gas stream temperatures without affecting performance.

The cryopumping system for the space simulation chamber, H. Nakagawa and R. Tsunoda, *SP336*, pp. 683-698 (Oct. 1970).

Key words: Cryopumping; ion pump; pumping speed; space simulation chamber; vacuum.

Recently, the space simulation facility which has distinctive feature was completed in Japan. This facility consists of main- and sub-chamber and other necessary equipment. The main-chamber, having 1.8 m dia. and 6 m length, is accompanied by the pumping system of very high pumping speed. The pumping system consists of cryopump, diffusion pump, mechanical Roots booster pump and rotary vacuum pumps. The ultimate pressure of the order of 10^{-9} torr was achieved by this system. The sub-chamber, having 60 cm dia. and 120 cm length, is accompanied by the pumping system which is completely oil free. The pumping system consists of cryopump, sputter-ion pump and cryosorption pumps. The ultimate pressure of the order of 10^{-10} torr was achieved by this system. Determination of the pumping speed of the cryopump is a very complicated procedure and in this study we propose the new factor: "Arrival Probability" which is computed by Monte Carlo method. The dynamic performance of oil free pumping system, especially the using order of cryosorption pump was investigated, and the residual gases were analyzed by mass-filter. The concept of "Self-contamination Factor" proposed by Dr. R. Chuan is adopted to this study to determine the performance of this system, and the factors of 0.006 and 0.0012 were obtained under the actual operating condition.

Simulation of surface-atmosphere interaction processes for Mars, K. M. Foreman, *SP336*, pp. 699-723 (Oct. 1970).

Key words: Convective processes; Mars atmosphere exploration; planetary atmosphere-surface interaction; planetary meteorology; research facility; simulation techniques; space research.

Landings of unmanned spacecraft on Mars can be affected by the dynamics of the lower planetary atmosphere. In an effort to understand the convective motion and effect of surface topography and soil on local atmospheric motion, a laboratory-scale simulator has been designed and built to examine parameters of significance systematically. Scaling law relationships were used in sizing the facility and appropriate test conditions within the terrestrial gravitational environment. This facility is a 4-foot diameter by 8-foot high stainless steel chamber capable of maintaining test conditions to about 10 microns absolute pressure and gas temperatures between −85 °C^b and +65 °C^b. The planetary surface is simulated by an electrically heated aluminum surface controlled to within ~±0.7 °C^b of the initial set conditions.

Measurements of test gas temperature above the simulated planetary surface are made with a specially designed traversing mechanism carrying thin film and thermistor sensors. Temperature profiles above the surface are similar to theoretical calculations for equatorial Mars regions at mid-morning, if the lower Martian atmosphere is assumed to have an eddy viscosity of about 5×10^5 cm²/s. Additional data show that temperature gradients increase near the surface as the gas pressure is decreased below atmospheric level, and that the degree of turbulence (as evidenced by temperature fluctuations) appears to diminish with lower pressure.

Exploratory tests of thin film sensors as wind speed indicators at simulated Mars surface pressure of 5mb show possible difficulty in differentiating velocity from temperature at wind speeds less than several m/s magnitude. However, thin films appear quite responsive as temperature sensors to pressures on the order of less than 1 mm Hg A.

Operation of a large thermal vacuum chamber at Martian pressure levels, T. Buna and J. R. Ratliff, *SP336*, pp. 725-748 (Oct. 1970).

Key words: Evacuating; heat transmission; infrared scanning; Mars environmental simulation; outgassing; thermal insulation; thermal-vacuum chambers.

A test program was conducted to evaluate techniques of insulating the cold shroud of a large thermal-vacuum chamber from its outer shell, in order to prevent excessive cooling of the latter during Mars environmental simulation tests. A fluidized insulation concept using polystyrene flakes in the shroud/shell interspaces was found to best meet both thermal and operational requirements. With 140 R (77.8 K) shroud, convective transport through the insulation was negligible up to 20 mm Hg chamber pressure, and did not exceed permissible levels up to 50 mm Hg. At the higher pressure levels local heat transfer through the insulation was found to be of a cyclic nature. Thermal data are presented in the form of Nusselt-Rayleigh type correlations. Unique techniques devised for rapid installation and removal of the insulation are described; chamber shell temperature monitoring techniques (including infrared scanning) are evaluated; and the pumpdown characteristics of the insulated chamber are established.

A cryopump for steady-state testing of rocket engines under altitude conditions, M. J. Triplett and W. E. Riggs, *SP336*, p. 749 (Oct. 1970).

Ablative heat shields for planetary entries—a technology review, G. D. Walberg and E. M. Sullivan, *SP336*, pp. 751-812 (Oct. 1970).

Key words: Ablation; evaluation; heat shields; heat transfer; planetary entry; radiation.

A review of ablation technology is carried out to assess the present state of the art and point out areas in which further research is required for planetary entry heat shields. Analyses and test techniques which have been developed to treat heat shields for Earth entry with combined radiative and convective heating are reviewed. With the lessons learned from Earth-entry research in mind, the work carried out to date for entry into various planetary atmospheres is reviewed and technological problem areas are discussed. In defining significant phenomena, various mechanisms and processes are discussed and their relative importance is illustrated by describing the analysis of a manned planetary-return Earth entry. In discussing the work to date on planetary entry, two broad categories of research are considered: (1) entry into tenuous atmospheres and (2) entry into the dense atmospheres of Venus and the giant planets. In each of these categories, atmospheric characteristics, entry velocities and modes, vehicle geometries, heating levels and candidate ablation materials are discussed. Present ground and flight-test capabilities are summarized and compared with planetary entry conditions. Particular attention is paid to coupled ablative-radiative phenomena which require the radiation spectrum of the facility to essentially duplicate that of the planetary atmosphere under study.

Ablation phenomena in supersonic laminar and turbulent flows, E. M. Winkler, M. T. Madden, R. L. Humphrey, and J. A. Koenig, *SP336*, pp. 813-835 (Oct. 1970).

Key words: Ablation; ablation-induced transition; cross-hatched striations; Teflon.

Arc tunnel experiments using pipe specimens of TFE-7 examine the ablation of Teflon under a supersonic laminar and turbulent boundary layer. Test conditions include Mach numbers of 2.3 and 3.0, supply pressures of 2×10^6 N/m^2 to 3×10^6 N/m^2 and supply temperatures of 2200 to 5000 °K. Experimental results are compared with computer predictions. In two laminar boundary-layer tests, parallel striations appear; in all turbulent boundary-layer tests, criss-cross striations appear.

Prediction of mechanical erosion of charring ablators, L. H. Hillberg, *SP336*, pp. 837-851 (Oct. 1970).

Key words: Ablation; aerodynamic shear; carbon; char; cork; epoxy-novolac; erosion; phenolic carbon; silicone rubber.

A simple method has been developed for predicting the mechanical erosion of charring ablators exposed to an aerodynamic environment. The method requires the knowledge of two variables: the aerodynamic shear stress at the ablating surface and the surface temperature. Test data are used to obtain two empirical constants necessary for correlating the erosion recession rate in terms of these two variables. The empirical constants have been determined for phenolic cork, phenolic carbon, epoxy-novolac, and high density silicone rubber.

Heating in cracks on ablative heat shields, E. M. Winkler, R. L. Humphrey, M. T. Madden, and J. A. Koenig, *SP336*, pp. 853-877 (Oct. 1970).

Key words: Ablation; catastrophic ablation; substructure heating; surface cracks.

An experimental program has been carried out in the U.S. Naval Ordnance Laboratory (NOL) 3 Megawatt Arc Tunnel to study the effect of cracks in an ablative heat shield on the substructure heating. The tests used a supersonic contoured nozzle with a Teflon duct attached to it. The ducts had transverse and longitudinal cracks machined into the surface. They were instrumented for pressure, temperature, heat transfer and skin-friction measurements. The cracks were found to have pronounced effects on the ablative behavior. The heating is moderate under a laminar boundary layer, but can be catastrophic when the boundary layer is turbulent, depending upon the size and direction of the crack. The results for the transverse cracks were compared with an available analytical prediction. The heat-transfer measurements tend to support the concept of vortex cells existing within the cracks. Cracks that are deep as compared with their width result in very little substructure heating.

Apparent operating limits of arc heaters with respect to total enthalpy and stagnation pressure, R. Richter, *SP336*, pp. 879-892 (Oct. 1970).

Key words: Arc currents; arc heaters; constricted arc; enthalpy; operational limits; stagnation pressure.

For many years arc heaters have been operated over a wide range of operating conditions. An apparent upper limit with respect to stagnation pressure and total enthalpy was found which could not be exceeded. It is attempted to show that this limit is not imposed by the enthalpy-pressure combination but is caused by the limit in total power input that can be achieved with the non-segmented constricted arc heater. The failure or fast deterioration of arc heater components is found to be primarily due to high arc currents which are employed to heat the gas to maximum temperature. It is concluded that the enthalpy-stagnation limit of nonsegmented constricted arc heaters operating under similar constraints can be exceeded.

Operating characteristics on the Air Force flight dynamics laboratory reentry nose tip (RENT) facility, J. C. Beachler, *SP336*, pp. 893-904 (Oct. 1970).

Key words: Ballistic missiles; heat protection; reentry; test facility.

Reentry missile nose tip development requires ground test facilities capable of simultaneously producing extreme pressures and heat transfer rates. The Reentry Nose Tip (RENT) Facility was developed by the Air Force Flight Dynamics Laboratory to produce this high pressure hyperthermal environment. The present and planned capability of this facility is described and typical pressure and heat transfer profiles of the test jet are shown.

Investigation of the characteristics of fluids vented into a vacuum, R. Steddum, D. Maples, and F. M. Donovan, *SP336*, pp. 905-914 (Oct. 1970).

Key words: Flow rate tests; high speed movies; particle velocities; vacuum tests; water jet.

For manned space stations planned for the future, it becomes necessary to eject fluids into the space environment. These ejected fluids form ice clouds which remain in the vicinity of the spacecraft and could interfere with optical instrumentation. In order to study the dynamics of fluid jets in a space environment, a high vacuum system was modified to allow the injection of fluids into a vacuum region while maintaining a pressure below 0.1 N/m^2. The cone angles, individual particle velocities, and mass flow rates of water sprays under vacuum conditions were measured. The individual particle velocities of sprays produced by outgassed water were lower than the particle velocities of sprays produced by water with a definite amount of dissolved gas.

Micrometeoroid impact simulation system, R. A. Golub and J. R. Davidson, *SP336*, pp. 915-933 (Oct. 1970).

Key words: Hypervelocity; impact damage; micrometeoroid; particle detectors.

This paper describes a Micrometeoroid Impact Simulation System (MIMS) at NASA Langley Research Center and outlines current research efforts. The MIMS electrostatically accelerates electrically charged, micrometer-size particles to velocities in excess of 30 km/s. Particles can be accelerated one at a time or at various rates to above 10/s. The major components of the MIMS are a microparticle charger-injector, a horizontal 4-million-volt Van de Graaff accelerator, an assemblage of particle detectors, a particle deflection system, a data system, and a series of target chambers. The data system is a computer-controlled, real-time system which records information to determine the velocity, mass, and diameter of each particle which enters the target area. The system also controls and selects particles, and rejects particles which do not have the desired velocities. The system is used to study damage to sensitive surfaces, develop micrometeoroid detectors, and obtain data about meteoroid entry physics.

Properties of optical materials in space, F. W. Paul, *SP336,* pp. 949-959 (Oct. 1970).

Key words: Information center; interferometric measurements; optical materials; physical property changes; space environment.

A program has been established to provide a central clearinghouse for information about the effects of space environment on the optical and other physical properties of optical materials. Information is being collected and organized on the effects of space environment on refractive index, dispersion, transmittance, reflectance, thermal expansion coefficient, Young's modulus, birefringence, and yield and breaking points of all materials of interest for the transmission or reflection of optical radiation in space.

In technical areas where information about the behavior of materials does not exist a program of laboratory investigations will provide the required information. In preparation for some in-house studies of materials at very low temperatures and also during exposure to a charged particle flux an experiment has been devised and instrumented to provide measurement of dimensional changes and refractive index changes at several wavelengths. The essence of the method is the use of Fabry-Perot interferometry to measure independently the dimensions of the sample of material and the optical path length through the material.

A space radiation environment simulator for the evaluation of solar cells, P. A. Newman, J. J. Hirshfield, H. E. Wannemacher, and M. Eck, *SP336,* pp. 935-947 (Oct. 1970).

Key words: High vacuum; solar cells; space radiation; space simulation; thermal control.

A facility for studying the properties of solar cells and other optically sensitive devices under a wide range of environmental conditions such as could be found on extra-terrestrial space missions has been developed at the NASA Goddard Space Flight Center. The system includes control of temperature, vacuum and solar irradiation while irradiating a 23 cm by 23 cm array of samples with 4 MeV protons or electrons. Typically the samples can be controlled in temperature between − 170 and 150 °C, while a shroud, used to control radiative coupling, can be independently controlled between − 196 and 150 °C. The vacuum system, which is virtually free of hydrocarbon contamination, will evacuate the chamber to less than 1×10^{-8} torr in less than 4 hours. A 400 1/s Noble Vac-Ion pump backed by a titanium bulk sublimator and a titanium filament evaporator has been designed to accommodate the large gas loads possible during irradiation. A 4.2 KW compact Xenon arc solar simulator provides a close match to the solar spectrum from low irradiances to an irradiance of four solar constants. An automatic data acquisition system modified to generate digital solar cell I-V characteristics is used to collect data in a form suitable for computer processing.

SP337. **Silicon device processing.** Proceedings of a symposium held at Gaithersburg, Maryland, June 2-3, 1970. C. P. Marsden, Editor, Nat. Bur. Stand. (U.S.), Spec. Publ. 337, 467 pages (Nov. 1970).

Key words: Analysis; device processing; diffusion; epitaxy; junctions; resistivity; surface preparation.

This Proceedings contains the information presented at the Symposium on Silicon Device Processing held at the National Bureau of Standards on June 2-3, 1970.

This Symposium covered the measurement field and was purposefully restricted to the generic topics of diffusion, epitaxy, surface preparation and interdependence of unit processing operations. This emphasis on measurement during the processing operation or on the characteristics of the processed material, showed the necessity and more important, the ambiguities of current methods of measurement. The application of some new techniques to measurement were also discussed. *These proceedings include the following papers (indented):*

Some thoughts on how we might improve our materials and process work, D. G. Thomas, *SP337,* pp. 3-10 (Nov. 1970).

Crystallographic imperfections as related to silicon crystal growth, J. A. Lenard, *SP337,* pp. 11-18 (Nov. 1970).

Epitaxial growth of silicon, B. A. Joyce, *SP337,* pp. 19-20 (Nov. 1970).

Diffusion in silicon: properties and techniques, C. F. Gibbon, *SP337,* pp. 21-35 (Nov. 1970).

Measurement and control of dielectric film properties during semiconductor device processing, B. E. Deal, *SP337,* pp. 36-50 (Nov. 1970).

Equipment considerations for silicon epitaxial reactors, M. L. Hammond and W. P. Cox, *SP337,* pp. 51-59 (Nov. 1970).

A comparison of a resistance-heated reactor for silicon epitaxial growth with other epitaxial systems, W. A. Kohler, *SP337,* pp. 60-65 (Nov. 1970).

Techniques for depositing highly uniform and defect-free epitaxial silicon, D. C. Gupta, *SP337,* pp. 66-78 (Nov. 1970).

Control of thin silicon films grown from silane, D. J. Dumin, *SP337,* pp. 79-86 (Nov. 1970).

The growth of submicron single and multilayer silicon epitaxy, J. Simpson, A. C. Adams, and M. H. Hanes, *SP337,* pp. 87-98 (Nov. 1970).

Techniques for determining surface concentration of diffusants, J. C. Irvin, *SP337,* pp. 99-110 (Nov. 1970).

Current status of the spreading resistance probe and its application, T. H. Yeh, *SP337,* pp. 111-122 (Nov. 1970).

Incremental sheet resistivity technique for determining diffusion profiles, R. P. Donovan and R. A. Evans, *SP337,* pp. 123-131 (Nov. 1970).

Nuclear methods for the determination of diffusion profiles, B. J. Masters, *SP337,* pp. 132-140 (Nov. 1970).

Use of high-energy ion beams for the analysis of doped surface layers, S. Chou, L. A. Davidson, and J. F. Gibbons, *SP337,* pp. 141-155 (Nov. 1970).

Determination of diffusion coefficients in silicon and accepted values, M. F. Millea, *SP337,* pp. 156-167 (Nov. 1970).

Diffusion technology for advanced microelectronic processing, W. Greig, K. Cunniff, H. Hyman, and S. Muller, *SP337*, pp. 168-174 (Nov. 1970).

Diffusion from doped-oxide sources, M. L. Barry, *SP337*, pp. 175-181 (Nov. 1970).

Capacitance—a device parameter and tool for measuring doping profiles, B. R. Chawla, *SP337*, pp. 182-183 (Nov. 1970).

Concentration dependent diffusion phenomena, P. E. Bakeman, Jr. and J. M. Borrego, *SP337*, pp. 184-191 (Nov. 1970).

Orientation dependent diffusion phenomena, L. E. Katz, *SP337*, pp. 192-201 (Nov. 1970).

Diffusion-induced defects and diffusion kinetics in silicon, S. Dash and M. L. Joshi, *SP337*, pp. 202-222 (Nov. 1970).

Limitations of current epitaxial evaluations, R. N. Tucker, *SP337*, p. 223 (Nov. 1970).

On the interpretation of some measurement methods for epitaxially grown layers, P. J. Severin, *SP337*, pp. 224-233 (Nov. 1970).

Thickness measurement of very thin epitaxial layers by infrared reflectance, P. A. Schumann, Jr., *SP337*, pp. 234-243 (Nov. 1970).

Spreading resistance measurements on buried layers in silicon structures, R. G. Mazur, *SP337*, pp. 244-255 (Nov. 1970).

Variations of a basic capacitance-voltage technique for determination of impurity profiles in semiconductors, W. C. Niehaus, W. van Gelder, T. D. Jones, and P. Langer, *SP337*, pp. 256-272 (Nov. 1970).

A new impurity profile plotter for epitaxy and device, B. J. Gordon and H. L. Stover, *SP337*, pp. 273-284 (Nov. 1970).

Structural faults in epitaxial and buried layers in silicon device fabrication, P. Wang, F. X. Pink, and D. C. Gupta, *SP337*, pp. 285-301 (Nov. 1970).

An instrument for automatic measurement of epitaxial layer thickness, A. Roddan and V. Vizir, *SP337*, pp. 302-312 (Nov. 1970).

Defects induced in silicon through device-processing, M. L. Joshi and J. K. Howard, *SP337*, pp. 313-364 (Nov. 1970).

A study relating MOS processes to a model of the Al-SiO_2-Si system, M. H. White, F. C. Blaha, and D. S. Herman, *SP337*, pp. 365-374 (Nov. 1970).

Activation analysis in silicon device processing, G. B. Larrabee and H. G. Carlson, *SP337*, pp. 375-383 (Nov. 1970).

The use of the scanning electron microscope as a semiconductor production line quality control tool, J. W. Adolphsen and R. J. Anstead, *SP337*, pp. 384-397 (Nov. 1970).

Metallization deposition parameters and their effect on device performance, J. R. Black, *SP337*, pp. 398-408 (Nov. 1970).

Methods for determination of the characteristics of hyperpure semiconductor silicon and their information content for the device production, F. G. Vieweg-Gutberlet, *SP337*, pp. 409-411 (Nov. 1970).

Mechanical damage—its role in silicon surface preparation, R. B. Soper, *SP337*, pp. 412-418 (Nov. 1970).

Crystallographic damage to silicon by typical slicing, lapping, and polishing operations, T. M. Buck and R. L. Meek, *SP337*, pp. 419-430 (Nov. 1970).

The preparation of practical, stabilized surfaces for silicon device fabrication, A. Mayer and D. A. Puotinen, *SP337*, pp. 431-435 (Nov. 1970).

Surface contamination, J. W. Faust, Jr., *SP337*, pp. 436-441 (Nov. 1970).

The precipitation of oxygen in silicon, and its effect on surface perfection, W. J. Patrick, *SP337*, pp. 442-449 (Nov. 1970).

Auger spectroscopy and silicon surfaces, J. H. Affleck, *SP337*, pp. 450-456 (Nov. 1970).

Characterization of semiconductor surfaces and interfaces by ellipsometry, N. M. Bashara, *SP337*, p. 457 (Nov. 1970).

SP339. **Source listing of OMNITAB II program,** S. T. Peavy, R. N. Varner, and D. Hogben, Nat. Bur. Stand. (U.S.), Spec. Publ. 339, 371 pages (Dec. 1970).

Key words: Accuracy; algorithms; ANSI FORTRAN; documentation; error checking; machine independent; OMNITAB II operating system subprograms; OMNITAB II source listing; programming techniques; transportable; user-oriented computing system.

OMNITAB II is a general-purpose interpretive computing system designed to allow a nonprogrammer to use a high-speed computer easily, accurately and effectively. The system permits the user to perform arithmetic operations including complex arithmetic, trigonometric calculations, miscellaneous function calculations, statistical analysis, Bessel function calculations, and operations on matrices and arrays.

The OMNITAB II system contains 177 subprograms written in the ANSI FORTRAN language. Every effort has been made to make the system transportable. This publication contains a complete listing of all these subprograms. The listing is preceded by a brief introduction which describes the programming techniques used; the use of system library functions; and the subprograms used to control the flow of operations in the OMNITAB system.

SP340. **Technical highlights of the National Bureau of Standards, Annual Report Fiscal Year 1970,** Nat. Bur. Stand. (U.S.), Spec. Publ. 340, 258 pages (Feb. 1971).

Key words: Annual report; technical highlights.

This is an illustrated digest of NBS technical and scientific activities during the fiscal year ending June 30, 1970. It lists major programs as they were carried out by the three NBS institutes: Institute for Basic Standards, Institute for Materials Research, Institute for Applied Technology and by the Bureau's Center for Radiation Research and Center for Computer Science and Technology. Summaries are given of typical projects in measurement engineering, applied mathematics, electricity, metrology, mechanics, heat, atomic physics, radio standards, laboratory astrophysics, cryogenics, analytical chemistry, polymers, metallurgy, inorganic materials, physical chemistry, engineering standards, weights and measures, invention and innovation, vehicle systems research, product evaluation, building research, electronic technology, technical analysis, computer sciences, and radiation research. Also included are discussions of the Clearinghouse for Federal Scientific and Technical Information, the National Standard Reference Data System, Standard Reference Materials program, and national and international cooperative activities. A special section is devoted to NBS and the Consumer, Metric Study, Flammable Fabrics Program, Measurements for Air Quality and Building Technology.

SP341. **Damage in laser materials.** Proceedings of a symposium sponsored by the American Society for Testing and Materials and by the National Bureau of Standards June 24-25, 1970, NBS, Boulder, Colorado, A. J. Glass and A. H. Guenther, Editors, Nat. Bur. Stand. (U.S.), Spec. Publ. 341, 126 pages (Dec. 1970).

Key words: Ferroelectric materials; glass; laser damage; lasers.

The second ASTM Symposium on Damage in Laser Materials was held at the National Bureau of Standards at Boulder, Colorado on June 24th and 25th, 1970. About 150 attendees heard papers by fourteen speakers, representing the major manufacturers of laser glass, government, industrial and university laboratories. Although the primary emphasis was on Nd:glass as a laser material, damage mechanisms and morphology in ruby, sapphire, and nonlinear optic materials were also considered. It was clear that substantial advances have been made in the last year in the production of damage-resistant laser glass for use in conventional Q-switched lasers. New diagnostic techniques have been developed, and in some cases, adopted as quality control procedures by the glass manufacturers. Theoretical understanding of the fundamental damage mechanisms is beginning to emerge, and material properties relevant to these damage mechanisms are beginning to be measured. It was equally clear that a great deal of effort remains to be expended to develop techniques suitable for nondestructive testing of laser materials, and that many properties of laser materials at high energy density are presently poorly understood.

SP342. **Report of the 55th National Conference on Weights and Measures 1970,** F. C. Bell and H. F. Wollin, Report Editors, Nat. Bur. Stand. (U.S.), Spec. Publ. 342, 315 pages (Apr. 1971).

Key words: Conference; weights and measures; weights and measures—history; weights and measures—law; weights and measures—regulations; weights and measures—technical requirements.

This is a report of the proceedings (edited) of the Fifty-fifth National Conference on Weights and Measures, sponsored by the National Bureau of Standards, held in Salt Lake City, Utah, July 13-17, 1970, and attended by state, county, and city weights and measures officials and representatives of the Federal Government, business, industry, railroads, and associations.

SP343. **Precision measurement and fundamental constants.** Proceedings of the international conference held at the NBS, Gaithersburg, Maryland, August 3-7, 1970, D. N. Langenberg and B. N. Taylor, Editors, Nat. Bur. Stand. (U.S.), Spec. Publ. 343, 543 pages (Aug. 1971).

Key words: Fundamental constants; least squares adjustments; precision measurements.

This volume presents the Proceedings of the International Conference on Precision Measurement and Fundamental Constants, held at the National Bureau of Standards in Gaithersburg, Maryland, from August 3 through August 7, 1970. The conference brought together theoretical, experimental, and applied scientists for the purpose of discussing modern techniques of precision physical measurement and their application, along with modern theoretical developments, to the determination of the fundamental constants. The topics covered were: frequency and time standards; length standards; the velocity of light; the Rydberg constant; electrical standards; the proton gyromagnetic ratio; the Faraday constant; atomic masses; the proton magnetic moment; Josephson effects; x rays; fine and hyperfine structure in simple atoms; lepton *g*-factor anomalies; the gravitational constants; least squares adjustments of the constants. These Proceedings contain the invited tutorial talks as well as the contributed papers presented at the Conference. Also included are the post-paper discussions and a panel discussion entitled "Should Least Squares Adjustments of the Fundamental Constants be Abolished?"

SP344. **General physical constants,** Nat. Bur. Stand. (U.S.), Spec. Publ. 344, 2 pages (Mar. 1971).

Key words: Atomic constants; fundamental constants; physical constants.

The National Bureau of Standards has issued a new edition of its handy wallet-sized plastic card containing a short table of fundamental physical constants. The values have been revised on the basis of those given by Taylor, Parker, and Langenberg (*Rev. Mod. Phys.* **41**, p. 375), which differ appreciably from the 1963 Cohen and Dumond values used in the first edition of the card. The revised values reflect improved and new measurement techniques, notably the a-c Josephson effect method of determining the ratio of electronic charge to Planck's constant. The main table lists values of 22 constants, their recommended symbols, uncertainties, and units in both SI and cgs systems. The other side of the card summarizes the definitions of the base units of the International System of Units (SI) and lists some frequently used defined values and conversion factors. (Supersedes NBS Misc. Publ. 253.)

SP345. **A metric America. A decision whose time has come,** D. V. De Simone, Nat. Bur. Stand. (U.S.), Spec. Publ. 345, 189 pages (July 1971).

Key words: Metrication; metric conversion; metric system; metric usage; Public Law 90-472; U.S. Metric Study.

This publication is the comprehensive report on the U.S. Metric Study undertaken by the National Bureau of Standards pursuant to Public Law 90-472. The report evaluates and distills the information contained in the twelve interim reports of the study series and also covers what has been learned from Great Britain and other countries that are now in or have been involved in a metric changeover. Data in the report show that America is already metric in some respects and that the great majority of businessmen, educators and other informed participants in the study reported that increased use of the metric system is in the best interests of America. Included in the publication are the recommendations of the Secretary of Commerce to Congress that the United States change to the metric system through a coordinated national program over a ten-year period.

SP345-2. **U.S. metric study interim report. Federal Government: civilian agencies,** R. E. Clark and J. M. Tascher, Nat. Bur. Stand. (U.S.), Spec. Publ. 345-2, 328 pages (July 1971).

Key words: Federal Government; International System of Units; metrication; metrication, attitudes toward; metrication, costs and benefits of; metrication, impact of; metric conversion; metric system; metric usage; SI; U.S. Metric Study.

This publication reports the findings of a survey to ascertain the views of the civilian agencies of the Federal Government on the issues raised by the U.S. Metric Study Act. With regard to internal operations of the Federal agencies, the report covers present metric (International System of Units, or SI) usage and its advantages and disadvantages, expectations of future changes in measurement usage if the U.S. continues its laissez faire policy toward the SI, and attitudes toward a possible nationally coordinated metrication program. In the latter connection, the report contains estimates of added cost or savings impacts on agency internal operating budgets to be expected from a nominally 10-year planned metrication program, both during the transition and thereafter. The survey also assessed the impacts of metric usage and of its increase on the areas of responsibility of the Federal agencies in the society at large (e.g., communications, science and technology, health, labor affairs, international affairs and trade), and on the agencies' interfaces therewith.

SP345-3. **U.S. metric study interim report. Commercial weights and measures,** S. L. Hatos, Nat. Bur. Stand. (U.S.), Spec. Publ. 345-3, 116 pages (July 1971).

Key words: Commercial weights and measures; International System of Units; metrication; metrication, attitudes toward; metrication, costs and benefits of; metrication, impact of; metric conversion; metric system; metric usage; SI; U.S. Metric Study.

This publication, one of a series prepared pursuant to the U.S. Metric Study Act, explores the impacts metrication would have on commercial weights and measures activities. More specifically, the report concerns: (1) the cost of adapting or changing commercial weighing and measuring devices to record and/or indicate in metric units, and (2) the effects of metrication on state and local weights and measures jurisdictions.

SP345-4. **U.S. metric study interim report. The manufacturing industry,** L. E. Barbrow, Coordinator, Nat. Bur. Stand. (U.S.), Spec. Publ. 345-4, 172 pages (July 1971).

Key words: International System of Units; manufacturing industry; metrication; metrication, attitudes toward; metrication, costs and benefits of; metrication, impact of; metric conversion; metric system; metric usage; SI; U.S. Metric Study.

This publication reports the results of a study to assess the impacts of increasing metric usage—past, present and future—on U.S. manufacturing industry. The study, conducted pursuant to the U.S. Metric Study Act, is based on responses from more than 2,000 manufacturing companies. Information was obtained on: past and present experience with use of the metric system, including advantages and disadvantages thereof, and the views of the firms with regard to future U.S. policy—whether the country should continue its laissez faire approach to metric usage, or should undertake some sort of national program to encourage more widespread use of metric weights and measures. A separate survey of a smaller number of selected firms obtained detailed information as to estimated cost impact of a national metrication effort.

SP345-5. **U.S. metric study interim report. Nonmanufacturing businesses,** J. R. Cornog and E. D. Bunten, Nat. Bur. Stand. (U.S.), Spec. Publ. 345-5, 200 pages (July 1971).

Key words: International System of Units; metrication; metrication, attitudes toward; metrication, costs and benefits of; metrication, impact of; metric conversion; metric system; metric usage; nonmanufacturing businesses; SI; U.S. metric Study.

This publication, prepared pursuant to the U.S. Metric Study Act, reports on the experiences and views of nonmanufacturing businesses with regard to metric usage and its increase. The study is based on a survey of more than 2500 companies and firms primarily involved in: agriculture, forestry, fisheries, mining, construction, transportation, communications, utilities, wholesale/retail trade (including exporters/importers), finance, insurance, real estate or services. Information was obtained on: past or present experience with use of the metric system (including perceived advantages and disadvantages thereof), attitudes toward future metrication in a world of increasing metric usage (including preferred U.S. policy regarding), and estimated cost impacts and benefits which would be attendant to a national metrication program.

SP345-6. **U.S. metric study interim report. Education,** B. D. Robinson, Nat. Bur. Stand. (U.S.), Spec. Publ. 345-6, 216 pages (July 1971).

Key words: Education; International System of Units; metrication; metrication, attitudes toward; metrication, costs and benefits of; metrication, impact of; metric conversion; metric system; metric usage; SI; U.S. Metric Study.

This publication concerns the effects of increasing worldwide use of the metric system on education in the United States. The study was carried out and the report prepared for the U.S. Metric Study by the Education Development Center in Newton, Massachusetts. The aims of this education study were fourfold: (1) to assess the educational advantages and disadvantages of both the metric and the customary systems of units, (2) to determine the current usage of metric measures in U.S. schools and trends in that usage, (3) to find the ways in which education would have to change as the U.S. accommodates to increased worldwide use of the metric system, under a laissez faire or a planned approach, and estimate the costs of the changes, and (4) to make recommendations of ways in which to take best advantage of said changes. The report also discusses and suggests ways of achieving curriculum changes needed in view of increasing metric usage. The publication includes the program of the Education Conference, held in October 1970, as one of a series of National Metric Study Conferences, and the texts of the key papers presented at that conference by the National Education Association and the National Science Teachers Association.

SP345-7. **U.S. metric study interim report. The consumer,** B. D. Rothrock, Editor, Nat. Bur. Stand. (U.S.), Spec. Publ. 345-7, 152 pages (July 1971).

Key words: Consumers; International System of Units; metrication; metrication, attitudes toward; metrication, costs and benefits of; metrication, impact of; metric conversion; metric system; metric usage; National Metric Study Conferences; SI; U.S. Metric Study.

This report, one of a series prepared pursuant to the U.S. Metric Study Act, presents information on U.S. consumers' knowledge of the metric system and attitudes and opinions regarding metrication in the U.S., and discusses the effects of increasing worldwide metric usage on selected areas of consumer concern. This study is based on (1) an extensive survey conducted by the Survey Research Center of the University of Michigan and (2) prepared expert papers on selected areas of consumer interest. The survey data permitted an analysis of the receptivity of consumers to metrication, and of the need and possible effectiveness of a program to educate citizens should planned metrication be undertaken.

SP345-8. **U.S. metric study interim report. International trade,** G. F. Gordon, Nat. Bur. Stand. (U.S.), Spec. Publ. 345-8, 188 pages (July 1971).

Key words: Foreign trade; International System of Units; metrication; metrication, impact of on foreign trade; metric conversion; metric conversion, effect on foreign trade; metric system; metric usage; metric usage, effect on foreign trade; SI; U.S. Metric Study.

This publication, one of a series prepared pursuant to the U.S. Metric Study Act, evaluates the potential effects that a U.S. conversion to the metric system may have on the Nation's foreign trade. The report is based on a survey of exporters and importers trading in measurement-sensitive products, which was conducted by the Bureau of Domestic Commerce of the Department of Commerce.

SP345-9. **U.S. metric study interim report. Department of Defense,** L. E. Barbrow, Coordinator, Nat. Bur. Stand. (U.S.), Spec. Publ. 345-9, 132 pages (June 1971).

Key words: Department of Defense; International System of Units; metrication; metrication, costs and benefits of; metrication, impact of; metric conversion; metric system; SI; U.S. Metric Study.

This publication reports the results of a Department of Defense study, conducted pursuant to the U.S. Metric Study Act, to determine and evaluate the advantages and disadvantages, including impact on operational capability, that would attend adoption of the International System of units of weights and measures (otherwise known as the Modernized Metric

System) for use in the Department (DoD). The report includes estimates for each of the major components of the DoD of the costs of a transition to metric system usage. In addition to discussing the specific advantages and disadvantages that would be expected within the Department, the report describes the dependence of the DoD on the National Industrial Base, and discusses how this interaction would be involved in a national metrication effort.

SP345-10. **U.S. metric study interim report. A history of the metric system controversy in the United States,** C. F. Treat, Nat. Bur. Stand. (U.S.), Spec. Publ. 345-10, 312 pages (Aug. 1971).

Key words: Metric system; weights and measures.

A review of the debate between 1790 and 1968 on the question of whether or not the United States should adopt the metric system of weights and measures. Legislative activities with respect to weights and measures and campaigns for and against adoption of the metric system are reviewed. Significant investigations of the question by both public and private bodies are highlighted. An extensive bibliography is included.

SP345-11. **U.S. metric study interim report. Engineering standards,** R. D. Stiehler, Nat. Bur. Stand. (U.S.), Spec. Publ. 345-11, 264 pages (July 1971).

Key words: Engineering standards; international standards; International System of Units; metrication; metrication and engineering standards; metric conversion; metric system; SI; standards; U.S. Metric Study.

This report, one of a series prepared pursuant to the U.S. Metric Study Act, is concerned with (1) the relationship between measurement language and engineering standards, and (2) the compatibility of U.S. Standards with corresponding international standards. Incompatibilities between corresponding standards result from differences of engineering practice. Measurement units contribute to the incompatibilities among many dimensional specifications which comprise about 25% of engineering standards. In the remaining standards, measurement units are either not involved or serve merely as a language. The study compares U.S. standards with other national and international standards.

SP345-12. **U.S. metric study interim report. Testimony of nationally representative groups,** J. V. Odom, Editor, Nat. Bur. Stand. (U.S.), Spec. Publ. 345-12, 180 pages (July 1971).

Key words: International System of Units; metrication; metrication, attitudes toward; metrication, costs and benefits of; metrication, impact of; metric conversion; metric system; metric usage; National Metric Study Conferences; SI; U.S. Metric Study.

This publication, a part of the U.S. Metric Study series, summarizes the inputs received from the more than 700 associations, societies, unions and other groups which were invited to submit their opinions and viewpoints on the issues raised by the U.S. Metric Study Act. Most of these submissions were publicly presented at hearings held during the course of the Study.

SP346. **Hydraulic research in the United States 1970. Including contributions from Canadian Laboratories,** G. Kulin and P. H. Gurewitz, Editors, Nat. Bur. Stand. (U.S.), Spec. Publ. 346, 354 pages (Mar. 1971).

Key words: Fluid mechanics; hydraulic engineering; hydraulic research; hydraulics; hydrodynamics; model studies; research summaries.

Current and recently concluded research projects in hydraulics and hydrodynamics for the years 1969-1970 are summarized. Projects from more than 250 university, industrial, state and federal government laboratories in the United States and Canada are reported.

SP347. **Proceedings of joint meeting of government operations research users and producers, held at the National Bureau of Standards, Gaithersburg, Maryland, June 5-6, 1969,** E. H. Hustvedt, Conference Coordinator and M. L. Friend, Editor, Nat. Bur. Stand. (U.S.), Spec. Publ. 347, 164 pages (May 1971).

Key words: Conference proceedings; contract research; federal government; information exchange; NBS; operations research/systems analysis studies; OR users and producers; planning.

Frequently government agencies are unsure as to whom to contact when they want Operations Research/Systems Analysis studies made, and many agencies know very little about what other agencies might be doing in the field of operations research. Many public and private agencies have little knowledge as to which government agencies might derive the most benefit from their kinds of expertise and experience.

The Joint Meeting of Government Operations Research Users and Producers was organized to improve the communications among Users of operations research within the government, and Producers of operations research in public and private organizations.

Government agencies were invited to report on exactly what they expect of their OR producers, what they expect to have done with the results, what the purposes and their uses of systems analysis are, and to give a general profile of their in-house work.

Universities were invited to report on their capabilities and their desires and to discuss the OR projects currently in progress on their campuses.

This meeting was the second in a planned series of meetings. It had for its purpose the longer range goal of providing more responsive and more adequate studies for improving government agency management and productivity.

SP350. **Time and frequency: a bibliography of NBS literature published July 1955-December 1970,** B. E. Blair, Nat. Bur. Stand. (U.S.), Spec. Publ. 350, 52 pages (June 1971).

Key words: Atomic clocks; atomic standards; clock dissemination; crystal oscillators; definition of second; flicker noise; frequency; frequency stability; lasers; length standards; measurement standards; spectral density; speed of light; standard frequency broadcasts; statistics of time/frequency measurements; time; time/frequency dissemination; time scales; timing (HF, LF, satellite, TV, VLF); wavelength standards; WWV; WWVB; WWVH; WWVL.

This publication gives bibliographic references to NBS time and frequency papers (principally those of the Time and Frequency Division or its predecessor sections) published over the past 15 years. The NBS material is classified under five general sections: Time and Frequency Standards; Time Scales, Time; Distribution/Reception of Time and Frequency Signals; Statistics of Time and Frequency Analyses, Frequency Stability; and General, Summary, and Status Reports. An additional section lists outside publications which describe the use of NBS time and frequency services or illustrate their varied use in seismic research, industrial practice, navigation, and propagation studies, among others. The bibliography documents past progress, will aid access to available literature, and gives an indication of the present direction, scope, and status of NBS time and frequency research.

SP352. **World index of plastic standards,** L. H. Breden, Editor, Nat. Bur. Stand. (U.S.), Spec. Publ. 352, 458 pages (Dec. 1971).

453-313 O - 72 - 6

Key words: Index of plastics standards; plastics standards, world index; standards, plastics.

This computer-produced Index contains the printed titles of more than 9,000 national and international standards on plastics and related materials which were in effect as of December 31, 1970. These standards are published by technical societies, trade associations, government agencies and military organizations. The title of each standard can be found under all the significant key words which it contains. These key words are arranged alphabetically down the center of each page together with their surrounding context. The date of publication or last revision, the standard number, and an acronym designating the standard-issuing organization appear as part of each entry. A list of these acronyms and the names and addresses of the organizations which they represent are found at the beginning of the World Index.

SP353. **The Menzel symposium on solar physics, atomic spectra, and gaseous nebulae in honor of the contributions made by Donald H. Menzel.** Proceedings of a symposium held at the Harvard College Observatory, Cambridge, Massachusetts, April 8-9, 1971, K. B. Gebbie, Editor, Nat. Bur. Stand. (U.S.), Spec. Publ. 353, 213 pages (Aug. 1971).

Key words: Atomic energy levels; gaseous nebulae; non-LTE thermodynamics; solar physics; transition probabilities.

A symposium in honor of Donald H. Menzel's contributions to astrophysics was held on his 70th birthday at the Harvard College Observatory, Cambridge, Massachusetts, 8-9 April 1971. Menzel and his school have made distinguished contributions to the theory of atomic physics, solar physics, and gaseous nebulae. The work on planetary nebulae represented the first investigations of non-equilibrium thermodynamic conditions in astronomy; the solar work extended these investigations to stellar atmospheres. The applied atomic physics laid the basis for what we now call laboratory astrophysics and, together with work on non-equilibrium thermodynamics, inspired the founding of the Joint Institute for Laboratory Astrophysics. Menzel has served as a distinguished consultant to the National Bureau of Standards, and publication of this volume represents a grateful acknowledgment of his service to the Bureau. The papers summarize the current status of work in the three fields he pioneered.

SP355. **Universal testing machine of 12-million-lbf capacity at the National Bureau of Standards,** A. F. Kirstein, Nat. Bur. Stand. (U.S.), Spec. Publ. 355, 18 pages (Sept. 1971).

Key words: Force calibration; large test facilities; structural testing; universal testing machine.

A 12-million pounds-force capacity universal testing machine, which is believed to be the largest of its kind in the world, has been put into operation in the Engineering Mechanics Laboratory of the National Bureau of Standards in Gaithersburg, Maryland. This hydraulically operated machine, which has an overall height of over 100 feet, was designed to test full scale structural components and to apply the forces needed to calibrate large capacity force measuring devices. The testing machine is capable of applying axial forces of 12,000,000 lbf in compression, 6,000,000 lbf in tension, and a transverse force of 4,000,000 lbf to a flexural specimen.

3.7. APPLIED MATHEMATICS SERIES

No publications in this series were issued during the period covered by this publication. Previously issued Applied Mathematics Series publications are listed in the predecessor volumes of this catalog. (Miscellaneous Publication 240, Supplement to Miscellaneous Publication 240, Special Publication 305, and Supplement 1 to Special Publication 305.)

3.8. NATIONAL STANDARD REFERENCE DATA SERIES

Includes the evaluated reference data and critical reviews of long-term interest that are produced by data centers within the NSRDS network. The National Standard Reference Data System is a Government-wide effort to provide the U.S. technical community with effective access to the quantitative data of physical science, critically evaluated and compiled for convenience.

NSRDS-NBS3, Section 3. **Selected tables of atomic spectra. A. Atomic energy levels-second edition, B. Multiplet tables, NIV, CIII, CIV, CV, CVI, data derived from the analyses of optical spectra,** C. E. Moore, Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), 3, Sec. 3, 71 pages (Nov. 1970).

Key words: Atomic energy levels, carbon spectra; atomic spectra of carbon; carbon spectra; multiplet tables, carbon spectra; spectra, carbon; wavelengths, carbon spectra.

The present publication is the third Section of a series being prepared in response to the persistent need for a current revision of two sets of tables containing data on atomic spectra as derived from analyses of optical spectra. As in the first two Sections, Part A contains the atomic energy levels and Part B the multiplet tables. All six spectra of carbon, CI through CVI are included. The form of presentation is described in detail in the text to Section 1, and need not be repeated here.

NSRDS-NBS3, Section 4. **Selected tables of atomic spectra. A. Atomic energy levels-second edition, B. Multiplet tables, NIV, NV, NVI, NVII, data derived from the analyses of optical spectra,** C. E. Moore, Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), 3, Sec. 4, 46 pages (Aug. 1971).

Key words: Atomic energy levels, NIV-NVII; multiplet tables, NIV-NVII; nitrogen spectra, NIV-NVII; spectra, NIV-NVII; wavelengths, nitrogen spectra NIV-NVII.

The present publication is the fourth Section of a series being prepared in response to the persistent need for a current revision of two sets of tables containing data on atomic spectra as derived from analyses of optical spectra. As in the previous Sections, Part A contains the atomic energy levels and Part B the multiplet tables. Four spectra of nitrogen, NIV, NV, NVI and NVII, are included. The form of presentation is described in detail in the test to Section 1.

NSRDS-NBS36. **Critical micelle concentrations of aqueous surfactant systems,** P. Mukerjee and K. J. Mysels, Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), 36, 227 pages (Feb. 1971).

Key words: Association colloid; bibliography; CMC; colloid; colloidal electrolyte; critical concentration; critical micelle concentration; detergent; hydrophobic bonding; Krafft point; long chain compounds; micelle; paraffin chain salts; selected values; soap; solubilization; standard values; surface active agents; surface chemistry; surface tension; surfactant.

Critical micelle concentrations (CMC's), have been collected, organized and evaluated. The literature has been scanned for numerical values from 1926 up to and including 1966. In addition, over 800 values, hitherto available only in graphical form or implied in experimental data, have been extracted from the publications and are included. Close to 5,000 entries, based on 333 references, dealing with 720 compounds are tabulated in the main tables. Whenever available, the temperature, any additives present, the method of determination and the literature source are given for each CMC value and an indication of the apparent quality of the preparation and method used are included. A shorter table gives selected values which are believed to be particularly reliable, including highly accurate ones. Among these, concordant values from at least two independent laboratories are emphasized.

Included in the Introduction is a general discussion of the importance and significance of CMC values and of methods for their determination, as well as a summary of the procedures used in the collection, evaluation and presentation of these values in the present work. Extensive indexes are provided.

NSRDS-NBS37. **JANAF thermochemical tables, second edition,** D. R. Stull and H. Prophet, Project Directors, Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), 37, 1141 pages (June 1971).

Key words: Evaluated data; thermal functions; thermodynamic properties of materials; thermodynamics.

This is the second edition of the JANAF Thermochemical Tables. It contains thermodynamic properties for some 1099 chemical species. The following properties are tabulated as functions of temperatures: C_p°, S°, $(F^\circ-H^\circ_{298})/T$, $H^\circ-H^\circ_{298}$, ΔH_f° and Log Kp. Superseding PB168-370 and Addenda 1, 2, and 3.

NSRDS-NBS38. **Critical review of ultraviolet photoabsorption cross sections for molecules of astrophysical and aeronomic interest,** R. D. Hudson, Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), 38, 106 pages (Aug. 1971).

Key words: Aeronomic; astrophysical; partial; photoabsorption cross sections; photodissociation; photoexcitation; photoionization; photon-scattering; total; ultraviolet cross sections.

This paper is devoted to a critical review of photoabsorption cross sections for molecules of aeronomic and astrophysical interest at wavelengths less than 3000 A. A discussion of the relative merits of various experimental techniques is given along with possible systematic and random errors that may be associated with them. The problems in data analysis associated with finite spectral bandwidths are reviewed, with special emphasis on the interpretation of published absorption cross sections. This review does not contain a complete set of cross-section-versus-wavelength values for each molecule; the prepared figures are used to compare the results of several determinations or to point out where difficulties of interpretation might arise. However, references to all papers believed to contain the more reliable data are given.

3.9. BUILDING SCIENCE SERIES

Disseminates technical information developed at the Bureau on building materials, components, systems, and whole structures. The series presents research results, test methods, and performance criteria related to the structural and environmental functions and the durability and safety characteristics of building elements and systems.

These publications, similar in style and content to the NBS Building Materials and Structure Reports (1938-59), are directed toward the manufacturing, design, and construction segments of the building industry, standards organizations, officials responsible for building codes, and scientists and engineers concerned with the properties of building materials.

BSS30. Wind loads on buildings and structures. Proceedings of a Technical Meeting held at the National Bureau of Standards, Gaithersburg, Maryland, January 27-28, 1969, R. D. Marshall, Editor, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 30, 169 pages (Nov. 1970).

Key words: Aerodynamic forces; atmospheric boundary layer; structural design; turbulence; wind effects; wind loads.

A technical meeting concerning wind loads on buildings and structures was held at the Gaithersburg Facility of the National Bureau of Standards on January 27 and 28, 1969. The meeting, jointly sponsored by the Building Research Division of the National Bureau of Standards and the Environmental Data Service of the Environmental Science Services Administration, was intended to promote the exchange of information between research workers and practicing engineers engaged in this important area of technology.

Thirteen papers covering four themes were presented. These themes were as follows: engineering problems in the design of structures to resist wind loads; atmospheric considerations; experimental and theoretical determination of aerodynamic forces; and recent advances in design procedures and current deficiencies. Presentations were followed by a panel discussion which included a summary of each theme. The last session of the meeting was devoted to open discussion.

Design and construction for what wind loads and why, L. C. Maugh, *BSS30*, pp. 5-8 (Nov. 1970).

Key words: Buildings; design criteria; dynamics; gust factors; smoke stacks; structural failure; wind loads.

This paper is primarily concerned with the design of various structures for wind forces from the viewpoint of the average structural engineer. The subject matter focuses attention upon three important types of structural problems whose solutions are still so uncertain as to require considerably more study and research. These problems are:

1. Wind action upon structural frameworks during construction with emphasis upon the relatively large number of partial or complete failures.

2. The behavior of completed structures of relatively high frequencies when subjected to wind loads. An important factor here is the amount and characteristics of motion in high-rise buildings that will be accepted by the occupants.

3. Some dynamic problems associated with wind forces acting upon structures of low frequencies such as tall chimneys and guyed towers.

The above problems are discussed from the need for better design criteria and specifications as well as more exact mathematical analysis and more refined wind measurements. The importance of the latter factor is recognized but the many empirical factors in structural design are also considered in this paper.

Design wind loads for building wall elements, W. F. Koppes, *BSS30*, pp. 9-18 (Nov. 1970).

Key words: Buildings; fluctuating pressure; gust factors; walls; wind damage; wind loads.

It is principally the structural engineer who has been concerned with wind forces acting on buildings, because it is his responsibility to design the structure to resist their overall effect. Recently, however, the importance of localized wind loads acting on the surfaces of buildings has also been receiving much attention. These local loads affect wall design, and are a matter of concern to both the architect and the manufacturer of wall parts.

The important differences between overall and local wind loads include magnitude of intensity, character, period of duration, significance in relation to building size and shape, and importance in respect to potential property loss. Complete destruction of buildings by wind action is rare, but local failures are not uncommon and, on the whole, are more costly.

Because gust and shape factors are highly unpredictable, increasing reliance is being placed on wind tunnel tests and measurements on actual buildings. Both confirm that negative pressures usually exceed positive pressures on parts of wall areas. Few building codes in this country recognize this, in specifying design wind loads for walls, though codes in some other countries do. The importance of terrain conditions is not reflected, either, in code provisions.

Failures of windows and other wall elements due to wind loads occur rather frequently, but relatively few of them are documented. Several interesting examples of such failures can, however, be cited.

Another important aspect of local wind effects is the funneling often experienced near the base of tall buildings. Notable examples of this phenomenon have been observed, and research studies directed at their causes have produced significant findings.

Codes and standards cannot be expected to provide guidance for designers in respect to unique local wind effects, but they should provide information as to loads which wall surfaces of typical buildings will likely experience. The only standard currently providing this kind of data is the Tentative Standard for Design Wind Loads on Walls of Rectangular Buildings, published by the National Association of Architectural Metal Manufacturers. The background, purpose and features of this Standard are noteworthy, and it is serving a useful purpose.

A review of current investigations of local wind loads, both by wind tunnel tests and field measurements, indicates that certain common assumptions regarding their intensity and distribution on building surfaces should be reexamined. Further information regarding the nature of these loads is urgently needed by, and should be more promptly disseminated to, the designers and producers of building wall systems.

Guidelines in selecting wind measuring instruments and their locations for wind loading studies, G. C. Gill, *BSS30,* p. 21 (Nov. 1970).

Key words: Anemometers; instrumentation; tower interference; transducers; wind vanes; wind loads.

The different types of wind speed sensors (cup, propeller, pressure tube, pressure sphere, hot wire, and sonic) will be discussed in relation to their suitability for wind loading studies. For very sound reasons the rotational types of anemometers (cup and propeller) have become the standard wind speed sensors used in North America today. Pressure type wind speed sensors will be considered but they have inherent weaknesses as anemometers. In view of the versatility of the rotational anemometers and in view of all weather records and charts being based on observations with these instruments it appears advisable for wind loading studies to measure wind speed with these conventional anemometers.

Wind vanes of different types (flat plate, splayed vane, and aerodynamic cross section) will be discussed and the transducers to be used with them. Very light vanes of the flat plate type are recommended.

The dynamic response and fidelity of recording of both anemometers and wind vanes will be discussed.

The wind-shadow effect of towers on the wind sensors mounted thereon, and the orientation of the sensors will be discussed. For good exposure the sensors should be mounted one to two tower widths out from the tower, and, either into the prevailing wind, or, into the wind direction of maximum concern. The height and location of towers relative to the building or structure under study will be discussed.

The adequacy of existing meteorological data for evaluating structural problems, I. A. Singer and M. E. Smith, *BSS30,* pp. 23-25 (Nov. 1970).

Key words: Climatology; meteorology; spatial correlation; turbulence; wind observations; wind profiles.

Available meteorological data are usually unsuitable for application to structural problems for a variety of reasons. The most obvious deficiency involves instrument location in the three-dimensional sense. Most meteorological observations have been obtained at low elevation in open country, and they therefore do not reveal the wind structure at the typical heights of modern urban buildings. Furthermore, few of the data have been processed to reflect the turbulent structure of the flow. More subtle problems are involved with the failure of any current programs to define the horizontal structure of turbulence, although a small number of appropriate studies have been made in the vertical. Very important also is the lack of data taken under extreme meteorological conditions, such as thunderstorms and hurricanes. These deficiencies derive in part from the difference in objectives that have led to existing meteorological programs and those that would suit the structural engineer, but they are also associated with the failure of the latter to define his requirements. An experimental program that may fill some of the gaps is outlined for discussion and criticism.

The characteristics of atmospheric turbulence as related to wind loads on tall structures, G. H. Fichtl, J. W. Kaufman, and W. W. Vaughan, *BSS30,* pp. 27-41 (Nov. 1970).

Key words: Atmospheric boundary layer; gust factors; peak values; power spectra; turbulence; wind profiles.

An engineering boundary layer wind model based upon data collected at the NASA 150-meter meteorological power facility at the Kennedy Space Center, Florida is discussed. A statistical power-law peak wind profile is used to extrapolate peak wind statistics valid at the 10-meter to other levels. The relationship between the instantaneous extreme wind profile and the peak wind profile for various periods of exposure up to ten minutes is examined. The gust factor profile, which depends on the peak wind speed, height, and averaging time, is applied to the peak wind profile to obtain a mean wind profile. A spectral model of the longitudinal and lateral components of turbulence for the neutral boundary layer (high wind speeds) is presented.

Fluctuating moments on tall buildings produced by wind loading, J. E. Cermak, W. Z. Sadeh, and G. Hsi, *BSS30,* pp. 45-59 (Nov. 1970).

Key words: Boundary layer; buildings; instrumentation; overturning moments; pressure fluctuations; wind loads; wind tunnel modeling.

Wind loading on a 1:384 scale model of a building 666 ft high was studied experimentally in a thick-boundary-layer wind tunnel. Measurements of mean velocity and turbulence intensity upstream of the model building verified that the wind tunnel flow was an adequate simulation of atmospheric-surface-layer flow over an urban area.

Mean pressure distributions and local pressure fluctuations were measured for a variety of upstream roughness conditions and wind directions. Use of a high frequency response pressure-measuring system permitted rms and peak values of the local pressure fluctuations to be determined at numerous points on the building surface.

Emphasis was placed on direct measurement of mean and fluctuating overturning moments by means of a strain-gage dynamometer. A stiff model, $U/Dn < 1$, was used to obtain moments due to wind action alone. Peak values of the moment fluctuations were found to have a magnitude of ± 34% of the mean moment. Root-mean-square values of the moment fluctuations were also determined in an effort to relate the moment fluctuations to the measured pressure fluctuations.

Experience with wind pressure measurements on a full-scale building, W. A. Dalgliesh, *BSS30,* pp. 61-71 (Nov. 1970).

Key words: Buildings; full-scale tests; power spectra; pressure fluctuations; wind loads; wind tunnel modeling.

Wind pressure measurements made over a 4-year period on a 34-story building in downtown Montreal were used to obtain data for checking and improving wind tunnel techniques of modeling flow characteristics of wind and aerodynamic behavior of buildings. It had been hoped that the measurements could be applied directly to certain problems of design such as evaluation of peak suction load over small wall areas. The small number of pressures recorded, however, combined with limitations of field measurements made direct application of the data extremely difficult.

The major problems involved in making field measurements and in comparing them with wind tunnel measurements were found to be:

(*a*) difficulty of establishing a static reference pressure and its relation to the static pressure in the wind tunnel;

(*b*) inadequacy of wind velocity information, which in this case consisted of one anemometer and wind vane located 1,500 ft southwest of the building;

(*c*) lack of stationarity and homogeneity of the velocity field as compared with the wind tunnel situation.

Comparisons with model measurements are made on the basis of mean pressures, rms pressures, power spectra, and the correlation between selected pairs of pressures measured at various points on the building. Examples have been found of excellent agreement in almost all respects, but for some wind directions the comparisons gave unsatisfactory correlation. The lack of agreement is attributed mainly to differences between indicated and actual on-site wind direction, but this cannot be shown conclusively because of incomplete wind information.

The total cost of the project over the 4-year period was of the order of $100,000. A greater expenditure would have been advisable, primarily for instrumentation to permit a better definition of the wind velocity around the building. Measurements are now under way on a 600-ft office building using a much more sophisticated data acquisition system by means of which it should be possible to acquire the desired information more efficiently and in a shorter period of time.

Influence of architectural features on the static wind loading of buildings, H. J. Leutheusser, *BSS30*, pp. 73-86 (Nov. 1970).

Key words: Architectural features; buildings; mullions; parapets; roof projections; static pressures; wind effects; wind tunnel modeling.

The paper deals with the exploration, by model tests, of the effects of roof parapets and roof projections onto the roof wind-loading, and of wall mullions (or ribs) onto the wall wind-loading, of bluff building forms. Results are presented which suggest that parapets are effective in equalizing the pressure distribution over the roof surface while slightly reducing the uplift force. Roof projections, on the other hand, have the opposite effects. The presence of wall mullions causes sawtooth like deviations from the peripheral wall pressure-distribution for the no-rib case. The deviations are particularly significant in regions of attached flow and tend to become more pronounced with an increase in rib spacing.

The unsteady surface pressure around circular cylinders in two-dimensional flow, W. E. Simon, *BSS30*, pp. 87-91 (Nov. 1970).

Key words: Circular cylinders; power spectra; pressure fluctuations; subcritical flow; supercritical flow; transcritical flow; turbulence.

The unsteady surface pressure around circular cylinders in two-dimensional flow has been measured in the subcritical, supercritical, and transcritical flow regions. A representation of the crosspower spectral density has been developed which is a reasonable representation of the data and which applies to all three regions. The most important result is the essential similarity of the subcritical and transcritical regions.

On the reliability of gust loading factors, B. J. Vickery, *BSS30*, pp. 93-104 (Nov. 1970).

Key words: Buildings; dynamics; gust factor; mode shape; probability theory; wind loads.

The accuracy of the simplified gust factor approach to the determination of wind loads is examined. An expression for the gust factor is derived which treats the scale of turbulence, mode shape of vibration, and parameters defining the vertical and crosswind cospectra as variables. The method formulated in this paper differs from previous methods primarily in the size reduction factor and in the form of the spectrum of velocity fluctuations. Predicted values of gust factors are compared with those observed on eight different aeroelastic models tested in a boundary layer wind tunnel. The gust factor relates only to overall loads in the mean wind direction. Where basic data are well defined, the ratio of expected peak values of wind-induced stress or deflection to their average values can be predicted to an accuracy of typically 5 percent to 10 percent.

The treatment of wind in the design of very tall buildings, L. E. Robertson and P. W. Chen, *BSS30*, pp. 107-114 (Nov. 1970).

Key words: Aeroelasticity; buildings; dynamics; statistical analysis; structural engineering; wind loads; wind tunnel modeling.

This paper describes briefly some highlights of a study of the wind effects for the design of the United States Steel Office Building in Pittsburgh, Pennsylvania. Three types of models were used in a boundary layer wind tunnel to obtain data of the wind effects on the building. The wind tunnel results are combined with Weather Bureau data to obtain statistical estimates of the design parameters. These parameters include the envelopes of maximum deflections, the contours of maximum and minimum wind pressures on the exterior walls, and the expected number of cycles of oscillation per year which exceeds specific values of acceleration and of deflection.

Dynamic response of tall flexible structures to wind loading, J. Vellozzi and E. Cohen, *BSS30*, pp. 115-128 (Nov. 1970).

Key words: Aeroelasticity; buildings; circular cylinders; gust factors; masts; structural engineering; towers; vortex shedding; wind loads.

The purpose of this paper is to present and discuss methods of calculating the dynamic response of tall, flexible structures, such as towers, stacks and masts, to wind loading. The paper is presented in two parts; the first part deals with the dynamic response of cylindrical structures to vortex shedding and the second part deals with dynamic response to gust loading.

Some deficiencies in current methods of analysis, R. W. Clough, Chairman, *BSS30*, pp. 129-131 (Nov. 1970).

Key words: Buildings; climatology; seismic loads; structural engineering; vibrations; wind loads.

Deficiencies in methods of analysis for structures subjected to wind forces are considered. Areas of similarity between wind and seismic forces and their treatment by current building codes are discussed. Deficiencies include a neglect of the dynamic nature of the wind problem, a lack of basic information, and an inadequate definition of acceptable levels of risk.

Combining a wind tunnel analysis with a three-dimensional analytic building analysis, G. C. Hart, *BSS30*, pp. 145-149 (Nov. 1970).

Key words: Buildings; dynamics; gust loads; matrix analysis; mode shape; probability theory; wind loads.

A three-dimensional oriented stiffness representation of a high-rise building is described. Statistical quantities obtained from aeroelastic models in a boundary layer wind tunnel are combined with the three-dimensional analytical building model to obtain a probabilistic description of the building's response. The response is expressed in terms of the mean and covariance of floor displacements and stresses in the structural members. The procedure is intended to provide a more realistic combination of the aerodynamic and structural behavior of a high-rise building.

The engineering interpretation of Weather Bureau records for wind loading on structures, S. C. Hollister, *BSS30*, pp. 151-164 (Nov. 1970).

Key words: Buildings; climatology; extreme value theory; gust factors; structural engineering; wind loads; wind profile.

This paper utilizes the records of the fastest mile as published by the United States Weather Bureau from data obtained at their airport stations, to develop wind loadings on engineering structures. It analyzes gusts and shows how gust loadings should be dealt with in structural design. Roughness of terrain and extent of cover in rural and urban localities are systemized for engineering purposes. Occurrence of extreme winds, as studied by the Weather Bureau, is extended to a stage where a practical code may be written. Finally, designing for a given structural life and for a desired level of risk is discussed.

BSS32. **Precoordination—basis for industrialized building.** Proceedings of a conference held at Gaithersburg, Md., September 24-26, 1969, R. W. Smith, Jr., Editor, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 32, 136 pages (Jan. 1971).

Key words: Building; components; precoordination; standards.

The Conference entitled "Precoordination—Basis for Industrialized Building" was held at the National Bureau of Standards, Gaithersburg, Md., on September 24-26, 1969. The Conference was sponsored by the American National Standards Institute's Committee A62, Precoordination of Building Components and Systems, to explore the standards required to establish a basis for an industrywide system of building using interchangeable components. Coordinated components, conforming to these standards, will be compatible and interchangeable in both dimension and function and thereby offer unlimited opportunities for product and material selection as well as design flexibility.

BSS34. **Strength of masonry walls under compressive and transverse loads,** F. Y. Yokel, R. G. Mathey, and R. D. Dikkers, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 34, 74 pages (Mar. 1971).

Key words: Brick; cavity walls; composite walls; compressive strength; concrete block; flexural strength; masonry; mortar; slenderness effects; standards; structural stability; walls.

Ninety walls of 10 different types of masonry construction were tested under various combinations of vertical and transverse load. It is shown that the effect of vertical load and wall slenderness on transverse strength can be predicted by rational analysis. The analysis is based on established theory which has been extended to account for the properties of masonry. Similar methods of rational analysis have been adopted for the design of steel structures and are presently being considered for reinforced concrete structures.

BSS35. **Interrelations between cement and concrete properties, Part 5. Freezing-and-thawing durability, saturation, water loss and absorption, dynamic modulus,** R. L. Blaine and H. T. Arni, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 35, 129 pages (Nov. 1971).

Key words: Absorption; autogenous healing; durability factor; dynamic modulus of elasticity; saturation coefficient.

The concretes described in earlier parts of this series were subjected to laboratory freezing and thawing tests, and measurements were made of the weight loss, dynamic modulus, durability factor, and number of cycles required to reach 40 percent reduction in dynamic modulus. Companion specimens were subjected to drying and subsequent soaking in the laboratory and to dynamic modulus tests at various ages and moisture conditions. The effect on these properties of a large number of variables connected with chemical and physical properties of the cements and with properties of the concretes was studied by multivariable regression techniques. Air content of the concretes and degree of saturation generally had the greatest effect on the measurements. In general, minor constituents and trace elements did not show significant relationships with the measured properties, but there was evidence that some of the variables, such as alkali content, water cement ratio, slump, and possibly setting time might have influenced durability through an effect on the air-void system. Specimens stored in the fog room after the freezing-and-thawing tests generally regained most or all of their original dynamic modulus. There were significant differences between cements with respect to regain of dynamic modulus (autogenous healing), with the non-air-entrained cements gaining more than the air-entraining cements, on the average.

BSS36. **Interrelations between cement and concrete properties, Part 6. Compilation of data from laboratory studies,** J. R. Clifton and R. G. Mathey, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 36, 118 pages (Aug. 1971).

Key words: Cement; chemical composition; concrete; durability; material properties; physical properties.

Data are presented on the properties of Portland cements, mortars and concretes from a long term study reported principally by Blaine and Arni.

These data are from laboratory studies and cover a wide range of cements and concretes. A total of 199 different cements were included in the study.

BSS37. **The effect of moisture on the heat transfer performance of insulated flat-roof constructions,** F. J. Powell and H. E. Robinson, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 37, 81 pages (Oct. 1971).

Key words: Flat roofs; heat transfer; moisture transfer; thermal insulation.

A solution to the problem of unwanted moisture in the thermal insulation of flat roofs was found during a recently completed laboratory investigation of the effects of moisture on heat transfer through these constructions. The objective of the research was to ascertain how much the insulating performance of conventional constructions, having insulation over concrete decks, was affected by moisture. This is presented as Part I. Also, the objective was to investigate properties of materials, their arrangement and dimensions which would yield a construction having an adequate degree of self-drying ability, combined with low winter moisture regain rate. This is presented as Part II. The results show that the best insulating and moisture performance was obtained by utilizing the heat of the summer sun on the roof to vaporize and transfer to the room beneath any free moisture contained within the construction. Roof specimens made from moderately vapor-permeable materials without conventional vapor barriers were, in winter, able to accommodate the small quantity of slowly accumulated condensation without dripping or severe loss of insulating value. During the nine-year investigation, the performance characteristics of 73 insulated roof deck specimens were obtained and two new methods of measurement were developed. Criteria for the design of self-drying insulated flat roofs were developed and limits of the parameters containing the main variables that affect performance were suggested.

This paper presents complete results of the research which was sponsored jointly by the National Bureau of Standards, the Army, the Navy, and the Air Force.

BSS38. **1939 exposure test of porcelain enamels on steel 30-year inspection,** M. A. Baker, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 38, 9 pages (Aug. 1971).

Key words: Acid resistance; color; gloss; porcelain enamel; weather resistance.

The weather resistance of 192 porcelain enameled panels representing 14 enamel types was evaluated after being exposed for 30 years at Washington, D.C. A direct correlation was found between the acid resistance and weather resistance of the enamels tested. The porcelain enamel protected the base metal from corrosion if the initial coverage was complete.

Similar evaluations and findings were made on 58 panels representing 13 enamel types that were added to this test in 1947.

BSS40. **Engineering aspects of the 1971 San Fernando earthquake,** H. S. Lew, E. V. Leyendecker, and R. D. Dikkers, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 40, 419 pages (Dec. 1971).

Key words: Bridge; building; codes; dams; earthquake damage; earthquakes; foundation geology; highways; hospital; housing; mobile home; seismic; standards; structural engineering.

Immediately following the San Fernando, California earthquake (February 9, 1971), a four-man team from the Building Research Division of the National Bureau of Standards' Institute for Applied Technology, surveyed the damage to buildings and other structures. This report is based primarily on the data gathered during the survey but includes some data provided by other agencies and individuals. Based on study of these data and observations made during the survey, recommendations are made pertaining to the improvement of building and other structural design and construction practices.

3.10. FEDERAL INFORMATION PROCESSING STANDARDS PUBLICATIONS

The publications in this series collectively constitute the Federal Information Processing Standards Register. The purpose of the Register is to serve as the official source of information in the Federal Government regarding (1) uniform Federal information processing standards resulting from provisions of Public Law 89-306 (the Brooks Bill), and (2) data elements and codes standards in data systems developed under the provisions of Bureau of the Budget Circular No. A-86. FIPS PUBS will include approved Federal information processing standards information of general interest, and a complete index of relevant standards publications.

FIPS PUB 8-1. **Metropolitan statistical areas,** H. S. White, Jr., Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS Pub.) 8-1, 7 pages (1971).

Key words: Computers; data processing; Federal Information Processing Standards Publication; national government; representations and codes; Standard Metropolitan Statistical Areas.

This publication provides identification and codes for representing Standard Metropolitan Statistical Areas. It supersedes FIPS PUB 8, same title, dated June 9, 1969. The general concept of a Standard Metropolitan Statistical Area is one of an integrated economic and social unit with a recognized large population nucleus.

FIPS PUB 12. **Federal information processing standards index,** H. E. McEwen, Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS Pub.) 12, 143 pages (1970).

Key words: American National Standards; computers, data elements and codes; data processing systems; Federal Information Processing Standards; International Organization for Standardization; management information systems; standards; U.S. Government.

This publication provides material concerning standardization activities in the area of information processing at the Federal, National and International levels. Also included are related policy and procedural guideline documents. A list of Federal Government participants involved in the development of Federal Information Processing Standards is provided.

FIPS PUB 13. **Rectangular holes in twelve-row punched cards,** H. S. White, Jr., Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS Pub.) 13, 4 pages (1971).

Key words: American Standard Code for Information Interchange; ASCII; card punch; card reader; data communications; data interchange; data processing; EAM cards; electric accounting machine; Federal Information Processing Standard; Hollerith punched cards; information interchange; information processing; punched cards; rectangular holes.

This publication provides information on the size, location and dimensional tolerances of rectangular holes in 12-row, 3 1/4 inch wide punched cards. It applies to card reading and punching equipment used in data processing, communications and similar operations in the Federal government. This Federal standard adopts in whole a revised version of American National Standard X3.21-1967, Rectangular Holes in 12-Row Punched cards.

FIPS PUB 14. **Hollerith punched card code,** H. S. White, Jr., Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS Pub.) 14, 4 pages (1971).

Key words: American Standard Code for Information Interchange; ASCII; card punch; card reader; data communications; data interchange; data processing; EAM cards; electric accounting machine; Federal Information Processing Standard; Hollerith punched card code; Hollerith punched cards; information interchange; information processing; punched cards.

This publication provides a standard set of 128 hole patterns which represent the 128 characters of the Federal Standard Code for Information Interchange (ASCII) FIPS 1, in 12-row, 80 column, rectangular hole, "Hollerith" punched cards, or the subsets of ASCII as specified in FIPS 15, Subsets of the Standard Code for Information Interchange. It adopts one-half of the 256 hole patterns given in the American National Standard X3.26-1969, Hollerith Punched Card Code.

FIPS PUB 15. **Subsets of the standard code for information interchange,** H. S. White, Jr., Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS Pub.) 15, 10 pages (1971).

Key words: American Standard Code for Information Interchange; ASCII; coded character subsets; codes; data communication; data interchange; data processing; Federal Information Processing Standards; graphic character subsets; graphic subsets; information interchange; information processing; standards; subsets.

This publication provides three subsets of 95, 64 and 16 graphic characters derived from the Federal Standard Code for Information Interchange (FIPS 1), which was adopted from the American Standard Code for Information Interchange (ASCII) X3.4-1968. These subsets are for use in Federal printers, display devices, punched card equipment, and other data processing or communication equipments which utilize a character subset less than the full 128-character set of FIPS 1.

FIPS PUB 16. **Bit sequencing of the code for information interchange in serial-by-bit data transmission,** H. S. White, Jr., Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS Pub.) 16, 4 pages (1971).

Key words: American Standard Code for Information Interchange; ASCII; communications; data communications equipment; data processing terminal equipment; data transmission; Federal information processing standards; serial-by-bit; serial-by-character; telecommunications; teleprocessing.

This publication prescribes the method for transmitting the American Standard Code for Information Interchange (ASCII) in systems employing serial-by-bit, serial-by-character data transmission. The least significant bit (b1) is transmitted first, the most significant bit (b7) last, followed by the character parity bit (if transmitted). (See also FIPS 17, CHARACTER STRUCTURE AND CHARACTER PARITY SENSE FOR SERIAL-BY-BIT DATA COMMUNICATION IN THE CODE FOR INFORMATION INTERCHANGE.)

FIPS PUB 17. **Character structure and character parity sense for serial-by-bit data communication in the code for information interchange,** H. S. White, Jr., Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS Pub.) 17, 4 pages (1971).

Key words: American Standard Code for Information Interchange; ASCII; character parity sense; character structure; communications; data transmission; Federal information processing standards; serial-by-bit; telecommunications; teleprocessing.

This publication specifies the character structure and character parity sense for transmitting the American Standard Code for Information Interchange (ASCII) in systems employing serial-by-bit data transmission. Characters are to be transmitted as eight bits (seven ASCII bits plus one character parity bit). The parity sense shall be odd for synchronous transmissions and even for asynchronous transmissions. (See also FIPS 16, BIT SEQUENCING OF THE CODE FOR INFORMATION INTERCHANGE IN SERIAL-BY-BIT DATA TRANSMISSION.)

FIPS PUB 18. **Character structure and character parity sense for parallel-by-bit data communication in the code for information interchange,** H. S. White, Jr., Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS Pub.) 18, 4 pages (1971).

Key words: American Standard Code for Information Interchange; ASCII; character structure; communications; data transmission; Federal information processing standards; parallel-by-bit; parity sense; serial-by-character; telecommunications; teleprocessing.

This publication specifies the character structure and character parity sense for transmitting the American Standard Code for Information Interchange (ASCII) in systems employing parallel-by-bit data transmission. The seven ASCII bits (b1 through b7) plus the character parity bit (P) are assigned to an ordered series of channel designators. The most significant bit (b1) is assigned to the lowest designator and (P) to the highest designator.

FIPS PUB 19. **Guidelines for registering data codes,** H. S. White, Jr., Standards Coordinator, Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS Pub.) 19, 7 pages (1972).

Key words: Data codes; data elements; data processing systems standards; Federal information processing standards; management information systems; United States Government.

Office of Management and Budget Circular No. A-86, Standardization of data elements and codes assigns to the National Bureau of Standards responsibility for maintaining registers of data elements and codes, and to Federal departments and agencies the responsibility for registering program and agency codes with NBS. This publication provides guidelines for registering data codes with NBS and for reporting the use of the codes to maintaining agencies for purposes of receiving changes.

3.11. PRODUCT STANDARDS

This series comprises voluntary standards that establish (1) dimensional requirements for standard sizes and types of various products, (2) technical requirements for the product, and (3) methods of testing, grading, and marking these products. The objective is to define requirements for products in accordance with the principal demands of the trade.

PS0-70. **Editorial format for Voluntary Product Standards,** D. R. Mackay, Nat. Bur. Stand. (U.S.), Prod. Stand. 0-70, 13 pages (Mar. 1971).

Key words: Editorial format; format; Product Standards; standard; Voluntary Product Standards.

This publication is intended to assist individuals, organizations, and agencies which are concerned with the writing of standards. It establishes and describes the material to be contained in a standard and provides specific instructions for writing standards. It is primarily intended for those developing initial drafts of standards to be submitted to the Bureau under the *Procedures for the Development of Voluntary Product Standards* published by the Department of Commerce. Supersedes NBS PS0-67.

PS29-70. **Plastic heat-shrinkable film,** L. H. Breden, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 29-70, 16 pages (Jan. 1971).

Key words: Balanced and unbalanced film; film, plastic; orientation release stress; plastic heat-shrinkable film; retraction ratio; shrink film, plastic.

This Voluntary Product Standard covers plastic film which, within its useful temperature range, will shrink at least 20 percent in either or both the machine and the transverse directions. Included are requirements and methods of test for shrink properties, dimensions, yield, weight, and slip.

PS30-70. **School chalk,** J. W. Eisele, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 30-70, 14 pages (May 1971).

Key words: Calcium carbonate; calcium sulfate; chalk; chroma; toxicity; whiting.

This standard provides requirements for the dimensions, material, breaking strength, characteristics, toxicity, workmanship, and chroma (as applicable) for six types and several classes and grades of school chalk. Test methods for determining the material content, breaking strength, and chroma are provided. Standard packages are given, and methods for labeling to indicate compliance with the standard are provided.

PS31-70. **Polystyrene plastic sheet,** L. H. Breden, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 31-70, 14 pages (Jan. 1971).

Key words: Impact resistance, plastic sheet; oriented sheet; plastic sheet; polystyrene plastic sheet; sheet; plastic.

This Voluntary Product Standard covers requirements and methods of test for dimensions, and mechanical and physical properties of hot-melt extruded polystyrene plastic sheet. The standard does not cover polystyrene foam or biaxially oriented sheet.

PS32-70. **Hinged interior wood door units,** W. H. Furcolow, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 32-70, 15 pages (Mar. 1971).

Key words: Door units, wood; hinged door units, interior; prefabricated door units; wood door units.

This Voluntary Product Standard covers the designs, grades, sizes, materials (including hardware), and construction of prefabricated wood door units, as well as a means of identifying units represented as conforming to the standard, and definitions of terms used in the standard.

PS33-70. **Polytetrafluoroethylene (PTFE) plastic lined steel pipe and fittings,** L. H. Breden, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 33-70, 12 pages (Mar. 1971).

Key words: Pipe and fittings, steel, plastic lined; plastic lined steel pipe; polytetrafluoroethylene plastic lined pipe; PTFE lined pipe; steel pipe and fittings, plastic lined.

This Voluntary Product Standard covers requirements and methods of test for the material, dimensions, construction, and performance of commercially available steel pipe and fittings lined with polytetrafluoroethylene (PTFE) plastic intended to be used for conveying acids, gases, solvents, and other corrosive materials.

PS34-70. **Fluorinated ethylene-propylene (FEP) plastic lined steel pipe and fittings,** L. H. Breden, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 34-70, 12 pages (Mar. 1971).

Key words: FEP lined pipe; fluorinated ethylene-propylene plastic lined pipe; pipe and fittings, steel, plastic lined; plastic lined steel pipe; steel pipe and fittings, plastic lined.

This Voluntary Product Standard covers requirements and methods of test for the material, dimensions, construction, and performance of commercially available steel pipe and fittings lined with fluorinated ethylene-propylene (FEP) plastic intended to be used for conveying acids, gases, solvents, and other corrosive materials.

PS35-70. **Poly(vinylidene fluoride) (PVF_2) plastic lined steel pipe and fittings,** L. H. Breden, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 35-70, 12 pages (Mar. 1971).

Key words: Pipe and fittings, steel, plastic lined; plastic lined steel pipe; poly(vinylidene fluoride) plastic lined pipe; PVF_2 lined pipe; steel pipe and fittings, plastic lined.

This Voluntary Product Standard covers requirements and methods of test for the material, dimensions, construction, and performance of commercially available steel pipe and fittings lined with poly(vinylidene fluoride) (PVF_2) plastic intended to be used for conveying acids, gases, solvents, and other corrosive materials.

PS36-70. **Body measurements for the sizing of boys' apparel,** C. W. Devereux, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 36-70, 24 pages (Dec. 1971).

Key words: Apparel, boys'; body measurements, boys'; pattern sizes, boys'; size designations, boys'; span charts, boys' sizing.

This Voluntary Product Standard covers standard size designations, size classifications, and body measurements for the sizing of boys' apparel. The standard includes sections on applications of the system, recommended methods of identification, methods of measuring, and clothing allowances. The measurements given in this standard are body, not garment, measurements.

PS37-70. **Package quantities of instant nonfat dry milk,** C. B. Phucas, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 37-70, 9 pages (Apr. 1971).

Key words: Dry milk package quantities; instant nonfat dry milk; nonfat dry milk, package quantities of; package quantities of dry milk.

This Voluntary Product Standard covers package quantities of instant nonfat dry milk based on quart equivalents within the range of 3 to 20 quarts. It also establishes the weight of instant nonfat dry milk required to make 1 quart. This Standard covers all types of packages of instant nonfat dry milk intended for household use including those containing individual quart or multi-quart equivalent envelopes.

PS38-70. **Steel bi-fold closet door units, frames, and trim,** C. W. Devereux, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 38-70, 12 pages (May 1971).

Key words: Bi-fold doors, steel; closet doors, steel bi-fold; doors, steel bi-fold; steel bi-fold doors.

This Voluntary Product Standard covers sizes, types, materials, construction, hardware, and finishing of steel bi-fold closet door units and frames intended to be stock items not subject to variations according to the customer's special requirements. Methods of marking and labeling are included so that products which comply with the standard may be clearly identified. Provisions for the erection of doors, frames, and accessories are not included in the standard, but certain recommendations for storage and erection as generally endorsed by the manufacturers are given for information and guidance.

PS39-70. **Clinical thermometers (maximum-self-registering, mercury-in-glass),** W. H. Furcolow, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 39-70, 12 pages (May 1971).

Key words: Clinical thermometers; glass thermometers, clinical; mercury-in-glass thermometers; thermometers, self-registering, clinical.

This Voluntary Product Standard covers the requirements and methods of testing maximum-self-registering, mercury-in-glass thermometers of the types commonly used for measuring body temperatures, such as oral and rectal types in both regular and basal temperature scales. It is intended to serve as a nationally recognized basis for certification of compliance by manufacturers and for procurement purposes by consumers. The standard includes requirements for bulb and stem glasses, mercury, dimensions, temperature scale ranges, and graduations, and performance criteria for thermometer aging, hard shaking determination, and accuracy of scale reading.

PS40-70. **Package quantities of green olives,** C. B. Phucas, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 40-70, 9 pages (May 1971).

Key words: Green olives, package quantities of; olives, green, package quantities of; package quantities of green olives.

This Voluntary Product Standard covers a range of package quantities that are recommended for green olives and establishes specific packaging requirements in terms of net drained weight. Methods of labeling products which comply with this Standard are provided.

PS41-70. **Package quantities of instant mashed potatoes,** C. B. Phucas, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 41-70, 8 pages (Apr. 1971).

Key words: Instant mashed potatoes, package quantities of; mashed potatoes, instant, package quantities of; package quantities of instant mashed potatoes; potatoes, instant mashed, package quantities of.

This Voluntary Product Standard covers a range of package quantities based on servings and establishes the definition of a serving which is based on the weight of the reconstituted product.

PS42-70. **Body measurements for the sizing of women's patterns and apparel,** C. W. Devereux, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 42-70, 29 pages (Sept. 1971).

Key words: Apparel, women's; body measurements, women's; classifications, women's size; grading charts, women's size; pattern size, women's; size designations, women's; span charts, women's sizing.

This Voluntary Product Standard covers standard size classifications, size designations, and body measurements to aid in the consistency of sizing of women's apparel and, by doing so, provides a means for the consumer to identify her body type and size for proper fit. This standard also covers applications of the system, definitions, methods of measurement, adjustments to compensate for the effect of foundation garments, spanning charts, and a recommended method of identification. The measurements given in this standard are body, not garment, measurements.

PS43-71. **Fluorinated ethylene-propylene (FEP) plastic tubing,** L. H. Breden, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 43-71, 12 pages (Sept. 1971).

Key words: Chemical, mechanical, and electrical tubing; FEP tubing; fluorocarbon plastic tubing; plastic tubing, fluorinated ethylene-propylene; tubing, FEP-fluorocarbon.

This Voluntary Product Standard covers plastic tubing made from fluorinated ethylene-propylene (FEP) resin intended for chemical, mechanical, or electrical use. It provides requirements and methods of test for materials, dimensions, and physical and chemical properties of FEP tubing. A method for identifying products which comply with this standard is provided.

PS44-71. **Paper ice bag sizes,** C. B. Phucas, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 44-71, 12 pages (Sept. 1971).

Key words: Bag sizes, ice; ice bag sizes; paper ice bag sizes.

This Voluntary Product Standard covers the dimensions and the capacities of paper ice bags intended for use in the packaging of cubed, sized, crushed, and block ice. Methods of measuring and for identifying bags that conform to this standard are provided.

PS46-71. **Flame-resistant paper and paperboard,** J. W. Eisele, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 46-71, 10 pages (Oct. 1971).

Key words: Flame-resistant; paper and paperboard; paper, paperboard, flame-resistant; paperboard, paper, flame-resistant.

This Voluntary Product Standard covers requirements and test methods for flame-resistant paper and paperboard which are 0.060 inch or less thick. Definitions are provided, and a method for identifying products conforming to the standard is given. Two classifications of flame-resistant paper and paperboard are covered: Type I, which if flame-resistant only before water leaching and Type II, which is flame-resistant both before and after water leaching.

PS47-71. **Heat-shrinkable fluorocarbon plastic tubing,** L. H. Breden, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 47-71, 14 pages (Sept. 1971).

Key words: FEP heat-shrinkable tubing; fluorocarbon plastic heat-shrinkable tubing; plastic tubing, fluorocarbon; PTFE heat-shrinkable tubing; tubing, heat-shrinkable fluorocarbon plastic.

This Voluntary Product Standard covers commercially available PTFE and FEP plastic tubing which can be reduced to a predetermined inside diameter by the application of heat. Included are requirements and methods of test for materials, dimensions, and physical and electrical properties. A method for identifying products which comply with this standard is provided.

PS48-71. **Package quantities of cubed, sized, crushed, and block ice,** C. B. Phucas, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 48-71, 10 pages (Nov. 1971).

Key words: Block ice, package quantities of; crushed ice, package quantities of; cubed ice, package quantities of; ice, package quantities of; package quantities of ice; sized ice, package quantities of.

This Voluntary Product Standard covers the net weights of the package quantities recommended for cubed, sized, crushed, and block ice. Definitions of terms and methods for identifying products packaged in accordance with this Standard are included.

PS49-71. **Portable picnic coolers,** C. B. Phucas, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 49-71, 9 pages (Oct. 1971).

Key words: Coolers, portable picnic; picnic coolers, portable; portable picnic coolers.

This Voluntary Product Standard covers portable picnic coolers in which the smallest of the internal dimensions exceeds 6 inches and the total continuous volume exceeds 1.1 cubic feet. Included in the Standard are requirements relating to the construction of coolers and to the closures, release devices, and handles of picnic coolers. A test for determining the force required to release the closure is included also. Methods of identifying products which conform to the Standard are provided.

For the purposes of this Standard, the term "picnic cooler" shall be used to include "beverage coolers," "ice chests," portable "food chests," and the like, which are designed to be carried by an individual.

PS50-71. **Package quantities of toothpaste,** C. B. Phucas, Technical Standards Coordinator, Nat. Bur. Stand. (U.S.), Prod. Stand. 50-71, 8 pages (July 1971).

Key words: Package quantities of toothpaste; toothpaste, package quantities.

This Voluntary Product Standard covers the net weights of the package quantities recommended for toothpaste having specific gravities within the range of 1.45 to 1.75. This standard also provides for the package quantities of toothpaste having specific gravities below 1.45 and above 1.75.

3.12. TECHNICAL NOTES

Designed to supplement the Bureau's regular publications program, Technical Notes provide a publication medium for communications and reports on data of limited or transitory interest. They often serve as final reports on work sponsored at NBS by other Government agencies.

TN270-5. **Selected values of chemical thermodynamic properties. Tables for elements 54 through 61 in the Standard Order of Arrangement,** D. D. Wagman, W. H. Evans, V. B. Parker, I. Halow, S. M. Bailey, R. H. Schumm, K. L. Churney, Nat. Bur. Stand. (U.S.), Tech. Note 270-5, 49 pages (Mar. 1971).

Key words: Enthalpy; entropy; Gibbs energy of formation; hafnium compounds; heat of formation; niobium compounds; scandium compounds; tantalum compounds; titanium compounds; vanadium compounds; yttrium compounds; zirconium compounds.

Contains tables of values for the standard heats and Gibbs (free) energies of formation, entropies and enthalpies at 298.15 K and heats of formation at 0 K for compounds of vanadium, niobium, tantalum, titanium, zirconium, hafnium, scandium, and yttrium (elements 54-61 in the Standard Order of Arrangement). These tables are a continuation of the comprehensive revision of NBS Circular 500.

TN270-6. **Selected values of chemical thermodynamic properties. Tables for the alkaline earth elements (elements 92 through 97 in the Standard Order of Arrangement),** V. B. Parker, D. D. Wagman, and W. H. Evans, Nat. Bur. Stand. (U.S.), Tech. Note 270-6, 119 pages (Nov. 1971).

Key words: Barium compounds; beryllium compounds; calcium compounds; enthalpy; entropy; Gibbs energy of formation; magnesium compounds; radium compounds; strontium compounds.

Contains tables of values for the standard heats and Gibbs (free) energies of formation, entropies and enthalpies at 298.15 K and heats of formation at 0 K for compounds of beryllium, magnesium, calcium, strontium, barium, and radium (elements 92-97 in the Standard Order of Arrangement). These tables are a continuation of the comprehensive revision of NBS Circular 500.

TN380. **Unassigned.**

TN384. **Thermophysical properties of oxygen from the freezing liquid line to 600 R for pressures to 5000 psia,** R. D. McCarty and L. A. Weber, Nat. Bur. Stand. (U.S.), Tech. Note 384, 189 pages (July 1971).

Key words: Density; dielectric constant; enthalpy; entropy; equation of state; fixed points; heat transfer coefficients; index of refraction; Joule-Thomson; latent heat; melting point; oxygen; Prandtl number; specific heat; speed of sound; surface tension; thermal conductivity; thermal diffusivity; vapor pressure; viscosity; volume.

Tables of thermophysical properties of oxygen are presented for temperatures from the melting line to 600 R for pressures to 5000 psia. The tables include, entropy, enthalpy, internal energy, density, volume, speed of sound, specific heat, thermal conductivity, viscosity, thermal diffusivity, Prandtl number and the dielectric constant for 79 isobars. Also included in the isobaric tables are quantities of special utility in heat transfer calculations: $(\partial P/\partial V)_T$, $(\partial P/\partial T)_\rho$, $V(\partial H/\partial V)_P$, $V(\partial P/\partial U)_V$, $-V(\partial P/\partial V)_T$, $1/V(\partial V/\partial T)_P$. In addition to the isobaric tables, tables for the saturated vapor and liquid are given which include all of the above properties, plus the surface tension. Tables for the P-T of the freezing liquid, index of refraction and the derived Joule-Thomson inversion curve are also presented. The specific heat of the saturated liquid is given in graphical form. A temperature-entropy chart and a Mollier diagram are also included.

TN395. **Design for a variable-output-coupling far-infrared Michelson laser,** J. S. Wells, K. M. Evenson, L. M. Matarrese, D. A. Jennings, and G. L. Wichman, Nat. Bur. Stand. (U.S.), Tech. Note 395, 23 pages (Jan. 1971).

Key words: HCN Lasers; H_2O lasers; infrared lasers; variable coupling lasers.

A technique for varying the coupling of power from far-infrared gas lasers and the design and construction of these lasers are described. The coupling method is based on Michelson's interferometric principle and permits a continuously variable coupling of the available power from the laser. The present laser design is the result of evolution over the last year and a half.

TN396. **Data analysis for isoperibol laser calorimetry,** E. D. West, Nat. Bur. Stand. (U.S.), Tech. Note 396, 34 pages (Feb. 1971).

Key words: Calorimetry; laser; laser calorimetry; laser energy; laser power.

Isoperibol calorimeters (those operating in a constant-temperature environment) are used to measure the power and energy in laser beams relative to electrical standards. The derivation of the basic formula is reviewed. Two methods are presented for analyzing the data taken at equal time intervals: (1) An approximate manual method with criteria for avoiding significant errors of approximation and (2) A least squares method for use with automatic digital computers.

TN397. **Tabulated values of cavitation B-factor for helium, H_2, N_2, F_2, O_2, refrigerant 114, and H_2O,** J. Hord and R. O. Voth, Nat. Bur. Stand. (U.S.), Tech. Note 397, 116 pages (Feb. 1971).

Key words: Cavitation; cryogenics; pumps.

A brief history is given on the development of the B-factor concept and its application to the design of liquid pumps. Adaptation of the "quasi-static" vaporization model to the cavitation process is discussed; previous methods of computing B-factor are reviewed and a simplified, more precise computation, consistent with the "quasi-static" model, is established. Merits of the different computational techniques are discussed and two of the methods are graphically compared. The best available property data are used to compute B-factors for several fluids over a wide range of temperatures. The results are tabulated as reference data; they are useful in the application of the B-factor concept to the prediction of performance in cavitating liquid pumps.

TN398. **Power and energy measurement of repetitively pulsed lasers,** D. A. Jennings, Nat. Bur. Stand. (U.S.), Tech. Note 398, 10 pages (Mar. 1971).

Key words: Average power; energy per pulse; laser; peak power; repetitively pulsed lasers.

The problem of measuring average power, energy per pulse, and peak power of some of the more common repetitively pulsed lasers is discussed. The techniques which have been used at the

National Bureau of Standards are mentioned along with some of the accuracies obtained. Accuracies of 3 to 10 percent can be achieved, depending on the laser source and the parameter of interest.

TN399. **The physical basis of atomic frequency standards,** A. S. Risley, Nat. Bur. Stand. (U.S.), Tech. Note 399, 54 pages (Apr. 1971).

Key words: Atomic frequency standards; cesium beam; energy levels; hydrogen maser; hyperfine interaction; rubidium gas cell; transition probability.

A tutorial discussion of the physical basis of atomic frequency standards is given. These principles are then related to the conditions under which an atom can be used as the working substance of a stable and accurate frequency standard. The three primary examples of atomic frequency standards—the hydrogen maser, the cesium beam, and the rubidium gas cell—are then discussed in terms of these principles and conditions. The functions of the fundamental parts of each device become apparent through this development.

TN467. **Part 1—Addendum 1. Activation analysis—a bibliography,** G. J. Lutz, R. J. Boreni, R. S. Maddock, and W. W. Meinke, Editors, Nat. Bur. Stand. (U.S.), Tech. Note 467, Part 1, 176 pages (Dec. 1969).

Key words: Activation analysis; bibliography; element determined; literature file; matrix analyzed; technique used.

References to activation analysis in the open literature are published from a computer readout. With this addendum the first part of the two-part series contains more than 4,000 references numbered according to their accession to the system. The second part contains an author index and three additional indexes for Element Determined, Matrix Analyzed, and Technique Used. Part 2 is superseded by revision 1 to include the cross references to the accessions listed in part 1.

TN467. **Part 2—Revision 1. Activation analysis—a bibliography,** G. J. Lutz, R. J. Boreni, R. S. Maddock, and W. W. Meinke, Editors, Nat. Bur. Stand. (U.S.), Tech. Note 467, Part 2, 264 pages (Dec. 1969).

Key words: Activation analysis; bibliography; element determined; literature file; matrix analyzed; technique used.

References to activation analysis in the open literature are published from a computer readout. The first part of the two-part series contains more than 6,000 references numbered according to their accession to the system. The second part contains an author index and three additional indexes for Element Determined, Matrix Analyzed, and Technique Used. Part 1 is updated by this addendum to include new references. Part 2 is superseded by revision 1 to include cross references to the new accessions listed in part 1.

TN471. **Unassigned.**

TN493. **Unassigned.**

TN540. **Unassigned.**

TN541. **Preliminary study on the characteristics and design parameters for a Mössbauer resonant detector,** J. J. Spijkerman. J. C. Travis, P. A. Pella, and J. R. DeVoe, Nat. Bur. Stand. (U.S.), Tech. Note 541, 65 pages (Jan. 1971).

Key words: Conversion electrons; iron; Mössbauer spectroscopy; resonant detector.

Progress in the design and fabrication of a resonant detector for Mössbauer spectroscopy is described. This report begins with a review of all of the methods of detection for this spectroscopy and describes the expected advantages of the resonant detector. If one uses conversion electron detection, considerable enhancement in signal to noise ratio and decrease in linewidth may be realized. Efforts to produce an iron bearing resonant material are described.

TN549. **Separation and Purification Section: summary of activities July 1969 to June 1970,** D. H. Freeman and W. L. Zielinski, Jr., Editors, Nat. Bur. Stand. (U.S.), Tech. Note 549, 86 pages (Jan. 1971).

Key words: Air pollution; bilirubin; infrared analysis; ion exchange; liquid chromatography; purification; separation; styrene/divinylbenzene; zeolites.

This represents the report of activities for the Separation and Purification Section for fiscal year 1970. Studies on the properties of ion exchange Standard Reference Material microbeads is extended into the effect of humidity on bead volume, thermal effects on bead stability, and measurement of ion exchanger capacity. Zeolitic particles are evaluated for their potential as ion exchange microstandards. Preliminary investigations are completed for the quantitative infrared measurement of crosslinking in poly (styrene/divinylbenzene) copolymers. Light and electron microscopy are used to help reveal the heterogeneity in a test dust standard. Progress is reported in the development and understanding of analytical liquid chromatography with an increased direction toward gel chromatography. The selection of apparatus components, their performance, and their application to examination of the clinical Standard Reference Material, bilirubin, is described. Particle contamination in inorganic salts and in container walls are examined, the former by ultrafiltration and accurate light scattering measurements and the latter by microscopic methods.

TN551. **Test problems and results for OMNITAB II,** R. N. Varner and S. T. Peavy, Nat. Bur. Stand. (U.S.), Tech. Note 551, 190 pages (Dec. 1970).

Key words: Accuracy; ANSI FORTRAN; computer system implementation; examples; OMNITAB II; software; test problems.

The lack of test problems and results for many software packages is a great hindrance to both the systems programmer and the general user. In this publication a set of fifty-two test problems and results for the OMNITAB II system is provided to assist individuals in checking the implementation of the OMNITAB II program on their particular computer. The general user will also find these descriptive examples instructive in the use of OMNITAB commands.

TN552. **OMNITAB II user's reference manual,** D. Hogben, S. T. Peavy, and R. N. Varner, Nat. Bur. Stand. (U.S.), Tech. Note 552, 264 pages (Oct. 1971).

Key words: Automatic printing; Bessel functions; data analysis; data manipulation; easy and effective programming in English; list of instructions; matrix operations; numerical analysis; OMNITAB II user oriented computing system; self-teaching; statistical analysis.

OMNITAB II, a highly user-oriented system for a large computer, is designed to make computing easy, accurate and effective, particularly for persons who are not programmers. It is a general-purpose program, which can be learned quickly, for both simple and complex numerical, statistical and data analysis. OMNITAB executes instructions written in the form of simple English sentences. Problem-solving is further enhanced by the natural structure of the system and its many features. OMNITAB has been used successfully in government, industry and universities across the country and in several centers abroad. The system has been implemented on large computers of at least seven different manufacturers.

The original version of OMNITAB has been completely rewritten to make it as machine independent as possible and to implement many improvements. This manual describes Version 5.0. Details are presented so that the user can easily find the specific information needed in any particular instance. PART A is a simple, compact introduction to OMNITAB for people who have had no experience using a large computer. PART B describes the general and special features of the OMNITAB system. PART C gives explanations, with short examples, for the use of specific instructions. PART D is a complete alphabetical list of the instructions which are in the system.

TN558. **Lubbock tornado: a survey of building damage in an urban area,** N. F. Somes, R. D. Dikkers, and T. H. Boone, Nat. Bur. Stand. (U.S.), Tech. Note 558, 38 pages (Mar. 1971).

Key words: Anchorage; building performance; glazing; hailstones; masonry; mobile homes; roofs; structural engineering; wind load.

The Building Research Division of the National Bureau of Standards' Institute of Applied Technology sent a three-man team to investigate the damage to buildings and other structures caused by the tornado which struck Lubbock, Texas, on May 11, 1970. The team members—the authors of this report—carried out photographic surveys on the ground and from a helicopter on the days of May 14, 15, and 16, 1970. The report is based largely on data gathered during this period but includes some data provided by other agencies and individuals whose assistance is acknowledged in the report. The report concludes that current good practice in the design and construction of buildings and mobile homes would have greatly reduced the damage observed at Lubbock. It also notes that natural disasters provide full-scale tests of buildings and urges the development of performance criteria with respect to wind loads for certain building elements.

TN559. **Spectroradiometry and conventional photometry—an interlaboratory comparison,** D. A. McSparron, K. Mohan, R. C. Raybold, R. D. Saunders, and E. F. Salewski, Nat. Bur. Stand. (U.S.), Tech. Note 559, 197 pages (Nov. 1970).

Key words: Barnes colorimeter; chromaticity coordinate; color correction; cool white fluorescent lamp; correlated color temperature; daylight fluorescent lamp; heterochromatic photometry; integrating sphere; intercomparison; luminous flux; photometry; spectroradiometry.

This report summarizes the results of a fluorescent lamp intercomparison carried out under the aegis of the National Bureau of Standards Photometry Section. The purpose of the intercomparison was to evaluate the interlaboratory precision obtainable in photometric and spectroradiometric measurements. The tests were also designed to disclose suspected systematic errors in measurement techniques.

The intercomparison consisted of five parts: (1) A homochromatic, photometric measurement of cool white fluorescent lamps and a heterochromatic, photometric measurement of a daylight fluorescent lamp and an incandescent lamp utilizing cool white fluorescent lamps as standards, all within an integrating sphere. (2) Spectroradiometric measurement of the above mentioned lamps in an integrating sphere. (3) Spectroradiometric measurement of a 25 cm section of the fluorescent lamps in a baffled enclosure. (4) An experiment designed to reveal systematic errors in heterochromatic photometry. (5) Measurement of the x and y chromaticity coordinates with a Barnes colorimeter.

TN560. **Methods of measurement for semiconductor materials, process control, and devices, quarterly report April 1 to June 30, 1970,** W. M. Bullis and A. J. Baroody, Jr., Editors, Nat. Bur. Stand. (U.S.), Tech. Note 560, 58 pages (Nov. 1970).

Key words: Alpha-particle detectors; aluminum wire; carrier lifetime; die attachment; electrical properties; epitaxial silicon; gamma-ray detectors; germanium; gold-doped silicon; metallization; methods of measurement; microelectronics; microwave devices; nuclear radiation detectors; resistivity; semiconductor devices; semiconductor materials; semiconductor process control; silicon; thermal resistance; thermographic measurements; ultrasonic bonder; wire bonds.

This quarterly progress report, eight of a series, describes NBS activities directed toward the development of methods of measurement for semiconductor materials, process control, and devices. Principal emphasis is placed on measurement of resistivity, carrier lifetime, and electrical inhomogeneities in semiconductor crystals; evaluation of wire bonds, metallization adhesion, and die attachment; and measurement of thermal properties of semiconductor devices and electrical properties of microwave devices. Work on related projects on silicon nuclear radiation detectors and specification of germanium for gamma-ray detectors is also described. Supplementary data concerning staff, standards committee activities, technical services, and publications are included as appendixes.

TN561. **Unassigned.**

TN562. **A right angle ^{3}He cryostat incorporating a high field superconducting solenoid,** H. Marshak and R. B. Dove, Nat. Bur. Stand. (U.S.), Tech. Note 562, 22 pages (Dec. 1970).

Key words: ^{3}He cryostat; ^{3}He refrigerator; nuclear orientation; superconducting solenoid.

Construction and operation of a novel ^{3}He cryostat, incorporating a large superconducting solenoid mounted at right angles to the cryostat's vertical axis, is described. This new cryostat which is part of the transportable National Bureau of Standards ^{3}He refrigerator, has been used successfully for nuclear orientation studies at the Atomic Energy Research Establishment, Harwell, England.

TN563. **Surface pressure fluctuations near an axisymmetric stagnation point,** R. D. Marshall, Nat. Bur. Stand. (U.S.), Tech. Note 563, 67 pages (Aug. 1971).

Key words: Disk; pressure fluctuations; stagnation point; turbulence.

Surface pressure fluctuations on a circular disk placed normal to a turbulent air stream have been investigated. Turbulence intensities of approximately 10% were produced by a coarse grid installed at the test-section entrance. The turbulent field in the neighborhood of the disk was homogeneous and nearly isotropic.

Experimental results indicate that existing linear theories which do not consider distortion of the flow fail to predict the nature of surface pressure fluctuations on a bluff body. Only for wavelengths which are large compared to the body do these theories yield satisfactory results. A strong attenuation of the high frequency components occurs as the flow stagnates. This is accompanied by a transfer of energy from short to long wavelengths. The opposite effect is observed as the flow attains a radial direction and approaches the edge of the disk. A neutral wavelength which undergoes little change in energy was observed. Integral scales of surface pressure fluctuations are much larger than the lateral integral scale of the free-stream turbulence.

Pressure-velocity correlations indicate the existence of two distinct regions, an inner region in which correlations and optimum delay times exhibit considerable change along the radius of the disk, and an outer region where there is little dependence on radial distance. Maximum values of the optimum correlations are found in the outer region. There is qualitative agreement between the experimental results and theoretical predictions which consider the effect of vortex stretching.

TN564. **Glass limit standards deposited at NBS for railway, highway and airway traffic signal colors—history, permanence**

and colorimetric properties, G. W. Haupt, Nat. Bur. Stand. (U.S.), Tech. Note 564, 121 pages (June 1971).

Key words: Aircraft signals; color standards; filter permanence; limit filters; railroad signals; signal colors; signal standards; spectral transmittance of glass filters; traffic signals.

Signal glass limit standards for railway, highway, and aviation colors, selected by user-organizations, are on deposit at the National Bureau of Standards. Many duplicates of these standards have been issued by NBS.

The first standards were selected in 1931 for railway use. Highway standards were adopted in 1940, and selection of aviation standards began in 1942. At the present time the NBS is custodian of 63 standards for these signal colors.

Permanence of the filters is examined, based on colorimetric conversions for CIE standard illuminant A derived from spectrophotometric measurements made on different instruments over periods of years.

Spectral transmittance data and the resulting colorimetric data are given for 9 illuminants ranging in distribution temperature from 1500 to 3250 kelvins and for CIE standard illuminants B and C. Figures show, for several filters of each color, the shifts occurring both in chromaticity (x,y) and in redness and brightness index (u,W*) with changes in illuminant.

TN565. **ARPA-NBS program of research on high temperature and laser materials, reporting period 1 January to 30 June, 1970,** A. D. Franklin and H. S. Bennett, Editors, Nat. Bur. Stand. (U.S.), Tech. Note 565, 84 pages (Jan. 1971).

Key words: Aluminum oxide; band structure; borides; bulk optical properties; chemical analysis; chromium ions; corundum; crystal defects; crystal growth; density of states; diffusion; glass; high temperature materials; laser damage; laser degradation; laser glass; laser materials; mass transport; neodymium glass; optical properties; opto-elastic properties; oxides; ruby; rutile; titanium; titanium dioxide; transition metal.

Brief reviews are given of work performed during this reporting period of several problems in the areas of High Temperature Materials and Laser Materials. Under the High Temperature Materials extremely pure Al_2O_3 crystals have been prepared and analysed chemically with the aim of providing specimens for research on mass transport, electronic, and similar properties. Oxygen diffusion data on TiO_2, obtained by the gas uptake method, agree with literature values, and work is now proceeding on developing a sectioning technique for oxygen diffusion. The optical constants of titanium have been determined over the visible portion of the spectrum. Soft x-ray spectra, nmr data, Mössbauer spectra, magnetic susceptibility, and other probes of the electronic density of states have been determined for a group of diborides of the first-series transition metals (Sc, Ti, V, Cr, and Mn) and interpreted in terms of the *d*-electron contribution to the density of states near the Fermi level. Both this project and the previous one on the optical properties of titanium have been completed. Under Laser Materials, the measurement of bulk optical properties and chemical analyses of ruby and Nd-glass are complete. Several techniques for determining the Cr^{3+} content in laser ruby have been developed and shown to agree; with these, it has been shown that very little loss of Cr^{3+} occurs when ruby turns orange under optical (x-ray or γ-ray) irradiation. A theory of laser pulse-induced damage at foreign particles in Nd-glass has been worked out; it suggests that detection before damage might be easiest with pulses of microsecond or longer duration. A high-power Nd-glass laser, Q-switched, has been purchased for damage studies. The beam characteristics, which must be properly controlled for meaningful damage threshold measurements, are currently being studied.

TN566. **Wet traction of tractionized tires,** A. H. Neill, Jr., Nat. Bur. Stand. (U.S.), Tech. Note 566, 14 pages (Feb. 1971).

Key words: Siping; stability; stopping distance; tires; traction; tractionizing.

A series of dynamic vehicle tests was performed at NBS to evaluate the performance of tractionized or siped tires. Stopping distance and lateral breakaway data is presented from a two wheel diagonally braked automobile which clearly shows that siped tires do not represent any improvement in the lateral stability or stopping distance characteristics of a typical passenger automobile.

TN567. **Reactor Radiation Division annual progress report for period ending October 31, 1970,** R. S. Carter, Editor, Nat. Bur. Stand. (U.S.), Tech. Note 567, 66 pages (Mar. 1971).

Key words: Crystal structure; diffraction; molecular structure; neutron; nuclear reactor; radiation; scattering.

The reactor has completed its first year of full power operation so it is now appropriate to review the progress made during the last year. This report is the first annual progress report of the Reactor Radiation Division.

TN568. **Simulation of air traffic control radar beacon code assignment plans. Final report,** R. D. Elbourn and J. F. Gilsinn, Nat. Bur. Stand. (U.S.), Tech. Note 568, 76 pages (Mar. 1971).

Key words: Air traffic control; beacon code assignment; digital simulation; radar beacon system.

In the Air Traffic Control Radar Beacon System transponders in the aircraft use one of 4096 identity codes when replying to interrogation from the Secondary Surveillance Radar. Two types of plans for assigning identity codes to aircraft were tested by simulating in a digital computer a peak day's IFR traffic in the USA. In one type each Air Route Traffic Control Center assigns codes independently of all the others, while in the other type a single master center makes all the code assignments for the USA. Four other types of plans are discussed, and an assignment plan of mixed type is proposed for further study. The strategy of simulation and the use of the SIMSCRIPT language are discussed in an appendix.

TN569. **Hurricane Camille—August 1969. A survey of structural damage along the Mississippi Gulf Coast,** R. D. Dikkers, R. D. Marshall, and H. C. S. Thom, Nat. Bur. Stand. (U.S.), Tech. Note 569, 71 pages (Mar. 1971).

Key words: Buildings; failure; hurricanes; mobile homes; roofs; structural engineering; tides; wind.

One week after Hurricane Camille devastated the Mississippi-Louisiana Gulf Coast with 125 mph winds and 20-ft tides on August 17, 1969, a four-man NBS team investigated the damage to buildings and other structures. This report presents photographic survey data from this investigation along with additional data on wind speeds and storm surge. Based on these data, suggestions are made pertaining to the improvement of building design and construction practices.

TN570. **Determination of deep impurities in silicon and germanium by infrared photoconductivity,** W. R. Thurber, Nat. Bur. Stand. (U.S.), Tech. Note 570, 13 pages (Mar. 1971).

Key words: Deep impurities; germanium; infrared; photoconductivity; photoresponse; semiconductors; silicon.

The feasibility of using infrared photoresponse and photoconductivity measurements to study deep impurities in germanium and silicon is examined by reviewing the literature. It is concluded that photoconductivity is useful in detecting the presence of specific impurities because each impurity has a long wavelength cut off in response associated with its ionization energy. However, when there are several deep impurities in the same specimen, it is difficult to be certain of detecting each one because some have broad cut offs and many have nearly the same ionization energies. Photoconductivity as a general technique has serious limitations for determining the total concentration of deep impurities. The equations for determining impurity concentration from the magnitude of the photoconductivity signal depend on the relative influence of deep and shallow centers. Equations are derived for several situations and experimental results from the literature are discussed for each one. Only uncompensated centers are available for photoionization and therefore the total concentration can not be obtained directly. In some situations the response due to a deep center is independent of its concentration. Other techniques for studying deep impurities are discussed briefly.

TN571. **Methods of measurement for semiconductor materials, process control, and devices, quarterly report July 1 to September 30, 1970.** W. M. Bullis, Editor, Nat. Bur. Stand. (U.S.), Tech. Note 571, 58 pages (Apr. 1971).

Key words: Alpha-particle detectors; aluminum wire; base transit time; carrier lifetime; die attachment; electrical properties; epitaxial silicon; gamma-ray detectors; germanium; gold-doped silicon; metallization; methods of measurement; microelectronics; microwave devices; nuclear radiation detectors; probe techniques (a-c); resistivity; semiconductor devices; semiconductor materials; semiconductor process control; silicon; thermal resistance; thermographic measurements; ultrasonic bonder; wire bonds.

This quarterly progress report, ninth of a series, describes NBS activities directed toward the development of methods of measurement for semiconductor materials, process control, and devices. Work is continuing on measurement of resistivity, carrier lifetime, and electrical inhomogeneities in semiconductor crystals; specification of germanium for gamma-ray detectors; evaluation of wire bonds, metallization adhesion, and die attachment; measurement of thermal properties of semiconductor devices and electrical properties of microwave devices; and characterization of silicon nuclear radiation detectors. New effort is being started on the measurement of transit-time and related carrier transport properties in junction devices. Supplementary data concerning staff, standards committee activities, technical services, and publications are included as appendixes.

TN572. **On computer performance measurement programming measuring indexing adroitness by isolating complex primes,** G. W. Reitwiesner, Nat. Bur. Stand. (U.S.), Tech. Note 572, 25 pages (Apr. 1971),

Key words: Assessment; complex; composite; computer; criteria; evaluation; Gaussian primes; indexing; measurement; performance; prime; program; test.

This writing, describing a computer performance test program, is concerned not primarily with specific measurements, but rather with a procedure for making measurement regarding specific properties of computer operation.

The program is written in a particular problem-oriented programming language; therefore assessment perforce spans the effects of the computer hardware, of the programming language, and of the intervening compiler processes.

The objective of the test is to assess adroitness in certain indexing operations. Assessment is accomplished by measuring execution time of a recursive programming loop.

The test problem was chosen as a convenient artifice to use certain specific indexing-type operations in the programming employed for solution.

The test program performs a simple computation for which the solution is completely definitive, yet for which both the solution and the time for achieving it are variable under parameters whose values are introduced as program input data.

TN573. **Application of capacitor microphones and magnetic pickups to the tuning and trouble-shooting of microelectronic ultrasonic bonding equipment,** G. G. Harman and H. K. Kessler, Nat. Bur. Stand. (U.S.), Tech. Note 573, 24 pages (May 1971).

Key words: Capacitor microphone; flip-chip; magnetic pickup; microelectronic interconnections; spider bonding; ultrasonic bonding; wire bonding.

Microelectronic ultrasonic wire bonding equipment typically welds wires to integrated circuits at frequencies between 50 and 65 kHz. Mechanical vibrations of these frequencies are difficult to measure directly and malfunctions of the system may not be recognized. Two different methods of measuring these vibrations are described. The first method involves use of a capacitor microphone and a tapered tip, and the second method use of a small magnetic pickup. Procedures are given for establishing a specific ultrasonic vibration amplitude, tuning the ultrasonic system to resonance, and diagnosing both mechanical and electrical problems in wire bonding equipment. Although these techniques and procedures were developed for ultrasonic wire bonding equipment, they are applicable to other ultrasonic welding systems of lead attachment, such as flip-chip, beam lead and spider bonding.

TN574. **ARPA-NBS program of research on high temperature materials and laser materials, reporting period July 1 to December 31, 1970,** A. D. Franklin and H. S. Bennett, Editors, Nat. Bur. Stand. (U.S.), Tech. Note 574, 44 pages (May 1971).

Key words: Al_2O_3; crystal growth; damage threshold; glass; high temperature materials; laser; oxides; oxygen diffusion; pure materials; sapphire.

Progress reports are given for projects on the growth of ultrapure Al_2O_3 crystals, the development of a mass spectrometer-based sectioning technique for measuring oxygen diffusion in oxides, the development of a precision facility for measuring the threshold energy in a laser beam producing damage in a transparent substance, and the study of the factors influencing this damage threshold in glass.

TN575. **On the absorptance of cavity-type receivers,** J. C. Geist and J. C. Richmond, Nat. Bur. Stand. (U.S.), Tech. Note 575, 38 pages (July 1971).

Key words: Absorptance; black coatings; cavity absorptance; cavity reflectance; laser-source reflectometer; Parsons black; retro-reflectance.

The directional-hemispherical reflectance of a number of flat samples that had been coated with Parsons Optical Black Lacquer procured from Thos. Parsons and Sons and The Eppley Laboratory, respectively, was measured at 0.6328 and 1.15 μm with a laser-source integrating sphere reflectometer. The reflectance varied significantly with method of application, and was significantly higher for the Eppley lacquer than for the Parsons lacquer. The reflectance of two cavity receivers, one coated with each lacquer, was also measured. At 0.6328 μm the reflectance of the Parsons cavity was higher, but at 1.15 μm it was lower. The measured reflectance of the Parsons cavity was appreciably higher than that computed from the measured reflectance of the lacquer and the geometry of the cavity, assuming the coating to be a perfectly diffuse reflector. Retro-reflectance measurements revealed that both lacquers reflected more radiant energy back into directions near the direction of incidence than would a perfect diffuser of the same directional-hemispherical reflectance, but the Parsons lacquer was by far the more pronounced retro-reflector. The principal conclusion is that the diffuse assumption can lead to significant errors in computing the absorptance of cavity-type receivers, when the cavity coating is in fact not diffuse.

TN576. **Computer code for the calculation of thermal neutron absorption in spherical and cylindrical neutron sources,** V. Spiegel, Jr. and W. M. Murphey, Nat. Bur. Stand. (U.S), Tech. Note 576, 25 pages (May 1971).

Key words: Manganous sulfate bath calibration of neutron sources; neutron; neutron standards.

A computer code has been written in FORTRAN IV for the calculation of thermal neutron absorption in spherical and cylindrical neutron sources. The formalism of the calculation, the structure of the computer code, a listing of the code, and some sample results are presented. The comparison of the results of this calculation to experiment appears elsewhere.

TN577. **Method of calibrating weights for piston gages,** H. E. Almer, Nat. Bur. Stand. (U.S.), Tech. Note 577, 54 pages (May 1971).

Key words: Balance; buoyancy; calibration; standards; substitution weighing; transposition weighing; true mass; uncertainty; value.

Generally weights for piston gages have odd denominations that are often not readily calibrated by intercomparison methods. Therefore, these weights are frequently calibrated by direct comparison methods. This paper presents direct comparison methods for calibrating piston gage weights for use with both equal-arm balances and single-pan balances. Methods of estimating the uncertainty of the values obtained are given. Also included are methods of checking for blunders or gross errors.

TN578. **Determination of dynamic loads in a high-frequency direct-stress fatigue machine,** D. C. Robinson, Nat. Bur. Stand. (U.S.), Tech. Note 578, 24 pages (June 1971).

Key words: Dynamic loads; dynamometer; fatigue machine.

A refined test procedure is given for accurately recording the dynamic signals from instrumented test bars used to measure loads during simulated fatigue tests. Loads indicated by the load transducer of a direct-stress fatigue machine are compared with those determined from these instrumented test bar specimens which have been calibrated under static conditions. An application of this procedure is described for a resonant, electromagnetic, direct-stress fatigue machine having an optical dynamometer for indicating programmed loads. The variables investigated were the operating frequency, cyclic load and specimen stiffness. In addition, the influence of test fixture mass on the load measurements was determined at one test frequency. The mean loads indicated by the instrumented test bars are compared with those indicated by the dynamometer to determine the errors in load measurements under various test conditions.

TN579. **Testing of cover glasses for hemacytometer chambers,** J. S. Beers, Nat. Bur. Stand. (U.S.), Tech. Note 579, 7 pages (Sept. 1971).

Key words: Cover glass, test method for; hemacytometer; interferometry; planarity.

If cover glasses used with hemacytometer chambers are not sufficiently flat, a volume error, causing erroneous blood cell counts, may be introduced in the chamber. This document describes a method of testing cover glasses for conformity to a planarity specification.

TN580. **Unassigned.**

TN584. **Analytical Coordination Chemistry Section: Summary of activities July 1970 to June 1971,** O. Menis and J. I. Shultz, Editors, Nat. Bur. Stand. (U.S.), Tech. Note 584, 175 pages (Dec. 1971).

Key words: Aluminum in steel; bilirubin; DTA standards; fluorescence filters Tl(I), Ce(III), Pb(II); glass filters (SRM 930); mercury in botanical; quantum efficiencies.

Progress in research in spectrophotometry, spectrofluorometry, flame emission, atomic absorption, thermal analysis and related programs is described. Efforts to improve accuracy of spectrophotometric measurements led to the construction of a high accuracy spectrophotometer, certification of glass filters, establishment of a more accurate value for molar absorptivity of the acid dichromate system, and the evaluation of spectrally neutral filters of interest for automation in clinical studies. The linearity of the single beam spectrophotometer was calibrated by the light addition technique. Glass filters were calibrated at 4 wavelengths with an uncertainty of 0.5 percent. Data for the dichromate system in perchloric acid led to new values for the dimerization equilibrium constant.

Studies were made of new fluorescence filters incorporating Ti(I), Ce(III), Pb(II) and rare earths in a variety of glass matrices. Quantum efficiencies of Tl in KCl and Eu in a silicate matrix were determined.

Developments in instrumentation led to increased sensitivity and improved precision and accuracy by flame spectroscopy. Mg, Ca, K and Na were determined with the multichannel spectrometer. A newly designed optical system and an ultrasonic spraying system provided increased signal and efficiency. The repetitive optical scan of flame emission overcame matrix and flame background problems for the determination of aluminum in steel. Certification was made on eight new materials in cooperation with the International Confederation on Thermal Analysis.

TN589. **Separation and Purification Section: Summary of activities—July 1970 to June 1971,** D. H. Freeman and W. L. Zielinski, Jr., Editors, Nat. Bur. Stand. (U.S.), Tech. Note 589, 64 pages (Oct. 1971).

Key words: Clinical Standard Reference Materials; fraction collecting; gas chromatography; interactive gels; liquid chromatography design; nitrilotriacetic acid.

This is the annual progress report on the activities of the Separation and Purification Section. During the past year our studies in liquid chromatography, its application, control, and systems design were continued at an accelerated rate. Mobile phase flow was treated as an analogy to current in direct current circuitry, following removal of liquid pulses generated by a piston pump. A sophisticated, yet simple and inexpensive liquid chromatograph design is fully described. This design has been incorporated into all liquid chromatography studies being conducted in this Section. The operating parameters of this system design are discussed. The development of the underlying theory and synthesis procedures for interactive gels has led to the control and prediction of solute retention, selectivity, and a magnified column capacity for use in fraction collection and ancillary characterization of solute impurities in clinical Standard Reference Materials. A gas chromatographic method is described for the analysis of nitrilotriacetic acid based upon the formation of its trisilyl ester derivative.

TN590. **A preliminary design of a data retrieval language to handle a generalized data base: DRL,** E. Fong, Nat. Bur. Stand. (U.S.), Tech. Note 590, 26 pages (July 1971).

Key words: Data base; data retrieval; data structure; information storage and retrieval; language extension; preprocessor; programming language.

DRL (Data Retrieval Language) is a high-level programming language for information retrieval. The language includes a data description language which can describe fixed-length hierarchical data structures, and DRL includes a data retrieval statement whereby a user can retrieve data by specifying conditions on to the data value. DRL also has an environment declaration statement in which the user can indicate specific peripheral devices by unit number for files. The rest of the language consists of an operation repertory of input-output functions and other data manipulations.

DRL is implemented as a preprocessor to FORTRAN V on the UNIVAC 1108, under EXEC II Operating system. Keywords act as triggers and are replaced by blocks of FORTRAN code.

The purpose of this project is to investigate the design of an information retrieval language to handle a generalized data base. The DRL system consists of a set of primitives utilizing both compile-time macros and run-time subroutines. These primitives are embedded in a high-level procedure-oriented programming language — the "host language" — FORTRAN in this case. These primitives form a base upon which a class of languages can be defined.

TN591. **A technique for measuring the surface temperature of transistors by means of fluorescent phosphor,** D. J. Brenner, Nat. Bur. Stand. (U.S.), Tech. Note 591, 49 pages (July 1971).

Key words: Surface temperature; temperature measurement; temperature-sensitive phosphor; thermographic phosphor; transistor-chip temperature.

A technique that uses temperature-sensitive phosphor (TSP) to make quantitative measurements of transistor-chip surface temperatures over the range of 170-210 °C is described. The experimental procedure consisted of depositing a thin coating of phosphor or uncapped power transistors, and then photographing the visible fluorescence generated under near-ultraviolet (uv) excitation. The cooler regions produced a brighter fluorescence than the hotter areas. The surface temperatures of operating transistors were determined by comparing, on a point-by-point basis, the photographic density of operating photographs to the density of a family of calibration photographs. Repeated temperature measurements always fell within a 4 °C overall error range when the phosphor surface was scanned with a 25×25 μm aperture. The error band dropped to less than 2 °C when a 50×50 μm aperture was used. Coarseness of the phosphor coating seemed to limit spacial resolution to about 20 μm. Any narrow temperature range between 20 and 400 °C can probably be measured by selecting a suitable level of uv irradiation and/or a suitable phosphor.

TN592. **Methods of measurement for semiconductor materials, process control, and devices, quarterly report October 1 to December 31, 1970,** W. M. Bullis, Editor, Nat. Bur. Stand. (U.S.), Tech. Note 592, 72 pages (Aug. 1971).

Key words: Alpha-particle detectors; aluminum wire; base transit time; carrier lifetime; die attachment; electrical properties; epitaxial silicon; gamma-ray detectors; germanium; gold-doped silicon; metallization; methods of measurement; microelectronics; microwave devices; nuclear radiation detectors; probe techniques (a-c); resistivity; semiconductor devices; semiconductor materials; semiconductor process control; silicon; thermal resistance; thermographic measurements; ultrasonic bonder; wire bonds.

This quarterly progress report, tenth of a series, describes NBS activities directed toward the development of methods of measurement for semiconductor materials, process control, and devices. Significant accomplishments during this reporting period include successful application of the surface photovoltage technique, a non-contacting method, to the measurement of carrier diffusion length in silicon epitaxial layers and development of a novel, but simple, method for measurement of acceleration and terminal angular velocity of a photoresist spinner. Work is continuing on measurement of resistivity, carrier lifetime, and electrical inhomogeneities in semiconductor crystals; specification of germanium for gamma-ray detectors; evaluation of wire bonds, metallization adhesion, and die attachment; measurement of thermal properties of semiconductor devices, transit-time and related carrier transport properties in junction devices, and electrical properties of microwave devices; and characterization of silicon nuclear radiation detectors. Supplementary data concerning staff, standards committee activities, technical services, and publications are included as appendixes.

TN595. **Effect of ceramic spectral emissivity variations on the computed luminous emissivity of the NBS standard of light,** W. B. Fussell, Nat. Bur. Stand. (U.S.), Tech. Note 595, 58 pages (Sept. 1971).

Key words: Ceramic; light; photometry; spectral emissivity; standard.

A simplified model of the National Bureau of Standards (NBS) 1970 design for the standard of light (platinum point blackbody) is introduced. This model is used to calculate the apparent luminous emissivity of the base of the sighttube of the standard of light, and of the wall near the base, by two different methods. The first method includes the effect of variations with wavelength in the spectral emissivity of the ceramic composing the sighttube; the second method does not include the effect of ceramic spectral emissivity variations. The results of the two methods are compared and their difference (about 6×10^{-6}) is found to be negligible for the NBS 1970 design when the sighttube is made of alumina, compared with other uncertainties and the precision of measurement. A formula is derived for estimating the apparent luminous emissivity of the standard of light, given: a. the length-to-diameter ratio of the sighttube; b. the half-angle of the conical base; c. the wall thickness of the sighttube; d. the thermal conductivity of the sighttube ceramic; e. the average thermal and luminous emissivities of the sighttube ceramic.

TN596. **The flammable fabrics program 1970. U.S. Department of Commerce report of activities under the Flammable Fabrics Act 1970,** Nat. Bur. Stand. (U.S.), Tech. Note 596, 68 pages (Sept. 1971).

Key words: Annual report to Congress; blankets; carpets and rugs; children's sleepwear; cooperation; flammability; flammability reduction; mattresses; research; small carpets and rugs; standards; test development.

This Annual Report to the Congress, required by the Flammable Fabrics Act, covers calendar year 1970. Specific flammability standards outputs were standards for carpets and rugs and for small carpets and rugs, a proposed standard for children's sleepwear, and notices of possible need and institution of proceedings for standards for certain items of children's apparel, all blankets, and all mattresses. Research included studies, in-house and by contract, on subjects such as full scale carpet burn experiments and heat transfer from burning fabrics. Studies of the feasibility of reducing flammability included pyrolysis of textile materials and chemical aspects of fire retardancy. Test development was completely related to the standards outputs, and training ranged from the preparation of bibliographies through Congressional and public presentations to full time Research Associateship participation in the program. Cooperation was carried out with HEW, the public, industry, and voluntary standards groups.

TN597. **Tabulation of data on semiconductor amplifiers and oscillators at microwave frequencies,** C. P. Marsden, Nat. Bur. Stand. (U.S.), Tech. Note 597, 48 pages (Dec. 1971).

Key words: Amplifiers; basic characteristics; microwave; oscillators; semiconductor; solid state.

This tabulation includes some of the basic characteristics of semiconductor microwave devices, specifically amplifiers and oscillators of foreign and domestic origin.

TN598. **Methods of measurement for semiconductor materials, process control, and devices, quarterly report January 1 to March 31, 1971,** W. M. Bullis, Editor, Nat. Bur. Stand. (U.S.), Tech. Note 598, 54 pages (Oct. 1971).

Key words: Alpha-particle detectors; aluminum wire; base transit time; carrier lifetime; die attachment; electrical properties; epitaxial silicon; gamma-ray detectors; germanium; gold-doped silicon; methods of measurement; microelectronics; microwave devices; nuclear radiation detectors; probe techniques (a-c); resistivity; semiconductor devices; semiconductor materials; semiconductor process control; silicon; thermal resistance; thermographic measurements; ultrasonic bonder; wire bonds.

This quarterly progress report, eleventh of a series, describes NBS activities directed toward the development of methods of measurement for semiconductor materials, process control, and devices. Significant accomplishments during this reporting period include application of tuning and other related procedures for ultrasonic wire bonders in an industrial environment with a reported reduction of rejection rate at visual inspection by more than a factor of two, more complete evaluation of the photovoltaic method for determining radial resistivity profiles of circular semiconductor wafers, and identification of test conditions in which a d-c calibration curve may properly be used in measurements of thermal resistance. Work is continuing on measurement of resistivity, carrier lifetime, and electrical inhomogeneities in semiconductor crystals; specification of germanium for gamma-ray detectors; evaluation of wire bonds and die attachment; measurement of thermal properties of semiconductor devices, transit-time and related carrier transport properties in junction devices, and electrical properties of microwave devices; and characterization of silicon nuclear radiation detectors. Supplementary data concerning staff, standards committee activities, technical services, and publications are included as appendixes.

TN599. **A survey of selected document processing systems,** E. Fong, Nat. Bur. Stand. (U.S.), Tech. Note 599, 67 pages (Oct. 1971).

Key words: Bibliographic system; computer package; data base; document processing; document storage and retrieval; information retrieval; text; text processing.

There are many document processing systems that are commercially available or government-owned. These systems emerged in the evolution from early efforts in library automation to current on-line systems. Due to the diverse nature of the facilities provided in the document processing systems, it is difficult to evaluate them. The purpose of this paper is to present a list of features as a set of dimensions along which to compare the surveyed systems. The feature list is also developed to serve as a common basis for describing document processing systems. Another purpose of this paper is to provide a reference tool for the eight systems surveyed. They are CIRCOL, DDC ITIRC, The Mead Data Central, MEDLARS II, New York Times Information Bank, ORBIT II, and RECON/STIM. This paper first explored the characteristics of available, large document processing systems in general. An overview of the eight systems surveyed is presented. The paper then defines the feature list. The description of the eight systems surveyed according to the feature list outline is included as an Appendix.

TN600. **Corrections and calculations on an x-ray diffraction line profile: a computer program,** R. E. Schramm, Nat. Bur. Stand. (U.S.), Tech. Note 600, 34 pages (June 1971).

Key words: Computer programs; Fourier analysis; nickel steels; statistics; x-ray analysis; x-ray diffraction.

This computer program was written to perform corrections and make calculations on an x-ray diffraction profile before Fourier analysis. The corrections are for background and for variations of intensity with the Bragg angle. Also calculated are the separation of the $K\alpha_1$-$K\alpha_2$ doublet and the centroid and position of peak maximum with their standard deviations. There is also an option to smooth the profile.

TN601. **Unassigned.**

TN602. **A broadband noncontacting sliding short,** W. Larson and R. D. Hunter, Nat. Bur. Stand. (U.S.), Tech. Note 602, 18 pages (June 1971).

Key words: Microwave; reflection coefficient; return loss; shorted termination; sliding short; waveguide.

A new sliding short that eases microwave measurements also yields superior electrical and mechanical properties. Easily fabricated by encasing noncontacting cylindrical brass slugs in a block of polytetrafluoroethylene, the device slides smoothly and prevents metal-to-metal contact with the inside walls of precision waveguide.

Design details and results of intercomparing other short circuits are given.

TN603. **Construction of a flashlamp-pumped dye laser and an acousto-optic modulator for mode-locking,** D. A. Jennings and D. L. Baldwin, Nat. Bur. Stand. (U.S.), Tech. Note 603, 33 pages (July 1971).

Key words: Acousto-optic modulator; flashlamp-pumped dye laser; mode-locking; subnanosecond pulses.

In this paper is presented the design of a flashlamp-pumped dye laser capable of emitting light pulses 500 ns (FWHM) with a risetime of 300 ns. The energy output in the visible region of light is 1 to 10 mJ with an energy conversion efficiency of about 0.01% at a repetition rate of 30 pps. The design of an acousto-optic modulator used to mode-lock the dye laser by intracavity loss modulation is presented. The laser output for a given cavity length depends on the frequency and voltage applied to the modulator; a 10 – 100% modulated output can be obtained with 1 – 20 V rms, whereas a train of light pulses narrower than 0.8 ns (FWHM) can be obtained with 80 V rms.

TN604. **Efficient numerical and analog modeling of flicker noise processes,** J. A. Barnes and S. Jarvis, Jr., Nat. Bur. Stand. (U.S.), Tech. Note 604, 22 pages (June 1971).

Key words: Analog noise simulation; computer noise simulation; digital filters; flicker noise; fractional integration; recursive digital filters.

It is shown that by cascading a few simple resistor-capacitor filters, a filter can be constructed which generates from a white noise source a noise signal whose spectral density is very nearly flicker, $|f|^{-1}$, over several decades of frequency f. Using difference equations modeling this filter, recursion relations are obtained which permit very efficient digital computer generation of flicker noise time-series over a similar spectral range. These analog and digital filters may also be viewed as efficient approximations to integrators of order one-half.

TN605. **An evaluation of positive displacement cryogenic volumetric flowmeters,** J. A. Brennan, J. W. Dean, D. B. Mann, and C. H. Kneebone, Nat. Bur. Stand. (U.S.), Tech. Note 605, 134 pages (July 1971).

Key words: Cryogenic; flow; flowmeters; liquid nitrogen; measurement; positive displacement.

The National Bureau of Standards (NBS) and the Compressed

Gas Association (CGA) have jointly sponsored a research program on cryogenic flow measurement. A cryogenic flow research facility was constructed and was first used to evaluate commercially available cryogenic flowmeters operating on a positive displacement principle.

The operation and the accuracy of the flow facility is briefly described. The performance of the flowmeters on liquid nitrogen is described by reporting the precision and bias of the meters before and after an 80-hour stability test and by defining the existence of temperature, flow rate, subcooling, and time order (wear) dependencies.

Meters were evaluated with flow rates ranging from 0.00126 to 0.0063 m^3/s (20 to 100 gpm), pressures ranging from 0.22 to 0.77 MN/m^2 (32 to 112 psia), and with temperatures ranging from 72 to 90 K.

TN606. **Cryogenic flow research facility provisional accuracy statement,** J. W. Dean, J. A. Brennan, D. B. Mann, and C. H. Kneebone, Nat. Bur. Stand. (U.S.), Tech. Note 606, 40 pages (July 1971).

Key words: Accuracy statement; cryogenic; flow facility; liquid nitrogen; measurement.

The National Bureau of Standards and the Compressed Gas Association have jointly sponsored a research program on cryogenic flow measurement. A cryogenic flow research facility was constructed and was first used to evaluate commercially available cryogenic flowmeters operating with liquid nitrogen on a positive displacement principle.

The performance of the flow facility was simultaneously being evaluated during the meter tests. This is a summary report of the performance evaluation of the flow facility. An accuracy statement is given for both totalized mass and volumetric flow.

TN607. **The errors in plasma measurements by the microwave cavity techniques,** K-B Persson and E. G. Johnson, Jr., Nat. Bur. Stand. (U.S.), Tech. Note 607, 64 pages (Oct. 1971).

Key words: Collision frequency; helium negative glow discharge; microwave cavity; plasma density.

This report presents the results of a theoretical and experimental study of the microwave cavity techniques used in measuring electron density and collision frequency in transient plasmas. Sources of errors are discussed and certain calibration procedures are recommended to minimize the error. In particular, the abnormal negative glow discharge in helium is presented as an inexpensive reference plasma for calibration purposes.

TN608. **Steam-water, critical flow in a venturi,** R. V. Smith, Nat. Bur. Stand. (U.S.), Tech. Note 608, 25 pages (July 1971).

Key words: Critical flow; pressure profile; steam; venturi; water.

This paper is the second part of an analytical and experimental investigation, in which the primary object was to test the hypothesis that the flow of the gas phase controls critical and near critical two-phase flow for cases where the gas and liquid flow essentially in separate streams. In the first part of the investigation, a two-component system (air-water) was used. The results presented here substantiate the hypothesis. The analytical results also indicate the use of one dimensional flow equations with reasonably accurate estimates for droplet size and for the drag and heat transfer coefficients (without consideration of mass transfer—vaporization or condensation) describe critical and near-critical flow reasonably well. This indicates that mass transfer may be a secondary effect for these flow conditions.

TN609. **Study of cryogenic storage tank fatigue life. Low temperature testing of AISI 304 and 310 stainless steels,** R. P. Reed, R. L. Durcholz, R. E. Schramm, and T. J. Patrician, Nat. Bur. Stand. (U.S.), Tech. Note 609, 86 pages (Aug. 1971).

Key words: Fatigue; fracture; impact; low temperature; mechanical property equipment; stainless steel.

Two 300 series stainless steels were tested for impact-fatigue life and tensile properties as a function of temperature, percent transformed phase (martensite), stress level, and specimen geometry. These alloys were studied to predict the fracture characteristics of parent material and weld joints in large cryogenic dewars which are subjected to periodic stresses. Normally, AISI 304 is employed in the construction of such dewars. Under fatigue loading conditions at cryogenic temperatures, the behavior of AISI 304 is complicated by the gradual transformation to a martensitic structure. The influence of this transformation on the fracture characteristics was studied. For this purpose, a new impact-fatigue test and necessary equipment were developed.

The fatigue strength of AISI 304 and 310 exhibit similar trends, but at a given fatigue life and temperature, the fatigue strength of AISI 304 is slightly superior. AISI 310 displays an endurance limit of about 20,000 psi; the 304 limit is 25-30,000 psi. However, the lowest endurance limit (weakest) specimens appear to be the triaxially-loaded AISI 304 weld specimens which have an endurance limit near 10,000 psi. Little temperature-dependence of the impact-fatigue properties was observed.

TN613. **Martensite transformation detection in cryogenic steels (magnetometer development),** F. R. Fickett, Nat. Bur. Stand. (U.S.), Tech. Note 613, 31 pages (Dec. 1971).

Key words: Fatigue monitor; low temperature; magnetometer; martensite; nondestructive.

This report presents design criteria for a magnetometer device developed to determine the martensite concentration in 304 stainless steel. Specifically, the device is designed to monitor the cold tank of an airborne liquid oxygen container which is subject to periodic stress pulses. The amount of martensite is relatable to the plastic strain and thus provides a mechanism for the prediction of impending failure.

The magnetometer, developed after a critical review of the constraints, is an excitation coil-Hall effect system. The system is very versatile in design and is easily adapted to particular problems. It is relatively insensitive to thermal and mechanical shock and easily capable of detecting martensite at the 1 percent level.

TN702. **Methods of measurement for semiconductor materials, process control, and devices, quarterly report April 1 to June 30, 1971,** W. M. Bullis, Editor, Nat. Bur. Stand. (U.S.), Tech. Note 702, 45 pages (Dec. 1971).

Key words: Alpha-particle detectors; aluminum wire; base transit time; carrier lifetime; die attachment; electrical properties; epitaxial silicon; gamma-ray detectors; germanium; gold-doped silicon; methods of measurement; microelectronics; microwave devices; nuclear radiation detectors; probe techniques (a-c); resistivity; semiconductor devices; semiconductor materials; semiconductor process control; silicon; thermal resistance; thermographic measurements; ultrasonic bonder; wire bonds.

This quarterly progress report, twelfth of a series, describes NBS activities directed toward the development of methods of measurement for semiconductor materials, process control, and devices. Significant accomplishments during this reporting period include a demonstration of the high sensitivity of the infrared response technique by the identification of gold in a germanium diode doped to a level of 10^{11} gold atoms per cubic centimeter, verification that transient thermal response is significantly more sensitive to the presence of voids in die attachment than steady-state thermal resistance, and development of a simplified circuit for screening transistors for susceptibility to hot-spot formation by the current-gain technique. Work is continuing on measurement of resistivity of semiconductor crystals; study of gold-doped silicon; specification of germanium for gamma-ray detectors; evaluation of wire bonds and die attachment; measurement of thermal properties of semiconductor devices, transit time and related carrier transport properties in junction devices, and electrical properties of microwave devices; and characterization of silicon nuclear radiation detectors. Supplementary data concerning staff, standards committee activities, technical services, and publications are included as appendixes.

TN703. **ARPA-NBS program of research on high temperature materials and laser materials, reporting period January 1 to June 30, 1971,** A. D. Franklin and H. S. Bennett, Editors, Nat. Bur. Stand. (U.S.), Tech. Note 703, 39 pages (Dec. 1971).

Key words: Al_2O_3; crystal growth; damage threshold; glass; high temperature materials; laser; oxides; oxygen diffusion; pure materials; sapphire.

Progress reports are given for projects on the growth of ultra-pure Al_2O_3 crystals, the development of a mass spectrometer-based sectioning technique for measuring oxygen diffusion in oxides and the development of a precision facility for measuring the threshold energy in a laser beam producing damage in a transparent substance.

TN708. **Interlaboratory evaluation of smoke density chamber,** T. G. Lee, Nat. Bur. Stand. (U.S.), Tech. Note 708, 80 pages (Dec. 1971).

Key words: Building materials; fire tests; interlaboratory tests; optical density; round robin; smoke; smoke density chamber; statistical analysis.

Results are reported of an interlaboratory (round-robin) evaluation of the smoke density chamber method for measuring the smoke generated by solid materials in fire. A statistical analysis of the results from 10 material-condition combinations and 18 laboratories is presented. For the materials tested, the median coefficient of variation of reproducibility was 7.2 percent under non-flaming exposure conditions and 13 percent under flaming exposure conditions. A discussion of errors and recommendations for improved procedures based on user experience is given. A tentative test method description is included as an appendix.

3.13. CONSUMER INFORMATION SERIES

Practical information, based on NBS research and experience, covering areas of interest to the consumer. Easily understandable language and illustrations provide useful background knowledge for shopping in today's technological marketplace.

CIS4. **Facts about hearing and hearing aids,** E. L. R. Corliss, Nat. Bur. Stand. (U.S.), Consum. Inf. Ser. 4, 35 pages (Nov. 1971).

Key words: Audition; communications; hearing; hearing aids; selection of hearing aids; speech communication.

A consumers information publication containing information on hearing aids including selection, use, and maintenance.

4. TITLES AND ABSTRACTS OF PAPERS PUBLISHED BY OTHERS, 1971

4.1. NBS OFFICE OF STANDARD REFERENCE DATA BIBLIOGRAPHY SERIES

The following OSRDB Bibliography series are available by purchase from the National Technical Information Service (NTIS), Springfield, Va. 22151 at the prices indicated.

NBS-OSRDB-70-1-V1 (PB191174). Merrill, L., **High pressure bibliography 1900-1968, Volume I. Section I—Bibliography. Section II—Author index** (Apr. 1970, $7.00).

Key words: Author index; bibliography; high pressure; subject index.

The Bibliography on High Pressure Research is a fairly complete compilation of references to scientific papers published in the field of high pressure research. In subject matter, it deals with many of the major research areas in the fields of Chemistry, Physics, Geology, Mechanics and Biology. The main emphasis is on work above 5 kilobar (5×10^8 N/m^2) and includes both static and dynamic pressure studies. This compilation is composed of three sections, the Bibliography listing the complete reference, the Subject Index, and Author Index.

NBS-OSRDB-70-1-V2 (PB191175). Merrill, L., **High pressure bibliography 1900-1968, Volume II—Subject index** (Apr. 1970, $7.00).

Key words: Author index; bibliography; high pressure; subject index.

The Bibliography on High Pressure Research is a fairly complete compilation of references to scientific papers published in the field of high pressure research. In subject matter, it deals with many of the major research areas in the fields of Chemistry, Physics, Geology, Mechanics and Biology. The main emphasis is on work above 5 kilobar (5×10^8 N/m^2) and includes both static and dynamic pressure studies. This compilation is composed of three sections, the Bibliography listing the complete reference, the Subject Index, and Author Index.

NBS-OSRDB-70-2 (COM-71-00722). Carter, G. C., Kahan, D. J., Bennett, L. H., Cuthill, J. R., and Dobbyn, R. C., **The NBS Alloy Data Center: Author index** (Dec. 1970, $10.00).

Key words: Alloy data; bibliography; index; information; Knight shifts; NMR; soft x ray.

This Index contains literature references to 12,000 research papers on physical properties of metals and alloys. The first contains all NMR Knight shift papers and many other papers dealing with NMR, NQR and FNR in metals. The second one contains all soft x-ray emission papers as well as many soft x-ray absorption papers. The third represents a collection of papers on generally related topics such as Mossbauer effect, susceptibilities, specific heats, hyperfine fields, and band structures. The papers are annotated in depth and coded information put onto a magnetic tape. The present Author Index was created from this tape, listing each paper under first author. The full annotation of each paper is given. For each metal or alloy system reported in a paper, a separate line appears in the Index.

NBS-OSRDB-70-3 (AD705110). Henderson, G. A., and Frattali, S., **Semiempirical and approximate methods for molecular calculations—bibliography and KWIC index** (Dec. 1, 1969, $3.00).

Key words: Atom-diatom transitions; data tables; distorted wave calculations; exact quantum mechanical calculations; inelastic transition probabilities; K matrix calculation; KWIC Index; mass values; numerical calculations; one-dimensional collisions; oscillator force constants; potential values; transition probabilities vs. energy values; translational-vibrational energy transfer.

In recent years a great many calculations on vibrational energy transfer have appeared in the literature. Since most of the calculations have been done for a one-dimensional atom-diatom exponential interaction, a large amount of data has accumulated that is easy to categorize. In the present compilation, therefore, we limit ourselves to these calculations. Specifically, only those results are included that refer to the system A—B—C with an exponential interaction between A and B and a harmonic interaction between B and C. This problem can be completely specified with the incident relative energy of A and B—C, a potential parameter, and a single mass parameter defined in the text. Collisional transition probabilities are tabulated as a function of these three parameters and the oscillator quantum numbers.

NBS-OSRDB-70-4 (COM-71-00025). Hudson, R. D., and Kieffer, L. J., **Bibliography of photoabsorption cross section data** (Oct. 1970, $4.00).

Key words: Absorption and ionization coefficients; cross section data; detachment; dissociation; ionization; photoabsorption; photoabsorption theory; total absorption cross sections.

A bibliography of photoabsorption cross section data is presented. Only references which report a measured or calculated photoabsorption cross section (relative or normalized) in regions of continuous absorption are included. The bibliography is current as of March 1, 1970.

NBS-OSRDB-71-1 (COM-71-00248). Jain, S. C., Khan, S. A., Sehgal, H. K., Garg., V. K., and Jain, R. K., **Bibliography on properties of defect centers in alkali halides** (Jan. 1971, $3.00).

Key words: Alkali halide crystal defect properties; alkali halide dopants; bibliography; impurity centers; optical magnetic and transport properties.

References to optical, magnetic and transport properties of defect centers for impurities in alkali halides are compiled. About 60 elemental impurities and selected molecular ion impurities are surveyed. The defect properties of pure alkali halides are also included. Twenty-five journals were scanned to produce the 3000 references presented in two sections. The first section covers references for the years 1927-1963 inclusively. The second section covers the years 1964 to present and is more comprehensive in scope.

NBS-OSRDB-71-2 (COM-71-00841). Westley, F., **A bibliography of kinetic data on gas phase reactions of nitrogen, oxygen, and nitrogen oxides** (Aug. 1971, $3.00).

Key words: Bibliography; chemical kinetics; gas phase; nitrogen; nitrogen oxides; oxygen; ozone.

A bibliography of references to published papers and reports containing rate data for reactions of N, N_2, N_3, N_2O, N_2O_2, N_2O_3, N_2O_4, N_2O_5, NO, NO_2, NO_3, NO_4, O, O_2 and O_3 with each other is presented. In addition two lists of critical reviews dealing with the above reactions are included. Over 900 papers are listed.

4.2. OTHER NBS PAPERS PUBLISHED IN NON-NBS MEDIA

Reprints from the journals listed in this section may often be obtained directly from the authors. See page 3 for additional information.

11798. Brauer, G. M., **Pyrolysis-gas chromatographic techniques for polymer identification,** Chapter 2 in *Thermal Characteristics Techniques in Techniques and Methods of Polymer Evaluations,* P. Slade, ed., **II,** 41-105 (Marcel Dekker Publ., New York, N.Y., 1970).

Key words: Chromatographic analysis of degradation products; polymer characterization; polymer identification; pyrolysis-gas chromatography of polymers; pyrolytic techniques.

Pyrolytic techniques used in conjunction with gas chromatography are very useful for elucidating the structure of macromolecules. These methods are a powerful tool in the qualitative characterization of the gross structure, the study of the thermal stability of polymers and the identification of their pyrolysis products, but have also found an increasing number of applications for the quantitative analysis of copolymeric systems and in studies of the kinetics of polymer degradation. The shape of the pyrograms is dependent on the structural characteristics such as the degree of branching or crosslinking, stereoregularity, crystallinity, and monomer sequence length distribution in block and graft copolymers. Thus the pyrolysis-gas chromatographic technique opens up new avenues in studying the ultimate arrangement of monomeric units within the polymer chain.

11799. Berger, M. J., Seltzer, S. M., **Bremsstrahlung and photoneutrons from thick tungsten and tantalum targets,** *Phys. Rev. C* **2,** No. 2, 621-631 (Aug. 1970).

Key words: Bremsstrahlung; bremsstrahlung efficiency; Monte Carlo; photon neutron; radiation transport; thick targets.

Monte Carlo calculations have been made of electron-photon cascades in thick tungsten targets bombarded by electrons with energies up to 60 MeV. The following information has been obtained: (1) the bremsstrahlung efficiency, (2) the angular distribution of the emitted bremsstrahlung intensity, (3) the spectra of the bremsstrahlung emitted in various directions, (4) the transmission of primary and secondary electrons through the target, (5) energy deposition as function of the depth in the target, (6) the differential photon track length distribution inside the target, and (7) the yield of photoneutrons. The paper also includes various comparisons with experimental data.

11800. Block, S., Weir, C. E., Piermarini, G. J., **Polymorphism in benzene, naphthalene, and anthracene at high pressure,** *Science* **169,** 586-587 (Aug. 7, 1970).

Key words: Anthracene; benzene; high-pressure; naphthalene; polymorphism.

Optical observations, in which a microscope was used with the diamond-anvil pressure cell, were carried out on benzene, naphthalene, and anthracene up to temperatures of about 600 °C and pressures of approximately 40 kilobars. New high-pressure phases of benzene (benzene III) and anthracene (anthracene II) were observed, and the existence of the high-pressure polymorph, naphthalene II, was verified. All three materials decompose initially to a reddish-orange liquid, and ultimately to amorphous carbon. The decomposition temperatures decrease with increasing molecular size.

11801. Borie, E., **Radiative corrections to back scattering,** *Phys. Rev. C* **2,** No. 2, 770-771 (Aug. 1970).

Key words: Anomalous moment; back scattering; electron; radiative correction.

It is shown that the anomalous magnetic moment of the electron contributes to the radiative correction to scattering by a charge, even at high energies, when the scattering angle is 180°. This effect increases the radiative correction slightly as compared with the usual Schwinger correction.

11802. Bowen, R. L., **Crystalline dimethacrylate monomers,** *J. Dental Res.* **49,** No. 4, 810-815 (July-Aug. 1970).

Key words: Biomaterials; dimethacrylates; phthalate monomers; purification methods; resins for composites; ternary eutectic; thermosetting monomers.

Certain dimethacrylate monomers can be prepared and purified by recrystallization. On mixing, the crystals liquefy by forming a ternary eutectic. The colorless oily liquid is suitable for use in composite formulations.

11803. Candela, G. A., **Spin relaxation process of chromium ion in potassium alum,** *J. Chem. Phys.* **52,** No. 7, 3754-3757 (Apr. 1, 1970).

Key words: Chromium alum; spin-lattice relaxation.

The electron spin relaxation process of potassium chrome alum and potassium chrome aluminum alum was investigated at 14.5 GHz by measuring the change in the static dc magnetization as a function of the cw microwave power absorbed at electron resonance. At liquid-helium temperatures, the direct spin-lattice relaxation process is the dominant rate-determining process for magnetically dilute potassium chrome aluminum alum, but for the magnetically concentrated crystals, the spin-lattice process can easily be obscured by the lattice-bath relaxation process. The spin-lattice relaxation measurements at 14.5 GHz and those of other workers at 9 GHz are in agreement with the calculations made by Van Vleck in 1940.

11804. Ensign, T. C., Chang, T. T., Kahn, A. H., **Hyperfine and nuclear quadrupole interactions in copper-doped TiO_2,** *Phys. Rev.* **188,** No. 2, 703-709 (Dec. 10, 1969).

Key words: Copper; EPR; *g*-factors; hyperfine interaction; quadrupole coupling; rutile; titanium dioxide.

Single crystals of TiO_2:Cu^{2+} have been investigated at 20 K using the technique of electron paramagnetic resonance. The major features of the EPR spectra can be attributed to divalent copper ($3d^9$) in substitutional (Ti^{4+}) sites. Information has been gained about both isotopes of copper and about the interactions which concern this ion. For the substitutional site, the spin-Hamiltonian parameters in the $S=1/2, I=3/2$ manifold are: $g_x=2.109$, $g_y=2.094$, $g_z=2.346$, $A_x^{63}=+18.7\times10^{-4}$ cm^{-1}, $A_y^{63}=+27.2\times10^{-4}$ cm^{-1}, $A_z^{63}=-87.5\times10^{-4}$ cm^{-1}, $A_x^{65}=+18.8\times10^{-4}$ cm^{-1}, $A_y^{65}=+28.7\times10^{-4}$ cm^{-1}, $A_z^{65}=-93.7\times10^{-4}$ cm^{-1}, $P_x=-2.56\times10^{-4}$, $P_y=-2.37\times10^{-4}$, and $P_z=+4.93\times10^{-4}$ cm^{-1}. The magnitudes and relative signs of these parameters have been determined experimentally, while the absolute signs have been predicted theoretically from a model which gives a consistent picture of the ordering of the d^9 electronic states. In addition, the theoretical treatment gives a satisfactory estimate of P. Departure from tetragonality was taken into account. The covalency parameter α^2 which measures the fraction of the hole wave function on the Cu^{2+} ion is found to be 0.71, and the factor κ giving rise to isotropic hyperfine structure is found to be 0.31.

11805. Ensign, T. C., Stokowski, S. E., **Shared holes trapped by charge defects in $SrTiO_3$**, *Phys. Rev. B* **1**, No. 6, 2799-2810 (Mar. 15, 1970).

Key words: Color centers; EPR; hole centers; optical absorption; shared holes; $SrTiO_3$.

Using the techniques of EPR and optical irradiation in conjunction with optical-absorption measurements, we have gained useful information about the nature of some hole centers in $SrTiO_3$. Primarily, we have investigated, at temperatures near 77 K, single crystals doped with aluminum. Two principal centers have been explored: (1) the Al-O^- center—a hole shared among the oxygens which surround Al^{3+}, and (2) the X-O^- center—a hole shared in a similar fashion, but more deeply trapped by a charge defect of unknown origin. The Al-O^- center arises after band-gap irradiation and is characterized at 77 K by the following g values and hyperfine constants: $g_{\parallel}=2.0137$, $g_{\perp}=2.0124$, $A_{\parallel}=8.3\times10^{-4}$ cm^{-1}, and $A_{\perp}=7.6\times10^{-4}$ cm^{-1}. The X-O^- center is present before optical irradiation. No hyperfine structure is observed, but the isotropic g value is 2.0130 at all temperatures from 4.2 to 300 K. An 800-nm absorption band arising after band-gap excitation has been correlated with the Al-O^- center. 430- and 600-nm absorption bands have been correlated with the absence of Fe^{3+} in the EPR spectrum, and a 500-nm band has also been observed. In addition, the role of iron in the photochromic processes of $SrTiO_3$ is presented. Finally, theoretical work utilizing the molecular orbital σ and π states in O_h symmetry has provided a firm basis for the sharing model. The experimental g values and hyperfine constants are discussed in light of this model and are found to be in good agreement.

11806. Evans, W., Garvin, D., **The evaluator versus the chemical literature,** *J. Chem. Doc.* **10**, No. 3, 147-150 (1970).

Key words: Abstracts; chemistry; content of articles; data; description of experiments; evaluation of data; numerical data; publication standards; titles.

The presentation of quantitative experimental results is discussed from the viewpoint of the evaluator of data. The principal needs are a detailed description of the experimentation and numerical results suitable for reanalysis. Suggestions are made for the improvement of the content of chemical papers and the retrieval of the results. Content may be improved by preparing guides that state the minimum acceptable detail for various types of measurements. Retrieval may be enhanced by judicious editing of titles and abstracts.

11807. Feldman, A., Brower, W. S., Jr., Horowitz, D., **Optical activity and Faraday rotation in bismuth oxide compounds,** *Appl. Phys. Letters* **16**, No. 5, 201-202 (Mar. 1, 1970).

Key words: $Bi_{34}Ga_2O_{54}$; $Bi_{12}GeO_{20}$; $Bi_{12}SiO_{20}$; $Bi_{12}TiO_{20}$; $Bi_{14}ZnO_{22}$; Faraday effect; modulator materials; optical activity; optical rotatory power; Verdet coefficient.

The optical rotatory power and Faraday rotation were measured in crystals of $17Bi_2O_3$: Ga_2O_3, $7Bi_2O_3$: ZnO, $Bi_{12}TiO_{20}$, $Bi_{12}GeO_{20}$, and $Bi_{12}SiO_{20}$ in the wavelength range 400 to 700 nm at room temperature. Our crystals were enantiomorphs of those reported previously. The large Verdet coefficients indicate that these crystals are potentially useful as magneto-optic modulator materials.

11808. Feldman, A., Kahn, A. H., **Landau diamagnetism from the coherent states of an electron in a uniform magnetic field,** *Phys. Rev. B* **1**, No. 12, 4584-4589 (June 15, 1970).

Key words: Coherent states; diamagnetism; electron in a magnetic field.

A complete set of coherent-state wave packets has been constructed for an electron in a uniform magnetic field. These states are nonspreading packets of minimum uncertainty that follow the classical motion. Use was made of the ladder operators that generate all the eigenstates of the Hamiltonian from any one energy eigenstate. The coherent states are the eigenstates of the two ladder operators that annihilate the zero-angular-momentum ground state. We have calculated the partition function, exploiting advantages of the coherent-state basis. The Landau diamagnetism and the de Haas-van Alphen oscillations are contained in the coherent-state framework.

11809. Frederikse, H. P. R., **Comments on electronic transport in transition metal oxides,** *J. Res. Develop.* **14**, No. 3, 295-300 (May 1970).

Key words: Electronic transport; $LaCoO_3$; magnetic ordering; transition metal oxides.

Several aspects of electronic transport in nonmagnetic and magnetic transition metal oxides are reviewed. These include high- and low-temperature measurements of conductivity, the Hall effect and the Seebeck effect, and their analysis in terms of the electronic energy structure. Particular emphasis is put on the temperature dependence of the Hall mobility, which gives essential information concerning the correct description of the energy states and the scattering of the charge carriers. The second half of the paper discusses the relation between the transport properties and the magnetic ordering. The properties of $LaCoO_3$ together with an interpretation suggested by Goodenough are presented to illustrate this point.

11810. Goldstein, J. I., Henderson, E. P., Yakowitz, H., **Investigation of lunar metal particles,** (Proc. Apollo 11 Lunar Science Conf., January 1970, Houston, Texas), *Geochim. Cosmochim. Acta* **1**, 499-512 (1970).

Key words: Electron probe microanalysis; lunar samples; lunar simulation; lunar thermal history; meteorites; scanning electron microscopy.

Several metallic particles from lunar fine samples 10084 and 10085-17M and from breccia sample 10046-18A were investigated by means of optical microscopy, scanning electron microscopy, and electron probe microanalysis. These particles consisted of two large globules, metal spread on glassy spheres, fragments and metal in the foamy vesicular-like fragments. The largest globule had a structure consisting of 40 μm Fe-Ni dendrites in a matrix of troilite. The dendrites showed typical Ni segregation, the composition at the outside being about 16 wt.% Ni with 13 wt.% Ni at the center. The troilite contained 0.1-1.5 wt.% Ni and appears to be in dis-equilibrium. A high Ni rim region was found at the troilite-dendrite interface. This region is taenite containing 29-46 wt.% Ni and about 0.3 wt.% S and was created by the rejection of Ni from the troilite. We were able to synthesize this globule; the same structure was obtained. From this simulation, the cooling rate was determined as 2.5 °C/sec. This globule probably was created by the impact of a chondrite on the moon.

A globule separated from the breccia rock apparently solidified quickly and then cooled slowly, the rock acting as a kind of crucible. This globule's metal regions contain 2 wt.% Ni, 1 wt.% P, 0.3 wt.% Co, balance Fe. There are also eutectic regions of phosphide with fine intergrowths of kamacite, troilite and carbides. This particle shows a striking similarity to spheroids from the Canyon Diablo iron. The evidence indicates that this globule was probably created by the impact of an iron meteorite on the moon.

The analysis of the metal particles makes it clear that both meteoritic and lunar Fe-FeS intergrowths are present in the lunar fines. The lunar metal is similar to the meteoritic material in that it is surrounded by sulfide; both metal constituents are of comparable structure and Co content. The two types of material can be differentiated by the significant Ni and P content of the transformed original meteoritic material.

11811. Holt, H. K., **Theory of gas lasers and its application to experiment,** *Phys. Rev. A* **2,** No. 1, 233-249 (July 1970).

> Key words: Collisions; gas laser; line widths; power output; theory; tuning curves.

The semiclassical theory of gas lasers has been reformulated by adding rate terms to the density-matrix component differential equations. The solution to these equations, in the form of a Fourier series, is applicable at high laser intensities. A calculation of the effect of phase-changing collisions is also included so that the results can be compared to experimental data taken with a He-Ne laser operating at a wavelength of 1.15 μm.

11812. Hosler, W. R., **Low resistance contacts on semiconducting oxides,** *Solid-State Electron.* **13,** 517-519 (1970).

> Key words: Contact resistance; oxide semiconductors; soldering; TiH_2.

A method using TiH_2 as a flux for a contacting metal in producing low resistance small area contacts in $KTaO_3$, $SrTiO_3$, TiO_2 and $BaTiO_3$ has been devised. The resulting contact resistances have been found to be near zero for $KTaO_3$ and to be greatly decreased for the other materials in comparison with conventional contacts.

11813. Howett, G. L., **Achromatic-point prediction,** *J. Opt. Soc. Am.* **60,** No. 7, 951-958 (July 1970).

> Key words: Achromatic; appearance; brightness; chromatic adaptation; chromaticity; color; least squares; luminance; model; neutral; perception; vision.

This paper constitutes a mathematical elaboration, in a form permitting direct predictions of data, of the empirical discoveries of Helson and Michels concerning the "effect of chromatic adaptation on achromaticity." An equation is developed permitting the chromaticity of a test spot that appears achromatic against an extended chromatic background to be predicted from the background chromaticity and the luminance ratio of spot to background. The technique for numerical solution of the equation is explained, and a family of curves allowing approximate solution by interpolation is presented. If the luminance of the achromatic spot is no greater than that of the background, the achromatic chromaticity always lies more than 3/4 of the way along the line directed from the absolute (black background) neutral point to the background point, regardless of the color of the background. As part of a discussion of additional numerical methods useful in applying the model to data, general least-squares formulas are presented for the coordinates of the point best representing the common intersection of any set of given lines; and for the line, passing through a specified point, that best fits a set of given points by the criterion of perpendicular deviations.

11814. Hubbell, J. H., **X-ray absorption 75 years later,** *Phys. Bull.* **21,** 353-357 (1970).

> Key words: Absorption corrections; attenuation coefficient; conference; crystallography; electron microprobe; fluorescence analysis; gamma rays; photons; Röntgen; x rays.

A Conference on X-Ray Absorption, organized jointly by the X-Ray Analysis Group, the Spectroscopy Group, and the Electron Microscopy and Analysis Group of the IPPS (Institute of Physics and the Physical Society) was held Nov. 14, 1969 in London. This article, besides reporting this conference, reviews some early developments in x-ray attenuation coefficient measurements starting with Röntgen (1895) and presents a graph of present coverage and uncertainties of measurements for elements $Z = 1$ to 100 and photon energies 10 eV to 100 GeV. The eleven presentations at the conference included, in addition to a paper on the present status of x-ray absorption data, papers on: (1) theoretical interpretations of these data including atomic photoeffect, phonon scattering and absorber grain-size effects, (2) measurement techniques including use of synchrotron light and Vodar discharge tubes as soft x-ray sources, and use and performance of various soft x-ray detectors, and (3) absorption data requirements in analysis applications including crystallography, fluorescence spectrometry, electron microprobe analysis, and x-ray reflection topography. Some possible directions of future experimental and theoretical work are indicated.

11815. Hummer, D. G., Mihalas, D., **Model atmospheres for the central stars of planetary nebulae,** *Monthly Notices Roy. Astron. Soc.* **147,** No. 4, 339-354 (1970).

> Key words: Planetary nebulae; stellar atmospheres; transfer equation.

Approximately 70 model atmospheres for the central stars of planetary nebulae have been computed under the assumptions of hydrostatic, radiative and local thermodynamic equilibrium and of plane-parallel stratification. These models have effective temperatures and surface gravities in the range 30,000 K $\leq T_{eff} \leq$ 200,000 K and $3.4 \leq \log g \leq 7.5$. The atmospheres have been taken to consist of hydrogen, helium, oxygen, nitrogen, carbon and neon, and the opacity included contributions from both ground and excited states of each ion. The transfer equation is solved using Feautrier's method and the temperature correction is calculated by means of the Krook-Avrett procedure. Particular attention is given to the effects of gravity and chemical composition on the surface fluxes. The photon fluxes in the H I, He I and He II continua and the stellar flux at H_β have been tabulated for use in the determination of Zanstra temperatures.

11816. Hust, J. G., **Thermal anchoring of wires in cryogenic apparatus,** *Rev. Sci. Instr.* **41,** No. 5, 622-624 (May 1970).

> Key words: Cryogenics; equipment design; heat transmission; thermal contact.

Thermal anchoring of wires to heat sinks in cryogenic equipment is discussed. An analysis is presented to relate the length of tempered wire required and measurable parameters of the system. The solution of the problem is included along with tabular values for typical situations.

11817. Johnson, W. T. K., Chertok, B. T., Dick, C. E., **Study of nuclear states of several odd-*A* nuclei $68 \leq Z \leq 79$ through electromagnetic excitation from 2.3 to 3.6 MeV,** *Phys. Rev. Letters* **25,** No. 9, 599-602 (Aug. 31, 1970).

> Key words: Electron and photon excitation; excited states; half-lives; isomeric levels; ^{197}Au; ^{167}Er; ^{179}Hf; ^{191}Ir.

Thirty-four excited states have been studied between 2.3 and 3.5 MeV in ^{167}Er, ^{179}Hf, ^{191}Ir, and ^{197}Au by observing the decay of the isomeric levels in these nuclei following electron and photon activation. Twenty-eight of these states are observed for the first time. Of the 34 observed transitions, $M1+E2$ multipolarity assignment is made to 20, two are identified as $E0$ transitions, and one is assigned $E1$ multipolarity. Accurate values for the isomeric half-lives are also presented.

11818. Kasen, M. B., **The effect of grain boundaries on the recovery of electrical properties during annealing,** *Scripta Met.* **4,** 575-580 (1970).

> Key words: Aluminum; electrical resistivity; grain boundaries; solute segregation; super-purity metals.

The change in residual resistivity at 4 K has been studied as a function of annealing temperature during step-isochronal annealing of recrystallized, cold-worked, aluminum of two purities. The continued recovery of electrical properties and the eventual development of a resistivity minimum are shown to reflect the decreasing grain boundary area per unit volume as annealing progresses, combined with changes in the amount of solute segregated to the grain boundaries. The resistivity minimum is found to coincide with removal from solid solution of an amount of solute approximating that required to form 1/3 of a monolayer of segregate at the existing boundaries.

11819. Klein, R., **A field emission study of carbon monoxide on hcp metals rhenium and ruthenium,** *Surface Sci.* **20,** No. 1, 1-17 (Mar. 1970).

Key words: Carbon monoxide; desorption; field emission; monoxide; rhenium; ruthenium; surface migration.

The surface migration, work function increments, and desorption of carbon monoxide on two hcp metals, rhenium and ruthenium, were observed with field emission techniques. Carbon monoxide is weakly bound to ruthenium and more strongly bound to rhenium. For a complete monolayer, the work function increment is 1.3 eV for ruthenium and 0.8 eV for rhenium. Surface migration commences at a readily observable rate at about 125 K on ruthenium. The migration is characterized by a sharp boundary that becomes boundary free in the later stages. Because desorption precedes surface migration for CO on rhenium, the onset of migration is ill defined. Two well-defined binding states α and β, are seen for CO on rhenium.

11820. Ledbetter, H. M., Reed, R. P., **On the martensite crystallography of Fe-Ni alloys,** *Mater. Sci. Eng.* **5,** No. 6, 341-349 (June 1970).

Key words: Crystallographic theory; iron-nickel alloy; martensite.

For the first time lattice parameter data and habit plane measurements are available for an alloy system whose crystallographic features change continuously with composition. Other workers have produced this information for the plate-like martensitic transformation in Fe-base alloys containing between 29 and 35 wt.% Ni. This paper presents a careful examination of these data from the viewpoint of the Wechsler-Lieberman-Read, and equivalent, theories of martensite crystallography. It is found that these theories cannot explain the variation of the habit plane with composition. assuming a $\{110\}_F\ \langle\bar{1}10\rangle_F$ deformation mode, without involving a varying δ (1.000 to 1.013), δ being an isotropic dilatation parameter. In addition to the habit plane, several quantities have been calculated as a function of composition: the volume change, the magnitude of the lattice invariant deformation, the magnitude and direction of the shape change, and the orientation relationship. The effects of errors in lattice parameters and of thermal expansion are considered.

11821. Mann, D. B., Roder, H. M., **Liquefied natural gas as a cryogenic fluid—instrumentation and properties,** *Proc. Transmission Conf. American Gas Association Operation Section, New Orleans, La., May 26-27, 1969,* pp. T-98-T-106 (American Gas Association, Arlington, Va., 1970).

Key words: Flowmeters; instrumentation; liquefied natural gas (LNG); methane; properties data.

The rapidly developing interest in liquefied natural gas as a fuel is based on existing and potential uses in a wide variety of fields. The advantages of liquefied natural gas have been explored by numerous interested parties and applied to transportation as a possible substitute for gasoline in internal combustion engines, public utility and industrial uses as a concentrated form of natural gas, and, more basically, as an attractive energy source which may be conveniently delivered throughout the world to those nations having insufficient energy producing resources.

Liquefied natural gas and methane are considered cryogenic fluids since their normal boiling temperatures lie within the cryogenic temperature range. A description of the current program of the Cryogenics Division in respect to methane and liquefied natural gas is presented. The program involves properties correlation, fluid measurement and instrumentation, and a study to determine the characteristics of high-density phases of liquefied natural gas and methane in the subcooled liquid or liquid-solid mixture states.

The presentation of material relating liquefied natural gas to the classical cryogenic fluids will be made in two parts. The first part by Douglas B. Mann will be a discussion of the measurement techniques currently being employed with varying degrees of success to cryogenic fluids. The purpose will be to illustrate what equipment and techniques might be utilized for LNG. Part II of this presentation by Hans M. Roder will deal with the situation that exists currently concerning the properties of liquefied natural gas.

11822. Meijer, P. H. E., O'Keeffe, D. J., **Low-temperature behavior of a pure dipole-dipole system,** *Phys. Rev. B* **1,** No. 9, 3786-3800 (May 1, 1970).

Key words: Cerous magnesium nitrate; dipole system; low temperature; paramagnetic salt; specific heat; susceptibility; thermometer scale.

The Van Vleck moment expansion is applied to a pure dipole system. On the basis of the long-range nature of the forces, sequences of diagrams are selected that give the dominant contributions in the lattice sums. A selection of diagrams contributing to the entropy and susceptibility is displayed. There are three different summations to be performed for each type of diagram: the trace over the spin variables, the lattice summation, and the summation over the Cartesian coordinates. The second was performed on a computer, and the last is obtained by means of the Kramers-Wannier diagonalization. In order to obtain the contributions of diagrams of higher order, a Fourier transform is employed. The calculations are performed for cerous magnesium nitrate using a g factor that is zero along the c axis. The results are compared with experiments. The susceptibility χ was calculated for a uniform and for a nonuniform field, and it is suggested that the critical temperature is determined by the infinity of $\chi(q)$ for $q \neq 0$, rather than by that of $\chi(0)$.

11823. Milligan, D. E., Jacox, M. E., **Spectra of radicals,** Chapter 5 in *Phys. Chem.* **4,** 193-231 (Academic Press Inc., New York, N.Y., 1970).

Key words: Electronic spectrum; flash photolysis; free radicals; matrix isolation; molecular orbitals; vibrational spectrum.

Problems arising in the direct spectroscopic detection of free radicals are surveyed. Apparatus used for the spectroscopic study of free radicals in the gas phase and trapped in inert solid matrices is described. The advantages and limitations of flash photolysis and of matrix isolation studies for the production and detection of free radicals are considered. Examples of radicals studied by these techniques are cited, and data on the structure and chemical bonding of these species derived from the observed spectra are correlated with the predictions of simple molecular orbital theory.

11824. Nimeroff, I., **Deuteranopic convergence point,** *J. Opt. Soc. Am.* **60,** No. 7, 966-969 (July 1970).

Key words: Color blindness; color vision; deuteranope; protanope.

The technique, described by Nuberg and Yustova in 1955 to determine the convergence points of dichromats, was used at the National Bureau of Standards for three deuteranopic eyes, to obtain data on the deuteranopic convergence point. A study of the convergence point for deuteranopes obtained at NBS and by several other investigators has indicated a fairly wide range of values for this convergence point (1.08 to 2.30 for x, −0.08 to

-1.30 for y). The NBS data for deuteranopic observers yield points that fall within this range.

11825. Reed, R. P., Arp, V. D., **Techniques for measuring stress, strain, and resistivity at 4 K for very soft materials,** *Cryogenics Letter to Editor* **9,** No. 5, 362-364 (Oct. 1969).

Key words: Cryostat; electrical resistance; soft materials; strain extensometer.

Existing techniques for conducting low temperature tensile tests have not proven satisfactory for super pure aluminum due to its extreme softness. The desire to concurrently measure specimen resistivity during 4 K tests also provided experimental difficulties, since the specimens had to be electrically isolated from the metallic load assembly. This paper discusses these problems and describes the apparatus designed to provide sensitive and accurate data on stress, strain, and resistivity at 4 K.

11826. Reimann, C. W., Santoro, A., Mighell, A. D., **The crystal molecular structure of hexapyrazolenickel(II)nitrate, $Ni(C_3H_4N_2)_6(NO_3)_2$,** *Acta Cryst.* **B26,** Part 5, 521-526 (May 1970).

Key words: Inorganic coordination complex; octahedral coordination; pyrazole; trigonal symmetry; x-ray structure determination.

The crystal structure of hexapyrazolenickel(II)nitrate, $Ni(C_3H_4N_2)_6(NO_3)_2$, was determined by single-crystal diffraction techniques. Crystals of $Ni(C_3H_4N_2)_6(NO_3)_2$ are trigonal with $a = 9.958$, $c = 7.278$ Å, space group $P\bar{3}$, $Z = 1$, $\rho_0 = 1.57$, $\rho_c = 1.57$ g.cm^{-3}. Three-dimensional counter data were collected (1115 reflections) and the structure was solved by an analysis of the Patterson map. The complex cation, $Ni(C_3H_4N_2)_6^{2+}$, formed by the coordination of six planar pyrazole molecules to the nickel ion, has $\bar{3}$ point symmetry. The nickel ion lies at the center of a nearly regular octahedron of coordinated nitrogen atoms. These complex cations and nitrate anions are linked by hydrogen bonds between each pyrrole type nitrogen atom ($\rangle$ N$-$H) in the pyrazole ring and an oxygen atom in the nitrate group. The final refinement by full-matrix anisotropic least-squares analysis resulted in an R value of 0.053.

11827. Roder, H. M., Diller, D. E., **Thermal conductivity of gaseous and liquid hydrogen,** *J. Chem. Phys.* **52,** No. 11, 5928-5949 (June 1, 1970).

Key words: Critical region; normal hydrogen; parahydrogen; thermal conductivity.

The thermal conductivity of gaseous and liquid hydrogen has been measured with a guarded horizontal flat-plate calorimeter at temperatures between 17 and 200 K and at pressures to 15 MN/m^2. The data have been analyzed as a function of density at fixed temperatures and as a function of temperature at fixed densities. Outside the critical region the thermal conductivity of both the gas and the liquid increases continuously with temperature and density. In the compressed liquid the temperature derivative at fixed density is positive and unusually large compared to that for most other simple liquids. In the critical region the thermal conductivity increases rapidly with both temperature and density as these parameters approach their critical values. The thermal conductivity of the dilute gas is consistent with the kinetic theory expression, $K_0(T) = f_{ME}(T)C_v^0(T)\eta_0(T)/M$, and the dilute gas viscosities to better than 3%.

11828. Ruff, A. W., Jr., **Measurement of stacking fault energy from dislocation interactions,** *Met. Trans.* **1,** No. 9, 2391-2413 (Sept. 1970).

Key words: Dislocation nodes; dislocation ribbons; dislocations; faulted dislocation dipoles; stacking fault energy; stacking fault tetrahedra.

The theories and methods applied to the determination of the stacking fault energy (γ) using techniques of direct observation of dislocation configurations are reviewed. The four principal methods, utilizing dislocation nodes, multiple ribbons, stacking fault tetrahedra, and faulted dipoles, are discussed in detail. Different theoretical treatments are compared wherever possible. Experimental procedures and quantitative measurement methods are reviewed, concentrating on transmission electron microscopy techniques. Detailed examples of the application of each method are given. For $\gamma/\mu b$ in the range of 2×10^{-4} to 5×10^{-3} (μ the shear modulus, b the Burgers vector), measurements on dislocation nodes or multiple ribbons in favorable cases should permit determinations of the stacking fault energy to a precision of 5 pct. For larger values of $\gamma/\mu b$ (up to 12×10^{-3}), measurements can be made on tetrahedra or faulted dipoles with less precision. Larger values of the stacking fault energy require high resolution studies of dislocations; these techniques are not yet well established. Possible sources of systematic bias are discussed. Two significant theoretical problems remain concerning the treatment of the dislocation core and the use of anisotropic elasticity. It is of prime importance to characterize as carefully as possible the materials studied if accurate results are desired.

11829. Searles, S. K., Sieck, L. W., **High pressure photoionization mass spectrometry, III. Reactions of $NO^+(X'\Sigma^+)$ with C_3-C_7 hydrocarbons at thermal kinetic energies,** *J. Chem. Phys.* **53,** No. 2, 794-797 (July 15, 1970).

Key words: Alkanes; excited states; ion-molecule reactions; mass spectrometry; photoionization; rate constants.

The vapor phase reaction of $NO^+(X'\Sigma^+)$ with C_3 through C_6 normal, branched, or cyclic alkanes was found to proceed exclusively via an H^- transfer mechanism:

$$NO^+(X'\Sigma^+) + RH_2 - RH^+ + HNO. \qquad (I)$$

In addition to (I), $C_4H_9^+$ was also formed by a second order process in the reaction with 3-methylhexane. Absolute rate constants were determined for all systems at thermal kinetic energies. Isomers containing tertiary H atoms were found to be the most reactive, exhibiting rate constants on the order of 10^{-9} cm^3/molecule-second. Isotopic labelling has verified that only the tertiary site is involved in the H^- transfer reaction in those molecules having both secondary and tertiary H atoms. The rate constants found for n-alkanes and nonsubstituted cycloalkanes fall in the range 10^{-12} to 10^{-10} cm^3/molecule-second. The bimolecular reaction cyclo-$C_6H_{11}^+ + NO - C_6H_{11}NO^+$ was also noted at higher pressures. No further reaction of the RH^+ species generated in (I) was found in any other $RH_2 - NO$ combination at pressures up to 0.5 torr.

11830. Searles, S. K., Sieck, L. W., Ausloos, P., **Reactions of $C_2H_6^+$. Formation of the $(C_2H_6)_2^+$ ion,** *J. Chem. Phys.* **53,** No. 2, 849-850 (July 15, 1970).

Key words: Alkane dimer ions; ethane; ion-molecule reactions; mass spectrometry; photoionization; protonated dimer ions.

This NOTE reports the discovery of a dimer alkane ion $(C_2H_6)_2^+$. To our knowledge this is the first time that such an ion has been observed in the mass spectrometer.

11831. Sharp, E. J., Weber, M. J., Cleek, G., **Energy transfer and fluorescence quenching in Eu- and Nd-doped silicate glasses,** *J. Appl. Phys.* **41,** No. 1, 364-369 (Jan. 1970).

Key words: Energy transfer; Eu and Nd doped glass; fluorescence; fluorescence decay times; fluorescence quenching; laser glass; rare earth glass.

Radiative and nonradiative energy transfer and decay processes have been investigated in high silicate glass co-doped with Eu and Nd. Energy transfer from Eu to Nd was established from an examination of the excitation spectra and the increased

Eu decay rates in the presence of Nd. Measurements of the concentration dependences of the Eu^{3+} and Nd^{3+} fluorescence lifetimes reveal the presence of four distinct processes arising from various ion-ion interactions: (1) self-quenching of the Nd^{3+} fluorescence, (2) self-quenching of the Eu^{3+} fluorescence, (3) nonradiative energy transfer from Eu^{3+} to Nd^{3+}, and (4) Eu quenching of the Nd^{3+} fluorescence. This last process decreases the radiative quantum efficiency of the $^4F_{3/2}$ state of Nd^{3+}, thus limiting the attractiveness of Eu sensitization for Nd laser action.

11832. Shinyayev, A. Ya., Butrymowicz, D. B., **Interdiffusion in and the phase diagram for vanadium-rich alloys of the V-Al system at pressures 0 to 47 kbar,** *Met. Trans.* **1,** No. 7, 1905-1907 (July 1970).

Key words: Alloys; aluminum; diffusion; high-pressure; phase-diagram; vanadium.

The V-Al system between 16 and 39 at. pct Al was studied at 1400 °C under pressures of 0, 30, and 47 kbar. Electron microprobe analysis, x-ray diffraction, microhardness readings, and metallographic examination revealed only a single solid solution. Interdiffusion coefficients were determined as a function of composition and pressure. Concentration gradients were measured with an electron microprobe analyzer and the diffusion coefficients were calculated by the Matano analysis. At 1400 °C, the value of the interdiffusion coefficient varied from 1 to 12×10^{-9} sq cm per s, increasing with aluminum content and decreasing with increasing pressure.

11833. Simson, B. G., Mandel, J., Brenner, F. C., **Research for a uniform quality grading system for tires. III. Breaking energy,** *Rubber Chem. Tech.* **43,** No. 2, 356-369 (Mar. 1970).

Key words: Bias ply; breaking energy; passenger car; radial; tires; tire strength; winter.

A test procedure designed to classify tires according to their average breaking energy has been applied to a sample of passenger car tires. Data are reported on 127 different tires of all grades and types over a range of sizes.

A scaling system is devised and applied to the data. It is found that the system leads to conclusions similar to those derived from the original data.

11834. Stein, P. G., Lipkin, L. E., Shapiro, H. M., **Spectre II: General-purpose microscope input for a computer,** *Science* **166,** 328-333 (Oct. 17, 1969).

Key words: Biological structure; biomedical instrumentation; computer; image processing; microscope; microspectrophotometry; pattern recognition.

This paper describes a system of instruments used in biological and medical research for microspectrophotometry and computer analysis of microscopic images. The apparatus includes an optical microscope, spectrophotometer, a scanner, and a motor driven stage and monochromator all controlled by a small general-purpose computer. A keyboard permits manual operation of the equipment under computer control.

The system was constructed with great flexibility to permit its use in the evaluation and design of special-purpose apparatus for specific biomedical applications. A discussion of design criteria and a comparison with existing input devices for microscopic image analysis is included.

11835. Straty, G. C., Prydz, R., **The vapor pressure of liquid fluorine,** (Proc. 1969 Cryogenic Engineering Conf., June 16-18, 1969, Univ. of California, Los Angeles, Calif.), Chapter in *Advances in Cryogenic Engineering* **15,** Paper No. B-1, 36-41 (Plenum Press Inc., New York, N.Y., 1970).

Key words: Critical point pressure; fluorine; normal boiling point; vapor pressure data; vapor pressure equation.

This paper reports new vapor pressure measurements on liquid fluorine from the triple point to the critical point at 1 K intervals. Accuracies in both temperature and pressure approach a few hundredths of a percent. The data were fitted to a newly developed, nonanalytic vapor pressure equation and compared graphically to earlier, inconsistent measurements available in the literature. Of this earlier data, the estimated P-T values above the normal boiling point and the value given for the critical pressure are in error by as much as 10 to 15 percent.

11836. Sugar, J., **Spectrum of doubly ionized thulium (Tm III),** *J. Opt. Soc. Am.* **69,** No. 4, 454-466 (Apr. 1970).

Key words: Doubly ionized thulium; energy levels of Tm III; radial energy integrals of Tm III; spectrum of Tm III.

A list of 848 low-excitation spectral lines of Tm III has been obtained by utilizing the sliding-spark light source at a peak current of 6 A. An analysis of these lines yielded 108 energy levels belonging to the configurations $4f^{13}$, $4f^{12}5d$, $4f^{12}6s$, and $4f^{12}6p$. The classified lines and level values are presented as well as a theoretical interpretation of these configurations.

11837. Sugar, J., **Configuration $4f^{13}5d$ of doubly ionized ytterbium,** *J. Opt. Soc. Am.* **60,** No. 4, 571-572 (Apr. 1970).

Key words: Radial integrals; Sack correction; ytterbium.

The "effective" interaction parameters introduced by Sack are applied to the $4f^{13}5d$ configuration of Yb III, reducing the rms error of the calculated levels from 179 cm^{-1} to 69 cm^{-1}.

11838. Swartzendruber, L. J., Bennett, L. H., **Clustering, cold work, and the Mössbauer effect doublet structure in Cu-Ni-Fe alloys,** *Physics Letters* **31A,** No. 10, 581-582 (May 18, 1970).

Key words: Alloys; clustering; cold work; Cu; Fe; magnetic moments; Mössbauer effect; Ni.

The doublet structure observed in the high temperature Mössbauer effect spectra of Cu-Ni-Fe alloys is present in a random alloy as well as in a metallurgically clustered alloy. The structure of the doublet is distorted by cold work.

11839. Ugiansky, G. M., Skolnick, L. P., Stiefel, S. W., **Directional effects in the stress corrosion cracking of an aluminum alloy,** *Corrosion* **25,** No. 2, 77-86 (Feb. 1969).

Key words: Aluminum alloy; corrosion; directional effects; grain morphology; preferred orientation; stress corrosion.

Studies of the relative effects of grain morphology and preferred orientation on the directional susceptibility to intergranular stress corrosion cracking of a 7075-T651 aluminum alloy plate have been conducted. The role of grain morphology was found to be of paramount importance in controlling crack propagation. It was found that a slow rate of propagation along grain boundaries parallel to the applied stress accounts for the low susceptibility of longitudinally stressed specimens. The results suggest that the threshold stress for short transverse specimens approximates the low stress necessary to crack grain boundaries normal to the applied stress, and the threshold stress for longitudinal specimens approximates the high stress needed to propagate cracks along boundaries parallel to the applied stress. Preferred orientation was found to be of secondary importance when compared to the effect of grain morphology. A high degree of preferred orientation, rather than any specific slip plane orientation, was found to increase the susceptibility of specimens with the same grain morphology. Pitting corrosion was found to occur to a much greater extent on unstressed than on stressed (undergoing stress corrosion cracking) specimens. This phenomenon is explained by what is termed an "internal cathodic protection mechanism."

11840. Wall, L. A., Flynn, J. H., Straus, S., **Rates of molecular**

vaporization of linear alkanes, *J. Phys. Chem.* **74,** No. 17, 3237-3242 (1970).

Key words: Alkanes; heats; *n*-hexatricontane; *n*-pristane; *n*-tetracosane; *n*-tetranonacontane; vaporization.

The rates of molecular vaporization of four linear alkanes, *n*-nonadecane (C_{19}), *n*-tetracosane (C_{24}), *n*-hexatricontane (C_{36}), and *n*-tetranonacontane (C_{94}), were measured. The tetranonacontane vaporized without detection of hydrocarbon decomposition products by mass spectral monitoring. The kinetics of the vaporization process showed zero-order behavior as a vaporization process proportional to the surface area should. The Arrhenius slope, $+3RT/2$, was compared to heats of vaporization of other *n*-alkanes in the literature. The data show that the heat of vaporization is closely proportional to the two-thirds power of the number *n*, of carbon atoms in the species and not to the first power. Our results and the majority of the known heats of vaporization are well fitted by the equation, $\Delta H_v = 13.43n^{2/3} - 0.08075T + 12.22$ kJ/mol. The results suggest a much higher upper limit to the size of species capable of molecular vaporization without decomposition than previously assumed.

11841. West, E. D., Churney, K. L., **Theory of isoperibol calorimetry for laser power and energy measurements,** *J. Appl. Phys.* **41,** No. 6, 2705-2712 (May 1970).

Key words: Calorimetry; laser calorimetry; lasers; thermodynamics.

Laser power and energy measurements are commonly made in calorimeters operating in a constant temperature environment. Calorimeters of this type are analyzed in terms of the first law of thermodynamics and the boundary value problem describing heat flow in the calorimeter. This theory of the measurement suggests design features of the calorimeter, sources of error to be avoided in design and operation, and tests to demonstrate experimentally the adequacy of the design. The analysis shows how time-temperature data can be used to allow for the temperature gradient on the calorimeter and the heat exchange due to transients in the temperature.

11842. Wilson, W. K., Fletcher, D. G., **Paper research at the National Bureau of Standards,** *Indian Pulp Paper* **24,** No. 7, 325-329 (Jan. 1970).

Key words: Appearance properties; paper research; preservation of records; tear reference; testing program.

A brief history of paper research at the National Bureau of Standards is followed by a description of the current program. Work is in progress on the preservation of records, currency paper, and optical properties of paper. A collaborative testing program enables participating laboratories to compare their test results with the results obtained in other laboratories. A tear reference standard also has been maintained for several years. Several staff members participate in a number of committees in the Technical Association of the Pulp and Paper Industry, American Society for Testing and Materials, USA Standards Institute and International Organization for Standardization.

11843. Wolcott, N. M., Falge, R. L., Jr., **Cluster specific heat in $Cu_{0.6}Ni_{0.4}$ alloy,** *J. Low Temp. Phys.* **2,** No. 314, 329-331 (1970).

Key words: Clustering; $Cu_{0.6}Ni_{0.4}$ alloy; electronic specific heat; specific heat; 0.48 to 10 K.

The specific heat of an alloy of copper with 40 at.% nickel has been measured. The "constant" or anomalous term is seen to decrease as the temperature is reduced below 1.4 K.

11844. Younglove, B. A., **Measurements of the dielectric constant of saturated liquid oxygen,** (Proc. 1969 Cryogenic Engineering Conf., June 16-18, 1969, Univ. of California, Los Angeles, Calif.), Chapter in *Advances in Cryogenic Engineering* **15,** Paper No. C-3, 70-75 (Plenum Press Inc., New York, N.Y., 1970).

Key words: Clausius-Mossotti function; dielectric constant; oxygen; polarizability; saturated liquid.

Dielectric constant measurements on saturated liquid oxygen ranged from 1.22 near the critical point to 1.57 near the triple point. The calculated "polarizability" (Clausius-Mossotti function) shows a variation of 1.3%, with the maximum occurring at about 150 K. The decrease in polarizability near critical is attributed to inaccuracies in the densities in this region. The uncertainty in dielectric constant is about 0.01%.

11845. Acquista, N., Abramowitz, S., **Structure of the alkali hydroxides. V. The infrared spectra of matrix-isolated RbOH, RbOD, NaOH, and NaOD,** *J. Chem. Phys.* **51,** No. 7, 2911-2914 (Oct. 1, 1969).

Key words: Alkali hydroxides; high temperature; infrared; matrix; NaOD; NaOH; RbOD; RbOH; vibrational assignment.

The infrared spectra of matrix-isolated RbOH, RbOD, NaOH, and NaOD have been observed. Both the alkali-metal-oxygen stretch ν_1 and the bending mode ν_2 have been assigned for each species. The metal-oxygen stretching mode is found at 354.4, 345, 431, and 422 cm^{-1} for RbOH, RbOD, NaOH, and NaOD, respectively; the bending mode ν_2 is observed at 309.0, 229, 337, and 250 cm^{-1}, respectively. Combination of the results of this study with the microwave measurements for RbOH and RbOD indicates an essentially linear structure for these species. The isotope shift for ν_2 observed in NaOH coupled with reasonable bond lengths indicates an equilibrium configuration of NaOH which probably does not deviate significantly from linearity. The assumption of a linear model with a harmonic bending potential yields force constants of 0.046×10^{-18} and 0.053×10^{-18} Nm (0.046 and 0.053 mdyn·Å) for RbOH and NaOH, respectively. These results are consistent with our previously reported results for CsOH.

11846. Acquista, N., Schoen, L. J., **Matrix isolation spectrum of the SH radical,** *J. Chem. Phys.* **53,** No. 3, 1290-1291 (Aug. 1, 1970).

Key words: Infrared spectrum; isolated SH; low temperature; matrix; SH; ultraviolet.

The free radical SH is produced in sufficient quantities by photodeposition of H_2S in argon matrices at 20 K for observation in the ultraviolet and infrared. Close agreement between the matrix data and the gas-phase work in the electronic region support the assignment.

11847. Ahearn, A. J., **Homogeneity of ion sensitive emulsions and precision of ion beam measurements in spark source mass spectrometry, (Summary),** *Proc. 16th Annual Conf. on Mass Spectrometry and Allied Topics, May 12-17, 1968, Pittsburgh, Pa., sponsored by ASTM Committee E14,* pp. 273-276 (1968).

Key words: Accuracy; circumvention; emulsions; homogeneity; ions; mass; platinum; precision; replicate; spark; spectrometry.

The precision and accuracy with which materials can be trace characterized by spark source mass spectrometry is determined in part by the precision with which ion beams can be measured with ion sensitive emulsions. Consequently, the homogeneity of the emulsion becomes an important factor. Replicate mass spectra of platinum extending over Q2 emulsions show that the sensitivity fluctuations about an average may be $\leq 5\%$, standard deviation in a 5 cm. length, or there may be as much as a 30% change in sensitivity over this distance.

11848. Anderson, H. J., Brenner, A., **Chemical vapor deposition**

of rhenium, *Proc. 2nd Intern. Conf. on Chemical Vapor Deposition, Los Angeles, Calif., May 1970,* pp. 356-366 (1970).

Key words: Chemical vapor deposition; rhenium; rhenium coatings; rhenium oxychlorides.

The chemical vapor deposition (CVD) of rhenium from a variety of compounds was investigated. The reduction of perrhenyl chloride and rhenium oxytetrachloride with hydrogen resulted in the production of deposits which ranged from bright to powdery, the latter being obtained at a temperature above 600 °C. The bright deposits were cracked and exfoliated from the substrate. The only ductile deposits were obtained by thermal decomposition of $ReOCl_4$ at about 1200 °C, which process has been previously described by Russian workers.

11849. Andrews, J. R., **Improved bias supply for tunnel-diode picosecond pulse generators,** *IEEE Trans. Instr. Meas.* **IM-19,** No. 3, 171-175 (Aug. 1970).

Key words: Jitter; picosecond; pulse generator bias supply; tunnel diode.

An improved bias supply for tunnel-diode (TD) picosecond-pulse generators is described. The supply is stable with temperature and, in a commercial 35-ps (nominal) risetime tunnel-diode pulse generator/sampling oscilloscope system, has produced a 4:1 reduction in time-base jitter and 2:1 reduction in time-base drift. Also described is a tunnel-diode pulse generator, which, when used with the bias supply, produces a stable pulse having a flat-top sag of no more than 2 percent in 1 μs.

11850. Armstrong, R. W., Waters, H. P., **Testing programs and research on restraint systems,** *Proc. Intern. Engineering Congress, Detroit, Michigan, January 13-17, 1969,* Report No. 690247, pp. 1-48 (Society of Automotive Engineers, New York, N.Y., 1969); Abstract in *SAE Trans.* **78,** 102 (1969).

Key words: Anthropomorphic dummies; auto seat tests; deceleration; human kinematics; human tests; restraint geometry; restraint systems; seat belt; sled tests; webbing abrasion; webbing degradation.

Extensive research in the field of occupant restraints has been made by the Office of Vehicle Systems Research at the National Bureau of Standards. Portions of that research, consisting of human dynamic sled tests at Holloman Air Force Base, tests of restraint systems on the NBS sled, and a variety of strength and degradation tests of seat belts are reported. The geometry of restraint systems in 1968 model production automobiles is documented.

Results of 75 human tests reported indicate the nature of human kinematic response to deceleration in seat belts and the forces the seat belt might be expected to withstand. Requirements for dynamic tests of seat belts have been investigated as well as degradation tests for improvement of the federal standards for seat belts for use in motor vehicles.

11851. Armstrong, R. W., Waters, H. P., Stapp, J. P., **Human muscular restraint during sled deceleration,** *Proc. 1968 Stapp Car Crash Conf., October 22-23, 1968, Detroit, Michigan,* Report No. 680793, pp. 440-462 (Society of Automotive Engineers, New York, N.Y., 1969); Abstract in *SAE Trans.* **77,** 179 (1969).

Key words: Acceleration (mechanical); biodynamics; biomechanics; human engineering; kinematics; occupant restraint systems; seat; seat belts.

The value of the restraint by legs and arms of a human being has been generally disregarded in the development of restraint systems for occupants of an automobile. As part of a series of tests on human beings in automotive restraints conducted for the National Bureau of Standards by the 6571st Aeromedical Research Laboratory, Holloman Air Force Base, New Mexico, measurements were made of the forces exerted on a foot rest during 15 g decelerations. Calculations revealed that for "lap belt only" configuration, 26% of the subject's kinetic energy absorbed was attributed to the seat belt and 55% attributed to the restraint by the legs.

11852. Arthur, M. G., **Impulse spectral intensity calibration at the National Bureau of Standards,** *Proc. Electromagnetic Compatability Symp., Ft. Monmouth, N.J., June 19-20, 1969,* pp. 133-138 (U.S. Army Electronics Command Hdq., Ft. Monmouth, N.J., 1969).

Key words: Fourier transform; impulse; impulse generator; impulse spectral intensity; impulse standards.

The National Bureau of Standards, in its Radio Standards Engineering Division, is working on standards and measurement techniques of impulsive signals. This work includes a study of impulse spectral intensity, the development of methods of measuring it, and the development of standard impulsive signal generators. These tasks are not yet completed, but certain useful accomplishments have been made.

An authoritative definition of impulse spectral intensity is lacking. Even so, two techniques are being developed at NBS for measuring the amplitude of the frequency spectrum of an impulsive signal. One technique involves the measurement of power spectral density, from which the spectrum amplitude is computed. The other technique involves the measurement of the relative amplitude of the spectrum, and makes use of the results of the first technique to obtain the actual spectrum amplitude. Also under development are two different types of precision impulse generators to be used as reference standards. Since none of this work is completed, no NBS calibration services for impulse spectral parameters are presently available.

11853. Ausloos, P., **Ion-molecule reactions and photoionization of hydrocarbons,** Chapter in *Progress in Reaction Kinetics,* G. Porter, ed., **5,** 113-179 (Mar.-Apr. 1970).

Key words: Hydrocarbons; ion-molecule reactions; photoionization; radiolysis; rate constants; theory.

This is a critical review of the literature on ion-molecule reactions in the radiolysis and photoionization of hydrocarbons.

11854. Ausloos, P., Lias, S. G., **Carbonium ions in radiation chemistry. Reactions of *t*-butyl ions with hydrocarbons,** *J. Am. Chem. Soc.* **92,** No. 17, 5037-5045 (Aug. 26, 1970).

Key words: Carbonium ions; ion-molecule reactions; neopentane; radiolysis; rate constants; *t*-butyl ion.

t-Butyl ions, generated by the γ irradiation of neopentane, undergo hydride transfer reactions with alkanes having tertiary hydrogen atoms ($t\text{-C}_4\text{H}_9^+ + \text{RH} \rightarrow i\text{-C}_4\text{H}_{10} + \text{R}^+$) to form isobutane and a tertiary carbonium ion as products. By irradiating neopentane in the presence of mixtures of two reactant molecules, one deuterated and one nondeuterated, the relative rates of the hydride transfer reaction for 22 $\text{C}_5 - \text{C}_8$ alkanes were determined with an unusually high accuracy, from the observed ratios of $i\text{-C}_4\text{H}_9\text{D}$ to $i\text{-C}_4\text{H}_{10}$. Absolute rate constants for reactions, based on a determination of the rate of depletion of the isobutane yield when ammonia is added, are given. The rate constants are generally very low [$10^{-11} - 10^{-10}$ cm^3/(molecule sec)^3, but are shown to depend on the heat of reaction and steric factors involving van der Waals interactions between the approaching ion and hydrogen atoms or methyl groups on the carbon atom β to the tertiary carbon. The evidence indicates that the hydride transfer reactions of the *t*-butyl ion have an activation energy, $E_{\text{act}} \leq 0.15$ eV. In another series of experiments, unsaturated hydrocarbons were added to neopentane-isopentane mixtures, and the rates of the condensation reaction of these additives with *t*-butyl ions were determined by measuring the rate of depletion of the isobutane yield. The rate constants for the condensation reactions are in the range $10^{-10}-10^{-9}$ cm^3/(molecule sec). Some insight into processes occurring in the radiolysis of neopentane can be gained from these results. It is shown, for example, that in the absence of reactive additives, not more than about 14% of the *t*-butyl ions undergoes processes resulting in the formation of isobutene.

11855. Baird, R. C., **Recent theoretical and experimental results of the determination of antenna pattern and gain from near-field measurements, (Summary),** *Proc. Conf. Precision Electromagnetic Measurements, National Bureau of Standards, Boulder, Colo., June 2-5, 1970, CPEM Digest,* p. 60 (1970).

Key words: Gains; microwave antennas; near-field measurements; patterns.

Recent results based on a new method of determining antenna pattern and gain from near-field measurements are summarized. A brief description of the method covering the important new features (such as the ability to correct for the effects of the measuring probe) is included. Preliminary results of measurements made on three different horn antennas (gains = 6.8 dB, 21 dB, 47 dB) are presented. The accuracy of the method appears to be at least as good as conventional far-field measurements and may be significantly better for many antennas. Some potential applications of the method are mentioned and references of publications containing more complete discussions are given.

11856. Baird, R. C., Newell, A. C., Wacker, P. F., Kerns, D. M., **Recent experimental results in near-field antenna measurements,** *Electronics Letters* **6,** No. 11, 349-351 (May 28, 1969).

Key words: Antenna gain; antenna pattern; calculated far-field patterns; near-field measurements; new antenna theorems.

Recent experimental results on determination of antenna pattern and effective gain from near-field measurements are described. Two new antenna measurement theorems were applied. Measurements were made on an electrically large horn-lens, a standard-gain horn, and a nominal duplicate of the measuring antenna. Some comparisons with direct far-field measurement results were made.

11857. Barnes, J. A., **Frequency measurement errors of passive resonators caused by frequency-modulated exciting signals,** *IEEE Trans. Instr. Meas.* **IM-19,** No. 3, 147-152 (Aug. 1970).

Key words: Frequency; resonance; standards.

The condition of resonance for a signal with FM is defined in this paper as the condition of maximum power transfer by the resonant device. It is shown that if the width of the signal spectrum is small compared to the resonator's linewidth, then the frequency error is proportional to the third moment of the instantaneous signal frequency about its mean.

One expects that this treatment should, at least, give the leading term for a precise treatment of atomic resonances. Experimental results with a cesium beam frequency standard confirm this expectation and add caution to the idea that higher *Q* atomic resonances make better absolute frequency standards.

11858. Bates, R. D., Jr., Flynn, G. W., Ronn, A. M., **Laser-induced vibrational fluorescence in nitrous oxide,** *J. Chem. Phys.* **49,** No. 3, 1432-1433 (1968).

Key words: Fluorescence; infrared; laser; nitrous oxide; Q-switching; vibrational relaxation.

A laser induced fluorescence technique has been utilized to obtain the relaxation time of N_2O in the 001 vibrational state. A thermalized N_2O absorption cell was placed within an N_2O-N_2-He Q-switched laser cavity and the fluorescent emission monitored on a side window with a Au:Ge detector. A quenching rate for the 001 level was found to be (672.6 ± 8.9 sec^{-1} torr^{-1}) where the uncertainty is the estimated standard deviation. This corresponds to a cross section of 1.23×10^{-19} cm^2.

11859. Bates, R. G., Staples, B. R., Robinson, R. A., **Ionic hydration and single ion activities in unassociated chlorides at high ionic strengths,** *Anal. Chem.* **42,** No. 8, 867-871 (July 1970).

Key words: Activity coefficients; activity scales of high concentrations; activity standard scales; chloride activity convention; ion activity standards; ionic activity; ion selective electrodes; single ion.

Although the convention on which standard reference values of pH are based is suitable at ionic strengths below 0.1, and extension of this formula is required to provide the single ionic activities needed for the standardization of ion-selective electrodes at high ionic strengths. This procedure must take into account the specific differences among activity coefficients of ions of the same charge, apparent at elevated concentrations but negligible at low ionic strengths. It is shown that a reasonable method for deriving single ionic activities can be based on the Stokes-Robinson hydration theory. The assumption is made that the chloride ion is not hydrated. Individual ionic activity coefficients in solutions of seven unassociated uni-univalent chlorides and four alkaline earth chlorides have been calculated. Advantages and limitations of the hydration treatment are discussed.

11860. Bennett, H. S., **Two-electron F' centers in the alkaline-earth oxides and in the alkali halides,** *Phys. Rev. B* **1,** No. 4, 1702-1715 (Feb. 15, 1970).

Key words: Alkali halides; alkaline earth oxides; *F* center; F' center; ionic crystals (NaCl, KCl, MgO, CaO).

The Hartree-Fock-Slater equations for the two electron orbitals localized about an anion vacancy in MgO, CaO, NaCl, and KCl have been solved numerically in the point-ion-lattice potential. The ionic polarization of the nearest-neighbor ions is treated in a self-consistent manner. It is found that the low lying F' center states for MgO and CaO have the following order for increasing values of the energy: $^1S(1s,1s)$, $^3P(1s,2p)$, $^1P(1s,2p)$, and either $^3S(1s,2s)$ or $^1S(1s,2s)$. The states $^3S(1s,2s)$ and $^1S(1s,2s)$ both lie above the other three states, but whether the $^3S(1s,2s)$ state lies above or below the $^1S(1s,2s)$ state depends upon the ionic polarization of the crystal potential. The above ordering, the optical absorption and emission energies between the states $^1S(1s,1s)$ and $^1P(1s,2p)$, and the spin-forbidden emission energy from the state $^3P(1s,2p)$ to the state $^1S(1s,1s)$ agree reasonably with the experimental ordering of the states and with the experimental transition energy values of CaO, respectively. The same physical model gives very different results for the F' center in NaCl and in KCl. It is found that only the ground state $^1S(1s,1s)$ contains spatially compact (bound) electronic orbitals. The ground-state energies of the F' center in NaCl and KCl agree to within 20% of the experimental values. The existence of bound excited states for the F' center in these monovalent crystals has been investigated. However, definitive statements on such states are not available at present.

11861. Berger, M. J., **Beta-ray dosimetry calculations with the use of point kernels,** (Proc. Symp. Medical Radionuclides: Radiation Dose and Effects, Oak Ridge Association Universities, Oak Ridge, Tennessee), *Atomic Energy Commission Report* **CONF-691212,** pp. 63-86 (June 1970).

Key words: Absorbed dose; beta ray; dosimetry; nuclear medicine; point kernel; radionuclide.

Some work on the evaluation, compilation, and use of point kernels in beta-ray dosimetry is described. Such kernels describe the distribution of absorbed dose around point sources. By the superposition of such kernels, one can determine the spatial pattern of absorbed dose in media in which a beta-emitting radionuclide is distributed in some specified fashion. The superposition method has the advantage of great economy. It is not completely realistic, however; its applicability is limited to media which are in effect unbounded and which are homogeneous in composition and uniform in density. Under the auspices of the Medical Internal Radiation Dose (MIRD) Committee of the Society of Nuclear Medicine, point kernels have been compiled for 75 radionuclides. These results are theoretical and are based on information about the shapes of beta spectra (obtained from the Oak Ridge National Laboratory Nuclear Data Group), data about electron stopping power and range values, and point kernels for monoenergetic sources calculated by Spencer. Confirming earlier findings by Cross, it is shown that the theoretical point kernels are in good agreement with corresponding experimental data for air and polystyrene. In a digression, a brief indication is given—derived from the analysis of Monte Carlo calculations—of how much the absorbed dose is reduced near a boundary through which the beta particles can escape from but not return to the medium, e.g., near an air-tissue interface. Finally, some considerations are presented concerning techniques useful for carrying out the numerical integrations for the superposition of point kernels. The examples discussed include the absorbed-dose distributions near line and plane sources, the absorbed-dose distributions inside and outside of volume sources with spherical and cylindrical shapes, and the self-absorption of beta-ray energy in slabs and spheres.

11862. Bergstrom, J. C., Bertozzi, W., Kowalski, S., Maruyama, X. K., Lightbody, J. W., Jr., Fivozinsky, S. P., Penner, S., **Electroexcitation of the low-lying states of O^{16}**, *Phys. Rev. Letters* **24,** No. 4, 152-155 (Jan. 26, 1970).

Key words: Electroexcitation; electron scattering; excited states of O^{16}; form factors; inelastic electron scattering; levels of O^{16}; low-lying states of O^{16}; O^{16}.

Measurements are reported of form factors for the electroexcitation of the O^+ (6.052-MeV), 3^- (6.131-MeV), 2^+ (6.916-MeV), and 1^- (7.115-MeV) states of 0^{16}, in the momentum-transfer region 0.5 to 1.0 fm^{-1}. The data are compared with the predictions of various particle-hole shell models and a two-component phenomenological model.

11863. Blaine, R. L., **A statistical study of the effects of trace elements on the properties of portland cement,** *Proc. 5th. Intern. Symp. on the Chemistry of Cements, Tokyo, Japan, October 7-11, 1968,* **3,** Part 3, 86-91 (Dec. 31, 1969).

Key words: Alkalies; concrete; durability; heat of hydration; portland cements; shrinkage; statistical evaluation; strength; sulfate expansion; trace elements.

A digital computer was used to find and evaluate significant relationships between the properties of a large number of portland cements and various independent variables which included chemical compounds, minor constituents, and trace elements. This article presents a review of the probable effects of minor constituents and trace elements on various properties including heat of hydration, sulfate expansion, compressive strength with different curing conditions, shrinkage, and durability. On the basis of the statistical study, Na_2O or K_2O were associated with most of the properties measured but not always to the same degree. Very few of the other individual trace elements had a highly significant relationship to the various properties measured, but when used in equations in addition to other commonly determined variables, there was usually a highly significant reduction in variance. The coefficients for Ba, Cu, SrO, P, and Li were significant at the 0.01 probability level in some tests and at the 0.05 probability level in other tests. The coefficients for Cr, Ni, Rb, Ti, V, and Zr were significant at the 0.05 probability level in equations for some of the tests. The effects of the alkalies and trace elements were generally small compared to the effects of major constituents and other independent variables.

11864. Blaugher, R. D., Hein, R. E., Cox, J. E., Waterstrat, R. M., **Atomic ordering and superconductivity in A-15 compounds,** *J. Low Temp. Phys.* **1,** No. 6, 539-561 (Dec. 1969).

Key words: Atomic ordering; binary A-15 compounds; superconductivity; transition elements.

Twenty-six different binary A-15 compounds were investigated to determine if superconductivity could be related to the degree of long-range atomic ordering on the crystallographic lattice sites. Significant changes in the superconducting transition temperatures and critical fields were produced by quenching from high temperatures followed by low-temperature annealing. These changes in T_c were accompanied by changes in the degree of long-range ordering as determined using x-ray diffraction methods. The results can be interpreted within the framework of Weger's "linear-chain" model only when the B-element is a nontransition element. When both the A and B components are transition elements, however, the superconducting behavior will apparently depend on the nature of "*d*-electron" interactions between the component atoms. Complete ordering is not always an essential requirement for optimizing the superconducting properties.

11865. Boyne, H. S., Hall, J. L., Barger, R. L., Bender, P. L., Ward, J., Levine, J., Faller, J., **Absolute strain measurements with a 30-meter vacuum interferometer,** (Proc. Conf. Laser Applications in the Geosciences, Huntington Beach, Calif., June 1969), Chapter in *Laser Applications in the Geosciences,* J. Gauger and F. F. Hall, Jr., eds., pp. 215-225 (Western Periodicals, North Hollywood, Calif., 1970).

Key words: Earth strain; earth tide; geophysics; laser strainmeter; seismograph.

We present details on the design and performance of a 30-meter interferometric strain gauge. We also discuss a practical method for recording absolute earth strain measurements by comparing length changes in the interferometer with an absolute wavelength standard.

11866. Brady, R. F., Jr., **Cyclic acetals of ketoses. Part III. Re-investigation of the synthesis of the isomeric Di-*O*-isopropylidene-β-D-fructopyranoses,** *Carbohydrate Res.* **15,** No. 1, 35-40 (1970).

Key words: Fructose; gas-liquid chromatography; rare sugars; rearrangement; 1,3-dioxolane rings.

Condensation of D-fructose with acetone in the presence of sulfuric acid gave first 1,2:4,5-di-*O*-isopropylidene-β-D-fructopyranose. This compound isomerizes, at a rate dependent on the concentration of the acid, to 2,3:4,5-di-*O*-isopropylidene-β-D-fructopyranose. Careful selection of reaction conditions permits the synthesis of either isomer in satisfactory yield. In acetone containing 5% of sulfuric acid, either compound is converted into an equilibrium mixture (3:47) of 1,2:4,5- and 2,3:4,5-diacetal within 5 min at room temperature, but, when anhydrous zinc chloride is used as the catalyst, the 1,2:4,5-diacetal does not rearrange to the 2,3:4,5-diacetal.

11867. Bridges, J. M., Wiese, W. L., **Transition probabilities for the prominent red lines of Ne I,** *Phys. Rev. A* **2,** No. 2, 285-293 (Aug. 1970).

Key words: Neon; spectrum; transition probabilities.

Relative transition probabilities of all 30 lines belonging to the prominent 3*s*-3*p* transition array of Ne I have been measured in emission with a wall-stabilized arc operating in an argon-neon mixture at atmospheric pressure. The data have been normalized to an absolute scale provided by recent lifetime measurements of the 3*p* levels. Our results, as well as the data from other emission measurements, have been subjected to extensive comparisons and tests, including a check for fulfillment of the *J*-file sum rule. It is found that our data exhibit a much better consistency than any other set of individual values. On the basis of this analysis as well as our uncertainty estimates, we estimate that the accuracy of our individual transition probabilities for this transition array, except for a few weak lines, is of the order of 10% on an absolute basis.

11868. Brown, D. W., Lowry, R. E., Wall, L. A., **Radiation-induced copolymerization of tetrafluoroethylene and 3,3,4,4,5,5,5-heptafluoropentene-1 under pressure,** *J. Polymer Sci.* Part A-1, **8,** No. 9, 2441-2452 (1970).

Key words: Amorphous polymer; copolymerization; fluoropolymers; glass temperature; high pressure; radiation-induced; tetrafluoroethylene; 3,3,4,4,5,5,5-heptafluoropentene-1.

An investigation was made of the γ-ray-induced copolymerization of tetrafluoroethylene and 3,3,4,4,5,5,5-heptafluoropentene-1. At 22 °C at 5000 and 10 000 atm the polymerization rate changes little between 0 and 75 mole-% tetrafluoroethylene. Above 90 mole-% the rate increases greatly. Molecular weights vary with composition in a fashion similar to the variation of the rates. Crystallization occurs in the bulk pentene at 13 500 atm at 24 °C. The polymerization rate is very low in the solid state. Under some conditions polymerization continues long after irradiation is ended. Both reactivity ratios favor the pentene. Several copolymer properties were studied. The polymers are amorphous and soluble in perfluoro ethers, perfluoro alkanes, and perfluoro-aromatics if they contain less than 80% tetrafluoroethylene. The glass temperatures of the amorphous polymers decrease and the thermal and radiation stability increases as the tetrafluoroethylene content increases.

11869. Bullis, W. M., Scace, R. I., **Measurement standards for integrated circuit processing,** *Proc. IEEE* **57,** No. 9, 1639-1646 (Sept. 1969).

Key words: ASTM standards; integrated circuits; microelectronics; semiconductor devices; semiconductor materials; semiconductor process control; silicon.

Both yield and quality of silicon monolithic integrated circuits depend on adequate control at all stages of their manufacture. Such control depends on measurement at each step, beginning with the selection of the substrate wafer, process chemicals, and parts, through the fabrication, assembly, and packaging of the finished circuit. The American Society for Testing and Materials Committee F-1 has developed standards for tests which have been widely used in the exchange of materials at various interfaces in the electron device industry. Many of these can be readily adapted for in-process control as well as for materials and parts acceptance tests. These standards and the process by which they were developed are reviewed; the importance of both industrial participation and the technical support activities of the National Bureau of Standards in this development is indicated. The need for additional standards is emphasized.

11870. Casella, R. C., **Possible failure of the Pomeranchuck theorem—shrinkage of the forward elastic peak,** *Phys. Rev. Letters* **24,** No. 25, 1463-1466 (June 22, 1970).

Key words: Asymptotics; cross section; diffraction shrinkage; high energy; Pomeranchuck theorem.

Assuming constant but unequal asymptotic total cross sections $\sigma_{\pm}(\infty)$ leads to a $(\ln s)^2$ shrinkage of the forward elastic peak. Moreover, under rather general assumptions, $d\sigma^{el}/dt$ exhibits an infinitude of oscillations in t as $s \rightarrow \infty$, a result derived earlier by Finkelstein within the Regge-cut model.

11871. Cezairliyan, A., McClure, J. L., Morse, M. S., Beckett, C. W., **Measurement of heat capacity of tantalum in the range 1900-3000 K by a pulse heating method,** Proc. 5th Symp. Thermophysical Properties, Newton, Massachusetts, September 30-October 2, 1960, C. F. Bonilla, ed., pp. 385-390 (American Society of Mechanical Engineers, New York, N.Y., 1970).

Key words: Heat capacity; high-speed measurements; high temperature; tantalum; thermodynamics.

A technique is described for the high-speed (millisecond resolution) measurement of heat capacity of electrical conductors at high temperatures (above 1900 K). Measurements on heat capacity of tantalum in the temperature range 1900 to 3000 K are reported and are compared with those in the literature. Duration of an individual experiment in which the specimen was heated from room temperature to near its melting point is less than one second. Temperature measurements were made with a high-speed photoelectric pyrometer. Experimental quantities (voltage, current, temperature) were recorded with a high-speed digital data acquisition system, which has a time resolution of 0.4 ms. Estimated inaccuracy of heat capacity measurements in the above temperature range is 2 to 3%.

11872. Champion, E. C., Marinenko, G., Taylor, J. K., Schmidt, W. E., **Determination of submicrogram amounts of chromium by coulometric titrimetry,** *Anal. Chem.* **42,** 11, 1210-1213 (Sept. 1970).

Key words: Chromium; coulometry; trace analysis.

An improved method has been developed for the determination of micro- and nanogram amounts of chromium by coulometric titrimetry. Samples containing 30 μg to 15 ng of chromium may be analyzed with an uncertainty limit of 1 ng. The method is bias-free within the uncertainty of the measurement due to random errors, and the end-point determination is the limiting factor for further improvements of the method.

11873. Clark, A. F., Childs, G. E., Wallace, G. H., **Electrical resistivity of some engineering alloys at low temperatures,** *Cryogenics* **10,** No. 4, 295-305 (Aug. 1970).

Key words: Aluminium alloys; copper alloys; cryogenics; electrical conductivity; iron alloys; nickel alloys; titanium alloys.

The electrical resistivities of several engineering alloys have been measured at 4, 20, 76, 192, and 273 K. Specimens of aluminium, nickel, copper, titanium, and iron alloys have been tested, some of them in different heat-treated conditions. Most of the alloys show a smooth decrease in resistivity with decreasing temperature, but some unusual results are reported. Comparisons are made between different alloys and between different heat treatments of the same alloys.

11874. Coxon, B., **The conformations of 1,2:4,6-Di-*O*-benzylidene-α-D-glucopyranose derivatives,** *Carbohydrate Res.* **14,** 9-15 (Oct. 1970).

Key words: Conformations; coupling constants; iterative analysis; *m*-dioxane ring; proton magnetic resonance; pyranoid ring; spectroscopy; 1,2:4,6-di-*O*-benzylidene-α-D-glucopyranoses.

The conformations of a series of 1,2:4,6-di-*O*-benzylidene-α-D-glucopyranose derivatives in solution have been studied by p.m.r. spectroscopy and double-resonance techniques at 100 MHz. The coupling constants obtained by first-order analysis of the spectra were compared with those computed by iterative analysis. It was concluded that these compounds adopt conformations in which the *m*-dioxane and pyranoid rings have chair and flattened-chair forms, respectively.

11875. Crissman, J. M., Passaglia, E., Eby, R. K., Colson, J. P.,

Crystal data on n-eicosane ($C_{20}H_{42}$), *J. Appl. Cryst.* **3,** 193-195 (1970).

Key words: Growth technique; n-eicosane; single crystal; unit cell.

A technique for growing relatively large crystals of n-eicosane ($C_{20}H_{42}$) is reported together with the unit cell parameters which are $a=4.28_2$ Å, $b=4.82_0$ Å, $c=25.5_2$ Å, $do^0_1=25.4_5$ Å, $\alpha=91\ °_{10'}$, $\beta=93\ °3_{2'}$, $\gamma=107\ °2_{0'}$. The density of the unit cell is 0.935_5 g/cm^3 at 24.5 °C and the macroscopic density is 0.93_6 g/cm^3 at 24.2 °C.

11876. Cruz, J. E., Jellison, J. C., **A digital technique for generating variable frequency multiphase waveforms,** *Rev. Sci. Instr.* **41,** No. 7, 1098-1099 (July 1970).

Key words: Digital; logic gating; quasi-sinusoid.

To drive a two or three phase synchronous motor over a wide frequency range has, until now, required complex electronic networks to keep the proper phase relationships.

In this paper a technique is described for driving a two phase synchronous motor over a frequency range of three decades. This method consists of using digital techniques for generation of the two driving waveforms, with constant phase between them, over the specified frequency range.

Discussion of the feasibility of automatic control of the speed of the motor and expansion of the digital logic to generate n-phase waveforms is presented.

11877. Currie, L. A., **Radioactivity monitors and accuracy in photonuclear experiments, (Summary),** *Trans. Am. Nucl. Soc.* **13,** No. 1, 59 (1970).

Key words: Photonuclear experiments; radioactivity monitors.

11878. Davis, D. D., Jespersen, J. L., Kamas, G., **The use of television signals for time and frequency dissemination,** *Proc. IEEE* **58,** No. 6, 931-933 (June 1970).

Key words: Frequency and time code; television; time.

Measurements indicate that a television microwave path is stable to a few microseconds over a period of months. The paths measured are those used by the three major U.S. television networks between Washington, D.C., and Denver, Colo. Path stabilities of ±5 ns (for half-hour periods) were measured by observing the phase of the television color subcarrier. A time dissemination system using the television signal format is described. Using locally broadcast VHF television signals, time information was recoverable with a resolution of several nanoseconds. This corresponds to a frequency stability of a few parts in 10^{12} for one hour averaging.

11879. Diller, D. E., Hanley, H. J. M., Roder, H. M., **The density and temperature dependence of the viscosity and thermal conductivity of dense simple fluids,** *Cryogenics* **10,** No. 4, 286-294 (Aug. 1970).

Key words: Density dependence; liquid state; simple fluids; temperature dependence; thermal conductivity; transport properties; viscosity.

This paper discusses the experimental information on the transport properties of dense simple fluids with emphasis on the compressed and saturated liquid states. Similarities and differences in the wide range density and temperature dependencies of the viscosity and thermal conductivity coefficients are summarized. The excess transport properties of argon, helium, hydrogen, oxygen, and carbon dioxide are graphically compared in the same reduced density and temperature ranges.

11880. Douglas, T. B., **New approach for evaluating lattice-configurational thermodynamic properties,** *J. Chem. Phys.* **51,** No. 7, 2831-2839 (Oct. 1, 1969).

Key words: Configurational thermodynamic properties; excluded volume; extrapolations; lattice models; noncombinatorial method; statistical equilibrium.

As a generalization of earlier work of the author [J. Chem. Phys. **40,** 2248 (1964); **45,** 1080 (1966)] a completely noncombinatorial method is derived which gives for any state the exact thermodynamic properties of a system of particles on a lattice infinite in one dimension. The method appears to be essentially equivalent to, but somewhat simpler in development and application than, the matrix method used for the same problems recently. Interaction of unit configurations is explicitly considered only at lattice boundaries, leading directly to a set of independent algebraic equations giving the complete solution for a specified state. Two simple examples are given to which alternative combinatorial procedures can be readily applied without approximations, yielding identical explicit results. The general method first given is modified for the imposition of artificial density constraints, and as an illustration it is shown how this variation improves markedly, over the range of disordered densities, the convergence to an infinite plane of the hard-core square-lattice fluid with nearest-neighbor exclusion.

11881. Engen, G. F., **A new method of characterizing amplifier noise performance (Summary),** (Proc. Conf. Precision Electromagnetic Measurements, National Bureau of Standards, Boulder, Colo., June 2-5, 1970) *CPEM Digest,* pp. 20-21 (1970).

Key words: Amplifier noise; noise; noise measurement.

Although the use of a noise figure or noise temperature to characterize amplifier performance is a well-established practice, it is also recognized that this parameter provides only a partial description of the amplifier noise properties. In general, the noise figure (or temperature) depends upon the generator impedance and is thus a function of the signal source and amplifier combination.

Typically, the noise figure is measured by the Y-factor method using hot and cold noise sources which are nominally matched (reflectionless). The result of this measurement is of value as a figure of merit; however, if optimum performance is to be realized, the applications engineer must know whether to adjust the signal source impedance for maximum power transfer, minimum noise figure, or according to some other criteria, and the deterioration in performance which results if this is not done. It is the purpose of this paper to present an alternative method of characterizing amplifier noise performance in terms of parameters which provide ready answers to these questions. In addition, the measurement of these parameters via a simple extension of the Y-factor method will be described.

11882. Farrar, T. C., **Pulsed and Fourier transform NMR spectroscopy,** *Anal. Chem.* **42,** No. 4, 109A-112A (Apr. 1970).

Key words: Fourier transform; nuclear magnetic; pulsed resonance.

Certain advantages in pulsed nmr spectroscopy, especially increased sensitivity, make it an attractive technique. With the solution of many of the problems in the spectrometers and associated computer instrumentation, it is safe to predict it will rival continuous wave-nmr spectroscopy in usage.

11883. Frederick, N. V., Scott, W. W., Jr., **A simple technique for metalizing boron nitride,** *Rev. Sci. Instr.* **40,** No. 9, 1240 (Sept. 1969).

Key words: Boron nitride; ceramic; metallizing; ultrasonic; vacuum.

Boron nitride is a relatively new material, first developed about ten years ago. It is a refractory ceramic of noteworthy physical and dielectric properties. Successful metallization of boron nitride results in a product which should be very useful in the electronics industry.

A process is described for preparing the boron nitride surface which ultimately results in a strongly attached gold film surface which easily passes the accepted "scotch tape" test.

11884. Freeman, D. H., Zielinski, W. L., Jr., Rittner, W. F., **Recognition of crosslinking in the infrared spectra of poly(styrene-divinylbenzene),** *Proc. Ion Exchange in the Process Industries Conf., Imperial College of Science and Technology, London, England,* pp. 27-30 (1970).

Key words: Copolymers; crosslinking; divinylbenzene; infrared; styrene.

Infrared spectra of polystyrene, poly(styrene/0.16 [mole fraction] *p*-DVB), poly(styrene/0.16 *m*-DVB) and poly(styrene/0.16 [nominal mole fraction] technical DVB) are given and discussed. Bands near 830 cm^{-1} for *p*-DVB and technical DVB copolymers, and near 797 cm^{-1} for the *m*-DVB and technical DVB copolymers are assigned to the *p*- and *m*-DVB crosslinkages.

11885. Gebbie, H. A., Kuhn, P., Bohlander, R. A., **Scattering by high cirrus: Its effect on submillimeter wave determinations of atmospheric water vapor,** *Nature Letter to Editor* **226,** No. 5242, 71-72 (Apr. 4, 1970).

Key words: Fourier spectroscopy; high cirrus; submillimeter waves; water vapor.

Submillimeter waves and, by implication in this context, the use of the pure rotation band, offer important advantages for determining the distribution of water vapor with height in the atmosphere. The reasons are these. (1) We can readily resolve single rotation lines in this region by Fourier spectroscopy using interferometers. The calibration for intensity of single lines is easily made and a range of lines with different absorption strengths can then be chosen to match the requirements of the inversion procedure used to construct the model radiating atmosphere. (2) The use of long wavelengths allows us to dispense with hot radiation sources and use, for example, the radiation exchange between a room temperature detector and cold sky.

11886. Gibson, B. F., O'Connell, J. S., **Angular distribution of the reaction ^{1}H(d, ^{3}He)γ,** *Physics Letters* **32B,** No. 5, 331-332 (Aug. 3, 1970).

Key words: Angular distribution; cross section; helium-3; photonuclear; radiative capture.

The angular distribution of the proton-deuteron radiative capture cross section is calculated using the plane wave form of the electromagnetic interaction operator and model wave functions for the ^{3}He S, S′ and D-states and a plane wave continuum state.

11887. Haar, L., Shenker, S. H., **A phenomenological equation of state,** *Proc. 5th Symp. Thermophysical Properties, Boston, Mass., September 30-October 2, 1970,* C. F. Bonilla, ed., pp. 223-226 (American Society of Mechanical Engineers, New York, N.Y. 1970).

Key words: Compressibility factors; equation of state; high density; high temperature; pairwise potentials; Redlich Kwong; second virial coefficient; thermodynamics.

A simple phenomenological equation of state for high temperature gases is proposed. It is developed in terms of a gas interacting as hard spheres with a superimposed Lennard-Jones attractive well. There are no arbitrary parameters as the equation is fixed by the values of the second virial coefficient and its temperature derivative. The equation has been appplied to two simple gases, nitrogen and argon. The results agree at least semiquantitatively with experimental data up to 10,000 bar and in the range of temperatures greater than twice the critical. Also included for comparison is the widely used Redlich Kwong equation. The present work compares favorably with the Redlich Kwong at the lowest temperature; however, as temperature is increased the present work becomes increasingly more accurate, whereas the corresponding states equation tends to degrade with temperature.

11888. Halford, D., **Frequency stability of quality quartz crystal oscillators: Performance and some critical applications,** *Proc. Intern. Colloq. Chronometrie, Paris, France, September 16-20, 1969*, **Serie A,** pp. A-11-1-A-11-3 (Sept. 1969).

Key words: Atomic frequency standards; cesium beam; flicker noise; frequency stability; frequency standards; hydrogen maser; long baseline interferometry; quartz crystal oscillators; time standards.

For time intervals, tau, of one second or less, the short-term fractional frequency stability of high quality quartz crystal oscillators is superior to all other known frequency sources. For time intervals in the range of 1 to 10 seconds, these quartz crystal oscillators are at least as good as all other devices, such as hydrogen maser oscillators and rubidium gas cell frequency standards. For time intervals in the range from 10 to 1000 seconds, only hydrogen maser oscillators and the best cesium beam frequency standards are capable of frequency stabilities which exceed those of the best quartz crystal oscillators.

The stability of good quartz crystal oscillators has been found to be at least as good as 2 parts in 10^{13} for time intervals, tau, in the vicinity of 10 seconds, and is not much different for tau equal to 100 seconds.

This superb stability of quartz crystal oscillators, together with their other desirable features, indicates their use in several critical applications. These include long baseline interferometry, stable frequency reference for the cavity tuning servo in the hydrogen maser frequency standard, and stable frequency reference for evaluating the accuracy capability of cesium beam frequency standards, as well as the slaved oscillator in even the finest atomic frequency standards.

At the Colloque, I will discuss the measured frequency stability of commercially available quartz crystal oscillators, and some of their critical applications (accomplished and proposed). I will also mention some possibilities of achieving fractional frequency stabilities in the few parts in 10^{14} range with quartz crystal oscillators in the future. The nature of the flicker of frequency noise of quartz crystal oscillators will be discussed.

11889. Hardy, S. C., Coriell, S. R., **Morphological stability of ice cylinders in aqueous solution,** *J. Crystal Growth* **7,** No. 2, 147-154 (Sept.-Oct. 1970).

Key words: Aqueous solutions; cylinder; ice; solute; stability; surface tension.

Cylindrical ice crystals oriented with the axis normal to the basal plane have been grown into slightly undercooled 0.1 molar HCl solution. The crystals develop approximately sinusoidal perturbations along the axis. The growth rates of these perturbations are in quantitative agreement with the predictions of a Mullins-Sekerka analysis of a cylinder growing into a binary melt. The ice-solution surface tension calculated from the perturbation growth rate is 23 mJ/m^2, essentially the same value found with distilled water. A number of other ionic solutes were studied at concentrations below 10^{-3} molar. Most solutes appear to have little effect on morphology or surface tension. However, ammonium compounds other than NH_4F and NH_4OH produce extreme changes in crystal morphology.

11890. Hayward, E., Schwartz, R. B., Murray, K. M., **Comments**

on isospin of the B^{11} giant resonance, *Phys. Rev.* **2,** No. 2, 761-762 (Aug. 1970).

Key words: Boron eleven; giant resonance; isobaric spin splitting; photonuclear.

It was recently shown that in the photodisintegration of B^{11} certain expected γ rays were missing. A partial explanation is offered here for the failure to observe these transitions. It is also pointed out that no conclusions about the strength of the $T=3/2$ giant resonance can be drawn from this experiment.

11891. Hellwig, H., **The hydrogen storage beam tube, a proposal for a new frequency standard,** *Metrologia* **6,** No. 2, 56-60 (Apr. 1970).

Key words: Atomic beam tube; cavity pulling; frequency stability; frequency standard; hydrogen maser.

The basic design features and the frequency stability and accuracy capabilities of a proposed new frequency standard are projected. The hydrogen storage beam tube combines the virtues of the hydrogen maser with those of beam tubes eliminating most of the problems associated with these devices. The projected frequency stability for one second averaging is better than 10^{-14}. The long term stability should be equally good. Ways for investigating the wall shift are discussed.

11892. Hellwig, H., Allan, D. W., Glaze, D. J., Vessot, R. F. C., Levin, M., Zitzewitz, P. W., Peters, H. E., **Measurement of the unperturbed hydrogen hyperfine transition frequency (Summary),** (Proc. Conf. Precision Electromagnetic Measurements, National Bureau of Standards, Boulder, Colo., June 2-5, 1970), *CPEM Digest,* pp. 72-73 (1970).

Key words: Frequency accuracy;hydrogen maser; wall shift.

We report the results of a joint experiment which was aimed at the determination of the frequency of the H^1 hyperfine transition $(F=1, m_F=0) \leftrightarrow (F=0, m_F=0)$. In terms of the frequency of the Cs^{133} hyperfine transition $(F=4, m_F=0) \leftrightarrow (F=3, m_F=0)$, defined as 9192 631 770 hertz, we obtain for the unperturbed hydrogen transition frequency the value

$$\nu_H = 1420\,405\,751.769 \text{ Hz}.$$

This result is the mean of two independent evaluations which differ by only 2×10^{-3} Hz. One evaluation is based on the wall shift experiments at Harvard University, the other is a result of a new measurement using many storage bulbs of different sizes at the National Bureau of Standards. We will describe the experimental procedures and the appplied corrections. We will compare our results with previously published values and discuss the error limits of our experiments.

11893. Hoer, C., Agy, D., **A broadhurst resistive coupler (Summary)** (Proc. Conf. Precision Electromagnetic Measurements, National Bureau of Standards, Boulder, Colo., June 2-5, 1970), *CPEM Digest,* pp. 18-19 (1970).

Key words: Coupler; directional coupler; directivity; impedance measurements; power measurements.

A new lumped circuit directional coupler is described for the 1 to 30 MHz frequency range. Directivity greater than 50 dB is achieved over this frequency range for coupling ratios of 30, 40, and 50 dB. Greater directivity can be achieved over a narrower frequency range, and the coupler can be tuned for essentially infinite directivity at a fixed frequency. The couplers, although resistive, can pass 100, 300, or 1000 Watts for the coupling ratios of 30, 40, and 50 dB respectively with less than 0.01 dB change in coupling ratio. The coupling ratios are constant with frequency to ±.25 dB.

11894. Homan, D. N., Zapf, T. L., **Two-stage guarded inductive voltage division for use at 100 kHz,** *Proc. 1969 Instrument Society of America Conf., Houston, Texas, October 27-30, 1969,* pp. 69-614 (1969); *ISA Trans.* **9,** No. 3, 201-209 (1970).

Key words: Divider; inductive voltage divider; ratio; voltage divider; voltage ratio.

A single decade inductive voltage divider with output tap corrections less than 5×10^{-7} of input voltage at a frequency of 100 kHz is described and evaluated both experimentally and theoretically. The divider is a two-stage device which is also guarded section by section. These two techniques greatly reduce errors caused by unequal leakage inductance and interwinding capacitances, which otherwise cause significant errors at 100 kHz. Design and construction details are presented for the dividers and for the bridge circuit used to make the measurements of the output tap corrections to the divider.

11895. Hunt, C. M., Woolf, A. R., **Comparison of some different methods for measuring particle size using microscopically calibrated glass beads,** *Powder Technol.* **3,** 9-23 (1969).

Key words: Air elutriation; air permeability; Andreasen pipette; calibrated glass beads; Coulter counter; electroformed sieves; microscopic size measurement; particle size measurement.

Measurements of particle size distribution by the microscope and by a number of other methods were compared using samples of glass beads from a single blended batch as the reference material. The other methods included a Coulter counter, electroformed sieves, the Andreasen pipette, and the Roller analyzer. Surface average particle size calculated from microscopic and Lea-Nurse air-permeability measurements were also compared. As an independent check of diameter measurements with the microscope, comparisons were made with an interferometer, using fibers drawn from a melt of the same glass. These comparisons afforded an opportunity to assess some of the sources of error in each of the methods.

Differences between the averages of results obtained with the microscope and those obtained with the Coulter counter, the Lea-Nurse apparatus, the Andreasen pipette as well as the interferometer were comparable in magnitude with the normal statistical variations inherent in the methods themselves. However, small systematic biases were observed. Agreement between results by the microscope and the Roller analyzer was satisfactory, although the latter is subject to greater uncertainties than the other methods investigated. Disagreements were obtained with fine electroformed sieves, which passed more material than predicted from the size distribution by the microscope.

11896. Jennings, D. A., West, E. D., **A laser power meter for large beams,** *Rev. Sci. Instr.* **41,** No. 1, 565-567 (Apr. 1970).

Key words: Calorimetry; laser; laser calorimetry; laser power.

A power meter is described in detail for large or divergent laser beams, either cw or repetitively pulsed. The meter measures the flow of heat generated by the beam and is calibrated with an electrical heater wound just behind the absorbing surface. The meter is capable of power measurements of 1 to 30 W accurate to ±2.5%.

11897. Johannesen, R. B., Ferretti, J. A., Harris, R. K., **UEAITR: A new computer program for analysis of NMR spectra analysis of the proton spectrum of triisopropylphosphine,** *J. Magnetic Resonance* **3,** No. 1, 84-93 (July 1970).

Key words: Computer program; isopropyl; NMR; nuclear magnetic resonance; phosphorus; spectral analysis.

A new computer program for the analysis of NMR spectra is reported. It adds iterative evaluation of input parameters to an earlier program (UEANMR II) which makes use of magnetic equivalence factoring to reduce the size of certain matrices. The present program, by iterating on line frequencies rather than energy levels, and by using magnetic equivalence factoring, offers advantages of speed and convenience over previously described computer programs for NMR analysis. The analysis of the proton spectrum of triisopropylphosphine is described as an example and the trend of $^2J_{H\text{-}P}$ with increased alkyl substitution is found to be opposite to that of the trend of $^2J_{H\text{-}X}$ for all other hetero-atoms, X, reported in the literature.

11898. Kidnay, A. J., Hiza, M. J., **Physical adsorption in cryogenic engineering,** *Cryogenics* **10,** No. 4, 271-277 (Aug. 1970).

> Key words: Adsorbent-reaction; adsorption; heat transfer; isotherm; kinetics; mass transfer.

This article is a selective review of the literature on physical adsorption that is pertinent to cryogenic engineering. Included are tabulations of references to experimental adsorption isotherms on high surface area adsorbents, both for pure materials and mixtures, and brief discussions of the more important techniques for correlating and predicting adsorption isotherms. Adsorption kinetics, heat and mass transfer in packed beds, and adsorbent bed reactivation techniques are also discussed.

11899. Krauss, M., Mies, F. H., **Molecular-orbital calculation of the shape resonance in N_2^-,** *Phys. Rev. A* **1,** No. 6, 1592-1598 (June 1970).

> Key words: Electron scatter; energy curve; local potential; N_2; resonance width; shape resonance; spectroscopic constant; valence orbital.

The 2-eV shape resonance in N_2-electron scattering is calculated by a self-consistent-field energy-variational procedure. The resonance state corresponds to the attachment of an incident *d*-wave electron to the $1\pi_g$ valence orbital of the metastable $^2\Pi_g$ state of N_2^-. The resonant behavior is due to the tunnelling of the electron through a $2(2+1)/r^2$ centrifugal barrier and temporary trapping in an attractive field. This tunnelling is reflected in the bimodal behavior of the calculated $1\pi_g$ orbitals; the inner portion of the orbital defines the resonance state. The "potential" curve for N_2^- is calculated in the Hartree-Fock approximation; a resonance threshold of 2.5 eV is predicted, with $R_e = 2.27$ a.u. and $\omega_e \approx 2000$ cm^{-1}. Expected correlation-energy corrections would improve the agreement with experiment. A local potential for electron scattering is generated by inverting the $1\pi_g$ orbital, and resonance widths are calculated. The widths vary from 0.13 eV at the equilibrium distance of N_2^- to 0.8 eV at the N_2 equilibrium distance.

11900. Lance, H. W., **Report on metrology sessions at the 24th annual ISA conference,** *Appl. Opt.* **9,** No. 6, 1497-1498 (June 1970).

> Key words: Education for metrology; measurements; measurement techniques; metrology.

This report is primarily about the ISA sessions on "Education for Metrology." These sessions described (1) metrology training programs in the military establishment and in industry—at least some of which are necessary because the nation's educational institutions largely neglect the subject of metrology—and (2) metrology courses being given or planned by a few universities. The latter verified the need for better measurement training, pointed the way toward revitalized courses, and hinted that the universities may be beginning to give more attention to this subject. The report also mentions selected papers from other sessions and summarizes briefly a Conference on Measurement Education held in England in July 1969.

11901. Lesclaux, R., Searles, S., Sieck, L. W., Ausloos, P., **Irradiation of cyclohexene with 8.4, 10.0 and 11.6-11.8 eV photons. Dissociation of neutral excited cyclohexene and reactions of $C_6H_{10}^+$,** *J. Chem. Phys.* **53,** No. 8, 3336-43 (Oct. 15, 1970).

> Key words: Cyclohexene; ion-molecule reactions; photoionization; photolysis; unimolecular-dissociation.

The photolysis of cyclohexene has been investigated at photon energies above (10.0 eV, 11.6-11.8 eV) and below (8.4 eV) its ionization potential (8.9 eV). The ionic processes were studied in a mass spectrometer equipped with a photon source. The parent $C_6H_{10}^+$ ion was seen to undergo the following reactions with cyclohexene:

$$C_6H_{10}^+ + \text{cyclo-}C_6H_{10} \rightarrow \text{cyclo-}C_6H_{12} + C_6H_8^+ \; k = 0.7 \times 10^{-10} \text{ cm}^3\text{/molecule-sec}$$

$$\rightarrow C_{12}H_{20}^+ \; k = 4.1 \times 10^{-10} \text{ cm}^3\text{/molecule-sec.}$$

Analysis of the yields of cyclohexane formed in the first of these reactions in the photolysis at 10.0 eV over the pressure range from 1 to 10 torr indicates that the relative importance of the two reactions is the same in this pressure range as in the ion source of the mass spectrometer at a pressure of 10^{-2} torr. At 11.6-11.8 eV, the parent ion also dissociates, mainly to form $C_5H_7^+$ and CH_3. Evidence is presented which indicates that at these energies, the majority of the $C_6H_{10}^+$ ions retain a cyclic structure. The neutral, electronically excited cyclohexene molecule dissociates mainly as follows:

$$C_6H_{10}^* \rightarrow 1,3\text{-}C_4H_6 + C_2H_4, \text{ at } 8.4 \text{ eV}, \Phi = 0.82$$

$$\rightarrow C_5H_7 + CH_3, \text{ at } 8.4 \text{ eV}, \Phi = 0.08$$

The photolysis of 3,3,6,6-d_4-cyclohexene demonstrated that the first of these processes occurs predominantly by the "symmetrical" cleavage of the 3-4 and 5-6 C—C bonds, at all energies.

11902. Levin, E. M., **Liquid immiscibility in oxide systems,** Chapter in *Phase Diagrams Materials Science and Technology,* **Volume 3.** *The Use of Phase Diagrams in Ceramics, Glass and Metal Technology,* pp. 143-236, (Academic Press Inc., New York, N.Y., 1970).

> Key words: Glass chromatography; immiscibility and courses of crystallization; immiscibility and practical applications; immiscibility and thermodynamics; immiscibility in oxides; liquid immiscibility; $Ln_2O_3-B_2O_3$ phase diagrams; mechanism of phase separation; metastable liquid immiscibility; microphase separation; phase diagrams of metastable immiscibility; spinodal; structural interpretation of immiscibility; super-duty silica brick.

Stable and metastable liquid immiscibility in oxide systems is discussed from the standpoint of thermodynamics, interpretation, and application. The classic Gibbs free energy of formation-composition diagrams are used to illustrate the difference between a stable and a metastable immiscibility gap and to define the spinodal. Phase equilibrium principles are applied to liquid immiscibility and typical courses of crystallization are described. Structural interpretation is applied to the occurrence and extent of immiscibility including the temperature of the monotectic and the effect of homogenizers. The general incompatibility of compound formation and liquid immiscibility is demonstrated for the rare earth oxide-boric oxide systems. Occurrence and methods of study of microphase separation are elucidated. Three mechanisms of microphase separation are discussed briefly: nucleation and growth, spinodal decomposition, and intersecting growth theory. Binary and ternary phase diagrams showing liquid immiscibility are presented. Application to the following commercial products are discussed: super-duty silica brick, Vycor glass, Pyrex glass, glass ceramics, and glass chromatography.

11903. Levin, E. M., Roth, R. S., **The system niobium pentoxide-phosphorus pentoxide,** *J. Solid State Chem.* 2, No. 2, 250-261 (1970).

Key words: $Nb_2O_5-P_2O_5$; $NbPO_5$; $Nb_2P_4O_{15}$; Nb_9PO_{25}; $Nb_{44}P_2O_{115}$; $P_2O_5-Nb_2O_5$; phase diagram; ReO_3-type compounds.

A partial phase diagram of the system $Nb_2O_5-P_2O_5$ has been determined experimentally, using the quenching technique and identifying the phases by x-ray powder diffractometry. The major phase, $NbPO_5$, has a melting point above 1650 °C. It transforms at about 1253 °C from a low-temperature, tetragonal phase to a high-temperature, monoclinic phase, isostructural with $TaPO_5$. The $9Nb_2O_5 \cdot P_2O_5$ phase shows a limited solid solution range and melts incongruently at 1435 °C. The eutectic between 9:1 and $NbPO_5$ is at 1365 °C and 67 mole % Nb_2O_5. At 96.4 mole % Nb_2O_5 another phase was found, stable between $\sim$ 1340 and 1420 °C and isostructural with the 9:1 phase. A new monoclinic phase, "22:1" *ss* was found, with a limited stability field in both temperature and composition. It is most likely composed of 3×3 and 3×4 ReO_6-type blocks of octahedrally oxygen-coordinated niobium. In the subsystem $NbPO_5-P_2O_5$ liquidus values could not be determined even in sealed Pt tubes because of reactivity and high vapor pressure of P_2O_5. One compound was identified of probable composition $Nb_2O_5 \cdot 2P_2O_5$, with pseudocubic symmetry and melting incongruently at about 1025 °C. X-ray powder diffraction data and unit cell dimensions are listed for the phases.

11904. Lias, S. G., Collin, G. J., Rebbert, R. E., Ausloos, P., **Photolysis of ethane at 11.6-11.8 eV,** *J. Chem. Phys.* 52, No. 4, 1841-1851 (Feb. 15, 1970).

Key words: Ethane; free radicals; ions; photolysis; primary processes; vacuum ultraviolet.

The photolysis of ethane, carried out with an argon resonance lamp, has been reinvestigated with the related purposes of (1) measuring quantum yields of all fragments formed in the dissociation of excited ethane, and (2) associating these fragments with the primary processes occurring in the photolysis of ethane. These, and their relative abundances are:

$$C_2H_6^* \rightarrow C_2H_6^+, 5\%$$

$$\rightarrow CH_4 + CH_2, 16\%$$

$$\rightarrow C_2H_5 + H, 41\%$$

$$\rightarrow C_2H_4 + H_2, 23\%$$

$$\rightarrow CH_3 + CH_3, 15\%$$

These results are compared with conclusions reached in earlier studies on the photolysis of ethane with xenon and krypton lamps in order to determine the effect of energy on the relative probabilities of the primary processes. It is found that direct bond scission increases in importance with increasing energy, while processes involving rearrangement decrease in importance.

The radical and molecular fragments formed in the dissociation of excited ethane were determined by (a) analyzing the products formed in $C_2H_6-C_2D_6-NO$ (1:1:0.1) mixtures and (b) C_2D_6 in the presence of H_2S, which scavenges free radicals to form isotopically-unique hydrocarbon products; and (c) C_2H_6 in the presence of C_3D_6, which scavenges H-atoms to form propyl radicals which in turn, react with radicals in the system to form characteristic products. Such experiments, as well as quantum yield determinations, were also carried out at tne krypton and xenon lines.

11905. Lias, S. G., Rebbert, R. E., Ausloos, P., **Irradiation of xenon-propane and argon-propane mixtures with gamma rays and 21.2 eV photons,** *J. Chem. Phys.* 52, No. 2, 773-783 (Jan. 15, 1970).

Key words: Deactivation; ion-molecule reactions; photoionization; radiolysis; unimolecular ion fragmentation.

Mixtures of xenon or argon with propane (20:1) are irradiated in the presence of radical scavengers by γ-rays and by 21.2 eV photons from a helium resonance lamp. The ion-pair yields of products originating in ionic fragmentation reactions or ion-molecule reactions are derived from isotopic analyses of product molecules formed with $C_3D_8-C_3H_8$ mixtures or with $CD_3CH_2CD_3$. At a given pressure, only minor differences are seen between the radiolysis and photolysis in the modes of dissociation of parent propane ions formed by charge transfer with a particular rare gas. Higher energy ionic fragmentation processes are seen to be quenched with increasing pressure; in the case of xenon-propane mixtures, it is demonstrated that the parent ion yield increases as primary fragmentation processes are quenched. In the irradiated argon-propane-scavenger mixtures, isotope effects in the ionic fragmentation mechanism are seen which indicate that collisional deactivation of the excited deuterated fragment ions is more efficient than that of the corresponding protonated ions. In the photolytic experiments, it was deduced that the decomposition of neutral excited propane molecules constitutes about 10% of the product forming processes in the xenon mixtures, while in the radiolytic experiments, the maximum contribution of neutral excited molecule decomposition is 5%. Similar deductions for the argon mixtures were not feasible.

11906. Mandel, J., Paule, R. C., **Interlaboratory evaluation of a material with unequal numbers of replicates,** *Anal. Chem.* **42,** No. 11, 1194-1197 (Sept. 1970).

Key words: Analysis of variance; average (weighted); interlaboratory evaluation; round robin; single classification; statistics; variance components; weighting.

Frequently, a "best value" has to be estimated on the basis of measurements from different sources, such as different laboratories. When the number of replicate measurements varies from source to source, a problem of proper weighting arises. The usual formulas cover only one or the other of two extreme situations: equal weighting of individual measurements, or equal weighting of source averages. The problem is described in detail, including the interpretation of the analysis of variance, and an iterative procedure is presented for obtaining a properly weighted average. Formulas are also given for the estimation of the uncertainty of the weighted average. An illustrative example is presented.

11907. Martin, W. C., Kaufman, V., **$4p^2$ configuration in neutral zinc (Zn I),** *J. Opt. Soc. Am.* **60,** No. 8, 1096-1099 (Aug. 1970).

Key words: Atomic spectra; emission spectroscopy; wavelengths; zinc.

The Zn I $4s4p\ {}^3P^\circ - p^2\ {}^3P$ multiplet (2070–2105 Å) was remeasured on spectrograms from 10.7-m grating spectrographs. The new wavelengths are used to determine improved values for the $4p^2\ {}^3P$ levels. Predicted positions and percentage compositions for the unknown $4p^2\ {}^1D_2$ and ${}^1S_0$ levels are calculated in a pure-configuration approximation. These results are combined with our measurement of the autoionization width for the ${}^3P_2$ level, to obtain a predicted autoionization probability of 1.3×10^{15} s^{-1} for the ${}^1D_2$ level. The autoionization probability for the ${}^1S_0$ level is similarly estimated to be $< 3 \times 10^{13}$ s^{-1}. Wavelengths are given for five new Zn I transitions (2040-2053 Å) from unknown autoionizing levels, probably belonging to the $4p4d$ configuration.

11908. Mazur, J., **Non-self-intersecting random walks in lattices with nearest-neighbor interactions,** Chapter in *Stochastic Processes in Chemical Physics,* pp. 261-280 (John Wiley & Sons Inc., New York, N.Y., 1969).

Key words: Chain partition function; Monte-Carlo computations; near-neighbor interactions; phase transition; stochastic matrix; theta point.

A polymer chain is simulated as a self-avoiding walk on a lattice with forces of attraction between nonbonded chain elements which are mutually separated by a distance equal to a spacing between nearest lattice sites. The chain partition function and the related thermodynamic functions are investigated. Two different approaches are discussed: (1) Monte-Carlo investigations, based on random samples of self-avoiding walks, and (2) stochastic matrix method. Monte-Carlo investigations point to the possibility of configurational transitions in the chain and to the existence of the ideal, a theta, point. At the theta point, the dependence of the chain partition function on the number of chain elements is the same as if the chain were simulated by an equivalent Markovian chain model. The stochastic matrix method is formulated with the idea to verify and explain these Monte-Carlo results by investigation of the distribution of eigenvalues and eigenvectors of certain transition matrices, and their dependence on the near-neighbor forces of attraction. In this method, the chain is treated as a Markovian, multidimensional chain of dependent events. Some preliminary results of the investigation of chain partition function by the stochastic matrix method are presented.

11909. Meijer, P. H. E., **The importance of dipole-dipole interactions in ultralow temperature physics,** (Proc. 1970 Ultralow Temperature Symp. sponsored by Office of Naval Research and Naval Research Laboratory, April 23-24, 1970), R. A. Hein, D. U. Gubser, E. H. Takken, eds., *NRL Report 7133,* pp. 123-128 (Apr. 1970).

Key words: Cerous magnesium nitrate; cesium titanium alum; dipole-dipole interaction; neodymium ethyl sulphate; shape dependent; specific heat.

Preliminary results are given for the entropy corrections for cerous magnesium nitrate, cesium titanium alum, and neodymium ethyl sulphate. The entropy corrections were computed for the dipole interaction using the known g-factors and lattice constants. Also explains why the zero field specific heat is shape independent.

11910. Meinke, W. W., **Analytical chemistry—a fading discipline? No!,** *Anal. Chem.* **42,** 26A-38A (June 1970).

Key words: Analysis; analytical chemistry; analytical chemistry as a discipline; analytical chemistry as a profession.

Early in this century university curricula were built around detailed analytical courses, and the major chemical contributions of a national laboratory such as NBS were primarily analytical. The 20's brought a blossoming of organic chemistry, the 30's saw physical chemistry come into its own, the 40's saw a renewed emphasis put on inorganic chemistry, while in the 50's borderline fields such as biochemistry, nuclear chemistry, and geochemistry developed their followings. Despite this explosive growth of diverse chemical disciplines, the spirit of analytical chemistry is today much more pervasive than at any time in the past 50 years. The analytical chemist must determine over a wide range of concentrations not only what and how much is present, but in what valence form, how it is bound, and where it is located spatially. Procedures must be rapid and easily automated, nondestructive if possible, and must give accurate and precise results. This demand for improved analytical measurement comes from fields as diverse as semiconductors and structural steel, air pollution and oceanography, clinical chemistry and lunar analysis.

11911. Melmed, A. J., Carroll, J. J., **Some initial observations of TiNi in the field-ion microscope,** *Appl. Phys. Letters* **17,** No. 6, 247-249 (Sept. 15, 1970).

Key words: Field-ion microscope; hydrogen; ion; liquid nitrogen temperature.

It is demonstrated that TiNi specimens can be successfully imaged with the field-ion microscope using liquid-nitrogen cooling, with hydrogen as the imaging gas. The material examined is shown to be structurally inhomogeneous, with relatively well-ordered regions in a less-ordered matrix. It is also shown that alternate atomic planes are different within some ordered regions.

11912. Meshkov, S., **Comments on baryon spectroscopy,** *Proc. Hyperon Resonances Conf., Duke University, Durham, N.C.,* pp. 471-500 (Apr. 24-25, 1970).

Key words: Baryons; configuration mixing; hyperons; resonances; rotations; $SU(6) \times 0(3)$.

A summary of the Hyperon Resonances Conference, together with various observations on the state of baryon spectroscopy is given.

11913. Nargolwalla, S. S., Niewodniczanski, J., Suddueth, J. E., **Experimental sensitivities for 3-MeV neutron activation analysis,** *J. Radioanal. Chem.* **5,** 403-423 (1970).

Key words: Absolute flux; Cockcroft-Walton neutron generator; sample attenuation corrections; sensitivity and gamma-ray spectra of the elements; 3-MeV neutron activation analysis.

The experimental sensitivity for 72 different elements using 3 MeV neutron activation has been investigated. Using a 200 kV Cockcroft-Walton neutron generator with a 3 MeV neutron flux of about $1.5 \cdot 10^6 n \cdot cm^{-2} \cdot sec^{-1}$, γ-ray spectra of 51 elements were obtained with a sufficient number of photopeak counts for sensitivity calculations using a photopeak integration method. A useful table summarizing the sensitivity results is given. That 3 MeV neutron activation analysis is practical, is demonstrated by the experimental sensitivities obtained.

11914. Nargolwalla, S. S., Suddueth, J. E., Rook, H. L., **Determination of pulse pileup and nuclear interferences in 14-MeV neutron activation analysis for trace oxygen, (Summary),** *Trans. Am. Nucl. Soc.* **13,** No. 1, 78-79 (1970).

Key words: Activation analysis; nuclear interferences; trace oxygen.

11915. Newton, C. J., Ruff, A. W., Jr., **X-ray study of annealing in plastically deformed Ag-Sn (silver-tin) alloys,** *Met. Trans.* **1,** No. 10, 2833-2838 (Oct. 1970).

Key words: Silver; silver-tin alloys; stacking fault probability; x-ray diffraction data.

The stacking fault probability, root-mean-square strain, and effective domain size are determined for pure silver and three Ag-Sn alloys using x-ray diffraction data. Both isochronal and isothermal annealing experiments were conducted to determine the nature of the recovery of plastic deformation in the filed powder specimens. An abrupt recovery of the above quantities was observed during isochronal annealing at temperatures that increased with solute concentration. Three recovery stages were observed in Ag-9 at. % Sn annealed at 165 °C for varying times. The principal stage is probably associated with recrystallization since both the stacking fault probability and rms strain recover together. An activation energy of 25 kcal per mol is determined for this stage.

11916. O'Connell, J. S., **Electron scattering sum rule for ^{2}H, ^{3}H, ^{3}He and ^{4}He,** *Physics Letters* **32B,** No. 5, 323-325 (Aug. 3, 1970).

Key words: Correlation; electron scattering; form factor; helium; hydrogen; sum rule.

A sum rule is derived for the spatially symmetric part of the 1s shell nuclei. The result depends on the mean square nucleon momentum in the ground state, the nucleon pair correlation form factor and, for the helium isotopes, a momentum pair correlation form factor.

11917. Otoshi, T. Y., Stelzried, C. T., Yates, B. C., Beatty, R. W., **Comparisons of waveguide losses calibrated by the dc potentiometer, ac ratio transformer, and reflectometer techniques,** *IEEE Trans. Microwave Theory Tech.* **MTT-18,** No. 7, 406-409 (July 1970).

Key words: Comparison of results; dc potentiometer test set; dual channel system; modulated subcarrier; ratio transformer test set; small attenuation measurement; small insertion loss measurement; small reflection coefficient measurements; stainless steel waveguide.

Comparisons are made of the losses of two precision waveguide sections that were calibrated by three independent attenuation measurement methods. The loss measurement systems involved were the (1) dual-channel system which uses thermistors and a dc potentiometer test set, (2) dual-channel system which uses barretters and an ac ratio transformer test set, and (3) National Bureau of Standards reflectometer system which utilizes a quarter-wave short circuit and an IF attenuation standard. Loss values of about 0.05 dB, as calibrated by the three independent methods, typically agreed to within 0.0006 dB. It is believed that the results of these calibrations are representative of the best that can be achieved with current state-of-the-art techniques and available instrumentation for low-loss waveguide measurements.

11918. Parker, R. L., **Crystal growth mechanisms: Energetics, kinetics, and transport,** *Solid State Phys.* **25,** 151-299 (Academic Press Inc., New York, N.Y., 1970).

Key words: Crystal; crystal growth; crystallization; growth mechanisms; morphological stability; nucleation; phase changes; transport processes.

A review is given of the mechanisms of crystal growth. Subjects discussed include thermodynamics and statistical mechanics of phase changes; the mathematical physics of crystal growth transport processes; nucleation; interface structure and interface kinetics; morphological stability; impurity effects; and fluid flow effects in crystallization. Particularly emphasized are the results of quantitative studies, both theoretical and experimental, on well defined systems. Experimental techniques and apparatus are not covered, nor are solid-solid transformations or the crystallization of polymers.

11919. Perel, J., Deslattes, R. D., **Extended fine-structure in x-ray absorption spectra of certain perovskites,** *Phys. Rev. B* **2,** No. 5, 1317-1323 (Sept. 1, 1970).

Key words: Absorption; fine-structure; perovskites; x ray.

In this paper we attempt to test the validity of the short-range-order (SRO) and the long-range-order (LRO) theories of the extended fine structure (EFS) in x-ray absorption spectra. This is done by comparing the EFS's of Ti, Ca, Zr, and Sr in the perovskitelike compounds $SrTiO_3$, $CaTiO_3$, $SrZrO_3$, and $CaZrO_3$. The regularities which have been anticipated from SRO or LRO theories have not been observed. We are thus led to suggest that models are required other than those which have been used to explain the EFS.

11920. Powell, C. J., **Validity of inelastic-electron-scattering data in determining the metallic or insulating properties of adsorbed atomic layers,** *Phys. Rev. B* **1,** No. 10, 4191-4192 (May 1970).

Key words: Adsorbed atomic layers; cesium; inelastic-electron scattering; metal-insulator transition; plasmon energy losses; tungsten.

It is pointed out that the observation of plasmon energy-loss peaks and determination of peak breadths in inelastic-electron-scattering experiments cannot be used to distinguish metallic or insulating materials. The recent claim, based on inelastic-electron-scattering data, by MacRae, Müller, Lander, Morrison, and Phillips that the initial (low-density) second layer of cesium adsorbed on a tungsten (100) surface is in an insulating state is considered not proved.

11921. Powell, C. J., **Comparison of optical data for sodium and potassium with interband-transition absorption theory,** *Optics Commun.* **2,** No. 2, 87-89 (July 1970).

Key words: Interband transition theory; optical absorption; potassium; pseudopotential; sodium.

Smith's optical data for Na and K have been used to test the validity of the Wilson-Butcher interband-transition absorption theory and recent theoretical modifications. Values of "optical" pseudopotential (V_{110}) have been obtained which deviate qualitatively from the pseudopotentials derived from de Haas-van Alphen data in the manner predicted by Animalu. Good agreement is found between the derived values of interband conductivity for Na and Animalu's calculations but the derived values for K are about a factor of two smaller than Animalu's result.

11922. Risley, A. S., Allan, D. W., Peters, H. E., Johnson, E. H., Vessot, R. F. C., Levine, M., Gray, J. E., Shoaf, J. H., **Stability characteristics of some atomic frequency standards (Summary)** (Proc. Conf. Precision Electromagnetic Measurements, National Bureau of Standards, Boulder, Colo., June 2-5, 1970), *CPEM Digest,* pp. 74-75 (1970).

Key words: Allan variance; cesium beam; frequency stability; hydrogen maser; NBS frequency standard; time scale.

Over a period of three and one-half months a frequency stability comparison was made between seven commercial cesium beams and a NASA (Goddard Space Flight Center) hydrogen maser. Two of the prime purposes in bringing the NASA maser to Boulder were: (1) to determine the general effect upon the NBS Time Scale of including the H maser as a part and (2) to determine the stability of the H maser for sampling times τ longer than 10^3 seconds.

Two of the major results of the time scale and NASA maser comparison were, first, $\sigma_y(N=2,\ T=\tau,\ \tau=1$ day) of the time scale—*including the maser*—was less than 1×10^{-13}, where $y \equiv \delta\nu/\nu$. Second, the inclusion of the maser in the time scale improved the precision about 30 percent.

Another hydrogen maser (from the Smithsonian Astrophysical Observatory) and a new four-foot long cesium beam (NBS-X4) were used along with the NASA maser to measure stabilities $\sigma_y(N=2,\ T=\tau,\ \tau)$ ($\tau \approx 1$ day). The stabilities for both masers and for NBS-X4 were better than one part in 10^{13}.

11923. Robertson, B., **Quantum statistical mechanical derivation of generalized hydrodynamic equations,** *J. Math. Phys.* **11,** No. 8, 2482-2488 (Aug. 1970).

Key words: Conservation equations; equation of motion; hydrodynamic equations; quantum fluids; quantum mechanical density distribution; quantum statistical mechanics.

Exact differential conservation equations are derived for the mass, momentum, and energy density operators for a one-component simple fluid of Bose or Fermi particles with arbitrary pairwise interactions. These equations are used in a statistical mechanical derivation of exact equations of motion for the expectations of these operators. The equations of motion are coupled to the exact equations relating the local temperature, chemical potential, and fluid velocity to these expectations. The coupled equations are closed in the sense that the expectations and their thermodynamic conjugates listed above are the only unknowns, although some of the dependence in the equations on the conjugates is expressed only implicitly. The equations of motion are memory-retaining nonlocal generalizations of the classical hydrodynamic equations and apply to a normal fluid arbitrarily far from equilibrium. The formalism is not carried as far as has the corresponding classical formalism.

11924. Schneider, S. J., **Cooperative determination of the melting point of alumina,** *J. Pure Appl. Chem.* **21**, No. 1, 117-122 (1970).

Key words: Al_2O_3; alumina; IUPAC; melting point of Al_2O_3; melting point standards.

A task force on secondary temperature standards, sponsored by the Commission on High Temperatures and Refractories, International Union of Pure and Applied Chemistry, has undertaken a programme to investigate various inorganic nonmetallic substances for use as high-temperature reference materials. As part of this programme a cooperative determination of the melting point of Al_2O_3 (alumina) was conducted by the task force. In all, nine scientific groups representing seven countries contributed experimental data. All work was performed utilizing a common supply of Al_2O_3 of nominal 99.9 percent purity. Experimental techniques varied depending upon the individual investigator. The value for the alumina point as recommended by the task force is 2054 ± 6 °C (IPTS 1968).

11925. Schooley, J. F., Soulen, R. J., Koonce, C. S., **Surface potential barrier in $SrTiO_3$,** *Solid State Commun.* **7**, 1077-1079 (1969).

Key words: Indium; semiconductors; $SrTiO_3$; strontium titanate; superconductivity; surface potential barrier; tunneling.

We have observed supercurrent flow in tunneling measurements in In-$SrTiO_3$ junctions. Applying the coherence-distance criterion to these results, we can set an upper bound of 100 Å on the thickness of the indium-$SrTiO_3$ potential barrier.

11926. Selby, M. C., **The Bolovac and its applications (Summary),** (Proc. Conf. Precision Electromagnetic Measurements, National Bureau of Standards, Boulder, Colo., June 2-5, 1970) *CPEM Digest*, pp. 14-15 (1970).

Key words: Bolovac; current measurement (HF & MW); (HF & MW); microwave currents; microwave voltages; power measurement; voltage measurement (HF & MW).

The Bolovac is a new device for the standardization and measurement of TEM voltage, current and power through 18 GHz (potentially through 36 GHz). It can be used for attenuation measurement and as a near perfect impedance termination. It is the first and only anywhere practical means of calibrating microwave current indicators and of evaluating oscilloscopes displaying 25-ps or shorter rise-time pulses.

The application of the Bolovac will revolutionize power measurements. It eliminates (1) "mismatch errors," the major present source of uncertainty in power measurement, (2) the measurement of complex reflection coefficients, (3) complex computations, (4) the use of "error-limit" charts, and (5) the measurement of "effective efficiency" and "calibration factor." Its application may radically increase optimum accuracy and measurement-time efficiency.

The Bolovac can be used as a source of voltage or as an absorption power meter. It needs no rf calibration. It has a 15 to 40 dB range depending on the desired precision and on whether one or more sensors (special bolometric disks) are used.

11927. Sieck, L. W., Searles, S. K., **High-pressure photoionization mass spectrometry. Reactions of alkane and cycloalkane molecular ions with water vapor at thermal kinetic energies,** *J. Chem. Phys.* **53**, No. 1, 2601-2604 (Oct. 1, 1970).

Key words: Hydrocarbons; ion-molecule reactions; mass spectrometry; photoionization; proton transfer; water.

The reactions of alkane molecular ions (RH_2^+) with water vapor were found to proceed via a bimolecular mechanism in both ethane and propane. Parent ions from cyclohexane, cyclopentane, *i*-butane, *n*-butane, *i*-pentane, *n*-pentane, and *n*-hexane were observed to react exclusively via a termolecular mechanism involving two water molecules: $RH_2^+ + 2H_2O \rightarrow H^+(H_2O)_2 + RH$. Thermal rate constants of 1.2 and 1.4×10^{-9} cm³/molecule·sec, respectively, were derived for the bimolecular reactions of $C_2H_6^+$ and $C_3H_8^+$ with H_2O. The termolecular rate constants found in other $RH_2^+ - H_2O$ combinations were quite high, falling in the range $10^{-25} - 10^{-27}$ cm⁶/molecule·sec. The nature of the collision complex is discussed, and new limits are estimated for $\Delta H_f(H_3O^+)$.

11928. Sieck, L. W., Searles, S. K., Rebbert, R. E., Ausloos, P., **Reactivity of the cyclohexane ion,** *J. Phys. Chem.* **74**, No. 21, 3829-3831 (Oct. 15, 1970).

Key words: Cyclohexane; effects impurity; ion-molecule reactions; mass spectrometry; radiolysis.

It is shown that contrary to the findings reported in a recent study (reference 2 cited in this communication) the cyclohexane ion reacts with cyclohexane very slowly ($k \leq 5 \times 10^{-14}$ cm³/molecule-sec). Cyclohexane has been studied very extensively by radiation chemists who consider it as a key compound in the interpretation of energy deposition mechanisms. It is therefore important that the misconception recently introduced in the literature be rectified as soon as possible.

11929. Simmons, J. H., Napolitano, A., Macedo, P. B., **Supercritical viscosity anomaly in oxide mixtures,** *J. Chem. Phys.* **53**, No. 3, 1165-1170 (Aug. 1, 1970).

Key words: Anomaly in oxide mixtures; oxide mixtures; viscosity anomaly.

The viscosity anomaly, previously detected above the critical point of some fluid binary mixtures, is investigated in the sodium-borosilicate oxide system. At the sodium-borosilicate dome, the critical composition is selected with small CaO and Al_2O_3 doping additions to obtain samples whose critical temperatures range over 190 °C and have minimum high-temperature structural differences. Viscosities between 10^2 and 10^9 P (10^{-1} N·sec/m²) are measured. A fractional excess viscosity is defined as the difference between the viscosity of each melt and a normal viscosity function, divided by the normal viscosity. The normal viscosity function is taken to have the form of the viscosity curve from the sample with the lowest critical temperature. The fractional excess viscosity then shows an anomalous increase near the critical point. The fractional excess viscosity, $\Delta\eta/\eta_0$, attains a value of 2 near the consolute temperature but appears to remain finite at the critical point. This critical-point effect can be detected 200 °C above the critical temperature. Such results indicate that the viscosity is quite sensitive to the presence of composition fluctuations above the critical point of this system, and represents a good tool for investigating supercritical phenomena.

11930. Straty, G. C., Prydz, R., **Fluorine compatible apparatus**

for accurate PVT measurements, *Rev. Sci. Instr.* **41,** No. 8, 1223-1227 (Aug. 1970).

Key words: Cryostat; fabrication techniques; fluorine, materials compatibility; PVT apparatus; PVT method.

A fluorine compatible apparatus, incorporating numerous safety features, is described. This apparatus has been used to make accurate determinations of the PVT properties of gaseous and liquid fluorine from 53.5 K (the triple point) to 300 K and to pressures of 20 MN/m^2 (3000 psi). The experimental method is similar to the isochoric one used previously in this laboratory for oxygen and hydrogen. A limited testing program, to determine the suitability of various materials for use with high pressure fluorine, is described and the test results tabulated. Some general fabrication techniques, suitable for construction of fluorine handling apparatus, are discussed.

11931. Thomas, A. M., **Further study of vacuum vane gauge criteria: Effects of port-vane geometry,** *J. Vacuum Sci. Technol.* **7,** No. 4, 501-503 (July-Aug. 1970).

Key words: Design criteria; port-vane geometry; vacuum vane gauge.

The force on a movable vane which covers the exit of a tube is related to the pressure at the tube entrance. This principle can be utilized in the construction of a "vane" gauge. The Monte Carlo method has previously been used to determine the correlation between the force on the vane and the pressure at the tube inlet. An extension of that work to a more complex and realistic geometry, which includes an elbow and a conical section, is presented here. This geometry represents the port structure of a gauge presently under construction in our laboratory. Details of the molecular motion, such as density and flux distributions throughout the system, were calculated. Under certain conditions, the geometry upstream of the port was shown to have negligible effect on the force imparted to the vane and a calibration curve is presented relating this force to the vane-to-port distance over a limited range.

11932. Waxman, M., Hastings, J. R., Chen, W. T., **Nonlinear statistical analysis of Burnett PVT data,** *Proc. 5th Symp. Thermophysical Properties, Boston, Massachusetts, September 30-October 2, 1970,* C. F. Bonilla, ed., pp. 248-261 (American Society of Mechanical Engineers, New York, N.Y., 1970).

Key words: Burnett; gas; model dependency; nonlinear; PVT; statistical.

The Burnett method, which requires only temperature and isothermal pressure measurements made before and after stepwise expansions between two volumes, is being used extensively for determining gas compressibilities and density or pressure virial coefficients. The measurements are simple, but the data reduction involves rather formidable nonlinear statistical analysis of relationships containing the compressibility factor, defined by a density or a pressure virial expansion, and optional constants. In this paper we compare the results of analyzing different Burnett relationships with independent parameters and no restrictions on the data, using two nonlinear statistical methods, due to Gauss and to Deming, and argon data at 25 °C for pressures up to 250 atm. We discuss the computational difficulties and present background information on the experimental and analytical methods.

11933. Yokel, F. Y., Somes, N. F., **Proposed revision of ACI 318-63 Building Code Requirements for Reinforced Concrete,** *J. Am. Concrete Inst.* **67,** No. 9, 723-725 (Sept. 1970).

Key words: Axial load (force); bending moment; building codes; end-fixity; reinforced concrete; slenderness; strength; structural analysis; walls.

This contribution discusses Chapters 10 and 14 of the Proposed Revision of ACI 318-63 Building Code Requirements of Reinforced Concrete Reported by ACI Committee 318 in the Journal of the American Concrete Institute, February 1970. It points out some inconsistencies in the respective ways in which these two Chapters cover bearing walls. Some changes are recommended which, if adopted, would extend the coverage of Chapter 10 to include those walls covered only by Chapter 14.

11934. Young, J. P., Lamb, V. A., Reid, G. I., Berkeley, J. F., Ng, W., **Electroplated coatings on maraging steel for retarding catalytic decomposition of hydrazine rocket fuel,** *Plating* **57,** No. 9, 921-926 (Sept. 1970).

Key words: Compatibility tests; electrolytic protection; hydrazine; maraging steel; metallic coatings; missiles; rocket-fuel tanks.

Hydrazine and methyl hydrazine are catalytically decomposed in contact with certain metals, e.g., Maraging steel, yielding gaseous decomposition products. As a result, dangerous pressures develop during prolonged storage of rockets that employ hydrazine-type fuels contained in Maraging steel tanks. The tanks therefore require a coating on their internal surfaces that will not be corroded by hydrazine nor cause it to decompose. The work reported is a general survey of a variety of materials, most of them applied as plated coatings, to determine their suitability for this application. Cadmium and electroless nickel are the most practicable of a number of materials that were found to have low catalytic effect and that were not significantly corroded.

11935. Younglove, B. A., Straty, G. C., **A capacitor for accurate wide range dielectric constant measurements on compressed fluids,** *Rev. Sci. Instr.* **41,** No. 7, 1087-1089 (July 1970).

Key words: Capacitance; dielectric constant; stable capacitance; temperature variation of capacitance.

A capacitor is described which has been used to make accurate measurements of the dielectric constant of liquid and gaseous oxygen over a wide temperature (55-300 K) and pressure (0.2-34 MN/m^2) range. The capacitor is simple to construct and its stability is unaffected by large hydrostatic pressure variations. The temperature variation of the vacuum capacitance is small and remains reproducible even after repeated temperature and pressure cycling.

11936. Zimmerman, J. E., **Low cost sensors with millikelvin temperatures and other virtues (Summary),** (Proc. Conf. Precision Electromagnetic Measurements, National Bureau of Standards, Boulder, Colorado, June 2-5, 1970), *CPEM Digest,* p. 1 (1970).

Key words: Josephson effect; magnetometry; superconducting devices.

This paper is a 280-word summary of a talk to be given at the Conference on Precision Electrical Measurements. It summarizes the simple theory of the superconducting quantum devices known as weak links or Josephson junctions, and reviews some applications to magnetometry, high-frequency radiation sensing, and dc and rf current and voltage standards. The inherent low-noise, absolute calibration, versatility, and low-cost of the devices are emphasized.

11937. Unassigned.

11938. Bagg, T. C., **Factors dictating characteristics of systems utilizing microforms,** *J. Micrographs* **3,** No. 3, 143-146 (1970); *ABFM Format* **1,** No. 2, 1-2 (May 1970).

Key words: Document storage and retrieval; microform-microfilm systems.

There is a wide variety of microform formats and equipment available for handling microimages. The systems designer therefore has the opportunity to select those procedures and equipment that will assure the fulfillment of the system's requirements. This paper will briefly discuss some questions he must answer before establishing the most effective design. Each application of microforms has its particular requirements; therefore the questions can serve only as guidelines. It cannot be over emphasized that the most useful systems are the simplest that will produce legible output images.

11939. Birky, M. M., **Simultaneous recording of near-field and far-field patterns of lasers,** *Appl. Opt.* **8,** No. 11, 2249-2253 (Nov. 1969).

Key words: Laser; near-field and far-field diffraction; neodymium; ruby.

A technique for simultaneous recording of near-field and far-field diffraction patterns at several exposures for a single laser pulse has been developed. A ruby laser and a neodymium doped glass laser have been investigated. The Nd^{+3} laser shows striking high order cylindrical mode operation as a result of thermal stress. The time resolved output of this laser shows the usual spikes about 500 nsec wide. When the cylindrical mode operation takes place some of the spikes consist of a large number of ultrashort pulses.

11940. Branscomb, L. M., **A fully integrated partnership between government laboratory and university,** *Proc. Education on Federal Laboratory-University Relationships Symp. sponsored by the Federal Council for Science and Technology and the American Council on Education, Washington, D.C., October 29-31, 1968,* pp. 139-151 (May 1969).

Key words: *Research management* principles embodied in *government-university collaboration* in the *Joint Institute for Laboratory Astrophysics.*

Invited talk to symposium "Education and Federal Laboratory-University Relationships" sponsored by the Federal Council for Science and Technology, at the Smithsonian Institution, Oct. 29-31, 1968.

The pattern of government laboratory-university collaboration inherent in the Joint Institute for Laboratory Astrophysics (JILA) is described, with emphasis on its advantages and shortcomings and the relevant management principles. (No technical information is included.)

11941. Branscomb, L. M., **Discussion,** *Can. J. Chem.* **47,** No. 10, 1703-1941 (May 15, 1969).

Key words: Aeronomy; editorial comments.

This manuscript contains the edited comments on invited papers by A. Dalgarno, A. V. Phelps, and E. E. Ferguson which will appear in Transactions of the IAGA (International Association of Geomagnetism and Aeronomy) Symposium on Laboratory Measurements of Aeronomic Interest, September 3-4, 1968, York University, Toronto, Canada. The Transactions are to be published in the Canadian Journal of Chemistry.

11942. Brenner, A., Anderson, H. J., **Chemical vapor deposition of rhenium,** *Proc. Interfinish 1968 7th International Metal Finishing Conf., May 5-9, 1968, Hanover, Germany,* pp. 28-31 (1968).

Key words: Carbonyl; chemical vapor deposition; electrodeposition; hexafluoroacetylacetone; rhenium coatings; trifluorophosphine.

Methods of depositing rhenium coatings are reviewed, and a brief account is given of work now in progress at NBS on the deposition of rhenium. The electrodeposition of rhenium from an aqueous perrhenate bath does not yield a satisfactory coating; work at NBS with various rhenium compounds in both aqueous and nonaqueous solutions did not lead to a better plating process. The chemical vapor deposition (CVD) of rhenium is more promising, particularly the reduction of rhenium hexafluoride with hydrogen. At NBS work has been done with the CVD of rhenium from the carbonyl, the hexafluoroacetylacetone derivative, and work is in progress with the trifluorophosphine derivatives.

11943. Carrington, T., Garvin, D., **The chemical production of excited states,** Chapter 3 in *Comprehensive Chemical Kinetics,* **Volume 3.** *The Formation and Decay of Excited Species,* pp. 107-181 (1969).

Key words: Atom-transfer reaction; chemical activation; chemical kinetics; chemi-excitation; gas phase; potential energy surfaces; recombination; review; unimolecular decomposition.

Chemical excitation, the production of molecules in nonequilibrium population distributions in electronic, vibrational and rotational states is described.

The applicable parts of reaction rate theory are reviewed. Typical cases are used as examples of chemi-excitation in combination, group transfer and decomposition reactions. Reactions involving excited electronic states are discussed in terms of the interaction of potential surfaces. Applications to lasers and to the study of unimolecular decompositions are described.

11944. Chandler, H. H., Bowen, R. L., Paffenbarger, G. C., Mullineaux, A. L., **Clinical investigation of a radiopaque composite restorative material,** *J. Am. Dental Assoc.* **81,** No. 4, 935-940 (Oct. 1970).

Key words: Clinical research (dental); composite restorations; diagnosis; physical properties of fillings; x-ray opaque.

A radiopaque composite restorative material was developed using a ternary eutectic dimethacrylate liquid formulation as the binder and a BaF$_2$-containing glass and fused silica as the reinforcing fillers. One hundred and ten restorations were placed with this newly developed material. The restorations will be observed for an extended time. They had sufficient radiopacity and yet were esthetically pleasing. Postoperative radiographs showed comparatively radiolucent areas in and around many of the restorations. These radiolucencies were usually caused by unfilled spaces at the tooth restoration interface.

11945. Chandler, R. F., Christian, R. A., **Comparative evaluation of dummy performance under $-G_x$ impact,** *Proc. 13th Stapp Car Crash Conf., Boston, Mass., December 2-4, 1969,* Report No. 690798, pp. 61-75 (Society of Automotive Engineers, New York, N.Y., 1970); Abstract in *SAE Trans.* **78,** 171-172 (1969).

Key words: Automobiles; dummies; dynamic; impact; performance; restraints.

Comparative evaluations of a variety of anthropomorphic dummies undertaken by the Office of Vehicle Systems Research at the National Bureau of Standards indicates a wide range of dummy performance. Dynamic tests, which were conducted on the NBS Dynamic Seat Belt Tester, simulated an impact environment with the dummies restrained by lap belt alone, or combined lap and torso diagonal belts of the type used in American automobiles. A variety of dummies, varying in construction from the most rudimentary to the most sophisticated were tested. Test parameters included variations in impact velocity and acceleration. Each dummy was tested with both types of restraints, and sufficient tests were made to demonstrate the ability of the dummy to reproduce its reaction performance.

These tests indicate that even when dummies are subjected to carefully controlled impacts with skilled technical personnel following identical procedures, it is difficult to reproduce test results. Techniques which were used to control dummy performance and modifications which were incorporated to improve reliability of the dummies are discussed.

11946. Christ, B. W., Smith, G. V., **Effects of nitrogen in lattice solution on the yielding and flow of zone-refined iron polycrystals between 128 and 300 K,** *Trans. Met. Soc. AIME* **1,** No. 4, 827-833 (Apr. 1970).

Key words: Flow stress; impurity softening; lattice solution; lower yield stress; nitrogen; polycrystals; solution hardening; upper yield point; zone-refined iron.

Up to 0.18 at. pct N was introduced into lattice solution in hydrogen-purified, zone-refined iron polycrystals. Tensile tests were conducted at 128, 173, 223, and 300 K on quenched samples at constant strain rate, 7×10^{-4} sec^{-1}. The following dynamic effects due to increasing nitrogen in lattice solution were found: (1) the temperature dependence of the flow stress at strains beyond the end of the Luder's plateau decreased, (2) serrated flow occurred at 300 K, but not at lower temperatures, (3) elongation to maximum load decreased at 300 K, but increased at 173 K, and (4) the magnitude of the yield drop at 173 K decreased substantially. These dynamic effects are interpreted in terms of a change in the relative mobility of nitrogen atoms and dislocations between 128 and 300 K.

11947. Coriell, S. R., Jackson, J. L., **Probability distribution of the radius of gyration for two statistical segments,** *J. Chem. Phys.* **53,** No. 8, 3389 (Oct. 15, 1970).

Key words: Distribution; gyration; polymer; radius; two segments.

An analytic expression is obtained for the distribution of the one-dimensional radius of gyration of a random flight polymer chain of two statistical segments. The result is a product of an exponential function and a modified Bessel function of order zero.

11948. Cornog, D. Y., Cornog, J. R., **Human factors engineering in the sorting and handling of mail,** *Proc. NATO Advanced Study Institute on "Human Factors/Ergonomics," Mondello, Sicily, September 29, 1969,* pp. 1-34 (Jan. 21, 1970).

Key words: Human factors; mail handling; mail processing; mail sorting; methodology.

A case study is used to illustrate both the technical and management aspects of human factors in a unique American organization—an organization which combines a government agency with the typical operations of a gigantic materials handling industry—the United States Post Office Department. Mail handling operations are described with an enumeration of the types of human factors problems to be found. The various approaches to solving human factors problems include: in-house Human Factors Engineering Laboratory research, field studies in postal installations, and contract research performed by industry, private research firms and university departments. Future human factors research in mail handling problem areas is discussed. Information is provided about data sources for American human factors research activities and personnel.

11949. Davis, D. D., **Transmission of time/frequency signals in the vertical interval,** *Proc. 108th Technical Conference and Equipment Exhibit, New York, N.Y., October 4-9, 1970,* Article No. 43, p. 3 (Society of Motion Picture and Television Engineers, New York, N.Y., 1970).

Key words: Frequency and time dissemination; television; vertical interval signals.

An abstract will be prepared from the synopsis, by the Society of Motion Picture and Television Engineers, subject to the author's clearance.

11950. Dick, C. E., Lucas, A. C., ***K*-shell fluorescence yields for light elements,** *Phys. Rev. A* **2,** No. 3, 580-586 (Sept. 1970).

Key words: Beryllium; boron; carbon; fluorescence yield; fluorine; K shell; magnesium; ω_K.

The K-shell fluorescence yield ω_K has been measured for the low-atomic-number elements beryllium, boron, carbon, fluorine, and magnesium. The primary vacancies in the K shell were produced by an intense beam of K x rays generated by electron bombardment of aluminum and carbon targets. The measured values of ω_K agree quite well with values calculated from a theoretical prediction of Wenzel. They exhibit only fair agreement with semiempirical formulas which include screening and relativistic effects, and with a recent calculation by McGuire based on the K-shell Auger transition rate.

11951. Dickens, B., Brown, W. E., **The crystal structure of calcium carbonate hexahydrate at $\sim -120°$,** *Inorg. Chem.* **9,** No. 3, 480-486 (Mar. 1970).

Key words: Calcification; calcium carbonate; crystal structure; hydrate; ion pairs; mineralization.

The crystal structure of $CaCO_3 \cdot 6H_2O$ has been determined from 1420 x-ray diffraction data collected photographically by the oscillation technique from a single crystal held at $\sim -120°$. The unit cell parameters are $a = 8.87$ (2) Å, $b = 8.23$ (1) Å, $c = 11.02$ (2) Å, and $\beta = 110.2$ (2)°, and the space group is C2/c with $Z = 4$. The calculated density at $\sim -120°$ is 1.80 g cm^{-3}, and the observed density at $\sim 0°$ is 1.82 g cm^{-3}. The final R factor is 0.10. The structure contains discrete $CaCO_3$ ion pairs, each surrounded by an envelope of 18 water molecules. Thus, Ca^{2+} is coordinated to only one CO_3^{2-}. Six of the surrounding H_2O molecules are bonded to Ca^{2+}, eight are hydrogen bonded to oxygens of the CO_3^{2-} group, and four are bonded to adjacent ion pairs and to other water molecules in the envelope. $CaCO_3 \cdot 6H_2O$ was found to be more stable than $CaCO_3 \cdot H_2O$ in water near 0°. The formation of $CaCO_3 \cdot 6H_2O$ from an equivalent amount of calcite ($CaCO_3$) and water is accompanied by a 20% decrease in volume. This may be important in explaining the scarcity of calcareous material in life in the ocean depths.

11952. Dobbyn, R. C., Williams, M. L., Cuthill, J. R., McAlister, A. J., **Occupied band structure of Cu: Soft-x-ray spectrum and comparison with other deep-band-probe studies,** *Phys. Rev. B* **2,** No. 6, 1563-1575 (Sept. 15, 1970).

Key words: Band structure; Cu; deep probes; emission; occupied bands; soft x ray.

We report a new measurement of the soft-x-ray $M_{2,3}$ emission spectrum of Cu, using improved experimental techniques. Previously unreported fine structure was observed in the spectrum. Although exact correction for satellite and subband overlap and self-absorption effects is not yet possible, careful consideration has been given to them, with the result that the M_3 band profile can be resolved from the accompanying structure in a plausible way. Its features can be taken with reasonable confidence to be characteristic of the true M_3 profile. Comparison is made with the complementary L_3 soft-x-ray profile, with band-theoretical estimates of both experimental x-ray profiles, and with the results of ultraviolet-photoemission, x-ray-photoemission, and ion-neutralization measurements. These comparisons favor a single-particle description of the occupied bands of Cu.

11953. Egelstaff, P. A., **Cooperative rotation of spherical molecules,** *J. Chem. Phys.* **53,** No. 7, 2590-2598 (Oct. 1970).

Key words: Diffusion; light scattering; neutron scattering; plastic crystal; rotational; spherical molecules.

The rotational diffusion of molecules in the liquid and solid states can be studied by radiation scattering experiments. Both neutron and light scattering data are interpreted, conventionally, on the basis of rotation of single molecules, although in dense systems cooperative rotation is a possibility. It is pointed out that a comparison of incoherent neutron data and depolarized light data allows the cooperative nature of molecular rotational diffusion to be verified. The method is applied to the plastic crystal phase of cyclohexane, and it is shown that individual molecules rotate about 10 times as rapidly as the relaxation rate of the mean orientation of a group of molecules.

11954. Evenson, K. M., Wells, J. S., Radford, H. E., **Infrared resonance of OH with the H_2O laser: A galactic maser pump?** *Phys. Rev. Letters* **25,** No. 4, 199-202 (July 27, 1970).

Key words: Astronomical OH emission; H_2O laser; magnetic resonance; OH; spectroscopy.

The 79-μm electric dipole spectrum of OH ($^2\Pi_{3/2}$, $J=3/2 \leftrightarrow {}^2\Pi_{1/2}$, $J=1/2$) has been measured by a magnetic-resonance absorption method, with a water-vapor laser as the source oscillator. Corresponding magnetic dipole spectra are calculated from the data. A near overlap of the water line on one magnetic-dipole transition suggests a possible pumping mechanism for the 18-cm maser emission of stellar OH.

11955. Florin, R. E., Wall, L. A., **Small and large radicals in thin-film polymer depolymerization,** *Macromolecules* **3,** No. 5, 560-566 (Sept.-Oct. 1970).

Key words: Diffusion effects; free radicals; polymer decomposition; polymer depolymerization; polymer irradiation; polymer pyrolysis.

Rates of polymer decomposition are enhanced or retarded as a result of the escape of small free radical or other species through the surface of thin films. Solutions for the rate equations are given as a function of thickness for a mechanism involving the competitive diffusion of small and large radicals. The enhancement of the rates of depolymerization of polytetrafluoroethylene observed with thin films is explained by the model. Comparison of the experimental results with theory indicates that the irradiation of polytetrafluoroethylene produces comparable amounts of both large and small radicals. The mechanisms discussed are undoubtedly operative in many other situations involving the radiolysis or pyrolysis of polymers, for example, the radiation-induced cross-linking of polymers.

11956. Franklin, A. D., Marzullo, S., **Orientation kinetics of Gd^{3+}-F^- interstitial pairs in CaF_2,** *J. Phys. C. Solid State Phys. Letters to Editor* **3,** L171-L174 (Sept. 1970).

Key words: Calcium fluoride; defect dipoles; dielectric relaxation; ESR line broadening; gadolinium; orientational relaxation.

A calculation of approximate density of states for a disordered covalent semiconductor shows that the energy gap is due to the presence of short range order.

11957. Freeman, D. H., Goldstein, S., Schmuckler, C., **Homogeneous sulfonation of styrene-divinylbenzene copolymers with oleum in organic solvents,** *Israel J. Chem.* **7,** No. 6, 741-749 (1969).

Key words: Cation exchangers; ion exchangers; oleum; sulfonation.

In order to obtain homogeneously sulfonated cation exchangers, the copolymers were sulfonated by oleum in a mixture of methylene-chloride and nitromethane. The influences of the chemical interaction and of the diffusion process on the kinetic behavior of these systems were investigated, and it was shown that raising the temperature of the sulfonation mixture markedly increases the chemical reaction rate, while the effect on the diffusion is small. A curve-fitting technique was used for the interpretation of the degree-of-sulfonation-vs.-time curves. These investigations served as guidelines for the subsequent preparation of homogeneous highly sulfonated copolymers.

11958. French, B. M., Walter, L. S., Heinrich, K. F. J., **Quantitative mineralogy of an Apollo 11 lunar sample,** (Proc. Apollo 11 Lunar Science Conf., January 1970, Houston, Texas), *Geochim. Cosmochim. Suppl. 1,* **Vol. 34,** 433-444 (Feb. 1970).

Key words: Apollo 11; electron probe analysis; mineralogy; moon; petrography; rocks.

Petrography and mineral analyses of Sample 10017, collected by the Apollo 11 mission, are reported. They indicate formation by relatively rapid crystallization of a silicate melt. Major components are clinopyroxene, plagioclase and ilmenite. Minor components include troilite, native iron, and apatite. The mineral compositions indicate differentiation during magmatic crystallization, leading to Fe enrichment in the pyroxenes and to alkali enrichment in the feldspars. The mesostasis, the residual liquid produced during crystallization, is strongly enriched in K and Si, but strikingly low in Na; this may be due to volatilization during the later stages of crystallization. The compositional trends, similar to those in other lunar samples, indicate formation by relatively rapid magmatic crystallization, which developed significant chemical fractionation, at low oxygen fugacity and under virtually anhydrous conditions.

11959. Glaze, D. J., **Improvements in atomic cesium beam frequency standards at the National Bureau of Standards,** *IEEE Trans. Instr. Meas.* **IM-19,** No. 3, 156-160 (Aug. 1970).

Key words: Atomic frequency standard; cesium beam; figure of merit; frequency accuracy; frequency multiplier; frequency precision; NBS-III; NBS-5; phase noise; quartz crystal oscillator; Ramsey cavity; slave oscillator.

The National Bureau of Standards Frequency Standard, NBS-III, a cesium beam with a 3.66-meter interaction region, has been in operation since 1963. The last published (1966) accuracy capability for NBS-III was $1.1 \times 10^{-12}(1\sigma)$. Recently, several new solid-state broad-band frequency-multiplier chains have been constructed. Reduction of the random phase noise by more than 20 dB compared to the previous state of the art has been obtained consistently. In addition, a solid-state servo system has been installed to control the frequency of the 5-MHz slave oscillator.

Comparisons were made between NBS-III and one of the commercial cesium standards in the NBS clock ensemble. The relative fractional frequency stability $\sigma(N=2, T=7$ days, $\tau=1$ day$) = 1 \times 10^{-13}$ was observed for nine weekly comparisons. The very-long-term frequency stability for the recently improved NBS-III system has not been evaluated fully. Due to the improvements both in electronic systems and evaluative techniques, however, an accuracy of $5 \times 10^{-13}(1\sigma)$ for a single evaluative experiment is reported.

Substantial effort is being expended toward improvement of the accuracy and figure of merit (presently 10) of the NBS cesium standard. The modified system, to be called NBS-5, is expected to be in operation in the latter half of 1970 and to exhibit a figure of merit in excess of 500.

11960. Goldman, A. J., **Analysis of a capacity concept for runway and final-approach path airspace,** *Proc. Ion National Air Meeting on Air Traffic Control in the 1970's, Institute of Navigation, St. Louis, Mo., April 14-16, 1970,* pp. 119-131 (1970).

Key words: Airport; air traffic control; capacity concept; Markov renewal process; runway.

This paper describes some highlights of a short-term analytical study leading: (a) to a "maximum throughput-rate" capacity concept in the context of a service facility handling a stream of customers of various types, and (b) to the specialization of this concept to a stream of IFR landings at a runway. The specialization is shown to be representable by a simple mathematical formula, of potential value (for example) in connection with cost-effectiveness analyses of proposed changes in ATC equipment or procedures. Directions for further research are identified, and the paper concludes with some general remarks on conceptual difficulties associated with the notion of "capacity."

11961. Hastie, J. W., Hauge, R. H., Margrave, J. L., **High temperature chemistry: Stabilities and structures of high temperature species,** *Ann. Rev. Phys. Chem.* **21,** 475-498 (1970).

Key words: High temperature species; stability structure.

Recent experimental and theoretical work on the stabilities and structures of high temperature species has been reviewed. Emphasis was given to data which may be used for the thermodynamic characterization of a high temperature species, such as molecular geometry vibrational and electronic energy levels. The techniques from which stability and structural data have been obtained for high temperature species are also discussed. These include, Knudsen effusion and photoionization mass spectrometry, matrix isolation infrared spectroscopy, electron diffraction, electric dipole deflection, electronic spectroscopy, microwave spectroscopy and semiempirical and abinitio molecular orbital calculations.

11962. Hiza, M. J., Duncan, A. G., **A correlation for the prediction of interaction energy parameters for mixtures of small molecules,** *AIChE J.* **16,** No. 5, 733-738 (Sept. 1970).

Key words: Binary fluid mixtures; correlation; deviations from geometric mean rule; interaction energy parameters; ionization potentials.

Low temperature, phase-equilibria data for binary systems containing hydrogen, helium, and neon were used to develop a correlation relating deviations from the geometric mean combining rule for the characteristic energy parameter to the ionization potentials of the component species. With the exception of oxygen systems, this relatively simple relationship correctly predicts published deviations, determined by different methods, for a number of systems within expected uncertainties. It is shown that consideration of attractive forces only, as done by Hudson and McCoubrey, is inadequate for such predictions.

11963. Hudson, R. P., **Conference Reports—Ultra-low temperatures 1970,** *Cryogenics* **10,** No. 5, 445 (Oct. 1970).

Key words: Cryogenics; low temperature physics.

A survey is given of a recent symposium at the Naval Research Laboratory on physics below 0.3 K.

11964. Jacox, M. E., Milligan, D. E., **Matrix-isolation study of the vacuum-ultraviolet photolysis of methyl chloride and methylene chloride. Infrared and ultraviolet spectra of the free radicals CCl, H_2CCl, and CCl_2,** *J. Chem. Phys.* **53,** No. 7, 2688-2701 (Oct. 1, 1970).

Key words: CCl; CCl_2; force constants; free radical; HCCl; $HCCl_2$; infrared spectrum; matrix isolation; photolysis; ultraviolet spectrum.

Infrared and ultraviolet spectroscopic studies have been conducted on the products of the vacuum-ultraviolet photolysis of normal and isotopically substituted methyl chloride and methylene chloride isolated in argon and nitrogen matrices at 14 K. The cage effect has been found to inhibit halogen detachment processes in these systems. Infrared absorptions attributable to CCl, HCCl, and H_2CCl and the 2800-Å ultraviolet absorption of CCl appear in the methyl chloride photolysis studies. Observation of a "negative anharmonicity" for the lowest-frequency infrared absorption of H_2CCl can be explained by postulating that the molecule is planar. The C–Cl stretching force constant of H_2CCl is exceptionally high. The implications of $(p\text{-}d)\pi$ bonding, which may account for the large C–Cl stretching force constant, are explored. An absorption near 2300 Å behaves appropriately for assignment to a second electronic transition of CCl, providing support for the previous tentative assignment of a group of emission bands to such a transition. Photolysis of methylene chloride in a matrix environment leads principally to the stabilization of CCl_2. A revised estimate of the force constants of CCl_2 is given.

11965. Johnson, D. R., Powell, F. X., **Microwave detection of thioformaldehyde,** *Science* **169,** 679-680 (Aug. 14, 1970).

Key words: Astronomically important; electrical discharge; interstellar medium; microwave spectroscopy; rotational spectrum; thioformaldehyde.

Thioformaldehyde (H_2CS) has been detected and characterized from its microwave spectrum. Preliminary analysis of rotational transitions for the sulfur-32-containing form of H_2CS shows this new species to have C_{2v} symmetry with rotational constants (in megahertz) of $A=292{,}729$, $B=17{,}698$, and $C=16{,}652$. The possibility of detection of thioformaldehyde in the interstellar medium is discussed, and a table of transitions expected to be of importance for that detection is presented.

11966. Kearsley, E. A., **Intrinsic errors for pressure measurements in a slot along a flow,** (Proc. Fifth Intern. Congress on Rheology, Kyoto, Japan, October 1968), *Trans. Soc. Rheology* **14:3,** 419-424 (1970).

Key words: Hole pressure; nonlinear rheology; normal stresses; pressure error; second order fluid.

Any rectilinear flow dynamically possible for a Newtonian fluid is shown to be possible also for a second order fluid. The stress which satisfies the condition of equilibrium is explicitly calculated. The component of stress normal to a wall bounding a shear flow is expressed in terms of the reading of a pressure gauge connected to a narrow slot in the wall, oriented in the direction of flow.

11967. Kerns, D. M., **Correction of near-field antenna measurements made with an arbitrary but known measuring antenna,** *Electronics Letters* **6,** No. 11, 346-347 (May 28, 1970).

Key words: Antenna gain; antenna gain measurement; antenna measurements; antenna pattern; antenna pattern measurement; near-field antenna measurements.

We describe a technique for rigorously correcting for the effects of an arbitrary but known measuring antenna (or "probe') in determination of vectorial far-field antenna pattern and power-gain function from near-field measurements.

11968. Kerns, D. M., **New method of gain measurement using two identical antennas,** *Electronics Letters* **6,** No. 11, 348-349 (May 28, 1970).

Key words: Antenna gain; antenna gain measurement; antenna measurements; antenna pattern; antenna pattern measurement; near-field antenna measurements.

A new method for the measurement of on-axis pattern vector and power gain using two identical antennas is described. The antennas must obey reciprocity, but may be otherwise arbitrary; the usual requirements in the conventional 2-antenna gain-measurement method, that the polarization be known *a priori* and that the separation be large compared with the Rayleigh distance, are eliminated.

11969. Krauss, M., **Potential energy surfaces,** *Ann. Rev. Phys. Chem.* **21,** 39-46 (1970).

Key words: Activation energy; configuration interaction; correlation energy surface; Hartree-Fock; H_3^+; H_3; H_3^-; H_4; LiH_2; LiHF; HNO; HeH_2^+; proton transfer.

Ab initio energy surfaces applicable to chemical kinetics and collisional phenomena are reviewed. The calculations are divided into two categories, Hartree-Fock and beyond. It is noted that Hartree-Fock calculations are routine but that correlation techniques are necessary for reactive collisions. Definitive work exists for H_3^+ and H_4, but the activation energy of H_3 is still inaccurate relative to the scattering calculational requirements. Other qualitative work is described for H or Li interaction with diatomics.

11970. Lafferty, W. J., **Microwave spectrum, dipole moment, and conformation of cyclopentene oxide,** *J. Mol. Spectry.* **36,** No. 1, 84-93 (Oct. 1, 1970).

Key words: Cyclopentene oxide; dipole moment; epoxy cyclopentene; microwave spectrum; ring conformation; rotational constants.

The microwave spectrum of cyclopentene oxide has been studied. Rotational constants for the ground state and two excited vibrational states of one ring conformation have been obtained. Ground state constants are $A_0 = 5709.38 \pm 0.02$, $B_0 = 4541.12 \pm 0.02$, and $C_0 = 3248.97 \pm 0.02$ (errors are 2 standard deviations). The dipole moment components of the molecule are $\mu_a = 1.16_3 \pm 0.033$, $\mu_c = 1.63_0 \pm 0.031$, and $\mu = 2.00_2 \pm 0.042$. The rotational constants and dipole moment components obtained experimentally can be satisfactorily explained only if the boat form is the most stable conformation of the ring.

11971. Lamb, V. A., **Evidence for a complex chloromolybdate ion in a molten salt medium from transference experiments,** *J. Electrochem. Soc.* **117,** No. 10, 1269-1270 (Oct. 1970).

Key words: Hexachloromolybdate complex ion; molten salt; transference numbers.

Transference experiments have been performed with solutions of potassium hexachloromolybdate in molten eutectic mixtures of potassium chloride and lithium chloride. The results indicate that a complex molybdenum-containing anion exists at 800 °C.

11972. Latanision, R. M., Westwood, A. R. C., **Surface- and environment-sensitive mechanical behavior,** Chapter in *Advances in Corrosion Sciences and Technology* **1,** 51-145 (Plenum Press, New York, N.Y., 1970).

Key words: Complex-ion embrittlement; dislocations; liquid metal embrittlement; surface; surface active agent.

The influences of surface structure and environment on the mechanical behavior of crystalline inorganic solids are reviewed and possible mechanisms discussed. In particular, the various roles of such factors as the atomic, electronic, and defect structures of the near-surface regions, the presence of adsorbed surface-active species, alloyed layers, oxide films, gaseous or liquid environments, etc., are considered in connection with Roscoe, Rebinder, and Joffe effects, liquid-metal embrittlement, complex-ion embrittlement, hydrogen embrittlement, and other phenomena.

11973. Maki, A. G., Hexter, R. M., **Resonance interactions with ν_5 of CH_3I; A method of determining A_0,** *J. Chem. Phys.* **53,** No. 1, 453-454 (July 1, 1970).

Key words: Absorption; gas; infrared; methyl iodide; molecular geometry; molecular structure; spectra.

Using a band contour computer program an analysis has been made of the Fermi resonance between the two perpendicular bands ν_5 and $\nu_3 + \nu_6$ of methyl iodide. A weak Coriolis interaction was found between the $K=4, -l$ levels of $\nu_3 + \nu_6$ and the $K=3, +l$ levels of ν_5. From an analysis of this Coriolis interaction it is shown that $A_0 = 5.15_8 \pm 0.02$ cm^{-1} where the uncertainty is an estimated 95% confidence limit. The ratio of the transition moments for ν_5 and $\nu_3 + \nu_6$ was found to be $|M_{3+6}|/|M_5| = 0.17 \pm 0.05$.

11974. Meshkov, S., **How good are symmetry predictions?,** *Proc. Intern. Conf. on Symmetries and Quark Models, Wayne State University, Detroit, Michigan, June 18-20, 1969,* Ramesh Chand, ed., pp. 199-212 (Nov. 1970).

Key words: Exotic; mesons; reactions; structure; $SU(6)_W$; symmetry.

A summary discussion of the comparison of experiment and $SU(6)_W$ reaction predictions is presented.

11975. Milligan, D. E., Jacox, M. E., **Infrared spectrum of the ClHCl-ion isolated in an argon matrix,** *J. Chem. Phys.* **53,** No. 5, 2034-2040 (Sept. 1, 1970).

Key words: Bichloride anion; ClHCl free radical; electron attachment; HCl dimer; hydrogen bonding; infrared spectrum; matrix isolation; ultraviolet spectrum; vacuum-ultraviolet photolysis.

Upon vacuum-ultraviolet photolysis at 14 K of samples of HCl isolated in an argon matrix at mole ratios favorable for the presence of an appreciable concentration of dimeric HCl, prominent absorptions appear at 696 and 956 cm^{-1}. The positions, contours, and relative intensities of these absorptions correspond within experimental error with those previously attributed to the ClHCl free radical isolated in an argon matrix. Studies of a chlorine-37 enriched sample have confirmed the presence of two chlorine atoms in the molecule. A broad, unstructured absorption at 2870 Å may also be contributed by this ClHCl species. When a small concentration of atomic potassium or cesium is codeposited with the Ar:HCl sample, evidence is obtained for the formation of an alkali-metal-containing complex. Photoionization of the alkali-metal atoms upon exposure of the resulting sample to the radiation of a medium-pressure mercury arc leads to the appearance of very prominent absorptions at 696 and 956 cm^{-1}. It is proposed that these absorptions may more suitably be assigned to the $ClHCl^-$ ion, trapped in an inert, essentially nonionic environment. Implications of this reassignment with regard to the nature of the hydrogen bonding of $ClHCl^-$ are discussed, and possible mechanisms for the production of $ClHCl^-$ under the conditions of these experiments are considered.

11976. Moore, C. E., **Annual Report, July 1, 1968-June 30, 1969, The National Bureau of Standards, Washington, D.C.,** *Bull. Am. Astron. Soc.* **2,** No. 1, 99-100 (1970).

Key words: Annual report, National Bureau of Standards; astrophysical work, National Bureau of Standards.

As each fiscal year ends, it is an established custom to submit an annual report covering work of interest to astronomers. A number of Bureau programs are useful astrophysically. The present report is a current summary of work in selected areas of the Bureau.

11977. Moore, G. A., **Is quantitative metallography quantitative?** *Am. Soc. Testing Mater. Spec. Publ.* **480,** pp. 3-48 (1970).

Key words: Evaluation; measurement; metallography; metallurgical analysis; microscopy; photogrammetry.

While the basic principles of quantitative metallography have been firmly established, the practice of such measurements yields highly variable results. Simple laws define the statistical limitation on any measuring method. Serious errors arise from improper selection and preparation of specimens. Anticipated gradients must be encompassed by a planned sampling scheme which guarantees unbiased representation and permits measurement of actual variation in the material studied. Specimen preparation must give a truthful image of the structure. Any free choices by the operator introduce bias. The precision of measurement of one micrograph is primarily controlled by a combination of statistical uncertainty and observational error at the edges of particles. The statistical uncertainty conforms to the ideal when the apparent particle size is small, but observation becomes inefficient as the average intercept width increases and the number of particles in the field decreases. Edge errors are maximum with small particles and vary with the observer or the instrument used. Maximum precision is obtained when these two errors are approximately equal. While quantitative metallography is a statistical, rather than exact, process and subject to serious or fatal errors when practiced crudely, carefully controlled measurements can yield several structural parameters with a precision adequate to satisfy any practical metallurgist.

11978. Pella, P. A., DeVoe, J. R., **The determination of tin in copper-base alloys by Mössbauer spectrometry,** *Anal. Chem.* **42,** No. 14, 1833-1835 (Dec. 1970).

Key words: Alloys; analysis; internal standard; Mössbauer spectrometry; stannic oxide.

The Mössbauer spectrometric method was applied to the determination of tin as stannic oxide in NBS SRM copper-base alloys. After converting the Sn in the alloy to SnO_2 the absorption intensity of SnO_2 was measured versus β-Sn as an internal standard absorber. Stannic oxide was obtained by the dissolution of the alloys in nitric acid. This produces a precipitate contaminated by the coprecipitation of a number of elements. Through the use of an appropriate standard, it was shown that the Mössbauer technique can measure the SnO_2 concentration without interference. The results for alloys 52c, 184, and 37e were $7.82 \pm .05\%$ (7.85), $6.31 \pm .06\%$ (6.38), and $0.99 \pm .01\%$ (1.00), respectively, where the uncertainties are the relative standard deviation of the mean values and the numbers in parentheses are the NBS certified values.

11979. Perloff, A., **The crystal structure of sodium hexamolybdochromate(III) octahydrate, $Na_3(CrMo_6O_{24}H_6) \cdot 8H_2O$,** *Inorganic Chem.* **9,** No. 10, 2228-2239 (1970).

Key words: Heteropolymolybdate; x-ray crystal structure.

The detailed structure of the heteropoly salt $Na_3(CrMo_6O_{24}H_6) \cdot 8H_2O$ has been determined using three-dimensional x-ray diffraction data. The crystals are triclinic, space group $P\bar{1}$, with cell dimensions $a = 10.9080$ (4) Å, $b = 10.9807$ (4) Å, $c = 6.4679$ (2) Å, $a = 107.594$ (2)°, $\beta = 84.438$ (2)°, and $\gamma = 112.465$ (3)° at 25°. There is one formula unit per unit cell. Final refinement by least-squares analysis with anisotropic temperature factors resulted in an R value of 3.3%. The anion has the same structure as the $TeMo_6O_{24}{}^{6-}$ anion with excellent agreement of comparable bond distances. Charge balance and hydrogen-bonding arguments suggest that the hydrogen atoms of the anion are bonded to the oxygen atoms which are coordinated to the Cr atom. The anions are linked together through sodium octahedra and hydrogen bonding. No hydrogen atoms could be located directly, but a reasonable hydrogen-bonding scheme was inferred from short oxygen-oxygen distances.

11980. Prydz, R., Straty, G. C., Timmerhaus, K. D., **Properties of fluorine along the vapor-liquid coexistence boundary,** *J. Chem. Phys.* **53,** No. 6, 2359-2363 (Sept. 15, 1970).

Key words: Critical point; fluorine; latent heats of vaporization; saturated liquid densities; saturated vapor densities; vapor pressure.

Saturated liquid and vapor densities from the triple point to the critical points are reported. These data were derived from experimental PVT isochores and an accurate vapor pressure equation. The critical point parameters were estimated by fitting an equation to all experimental data within 20% of the critical temperature. Separate equations, each constrained to the new critical point parameters, were fitted to the saturated liquid and vapor densities. Latent heats of vaporization were calculated from the Clapeyron equation and compared to other published values. A vapor pressure equation based on the IPTS 1968 temperature scale is reported.

11981. Radebaugh, R., Siegwarth, J. D., **Theory of He^3-He^4 dilution refrigerators,** (Proc. 1970 Ultralow Temperature Symp., Washington, D.C., April 23-24, 1970), *NRL Report 7133*, pp. 63-81 (1970).

Key words: Cryogenics; dilution refrigerator; Fermi-Dirac statistics; heat exchangers; helium-3; helium-4; liquid helium; mixtures; quantum fluid; thermodynamic properties.

A review is given concerning the theoretical analysis of the dilution refrigerator. The weakly interacting Fermi-Dirac gas model for He^3 dissolved in superfluid He^4 is developed in detail to give accurate and self-consistent values for thermodynamic properties of the dilute solutions. These calculated properties, along with measured properties of pure He^3, are used to analyze the behavior of the dilution refrigerator in the continuous mode. The temperature which can be reached with a given number of perfect discrete heat exchangers is derived. The analysis of a typical discrete heat exchanger taking thermal conductivity of the liquids into account shows it behaves nearly like the extreme of small length to area ratio, $l/A \ll 1$. The other extreme of zero liquid conductivity, or $l/A \gg 1$, is shown to be much more efficient for the same liquid volume but is difficult to make with low flow impedance. The optimum ratio of dilute to concentrated liquid volumes is found to be 2.1 for the heat exchanger analyzed.

11982. Reader, J., Sugar, J., **Ionization energies of Ce I and Gd I,** *J. Opt. Soc. Am. Letter to Editor* **60,** No. 10, 1421-1422 (Oct. 1970).

Key words: Cerium; gadolinium; ionization energy.

The ionization energies of neutral cerium and gadolinium are derived using a semi-empirical method.

11983. Rush, J. J., Schroeder, L. W., Melveger, A. J., **Infrared and Raman spectra of sodium bifluoride: Isotope dilution studies,** *Chem. Phys. Letters* **6,** No. 5, 533-536 (Sept. 1, 1970).

Key words: Bending vibration; hydrogen bond; infrared; isotope dilution; lattice mode; Raman; sodium bifluoride; stretching vibration.

IR and Raman spectra for sodium bifluoride containing 2, 11 and $\approx 80\%$ $DF_2{}^-$ are presented. Changes in the $DF_2{}^-$ ν_2 and ν_3 IR bands with deuteration are related to coupling between like oscillators or states. Raman assignments are made for the $HF_2{}^-$ ν_1 and lattice librational (E_g) modes.

11984. Saylor, C. P., **Broken Virtue,** *Capital Chem.* **20,** No. 6, 137-140 (Sept. 1970).

Key words: Art restoration; Cellini; chemical microscopy; National Gallery of Art; Renaissance bronzes; Widener collection.

A bronze statuette now named Virtue Overcoming Vice, assigned to Benvenuto Cellini was broken on arrival at the National Gallery of Art. Chemical microscopical studies established that the break was not new. The piece had been broken before and repaired. Spectroscopic studies were compatible with the attribution to Cellini.

11985. Sengers, J. M. H. L., **Scaling predictions for thermodynamic anomalies near the gas-liquid critical point,** *Ind. Eng. Chem. Fundamentals,* **9,** No. 3, 470-480 (Nov. 9, 1970).

Key words: Argon; carbon dioxide; classical equation; coexistence curve; critical exponents; critical point; lattice gas; power laws; rectilinear diameter; steam; thermodynamic anomalies; vapor pressure.

Most empirical equations of state for gases have derivatives of all order in density and temperature at the critical point. This implies definite asymptotic characteristics ('classical') for thermodynamic anomalies in the critical region. Classical critical anomalies and symmetries are treated in some detail. The Ising model of statistical mechanics reveals an essentially different kind of critical behavior (nonclassical). A brief discussion is given. Real gases behave nonclassically. Therefore, classical equations of state cannot be valid in the critical region. The homogeneous or scaled equation of state, recently proposed by Widom, Kadanoff, and Griffiths, incorporates nonclassical critical anomalies. Its form and some of its consequences are discussed. Scaling ideas are applied to the correlation of coexistence curve data (for argon and steam) and vapor pressure data (for CO_2).

11986. Simmons, J. H., Macedo, P. B., **Viscous relaxation above the liquid-liquid phase transition of some oxide mixtures,** *J. Chem. Phys.* **53,** No. 7, 2914-2922 (Oct. 1, 1970).

Key words: Immiscibility; oxide glasses; relaxation times; supercritical fluctuations; ultrasonic spectroscopy; viscous relaxation.

The viscosity anomaly observed above the critical points of a series of sodium borosilicate melts is investigated by ultrasonic shear relaxation spectroscopy. The measurements were conducted at frequencies between 3 and 25 MHz and temperatures between 800 and 1300 °C. The samples tested have different critical temperatures as a result of small doping additions to the critical composition of the immiscibility surface in the phase diagram of the sodium borosilicate system. This permitted measurements over a wide range of reduced temperatures. Analysis of the data yields three structural relaxation parameters which are: the instantaneous shear modulus, the most probable relaxation time, and the width of the distribution of shear relaxation times. These parameters are related to the viscosity. It is found that while the instantaneous modulus and the most probable relaxation time appear unaffected by the presence of supercritical composition fluctuations, the width of the spectrum of shear relaxation times broadens drastically as the critical temperature is approached from above. Similar and parallel curves are formed from the widths of the distributions of relaxation times of all four samples when the temperature is properly normalized by the critical temperature. The general behavior of these curves exhibits the three reduced temperature regions predicted in a previously published relaxation model. The supercritical broadening of the width of the distribution of relaxation times accounts for the observed viscosity anomaly.

11987. Sitterly, C. M., **The present state of atomic spectra,** *J. Opt. Pura Aplicada* **11,** No. 3, 103-113 (1969).

Key words: Atomic spectra; coronal spectra; rare-earth spectra; solar spectra; spectra, atomic; spectra, rare-earth.

The present state of the analysis of atomic spectra is presented with special reference to the grades of analysis of all known spectra, the present work on rare-earth spectra and the needs for future work of astrophysical interest.

11988. Spencer, L. V., Stanley, W., **On neutron penetration in duct systems with large cross section,** *Proc. Special Session on Gamma-Ray Production and Transport and on Civil Defense Shielding, American Nuclear Society,* pp. 199-221 (Aug. 1969).

Key words: Albedo; civil defense; ducts; neutron penetration; nuclear weapons data; structure shielding.

Neutron albedo data for nonhydrogenous wall materials is insensitive to total cross section energy variations and to some extent details of cross section angular distributions. As a result, it makes sense to explore models in which the differential albedo is factored into energy dependent and direction dependent parts. This approximation results in a factoring of the transport equation for large enclosures into two parts, a one-velocity type of problem and a general problem of determining spectra for different orders of reflection. We extend this further to identify suitable parameters in terms of which data for elementary types of enclosure can be applied to complex configurations. These parameters are given, the procedure for combining duct sections is sketched, and calculations for a 3-legged duct are compared with Monte Carlo data for such a duct.

11989. Staveley, L. A. K., **Hard-sphere model applied to the solubility of gases in low-boiling liquids,** *J. Chem. Phys.* **53,** No. 8, 3136-3138 (Oct. 15, 1970).

Key words: Gas solubility; hard-sphere model; liquefied gases; phase equilibria; predicted thermodynamic parameters.

The hard-sphere model for fluids has been applied by Snider and Herrington to the calculation of the excess thermodynamic functions of binary liquid mixtures and also to the problem of the solubility of gases in liquids. While remarkably successful in the first case, it appeared to fail rather badly when applied to gas solubility. It is shown that this apparent failure was due to Snider and Herrington's choice of experimental data, and that in fact the approach is much more effective than they concluded in correlating and predicting the thermodynamic parameters for solutions of gases in low-boiling liquids. Results of calculations are presented for the systems argon-neon, nitrogen-hydrogen, methane-helium, and hydrogen-helium, where the first named component is the liquid solvent.

11990. Stein, P. G., **Image-analyzing microscopes,** *Anal. Chem.* **42,** No. 13, 103A-107A (Nov. 1970).

Key words: Computers; digital logic; image processing; microscope; microspectrophotometry; pattern recognition.

Image-processing technology, through expanded data gathering and storage capabilities, now has the potential to solve difficult problems in metallurgy, polymer and fiber chemistry, and cell biology. Many studies involving the counting and sizing of particles or fibers can be automated through the use of image-processing techniques.

11991. Wexler, A., **Measurement of humidity in the free atmosphere near the surface of the earth,** (Proc. American Meterological Society Symp. on Meterological Observations and Instrumentation, Washington, D.C., February 10-14, 1969), *Meterological Monographs* **11,** No. 33, 262-282 (Oct. 1970).

Key words: Dew point; hygrometry; meterology; moisture measurement in gases; psychrometry.

This paper is a survey of the state of the art in hygrometry as applied to humidity measurement in gases near atmospheric pressure. Hygrometric methods, techniques and instruments are divided arbitrarily into the following six classes involving methods dependent on: (1) the total removal of water vapor from a moist gas; (2) the addition of water vapor to produce a saturated gas; (3) the reversible sorption of water vapor by a sensor;

(4) the measurement of a physical property of a gas; (5) attaining the liquid-vapor or the solid-vapor equilibrium state of the water substance; and (6) chemical reactions and procedures. The methods of each class are further subdivided by principles of operation and are examined to assess such characteristics as range, accuracy, sensitivity, speed of response, effect of environmental conditions, and limitations in behavior and utility.

11992. Wiederhorn, S. M., Bolz, L. H., **Stress corrosion and static fatigue of glass,** *J. Am. Ceram. Soc.* **53,** No. 10, 543-548 (Oct. 1970).

Key words: Crack propagation; fracture; glass; static fatigue; stress corrosion.

Stress corrosion cracking of six glasses was studied using fracture mechanics techniques. Crack velocities in water were measured as a function of applied stress intensity factor and temperature, and apparent activation energies for crack motion were obtained. Data were consistent with the universal fatigue curve for static fatigue of glass, which depended on glass composition. Of the glasses tested, silica glass was most resistant to static fatigue, followed by the low-alkali aluminosilicate and borosilicate glasses. Sodium was detrimental to stress corrosion resistance. The crack velocity data could be explained by the Charles and Hillig theory of stress corrosion. It is probable that stress corrosion of glass is normally caused and controlled by a chemical reaction between the glass and water.

11993. Wiederhorn, S. M., Townsend, P. R., **Crack healing in glass,** *J. Am. Ceram. Soc.* **53,** No. 9, 486-489 (Sept. 1970).

Key words: Crack healing; fracture; glass; strength; surface.

Cracks in soda-lime-silica glass specimens closed spontaneously; the recovery in strength was determined by fracture mechanics techniques. Approximately 80% strength was recovered in cracks formed by mechanical shock, whereas approximately 20% was recovered in cracks that closed after being held open to the atmosphere for several minutes. The high strength recovery in the mechanically shocked specimens is attributed to the very active surface formed during fracture. If the surface is allowed to adsorb O_2 or H_2O vapor, the activity is reduced, and healing is less complete. Crack healing can introduce surface flaws into glass that cannot be detected by current methods of nondestructive testing.

11994. Yakowitz, H., **Some uses of color in metallography,** *Am. Soc. Testing Mater., Spec. Publ.* **480,** pp. 49-66 (1970).

Key words: Color photography; electron microscopy; electron probes; evaluation; metallography; microscopy; polarized electromagnetic radiation.

The application of various methods for using color in metallography is outlined. The methods include plane and circularly polarized light, color etching, and color separation photography. Instruments used to obtain subjects for the color metallography examples shown in this paper include the optical microscope, the electron probe microanalyzer, the scanning electron microscope, and the transmission electron microscope. A brief discussion of color films is given. The technique used to obtain color photographs is given in detail for each aspect of color metallography discussed.

11995. Adler, I., Walter, L. S., Lowman, P. D., Glass, B. P., French, B. M., Philpotts, J. A., Heinrich, K. F. J., Goldstein, J. I., **Electron microprobe analysis of Apollo 11 lunar samples,** (Proc. Apollo 11 Lunar Science Conf., January 1970, Houston, Texas), *Geochim. Cosmochim.* **34,** Suppl. 1, 87-92 (Jan. 30, 1970).

Key words: Analysis; electron probe; lunar samples; microanalysis; minerals; rocks.

Plagioclase feldspar, clinopyroxene and ilmenite in a polished thin section of a "Type A" crystalline rock were analyzed. The clinopyroxene grains are compositionally variable and both high Ca and low Ca phases are present. The plagioclase is compositionally homogeneous. The ilmenite is chemically homogeneous except for occasional, small areas of high local chromium concentration. Accessory minerals are: apatite (containing Cl, F, Y and Ce), troilite, and metallic iron.

Glassy spherules from the lunar soil are mostly similar in composition to the crystalline rocks; however, some appear to have been monomineralic.

The crystalline rock has apparently formed by relatively rapid cooling of a silicate melt under conditions of low oxygen partial pressure. Many components of the soil appear to have formed by meteoritic impact.

11996. Brauer, G. M., Huget, E. F., Termini, D. J., **Plastic modified *o*-ethoxybenzoic acid cements as temporary restorative materials,** *J. Dental Res.* **49,** No. 6, 1487-1494 (Nov.-Dec. 1970).

Key words: Dental restorative materials; EBA cements; plastic reinforced restoratives; restorative materials; temporary dental cements.

Effects of adding polymeric materials to powder components of EBA cements were studied. The most suitable additives for reducing the brittleness of EBA cements were acrylic and vinyl chloride copolymers.

11997. Davis, M. M., **Bronsted acid-base behavior in "inert" organic solvents,** Chapter 1 in *The Chemistry of Nonaqueous Solvents* **III,** 1-135 (Academic Press Inc., New York, N.Y., 1970).

Key words: Acid-base behavior; acidity and basicity scales; aprotic organic solvents; hydrogen bonding; titrations.

A unified picture of acid-base behavior in aprotic organic solvents is presented, based on an extensive survey of the literature and experimental results of the author and associates. Evidence given to support this picture includes data pertaining to colligative properties of acids, bases, and salts and also conductance, dielectric constants, distribution between immiscible solvents, and spectral absorption in the infrared, visible, and ultraviolet. The acids upon which attention is centered are proton-donor compounds that are measurably ionized in water, such as aliphatic and aromatic carboxylic acids, substituted phenols, and mineral acids. The bases of principal interest are likewise compounds capable of forming ions in water, for example, aliphatic and aromatic amines and derivatives of guanidine or pyridine. The solvents emphasized are hydrocarbons and halohydrocarbons, but data for dipolar aprotic solvents (for example, acetone, acetonitrile, and nitrobenzene) are included. Contrasts in acid-base behavior and in acidity and basicity scales in aprotic and water-like solvents are discussed.

The role of hydrogen bonding in aprotic solvents is discussed at length. Important types of hydrogen-bonded structures include chelate rings; self-associated acids, bases, and salts; hydrogen-bonded ion pairs; and homo- and heteroconjugate cations and anions. Examples are given in which hydrogen bonding of these types affects such properties as the absorption spectrum of a salt, the catalytic effect of an acid, and the accurate location of a titration endpoint.

11998. Dehl, R. E., **Collagen: Mobile water content of frozen fibers,** *Science* **170,** 738-739 (Nov. 13, 1970).

Key words: Adsorbed water; calorimetry; collagen; frozen collagen; mobile water; NMR.

The NMR spectra of frozen wet collagen fibers indicate the presence of a considerable amount of unfrozen, mobile water.

The quantity of mobile water may be estimated from the approximate convergence of the low temperature NMR splitting constants. An independent estimate of the mobile water content by calorimetry agrees well with the NMR estimate.

11999. Durst R. A., **Pick an ion, any ion,** *Ind. Res.* pp. 36-39 (Nov. 1970).

Key words: Electrode monitoring; industrial monitoring; ion-selective electrodes; pollutant monitoring.

A brief discussion is given of the types of ion-selective electrodes and the basic principles of their operation. The advantages of these sensors for industrial and environmental pollution monitoring are given, such as, the continuous direct-reading nature of the measurement, fast response time, and portability. Examples of typical industrial and environmental monitoring applications are included, for example, sulfide ion in pulp processing, nitrogen oxides and fluoride in air pollution, and nitrate in soil slurries. Care is necessary in applying these sensors to complex systems where interferences could be a problem and ingenuity is required in modifying the analysis parameters to obtain reliable results. The specificity and sensitivity of these sensors to several serious pollutants will probably result in their future use in pollution-monitoring systems.

12000. Gills, T. E., Marlow, W. F., Thompson, B. A., **Determination of trace elements in glass by activation analysis using hydrated antimony pentoxide for sodium removal,** *Anal. Chem.* **42,** 1831-1833 (Dec. 1970).

Key words: Activation analysis; glass; hydrated antimony pentoxide (HAP); radiochemical separations; sodium; trace elements.

A method has been developed for the determination of a number of trace elements at the ppm and ppb levels in high-sodium glass by neutron activation analysis. For glass containing about 10% sodium, neutron irradiation at levels sufficient to allow determination of trace constituents results in production of 10 mCi or more of ^{24}Na. If the ^{24}Na is allowed to decay before analysis, information about elements producing short-lived radioisotopes is lost. In the procedure described the radiosodium is removed by passing the dissolved glass through a column of hydrated antimony pentoxide (HAP). The effluent can be counted directly with a Ge(Li) or NaI(Tl) detector. The method has been applied to the analysis of NBS Standard Reference Material (SRM) glass which was found to contain 1 ppm of Cu and sub-ppm levels of Mn, Au, Ga, Sb, La, Co, and Ir.

12001. Greenberg, L., Newman, M., **Some results on solvable groups,** *Arch. Math.* **21,** No. 4, 349-352 (1970).

Key words: Density; solvable groups; 2-generator groups.

Let a, b be fixed relatively prime integers > 1. Let $s(n) = 1$ if a solvable group of order n exists generated by elements x, y such that $x^a / y^b = 1$; and 0 otherwise. It is proved that

$$1/x \sum_{n \leq x} s(n) \to 0 \qquad x \to \infty.$$

12002. Grosch, H. R. J., **A view of computers from the Bureau of Standards,** *Input* **6,** No. 2, 3-7 (1970).

Key words: Computer activities, NBS; computers; computer science at NBS.

A brief review is given of the activities of the Center for Computer Sciences at the National Bureau of Standards, in a popularized, informal treatment.

12003. Guttman, C. M., DiMarzio, E. A., **Separation by flow. II. Application to gel permeation chromatography,** *Macromolecules* **3,** No. 5, 681-691 (Sept.-Oct. 1970).

Key words: Chromatography; gel filtration; gel permeation chromatography; macromolecules; separation by flow.

Models of a gel permeation chromatography column are proposed in which there is flow through each of the beads as well as around them. Diffusion is allowed within and outside of the beads. By making general arguments on particle current flow, the volume elution is computed as a function of solute particle size for a simplified view of the column. The equation for the location of volume elution peaks thus derived shows functional dependences on the particle radius and the column geometry very much like equations derived by previous workers for models in which there was no flow in the beads. The method of Hermans to calculate the peak broadening is extended to allow for flow within the beads. Two times characterize the system; the time for a particle to diffuse into and out of the bead and the time to flush the particle out of the bead. The width of the volume elution peak no longer becomes infinite as the diffusion coefficient goes to zero (in contradistinction to the work of Hermans) since the residence time within the bead is never larger than the flush time. Explicit formulas are given for the first three moments of the volume elution; it is shown that the elution volume for a monodisperse species is Gaussian. In all cases systems with open pores which allow flow show better separation capabilities than those which do not allow flow.

12004. Henderson, M., Berry, P. L., **Progress of federal library automation,** *Drexel Library Quart.* **6,** Nos. 3 & 4, 249-263 (July-Oct. 1970).

Key words: Automatic data processing; automation of library functions; Federal libraries; Federal Library Committee (FLC); library automation; system design for libraries; Task Force on Automation.

Progress in automation for Federal libraries other than the three National libraries is the concern of the Federal Library Committee's Task Force on Automation. Its mission is to review automation developments in Federal libraries, to encourage compatible systems design, and to provide liasion between Federal libraries and other groups involved in automation of library functions and services. To fulfill this mission the Task Force has undertaken a phased program with four objectives: to review library automation developments; to define library functions not yet automated, but which benefit from automation; to develop a generalized system design for functions of the Federal Library community; and to establish a study and design sequence, for stepwise implementation of the system within that community. The first objective has been realized through the medium of two studies; the third phase, about to get underway, will work toward the longer-range objectives while building on and extending the earlier studies.

12005. Hirshfeld, A. T., Hoppes, D. D., **Transition mixing ratios determined from a study of the electron and gamma-ray distributions from oriented ^{192}Ir,** *Phys. Rev. C* **2,** No. 6, 2341-2349 (Dec. 1970).

Key words: Beta rays, angular distribution of; gamma rays, angular distribution of; hyperfine field in iron; nuclear orientation; transition mixing ratios; ^{192}Ir, magnetic moment of.

The angular distributions measured for 12 γ rays in ^{192}Os and ^{192}Pt resulting from the decay of cryogenically oriented ^{192}Ir have been used to determine the following $E2/M1$ mixing ratios: 201 keV, $\delta^2 > 3.7$; 296 keV, $\delta = -(6^{+3}_{-1})$; 308 keV, $\delta = -(7.1 \pm 0.6)$; 417 keV, $\delta = 4^{+7}_{-3}$; 485 keV, $\delta = 5.8 \pm 0.8$; 604 keV, $\delta = 1.5 \pm 0.1$, following the Rose-Brink sign convention. The angular distribution of the 672-keV β group and the above γ measurements limit the relative contribution, I_L, of different operator tensor ranks, L, involved in each β transition. The results for electron-capture transitions terminating at levels in osmium are: 694-keV level, $I_1 > 0.9$; 584-keV level, $I_0 > 0.6$, $I_2 < 0.1$. For β transitions feeding platinum states, we determine: 921-keV level, $I_1 > 0.8$; 785-keV level, $I_1 > 0.92$, $I_2 < 0.03$. The ^{192}Ir ground-state magnetic moment is determined to be positive.

12006. Ledbetter, H. M., **On the martensite crystallography of the cubic to orthorhombic transformation in Au-47.5 Cd,** *Scripta Met.* **4,** No. 11, 931-937 (Nov. 1970).

Key words: Crystallography; gold-cadmium alloy; martensite; phase transformation; twinning.

Complete calculations of the geometrical features of the cubic to orthorhombic martensitic transformation in the Au-47.5 Cd alloy system have been made for both Type I and Type II transformation twinning. None of the usual crystallographic features are sufficiently sensitive to distinguish between these two possible modes of lattice invariant deformation. Alternatives are offered which are believed to be experimentally simpler than those previously proposed.

12007. Marshak, H., Langsford, A., Tamura, T., Wong, C. Y., **Total neutron cross section of oriented ^{165}Ho from 2 to 135 MeV,** *Phys. Rev. C* **2,** No. 5, 1862-1881 (Nov. 1970).

Key words: Black-nucleus model; coupled channel calculation; nuclear orientation; nuclear Ramsauer effect; nuclear shape; optical-model; total neutron cross section; ^{165}Ho.

The difference in the total neutron cross section due to nuclear orientation, $\Delta\sigma_{def}$, has been measured for ^{165}Ho over the energy range of 2 to 135 MeV. The results show that $\Delta\sigma_{def}$ oscillates as well as changing sign, contrary to our classical concept of the interaction. The data, both σ_t and $\Delta\sigma_{def}$, are successfully fitted by adiabatic coupled-channel calculations using the optical model. The parameters for the optical model were determined by fitting σ_t and σ_R data (over approximately the same energy range as in the present work) for the two spherical nuclei Cd and Pb. The only additional quantity introduced was the quadrupole deformation parameter for ^{165}Ho which is known to be 0.33. The data for $\Delta\sigma_{def}$ can also be explained quite well by a simple semiempirical model which makes use of the black-nucleus model, the nuclear Ramsauer effect, and the experimental σ_t data. The temperature dependence of $\Delta\sigma_{def}$ agrees very well with our calculated values for the degree of nuclear orientation, which is consistent with ^{165}Ho being almost a pure quadrupole-shaped nucleus.

12008. Meadow, C. T., Meadow, H. R., **Organization, maintenance, and search of machine files,** Chapter 7 in *Annual Review of Information Science and Technology,* C. A. Cuadra, ed., pp. 169-191 (Encyclopedia Britannica, Chicago, Ill., 1970).

Key words: Data management; data structures; file organization; information retrieval; information systems; programming languages.

This article reviews the most significant literature in the field of file organization and search procedures that appeared during 1969. Among the points noted are the differences between total information systems and data management support systems and the separate development of several instances of each. The most important development is the trend toward data independence—separation of the concepts of logical and physical data organization.

12009. Meshkov, S., **Commentary on meson spectroscopy,** Chapter in *Experimental Meson Spectroscopy,* C. Baltay and A. H. Rosenfeld, eds., pp. 535-546 (Columbia Univ. Press, New York, N.Y., 1970).

Key words: A_2; mesons; resonances; spectroscopy; SU(3); SU(6)$_W$.

A description of a method for describing the split A_2 is presented, as well as some comments on the general problem of describing mesons and analyzing their structure.

12010. Moore-Sitterly, C. E., **Silicon in the sun,** Chapter in *Vistas in Astronomy (Commemoration of H. N. Russell),* A. Beer, ed., **12,** 307-312 (Pergamon Press Inc., New York, N.Y., 1970).

Key words: Silicon spectra in the sun's atmosphere; spectra of silicon, atomic and ionic in the sun; sun, silicon in the.

A brief survey is given of silicon lines in the spectra of the solar photosphere, chromosphere and corona. These lines arise not only from the spectrum of the neutral atom, but also from the ionic spectra of every stage of ionization, i.e., Si I through Si XIV. The ionization potentials range from 8 to 2673 eV, and the wavelengths of the solar identifications span the interval from 6 to 25129 Å. The wide range of excitation and ionization thus represented makes silicon a suitable element for detailed study of solar models, fluxes, abundances and the like.

12011. Neill, A. H., Jr., **High-energy light detector for use with pulsed ruby and glass lasers,** *Appl. Opt.* **9,** No. 10, 2392-2393 (Oct. 1970).

Key words: Calorimeter; detector; energy; laser; power; ruby.

A portable solid state light detector capable of measuring up to 100 joules of laser energy in the conventional mode has been designed and tested. Details on construction and operation are presented along with results of calibration.

12012. Okabe, H., **Photodissociation of HNCO in the vacuum ultraviolet; production of NCO $A^2\Sigma$ and NH ($A^3\pi$, $c^1\pi$),** *J. Chem. Phys.* **53,** No. 9, 3507-3515 (Nov. 1, 1970).

Key words: Bond dissociation energy; fluorescence; HNCO; NCO $A^2\Sigma$; NH $A^3\pi$, $c^1\pi$; photodissociation; vacuum ultraviolet.

Strong emissions bands originating from NCO $A^2\Sigma$ and NH ($A^3\pi$, $c^1\pi$) were found in the photodissociation of HNCO in the vacuum ultraviolet. In addition, weak bands coming from NCO $B^2\pi$ were observed. Threshold energies of incident photons to produce these bands were measured, from which the following bond dissociation energies and heats of formation were obtained: D(H-NCO) = 4.90 ± 0.01 eV, D(HN-CO) = 3.38 ± 01 eV, D(N-CO) = 2.14 ± 0.15 eV, ΔH_f(HNCO) = − 1.0 ± 0.14 eV, ΔH_f(NCO) = 1.6 ± 0.15 eV. The emission spectrum, NCO $A^2\Sigma \rightarrow X^2\pi$, produced from the photolysis at the Xe and Kr lines shows that NCO $A^2\Sigma$ is highly excited in bending vibration, indicating that the upper state of HNCO from which NCO $A^2\Sigma$ predissociates has a bent NCO configuration. NH $c^1\Pi$ formed is highly rotationally excited. Experimental evidence is presented to show that NH $A^3\pi$ is produced primarily by a secondary process, CO $a^3\pi$ + NH $X^3\Sigma \rightarrow$ CO $X^1\Sigma$ + NH $A^3\pi$. Primary processes in the near-ultraviolet photolysis of HNCO are discussed on the basis of bond dissociation energies obtained in the present work.

12013. Parker, H. S., Harding, C. A., **Vapor growth of Al_2O_3 bicrystals,** *J. Am. Ceram. Soc.* **53,** No. 11, 583-585 (Nov. 11, 1970).

Key words: Aluminum oxide; bicrystals; crystal growth; vapor crystal growth.

Bicrystals containing symmetrical tilt boundaries with either the $[10\bar{1}0]$ or the $[11\bar{2}0]$ direction as the rotation axis were vapor-grown at 1740 °C using the reaction $2AlCl_3(g) + 3CO_2(g) + 3H_2(g) \rightarrow Al_2O_3(s) + 6HCl(g) + 3CO(g)$. Specimens as large as 3 by 5 by 20 mm were produced in 24 h. Chemical purity of the specimens is high, with < 0.1 ppm total cation impurities, as determined by activation analysis.

12014. Plante, E. R., Paule, R. C., **Explanation of the ΔH° vs ΔS° correlation,** *J. Chem. Phys.* **53,** No. 9, 3770-3771 (Nov. 1, 1970).

Key words: Heat of vaporization; least squares fits; second and third heats; ΔH-ΔS correlation.

A correlation of ΔH° vs ΔS° proposed in the literature as a means of evaluating best heats of vaporization is examined. The correlation which seems to employ second law heats is found to be a modification of the familiar third law method. It utilizes a different method of averaging experimental free energy changes than that employed by the usual third law method. It is shown that the correlation will normally produce a less precise heat than that obtained by averaging the usual third law heats.

12015. Rasmussen, A. L., **Laser energy and power measurement with a double reflecting plate calorimeter,** *Rev. Sci. Instr.* **41,** No. 10, 1479-1484 (Oct. 1970).

Key words: Calorimetry; laser; laser calorimetry; laser energy; laser power.

In a double reflecting plate calorimeter, the energy from a laser beam is partially absorbed by metal mirrors. The rest is reflected through an exit where it is free to interact with some medium. Characteristics of this calorimeter with a pair of aluminum plate mirrors are (1) wavelength range $\sim 0.1 - \sim 1\mu$, (2) energy input range $\sim 0.1 - \sim 50$ J/cm^2 (pulsed normal mode) and estimated power $\sim 100 - \sim 1000$ MW/cm^2 (pulsed Q switched) depending upon energy density, (3) estimated error $\pm 2\%$ over most of the ranges given, (4) 5 sec for the plates to reach a uniform temperature and to make measurements, and 2-4 min required cooling time between inputs, and (5) both absorption and reflection determined from plate calorimetric data. The sensitivity and the wavelength, energy, and power ranges may be increased by using different plate dimensions and materials. Data from an intercomparison between this calorimeter and an NBS liquid cell calorimeter yield agreement of about 0.6% at 0.6943 μ. The light was *p* polarized (electric vector parallel to the plane of incidence). The energy of the components of polarization parallel and perpendicular to the plane of incidence of a light beam may be evaluated.

12016. Raveché, H. J., Mountain, R. D., **Three body correlations in simple dense fluids,** *J. Chem. Phys.* **53,** No. 8, 3101-3107 (Oct. 15, 1970).

Key words: Neutron diffraction; Percus-Yevick equation; radial distribution function; simple liquids; superposition approximation; three body correlation function; x-ray diffraction.

Correlations between triples of molecules in simple fluids at thermodynamic equilibrium are studied through their contribution to the isothermal density derivative of the pair probability density. Explicit computations are performed to indicate the role of the triplet function in accounting for the structure of the density derivative of the radial distribution function. The results imply that contributions from triplet correlations are in general quite appreciable. Various consequences of the results are discussed, and the procedure is examined in general as a method for studying correlations between triples of molecules in simple fluids.

12017. Roth, R. S., Waring, J. L., Parker, H. S., **Effect of oxide additions on the polymorphism of tantalum pentoxide. IV. The system Ta_2O_5-Ta_2WO_8,** *J. Solid State Chem.* **2,** 445-461 (1970).

Key words: Melting points; phase equilibria; system tantalum oxide-tantalum tungstate.

The low-temperature form of pure Ta_2O_5 has been found to exist in two slightly different modifications. The lowest temperature form has a *b* axis multiplicity of 14 whereas the highest temperature form (about 1350 °C) has a multiplicity of 11. At intermediate temperatures an "infinite" number of at least partially ordered sequences of these two modifications exist in equilibrium.

The addition of WO_3 to Ta_2O_5 causes the "stabilization" of an "infinite" number of phases similar in structure to the low temperature form of Ta_2O_5. From just less than 10 mol% WO_3 to the last compound in the series at 26 2/3 mol% WO_3 these phases are in equilibrium with liquid, and the high temperature structure type of pure Ta_2O_5 is eliminated from the phase diagram. One compound, $15Ta_2O_5 \cdot 2WO_3$ with a multiplicity of 8, was found to melt congruently at about 1815 °C and the last phase, $11Ta_2O_5 \cdot 4WO_3$ with a multiplicity of 13, melts incongruently at about 1605 °C.

12018. Santone, L. C., Berlin, G., **Location of fire stations,** *Proc. WORC Symp. Systems Analysis for Social Problems, National Bureau of Standards, Gaithersburg, Maryland, May 26-28, 1969,* pp. 79-91 (Dec. 3, 1970).

Key words: East Lansing, Mich.; facility location; fire station; simulation model; systems analysis; urban analysis.

This study was part of a project to demonstrate how a city staff, given adequate technical assistance and guidance, could use the methods of systems analysis to solve a particular problem. The city of East Lansing, Michigan, with the Technical Analysis Division of the National Bureau of Standards serving as "technical coach," developed a simulation model to aid in determining the number and location of fire stations necessary to protect the city adequately now and in future years.

12019. Sleater, G. A., Freeman, D. H., **Rapid desorption of chromium (III) from cation exchanger with hydrogen peroxide solutions,** *Anal. Chem.* **42,** No. 13, 1666-1668 (Nov. 1970).

Key words: Cation exchanger; chromium; hydrogen peroxide.

Conventional cation exchange resin is readily saturated with one Cr(III) cation per three exchange sites, but the adsorbed metal ion is then very difficult to desorb. This problem is solved by utilizing the rapid, irreversible and quantitative desorption that can be obtained with basic aqueous hydrogen peroxide. Under these conditions the desorption is caused by charge reversal, and the lack of affinity in the exchanger for the chromate anion. As expected, hydrogen peroxide in neutral or acid media is much less effective.

12020. Stevens, M. E., **Introduction to the Special Issue on Optical Character Recognition (OCR),** *Pattern Recog.* **2,** No. 3, 147-150 (Sept. 1970).

Key words: Automatic pattern recognition; handprinted characters; OCR standards; optical character recognition.

A brief introduction, stressing some aspects of the state of the art and the state of the practice of optical character recognition (OCR), is provided for a special issue of the journal, Pattern Recognition.

12021. Stevens, M. E., **Selected R&D requirements in the computer and information sciences,** *Proc. Fall Joint Computer Conf., Houston, Texas, November 17-19, 1970,* pp. 159-168 (AFIPS Press, Montvale, N.J., 1970).

Key words: Communication; information processing; languages; man-machine relationships; teleprocessing.

This paper presents an advance overview of a series of reports on R&D requirements in the computer and information sciences, based upon selective reviews of the literature. Examples of topics include: information acquisition, sensing and input, including pattern recognition; some overall systems design requirements with emphasis upon programming languages and advanced hardware technologies, and communication problems of machine-with-machine, man-with-machine, and man-with-man. Some of the possible contributions of the computer sciences to the more traditional library and information sciences are noted, but there are fundamental problems of human preception, learning, concept formation, and knowledge requiring interdisciplinary attack.

12022. Tsai, D. H., Bullough, R., Perrin, R. C., **Molecular dynamical studies of the motion of point defects in a crystalline**

lattice, *Proc. Phys. Soc. (London) C: Solid State Phys.* **3,** 2022-2036 (1970).

Key words: Atomic diffusion; defect motion; interstitial motion; jump frequency; lattice model; migration energy; migration entropy; molecular dynamics; random-walk theory; vacancy motion.

We have applied molecular dynamical type of calculations to the study of the motion of interstitials and vacancies in a crystalline lattice. Our purpose was to investigate the effects of lattice thermal oscillations on the motion and the interactions of these simple defects and to study the "random walk" problem of defect motion on an atomic scale. The lattice model was a three dimensional body centered cubic (bcc) model with a central force interaction potential which extended to second neighbours and simulated the interaction energies in α-iron. The lattice containing one or more defects was first relaxed statically to a configuration of minimum energy, corresponding to the condition of zero absolute temperature. A temperature was then given to the lattice by assigning a Maxwellian distribution to the velocity of components of the lattice points in a random order. The subsequent motion of the lattice points and of the defects was calculated according to classical mechanics.

Our dynamical results showed that the temperature dependence of the jump frequency of the defects was in general agreement with the random walk theory of atomic diffusion. From this temperature dependence, the energy and the entropy of defect migration were obtained. For interstitial motion, the migration energy from the dynamical model (0.23 eV) was the same as that from static calculations. For vacancy motion, the migration energy from the dynamical model (0.42 eV) was lower than that from static calculations (0.60 eV). Possible reasons for this difference are discussed.

12023. Wasik, S. P., Tsang, W., **Determination of trace amounts of contaminants in water by isotope dilution gas chromatography,** *Anal. Chem.* **42,** No. 13, 1649-1651 (Nov. 1970).

Key words: Aromatics; gas chromatography; isotope dilution; olefins; water analysis.

An isotope dilution technique using gas liquid chromatography is proposed for the quantitative analysis of trace organic pollutants in water supplies. The method was demonstrated using benzene with perdeuterated benzene as the isotope with both substances in the ppb concentration range. Columns with aqueous silver nitrate as the stationary phase were used to determine the ratio of the concentration of benzene to perdeuterated benzene.

12024. Wasik, S. P., Tsang, W., **Gas-liquid chromatography separations of hydrocarbons using columns with aqueous solutions of complexing metal ions as stationary phases,** *Anal. Chem.* **42,** No. 13, 1648-1649 (Nov. 1970).

Key words: Aliphatics; aromatics; complexing effects; gas chromatography; group separation; mercuric nitrate; olefins; silver nitrate; surface effect.

Interesting hydrocarbon selectivity was obtained in gas-liquid chromatography using aqueous solutions of Ag^+ and Hg^{++} ions as the stationary phases. This was achieved by taking advantage of the complexing properties of these ions and the large surface effect of the solution. Columns may be designed to be specific for certain hydrocarbon groups using this technique.

12025. Weir, C. E., Block, S., Piermarini, G. J., **Compressibility of inorganic azides,** *J. Chem. Phys.* **53,** No. 1, 4265-4269 (Dec. 1970).

Key words: Anisotropic compressibility; azides; compressibility; high pressure; single crystal; x-ray diffraction.

The compressibility of α lead azide, β lead azide, barium azide, potassium azide, sodium azide, and thallium azide have been measured by single-crystal x-ray diffraction techniques for the first time in a new application of the diamond anvil pressure cell. Both the anisotropic and volume compressibilities are reported. The pressures were determined by measurements at the known freezing points of n-hexane and ethanol. A phase transition occurs in thallium azide at a pressure between the freezing points of chloroform (5390 bar) and n-decane (2990 bar). Pressure-temperature observations in the diamond cell of lead azide were carried out to 300 °C and approximately 30 kbar. No phase transitions were observed. Radiation damage to azide crystals under high pressures is reduced significantly.

12026. Unassigned.

12027. Brenner, A., **Note on the electrodeposition of magnesium from an organic solution of a magnesium-boron complex,** *J. Electrochem. Soc.* **118,** No. 1, 99-100 (Jan. 1971).

Key words: Decaborane; electrodeposition of magnesium; lithium deposition; nonaqueous electroplating; organometallic compound.

A magnesium electroplating bath which yields smooth, white deposits, has been prepared from lithium methyl, decaborane, and magnesium chloride. The solvent consisted mostly of tetrahydrofuran.

12028. Cezairliyan, A., **High-speed methods of measuring thermophysical properties at high temperatures,** (Proc. Conf. Thermophysical Properties, Manchester, England, April 7-10, 1970), *Rev. Inst. Hautes Temper. Refract.* **T.7,** 215-229 (1970).

Key words: High-speed measurement methods; high temperatures; thermodynamics; thermophysical properties.

In this paper, "high-speed" refers to experiments which are of subsecond duration. However, in some cases quasi-dynamic experiments with durations greater than one second are also included. Advantages of high-speed measurement of thermophysical properties of substances at high temperatures (above 2000 K) are presented. Requirements of high-speed measurements are given. Methods used for the generation and measurement of thermal energy in short times are described. Various techniques (photoelectric, photographic, and others) used for the measurement of the temperature of rapidly heating or cooling specimen are presented. Techniques for high-speed recording of quantities are described. Particular attention is given to millisecond-resolution digital data acquisition systems. Application of the high-speed techniques to the measurement of specific heat, electrical resistivity, thermal radiation properties, melting point, thermal diffusivity and others are described. Accuracy of high-speed measurements are discussed and are compared with those of conventional methods. Potential applications of high-speed methods are presented.

12029. Chamberlain, G. E., Mielczařek, S. R., Kuyatt, C. E., **Absolute measurement of differential cross sections for electron scattering in helium,** *Phys. Rev. A* **2,** No. 5, 1905-1922 (Nov. 1970).

Key words: Absolute differential cross section; Born; elastic; electron impact; helium; inelastic.

Absolute measurements of cross sections for electron-impact scattering in helium at an angle of 5° have been made for elastic scattering and excitation of the 2^1P and 2^1S states and for incident energies of 50-400 eV. Cross-section values of $\sigma(2^1P,5°)$ are found to be lower than theoretical Born values by $(9.5 \pm 5.4)\%$ at 400 eV, $(31.5 \pm 4.6)\%$ at 100 eV, and $(62.5 \pm 3.4)\%$ at 50 eV. Deduced values of total 2^1P excitation cross sections ($E \geqslant 100$ eV) are in agreement with other experimental values. Our measurements for elastic scattering agree well with recent theoretical calculations.

12030. Colson, J. P., Reneker, D. H., **Polyoxymethylene crystals grown within irradiated trioxane crystals,** *J. Appl. Phys.* **41,** No. 11, 4296-4312 (Oct. 1970).

Key words: Chain folded crystals; crystal growth mechanisms; electron diffraction of polymers; electron microscopy of polymers; polymer crystals; polymer morphology; polyoxymethylene crystals; post irradiation heat treatment; α-particle initiation.

The morphological development of polyoxymethylene crystals polymerized from and grown within trioxane crystals was observed following irradiation of the trioxane with alpha particles and a subsequent heat treatment. A novel method of sample preparation enabled the morphology to be observed in detail and resulted in the discovery of new forms of polyoxymethylene crystals as well as an improved description of previously reported forms. A solid-gas-solid crystal growth mechanism was postulated to account for the predominantly acicular habit of the polyoxymethylene crystals.

12031. Czyz, W., Maximon, L. C., **Coulomb effects in high energy He^4-He^4 elastic scattering,** *Ann. Phys.* **60,** No. 2, 484-486 (Oct. 1970).

Key words: Diffraction scattering; Glauber model; He^4-He^4 elastic scattering; high energy Coulomb effects; high energy scattering.

In this note we extend the results of previous work (Ref. [1]) for high energy He^4-He^4 elastic scattering to include the Coulomb corrections. We find these corrections important around the diffractive minima.

12032. Day, G. W., Gruzensky, P. M., **Some optical properties of cesium cupric chloride,** *Appl. Opt.* **9,** No. 12, 2794-2795 (Dec. 1970).

Key words: Crystal growth; $CsCuCl_3$; electrooptic effect; index of refraction; nonlinear optics; transmission.

Cesium cupric chloride has been suggested as a possible material for nonlinear optical processes in the wavelength region near 10 μm. However, insufficient information about the optical properties of this material has been available to evaluate its suitability for these applications. This paper reports data on the transmission characteristics and index of refraction of $CsCuCl_3$ as well as method of growth. Possible applications are discussed, based on this information.

12033. Dillon, T. A., Smith, E. W., Cooper, J., Mizushima, M., **Semiclassical treatment of strong collisions in pressure broadening,** *Phys. Rev. A* **2,** No. 5, 1839-1846 (Nov. 1970).

Key words: Classical path approximation; intermolecular potential; pressure broadening; strong collision.

The classical-path approximation reduces the problem of pressure broadening of spectral lines to the evaluation of matrix elements of the scattering operator. If the intermolecular potential is long range and the interaction volume is large, the broadening is caused by distant or weak collisions. In this case, the scattering operator can be approximated by a second-order expansion, and the perturber trajectories can be taken to be straight paths. For neutral atoms or molecules, the intermolecular potential is short range and broadening arises from close or "strong" collisions. In this paper it is shown how classical trajectories, determined by a "scalar interaction" (i.e., one that does not depend upon the state of the radiator), can be used to expand the scattering operator in the sum of operators characteristic of the radiator's internal states.

12034. Ederer, D. L., Lucatorto, T., Madden, R. P., **Autoionization spectra of lithium,** *Phys. Rev. Letters* **25,** No. 22, 1537-1540 (Nov. 30, 1970).

Key words: Absorption spectroscopy; autoionization; configuration interaction; K electron excitation; lithium vapor; two electron excitation.

Resonances have been observed in neutral lithium vapor by absorption spectroscopy for photons in the 50- to 70-eV energy range. These resonances are due to the excitation of a *K*-shell electron, or the simultaneous excitation of a *K*-shell electron and an outer electron to final states of the type $(1s2pnl)$ or $(1snln'l')$. Several well-developed series have been observed as well as resonances where energy position and intensity are perturbed by neighboring configurations.

12035. Gadzuk, J. W., **A comparison between the Fermi-Thomas and quantum dielectric response of a metal surface to a static point charge,** *Surface Sci.* **23,** 58-68 (1970).

Key words: Adsorption; electron gas; impurities; surface physics.

Recently published theoretical treatments of the screening of a point charge in the surface region of a bounded electron gas are considered. The Fermi-Thomas semi-classical electrostatic screening theory of Newns is compared with the quantum screening theory of the present author. Simple formulae for dipole moments and binding energies are given. The results are essentially equivalent for the two cases aside from numerical factors which are manifestations of the fact that Fermi-Thomas screening is too efficient.

12036. Hahn, T. A., **Thermal expansion of copper from 20 to 800 K—Standard Reference Material 736,** *J. Appl. Phys.* **41,** No. 13, 5096-5101 (Dec. 1970).

Key words: Components of error (within and between samples); copper; interferometer; standard reference material; thermal expansion.

Copper is the first of a series of materials that will be certified as thermal-expansion standards by the National Bureau of Standards. The results of tests on five specimens indicate the stock is of consistent quality so that it may be certified as Standard Reference Material 736. A Fizeau interferometer was used for the expansion measurements. Above room temperature a controlled-atmosphere furnace using a calibrated Pt vs Pt-10% Rh thermocouple was used. Below room temperature a cryostat capable of operation with both liquid nitrogen and helium was used with a calibrated platinum resistance thermometer. Values of expansivity were calculated between equilibrium temperatures. The expansivity was used in the analysis of the data. Third-order polynomials were fitted to the data for each of the five specimens in the overlapping temperature ranges from 0 to 70 K, 50 to 270 K, and 210 to 800 K to test for variations between the specimens. The deviations between the five equations were well within the standard deviations of the data for each of the specimens in the respective temperature intervals. All the expansivity data were then pooled and used to obtain an equation for each of the temperature ranges given above. These equations and their integrals were used to calculate the final values of expansivity and expansion, respectively. The results of the statistical analysis of the expansion and expansivity data are presented. A comparison is made with the data in the literature.

12037. Hamer, W. J., **Standard cells,** *The Primary Battery,* George W. Heise and N. Corey Cahoon, eds., **1,** No. 12, 433-477 (John Wiley & Sons Inc., New York, N.Y., Jan. 1971).

Key words: Electromotive force; saturated standard cells; standard cells; unsaturated standard cells.

This paper gives a survey of saturated and unsaturated standard cells including descriptions of their construction and their behavior under diversified conditions. The survey also includes a discussion of the role standard cells play in the maintenance of the unit of electromotive force. A discussion of the Hulett standard battery is also included.

12038. Harvey, J. L., Milliken L. T., Forthofer, R. J., **Trends in motor vehicle brake fluids and their standards,** *Proc. Society of Automotive Engineering Conf.,* Paper No. 710253, pp. 1-17, (Jan. 11-15, 1971).

Key words: Brake fluids; brake fluid standards; motor vehicle brake fluid; passenger car braking systems.

The development of motor vehicle brake fluids (MVBF's) and of their specification requirements is reviewed and discussed with emphasis on the major problems encountered in service. Those factors held to be of major importance in establishing performance requirements for MVBF's are considered also, and applied to the major changes that have recently been proposed for revision of Federal Motor Vehicle Safety Standard No. 116. The needs and possibilities for further revisions in the MVBF safety standard are examined. Finally, potential effects of some current trends in the design of passenger car braking systems are considered.

12039. Heydemann, P. L. M., **A simple and dependable electrical feedthrough for high pressures,** *Rev. Sci. Instr.* **41,** No. 12, 1896 (Dec. 1970).

Key words: Closure; feedthrough; high pressure; leads.

This note describes a novel type of high pressure feedthrough capable of withstanding more than 25 kbar repeatedly. It can be used for measurements with DC requiring very high insulation resistance as well as for RF up to 30 MHz.

12040. Kelley, R. D., Klein, R., Scheer, M. D., **Isotope effects in the hydrogen-atom addition to olefins at low temperatures,** *J. Phys. Chem.* **74,** No. 25, 4301-4309 (1970).

Key words: Atom addition; hydrogen isotopes; low temperatures; olefins; orientation; quantum tunneling.

The ratio of rates of addition of atomic hydrogen to the two possible sites of the double bond for several olefins has been measured over the temperature range 63-143 K. A pronounced isotope effect was found. In the comparison of addition ratios at a given temperature, the data show that the isotope effect is related to the value of the addition ratio, large ratios showing relatively large effects. The ratio of terminal to nonterminal addition of H to propylene at 90 K is 126, while for D it is 398. The ratio of H addition to carbon 2 relative to carbon 3 in *cis*-2-pentene at 90 K is 1.5 and that of D is the same. The results of these finds are discussed in terms of a one and two barrier model for the reaction of H with the olefinic bond. Both zero point energy effects and quantum tunneling of H through the reaction barriers are considered. It is concluded that a two barrier model with tunneling is most appropriate. The data generated from the H atom-olefin addition reactions in the low temperature region support the existence of chemical quantum tunneling. This is apart from the more equivocal arguments based on curvature of Arrhenius plots although indeed such curvature is found in the low-temperature H-atom additions.

12041. Lamb, V. A., Johnson, C. E., Valentine, D. R., **Physical and mechanical properties of electrodeposited copper, III. Deposits from sulfate, fluoborate, pyrophosphate, cyanide, and amine baths,** *J. Electrochem. Soc.* **117,** Nos. 9, 10, 11, 291C-318C, 341C-352C, 381C-404C (Sept., Oct., Nov. 1970).

Key words: Annealing-electrolylic copper; electrodeposited copper; impurity content; properties of mechanical structure.

This paper is the third published report on the results of a broad program on properties of electrodeposited copper, sponsored jointly by the American Electroplaters' Society, The International Copper Research Association, Inc., The Copper Development Association, and the National Bureau of Standards. The first paper is a comprehensive review of the literature to 1965. The second paper is an interim report on experimental results. The present and final paper, which incorporates the data in the second, includes data from the baths designated in the title, for deposits prepared under a wide range of operating conditions and with use of a variety of addition agents. Properties measured include tensile strength, yield strength, elongation, modulus of elasticity, fatigue strength, hardness, internal stress, density, electrical resistivity, and thermal expansivity. Properties were measured for as-plated deposits, deposits after annealing at several temperatures, after cold-working, and at low and high ambient temperatures. Structure of deposits was examined by optical, electron micrograph, and x-ray methods. Content of impurities in deposits was determined. Correlations are developed among properties, structure, impurity content, type of bath, and operating conditions.

12042. Larsen, N. T., Clague, F. R., **The NBS type II power measurement system,** *Proc. 25th Annual 1970 Instrument Society of America Conf. and Exhibit, Philadelphia, Pa., October 26-29, 1970,* 11 pages (1970).

Key words: Bridge; leveler; microwave; power; self balancing; stabilizer.

The design, construction, and performance of a new solid state microwave power measuring system are described. The instrument consists of two modules – a self-balancing bolometer bridge and a reference generator. The reference generator is a multifunction module which may be used as either a 0.01 percent dc voltmeter with a 0 to 10 volt range, a 0 to 10 volt dc reference voltage source of 0.01 percent absolute accuracy, or a precision microwave power leveler. A six-decade divider provides high precision in all three functions.

A comprehensive error analysis and complete schematic diagrams are included.

12043. Lightbody, J. W., Jr., **Electron scattering sum rule for ^{12}C-experiment and theory,** *Physics Letters* **33B,** No. 2, 129-132 (Sept. 1970).

Key words: Electron scattering; momentum transfer; pair correlation; shell model; spurious; sum rule.

Inelastic electron scattering cross sections for ^{12}C have been integrated to form the longitudinal and transverse sums as a function of momentum transfer. Comparison is made with sum rules calculated in the harmonic oscillator model. The various two-body correlation functions which enter the sum are evaluated for ^{4}He, ^{12}C and ^{16}O in the oscillator model.

12044. Maki, A. G., Olson, W. B., Sams, R. L., **HCN rotational-vibrational energy levels and intensity anomalies determined from infrared measurements,** *J. Mol. Spectry.* **36,** No. 3, 433-447 (Dec. 1970).

Key words: Absorption; energy levels; gas laser; HCN, hydrogen cyanide; infrared; rotational constants; spectra; vibrational constants.

New measurements have been made on the infrared transitions 11^10-00^00, 04^00-00^00, 12^00-01^10, 12^20-01^10, 05^10-01^10, 13^30-02^20, 13^10-02^00, 12^20-00^00, and 20^00-00^00 for HCN and on the 11^10-00^00 transitions for both $H^{13}C^{14}N$ and $H^{12}C^{15}N$. Wherever possible those measurements were combined with laser measurements to obtain the best set of constants for describing the energy levels. Unusual intensity distributions were observed and attributed to intensity mixing through *l*-type resonance. Several *P*-branch lines of a Δ-Σ ($12^{2}0$-$00^{0}0$) transition were also observed although the intensity was somewhat less than predicted from *l*-type resonance effects.

12045. McCaa, W. D., Jr., Nahman, N. S., **Generation of reference waveforms by uniform lossy transmission lines,** *IEEE Trans. Instr. Meas.* **IM-19,** No. 4, 382-390 (Nov. 1970).

Key words: Lossy uniform transmission lines; oscilloscope errors; pulse generators; standard waveforms.

This paper describes a method for generating fractional nanosecond pulsed waveforms of known shape thereby providing an a priori means for establishing reference waveform generators or standards to be used in pulsed measurements and other applications. The method employs the band-limiting properties of a lossy uniform transmission line to produce a known waveform and generator impedance. A theory for generator characterization and application is presented that defines a given generator in terms of time-domain or frequency-domain functions. A new term called the "available" waveform is defined. Rms error is employed as the error criteria.

An example of generator design is given that employs planar skin-effect loss and provides an output response having 0.2 percent rms error over the interval $0 \leq t \leq 600$ ps referred to the inherent step response of the waveshaping line. The input transition generator is assumed to be a 30-ps unit ramp generator. Also, an application example is given that employs a reference waveform generator to evaluate a sampling oscilloscope. The reference waveform generator uses a Debye dielectric lossy transmission line. The rms error of the oscilloscope time-domain response is determined as a function of time.

12046. Mangum, B. W., Thornton, D. D., **Vibrating sample magnetometer for use at very low temperatures and in high magnetic fields,** *Rev. Sci. Instr.* **41,** No. 12, 1764-1766 (Dec. 1970).

Key words: Bimorph; cryogenic; low-temperature; magnetometer; piezoelectric; vibrating-sample magnetometer.

A high sensitivity vibrating sample magnetometer for use at very low temperatures is described. It can be made extremely compact by the use of a piezoelectric element as the vibrator. The complete magnetometer can be placed in the cryostat between the poles of an electromagnet and can be operated at high applied magnetic fields.

12047. Meinke, W. W., **The universal analytical instrument,** *Proc. 5th Annual National Conference on Industrial Research, Applying Emerging Technologies, Industrial Research, Inc., Chicago, Ill., September 18, 1969,* pp. 31-41 (1970).

Key words: Automated analysis; clinical chemistry; instrumentation; standard reference materials.

The Fifth Annual National Conference on Industrial Research focused attention on the "Application of Emerging Technologies." As part of a panel discussion on "Instrumentation Applications," the author was asked to discuss "The Universal Analytical Instrument." This topic has been interpreted as applying to the overall field of automated laboratory instrumentation.

A summary was given of the experience in automation of the NBS Analytical Chemistry Division consisting of nine sections and approximately sixty different analytical competences. Several specific areas, such as clinical chemistry, where standardized instrumentation has not kept pace with the needs were discussed. Automation in optimum operation should free a scientist for the important and essential decision-making process rather than replacing him entirely. Furthermore, when automated systems become the rule rather than the exception, it is absolutely essential that there be some kind of standardization (often using standard reference materials) built into the system so that one can get a measurement that really means something. Finally, there is a need for finding new ideas for automation rather than extending old ones.

12048. Murphey, W. M., Caswell, R. S., **Analysis of results of the Bureau International des Poids et Mesures thermal neutron flux density intercomparison,** *Metrologia* **6,** No. 4, 111-115 (Oct. 1970).

Key words: Data analysis; flux density; intercomparisons; least squares; standards; thermal neutrons.

The results of an international comparison of thermal neutron flux density standards sponsored by the Neutron Working Group of the Bureau International des Poids et Mesures have been analyzed using a method conceptually different from a companion analysis by Axton. Both methods, however, yield closely the same results. All individual values are within ±2.6% of the adjusted value, the average absolute deviation being about 1%.

12049. Plummer, E. W., Gadzuk, J. W., **Surface states on tungsten,** *Phys. Rev. Letters* **25,** No. 21, 1493-1495 (Nov. 23, 1970).

Key words: Electrons; single crystal faces of tungsten; spin-orbit split bands; tungsten.

The energy distribution of field-emitted electrons from single-crystal faces of tungsten exhibits structure which is extremely sensitive to surface contaminants. The structure for the (100) plane has the correct shape and energy expected for surface states resulting from spin-orbit-split bands. These results are in good agreement with recent theoretical predictions.

12050. Potzik, J., **A method for determining the dynamic response of an elastic load cell element,** *Rev. Sci. Instr.* **41,** No. 12, 1726-1731 (Dec. 1970).

Key words: Dynamic force; load cell; viscoelastic damping.

A method has been developed for determining the dynamic characteristics of a load cell element by subjecting it to sinusoidally time dependent forces, and an experiment using a piezoelectric shaker is described which illustrates the feasibility of the method. At present a simple viscoelastic model is assumed for the load cell element, and relaxation times on the order of 10^{-7} sec have been measured. The application of this information to load cells subjected to other types of dynamic forces is also discussed.

12051. Preston, J. D., Forthofer, R. J., **Correlation of vehicle, dynamometer and other laboratory tests for brake friction materials,** *Proc. Society of Automotive Engineers Conf., Detroit, Michigan, January 11-15, 1971,* Paper No. 710250, pp. 1-10 (1971).

Key words: Brake friction materials; coefficient of friction; friction assessment screening test machine; friction materials test machine; Girling scale dynamometer; inertia brake dynamometer; vehicle road tests.

The frictional properties of brake lining materials are greatly influenced by the manner in which they are used. Test procedures designed to measure the coefficient of friction of these materials can likewise produce widely differing results depending on the type of test conducted. This paper presents data illustrating the performance correlation of three commercially available brake lining materials when subjected to vehicle tests and some of the more commonly used laboratory test procedures.

12052. Radlinski, R. W., Forthofer, R. J., Harvey, J. L., **Operating performance of motor vehicle braking systems as affected by fluid water content,** *Proc. Society of Automotive Engineering Conf.,* Paper No. 710253, pp. 1-11 (Jan. 11-15, 1971).

Key words: Automotive hydraulic brake fluids; brake fluids performance; braking systems; low temperature viscosity.

Automotive hydraulic fluids are known to pick up water in service. This paper shows that a major portion of the water picked up by the brake fluid in a braking system is transmitted through the hoses. It discusses two major effects of water pick-up on brake fluid performance—reduction in vapor lock temperature and increase in low temperature viscosity. Performance data for several "wet" brake fluids operating in actual braking systems at high and low temperatures are presented.

12053. Santoro, A., **Absorption correction for diffraction measurements in complex cases,** (Proc. Intern. Summer School organized by the Commission on Crystallographic Computing of the Intern. Union of Crystallography, Ottawa, Canada, August 4-11, 1969), Chapter in *Crystallographic Computing,* F. R. Ahmed, S. R. Hall, and C. P. Huber, eds., pp. 283-290 (Munksgaard, Copenhagen, Denmark, 1970).

Key words: Absorption correction; diffraction; x ray.

A method is described for evaluating the absorption corrections in those cases in which, in addition to the crystal, other objects take part in the absorption.

The method is applied to the most commonly used diffraction technique.

12054. Santoro, A., Mighell, A. D., Reimann, C. W., **The crystal structure of a 1:1 cupric nitrate-pyrazine complex $Cu(NO_3)_2 \cdot (C_4N_2H_4)$,** *Acta Cryst.* **B26,** 979-984 (July 7, 1970).

Key words: Coordination complex; inorganic polymer; pyrazine ligand; x-ray structure determination.

The crystal structure of a 1:1 cupric nitrate-pyrazine complex, $Cu(NO_3)_2 \cdot (C_4N_2H_4)$, was determined by single-crystal x-ray diffraction techniques. This compound crystallizes in the orthorhombic system with $a = 6.712$, $b = 5.142$, and $c = 11.732$ Å, space group *Pmna*, $\rho = 2.19$ g.cm^{-3} and $Z = 2$. The intensities of 642 unique reflections were recorded by the 2θ-scan method and the structure was solved by an analysis of the three-dimensional Patterson map. The structure is a coordination polymer and consists of linear —Cu—pyrazine—Cu—pyrazine— chains. The nitrate groups lie in mirror planes normal to the chain axes and they are coordinated to the Cu^{II} ion unsymmetrically through two oxygen atoms. Refinement by anisotropic least-squares analysis gave an R value of 0.04.

12055. Selby, M. C., **The Bolovac and its applications,** *IEEE Trans. Instr. Meas.* **IM-19,** No. 4, 324-331 (Nov. 1970).

Key words: BOLOVAC; microwave current measurements; microwave power measurements; microwave voltage measurements.

The Bolovac is a novel device for the standardization and measurement of TEM voltage, current, and power from below 1 MHz through 18 GHz (potentially through 36 GHz). It can be used for attentuation measurement and as a superior impedance termination at all the above-mentioned frequencies. To date it is the first and only practical means of calibrating microwave current indicators and of evaluating oscilloscopes displaying 25-ps or shorter rise-time pulses.

It is felt that application of the Bolovac will radically improve power measurements. It reduces the problems arising from mismatch-error uncertainties, one of the major present sources of concern in power measurement; measurement of complex reflection coefficients; complex computations; use of error-limit charts; and measurement of effective efficiency and calibration factors. Its application should radically increase optimum accuracy and measurement-time efficiency in calibration facilities outside the National Bureau of Standards.

The Bolovac together with an RF generator can be used as a source of known voltage. It can also be used as an absorption power meter. It needs no RF calibration. It has a range as high as 40 dB depending on the desired precision and on whether one or more sensors (special bolometric disks) are used. Voltages down to 0.1 volt with accuracies of 0.5 percent and better (and corresponding power in 50-ohm systems) have been measured.

The paper describes the general features and application of the Bolovac and lists references to more comprehensive papers on the subject.

12056. Tjon, J. A., Gibson, B. F., O'Connell, J. S., **Trinucleon form factors calculated from realistic local potentials,** *Phys. Rev. Letters* **25,** No. 8, 540-542 (Aug. 24, 1970).

Key words: Charge; form factor; magnetic; nucleon potentials; repulsive core; ^{3}He; ^{3}H.

Charge and magnetic form factors are calculated using solutions of the three-nucleon Faddeev equations with the local two-nucleon potentials of Reid and of Malfliet and Tjon. The results give reasonable agreement with the data up to 9-fm^{-2} transfer, but do not reproduce the minimum at 11.8 fm^{-2} in the ^{3}He charge form factor.

12057. Van Brunt, R. J., Kieffer, L. J., **Angular distribution of O^- from dissociative electron attachment to O_2,** *Phys. Rev. A* **2,** No. 5, 1899-1905 (Nov. 1970).

Key words: Angular distribution of O_2; dissociative electron attachment; electron energy.

The angular distribution of O^- produced by electron bombardment of O_2 has been measured in the electron energy range 5.75-8.40 eV. The results show a strong energy dependence and are consistent with the theory of O'Malley and Taylor if the final O_2^- repulsive resonance state is assumed to have the symmetry $^2\Pi_u$, and if only the first two allowed partial waves of the incident electron corresponding to $L = 1$ and $L = 3$ contribute. The results indicate that the $L = 3$ term becomes more important as energy increases and thereby demonstrate that the single-term approximation for the angular distribution does not apply for this process.

12058. Van Brunt, R. J., Kieffer, L. J., **Angular distribution of protons and deuterons produced by dissociative ionization of H_2 and D_2 near threshold,** *Phys. Rev. A* **2,** No. 4, 1293-1304 (Oct. 1970).

Key words: Deuterium; dissociation; electron; hydrogen; molecule.

From observations of the kinetic-energy distribution of protons and deuterons at corresponding forward and backward angles with respect to the electron-beam direction, the forward momentum imparted to the dissociating H_2 (D_2) molecule by the incident electrons has been determined for electron energies up to 300 eV. The momentum transfer along the beam was found to remain nearly constant at all energies above threshold, although above 100 eV the values obtained for D_2 were systematically higher than the values for H_2. When corrected to the center-of-mass system, the angular distribution of H^+ (D^+) near threshold was found to contain a large isotropic component and an anisotropic component which deviates, in a manner suggested by Zare, from the $\cos^2\Theta$ dependence predicted from a simple dipole Born approximation.

12059. Allpress, J. G., Roth, R. S., **Structural studies by electron microscopy: Polymorphism of $ZrO_2 \cdot 12Nb_2O_5$,** *J. Solid State Chem.* **2,** 366-376 (1970).

Key words: Electron microscopy; lattice images; niobia; polymorphism; zirconia; $ZrO_2 \cdot 12Nb_2O_5$.

Three polymorphs of $ZrO_2 \cdot 12Nb_2O_5$ have been identified by the combined use of x-ray diffraction and electron optical techniques. The α form, which is the initial product of the reaction of ZrO_2 with Nb_2O_5 in the molar ratio 1:12, is isostructural with $TiNb_{24}O_{62}$. The monoclinic β form, produced by long annealing, has a more complex structure, and may contain intergrowths of a third, γ, polymorph. Lattice images of the β form, together with the diffraction data, are used to derive possible structures for these materials.

12060. Ballard, D., Yakowitz, H., **Spectrometer shield for stray iron x-ray radiation in the scanning electron microscope,** *Rev. Sci. Instr.* **42,** No. 1, 14-15 (Jan. 1971).

Key words: Increased sensitivity of touch alarm; scanning electron microscope; x-ray spectrometer shield.

A spectrometer shield for stray iron x-ray radiation was devised and installed in the scanning electron microscope. A modification to the touch alarm was also made to make the system operative.

12061. Boyd, M. E., Mountain, R. D., **Methods for determining the second virial coefficient of a gas from speed-of-sound data,** *Phys. Rev. A* **2,** No. 5, 2164-2167 (Nov. 1970).

Key words: Acoustic thermometry; equation of state; equilibrium gas properties; helium; second virial coefficient; speed of sound in gases.

Two methods of analyzing speed-of-sound data in gases to obtain the second virial coefficients $B(T)$ are compared. The older method, which assumes a form for the temperature dependence of B, is shown to correspond to finding an exact solution to an approximate differential equation for B, while a method recently proposed by Bruch solves the exact equation, but in an approximate manner. Examination of the errors in each method indicates that the first method is preferable.

12062. Brenner, A., Anderson, H. J., **Note on the preparation of rhenium oxychlorides,** *J. Electrochem. Soc.* **118,** No. 2, 373-374 (Feb. 1971).

Key words: Chemical vapor deposition; perrhenyl chloride; rhenium heptaoxide; rhenium oxytetrachloride.

This note describes a new method of preparing perrhenyl chloride, ReO_3Cl, by the reaction of rhenium heptaoxide with hydrogen chloride.

12063. Chappell, S. E., Humphreys, J. C., **Energy deposition in surface layers of silicon by monoenergetic electrons,** *Proc. 4th Intern. Conf. Electron and Ion Beam Science and Technology, May 10-14, 1970, Los Angeles, Calif.,* pp. 655-666 (The Electrochemical Society Inc., New York, N.Y., 1970).

Key words: Absorbed dose; absorbed-energy distributions; electron beams; energy deposition; silicon detectors; surface layers.

The energy absorbed from a normally incident electron beam by a thin silicon layer has been measured. The silicon layer was a transmission, semiconductor detector having a thickness less than the mean range of the incident electrons which had energies of 0.25, 0.50, 0.75, and 1.0 MeV. The fraction of beam energy absorbed in the silicon layer was determined from absorbed-energy distributions which were derived from pulse-height distributions measured with the detector. Measurements were made for two different cases: (1) energy absorbed in the specific layer alone and (2) the energy absorbed in the same layer as a part of a homogeneous, semi-infinite medium, i.e., a surface layer. In the latter case, a larger fraction of energy is absorbed for each incident energy. The results were compared with Monte Carlo calculations, with the measurements and calculations showing agreement better than 10 percent.

12064. Dibeler, V. H., Walker, J. A., McCulloh, K. E., **Photoionization study of chlorine monofluoride and the dissociation energy of fluorine,** *J. Chem. Phys.* **53,** No. 12, 4414-4417 (Dec. 15, 1970).

Key words: Chlorine monofluoride; dissociation energy; ionization energy; mass spectrometry; photoionization; vacuum ultraviolet.

Mass spectra and photoionization yield curves are obtained for the molecular and atomic ions of chlorine monofluoride. The atomic ions are formed both by ion-pair and by dissociative ionization processes, although the F^+ ion formed by the latter process is too weak for quantitative measurements. The ClF^+ curve exhibits a weak onset at 12.55 eV, ascribed to a hot band. An intense onset at 12.65 eV is ascribed to the (0, 0) transition. The observed thresholds for the Cl^+ ion support the spectroscopic determination of $D(ClF) = 2.558$ eV and, combined with a recent determination of the heat of formation of ClF, support the previously reported photoionization value of $D_0°(F_2) = 1.34$ eV.

12065. Edqvist, O., Lindholm, E., Selin, L. E., Asbrink, L., Kuyatt, C. E., Mielczarek, S. R., Simpson, J. A., Fischer-Hjalmars, I., **Rydberg series of small molecules. VIII. Photoelectron spectroscopy and electron spectroscopy of NO_2,** *Phys. Scrip.* **1,** 172-178 (1970).

Key words: Electron spectroscopy; NO_2; photoelectron spectroscopy; Rydberg series.

The photoelectron spectrum of NO_2 has been measured with high resolution up to 27.5 eV and interpreted by use of molecular orbital theory, taking especially the vibrational structure into account. The electron impact energy loss spectrum has been measured with electron energy 100 eV. The spectrum above 6.5 eV has been interpreted as due to Rydberg transitions and comparison with spectroscopic measurements have been made.

12066. Farabaugh, E. N., Mauer, F. A., **Application of a modified technique for x-ray topography of large crystals,** *J. Crystal Growth* **7,** 282-284 (1970).

Key words: Laser rod; orientation; ruby; single crystal; topography; x ray.

A transmission x-ray topography technique has been developed which is suitable for examining large, uncut crystals. A relatively large volume is represented in each photograph, and regions that are misoriented by more than 0.3° can be detected. Examination of single crystal ruby laser rods is used to illustrate the capabilities and limitations of the method.

12067. Harris, F. K., Fowler, H. A., Olsen, P. T., **Accurate Hamon-pair potentiometer for Josephson frequency-to-voltage measurements,** *Metrologia* **6,** No. 4, 134-142 (Oct. 1970).

Key words: Frequency-to-voltage ratio; Josephson effect; potentiometer; voltage standard.

Accuracy and precision of parts in 10^7 have been demonstrated in a potentiometer which compares dc signals in the 2 to 10 millivolts range from Josephson junctions, against the U.S. "legal volt," as maintained by a group of standard cells. The circuit comprises two (10×100 ohms) Hamon networks in series-to-parallel transposition, linked by a calibrated Kelvin-Varley current divider. The critical Hamon-circuit contacts are made through mercury-wetted amalgams; the entire circuit operates in smoothly stirred oil. Observations indicate the pair of Hamon boxes to be initially matched within 0.2 ppm at the operating temperature. Typical standard deviation in the day-to-day, run-to-run scatter of Josephson frequency-to-voltage ratio, measured with this instrument, is 0.3 ppm or less. Preliminary values for the observed ratio are in general accord with the quoted values of Parker et al., Petley and Morris, and Finnegan et al.

12068. Hellwig, H., **Areas of promise for the development of future primary frequency standards,** *Metrologia* **6,** No. 4, 118-126 (Oct. 1970).

Key words: Ion storage; laser stabilization; maser oscillator; metrology; quantum electronics; saturated absorption; slave oscillators.

This paper discusses possibilities which may lead to the development of future primary frequency standards of superior accuracy capability. Aspects of costs and field-usage are totally neglected. A review is given of the various methods and techniques which are currently employed in quantum electronic frequency standards or which have a potential usefulness. Various effects which influence the output frequency of a primary standard are associated with these methods. They are discussed in detail, and expectation values for the related uncertainties are given. For selected particles certain methods of interrogation, confinement, and particle preparation can be combined such as to minimize the net uncertainty due to all applicable effects. Different technical solutions are the result. A review of existing and proposed devices is given, including quantitative data on the stability and accuracy capability. Aspects of the most promising devices are discussed, and it is concluded that accuracy capabilities of 10^{-14} should be within reach of today's research and development.

12069. Hellwig, H., Vessot, R. F. C., Levine, M. W., Zitzewitz, P. W., Allan, D. W., Glaze, D. J., **Measurement of the unperturbed hydrogen hyperfine transition frequency,** *IEEE Trans. Instr. Meas.* **IM-19,** No. 4, 200-209 (Nov. 1970).

Key words: Frequency shift; frequency stability; hydrogen hyperfine transition; hydrogen maser; hydrogen storage; hydrogen wall collisions; NBS-III; teflon; universal time.

The results of a joint experiment aimed primarily at the determination of the frequency of the H^1 hyperfine transition $(F=1, m_F=0) \leftrightarrow (F=0, m_F=0)$ is reported. In terms of the frequency of the Cs^{133} hyperfine transition $(F=4, m_F=0) \leftrightarrow (F=3, m_F=0)$, defined as 9192 631 770 Hz, for the unperturbed hydrogen transition frequency the value

$$\nu_H = 1420\,405\,751.768 \text{ Hz}$$

is obtained. This result is the mean of two independent evaluations against the same cesium reference, which differ by 2×10^{-3} Hz. We estimate the one-sigma uncertainty of the value ν_H also to be 2×10^{-3} Hz. One evaluation is based on wall-shift experiments at Harvard University; the other is a result of a new wall-shift measurement using many storage bulbs of different sizes at the National Bureau of Standards. The experimental procedures and the applied corrections are described. Results for the wall shift and for the frequency of hydrogen are compared with previously published values, and error limits of the experiments are discussed.

12070. Hoer, C. A., Agy, D. L., **Broad-band resistive-divider-type directional coupler,** *IEEE Trans. Instr. Meas.* **IM-19,** No. 4, 336-343 (Nov. 1970).

Key words: Coupler; directional coupler; directivity; impedance measurements; power measurements.

A new lumped-circuit directional coupler is described for the 1-30 MHz frequency range. Directivity greater than 50 dB is achieved over this frequency range for coupling ratios of 30, 40, and 50 dB. Greater directivity can be achieved over a narrower frequency range, and the coupler can be tuned for essentially infinite directivity at a fixed frequency. The couplers, although resistive, can pass 100, 300, or 1000 watts for the coupling ratios of 30, 40, and 50 dB, respectively, with less than a 0.01-dB change in coupling ratio. The coupling ratios are constant with frequency to ±0.25 dB. Equations and curves are given for obtaining component values needed to design a resistive-divider-type coupler with any coupling from 3 to 60 dB.

12071. Hummer, D. G., Rybicki, G. B., **Noncoherent scattering-VII. Frequency-dependent thermalization lengths and scattering with continuous absorption,** *Monthly Notices Roy. Astron. Soc.* **150,** No. 4, 419-434 (1970).

Key words: Activation energy; H atoms; H_2S; rate constant; resonance fluorescence; vacuum-uv.

Our previous definition of the thermalization length is generalized to cases in which the initial photon frequency is prescribed. This permits treatment of cases in which the emissivity does not have a unique frequency dependence. This definition is then applied to the case of a line formed by scattering in the presence of continuous opacity. In this case the emissivity in the line has a unique frequency dependence but the total emissivity does not. Equations for the distribution of thermalization distances are derived both by a diagrammatic technique and by use of resolvents. Median thermalization lengths are defined in terms of these distributions. Extensive numerical results are reported and the utility of this approach is discussed.

12072. Ives, L. K., Ruff, A. W., Jr., **Extended dislocation configurations in hcp silver-tin alloys of low stacking-fault energy,** *Metal Sci. J.* **4,** 201-209 (May 1970).

Key words: Dislocation multipoles; dislocation networks; dislocation nodes; dislocations; electron microscopy; hexagonal alloys; silver-tin alloys.

Configurations resulting from the interaction of extended dislocations in hcp silver-tin alloys of low stacking-fault energy have been studied by means of transmission electron microscopy. The interactions of all possible sets of two different extended dislocations are considered. Since there are two distinct modes by which dislocations extend in the hcp structure, these interactions fall into two classes: Class I interactions occur between two extended dislocations having the same fault shear vector; Class II interactions involve two extended dislocations having opposite fault shear vectors. Interactions between two arrays of extended dislocations lead to the formation of networks. Among the configurations studied were two different types each of dipoles, dipole networks, multipoles, and extended nodes. The observed configurations are compared to those reported in hexagonal graphite. The Class I configurations are similar to those found in low-stacking-fault-energy fcc metals.

12073. Kuriyama, M., Miyakawa, T., **Primary and secondary extinctions in the dynamical theory for an imperfect crystal,** *Acta Cryst.* **A26,** Part 6, 667-673 (Nov. 1970).

Key words: Dynamical diffraction; imperfections; kinematical scattering; piezoelectric vibration; secondary extinction; theory; x-ray diffraction.

Primary and secondary extinction are studied using the dynamical theory of x rays diffracted by imperfect crystals. The transition from dynamical to kinematical scattering is explained in terms of fundamental processes in diffraction. Contrary to existing extinction theories, where the intensities diffracted dynamically by single coherent domains of a mosaic are combined using an *ad hoc* assumption of mosaic distributions, the present theory permits the dynamical *amplitudes* to change in response to disturbances of the dynamical interactions by imperfections. Neither the mosaic block model nor the statistical treatment of imperfections is used. The extinction of diffracted intensities is thereby treated as caused solely by *inhomogeneous* strains in a single coherent domain.

12074. Kurylo, M. J., Peterson, N. C., Braun, W., **Absolute rate of the reaction $H + H_2S$,** *J. Chem. Phys.* **54,** No. 3, 943-946 (Feb. 1, 1971).

Key words: Activation energy; H atoms; H2S; rate constant; resonance fluorescence; vacuum-uv.

Flash photolysis coupled with resonance fluorescence of Lyman-α radiation at 121.6 nm has been used to investigate the rate of reaction of H atoms with H_2S over the temperature range 190-464 K. Conditions were chosen under which atom-radical and radical-radical reactions were unimportant and only the H-atom-H_2S reaction occurred. The rate constant thus obtained can be expressed as $k_1 = (1.29 \pm 0.15) \times 10^{-11} \exp[-(1709 \pm 60)/1.987\ T]$ cm^3 molecule^{-1}·sec^{-1}. Comparison of the Arrhenius *A* factor with that predicted by entropy considerations suggests a somewhat loose activated complex, but not as loose as expected on the basis of the exothermicity of the $H + H_2S$ reaction.

12075. Laufer, A. H., Keller, R. A., **Lowest excited states of ketene,** *J. Am. Chem. Soc.* **93,** No. 1, 61-63 (Jan. 1971).

Key words: Absorption spectrum; excited states; ketene; spectroscopy; triplet state.

Analysis of the vibrational progression evident in the absorption spectrum of ketene suggests the absorption is due to a singlet-singlet transition and indicates the energy of the lowest singlet state is less than 61 kcal/mol (2.65 eV) above the ground state. Reasonable singlet-triplet energy splittings place the energy of the lowest triplet at less than 55 kcal/mol (2.39 eV). This conclusion is in agreement with recent results which demonstrate that ketene quenches the triplet state of biacetyl. Attempts to directly observe the triplet state of ketene by a variety of spectroscopic methods, including gas- and liquid-phase absorption spectroscopy, oxygen enhancement techniques, and triplet ← triplet absorption spectroscopy, were unsuccessful.

12076. Lutz, G. J., **Photon activation analysis—A review,** *Anal. Chem.* **43,** No. 1, 93-104 (Jan. 1971).

Key words: Bremsstrahlung; carbon; electron accelerators; nitrogen; oxygen; photon activation analysis; review; sensitivities.

Prior to the availability of high-energy electron accelerators, photon activation analysis was limited to the determination of deuterium and beryllium with isotopic gamma-ray sources. During the past 15 years, however, the development of high-current cyclic and linear electron accelerators has made possible many analyses not readily acomplished by other methods. These include the determination of carbon, nitrogen, and oxygen at levels well below 1 μg. This review discusses the determination of beryllium and deuterium with isotope sources; accelerator-produced photons and nuclear considerations in photon activation analysis; the determination of carbon, nitrogen, and oxygen; the determination of heavier elements, with emphasis on biological, geochemical, oceanographic, and forensic matrices; and errors and corrections in photon activation analysis.

12077. Meijer, P. H. E., **Influence of the dipole-dipole coupling on the specific heat of cesium titanium alum,** *Phys. Rev. B* **3,** No. 1, 182-185 (Jan. 1, 1971).

Key words: Cesium titanium alum; critical temperature; face centered cubic lattice; magnetic dipole-dipole coupling; specific heats.

To find the influence of the magnetic dipole-dipole coupling on the specific heat in a fcc lattice, the Hamiltonian was computed in a straightforward way. If one omits the nonring diagrams, the successive terms in $1/kT$ can be obtained from the Fourier transform. We found that the third-order term was different from the results quoted in the literature, both in sign and in magnitude. Some discussion is devoted to the question of what magnetic state will be realized below the critical temperature.

12078. Peterson, R. L., **Numerical study of deformation-potential scattering of electrons by optical phonons in a longitudinal magnetic field,** *Phys. Rev. B* **2,** No. 10, 4135-4144 (Nov. 15, 1970).

Key words: Magnetic field; Maxwellian distribution; scattering; semiconductor.

A detailed numerical study of the influence of a longitudinal magnetic field on carrier scattering is presented for the simple model of the band structure of a semiconductor and for deformation-potential scattering of carriers by optical phonons. A drifted Maxwellian distribution is used, and parallel electric and magnetic fields of arbitrary magnitude are considered. Interesting results of this study include magnetic-field-induced negative differential mobility, magnetic-field-induced "runaway" in the quantum limit, although not for ordinarily large magnetic fields, and longitudinal magnetoresistance resonances whose amplitudes are quite sensitive to electric field strength.

12079. Pierce, S., **Orthogonal groups of positive definite multilinear functionals,** *Pacific J. Math.* **33,** No. 1, 183-189 (1970).

Key words: Elementary divisors; multilinear functional; isometry.

Let V be a finite dimensional vector space over the real numbers R and let $T: V \rightarrow V$ be a linear transformation. If $\phi: \times_1{}^m V \rightarrow R$ is a real multilinear functional and

$$\phi(Tx_1, \ldots, Tx_m) = \phi(x_1, \ldots, x_m),$$

$x_1, \ldots, x_m \in V$, T is called an isometry with respect to ϕ. We say ϕ is positive definite if $\phi(x, \ldots, x) > 0$ for all nonzero $x \in V$. In this paper we prove that if ϕ is positive definite and T is an isometry with respect to ϕ, then all eigenvalues of T have modulus one and all elementary divisors of T over the complex numbers are linear.

12080. Robinson, D. C., **Determination of load errors in universal testing machines due to speed of testing,** *Mater. Res. Stand.* **11,** No. 1, 14-17 (Jan. 1971).

Key words: Compression tests; dynamic loads; high-speed photography; indicating instruments; indicator characteristics; loading rate; loads (forces); motion picture cameras; photographic equipment; static loads; test equipment.

A modification of an ASTM Proposed Method of Determining Errors in Testing Machines was used as the basis to measure the indicator errors caused by dynamic loading for three universal machines of different design. For each of the machines, load errors due to the lag of the indicator were found to be linearly related to the rate of applied load. Based on the experimental results, it appears that for testing machines of various design the response of the indicating system to uniformly increasing loads resembles that of a proportional error servomechanism which has a velocity-lag steady state error when following a ramp function input. A discussion is given of the variables which were found to be significant in determining the load errors for the three machines investigated. The essential components in the auxiliary load measuring system were a load cell, a fast response digital voltmeter, and a high-speed still camera. The modified method was found to provide higher quality photographic information from which to determine indicator errors than that obtained when using a moving picture camera as proposed in the ASTM procedure.

12081. Rowland, G. A., **The increasing role of states in building codes and standards,** *Proc. 26th Annual Conf. Reinforced Plastics, Composites Division, Washington, D.C., February 9-12, 1971,* Section 5-B, pp. 1-3 (Feb. 10, 1971).

Key words: Interstate; intrastate; "National Conference of States on Building and Standards"; uniformity.

Building codes promulgated, modified, and interpreted on a local basis have been deemed to be major deterrents to the development of reasonably large aggregated markets for many new or little-used materials needed in meeting the country's present and future building and housing requirements.

Since its inception in 1967, the National Conference of States on Building Codes and Standards has been increasingly active in promoting greater involvement of the States in the complex building regulatory system. The hope of more competent technical procedures for accrediting new materials, including reinforced plastics, for acceptance statewide, and possibly nationwide, rather than city-by-city will be a very important contribution toward progress.

The responsibilities of health and safety constitutionally rests in the several states and the differences in their administration of this responsibility is now being seriously reviewed. The Conference in its three years of existence has been able to bring together delegates from the several states, establish working arrangements, and proceed in developing a program of study and recommendations for consideration by the Conference in solving many of the present building regulatory problems.

The national effort is a new, refreshing, coordinated approach toward what has been a rather chaotic, restrictive, individual approach to building regulations.

A current report of the National Conference of States on Building Codes and Standards and the aforementioned organizational structure and activities will be presented.

12082. Sullivan, D. B., Peterson, R. L., Kose, V. E., Zimmerman, J. E., **Generation of harmonics and subharmonics of the Josephson oscillation,** *J. Appl. Phys.* **41,** No. 12, 4865-4873 (Nov. 1970).

Key words: Josephson effect; superconductivity.

The observation of harmonics and subharmonics of the Josephson oscillation is shown to be in agreement with a rather simple model of the junction. The generation of harmonics provides an explanation of induced steps in the current-voltage characteristic which occur at submultiples of the usual induced step voltages. The subharmonic oscillation is seen to be a relaxation-like process which can be easily understood in terms of a mechanical analog.

12083. Tighe, N. J., **Microstructure of fine-grain ceramics,** (Proc. 15th Sagamore Army Materials Research Conf., Sagamore Conference Center, Raquette Lake, N.Y., Aug. 20-23, 1968), Chapter in *Ultrafine-Grain Ceramics,* pp. 109-133 (Syracuse University Press, Syracuse, N.Y., 1970).

Key words: Alumina; Al_2O_3; ceramics; electron microscopy; fine-grain ceramic; ion bombardment; magnesia; MgO; microstructure; rock; zirconia.

This chapter describes the use of transmission electron-microscopy to characterize the microstructure of fine-grain ceramics. Observations have been made on a number of polycrystalline materials including alumina, magnesia, zirconia, metal-ceramic composites, and rock specimens.

Thin sections were prepared by ion bombardment. In these sections grain boundaries, pores, impurity precipitates, and dislocations could be observed directly. Crystalline second-phase material formed as grains and small precipitates could be identified by means of electron diffraction. The method of specimen preparation and the results obtained from the observation of the specimens will be discussed.

12084. Vidal, C. R., Cooper, J., Smith, E. W., **Hydrogen Stark broadening calculations with the unified classical path theory,** *J. Quant. Spectry. Radiative Transfer* **10,** No. 9, 1011-1063 (Sept. 1970).

Key words: Classical path; hydrogen lines; line wings; one-electron theory; Stark broadening; unified theory.

The unified theory has been generalized for the case of upper and lower state interaction by introducing a more compact tetradic notation. The general result is then applied to the Stark broadening of hydrogen. The thermal average of the time development operator for upper and lower state interaction is presented. Except for the time ordering it contains the effect of finite interaction time between the radiator and perturbers to all orders, thus avoiding a Lewis type cutoff. A simple technique for evaluating the Fourier transform of the thermal average has been developed. The final calculations based on the unified theory and on the one-electron theory are compared with measurements in the high and low electron density regime. The unified theory calculations cover the entire line profile from the line center to the static wing and the simpler one-electron theory calculations provide the line intensities only in the line wings.

12085. Watson, R. E., Bennett, L. H., Carter, G. C., Weisman, I. D., **Comments on the Knight shift in bismuth and other *p*-band diamagnetic metals,** *Phys. Rev. B* **3,** No. 1, 222-225 (Jan. 1971).

Key words: $AuGa_2$; BiIn; bismuth; diamagnetism; Knight shift; NaTl; polarization; V_3Ga.

The role of *p*-polarization and conduction-electron diamagnetism in some diamagnetic metals and intermetallic compounds, which have negative Knight shifts, is examined.

12086. Weiss, A. W., **Symmetry-adapted pair correlations in Ne, F^-, Ne^+, and F,** *Phys. Rev. A* **3,** No. 1, 126-129 (Jan. 1971).

Key words: Electron affinity; electron correlation; ionization potential; superposition of configurations.

The superposition-of-configurations method has been used to calculate, a single pair at a time, the pair correlation energies for Ne, Ne^+, F^-, and F. The approach is essentially a symmetry-adapted variation of Nesbet's formulation of the Bethe-Goldstone scheme for the atomic correlation problem, and the aim of this research was to test the usefulness of the method for predicting such physically observable quantities as ionization potentials and electron affinities. The calculations predict an ionization potential for neon of 21.52 eV, compared with a 21.56-eV experimental value, and a fluorine electron affinity of 3.47 eV, for which the experimental value is 3.45 eV.

12087. Weiss, B. Z., Meyerson, M. R., **Fatigue crack initiation and propagation in chromium diffusion coated Ti bearing steel,** *J. Iron Steel Inst.* **208,** No. 12, 1069-1077 (Dec. 1970).

Key words: Chromium diffusion coating; columnar grains; fatigue crack initiation; fatigue crack propagation; residual stress; titanium bearing steels.

Chromium diffusion coatings on Ti-bearing steel frequently lead to columnar growth beneath the Cr-rich layer. The grains are preferentially oriented. The depth of the columnar zone does not depend on the chromizing time. A high rate of cooling prevents columnar growth. No grain boundary diffusion or carbide formation at the grain boundaries was observed. The Cr-rich layer is structurally homogenous and consists of α-solid solution. The hardness of the coating does not vary with the chromizing time.

Compressive residual stresses were found in the Cr-rich layer. The stresses, whose magnitude does not change with the depth of the layer, may be decreased by additional heat treatment.

Three modes of fatigue crack nucleation were observed all beneath the Cr-rich layer. Cracks were formed after 10 to 18% of total fatigue lifetime. Crack propagation in its initial stages is primarily dependent on the mode of nucleation. In the later stage propagation is dependent on stress and grain size. Fatigue properties may be improved considerably by a factor of 3 to 5 by additional "normalizing" after chromizing.

12088. Brenner, A., **Note on an organic-electrolyte cell with a high voltage,** *J. Electrochem. Soc.* **118,** No. 3, 461-462 (Mar. 1971).

Key words: Graphite electrode; high energy density cell; lithium deposition; organic electrolyte.

An unusually high back EMF of 5.2 volts was obtained after electrolysis of a 10% solution of lithium fluoborate in sulfolane with a graphite anode.

12089. Brown, D. W., Lowry, R. E., Wall, L. A., **The radiation-induced polymerization of 3,3,4,4,5,5,5-heptafluoropentene-1 at high pressure,** *J. Polymer Sci.,* Part A-1, **8,** 3483-3493 (1970).

Key words: Irradiation; polymerization; pressure; 3,3,4,4,5,5,5-heptafluoropentene-1.

A study was made of the radiation-induced polymerization under pressure of 3,3,4,4,5,5,5-heptafluoropentene-1. Polymerization rates increase with pressure (activation volume equals − 11 cc/mol) and temperature (activation enthalpy equals 6.5 kcal/mol) in liquid phase. At 13800 atm and 25 °C freezing occurs; the polymerization rate in the solid is very small. In liquid phase polymerization can continue for many hours after the irradiation is terminated. An active species is formed by radiation which initiates polymerization in the dark period.

12090. Brown, R. L., **An upper limit for the rate of destruction of $O_2(^1\Delta_g)$ by atomic hydrogen,** *J. Geophys. Res. Space Phys.* **75,** No. 19, 3935-3936 (July 1, 1970).

Key words: Hydrogen atoms; nitrogen atoms; $O_2(^1\Delta_g)$; oxygen atoms; quenching reactions; upper atmosphere.

From an analysis by EPR spectroscopy of the products of a microwave discharge through wet O_2, an upper limit of 6.5×10^{-15} cm^3 molecule^{-1} sec^{-1} was obtained for the rate constant of a reaction between $O_2(^1\Delta_g)$ and H which destroys H. Also determined was an upper limit of 1.5×10^{-14} for the rate constant of a reaction which destroys $O_2(^1\Delta_g)$ but not H.

12091. Brown, R. L., **Diffusion of a trace gas into a flowing carrier,** *Intern. J. Chem. Kinetics* **2,** 475-477 (1970).

Key words: Diffusion equation; diffusion of gases; flow reactor; gas mixing; mixing by diffusion; relaxation methods.

Numerical methods were used to solve the differential equation for diffusion of a trace gas into a flowing carrier gas having a parabolic velocity profile in a cylindrical tube. Steady state solutions are given in the form of contour diagrams of constant trace gas concentration.

12092. Chandler, H. H., Rupp, N. W., Paffenbarger, G. C., **Poor mercury hygiene from ultrasonic amalgam condensation,** *J. Am. Dental Assoc.* **82,** 553-557 (Mar. 1971).

Key words: Amalgam condensation; mercury; mercury vapor levels; threshold limit.

A cloud of mercury droplets and alloy particles was emitted from the soft amalgam at the working tip of the ultrasonic instrument tested. Mercury vapor levels were 20% of the allowable threshold limit value and probably are not hazardous. However, continued use of the ultrasonic instrument would result in deposition of numerous mercury droplets throughout the dental operatory and could thereby cause higher mercury vapor levels, especially in poorly ventilated places. Inhalation of the emitted material by the patient and the dental health personnel is not good hygiene. Therefore, the use of this instrument for amalgam condensation is contraindicated until the safety of the instrument for this purpose is firmly established.

12093. Cohen, J., Edelman, S., **Direct piezoelectric effect in polyvinylchloride films,** *J. Appl. Phys.* **42,** No. 2, 893-894 (Feb. 1971).

Key words: G modulus; piezoelectricity; polymers; polyvinylchloride films.

The piezoelectric modulus, g_{31}, of polyvinylchloride films has been measured at 20 Hz. Values are in the range of approximately 0.4 to 3 Vm^{-1}/Nm^{-2}, which are larger than the g values of conventional piezoelectric materials.

12094. Cooper, J. W., Conneely, M. J., Smith, K., Ormonde, S., **Resonant structure of lithium between the 2^3S and 2^1P thresholds,** *Phys. Rev. Letters* **25,** No. 22, 1540-1543 (Nov. 30, 1970).

Key words: Atomic absorption; close coupling; configuration; interaction; resonant structure.

Close coupling calculations of the optically allowed states in the 60-70 eV range above the ground state of atomic lithium have been performed. An interpretation of the resonant structure in this region is given based upon these calculations and recent experimental evidence.

12095. Fatiadi, A. J., **Oxidative cleavage of aromatic azines with periodic acid: e.s.r. evidence for the liberation of nitrogen dioxide,** *Chem. Ind.,* pp. 64-66 (Jan. 9, 1971).

Key words: Aromatic; azines; cleavage; complex; nitrogen paramagnetic; periodic acid; radical.

Aromatic azines were cleaved by periodic acid to the parent aldehyde or ketone in over 95% yield. The oxidative cleavage proceeds through a paramagnetic intermediate, as evidenced by trapping of the nitrogen dioxide at 77 K (e.s.r. evidence).

12096. Garvin, D., **The information analysis center and the library,** *Spec. Libraries* **62,** No. 1, 17-23 (Jan. 1971).

Key words: Standard reference data.

The information analysis center and the library have complementary functions. The former is both a user of library services and a source of information for libraries. How they can cooperate to their mutual profit is described. The evaluation of information is the principal task of the information analysis center. This process, and the organized program in the USA to foster it, are described.

12097. Gebbie, K. B., Thomas, R. N., **On the dependence of T_e upon quantity versus quality of the radiation field in a stellar atmosphere,** *Astrophys. J.* **161,** No. 1, 229-241 (July 1970).

Key words: Electron temperature; line-blanketing; mechanical heating; radiation quality; radiation quantity.

We derive a simple algebraic expression for $T_e(\tau)$ that demonstrates as a function of collisions how and where the control of T_e shifts from the quantity to the quality of the radiation field in a stellar atmosphere. We obtain explicit formulae for the gray case and show that mechanical heating and nongray processes can be treated algebraically as perturbations. We illustrate the size and effect of these processes by applying them to the Sun in the region $10^{-2} > \tau_5 > 10^{-5}$.

12098. Unassigned.

12099. Hellwig, H., **Areas of promise for the development of future primary frequency standards,** *Proc. 24th Annual Symp. on Frequency Control, Atlantic City, N.J., April 27-29, 1970,* pp. 246-258 (Electronic Industries Assn., Washington, D.C. 1970).

Key words: Accurate frequency standards; accurate length standards; accurate time standards; accurate voltage standards; ion storage; laser stabilization; maser oscillator; metrology; quantum electronics; saturated absorption; slave oscillators.

In this paper possibilities are discussed which may lead to the development of future primary frequency standards of superior accuracy capability. As the reference in performance today's most advanced primary frequency standard, the laboratory type cesium beam tube, is used. Aspects of costs and field-usage are totally neglected. A review is given of the various methods and techniques which are currently employed in quantum electronic frequency standards or which have a potential usefulness. Various effects which influence the output frequency of a primary standard are associated with these methods. A classification is given: (a) Effects associated with the interrogation of particles (atoms or molecules), (b) effects related to the method of confining the particles, and (c) effects associated with the particles themselves and the way in which they are treated for an effective interrogation by electromagnetic radiation. These classes of effects are discussed in detail, and expectation values for the related uncertainties are given. For selected particles certain methods of interrogation, confinement, and particle preparation can be combined such as to minimize the net uncertainty due to all applicable effects. Different technical solutions are the result. A review of existing and proposed devices is given, including quantitative data on the stability and accuracy capability. Aspects of the most promising devices are discussed, and it is concluded that accuracy capabilities of ten to the minus fourteen should be within reach of today's research and development.

12100. Hussman, E. K., **A holographic interferometer for measuring radiation energy deposition profiles in transparent liquids,** *Appl. Opt.* **10,** No. 1, 182-186 (Jan. 1971).

Key words: Absorbed dose; calorimetry; dose distribution; electron beams; holography; interferometry; pulsed beams; radiation.

An apparatus has been designed for real-time and double-exposure holographic interferometry to determine radiation absorbed dose distributions in transparent liquids. The change in refractive index of the liquid due to a temperature rise after irradiation is measured interferometrically. In a cylindrically symmetrical radiation field, the dose distribution can be computed from data supplied by the reconstruction of the holographic interferogram taken as a side-view profile of the change in optical pathlength. Relatively inexpensive components such as a low-powered He-Ne laser together with a conventional photographic shutter and low-cost mirrors and lenses were used. The mathematical procedure for unfolding the three-dimensional dose distribution is described, and an example is given for use with a high-intensity, pulsed, 2-MV electron source.

12101. Jacox, M. E., Milligan, D. E., **Infrared spectrum and structure of the species CO_3,** *J. Chem. Phys.* **54,** No. 3, 919-926 (Feb. 1, 1971).

Key words: CO_2; CO_3; force constants; infrared spectrum; matrix isolation; O-atom reaction; structure; ultraviolet spectrum; vacuum-ultraviolet photolysis.

Upon photolysis of solid CO_2 by 1216-Å radiation, very high yields of CO_3 have been obtained. There is no evidence for the production of hydrogen-containing species in experiments in which photolytically produced H or D atoms are also present. Experimental evidence supports a C_{2v} structure for CO_3 in its ground state, as predicted by molecular orbital calculations. The vibrational frequency pattern for the planar modes of isotopically substituted species of CO_3 has been fitted to a valence force potential having a minimal number of interaction force constants, assuming both an open structure having an O-C-O angle of 80° and a three-membered ring structure having an O-C-O angle of 65°. Although the force constants obtained for the ring structure appear to be quite reasonable, exceptionally large values have been obtained for the O-C-O bending force constant and for all of the interaction constants for the open structure. On this basis, the three-membered ring structure is favored for CO_3 in its ground state.

12102. Julienne, P. S., **Predissociation of the H_2 $D^1\Pi_u$ state,** *Chem. Phys. Letters* **8,** No. 1, 27-28 (Jan. 1, 1971).

Key words: Born-Oppenheimer; Hartree-Fock; molecular hydrogen; partial widths; potential curve; predissociation; vibrational overlap.

The electronic nondiagonal Born-Oppenheimer coupling matrix elements between the molecular hydrogen $D^1\Pi_u$ state and the $B'^1\Sigma_u$ and $B^1\Sigma_u$ states were calculated in the Hartree-Fock approximation at $R = 1.0$, 1.2, 1.6, and 2.0 au. These were used to calculate the predissociation widths for the $v = 3$ to 12 levels of the D state with $J = 1$. The predissociation can only be caused by B′ state. The widths are around 1 cm^{-1}.

12103. Kamas, G., Hanson, D. W., **Recent VHF/UHF satellite timing experiments at the National Bureau of Standards,** *Proc. Precise Time and Time Interval (PTTI) Strategic Planning Meeting (U), Washington, D.C., December 10-11, 1970,* **1,** 79-82 (1970).

Key words: ATS satellite; LES-6 satellite; NBS satellite timing; satellites; TACSAT satellite; time; timing accuracy.

A summary discussion is presented of the current work accomplished by NBS in the field of time dissemination by geostationary satellites. The results of that program and its implication for the future are given.

12104. Kruger, J., Frankenthal, R. P., **B. Corrosion of metals,** Chapter in **Volume IV,** *Techniques in Metals Research,* Chapter 10B **Oxidation and corrosion,** R. A. Rapp, ed., R. F. Bunshah, Series ed., **14,** Part 2, 571-667 (John Wiley and Sons Inc., New York, N.Y. 1970).

Key words: Corrosion; electron diffraction; electron microscopy; research techniques.

The application of nonelectrochemical techniques to corrosion research are discussed. These include optical techniques, x-ray techniques, electron microscopy and diffraction, tracer techniques and mechanical techniques.

12105. Latanision, R. M., Ruff, A. W., **The temperature dependence of stacking fault energy in Fe-Cr-Ni alloys,** *Met. Trans.* **2,** 505-509 (Feb. 1971).

Key words: Dislocations; electron microscopy; iron alloys; stacking fault energy; temperature.

The variation of intrinsic stacking fault energy (γ_i) in two austenitic Fe-Cr-Ni alloys has been determined from dislocation node measurements over the range 25 to 325 °C by means of high temperature transmission electron microscopy. In both alloys γ_i increases with temperature. Both reversible and irreversible effects have been observed in cyclic heating-cooling experiments. After the first heating to elevated temperature the irreversible component is removed and thereafter cyclic annealing produces essentially reversible changes in γ_i. The large reversible changes are best understood in terms of the variation in the stability of austenite with temperature. The smaller irreversible effect appears to arise from the formation of substitutional solute atmospheres around partial dislocations at elevated temperature.

12106. Linsky, J. L., Avrett, E. H., **The solar H and K lines,** *Astron. Soc. Pacific* **82,** 169-248 (Apr. 1970).

Key words: Ca H and K lines; non-LTE line formation; plages; radiative transport; solar chromosphere; solar spectrum; sunspots; Wilson-Bappu effect.

We review our current understanding of the formation of the Ca II H and K resonance and infrared triplet subordinate lines in the sun in view of the wealth of observations of these lines and the development of non-LTE line formation theory. We describe the low- and high-spatial resolution data of these lines on the solar disk, off the limb, and in stellar spectra. We also describe observations on the analogous Mg II resonance lines.

We review the various explanations proposed for the observed features of the lines including the double reversal, limb darkening, plage and spot profiles, and the anomalous line ratios. Line profiles are computed according to a first-order steady-state theory in which we assume a one-component atmosphere in hydrostatic equilibrium, noncoherent scattering, and a five-level atom and continuum representation for Ca II. The chromospheric model chosen is meant to be representative rather than definitive, but it produces profiles of all five lines and a microwave continuum in agreement with observations at the center of the disk. We then discuss extensions of this first-order theory.

12107. Liu, Y. M., Coleman, J. A., **Electron radiation damage effects in silicon surface-barrier detectors,** *IEEE Trans. Nucl. Sci.* **NS-18,** No. 1, 192-199 (Feb. 1971)

Key words: Alpha particles counting response; capacitance; detector noise; electron fluence; electrons radiation damage; front and rear contact; leakage current; silicon surface-barrier detector.

Silicon surface-barrier detectors have been irradiated at room temperature with monoenergetic electrons in the energy range of 200 keV to 1 MeV. The changes of detector reverse leakage current, noise, capacitance and alpha-particle counting response were determined. In general, detector current and noise increased with electron fluence and energy for electron energies of 400 keV and above. Detector capacitances tended to decrease slightly for electron fluences up to 10^{13} cm^{-2} and increase at higher fluences. No significant degradation of detector performance was observed as a result of irradiation with 200-keV electrons for fluences up to 10^{16} cm^{-2}. The effects of damage on detector performance were reduced when the rear, aluminum contact was irradiated rather than the front, gold contact.

12108. Madey, T. E., Yates, J. T., Jr., **Electron-stimulated desorption and work function studies of clean and cesiated (110) GaAs,** *J. Vacuum Sci. Technol.* **8,** No. 1, 39-44 (Jan.-Feb. 1971).

Key words: Adsorption; cesium; desorption; electron reflection; electron stimulated desorption; gallium arsenide; work function.

The surface of a degenerate *p*-type GaAs crystal, cleaved in ultrahigh vacuum to expose the (110) plane, has been examined as a function of cesium coverage using several methods. Electron stimulated desorption (ESD) of ions upon bombardment of the surface by 100-eV electrons is found to be extremely sensitive to trace quantities of adsorbed impurities. The work function-coverage relation for Cs^+ deposited from a Cs zeolite ion gun was determined using a retarding potential method; the energy dependence of electron reflection in the range 0-10 eV was found to differ markedly between the clean and cesiated surfaces.

12109. Mandel, J., **A new analysis of variance model for nonadditive data,** *Technometrics* **13,** No. 1, 1-18 (Feb. 1971).

Key words: Factorial experiments; interaction; nonadditivity; principal components; surface fitting; two-way arrays.

A method is presented for the analysis of data representing functions of two variables, when the response can be tabulated in a rectangular array. The procedure is based on a partitioning of the row by column interaction effects into a sum of terms, each of which is the product of a row factor by a column factor. The factors in each term are estimated by a method involving the extraction of characteristic roots.

The method contains as special cases a number of procedures used for the handling of nonadditivity in two-way arrays. It is very useful for the fitting of empirical surfaces, but is also applicable to cases in which the data depend on qualitative rather than quantitative factors.

Comparisons with other techniques are made and an illustrative example is given.

12110. Menis, O., McClellan, B. E., Bright, D. S., **Determination of the formation constants of iron(III) and vanadium(V) with β-isopropyltropolone using the extraction method,** *Anal. Chem.* **43,** No. 3, 431-435 (Mar. 1971).

Key words: Chelate; equilibrium constants; extraction method; ferric; graphical; least squares computer calculations; vanadyl; β-isopropyltropolone.

Equilibrium constants of ferric and vanadyl ions for the formation of the chelate with β-isopropyltropolone (HIPT) were determined by the extraction method. The values for these constants were derived by graphic and least squares computer calculations. The constants for the vanadyl system are reported for the first time. It is postulated that an adduct $VO_2IPT \cdot HIPT$ is formed and its formation constant, log $\beta_N = K_1K'$, was determined as 13.8 and 13.6 ± 0.8 by graphic and least squares calculations, respectively. The partition constant, K_{DC}, was 2.45 and 2.6 ± 0.4, respectively. The values for Fe(IPT)$_3$ complex were for log β_N, 37.7 and 37.8 ± 0.1, respectively, while the log K_{DC} was 2 and 2.0 ± 0.1, respectively. It was also possible to calculate the overall stepwise constants, log $\beta_1 = 13.0 \pm 0.2$ and log $K_2K_3 = 24.8 \pm 0.1$ by the least squares method. The other experimental parameters which were studied were the effect of solvent and ionic strength.

12111. Menis, O., Rains, T. C., **Sensitivity, detection limit, precision, and accuracy in flame emission and atomic absorption spectrometry,** Chapter 2 in *Analytical Flame Spectroscopy, Selected Topics,* R. Mavrodineanu, ed., pp. 47-77 (Springer-Verlag Publishing Co., New York, N.Y., 1970).

Key words: Accuracy; atomic absorption; detection limits; differential method; flame emission; nonaqueous media; precision; sensitivity; tables.

This chapter on sensitivity, detection limits, precision, and accuracy in flame emission and atomic absorption spectrometry discusses the principles, definitions, and methodology in establishing and evaluating these criteria. The various instrumental components and their optimum operation are described to enable the analyst to achieve these goals. Tables of data for all reported elements are presented for the current results on detection limits and sensitivity. The problem associated with the environment of the analyte and the effect of nonaqueous media are discussed from the standpoint of enhanced sensitivity. Finally the criteria for attaining improved precision and accuracy are discussed and the role of the differential method, ionization buffers and standard additions is discussed.

12112. Milligan, D. E., Jacox, M. E., **Infrared spectrum and structure of intermediates in the reaction of OH with CO,** *J. Chem. Phys.* **54,** No. 3, 927-942 (Feb. 1, 1971).

Key words: CHO_2 free radical; force constants; infrared spectrum; matrix isolation; reaction of OH with CO; stereoisomers; vacuum-ultraviolet photolysis.

Upon vacuum-ultraviolet photolysis of H_2O in a CO matrix at 14 K, infrared absorptions of HCO, H_2CO, HCOOH, and CO_2 become prominent. Furthermore, new absorptions due to reactive product species appear at 615, 620, 1077, 1088, 1160, 1261, 1797, 1833, 3316, and 3456 cm^{-1}. These absorptions diminish in intensity when the sample is subjected to radiation in the 2000-3000-Å spectral range. Detailed consideration of the processes which may occur in this system and extensive isotopic substitution studies support the assignment of these absorptions to the *cis* and *trans* stereoisomers of $H-O-C=O$, produced by the reaction of OH with the CO matrix. Valence force potentials having only small contributions from interaction terms have been found which correspond to a physically reasonable vibrational assignment and which satisfactorily reproduce the pattern of observed frequencies for the various isotopic species of both *cis*- and *trans*-HOCO. Evidence suggests that *cis*- and *trans*-HOCO photodecompose to produce H atoms and CO_2.

12113. Missoni, G., Dick, C. E., Placious, R. C., Motz, J. W., **Inelastic atomic scattering of 0.1-, 0.2-, 0.4-, and 3.0-MeV electrons,** *Phys. Rev. A* **2,** No. 6, 2309-2317 (Dec. 1970).

Key words: Carbon; copper; experimental cross sections; gold; inelastic electron scattering; multiple scattering; 0.1 to 3.0 MeV.

Spectral data obtained with a magnetic spectrometer are presented for inelastic electron scattering from thin targets of carbon, copper, and gold at incident electron energies of 0.1, 0.2, 0.4, and 3.0 MeV, for scattering angles between 20 and 120°. For angles less than 90°, each spectrum consists of (a) a Møller line which has a half-width that increases with atomic number and which yields an experimental cross section that agrees within experimental error with the theoretical Møller cross section, and (b) a low-energy continuum which rises steeply at energies less than 40 keV. For angles greater than 90°, the Møller line which is kinematically forbidden vanishes, but the steeply rising continuum remains. This continuum may arise from single electron-atom scattering and from multiple scattering in the target. The latter process depends on target thickness. The experimental results for this low-energy continuum tend to confirm that the multiple-scattering effects as calculated by Ford and Mullin dominate the single-scattering process as calculated by Weber, Deck, and Mullin, and by Kolbenstvedt and Cooper even for an 11-$\mu g/cm^2$ carbon target which was the most favorable case for studying the single-scattering process. Because of multiple scattering, accurate experimental data for the low-energy continuum produced by single electron-atom inelastic scattering can best be obtained with gas targets.

12114. Mohan, R., Danos, M., Biedenharn, L. C., **Isospin impurities in the nuclear ground states,** *Phys. Rev. C* **3,** No. 2, 468-479 (Feb. 1971).

Key words: Excess neutrons; isospin; nuclear charge distribution; nuclear structure; three-fluid model; two-fluid model.

Isospin impurities in the ground states of some even-even nuclei are calculated in the shell model including the effective residual interactions and in the three-fluid model. It is shown that the residual interactions reduce the calculated impurities by an order of magnitude. The impurities given by the three-fluid model are even smaller. Comparison of the present results is made with those of the two-fluid model.

12115. McClellan, B. E., Menis, O., **Kinetics and mechanism of extraction of iron(III) with β-isopropyltropolone,** *Anal. Chem.* **43,** No. 3, 436-438 (Mar. 1971).

Key words: Fe(III)-β-isopropyltropolone (HIPT) complex; first order in Fe(III) and in HIPT; kinetics.

The kinetics and mechanism of the reaction between Fe(III) and β-isopropyltropolone (HIPT) were studied by the extraction technique. The reaction was found to be first order in Fe(III) and in HIPT, indicating the addition of the first ligand to the Fe(III) to be the rate-controlling step in the reaction. A first-order dependence on $NaClO_4$ was observed. No dependence on $[H^+]$ was observed in the rate under the acid (1M) conditions of the extraction. The rate constant for the reaction was 1.5×10^{10} M^{-1}. Addition of ethanol prior to extraction greatly enhances the reaction rate.

12116. Noack, M., Kokoszka, G. F., Gordon, G., **Dynamic Jahn-Teller effects and magnetic anisotropies in aqueous solutions and water-ethanol glasses of copper(II) solvates and complexes with 2,2′-dipyridine,** *J. Chem. Phys.* **54,** No. 3, 1342-1350 (Feb. 1, 1971).

Key words: Aqueous solutions; EPR; exponential temperature dependence; intramolecular relaxation; Jahn-Teller effect; tris(2,2′-dipyridine)copper(II).

Dynamic Jahn-Teller effects have been recognized previously in solids which contain copper(II) ions in octahedral environments. In solutions, dynamic Jahn-Teller effects have now been observed in the EPR spectrum of the tris(2,2′-dipyridine)copper(II) complex. This is shown by the small temperature coefficient of the apparent tumbling correlation time, τ_c, which is associated with anisotropy contributions to the EPR linewidth and by the insensitivity of τ_c to variations of the solvent viscosity. In partially substituted complexes, such as the tetraaquo(2,2′-dipyridine)copper(II) species which has also been studied here, the dynamic Jahn-Teller effects are inhibited due to the inhomogeneous nature of the first coordination sphere. The possible importance of dynamic Jahn-Teller effects in homogeneous solvates of copper(II) is discussed. Evidence is presented to show that addition of ethanol to aqueous solutions of copper(II) nitrate results in the formation of inhomogeneous species.

12117. Redding, R. W., Hougen, J. T., **Calculation of the Eulerian angles and large amplitude vibrational coordinate corresponding to an arbitrary instantaneous molecular configuration,** *J. Mol. Spectry.* **37,** No. 2, 366-370 (Feb. 1971).

Key words: Constraint equations; Eckart conditions; Eulerian angles; large amplitude vibrational coordinate; molecule-fixed axes; reference configuration.

The three Eulerian angles and the large amplitude vibrational coordinate of a nonrigid molecule are determined implicitly, for a given configuration in space of the nuclei, by four equations in four unknowns. A method is presented for reducing this program to the solution of a single equation in the large amplitude coordinate. Once a value is determined for the large amplitude coordinate, numerical values for the direction cosine functions, and hence for the three Eulerian angles, can be calculated immediately from expressions derived. For rigid molecules, i.e., those not having a large amplitude vibrational coordinate, the method presented reduces to a set of explicit expressions for calculating the direction cosine functions for a given configuration in space of the nuclei of the molecule.

12118. Rosenstock, H. M., Botter, R., **Franck-Condon principle for the ionization of polyatomic molecules** (Proc. Intern. Conf. on Mass Spectroscopy, Kyoto, Japan, Sept. 1969), Chapter in *Recent Development in Mass Spectroscopy*, K. Ogata and T. Hayakawa, eds., pp. 797-806 (University of Tokyo Press, Tokyo, Japan, 1970).

Key words: C_2H_2; Franck-Condon principle; H_2O; NH_3; N_2O; photoelectrons; photoionization.; spectroscopy.

Recent work on the application of the Franck-Condon principle to the ionization of polyatomic molecules is reviewed. The vibrational structure of ionization curves in C_2H_2 H_2O, NH_3 and N_2O, is discussed. Examples are given illustrating various problems encountered in Franck-Condon problems, including choice of frequencies and force fields and the importance of normal coordinate transformations between two states of different geometry and symmetry.

12119. Schroeder, L. W., Rush, J. J., **Neutron diffraction study of the structure and thermal motion of phosphonium bromide,** *J. Chem. Phys.* **54,** No. 5, 1968-1973 (Mar. 1, 1971).

Key words: Crystal structure; neutron diffraction; PH_4Br; rigid-body analysis; thermal motion.

The crystal structure of PH_4Br has been determined by a single-crystal neutron diffraction study. The tetragonal structure is similar to that determined previously for PH_4I with the P–H bonds of the phosphonium ions directed at the four *next-nearest*-neighbor halide ions. The corresponding P–H and H···Br distances are 1.414 and 2.65 Å, respectively, with a P–H···Br angle of 172°. The orientation of the PH_4^+ ions (90° away from the orientation of NH_4^+ in the analogous phase III (NH_4Br)) suggests that hydrogen bonding plays a minor role in determining the crystal structure. A "rigid-body" analysis of the motion of the PH_4^+ ion was performed using the anisotropic thermal parameters of the phosphonium and hydrogen atoms derived from the PH_4Br and PH_4I diffraction data. The resulting mean-square amplitudes of translational and torsional motion of the PH_4^+ ion lead to frequencies which are in good agreement with spectroscopic observations.

12120. Simmons, J. H., Macedo, P. B., **Analysis of viscous relaxation in critical oxide mixtures,** *J. Chem. Phys.* **54,** No. 3, 1325-1331 (Feb. 1, 1971).

Key words: Critical transport; critical viscosity; critical viscous flow; structural relaxation; ultrasonic spectroscopy.

An analysis of shear viscosity and ultrasonic measurements on a series of critical oxide mixtures shows that the supercritical, excess static viscosity is associated with a broadening in the distribution of structural relaxation times, rather than with an interaction between the long-wavelength components of the fluctuations and the shear flow processes. The broadening saturates near the critical point, and the excess static viscosity approaches a finite limit as a function of reduced temperature. These results are in disagreement with existing excess-viscosity theories. A new model is proposed which relates the distribution of relaxation times to microstructure in the melt resulting from the supercritical fluctuations in composition. It also limits the range of interaction associated with structural relaxation to a finite value. The resulting conclusions are consistent with the observed lack of divergence in the excess viscosity and width of the distribution of relaxation times at T_c.

12121. Tipson, R. S., Brady, R. F., Jr., West, B. F., **Cyclic acetals of ketoses. Part IV. Re-investigation of the oxidation of 1,2:4,5-Di-*O*-isopropylidene-β-D-fructopyranose with methyl sulfoxide-acetic anhydride,** *Carbohydrate Res.* **16,** 383-393 (Mar. 1971).

Key words: Acetals; fructose; ketoses; oxidation; psicose; reduction; ruthenium tetraoxide; sodium borohydride.

For the preparation of pure D-psicose (**5a**) via oxidation of 1,2:4,5-di-*O*-isopropylidene-β-D-fructopyranose (**2a**), the latter must be free from its 2,3:4,5 isomer (**6a**), which is oxidized to the corresponding aldosulose acetal. Pure 1,2:4,5-di-*O*-isopropylidene-β-D-*erythro*-2,3-hexodiulo-2,6-pyranose (**3**) undergoes stereospecific reduction with sodium borohydride to give only 1,2:4,5-di-*O*-isopropylidene-β-D-*ribo*-hexulopyranose (**4a**), which exists as two different crystal modifications. Compounds **3** and **4a** have been characterized, and discrepancies in the literature have been explained.

12122. Walther, H., Hall, J. L., **Tunable dye laser with narrow spectral output,** *Appl. Phys. Letters* **17,** No. 6, 239-242 (Sept. 15, 1970).

Key words: Birefringent filter; dye laser; frequency control.

A tunable dye laser with narrow-banded spectral output in the order of 0.01 Å or smaller is described. This narrow spectral output is obtained by means of a birefringent filter (Lyot filter) which was inserted into the laser cavity. The properties of this laser setup have been investigated and are described.

12123. Weiss, A. W., **A review of theoretical developments in atomic *f*-values,** (Proc. 2nd Intern. Conf. Beam-Foil Spectroscopy in Nuclear Instruments and Methods, Lysekil, Sweden, June 8-12, 1970), Part III, *Theoretical transition probabilities, Nucl. Instr. Methods* **90,** 121-131 (North-Holland Publ. Co., Amsterdam, The Netherlands, 1970).

Key words: Atomic lifetimes; atomic spectra; configuration interaction; oscillator strengths.

Theoretical work on atomic *f*-values are reviewed with particular emphasis on the relation to recent beam-foil measurements. One-electron models currently in use are reviewed and their limitations and range of applicability are discussed. Many-electron, or multi-configuration, models are also described and their results compared with experiment. Regularities and irregularities along isoelectronic sequences will be discussed, and some current problems will be presented.

12124. Wiese, W. L., **Atomic transition probabilities – A survey of our present knowledge and future needs,** (Proc. 2nd Intern. Conf. Beam-Foil Spectroscopy in Nuclear Instruments and Methods, Lysekil, Sweden, June 8-12, 1970). Part II, *Lifetimes and transition probabilities, Nucl. Instr. Methods* **90,** 25-33 (North-Holland Publ. Co., Amsterdam, The Netherlands, 1970).

Key words: Atomic transition probabilities; beam foil spectroscopy; lifetimes; regularities; review.

A general survey of the present status of our knowledge of atomic transition probabilities is given and the principal methods for obtaining the numerical data are briefly reviewed on a critical basis. Areas of particular relevance to beam foil spectroscopy are emphasized. Using a number of numerical examples and employing systematic trends and comparison data, some general problems encountered with beam foil data are pointed out. Finally, some of the most pressing future needs for new and improved transition probabilities are indicated.

12125. Yates, J. T., Jr., Madey, T. E., **Interactions between chemisorbed species: H_2 and N_2 on (100) tungsten,** *J. Vacuum Sci. Technol.* **8,** No. 1, 63-68 (Jan.-Feb. 1971).

Key words: Chemisorption; flash desorption; hydrogen; nitrogen; tungsten; tungsten (100) plane; work function.

The interactions between hydrogen and nitrogen adsorbed species on a (100) tungsten crystal have been investigated by flash desorption methods. When the crystal covered with a monolayer of hydrogen is exposed to gaseous N_2, the nitrogen slowly replaces the two chemisorbed hydrogen β states by means of a slight lowering of the hydrogen desorption energy. This displacement process occurs via slow thermal desorption of hydrogen in the presence of gaseous N_2 when the surface temperature is $\gtrsim$ 300 K; no such replacement is observed at 273 K. Coverage measurements indicate that there is a stoichiometric ratio between N atoms adsorbed and H atoms displaced from the crystal at ~ 300 K. Although virtually no hydrogen will adsorb on the nitrogen-covered surface at 300 K, several weakly bound hydrogen states are populated at 100 K on this surface. No chemical difference between the β_1 and β_2 hydrogen species was detected, suggesting that both states originate from adsorbed atoms.

12126. Wright, J. C., Moos, H. W., Colwell, J. H., Mangum, B.

W., Thornton, D. D., **$DyPO_4$: A three-dimensional Ising antiferromagnet,** *Phys. Rev. B* **3,** No. 3, 843-858 (Feb. 1, 1970).

Key words: Critical phenomena; diamond lattice; $DyPO_4$; Ising system; low temperature; magnetic susceptibility; metamagnetism; optical absorption.

The magnetic susceptibility, heat capacity, and optical-absorption spectrum of $DyPO_4$ have been measured as a function of temperature and magnetic field. The optical-absorption spectrum indicates that the magnetic interactions in $DyPO_4$ have the form of the Ising interaction and occur primarily between nearest neighbors. The magnetic-susceptibility and heat-capacity measurements have been compared with exact series expansions for a diamond lattice assuming an Ising system with nearest-neighbor interactions. The theoretical calculations are in agreement with the measurements. The nature of the divergence of the heat capacity at the critical point is examined. Our data do not permit us to distinguish between the applicability of the logarithmic and power-law divergencies since they are indistinguishable in the region of our measurements. The temperature dependence of the critical field for the metamagnetic phase transition has also been determined and compared with the calculated value for the critical field at 0 K obtained from the spectroscopic measurements.

12127. Ahearn, A. J., **Quantitative analysis of solids by spark source mass spectrometry,** (Proc. Intern. Conf. on Mass Spectroscopy, Kyoto, Japan, Sept. 6-13, 1969), Chapter in *Recent Development in Mass Spectroscopy,* K. Ogata and T. Hayakawa, eds., pp. 150-157 (University of Tokyo Press, Tokyo, Japan, 1970).

Key words: Fluctuations; homogeneity; ion sensitive emulsion; mass spectrometry; precision; quantitative analysis; solids; spark source; trace elements.

In spark source mass spectrometry, the ion sample generally misrepresents the solid sample. Consequently, standard reference materials are needed for direct comparison with the unknown or for the determination of correction factors. The precision in measurement of matrix element ions, trace element ions and their ratio is dependent on the homogeneity of the ion sensitive emulsion used. Methods for testing emulsion uniformity and results on Q2 plates are presented. In some the nonuniformity is less than 5%; in others up to a 60% change in 8 cm has been detected. Under optimum conditions, matrix ions are measured with an RSD $\leq$ 5% but with trace ions this precision is usually poorer. This means that the trace element contents of the recorded ion sample fluctuate. The trace ions in a spark source ion sample from NBS SRM Platinum 681 fluctuate but not independently. Ion microprobe and other tests should indicate whether the observed fluctuations arise in solid sample inhomogeneities or in fluctuations in the production and/or transmission of trace ions in SSMS.

12128. Armstrong, G. T., **Gibbs energy vs. free energy,** *Chem. Eng. News Letter to the Editor,* p. 3 (Apr. 26, 1971).

Key words: Energy; free energy; Gibbs energy; Helmholtz energy.

A rationale is given for the change of name of free energy to Gibbs energy, and the change of symbol from F to G, in answer to a letter of protest by E. J. Davis.

12129. Ausloos, P., Rebbert, R. E., Sieck, L. W., **Ion-molecule reactions in the radiolysis of ethane,** *J. Chem. Phys.* **54,** No. 6, 2612-2618 (Mar. 15, 1971).

Key words: Charge transfer; deactivation; ethane; ion-molecule reactions; mass spectrometry; radiolysis.

The reactions of ions generated in ethane irradiated with gamma rays have been studied by analyzing the neutral products formed in reactions with ethane and with other molecules. In experiments in the presence of added $(C_2D_5)_2CDCD_3$, for example, it is shown that the following reactions take place: $C_2H_5^+ + C_2H_6 \rightarrow (C_4H_{11}^+)^* \rightarrow sec\text{-}C_4H_9^+ + H_2$; $sec\text{-}C_4H_9^+ + (C_2D_5)_2CDCD_3 \rightarrow n\text{-}C_4H_9D + C_6D_{13}^+$. The intermediate $(C_4H_{11}^+)^*$ ion can be stabilized by collisions and will then undergo an undetermined reaction (neutralization or proton transfer) to give $n\text{-}C_4H_{10}$ as a product. The over-all rate constant for reaction of the ethyl ion with ethane is shown to be $\leq 10^{-10}$ cm³/molecule·sec. Similarly, it is demonstrated that the reaction $C_2H_3^+ + C_2H_6 \rightarrow C_4H_9^+$ leads predominantly to the formation of *t*-butyl ions under these conditions: $C_4H_9^+ + (C_2D5)_2CDCD_3 \rightarrow (CH_3)_3CD + C_6D_{13}^+$. Supplementary experiments performed in a photoionization mass spectrometer demonstrate that ethylene ions undergo a "resonance H_2^- transfer" reaction with ethane: $C_2H_4^+ + C_2D_6 \rightarrow C_2D_4^+ + C_2H_4D_2$, with a rate constant of 1.1×10^{-10} cm³/molecule·sec. Similarly, the ethane parent ion reacts with ethylene: $C_2H_6^+ + C_2D_4 \rightarrow C_2H_4^+ + C_2H_2D_4$.

12130. Baker, M. A., **Study of the adherence of porcelain enamel to aluminum-use of the electron microscope and electron microprobe,** *Proc. Porcelain Enamel Institute Technical Forum, University of Illinois, Urbana, Ill., Oct. 7-9, 1970,* **32,** 48-51 (Porcelain Enamel Institute, Washington, D.C., 1971).

Key words: Adherence; aluminum; electron microprobe; electron microscope; interaction zone.

The interfacial zone between porcelain enamel and aluminum has been examined with the electron microprobe and the electron microscope to gain insight into the mechanism of adherence of the porcelain enamel to aluminum. The results obtained indicate that good adherence may be associated with an interaction between the enamel and the aluminum.

12131. Ballard, D. B., Yakowitz, H., Goldstein, J. I., **Study of metal in the lunar soil,** *Proc. 4th Annual Scanning Electron Microscope Symposium, ITT Research Institute, Chicago, Ill., April 29, 1971,* Part 1, 169-176 (Apr. 29, 1971).

Key words: Lunar soil; metal inclusions; meteorite; microstructure; SEM.

Metal particles and metallic inclusions in lunar (Apollo 11 and 12) soil particles were investigated using a SEM with a solid state detector. Many of the metallic particles were coated with nonmetallic lunar material and had impact craters on the surface. The SEM was used specifically to identify the type of lunar material in the craters and the exposed dendrites on the surface. Slip bands indicating plastic deformation were observed in several metal particles.

Several glassy spherules in the Apollo 11 soil were studied because the surfaces contained metal particles. Metal (Fe-Ni-Co), as identified with the solid state x-ray detector, was spread on the surface presumably as a result of the same impact event which produced the spherule. Other impacts may have formed the craters on the surface.

Several nonmetallic soil particles were sectioned and metallographically polished. Metallic inclusions in these soil particles are small, < 100 μm in their largest dimension. The SEM was employed to study the microstructure of these inclusions. Evidence of various degrees of shock damage in the metal was obtained.

12132. Becker, D. A., LaFleur, P. D., **Production and certification of NBS biological standard reference materials,** *Proc. 4th Annual Conf. on Trace Substances in Environmental Health, June 1970,* pp. 433-435 (University of Missouri, Columbia, Mo., Mar. 1971).

Key words: Biological standards; blood standard; botanical standards; environmental samples; Standard Reference Material; tissue standard; trace analysis.

The use of adequate standards is important in the trace element analyses of complex biological materials comprising many environmental and biomedical samples. Available biological materials for interlaboratory comparisons are almost exclusively "round-robin" type samples, and have failed to provide a well-characterized widely distributed and easily available standard. The NBS Office of Standard Reference Materials is in the process of acquiring, analyzing and certifying a series of biological standards. These standards, when issued, will include six botanical standards, a blood standard and a tissue standard.

12133. Bennett, H. S., **Absorbing centers in laser materials,** *J. Appl. Phys.* **42,** No. 2, 619-630 (Feb. 1971).

Key words: Antimony; heat conduction; laser materials; Nd-doped glass; platinum; stress components; thermoelastic theory.

One of the severe problems encountered in high-power-solid-state laser systems is the thermal damage to laser rods and optical elements arising from metallic or dielectric inclusions; i.e., impurities with physical and optical properties which differ substantially from those of the host material. Such inclusions may absorb an appreciable amount of the incident radiation and thereby may produce major stresses within the host material. In this paper, the dependence of the maximum value of the tensile stress upon the size of the inclusion and upon the physical properties of the host is examined. The feasibility of using optical techniques to detect metallic and dielectric inclusions in laser materials before they cause damage also is studied. The computations suggest that the use of laser pulse widths of the order of microseconds or longer may be more promising for the detection of small incipient absorbing centers than the use of nanosecond pulse widths.

12134. Bennett, H. S., ***F* centers in ionic crystals: semicontinuum-polaron models and polarizable-ion models,** *Phys. Rev. B* **3,** No. 8, 2763-2777 (Apr. 15, 1971).

Key words: CaF_2; CaO; *F* center; internal Stark effect; KCl; optical phonons; polarizable ion model; semicontinuum polaron model.

The three lowest-lying *F*-center states for KCl, CaO, and CaF_2 are calculated within the framework of five semicontinuum-polaron models and one polarizable-ion model. The movement of the nearest-neighbor ions to the *F* center and the *F* electron are treated in a self-consistent manner in these models. Exact solutions to these models for the states involved in the transitions of optical absorption and emission are obtained numerically. In addition, the internal Stark effect due to noncubic phonons is estimated. The absorption energy, the emission energy, and the lifetime of the first excited state are evaluated for the six models. It is shown that a semicontinuum-polaron model agrees best with the experimental results for KCl and that the polarizable-ion model gives the best results for CaO and CaF_2. In addition, the semicontinuum-polaron model and the internal Stark effect predict that the relaxed excited state in KCl consists of a strong mixing of 2*p*-like and 2*s*-like states which are spatially diffuse.

12135. Boyne, H. S., **Laser frequency stabilization techniques and applications,** *Proc. 24th Annual Frequency Control Symp., Atlantic City, N.J., April 27-29, 1970,* pp. 233-339 (U.S. Army Electronics Command, Fort Monmouth, N.J., 1970), *IEEE Trans. Instr. Meas.* **IM-20,** No. 1, 19-22 (Feb. 1971).

Key words: Frequency; laser; laser frequency measurement; stabilization; techniques; time standard.

A review of progress in laser stabilization techniques and laser frequency measurement is given. Methods for relating laser frequencies to the time standard and methods for absolute laser frequency stabilization are described. Experimental information on reproducibility and noise characteristics is reported. Application to frequency and wavelength standards is discussed.

12136. Unassigned.

12137. Brower, W. S., Jr., Parker, H. S., **Growth of single crystal cuprous oxide,** *J. Crystal Growth* **8,** 227-229 (1971).

Key words: Crystal growth; cuprous oxide; single crystal.

Single crystals of Cu_2O in sizes up to 1 cm dia and several cm long have been grown by a floating zone technique in a controlled oxygen pressure of 0.4 torr. Total cation impurities in the crystals were determined to be < 40 ppm.

12138. Burdick, M. D., **An instrumental procedure for evaluating adherence of porcelain enamel cover coats direct-to-steel,** *Proc. Porcelain Enamel Institute Technical Forum, University of Illinois, Urbana, Ill., Oct. 7-9, 1970,* **32,** 160-167 (Porcelain Enamel Institute, Washington, D.C., 1971).

Key words: Adherence; instrumental evaluation; porcelain enamel direct-to-steel.

An instrumental method for rating the quality of direct-on adherence is described. It is appropriate either for monitoring day-to-day production or for making interlaboratory comparisons. The method is based on present practices, is rapid and eliminates subjective judgments. Other approaches to direct-on adherence measurements will be discussed.

12139. Cezairliyan, A., **A high speed method of measuring thermal expansion of electrical conductors,** *Rev. Sci. Instr.* **42,** No. 4, 540-541 (Apr. 1971).

Key words: High-speed measurements; high temperature; platinum; thermal expansion.

A transient method for the measurement of thermal expansion of electrical conductors is described. The method is based on detecting the change in radiance coming from a constant radiation source as a result of the expansion of the specimen placed between the radiation source and a radiation detecting system. The specimen can be pulse heated from room temperature to near its melting point in less than one second and pertinent experimental quantities can be measured with a time resolution of 0.4 ms and a full-scale signal resolution of one part in 8000. To check the method, preliminary experiments were performed on platinum in the temperature range 300 to 700 K. The estimated inaccuracy of the results is within 5 percent. The agreement of the results with those in the literature is within 3 percent.

12140. Chappell, S. E., Humphreys, J. C., **Silicon detector measurements of energy deposition in aluminum by monoenergetic electrons,** (Proc. Annual Conf. Nuclear Space Radiation, La Jolla, Calif., July 1970), *IEEE Trans, Nucl. Sci.* **NS-17,** No. 6, 272-277 (Dec. 1970).

Key words: Absorbed energy vs depth; absorbed-energy distributions; incident monoenergetic electrons; Monte Carlo calculations; semi-infinite aluminum medium; silicon detector.

The energy deposited at various depths in aluminum by incident monoenergetic electrons has been measured with a silicon-semiconductor, transmission detector. Beams of monoenergetic electrons with incident energies of 0.50, 0.75, and 1.0 MeV were directed normally on a semi-infinite slab of aluminum in which a 0.196-mm silicon detector was positioned at various depths. The pulse-height distributions recorded with the detector were converted to absorbed-energy distributions from which the probability of energy absorption per incident electron in the specific layer, as well as the absorbed energy as a function of depth in the material, could be determined. The curves of absorbed energy as a function of depth obtained for aluminum at each energy were compared to those calculated by Berger and Seltzer, employing a Monte Carlo method. Good agreement is shown between calculations and measurements.

12141. Collin, G. J., Ausloos, P., **Ion-molecule reactions in the condensed-phase radiolysis of hydrocarbon mixtures. III. Reactions of *i*-$C_4H_8^+$ and *tert*-$C_4H_9^+$ ions originating from neopentane,** *J. Am. Chem. Soc.* **93,** No. 6, 1336-1340 (Mar. 24, 1971).

Key words: Ion-molecule reactions; neopentane; neutralization; radiolysis; unimolecular fragmentation.

The liquid-phase radiolysis of neopentane has been investigated in the presence of various hydrocarbons and electron scavengers. It is found that the neopentane parent ion dissociates to yield *tert*-$C_4H_9^+$ and *i*-$C_4H_8^+$ ions. The yields of these ions which are intercepted in these experiments under optimum conditions are ~ 2.4 and ~ 0.9, respectively. The *i*-$C_4H_8^+$ ion reacts with various added alkanes by the H_2^- transfer mechanism: $C_4H_8^+ + RH_2 \rightarrow i\text{-}C_4H_{10} + R^+$. The relative rates of reaction with different RH_2 additives have been determined and show the same trends as those observed for these reactions in the gas phase. That is, the rate is seen to increase with an increase in the exothermicity of the reaction (as calculated from gas-phase thermodynamic data). The effect of the ΔH of reaction is, however, more pronounced in the liquid than in the gas phase. The *tert*-butyl ion reacts more slowly with alkane additives than does the isobutylene ion, but reacts effectively with a negative ion from CCl_4 to form *tert*-C_4H_9Cl. Neutralization of the *tert*-butyl ion leads to the formation of isobutylene and propylene.

12142. Costrell, L., **CAMAC instrumentation system—introduction and general description,** (Proc. Nuclear Science Symp., New York, N.Y., Nov. 6, 1970), *IEEE Trans. Nucl. Sci.* **NS-18,** No. 2, 1-6 (Apr. 1971).

Key words: CAMAC; data; dataway; digital; instrumentation; modules; nuclear; standards.

The CAMAC instrumentation system developed by the ESONE Committee on European laboratories has been endorsed by the U.S. AEC NIM Committee as a dataway system complementary to the NIM (Nuclear Instrument Module) system. CAMAC is described in a general way in this introductory paper which is followed by papers that discuss the system in greater detail and describe typical implementation.

12143. Currie, L. A., Rodríguez-Pasqués, R. H., **Photonuclear tritium yields at 90 MeV,** *Nucl. Phys.* **A157,** 49-60 (1971).

Key words: Absolute tritium yields; hydrogen extraction; nuclear evaporation calculations; photonuclear reactions; 90 MeV bremsstrahlung; ^{64}Cu, ^{61}Cu, ^{11}C activation monitor yields.

Photonuclear (γ,t) yields have been determined for Al, Zn, Sn and Bi using 90 MeV bremsstrahlung from the NBS electron synchrotron. The National Bureau of Standards P2 ionization chamber was used for primary monitoring of the bremsstrahlung beam; supplementary C and Cu activation foils, whose absolute yields are reported, were employed for relative intensity measurements. Tritium yields were determined by quantitative extraction from the molten samples with hydrogen carrier followed by activity measurement by means of low-level gas counters. The observed yields were generally consistent with those of other workers at lower energies. Comparison of the tritium yields with the results of statistical model calculations suggests the predominance of non-evaporative processes in the higher mass region ($A \gtrsim 100$).

12144. Danos, M., Gibson, B. F., **Very high-momentum components in nuclei and far "subthreshold" production of quarks,** *Phys. Rev. Letters* **26,** No. 8, 473-476 (Feb. 22, 1971).

Key words: Coherent production; cosmic rays; high momentum components; many-body clusters; nuclei; quarks.

An estimate, valid for inelastic processes, of the probabilities of the high-momentum components in nuclei resulting from many-body correlations, together with data from Serpukhov, is used to derive upper limits for the quark-production cross section near threshold.

12145. Danos, M., Gillet, V., **Evidence for quartet structure in medium and heavy nuclei,** *Physics Letters* **34B,** No. 1, 24-26 (Jan. 18, 1971).

Key words: Binding energy; mass formulae; nuclei; particle-hole energy; quartet structure; rearrangement.

The second differences of the nuclear masses keeping T constant are discussed for even-even nuclei throughout the mass table. They are shown to be consistent with the quartet picture of weakly interacting tight two-proton two-neutron structures.

12146. Danos, M., Spicer, B. M., **Quartet structure in light nuclei,** *Z. Physik* **237,** 320-326 (1970).

Key words: Collective correlations; four particle-four hole states; light nuclei; quartets; rotational states; vibrational states.

The nature of the low-lying even parity, even spin states of $4n$-nuclei are discussed in terms of the quartet scheme, and many of their properties can be given by it. These states are also the low-lying states important in the collective correlations model of the giant dipole resonance, and the quartet scheme thus provides a description of them.

12147. DeVoe, J. R., Spijkerman, J. J., **Mössbauer spectrometry,** *Anal. Chem. Annual Reviews* **42,** No. 5, 366R-388R (Apr. 1970).

Key words: Chemical applications; literature; Mössbauer spectroscopy; review.

A review of the literature on chemical applications of Mössbauer Spectrometry for 1968 and 1969 are presented. This is done primarily with a table of pertinent information on compounds and techniques. New developments in the field are also presented.

12148. Dibeler, V. H., **Photoionization studies and thermodynamic properties of some halogen molecules,** (Proc. Intern. Conf. on Mass Spectroscopy, Kyoto, Japan, Sept. 8-13, 1969), Chapter in *Recent Development in Mass Spectroscopy,* K. Ogata and T. Hayakawa, eds., pp. 781-790 (University of Tokyo Press, Tokyo, Japan, 1970).

Key words: Chlorine monofluoride; dissociative ionization; fluorine; heats of formation; hot bands; hydrogen fluoride; ion pairs; mass spectrometry; molecular ionization; photoionization; vacuum ultraviolet.

Mass spectra and ion yield curves for molecular and dissociative ionization processes are measured for fluorine, hydrogen fluoride, chlorine, and chlorine monofluoride by means of a combined vacuum uv monochromator and mass spectrometer. Ionization and dissociation energies and heats of formation of the molecules are obtained and compared with values derived from thermochemical and spectroscopic studies.

12149. DiMarzio, E. A., Guttman, C. M., **Separation by flow and its application to gel permeation chromatography,** *J. Chromatog.* **55,** 83-97 (1971).

Key words: Chromatography; elution volume; flow; gel permeation chromatography; hydrodynamic volume; polymer; polymer separation.

When dilute solutions of finite size particles undergoing Brownian motion flow through a capillary, the larger particles have higher average velocities than the smaller particles. Thus one can obtain a separation of particles of different sizes due to fluid flow. The elution volumes of suspended particles or polymer molecules are derived for various tube geometries. Following TAYLOR, the effects of diffusional broadening of the volume elution peak for finite size particles are discussed and the process is shown to be chromatographic.

Models of a gel permeation chromatographic column are proposed in which there is fluid and particle flow through each of the beads as well as around them. Diffusion is allowed within and outside of the beads. Equations for the location of the volume elution peaks are computed for such models and shown to yield functional dependence on the polymer radius and column geometry very much like equations derived by previous workers for models of gel permeation chromatographic columns in which there was no flow allowed within the beads. Explicit formulae are given for the second and third moments for the above models. It is shown that for a monodisperse species the volume elution peak is always a gaussian of a finite width. It is shown that beads with open pores that allow for flow always have better separation capabilities than beads with pores that do not allow for flow.

12150. Dziuba, R. F., Dunfee, B. L., **Resistive voltage-ratio standard and measuring circuit,** *IEEE Trans. Instr. Meas.* **IM-19,** No. 4, 266-277 (Nov. 1970).

Key words: Divider; measurement system; ratio; ratio standard; resistive divider; voltage ratio.

This paper describes a highly stable, guarded dc voltage-ratio standard and the measuring network and techniques used to establish the values of its ratios to an accuracy of 0.2 ppm. The entire system is housed within a dry-air enclosure whose temperature is maintained at 23 ± 0.05 °C. Discrete ratios from 1:1 to 1000:1 are provided, with maximum rated voltage set at 1000 volts. The design of the standard was chosen so that a redundancy of measurement could be incorporated in the system. Thus each successive ratio is measured by a substitution or "bootstrap" method and by satisfying the conditions of the series-parallel principle, the 10:1, 100:1, and 1000:1 ratios are measured by a second independent method. The design also admits additional checks on the validity of the measurements. An analysis of measurement errors and a discussion of their possible origin are included. Since the intent also was to design the ratio standard for low-frequency operation some preliminary data are included on its ac performance.

12151. Fatiadi, A. J., **Determination of inososes with an alkaline solution of copper (II) oxalate-tartrate complex (the Somogyi reagent) and reaction mechanisms involved,** *Carbohydrate Res.* **17,** 419-430 (Mar. 1971).

Key words: Determination; electron-transfer; inosose; oxidation; quantitative; radical; reagent.

Four inososes have been analyzed with the Somogyi reagent and empirical equations for their quantitative determination were derived. Results from spectrophotometric and electron-spin resonance studies of the mechanism of oxidation of inososes with the Somogyi reagent at 25 to 55° are in agreement with a one-electron transfer process; however, at 90 to 100°, extensive degradation of inososes by the Somogyi reagent occurs, doubtless caused by generation of transient radicals during the oxidation, as evidenced by results of a radical-scavenging experiment.

12152. Fickett, F. R., **Resistivity of polycrystalline aluminum and copper in high magnetic fields: The effect of temperature and purity,** *Appl. Phys. Letters* **17,** No. 12, 525-527 (Dec. 15, 1970).

Key words: Aluminum; copper; magnetoresistance.

Data are presented on the resistivity of polycrystalline aluminum and copper at 40 kOe and at temperatures from 4 to 30 K. Specimen purity varies over three decades of residual resistance ratio. For either metal, the actual resistivity measured in the field at a given temperature decreases with increasing specimen purity. This result is important for proposed high magnetic field applications of these metals.

12153. Fickett, F. R., Clark, A. F., **Longitudinal magnetoresistance anomalies,** *J. Appl. Phys.* **42,** No. 1, 217-219 (Jan. 1971).

Key words: Copper; magnetoresistance.

We have observed the anomalous longitudinal magnetoresistance conditions $R(H) = 0$ and $0 < R(H) < R(0)$ on a [111]-oriented copper crystal specimen. The magnetoresistance voltages measured by two probe sets on mutually perpendicular faces of the specimen are observed to have a significant difference. Both of these effects are shown to be due to very slight misorientations of the specimen with respect to the magnetic field. In light of the observations, we present some precautions which should be observed in making longitudinal magnetoresistance measurements on high-purity materials.

12154. Gadzuk, J. W., Plummer, E. W., **Hot-hole-electron cascades in field emission from metals,** *Phys. Rev. Letters* **26,** No. 2, 92-95 (Jan. 11, 1971).

Key words: Attenuation length; electron gas theory; field emission; surface physics; tunneling.

Recent field-emission tunneling experiments have shown a current-dependent tail in the energy distribution for energies above the Fermi energy. This tail can be understood in terms of the products of a cascade process initiated by the injection of hot holes (removal of electrons by field emission) into the interacting electron gas or metal conduction band. The derived shapes of the tails, numerical values of the high-energy distributions, and field dependences of the current in the tails are in good agreement with our experimentally observed results.

12155. Geltman, S., Burke, P. G., **Electron scattering by atomic hydrogen using a pseudo-state expansion II. Excitation of 2s and 2p states near threshold,** *J. Phys. B: Atom. Molec. Phys.* **3,** No. 8, 1062-1072 (Aug. 1970).

Key words: Close coupling calculation; electron scattering; pseudo-state expansion.

The pseudo-state modification of the close-coupling expansion is applied to the 2s and 2p excitation of atomic hydrogen by electron impact. Pseudo-states are used which ensure the implicit inclusion of all important excited state polarizabilities. A detailed comparison is made with results obtained from other modifications of the close-coupling expansion and the eigenphase minimum principle is used to determine the best result for each partial cross section. Comparison of the theory and experiment in the first electron volt above the $n = 2$ threshold shows very good agreement in the ratio $Q(1s-2s)/Q(1s-2p)$, but a 20% discrepancy exists between the individual cross section magnitudes when experiment is normalized to the Born approximation at higher energies.

12156. Green, M. S., Cooper, M. J., Sengers, J. M. H. L., **Extended thermodynamic scaling from a generalized parametric form,** *Phys. Rev. Letters* **26,** No. 9, 492-495 (Mar. 1, 1971).

Key words: Coexistence curve; critical point; liquid-gas phase transition; parametric form; scaling; thermodynamic properties.

A generalization of the parametric representation for thermodynamic scaling is proposed, introducing a new critical exponent ϵ. Expansions about the critical point are deduced for the fluids, and to lowest order the asymptotic power-law forms are recovered. An exponent $1-\alpha'$ is obtained for the diameter of the coexistence curve. Experimental data are shown to support the predicted forms.

12157. Hastie, J. W., Hauge, R. H., Margrave, J. L., **Infrared spectra and geometries of heavy metal halides: $SrCl_2$, $BaCl_2$, $EuCl_2$, EuF_2, $PbCl_2$, and UCl_2,** *High Temp. Sci.* **3,** No. 1, 56-71 (Jan. 1971).

Key words: Heavy metal halides; infrared spectra; matrix isolation; molecular geometries.

The heavy metal dihalide species $SrCl_2$, $BaCl_2$, $EuCl_2$, EuF_2, $PbCl_2$, and UCl_2, generated under thermodynamic equilibrium conditions, have been isolated in matrices of solid Ne, Ar, Kr, and N_2. Methods of production varied from simple Knudsen vaporization for $SrCl_2$, $BaCl_2$, and $PbCl_2$, and decomposition vaporization, i.e.,

$$EuX_3(s) \rightarrow EuX_2(g) + 1/2\, X_2,$$

to oxidation vaporization, i.e.,

$$CaCl_2(g) + U(s) \rightarrow UCl_2(g) + Ca(g),$$

$$Cl_2(g) + U(s) \rightarrow UCl_2(g),$$

$$\text{and } 2HCl(g) + U(s) \rightarrow UCl_2(g) + H_2.$$

Infrared spectra for these matrix-isolated species were obtained ($33-4000$ cm^{-1}) and the symmetric (ν_1) and the antisymmetric (ν_3) vibrations observed in each case. For the chlorides the extreme low-intensity nature of the bending frequency (ν_2), the numerous extraneous low-frequency absorptions associated with lattice modes of the solid matrices, and the ever-present HCl impurities resulted in a less reliable assignment of ν_2 values. In some cases frequency measurement of the various naturally occurring Cl^{35}, Cl^{37} isotopic species allowed definite assignments of the stretching frequencies to be made and the following bond angles were calculated: $SrCl_2$ ($130 \pm 8°$), $EuCl_2$ ($135 \pm 8°$), and $PbCl_2$ ($96 \pm 3°$). Fermi interactions between ν_1 and ν_3 for the unsymmetrical isotopic species were observable in these cases and provided added verification of the frequency assignments. From the relative intensities of ν_1 and ν_3 the following bond angle estimates were made: $BaCl_2$ ($120 \pm 10°$), EuF_2 ($110 \pm 15°$), and UCl_2 ($100 \pm 15°$). These bond angles were also in accord with a consistent set of force-constant data.

12158. Herron, J. T., Huie, R. E., **Mass spectrometric studies of the reactions of singlet oxygen in the gas phase,** *Ann. N. Y. Acad. Sci.* **171,** Article 1, 229-238 (Oct. 15, 1970).

Key words: Air pollution; chemical kinetics; chemistry; gas kinetics; olefins; singlet oxygen.

The reactions of singlet molecular oxygen $(0_2{}^1\Delta_g)$ with some olefins and other organic reactants have been studied in the gas phase. Rate constants have been measured and the mechanisms of the reactions investigated. The significance of these reactions in air pollution is discussed.

12159. Kamper, R. A., Zimmerman, J. E., **Noise thermometry with the Josephson effect,** *J. Appl. Phys.* **42,** No. 1, 132-136 (Jan. 1971).

Key words: Josephson effect; noise; superconductivity; thermometry.

Thermal noise causes a random frequency modulation of the self-oscillation of a Josephson junction, and the temperature of the noise source can be determined by analysis of the generated signal. We show that a thermometer based on this principle would be theoretically capable of measuring temperatures in the microkelvin range, and describe a prototype thermometer which has recorded noise temperatures down to 0.075 K.

12160. Kidnay, A. J., Hiza, M. J., **The purification of helium gas by physical adsorption at 76 °K,** *AIChE J.* **16,** No. 7, 949-954 (Nov. 1970).

Key words: Breakthrough time; helium; mixture adsorption; nitrogen methane.

The physical adsorption isotherms for three methane-helium mixtures, two nitrogen-helium mixtures, and one methane-nitrogen-helium mixture were measured at 76 °K, and pressures of 2 to 65 atm on a coconut shell charcoal. The adsorption isotherms of the pure components (nitrogen, methane, and helium) were also determined over the appropriate pressure ranges.

Methods for predicting the mixture adsorption isotherms by using only the pure component isotherms are discussed and are shown to be adequate for these systems.

The concentration vs. time or breakthrough curves were also measured for both the binary and ternary mixtures at a number of different flow rates. Mass transfer coefficients for both the gas phase and the adsorbed phase were obtained from these breakthrough curves.

12161. Kieffer, L. J., **Low energy electron collision cross section data. Part II. Electronic excitation level and line cross sections,** *Atomic Data* **1,** No. 2, 121-287 (Nov. 1969).

Key words: Atom; cross section; electron; molecule.

This is the second part of a comprehensive compilation of low energy electron collision cross section data. The compilation is limited to experimental measurements and includes data for all atomic species and for those molecules which are important in aeronomy, astrophysics, and plasma physics. The data included were taken from literature published through December 1968.

12162. Klein, M., Hanley, H. J. M., **The m-6-8 potential function,** *J. Chem. Phys.* **53,** No. 12, 4722-4723 (Dec. 15, 1970).

Key words: Gas; intermolecular potential; potential function; scattering; second virial; viscosity.

We have studied the four parameter, semitheoretical m-6-8 potential as a potential function for some simple molecules. We find that the addition of the inverse eighth term to a three parameter function substantially improves the relation found previously between theory and experiment. We show here that with the m-6-8 potential we essentially duplicate the experimental viscosity data for argon both at very high and very low temperatures. With the same parameters we were also able to reproduce the experimental second virial coefficient data for argon. This improvement would appear to be due specifically to the addition of an eighth power attraction. It was further found that the value of the repulsive exponent is consistent with that obtained from the analysis of scattering data. Based on comparisons between our results and those obtained for the more elaborate function of Barker and Pompe we feel that modification of the repulsive term would not significantly alter the behavior of our results with respect to data.

12163. Lane, N. F., Geltman, S., **Differential elastic and rotational excitation cross sections for electron-H_2 scattering,** *Phys. Rev.* **184,** No. 1, 46-51 (Aug. 5, 1969).

Key words: Close coupling calculation; differential cross sections; elastic scattering; electron; H_2 (hydrogen molecule); rotational excitation.

Differential elastic and rotational excitation cross sections for electron-H_2 scattering have been calculated in the close-coupling approximation with electron exchange neglected. The resulting elastic angular distributions are found to be in very good agreement with measurements. An apparent oscillation in the measured differential cross section for rotational excitation is not found in the calculation.

12164. Laufer, A. H., **Low-temperature chromatographic deter-**

mination of ketene and methyl ketene, *J. Chromatogr. Sci.* **8,** 677-678 (Nov. 1970).

Key words: Analysis; gas chromatography; ketene; methyl ketene.

A quantitative chromatographic technique for the analysis of small quantities of ketene and methyl ketene has been developed. The method involves low temperature separation of the components on a "Haloport-F" column.

12165. McConnell, P. M., Daney, D. E., Kirgis, J. B., **Thermoelastic expansion and creep of polyethylene terephthalate and polypyromelitimide film and polyethylene terephthalate fibers from 20 to 295 K,** *J. Appl. Phys.* **41,** No. 13, 5066-5070 (Dec. 1970).

Key words: Longitudinal; polyethylene terephthlate; polypyromelitimide; relative creep; thermoelastic; transverse.

A quartz tube dilatometer was used to measure the lineal thermal expansion and creep of single lengths of polyethylene terephthalate (PETP) film, polypyromelitimide (PPMI) film, and PETP multifiber yarn, while stressed under constant tension. Tensions below and above the conventionally defined yield strength were used and the sample temperature ranged from 20 to 295 K. Relative creep strain measurements, taken at the constant temperatures 77, 195, and 295 K were found to obey the equation

$$\epsilon = \exp\left[-2.3 \exp(A'y)\right],$$

where y is a function of stress, time, and temperature and A' is a constant depending on the material. This equation was used to correct the thermoelastic expansion measurements for creep at the higher stresses. PETP multifiber yarn subjected to a slight tension was found to elongate during cooldown from 293 to 20 K. Higher stresses caused less elongation; i.e., the coefficient of expansion increased with stress. This result is believed to be due to changes in crystallinity at the higher stresses. A similar stress effect was found with PETP film but not with PPMI film. The thermoelastic expansion of the film samples was also found to be sensitive to the thickness.

12166. McDonald, D. G., Evenson, K. M., Wells, J. S., Cupp, J. D., **High-frequency limit of the Josephson effect,** *J. Appl. Phys.* **42,** No. 1, 179-181 (Jan. 1971).

Key words: Detectors; infrared; Josephson effect; lasers; superconductivity.

Coherent detection of applied radiation via a Josephson current step has been achieved with an applied frequency approximately a factor of 3 higher than heretofore reported. The detected signal is at 2.5 THz (118 μ). The inadequacy of existing theory to predict the frequency dependence of the Josephson effect is discussed.

12167. Manning, J. R., **Correlation effects and activation energies for diffusion in alloys,** (Proc. Conf. Atomic Transport in Solids and Liquids, Marstand, Sweden, June 1970), *Z. Naturforsch.* **26A,** No. 1, 69-76 (Jan. 1971).

Key words: Activation analysis; concentrated alloys; correlation factor; diffusion; random alloy; vacancies.

The problems involved in calculating correlation factors for diffusion in dilute alloys can be contrasted to those arising in concentrated solid solutions. As one moves from the pure element to the dilute alloy to the concentrated alloy, the calculation becomes progressively more difficult. Because of the complex atom configurations which can occur in concentrated alloys, it usually is not possible to calculate correlation factors in these alloys exactly.

Several important simplifications are available in non-dilute random alloys. A large reduction in complexity can be secured by using a random alloy model where each atom is treated as diffusing in a uniform matrix, with the matrix properties being determined by the composition and jump frequencies in the alloy. Resulting equations in this random alloy model can be expressed directly in terms of the experimentally measurable tracer diffusion coefficients with no unknown vacancy jump frequencies appearing. Also these equations have the advantage of being in simple analytic form and not requiring numerical methods to evaluate the correlation factors. These two features make possible the direct expression of the temperature dependence of the correlation factor in terms of the experimental activation energies.

Equations are found for $\Delta H/\Delta Q$ in random binary cubic alloys, where ΔH is the difference between the activation enthalpies for diffusion of the two species and ΔQ is the difference between the experimentally measured activation energies of the two species. This ratio is never less than unity and can be much larger than unity. Values are plotted for diamond, body-centered cubic and face-centered cubic structures. From the magnitude and composition dependence of $\Delta H/\Delta Q$, it is concluded that the temperature dependence of the correlation factor cannot by itself explain the difference between the activation energies measured from tracer diffusion and from internal friction in the non-dilute range.

12168. Matarrese, L. M., Evenson, K. M., **Improved coupling to infrared whisker diodes by use of antenna theory,** *Appl. Phys. Letters* **17,** No. 1, 8-10 (July 1, 1970).

Key words: Antenna theory; infrared detectors; lasers; whisker diode.

It is shown that the dependence of the output of a whisker diode on its orientation in the polarized beam of an infrared laser can be explained on the basis of simple long-wire antenna theory. Outstanding improvements in coupling the diode to the radiation field can result when this fact is utilized in applications.

12169. Moore, C. E., **Annual report on spectroscopy, July 1, 1969-June 30, 1970,** *Bull. Am. Astron. Soc.* **3,** No. 1, 154-155 (1971).

Key words: Atomic spectra; references; spectroscopy; transition probabilities.

A report of the activities at the National Bureau of Standards that are of special interest to astronomers and astrophysicists, is submitted annually for publication, along with observatory reports. The present report covers the fiscal year 1970.

12170. Olson, W. B., Papousek, D., **High-resolution infrared spectra of ethanelike molecules and the barrier to internal rotation: the ν_9,ν_{13} band of dimethylacetylene,** *J. Mol. Spectry.* **37,** No. 3, 527-534 (Mar. 1971).

Key words: Dimethylacetylene; internal rotation; rotational constants; spectrum; vibration-rotation.

The infrared spectrum of dimethylacetylene was measured with high resolution in the region of the perpendicular band of the C—H stretching vibration and the Q branches were partially resolved in the bunches of Q branches. The upper limit to the torsional barrier was estimated to be 4 cm^{-1}.

12171. Pecker, J. C., Thomas, R. N., **Personal libraries and publication policies,** *Atoms* **25,** 37-38 (Jan. 1970).

Key words: Astronomy, working library; libraries, astronomy; publication policies, astronomy.

The authors have been concerned for some time with the difficulties involved in maintaining an adequate personal, working library in the field of astronomy. The problem is especially acute for younger astronomers and for students and researchers working in less affluent geographical areas or institutions. In this discussion, we present some thoughts on the relation of the current situation to the problem of publishing in our field, and some proposals which we believe will improve it.

12172. Ramboz, J. D., **A link-compensated ratio transformer bridge,** *Rev. Sci. Instr.* **42,** No. 4, 522-524 (Apr. 1971).

> Key words: Bridge; impedance; impedance bridge; measurement; ratio transformer; ratio transformer bridge.

A ratio transformer impedance bridge that is capable of measuring either capacitive or inductive impedances is described. It is made of commercially available laboratory apparatus and can yield measurements to an uncertainty of less than ±0.1 percent. The unique feature is an injection transformer which reduces the effect of the interconnecting "link-resistance" between the unknown impedance and the bridge reference reactance. Five circuit variations of the bridge are shown and the equations which yield the solutions for the unknown resistance, capacitance, or inductance and phase angle are given.

12173. Ruegg, F. C., **A circuit which expands the count storage capacity of a multichannel analyzer,** *Nucl. Instr. Methods* **92,** 7-11 (1971).

> Key words: Multichannel scaler; nuclear instrumentation; overflow counter.

A circuit has been designed which allows the experimenter to store up to 10^{10} counts/channel in a 10^5 count capacity multichannel analyzer. The circuit uses the analyzer's second subgroup to store the overflow counts of the first subgroup. The circuit was designed to be used with an analyzer operating in the multichannel scaling mode.

12174. Scharf, K., **Spectrophotometric measurement of ferric ion concentration in the ferrous sulphate (Fricke) dosimeter,** *Phys. Med. Biol.* **16,** No. 1, 77-86 (1971).

> Key words: Chemical dosimeter; chemical dosimetry, ferrous sulfate; ferrous sulfate dosimeter; ferric ions; Fricke dosimeter; radiation dosimeter; radiation dosimetry; spectrophotometry; spectrophotometric measurements.

A systematic error in the spectrophotometric measurement of ferric ion concentrations in the ferrous sulphate dosimeter may be made by an incorrect evaluation of a non-linear spectrophotometric calibration curve. Methods are discussed for determining the radiation-produced change in molarity from the actual calibration curve, and a method of normalization of measured absorbances is suggested. Normalization factors, converting measured absorbances into normalized values, can either be calculated by choosing a reference value of the molar extinction coefficient, or can be determined by comparative absorbance measurements on two spectrophotometers, one of them to be a precision instrument. Normalized absorbances are proportional to molarity and may be considered to be free of errors due to instrumental parameters and inaccuracies in acidity and temperature of solutions, and of errors in molarity if derived by comparative measurements.

12175. Sieck, L. W., Searles, S., Ausloos, P., **High-pressure photoionization mass spectrometry. Photoionization of propane at 11.6-11.8 eV. Formation and reactivity of the $(C_3H_8)_2^+$ dimer ion,** *J. Chem. Phys.* **54,** No. 1, 91-95 (Jan. 1, 1971).

> Key words: Ion-molecule reaction; kinetics; mass spectrometry; photoionization; propane; radiation chemistry.

The major reaction path of the propane molecular ion with propane was found to be the formation of the dimer ion $(C_3H_8)_2^+$ via a termolecular mechanism,

$$C_3H_8^+ + C_3H_8 \xrightarrow{C_3H_8} (C_3H_8)_2^+ + C_3H_8.$$

In addition, $C_3H_6^+$ and $C_3H_7^+$ were also found as minor reaction products at lower pressures. The reactions of the dimeric ions with ethylene and NO were also investigated. The charge exchange reaction, $(C_3H_8)_2^+ + NO \rightarrow NO^+ + 2C_3H_8$, was found in propane-NO mixtures, suggesting a recombination energy in excess of 9.24 eV. The formation of $C_3H_8NO^+$ was also detected at higher total pressures. The dimeric ion was also found to transfer H_2 to ethylene without affecting the structural integrity of the carbon skeleton, $(C_3H_8)_2^+ + C_2H_4 \rightarrow C_6H_{14}^+ + C_2H_6$, indicating that this species exhibits the chemical behavior of a saturated hydrocarbon ion.

12176. Sixsmith, H., Giarratano, P., **A minature centrifugal pump,** *Rev. Sci. Instr.* **41,** No. 11, 1570-1573 (Nov. 1970).

> Key words: Centrifugal; helium; nitrogen; pump; pump design; pump performance.

A miniature centrifugal pump designed to circulate helium in a flow loop is described. It is designed to operate in the liquid helium temperature range under ambient pressures up to 100 atm (10^7 N/m^2), producing a maximum flow rate of 50 cm^3/sec and a maximum pressure rise of 3400 N/m^2. The operating characteristics obtained from preliminary tests with cold nitrogen gas and an analysis of the performance are included.

12177. Spiegel, V., Jr., Murphey, W. M., **Calculation of thermal neutron absorption in cylindrical and spherical neutron sources,** *Metrologia* **7,** No. 1, 34-38 (Jan. 1971).

> Key words: Manganous sulfate bath; neutron source absorption; neutron source calibration; thermal neutron absorption.

A calculation of the thermal neutron self-absorption for cylindrical or spherical neutron sources has been made. The calculations are confirmed by the experimentally-measured difference in manganous sulfate bath activity for bare and cadmium-covered Pu-Be and Am-Be neutron sources. The calculation is done in single interaction approximation and assumes that the incident thermal neutron flux is isotropic. The source material may be fissionable and be covered by up to three cladding materials. A computer program has been written for the numerical calculations.

12178. Tate, E. L., **Improving library collections by weeding,** *Proc. U.S. Department of Interior, 1970 Departmental Library Workshop, Washington, D.C., Sept. 28-Oct. 2-1970,* pp. 54-61 (U.S. Department of Interior, Office of Library Services, Washington, D.C., Feb. 1971).

> Key words: Scientists' use of literature; weeding a scientific library; weeding criteria.

Four recommendations for weeding a scientific and technical library are given: (1) develop written criteria for weeding a specific collection; (2) involve in the selection process the scientific staff of the agency served by the library; (3) take ample time to make the weeding a collection improvement program; and (4) do not regret the loss of one or two titles needed later but consider the overall benefits in terms of dynamic use of the library. Specific suggestions based on research on the use of scientific and technical literature are included as an aid in formulating weeding criteria.

12179. Uzgiris, E. E., Hall, J. L., Barger, R. L., **Precision infrared Zeeman spectra of CH_4 studied by laser-saturated absorption,** *Phys. Rev. Letters* **26,** No. 6, 289-293 (Feb. 8, 1971).

> Key words: Lasers; methane; saturated absorption; Zeeman effect.

Zeeman splitting of the methane 2947.912-cm^{-1} F_1 line was studied. The g factor of the rotational magnetic moment of methane was measured to be $g_J = +0.311 \pm 0.006$ and it was found that $g_J(\nu_3 = 1)$ is equal to $g_J(\nu_3 = 0)$. A Doppler-generated "level-crossing" saturated absorption signal was observed and is described.

12180. Van Blerkom, D., Hummer, D. G., **The normalized on-the-spot approximation for line transfer problems,** *J. Quant. Spectrosc. Radiat. Transfer Note* **9,** No. 11, 1567-1571 (Nov. 1969).

Key words: Doppler broadening; escape probability; planetary nebula; spectral line formation.

A simple approximation for line transfer problems is presented which is useful when photons scatter only a few times before being destroyed. Comparison is made to solutions of high accuracy.

12181. Wachtman, J. B., Jr., **Standard materials for measurements on ceramics,** *Am. Ceram. Soc. Bull.* **50,** No. 3, 242-247 (Mar. 1971).

Key words: Ceramics; chemical composition; mechanical properties; pressure; properties; standards; standard reference materials; temperature; thermal.

Standard materials having well determined values of specific properties are useful in establishing the validity of techniques for characterization and property measurements on ceramics. For some properties certified materials are available "off-the-shelf"; for other properties certification is in progress and a few specimens may be available on a collaborative basis. Recent progress and current work on standardized materials are briefly reviewed for temperature, pressure, chemical composition, thermal emittance, thermal expansion, thermal conductivity, vapor pressure, elasticity and viscosity.

12182. Wait, D. F., **The precision measurement of noise temperature of mismatched noise generators,** *IEEE Trans. Microwave Theory Tech.* **MTT-18,** No. 10, 715-724 (Oct. 1970).

Key words: Compensation method; cryogenic noise generators; mismatch error; noise temperature measurement.

By refining the technique and analysis of an earlier paper, it is shown that a compensation method is the basis of the most precise measurement of noise temperature, especially for cryogenic noise generators. The measurement system is adjusted so that it is in thermal equilibrium with the generator under test. As is typical for the compensation method, the generator under test may be mismatched, and the comparison errors and detector limitations can be verified experimentally. For generators with small reflection coefficients ($|\Gamma| \leq 0.1$), the comparison error is very close to the theoretical minimum, namely, twice the system resolution. For reflection coefficients as large as 0.5, the comparison error increases in a typical system to about four times the system resolution.

12183. Wallace, B., Brown, W. E., **Stoichiometric composition of whitlockite,** *J. Dental Res.* **50,** No. 2, 343-346 (Mar.-Apr. 1971).

Key words: Ca/P ratio; pyrolysis; pyrophosphate; stoichiometry; tricalcium phosphate; whitlockite.

The mineral whitlockite has been described as having Ca/P ratios of 3:2 and 10:7. This study used the pyrolytic formation of pyrophosphate and whitlockite from calcium orthophosphates and their mixtures with $CaCO_3$ to determine this Ca/P ratio. Its mean value of 1.506 ± 0.0015 indicated a formula of $Ca_3(PO_4)_2$.

12184. Wampler, R. H., **A report on the accuracy of some widely used least squares computer programs,** *J. Am. Stat. Assoc.* **65,** No. 330, 549-565 (June 1970).

Key words: Computer programs; curve fitting; Gram-Schmidt orthogonalization; Householder transformations; iterative refinement; least squares; linear equations; orthogonalization; orthogonal polynomials; regression; rounding error; stepwise regression.

Linear least squares test problems based on fifth degree polynomials have been run on more than twenty different computer programs in order to assess their numerical accuracy. The programs tested, all in present-day use, included representatives from several statistical packages as well as some from the SHARE library. Essentially five different algorithms were used in the various programs to obtain the coefficients of the least squares fits. The tests were run on several different computers, in double precision as well as single precision. By comparing the coefficients reported, it was found that those programs using orthogonal Householder transformations, classical Gram-Schmidt orthonormalization or modified Gram-Schmidt orthogonalization were generally much more accurate than those using elimination algorithms. Programs using orthogonal polynomials (suitable only for polynomial fits) also proved to be superior to those using elimination algorithms. The most successful programs accumulated inner products in double precision and made use of iterative refinement procedures.

12185. Weber, L. A., **Density and compressibility of oxygen in the critical region,** *Phys. Rev. A* **2,** No. 6, 2379-2388 (Dec. 1970).

Key words: Chemical potential; coexistence curve; compressibility; critical point; oxygen; PVT.

Density-versus-height profiles have been measured in the critical region of oxygen by means of capacitance techniques. Results are given for the liquid and vapor densities at coexistence, for compressibilities along the coexistence curve to within $t \equiv (T-T_c)/T_c = -6 \times 10^{-5}$, for compressibilities along the critical isotherm to within $(\rho - \rho_c)/\rho_c = 5 \times 10^{-2}$, and for compressibilities along the critical isochore to within $t = 2 \times 10^{-4}$. The data are analyzed in terms of power-law descriptions and are shown to be in excellent agreement with recent scaling-law analyses of data for other fluids.

12186. Weber, L. A., **Some vapor pressure and *P,V,T* data on nitrogen in the range 65 to 140 K,** *J. Chem. Thermodynamics* **2,** No. 6, 839-846 (Nov. 1970).

Key words: Density; liquids; nitrogen; *P,V,T;* phase boundary; saturation density; vapor pressure.

New results are presented for the vapor pressure of nitrogen from 65 to 126 K and for seven *P,V,T* isochores between 80 and 140 K. The isochores range in density from 0.85 to 2.6 times the critical. The vapor pressures are compared with existing literature values, and an equation is given for the vapor pressure on the IPTS-68 temperature scale between the triple point and the critical point.

12187. Weir, C. E., Piermarini, G. J., Block, S., **On the crystal structures of Cs II and Ga II,** *J. Chem. Phys.* **54,** No. 6, 2768-2770 (Mar. 15, 1971).

Key words: Cesium; gallium; high-pressure; polymorph; single crystal; x-ray diffraction.

The structures of Cs II and Ga II have been confirmed by high pressure single crystal x-ray studies. Cs II is Face Centered Cubic with $a = 6.465 \pm 0.015$ Å and Ga II is Body Centered Tetragonal with $a = 2.808 \pm 0.003$ Å and $c = 4.458 \pm 0.0003$ Å.

12188. Wiederhorn, S. M., Johnson, H., **Effect of pressure on the fracture of glass,** *J. Appl. Phys.* **42,** No. 2, 681-684 (Feb. 1971).

Key words: Deep submergence; fracture; fracture energy; glass; high pressure; strength.

The fracture surface energy of three glass compositions was measured as a function of hydrostatic pressure and was found to be independent of pressure to 20 kbar. This suggests that no change in the fracture mechanism occurs. The brittle behavior of glass thus differs from plastics and metals which are observed to become stronger and more ductile with increasing pressure.

12189. Woelfel, J. B., Paffenbarger, G. C., **Expanding and shrinking 7-year-old dentures: report of cases,** *J. Am. Dental Assoc.* **81,** No. 6, 1342-1348 (Dec. 1970).

Key words: Adaption; acrylic; contraction; dentures; epoxy; expansion; hard rubber; retention; serviceability; stability.

Two sets of upper and lower complete dentures, one made of vulcanite and one made of epoxy resin, were evaluated for serviceability and for dimensional changes from the time they were made until they had been worn seven years. Deterioration in serviceability was caused by changes in the tissues of the patient rather than by dimensional changes in the dentures. The epoxy resin dentures expanded gradually but there was practically no warpage. There was warpage in the vulcanite dentures, possibly caused by the differences in water absorption between the two types of rubber than were used for the facial sides and for the bases.

12190. Zimmerman, J. E., **Recent developments in superconducting devices,** *J. Appl. Phys.* **42,** No. 1, 30-71 (Jan. 1971).

Key words: Cardiography; instrumentation; Josephson effect; magnetometry; superconductivity.

A simple model of the electrical characteristics of thin-film-bridge, point-contact, and tunnel junction Josephson devices is given, along with some comments on their relative performance at very low and at very high frequencies. A particular example is the dc *IV* characteristic of a point contact at the center of a parallel-disk microwave cavity. Some recent developments in devices and the application of a point-contact loop (SQUID) device to magnetocardiography is described.

12191. Engen, G. F., **A new method of characterizing amplifier noise performance,** *IEEE Trans. Meas. Instr.* **IM-19,** No. 4, 344-349 (Nov. 1970).

Key words: Amplifier noise; noise; noise factor; noise temperature; Y-factor.

Although the use of noise figure or noise temperature to characterize amplifier performance is a well-established practice, it is also recognized that this parameter provides only a partial description of the amplifier noise properties. In general, the noise figure (or temperature) depends upon the generator impedance and is thus a function of the signal-source and amplifier combination.

Typically, the noise figure is measured by the Y-factor method using hot and cold noise sources that are nominally matched (reflectionless). The result of this measurement is of value as a figure of merit; however, if optimum performance is to be realized, the applications engineer must know whether to adjust the signal source impedance for maximum power transfer, minimum noise figure, or some other criterion, and he must know the deterioration in performance that results if this is not done. It is the purpose of this paper to present an alternative method of characterizing amplifier noise performance in terms of parameters that provide ready answers to these questions. In addition, the measurement of these parameters via a simple extension of the Y-factor method will be described.

12192. Gadzuk, J. W., Plummer, E. W., **Energy distributions for thermal field emission,** *Phys. Rev. B* **3,** No. 7, 2125-2129 (Apr. 1, 1971).

Key words: Field emission; surfaces; tunneling.

A sequence of total energy distribution curves for field emission was experimentally obtained for a tungsten emitter heated to 1570 K. Theoretical curves using the Miller-Good WKB-type approximation for tunneling probabilities are in good agreement with the experimental measurements. A significant feature of both sets of curves is a change in slope corresponding to electron emission near the top of the surface barrier where the emission mechanism changes from tunneling to thermionic emission. This feature is in accord with the classical-image force model for the surface potential which appears to be valid for distances approaching 3-4 Å to the metal surface.

12193. McLaughlin, W. L., Hussmann, E. K., Eisenlohr, H. H., Chalkley, L., **A chemical dosimeter for monitoring gamma-radiation doses of 1-100 krad,** *Intern. J. Appl. Radiation Isotopes* **22,** 135-140 (1971).

Key words: Chemical dosimeter; disinfestation; dosimetry; dyes; gamma rays; insect sterilization; shelf-life extension; sprouting inhibition.

A simple chemical dosimeter is described for measuring gamma-ray doses useful for insect sterilization, seed-sprouting inhibition, and food shelf-life extension. The solutions, colorless before irradiation, assume a stable blue-violet color when irradiated to absorbed doses from 1-100 krad. The readout may be made either visually, colorimetrically, or spectrophotometrically. The optical density is linear with dose, and the response does not vary with dose rate.

12194. Meinke, W. W., **Standard reference materials for clinical measurements,** *Anal. Chem.* **43,** 28A-47A (May 1971).

Key words: Clinical chemistry; organic SRMs; spectrophotometry SRMs; standard reference materials.

The NBS Program in Standard Reference Materials for Clinical Chemistry measurements is described. Each of the SRMs issued in this area in the last five years is discussed. Future directions of the program are also mentioned.

12195. Mountain, R. D., **Comment on "rotational diffusion of spherical-top molecules in liquids,"** *J. Chem. Phys.* **54,** No. 7, 3243 (Apr. 1, 1971).

Key words: Angular relaxation; ClO_3F; magnetic resonance; relaxation times; rotational diffusion; spherical-top molecules.

The formal equivalence of the J- and M-diffusion models for rotational diffusion of spherical-top molecules with two models worked out by Fixman and Ryder is noted.

12196. Nimeroff, I., **Color-match classification by variable parameters,** *Color. Engr.* **9,** No. 2, 13-17 (Mar.-Apr. 1971).

Key words: Color-match classification; color; isomerism; metamerism.

There is an increasing need for standard procedures by which to assess the nature of achieved color matches. It has been found that there are seven different classes of color matches in which the colorimetric parameters, the spectral characteristics of observer, source and specimen, are variable. The different classes result from the seven possible combinations of these three variable parameters, taken one, two and three at a time. Those matches in which one parameter varies are called, in accord with the variable parameter, observer-variable, source-variable or specimen-variable matches; those in which two parameters vary are called source-specimen-variable, source-observer-variable, or specimen-observer-variable matches; those in which all three vary are called source-specimen-observer-variable matches. Three of these classes of color match are currently designated metameric matches, one class is currently designated spectral match, while the other three classes have no current designation. The colorimetric effect of spectral differences in all of these classes of color matches may be characterized by an index of spectral difference. Such an index has been developed by Nimeroff and Yurow for matches that are currently designated metameric matches. A generalization of this index and its applications are presented.

12197. Robertson, B., Mitchell, W. C., **Equations of motion in nonequilibrium statistical mechanics. III. Open systems,** *J. Math. Phys.* **12,** No. 3, 563-568 (Mar. 1971).

Key words: Equations of motion; nonequilibrium statistical mechanics; open systems; thermal transport.

A simple hypothesis on the effect of the interaction between a system and its surroundings is used to generalize nonequilibrium statistical mechanics to apply to open systems. Thermal driving of a system by its surroundings is defined in statistical mechanics by analogy with the first law of thermodynamics, which describes exchange of heat between the system and an external source. The assumption that an isolated system is thermally driven is used to derive a Liouville equation with an additional term that is linear in the external source strength. The generalized Liouville equation is used to derive closed equations of motion that are the same as for an isolated system except for an additional term, which is just the source strength. This formalism is attractive because the source strength, which is assumed known, appears in the equation linearly just as in classical thermodynamics or hydrodynamics. A microscopic expression for the source strength is obtained by comparing the thermal driving formalism with an exact dynamical analysis of the system interacting with its surroundings.

12198. Scott, W. W., Jr., **New coaxial RF-DC ammeter,** *IEEE Trans. Instr. Meas.* **IM-19,** No. 4, 318-323 (Nov. 1970).

Key words: Ammeter; coax; infrared; rf-dc; thermopile radiation.

A unique new type of RF ammeter is described. The ammeter combines broad frequency coverage with broad current range and is designed for use in a 50-ohm coaxial transmission line.

The ammeter consists of an elliptic-cylinder silver reflector of infrared energy with a cylindrical thick-film heater along one focus and a heat-sensing thermopile along the other focus. Advantages over older ammeter designs include a shielded construction with inherent electrical isolation between the RF and dc circuits, a large dc output (approximately 1-100 mV) corresponding to a decade dynamic range (0.25-2.5 amperes), and a frequency range from dc to about 1 GHz.

This coaxial ammeter is believed to be the first to have very low standing-wave ratio (SWR) (1.03) in a 50-ohm transmission line. Ammeters of lower current range can be built, but at a penalty of increased SWR due to the larger heater resistance required.

12199. Bennett, L. H., Swartzendruber, L. J., Watson, R. E., **Interactions between small magnetic clusters in copper-rich Cu-Ni-Fe alloys,** *J. Appl. Phys.* **42,** No. 4, 1547-1548 (Mar. 15, 1971).

Key words: Alloys; clustering; copper; iron; local moments; Mössbauer effect; nickel.

Traces of iron in "nonmagnetic" Cu-rich Cu-Ni alloys produce small magnetic clusters largely limited to an Fe site and its Ni nearest neighbors, as observed in Mössbauer *source* experiments. The present work concerns ^{57}Fe Mössbauer *absorber* data for higher Fe concentrations (1/4-3%), in the 10-30% Ni range, which demonstrates the existence of a magnetic-moment distribution centered about *two* distinct moment values. For the lower Fe concentrations, the smaller and more abundant of these moments is identical to that observed in the source experiments and is associated with isolated small Fe-Ni clusters. The other moment is about twice as large and can be ascribed to coupled pairs of these small clusters. These results are almost free of effects of metallurgical clustering. By appropriate heat treatment, clustered samples are obtained with different moment distributions and higher Curie temperatures.

12200. Brenner, F. C., Kondo, A., **Research for a uniform quality grading system for tires IV. Tread wear,** *Rubber Chem. Technol.* **44,** No. 1, 106-121 (Mar. 1971).

Key words: Automobile tires; grading; rating; test method; tread wear.

This research had as its objective the development of a test procedure for rating tires for tread wear. The results of preliminary experiments on roads of different composition and severity are discussed. The authors conclude that the course on which tires are to be rated should include several different pavements and a variety of maneuvers of unequal severity.

Two courses, one near Bryan, Texas and the other near San Antonio, Texas, were designed on this principle. Eighteen brands of tires including bias, radial and G-78 belted-bias tires were run on each course. The tires ranked in order of decreasing projected mileage on each course were highly correlated, although the mileages were not equal.

12201. Cezairliyan, A., **Short-time (msec) fluctuations of radiance temperature of graphite arc,** *Appl. Opt.* **10,** No. 5, 1178 (May 1971).

Key words: Graphite arc; high-speed measurements; high temperatures; pyrometry; radiance; standards.

Short-time fluctuations of the radiance temperature of graphite arcs are investigated with a millisecond resolution photoelectric pyrometer. Standard deviation of the fluctuations around their mean is found to be 4 K. The range of low and high temperatures for four experiments extended from 3799 to 3808 K, with an average of 3804 K on IPTS-68.

12202. Colwell, J. H., Mangum, B. W., Thornton, D. D., **Low-temperature magnetic susceptibility and heat capacity of $GdAsO_4$,** *Phys. Rev. B* **3,** No. 11, 3855-3861 (June 1, 1971).

Key words: Antiferromagnetism; exchange interactions; $GdAsO_4$; heat capacity; Heisenberg; Ising model; low temperature.

We report measurements obtained in zero applied magnetic field of the magnetic susceptibility and heat capacity of $GdAsO_4$ in the temperature range 0.3-20 K. This material is antiferromagnetic below 1.262 K. A detailed comparison of the experimental results is made with those reported for the isomorphic compound $GdVO_4$. The entropy and energy of $GdAsO_4$ above and below the Néel temperature are in close agreement with the predictions of the Heisenberg model suggesting that the interactions are not only isotropic, but predominantly with the nearest neighbors as well. The magnetic measurements, on the other hand, indicate considerable anisotropy such that $GdAsO_4$ does not undergo a spin-flop transition. Attempts to explain this discrepancy are given. We have derived a value of the exchange-interaction constant $J/k \approx -0.04$ K, assuming a coordination number of 4 where J is defined by the Hamiltonian

$$\mathscr{H} = -2 \sum_{i<j} J_{ij} \vec{S}_i \cdot \vec{S}_j - g\mu_B \sum_i \vec{H}_0 \cdot \vec{S}_i.$$

12203. Day, G. W., **Linear and nonlinear optical properties of trigonal selenium,** *Appl. Phys. Letters* **18,** No. 8, 347-349 (Apr. 15, 1971).

Key words: Nonlinear optics; optical activity; optical properties; second harmonic generation; selenium.

Measurement of the second-order nonlinear optical susceptibility of trigonal selenium yielded $d_{11} = (9.7 \pm 2.5) \times 10^{-11}$ m/V. This value was obtained by cw SHG with a 106-μm CO_2 laser at a phase-matching angle of 5.5 ± 0.3° to the optic axis. Factors affecting this measurement are discussed along with data on absorption, optical activity, and birefringence.

12204. Domalski, E. S., **Thermochemical properties of peroxyacetyl (PAN) and peroxybenzoyl nitrate (PBN),** *Environ. Sci. Tech. Communications* **5,** 443-444 (1971).

Key words: Bond additivity method; group additivity method; peroxyacetyl nitrate; peroxybenzoyl nitrate; thermochemical properties.

The thermochemical properties of peroxyacetyl nitrate (PAN) and peroxybenzoyl nitrate (PBN) were estimated by means of bond and group additivity schemes. Values are given at 298.15 K for the following properties: ΔHf°(g), Cp°(g), S°(g), Cp°(liq), ΔHvap, and ΔHsublim.; these values were used to calculate ΔSf°(g), ΔGf°(g), ΔCp°[(liq) – (g)], ΔHf°(liq), and ΔHf°(s), which are also cited.

12205. Evans, B. J., Swartzendruber, L. J., **Mössbauer study of local molecular fields, cation distributions and recoilless fractions in Sb-substituted lithium ferrite,** *J. Appl. Phys.* **42,** No. 4, 1628-1630 (Mar. 15, 1971).

Key words: Antimony; ferrites; hyperfine fields; iron; isomer shift; lithium; Mössbauer effect; recoilless fraction.

Previous studies of the *B*-site hyperfine field distribution in spinel ferrites utilizing a local-molecular-field model have demonstrated that *A*-site cation disorder has a pronounced effect on $H_{eff}(B)$ and virtually no influence on $H_{eff}(A)$. The influence of *B*-site disorder on these hyperfine fields is less well known. We have made ^{57}Fe Mössbauer measurements on $Li_{1.2}Fe_{4.6}Sb_{0.2}O_8$ in which *B*-site disorder greatly predominates over *A*-site disorder. From the near natural linewidths for the *A* and *B*-site patterns we conclude that, in this material, *B*-site cation disorder is not nearly as effective as *A*-site cation disorder in producing inhomogeneities in H_{eff} at either site. The area ratio of the two hyperfine field patterns, which are well resolved in an applied field, yields equal recoilless fractions for the two sites.

12206. Evenson, K. M., Radford, H. E., Moran, M. M., Jr., **CH free radicals detected by infrared laser magnetic resonance,** *Appl. Phys. Letters* **18,** No. 10, 426-429 (May 15, 1971).

Key words: CH; far infrared; free radical; laser; laser magnetic resonance.

CH radicals in an oxyacetylene flame have been detected by a magnetic resonance absorption method, with a water-vapor laser as the source oscillator at a frequency of 2.5 THz. The absorption spectrum is identified with the pure rotational transition, $J, K = (5/2,2) \rightarrow (7/2,3)$ at a wavelength of 118.6 μm.

12207. Evenson, K. M., Wells, J. S., Matarrese, L. M., Jennings, D. A., **Variable output-coupling far-infrared Michelson laser,** *J. Appl. Phys.* **42,** No. 3, 1233-1234 (Mar. 1, 1971).

Key words: HCN lasers; H_2O lasers; infrared lasers; variable laser coupling.

A method for varying the coupling out of far-infrared gas lasers is described. It is based on the Michelson interferometer principle and has the advantage of increasing the power available from the laser by providing a smooth variation of the coupling.

12208. Godfrey, J. T., Vidal, C. R., Smith, E. W., Cooper, J., **Effect of time ordering in the unified theory,** *Phys. Rev. A* **3,** No. 5, 1543-1546 (May 1971).

Key words: Lyman-α; Stark-broadening; time-ordering; unified theory.

Using a previously developed unified theory of spectral line broadening, the effects of time ordering over the complete line profile are investigated. The results of calculations for the Lyman-α line are presented.

12209. Greenspan, M., **Comment on "response of ideal circuit elements to sinusoidal excitations,"** *Am. J. Phys.* **39,** No. 5, 586-587 (May 1971).

Key words: Transients.

In treating the response of a capacitor (say) to a suddenly impressed half-sinusoidal voltage, the original authors err and so do not predict the spike-like transient. The algebra is corrected and oscillograms of the phenomenon are presented.

12210. Hudson, R. D., Kieffer, L. J., **Compilation of atomic ultraviolet photoabsorption cross sections for wavelengths between 3000 and 10 Å,** *Atomic Data* **2,** No. 3, 205-262 (May 1971).

Key words: Atoms; compilation; cross section data; photoabsorption; photoionization; photon.

In the past several years the Information Center of the Joint Institute for Laboratory Astrophysics, University of Colorado, Boulder, Colorado, has been engaged in a program of critically evaluating the reliability of cross section data for many atomic and molecular processes, and in producing comprehensive compilations of these data. This report, the result of a joint effort between the JILA Information Center and NASA Manned Spacecraft Center, is a compilation of ultraviolet photoabsorption cross sections for atoms between 3000 and 10 Å. The compilation is limited to experimental measurements only and includes data for all atomic species that have been measured within this energy range. The literature was searched for data through October 1969, but because the Information Center covers some material through abstracting journals, a few recent measurements may not be included.

12211. Klose, J. Z., **Mean lives and absolute *f* = values in neutral iron,** *Astrophys. J.* **165,** No. 3, 637-642 (May 1, 1971).

Key words: Atomic lifetimes; atomic spectra; *f*-values; iron.

Mean lives of three levels in Fe I have been determined by using electronic excitation and a method of delayed coincidence. By the use of known relative *f*-values, absolute *f*-values were derived from the lifetime results for the transitions used in the lifetime measurements. The experimental results are summarized in the following table.

Level	λ (Å)	Mean Life (nsec)	*f*-Value
$z^5F_5^o$............	3719.9	61.5 ± 0.4	0.0410 ± 0.0003
$z^5F_4^o$............	3737.1	67.1 ± 1.1	0.034
$y^5F_5^o$............	3734.9	11.5 ± 1.5	0.14

The error given with each quantity is the standard deviation as determined from the dispersion of the individual measurements. In addition, the experimental results are estimated to contain systematic errors of up to 2 percent. Both the lifetimes and the *f*-values are presented in comparison with experimental results of other workers.

12212. Kurylo, M. J., Peterson, N. C., Braun, W., **Temperature and pressure effects in the addition of H atoms to propylene,** *J. Chem. Phys.* **54,** No. 11, 4662-4666 (June 1, 1971).

Key words: Absolute rate constant; activation energy; fluorescence; H atom; propylene; reaction kinetics.

The effect of He pressure on the rate of addition of hydrogen atoms to propylene was measured at 298 °K. H-atom concentration was measured by the method of resonance fluorescence of Lyman α radiation at 121.6 nm. The results are consistent with the $1/p^{1/2}$ dependence of k_{bi} recently observed in the H-atom-ethylene system. The limiting high-pressure rate constant obtained in this work is $H + C_3H_6 \rightarrow C_3H_7$, $k_1 = 1.61 \pm 0.04 \times 10^{-12}$ cm^3 molecule^{-1}·sec^{-1}. The temperature dependence of the H-atom addition was investigated at 50 torr total pressure over the temperature range 177-473 K. Analysis of the data below room temperature gives the following Arrhenius parameters for addition to the terminal olefinic position: $k_{bi}^{50} = (10.18 \pm 0.26) \times 10^{-12} \exp[-(1211 \pm 11)/1.987T]$ cm^3 molecule^{-1}·sec^{-1}. Deviations from this dependence above 298 K can be assigned to nonterminal addition, H-atom abstraction, and increased decomposition of the excited propyl radicals.

12213. Merris, R., Pierce, S., **A class of representations of the full linear group,** *J. Algebra* **17,** No. 3, 346-351 (Mar. 1971).

Key words: Full linear group; irreducible character; symmetry class of tensors.

Let V be a finite dimensional complex inner product space and let $\oplus^m V$ be the mth tensor space over V. Given a subgroup H of S_m and an irreducible character χ on H, we define a certain subspace $V_\chi{}^m(H)$ of $\oplus^m V$. If $T:V \rightarrow V$ is linear, let $\Pi \cdot T$: $\oplus^m V \rightarrow \oplus^m V$ be the mth Kronecker power of T. Then $V_\chi{}^m(H)$ is invariant under $\Pi \cdot T$ and let $K(T)$ be the restriction of $\Pi \cdot T$ to $V_\chi{}^m(H)$. The map $T \rightarrow K(T)$ is a representation of the full linear group. We prove that if χ is not linear, then this representation is reducible.

12214. Motz, J. W., Dick, C. E., Lucas, A. C., Placious, R. C., Sparrow, J. H., **Production of high-intensity *K* x-ray beams,** *J. Appl. Phys.* **42,** No. 5, 2131-2133 (Apr. 1971).

Key words: Beryllium to gold; electron produced; high intensity; monochromatic yields; purity; x-ray beams.

K x-ray beams are produced by direct electron excitation in beryllium, carbon, aluminum, titanium, copper, silver, and gold targets. With excitation currents of 10 milliamperes from dc electron accelerators or 1000 amperes from single pulse machines, the *K* x-ray yields are respectively 4 to 9 orders of magnitude larger than the yields produced by the conventional fluorescence method. The bremsstrahlung contamination in the *K* x-ray beam is minimized by observing the *K* x-rays at 180 degrees with respect to the incident electron beam, in order to exploit the fact that the bremsstrahlung intensities become more peaked in the forward direction as the electron energy increases. Values are given for the maximum yields and purities of the *K* x-ray beams with the corresponding electron energies, and a comparison is made with values obtained by other methods involving atomic ion or photon excitation of *K* x-rays.

12215. Ogburn, F., Shives, T. R., Brady, C. H., **Calibration of a filar micrometer,** *J. Mater.* **6,** No. 1, 60-66 (Mar. 1971).

Key words: Metal coatings; micrometers; microscopes; optical equipment; optical microscopes; thickness; thickness gages.

The precision with which a filar micrometer can be calibrated against a fixed interval of a stage micrometer was determined at magnifications of about 175 and 1900 for a group of 15 individuals familiar with microscopes. At each magnification the spread of measurements among the 15 operators was about 0.8 percent, whereas the spreads for the individual operators were substantially less.

12216. Osinsky, V. I., Winogradoff, N. N., **Excitation and temperature dependence of band-edge photoluminescence in gallium arsenide,** *Phys. Rev. B* **3,** No. 10, 3341-3346 (May 15, 1971).

Key words: Band-to-band recombination; concentration dependence; excitation dependence; gallium arsenide; impurity effects; photoluminescence; temperature dependence.

Photoluminescent spectra of *n*-type GaAs were studied as a function of the excitation intensity, temperature, and doping level. The spectra consisted of two major bands representing radiative band-to-band recombination and radiative transitions through impurity centers, respectively. The intensity of the peak of the former went through a minimum and a maximum as the temperature was increased from 175 to 500 K. The temperature corresponding to the above maximum increased as the excitation intensity was decreased or the doping level increased. These results suggest that the temperature dependence of the peak intensity in band-to-band transitions is primarily due to the thermal distribution of the carriers over the available energy states. The peak intensity would therefore normally be expected to decrease monotonically with an increase in temperature, while the above maxima and minima represent perturbations imposed by the presence of temperature-dependent transitions through radiative or nonradiative impurity recombination centers.

12217. Page, C. H., **Comments on "nonlinear resistors that generate subharmonics,"** *Proc. IEEE Letters* **59,** No. 2, 301 (Feb. 1971).

Key words: Nonlinear; subharmonics.

The analysis reported by Erdey is shown to be incorrect.

12218. Parks, E. J., **Thermal analysis of modified cellulose,** *Tappi* **54,** No. 4, 537-544 (Apr. 1971).

Key words: Alum; aluminum; apparent activation energy; calcium; cellulose; crosslinking; differential thermal analysis; ion exchange; organic acid; oxycellulose; stability; sulfuric acid; thermogravimetric analysis.

Differential thermal analysis (DTA) and thermogravimetric analysis (TGA) techniques have been applied to characterize thermal properties of cellulose and modifications of the type that might reasonably occur in papermaking pulps. Periodate, periodate-chlorite, chromate, chromate-chlorite, hypochlorous acid, and hypochlorous acid—chlorite oxycelluloses all were examined, as were their calcium and aluminum exchange products. In addition, the effects on thermal properties of cellulose exerted by alum, sulfuric acid, and two organic acids that cause color reversion all were investigated. The peak temperature of a massive decomposition endotherm (T_3), the apparent activation energy of this endothermic reaction (E^*), and the integral procedural decomposition temperatures (IPDT) seem to be the best suited of the thermal variables to denote stability. Oxidation usually destabilizes cellulose slightly. An exception is exhaustive oxidation of periodate oxycellulose with chlorous acid. This causes T_3 and E^* to increase, although the IPDT drops. Exchange with calcium greatly stabilizes cellulose containing carboxyl groups, whereas aluminum destabilizes the same material. Each effect is concentration dependent. The importance of pH in these relationships is not known. Sulfuric acid has a destabilizing effect qualitatively different from that of aluminum covering carboxyls and that of alum added to cellulose. Destabilization by alum is probably a result of contributions both by sulfate and by aluminum. Organic acids have little effect. Each treatment has resulted in a higher percentage of residue than that of cellulose, which may indicate the promotion of crosslinking by oxygen, metals, and acid.

12219. Smith, C. E., Milligan, D. E., Jacox, M. E., **Matrix-isolation study of the vacuum-ultraviolet photolysis of chlorofluoromethane. The infrared and ultraviolet spectra of the free radical ClCF,** *J. Chem. Phys.* **54,** No. 7, 2780-2793 (Apr. 1, 1971).

Key words: ClCF; chlorofluoromethane; chlorofluoromethane-d$_2$; fluorescence spectrum; free radical; infrared spectrum; matrix isolation; photolysis; ultraviolet spectrum.

The vacuum-ultraviolet photolysis of CH_2ClF and of CD_2ClF isolated in an argon matrix at 14 K leads to the appearance of prominent absorptions at 742 and at 1146 cm^{-1} which have been assigned to the two stretching fundamentals of ClCF. A weak absorption band system between 3900 and 3400 Å, with a 376 ± 10 cm^{-1} average band spacing, may be tentatively attributed to ClCF, as may be an emission band system which appears between 4000 and 4900 Å when the sample is excited by 3650 Å radiation. The 379 ± 10 cm^{-1} average band spacing associated with this emission band system has been tentatively attributed to the bending mode of ground-state ClCF, permitting a normal coordinate analysis for this molecule. The bending and the C-Cl stretching modes are appreciably mixed. Several other groups of absorptions also have been observed in these experiments, but the species responsible for them have not been definitively identified.

12220. Swartzendruber, L. J., **Localized moments on Fe impurities in Nb-Mo alloys: Mössbauer-effect absorber study,** *J. Appl. Phys.* **42,** No. 4 (Mar. 15, 1971).

Key words: Alloys; magnetism; Mo; Mössbauer Effect; Nb.

Mössbauer-effect spectra for absorbers of Mo and $Mo_{0.8}Nb_{0.2}$ alloys containing ^{57}Fe impurities have been obtained in an external field as a function of temperature. The spectra for the Mo-Fe alloys are in close agreement with the results of Kitchens *et al.* for (^{57}Co) Mo sources. The $Mo_{0.8}Nb_{0.2}$ spectra show directly the presence of two distinct moment values for the Fe impurities, one with a moment of $1.9\mu_B$ and one with a moment of less than $0.6\mu_B$, with the two moments present in roughly equal proportions. This result gives support for a discontinuous formation model of the type proposed by Jaccarino and Walker. The saturation hyperfine field of 115 kG for Fe in Mo is apparently reduced to 90 kG for moment bearing Fe in $Mo_{0.8}Nb_{0.2}$. There appears to be no quenching of the Fe moment for Fe-Fe pairs such as that observed for Co-Co pairs in Mo-Nb alloys.

12221. Taylor, B. N., **Report on the International Conference on Precision Measurement and Fundamental Constants,** held at the National Bureau of Standards, Gaithersburg, Md., August 3-7, 1970, *Metrologia* **7,** No. 1, 39-42 (Jan. 1971).

Key words: Fundamental constants; least squares adjustments; precision measurements.

This is a report on the International Conference on Precision Measurement and Fundamental Constants held at the National Bureau of Standards, Gaithersburg, Maryland, August 3 – 7, 1970. It includes a brief discussion of the purpose and significance of the Conference as well as some of the organizational details as they pertain to the Conference sponsors, topics covered, publication of the Conference Proceedings, etc. The bulk of the report is devoted to a summary by topic of the Conference highlights and conclusions.

12222. Vidal, C. R., Cooper, J., Smith, E. W., **Unified theory calculations of Stark broadened hydrogen lines including lower state interactions, (Short Version),** *J. Quant. Spectry. Radiative Transfer* **11,** 263-281 (1970).

Key words: Hydrogen lines; line wings; Stark broadening; theory; unified classical path.

Recently published calculations of hydrogen Stark broadening on the basis of the unified classical path theory have been extended to include lower state interactions in the final line profile. A detailed comparison with experiments in the density range $10^{13} - 10^{17}$ cm^{-3} is given.

12223. Waxler, R. M., **Laser glass composition and the possibility of eliminating electrostrictive effects,** *IEEE, J. Quantum Electron.* **QE-7,** No. 4, 166-167 (Apr. 1971).

Key words: Electrostrictive; glass; lasers; photoelasticity.

Many authors have stated that electrostrictive self-trapping of the light beam initiates laser damage in solid transparent dielectrics. By systematically varying composition, it may be possible to find a glass in which electrostrictive effects are eliminated.

12224. Weiss, M. J., Kuyatt, C. E., Mielczarek, S., **Inelastic electron scattering from formaldehyde,** *J. Chem. Phys.* **54,** No. 10, 4147-4150 (May 15, 1971).

Key words: Formaldehyde; inelastic electron scattering; ultraviolet absorption.

The electron scattering spectrum of H_2CO has been determined in the energy loss range between 0 and 16.0 eV. Three Rydberg series in the region 7-11 eV can be identified with the *s*, *p*, and *d* series reported in the literature by ultraviolet absorption studies. Oscillator strengths are determined for some of the Rydberg states and comparison is made with recent ultraviolet absorption work employing photoelectric methods of detection. A serious disagreement exists between the *f* values obtained by the two methods for the $3sa_1$ Rydberg. Another Rydberg series, probably converging to the third ionization potential of H_2CO, is observed in the electron scattering spectrum in the region 12.4-14.0-eV energy loss. Erratic behavior of the quantum defects of the first Rydberg series as well as failure to detect the $\pi \rightarrow \pi^*$ transition in H_2CO is discussed in the light of recent theories involving valence states which can seriously perturb members of a Rydberg series.

12225. Weiss, M. J., Mielczarek, S. R., Kuyatt, C. E., **Inelastic electron scattering from nitrous oxide between 5.0 and 20.0 eV energy loss,** *J. Chem. Phys.* **54,** No. 3, 1412-1414 (Feb. 1, 1971).

Key words: Far uv absorption; inelastic electron scattering; nitrous oxide; oscillator strengths.

The electron impact spectrum of N_2O is reported between 5.0 and 20.0 eV energy loss. A number of Rydberg series, converging to the second and fourth ionization potentials of N_2O, are observed in the spectra above the first i.p. Relative *f*-values, determined for some of the transitions in the 13-17 eV region, are in excellent agreement with those derived from recent vacuum ultraviolet absorption measurements.

12226. Wiese, W. L., Kelleher, D. E., **On the cause of the redshifts in white-dwarf spectra,** *Astrophys. J.* **166,** L59-L63 (June 1, 1971).

Key words: Balmer lines H_α, H_β, and H_γ; gravitational red shift; Stark broadening; Stark-induced red shift; white dwarf spectra.

Detailed laboratory measurements of the profiles of some Stark-broadened Balmer lines reveal systematic slight shifts of these lines to the red, which are linear functions of the electron density. It appears that the Stark-induced redshift accounts for a portion of the observed redshift in white dwarfs which has previously been attributed entirely to gravitation.

12227. Yokel, F. Y., Dikkers, R. D., **Strength of load bearing masonry walls,** *J. Struct. Div. Am. Soc. Civil Engineers* **97,** No. ST5, 1593-1609 (May 1971).

Key words: Bricks; buckling; deflection; loads (forces); masonry; moments; slenderness ratio; stability; structural engineering; walls.

A theory is presented, for the rational analysis of masonry walls under eccentric vertical compressive load, or under a combination of vertical compressive and transverse load. The theory is based on established concepts, which have been modified to account for the properties of masonry. Similar methods of rational analysis have been adopted for the design of steel columns and are in the process of being adopted for reinforced concrete columns. An investigation of the results of 192 tests of full-scale walls of various types of masonry construction established the feasibility of applying this theory to closely predict the strength of these walls. The analysis accounts for variables not presently considered in the design of masonry structures. The correlation between test results and theory is illustrated by several typical examples.

12228. Barnes, J. A., Chi, A. R., Cutler, L. S., Healey, D. J., Leeson, D. B., McGunigal, T. E., Mullen, J. A. Jr., Smith, W. L., Sydnor, R. L., Vessot, R. F. C., Winkler, G. M. R., **Characterization of frequency stability,** *IEEE Trans. Instr. Meas.* **IM-20,** No. 2, 105-120 (May 1971).

Key words: Allan variance; frequency; frequency stability; sample variance; spectral density; variance.

Consider a signal generator whose instantaneous output voltage $V(t)$ may be written as

$$V(t)=[V_0+\epsilon(t)]\sin[2\pi\nu_0 t+\phi(t)]$$

where V_0 and ν_0 are the nominal amplitude and frequency, respectively, of the output. Provided that $\epsilon(t)$ and $\phi(t)=(d\phi)/(dt)$ are sufficiently small for all time t, one may define the fractional instantaneous frequency deviation from nominal by the relation

$$y(t)\equiv\frac{\dot{\varphi}(t)}{2\pi\nu_0}.$$

A proposed definition for the measure of frequency stability is the spectral density $S_y(f)$ of the function $y(t)$ where the spectrum is considered to be one sided on a per hertz basis.

An alternative definition for the measure of stability is the infinite time average of the sample variance of two adjacent averages of $y(t)$; that is, if

$$\bar{y}_k=\frac{1}{\tau}\int_{t_k}^{t_k+\tau} y(t)\ dt$$

where τ is the averaging period, $t_{k+1}=t_k+T, k=0, 1, 2\ldots, t_0$ is arbitrary, and T is the time interval between the beginnings of two successive measurements of average frequency; then the second measure of stability is

$$\sigma_y^2(\tau)\equiv\left\langle\frac{(\bar{y}_{k+1}-\bar{y}_k)^2}{2}\right\rangle$$

where $\langle\ \rangle$ denotes infinite time average and where $T=\tau$.

In practice, data records are of finite length and the infinite time averages implied in the definitions are normally not available; thus estimates for the two measures must be used. Estimates of $S_y(f)$ would be obtained from suitable averages either in the time domain or the frequency domain. An obvious estimate for $\sigma_y{}^2(\tau)$ is

$$\sigma_y^2(\tau)\approx\frac{1}{m}\sum_{k=1}^{m}\frac{(\bar{y}_{k+1}-\bar{y}_k)^2}{2}.$$

Parameters of the measuring system and estimating procedure are of critical importance in the specification of frequency stability. In practice, one should experimentally establish confidence limits for an estimate of frequency stability by repeated trials.

12229. Beatty, R. W., Fentress, G. H., **A simple tuning circuit for waveguide and transmission line systems,** *IEEE Trans. Microwave Theory Tech.* **MTT-19,** No. 3, 337-338 (Mar. 1971).

Key words: Impedance measurement; microwaves; mm-waves; reflection coefficient measurement; tuners; tuning circuit.

A simple tuning circuit for source or load matching is described that makes possible smooth and sensitive adjustments with no "holes" in frequency coverage over a complete waveguide band. Energy is coupled out of the mainline, the phase and magnitude adjusted with phase shifter and attenuator and fed back into the mainline to cancel the reflected signal. A simple analysis of the circuit is presented, and a graph given for estimating the maximum voltage standing-wave (VSWR) that can be "tuned out." Application to measurement of reflection coefficient or to impedance is proposed.

12230. Brauer, G. M., Huget, E. F., **Heats of immersion of the components of tooth structure,** *J. Dental Res.* **50,** No. 3, 776 (May-June 1971).

Key words: Heats of immersion; heats of immersion of tooth structure; reactivity of anorganic whole tooth; reactivity of dentin.

The apparent heat of immersion of dentin and anorganic whole tooth in aqueous solutions of phenol, urea, hydrogen peroxide, potassium permanganate and silver nitrate were determined at 30 °C. Phenol and urea solutions react either endothermically with the dentinal protein or are bound preferentially to charged sites at the expense of water. Potassium permanganate and silver nitrate react exothermically with dentin surfaces. For anorganic whole tooth, the apparent heat of immersion in water did not differ from those values obtained on exposure to the aqueous solutions considered in this study.

12231. Cezairliyan, A., Morse, M. S., Beckett, C. W., **Measurement of melting point and electrical resistivity (above 2,840 K) of molybdenum by a pulse heating method,** (Proc. Conf. Thermophysical Properties, Manchester, England, April 7-10, 1970), *Rev. Int. Hautes Tempér. et Réfract.,* **t. 7,** 382-388 (1970).

Key words: Electrical resistivity; high-speed methods; high temperature; melting point; metals; molybdenum; premelting; thermodynamics.

A pulse heating method is used to measure the melting point and electrical resistivity of molybdenum in the temperature range 2,840 to 2,889 K. The specimen is heated from room temperature to its melting point in approximately 0.8 s. Specimen temperature is measured with a high-speed photoelectric pyrometer. During the heating period, voltage, current, and temperature are recorded with a high-speed digital data acquisition system which has a full-scale signal resolution of approximately one part in 8,000, and a time resolution of 0.4 ms. Results are compared with those in the literature. Estimated inaccuracy in the melting point (2,889 K) and in electrical resistivity is 10 K and 0.5 percent, respectively.

12232. Chandler, H. H., Bowen, R. L., Paffenbarger, G. C., **Development of a radiopaque denture base material,** *J. Biomed. Mater. Res.* **5,** 253-265 (Mar. 1971).

Key words: Bonding; composites; denture base materials; diagnosis; light translucency; physical properties; radiopacity.

Radiopaque glass-resin composites were made for evaluation as denture base materials. The addition of silane-treated, radiopaque, powdered glass to clear poly(methyl methacrylate) resulted in composites that had greater optical translucency than commercially available pink denture base resins. These formulations could be pigmented and opacified to produce materials that simulated oral soft tissues in color and translucency.

Other composites were made using various monomer, polymer and glass combinations. Those made from mixes of BIS–GMA, methyl methacrylate, poly(methyl methacrylate), and radiopaque glass had excellent translucency but handling characteristics were less than ideal.

Removal of very small glass particles (less than a few μm) appeared to improve optical translucency.

A radiographic survey of 12 specimens that contained from 29 to 57% of the radiopaque glass, indicated that all had sufficient radiopacity to aid in localization of swallowed or aspirated dentures made from such materials.

Finishing procedures on composite specimens were more difficult and time-consuming and did not produce surfaces as smooth as those obtained on poly(methyl methacrylate). The finished surfaces felt smooth to the tongue but might stain more easily in the mouth.

12233. Chandler, H. H., Bowen, R. L., Paffenbarger, G. C., **The need for radiopaque denture base materials: A review of the literature,** *J. Biomed. Mater. Res.* **5,** 245-252 (Mar. 1971).

Key words: Denture foreign bodies: type, cause, prevention; prosthetic materials: radiopaquing agents; radiopaque denture base materials.

The need for esthetic and functionally acceptable radiopaque denture base materials is reflected by numerous reports of patients who ingested or aspirated portions of dentures and reports of difficulties encountered in the removal of these dentures because they could not be located radiographically.

The type of denture most commonly ingested or aspirated is a maxillary partial consisting of a palatal piece to which is attached one or more anterior teeth. It may or may not have clasps. Ingestion or aspiration of the foreign body commonly occurs when either broken or ill-fitting dentures are being worn. Few cases have been reported where patients swallowed portions of complete dentures.

Previous attempts at providing radiopacity have included addition of heavy metal salts or radiopaque inserts to denture base resins. None of these attempts has been entirely successful.

Elimination of dentures as foreign bodies requires a greater effort toward preventive measures by the dentist and the patient. When dentures are swallowed or inhaled, the dentist should immediately seek medical assistance for the patient. The common symptomless period following ingestion or aspiration should not lead the dentist to believe that there will not be serious subsequent complications.

12234. Davis, D. D., **Frequency standard hides in every color TV set,** *Electronics*, pp. 96-98 (May 10, 1971).

Key words: Dissemination; frequency; frequency synthesizers; linear phase comparators; television color subcarrier; time.

In color television broadcasting, a color "subcarrier" is transmitted at about 3.58 MHz. It is used as a reference signal in the color television receiver to demodulate the chrominance sidebands. The major U.S. networks use rubidium frequency standards to generate the color subcarrier. This paper describes a method for making use of the color subcarrier as a frequency standard. The output of a 1 MHz local standard synthesized to 3.58 MHz is used as one input to a phase comparator and is adjusted to agree with the received subcarrier signal. Results of actual network measurements are given.

12235. Dove, R. B., Marshak, H., **Shaft seal for mechanical pump,** *J. Vacuum Sci. Technol.* **8,** No. 3, 519 (May-June 1971).

Key words: Closed pumping system; He^3-He^4 dilution refrigerator; mass spectrometer leak detector; mechanical pump; shaft seal.

A simple vacuum shaft seal for a mechanical pump is described.

12236. Engen, G. F., **Power equations: A new concept in the description and evaluation of microwave systems,** *IEEE Trans. Instr. Meas.* **IM-20,** No. 1, 49-57 (Feb. 1971).

Key words: Attenuation; impedance; microwave power; mismatch error.

In the existing art, the description and evaluation of microwave systems is usually in terms of the complex wave amplitudes in the (assumed) uniform waveguide by which the components are interconnected. The interrelationships among these amplitudes are given by the scattering equations or indirectly by impedance parameters.

This paper introduces an alternative description, based on *power equations*, where the basic parameter is the net power in the waveguide of interest. Compared with the circuit description, there is a substantial suppression of detail and the remaining parameters are placed in better perspective. In particular, the technique provides a simplified method of describing and evaluating mismatch corrections, in which the precision connector and uniform waveguide requirements have been eliminated.

12237. Franklin, A. D., Marzullo, S., **9.—EPR study of point-defect equilibria in CaF_2 containing GdF_3,** *Proc. No. 19 British Ceramic Society, "Role of Point Defects in Solid State Mass," Mass Transport Proc. Non-Metallic Solids, London, England, Dec. 17-18, 1969,* pp. 135-150 (British Ceramic Society, Stoke-on-Trent, England, 1971).

Key words: Calcium fluoride; defect equilibria; electron paramagnetic resonance; point defects.

Room-temperature measurements have been made of E.P.R. spectra at 9.5 GHz arising from tetragonal and cubic centres in CaF_2 containing between 0.01 and 0.45 mol % GdF_3. The crystals were annealed in a 30:1 He-HF atmosphere at temperatures ranging from 500 to 1100 °C and then rapidly cooled to room temperature. The annealing times were long enough to achieve steady-state E.P.R. data, and the cooling was rapid enough so that a considerably slower cooling gave essentially the same result. The ratio of the concentration of tetragonal centres to that of cubic centres diminished as the total GdF_3 concentration increased. At a given GdF_3 concentration, this ratio passed over a maximum as the annealing temperature increased. This behaviour is inconsistent with a model including only anion interstitials and vacancies. If cation vacancies are included, and if they are assumed to be immobile while the anions can move during cooling, the qualitative features of the data can be produced by the model. Direct experimental confirmation of these assumptions and of the presence of cation vacancies has not been obtained.

12238. Haller, W., Simmons, J. H., Napolitano, A., **Viscosity-drift technique for determination of critical liquid-liquid immiscibility temperature of glasses,** *J. Am. Ceram. Soc.* **54,** No. 6, 299-302 (1971).

Key words: Glass; immiscibility; phase-separation; viscosity; viscosity-drift.

The time dependence of the low-temperature viscosity was used to determine the occurrence of phase separation in glass systems and to measure the critical immiscibility temperature. The technique is fast and easily performed and can be applied to materials with very low immiscibility gaps. Immiscibility temperatures for several technically important glass compositions are given.

12239. Haller, W., Winogradoff, N. N., **Explosive vapor release as cause of laser-induced surface damage of glass,** *J. Am. Ceram. Soc.* **54,** No. 6, 314-315 (1971).

Key words: Glass; laser damage; surface.

Gigawatt laser pulse produced surface lesions on an alkali lead silicate glass were investigated. Macroscopically, the lesions resemble thermal spall fractures. Electromicroscopic pictures and electron microprobe profiles, however, reveal that the damage is caused by the explosive release of alkali oxide vapors from the shock molten glass surface.

12240. Hoeve, C. A. J., **On the general theory of polymer absorption at a surface,** *J. Polymer Sci. Symposia,* **Part C,** No. 30, 361-367 (1970).

Key words: Configurations; excluded volume effect; loops; polymer adsorption; surface layer; trains; Θ-point.

Previous theoretical work dealt with polymer adsorption in which the adsorbed segments (trains) interact in the surface layer only. In this work the treatment is extended to include also interaction between the loops dangling in solution. Fortunately, the excluded volume effects for adsorbed polymer chains are found to be small. Therefore an approximate treatment is possible that leads to equations that govern polymer chains under a wide variety of conditions.

12241. Hummer, D. G., Rybicki, G. B., **Radiative transfer in**

spherically symmetric systems. The conservative grey case, *Monthly Notices Roy. Astron. Soc.* **152,** No. 1, 1-19 (1971).

Key words: Eddington factor; model atmospheres; spherical radiative transfer.

A practical computational method is presented for the solution of radiative transfer problems in spherically symmetric systems. This procedure involves iteration on the "Eddington factor" $f = K/J$ and is designed to handle the outward peaking of the radiation field in extended spherical systems. Extensive numerical results are obtained and discussed for systems in which $\kappa\rho = r^{-n}$, $0 < r \leq R$, for $n = 3/2$, 2 and 3.

12242. Jacox, M. E., Milligan, D. E., **Matrix-isolation study of the vacuum-ultraviolet photolysis of chloroform. Infrared spectra of the CCl_3^+, $HCCl_2^+$, and $HCCl_2^-$ molecular ions,** *J. Chem. Phys.* **54,** No. 9, 3935-3950 (May 1, 1971).

Key words: CCl_3^+; chloroform; electron attachment; $HCCl_2^+$; $HCCl_2^-$; $HCCl_3^-$; infrared spectrum; matrix isolation; photoionization; vacuum ultraviolet photolysis.

Photolysis of samples of $HCCl_3$ isolated in an argon matrix at 14 K using 1216-Å radiation leads not only to the isolation of a high yield of CCl_3, but also to the photoionization of CCl_3, resulting in the stabilization of a sufficient concentration of CCl_3^+ for direct infrared spectroscopic identification. The assignment of still other infrared absorptions which appear in this system to negatively charged species has been confirmed by experiments in which a small concentration of an alkali metal atom is also present in the matrix, providing a photoelectron source. When matrix-isolated $HCCl_3$ is subjected to photolysis by 1067-Å argon resonance radiation, very little CCl_3 is produced, but $HCCl_2$, $HCCl_2^+$, and the same negatively charged species are stabilized in significant concentration. Studies of chloroform samples enriched in carbon-13 and of $DCCl_3$ samples have provided support for these identifications and have yielded data necessary for obtaining several of the force constants of these species. The infrared spectrum of the negatively charged species can most satisfactorily be explained by postulating that dissociative electron attachment to chloroform occurs, resulting in the stabilization of $HCCl_2^-$ in the matrix environment.

12243. Karp, S. S., Matteson, T. T., **The integrated team concept of simulation model development,** *Proc. 1971 Summer Computer Simulation Conf., Boston, Mass., July 19-21, 1971,* pp. 1301-1307 (July 1971).

Key words: Coast Guard; development; interdisciplinary team; management science; model building; organization; search and rescue; simulation; team development.

The ultimate measure of a simulation model's effectiveness is the extent to which it provides meaningful insight towards the solutions of management's problem. Participation in model development by analysts from the management organization has proven to be highly beneficial in producing an effective simulation. An integrated team concept is a successful means of achieving management participation in the model development. This concept involves varying degrees of client (management) participation throughout the entire period of simulation development, with maximum interaction occurring during the conceptualization/modeling and validation/exercise phases. The participants in this integrated development team are personnel from both the client and consultant organizations. The integrated client-consultant approach to model development was used by the National Bureau of Standards and the U.S. Coast Guard to successfully develop an effective simulation model of the Coast Guard Search and Rescue system.

12244. Klein, M., **Practical treatment of coupled gas equilibrium,** Chapter 7 in *Physical Chemistry,* **Vol. 1.** Thermodynamics, 489-544 (Academic Press, Inc., New York, N.Y., 1971).

Key words: Chemical equilibrium; chemical reactions; equilibrium; gases; mass action; non-linear search.

Equations are derived for the species concentrations in coupled chemical equilibria in the gas phase. This is done both for the method of the direct minimization of the free energy as well as for the equilibrium constant method. The relations developed are such as to allow for the inclusion of detailed real gas effects. The emphasis is on practical problems encountered in the actual calculation of the species and the thermodynamic properties. Expressions are derived for the direct calculation of the concentration derivatives with respect to temperature and density required for the calculation of the derived properties (i.e., specific heats, sound velocities, etc.) Considerable space is given to discussions of the non-linear numerical methods available for the solution of the non-linear equations for the species concentrations.

12245. Kushner, L. M., **Welcoming address,** *Proc. Footwear Manufacturing Executives Conf. held at the King's Grant Motor Inn, Danvers, Mass., Dec. 1, 1970,* pp. 7-11 (Sponsored by the COMTECH, American Footwear Manufacturers Association, and the New England Footwear Association, December 1970).

Key words: New technology; performance standards; product standards; standardization.

12246. Linsky, J. L., **Can the ion H_3^+ account for missing opacity in the solar ultraviolet?** *Solar Physics* **11,** No. 2, 198-207 (Feb. 1970).

Key words: H_3^+; opacity, continuous; solar photosphere; solar ultraviolet spectrum.

Limb darkening and specific intensity data imply more continuous opacity in the solar photosphere between 2000 A and 3500 Å than has been predicted theoretically. The temperature dependence and wavelength dependence of this missing opacity are in qualitative agreement with those deduced for the ion H_3^+, but it is unlikely that H_3^+ is sufficiently abundant to account for this opacity.

12247. Linsky, J. L., **On the relative residual intensities of the calcium H and K lines,** *Solid Physics* **11,** No. 3, 355-373 (Mar. 1970).

Key words: Non-LTE radiative transfer; resonance lines, Ca II; solar chromosphere, physical properties; solar chromosphere, structure; spectral line formation; spectroscopic diagnostics.

We have observed the solar Ca II H and K lines to obtain well-calibrated ratios of their core residual intensities. From three independent calibrations, one using a standard lamp, we conclude that the residual intensity ratio $r(K_3)/r(H_3)$ is 1.048 ± 0.03 in the quiet chromosphere and 1.20 ± 0.03 in a plage region. These ratios correspond closely to those observed in stars with quiet and active chromospheres, respectively. For a chromospheric model suggested by the calcium lines and a four-level Ca II ion, we compute H and K line profiles varying the direct collisional coupling and indirect radiative and collisional coupling via the 3 ^2D level. We conclude that enhanced chromospheric activity in the sun and late-type stars results more from a steepening of the chromospheric thermal gradient than from a change in density.

12248. Linsky, J. L., Teske, R. G., Wilkinson, C. W., **Observations of the infrared triplet of singly ionized calcium,** *Solar Physics* **11,** No. 3, 374-383 (Mar. 1970).

Key words: Non-LTE radiative transfer; resonance lines, Ca II; solar chromosphere, physical properties; spectral line formation; spectroscopic diagnostics.

Observations are presented of the Ca II infrared triplet (8498 Å, 8542 Å, and 8662 Å) at three positions on the solar disk to make possible direct analyses of the lines and comparisons with theoretical computations. The source functions for the two strongest lines (8542 Å and 8662 Å) are equal at those heights corresponding to the wings of the lines ($|\Delta\lambda| > 0.4$ Å) but not to those of the cores. We suggest that the apparent source function inequality in the cores is due to limb darkening caused by inhomogeneities in the chromosphere.

12249. Loebenstein, W. V., **The exchange of ^{45}Ca and ^{32}P with hydroxyapatite as interpreted by adsorption from solution,** *J. Colloid Interface Sci.* **36,** No. 2, 234-246 (June 1971).

Key words: Adsorption from solution; calcium phosphate; composite adsorption; isotopic exchange; kinetics of adsorption; mechanism of adsorption; solution adsorption.

A theory has been developed based on Langmuir kinetics for the adsorption of a component from solution by a reversible and an irreversible process, simultaneously. The theory has been applied to the removal of traces of ^{45}Ca and of ^{32}P from saturated solutions of their nonradioactive counterparts as calcium and phosphate ions by isotopic exchange at the surface of hydroxyapatite. In testing the theory, a computer-programmed nonlinear least-square fit was used to evaluate the physically significant characteristic parameters. This has been accomplished for a number of similar experiments, each of which had a different pH, slurry density, and tagged ion concentration. The results of this study confirm that the approach is feasible and that the assumed model is reasonable. Not only does the theory fit the data, but the magnitude of the derived quantities is internally consistent. No change in calcium to phosphate ratio of the respective surface sites was evident from one experiment to another.

12250. Means, C. R., Rupp, N. W., Paffenbarger, G. C., **Clinical evaluation of two types of resilient liners on dentures,** *J. Am. Dental Assoc.* **82,** 1375-1380 (June 1971).

Key words: Denture base; protective; resilient liners; temporary expedients; tissue bearing.

This is a report of observations made on the clinical experiences of 14 patients wearing 23 dentures. The dentures were lined with one of these two resilient liners, Coe Super Soft or Silastic 616. These observations yielded results on which the following conclusions or recommendations are based. 1. Both materials are safe to use against oral tissues. 2. Since deterioration and loss of resilience reduce their effectiveness in a relatively short time, dentures lined with these materials should be observed every 3 months. 3. The border junction between the resilient liner and the denture base should be a butt joint. A thin tapered junction is unsatisfactory. The finish line should be well away from the borders of the flanges. 4. These resilient liners should be considered as temporary expedients to be used only in selected cases which require a protective resilient surface on the tissue bearing side of the denture base. 5. A denture that carries a resilient liner should be sufficiently thick in cross section to resist fracture. Thinning of a denture to make room for a resilient liner may lead to fracture in service.

12251. Myklebust, R. L., Heinrich, K. F. J., **Rapid quantitative electron probe microanalysis with a nondiffractive detector system,** *Am. Soc. Testing Mater. Spec. Tech. Publ.* **485,** pp. 232-242 (1971).

Key words: Electron diffraction; electron probes; evaluation; gas flow; lithium; microanalysis; multichannel analyzer; proportional counters; quantitative analysis; solid state counters; tests; x-ray spectra; x-ray spectrometers.

Nondiffractive detector systems on electron probe microanalyzers have decreased the time required for a qualitative analysis from 30 or 40 min to 1 or 2 min. The nondiffractive technique may be extended to the quantitative determination of an element by comparing either the peak height or the area beneath the peak of the signal from the specimen with that from the pure chemical element or a standard of known composition run under identical conditions. Results are given for quantitative analyses of several materials with a lithium-drifted silicon detector, used for x-ray lines above 1 keV, and a gas flow proportional detector, for x-ray lines from 0.16 to 1.5 keV. Quantitative analyses can be accomplished only when the experimental conditions are carefully selected and maintained throughout the measurement. They are then sufficiently precise to warrant the use of a "matrix" correction procedure to obtain concentrations. An analog curve analyzer is useful for resolving overlapping peaks and for integrating the areas beneath the peaks.

12252. Nuttall, R. L., Laufer, A. H., Kilday, M. V., **The enthalpy of formation of ketene,** *J. Chem. Thermodynamics,* No. 3, 167-174 (1971).

Key words: Bond energy; enthalpy of formation; heat of formation; ketene; methylene.

The enthalpy of reaction of ketene gas with aqueous sodium hydroxide was measured in an adiabatic solution calorimeter. For the reaction

$$CH_2CO(g) + NaOH(aq, 500H_2O) = CH_3CO_2Na(aq, NaOH\ soln),$$

$\Delta H(298\ K) = -(208.2 \pm 1.6)\ kJ\ mol^{-1} = -(49.75 \pm 0.38)$ kcal mol^{-1}. The uncertainties indicated include estimated systematic errors and a 95 percent confidence interval of ± 1.34 kJ mol^{-1}. This value of ΔH was combined with published values for the enthalpy of formation of aqueous sodium hydroxide and of aqueous sodium acetate to calculate the enthalpy of formation of ketene gas:

$$\Delta H_f°(298\ K) = -(47.7 \pm 1.6)\ kJ\ mol^{-1} = -(11.4 \pm 0.4)\ kcal\ mol^{-1}.$$

12253. Peterson, N. C., Kurylo, M. J., Braun, W., Bass, A. M., Keller, R. A., **Enhancement of absorption spectra by dye-laser quenching,** *J. Opt. Soc. Am.* **61,** No. 6, 746-750 (June 1971).

Key words: Absorption; laser; spectra.

A new technique has been developed to enhance the detection of absorption spectra of weak absorbers. Preliminary experiments, which illustrate the technique, are described. An organic-dye laser normally emits a continuous spectrum with a bandwidth of 2-10 nm. The effect of placing an absorbing-gas sample inside a dye-laser cavity results in laser quenching at those wavelengths where the sample absorption exceeds a minimum threshold absorption. The threshold for absorption quenching appears to be very low; absorption of the order of 0.5% can cause spoiling of laser action at the absorbing wavelengths and displacement of laser emission to wavelengths where absorption is below the critical switching level. Detection limits for atoms and molecules by means of absorption spectroscopy inside a laser cavity can be more than two orders of magnitude lower than those attainable through conventional absorption spectroscopy. Experiments with I_2 and sodium both inside and outside the cavity of a rhodamine 6-G laser are described. A qualitative consideration of the proposed mechanism indicates that the technique can be significantly improved with further development.

12254. Rupp, N. W., Paffenbarger, G. C., **Significance to health of mercury used in dental practice: A review,** *J. Am. Dental Assoc.* **82,** 1401-1407 (June 1971).

Key words: Contamination; dental amalgam; environment; hazards; hygiene; mercury; vapor.

This is a literature review of the hazards of mercury to the patient, to the dental office personnel and the environment. Mercury content of urine is most frequently used and is reliable measure for evaluating exposure to mercury. The urine level drops however with the onset of toxic symptoms so this test is not reliable in diagnosing toxic responses. Patients have slightly elevated mercury levels in their urine after dental amalgam restorations are placed. After a few weeks this level returns to "normal." Scrap amalgam is usually collected and salvaged for the mercury and silver content. Mercury vapor from the surfaces of droplets, heating and other sources, is potentially hazardous to dental personnel since they are exposed to it for prolonged periods. Proper mercury hygiene practice includes prevention of spills, adequate ventilation and never heating mercury or its compounds. There is little danger to the patient, environment or dental personnel as long as all who handle it realize the potential hazard and observe good mercury hygiene.

12255. Sher, A. H., **Carrier trapping in Ge(Li) detectors,** *IEEE Trans. Nucl. Sci.* **NS-18,** No. 1, 175-183 (Feb. 1971).

Key words: Charge carriers; electrons; gamma rays; Ge(Li) detectors; germanium gamma-ray spectrometers; holes; lifetime; theoretical model; trapping.

The results of previously published studies relating to the trapping of charge carriers in semiconductor nuclear radiation detectors, including theoretical models and experimental data, have been used to construct a more realistic operational model which can be used to describe the trapping process. Specifically, the model has been developed for the situation most commonly reported in the literature, that of electron trapping in planar Ge(Li) detectors. The success of the present model has been judged on its ability to predict the variation of the peak shape resulting from γ-irradiation of a planar Ge(Li) detector as a function of applied bias. Full-energy γ-ray peaks have been calculated with digital computation techniques by incorporating the variation of peak amplitude as a function of charge collection efficiency as well as the variation of carrier lifetime with applied field into a previously published model.

12256. Souders, T. M., **A wide range current comparator system for calibrating current transformers,** *IEEE Trans. Power Appar. Syst.* **PAS-90,** No. 1, 318-324 (Jan.-Feb. 1971).

Key words: Calibration; current comparator; current transformer; overload testing; self-balancing current comparator; transformer; wide-range.

This paper describes a new measurement system for the calibration of current transformers at 60 Hz for all ratios up to 10000/5 and higher and at four time rated current. For ratios up to 1200/5, no reference transformer is needed and the system is accurate to five parts per million (ppm). Most higher ratios can be measured using only one reference transformer. Included is an example of how a laboratory could use such a system to measure all ratios up to 8000/5, requiring a calibration of only one reference transformer on one ratio (4000/5).

12257. Sugar, J., **New energy levels of triply ionized praseodymium,** *J. Opt. Soc. Am.* **61,** No. 6, 727-732 (June 1971).

Key words: Praseodymium; spectra; wavelengths.

Measurements of the spectrum of triply ionized praseodymium produced by a 500-A sliding-spark discharge revealed new high-lying energy levels of both even and odd parity. Nearly all levels of the $4f5f$ configuration were found as well as portions of $4f6d$, $4f7s$, and $5d6p$. Radial parameters were fitted to $4f5f$ and $4f6d$. A value for the ionization limit of 314 200 ± 200 cm^{-1} was deduced from the $4f6s$, $7s$ series.

12258. Utton, D. B., **Temperature dependence of ^{35}Cl NQR sodium chlorate,** *J. Chem. Phys.* **54,** No. 12, 5441-5442 (June 15, 1971).

Key words: Nuclear quadrupole resonance; sodium chlorate; temperature dependence 14-90 K; ^{35}chlorine.

The temperature dependence of the ^{35}Cl NQR in sodium chlorate has been measured in the temperature range 14-90 K. It is shown that the Bayer-Kushida theory satisfactorily explains the data if two distinct lattice vibrations are active. The results are compared with the Raman spectrum and the crystal structure.

12259. Vadelund, E. A., **The role of the Department of Commerce under the fair packaging and labeling act,** (Proc. Conf. 11th Annual Meeting—Food Distribution Research Society, St. Louis, Mo., Oct. 25-28, 1970), *J. Food Distribution Res.* **2,** No. 1, 103-106 (The Food Distribution Research Society, Inc., Hyattsville, Md., Feb. 1971).

Key words: Consumer commodities; labeling; packaging; proliferation; quantity standards; regulations.

A description of the responsibilities and activities of the NBS in the FPLA program to date. The paper details the responsibilities assigned to the NBS and the steps taken to implement the Act. A brief compilation of results in the various program areas is also presented.

12260. Weissler, P. G., **ANSI-1969 standard reference threshold sound-pressure levels for audiometers: Some comments,** *J. Acoust. Soc. Am.* **49,** No. 4, Part 2, 1319-1320 (Apr. 1971).

Key words: Audiometry; earphones; NBS 9-A coupler; reference threshold sound pressure levels; standards for audiometers; threshold of hearing.

New standard reference threshold sound pressure levels for four audiometric earphones are given in Appendix F of ANS Specification for Audiometers S3.6-1969 effective September 1, 1970. The change in reference level from ASA-1951 to ANSI-1969 is shown to be different for each earphone type. The sources of data for these new reference levels and the relationship of these new levels to ISO standards is discussed.

12261. Yates, J. T., Jr., Madey, T. E., **Interactions between chemisorbed species: H_2 and CO on (100) tungsten,** *J. Chem. Phys.* **54,** No. 12, 4969-4978 (June 15, 1971).

Key words: Carbon monoxide; chemisorption; co-adsorption; displacement reaction; hydrogen; single crystal; tungsten; work function.

The interaction of CO with chemisorbed β-hydrogen on the (100) plane of tungsten has been investigated using flash desorption and work function methods. CO efficiently displaces chemisorbed hydrogen from tungsten at temperatures near 300 K. This is a result of the CO-induced lowering of the activation energy for H_2 desorption, with CO chemisorbing initially on sites other than those occupied by hydrogen. At ~ 100 K, little CO-induced displacement of chemisorbed hydrogen occurs, and the production of three weakly bound hydrogen states (designated ν-hydrogen) is observed. Each ν state exhibits a range of desorption energies. During the CO-induced surface conversion of β-hydrogen to ν-hydrogen, a decrease in work function is observed. All of this behavior is indicative of a major interaction between adsorbed CO and adsorbed hydrogen. A weakly-bound molecular H_2 state (δ-hydrogen) may be populated by adsorption of H_2 on top of partial CO layers on W(100) at ~ 100 K. The sites adsorbing the molecular state of hydrogen are related to the presence of β-CO species, and are probably the same sites which could adsorb α-CO at higher CO coverages. In thermal desorption, the liberation of two discrete hydrogen binding states (β_1 and β_2) from pure hydrogen layers on W(100) is probably a result of coverage-dependent interactions between identical adsorbed H-atom species. No chemical differences are observed in this work between hydrogen species responsible for the two β-hydrogen binding states. No catalytic production of H_2CO, HCO, CH_4, or C_2H_6 was observed in coadsorption of hydrogen and CO on W(100).

12262. Abramowitz, S., Acquista, N., Thompson, K. R., **The infrared spectrum of matrix-isolated uranium monoxide,** *J. Phys. Chem.* **75,** No. 15, 2283-2285 (1971).

Key words: High temperature matrix isolation; infrared; uranium monoxide; uranium oxides; vibrational frequency.

The infrared spectra of matrix-isolated uranium oxides have been observed. By varying the O/U ratio of the condensed phase from 1.5 to 3.0 and comparing the observed spectra of the matrix-isolated vapors in equilibrium with the condensed phases it has been possible to assign a frequency of 776.0 cm^{-1} to $U^{16}O$. Verification of this assignment has been obtained in similar experiments using oxygen-18 enriched uranium oxides; a frequency of 736.2 cm^{-1} has been observed for $U^{18}O$. This yields a force constant to the harmonic approximation of 5.32 mdyn/Å for this species. A stretching mode of UO_2 has also been assigned for $U^{16}O_2$, $U^{18}O_2$, and $U^{16}O^{18}O$.

12263. Allpress, J. G., Roth, R. S., **The effect of annealing on the concentration of Wadsley defects in the Nb_2O_5-WO_3 system,** *J. Solid State Chem.* **3,** 209-216 (1971).

Key words: Annealing equilibria; electron microscopy; niobium tungsten system; Wadsley defects.

Mixtures of $xNb_2O_5 \cdot yWO_3$ with $x:y = 9:8$, 8:5, and 8:1 have been annealed at high temperatures for prolonged periods before quenching to room temperature. The concentration of Wadsley defects, estimated from lattice image electron micrographs of a few fragments in each sample, is reduced during this treatment. The results indicate that (1) the high temperature equilibrium is attained very slowly, and in stoichiometric samples probably involves the complete removal of Wadsley defects; (2) the high temperature situation is not seriously affected by the quenching treatment; and (3) variations in stoichiometry may be accommodated by means other than the presence of Wadsley defects.

12264. Barnes, J. A., **A non-mathematical discussion of some basic concepts of precise time measurement,** *Frequency* **2,** No. 2, 1-6 (Tracor Inc., Austin, Texas, May 1971).

Key words: Atomic time; standards; time; time standards, universal time.

A non-mathematical discussion of some of the basic concepts which must be understood by scientists and engineers who need to use precise time. It distinguishes between the concepts of date and time interval, describes the various scales used to measure astronomical and atomic time, and compares some major characteristics of astronomical and atomic time.

12265. Bennett, H. S., **Acoustic phonons in Heisenberg paramagnets,** *J. Phys.* **32,** No. C1, 526-527 (Feb.-Mar. 1971).

Key words: Frequency shift; Heisenberg paramagnet; specific heat; spin-diffusion; susceptibility; ultrasonic attenuation.

The propagation of sound waves in ferromagnetic and antiferromagnetic insulators is examined in terms of a volume magnetostrictive interaction. Expressions for the ultrasonic attenuation coefficients and for the phonon frequency shifts near the transition temperature are given as functions of the static susceptibilities, the spin diffusion coefficients, and the specific heats. The results agree with scaling law calculations and qualitatively with experiment.

12266. Bloom, D. W., Finegold, L., Lye, R. G., Radebaugh, R., Siegwarth, J. D., **Upper limit on electron-phonon interaction in vanadium carbide,** *Physics Letters* **33A,** No. 3, 137-138 (Oct. 19, 1970).

Key words: Band structure of solids; cryogenics; superconductivity; transition temperatures; vanadium carbides.

Single crystals of VC_x (x 0.87, 0.84, 0.81, 0.76) were not superconducting above 30 mK, indicating that the electron-phonon enhancement of the densities of states determined from electronic specific heats is less than 30%.

12267. Braun, W., Peterson, N. C., Bass, A. M., Kurylo, M. J., **A vacuum ultraviolet atomic emission detector: Quantitative and qualitative chromatographic analysis of typical C, N, and S containing compounds,** *J. Chromatog.* **55,** 237-248 (1971).

Key words: Analytical; atomic emission; detector; gas chromatography; spectroscopy; vacuum ultraviolet.

Vacuum ultraviolet atomic emission detection of effluent gases from a chromatographic column is a very sensitive and selective method for qualitative and quantitative elemental analysis of carbon, nitrogen, and sulfur compounds. A low pressure microwave discharge through helium, with added trace amounts of molecular oxygen, produced complete fragmentation of all compounds used and generated intense atomic emissions in the vacuum ultraviolet. Photometric measurement of these monochromator-isolated atomic emissions was successfully used to establish absolute concentration calibrations for the elements carbon, sulfur and nitrogen in various compounds. This detection method is sensitive, highly selective, and has a range of linearity greater than four decades.

12268. Byerly, R., Jr., Beaty, E. C., **Sunlight photodetachment of O_3^-,** *J. Geophys. Res.* **76,** No. 19, 4596-4601 (July 1, 1971).

Key words: Ion mobility; O_3^-; photodetachment; photodetachment rate measurement; sunlight.

The rate of photodetachment of O_3^- by sunlight has been determined. The O_3^- ions were identified by their mobility as they drifted in a weak field in 1 torr of O_2 buffer gas. This allowed the ions to lose any vibrational or electronic excitation through collisions with the buffer gas. Energy dependence of the cross section was estimated by the use of colored filters in the photon beam. The sunlight photodetachment rate measured was 0.2 ± 0.1 sec^{-1}.

12269. Carpenter, B. S., **The use of the nuclear track technique for boron and uranium analyses in botanical material,** (Proc. American Nuclear Society Meeting, Boston, Mass., June 17, 1971), *Trans. Am. Nucl. Soc.* **14,** No. 1, 130-131 (1971).

Key words: Alpha tracks; boron; botanical material; fission tracks; kale; orchard leaves; uranium.

The Nuclear Track Technique is used to determine trace quantities of boron and uranium in botanical materials. This technique uses both method of standard additions and the absolute method in its determinations.

12270. Carroll, J. J., Melmed, A. J., **Optical constants of (011) tungsten in the visible region,** *J. Opt. Soc. Am.* **61,** No. 4, 470-473 (Apr. 1971).

Key words: Absorption; ellipsometry; refractive index; tungsten.

Optical constants for tungsten measured ellipsometrically at room temperature in the visible spectrum are reported. Results are given for (011)-oriented tungsten characterized as clean by low-energy-electron diffraction, for the same surface saturated with oxygen, and for the surface after exposure to air at atmospheric pressure for several hours. Results are compared with earlier work and differences are attributed primarily to differences of surface contamination.

12271. Cohen, J., Edelman, S., **Piezoelectric effect in oriented polyvinylchloride and polyvinylfluoride,** *J. Appl. Phys.* **42,** No. 8, 3072-3074 (July 1971).

Key words: g moduli; piezoelectricity; polyvinylchloride; polyvinylfluoride.

The direct piezoelectric effect has been observed in roll-elongated films of polyvinylchloride and polyvinylfluoride. The effect was produced by applying tensile stress to a clamped specimen at a fixed frequency of 20 Hz. The piezoelectric modulus g_{31} was determined to be 0.2 to 0.7 V m^{-1}/N m^{-2} in polyvinylchloride; in polyvinylfluoride $g_{31} \simeq 0.2$ V m^{-1}/N m^{-2} and $g_{32} \simeq 1$ V m^{-1}/N m^{-2}. The piezoelectric effect in these films is believed to be due to mechanical distortion of oriented dipoles, resulting from the tensile stress, and the orientation appears to differ in the two materials.

12272. Coxon, B., **Application of internuclear, double-resonance techniques to carbohydrates. Detection of small coupling-constants,** *Carbohydrate Res.* **18,** No. 3, 427-442 (1971).

Key words: General Overhauser effect; internuclear double resonance; long-range coupling; magnetic equivalence factoring; spin-tickling; transient nutations; 6-Deoxy-α-D-glucofuranose derivative.

6-Deoxy-1, 2:3, 5-di-*O*-isopropylidene-α-D-glucofuranose-d_{12} (**1**-d_{12}) has been synthesized by exchange of its non-deuterated analog (**1**) with acetone-d_6. The p.m.r. spectrum of **1**-d_{12} at 90 MHz has been analyzed iteratively by means of a computer program for magnetic-equivalence factoring. Confirmation of the assignments of lines in the analysis has been investigated by proton-proton, internuclear, double-resonance (i.n.d.o.r.) techniques, which served also for the detection of a small long-range coupling-constant.

Examples of i.n.d.o.r. spectra containing general Overhauser effects, spin-tickling effects, or transient nutations are shown, and are discussed in relation to the experimental power-levels of the observing and double-resonance frequencies, and their sweep-rates.

12273. Dickens, B., Brown, W. E., **The crystal structure of $Ca_5(PO_4)_2SiO_4$ (silico-carnotite),** *Tschermaks Mineral. Petrog. Mitt.* **16,** 1-27 (June 1971).

Key words: Calcium phosphate; calcium phosphate-calcium silicate solid solution; calcium phosphosilicates; calcium silicates; crystal structures; glaserite; hydroxyapatite; single crystal x-ray diffraction.

The crystal structure of $Ca_5(PO_4)_2SiO_4$ (silico-carnotite) has been determined from 3358 x-ray diffraction data collected by a counter method and has been refined to $R_w = 0.038$, $R = 0.045$, in space group Pnma. The unit cell parameters are $a = 6.737$ (1) Å, $b = 15.508$ (2) Å and $c = 10.132$ (1) Å at 24 °C; $Z = 4$. The observed density is 3.06 and the calculated density is 3.03 g·cm^{-3}. The crystal contains about 2.5% V_2O_5 as an impurity. The bond lengths within the tetrahedral anions suggest that substitution or disorder of PO_4^{3-}, SiO_4^{4-} and possibly VO_4^{3-} occurs among the anion sites. The structure has some relationship to that of $Ca_5(PO_4)_3OH$, the predominant inorganic phase in the human body, but suggests that the $Ca_5(PO_4)_3OH$ type structure may not be stable without some of the OH positions being filled. $Ca_5(PO_4)_2SiO_4$ is more closely related to $K_3Na(SO_4)_2$ (glaserite) if it is considered that there are systematic cation vacancies in $Ca_5(PO_4)_2SiO_4$.

This type of structure is consistent with the view that cation vacancies in the glaserite-type structure account for solid solutions between Ca_2SiO_4 and $Ca_3(PO_4)_2$ and between $Ca_3(PO_4)_2$ and $CaNaPO_4$.

12274. Dickens, B., Brown, W. E., **The crystal structure of $Ca_7Mg_9(Ca,Mg)_2(PO_4)_{12}$,** *Tschermaks Mineral. Petrog. Mitt.* **16,** 79-104 (June 1971).

Key words: Calcium magnesium phosphate; cation vacancies; glaserite; single crystal x-ray diffraction; α-$Ca_3(PO_4)_2$.

The unit cell of $Ca_7Mg_9(Ca,Mg)_2(PO_4)_{12}$ is $a = 22.841(3)$ Å, $b = 9.994(1)$ Å, $c = 17.088(5)$ Å and $\beta = 99.63(3)°$ at 24 °C. The space-group is C2/c with four formula weights per cell. The crystal structure has been determined from 6330 x-ray reflections measured from a single crystal by a counter method and has been refined to $R_w = 0.044$, $R = 0.046$ (based on 4227 observed reflections and 322 of the unobserved reflections). One cation site may be occupied by Ca or Mg and gives rise to variability in composition as is reflected in the formula given above. In the sample studied, Ca and Mg occupy the site approximately equally. The $[10\bar{2}]$ direction in the unit cell is pseudo-hexagonal. The structure of $Ca_7Mg_9(Ca,Mg)_2(PO_4)_{12}$ is related to that of $K_3Na(SO_4)_2$ in that along $[10\bar{2}]$ it has columns of cations and columns of cations and anions. These columns are arranged in a $K_3Na(SO_4)_2$-type pseudo-cell. In the cation-anion columns, every other cation site in $K_3Na(SO_4)_2$ is vacant in $Ca_7Mg_9(Ca,Mg)_2(PO_4)_{12}$.

12275. Dehmer, J. L., Starace, A. F., Fano, U., Sugar, J., Cooper, J. W., **Raising of discrete levels into the far continuum,** *Phys. Rev. Letters* **26,** No. 25, 1521-1525 (June 21, 1971).

Key words: Autoionization; exchange interaction; photoabsorption transition elements; rare earths.

Broad peaks observed in the photoabsorption spectra of rare earths ~ 10-20 eV above the $4d$ edge are attributed to transitions $4d^{10}4f^N \rightarrow 4d^9 4f^{N+1}$. Exchange interaction splits the $4d^9 4f^{N+1}$ configuration and raises some multiplets by ~ 20 eV. Autoionization to $4d^9 - 4f^N \epsilon f$ broadens the high levels. The interpretation extends to $p \rightarrow d$ processes observed in the absorption of synchrotron light by transition elements.

12276. Edelman, S., Grisham, L. R., Roth, S. C., Cohen, J., **Improved piezoelectric effect in polymers,** *J. Acoust. Soc. Am.* **48,** No. 5, Part 1, 1040-1043 (Nov. 1970).

Key words: Piezoelectricity; piezoelectric modulus; polymer; polyvinylchloride; transducer; underwater sound.

Improved poling techniques have led to improvement in the piezoelectric activity of bulk polymers. Results now achieved approach the activity of conventional piezoelectric materials such as quartz, and further improvement is anticipated. The measured value of the piezoelectric strain modulus d_{31} of a length expander bar of polyvinylchloride was 0.6×10^{-12} m V^{-1} and the electromechanical coupling factor k_{31} was 0.6%. The response of a sample as an underwater sound receiver was −112 dB *re* 1V/μbar.

12277. Edsinger, R. E., Guildner, L. A., Anderson, R. L., **Precision measurement of internal diameters of long, small bore metal tubing,** *Rev. Sci. Instr.* **42,** No. 7, 945-950 (July 1971).

Key words: Capacitance probe; cylindrical gauge blocks; inside diameters; small-bore tubes; standard hole; wringing.

Internal diameters of a long, small bore metal tube were calculated from the measured capacitances between it and a cylindrical coaxial probe of known characteristics. The tube and the probe were used as the electrodes of a three-lead capacitor, measurable with high accuracy in a transformer ratio arm bridge. For tubes of 0.1 cm bore or less, average diameters as a function of position can be determined by this method with an over-all uncertainty of $\pm 6 \times 10^{-5}$ cm over lengths of 1 m. The method can readily be extended to larger bores and greater lengths.

12278. Fickett, F. R., **Magnetoresistance of very pure polycrystalline aluminum,** *Phys. Rev. B* **3,** No. 6, 1941-1952 (Mar. 15, 1971).

Key words: Aluminum; electron scattering; magnetoresistance; resistance.

The behavior of the resistance of polycrystalline aluminum wires as a function of magnetic field and purity at temperatures of 4, 15, and 19.6 K is reported. Both longitudinal and transverse configurations were measured. The residual resistance ratios of the specimens varied from 1600 to 31 000. The measured magnetoresistance ($\Delta R/R_0$) is separated into a saturating and a linear part. The value of the saturating component is high at 19.6 K but is shown to be less than 6, even in the limit of infinite specimen purity. The linear component varies with both temperature and purity. Possible sources for the large saturating magnetoresistance values and for the variations observed in the linear portion are discussed. An analysis scheme is presented which allows prediction of the saturating component from zero-field resistance values. A deviation from Matthiessen's rule observed here, and by several other experimenters, is presented and discussed.

12279. Gibson, B. F., Williams, H. T., **Virtual photon cross sections for two-body electrodisintegration,** *Nucl. Phys.* **A163,** 193-202 (1971).

Key words: Cross section; electric transition; electrodisintegration; few nucleon systems; long wavelength.

Two-body electrodisintegration cross sections (differential with respect to the angles of the ejected nuclear fragment) are developed in the long wavelength limit of virtual photon theory for the few-nucleon system. Only the non-spin-flip electric transitions are considered. Contributions from the multipole expansion through the E1-E3 interference terms are retained. Comparable photodisintegration expressions are included to facilitate the extraction of photo cross sections from appropriate inelastic electron scattering data.

12280. Hastie, J. W., **Thermodynamic studies, by mass spectrometry, of molten mixed halide systems,** Chapter 5 in *Advances in Molten Salt Chemistry* **1,** 225-257 (Plenum Press, Inc., New York, N. Y., 1971).

Key words: Complex molecules; mass spectrometry; molten salt halides; thermodynamics.

The thermodynamic properties of the complex vapors, present in molten mixed halide systems, are reviewed and evaluated. Also, the special techniques required for these studies are critically discussed. A model, based on entropy and enthalpy correlations, is proposed whereby the complex vaporization phenomenon can be rationalized and predictions made for unstudied systems.

12281. Hastie, J. W., Hauge, R. H., Margrave, J. L., **Infrared spectra and geometries for the dichlorides of Ca, Sc, Ti, V, Cr, Mn, Fe, and Ni,** *High Temp. Sci.* **3,** No. 3, 257-274 (May 1971).

Key words: Dichlorides of Ca, Sc, Ti, V, Cr, Mn, Fe, Ni; geometry; infrared spectra of species; matrix isolation; $ScCl_3$; $TiCl_3$; $TiCl_4$.

The dichloride species of Ca, Sc, Ti, V, Cr, Mn, Fe, and Ni, prepared by Knudsen cell techniques have been isolated in solid inert gas matrices and infrared spectra obtained over the range 33-1000 cm^{-1}. Spectra were also observed for $ScCl_3$, $TiCl_3$ and $TiCl_4$. Isotope shift measurements and the infrared selection rules indicate each of the dichlorides to be linear $D_{\infty h}$ species within the experimental bond angle uncertainty of about 10°. In several instances, the results implied a significant anharmonic effect on the isotope shifts. Significant differences in the geometry and vibrational data between the dichlorides and the corresponding difluorides are noted.

12282. Heuer, A. H., Hockey, B. J., Wiederhorn, S. M., **Discussion of "Observation of plastic deformation in sapphire base ceramics,"** *Metallurgical Trans.* **2,** 1475-1476 (May 1971).

Key words: Alumina; fracture; mechanical properties; plastic deformation; sapphire; strength.

A paper presented in Metallurgical Transactions by George F. Hurley is discussed. It is concluded that the observations concerning plastic deformation in sapphire-based ceramics are incorrect and that there is no evidence at present to link plastic deformation and fracture to alumina ceramics.

12283. Kieffer, L. J., **Low-energy electron-collision cross-section data Part III: Total scattering; differential elastic scattering,** *Atomic Data* **2,** No. 4, 293-391 (June 1971).

Key words: Atom; cross section; elastic scattering; electron; molecule.

This is the final part of a three part compilation of low-energy electron-collision cross-section data issued by the Joint Institute for Laboratory Astrophysics (JILA) Information Center. Only experimental values are included for all atomic species and for those molecules which are important for aeronomy, astrophysics and plasma physics. The data included here were taken from literature published through July 1970.

12284. Kirsch, R. A., **Computer determination of the constituent structure of biological images,** *Comput. Biomed. Res.* **4,** 315-328 (1971).

Key words: Biological images; image processing; morphology; pattern recognition.

A class of algorithms is described which enables computer quantized images to be decomposed into constituent parts reflecting the structure of the images. This decomposition is viewed as the morphological precursor to a higher level syntactic analysis. Numerical results for a typical biological image are presented.

12285. Kuriyama, M., **On the principle of x-ray interferometry,** *Acta Cryst.* **A27,** 273-280 (1971).

Key words: Diffraction theory; lattice constants; measurements; wave optics; x-ray interferometry.

The scattering amplitude of an x-ray interferometer is calculated using a general theory of x-ray diffraction. Analytic expressions are given for the intensities of diffracted beams in interferometry; these expressions include the effect of the positions of each crystal lattice in addition to ordinary dynamical effects. It is concluded that the fringes observed in x-ray interferometry of a lattice spacing are accounted for by an optical (Moiré) effect rather than by dynamical effects of x-ray diffraction.

12286. LaVilla, R. E., **Neon *K* emission spectrum,** *Phys. Rev. A* **4,** No. 2, 476-480 (Aug. 1971).

Key words: Electron excitation; neon *K* emission spectrum; x-ray emission; x-ray satellites.

The neon *K* emission spectrum, excited by direct electron bombardment of the neon gas, has been obtained with photon counting on a single-crystal potassium-acid-phthalate (KAP) planar spectrometer. The measured relative integrated intensity of the $\alpha'\alpha_3\alpha_4$ and $\alpha_5\alpha_6$ satellite groups was found to be larger than theoretical prediction, but in accord with the trend of previous comparisons for *K* satellites of neonlike ions in solids. A comparison of the present results for electron excitation and the preliminary results by O. Keski-Rahkonen and T. Åberg for photon excitation indicates that the relative integrated intensity of the neon *K* satellites is independent of excitation mode at the excess excitation energies employed. A weak increase of intensity on the low-energy side of $K\alpha_{1,2}$ in the (803 − 809)-eV region was recorded and can be attributed to a radiative Auger transition.

12287. Mohan, R., Danos, M., Biedenharn, L. C., **Three-fluid hydrodynamical model of nuclei,** *Phys. Rev. C* **3,** No. 5, 1740-1749 (May 1971).

Key words: Charge distribution; collective model; giant resonance; hydrodynamic model; isospin; nuclear structure.

A three-fluid model of nuclei is introduced, the three fluids being the protons, the neutrons of the same orbitals as protons, and the excess neutrons, to account for the fact that the excess neutrons interact less strongly with the protons than do the neutrons which occupy the same space-spin states as the protons. Calculations of proton and neutron density distributions, of isotope shifts, and of isospin impurities have been carried out. The giant-dipole phenomenon is also studied in the present model. It is found that considerable improvement is achieved in the results for the proton density distribution and for the isospin impurities as compared with the two-fluid model. The other results are found to be consistent with previous calculations.

12288. Moore-Sitterly, C., **The periodic table interpreted from atomic spectra,** *Proc. Mendeleev Conf., Torino-Rome, Italy, September 15-21, 1969,* pp. 163-188 (1969).

Key words: Atomic spectra; coronal spectra; periodicities, atomic spectra; rare-earth spectra; regularities, atomic spectra; solar spectra.

The properties of the valence electrons as revealed by the configurations and energy levels in atomic and ionic spectra are discussed by considering four aspects of the Periodic Chart of the Atoms.

The series in first spectra of three *vertical* groups are described: similarities in the doublet series Li I, Na I etc.; the significance of the double-electron jump in the spectra Ca I, Sr I, Ba I; the pair-coupling in Ne I, Ar I etc. The importance of Zeeman observations in interpreting spectra of magnetic stars, and similarities in complex spectra such as Mn I and Tc I reveal different types of regularities.

In the *horizontal* grouping, the effect of building on electrons with increasing atomic number is illustrated by considering ionization potentials from H through Ca, and by inverted terms in complex spectra.

Isoelectronic sequences are extremely important for the analyses of spectra of highly-ionized atoms. The observations of the solar spectrum and of other stellar spectra from rockets and orbiting telescopes has created a sudden demand for laboratory data on these spectra. Extrapolation of intervals along the sequences of light elements has led to the identification of strong lines in the solar corona. Coronal lines recently identified by B. Edlén are described. A summary of spectra detected in the sun from H through Ni is presented.

Finally, the inherent regularities in electron structure revealed by known spectra furnish methods that are a valuable guide in locating overlapping configurations in the complex *rare-earth spectra*. The theoretical work of G. Racah and the analysis of Yb II are used as examples.

12289. Okabe, H., Laufer, A. H., Ball, J. J., **Photodissociation of $OCCl_2$ in the vacuum ultraviolet: Production and electronic energy of excited Cl_2,** *J. Chem. Phys.* **55,** No. 1, 373-378 (July 1, 1971).

Key words: Absorption coefficient; Cl_2; emission; electronic energy; $OCCl_2$; photodissociation; vacuum ultraviolet.

The photodissociation of $OCCl_2$ in the vacuum ultraviolet yields electronically excited Cl_2 producing emission continua in the region 2000-3100 Å. A curve obtained by plotting fluorescence efficiencies as a function of incident wavelength shows diffuse vibrational structure corresponding to the ν_1 symmetric stretching mode of $OCCl_2$, indicating that the process is predissociative. Three main continua at 3063, 2565, and 2460 Å were observed by the photolysis of $OCCl_2$ with the Kr 1236-Å line, while only one continuum at 2580 Å was obtained by the Xe 1470-Å line. From threshold energies of the incident photons to produce each continuum it was possible to obtain electronic energies of excited Cl_2. Electronic energies thus obtained are 7.21 ± 0.05 eV and 7.93 ± 0.03 eV for the upper states associated with the 2580- and 3063-Å continua, respectively. The electronic energy of the upper state responsible for the 2460-Å continuum lies between 7.33 and 8.93 eV. The effect of inert gas on the emission continua was investigated. A comparison has been made of the emission continua obtained by the photolysis of $OCCl_2$ and those produced by an electric discharge of Cl_2. The absorption coefficient of $OCCl_2$ has been measured in the region 1170-1600 Å.

12290. Pilling, M. J., Bass, A. M., Braun, W., **Oscillator strengths of CH_2 and CH_3 in the vacuum ultraviolet,** *Chem. Phys. Letters* **9,** No. 2, 147-148 (Apr. 15, 1971).

Key words: Methyl radicals; methylene; oscillator strengths; spectroscopy; vacuum UV.

Maximum extinction coefficients and oscillator strength were measured for several CH_2 and CH_3 transitions in the vacuum UV. The method employed involved in the vacuum UV flash photolysis of ketene and diazomethane and vacuum UV spectrophotometry.

12291. Reimann, C. W., Zocchi, M., **The crystal structure of Bis-[μ-(tri-1,2,4-triazolo-N^1,N^2)-triaquonickel]nickel hexanitrate dihydrate, $[(H_2O)_3(C_2H_3N_3)_3Ni]_2Ni(NO_3)_6(H_2O)_2$,** *Acta Cryst.* **B27,** Part 3, 682-691 (Mar. 1971).

Key words: Bis-[μ-(tri-,1,2,4-triazolo-N^1,N^2)-triaquonickel] nickel hexanitrate dihydrate; trinuclear nickel(II) complex; x-ray structure analysis.

The crystal structure of bis-[μ-(tri-1,2,4-triazolo-N^1,N^2)-triaquonickel]nickel hexanitrate dihydrate, $[(H_2O)_3(C_2H_3N_3)_3Ni]_2Ni(NO_3)_6(H_2O)_2$, has been solved by the Patterson method. This compound crystallizes in the monoclinic system with $a = 14.261$ (8), $b = 11.745$ (6), $c = 14.948$ (8) Å, $\beta = 127.13$ (4)°, space group $P2_1/c$, $\rho_c = 1.84$ g.cm^{-3}, and $Z = 2$. The structure consists of discrete centrosymmetric trinuclear cations, $[(H_2O)_3(C_2H_3N_3)_3Ni]_2Ni^{6+}$, in which the central nickel ion is joined to each terminal nickel ion by three planar triazole molecule bridges. The nickel-nickel distance is 3.737 Å. Three molecules of water complete the octahedral coordination of the terminal nickel ions. The N-H groups in the triazole rings and the coordinated water molecules participate in hydrogen bonding with the nitrate groups and non-coordinating water molecules. All hydrogen atoms in this structure were located in a difference map. Final refinement by three-dimensional anisotropic least-squares analysis resulted in an R value of 0.045 based upon 5201 observed reflections.

12292. Ritter, J. J., Coyle, T. D., Bellama, J. M., **Reactions of diboron tetrahalides with haloolefins. Formation of poly(dihaloboryl) ethanes,** *J. Organometal. Chem.* **29,** 175-184 (1971).

Key words: Boron; boron subhalides; halides; haloolefins; organoboron compounds; tetrachlorodiborane(4); tetrafluorodiborane(4).

Tetrachlorodiborane(4) reacts with vinyl chloride in 2/1 ratio to yield 1,1,2-tris-(dichloroboryl)ethane and boron trichloride. The reaction appears to be general for a variety of haloolefins. Both B_2Cl_4 and B_2F_4 react similarly with haloethylenes containing halogens heavier than the halogen on the diboron moiety. Evidence has been obtained for a reaction sequence involving addition of B_2X_4 to the haloolefin, elimination of trihaloborane, and subsequent addition of B_2X_4 to the resulting vinyldihaloborane.

12293. Sanchez, I. C., DiMarzio, E. A., **Dilute solution theory of polymer crystal growth: A kinetic theory of chain folding,** *J. Chem. Phys.* **55,** No. 2, 893-908 (July 15, 1971).

Key words: Cilia; conformational entropy; free energy; nucleation rate; rate constants; self-nucleation; steady-state.

A kinetic theory of polymer crystallization from dilute solution is formulated for linear chain molecules of finite molecular weight (monodisperse). Two models of crystal growth are considered; both are essentially "regular" chain folding type models. Formulas for the crystal growth rates are derived as a function of the fundamental rate constants associated with the various states of molecular crystallization. These rate constants are evaluated as a function of polymer concentration, molecular weight, crystallization temperature, and crystal thickness. Consideration of finite molecular weight molecules requires an understanding of how these molecules are incorporated into the crystal and what happens to chain ends. Attention is focused on these problems and a description of how "cilia" are formed in polymer crystals is given. A remarkable aspect of cilia formation is that the uncrystallized portion of a chain molecule which dangles in the solution can participate in nucleating a new growth strip (fold plane) on the crystal face—a kind of "self-nucleating" mechanism.

12294. Simmons, J. H., Macedo, P. B., Napolitano, A., Haller, W. K., **Investigation of liquid-liquid phase transitions in oxide melts by viscosity measurements,** *Discussions Faraday Soc., Bristol, England, September 1970,* No. 50, 155-165 (1970).

Key words: Critical phenomena; immiscibility; oxide glasses; viscosity.

Results from viscosity measurements conducted both above and below the liquid-liquid phase transition of a series of molten oxide glasses are reported in order to analyze the effect of supercritical composition fluctuations on viscous flow, and to investigate the mechanisms of phase separation. Measurements of four oxide mixtures with similar high temperature structures and widely different critical temperatures, revealed an anomalous increase in viscosity at temperatures above the critical point. The anomalous increase occurs when large composition fluctuations characterizing the critical point are present. The effect is explained in terms of an interaction between viscous flow and the supercritical fluctuations through the structural relaxation process. An analysis of this interaction is presented.

Measurements conducted at temperatures slightly below the critical point of one of these glasses indicate that the microstructure resulting from the phase separation is highly sensitive to the preceding heat-treatment. Phase separation by the formation of isolated spheres of the silica-rich component is identified a few degrees below the critical point. Further measurements of viscosity by a fibre elongation method, conducted far below the critical temperature, are reported in order to analyze the growth mechanisms occurring in the separated phases. In this case, the rearrangement stage of phase separation is characterized by a growing interconnected structure.

12295. Simpson, P. A., Ondrejka, A. R., **Improvements to the NBS rf peak-pulse power standard,** *Instrument Society of America Silver Jubilee International Conference and Exhibit, October 26-29, 1970, Philadelphia, Pa.,* Paper **709-70,** 1-7 (Oct. 26-29, 1970).

Key words: Peak pulse power measurement; sampling power measurement; solid state switch.

The National Bureau of Standards maintains a standard for measuring rf peak-pulse power. This standard employs a sampling-comparison method in which a solid state diode switch is used to intercompare equal time-interval samples of cw and pulsed rf power. Recently a new type diode switch has been developed which, when coupled with a sensitive peak detection system, has greatly improved the performance of the standard in two general areas.

The first major improvement is in the frequency coverage. The earlier version of the standard used two separate diode switches to cover the frequency bands 300 to 500 MHz and 950 to 1200 MHz. The new diode switch permits measurements to be made over the frequency range 0.1 to 4.4 GHz because of its low VSWR (typically 1.1 or less).

The other major improvement is in the dynamic power range of the system. The basic range of the earlier version was 0.1 to 1.2 watts. The new version operates over a power range of 5 mW to 2 W.

This paper reviews the history of the system, describes its performance characteristics, and gives some of its more important constructional details.

12296. Smith, S. J., **Lasers and lengths,** *Comments At. Mol. Phys.* **2,** No. 3, 92-97 (Aug. 1970).

Key words: Coherence; laser stabilization; length; methane; saturated absorption.

We review here developments which strongly suggest that laser stabilization techniques fully complementary to the amazing coherence properties of the laser will ultimately be found. Indeed progress in hand assures an advance more revolutionary than evolutionary, and discussions of a possible redefinition of the standard of length are now beginning to be taken seriously.

12297. Spencer, L. V., **Remarks on the theory of energy deposition in cavities,** *Acta Radiol.* **10,** No. 1, 1-20 (Feb. 1971).

Key words: Bragg-Gray principle; cavity; detector response functions; dosimetry; electron-energy deposition; Gray medal; ionization.

The contributions of Gray and Bragg to the theory of energy deposition in cavities are reviewed in connection with a mathematical formulation of the problem. The two principal contributors to the Bragg-Gray theory apparently used approaches that were equivalent but dual in the sense of involving adjoint expressions of the energy deposition. Burch has later attempted an extension of Gray's ideas and Spencer-Attix have extended the theory by applying Bragg's point of view. Some comments on future cavity theory research are included.

12298. Yokel, F. Y., **Stability and load capacity of members with no tensile strength,** *J. Struct. Div. Am. Soc. Civil Engineers* **97,** No. ST7, 1913-1926 (July 1, 1971).

Key words: Buckling; compression members, concrete; deflection; equilibrium; load eccentricity; masonry; section cracking; stability; stress distribution; unreinforced concrete.

A mathematical solution is derived, which permits the computation of critical load, deflection and stresses for eccentrically loaded slender prismatic compression members, made of materials that have compressive strength but no tensile strength. A graphical presentation of the solution facilitates its application. In an example of application, the solution is used to compute the strength of masonry walls which were tested by the Structural Clay Products Institute. Even though there are limitations to our ability of predicting the behavior of a complex material such as masonry by a mathematical solution based on a simplified model, there is good agreement between computed and measured strength.

12299. Abramowitz, S., Levin, I. W., **Raman spectra of the hexahalogenated benzenes in the solid phase,** *Spectrochim. Acta* **26A,** 2261-2268 (1970).

Key words: C_6F_6; C_6Cl_6; C_6Br_6; C_6I_6; hexahalogenated benzenes; laser; Raman; vibrational assignment.

Solid Raman spectra of the hexahalogenated benzenes are examined at both room and liquid nitrogen temperatures. Tentative assignments for C_6Cl_6, C_6Br_6 and C_6I_6 are proposed on the basis of a puckered (D_{3d}) geometry.

12300. Bardos, D. I., Waterstrat, R. M., Rowland, T. J., Darby, J. B., Jr., **The magnetic susceptibility of transition-metal A15-type phases,** *J. Low Temp. Phys.* **3,** No. 5, 509-518 (1970).

Key words: Atomic ordering; intermetallic compounds; magnetic susceptibility; superconductors.

The temperature dependence of the paramagnetic susceptibility was measured for several binary A15-type compounds of transition elements. Measurements were made between room temperature and either 3 K or the superconducting transition temperature, whichever was higher. The susceptibilities were found to have, in most cases, a small linear temperature dependence. Molar susceptibilities X_M, superconducting transition temperatures T_c, and electronic heat coefficients γ for these compounds, when plotted as a function of the valence-electron concentration e/a, reveal peaks at an e/a of about 6.5 for all three properties. Compounds containing the 4*d*-series transition-elements molybdenum or niobium have higher Tc and lower X_M values than compounds containing the 3*d* transition-element chromium or vanadium. It appears that an increased mixing of atoms on either of the two crystallographic sites in the A15-type structure can be associated with a significant decrease in the paramagnetic susceptibility of the compound.

12301. Bennett, H. S., **Two-electron F^- centers in the alkaline-earth fluorides,** *Phys. Rev. B* **4,** No. 4, 1327-1335 (Aug. 15, 1971).

Key words: Alkaline earth; color centers; F^- centers; fluorides.

The Hartree-Fock-Slater (HFS) equations for the two-electron orbitals localized about an anion vacancy in CaF_2, SrF_2, and BaF_2 have been solved numerically in the point-ion-lattice potential. It is found that the ground state $^1S(1s, 1s)$ contains bound electronic orbitals which are spatially compact. The existence of bound excited states for the F^- center in these crystals has been investigated. However, definitive statements on such excited states are not available at present.

12302. Bowen, R. L., Argentar, H., **Amine accelerators for methacrylate resin systems,** *J. Dental Res.* **50,** No. 4, 923-928 (July/Aug. 1971).

Key words: Accelerators; amines; color-stable composites; methacrylates; polymerization; resins; synthesis.

Tertiary aromatic amines were synthesized with various nitrogen and ring substituents. They were compared with commercial homologues using composites based on dimethacrylate monomer formulations containing benzoyl peroxide. Equimolar amounts of the different amines were the only variables. Although accelerating ability was a function of both ring and nitrogen substitution, color stability was influenced more by the substituents on the ring than by the substituents on the nitrogen.

12303. Boyd, M. E., Larsen, S. Y., **First quantum-mechanical correction to the classical viscosity cross section of hard spheres,** *Phys. Rev. A* **4,** No. 3, 1155-1163 (Sept. 1971).

Key words: Boltzmann gas; cross-section for viscosity; hard sphere gas; quantum corrections; statistical mechanics; viscosity.

The classical and first quantum correction terms in a high-energy expansion of the viscosity cross section $Q^{(2)}$ for a Boltzmann gas of hard spheres is derived. The first correction is found to be proportional to $(1/k\sigma)^{4/3}$, which is a term nonanalytic in $\hbar$ (i.e., $\hbar^{4/3}$), and results from scattering near the edge of the sphere. A bound is established showing the remainder of the asymptotic series to be of $O[(\ln k\sigma)/(k\sigma)^2]$. This asymptotic formula is compared with calculations based on the exact phase-shift expressions and its range of validity is established. The next correction terms are deduced to be proportional to $(\ln k\sigma)/(k\sigma)^2$ and $1/(k\sigma)^2$ which involve $\hbar^2 \ln\hbar$ and $\hbar^2$, respectively.

12304. Brenner, A., Sligh, J. L., **Electrodeposition of magnesium and beryllium from organic baths,** *Trans. Inst. Metal Finishing* **49,** 71-78 (May 1971).

Key words: Beryllium, electrodeposition of; beryllium azide; beryllium thiocyanate, decaborane; dimethyl beryllium; magnesium, electrodeposition of; nonaqueous plating baths; Grignard reagents; organic plating baths; triethylboron.

Solutions that are feasible for electrodepositing magnesium were prepared from Grignard reagents with the addition of boranes in ether solutions. A typical bath consisted of methylmagnesium chloride, 3-molar (dissolved in tetrahydrofuran), and 1-molar in triethylboron. The deposits were white, ductile and contained at least 99% of Mg. Cathode and anode current efficiencies were 100%. A similar beryllium plating solution, prepared with beryllium dimethyl and decaborane, yielded dark grey, coherent deposits containing 85% to 90% beryllium.

12305. Broadhurst, M. G., Mopsik, F. I., **Normal mode calculation of Grüneisen thermal expansion in *n*-alkanes,** *J. Chem. Phys.* **54,** No. 10, 4239-4246 (May 15, 1971).

Key words: Bulk modulus; Grüneisen; *n*-alkanes; normal mode; polyethylene; quasiharmonic specific heat; string of beads; thermal expansion; thermal properties; volume.

The normal mode problem is solved for a semirigid chain of beads in a quasiharmonic potential in order to separate the inter- and intrachain parts of the specific heat. The effects of lattice vibrations are included in an approximate way. The usual Grüneisen relation, $\alpha B_T = \gamma C_v/V$, valid only for acoustical modes, is generalized for optical modes to give $\alpha B_T = \Sigma_j(\gamma_j/V)(\partial S_j/\partial ln\omega_{jmax})$, where s_j and ω_{jmax} are the entropy and frequency cutoff of mode *j*. The predicted thermodynamic properties of the system are unusually sensitive to chain length because of interchain thermal energy effects. The parameters are given values from independent solid *n*-alkane data, and the calculated results are shown to predict quite well experimental C_p and $V-T$ behavior of the *n*-alkanes.

12306. Cassidy, E. C., Cones, H. N., Booker, S. R., **Development and evaluation of electrooptical high-voltage pulse measurement techniques,** *IEEE Trans. Instr. Meas.* **IM-19,** No. 4, 395-402 (Nov. 1970).

Key words: Dielectric liquids; electric field measurements; electrooptical measurements; high voltage measurements; Kerr cell; laser applications; pulse measurements.

Use of the Kerr electrooptical effect for time-resolved pulse measurements is extended to the 300-kV level. Pulse durations are as short as 5 μs. The performance of systems equipped with Kerr cells of various designs is investigated under a variety of operating conditions. Calibrations are achieved using both pulse-divider and high direct-voltage techniques. Methods are devised for measurement and correction of errors resulting from the fringing electric field at the ends of the Kerr-cell electrodes. Measurements of the temperature coefficient of the Kerr-cell constant are also included.

The pulse waveform is reconstructed from typical Kerr-system results by automatic computation and compared with simultaneous time-resolved pulse-divider measurements. Comparisons at the peak of the pulse, where a "slideback" technique is used to enhance the resolution of the divider measurement, demonstrate agreement to better than 1 percent.

In addition, a novel technique is developed for measurement of the pulse magnitude from photographs of the Kerr-effect fringe patterns produced by passing an expanded, pulsed laser beam through the system. By this approach, voltage is measured optically without use of sophisticated electrical metering instrumentation.

12307. Cezairliyan, A., **Measurement of the variation of normal spectral emittance of tantalum during melting by a pulse heating method,** *High Temperatures-High Pressures* **2,** 501-506 (1970).

> Key words: Emittance; high-speed measurements; melting; normal spectral emittance; tantalum; thermal radiation properties.

A pulse heating method was used to measure the change in normal spectral emittance (at 650 nm) of tantalum as a function of the change in electrical resistance during the initial melting period. Duration of an individual experiment, in which the specimen was heated from room temperature to its melting point, was approximately 400 ms. The partial melting period was approximately 100 ms. A millisecond resolution photoelectric pyrometer was used for temperature measurements. The recordings of experimental quantities were made with a digital data acquisition system, which has a full-scale signal resolution of approximately one part in 8000 and a time resolution of 0.4 ms. Results of the study show that normal spectral emittance decreased by approximately 3.5% during the initial one third of the melting period.

12308. Chandler, H. H., Bowen, R. L., Paffenbarger, G. C., **Method for finishing composite restorative materials,** *J. Am. Dental Assoc.* **83,** No. 2, 344-348 (Aug. 1971).

> Key words: Composite restorative materials; finishing; operative dentistry; polishing instruments; surface finish.

An instrument, designed to finish the surface of composite restorative materials, was made by bonding 1μ to 5μ diamond particles to flexible paper disks. The surface finish produced by this instrument was superior to that obtained by fine cuttle-fish disks and inferior to surfaces obtained by the hardening of the material in contact with polished glass. Results are presented with use of scanning electron photomicrographs.

12309. Chandler, H. H., Bowen, R. L., Paffenbarger, G. C., **Physical properties of a radiopaque denture base material,** *J. Biomed. Mater. Res.* **5,** 335-337 (July 1971).

> Key words: Composite materials; denture base materials; physical properties; prosthetic materials; radiopacity-radiopaque.

Physical properties were determined for radiopaque composite denture base materials consisting of poly(methyl methacrylate) as the matrix and 30, 40, and 50% by weight of a silane-treated barium fluoride-containing glass powder as the reinforcing filler. Specimens without glass were included for comparison.

All of the materials met the requirements of American Dental Association Specification No. 12 for Denture Base Polymer except that the material containing 50% glass had less deflection than the minimum required at the 5000-gm load in transverse testing.

There was little or no difference among the materials with respect to hardness, indentation resistance, water sorption, color stability, and resistance to drop impact.

Addition of glass to the 30% level decreased the transverse strength while 50% glass specimens had slightly greater transverse strengths as compared to specimens with no glass. In general, the addition of glass increased the time to reach the packing stage, densities, and Young's, bulk, shear, and flexural moduli, had only slight effect on solubility and decreased the cold-cure repairability and the coefficient of linear thermal expansion.

The solubility of the glass powder was about four times that of powdered porcelain teeth after 24 hr, and totaled 0.55% after 5 days.

12310. Chandler, H. H., Bowen, R. L., Paffenbarger, G. C., **Radiopaque denture base materials technic dentures,** *J. Biomed. Mater. Res.* **5,** 359-371 (July 1971).

> Key words: Composites; denture base materials; dentures; dimensional stability; foreign bodies; prosthetics; radiopacity; silane bonding.

Technic dentures were made using composite base materials containing 30, 40, and 50 weight percent of a silane-treated, radiopaque, powdered glass as the reinforcing filler and poly(methyl methacrylate) as the matrix. Dentures containing no glass were included for comparison. Molar-to-molar dimensional changes, effects of silane treatment of the porcelain teeth and handling and finishing characteristics were determined.

Dentures containing glass had less dimensional change during curing and subsequent water storage than those without glass. Thick upper dentures exhibited the least change and thin lowers, the most. The differences in the magnitudes of the changes would not be clinically noticeable.

Silane treatment of the porcelain teeth in thick upper dentures resulted in breakage of the posterior teeth in almost all instances. Posterior teeth also fractured in thick upper dentures containing 40 and 50% of the silane-treated glass even though the teeth were not treated with silane.

Mixing and molding properties of the composite materials, while acceptable, were slightly inferior to the material containing no glass. Finishing characteristics were definitely inferior in that it was more difficult and time-consuming to attain the final surfaces and these surfaces were not as smooth as those in dentures without glass.

12311. Chang, S. S., Bestul, A. B., **Heat capacities of cubic, monoclinic, and vitreous arsenious oxide from 5 to 360 K,** *J. Chem. Phys.* **55,** No. 2, 933-946 (July 15, 1971).

> Key words: Arsenious oxide; arsenolite; claudetite; crystal transition; cubic crystal; glass; heat capacity; monoclinic crystal; low temperature; planar molecular structure; spherical shell molecules; vitreous state.

Experimentally determined heat capacities, C_p, precise to better than 0.1%, and derived thermal data are reported for cubic and monoclinic crystalline and vitreous arsenious oxide at temperatures from 5 to 360 K. C_p for the glass is higher than for either crystal at all temperatures. C_p's for the cubic crystal are lower than those for the monoclinic between about 20 and 310 K and higher at temperatures below and above this range. C_p/T^3 for the glass is still increasing with decreasing temperature at 5 K, although C_p/T^3 for both crystals peaks a few degrees above this. C_p's reported here for the monoclinic crystal are grossly different from those previously reported by Stranski's school. The corresponding entropy difference between the two crystals at 298.15 K reported here is 5.9 ± 0.2 J deg^{-1}·mole^{-1}, whereas that previously reported from C_p measurements by Stranski's school was 14.4 deg^{-1}·mole^{-1}. Combined with a value newly obtained elsewhere for the enthalpy difference between the two crystals at 298.15 K, the value reported here for the entropy difference yields a transition temperature between them of 311 ± 30 K, which is in the range currently cited on other bases. C_p values reported here for the cubic crystal and the glass are consistently 4-5% lower than those previously reported by Tarasov's school, suggesting a systematic proportional effect of the magnitude in those previous values. The proportionality of C_p to T for the cubic crystal from 65 to 160 K, previously erroneously attributed to the monoclinic crystal by Tarasov on the basis of Anderson's C_p data, are discussed.

12312. Chang, T-T., Cohen, M. I., Hosler, W. R., **Superhyperfine interactions in CdF_2:Yb,** *J. Chem. Phys.* **54,** No. 10, 4278-4280 (May 15, 1971).

Key words: Cadmium fluoride; EPR; superhyperfine interaction; ytterbium.

The superhyperfine structure of Yb^{3+} in CdF_2 has been observed. Fitting of the structure was done according to the model of Ranon and Hyde. The principal values of the interaction tensor T were approximated to be -16.7 MHz for $T_\perp$ and 37.8 MHz for $T_\parallel$.

12313. Creutzberg, F., Hougen, J. T., **Rotational line intensities for singlet-triplet transitions in molecules belonging to the point groups D_{2h}, C_{2v}, and D_2,** *J. Mol. Spectry.* **38,** No. 2, 257-272 (1971).

Key words: Asymmetric rotors; matrix elements; rotational line intensities; singlet-triplet transitions; spin forbidden transitions; transition calculations.

Explicit expressions are presented for transition moment matrix elements and Hamiltonian matrix elements which can be used directly in computer programs for calculating rigid rotor line intensities for singlet-triplet transitions in molecules belonging to the point groups D_{2h}, C_{2v}, and D_2. The calculational procedure outlined and the various matrix elements presented can be used for triplet states exhibiting large or small spin splittings in the nonrotating molecule.

12314. Fatiadi, A. J., **Evidence for adsorption as the first step in the solid-state oxidation of benzenehexol with active manganese dioxide,** *J. Chem. Soc.* Section B, 889-894 (1971).

Key words: Adsorption; amorphous; free-radical; ionic; manganese dioxide; polycrystalline; structure; surface.

Oxidation of benzenehexol on the surface of amorphous, precipitated ('active') manganese dioxide proceeds by a concerted mechanism, involving ionic and free-radical pathways, to give a croconic acid derivative. This manganese dioxide has a polycrystalline chain structure, in contrast to the crystalline oxidant prepared in deuterium oxide.

12315. Fraker, A. C., Ruff, A. W., Jr., **Observations of hot saline water corrosion of aluminum alloys,** *Corrosion* **27,** No. 4, 151-156 (Apr. 1971).

Key words: Aluminum alloys; hot saline water corrosion; oxide films; precipitates; transmission microscopy.

Corrosion films formed on aluminum in hot salt water (100 to 177 °C) after short time tests of thirty seconds to one hour were studied by transmission electron microscopy and diffraction. It was concluded from observation of 6061, 5454, 2024, Al-1.52Mn and Al-1.66Ni alloys that one controlling factor in the initiation and growth of the outer film of the duplex oxide film is the alloy composition. The outer film formed earlier on alloys containing copper and the film growth was also more rapid on these alloys. Additions of magnesium, manganese and nickel retarded this outer film formation but with nickel additions, pitting attack was more severe and deposition of copper from solution was increased. The formation and growth of the outer film was slowest on the 5454 alloy which was also the most resistant alloy tested.

12316. Frenkiel, F. N., Klebanoff, P. S., **Statistical properties of velocity derivatives in a turbulent field,** *J. Fluid Mech.* **48,** Part 1, 183-208 (July 13, 1971).

Key words: Computer; correlations; grid; intermittency; isotropy; moments; probability-distributions; turbulence; velocity-gradients.

High-speed digital computing methods are applied to the study of the statistical behaviour of turbulent velocity derivatives in a nearly isotropic turbulent field downstream of a grid. Higher-order correlations of turbulent velocity gradients, up to the eighth order, are measured. Contrary to the case of *velocities,* the higher even-order correlations of *velocity gradients* more clearly evidence the departure from a two-dimensional Gaussian probability distribution. Using non-Gaussian probability distribution laws the relations between different odd- and even-order correlations are obtained and compared with the experimental measurements. The conditions of a similarity and isotropy are evaluated for the small-scale structure as evidenced by the behaviour of the turbulent velocity gradients. The concept of intermittency of the small-scale structure is also discussed.

12317. Gadzuk, J. W., Hartman, J. K., Rhodin, T. N., **Approach to alkali-metal chemisorption within the Anderson model,** *Phys. Rev. B* **4.** No. 2, 241-255 (July 15, 1971).

Key words: Chemisorption; impurities; surface physics.

A theory of chemisorption relevant to alkali atoms on metal surfaces is presented. The virtual-impurity-state problem is modeled in the manner presented by Kjöllerström, Scalapino, and Schrieffer by solving the Anderson impurity problem in the low-density approximation (LDA). It is assumed that the binding or chemisorption energy of the alkali metal is composed of two parts, a metallic and an ionic component. Since considerable charge transfer from the alkali atom to the metal occurs, the LDA is appropriate for describing the metallic part of the binding. Another consequence of the large charge transfer is that the major portion of the binding results from an ionic type of bond between the partially charged alkali ion on the surface and a polarization or screening charge inside the metal. The results of the theoretical calculations indicate that binding energies for alkali atoms adsorbed on clean single-crystal faces of metals generally fall within the range of 1.5 – 2.5 eV, in accord with available experimental data on metals such as W, Mo, Ta, and Ni.

12318. Grabner, L., Stokowski, S. E., **Photoluminescence of Cr-doped CaTiO,** *Phys. Rev. B* **2,** No. 11, 4351-4353 (Dec. 1, 1970).

Key words: Cr^{3+}; energy transfer; excitation; lifetime; photoluminescence.

At 4 and 77 K, photoluminescence from nominally undoped and 0.0025% Cr-doped $CaTiO_3$ shows identical spectra in the infrared with an intensity ratio of 1:2. The emission is attributed to the $^2E \rightarrow ^4A_2$ transition of the Cr^{3+} ion at a Ti^{4+} site. At 4 K it consists of a single no-phonon line at 1.744 eV of half-width 1.5 MeV and a complex vibronic spectrum which is anomalously intense. Data at 77 K show a 2-MeV splitting of the ^2E state. The absorption spectrum of $CaTiO_3$:Cr is dominated by a "background absorption" by unknown defects. From the coincidence of the excitation spectrum with the absorption spectrum, we conclude that the excitation is dominated by absorption by these unknown defects which transfer energy into Cr^{3+}. In undoped $CaTiO_3$ a single-exponential decay of the emission is reported, with decay time 700 μsec. In $CaTiO_3$:0.0025% Cr, on the other hand, two exponentials with decay times 700 μsec and 11 msec were observed. The former is assigned to Cr^{3+}, the latter to the time of energy transfer from defects responsible for the background absorption to the Cr^{3+}. We also report a visible emission consisting of a broad structureless band centered at 2.7 eV, with half-width 0.7 eV. Presumably, it is recombination radiation caused by the recombination of a free charge carrier with a trapped charge at an unknown defect. Its excitation spectrum gives a band gap for $CaTiO_3$ of 3.70 eV at 4 K.

12319. Grabner, L., Stokowski, S. E., Brower, W. S., Jr., **No-phonon ^4T_2g–^4A_2g transitions of Cr^{3+} in TiO_2,** *Phys. Rev. B* 2, No. 3, 590-598 (Aug. 1, 1970).

Key words: Absorption; defect phonon; emission; excitation; lifetime; $^4T_2$ state.

Absorption and emission at 4 and 77 K are observed in Cr-doped TiO_2 consisting of two sharp no-phonon lines at 12685 and 12732 cm^{-1}, and vibronic sidebands with an integrated intensity 10^4 times that of the no-phonon lines. In undoped TiO_2, identical spectra are observed but are a factor of 100 less intense. The center responsible for these spectra is identified as substitutional Cr^{3+} by observing, in emission, a splitting of the 12685-cm^{-1} line of 1.4 cm^{-1}, a value previously determined by EPR measurements. The vibronic sidebands have some structure superposed on a broad band. The vibronics are different in emission and absorption and have a lifetime of 45 μsec, equal to that of the no-phonon line. They are shown to be principally due to defect-induced phonons arising from the Cr^{3+} defect. We argue that the spectra observed are not characteristic of the usual ^2E_g-$^4A_{2g}$ transition, and propose that the $^4T_2$ lies lower in energy than the ^2E_g state. If so, the new results of this work are (1) no-phonon line emission for the $^4T_2$-$^4A_2$ transition and (2) defect phonon states which are different for the $^4A_2$ and $^4T_2$ states. The excitation spectrum is also presented. It shows that the excitation of the Cr^{3+} emission occurs mainly by the transfer of energy from excited trapping centers rather than by direct excitation.

12320. Grimes, D. N., **Imaging of tri-bar targets and the theoretical resolution limit in partially coherent illumination,** *J. Opt. Soc. Am.* **61,** No. 7, 870-876 (July 1971).

Key words: Coherence; partially coherent imaging; resolution; resolving power; tri-bar targets.

In viewing systems that employ critical, Kohler, or collimated illumination, the illumination may frequently be characterized by the complex degree of coherence in the form of a first-order Bessel function divided by its argument. The anomalies that occur in the image of a tri-bar target viewed in partially coherent illumination of this form are discussed for a two-dimensional circular diffraction-limited imaging system. The Sparrow criterion, which in this case correlates with experimental measurements of resolving power, is applied to determine the resolution limit. The computed resolution-limit curve for a tri-bar target is shown and compared to the previously published two-point resolution-limit curve for a one-dimensional system and to the limiting values obtained in a two-dimensional system for coherent and incoherent illumination. In the latter case, the full curve is shown as a special case of the application of the Sparrow criterion to the partially coherent imaging equations for a circular two-dimensional system. Experimental confirmation of the calculations is given.

12321. Grimes, D. N., **Measurement of the second-order degree of coherence by means of a wavefront shearing interferometer,** *Appl. Opt.* **10,** No. 7, 1567-1570 (July 1971).

Key words: Coherence; coherence measurement; interferometry; wavefront shearing interferometer.

A method of measuring the second-order degree of coherence in an arbitrary plane by means of a compact wavefront shearing interferometer is described. The prism interferometer previously described by Saunders produces two sheared images that interfere, allowing measurement of the degree of spatial coherence. If the degree of coherence is a function of coordinate differences only, the visibility is constant; otherwise it varies over the field. Experimental results are given.

12322. Heydemann, P. L. M., **A fringe-counting pulsed ultrasonic interferometer,** *Rev. Sci. Instr.* **42,** No. 7, 983-986 (July 1971).

Key words: Phase sensitive detection; speed of sound; ultrasonic interferometer; ultrasonics.

A new ultrasonic interferometer for the automatic measurement of transit times is described. Its main advantage is its ability to follow very large changes of the transit time (1-20) and still maintain a resolution of typically 2.5×10^{-10} sec. The method is based on the phase sensitive detection of multiple echoes, counting of the output signal at the rate of four counts per full cycle, and an additional interpolation.

12323. Hougen, J. T., **Interpretation of molecular-beam radiofrequency ortho-para transitions in methane,** *J. Chem. Phys.* **55,** No. 3, 1122-1127 (Aug. 1, 1971).

Key words: Group theory; inversion splitting; methane; molecular-beam data; ortho-para transitions; radio frequency.

A modified formalism, involving primarily changes in certain group-theoretical arguments, is presented for the data leading to the recent report that the splitting between the two inversion levels of methane has been resolved.

12324. Hussman, E. K., McLaughlin, W. L., **Dose-distribution measurement of high-intensity pulsed radiation by means of holographic interferometry,** *Radiation Res.* **47,** No. 1, 1-14 (July 1971).

Key words: Absorbed dose; calorimetry; electron beams; interference fringes; interferometry; pulsed beams; refractive-index holography; temperature profile.

A novel calorimetric method has been developed for evaluating the spatial distribution of radiation absorbed dose in transparent liquids, particularly for dosimetry in pulsed high-intensity electron beams. Local temperature change is determined without the introduction of temperature sensors that may disturb the radiation field. The change in a liquid's refractive index, which is a function of temperature, is measured by an interferometric method employing holographic wavefront reconstruction. For radiation beams essentially symmetric to the direction of propagation, the dose distribution can be derived from the information given by the interferogram. Dose distributions in water have been evaluated for short electron pulses of different energy spectra.

12325. Johnson, D. R., Powell, F. X., Kirchhoff, W. H., **Microwave spectrum, ground state structure, and dipole moment of thioformaldehyde,** *J. Mol. Spectry.* **39,** No. 1, 136-145 (July 1971).

Key words: Dipole moment; microwave spectrum; reactive species; rotational spectra; structure; thioformaldehyde.

The microwave spectrum of the reactive species thioformaldehyde (H_2CS) has been studied in the ground vibrational state. Rotational transitions in $H_2{}^{12}C^{32}S$, $H_2{}^{13}C^{32}S$, $H_2{}^{12}C^{34}S$, and $D_2{}^{12}C^{32}S$ have been measured and assigned. A detailed centrifugal distortion analysis has been carried out on the species $H_2{}^{12}C^{32}S$ with a total of 27 transitions up to $J=27$ fit to a standard deviation of 26 kHz. Rotational constants obtained from these four isotopic species have been used to obtain the following completely substituted structure: $r_{S=C}=1.6108(9)$Å, $r_{C-H}=1.0925(9)$Å, and $<HCH=116.85(5)°$. The dipole moment of H_2CS was found to be $\mu=1.6474(14)$ Debye from Stark effect measurements on the $J=1_{01}\leftarrow 0_{00}$ transition. The typical reactive half-life of this new species was found to be about 6 min in a static system.

12326. Krauss, M., Maldonado, P., Wahl, A. C., **Interaction energy curves of LiHe and NaHe ($X\ {}^2\Sigma^+$, $A\ {}^2\Pi$, $B\ {}^2\Sigma^+$) and $X\ {}^1\Sigma^+$ ions,** *J. Chem. Phys.* **54,** No. 11, 4944-4953 (June 1, 1971).

Key words: Hartree-Fock; interaction energy; LiHe; NaHe; transition probabilities.

Hartree-Fock interaction energy curves have been calculated for the $X\,^2\Sigma^+$, $A\,^2\Pi$, and $B\,^2\Sigma^+$ states of neutral LiHe and NaHe as well as for the ground state $X\,^1\Sigma^+$ ions over a range of distances from 3 to 10 a.u. Since it is intended to apply these results to scattering problems, the variation of the dipole and quadrupole moments and the electronic transition probabilities with internuclear distance were also obtained. Both Slater-type functions and Gaussian-type functions were used as variational trial functions with the intention of gauging the efficacy of the Gaussian basis. Except for situations involving small energy minima the Gaussian basis yielded results accurate relative to the Slater basis. The features of the Hartree-Fock interaction energy curves can be summarized as follows:

(1) The $X\,^2\Sigma^+$ interaction energy is purely repulsive for both molecules to the accuracy of the present calculation.

(2) The $A\,^2\Pi$ and $X\,^1\Sigma^+$ curves are strikingly similar for both Li and Na confirming the penetration of the He for this interatomic orientation.

(3) The long-range repulsive behavior of the $B\,^2\Sigma^+$ curve compared with estimates of the correlation energy shows that the internuclear distance dependence of the energy in the region of 10 a.u. is dominated by the Hartree-Fock repulsive curve.

Charge-density plots have been obtained for all states and distances. These are used to illustrate the physical basis of the energy curves.

12327. Krauss, M., Mielczarek, S. R., Neumann, D., Kuyatt, C. E., **Mechanism for production of the fourth positive band system of CO by electron impact on CO_2,** *J. Geophys. Res.* **76,** No. 16, 3733-3737 (June 1, 1971).

Key words: CO; CO_2; electron impact; fourth positive bands; oscillator strength; Rydberg state; valence state.

The electron impact energy loss spectrum for CO_2 is presented over an energy range of 10 to 20 eV. Analysis of this spectrum and molecular orbital calculations indicate that valence state perturbers of $^1\Sigma_u^+$ and $^1\Pi_u$ symmetry contribute significantly to the oscillator strength in the range from 11 to 14 eV. The $^1\Sigma_u^+$ state is then determined to be the predominant contributor to the reaction $CO_2 + e \rightarrow CO_2(^1\Sigma_u^+) + e \rightarrow CO(A^1\Pi) + O(^3P) + e$. Unusual intensity distributions in the observed fluorescence of the vibrational states of $CO(A^1\Pi)$ observed by M. J. Mumma, E. J. Stone, and E. C. Zipf (1970) are explained on the basis of competition between predissociation and autoionization from this single state. This mechanism would be one means for production of the fourth positive bands of CO in the ultraviolet dayglow of the upper atmosphere of Mars.

12328. Lafferty, W. J., Ritter, J. J., **Microwave spectrum, dipole moment, and structure of ethynyldifluoroborane,** *J. Mol. Spectry.* **38,** No. 1, 181-194 (Apr. 1971).

Key words: Dipole moment; ethynyldifluoroborane; microwave spectrum; molecular structure; rotational spectrum; Stark effect.

The microwave spectrum of ten isotopic species of ethynyldifluoroborane ($HCCBF_2$) has been measured. Rotational constants of the ground state and the lowest excited vibrational state have been obtained. Structural parameters obtained are: $r_{C-H} = 1.058 \pm 0.003$ Å, $r_{C\equiv C} = 1.206 \pm 0.003$ Å, $r_{C-B} = 1.513 \pm 0.005$ Å, $r_{B-F} = 1.323 \pm 0.005$ Å, and $\angle FBF = 116.5 \pm 1.0°$. The dipole moment is $1.87_6 \pm 0.010\ D$.

12329. Leasure, W. A., Jr., **Truck tire noise—preliminary results of a field measurement program,** *Proc. Purdue Noise Control Conference, Purdue University, West Lafayette, Indiana, July 14-16, 1971,* pp. 41-48 (July 1971).

Key words: Acoustics; noise measurement; noise pollution; noise (sound); sound transmission; tires; transportation noise; trucks; urban planning.

This paper presents an inventory of peak A-weighted sound levels measured during an extensive parametric study conducted to characterize the noise generated by typical rib, cross-bar, and retread type truck tires in actual use. A test sample of nine tread designs, estimated to represent 70-80% (these exact designs) of the truck tire population on the road today, was investigated considering the following variables: wear, loading, speed, pavement surface, and tire location. Test vehicles included both single-chassis vehicles and a tractor-trailer.

The results show that the A-weighted sound level increased with either an increase in load or speed. The pocket retread design always produced the highest level followed by the cross-bar tires and then the rib tires. This ranking held for both new and half-worn tires. The influence of wear and pavement surface is more complex. For all of the tread designs except one there was an increase in noise level between the new and half-worn states. The results for different pavement surfaces are much the same as with wear. The generated noise appears to depend on both the specific tread design and the surface roughness. Individual tires do contribute differently to the overall level depending on their location on the vehicle. In some cases, significant reductions in the noise level were observed when "noisy" tires were mounted inboard of "quieter" tires.

The paper includes a discussion of the measurement and analysis techniques utilized for the establishment of this data base.

12330. Loebenstein, W. V., **Calculations and comparisons of nonideal gas corrections for use in gas adsorption,** *J. Colloid Interface Sci.* **36,** No. 3, 397-400 (July 1971).

Key words: Adsorption; correction for gas; gas; gas law correction; imperfect gas; second virial coefficient.

Volumetric gas adsorption measurements have become increasingly popular in recent years. The techniques for determination of surface area and pore size distribution have become so commonplace that they can almost be termed routine. At the temperature of the adsorption experiment, it is necessary at each equilibrium pressure to correct for the nonideal behavior of the gas surrounding the sample in order to obtain by difference an accurate evaluation of the amount of gas actually adsorbed. The correction factors that are continually used by most adsorption chemists have not been critically reexamined by these ultimate users since they were originally recommended more than thirty years ago. Indeed, textbooks published more than 25 years later continue to perpetuate the same correction factors. It is the purpose of this paper, by comparing correction factors derived from various sources, to avoid gross inaccuracies and to suggest a procedure whereby the investigator may estimate his own factor in instances where tabulated values are not readily available to him.

12331. McNesby, J. R., Kelly, R. V., **Abstraction of hydrogen by methylene,** *Intern. J. Chem. Kinetics* **3,** 293-305 (1971).

Key words: Abstraction; deuterium; isotope effect; ketene; kinetics; methylene.

The photolysis of CD_2CO at 313 nm in the presence of neopentane was carried out over the temperature range 576-706 K. Analysis of the products and isotopic analysis of the methanes demonstrate abstraction of H from neopentane and D from CD_2CO by methylene. The relative kinetics of abstraction of H and D have been measured over the temperature range, and the absolute value for the collision yield of the abstraction of H from neopentane by CD_2 at 653 K has been estimated to be about 1.5×10^{11} mole^{-1} cm^3 sec^{-1}, a value 10^3 times larger than the corresponding reaction of CH_3.

12332. Madey, T. E., Yates, J. T., Jr., **Electron-stimulated desorption as a tool for studies of chemisorption: A review,** *J. Vacuum Sci. Technol.* **8,** No. 4, 525-555 (July/Aug. 1971).

Key words: Adsorption; chemisorption; cross section; desorption; electron stimulated desorption; hydrogen; nickel; nitrogen; oxygen; surface; tungsten.

Bombardment of solids by low-energy electrons (< 500 eV) can cause various changes in the surface region, particularly if the surface contains an adsorbed layer. Electron bombardment can promote the desorption of energetic neutral and ionic fragments from the surface, can alter the bonding of surface species, and in some cases can cause decomposition of the surface region. These processes are termed electron-stimulated desorption (ESD) phenomena, and this review is primarily concerned with the use of ESD in studies of species adsorbed on surfaces. Topics covered include experimental methods, a theoretical discussion of physical mechanisms, and a detailed discussion of certain specific and well-studied adsorbate-substrate systems.

12333. Mandel, J., **Repeatability and reproducibility,** *Mater. Res. Stand.* **11,** No. 8, 8-16 (Aug. 1971).

Key words: Interlaboratory testing; precision; repeatability; reproducibility; test methods, evaluation of.

A simple method is presented for the evaluation of the repeatability and the reproducibility of test methods. The method obviates such difficulties as transformations of scale or weighted analysis of variance.

It is shown, furthermore, that the concepts of repeatability and reproducibility are, by themselves, insufficient to answer the major questions related to interlaboratory testing. Alternative procedures are mentioned. Finally, the paper presents a rationale for a proper choice of the number of laboratories and the number of replicate determinations required for an adequate interlaboratory study.

12334. Marlow, W. F., LaFleur, P. D., **Standard reference materials for the analysis of environmental samples,** *Proc. Symp. Nuclear Techniques in Measurement and Control of Environmental Pollution, Salzburg, Austria, Oct. 26-30, 1970,* pp. 91-94 (International Atomic Energy Agency, Vienna, Austria, March 1971).

Key words: Activation analysis; biological; botanical; environment; Standard Reference Material.

As is evidenced by the large number of publications on the subject, especially at this Symposium, many groups are engaged in the analysis of environmental samples of all kinds for their trace element content, as well as for their major constituent content. Perhaps the most versatile and popular method for the rapid, economical analysis of environmental samples for a large number of elements is neutron activation analysis. Also extensively used are x-ray fluorescence analysis, atomic absorption spectroscopy, spark-source mass spectrometry, and emission spectrometry. In many cases, meaningful results for multielement analysis have been difficult to obtain because of the lack of adequate standard materials, despite the limited efforts by some investigators to produce them. Particularly, in the cases of neutron activation analysis and spark-source mass spectrometry the matrix of the sample can have a pronounced effect upon the analysis. It is extremely important that the standard material have a matrix as similar as possible to that of the sample. At present such suitable standard materials are not widely available. Therefore, the U.S. Atomic Energy Commission and the U.S. National Bureau of Standards have instituted a program for the production of a series of special Standard Reference Materials, fully characterized for at least 22 and possibly 30 elements, suitable for use in the analysis of environmental samples, particularly biological samples. These Standard Reference Materials will be available for purchase by all laboratories. Multilaboratory intercomparisons of these Standard Reference Materials will be encouraged.

Details of the nature of these materials, elements for which they will be characterized and analytical techniques used in standardizing them are discussed.

12335. Menis, O., Iyer, C. S. P., **Spectrophotometric determination of vanadium and iron with β-isopropyltropolone,** *Anal. Chem. Acta* **55,** 89-95 (1971).

Key words: Analysis of steel samples; extraction with β-isopropyltropolone; simultaneous determination of vanadium and iron; spectrophotometric determination of vanadium.

A spectrophotometric procedure is described for the determination of vanadium and for the simultaneous determination of iron and vanadium using two wavelength measurements, at 470 and 540 nm or 418 and 470 nm. It is based on the formation of chelate complex with β-isopropyltropolone. The complex is extracted with chloroform and in the presence of alcohol the color develops rapidly and is stable for at least 24 hours. The precision of the calibration curve is 1 per cent relative standard deviation. The application and results of the analysis of NBS Standard Reference Material steel samples are presented.

12336. Milligan, D. E., Jacox, M. E., **Infrared spectrum and structure of the SO_2^- radical ion,** *J. Chem. Phys.* **55,** No. 3, 1003-1012 (Aug. 1, 1971).

Key words: Alkali metal reactions; charge transfer; electron capture; infrared spectrum; matrix isolation; molecular orbitals; SO_2^- anion; sulfur dioxide.

When a sample of SO_2 in a large excess of argon is codeposited at 4 or at 14 K with an atomic beam of an alkali metal, prominent new absorptions appear near 500 cm^{-1} and between 975 and 1100 cm^{-1}. The pattern of absorptions is somewhat dependent both upon the alkali metal and upon the temperature at which the sample is deposited. Product absorptions which appear at 495, 985, and 1042 cm^{-1} in samples containing a small concentration of cesium atoms have been demonstrated to be contributed by a single species, shown by isotopic substitution studies to contain one sulfur and two oxygen atoms. A slight splitting in the absorptions of the mixed oxygen isotopic species indicates that the two oxygen atoms are not symmetrically equivalent, either because of a site perturbation or because of a slight nonequivalence of the two S-O bonds. The absorptions have been assigned to the three SO_2^- vibrational fundamentals of a charge-transfer complex in which the residual interaction of the cation is sufficiently small that all of the vibrational data can be fitted within experimental error without considering the motion of the cation. The data are consistent with an O-S-O valence angle of 110±5°. The S-O stretching force constant is significantly lower than that of SO_2, consistent with the addition of an electron to an orbital which is antibonding between the sulfur and two oxygen atoms.

12337. Ming, T-K., Tauber, S. J., **Chemical structure and substructure search by set reduction,** *J. Chem. Doc.* **11,** No. 1, 47-51 (Feb. 1971).

Key words: Ambiguity; binary matrices; bond adjacency; chemical information; computer; control vector; set reduction; structure search; substructure search.

The set reduction method of Sussenguth for chemical structure and substructure searching has been adapted: structure search and substructure search have been separated into distinct subroutines; first-order and second-order degree have been included in the control vector. This method has been tested on structures with greater symmetry than has been done previously, and it has been verified for disjoint substructures. A method has been demonstrated for removing the ambiguity inherent in using a bond adjacency matrix.

12338. Newman, M., **Invariant factors of combinatorial matrices,** *Israel J. Math.* **10,** No. 1, 126-130 (1971).

Key words: Designs; incidence matrices; invariant factors; Smith normal form.

The Smith normal forms of an Hadamard matrix of order $4m$ (m square-free), and of the incidence matrix of a (v, k, λ) configuration ($n=k-\lambda$ square-free $(n,\lambda)=1$), are determined.

12339. Rukwied, A., Ruff, A. W., Willard, W. A., **Study of the cellular solidification structure in continuously cast high purity copper,** *Metallurgical Trans.* **2,** 2105-2114 (Aug. 1971).

Key words: Cavities; cellular solidification; constitutional supercooling; copper (99.999%); dislocation arrangements; distribution of impurities; precipitate particles; thermomechanical treatment.

The aim of this paper is to characterize the principal microstructural features of continuously cast high purity copper (99.999 pct Cu), particularly those which might influence high temperature creep. This material contains a cellular solidification structure resulting from impurity segregation due to constitutional supercooling of the melt during solidification. This structure could not be eliminated from the solid copper by thermomechanical treatment. The grown-in structure was studied using optical and electron metallography as well as etch-pitting techniques. In the as-cast material a loose network of dislocation tangles was observed, and in certain locations, preferential etching attack. In addition, small voids were found within the dislocation tangles. Thermomechanical treatment eliminated the dislocation tangles almost entirely, but left locations susceptible to preferential etching attack. At those locations impurities were probably concentrated into zones of a size of a few 1000 Å. From solubility and concentration considerations, small precipitates (less than 80 Å in size) or clusters of carbon are suspected.

12340. Rupp, N. W., Bowen, R. L., Paffenbarger, G. C., **Bonding cold-curing denture base acrylic resin to acrylic resin teeth,** *J. Am. Dental Assoc.* **83,** 601-606 (Sept. 1971).

Key words: Acrylic teeth; adhesion; autoadhesion; bonding; cold-curing methyl methacrylate; dentures; tensile strength.

Bonding of cold-curing acrylic resin to acrylic resin teeth increases tooth retention and strengthens denture bases because the plastic teeth become an integral part of the denture base. Bonding was effected in this manner: the necks of the teeth were coated with a solution of equal parts by volume of methylene chloride and cold-curing methyl methacrylate monomer. This treatment combines a solvent attack on the teeth with polymerization bonding and develops tensile strengths of more than 80% of those of the acrylic resin denture base materials. The bonding was verified in experimental dentures made of a compression molded and a pour type poly(methyl methacrylate). The resin teeth became integral parts of the denture as evidenced by their retention in the base. On application of stresses, the fracture lines went through the teeth rather than through the tooth-denture base interfaces as before. The technique adds neither time nor equipment to currently used laboratory procedures.

12341. Sengers, J. M. H. L., Straub, J., Vicentini-Missoni, M., **Coexistence curves of CO_2, N_2O, and $CClF_3$ in the critical region,** *J. Chem. Phys.* **54,** No. 12, 5034-5050 (June 15, 1971).

Key words: $CClF_3$; CO_2; coexistence curve; critical region; N_2O; rectilinear diameter; refractive index.

The coexistence curves of CO_2, N_2O, and $CClF_3$ are analyzed in the critical region. The curves were obtained by refractive index measurements which are virtually free of gravity effects and contain much detail near T_c. After proper weight assignment, it is established that the top of the coexistence curve is asymptotically symmetric: $\rho^{\pm}=\rho_c\pm Bt^{\beta}$; that the exponent β is independent of the range, varies little from substance to substance, and is insensitive to impurities; and that the data are in agreement with the law of the rectilinear diameter. "Best" values for β, B, and for the slope of the diameter are presented. An analysis of earlier coexistence curves for CO_2 and N_2O, including a weight assignment, is presented; there is agreement between the older and newer data.

12342. Winnewisser, G., Maki, A. G., Johnson, D. R., **Rotational constants for HCN and DCN,** *J. Mol. Spectry.* **39,** No. 1, 149-158 (1971).

Key words: Bond distances; hydrogen cyanide; infrared; microwave; molecular structure; rotational constants; spectra.

Microwave measurements of rotational transitions within vibrationally excited states of several isotopic species of HCN have given improved values for the pertinent B_v constants. These new data have been combined with infrared measurements given in the literature (including D_v terms) to arrive at a set of rovibrational constants (α and γ constants) which is consistent with all available data. Bond distances resulting from several different B_e approximations are intercompared to assess the variability of the r_e values and the importance of the γ terms. The latest r_0 and r_s bond distances are also given.

12343. Winogradoff, N. N., Osinsky, V. I., **Density-of-states tails associated with the ⟨100⟩ conduction band minima in heavily doped n-type GaAs,** *Solid State Commun.* **8,** No. 23, 2001-2003 (Dec. 1, 1970).

Key words: Band tailing; gallium arsenide; indirect valleys; *n*-type gallium arsenide; photoluminescence; temperature dependence.

In contrast with the photoluminescence of lightly doped *n*-type GaAs, a *reduction* in the temperature of heavily doped material produced an intensification and a *broadening* of the spectrum on the high-energy side of the band gap. This effect is attributed to the presence of 'density-of-states' tails associated with the indirect ⟨100⟩ minima in the conduction band of the heavily doped material.

12344. Yule, H. P., **Computer data reduction in activation analysis,** *Proc. NATO Advanced Study Institute on Activation Analysis in Geochemistry and Cosmochemistry, Kjeller, Norway, Sept. 7-12, 1970,* pp. 145-166 (1971).

Key words: Activation analysis; component identification; result computation; spectral resolution.

Methods of result computation with activation analysis gamma-ray spectra are reviewed, emphasizing recent developments. For NaI(Tl) detector spectra, the multiple linear regression technique is reported. For Ge(Li) detector, methods of peak location, net peak area computation, and complex peak resolution are indicated. Each technique is discussed for applicability and difficulties in utilization. General features of result computation and of various numerical analytic techniques are discussed.

12345. Alexandropoulos, N. G., Parks, S. H., Kuriyama, M., **Polarization of the x-ray Compton-Raman radiation,** *Physics Letters* **35A,** No. 5, 369-370 (June 28, 1971).

Key words: Azimuthal angle; Compton-Raman interaction; Hamiltonian; polarization; radiation; spectrometer.

The polarization of x-ray photons in the Compton-Raman scattering from polycrystalline lithium has been analyzed by a crystal-polarizer to show that the inelastically scattered photons satisfy the law of Malus, $\cos^2 \phi$ dependence, where ϕ is the azimuthal angle of the crystal-polarizer. This result indicates that the A^2 term in the interaction Hamiltonian is dominant in the elastic scattering when the transferred energy is different from the binding energy of atomic electrons.

12346. Ballantyne, J. P., Yakowitz, H., Munro, E., Nixon, W. C., **Analysis of a variable geometry cylindrical detector for the scanning electron microscope,** *Proc. 25th Anniversary Meeting of the Electronmicroscopy and Analysis Institute Physics Group Conference, Cambridge, England, June 29-July 1, 1971,* pp. 194-197 (1971).

Key words: Electron detector; image contrast; magnetic domains; scanning electron microscope.

The cylindrical detector described by Banbury and Nixon (1969) provides enhanced contrast and directional information from many SEM specimens. This paper describes an initial theoretical analysis of such a detector.

12347. Benjamin, I. A., **Research needs in fire and smoke control,** *Proc. Symp. Fire Hazards in Buildings, Semiannual Meeting, American Society of Heating, Refrigerating and Air-Conditioning Engineers, San Francisco, Calif., Jan. 19-22, 1970,* pp. 35-38 (1971).

Key words: Building design; dampers; ducts; fire control; fire spread; smoke movement.

The author discusses problems associated with the movement of smoke and fire in buildings and reviews some of the current design requirements. Selected areas of needed research are pointed out and mention is made of some of the work being conducted by the Fire Research Section of the National Bureau of Standards.

12348. Blunt, R. F., Candela, G. A., Forman, R. A., Kahn, A. H., Mangum, B. W., **Magnetic susceptibility and optical studies of Cr^{3+} in Al_2O_3 (ruby): Magnetic method for determining concentration,** *J. Appl. Phys.* **42,** No. 8, 3058-3062 (July 1971).

Key words: Concentration determination; magnetic susceptibility; optical absorption coefficient; radiation damage; ruby.

Magnetic-susceptibility and optical-absorption measurements were performed on ruby samples of varying chromium concentration. Susceptibilities were measured by the Faraday method, both with and without selective microwave saturation of the Cr^{3+} susceptibility at resonance. The susceptibility values were used to calculate the Cr^{3+} concentrations, and these together with the optical absorption were used to obtain the "molar" absorption coefficients. The absorption coefficient of 50 cm^{-1}/wt% equivalent Cr_2O_3, for both the 0.40- and 0.56-μm band maxima ($E \perp c$), resulted. A Co^{60} γ irradiation was performed and the susceptibility was unchanged within experimental error.

12349. Cali, J. P., Seward, R. W., **The challenge of the 70's NBS standard reference materials program,** *Am. Lab.* **3,** No. 6, 10-14 (June 1971).

Key words: Agriculture; air and water pollution; biology; botany; health and medicine; instrument calibration; metrology; research materials; standard reference materials; SRM's; Standard Reference Materials Program.

The direction the National Bureau of Standards' Standard Reference Materials Program will take in the next decade is outlined with emphasis on those areas that have only recently been included in the SRM program such as health, pollution, botany, biology and agriculture, and also on areas in which no SRM's now exist. As the program moves into these new areas, the traditional industry-oriented aspects of the program will be maintained and improved through close cooperation with such standards-making bodies as ASTM and ANSI.

12350. Carpenter, R. J., Forman, R. A., **Zeeman modulator for nuclear quadrupole resonance spectroscopy,** *J. Phys. E: Sci. Instr.* **3,** 922-924 (Nov. 1970).

Key words: Current; modulator; nuclear; pulse; quadrupole; resonance; spectroscopy; transistor; Zeeman.

An instrument has been developed to drive modulation coils to produce Zeeman modulation in nuclear quadrupole resonance spectroscopy. A sequence of alternately negative and positive current pulses of up to 4 A, spaced by no-current intervals, is produced. The frequency may be as high as 500 Hz, since no electromechanical components are employed. The instrument is described in detail and sample resonance curves are presented.

12351. Carter, R. S., **The NBS reactor as a source of neutrons,** *Proc. American Nuclear Society Topical Meeting on Neutron Sources and Applications, April 19-21, 1971, Augusta, Ga.,* **2,** *1-10—17 (Apr. 1971).*

Key words: Cold neutron source; high flux; irradiation; neutron diffraction; research reactor; split core.

The NBS Reactor (NBSR) is a 10 Mw D_2O moderated and reflected reactor. The fuel elements are located seven inches apart in hexagonal arrays around experimental irradiation facilities. In order to support the broad range of research programs typical of a laboratory like the NBS, the reactor has extensive in-core, beam tube, and pneumatic tube facilities. Thermal neutron fluxes in the beam tubes and higher-flux irradiation facilities are about 10^{14} n/cm^2 -s. Several unique features of the NBSR contribute to its versatility. They include a thermal column with cadmium ratios for gold foils as high as 30,000 to 1, a split core to minimize the intensity of very high energy neutrons in the beam tubes, and a cold neutron source to enhance the intensity of very low energy neutrons available for certain inelastic scattering experiments. Extensive, automated experimental facilities have been developed to fully utilize the neutron beams and irradiations provided by the NBSR.

12352. Cohen, J., Edelman, S., Vezzetti, C. F., **Pyroelectric effect in polyvinylfluoride,** *Nature (London) Phys. Sci.* **233,** 12 (Sept. 6, 1971).

Key words: Infrared; piezoelectricity; polymers; polyvinylfluoride; pyroelectricity.

Significant infrared sensitivity has been obtained in oriented polyvinylfluoride, apparently due to pyroelectricity.

12353. Durst, R. A., Duhart, B. T., **Ion-selective electrode study of trace silver ion adsorption on selected surfaces,** *Anal. Chem.* **42,** No. 9, 1002-1004 (1970).

Key words: Electrometric study of silver adsorption; silver adsorption; silver ion-selective electrode; trace silver determination.

This study demonstrates the feasibility of using a silver ion-selective electrode for monitoring silver ion losses in long-term investigations of trace silver adsorption on various container surfaces. The electrometric technique offers the advantages of less complex and costly equipment, simplified procedure, and improved precision over the radiometric method. Nernstian electrode response was observed down to 4×10^{-7} M silver. For maximum sensitivity, 2×10^{-6} M (0.2 ppm) silver was selected as the concentration for the test solution which was placed in Pyrex, Desicoted Pyrex, polyethylene, Vycor, and Teflon containers. At various intervals up to 46 days, duplicate EMF readings were made on each of the five solutions with periodic restandardization of the electrode to permit drift corrections. Adsorption levels at the end of 30 days increased in the order: Vycor < polyethylene ≈ Teflon < Desicoted Pyrex < Pyrex; ranging from 28 percent adsorption for Vycor to 48 percent for Pyrex. Although for periods of up to a day, silver losses on Teflon were less than 2 percent, this study indicates that none of the above materials is suitable for long-term storage of solutions containing low levels of silver.

12354. Evans, J. P., Wood, S. D., **An intercomparison of high temperature platinum resistance thermometers and standard thermocouples,** *Metrologia* **7,** No. 3, 108-130 (July 1971).

Key words: Calibration; fixed point; freezing point; furnaces; high temperature; IPTS-68; platinum resistance thermometer; temperature scale; thermocouple; triple point.

To obtain some of the information necessary for redefining a practical temperature scale in terms of resistance thermometry up to the gold point, we have intercompared nine high temperature platinum resistance thermometers and eight standard thermocouples at 50 degree intervals over the range 630.74 to 1064.43 °C. Values of temperature were derived from "before and after" calibrations of the instruments at the freezing points of gold, silver, antimony, zinc, and tin, and at the triple point of water. Analysis of the data showed that the standard deviation of temperatures measured with thermometers was about 4 mK, while with thermocouples it ranged from 25 to 30 mK. When systematic errors were accounted for, we found that values of temperatures on IPTS-68 could be determined with a single thermometer, using an interpolation formula analogous to that used below 630.74 °C, with about one-third the uncertainty usually attributed to a single thermocouple determination (±200 mK). The data also revealed that there is a lack of "smoothness" in the scale at 630.74 °C—first derivatives with respect to t_{68} are discontinuous by about 0.1 percent at this temperature. We conclude from the results of this work that if a practical temperature scale were redefined in terms of presently available high temperature platinum resistance thermometers, it could be realized with significantly less uncertainty (±12 mK for a single determination) than IPTS-68, as it is now realized with thermocouples (±200 mK for a single determination). We recommend, however, that the adoption of such a scale be deferred until indicated improvements in thermometers have been made, and until current researches in gas thermometry have provided new values of thermodynamic temperatures for calibrating fixed points.

12355. Fetters, L. J., Yu, H., **Equilibrium conformation and "worm-like coil" configuration of poly(*n*-alkyl isocyanates),** *Macromolecules* **4,** No. 4, 385-389 (July-Aug. 1971).

Key words: Configuration; conformation; Kratky-Porod model; light scattering; osmotic pressure; poly(*n*-alkyl isocyanates); radii of gyration; second virial coefficients.

Osmotic pressure and light-scattering measurements of the polymers of *n*-butyl, *n*-hexyl, and *n*-octyl isocyanates are presented. The molecular weight dependence of the osmotic second virial coefficients and the radii of gyration is analyzed in terms of the worm-like-coil model of Kratky and Porod. The characterization of the *n*-butyl polymer, which has been studied most extensively, results in 500-600 Å for the persistence length and 1.8-2.1 Å for the monomeric projection along the contour direction of the chain. The dependence of the radii of gyration on the weight-average molecular weights for the *n*-hexyl and *n*-octyl polymers is found to be similar to that for the *n*-butyl polymer. Thus, although our analysis has focused on the *n*-butyl species, it appears that a similar set of Kratky-Porod parameters should be applicable to the other polymers with normal aliphatic side chains of moderate length.

12356. Flynn, J. H., **The historical development of applied nonisothermal kinetics,** (Proc. 2nd Intern. Conf. on Thermal Analysis, Holy Cross College, Worcester, Mass., Aug. 19-23, 1969), *Thermal Analysis* **2,** 1111-1126 (Academic Press, Inc., New York, N.Y., 1969).

Key words: Applied nonisothermal kinetics; generalized techniques; historical review; isoconversional and isokinetic methods; isothermal; kinetic parameters; thermogravimetric analysis.

In spite of a surprisingly extensive literature prior to 1950 on nonisothermal kinetic methods, this field was long ignored by chemical kineticists who were preoccupied with simple systems in the gas phase or in homogeneous solution. In such systems, the equations of state of each involved species change with temperature so that isothermal restrictions were often necessary.

However, the advent of wide interest in thermogravimetric techniques applied to condensed phase volatilization reactions has helped the kineticist shake off the shackles of isothermicity and has fostered the development of new and powerful methods of kinetic analysis.

The neglected early literature is reviewed briefly in light of modern developments. Generalized techniques for determining kinetic parameters under isothermal, isoconversional and isokinetic conditions are outlined and illustrated.

12357. Franklin, A. D., Crissman, J., **Reorientation of trivalent cation-interstitial fluorine pair in CaF_2,** *Letters to the Editor, J. Phys. C: Solid State Phys.* **4,** L239-L242 (July 12, 1971).

Key words: Anelastic relaxation; calcium fluoride; defect pairs; dielectric relaxation; relaxation modes; reorientation.

A simple model based on the synthesis of de Gennes' double exchange concept and Hubbard's treatment of correlation in narrow band systems is proposed to account for the transition from the antiferromagnetic insulating state to the metallic state observed in various transition metal compounds.

12358. French, J. L., **Discussion of "Are individual current-meter ratings necessary,"** *J. Hydraulics Div. Proc. Am. Soc. Civil Engrs.* **HY1,** 507-511 (Jan. 1969).

Key words: Calibration; current meters (fluids); hydraulics; measurement; open-channel flow; standards.

This is a discussion of the paper "Are Individual Current-Meter Ratings Necessary?", Journal of the Hydraulics Division, American Society of Civil Engineers, March 1968. Experimental data relating to the performance of a Price current meter are presented. The data were obtained in a simulated working section of a water tunnel. It is concluded that the precision with which a Price meter responds to a given water flow is greater than might be expected from the data listed in the authors' tables 1 and 2.

12359. French, J. L., **Nonenlarged box culvert inlets,** *J. Hydraulics Div. Proc. Am. Soc. Civil Engrs.* **HY6,** 2115-2137 (Nov. 1969).

Key words: Culverts; entrance control; hydraulics; inlets.

The effect of variation in the dimensions of beveled leading edges on the discharge capacity of box culvert inlets of rectangular cross section is investigated. It is demonstrated that the effective control surface of a beveled edge may be either the face of the headwall or the beveled surface of the edge geometry, depending on the relative dimensions of the beveled edge. The bevel dimensions required to ensure bevel surface control are determined. The dependence of the discharge coefficient on the dimensions of the beveled leading edge and on the cross-sectional shape of the barrel is demonstrated. Methods for estimating the capacity in submerged entrance flow of box culvert inlets operating in entrance control are developed for various beveled leading edge geometries.

12360. Gebbie, K. B., Thomas, R. N., **The temperature control bracket,** *Astrophys. J.* **168,** No. 3, 461-479 (Sept. 15, 1971).

Key words: Boundary temperature; collisional-control; non-LTE; radiative-control; temperature-control-bracket.

The factors determining the temperature distribution in a stellar atmosphere are divided into transfer effects and population effects. As a measure of the latter, we introduce the Temperature Control Bracket [TCB], which, in radiative equilibrium, describes the control of T_e by the quantity and spectral distribution of the radiation field. Algebraic expressions for the [TCB] are given in terms of the microscopic rate processes for a pure hydrogen atmosphere. A caricatured computation is presented to demonstrate the influence of the various physical effects on the distribution of T_e in radiative equilibrium.

12361. Gravatt, C. C., **The application of light scattering,** *Appl. Spectry.* **25,** No. 5, 509-516 (Sept.-Oct. 1971).

Key words: Air pollution; Brillouin spectroscopy; lasers; light scattering; macromolecules; optical mixing spectroscopy; review.

Light scattering provides information concerning the size, shape, number, and time dependence of the physical nonuniformities of a system. Measurements of the scattered intensity as a function of both scattering angle and wavelength describe static properties, whereas the spectral distribution of the scattered radiation is related to time dependent phenomena. The applications of light scattering are discussed, including critical phenomena, molecular weight determination, air pollution analysis, and diffusion phenomena.

12362. Grimes, D. N., **Linear microdensitometry,** *J. Opt. Soc. Am.* **61,** No. 9, 1263 (Sept. 1971).

Key words: Diffuse density measurement; linear microdensitometer; microdensitometry.

A linear microdensitometer is proposed whose operation is independent of the coherence of the source used and which measures diffuse density. A theoretical analysis is given.

12363. Grundl, J. A., **Fission-neutron spectra: macroscopic and integral results,** *Proc. Neutron Standards and Flux Normalization, Symp. Argonne National Laboratory, Argonne, Ill., Oct. 21-23, 1970, sponsored by the European American Nuclear Data Committee,* pp. 417-451 (Aug. 1971).

Key words: Fission cross sections; fission neutron spectra; integral measurements.

Certain integral measurements performed with pure fission neutrons, and also with macroscopic systems that are dominated by the fission spectrum, locate an important area of difficulty for differential microscopic data. The classic measured value for the ^{238}U average fission cross section for ^{235}U thermal-neutron-induced fission neutrons, $\sigma_f(\chi_{25}, {}^{238}\text{U}) = 310 \pm 4$ mb, is in serious disagreement with predicted values which fall between 270 and 282 mb depending upon the choice of ^{238}U fission cross section and fission spectrum shape. Critical consideration is given to direct absolute determinations of $\sigma_f(\chi_{25}, {}^{238}\text{U})$, and to indirect values obtained from fission ratio measurements with activation detectors. The latter substantiate the classic value and also provide a new value for the ^{239}Pu fission spectrum. Equivalent disagreements with prediction occur in the interpretation fission ratio measurements performed in ^{235}U and ^{239}Pu metal critical spheres, and the discrepancy between calculated and measured age-to-indium-resonance of fission neutrons in water is in a direction consistent with the fission spectrum discrepancy. The growing importance of integral measurements for the technology of nuclear energy, and the consequent need for fast-neutron standardization to serve it, is assumed to emphasize the difficulties summarized in this review.

12364. Hall, J. T., Dixon, R. G., **Getting it all together the cybernetic way,** *Management Rev.* pp. 16-22 (American Management Association, Inc., New York, N.Y., July 1971).

Key words: Brainstorming; cybernetic technique; data collection; group dynamics; interpersonal relationships; management research; opinion survey.

This paper describes a number of management research experiments with a technique for generating and gathering ideas, quickly and effectively, from people in moderate to large size groups. The experiments were conducted by the Management and Organization Division of the National Bureau of Standards. The paper also describes applications of this technique by Bureau staff members to various community related situations.

The mechanics by which this technique works involve the collection of inputs and feedbacks from individuals arrayed in a variety of configurations. As the collection process proceeds, a process of synthesis and a process of evaluation also occur. The primary value of the technique, again, is the ease with which it allows us to comprehend and capture complex ideas from groups of people.

Through the dynamics of capture, feedback, and recapture of thoughts in a changing interpersonal environment, users get much closer to the reality or at least to the shape of group opinions and ideas; closer than any survey or questionnaire techniques we have used or seen used in the management field.

12365. Hellwig, H., Barnes, J. A., Glaze, D. J., **Frequency biases in a beam tube caused by Ramsey excitation phase differences,** *Proc. 25th Annual Symp. on Frequency Control, Atlantic City, N. J., April 26-28, 1971,* pp. 309-312 (Electronic Industries Association, Washington, D.C., April 1971).

Key words: Cavity phase shift; cesium beam tube; frequency accuracy; frequency modulation; frequency standard; power shift; resonance line shape.

A phase difference between the two interaction regions of a Ramsey excitation resonance structure results in a frequency bias in the measured beam resonance. A simple mathematical model is discussed which describes the dependence of this bias on the phase difference, the microwave power level, the modulation amplitude, and the resonance linewidth. This dependence results from the interaction of the modulated microwave excitation frequency with the asymmetric shape of the slightly shifted resonance line. In a first order approximation, no dependency on the frequency modulation amplitude is expected. Near-linear dependencies on the linewidth and microwave power level which are quite pronounced even at relatively small cavity phase differences are predicted.

The theoretical results are compared with one set of experimental data on the microwave power dependence as measured in 1969 with the primary cesium beam standard NBS-III. After a correction is applied to remove the power dependence due to spectral impurity of the microwave excitation, the remaining measured power dependence agrees quantitatively with that calculated using a cavity phase difference of about 3 milliradians.

12366. Kulin, G., **Discussion of the paper "Triangular broad-crested weir," by C. D. Smith and W. S. Liang,** *Proc. Am. Soc. Civil Engrs., Irrigation Drainage Div. 96,* **IR4,** 494-497 (Dec. 1970).

Key words: Flow measurement; weirs, broad-crested.

Published data on discharge coefficients for triangular broad-crested weirs are analyzed using a boundary layer model. Effects of changing the critical Reynolds number for boundary layer transition and possible scale effects are pointed out.

12367. Laufer, A. H., Okabe, H., **Heat of formation and bond dissociation energy of diazomethane by a photodissociation method,** *J. Am. Chem. Soc.* **93,** 4137-4140 (1971).

Key words: Bond dissociation energy; diazomethane; heat of formation; vacuum ultraviolet.

A lower limit for the heat of formation of diazomethane has been obtained from measurement of the minimum energy required to produce the $A^2\Delta$ state of CH in the low-intensity vacuum-ultraviolet photolysis of diazomethane. The value obtained is $\Delta H_f{}^\circ{}_0(CH_2N_2) \geq 51.3$ kcal/mol (2.22 eV). In conjunction with $\Delta H_f{}^\circ{}_0\ (CH_2) = 93.0$ kcal/mol, the dissociation energy of the C=N bond in diazomethane is ≤ 41.7 kcal/mol (1.81 eV). Reasonable upper limits for $\Delta H_f{}^\circ{}_0(CH_2N_2)$ are discussed.

12368. Lawless, W. N., Radebaugh, R., Soulen, R. J., **Studies of a glass-ceramic capacitance thermometer btween 0.025 and 2.4 K,** *Rev. Sci. Instr.* **42,** No. 5, 567-570 (May 1971).

Key words: Capacitor; depolarization; dielectric; dilution refrigerator; glass ceramic; phase transition; strontium titanate; thermometer.

Capacitance measurements from 0.025 to 2.4 K are reported for capacitance thermometers (made from an $SrTiO_3$ glass-ceramic crystallized at 1100 and 1203 °C), two of which were the ones reported in the previous article. It was found that the 1200-type thermometer has a useful thermometric range down to 0.06 K and a linear C-T region down to 0.5 K. The 1100-type thermometer has a useful range down to 0.110 K and a linear region down to 1.1 K. The measured data do not appear to be influenced by self-heating or adiabatic correction effects. Both thermometers display an unexpected increase in capacitance with decreasing temperature below their monotonically decreasing ranges. The 1100-type thermometer displays the more pronounced increase, with $C \propto T^{-1}$ from 0.100 to 0.025 K. It is argued that this T^{-1} behavior is due to the onset of an ultralow temperature phase transition in the glass crystallized $SrTiO_3$, and the possibility of using this effect to achieve adiabatic depolarization cooling is discussed.

12369. Milligan, D. E., Jacox, M. E., **Infrared spectrum of the $BrHBr^-$ ion isolated in an argon matrix,** *J. Chem. Phys.* **55,** No. 5, 2550-2560 (Sept. 1, 1971).

Key words: Alkali metal reactions; $BrHBr^-$; charge transfer; $ClHCl^-$; electron attachment; infrared spectrum; matrix isolation; molecular rotation; vacuum-ultraviolet photolysis; vibrational potential function.

Infrared absorptions assigned to ν_3,$(\nu_3+\nu_1)$, and $(\nu_3+2\nu_1)$ of $BrHBr^-$ have been observed in samples of HBr in an argon matrix which have been subjected to 1216-Å photolysis or which have been co-deposited with an alkali metal atomic beam and then subjected to mercury-arc radiation. The corresponding experiments on deuterium-enriched samples support this identification. Mechanisms by which $BrHBr^-$ is produced in these experiments are considered in detail. An atomic mechanism leading to the stabilization of the uncharged species is shown to be inadequate. However, several ionic processes may contribute to the observed production of the anion. As previously postulated, dissociative electron attachment to $(HBr)_2$ may occur. In addition, it is necessary to postulate the production of Br^- by various charge-transfer processes, followed by the reaction of Br^- with HBr. Analysis of the infrared spectra of $BrHBr^-$ and of $BrDBr^-$ indicates that the vibrational potential function must include significant contributions from both cubic and quartic terms.

12370. Mountain, R. D., Raveché, H. J., **Entropy and molecular correlation functions in open systems. II. Two- and three-body correlations,** *J. Chem. Phys.* **55,** No. 5, 2250-2255 (Sept. 1, 1971).

Key words: Configuration entropy; correlation function; entropy; hard sphere; liquid state; neon; Percus-Yevick equation.

We consider the contributions from the correlation of pairs and triples of molecules to the configurational entropy per molecule of a simple fluid system. Using numerical values of the pair function and only certain moments of the triplet function, we have computed the first few terms in an expression for the entropy in terms of the correlation functions. The results, which compare favorably with experimental values over a range of densities including that of the liquid, indicate that the contributions from the correlations of triples of molecules can be appreciable. The computations are done for a fluid of hard spheres and liquid neon and the results are discussed in terms of the molecular correlations in a simple fluid.

12371. Page, C. H., **External field of an ideal toroid,** *Am. J. Phys.* **39,** No. 9, 1039-1043 (Sept. 1971).

Key words: Leakage flux; magnetic field; toroid; transformer; vector potential.

The external magnetic field of an ideal toroid vanishes for dc excitation but not for an ac excitation. The external static field has a nonvanishing vector potential; the emf in a transformer winding is due to the time variation of this vector potential. An expression for the external magnetic field is derived, and it is shown that the external flux density is a negligible fraction of the flux density in the core.

12372. Page, C. H., **On the external magnetic field of a closed-loop core,** *Am. J. Phys.* **39,** No. 10, 1206-1209 (Oct. 1971).

Key words: Magnetic field; solenoid; toroid; transformer; vector potential.

An infinite solenoid, or a toroidal coil, has no external magnetic field for dc excitation but has a nonvanishing vector potential field. The development of the steady-state condition from the transient response to step excitation is discussed. Under ac excitation, an external magnetic field must be present, but in practical cases its magnitude is negligible.

12373. Raveché, H. J., **Entropy and molecular correlation functions in open systems. I. Derivation,** *J. Chem. Phys.* **55,** No. 5, 2242-2250 (Sept. 1, 1971).

Key words: Activity derivatives; closed system; correlation functions; entropy; open system; potentials of mean force.

A method is presented for obtaining an expression for the entropy in terms of molecular correlation functions defined in the grand canonical ensemble. The procedure is for a system of a single molecular species whose dynamics are determined by classical equations of motion. The entropy is obtained as a sum of two different classes of functions each involving the correlations between n-tuples of molecules. One class contains logarithmic terms similar to those obtained for the closed system; the other class involves isothermal activity derivatives of potentials of mean force. The latter terms, which are moments of the correlations between disjoint sets of molecules, can make appreciable contributions to the entropy. The method leads to results similar to those obtained from a different procedure by Nettleton and Green. The expression for the entropy is obtained and properties of the results are discussed for a simple fluid system.

12374. Rubin, R. J., **Comment on "Conformation of adsorbed polymeric chain. II,"** *J. Chem. Phys.* **51,** No. 10, 4681 (Nov. 15, 1969).

Key words: Adsorption; chain polymer; lattice model; partition function; random walk.

There is an error in one of the results in a recent paper by Motomura and Matuura [K. Motomura and R. Matuura, Mem.

Fac. Sci., Kyushu University **6**, 97 (1968)]. The result in question, which concerns the mean square end-to-end separation of an adsorbed polymer chain, is quoted in a subsequent paper [K. Motomura and R. Matuura, J. Chem. Phys. **50**, 1281 (1969)]. In this Comment, the origin of the error is identified and the form of the correct result is indicated.

12375. Rubin, R. J., **Transmission properties of an isotopically disordered one-dimensional harmonic crystal. II. Solution of a functional equation,** *J. Math. Phys.* **11,** No. 6, 1857-1867 (June 1970).

Key words: Defects in harmonic crystal; functional equation; many-body problem; multiple scattering; statistical physics; transmission coefficient.

The amplitude of a wave of frequency ω which is transmitted by a disordered array of N isotopic defects in a 1-dimensional harmonic crystal is investigated in the limit $N \rightarrow \infty$. In particular, the ratio $\hat{T}_N(\omega)$ of the amplitude of the Nth defect to the amplitude of the first defect is represented as $\exp[-N\hat{\alpha}_N(\omega, Q, \{a_n\})]$, where $\{a_n\}$, $n=2, \cdots, N$, is the sequence of nearest-neighbor spacings and $Q=(M-m)/m$. It is known from earlier work that $\hat{\alpha}_N(\omega, Q, \{a_n\})$ is the logarithm of the Nth root of the magnitude of a continuant determinant of order N. The value of the continuant is expressed formally as a product of N factors $\hat{g}_n$ which are recursively related. In the present case, the $\hat{g}_n$ happen to lie on a circle K_0 in the complex $\hat{g}$ plane. Assuming that the spacings between defects are independent identically distributed random variables with the mean value c^{-1} and going to the limit $N \rightarrow \infty$, a functional equation for the limiting distribution function of the $\hat{g}_n$ on K_0 is derived. The limiting value $\alpha(\omega, Q, c) = \lim \hat{\alpha}_N(\omega, Q, \{a_n\})$, as $N \rightarrow \infty$, can be determined from the limiting distribution function of the $\hat{g}_n$. We determine the solution of the functional equation in three different ways for three different cases: (a) In the case of the special frequency of Matsuda, $\omega = 2^{-1/2}$ and $Q=1$, we obtain exact values of the integral of the $\hat{g}$ distribution function which are in excellent agreement with Monte Carlo estimates; (b) in the physically interesting case where the mean spacing between defects is small compared to the incident wavelength, i.e., $c^{-1}\omega \ll 1$, we obtain the solution of the functional equation correct to first order in $c^{-1}\omega$ and we calculate the lowest-order nonzero value of $\alpha(\omega, Q, c)$; (c) for the general case of moderate values of ω, Q, and c, we develop a numerical method for solving the functional equation and present the results of the numerical calculations in several representative cases. These numerical results are in good agreement with Monte Carlo estimates. One of the principal results, obtained by solving the functional equation, is that $\alpha(\omega, Q, c) > 0$ for $\omega \ll c < 1$ and $\omega(|Q| + c^{-1}) \ll 1$ with $Q \neq 0$.

12376. Rubin, R. J., Greer, W. L., **Abnormal lattice thermal conductivity of a one-dimensional, harmonic, isotopically disordered crystal,** *J. Math Phys.* **12,** No. 8, 1686-1701 (Aug. 1971).

Key words: Disordered one-dimensional crystal; multiple scattering; statistical physics; thermal conductivity; transport properties.

Energy transport is investigated in a model system for which exact analytic results can be obtained. The system is an infinite, one-dimensional harmonic crystal which is perfect everywhere except in a finite segment which contains N isotopic defects. Initially, the momenta and displacements of all atoms to the left of the defect region are canonically distributed at a temperature T, and the right half of the crystal is at a lower temperature. This initial nonequilibrium state evolves according to the equations of motion, and ultimately a steady state is established in the vicinity of the region containing the defects. The thermal conductivity is calculated from exact expressions for the steady state energy flux and thermal gradient. For a crystal in which the N isotopic defects are distributed at random but in which the overall defect concentration is fixed, we demonstrate that the thermal conductivity approaches infinity as least as fast as $N^{1/2}$. A Monte Carlo evaluation of the thermal conductivity for a given defect-to-host mass ratio and concentration is carried out for a series of random configurations of N defects for N in the range, $25 \leq N \leq 600$. The thermal conductivity is proportional to $N^{1/2}$ within the statistical uncertainty except for slight deviations at the smallest values of N.

12377. Saylor, C. P., **Return of the prodigal,** *Capital Chem.* **21,** No. 6, 95-99 (Sept. 1971).

Key words: Cathedral; deformation; lead; roof; Washington Cathedral; "1921."

The Washington Cathedral, built in the English style, was given a lead roof. Under the hot Washington sun, it crept. This caused it to leak. E. W. Washburn, Chief Chemist of NBS, diagnosed the difficulty and suggested correction. The events recounted in this article took place shortly after 1921.

12378. Shoup, R. R., VanderHart, D. L., **Effect of CH scalar coupling on ^{13}C transverse relaxation times,** *J. Am. Chem. Soc.* **93,** 2053-2054 (1971).

Key words: Fourier transform; nmr; relaxation; scalar coupling; sensitivity; ^{13}C.

Experimental ^{13}C NMR relaxation rates are reported for 60 percent enriched $^{13}CH_3I$, $^{13}CH_3COOCD_3$, and $^{13}CS_2$. Except for CS_2 transverse relaxation rates, R_{2C}'s, are found to be substantially higher than the corresponding longitudinal relaxation rates. This effect is shown, on the basis of the variation of R_{2C} with Carr-Purcell pulse repetition rate, to arise from scalar coupling of ^{13}C with relaxing protons. Implications for ^{13}C spectroscopy, particularly Fourier transform techniques, are discussed.

12379. Smith, J. C., Kermish, G. A., Fenstermaker, C. A., **Separation of filler particles from the matrix in a particulate-loaded composite subjected to tensile stress,** *Proc. 162nd Meeting American Chemical Society, Organic Coatings and Plastics Chemistry, Washington, D.C., Sept. 13-15, 1971,* **31,** No. 2, 149-155 (Sept. 1971).

Key words: Composite materials; coupling agents; epoxy polymer; parting agents; poisson's ratio; release agents; stress-strain curve; volume dilation.

Simultaneous measurements of tensile stress, longitudinal strain, and transverse strain were obtained on particulate-filled composites. The matrix was a flexible epoxy polymer. Small glass spheres were used as filler in various volume ratios up to .35. The spheres were pretreated as follows: clean, coated with a parting agent, coated with either of two silane coupling agents. The volume expansion behavior of composites containing parting agent treated spheres could readily be distinguished from that of composites containing clean glass spheres, but differences caused by coating the spheres with coupling agents could not be distinguished. Stress-strain behaviors for the various composite systems also showed differences. These differences in both kinds of data are taken as indicative of matrix-filler separation and subsequent vacuole formation.

12380. Tech, J. L., Ward, J. F., **Accurate wavelength measurement of the $1s2p3P°-2p^2\,{}^3P$ transition in ^{4}He I,** *Phys. Rev. Letters* **27,** No. 7, 367-370 (Aug. 16, 1971).

Key words: Atomic energy levels; atomic theory; autoionization; helium; wavelength measurement.

An accurate spectroscopic measurement has yielded 320.2926 ±0.0010 Å for the wavelength of the $1s2p\,{}^3P°-2p^2\,{}^3P$ transition in ^{4}He I. Combining this wavelength with the well-known position of the $1s2p$ term gives an experimental value of 481301.5 ± 1.2 cm^{-1} for the position of the doubly excited $2p^2\,{}^3P$ term relative to the ground $1s^2\,{}^1S$. The new measurement is in excellent agreement with Aashamar's theoretical calculation of 481301.6 cm^{-1} for the energy of the term.

5. INDEXES

5.1. HOW TO USE THE INDEXES

In addition to the usual author index, a subject index is provided in the form of a permuted key word index. In this type of index the key words in each publication or paper are arranged by shifting each group of key words along the horizontal printing line so that each key word in turn has an opportunity to appear alphabetically. The user is thus able to locate papers of interest to him through the subject-related words he finds in the key word index.

The index symbols used in the author and key word indexes are explained in the following three tables. These tables also give the pages on which the abstracts of the various publication series begin.

Table A. Symbols for the Periodicals

NBS Journal of Research	Index Symbol			Issue Date	Page Number
	Vol.	Sec.	No.		
Section A	J75	A	1	January–February 1971	23
	J75	A	2	March–April 1971	24
	J75	A	3	May–June 1971	24
	J75	A	4	July–August 1971	26
	J75	A	5	September–October 1971	27
	J75	A	6	November–December 1971	29
Section B	J75	B	1 & 2	January–June 1971	31
	J75	B	3 & 4	July–December 1971	32
Section C	J75	C	1	January–March 1971	34
	J75	C	2	April–June 1971	35
	J75	C	3 & 4	July–December 1971	36

Table B. Symbols for the Nonperiodicals

NBS Nonperiodical Series	Index Symbol	Page Number
Monographs	Monogr.	38
Handbooks	H	39
Special Publications	SP	40
Applied Mathematics Series	AMS	78
National Standard Reference Data Series	NSRDS	79
Building Science Series	BSS	80
Federal Information Processing Standards	FIPS PUBS	85
Product Standards	PS	87
Technical Notes	TN	90
Consumer Information Series	CIS	100

Table C. Symbols for the Papers Published By Others (1971)

NBS Papers Published by Others (1971)	Index Symbol	Page Number
Professional Journals, Book, Book Chapters, Proceedings, etc.	Five-Digit numbers, 11798 through 12380	101

5.2. AUTHOR INDEX

Beachler, J. C., *SP336*, pp. 893-904.
Bean, B. L., Park, S. G., Cunningham, F. G., *SP336*, pp. 345-358.
Beatty, R. W., Fentress, G. H., *12229*.
Beatty, R. W., Otoshi, T. Y., Stelzried, C. T., Yates, B. C., *11917*.
Beaty, E. C., Byerly, R. Jr., *12268*.
Becker, D. A., LaFleur, P. D., *12132*.
Beckett, C. W., Cezairliyan, A., McClure, J. L., Morse, M. S., *11871*.
Beckett, C. W., Cezairliyan, A., McClure, J. L., J.75A *No. 1, 1-13 (1971)*.
Beckett, C. W., Cezairliyan, A., Morse, M. S., *12231*.
Bedard, A. J. Jr., J.75C *No. 1, 41-45 (1971)*.
Beers, J. S., *TN579*.
Bell, F. C., Wollin, H. F., *SP342*.
Bell, P. M., Boyd, F. R. Jr., England, J. L., *SP326*, pp. 63-65.
Bellama, J. M., Ritter, J. J., Coyle, T. D., *12292*.
Ben-Abraham, S. I., *SP317*, pp. 943-962.
Ben-Abraham, S. I., *SP317*, pp. 999-1020.
Bender, P. L., Ward, J., Levine, J., Faller, J., Boyne, H. S., Hall, J. L., Barger, R. L., *11865*.
Benedict, W. S., Quinn, J. W., Dowling, J. A., Silverman, S., J.75A *No. 5, 469-479 (1971)*.
Benjamin, I. A., *12347*.
Bennett, H. S., Franklin, A. D., *TN565*.
Bennett, H. S., Franklin, A. D., *TN574*.
Bennett, H. S., Franklin, A. D., *TN703*.
Bennett, H. S., J.75A *No. 4, 247-260 (1971)*.
Bennett, H. S., J.75A *No. 4, 261-268 (1971)*.
Bennett, H. S., *11860*.
Bennett, H. S., *12133*.
Bennett, H. S., *12134*.
Bennett, H. S., *12265*.
Bennett, H. S., *12301*.
Bennett, L. H., Carter, G. C., Weisman, I. D., Watson, R. E., *12085*.
Bennett, L. H., Cuthill, J. R., Dobbyn, R. C., Carter, G. C., Kahan, D. J., *NBS-OSRDB-70-2 (COM-71-00722)*.
Bennett, L. H., Cuthill, J. R., Dobbyn, R. C., Carter, G. C., Kahan, D. J., *SP324*.
Bennett, L. H., Swartzendruber, L. J., Watson, R. E., *12199*.
Bennett, L. H., Swartzendruber, L. J., *11838*.
Berg, H. M., Bloom, J. E., Ishii, H., Marion, R. H., Pease, D. E., Spreng, D. T., Vander Sande, J. B., Weertman, J., *SP317*, pp. 71-82.
Berger, M. J., Seltzer, S. M., *11799*.
Berger, M. J., *11861*.
Bergstrom, J. C., Bertozzi, W., Kowalski, S., Maruyama, X. K., Lightbody, J. W. Jr., Fivozinsky, S. P., Penner, S., *11862*.
Berkeley, J. F., Ng, W., Young, J. P., Lamb, V. A., Reid, G. I., *11934*.
Berlin, G., Santone, L. C., *12018*.
Berry, P. L., Henderson, M., *12004*.
Bertozzi, W., Kowalski, S., Maruyama, X. K., Lightbody, J. W. Jr., Fivozinsky, S. P., Penner, S., Bergstrom, J. C., *11862*.
Bestul, A. B., Chang, S. S., J.75A *No. 2, 113-120 (1971)*.
Bestul, A. B., Chang, S. S., *12311*.
Bhat, V. N., Kapoor, S. F., J.75B *Nos. 1 and 2, 63-66 (1971)*.
Biedenharn, L. C., Mohan, R., Danos, M., *12287*.
Biedenharn, L. C., Mohan, R., Danos, M., *12114*.
Birky, M. M., *11939*.
Black, J. R., *SP337*, pp. 398-408.
Blackburn, J. H., Cowperthwaite, M., *SP326*, pp. 137-145.
Blado, L. D., Lilienkamp, R. H., *SP336*, pp. 141-150.
Blaha, F. C., Herman, D. S., White, M. H., *SP337*, pp. 365-374.
Blaine, R. L., Arni, H. T., *BSS35*.
Blaine, R. L., *11863*.
Blair, B. E., *SP350*.
Blaugher, R. D., Hein, R. E., Cox, J. E., Waterstrat, R. M., *11864*.
Block, S., Piermarini, G. J., Weir, C. E., *12025*.
Block, S., Weir, C. E., Piermarini, G. J., *11800*.
Block, S., Weir, C. E., Piermarini, G. J., *12187*.
Bloom, D. W., Finegold, L., Lye, R. G., Radebaugh, R., Siegwarth, J. D., *12266*.
Bloom, J. E., Ishii, H., Marion, R. H., Pease, D. E., Spreng, D. T., Vander Sande, J. B., Weertman, J., **Berg, H. M.**, *SP317*, pp. 71-82.
Blunt, R. F., Candela, G. A., Forman, R. A., Kahn, A. H., Mangum, B. W., *12348*.
Bogdanov, V. S., Levin, Yu. L., Sekoyan, S. S., Shmin, Yu. I., *SP326*, pp. 297-301.
Bohlander, R. A., Gebbie, H. A., Kuhn, P., *11885*.
Bollmann, W., *SP317*, pp. 465-477.
Bolz, L. H., Wiederhorn, S. M., *11992*.
Booker, S. R., Cassidy, E. C., Cones, H. N., *12306*.
Boone, T. H., Somes, N. F., Dikkers, R. D., *TN558*.
Boreni, R. J., Maddock, R. S., Meinke, W. W., Lutz, G. J., *TN467, Part 1*.
Boreni, R. J., Maddock, R. S., Meinke, W. W., Lutz, G. J., *TN467, Part 2*.
Borie, E., *11801*.
Borrego, J. M., Bakeman, P. E. Jr., *SP337*, pp. 184-191.
Bortner, M. H., Pikus, I. M., Cooper, A. M., Baurer, T., *SP336*, pp. 79-103.
Bosco, C. D., Zeto, R. J., Vanfleet, H. B., Hryckowian, E., *SP326*, pp. 25-33.
Botter, R., Rosenstock, H. M., *12118*.
Bowen, J. S., Dickens, B., J.75A *No. 1, 27-32 (1971)*.
Bowen, J. S., Dickens, B., J.75A *No. 3, 197-203 (1971)*.
Bowen, R. L., Argentar, H., *12302*.
Bowen, R. L., Paffenbarger, G. C., Chandler, H. H., *12232*.
Bowen, R. L., Paffenbarger, G. C., Chandler, H. H., *12233*.
Bowen, R. L., Paffenbarger, G. C., Chandler, H. H., *12308*.
Bowen, R. L., Paffenbarger, G. C., Chandler, H. H., *12309*.
Bowen, R. L., Paffenbarger, G. C., Chandler, H. H., *12310*.
Bowen, R. L., Paffenbarger, G. C., Mullineaux, A. L., Chandler, H. H., *11944*.
Bowen, R. L., Paffenbarger, G. C., Rupp, N. W., *12340*.
Bowen, R. L., *11802*.
Boyd, F. R. Jr., England, J. L., Bell, P. M., *SP326*, pp. 63-65.
Boyd, M. E., J.75A *No. 1, 57-89 (1971)*.
Boyd, M. E., Larsen, S. Y., *12303*.
Boyd, M. E., Mountain, R. D., *12061*.
Boyne, H. S., Hall, J. L., Barger, R. L., Bender, P. L., Ward, J., Levine, J., Faller, J., *11865*
Boyne, H. S., *12135*.
Brady, C. H., Ogburn, F., Shives, T. R., *12215*.
Brady, R. F. Jr., West, B. F., Tipson, R. S., *12121*.
Brady, R. F. Jr., *11866*.
Bramall, K. E., J.75C *Nos. 3 and 4, 181-186 (1971)*.
Branscomb, L. M., *11940*.
Branscomb, L. M., *11941*.
Brauer, G. M., Huget, E. F., Termini, D. J., *11996*.
Brauer, G. M., Huget, E. F., *12230*.
Brauer, G. M., *11798*.

Hall, J. T., Dixon, R. G., *12364*.
Haller, W., Simmons, J. H., Napolitano, A., *12238*.
Haller, W., Winogradoff, N. N., *12239*.
Haller, W. K., Simmons, J. H., Macedo, P. B., Napolitano, A., *12294*.
Halow, I., Bailey, S. M., Schumm, R. H., Churney, K. L., Wagman, D. D., Evans, W. H., Parker, V. B., *TN270-5*.
Hamer, W. J., *12037*.
Hammond, H. K. III, Mason, H. L., *SP300. Vol. 7*
Hammond, M. L., Cox, W. P., *SP337*, pp. 51-59.
Hanes, M. H., Simpson, J., Adams, A. C., *SP337*, pp. 87-98.
Hanley, H. J. M., Klein, M., *12162*.
Hanley, H. J. M., Roder, H. M., Diller, D. E., *11879*.
Hanneman, R. E., Strong, H. M., Bundy, F. P., *SP326*, pp. 53-61.
Hanson, D. W., Kamas, G., *12103*.
Harding, C. A., Parker, H. S., *12013*.
Hardy, J. R., Flocken, J. W., *SP317*, pp. 219-245.
Hardy, S. C., Coriell, S. R., *11889*.
Harman, G. G., Kessler, H. K., *TN573*.
Harris, F. K., Fowler. H. A., Olsen, P. T., *12067*.
Harris, R. K., Johannesen, R. B., Ferretti, J. A., *11897*.
Harris, W. F., *SP317*, pp. 579-592.
Hart, G. C., *BSS30*, pp. 145-149.
Hartley, C. S., Eisenberg, M. A., *SP317*, pp. 925-941.
Hartman, J. K., Rhodin, T. N., Gadzuk, J. W., *12317*.
Harvey, J. L., Milliken L. T., Forthofer, R. J., *12038*.
Harvey, J. L., Radlinski, R. W., Forthofer, R. J., *12052*.
Harvey, W. L., *SP336*, pp. 473-485.
Hastie, J. W., Hauge, R. H., Margrave, J. L., *12281*.
Hastie, J. W., Hauge, R. H., Margrave, J. L., *11961*.
Hastie, J. W., Hauge, R. H., Margrave, J. L., *12157*.
Hastie, J. W., *12280*.
Hastings, J. R., Chen, W. T., Waxman, M., *11932*.
Hastings, J. R., Waxman, M., **J.75C** *No. 2, 79-83 (1971)*.
Hastings, J. R., Waxman, M., **J.75C** *Nos. 3 and 4, 163-172 (1971)*.
Hatos, S. L., *SP345-3*.
Hauge, R. H., Margrave, J. L., Hastie, J. W., *12281*.
Hauge, R. H., Margrave, J. L., Hastie, J. W., *11961*.
Hauge, R. H., Margrave, J. L., Hastie, J. W., *12157*.
Haupt, G. W., *TN564*.
Haygarth, J. C., Luedemann, H. D., Getting, I. C., Kennedy, G. C., *SP326*, pp. 35-37.
Hayward, E., Schwartz, R. B., Murray, K. M., *11890*.
Head, A. K., *SP317*, pp. 5-9.
Healey, D. J., Leeson, D. B., McGunigal, T. E., Mullen, J. A. Jr., Smith, W. L., Sydnor, R. L., Vessot, R. F. C., Winkler, G. M. R., Barnes, J. A., Chi, A. R., Cutler, L. S., *12228*.
Hearst, P. J., *SP336*, pp. 299-312.
Hein, R. E., Cox, J. E., Waterstrat, R. M., Blaugher, R. D., *11864*.
Heinrich, K. F. J., French, B. M., Walter, L. S., *11958*.
Heinrich, K. F. J., Goldstein, J. I., Adler, I., Walter, L. S., Lowman, P. D., Glass, B. P., French, B. M., Philpotts, J. A., *11995*.
Heinrich, K. F. J., Myklebust, R. L., Rasberry, S. D., Michaelis, R. E., *SP260-28*.
Heinrich, K. F. J., Myklebust, R. L., *12251*.
Hellner, L., Sieck, L. W., **J.75A** *No. 5, 487-493 (1971)*.
Hellwig, H., Allan, D. W., Glaze, D. J., Vessot, R. F. C., Levin, M., Zitzewitz, P. W., Peters, H. E., *11892*.
Hellwig, H., Barnes, J. A., Glaze, D. J., *12365*.
Hellwig, H., Vessot, R. F. C., Levine, M. W., Zitzewitz, P. W., Allan, D. W., Glaze, D. J., *12069*.
Hellwig, H., *11891*.
Hellwig, H., *12068*.
Hellwig, H., *12099*.
Henderson, E. P., Yakowitz, H., Goldstein, J. I., *11810*.
Henderson, G. A., Frattali, S., *NBS-OSRDB-70-3 (AD705110)*.
Henderson, M., Berry, P. L., *12004*.
Henniger, J. H., Donohoe, M. J., McIntosh, R. Jr., *SP336*, pp. 383-392.
Herman, D. S., White, M. H., Blaha, F. C., *SP337*, pp. 365-374.
Herron, J. T., Huie, R. E., *12158*.
Heuer, A. H., Hockey, B. J., Wiederhorn, S. M., *12282*.
Hexter, R. M., Maki, A. G., *11973*.
Heydemann, P. L. M., Houck, J. C., **J.75A** *No. 2, 121-127 (1971)*.
Heydemann, P. L. M., Houck, J. C., *SP326*, pp. 11-22.
Heydemann, P. L. M., *12039*.
Heydemann, P. L. M., *12322*.
Hicho, G. E., Yakowitz, H., Rasberry, S. D., Michaelis, R. E., *SP260-25*.
Hikata, A., Elbaum, C., *SP317*, pp. 1291-1292.
Hikata, A., Elbaum, C., *SP317*, pp. 427-445.
Hillberg, L. H., *SP336*, pp. 837-851.
Hirsch, P. B., Duesbery, M. S., *SP317*, pp. 1115-1134.
Hirsch, P. B., Humphreys, F. J., Foreman, A. J. E., *SP317*, pp. 1083-1098.
Hirshfeld, A. T., Hoppes, D. D., *12005*.
Hirshfield, J. J., Wannemacher, H. E., Eck, M., Newman, P. A., *SP336*, pp. 935-947.
Hirth, J. P., *SP317*, pp. 683-685.
Hiza, M. J., Duncan, A. G., *11962*.
Hiza, M. J., Kidnay, A. J., *11898*.
Hiza, M. J., Kidnay, A. J., *12160*.
Hobart, R., *SP317*, pp. 1157-1161.
Hockey, B. J., Wiederhorn, S. M., Heuer, A. H., *12282*.
Hoer, C., Agy, D., *11893*.
Hoer, C. A., Agy, D. L., *12070*.
Hoeve, C. A. J., *12240*.
Hogben, D., Peavy, S. T., Varner, R. N., *TN552*.
Hogben, D., Peavy, S. T., Varner, R. N., *SP339*.
Holder, J., Granato, A. V., *SP317*, pp. 1223-1225.
Hollister, S. C., *BSS30*, pp. 151-164.
Holmes, R. R., Elbaum, C., *SP317*, pp. 1293-1302.
Holt, A. C., Grover, R., *SP326*, pp. 131-135.
Holt, H. K., *11811*.
Hölzler, A., Siems, R., *SP317*, pp. 291-298.
Homan, D. N., Zapf, T. L., *11894*.
Hoppes, D. D., Hirshfeld, A. T., *12005*.
Hord, J., Voth, R. O., *TN397*.
Horn, W. A., **J.75B** *Nos. 1 and 2, 49-61 (1971)*.
Horowitz, D., Feldman, A., Brower, W. S. Jr., *11807*.
Hosler, W. R., Chang, T-T., Cohen, M. I., *12312*.
Hosler, W. R., *11812*.
Houck, J. C., Heydemann, P. L. M., **J.75A** *No. 2, 121-127 (1971)*.
Houck, J. C., Heydemann, P. L. M., *SP326*, pp. 11-22.
Hougen, J. T., Creutzberg, F., *12313*.
Hougen, J. T., Redding, R. W., *12117*.
Hougen, J. T., *12323*.
Howard, J. K., Joshi, M. L., *SP337*, pp. 313-364.
Howett, G. L., *11813*.
Hryckowian, E., Bosco, C. D., Zeto, R. J., Vanfleet, H. B., *SP326*, pp. 25-33.
Hsi, G., Cermak, J. E., Sadeh, W. Z., *BSS30*, pp. 45-59.
Hubbell, J. H., *11814*.
Hudson, R. D., Kieffer, L. J., *NBS-OSRDB-70-4 (COM-71-00025)*.
Hudson, R. D., Kieffer, L. J., *12210*.
Hudson, R. D., *NSRDS-NBS38*.
Hudson, R. P., *11963*.
Huffman, G. P., Louat, N., *SP317*, pp. 1303-1322.
Huget, E. F., Brauer, G. M., *12230*.
Huget, E. F., Termini, D. J., Brauer, G. M., *11996*.

Taylor, J. K., Schmidt, W. E., Champion, E. C., Marinenko, G., *11872*.
Tech, J. L., *Monogr. 119*.
Tech, J. L., Ward, J. F., *12380*.
Teodosiu, C., Seeger, A., *SP317*, pp. 877-905.
Teodosiu, C., *SP317*, pp. 837-876.
Termini, D. J., Brauer, G. M., Huget, E. F., *11996*.
Teske, R. G., Wilkinson, C. W., Linsky, J. L., *12248*.
Thom, H. C. S., Dikkers, R. D., Marshall, R. D., *TN569*.
Thomas, A. M., *11931*.
Thomas, D. G., *SP337*, pp. 3-10.
Thomas, R. N., Gebbie, K. B., *12097*.
Thomas, R. N., Gebbie, K. B., *12360*.
Thomas, R. N., Pecker, J. C., *12171*.
Thompson, B. A., Gills, T. E., Marlow, W. F., *12000*.
Thompson, B. A., Miller, E. C., *J.* **75A** *No. 5, 429-433 (1971)*.
Thompson, K. R., Abramowitz, S., Acquista N., *12262*.
Thompson, R. C., Garbanati, L. F., *J.* **75B** *Nos. 3 and 4, 117-124 (1971)*.
Thomsen, L., Anderson, O. L., *SP326*, pp. 209-217.
Thomson, R. M., *SP317*, pp. 1279-1288.
Thomson, R. M., *SP317*, pp. 563-576.
Thornton, D. D., Colwell, J. H., Mangum, B. W., *12202*.
Thornton, D. D., Mangum, B. W., *12046*.
Thornton, D. D., Wright, J. C., Moos, H. W., Colwell, J. H., Mangum, B. W., *12126*.
Thurber, W. R., *TN570*.
Tighe, N. J., *12083*.
Tilford, S. G., Simmons, J. D., *J.* **75A** *No. 5, 455-467 (1971)*.
Timmerhaus, K. D., Prydz, R., Straty, G. C., *11980*.
Tipson, R. S., Brady, R. F. Jr., West, B. F., *12121*.
Tjon, J. A., Gibson, B. F., O'Connell, J. S., *12056*.
Tompa, H., Bullough, R., Englert, A., *SP317*, pp. 273-283
Townsend, P. R., Wiederhorn, S. M., *11993*.
Traub, R. D., *J.* **75B** *Nos. 3 and 4, 139-148 (1971)*.
Travis, J. C., Pella, P. A., DeVoe, J. R., Spijkerman, J. J., *TN541*.
Treat, C. F., *SP345-10*.
Triplett, M. J., Riggs, W. E., *SP336*, p. 749.
Tsai, D. H., Bullough, R., Perrin, R. C., *12022*.
Tsai, D. H., *SP326*, pp. 105-122.
Tsang, W., Wasik, S. P., *12023*.
Tsang, W., Wasik, S. P., *12024*.
Tsunoda, R., Nakagawa, H., *SP336*, pp. 683-698.
Tucker, M. O., *SP317*, pp. 163-171.
Tucker, R. N., *SP337*, p. 223.

U

Ugiansky, G. M., Skolnick, L. P., Stiefel, S. W., *11839*.
Umansky, S. V., Evlanov, E. N., Leonas, V. B., *SP336*, pp. 189-196.
Utton, D. B., *12258*.
Uzgiris, E. E., Hall, J. L., Barger, R. L., *12179*.

V

Vadelund, E. A., *12259*.
Valentine, D. R., Lamb, V. A., Johnson, C. E., *12041*.
Van Blerkom, D., Hummer, D. G., *12180*.
Van Brunt, R. J., Kieffer, L. J., *12057*.
Van Brunt, R. J., Kieffer, L. J., *12058*.
van Gelder, W., Jones, T. D., Langer, P., Niehaus, W. C., *SP337*, pp. 256-272.
van Lint, V. A. J., Flanagan, T. M., *SP336*, pp. 525-534.
van Thiel, M., Kusubov, A., *SP326*, pp. 125-130.
VanderHart, D. L., Shoup, R. R., *12378*.
Vander Sande, J. B., Weertman, J., Berg, H. M., Bloom, J. E., Ishii, H., Marion, R. H., Pease, D. E., Spreng, D. T., *SP317*, pp. 71-82.
Vanfleet, H. B., Hryckowian, E., Bosco, C. D., Zeto, R. J., *SP326*, pp. 25-33.
Varner, R. N., Hogben, D., Peavy, S. T., *TN552*.
Varner, R. N., Hogben, D., Peavy, S. T., *SP339*.
Varner, R. N., Peavy, S. T., *TN551*.
Vaughan, W. W., Fichtl, G. H., Kaufman, J. W., *BSS30*, pp. 27-41.
Vedam, K., *SP326*, pp. 39-43.
Vellozzi, J., Cohen, E., *BSS30*, pp. 115-128.
Vessot, R. F. C., Levin, M., Zitzewitz, P. W., Peters, H. E., Hellwig, H., Allan, D. W., Glaze, D. J., *11892*.
Vessot, R. F. C., Levine, M., Risley, A. S., Allan, D. W., Gray, J. E., Shoaf, J. H., Machlan, H. E., Glaze, D. J., Peters, H. E., Johnson, E. H., *11922*.
Vessot, R. F. C., Levine, M. W., Zitzewitz, P. W., Allan, D. W., Glaze, D. J., Hellwig, H., *12069*.
Vessot, R. F. C., Winkler, G. M. R., Barnes, J. A., Chi, A. R., Cutler, L. S., Healey, D. J., Leeson, D. B., McGunigal, T. E., Mullen, J. A. Jr., Smith, W. L., Sydnor, R. L., *12228*.
Vezzetti, C. F., Cohen, J., Edelman, S., *12352*.
Vicentini-Missoni, M., Sengers, J. M. H. L., Straub, J., *12341*.
Vickery, B. J., *BSS30*, pp. 93-104.
Vidal, C. R., Cooper, J., Smith, E. W., *12222*.
Vidal, C. R., Cooper, J., Smith, E. W., *12084*.
Vidal, C. R., Cooper, J., Smith, E. W., *Monogr. 120*.
Vidal, C. R., Smith, E. W., Cooper, J., Godfrey, J. T., *12208*.
Vidal, C. R., Smith, E. W., Cooper, J., Godfrey, J. T. *Monogr. 121*.
Vieweg-Gutberlet, F. G., *SP337*, pp. 409-411.
Viezbicke, P. P., *SP236, 1971 Edition*.
Vigoureux, P., Page, C. H., *SP330*.
Vizir, V., Roddan, A., *SP337*, pp. 302-312.
Vodar, B., Leger, J. M., Susse, C., *SP326*, pp. 251-256.
Voigt, P. A., Roberts, J. R., *J.* **75A** *No. 4, 291-333 (1971)*.
Voth, R. O., Hord, J., *TN397*.

W

Wachtman, J. B. Jr., Dickson, R. W., *J.* **75A** *No. 3, 155-162 (1971)*.
Wachtman, J. B. Jr., *12181*.
Wacker, P. F., Kerns, D. M., Baird, R. C., Newell, A. C., *11856*.
Wagman, D. D., Evans, W. H., Parker, V. B., *TN270-6*.
Wagman, D. D., Evans, W. H., Parker, V. B., Halow, I., Bailey, S. M., Schumm, R. H., Churney, K. L., *TN270-5*.
Wahl, A. C., Krauss, M., Maldonado, P., *12326*.
Waisman, A. M., Kunin, I. A., *SP317*, pp. 747-759.
Wait, D. F., *12182*.
Wakabayashi, I., Minomura, S., Nagasaki, H., *SP326*, pp. 159-165.
Walberg, G. D., Sullivan, E. M., *SP336*, pp. 751-812.
Walker, J. A., McCulloh, K. E., Dibeler, V. H., *12064*.
Wall, L. A., Brown, D. W., Lowry, R. E., *11868*.
Wall, L. A., Brown, D. W., Lowry, R. E., *12089*.
Wall, L. A., Florin, R. E., *11955*.
Wall, L. A., Flynn, J. H., Straus, S., *11840*.
Wallace, B., Brown, W. E., *12183*.
Wallace, G. H., Clark, A. F., Childs, G. E., *11873*.
Walter, L. S., Heinrich, K. F. J., French, B. M., *11958*.
Walter, L. S., Lowman, P. D., Glass, B. P., French, B. M., Philpotts, J. A., Heinrich, K. F. J., Goldstein, J. I., Adler, I., *11995*.
Walther, H., Hall, J. L., *12122*.
Wampler, R. H., *12184*.
Wang, C. C., *SP317*, pp. 907-924.

Wang, P., Pink, F. X., Gupta, D. C., *SP337*, pp. 285-301.
Wannemacher, H. E., Eck, M., Newman, P. A., Hirshfield, J. J., *SP336*, pp. 935-947.
Wappaus, W. A., *SP336*, pp. 393-402.
Ward, J., Levine, J., Faller, J., Boyne, H. S., Hall, J. L., Barger, R. L., Bender, P. L., *11865*.
Ward, J. F., Tech, J. L., *12380*.
Waring, J. L., Parker, H. S., Roth, R. S., *12017*.
Wasik, S. P., Tsang, W., *12023*.
Wasik, S. P., Tsang, W., *12024*.
Waters, H. P., Armstrong, R. W., *11850*.
Waters, H. P., Stapp, J. P., Armstrong, R. W., *11851*.
Waterstrat, R. M., Blaugher, R. D., Hein, R. E., Cox, J. E., *11864*.
Waterstrat, R. M., Rowland, T. J., Darby, J. B. Jr., Bardos, D. I., *12300*.
Watson, R. E., Bennett, L. H., Carter, G. C., Weisman, I. D., *12085*.
Watson, R. E., Bennett, L. H., Swartzendruber, L. J., *12199*.
Waxler, R. M., Cleek, G. W., **J.75A** *No. 4, 279-281 (1971)*.
Waxler, R. M., Cleek, G. W., Malitson, I. H., Dodge, M. J., Hahn, T. A., **J.75A** *No. 3, 163-174 (1971)*.
Waxler, R. M., *12223*.
Waxman, M., Hastings, J. R., Chen, W. T., *11932*.
Waxman, M., Hastings, J. R., **J.75C** *No. 2, 79-83 (1971)*.
Waxman, M., Hastings, J. R., **J.75C** *Nos. 3 and 4, 163-172 (1971)*.
Weaver, J. S., *SP326*, pp. 325-329.
Weaver, J. S., Takahashi, T., Bassett, W. A., *SP326*, pp. 189-199.
Weber, L. A., McCarty, R. D., *TN384*.
Weber, L. A., *12185*.
Weber, L. A., *12186*.
Weber, M. J., Cleek, G., Sharp, E. J., *11831*.
Weertman, J., Berg, H. M., Bloom, J. E., Ishii, H., Marion, R. H., Pease, D. E., Spreng, D. T., Vander Sande, J. B., *SP317*, pp. 71-82.
Weertman, J., Parameswaran, V. R., *SP336*, pp. 487-508.
Weichbrodt, B., Smith, K. A., *SP336*, pp. 407-448.
Weiner, J. H., *SP317*, pp. 403-414.
Weir, C. E., Block, S., Piermarini, G. J., *12025*.
Weir, C. E., Piermarini, G. J., Block, S., *11800*.
Weir, C. E., Piermarini, G. J., Block, S., *12187*.
Weisman, I. D., Watson, R. E., Bennett, L. H., Carter, G. C., *12085*.
Weiss, A. W., *12086*.
Weiss, A. W., *12123*.
Weiss, B. Z., Meyerson, M. R., *12087*.
Weiss, M. J., Kuyatt, C. E., Mielczarek, S., *12224*.
Weiss, M. J., Mielczarek, S. R., Kuyatt, C. E., *12225*.
Weissler, P. G., *12260*.
Weitzel, D. H., Powell, R. L., Hust, J. G., **J.75A** *No. 4, 269-277 (1971)*.
Wells, J. S., Cupp, J. D., McDonald, D. G., Evenson, K. M., *12166*.
Wells, J. S., Evenson, K. M., Matarrese, L. M., Jennings, D. A., Wichman, G. L., *TN395*.
Wells, J. S., Matarrese, L. M., Jennings, D. A., Evenson, K. M., *12207*.
Wells, J. S., Radford, H. E., Evenson, K. M., *11954*.
Wentorf, R. H. Jr., *SP326*, pp. 81-89.
West, B. F., Tipson, R. S., Brady, R. F. Jr., *12121*.
West, E. D., Churney, K. L., *11841*.
West, E. D., Jennings, D. A., *11896*.
West, E. D., *TN396*.
Westley, F., *NBS-OSRDB-71-2 (COM-71-00841)*.
Westwood, A. R. C., Latanision, R. M., *11972*.
Wexler, A., Greenspan, L., **J.75A** *No. 3, 213-230 (1971)*.
Wexler, A., *11991*.
White, H. S. Jr., *FIPS PUB 13*.
White, H. S. Jr., *FIPS PUB 14*.
White, H. S. Jr., *FIPS PUB 15*.
White, H. S. Jr., *FIPS PUB 16*.
White, H. S. Jr., *FIPS PUB 17*.
White, H. S. Jr., *FIPS PUB 18*.
White, H. S. Jr., *FIPS PUB 19*.
White, H. S. Jr., *FIPS PUB 8-1*.
White, H. S., Kearsley, E. A., *J.* **75A** *No. 6, 541-551 (1971)*.
White, M. H., Blaha, F. C., Herman, D. S., *SP337*, pp. 365-374.
Wichman, G. L., Wells, J. S., Evenson, K. M., Matarrese, L. M., Jennings, D. A., *TN395*.
Wiederhorn, S. M., Bolz, L. H., *11992*.
Wiederhorn, S. M., Heuer, A. H., Hockey, B. J., *12282*.
Wiederhorn, S. M., Johnson, H., *12188*.
Wiederhorn, S. M., Townsend, P. R., *11993*.
Wiese, W. L., Bridges, J. M., *11867*.
Wiese, W. L., Fuhr, J. R., *SP320. Suppl. 1*.
Wiese, W. L., Kelleher, D. E., *12226*.
Wiese, W. L., *12124*.
Wilkens, M., *SP317*, pp. 1191-1193.
Wilkens, M., *SP317*, pp. 1195-1221.
Wilkinson, C. W., Linsky, J. L., Teske, R. G., *12248*.
Willard, W. A., Rukwied, A., Ruff, A. W., *12339*.
Williams, C. W., McClure, C. M., *SP336*, pp. 623-649.
Williams, E. S., **J.75C** *Nos. 3 and 4, 145-153 (1971)*.
Williams, H. T., Gibson, B. F., *12279*.
Williams, M. L., Cuthill, J. R., McAlister, A. J., Dobbyn, R. C., *11952*.
Wilson, L. B., *SP335*, pp. 85-88.
Wilson, W. K., Fletcher, D. G., *11842*.
Winkler, E. M., Humphrey, R. L., Madden, M. T., Koenig, J. A., *SP336*, pp. 853-877.
Winkler, E. M., Madden, M. T., Humphrey, R. L., Koenig, J. A., *SP336*, pp. 813-835.
Winkler, G. M. R., Barnes, J. A., Chi, A. R., Cutter, L. S., Healey, D. J., Leeson, D. B., McGunigal, T. E., Mullen, J. A. Jr., Smith, W. L., Sydnor, R. L., Vessot, R. F. C., *12228*.
Winnewisser, G., Maki, A. G., Johnson, D. R., *12342*.
Winogradoff, N. N., Haller, W., *12239*.
Winogradoff, N. N., Osinsky, V. I., *12216*.
Winogradoff, N. N., Osinsky, V. I., *12343*.
Wisnieff, S., Bardach, H., *SP335*, pp. 11-21.
Woelfel, J. B., Paffenbarger, G. C., *12189*.
Wolcott, N. M., Falge, R. L. Jr., *11843*.
Wolff, C. M., Ritter, M. L., *SP336*, pp. 25-49.
Wollin, H. F., *H44*.
Wollin, H. F., Bell, F. C., *SP342*.
Wong, C. Y., Marshak, H., Langsford, A., Tamura, T., *12007*.
Wood, B. E., Smith, A. M., Seiber, B. A., Roux, J. A., *SP336*, pp. 165-183.
Wood, S. D., Evans, J. P., *12354*.
Woolf, A. R., Hunt, C. M., *11895*.
Woolley, R. M., Fisher, C. R., Mitchell, R. A., **J.75C** *Nos. 3 and 4, 155-161 (1971)*.
Wright, J. C., Moos, H. W., Colwell, J. H., Mangum, B. W., Thornton, D. D., *12126*.
Wright, J. R., *SP334*.

Y

Yakowitz, H., Ballard, D., *12060*.
Yakowitz, H., Fiori, C. E., Michaelis, R. E., *SP260-22*.
Yakowitz, H., Goldstein, J. I., Ballard, D. B., *12131*.
Yakowitz, H., Goldstein, J. I., Henderson, E. P., *11810*.
Yakowitz, H., Munro, E., Nixon, W. C., Ballantyne, J. P., *12346*.
Yakowitz, H., Rasberry, S. D., Michaelis, R. E., Hicho, G. E., *SP260-25*.

5.3. KEY WORD INDEX

lines; Ionization in stars; Oscillator strengths; Temperature in stars; Turbulence in stars; *Monogr. 119.*

α-Ca$_3$(PO$_4$)$_2$; Calcium magnesium phosphate; Single crystal x-ray diffraction; Cation vacancies; Glaserite; *12274.*

Accelerated testing; Cumulative damage; Failure; Life testing; Mechanical reliability; *SP336*, pp. 457-471.

Acceleration (mechanical); Biodynamics; Biomechanics; Human engineering; Kinematics; Occupant restraint systems; Seat; Seat belts; *11851.*

Acceleration response; Evaluation; Fatigue life; Lumped parameter system; Mechanical impedance; Random vibration; Test; Transfer impedance; Transmissivity equalization; Vibration; *SP336*, pp. 509-524.

Accelerators; Amines; Color-stable composites; Methacrylates; Polymerization; Resins; Synthesis; *12302.*

Accelerometer round robin; Computer program for Youden diagrams; Correlation effect; End standard of length; *SP335*, pp. 39-40.

Accuracy; Algorithms; ANSI FORTRAN; Documentation; Error checking; Machine independent; OMNITAB II operating system subprograms; OMNITAB II source listing; Programming techniques; Transportable; User-oriented computing system; *SP339.*

Accuracy; ANSI FORTRAN; Computer system implementation; Examples; OMNITAB II; Software; Test problems; *TN551.*

Accuracy; Atomic absorption; Detection limits; Differential method; Flame emission; Nonaqueous media; Precision; Sensitivity; Tables; *12111.*

Accuracy; Circumvention; Emulsions; Homogeneity; Ions; Mass; Platinum; Precision; Replicate; Spark; Spectrometry; *11847.*

Accuracy of viscosity measurement; Calibration of viscometers; Viscosity; Uncertainty of viscosity measurements; Absolute measurement of viscosity; **J.75A** *No. 6, 535-540 (1971).*

Accuracy statement; Cryogenic; Flow facility; Liquid nitrogen; Measurement; *TN606.*

Accurate; Calibration; Directional coupler; High power; Measurement; Microwave; **J.75C** *Nos. 3 and 4, 181-186 (1971).*

Accurate analysis; Boric acid; Coulometric titration; High-precision acidimetry; High precision coulometer; **J.75A** *No. 5, 421-428 (1971).*

Accurate frequency standards; Accurate length standards; Accurate time standards; Accurate voltage standards; Ion storage; Laser stabilization; Maser oscillator; Metrology; Quantum electronics; Saturated absorption; Slave oscillators; *12099.*

Accurate length standards; Accurate time standards; Accurate voltage standards; Ion storage; Laser stabilization; Maser oscillator; Metrology; Quantum electronics; Saturated absorption; Slave oscillators; Accurate frequency standards; *12099.*

Accurate measurement; Equation-of-state; Fixed points; High pressure; High-pressure equipment; Instrumentation; Pressure scale; Shock wave technique; Temperature; *SP326.*

Accurate measurements of volume of liquids; Field standard measuring flasks; Specification; Tolerances; Weights and measures inspection; *H105-2.*

Accurate measurements of volumes; Field standard; Metal volumetric field standards; Provers; Specifications; Test measures; Tolerances; Weights and measures inspection; *H105-3.*

Accurate time standards; Accurate voltage standards; Ion storage; Laser stabilization; Maser oscillator; Metrology; Quantum electronics; Saturated absorption; Slave oscillators; Accurate frequency standards; Accurate length standards; *12099.*

Accurate voltage standards; Ion storage; Laser stabilization; Maser oscillator; Metrology; Quantum electronics; Saturated absorption; Slave oscillators; Accurate frequency standards; Accurate length standards; Accurate time standards; *12099.*

AC-DC difference; Comparator; Thermoelement; Transfer voltmeter, voltage measurements; **J.75C** *Nos. 3 and 4, 145-153 (1971).*

Acetals; Fructose; Ketoses; Oxidation; Psicose; Reduction; Ruthenium tetraoxide; Sodium borohydride; *12121.*

Achromatic; Appearance; Brightness; Chromatic adaptation; Chromaticity; Color; Least squares; Luminance; Model; Neutral; Perception; Vision; *11813.*

Acid resistance; Color; Gloss; Porcelain enamel; Weather resistance; *BSS38.*

Acid-base behavior; Acidity and basicity scales; Aprotic organic solvents; Hydrogen bonding; Titrations; *11997.*

Acidity and basicity scales; Aprotic organic solvents; Hydrogen bonding; Titrations; Acid-base behavior; *11997.*

Acoustic thermometry; Equation of state; Equilibrium gas properties; Helium; Second virial coefficient; Speed of sound in gases; *12061.*

Acoustical pulse; Longitudinal and shear sound waves; Solids sound speed accuracy; Speed of sound; Transient pulse-acoustical; **J.75C** *No. 1, 33-40 (1971).*

Acoustics; Noise measurement; Noise pollution; Noise (sound); Sound transmission; Tires; Transportation noise; Trucks; Urban planning; *12329.*

Acousto-optic modulator; Flashlamp-pumped dye laser; Mode-locking; Subnanosecond pulses; *TN603.*

Acrylic; Contraction; Dentures; Epoxy; Expansion; Hard rubber; Retention; Serviceability; Stability; Adaption; *12189.*

Acrylic teeth; Adhesion; Autoadhesion; Bonding; Cold-curing methyl methacrylate; Dentures; Tensile strength; *12340.*

Activation analysis; Al$_2$O$_3$; Interfering reactions; Laser; Nondestructive analysis; Ruby; Trace elements; **J.75A** *No. 5, 429-433 (1971).*

Activation analysis; Bibliography; Element determined; Literature file; Matrix analyzed; Technique used; *TN467, Part 1.*

Activation analysis; Bibliography; Element determined; Literature file; Matrix analyzed; Technique used; *TN467, Part 2.*

Activation analysis; Biological; Botanical; Environment; Standard Reference Material; *12334.*

Activation analysis; Component identification; Result computation; Spectral resolution; *12344.*

Activation analysis; Concentrated alloys; Correlation factor; Diffusion; Random alloy; Vacancies; *12167.*

Activation analysis; Glass; Hydrated antimony pentoxide (HAP); Radiochemical separations; Sodium; Trace elements; *12000.*

Activation analysis; Nuclear interferences; Trace oxygen; *11914.*

Activation energy; Configuration interaction; Correlation energy surface; Hartree-Fock; H$_3^+$; H$_3$; H$_3^-$; H$_4$; LiH$_2$; LiHF; HNO; HeH$_2^+$; Proton transfer; *11969.*

Activation energy; Cross slip; Mechanical properties; Misfit strain; Precipitation hardening; *SP317*, pp. 1115-1134.

Activation energy; Fluorescence; H atom; Propylene; Reaction kinetics; Absolute rate constant; *12212.*

Activation energy; H atoms; H$_2$S; Rate constant; Resonance fluorescence; Vacuum-uv; *12074.*

Activity coefficients; Activity scales of high concentrations; Activity standard scales; Chloride activity convention; Ion activity standards; Ionic activity; Ion selective electrodes; Single ion; *11859.*

Activity derivatives; Closed system; Correlation functions; Entropy; Open system; Potentials of mean force; *12373.*

Activity scales of high concentrations; Activity standard scales; Chloride activity convention; Ion activity standards; Ionic activity; Ion selective electrodes; Single ion; Activity coefficients; *11859.*

Activity standard scales; Chloride activity convention; Ion activity standards; Ionic activity; Ion selective electrodes; Single ion; Activity coefficients; Activity scales of high concentrations; *11859.*

Adaption; Acrylic; Contraction; Dentures; Epoxy; Expansion; Hard rubber; Retention; Serviceability; Stability; *12189.*

Adaptor; Connector; Efficiency; Sliding short; **J.75C** *Nos. 3 and 4, 173-180 (1971).*

Adherence; Aluminum; Electron microprobe; Electron microscope; Interaction zone; *12130.*

Adherence; Instrumental evaluation; Porcelain enamel direct-to-steel; *12138.*

Adhesion; Autoadhesion; Bonding; Cold-curing methyl methacrylate; Dentures; Tensile strength; Acrylic teeth; *12340.*

Adhesion; Basalt; Fiberglass; Friction; Steel; Titanium; Ultrahigh vacuum; *SP336,* pp. 225-244.

Adiabatic saturation; Dew point temperature; Humidity; Hygrometer; Mixing ratio; Moist gas; Psychrometer; Vapor pressure; **J.75C** *No. 2, 69-78 (1971).*

Adsorbed atomic layers; Cesium; Inelastic-electron scattering; Metal-insulator transition; Plasmon energy losses; Tungsten; *11920.*

Adsorbed water; Calorimetry; Collagen; Frozen collagen; Mobile water; NMR; *11998.*

Adsorbent-reaction; Adsorption; Heat transfer; Isotherm; Kinetics; Mass transfer; *11898.*

Adsorption; Amorphour; Free-radical; Ionic; Manganese dioxide; Polycrystalline; Structure; Surface; *12314.*

Adsorption; "bake out"; Components; Decomposition; Degassing; Environment; Evaporation; Outgassing; Simulation; Sublimation; Thermal conduction; Thermal vacuum tests; Volatile constituents; Volatilization; Absorption; *SP336,* pp. 473-485.

Adsorption; Cesium; Desorption; Electron reflection; Electron stimulated desorption; Gallium arsenide; Work function; *12108.*

Adsorption; Chain polymer; Lattice model; Partition function; Random walk; *12374.*

Adsorption; Chemisorption; Cross section; Desorption; Electron stimulated desorption; Hydrogen; Nickel; Nitrogen; Oxygen; Surface; Tungsten; *12332.*

Adsorption; Correction for gas; Gas; Gas law correction; Imperfect gas; Second virial coefficient; *12330.*

Adsorption; Electron gas; Impurities; Surface physics; *12035.*

Adsorption; Heat transfer; Isotherm; Kinetics; Mass transfer; Adsorbent-reaction; *11898.*

Adsorption from solution; Calcium phosphate; Composite adsorption; Isotopic exchange; Kinetics of adsorption; Mechanism of adsorption; Solution adsorption; *12249.*

Adsorption, gas on metal; Argon, compressibility factor of; Burnett data reduction; Carbon dioxide, second virial coefficient of; Compressibility factor; Gas; Gas. compressibility factor of; **J.75C** *Nos. 3 and 4, 163-172 (1971).*

Aerodynamic forces; Atmospheric boundary layer; Structural design; Turbulence; Wind effects; Wind loads; *BSS30.*

Aerodynamic shear; Carbon; Char; Cork; Epoxy-novolac; Erosion; Phenolic carbon; Silicone rubber; Ablation; *SP336,* pp. 837-851.

Aeroelasticity; Buildings; Circular cylinders; Gust factors; Masts; Structural engineering; Towers; Vortex shedding; Wind loads; *BSS30,* pp. 115-128.

Aeroelasticity; Buildings; Dynamics; Statistical analysis; Structural engineering; Wind loads; Wind tunnel modeling; *BSS30,* pp. 107-114.

Aeronomic; Astrophysical; Partial; Photoabsorption cross sections; Photodissociation; Photoexcitation; Photoionization; Photon-scattering; Total; Ultraviolet cross sections; *NSRDS-NBS38.*

Aeronomy; Editorial comments; *11941.*

Affine connection; Continuum mechanics; Non-Riemannian geometry; Stress; *SP317,* pp. 943-962.

Affine connection; Continuum mechanics; Kinematics; Non-Riemannian geometry; *SP317,* pp. 999-1020.

Affine connexions; Continuum mechanics; Curvature tensor; Disclination; Internal stresses; Quasidisclination; *SP317,* pp. 637-649.

Agriculture; Air and water pollution; Biology; Botany; Health and medicine; Instrument calibration; Metrology; Research materials; Standard reference materials; SRM's; Standard Reference Materials Program; *12349.*

Air and water pollution; Biology; Botany; Health and medicine; Instrument calibration; Metrology; Research materials; Standard reference materials; SRM's; Standard Reference Materials Program; Agriculture; *12349.*

Air elutriation; Air permeability; Andreasen pipette; Calibrated glass beads; Coulter counter; Electroformed sieves; Microscopic size measurement; Particle size measurement; *11895.*

Air permeability; Andreasen pipette; Calibrated glass beads; Coulter counter; Electroformed sieves; Microscopic size measurement; Particle size measurement; Air elutriation; *11895.*

Air pollution; Bilirubin; Infrared analysis; Ion exchange; Liquid chromatography; Purification; Separation; Styrene/divinylbenzene; Zeolites; *TN549.*

Air pollution; Brillouin spectroscopy; Lasers; Light scattering; Macromolecules; Optical mixing spectroscopy; Review; *12361.*

Air pollution; Chemical kinetics; Chemistry; Gas kinetics; Olefins; Singlet oxygen; *12158.*

Air traffic control; Beacon code assignment; Digital simulation; Radar beacon system; *TN568.*

Air traffic control; Capacity concept; Markov renewal process; Runway; Airport; *11960.*

Aircraft signals; Color standards; Filter permanence; Limit filters; Railroad signals; Signal colors; Signal standards; Spectral transmittance of glass filters; Traffic signals; *TN564.*

Airport; Air traffic control; Capacity concept; Markov renewal process; Runway; *11960.*

Albedo; Civil defense; Ducts; Neutron penetration; Nuclear weapons data; Structure shielding; *11988.*

Algorithms; ANSI FORTRAN; Documentation; Error checking; Machine independent; OMNITAB II operating system subprograms; OMNITAB II source listing; Programming techniques; Transportable; User-oriented computing system; Accuracy; *SP339.*

Aliphatics; Aromatics; Complexing effects; Gas chromatography; Group separation; Mercuric nitrate; Olefins; Silver nitrate; Surface effect; *12024.*

Alkali halide crystal defect properties; Alkali halide dopants; Bibliography; Impurity centers; Optical magnetic and transport properties; *NBS-OSRDB-71-1 (COM-71-00248).*

Alkali halide dopants; Bibliography; Impurity centers; Optical magnetic and transport properties; Alkali halide crystal defect properties; *NBS-OSRDB-71-1 (COM-71-00248).*

Alkali halides; Alkaline earth oxides; F center; F' center; Ionic crystals (NaCl, KCl, MgO, CaO); *11860.*

Alkali hydroxides; High temperature; Infrared; Matrix; NaOD; NaOH; RbOD; RbOH; Vibrational assignment; *11845.*

Alkali metal reactions; $BrHBr^-$; Charge transfer; $ClHCl^-$; Electron attachment; Infrared spectrum; Matrix isolation; Molecular rotation; Vacuum-ultraviolet photolysis; Vibrational potential function; *12369.*

Alkali metal reactions; Charge transfer; Electron capture; Infrared spectrum; Matrix isolation; Molecular orbitals; SO_2^- anion; Sulfur dioxide; *12336.*

Alkalies; Concrete; Durability; Heat of hydration; Portland cements; Shrinkage; Statistical evaluation; Strength; Sulfate expansion; Trace elements; *11863.*

Alkaline earth; Color centers; F^- centers; Fluorides; *12301.*

Alkaline earth oxides; *F* center; *F′* center; Ionic crystals (NaCl, KCl, MgO, CaO); Alkali halides; *11860.*

Alkaline paint; Conduction of paints during ultraviolet exposure; Electrode potential of paints; Photo degradation; Thermal control coatings; Ultraviolet degradation; *SP336,* pp. 393-402.

Alkane dimer ions; Ethane; Ion-molecule reactions; Mass spectrometry; Photoionization; Protonated dimer ions; *11830.*

Alkanes; Excited states; Ion-molecule reactions; Mass spectrometry; Photoionization; Rate constants; *11829.*

Alkanes; Heats; *n*-hexatricontane; *n*-pristane; *n*-tetracosane; *n*-tetranonacontane; Vaporization; *11840.*

Allan variance; Cesium beam; Frequency stability; Hydrogen maser; NBS frequency standard; Time scale; *11922.*

Allan variance; Frequency; Frequency stability; Sample variance; Spectral density; Variance; *12228.*

Allowed; Atomic; Discrete; Forbidden; Transition probability; *SP320. Suppl. 1.*

Alloy data; Bibliography; Index; Information; Knight shifts; NMR; Soft x ray; *NBS-OSRDB-70-2 (COM-71-00722).*

Alloy data; Bibliography; Index; Information; Knight shifts; NMR; Soft x ray; *SP324.*

Alloys; Aluminum; Diffusion; High-pressure; Phase-diagram; Vanadium; *11832.*

Alloys; Analysis; Internal standard; Mössbauer spectrometry; Stannic oxide; *11978.*

Alloys; Clustering; Cold work; Cu; Fe; Magnetic moments; Mössbauer effect; Ni; *11838.*

Alloys; Clustering; Copper; Iron; Local moments; Mössbauer effect; Nickel; *12199.*

Alloys; Corrections; Electron probe; Homogeneity; Matrix scanner; Microanalysis; Quantitative analysis; Standard reference materials; X-ray emission; *SP260-28.*

Alloys; Magnetism; Mo; Mössbauer Effect; Nb; *12220.*

Alpha particles counting response; Capacitance; Detector noise; Electron fluence; Electrons radiation damage; Front and rear contact; Leakage current; Silicon surface-barrier detector; *12107.*

Alpha tracks; Boron; Botanical material; Fission tracks; Kale; Orchard leaves; Uranium; *12269.*

Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; *TN702.*

Alpha-particle detectors; Aluminum wire; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; *TN560.*

Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; *TN571.*

Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; *TN592.*

Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; *TN598.*

Alum; Aluminum; Apparent activation energy; Calcium; Cellulose; Crosslinking; Differential thermal analysis; Ion exchange; Organic acid; Oxycellulose; Stability; Sulfuric acid; Thermogravimetric analysis; *12218.*

Alumina; Aluminum oxide; Corundum; Drop calorimetry; Enthalpy; Heat capacity standard; Specific heat; Standard reference material; Synthetic sapphire; Thermodynamic functions; J.75A *No. 5, 401-420 (1971).*

Alumina; Al_2O_3; Ceramics; Electron microscopy; Fine-grain ceramic; Ion bombardment; Magnesia; MgO; Microstructure; Rock; Zirconia; *12083.*

Alumina; Elastic modulus; Resonance frequency; Shear modulus; Standard reference material; Young's modulus; J.75A *No. 3, 155-162 (1971).*

Alumina; Fracture; Mechanical properties; Plastic deformation; Sapphire; Strength; *12282.*

Alumina; IUPAC; Melting point of Al_2O_3; Melting point standards; Al_2O_3; *11924.*

Aluminium alloys; Copper alloys; Cryogenics; Electrical conductivity; Iron alloys; Nickel alloys; Titanium alloys; *11873.*

Aluminum; Apparent activation energy; Calcium; Cellulose; Crosslinking; Differential thermal analysis; Ion exchange; Organic acid; Oxycellulose; Stability; Sulfuric acid; Thermogravimetric analysis; Alum; *12218.*

Aluminum; Copper; Magnetoresistance; *12152.*

Aluminum; Diffusion; High-pressure; Phase-diagram; Vanadium; Alloys; *11832.*

Aluminum; Electrical resistivity; Grain boundaries; Solute segregation; Super-purity metals; *11818.*

Aluminum; Electron microprobe; Electron microscope; Interaction zone; Adherence; *12130.*

Aluminum; Electron scattering; Magnetoresistance; Resistance; *12278.*

Aluminum alloy; Corrosion; Directional effects; Grain morphology; Preferred orientation; Stress corrosion; *11839.*

Aluminum alloy; Cryogenics; Electrical resistivity; Lorenz ratio; Nickel alloys; Seebeck effect; Thermal conductivity; Titanium alloy; Transport properties; J.75A *No. 4, 269-277 (1971).*

Aluminum alloys; Hot saline water corrosion; Oxide films; Precipitates; Transmission microscopy; *12315.*

Aluminum coated teflon; Electron degradation; Proton degradation; Silver coated teflon; Teflon film; Ultraviolet degradation; *SP336,* pp. 345-358.

Aluminum in steel; Bilirubin; DTA standards; Fluorescence filters Tl(I), Ce(III), Pb(II); Glass filters (SRM 930); Mercury in botanical; Quantum efficiencies; *TN584.*

Aluminum oxide; Band structure; Borides; Bulk optical properties; Chemical analysis; Chromium ions; Corundum; Crystal defects; Crystal growth; Density of states; Diffusion; Glass; High temperature materials; Laser damage; Laser degradation; *TN565.*

Aluminum oxide; Bicrystals; Crystal growth; Vapor crystal growth; *12013.*

Aluminum oxide; Corundum; Drop calorimetry; Enthalpy; Heat capacity standard; Specific heat; Standard reference material; Synthetic sapphire; Thermodynamic functions; Alumina; J.75A *No. 5, 401-420 (1971).*

Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; *TN702.*

Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; *TN571.*

Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; *TN592.*

Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; *TN598.*

Aluminum wire; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; *TN560.*

Alzak; Thermal control coatings; Ultraviolet degradation; Vacuum UV; *SP336*, pp. 383-392.

Al_2O_3; Alumina; IUPAC; Melting point of Al_2O_3; Melting point standards; *11924.*

Al_2O_3; Ceramics; Electron microscopy; Fine-grain ceramic; Ion bombardment; Magnesia; MgO; Microstructure; Rock; Zirconia; Alumina; *12083.*

Al_2O_3; Crystal growth; Damage threshold; Glass; High temperature materials; Laser; Oxides; Oxygen diffusion; Pure materials; Sapphire; *TN703.*

Al_2O_3; Crystal growth; Damage threshold; Glass; High temperature materials; Laser; Oxides; Oxygen diffusion; Pure materials; Sapphire; *TN574.*

Al_2O_3; Interfering reactions; Laser; Nondestructive analysis; Ruby; Trace elements; Activation analysis; **J.75A** *No. 5, 429-433 (1971).*

Amalgam condensation; Mercury; Mercury vapor levels; Threshold limit; *12092.*

Ambiguity; Binary matrices; Bond adjacency; Chemical information; Computer; Control vector; Set reduction; Structure search; Substructure search; *12337.*

American National Standards; Computers, data elements and codes; Data processing systems; Federal Information Processing Standards; International Organization for Standardization; Management information systems; Standards; U.S. Government; *FIPS PUB 12.*

American Standard Code for Information Interchange; ASCII; Card punch; Card reader; Data communications; Data interchange; Data processing; Electric accounting machine; EAM cards; Federal Information Processing Standard; *FIPS PUB 13.*

American Standard Code for Information Interchange; ASCII; Card punch; Card reader; Data communications; Data interchange; Data processing; Electric accounting machine; EAM cards; Federal Information Processing Standard; *FIPS PUB 14.*

American Standard Code for Information Interchange; ASCII; Coded character subsets; Codes; Data communication; Data interchange; Data processing; Federal Information Processing Standards; Graphic character subsets; Graphic subsets; *FIPS PUB 15.*

American Standard Code for Information Interchange; ASCII; Communications; Data communications equipment; Data processing terminal equipment; Data transmission; Federal information processing standards; Serial-by-bit; Serial-by-character; *FIPS PUB 16.*

American Standard Code for Information Interchange; ASCII; Character structure; Character parity sense; Communications; Data transmission; Federal information processing standards; Serial-by-bit; Telecommunications; Teleprocessing; *FIPS PUB 17.*

American Standard Code for Information Interchange; ASCII; Character structure; Communications; Data transmission; Federal information processing standards; Parallel-by-bit; Parity sense; Serial-by-character; Telecommunications; *FIPS PUB 18.*

Amines; Color-stable composites; Methacrylates; Polymerization; Resins; Synthesis; Accelerators; *12302.*

Ammeter; Coax; Infrared; Rf-dc; Thermopile radiation; *12198.*

Amorphous; Free-radical; Ionic; Manganese dioxide; Polycrystalline; Structure; Surface; Adsorption; *12314.*

Amorphous polymer; Copolymerization; Fluoropolymers; Glass temperature; High pressure; Radiation-induced; Tetrafluoroethylene; 3,3,4,4,5,5,5-heptafluoropentene-1; *11868.*

Amplifier noise; Noise; Noise factor; Noise temperature; Y-factor; *12191.*

Amplifier noise; Noise; Noise measurement; *11881.*

Amplifiers; Basic characteristics; Microwave; Oscillators; Semiconductor; Solid state; *TN597.*

Analog noise simulation; Computer noise simulation; Digital filters; Flicker noise; Fractional integration; Recursive digital filters; *TN604.*

Analysis; Analytical chemistry; Analytical chemistry as a discipline; Analytical chemistry as a profession; *11910.*

Analysis; Device processing; Diffusion; Epitaxy; Junctions; Resistivity; Surface preparation; *SP337.*

Analysis; Electron probe; Lunar samples; Microanalysis; Minerals; Rocks; *11995.*

Analysis; Gas chromatography; Ketene; Methyl ketene; *12164.*

Analysis; Internal standard; Mössbauer spectrometry; Stannic oxide; Alloys; *11978.*

Analysis of steel samples; Extraction with β-isopropyltropolone; Simultaneous determination of vanadium and iron; Spectrophotometric determination of vanadium; *12335.*

Analysis of variance; Average (weighted); Interlaboratory evaluation; Round robin; Single classification; Statistics; Variance components; Weighting; *11906.*

Analytic solutions; Boundary conditions; Computation, temperature distribution; Furnaces, high-pressure; High-pressure furnaces; High-temperature, high-pressure research; Power dissipation; Temperature distribution, steady-state; **J.75C** *No. 2, 79-83 (1971).*

Analytical; Atomic emission; Detector; Gas chromatography; Spectroscopy; Vacuum ultraviolet; *12267.*

Analytical chemistry; Analytical chemistry as a discipline; Analytical chemistry as a profession; Analysis; *11910.*

Analytical chemistry as a discipline; Analytical chemistry as a profession; Analysis; Analytical chemistry; *11910.*

Analytical chemistry as a profession; Analysis; Analytical chemistry; Analytical chemistry as a discipline; *11910.*

Analytical functions; Approximation; Gaussian quadrature; Integration; Optimal quadrature; Quadrature; **J.75B** *Nos. 1 and 2, 85-88 (1971).*

Anchorage; Building performance; Glazing; Hailstones; Masonry; Mobile homes; Roofs; Structural engineering; Wind load; *TN558.*

Andreasen pipette; Calibrated glass beads; Coulter counter; Electroformed sieves; Microscopic size measurement; Particle size measurement; Air elutriation; Air permeability; *11895.*

Anelastic relaxation; Calcium fluoride; Defect pairs; Dielectric relaxation; Relaxation modes; Reorientation; *12357.*

Anemometers; Instrumentation; Tower interference; Transducers; Wind vanes; Wind loads; *BSS30*, p. 21.

Angular distribution; Cross section; Helium-3; Photonuclear; Radiative capture; *11886.*

Angular distribution of O_2; Dissociative electron attachment; Electron energy; *12057.*

Angular relaxation; ClO_3F; Magnetic resonance; Relaxation times; Rotational diffusion; Spherical-top molecules; *12195.*

Angular velocity; Effective axis and angle of rotation; Intrinsic vector; Kinematics of a rigid body; Rotation group; Spatial rotation; **J.75B** *Nos. 3 and 4, 179-186 (1971).*

Anharmonic properties; Dislocation dynamics; Ultrasonics; *SP317*, pp. 427-445.

Anharmonicity; Dislocations in lattices; Peierls stress; Zero point motion; *SP317*, pp. 253-272.

Anisotropic compressibility; Azides; Compressibility; High pressure; Single crystal; X-ray diffraction; *12025.*

Anisotropic elasticity; Anisotropic plasticity dislocations; Constitutive relations; Dislocation dynamics; Non-linear elasticity; *SP317,* pp. 837-876.

Anisotropic elasticity; Cerenkov waves; Dislocation dynamics; Dislocation stability; *SP317,* pp. 23-33.

Anisotropic elasticity; Dislocations; Green's tensor; Incompatibility; Internal stress; Source kernels; Stress functions; *SP317,* pp. 89-124.

Anisotropic elasticity; Dislocations-elasticity; Dislocation pileups; Grain boundaries; *SP317,* pp. 163-171.

Anisotropic elasticity; Dislocation dynamics; Dislocation; Elasticity; Non-linear elasticity; *SP317,* pp. 877-905.

Anisotropic elasticity; Dislocation dynamics; Dislocations; Green's tensors; *SP317,* pp. 977-996.

Anisotropic plasticity dislocations; Constitutive relations; Dislocation dynamics; Non-linear elasticity; Anisotropic elasticity; *SP317,* pp. 837-876.

Anisotropy; Compression tests; Mass spectroscopy; Mechanical properties; Outgassing; Pressure measurements; Rock mechanics; Space environment simulation; Ultrahigh vacuum; *SP336,* pp. 209-223.

Anisotropy; Cubic materials; Elasticity; Green's tensor; *SP317,* pp. 125-134.

Annealed and quenched glass; Calorimetry; *cis*-1,4-polyisoprene; Glass transformation; Heat capacity; Natural rubber; Normal and supercooled liquid; Rubber, natural; Thermal diffusivity; Thermodynamic properties; **J.75A** *No. 2, 113-120 (1971).*

Annealing equilibria; Electron microscopy; Niobium tungsten system; Wadsley defects; *12263.*

Annealing-electrolylic copper; Electrodeposited copper; Impurity content; Properties of mechanical structure; *12041.*

Annual report; Technical highlights; *SP340.*

Annual report, National Bureau of Standards; Astrophysical work, National Bureau of Standards; *11976.*

Annual report to Congress; Blankets; Carpets and rugs; Children's sleepwear; Cooperation; Flammability; Flammability reduction; Mattresses; Research; Small carpets and rugs; Standards; Test development; *TN596.*

Anomalous dispersion; Carbon dioxide; Cryodeposit; Cryogenics; Frost; Infrared; Integrating sphere; Mars; Reflectance; Scattering; Simulation; Spectral; Absorbing; *SP336,* pp. 165-183.

Anomalous moment; Back scattering; Electron; Radiative correction; *11801.*

Anomaly in oxide mixtures; Oxide mixtures; Viscosity anomaly; *11929.*

ANSI FORTRAN; Computer system implementation; Examples; OMNITAB II; Software; Test problems; Accuracy; *TN551.*

ANSI FORTRAN; Documentation; Error checking; Machine independent; OMNITAB II operating system subprograms; OMNITAB II source listing; Programming techniques; Transportable; User-oriented computing system; Accuracy; Algorithms; *SP339.*

Antenna gain; Antenna gain measurement; Antenna measurements; Antenna pattern; Antenna pattern measurement; Near-field antenna measurements; *11967.*

Antenna gain; Antenna gain measurement; Antenna measurements; Antenna pattern; Antenna pattern measurement; Near-field antenna measurements; *11968.*

Antenna gain; Antenna pattern; Calculated far-field patterns; Near-field measurements; New antenna theorems; *11856.*

Antenna gain measurement; Antenna measurements; Antenna pattern; Antenna pattern measurement; Near-field antenna measurements; Antenna gain; *11967.*

Antenna gain measurement; Antenna measurements; Antenna pattern; Antenna pattern measurement; Near-field antenna measurements; Antenna gain; *11968.*

Antenna measurements; Antenna pattern; Antenna pattern measurement; Near-field antenna measurements; Antenna gain; Antenna gain measurement; *11967.*

Antenna measurements; Antenna pattern; Antenna pattern measurement; Near-field antenna measurements; Antenna gain; Antenna gain measurement; *11968.*

Antenna pattern; Antenna pattern measurement; Near-field antenna measurements; Antenna gain; Antenna gain measurement; Antenna measurements; *11967.*

Antenna pattern; Antenna pattern measurement; Near-field antenna measurements; Antenna gain; Antenna gain measurement; Antenna measurements; *11968.*

Antenna pattern; Calculated far-field patterns; Near-field measurements; New antenna theorems; Antenna gain; *11856.*

Antenna pattern measurement; Near-field antenna measurements; Antenna gain; Antenna gain measurement; Antenna measurements; Antenna pattern; *11967.*

Antenna pattern measurement; Near-field antenna measurements; Antenna gain; Antenna gain measurement; Antenna measurements; Antenna pattern; *11968.*

Antenna theory; Infrared detectors; Lasers; Whisker diode; *12168.*

Anthracene; Benzene; High-pressure; Naphthalene; Polymorphism; *11800.*

Anthropomorphic dummies; Auto seat tests; Deceleration; Human kinematics; Human tests; Restraint geometry; Restraint systems; Seat belt; Sled tests; Webbing abrasion; Webbing degradation; *11850.*

Antiferromagnetism; Exchange interactions; $GdAsO_4$; Heat capacity; Heisenberg; Ising model; Low temperature; *12202.*

Anti-migration traps; Cold shrouding; Contamination; Environment; Ion pumping; Low pressure; Low temperature; Pumping; Ultraclean; Vacuum; *SP336,* pp. 661-668.

Antimony; Ferrites; Hyperfine fields; Iron; Isomer shift; Lithium; Mössbauer effect; Recoilless fraction; *12205.*

Antimony; Heat conduction; Laser materials; Nd-doped glass; Platinum; Stress components; Thermoelastic theory; **J.75A** *No. 4, 247-260 (1971).*

Antimony; Heat conduction; Laser materials; Nd-doped glass; Platinum; Stress components; Thermoelastic theory; *12133.*

α-particle initiation; Chain folded crystals; Crystal growth mechanisms; Electron diffraction of polymers; Electron microscopy of polymers; Polymer crystals; Polymer morphology; Polyoxymethylene crystals; Post irradiation heat treatment; *12030.*

Apollo 11; Electron probe analysis; Mineralogy; Moon; Petrography; Rocks; *11958.*

Apparatus; Beam diagnostic; Ion source; Ion transportation; Laboratory space simulation; Vacuum system; *SP336,* pp. 189-196.

Apparel, boys'; Body measurements, boys'; Pattern sizes, boys'; Size designations, boys'; Span charts, boys' sizing; *PS36-70.*

Apparel, women's; Body measurements, women's; Classifications, women's size; Grading charts, women's size; Pattern size, women's; Size designations, women's; Span charts, women's sizing; *PS42-70.*

Apparent activation energy; Calcium; Cellulose; Crosslinking; Differential thermal analysis; Ion exchange; Organic acid; Oxycellulose; Stability; Sulfuric acid; Thermogravimetric analysis; Alum; Aluminum; *12218.*

Appearance; Brightness; Chromatic adaptation; Chromaticity; Color; Least squares; Luminance; Model; Neutral; Perception; Vision; Achromatic; *11813.*

Appearance properties; Paper research; Preservation of records; Tear reference; Testing program; *11842.*

Applied nonisothermal kinetics; Generalized techniques;

Historical review; Isoconversional and isokinetic methods; Isothermal; Kinetic parameters; Thermogravimetric analysis; *12356*.

Approximation; Gaussian quadrature; Integration; Optimal quadrature; Quadrature; Analytical functions; **J.75B** *Nos. 1 and 2, 85-88 (1971)*.

Aprotic organic solvents; Hydrogen bonding; Titrations; Acid-base behavior; Acidity and basicity scales; *11997*.

Aqueous solutions; Cylinder; Ice; Solute; Stability; Surface tension; *11889*.

Aqueous solutions; EPR; Exponential temperature dependence; Intramolecular relaxation; Jahn-Teller effect; Tris(2,2.-dipyridine)copper(II); *12116*.

Aragonite; Barium calcium carbonate; Calcium carbonate; Crystal structure; Single crystal x-ray diffraction; **J.75A** *No. 3, 197-203 (1971)*.

Arc currents; Arc heaters; Constricted arc; Enthalpy; Operational limits; Stagnation pressure; *SP336*, pp. 879-892.

Arc heaters; Constricted arc; Enthalpy; Operational limits; Stagnation pressure; Arc currents; *SP336*, pp. 879-892.

Architectural features; Buildings; Mullions; Parapets; Roof projections; Static pressures; Wind effects; Wind tunnel modeling; *BSS30*, pp. 73-86.

Archival film; Hypo; Microfilm; Permanent record film; **J.75C** *No. 1, 19-22 (1971)*.

Argon; Carbon dioxide; Classical equation; Coexistence curve; Critical exponents; Critical point; Lattice gas; Power laws; Rectilinear diameter; Steam; Thermodynamic anomalies; Vapor pressure; *11985*.

Argon, compressibility factor of; Burnett data reduction; Carbon dioxide, second virial coefficient of; Compressibility factor; Gas; Gas, compressibility factor of; Gas, *PVT* properties of; Measurements; **J.75C** *Nos. 3 and 4, 163-172 (1971)*.

Aromatic; Azines; Cleavage; Complex; Nitrogen paramagnetic; Periodic acid; Radical; *12095*.

Aromatics; Complexing effects; Gas chromatography; Group separation; Mercuric nitrate; Olefins; Silver nitrate; Surface effect; Aliphatics; *12024*.

Aromatics; Gas cnromatography; Isotope dilution; Olefins; Water analysis; *12023*.

Arrhenius law; Mechanical properties; Precipitation hardening; Thermal activation; *SP317*, pp. 1077-1082.

Arrhenius rate theory; Dislocation dynamics; Statistical theory of dislocation; Thermal acceleration; *SP317*, pp. 1065–1076.

Arsenious oxide; Arsenolite; Claudetite; Crystal transition; Cubic crystal; Glass; Heat capacity; Monoclinic crystal; Low temperature; Planar molecular structure; Spherical shell molecules; Vitreous state; *12311*.

Arsenolite; Claudetite; Crystal transition; Cubic crystal; Glass; Heat capacity; Monoclinic crystal; Low temperature; Planar molecular structure; Spherical shell molecules; Vitreous state; Arsenious oxide; *12311*.

Art restoration; Cellini; Chemical microscopy; National Gallery of Art; Renaissance bronzes; Widener collection; *11984*.

Articles; Publications; *SP305. Suppl. 1*.

ASCII; Card punch; Card reader; Data communications; Data interchange; Data processing; Electric accounting machine; EAM cards; Federal Information Processing Standard; Hollerith punched cards; Information interchange; Information processing; *FIPS PUB 13*.

ASCII; Card punch; Card reader; Data communications; Data interchange; Data processing; Electric accounting machine; EAM cards; Federal Information Processing Standard; Hollerith punched card code; Hollerith punched cards; *FIPS PUB 14*.

ASCII; Character structure; Character parity sense; Communications; Data transmission; Federal information processing standards; Serial-by-bit; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; *FIPS PUB 17*.

ASCII; Character structure; Communications; Data transmission; Federal information processing standards; Parallel-by-bit; Parity sense; Serial-by-character; Telecommunications; Teleprocessing; *FIPS PUB 18*.

ASCII; Coded character subsets; Codes; Data communication; Data interchange; Data processing; Federal Information Processing Standards; Graphic character subsets; Graphic subsets; Information interchange; Information processing; Standards; *FIPS PUB 15*.

ASCII; Communications; Data communications equipment; Data processing terminal equipment; Data transmission; Federal information processing standards; Serial-by-bit; Serial-by-character; Telecommunications; Teleprocessing; *FIPS PUB 16*.

Assessment; Complex; Composite; Computer; Criteria; Evaluation; Gaussian primes; Indexing; Measurement; Performance; Prime; Program; Test; *TN572*.

Association colloid; Bibliography; CMC; Colloid; Colloidal electrolyte; Critical concentration; Critical micelle concentration; Detergent; Hydrophobic bonding; Krafft point; Long chain compounds; Micelle; Paraffin chain salts; Selected values; *NSRDS-NBS36*.

ASTM standards; Integrated circuits; Microelectronics; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; *11869*.

Astronomical OH emission; H_2O laser; Magnetic resonance; OH; Spectroscopy; *11954*.

Astronomically important; Electrical discharge; Interstellar medium; Microwave spectroscopy; Rotational spectrum; Thioformaldehyde; *11965*.

Astronomy, working library; Libraries, astronomy; Publication policies, astronomy; *12171*.

Astrophysical; Partial; Photoabsorption cross sections; Photodissociation; Photoexcitation; Photoionization; Photon-scattering; Total; Ultraviolet cross sections; Aeronomic; *NSRDS-NBS38*.

Astrophysical work, National Bureau of Standards; Annual report, National Bureau of Standards; *11976*.

Asymmetric rotors; Matrix elements; Rotational line intensities; Singlet-triplet transitions; Spin forbidden transitions; Transition calculations; *12313*.

Asymptotics; Cross section; Diffraction shrinkage; High energy; Pomeranchuck theorem; *11870*.

Atmospheric boundary layer; Gust factors; Peak values; Power spectra; Turbulence; Wind profiles; *BSS30*, pp. 27-41.

Atmospheric boundary layer; Structural design; Turbulence; Wind effects; Wind loads; Aerodynamic forces; *BSS30*.

Atmospheric environment; Balloon; Computer; Ozone; Plastic material; Simulation; Solar ultraviolet radiation; *SP336*, pp. 245-259.

Atmospheric exposure; ATR spectroscopy; Clear and pigmented films; Infrared analysis; Internal reflection spectroscopy; Mercury-arc irradiation; Organic coatings; Photodegradation; Surface degradation; Volatile degradation products; *SP336*, pp. 299-312.

Atom; Cross section; Elastic scattering; Electron; Molecule; *12283*.

Atom; Cross section; Electron; Molecule; *12161*.

Atom addition; Hydrogen isotopes; Low temperatures; Olefins; Orientation; Quantum tunneling; *12040*.

Atom-diatom transitions; Data tables; Distorted wave calculations; Exact quantum mechanical calculations; Inelastic transition probabilities; K matrix calculation; KWIC Index; Mass values; Numerical calculations; *NBS-OSRDB-70-3 (AD705110)*.

Atomic; Discrete; Forbidden; Transition probability; Allowed; *SP320. Suppl. 1*.

Atomic absorption; Close coupling; Configuration; Interaction; Resonant structure; *12094*.

Atomic absorption; Detection limits; Differential method; Flame emission; Nonaqueous media; Precision; Sensitivity; Tables; Accuracy; *12111*.

Atomic beam tube; Cavity pulling; Frequency stability; Frequency standard; Hydrogen maser; *11891*.

Atomic calculation; Interatomic potential; Krypton; *SP317*, pp. 285-289.

Atomic clocks; Atomic standards; Clock dissemination; Crystal oscillators; Definition of second; Flicker noise; Frequency; Frequency stability; Lasers; Length standards; Measurement standards; Spectral density; Speed of light; *SP350*.

Atomic constants; Fundamental constants; Physical constants; *SP344*.

Atomic diffusion; Defect motion; Interstitial motion; Jump frequency; Lattice model; Migration energy; Migration entropy; Molecular dynamics; Random-walk theory; Vacancy motion; *12022*.

Atomic emission; Detector; Gas chromatography; Spectroscopy; Vacuum ultraviolet; Analytical; *12267*.

Atomic energy levels; Atomic theory; Autoionization; Helium; Wavelength measurement; *12380*.

Atomic energy levels; Gaseous nebulae; Non-LTE thermodynamics; Solar physics; Transition probabilities; *SP353*.

Atomic energy levels, carbon spectra; Atomic spectra of carbon; Carbon spectra; Multiplet tables, carbon spectra; Spectra, carbon; Wavelengths, carbon spectra; *NSRDS-NBS3, Section 3*.

Atomic energy levels, Niv-Nvii; Nitrogen spectra, Niv-Nvii; Multiplet tables, Niv-Nvii; Spectra, Niv-Nvii; Wavelengths, nitrogen spectra Niv-Nvii; *NSRDS-NBS3, Section 4*.

Atomic frequency standard; Cesium beam; Figure of merit; Frequency accuracy; Frequency multiplier; Frequency precision; NBS-III; NBS-5; Phase noise; Quartz crystal oscillator; Ramsey cavity; Slave oscillator; *11959*.

Atomic frequency standards; Cesium beam; Flicker noise; Frequency stability; Frequency standards; Hydrogen maser; Long baseline interferometry; Quartz crystal oscillators; Time standards; *11888*.

Atomic frequency standards; Cesium beam; Energy levels; Hydrogen maser; Hyperfine interaction; Rubidium gas cell; Transition probability; *TN399*.

Atomic lifetimes; Atomic spectra; Configuration interaction; Oscillator strengths; *12123*.

Atomic lifetimes; Atomic spectra; *f*-values; Iron; *12211*.

Atomic ordering; Binary A-15 compounds; Superconductivity; Transition elements; *11864*.

Atomic ordering; Intermetallic compounds; Magnetic susceptibility; Superconductors; *12300*.

Atomic spectra; Atomic theory; Spin-orbit interaction; **J.75A** *No. 2, 109-111 (1971)*.

Atomic spectra; Configuration interaction; Oscillator strengths; Atomic lifetimes; *12123*.

Atomic spectra; Coronal spectra; Periodicities, atomic spectra; Rare-earth spectra; Regularities, atomic spectra; Solar spectra; *12288*.

Atomic spectra; Coronal spectra; Rare-earth spectra; Solar spectra; Spectra, atomic; Spectra, rare-earth; *11987*.

Atomic spectra; Emission spectroscopy; Wavelengths; Zinc; *11907*.

Atomic spectra; *f*-values; Iron; Atomic lifetimes; *12211*.

Atomic spectra; References; Spectroscopy; Transition probabilities; *12169*.

Atomic spectra of carbon; Carbon spectra; Multiplet tables, carbon spectra; Spectra, carbon; Wavelengths, carbon spectra; Atomic energy levels, carbon spectra; *NSRDS-NBS3, Section 3*.

Atomic standards; Clock dissemination; Crystal oscillators; Definition of second; Flicker noise; Frequency; Frequency stability; Lasers; Length standards; Measurement standards; Spectral density; Speed of light; Standard frequency broadcasts; *SP350*.

Atomic theory; Autoionization; Helium; Wavelength measurement; Atomic energy levels; *12380*.

Atomic theory; Spin-orbit interaction; Atomic spectra; **J.75A** *No. 2, 109-111 (1971)*.

Atomic time; Standards; Time; Time standards, universal time; *12264*.

Atomic transition probabilities; Beam foil spectroscopy; Lifetimes; Regularities; Review; *12124*.

Atomic weight; Coulometry; Zinc, atomic weight; **J.75A** *No. 6, 561-564 (1971)*.

Atoms; Compilation; Cross section data; Photoabsorption; Photoionization; Photon; *12210*.

Atom-transfer reaction; Chemical activation; Chemical kinetics; Chemi-excitation; Gas phase; Potential energy surfaces; Recombination; Review; Unimolecular decomposition; *11943*.

ATR spectroscopy; Clear and pigmented films; Infrared analysis; Internal reflection spectroscopy; Mercury-arc irradiation; Organic coatings; Photodegradation; Surface degradation; Volatile degradation products; Xenon-arc irradiation; *SP336*, pp. 299-312.

ATS satellite; LES-6 satellite; NBS satellite timing; Satellites; TACSAT satellite; Time; Timing accuracy; *12103*.

Attenuation; Impedance; Microwave power; Mismatch error; *12236*.

Attenuation coefficient; Conference; Crystallography; Electron microprobe; Fluorescence analysis; Gamma rays; Photons; Röntgen; X rays; Absorption corrections; *11814*.

Attenuation length; Electron gas theory; Field emission; Surface physics; Tunneling; *12154*.

Attenuation measurement; Automatic data correction; Auxiliary receiver for microwave measurements; Dual admittance Woods bridge; Engen microcalorimeter; Rf coaxial impedance standards; *SP335*, pp. 117-119.

Attenuation of betas; Beta-transmission phenomenology; Counting geometry; Mass absorption coefficient derivation; Strontium 90 wall-thickness measurement gage; Thin-wall mensuration; *SP335*, pp. 11-21.

Attenuator; Microwave; Precision; Rotary vane; **J.75C** *No. 1, 1-5 (1971)*.

Audiometry; Earphones; NBS 9-A coupler; Reference threshold sound pressure levels; Standards for audiometers; Threshold of hearing; *12260*.

Audit examinations; Audit package; Precision Measurement Equipment Laboratories (PMEL); Technician skills; U.S. Air Force; *SP335*, pp. 105-109.

Audit package; Precision Measurement Equipment Laboratories (PMEL); Technician skills; U.S. Air Force; Audit examinations; *SP335*, pp. 105-109.

Audition; Communications; Hearing; Hearing aids; Selection of hearing aids; Speech communication; *CIS4*.

$AuGa_2$; BiIn; Bismuth; Diamagnetism; Knight shift; NaTl; Polarization; V_3Ga; *12085*.

Austenite in ferrite; Electron microprobe; Powder metallurgy; Quantitative microscopy; SRM; X-ray fluorescence analysis; *SP260-25*.

Author index; Bibliography; High pressure; Subject index; *NBS-OSRDB-70-1-V1 (PB191174)*.

Author index; Bibliography; High pressure; Subject index; *NBS-OSRDB-70-1-V2 (PB191175)*.

Auto seat tests; Deceleration; Human kinematics; Human tests; Restraint geometry; Restraint systems; Seat belt; Sled tests; Webbing abrasion; Webbing degradation; Anthropomorphic dummies; *11850*.

Autoadhesion; Bonding; Cold-curing methyl methacrylate;

Gibbs energy of formation; Beryllium compounds; Magnesium compounds; Calcium compounds; Strontium compounds; *TN270-6.*

Barium oxides; High temperature; Infrared; Matrix isolations; Barium; *J.75A No. 1, 23-25 (1971).*

Barnes colorimeter; Chromaticity coordinate; Color correction; Cool white fluorescent lamp; Correlated color temperature; Daylight fluorescent lamp; Heterochromatic photometry; Integrating sphere; Intercomparison; Luminous flux; Photometry; *TN559.*

Baryons; Configuration mixing; Hyperons; Resonances; Rotations; $SU(6) \times 0(3)$; *11912.*

Basalt; Fiberglass; Friction; Steel; Titanium; Ultrahigh vacuum; Adhesion; *SP336*, pp. 225-244.

Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; *TN702.*

Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; *TN571.*

Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; *TN592.*

Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; *TN598.*

Basic characteristics; Microwave; Oscillators; Semiconductor; Solid state; Amplifiers; *TN597.*

Basic electrical standards; Quantum electric standards; Radiofrequency standards; Absolute measurements; *SP335*, pp. 129-132.

Beacon code assignment; Digital simulation; Radar beacon system; Air traffic control; *TN568.*

Beam diagnostic; Ion source; Ion transportation; Laboratory space simulation; Vacuum system; Apparatus; *SP336*, pp. 189-196.

Beam foil spectroscopy; Lifetimes; Regularities; Review; Atomic transition probabilities; *12124.*

Bearings; Diagnostics; Gears; Reliability; Signature analysis; Vibration; *SP336*, pp. 407-448.

Bending moment; Building codes; End-fixity; Reinforced concrete; Slenderness; Strength; Structural analysis; Walls; Axial load (force); *11933.*

Bending vibration; Hydrogen bond; Infrared; Isotope dilution; Lattice mode; Raman; Sodium bifluoride; Stretching vibration; *11983.*

Benzene; High-pressure; Naphthalene; Polymorphism; Anthracene; *11800.*

Beryllium; Boron; Carbon; Fluorescence yield; Fluorine; *K*-shell; Magnesium; ω_K; *11950.*

Beryllium azide; Beryllium thiocyanate, decaborane; Dimethyl beryllium; Magnesium, electrodeposition of; Nonaqueous plating baths; Grignard reagents; Organic plating baths; Triethylboron; Beryllium, electrodeposition of; *12304.*

Beryllium compounds; Magnesium compounds; Calcium compounds; Strontium compounds; Barium compounds; Radium compounds; Enthalpy; Entropy; Gibbs energy of formation; *TN270-6.*

Beryllium, electrodeposition of; Beryllium azide; Beryllium thiocyanate, decaborane; Dimethyl beryllium; Magnesium, electrodeposition of; Nonaqueous plating baths; Grignard reagents; Organic plating baths; Triethylboron; *12304.*

Beryllium thiocyanate, decaborane; Dimethyl beryllium; Magnesium, electrodeposition of; Nonaqueous plating baths; Grignard reagents; Organic plating baths; Triethylboron; Beryllium, electrodeposition of; Beryllium azide; *12304.*

Beryllium to gold; Electron produced; High intensity; Monochromatic yields; Purity; X-ray beams; *12214.*

Bessel functions; Data analysis; Data manipulation; Easy and effective programming in English; List of instructions; Matrix operations; Numerical analysis; OMNITAB II user oriented computing system; Self-teaching; Statistical analysis; Automatic printing; *TN552.*

Beta ray; Dosimetry; Nuclear medicine; Point kernel; Radionuclide; Absorbed dose; *11861.*

Beta rays, angular distribution of; Gamma rays, angular distribution of; Hyperfine field in iron; Nuclear orientation; Transition mixing ratios; ^{192}Ir, magnetic moment of; *12005.*

Beta-transmission phenomenology; Counting geometry; Mass absorption coefficient derivation; Strontium 90 wall-thickness measurement gage; Thin-wall mensuration; Attenuation of betas; *SP335*, pp. 11-21.

Between-group variance; Mass comparisons of 1969; Systematic and random weighing errors; Within-group variance; *SP335*, pp. 41-45.

Bias ply; Breaking energy; Passenger car; Radial; Tires; Tire strength; Winter; *11833.*

Bibliographic system; Computer package; Data base; Document processing; Information retrieval; Document storage and retrieval; Text; Text processing; *TN599.*

Bibliography; Chemical kinetics; Gas phase; Nitrogen; Nitrogen oxides; Oxygen; Ozone; *NBS-OSRDB-71-2 (COM-71-00841).*

Bibliography; CMC; Colloid; Colloidal electrolyte; Critical concentration; Critical micelle concentration; Detergent; Hydrophobic bonding; Krafft point; Long chain compounds; Micelle; Paraffin chain salts; Selected values; Soap; *NSRDS-NBS36.*

Bibliography; Element determined; Literature file; Matrix analyzed; Technique used; Activation analysis; *TN467, Part 1.*

Bibliography; Element determined; Literature file; Matrix analyzed; Technique used; Activation analysis; *TN467, Part 2.*

Bibliography; High pressure; Subject index; Author index; *NBS-OSRDB-70-1-V1 (PB191174).*

Bibliography; High pressure; Subject index; Author index; *NBS-OSRDB-70-1-V2 (PB191175).*

Bibliography; Impurity centers; Optical magnetic and transport properties; Alkali halide crystal defect properties; Alkali halide dopants; *NBS-OSRDB-71-1 (COM-71-00248).*

Bibliography; Index; Information; Knight shifts; NMR; Soft x ray; Alloy data; *NBS-OSRDB-70-2 (COM-71-00722).*

Bibliography; Index; Information; Knight shifts; NMR; Soft x ray; Alloy data; *SP324.*

Bichloride anion; ClHCl free radical; Electron attachment; HCl dimer; Hydrogen bonding; Infrared spectrum; Matrix isolation; Ultraviolet spectrum; Vacuum-ultraviolet photolysis; *11975.*

Bicrystals; Crystal growth; Vapor crystal growth; Aluminum oxide; *12013.*

Bi-fold doors, steel; Closet doors, steel bi-fold; Doors, steel bi-fold; Steel bi-fold doors; *PS38-70.*

BiIn; Bismuth; Diamagnetism; Knight shift; NaTl; Polarization; V_3Ga; $AuGa_2$; *12085.*

Bilirubin; DTA standards; Fluorescence filters Tl(I), Ce(III), Pb(II); Glass filters (SRM 930); Mercury in botanical; Quantum efficiencies; Aluminum in steel; *TN584.*

Bilirubin; Infrared analysis; Ion exchange; Liquid chromatography; Purification; Separation; Styrene/divinylbenzene; Zeolites; Air pollution; *TN549*.

Bimorph; Cryogenic; Low-temperature; Magnetometer; Piezoelectric; Vibrating-sample magnetometer; *12046*.

Binary A-15 compounds; Superconductivity; Transition elements; Atomic ordering; *11864*.

Binary fluid mixtures; Correlation; Deviations from geometric mean rule; Interaction energy parameters; Ionization potentials; *11962*.

Binary matrices; Bond adjacency; Chemical information; Computer; Control vector; Set reduction; Structure search; Substructure search; Ambiguity; *12337*.

Binding energy; Mass formulae; Nuclei; Particle-hole energy; Quartet structure; Rearrangement; *12145*.

Biodynamics; Biomechanics; Human engineering; Kinematics; Occupant restraint systems; Seat; Seat belts; Acceleration (mechanical); *11851*.

Biological; Botanical; Environment; Standard Reference Material; Activation analysis; *12334*.

Biological images; Image processing; Morphology; Pattern recognition; *12284*.

Biological standards; Blood standard; Botanical standards; Environmental samples; Standard Reference Material; Tissue standard; Trace analysis; *12132*.

Biological structure; Biomedical instrumentation; Computer; Image processing; Microscope; Microspectrophotometry; Pattern recognition; *11834*.

Biology; Botany; Health and medicine; Instrument calibration; Metrology; Research materials; Standard reference materials; SRM's; Standard Reference Materials Program; Agriculture; Air and water pollution; *12349*.

Biomaterials; Dimethacrylates; Phthalate monomers; Purification methods; Resins for composites; Ternary eutectic; Thermosetting monomers; *11802*.

Biomechanics; Human engineering; Kinematics; Occupant restraint systems; Seat; Seat belts; Acceleration (mechanical); Biodynamics; *11851*.

Biomedical instrumentation; Computer; Image processing; Microscope; Microspectrophotometry; Pattern recognition; Biological structure; *11834*.

Biorthogonal polynomials; Gamma-ray transport; Moment method; Neutron transport; Polynomial truncation errors; Sievert function; **J.75B** *Nos. 1 and 2, 1-16 (1971)*.

Birefringent filter; Dye laser; Frequency control; *12122*.

Bismuth; Diamagnetism; Knight shift; NaTl; Polarization; V_3Ga; $AuGa_2$; BiIn; *12085*.

β-isopropyltropolone; Chelate; Equilibrium constants; Extraction method; Ferric; Graphical; Least squares computer calculations; Vanadyl; *12110*.

Bis(phenylhydrazone); E.s.r.; Glyoxal; Methyl sulfoxide; Oxygen; Radical-anion; **J.75A** *No. 6, 573-577 (1971)*.

Bis-[μ-(tri-,1,2,4-triazolo-N^1,N^2)-triaquonickel]nickel hexanitrate dihydrate; Trinuclear nickel(II) complex; X-ray structure analysis; *12291*.

$Bi_{12}GeO_{20}$; $Bi_{12}SiO_{20}$; $Bi_{12}TiO_{20}$; $Bi_{14}ZnO_{22}$; Faraday effect; Modulator materials; Optical activity; Optical rotatory power; Verdet coefficient; $Bi_{34}Ga_2O_{54}$; *11807*.

$Bi_{12}SiO_{20}$; $Bi_{12}TiO_{20}$; $Bi_{14}ZnO_{22}$; Faraday effect; Modulator materials; Optical activity; Optical rotatory power; Verdet coefficient; $Bi_{34}Ga_2O_{54}$; $Bi_{12}GeO_{20}$; *11807*.

$Bi_{12}TiO_{20}$; $Bi_{14}ZnO_{22}$; Faraday effect; Modulator materials; Optical activity; Optical rotatory power; Verdet coefficient; $Bi_{34}Ga_2O_{54}$; $Bi_{12}GeO_{20}$; $Bi_{12}SiO_{20}$; *11807*.

$Bi_{14}ZnO_{22}$; Faraday effect; Modulator materials; Optical activity; Optical rotatory power; Verdet coefficient; $Bi_{34}Ga_2O_{54}$; $Bi_{12}GeO_{20}$; $Bi_{12}SiO_{20}$; $Bi_{12}TiO_{20}$; *11807*.

$Bi_{34}Ga_2O_{54}$; $Bi_{12}GeO_{20}$; $Bi_{12}SiO_{20}$; $Bi_{12}TiO_{20}$; $Bi_{14}ZnO_{22}$ Faraday effect; Modulator materials; Optical activity; Optical rotatory power; Verdet coefficient; *11807*.

BKZ fluid; Nonlinear behavior; Polyisobutylene; Stress relaxation; Viscosity; **J.75A** *No. 1, 33-40 (1971)*.

Black coatings; Cavity absorptance; Cavity reflectance; Laser-source reflectometer; Parsons black; Retro-reflectance; Absorptance; *TN575*.

Black-nucleus model; Coupled channel calculation; Nuclear orientation; Nuclear Ramsauer effect; Nuclear shape; Optical-model; Total neutron cross section; ^{165}Ho; *12007*.

Blankets; Carpets and rugs; Children's sleepwear; Cooperation; Flammability; Flammability reduction; Mattresses; Research; Small carpets and rugs; Standards; Test development; Annual report to Congress; *TN596*.

Blast over-pressure; Combustion front; Hypervelocity impact; Meteorid penetration; Oxidative detonation; Oxidative flash; Oxygen atmosphere; Spacecraft; *SP336*, pp. 569-585.

Block design; Combinatorial analysis; Configurations; König's theorem; Matrices; 0,1 matrices; Matrix equations; Permutation matrix decompositions; **J.75B** *Nos. 1 and 2, 23-30 (1971)*.

Block ice, package quantities of; Crushed ice, package quantities of; Cubed ice, package quantities of; Ice, package quantities of; Package quantities of ice; Sized ice, package quantities of; *PS48-71*.

Blood standard; Botanical standards; Environmental samples; Standard Reference Material; Tissue standard; Trace analysis; Biological standards; *12132*.

Body measurements, boys'; Pattern sizes, boys'; Size designations, boys'; Span charts, boys' sizing; Apparel, boys'; *PS36-70*.

Body measurements, women's; Classifications, women's size; Grading charts, women's size; Pattern size, women's; Size designations, women's; Span charts, women's sizing; Apparel, women's; *PS42-70*.

Bolometer calibration; Radiofrequency power measurement; Self-balancing Wheatstone bridge; Automated dc substitution; *SP335*, pp. 35-37.

Bolovac; Current measurement (HF & MW); (HF & MW); Microwave currents; Microwave voltages; Power measurement; Voltage measurement (HF & MW); *11926*.

BOLOVAC; Microwave current measurements; Microwave power measurements; Microwave voltage measurements; *12055*.

Boltzmann gas; Cross-section for viscosity; Hard sphere gas; Quantum corrections; Statistical mechanics; Viscosity; *12303*.

Bond additivity method; Group additivity method; Peroxyacetyl nitrate; Peroxybenzoyl nitrate; Thermochemical properties; *12204*.

Bond adjacency; Chemical information; Computer; Control vector; Set reduction; Structure search; Substructure search; Ambiguity; Binary matrices; *12337*.

Bond dissociation energy; Diazomethane; Heat of formation; Vacuum ultraviolet; *12367*.

Bond dissociation energy; Fluorescence; HNCO; NCO $A^2\Sigma$; NH $A^3\pi$, $c^1\pi$; Photodissociation; Vacuum ultraviolet; *12012*.

Bond distances; Hydrogen cyanide; Infrared; Microwave; Molecular structure; Rotational constants; Spectra; *12342*.

Bond energy; Enthalpy of formation; Heat of formation; Ketene; Methylene; *12252*.

Bonding; Cold-curing methyl methacrylate; Dentures; Tensile strength; Acrylic teeth; Adhesion; Autoadhesion; *12340*.

Bonding; Composites; Denture base materials; Diagnosis; Light translucency; Physical properties; Radiopacity; *12232*.

Bordoni-peaks; Dislocation motion; Kink relaxation; Mechanical properties; Thermal activation; *SP317*, pp. 1137-1156.

Boric acid; Coulometric titration; High-precision acidimetry; High precision coulometry; Accurate analysis; **J.75A** *No. 5, 421-428 (1971)*.

Republics; Building economics; *SP334.*

Buildings; Circular cylinders; Gust factors; Masts; Structural engineering; Towers; Vortex shedding; Wind loads; Aeroelasticity; *BSS30,* pp. 115-128.

Buildings; Climatology; Extreme value theory; Gust factors; Structural engineering; Wind loads; Wind profile; *BSS30,* pp. 151-164.

Buildings; Climatology; Seismic loads; Structural engineering; Wind loads; Vibrations; *BSS30,* pp. 129-131.

Buildings; Design criteria; Dynamics; Gust factors; Smoke stacks; Structural failure; Wind loads; *BSS30,* pp. 5-8.

Buildings; Dynamics; Gust factor; Mode shape; Probability theory; Wind loads; *BSS30,* pp. 93-104.

Buildings; Dynamics; Gust loads; Matrix analysis; Mode shape; Probability theory; Wind loads; *BSS30,* pp. 145-149.

Buildings; Dynamics; Statistical analysis; Structural engineering; Wind loads; Wind tunnel modeling; Aeroelasticity; *BSS30,* pp. 107-114.

Buildings; Failure; Hurricanes; Mobile homes; Roofs; Structural engineering; Tides; Wind; *TN569.*

Buildings; Fluctuating pressure; Gust factors; Walls; Wind damage; Wind loads; *BSS30,* pp. 9-18.

Buildings; Full-scale tests; Power spectra; Pressure fluctuations; Wind loads; Wind tunnel modeling; *BSS30,* pp. 61-71.

Buildings; Mullions; Parapets; Roof projections; Static pressures; Wind effects; Wind tunnel modeling; Architectural features; *BSS30,* pp. 73-86.

Buildings; Pressure fluctuations; Instrumentation; Overturning moments; Wind loads; Wind tunnel modeling; Boundary layer; *BSS30,* pp. 45-59.

Bulk modulus; Compressibility; Density; Dilatometric measurements; High pressure; Liquids; Ultrasonics; 2-methylbutane; **J.75A** *No. 2, 121-127 (1971).*

Bulk modulus; Density; Dilatometric measurements; High pressure; Liquids; Solids; Ultrasonics; *SP326,* pp. 11-22.

Bulk modulus; Dislocations and thermodynamics; Entropy; Specific heat; Thermal expansion; Thermodynamics and expansions; *SP317,* pp. 1223-1225.

Bulk modulus; Grüneisen; *n*-alkanes; Normal mode; Polyethylene; Quasiharmonic specific heat; String of beads; Thermal expansion; Thermal properties; Volume; *12305.*

Bulk optical properties; Chemical analysis; Chromium ions; Corundum; Crystal defects; Crystal growth; Density of states; Diffusion; Glass; High temperature materials; Laser damage; Laser degradation; Laser glass; Laser materials; Mass transport; *TN565.*

Buoyancy; Calibration; Standards; Substitution weighing; Transposition weighing; True mass; Uncertainty; Value; Balance; *TN577.*

Burgers vector; Compatibility; Continuum; Contortion; Cosserat; Couple-stress; Defect; Deformation; Disclination; Dislocation; Dualism; Elasticity; Incompatibility; Motor calculus; Plasticity; *SP317,* pp. 651-673.

Burnett; Gas; Model dependency; Nonlinear; PVT; Statistical; *11932.*

Burnett data reduction; Carbon dioxide, second virial coefficient of; Compressibility factor; Gas; Gas, compressibility factor of; Gas, *PVT* properties of; Measurements; Second virial coefficient; **J.75C** *Nos. 3 and 4, 163-172 (1971).*

Butene; Cyclobutane; Ion structure; Isomerization; Methylcyclopropane; Photoionization; Photolysis; Radiolysis; **J.75A,** *No. 6, 591-605 (1971).*

C

Ca H and K lines; Non-LTE line formation; Plages; Radiative transport; Solar chromosphere; Solar spectrum; Sunspots; Wilson-Bappu effect; *12106.*

Cadmium; Components of error (within- and between-laboratory); Heats of sublimation (second and third law); Interlaboratory measurements; Silver; Standard errors; Standard reference materials; Vapor pressure; *SP260-21.*

Cadmium fluoride; EPR; Superhyperfine interaction; Ytterbium; *12312.*

CaF$_2$; CaO; *F* center; Internal Stark effect; KCl; Optical phonons; Polarizable ion model; Semicontinuum polaron model; *12134.*

Calcification; Calcium carbonate; Crystal structure; Hydrate; Ion pairs; Mineralization; *11951.*

Calcium; Cellulose; Crosslinking; Differential thermal analysis; Ion exchange; Organic acid; Oxycellulose; Stability; Sulfuric acid; Thermogravimetric analysis; Alum; Aluminum; Apparent activation energy; *12218.*

Calcium carbonate; Calcium sulfate; Chalk; Chroma; Toxicity; Whiting; *PS30-70.*

Calcium carbonate; Crystal structure; Hydrate; Ion pairs; Mineralization; Calcification; *11951.*

Calcium carbonate; Crystal structure; Single crystal x-ray diffraction; Aragonite; Barium calcium carbonate; **J.75A** *No. 3, 197-203 (1971).*

Calcium carbonates; Carbonates; Crystal structure; Single crystal x-ray diffraction; **J.75A** *No. 1, 27-32 (1971).*

Calcium compounds; Strontium compounds; Barium compounds; Radium compounds; Enthalpy; Entropy; Gibbs energy of formation; Beryllium compounds; Magnesium compounds; *TN270-6.*

Calcium fluoride; Defect dipoles; Dielectric relaxation; ESR line broadening; Gadolinium; Orientational relaxation; *11956.*

Calcium fluoride; Defect equilibria; Electron paramagnetic resonance; Point defects; *12237.*

Calcium fluoride; Defect pairs; Dielectric relaxation; Relaxation modes; Reorientation; Anelastic relaxation; *12357.*

Calcium magnesium phosphate; Single crystal x-ray diffraction; Cation vacancies; Glaserite; α-Ca$_3$(PO$_4$)$_2$; *12274.*

Calcium phosphate; Calcium phosphate-calcium silicate solid solution; Calcium phosphosilicates; Calcium silicates; Crystal structures; Glaserite; Hydroxyapatite; Single crystal x-ray diffraction; *12273.*

Calcium phosphate; Composite adsorption; Isotopic exchange; Kinetics of adsorption; Mechanism of adsorption; Solution adsorption; Adsorption from solution; *12249.*

Calcium phosphate-calcium silicate solid solution; Calcium phosphosilicates; Calcium silicates; Crystal structures; Glaserite; Hydroxyapatite; Single crystal x-ray diffraction; Calcium phosphate; *12273.*

Calcium phosphosilicates; Calcium silicates; Crystal structures; Glaserite; Hydroxyapatite; Single crystal x-ray diffraction; Calcium phosphate; Calcium phosphate-calcium silicate solid solution; *12273.*

Calcium silicates; Crystal structures; Glaserite; Hydroxyapatite; Single crystal x-ray diffraction; Calcium phosphate; Calcium phosphate-calcium silicate solid solution; Calcium phosphosilicates; *12273.*

Calcium sodium carbonate; Crystal structure; Shortite; Single-crystal x-ray diffraction; **J.75A** *No. 2, 129-135 (1971).*

Calcium sulfate; Chalk; Chroma; Toxicity; Whiting; Calcium carbonate; *PS30-70.*

Calculated far-field patterns; Near-field measurements; New antenna theorems; Antenna gain; Antenna pattern; *11856.*

Calculation of bounds; Calibration; Poiseuille flow; Standard; Viscosity; Viscous flow; Absolute measurement; **J.75A** *No. 6, 553-560 (1971).*

Calibrated glass beads; Coulter counter; Electroformed sieves; Microscopic size measurement; Particle size measurement; Air elutriation; Air permeability; Andreasen pipette; *11895.*

Calibration; Connectors; Mismatch; Power equation; Power measurement; *J.*75C *No. 2, 89-93 (1971).*

Calibration; Current comparator; Current transformer; Overload testing; Self-balancing current comparator; Transformer; Wide-range; *12256.*

Calibration; Current meters (fluids); Hydraulics; Measurement; Open-channel flow; Standards; *12358.*

Calibration; Directional coupler; High power; Measurement; Microwave; Accurate; *J.*75C *Nos. 3 and 4, 181-186 (1971).*

Calibration; Fixed point; Freezing point; Furnaces; High temperature; IPTS-68; Platinum resistance thermometer; Temperature scale; Thermocouple; Triple point; *12354.*

Calibration; Poiseuille flow; Standard; Viscosity; Viscous flow; Absolute measurement; Calculation of bounds; *J.*75A *No. 6, 553-560 (1971).*

Calibration; Standard; Torsional pendulum; Viscosity; Absolute measurement; *J.*75A *No. 6, 541-551 (1971).*

Calibration; Standards; Substitution weighing; Transposition weighing; True mass; Uncertainty; Value; Balance; Buoyancy; *TN577.*

Calibration and maintenance manhours; Digital counters; Digital voltmeters; Exchange program on costs; Oscilloscopes; *SP335,* pp. 51-55.

Calibration data system; Calibration interval adjustment method; Instrument reliability; Instrument standardization; *SP335,* pp. 99-104.

Calibration histories; Equal likelihood; Oscilloscopes; RX meters; Vacuum-tube voltmeters; *SP335,* pp. 81-84.

Calibration interval adjustment method; Instrument reliability; Instrument standardization; Calibration data system; *SP335,* pp. 99-104.

Calibration intervals; Economy in adjusting quality level; Measurement uncertainty; Reliability of working instruments; *SP335,* pp. 57-64.

Calibration intervals; Exponential distribution; Reliability, systems effectiveness, tradeoffs; *SP335,* pp. 65-72.

Calibration of carrier-frequency filters; Microwave transmission lines; Siemens-Halske AEG; Wandel & Goltermann; Automatic noise-level recorders; *SP335,* pp. 125-127.

Calibration of viscometers; Viscosity; Uncertainty of viscosity measurements; Absolute measurement of viscosity; Accuracy of viscosity measurement; *J.*75A *No. 6, 535-540 (1971).*

Calibration records; Calibration system specification; Intervals; Procedures; Recall; Reliability; Traceability; *SP335,* pp. 47-50.

Calibration services; Fees for testing; Test fee schedule; Test procedures; *SP250, 1970 Edition.*

Calibration system specification; Intervals; Procedures; Recall; Reliability; Traceability; Calibration records; *SP335,* pp. 47-50.

Calorimeter; Detector; Energy; Laser; Power; Ruby; *12011.*

Calorimetry; *cis*-1,4-polyisoprene; Glass transformation; Heat capacity; Natural rubber; Normal and supercooled liquid; Rubber, natural; Thermal diffusivity; Thermodynamic properties; Annealed and quenched glass; *J.*75A *No. 2, 113-120 (1971).*

Calorimetry; Collagen; Frozen collagen; Mobile water; NMR; Adsorbed water; *11998.*

Calorimetry; Dose distribution; Electron beams; Holography; Interferometry; Pulsed beams; Radiation; Absorbed dose; *12100.*

Calorimetry; Electron beams; Interference fringes; Interferometry; Pulsed beams; Refractive-index holography; Temperature profile; Absorbed dose; *12324.*

Calorimetry; Laser; Laser calorimetry; Laser power; *11896.*

Calorimetry; Laser; Laser calorimetry; Laser energy; Laser power; *12015.*

Calorimetry; Laser; Laser calorimetry; Laser energy; Laser power; *TN396.*

Calorimetry; Laser calorimetry; Lasers; Thermodynamics; *11841.*

CAMAC; Data; Dataway; Digital; Instrumentation; Modules; Nuclear; Standards; *12142.*

CaO; *F* center; Internal Stark effect; KCl; Optical phonons; Polarizable ion model; Semicontinuum polaron model; CaF_2; *12134.*

Ca/P ratio; Pyrolysis; Pyrophosphate; Stoichiometry; Tricalcium phosphate; Whitlockite; *12183.*

Capacitance; Detector noise; Electron fluence; Electrons radiation damage; Front and rear contact; Leakage current; Silicon surface-barrier detector; Alpha particles counting response; *12107.*

Capacitance; Dielectric constant; Stable capacitance; Temperature variation of capacitance; *11935.*

Capacitance probe; Cylindrical gauge blocks; Inside diameters; Small-bore tubes; Standard hole; Wringing; *12277.*

Capacitor; Depolarization; Dielectric; Dilution refrigerator; Glass ceramic; Phase transition; Strontium titanate; Thermometer; *12368.*

Capacitor microphone; Flip-chip; Magnetic pickup; Microelectronic interconnections; Spider bonding; Ultrasonic bonding; Wire bonding; *TN573.*

Capacity concept; Markov renewal process; Runway; Airport; Air traffic control; *11960.*

Carbon; Char; Cork; Epoxy-novolac; Erosion; Phenolic carbon; Silicone rubber; Ablation; Aerodynamic shear; *SP336,* pp. 837-851.

Carbon; Copper; Experimental cross sections; Gold; Inelastic electron scattering; Multiple scattering; 0.1 to 3.0 MeV; *12113.*

Carbon; Electron accelerators; Nitrogen; Oxygen; Photon activation analysis; Review; Sensitivities; Bremsstrahlung; *12076.*

Carbon; Fluorescence yield; Fluorine; *K*-shell; Magnesium; ω_K; Beryllium; Boron; *11950.*

Carbon dioxide; Classical equation; Coexistence curve; Critical exponents; Critical point; Lattice gas; Power laws; Rectilinear diameter; Steam; Thermodynamic anomalies; Vapor pressure; Argon; *11985.*

Carbon dioxide; Cryodeposit; Cryogenics; Frost; Infrared; Integrating sphere; Mars; Reflectance; Scattering; Simulation; Spectral; Absorbing; Anomalous dispersion; *SP336,* pp. 165-183.

Carbon dioxide, second virial coefficient of; Compressibility factor; Gas; Gas, compressibility factor of; Gas, *PVT* properties of; Measurements; Second virial coefficient; Adsorption, gas on metal; *J.*75C *Nos. 3 and 4, 163-172 (1971).*

Carbon in iron; Computer simulation; Dislocation-interstitial interaction; Interatomic potentials; Lattice defects; *SP317,* pp. 299-303.

Carbon monoxide; Chemisorption; Co-adsorption; Displacement reaction; Hydrogen; Single crystal; Tungsten; Work function; *12261.*

Carbon monoxide; Collision parameters; Equivalent width; Flame spectra; Line shapes; *J.*75A *No. 5, 469-479 (1971).*

Carbon monoxide; Desorption; Field emission; Monoxide; Rhenium; Ruthenium; Surface migration; *11819.*

Carbon spectra; Multiplet tables, carbon spectra; Spectra, carbon; Wavelengths, carbon spectra; Atomic energy levels, carbon spectra; Atomic spectra of carbon; *NSRDS-NBS3, Section 3.*

Carbonates; Crystal structure; Single crystal x-ray diffraction; Calcium carbonates; *J.*75A *No. 1, 27-32 (1971).*

Carbonium ions; Ion-molecule reactions; Neopentane; Radiolysis; Rate constants; *t*-butyl ion; *11854.*

Carbonyl; Chemical vapor deposition; Electrodeposition; Hexafluoroacetylacetone; Rhenium coatings; Trifluorophosphine; *11942.*

Card punch; Card reader; Data communications; Data interchange; Data processing; Electric accounting machine; EAM cards; Federal Information Processing Standard; Hollerith punched cards; Information interchange; Information processing; *FIPS PUB 13.*

Card punch; Card reader; Data communications; Data interchange; Data processing; Electric accounting machine; EAM cards; Federal Information Processing Standard; Hollerith punched card code; Hollerith punched cards; Information interchange; *FIPS PUB 14.*

Card reader; Data communications; Data interchange; Data processing; Electric accounting machine; EAM cards; Federal Information Processing Standard; Hollerith punched cards; Information interchange; Information processing; Punched cards; *FIPS PUB 13.*

Card reader; Data communications; Data interchange; Data processing; Electric accounting machine; EAM cards; Federal Information Processing Standard; Hollerith punched card code; Hollerith punched cards; Information interchange; *FIPS PUB 14.*

Cardiography; Instrumentation; Josephson effect; Magnetometry; Superconductivity; *12190.*

Carpets and rugs; Children's sleepwear; Cooperation; Flammability; Flammability reduction; Mattresses; Research; Small carpets and rugs; Standards; Test development; Annual report to Congress; Blankets; *TN596.*

Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); *TN702.*

Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Resistivity; *TN560.*

Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; *TN571.*

Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; *TN592.*

Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); *TN598.*

Casimir operator; Checking parameters; $(d+s)^n p$, SU_3; **J.75B** *Nos. 1 and 2, 31-47 (1971).*

Catastrophic ablation; Substructure heating; Surface cracks; Ablation; *SP336,* pp. 853-877.

Cathedral; Deformation; Lead; Roof; Washington Cathedral; "1921"; *12377.*

Cation exchanger; Chromium; Hydrogen peroxide; *12019.*

Cation exchangers; Ion exchangers; Oleum; Sulfonation; *11957.*

Cation vacancies; Glaserite; α-$Ca_3(PO_4)_2$; Calcium magnesium phosphate; Single crystal x-ray diffraction; *12274.*

Cavitation; Cryogenics; Pumps; *TN397.*

Cavities; Cellular solidification; Constitutional supercooling; Copper (99.999%); Dislocation arrangements; Distribution of impurities; Precipitate particles; Thermomechanical treatment; *12339.*

Cavity; Detector response functions; Dosimetry; Electron-energy deposition; Gray medal; Ionization; Bragg-Gray principle; *12297.*

Cavity absorptance; Cavity reflectance; Laser-source reflectometer; Parsons black; Retro-reflectance; Absorptance; Black coatings; *TN575.*

Cavity phase shift; Cesium beam tube; Frequency accuracy; Frequency modulation; Frequency standard; Power shift; Resonance line shape; *12365.*

Cavity pulling; Frequency stability; Frequency standard; Hydrogen maser; Atomic beam tube; *11891.*

Cavity reflectance; Laser-source reflectometer; Parsons black; Retro-reflectance; Absorptance; Black coatings; Cavity absorptance; *TN575.*

Cavity walls; Composite walls; Compressive strength; Concrete block; Flexural strength; Masonry; Mortar; Slenderness effects; Standards; Structural stability; Walls; Brick; *BSS34.*

CCl; CCl_2; Force constants; Free radical; HCCl; $HCCl_2$; H_2CCl; Infrared spectrum; Matrix isolation; Photolysis; Ultraviolet spectrum; *11964.*

$CClF_3$; CO_2; Coexistence curve; Critical region; N_2O; Rectilinear diameter; Refractive index; *12341.*

CCl_2; Force constants; Free radical; HCCl; $HCCl_2$; H_2CCl; Infrared spectrum; Matrix isolation; Photolysis; Ultraviolet spectrum; CCl; *11964.*

CCl_3^+; Chloroform; Electron attachment; $HCCl_2^+$; $HCCl_2^-$; $HCCl_3^-$; Infrared spectrum; Matrix isolation; Photoionization; Vacuum ultraviolet photolysis; *12242.*

Cellini; Chemical microscopy; National Gallery of Art; Renaissance bronzes; Widener collection; Art restoration; *11984.*

Cellular solidification; Constitutional supercooling; Copper (99.999%); Dislocation arrangements; Distribution of impurities; Precipitate particles; Thermomechanical treatment; Cavities; *12339.*

Cellulose; Crosslinking; Differential thermal analysis; Ion exchange; Organic acid; Oxycellulose; Stability; Sulfuric acid; Thermogravimetric analysis; Alum; Aluminum; Apparent activation energy; Calcium; *12218.*

Cement; Chemical composition; Concrete; Durability; Material properties; Physical properties; *BSS36.*

Centrifugal; Helium; Nitrogen; Pump; Pump design; Pump performance; *12176.*

Ceramic; Light; Photometry; Spectral emissivity; Standard; *TN595.*

Ceramic; Metallizing; Ultrasonic; Vacuum; Boron nitride; *11883.*

Ceramics; Chemical composition; Mechanical properties; Pressure; Properties; Standards; Standard Reference Materials; Temperature; Thermal; *12181.*

Ceramics; Electron microscopy; Fine-grain ceramic; Ion bombardment; Magnesia; MgO; Microstructure; Rock; Zirconia; Alumina; Al_2O_3; *12083.*

Cerenkov waves; Dislocation dynamics; Dislocation stability; Anisotropic elasticity; *SP317,* pp. 23-33.

Cerium; Gadolinium; Ionization energy; *11982.*

Cerous magnesium nitrate; Cesium titanium alum; Dipole-dipole interaction; Neodymium ethyl sulphate; Shape dependent; Specific heat; *11909.*

Cerous magnesium nitrate; Dipole system; Low temperature; Paramagnetic salt; Specific heat; Susceptibility; Thermometer scale; *11822.*

Cesium; Desorption; Electron reflection; Electron stimulated desorption; Gallium arsenide; Work function; Adsorption; *12108.*

Cesium; Gallium; High-pressure; Polymorph; Single crystal; X-ray diffraction; *12187.*

Cesium; Inelastic-electron scattering; Metal-insulator transition; Plasmon energy losses; Tungsten; Adsorbed atomic layers; *11920.*

Cesium beam; Energy levels; Hydrogen maser; Hyperfine interaction; Rubidium gas cell; Transition probability; Atomic frequency standards; *TN399.*

Cesium beam; Figure of merit; Frequency accuracy; Frequency multiplier; Frequency precision; NBS-III; NBS-5; Phase noise; Quartz crystal oscillator; Ramsey cavity; Slave oscillator; Atomic frequency standard; *11959.*

Cesium beam; Flicker noise; Frequency stability; Frequency standards; Hydrogen maser; Long baseline interferometry; Quartz crystal oscillators; Time standards; Atomic frequency standards; *11888*.

Cesium beam; Frequency stability; Hydrogen maser; NBS frequency standard; Time scale; Allan variance; *11922*.

Cesium beam tube; Frequency accuracy; Frequency modulation; Frequency standard; Power shift; Resonance line shape; Cavity phase shift; *12365*.

Cesium titanium alum; Critical temperature; Face centered cubic lattice; Magnetic dipole-dipole coupling; Specific heats; *12077*.

Cesium titanium alum; Dipole-dipole interaction; Neodymium ethyl sulphate; Shape dependent; Specific heat; Cerous magnesium nitrate; *11909*.

CH; Far infrared; Free radical; Laser; Laser magnetic resonance; *12206*.

Chain folded crystals; Crystal growth mechanisms; Electron diffraction of polymers; Electron microscopy of polymers; Polymer crystals; Polymer morphology; Polyoxymethylene crystals; Post irradiation heat treatment; α-particle initiation; *12030*.

Chain partition function; Monte-Carlo computations; Near-neighbor interactions; Phase transition; Stochastic matrix; Theta point; *11908*.

Chain polymer; Lattice model; Partition function; Random walk; Adsorption; *12374*.

Chain rule; Continuum mechanics; Gradient; Matrices; Matrix calculus; Partial differentiation; Product rule; Tensor function; Trace; **J.75B** *Nos. 3 and 4, 97-107 (1971)*.

Chalk; Chroma; Toxicity; Whiting; Calcium carbonate; Calcium sulfate; *PS30-70*.

Char; Cork; Epoxy-novolac; Erosion; Phenolic carbon; Silicone rubber; Ablation; Aerodynamic shear; Carbon; *SP336*, pp. 837-851.

Character parity sense; Communications; Data transmission; Federal information processing standards; Serial-by-bit; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; Character structure; *FIPS PUB 17*.

Character structure; Character parity sense; Communications; Data transmission; Federal information processing standards; Serial-by-bit; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; *FIPS PUB 17*.

Character structure; Communications; Data transmission; Federal information processing standards; Parallel-by-bit; Parity sense; Serial-by-character; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; *FIPS PUB 18*.

Charge; Form factor; Magnetic; Nucleon potentials; Repulsive core; ^{3}He; ^{3}H; *12056*.

Charge carriers; Electrons; Gamma rays; Ge(Li) detectors; Germanium gamma-ray spectrometers; Holes; Lifetime; Theoretical model; Trapping; *12255*.

Charge distribution; Collective model; Giant resonance; Hydrodynamic model; Isospin; Nuclear structure; *12287*.

Charge exchange; Charge neutralization; Ion optics; Mass separators; Proton sources; Solar wind; Sputtering; Ultrahigh vacuum systems; *SP336*, pp. 261-277.

Charge neutralization; Ion optics; Mass separators; Proton sources; Solar wind; Sputtering; Ultrahigh vacuum systems; Charge exchange; *SP336*, pp. 261-277.

Charge transfer; ClHCl$^-$; Electron attachment; Infrared spectrum; Matrix isolation; Molecular rotation; Vacuum-ultraviolet photolysis; Vibrational potential function; Alkali metal reactions; BrHBr$^-$; *12369*.

Charge transfer; Deactivation; Ethane; Ion-molecule reactions; Mass spectrometry; Radiolysis; *12129*.

Charge transfer; Electron capture; Infrared spectrum; Matrix isolation; Molecular orbitals; SO$_2^-$ anion; Sulfur dioxide: Alkali metal reactions; *12336*.

Charged dislocations; Diamond lattice; Dislocation-electron interactions; Semiconductors; Band structures; *SP317*, pp. 1231-1253.

Checking parameters; $(d+s)^n p$, SU_3; Casimir operator; **J.75B** *Nos. 1 and 2, 31-47 (1971)*.

Chelate; Equilibrium constants; Extraction method; Ferric; Graphical; Least squares computer calculations; Vanadyl; β-isopropyltropolone; *12110*.

Chemical activation; Chemical kinetics; Chemi-excitation; Gas phase; Potential energy surfaces; Recombination; Review; Unimolecular decomposition; Atom-transfer reaction; *11943*.

Chemical analysis; Chromium ions; Corundum; Crystal defects; Crystal growth; Density of states; Diffusion; Glass; High temperature materials; Laser damage; Laser degradation; Laser glass; Laser materials; Mass transport; Neodymium glass; *TN565*.

Chemical analysis; Contamination; Organic residues; Outgassing; Polymeric materials; Residual gas analysis; Test facility; Vacuum; *SP336*, pp. 1-24.

Chemical applications; Literature; Mössbauer spectroscopy; Review; *12147*.

Chemical composition; Concrete; Durability; Material properties; Physical properties; Cement; *BSS36*.

Chemical composition; Density; Glasses; Hardness; Laser; Optical homogeneity; Photoelasticity; Refractive index; Thermal conductivity; Thermo-optic properties; Transmittance; **J.75A** *No. 3, 163-174 (1971)*.

Chemical composition; Mechanical properties; Pressure; Properties; Standards; Standard reference materials; Temperature; Thermal; Ceramics; *12181*.

Chemical dosimeter; Chemical dosimetry, ferrous sulfate; Ferrous sulfate dosimeter; Ferric ions; Fricke dosimeter; Radiation dosimeter; Radiation dosimetry; Spectrophotometry; Spectrophotometric measurements; *12174*.

Chemical dosimeter; Disinfestation; Dosimetry; Dyes; Gamma rays; Insect sterilization; Shelf-life extension; Sprouting inhibition; *12193*.

Chemical dosimetry, ferrous sulfate; Ferrous sulfate dosimeter; Ferric ions; Fricke dosimeter; Radiation dosimeter; Radiation dosimetry; Spectrophotometry; Spectrophotometric measurements; Chemical dosimeter; *12174*.

Chemical equilibrium; Chemical reactions; Equilibrium; Gases; Mass action; Non-linear search; *12244*.

Chemical information; Computer; Control vector; Set reduction; Structure search; Substructure search; Ambiguity; Binary matrices; Bond adjacency; *12337*.

Chemical kinetics; Chemi-excitation; Gas phase; Potential energy surfaces; Recombination; Review; Unimolecular decomposition; Atom-transfer reaction; Chemical activation; *11943*.

Chemical kinetics; Chemistry; Gas kinetics; Olefins; Singlet oxygen; Air pollution; *12158*.

Chemical kinetics; Gas phase; Nitrogen; Nitrogen oxides; Oxygen; Ozone; Bibliography; *NBS-OSRDB-71-2 (COM-71-00841)*.

Chemical, mechanical, and electrical tubing; FEP tubing; Fluorocarbon plastic tubing; Plastic tubing, fluorinated ethylene-propylene; Tubing, FEP-fluorocarbon; *PS43-71*.

Chemical microscopy; National Gallery of Art; Renaissance bronzes; Widener collection; Art restoration; Cellini; *11984*.

Chemical potential; Coexistence curve; Compressibility; Critical point; Oxygen; PVT; *12185*.

Chemical reactions; Equilibrium; Gases; Mass action; Non-linear search; Chemical equilibrium; *12244*.

Chemical vapor deposition; Electrodeposition; Hexafluoroacetylacetone; Rhenium coatings; Trifluorophosphine; Carbonyl; *11942*.

Chemical vapor deposition; Perrhenyl chloride; Rhenium heptaoxide; Rhenium oxytetrachloride; *12062*.

Chemical vapor deposition; Rhenium; Rhenium coatings; Rhenium oxychlorides; *11848*.

Chemi-excitation; Gas phase; Potential energy surfaces; Recombination; Review; Unimolecular decomposition; Atom-transfer reaction; Chemical activation; Chemical kinetics; *11943*.

Chemisorption; Co-adsorption; Displacement reaction; Hydrogen; Single crystal; Tungsten; Work function; Carbon monoxide; *12261*.

Chemisorption; Cross section; Desorption; Electron stimulated desorption; Hydrogen; Nickel; Nitrogen; Oxygen; Surface; Tungsten; Adsorption; *12332*.

Chemisorption; Flash desorption; Hydrogen; Nitrogen; Tungsten; Tungsten (100) plane; Work function; *12125*.

Chemisorption; Impurities; Surface physics; *12317*.

Chemistry; Content of articles; Data; Description of experiments; Evaluation of data; Numerical data; Publication standards; Titles; Abstracts; *11806*.

Chemistry; Gas kinetics; Olefins; Singlet oxygen; Air pollution; Chemical kinetics; *12158*.

Children's sleepwear; Cooperation; Flammability; Flammability reduction; Mattresses; Research; Small carpets and rugs; Standards; Test development; Annual report to Congress; Blankets; Carpets and rugs; *TN596*.

Chloride activity convention; Ion activity standards; Ionic activity; Ion selective electrodes; Single ion; Activity coefficients; Activity scales of high concentrations; Activity standard scales; *11859*.

Chlorine monofluoride; Dissociation energy; Ionization energy; Mass spectrometry; Photoionization; Vacuum ultraviolet; *12064*.

Chlorine monofluoride; Dissociative ionization; Fluorine; Heats of formation; Hot bands; Hydrogen fluoride; Ion pairs; Mass spectrometry; Molecular ionization; Photoionization; Vacuum ultraviolet; *12148*.

Chlorofluoromethane; Chlorofluoromethane-d_2; Fluorescence spectrum; Free radical; Infrared spectrum; Matrix isolation; Photolysis; Ultraviolet spectrum; ClCF; *12219*.

Chlorofluoromethane-d_2; Fluorescence spectrum; Free radical; Infrared spectrum; Matrix isolation; Photolysis; Ultraviolet spectrum; ClCF; Chlorofluoromethane; *12219*.

Chloroform; Electron attachment; $HCCl_2^+$; $HCCl_2^-$; $HCCl_3^-$; Infrared spectrum; Matrix isolation; Photoionization; Vacuum ultraviolet photolysis; CCl_3^+; *12242*.

Cholesteric crystals; Faulted ribbon; Liquid crystals; Nematic crystals; Smectic crystals; *SP317*, pp. 607-636.

CHO_2 free radical; Force constants; Infrared spectrum; Matrix isolation; Reaction of OH with CO; Stereoisomers; Vacuum-ultraviolet photolysis; *12112*.

Chroma; Toxicity; Whiting; Calcium carbonate; Calcium sulfate; Chalk; *PS30-70*.

Chromates; Langbeinites; Lattice constants; Sulfates; Tutton salts; **J.75A** *No. 5, 435-439 (1971)*.

Chromatic adaptation; Chromaticity; Color; Least squares; Luminance; Model; Neutral; Perception; Vision; Achromatic; Appearance; Brightness; *11813*.

Chromaticity; Color; Least squares; Luminance; Model; Neutral; Perception; Vision; Achromatic; Appearance; Brightness; Chromatic adaptation; *11813*.

Chromaticity coordinate; Color correction; Cool white fluorescent lamp; Correlated color temperature; Daylight fluorescent lamp; Heterochromatic photometry; Integrating sphere; Intercomparison; Luminous flux; Photometry; Spectroradiometry; *TN559*.

Chromatographic analysis of degradation products; Polymer characterization; Polymer identification; Pyrolysis-gas chromatography of polymers; Pyrolytic techniques; *11798*.

Chromatography; Elution volume; Flow; Gel permeation chromatography; Hydrodynamic volume; Polymer; Polymer separation; *12149*.

Chromatography; Gel filtration; Gel permeation chromatography; Macromolecules; Separation by flow; *12003*.

Chromium; Coulometry; Trace analysis; *11872*.

Chromium; Hydrogen peroxide; Cation exchanger; *12019*.

Chromium alum; Spin-lattice relaxation; *11803*.

Chromium diffusion coating; Columnar grains; Fatigue crack initiation; Fatigue crack propagation; Residual stress; Titanium bearing steels; *12087*.

Chromium ions; Corundum; Crystal defects; Crystal growth; Density of states; Diffusion; Glass; High temperature materials; Laser damage; Laser degradation; Laser glass; Laser materials; Mass transport; Neodymium glass; Optical properties; *TN565*.

Cilia; Conformational entropy; Free energy; Nucleation rate; Rate constants; Self-nucleation; Steady-state; *12293*.

Circular cylinders; Gust factors; Masts; Structural engineering; Towers; Vortex shedding; Wind loads; Aeroelasticity; Buildings; *BSS30*, pp. 115-128.

Circular cylinders; Power spectra; Pressure fluctuations; Subcritical flow; Supercritical flow; Transcritical flow; Turbulence; *BSS30*, pp. 87-91.

Circumvention; Emulsions; Homogeneity; Ions; Mass; Platinum; Precision; Replicate; Spark; Spectrometry; Accuracy; *11847*.

cis-1,4-polyisoprene; Glass transformation; Heat capacity; Natural rubber; Normal and supercooled liquid; Rubber, natural; Thermal diffusivity; Thermodynamic properties; Annealed and quenched glass; Calorimetry; **J.75A** *No. 2, 113-120 (1971)*.

Civil defense; Ducts; Neutron penetration; Nuclear weapons data; Structure shielding; Albedo; *11988*.

Classical equation; Coexistence curve; Critical exponents; Critical point; Lattice gas; Power laws; Rectilinear diameter; Steam; Thermodynamic anomalies; Vapor pressure; Argon; Carbon dioxide; *11985*.

Classical path; Hydrogen lines; Line wings; One-electron theory; Stark broadening; Unified theory; *12084*.

Classical path; Hydrogen lines; Line wings; Stark broadening; Unified theory; *Monogr. 120*.

Classical path approximation; Intermolecular potential; Pressure broadening; Strong collision; *12033*.

Classifications, women's size; Grading charts, women's size; Pattern size, women's; Size designations, women's; Span charts, women's sizing; Apparel, women's; Body measurements, women's; *PS42-70*.

Claudetite; Crystal transition; Cubic crystal; Glass; Heat capacity; Monoclinic crystal; Low temperature; Planar molecular structure; Spherical shell molecules; Vitreous state; Arsenious oxide; Arsenolite; *12311*.

Clausius-Clapeyron equation; Saturation vapor pressure over water; Vapor pressure; Vapor pressure of water; Water vapor; Steam; Virial coefficients; **J.75A** *No. 3, 213-230 (1971)*.

Clausius-Mossotti function; Dielectric constant; Oxygen; Polarizability; Saturated liquid; *11844*.

ClCF; Chlorofluoromethane; Chlorofluoromethane-d_2; Fluorescence spectrum; Free radical; Infrared spectrum; Matrix isolation; Photolysis; Ultraviolet spectrum; *12219*.

Cleaning; Desorption; Ions; Outgassing; Quartz crystal microbalance; Solar panels; Space; Sputtering; Surface contamination; *SP336*, pp. 113-127.

Clear and pigmented films; Infrared analysis; Internal reflection spectroscopy; Mercury-arc irradiation; Organic coatings; Photodegradation; Surface degradation; Volatile degradation products; Xenon-arc irradiation; Atmospheric exposure; *SP336*, pp. 299-312.

Cleavage; Complex; Nitrogen paramagnetic; Periodic acid; Radical; Aromatic; Azines; *12095*.

$ClHCl^-$; Electron attachment; Infrared spectrum; Matrix isolation; Molecular rotation; Vacuum-ultraviolet photolysis; Vibrational potential function; Alkali metal reactions; $BrHBr^-$; Charge transfer; *12369*.

ClHCl free radical; Electron attachment; HCl dimer; Hydrogen bonding; Infrared spectrum; Matrix isolation; Ultraviolet spectrum; Vacuum-ultraviolet photolysis; Bichloride anion; *11975*.

Climatology; Extreme value theory; Gust factors; Structural engineering; Wind loads; Wind profile; Buildings; *BSS30*, pp. 151-164.

Climatology; Meteorology; Spatial correlation; Turbulence; Wind observations; Wind profiles; *BSS30*, pp. 23-25.

Climatology; Seismic loads; Structural engineering; Wind loads; Vibrations; Buildings; *BSS30*, pp. 129-131.

Clinical chemistry; Instrumentation; Standard reference materials; Automated analysis; *12047*.

Clinical chemistry; Organic SRMs; Standard reference materials; Spectrophotometry SRMs; *12194*.

Clinical research (dental); Composite restorations; Diagnosis; Physical properties of fillings; X-ray opaque; *11944*.

Clinical Standard Reference Materials; Fraction collecting; Gas chromatography; Interactive gels; Liquid chromatography design; Nitrilotriacetic acid; *TN589*.

Clinical thermometers; Glass thermometers, clinical; Mercury-in-glass thermometers; Thermometers, self-registering, clinical; *PS39-70*.

Clock dissemination; Crystal oscillators; Definition of second; Flicker noise; Frequency; Frequency stability; Lasers; Length standards; Measurement standards; Spectral density; Speed of light; Standard frequency broadcasts; *SP350*.

Close coupling; Configuration; Interaction; Resonant structure; Atomic absorption; *12094*.

Close coupling calculation; Differential cross sections; Elastic scattering; Electron; H_2 (hydrogen molecule); Rotational excitation; *12163*.

Close coupling calculation; Electron scattering; Pseudo-state expansion; *12155*.

Closed ecological system; Habitability; Maintainability prediction; Microbiology; Microflora shift; Physiology; Psychology; Space station simulator; Submersible; *SP336*, pp. 599-621.

Closed pumping system; He^3-He^4 dilution refrigerator; Mass spectrometer leak detector; Mechanical pump; Shaft seal; *12235*.

Closed system; Correlation functions; Entropy; Open system; Potentials of mean force; Activity derivatives; *12373*.

Closet doors, steel bi-fold; Doors, steel bi-fold; Steel bi-fold doors; Bi-fold doors, steel; *PS38-70*.

Closure; Feedthrough; High pressure; Leads; *12039*.

ClO_3F; Magnetic resonance; Relaxation times; Rotational diffusion; Spherical-top molecules; Angular relaxation; *12195*.

Clustering; Cold work; Cu; Fe; Magnetic moments; Mössbauer effect; Ni; Alloys; *11838*.

Clustering; Copper; Iron; Local moments; Mössbauer effect; Nickel; Alloys; *12199*.

Clustering; $Co_{0.6}Ni_{0.4}$ alloy; Electronic specific heat; Specific heat; 0.48 to 10 K; *11843*.

Cl_2; Emission; Electronic energy; $OCCl_2$; Photodissociation; Vacuum ultraviolet; Absorption coefficient; *12289*.

CMC; Colloid; Colloidal electrolyte; Critical concentration; Critical micelle concentration; Detergent; Hydrophobic bonding; Krafft point; Long chain compounds; Micelle; Paraffin chain salts; Selected values; Soap; Solubilization; *NSRDS-NBS36*.

CO; CO_2; Electron impact; Fourth positive bands; Oscillator strength; Rydberg state; Valence state; *12327*.

CO; Electronic transitions; Rotational analysis; Vibrational analysis; Vibrational and rotational constants; Absorption spectrum; **J.75A** *No. 5, 455-467 (1971)*.

Co-adsorption; Displacement reaction; Hydrogen; Single crystal; Tungsten; Work function; Carbon monoxide; Chemisorption; *12261*.

Coast Guard; Development; Interdisciplinary team; Management science; Model building; Organization; Search and rescue; Simulation; Team development; *12243*.

Coax; Infrared; Rf-dc; Thermopile radiation; Ammeter; *12198*.

Cockcroft-Walton neutron generator; Sample attenuation corrections; Sensitivity and gamma-ray spectra of the elements; 3-MeV neutron activation analysis; Absolute flux; *11913*.

CODATA; Key values; Thermodynamics; **J.75A** *No. 2, 97-101 (1971)*.

Coded character subsets; Codes; Data communication; Data interchange; Data processing; Federal Information Processing Standards; Graphic character subsets; Graphic subsets; Information interchange; Information processing; Standards; Subsets; *FIPS PUB 15*.

Codes; Dams; Earthquake damage; Earthquakes; Foundation geology; Highways; Hospital; Housing; Mobile home; Seismic; Standards; Structural engineering; Bridge; Building; *BSS40*.

Codes; Data communication; Data interchange; Data processing; Federal Information Processing Standards; Graphic character subsets; Graphic subsets; Information interchange; Information processing; Standards; Subsets; *FIPS PUB 15*.

Coefficient of friction; Friction assessment screening test machine; Friction materials test machine; Girling scale dynamometer; Inertia brake dynamometer; Vehicle road tests; Brake friction materials; *12051*.

Coexistence curve; Compressibility; Critical point; Oxygen; PVT; Chemical potential; *12185*.

Coexistence curve; Critical exponents; Critical point; Lattice gas; Power laws; Rectilinear diameter; Steam; Thermodynamic anomalies; Vapor pressure; Argon; Carbon dioxide; Classical equation; *11985*.

Coexistence curve; Critical point; Liquid-gas phase transition; Parametric form; Scaling; Thermodynamic properties; *12156*.

Coexistence curve; Critical region; N_2O; Rectilinear diameter; Refractive index; $CClF_3$; CO_2; *12341*.

Coherence; Coherence measurement; Interferometry; Wavefront shearing interferometer; *12321*.

Coherence; Laser stabilization; Length; Methane; Saturated absorption; *12296*.

Coherence; Partially coherent imaging; Resolution; Resolving power; Tri-bar targets; *12320*.

Coherence measurement; Interferometry; Wavefront shearing interferometer; Coherence; *12321*.

Coherent production; Cosmic rays; High momentum components; Many-body clusters; Nuclei; Quarks; *12144*.

Coherent states; Diamagnetism; Electron in a magnetic field; *11808*.

Cohesion; Core-core interactions; Electron density; Interatomic; One-electron potentials; Pseudopotentials; Band structure; *SP317*, pp. 179-200.

Cold neutron source; High flux; Irradiation; Neutron diffraction; Research reactor; Split core; *12351*.

Cold shrouding; Contamination; Environment; Ion pumping; Low pressure; Low temperature; Pumping; Ultraclean; Vacuum; Anti-migration traps; *SP336*, pp. 661-668.

Cold work; Cu; Fe; Magnetic moments; Mössbauer effect; Ni; Alloys; Clustering; *11838*.

Cold-curing methyl methacrylate; Dentures; Tensile strength;

Acrylic teeth; Adhesion; Autoadhesion; Bonding; *12340.*

Collagen; Frozen collagen; Mobile water; NMR; Adsorbed water; Calorimetry; *11998.*

Collective correlations; Four particle-four hole states; Light nuclei; Quartets; Rotational states; Vibrational states; *12146.*

Collective model; Giant resonance; Hydrodynamic model; Isospin; Nuclear structure; Charge distribution; *12287.*

Collision frequency; Helium negative glow discharge; Microwave cavity; Plasma density; *TN607.*

Collision parameters; Equivalent width; Flame spectra; Line shapes; Carbon monoxide; **J.75A** *No. 5, 469-479 (1971).*

Collisional-control; Non-LTE; Radiative-control; Temperature-control-bracket; Boundary temperature; *12360.*

Collisions; Gas laser; Line widths; Power output; Theory; Tuning curves; *11811.*

Colloid; Colloidal electrolyte; Critical concentration; Critical micelle concentration; Detergent; Hydrophobic bonding; Krafft point; Long chain compounds; Micelle; Paraffin chain salts; Selected values; Soap; Solubilization; Standard values; *NSRDS-NBS36.*

Colloidal electrolyte; Critical concentration; Critical micelle concentration; Detergent; Hydrophobic bonding; Krafft point; Long chain compounds; Micelle; Paraffin chain salts; Selected values; Soap; Solubilization; Standard values; *NSRDS-NBS36.*

Color; Gloss; Porcelain enamel; Weather resistance; Acid resistance; *BSS38.*

Color; Isomerism; Metamerism; Color-match classification; *12196.*

Color; Least squares; Luminance; Model; Neutral; Perception; Vision; Achromatic; Appearance; Brightness; Chromatic adaptation; Chromaticity; *11813.*

Color blindness; Color vision; Deuteranope; Protanope; *11824.*

Color centers; EPR; Hole centers; Optical absorption; Shared holes; $SrTiO_3$; *11805.*

Color centers; F^- centers; Fluorides; Alkaline earth; *12301.*

Color correction; Cool white fluorescent lamp; Correlated color temperature; Daylight fluorescent lamp; Heterochromatic photometry; Integrating sphere; Intercomparison; Luminous flux; Photometry; Spectroradiometry; Barnes colorimeter; *TN559.*

Color photography; Electron microscopy; Electron probes; Evaluation; Metallography; Microscopy; Polarized electromagnetic radiation; *11994.*

Color standards; Filter permanence; Limit filters; Railroad signals; Signal colors; Signal standards; Spectral transmittance of glass filters; Traffic signals; Aircraft signals; *TN564.*

Color vision; Deuteranope; Protanope; Color blindness; *11824.*

Color-match classification; Color; Isomerism; Metamerism; *12196.*

Color-stable composites; Methacrylates; Polymerization; Resins; Synthesis; Accelerators; Amines; *12302.*

Columnar grains; Fatigue crack initiation; Fatigue crack propagation; Residual stress; Titanium bearing steels; Chromium diffusion coating; *12087.*

Combinatorial analysis; Configurations; König's theorem; Matrices; 0,1 matrices; Matrix equations; Permutation matrix decompositions; Block design; **J.75B** *Nos. 1 and 2, 23-30 (1971).*

Combined environmental stress; Dynamic environment simulator; Man-machine system; Man-rated centrifuge; Simulation research; *SP336,* pp. 587-598.

Combined environments; Components; Material performance; Predictive testing; Structures; *SP336,* pp. 403-404.

Combustion front; Hypervelocity impact; Meteorid penetration; Oxidative detonation; Oxidative flash; Oxygen atmosphere; Spacecraft; Blast over-pressure; *SP336,* pp. 569-585.

Commercial weighing and measuring devices; Specifications; Technical requirements; Tolerances; *H44.*

Commercial weights and measures; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; *SP345-3.*

Communication; Information processing; Languages; Man-machine relationships; Teleprocessing; *12021.*

Communications; Data communications equipment; Data processing terminal equipment; Data transmission; Federal information processing standards; Serial-by-bit; Serial-by-character; Telecommunications; Teleprocessing; *FIPS PUB 16.*

Communications; Data transmission; Federal information processing standards; Serial-by-bit; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; Character structure; Character parity sense; *FIPS PUB 17.*

Communications; Data transmission; Federal information processing standards; Parallel-by-bit; Parity sense; Serial-by-character; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; *FIPS PUB 18.*

Communications; Hearing; Hearing aids; Selection of hearing aids; Speech communication; Audition; *CIS4.*

Commutator; Matrix; Orthogonal; Skew-symmetric; **J.75B** *Nos. 1 and 2, 17-21 (1971).*

Compaction density; Eddy current measurements; Fuel rods; Impregnation density; Monitor tests; Neutron radiography; Ultrasonics; X rays; *SP336,* p. 405.

Comparator; Thermoelement; Transfer voltmeter, voltage measurements; AC-DC difference; **J.75C** *Nos. 3 and 4, 145-153 (1971).*

Comparison of results; Dc potentiometer test set; Dual channel system; Modulated subcarrier; Ratio transformer test set; Small attenuation measurement; Small insertion loss measurement; Small reflection coefficient measurements; Stainless steel waveguide; *11917.*

Compatibility; Continuum; Contortion; Cosserat; Couple-stress; Defect; Deformation; Disclination; Dislocation; Dualism; Elasticity; Incompatibility; Motor calculus; Plasticity; Burgers vector; *SP317,* pp. 651-673.

Compatibility tests; Electrolytic protection; Hydrazine; Maraging steel; Metallic coatings; Missiles; Rocket-fuel tanks; *11934.*

Compensation; Ground motion; Infrasonic microphones; Seismic response; **J.75C** *No. 1, 41-45 (1971).*

Compensation method; Cryogenic noise generators; Mismatch error; Noise temperature measurement; *12182.*

Compilation; Cross section data; Photoabsorption; Photoionization; Photon; Atoms; *12210.*

Complementary error function; Heat diffusion; Laser host; Absorbing center; **J.75A** *No. 4, 261-268 (1971).*

Complex; Composite; Computer; Criteria; Evaluation; Gaussian primes; Indexing; Measurement; Performance; Prime; Program; Test; Assessment; *TN572.*

Complex molecules; Mass spectrometry; Molten salt halides; Thermodynamics; *12280.*

Complex; Nitrogen paramagnetic; Periodic acid; Radical; Aromatic; Azines; Cleavage; *12095.*

Complexing effects; Gas chromatography; Group separation; Mercuric nitrate; Olefins; Silver nitrate; Surface effect; Aliphatics; Aromatics; *12024.*

Complex-ion embrittlement; Dislocations; Liquid metal embrittlement; Surface; Surface active agent; *11972.*

Component identification; Result computation; Spectral resolution; Activation analysis; *12344.*

Components; Decomposition; Degassing; Environment; Evaporation; Outgassing; Simulation; Sublimation; Thermal conduction; Thermal vacuum tests; Volatile constituents; Volatilization; Absorption; Adsorption; "bake out"; *SP336,* pp. 473-485.

Components; Material performance; Predictive testing; Structures; Combined environments; *SP336*, pp. 403-404.

Components; Precoordination; Standards; Building; *BSS32*.

Components of error (within and between samples); Copper; Interferometer; Standard reference material; Thermal expansion; *12036*.

Components of error (within- and between-laboratory); Heats of sublimation (second and third law); Interlaboratory measurements; Silver; Standard errors; Standard reference materials; Vapor pressure; Cadmium; *SP260-21*.

Composite; Computer; Criteria; Evaluation; Gaussian primes; Indexing; Measurement; Performance; Prime; Program; Test; Assessment; Complex; *TN572*.

Composite adsorption; Isotopic exchange; Kinetics of adsorption; Mechanism of adsorption; Solution adsorption; Adsorption from solution; Calcium phosphate; *12249*.

Composite materials; Coupling agents; Epoxy polymer; Parting agents; Poisson's ratio; Release agents; Stress-strain curve; Volume dilation; *12379*.

Composite materials; Denture base materials; Physical properties; Prosthetic materials; Radiopacity-radiopaque; *12309*.

Composite restorations; Diagnosis; Physical properties of fillings; X-ray opaque; Clinical research (dental); *11944*.

Composite restorative materials; Finishing; Operative dentistry; Polishing instruments; Surface finish; *12308*.

Composite walls; Compressive strength; Concrete block; Flexural strength; Masonry; Mortar; Slenderness effects; Standards; Structural stability; Walls; Brick; Cavity walls; *BSS34*.

Composites; Denture base materials; Diagnosis; Light translucency; Physical properties; Radiopacity; Bonding; *12232*.

Composites; Denture base materials; Dentures; Dimensional stability; Foreign bodies; Prosthetics; Radiopacity; Silane bonding; *12310*.

Compressibility; Critical point; Oxygen; PVT; Chemical potential; Coexistence curve; *12185*.

Compressibility; Density; Dilatometric measurements; High pressure; Liquids; Ultrasonics; 2-methylbutane; Bulk modulus; **J.75A** *No. 2, 121-127 (1971)*.

Compressibility; High pressure; Single crystal; X-ray diffraction; Anisotropic compressibility; Azides; *12025*.

Compressibility factor; Gas; Gas, compressibility factor of; Gas, *PVT* properties of; Measurements; Second virial coefficient; Adsorption, gas on metal; Argon, compressibility factor of; **J.75C** *Nos. 3 and 4, 163-172 (1971)*.

Compressibility factors; Equation of state; High density; High temperature; Pairwise potentials; Redlich Kwong; Second virial coefficient; Thermodynamics; *11887*.

Compression members, concrete; Deflection; Equilibrium; Load eccentricity; Masonry; Section cracking; Stability; Stress distribution; Unreinforced concrete; Buckling; *12298*.

Compression tests; Dynamic loads; High-speed photography; Indicating instruments; Indicator characteristics; Loading rate; Loads (forces); Motion picture cameras; Photographic equipment; Static loads; Test equipment; *12080*.

Compression tests; Mass spectroscopy; Mechanical properties; Outgassing; Pressure measurements; Rock mechanics; Space environment simulation; Ultrahigh vacuum; Anisotropy; *SP336*, pp. 209-223.

Compressive strength; Concrete block; Flexural strength; Masonry; Mortar; Slenderness effects; Standards; Structural stability; Walls; Brick; Cavity walls; Composite walls; *BSS34*.

Compton-Raman interaction; Hamiltonian; Polarization; Radiation; Spectrometer; Azimuthal angle; *12345*.

Computation, temperature distribution; Furnaces, high-pressure; High-pressure furnaces; High-temperature, high-pressure research; Power dissipation; Temperature distribution, steady-state; Temperature gradients; **J.75C** *No. 2, 79-83 (1971)*.

Computer; Control vector; Set reduction; Structure search; Substructure search; Ambiguity; Binary matrices; Bond adjacency; Chemical information; *12337*.

Computer; Correlations; Grid; Intermittency; Isotropy; Moments; Probability-distributions; Turbulence; Velocity-gradients; *12316*.

Computer; Criteria; Evaluation; Gaussian primes; Indexing; Measurement; Performance; Prime; Program; Test; Assessment; Complex; Composite; *TN572*.

Computer; Image processing; Microscope; Microspectrophotometry; Pattern recognition; Biological structure; Biomedical instrumentation; *11834*.

Computer; Ozone; Plastic material; Simulation; Solar ultraviolet radiation; Atmospheric environment; Balloon; *SP336*, pp. 245-259.

Computer activities, NBS; Computers; Computer science at NBS; *12002*.

Computer amplitude reference; Magnetic tape; Master standard; Saturation curves; Secondary standard; Signal level calibration; Standard reference materials; Unrecorded reference; Average signal peak level; *SP260-29*.

Computer automation; Resistance thermometers; Resistor intercomparison; Standard cell surveillance; *SP335*, pp. 29-33.

Computer control systems; Instrument calibration procedures; Instrument performance testing; Pulse technology; Time domain testing; Automatic measuring devices; Automatic performance test; *SP335*, pp. 23-28.

Computer noise simulation; Digital filters; Flicker noise; Fractional integration; Recursive digital filters; Analog noise simulation; *TN604*.

Computer package; Data base; Document processing; Information retrieval; Document storage and retrieval; Text; Text processing; Bibliographic system; *TN599*.

Computer program; Isopropyl; NMR; Nuclear magnetic resonance; Phosphorus; Spectral analysis; *11897*.

Computer program for Youden diagrams; Correlation effect; End standard of length; Accelerometer round robin; *SP335*, pp. 39-40.

Computer programs; Curve fitting; Gram-Schmidt orthogonalization; Householder transformations; Iterative refinement; Least squares; Linear equations; Orthogonalization; Orthogonal polynomials; Regression; Rounding error; Stepwise regression; *12184*.

Computer programs; Fourier analysis; Nickel steels; X-ray analysis; X-ray diffraction; Statistics; *TN600*.

Computer science at NBS; Computer activities, NBS; Computers; *12002*.

Computer simulation; Copper; Dislocation structure; Pair-potential; Point defects; *SP317*, pp. 273-283.

Computer simulation; Dislocation core structure; Interatomic potentials; Iron; *SP317*, pp. 305-308.

Computer simulation; Dislocation motion; Mechanical properties; Precipitation hardening; *SP317*, pp. 1083-1098.

Computer simulation; Dislocation-interstitial interaction; Interatomic potentials; Lattice defects; Carbon in iron; *SP317*, pp. 299-303.

Computer simulation; Dislocation-phonon interaction; Frenkel-Kontorowa model; *SP317*, pp. 403-414.

Computer simulation; Green's tensors; Interatomic potential; Lattice studies; Peierl's energy; Screw dislocation; *SP317*, pp. 291-298.

Computer simulation; Kansaki method; Lattice statics; Point defects; Schottky pairs; *SP317*, pp. 219-245.

Computer system implementation; Examples; OMNITAB II; Software; Test problems; Accuracy; ANSI FORTRAN; *TN551*.

Computers; Computer science at NBS; Computer activities, NBS; *12002*.

Computers; Data processing; Federal Information Processing Standards Publication; National government; Representations and codes; Standard Metropolitan Statistical Areas; *FIPS PUB 8-1*.

Computers; Digital logic; Image processing; Microscope; Microspectrophotometry; Pattern recognition; *11990.*

Computers, data elements and codes; Data processing systems; Federal Information Processing Standards; International Organization for Standardization; Management information systems; Standards; U.S. Government; American National Standards; *FIPS PUB 12.*

Concentrated alloys; Correlation factor; Diffusion; Random alloy; Vacancies; Activation analysis; *12167.*

Concentration dependence; Excitation dependence; Gallium arsenide; Impurity effects; Photoluminescence; Temperature dependence; Band-to-band recombination; *12216.*

Concentration determination; Magnetic susceptibility; Optical absorption coefficient; Radiation damage; Ruby; *12348.*

Concrete; Durability; Heat of hydration; Portland cements; Shrinkage; Statistical evaluation; Strength; Sulfate expansion; Trace elements; Alkalies; *11863.*

Concrete; Durability; Material properties; Physical properties; Cement; Chemical composition; *BSS36.*

Concrete block; Flexural strength; Masonry; Mortar; Slenderness effects; Standards; Structural stability; Walls; Brick; Cavity walls; Composite walls; Compressive strength; *BSS34.*

Condensation; Contamination control; Evaluation; Far infrared; Fluid dynamic force; Microorganisms; Optical properties; Planetary quarantine; Polymers; Shock force; Space simulation; Testing; Volatile products; Absorption; *SP336,* pp. 51-77.

Conditions for convergence of solutions; Integral equation of first kind; Shifting operators; Slit correction; Slit weighting-function; Small-angle x-ray scattering; Strong numerical instability; **J.75B,** *Nos. 3 and 4, 187-207 (1971).*

Conduction of paints during ultraviolet exposure; Electrode potential of paints; Photo degradation; Thermal control coatings; Ultraviolet degradation; Alkaline paint; *SP336,* pp. 393-402.

Conference; Continuum mechanics; Crystal physics, disclinations; Dislocations; Elasticity; Electron-dislocation interactions; Lattice defects; Phonon-dislocation interactions; Solid-state; Theoretical physics; Thermally activated processes; Twinning; *SP317.*

Conference; Crystallography; Electron microprobe; Fluorescence analysis; Gamma rays; Photons; Röntgen; X rays; Absorption corrections; Attenuation coefficient; *11814.*

Conference; Weights and measures; Weights and measures—history; Weights and measures—law; Weights and measures—regulations; Weights and measures—technical requirements; *SP342.*

Conference proceedings; Contract research; Federal government; Information exchange; NBS; Operations research/systems analysis studies; OR users and producers; Planning; *SP347.*

Configuration; Conformation; Kratky-Porod model; Light scattering; Osmotic pressure; Poly(n-alkyl isocyanates); Radii of gyration; Second virial coefficients; *12355.*

Configuration; Interaction; Resonant structure; Atomic absorption; Close coupling; *12094.*

Configuration entropy; Correlation function; Entropy; Hard sphere; Liquid state; Neon; Percus-Yevick equation; *12370.*

Configuration interaction; Correlation energy surface; Hartree-Fock; H_3^+; H_3; H_3^-; H_4; LiH_2; LiHF; HNO; HeH_2^+; Proton transfer; Activation energy; *11969.*

Configuration interaction; K electron excitation; Lithium vapor; Two electron excitation; Absorption spectroscopy; Autoionization; *12034.*

Configuration interaction; Oscillator strengths; Atomic lifetimes; Atomic spectra; *12123.*

Configuration mixing; Hyperons; Resonances; Rotations; SU(6) × 0(3); Baryons; *11912.*

Configurational thermodynamic properties; Excluded volume; Extrapolations; Lattice models; Noncombinatorial method; Statistical equilibrium; *11880.*

Configurations; Excluded volume effect; Loops; Polymer adsorption; Surface layer; Θ-point; Trains; *12240.*

Configurations; König's theorem; Matrices; 0,1 matrices; Matrix equations; Permutation matrix decompositions; Block design; Combinatorial analysis; **J.75B** *Nos. 1 and 2, 23-30 (1971).*

Conformation; Kratky-Porod model; Light scattering; Osmotic pressure; Poly(n-alkyl isocyanates); Radii of gyration; Second virial coefficients; Configuration; *12355.*

Conformational entropy; Free energy; Nucleation rate; Rate constants; Self-nucleation; Steady-state; Cilia; *12293.*

Conformations; Coupling constants; Iterative analysis; m-dioxane ring; Proton magnetic resonance; Pyranoid ring; Spectroscopy; 1,2:4,6-di-O-benzylidene-α-D-glucopyranoses; *11874.*

Congruences; Exact solutions; Linear equations; Modular arithmetic; **J.75B** *Nos. 1 and 2, 69-75 (1971).*

Connector; Efficiency; Sliding short; Adaptor; **J.75C** *Nos. 3 and 4, 173-180 (1971).*

Connectors; Mismatch; Power equation; Power measurement; Calibration; **J.75C** *No. 2, 89-93 (1971).*

Conservation equations; Equation of motion; Hydrodynamic equations; Quantum fluids; Quantum mechanical density distribution; Quantum statistical mechanics; *11923.*

Constitutional supercooling; Copper (99.999%); Dislocation arrangements; Distribution of impurities; Precipitate particles; Thermomechanical treatment; Cavities; Cellular solidification; *12339.*

Constitutive relations; Continuum mechanics; Dislocations; Inhomogeneous elastic bodies; *SP317,* pp. 907-924.

Constitutive relations; Continuum mechanics; Dislocation kinematics; Dislocations; Oriented media; Thermodynamics and dislocation motion; *SP317,* pp. 1041-1052.

Constitutive relations; Dislocation dynamics; Non-linear elasticity; Anisotropic elasticity; Anisotropic plasticity dislocations; *SP317,* pp. 837-876.

Constraint equations; Eckart conditions; Eulerian angles; Large amplitude vibrational coordinate; Molecule-fixed axes; Reference configuration; *12117.*

Constricted arc; Enthalpy; Operational limits; Stagnation pressure; Arc currents; Arc heaters; *SP336,* pp. 879-892.

Construction industry; Housing; Precast concrete; Production capacity; Production management; Production methods; Standardization; United Soviet Socialist Republics; Building economics; Building systems; *SP334.*

Consumer commodities; Labeling; Packaging; Proliferation; Quantity standards; Regulations; *12259.*

Consumer package; Exemption; Fluid measure; Labeling; Net quantity; Principal display panel; Regulations; Weights and measures; *H108.*

Consumers; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; SI; *SP345-7.*

Contact resistance; Oxide semiconductors; TiH_2; Soldering; *11812.*

Contamination; Dental amalgam; Environment; Hazards; Hygiene; Mercury; Vapor; *12254.*

Contamination; Environment; Ion pumping; Low pressure; Low temperature; Pumping; Ultraclean; Vacuum; Anti-migration traps; Cold shrouding; *SP336,* pp. 661-668.

Contamination; Mass transfer; Spacecraft; *SP336,* pp. 79-103.

Contamination; Organic residues; Outgassing; Polymeric materials; Residual gas analysis; Test facility; Vacuum; Chemical analysis; *SP336,* pp. 1-24.

Contamination collection units; Gas-liquid chromatography; Infrared spectrometry; Mass spectrometry; Quartz crystal oscillator mass monitors; Radiometry; Reflectometry; Space environment simulation chambers; *SP336*, pp. 25-49.

Contamination control; Evaluation; Far infrared; Fluid dynamic force; Microorganisms; Optical properties; Planetary quarantine; Polymers; Shock force; Space simulation; Testing; Volatile products; Absorption; Condensation; *SP336*, pp. 51-77.

Content of articles; Data; Description of experiments; Evaluation of data; Numerical data; Publication standards; Titles; Abstracts; Chemistry; *11806*.

Continuum; Contortion; Cosserat; Couple-stress; Defect; Deformation; Disclination; Dislocation; Dualism; Elasticity; Incompatibility; Motor calculus; Plasticity; Burgers vector; Compatibility; *SP317*, pp. 651-673.

Continuum mechanics; Cosserat continua; Dislocation field theory; Oriented media; *SP317*, pp. 817-829.

Continuum mechanics; Crystal physics, disclinations; Dislocations; Elasticity; Electron-dislocation interactions; Lattice defects; Phonon-dislocation interactions; Solid-state; Theoretical physics; Thermally activated processes; Twinning; Conference; *SP317*.

Continuum mechanics; Curvature tensor; Disclination; Internal stresses; Quasidisclination; Affine connexions; *SP317*, pp. 637-649.

Continuum mechanics; Dislocation distributions; Micromorphic dislocations; Micropolar dislocations; *SP317*, pp. 1023-1040.

Continuum mechanics; Dislocation field theory; Statistical methods; *SP317*, pp. 785-816.

Continuum mechanics; Dislocation kinematics; Dislocations; Oriented media; Thermodynamics and dislocation motion; Constitutive relations; *SP317*, pp. 1041-1052.

Continuum mechanics; Dislocations; Inhomogeneous elastic bodies; Constitutive relations; *SP317*, pp. 907-924.

Continuum mechanics; Gradient; Matrices; Matrix calculus; Partial differentiation; Product rule; Tensor function; Trace; Chain rule; *J.***75B**, *Nos. 3 and 4, 97-107 (1971)*.

Continuum mechanics; Kinematics; Non-Riemannian geometry; Affine connection; *SP317*, pp. 999-1020.

Continuum mechanics; Non-Riemannian theories; Plasticity; Yielding; *SP317*, pp. 761-784.

Continuum mechanics; Non-Riemannian geometry; Stress; Affine connection; *SP317*, pp. 943-962.

Contortion; Cosserat; Couple-stress; Defect; Deformation; Disclination; Dislocation; Dualism; Elasticity; Incompatibility; Motor calculus; Plasticity; Burgers vector; Compatibility; Continuum; *SP317*, pp. 651-673.

Contract research; Federal government; Information exchange; NBS; Operations research/systems analysis studies; OR users and producers; Planning; Conference proceedings; *SP347*.

Contraction; Dentures; Epoxy; Expansion; Hard rubber; Retention; Serviceability; Stability; Adaption; Acrylic; *12189*.

Control vector; Set reduction; Structure search; Substructure search; Ambiguity; Binary matrices; Bond adjacency; Chemical information; Computer; *12337*.

Convective processes; Mars atmosphere exploration; Planetary atmosphere-surface interaction; Planetary meteorology; Research facility; Simulation techniques; Space research; *SP336*, pp. 699-723.

Conversion electrons; Iron; Mössbauer spectroscopy; Resonant detector; *TN541*.

Convex functions; Convex sets; Homotopy; *J.***75B** *Nos. 1 and 2, 49-61 (1971)*.

Convex sets; Homotopy; Convex functions; *J.***75B** *Nos. 1 and 2, 49-61 (1971)*.

Cool white fluorescent lamp; Correlated color temperature; Daylight fluorescent lamp; Heterochromatic photometry; Integrating sphere; Intercomparison; Luminous flux; Photometry; Spectroradiometry; Barnes colorimeter; Chromaticity coordinate; *TN559*.

Coolers, portable picnic; Picnic coolers, portable; Portable picnic coolers; *PS49-71*.

Cooperation; Flammability; Flammability reduction; Mattresses; Research; Small carpets and rugs; Standards; Test development; Annual report to Congress; Blankets; Carpets and rugs; Children's sleepwear; *TN596*.

Coordination complex; Inorganic polymer; Pyrazine ligand; X-ray structure determination; *12054*.

Copolymerization; Fluoropolymers; Glass temperature; High pressure; Radiation-induced; Tetrafluoroethylene; 3,3,4,4,5,5,5-heptafluoropentene-1; Amorphous polymer; *11868*.

Copolymers; Crosslinking; Divinylbenzene; Infrared; Styrene; *11884*.

Copper; Dislocation structure; Pair-potential; Point defects; Computer simulation; *SP317*, pp. 273-283.

Copper; EPR; *g*-factors; Hyperfine interaction; Quadrupole coupling; Rutile; Titanium dioxide; *11804*.

Copper; Experimental cross sections; Gold; Inelastic electron scattering; Multiple scattering; 0.1 to 3.0 MeV; Carbon; *12113*.

Copper; Interferometer; Standard reference material; Thermal expansion; Components of error (within and between samples); *12036*.

Copper; Iron; Local moments; Mössbauer effect; Nickel; Alloys; Clustering; *12199*.

Copper; Magnetoresistance; Aluminum; *12152*.

Copper; Magnetoresistance; *12153*.

Copper alloys; Cryogenics; Electrical conductivity; Iron alloys; Nickel alloys; Titanium alloys; Aluminium alloys; *11873*.

Copper (99.999%); Dislocation arrangements; Distribution of impurities; Precipitate particles; Thermomechanical treatment; Cavities; Cellular solidification; Constitutional supercooling; *12339*.

Core-core interactions; Electron density; Inter-atomic; One-electron potentials; Pseudopotentials; Band structure; Cohesion; *SP317*, pp. 179-200.

Cork; Epoxy-novolac; Erosion; Phenolic carbon; Silicone rubber; Ablation; Aerodynamic shear; Carbon; Char; *SP336*, pp. 837-851.

Coronal spectra; Periodicities, atomic spectra; Rare-earth spectra; Regularities, atomic spectra; Solar spectra; Atomic spectra; *12288*.

Coronal spectra; Rare-earth spectra; Solar spectra; Spectra, atomic; Spectra, rare-earth; Atomic spectra; *11987*.

Correction for gas; Gas; Gas law correction; Imperfect gas; Second virial coefficient; Adsorption; *12330*.

Corrections; Electron probe; Homogeneity; Matrix scanner; Microanalysis; Quantitative analysis; Standard reference materials; X-ray emission; Alloys; *SP260-28*.

Correlated color temperature; Daylight fluorescent lamp; Heterochromatic photometry; Integrating sphere; Intercomparison; Luminous flux; Photometry; Spectroradiometry; Barnes colorimeter; Chromaticity coordinate; Color correction; *TN559*.

Correlation; Deviations from geometric mean rule; Interaction energy parameters; Ionization potentials; Binary fluid mixtures; *11962*.

Correlation; Electron scattering; Form factor; Helium; Hydrogen; Sum rule; *11916*.

Correlation effect; End standard of length; Accelerometer round robin; Computer program for Youden diagrams; *SP335*, pp. 39-40.

Correlation energy surface; Hartree-Fock; H_3^+; H_3; H_3^-; H_4; LiH_2; LiHF; HNO; HeH_2^+; Proton transfer; Activation energy; Configuration interaction; *11969*.

Correlation factor; Diffusion; Random alloy; Vacancies; Activation analysis; Concentrated alloys; *12167*.

Correlation function; Entropy; Hard sphere; Liquid state; Neon;

Percus-Yevick equation; Configuration entropy; *12370.*

Correlation functions; Entropy; Open system; Potentials of mean force; Activity derivatives; Closed system; *12373.*

Correlations; Grid; Intermittency; Isotropy; Moments; Probability-distributions; Turbulence; Velocity-gradients; Computer; *12316.*

Corrosion; Corrosion rate; Disturbed soil; Instantaneous rate; Pit depth; Pitting factor; Polarization; Steel piling; Undisturbed soil; Weight loss; **J.75C** *No. 2, 107-121 (1971).*

Corrosion; Directional effects; Grain morphology; Preferred orientation; Stress corrosion; Aluminum alloy; *11839.*

Corrosion; Electron diffraction; Electron microscopy; Research techniques; *12104.*

Corrosion rate; Disturbed soil; Instantaneous rate; Pit depth; Pitting factor; Polarization; Steel piling; Undisturbed soil; Weight loss; Corrosion; **J.75C** *No. 2, 107-121 (1971).*

Corundum; Crystal defects; Crystal growth; Density of states; Diffusion; Glass; High temperature materials; Laser damage; Laser degradation; Laser glass; Laser materials; Mass transport; Neodymium glass; Optical properties; Opto-elastic properties; *TN565.*

Corundum; Drop calorimetry; Enthalpy; Heat capacity standard; Specific heat; Standard reference material; Synthetic sapphire; Thermodynamic functions; Alumina; Aluminum oxide; **J.75A** *No. 5, 401-420 (1971).*

Corundum; Energy levels of Gd^{+++} in Al_2O_3; Quadrupole transitions; Spin Hamiltonian; Transition probabilities; Ultrasonic (paramagnetic) resonance; Ultrasonic transition probabilities; Wave functions of Gd^{+++}; **J. 75A** *No. 5, 493-523 (1971).*

Cosmic rays; High momentum components; Many-body clusters; Nuclei; Quarks; Coherent production; *12144.*

Cosserat; Couple-stress; Defect; Deformation; Disclination; Dislocation; Dualism; Elasticity; Incompatibility; Motor calculus; Plasticity; Burgers vector; Compatibility; Continuum; Contortion; *SP317,* pp. 651-673.

Cosserat continua; Dislocation field theory; Oriented media; Continuum mechanics; *SP317,* pp. 817-829.

Cottrell atmospheres; Mechanical properties; Phonon scattering; Thermal resistivity; *SP317,* pp. 391-394.

Coulometric titration; High-precision acidimetry; High precision coulometry; Accurate analysis; Boric acid; **J.75A** *No. 5, 421-428 (1971).*

Coulometry; Trace analysis; Chromium; *11872.*

Coulometry; Zinc, atomic weight; Atomic weight; **J.75A** *No. 6, 561-564 (1971).*

Coulter counter; Electroformed sieves; Microscopic size measurement; Particle size measurement; Air elutriation; Air permeability; Andreasen pipette; Calibrated glass beads; *11895.*

Counting geometry; Mass absorption coefficient derivation; Strontium 90 wall-thickness measurement gage; Thin-wall mensuration; Attenuation of betas; Beta-transmission phenomenology; *SP335,* pp. 11-21.

Coupled channel calculation; Nuclear orientation; Nuclear Ramsauer effect; Nuclear shape; Optical-model; Total neutron cross section; ^{165}Ho; Black-nucleus model; *12007.*

Coupled equations; Differential equations; Self-adjoint equations; Sturm-Liouville systems; Boundary value problems; **J.75B** *Nos. 3 and 4, 125-138 (1971).*

Coupler; Directional coupler; Directivity; Impedance measurements; Power measurements; *11893.*

Coupler; Directional coupler; Directivity; Impedance measurements; Power measurements; *12070.*

Couple-stress; Defect; Deformation; Disclination; Dislocation; Dualism; Elasticity; Incompatibility; Motor calculus; Plasticity; Burgers vector; Compatibility; Continuum; Contortion; Cosserat; *SP317,* pp. 651-673.

Coupling agents; Epoxy polymer; Parting agents; Poisson's ratio; Release agents; Stress-strain curve; Volume dilation; Composite materials; *12379.*

Coupling constants; Iterative analysis; *m*-dioxane ring; Proton magnetic resonance; Pyranoid ring; Spectroscopy; 1,2:4,6-di-*O*-benzylidene-α-D-glucopyranoses; Conformations; *11874.*

Covalent-ionic solids; Dislocation-electron interactions; Fermi energy; Semiconductors; Band structure; *SP317,* pp. 1293-1302.

Cover glass, test method for; Hemacytometer; Interferometry; Planarity; *TN579.*

CO_2; Coexistence curve; Critical region; N_2O; Rectilinear diameter; Refractive index; $CClF_3$; *12341.*

CO_2; CO_3; Force constants; Infrared spectrum; Matrix isolation; O-atom reaction; Structure; Ultraviolet spectrum; Vacuum-ultraviolet photolysis; *12101.*

CO_2; Electron impact; Fourth positive bands; Oscillator strength; Rydberg state; Valence state; CO; *12327.*

CO_3; Force constants; Infrared spectrum; Matrix isolation; O-atom reaction; Structure; Ultraviolet spectrum; Vacuum-ultraviolet photolysis; CO_2; *12101.*

Crack healing; Fracture; Glass; Strength; Surface; *11993.*

Crack nucleation; Dislocations-elasticity; Internal stresses; *SP317,* pp. 151-162.

Crack propagation; Fracture; Glass; Static fatigue; Stress corrosion; *11992.*

Criteria; Evaluation; Gaussian primes; Indexing; Measurement; Performance; Prime; Program; Test; Assessment; Complex; Composite; Computer; *TN572.*

Critical concentration; Critical micelle concentration; Detergent; Hydrophobic bonding; Krafft point; Long chain compounds; Micelle; Paraffin chain salts; Selected values; Soap; Solubilization; Standard values; Surface active agents; *NSRDS-NBS36.*

Critical exponents; Critical point; Lattice gas; Power laws; Rectilinear diameter; Steam; Thermodynamic anomalies; Vapor pressure; Argon; Carbon dioxide; Classical equation; Coexistence curve; *11985.*

Critical flow; Pressure profile; Steam; Venturi; Water; *TN608.*

Critical micelle concentration; Detergent; Hydrophobic bonding; Krafft point; Long chain compounds; Micelle; Paraffin chain salts; Selected values; Soap; Solubilization; Standard values; Surface active agents; Surface chemistry; Surface tension; *NSRDS-NBS36.*

Critical phenomena; Diamond lattice; $DyPO_4$; Ising system; Low temperature; Magnetic susceptibility; Metamagnetism; Optical absorption; *12126.*

Critical phenomena; Immiscibility; Oxide glasses; Viscosity; *12294.*

Critical point; Fluorine; Latent heats of vaporization; Saturated liquid densities; Saturated vapor densities; Vapor pressure; *11980.*

Critical point; Lattice gas; Power laws; Rectilinear diameter; Steam; Thermodynamic anomalies; Vapor pressure; Argon; Carbon dioxide; Classical equation; Coexistence curve; Critical exponents; *11985.*

Critical point; Liquid-gas phase transition; Parametric form; Scaling; Thermodynamic properties; Coexistence curve; *12156.*

Critical point; Oxygen; PVT; Chemical potential; Coexistence curve; Compressibility; *12185.*

Critical point pressure; Fluorine; Normal boiling point; Vapor pressure data; Vapor pressure equation; *11835.*

Critical point theories; Immiscibility; Phase transitions; Structural relaxation; Transport phenomena; Viscous flow; **J.75A** *No. 3, 175-184 (1971).*

Critical region; Equation of state; Liquid-gas transition; Phase boundary; Phase transition; Thermodynamic scaling; **J.75A** *No. 2, 103-107 (1971).*

Critical region; Normal hydrogen; Parahydrogen; Thermal conductivity; *11827.*

Critical region; N_2O; Rectilinear diameter; Refractive index; $CClF_3$; CO_2; Coexistence curve; *12341.*

Critical temperature; Face centered cubic lattice; Magnetic dipole-dipole coupling; Specific heats; Cesium titanium alum; *12077.*

Critical transport; Critical viscosity; Critical viscous flow; Structural relaxation; Ultrasonic spectroscopy; *12120.*

Critical viscosity; Critical viscous flow; Structural relaxation; Ultrasonic spectroscopy; Critical transport; *12120.*

Critical viscous flow; Structural relaxation; Ultrasonic spectroscopy; Critical transport; Critical viscosity; *12120.*

Cross section; Desorption; Electron stimulated desorption; Hydrogen; Nickel; Nitrogen; Oxygen; Surface; Tungsten; Adsorption; Chemisorption; *12332.*

Cross section; Diffraction shrinkage; High energy; Pomeranchuck theorem; Asymptotics; *11870.*

Cross section; Elastic scattering; Electron; Molecule; Atom; *12283.*

Cross section; Electric transition; Electrodisintegration; Few nucleon systems; Long wavelength; *12279.*

Cross section; Electron; Molecule; Atom; *12161.*

Cross section; Helium-3; Photonuclear; Radiative capture; Angular distribution; *11886.*

Cross section data; Detachment; Dissociation; Ionization; Photoabsorption; Photoabsorption theory; Total absorption cross sections; Absorption and ionization coefficients; *NBS-OSRDB-70-4 (COM-71-00025).*

Cross section data; Photoabsorption; Photoionization; Photon; Atoms; Compilation; *12210.*

Cross slip; Mechanical properties; Misfit strain; Precipitation hardening; Activation energy; *SP317,* pp. 1115-1134.

Cross-hatched striations; Teflon; Ablation; Ablation-induced transition; *SP336,* pp. 813-835.

Crosslinking; Differential thermal analysis; Ion exchange; Organic acid; Oxycellulose; Stability; Sulfuric acid; Thermogravimetric analysis; Alum; Aluminum; Apparent activation energy; Calcium; Cellulose; *12218.*

Crosslinking; Divinylbenzene; Infrared; Styrene; Copolymers; *11884.*

Cross-section for viscosity; Hard sphere gas; Quantum corrections; Statistical mechanics; Viscosity; Boltzmann gas; *12303.*

Crushed ice, package quantities of; Cubed ice, package quantities of; Ice, package quantities of; Package quantities of ice; Sized ice, package quantities of; Block ice, package quantities of; *PS48-71.*

Cryodeposit; Cryogenics; Frost; Infrared; Integrating sphere; Mars; Reflectance; Scattering; Simulation; Spectral; Absorbing; Anomalous dispersion; Carbon dioxide; *SP336,* pp. 165-183.

Cryogenic; Flow; Flowmeters; Liquid nitrogen; Measurement; Positive displacement; *TN605.*

Cryogenic; Flow facility; Liquid nitrogen; Measurement; Accuracy statement; *TN606.*

Cryogenic; Low-temperature; Magnetometer; Piezoelectric; Vibrating-sample magnetometer; Bimorph; *12046.*

Cryogenic noise generators; Mismatch error; Noise temperature measurement; Compensation method; *12182.*

Cryogenics; Dilution refrigerator; Fermi-Dirac statistics; Heat exchangers; Helium-3; Helium-4; Liquid helium; Mixtures; Quantum fluid; Thermodynamic properties; *11981.*

Cryogenics; Electrical conductivity; Iron alloys; Nickel alloys; Titanium alloys; Aluminium alloys; Copper alloys; *11873.*

Cryogenics; Electrical resistivity; Lorenz ratio; Nickel alloys; Seebeck effect; Thermal conductivity; Titanium alloy; Transport properties; Aluminum alloy; **J.75A** *No. 4, 269-277 (1971).*

Cryogenics; Electrical resistivity; Electrolytic iron; Lorenz ratio; Seebeck effect; Thermal conductivity; Transport properties; *SP260-31.*

Cryogenics; Equipment design; Heat transmission; Thermal contact; *11816.*

Cryogenics; Frost; Infrared; Integrating sphere; Mars; Reflectance; Scattering; Simulation; Spectral; Absorbing; Anomalous dispersion; Carbon dioxide; Cryodeposit; *SP336,* pp. 165-183.

Cryogenics; Liquid air; Liquid nitrogen; Liquid oxygen; Neutral buoyancy; Space simulation; *SP336,* pp. 623-649.

Cryogenics; Low temperature physics; *11963.*

Cryogenics; Pumps; Cavitation; *TN397.*

Cryogenics; Superconductivity; Transition temperatures; Vanadium carbides; Band structure of solids; *12266.*

Cryopumping; Ion pump; Pumping speed; Space simulation chamber; Vacuum; *SP336,* pp. 683-698.

Cryostat; Electrical resistance; Soft materials; Strain extensometer; *11825.*

Cryostat; Fabrication techniques; Fluorine, materials compatibility; PVT apparatus; PVT method; *11930.*

Cryostat; Fatigue; Impact; Low temperature; Mechanical property equipment; Stainless steel; **J.75C** *No. 2, 95-98 (1971).*

Crystal; Crystal growth; Crystallization; Growth mechanisms; Morphological stability; Nucleation; Phase changes; Transport processes; *11918.*

Crystal defects; Crystal growth; Density of states; Diffusion; Glass; High temperature materials; Laser damage; Laser degradation; Laser glass; Laser materials; Mass transport; Neodymium glass; Optical properties; Opto-elastic properties; Oxides; *TN565.*

Crystal growth; Crystallization; Growth mechanisms; Morphological stability; Nucleation; Phase changes; Transport processes; Crystal; *11918.*

Crystal growth; $CsCuCl_3$; Electrooptic effect; Index of refraction; Nonlinear optics; Transmission; *12032.*

Crystal growth; Cuprous oxide; Single crystal; *12137.*

Crystal growth; Damage threshold; Glass; High temperature materials; Laser; Oxides; Oxygen diffusion; Pure materials; Sapphire; Al_2O_3; *TN703.*

Crystal growth; Damage threshold; Glass; High temperature materials; Laser; Oxides; Oxygen diffusion; Pure materials; Sapphire; Al_2O_3; *TN574.*

Crystal growth; Density of states; Diffusion; Glass; High temperature materials; Laser damage; Laser degradation; Laser glass; Laser materials; Mass transport; Neodymium glass; Optical properties; Opto-elastic properties; Oxides; Ruby; Rutile; *TN565.*

Crystal growth; Vapor crystal growth; Aluminum oxide; Bicrystals; *12013.*

Crystal growth mechanisms; Electron diffraction of polymers; Electron microscopy of polymers; Polymer crystals; Polymer morphology; Polyoxymethylene crystals; Post irradiation heat treatment; α-particle initiation; Chain folded crystals; *12030.*

Crystal oscillators; Definition of second; Flicker noise; Frequency; Frequency stability; Lasers; Length standards; Measurement standards; Spectral density; Speed of light; Standard frequency broadcasts; Statistics of time/frequency measurements; Time; *SP350.*

Crystal physics, disclinations; Dislocations; Elasticity; Electron-dislocation interactions; Lattice defects; Phonon-dislocation interactions; Solid-state; Theoretical physics; Thermally activated processes; Twinning; Conference; Continuum mechanics; *SP317.*

Crystal structure; Diffraction; Molecular structure; Neutron; Nuclear reactor; Radiation; Scattering; *TN567.*

Crystal structure; Hydrate; Ion pairs; Mineralization; Calcification; Calcium carbonate; *11951.*

Crystal structure; Integrated intensities; Lattice constants; Peak intensities; Powder patterns; Reference intensities; Standard; X-ray diffraction; *Monogr. 25, Section 9.*

Crystal structure; Neutron diffraction; PH_4Br; Rigid-body analysis; Thermal motion; *12119.*

Crystal structure; Shortite; Single-crystal x-ray diffraction; Calcium sodium carbonate; J.75A*No. 2, 129-135 (1971).*

Crystal structure; Single crystal x-ray diffraction; Calcium carbonates; Carbonates; J.75A*No. 1, 27-32 (1971).*

Crystal structure; Single crystal x-ray diffraction; Aragonite; Barium calcium carbonate; Calcium carbonate; J.75A *No. 3, 197-203 (1971).*

Crystal structures; Glaserite; Hydroxyapatite; Single crystal x-ray diffraction; Calcium phosphate; Calcium phosphate-calcium silicate solid solution; Calcium phosphosilicates; Calcium silicates; *12273.*

Crystal surface imperfections; Disclinations; Screw disclinations; *SP317,* pp. 593-606.

Crystal transition; Cubic crystal; Glass; Heat capacity; Monoclinic crystal; Low temperature; Planar molecular structure; Spherical shell molecules; Vitreous state; Arsenious oxide; Arsenolite; Claudetite; *12311.*

Crystallization; Growth mechanisms; Morphological stability; Nucleation; Phase changes; Transport processes; Crystal; Crystal growth; *11918.*

Crystallographic theory; Iron-nickel alloy; Martensite; *11820.*

Crystallography; Electron microprobe; Fluorescence analysis; Gamma rays; Photons; Röntgen; X rays; Absorption corrections; Attenuation coefficient; Conference; *11814.*

Crystallography; Gold-cadmium alloy; Martensite; Phase transformation; Twinning; *12006.*

Cr^{3+}; Energy transfer; Excitation; Lifetime; Photoluminescence; *12318.*

$CsCuCl_3$; Electrooptic effect; Index of refraction; Nonlinear optics; Transmission; Crystal growth; *12032.*

Cu; Deep probes; Emission; Occupied bands; Soft x-ray; Band structure; *11952.*

Cu; Fe; Magnetic moments; Mössbauer effect; Ni; Alloys; Clustering; Cold work; *11838.*

Cubed ice, package quantities of; Ice, package quantities of; Package quantities of ice; Sized ice, package quantities of; Block ice, package quantities of; Crushed ice, package quantities of; *PS48-71.*

Cubic crystal; Glass; Heat capacity; Monoclinic crystal; Low temperature; Planar molecular structure; Spherical shell molecules; Vitreous state; Arsenious oxide; Arsenolite; Claudetite; Crystal transition; *12311.*

Cubic materials; Elasticity; Green's tensor; Anisotropy; *SP317,* pp. 125-134.

Culverts; Entrance control; Hydraulics; Inlets; *12359.*

Cumulative damage; Failure; Life testing; Mechanical reliability; Accelerated testing; *SP336,* pp. 457-471.

Cuprous oxide; Single crystal; Crystal growth; *12137.*

Current; Modulator; Nuclear; Pulse; Quadrupole; Resonance; Spectroscopy; Transistor; Zeeman; *12350.*

Current comparator; Current transformer; Overload testing; Self-balancing current comparator; Transformer; Wide-range; Calibration; *12256.*

Current measurement (HF & MW); (HF & MW); Microwave currents; Microwave voltages; Power measurement; Voltage measurement (HF & MW); Bolovac; *11926.*

Current meters (fluids); Hydraulics; Measurement; Open-channel flow; Standards; Calibration; *12358.*

Current transformer; Overload testing; Self-balancing current comparator; Transformer; Wide-range; Calibration; Current comparator; *12256.*

Curvature tensor; Disclination; Internal stresses; Quasidisclination; Affine connexions; Continuum mechanics; *SP317,* pp. 637-649.

Curve fitting; Data analysis; Equations of state; Model discrimination; Surface fitting; J.75A *No. 5, 441-453 (1971).*

Curve fitting; Gram-Schmidt orthogonalization; Householder transformations; Iterative refinement; Least squares; Linear equations; Orthogonalization; Orthogonal polynomials; Regression; Rounding error; Stepwise regression; Computer programs; *12184.*

Curve of growth; Equivalent widths; Identification of spectral lines; Ionization in stars; Oscillator strengths; Temperature in stars; Turbulence in stars; Abundances of elements in stars; Ba II stars (ζ Capricorni); *Monogr. 119.*

$Cu_{0.6}Ni_{0.4}$ alloy; Electronic specific heat; Specific heat; 0.48 to 10 K; Clustering; *11843.*

Cybernetic technique; Data collection; Group dynamics; Interpersonal relationships; Management research; Opinion survey; Brainstorming; *12364.*

Cyclic inter-intramolecular mechanism; Diene polymerization; Fluorodienes; Intermediates; Polymerization; Purity; Synthesis; Telomerization; J.75A *No. 1, 41-56 (1971).*

Cyclobutane; Ion structure; Isomerization; Methylcyclopropane; Photoionization; Photolysis; Radiolysis; Butene; J. 75A, *No. 6, 591-605 (1971).*

Cyclohexane; Effects impurity; Ion-molecule reactions; Mass spectrometry; Radiolysis; *11928.*

Cyclohexene; Ion-molecule reactions; Photoionization; Photolysis; Unimolecular-dissociation; *11901.*

Cyclopentene oxide; Dipole moment; Epoxy cyclopentene; Microwave spectrum; Ring conformation; Rotational constants; *11970.*

Cylinder; Ice; Solute; Stability; Surface tension; Aqueous solutions; *11889.*

Cylindrical gauge blocks; Inside diameters; Small-bore tubes; Standard hole; Wringing; Capacitance probe; *12277.*

C_2H_2; Franck-Condon principle; H_2O; NH_3; N_2O; Photoelectrons; Photoionization.; Spectroscopy; *12118.*

C_6Br_6; C_6I_6; Hexahalogenated benzenes; Raman; Laser; Vibrational assignment; C_6F_6; C_6Cl_6; *12299.*

C_6Cl_6; C_6Br_6; C_6I_6; Hexahalogenated benzenes; Raman; Laser; Vibrational assignment; C_6F_6; *12299.*

C_6F_6; C_6Cl_6; C_6BR_6; C_6I_6; Hexahalogenated benzenes; Raman; Laser; Vibrational assignment; *12299.*

C_6I_6; Hexahalogenated benzenes; Raman; Laser; Vibrational assignment; C_6F_6; C_6Cl_6; C_6Br_6; *12299.*

D

Damage threshold; Glass; High temperature materials; Laser; Oxides; Oxygen diffusion; Pure materials; Sapphire; Al_2O_3; Crystal growth; *TN703.*

Damage threshold; Glass; High temperature materials; Laser; Oxides; Oxygen diffusion; Pure materials; Sapphire; Al_2O_3; Crystal growth; *TN574.*

Dampers; Ducts; Fire control; Fire spread; Smoke movement; Building design; *12347.*

Dams; Earthquake damage; Earthquakes; Foundation geology; Highways; Hospital; Housing; Mobile home; Seismic; Standards; Structural engineering; Bridge; Building; Codes; *BSS40.*

Data; Dataway; Digital; Instrumentation; Modules; Nuclear; Standards; CAMAC; *12142.*

Data; Description of experiments; Evaluation of data; Numerical data; Publication standards; Titles; Abstracts; Chemistry; Content of articles; *11806.*

Data acquisition; Data dissemination; Data processing; Maintenance; Operational readiness; Performance monitoring; Testing; *SP336,* pp. 549-568.

Data analysis; Data manipulation; Easy and effective programming in English; List of instructions; Matrix operations; Numerical analysis; OMNITAB II user oriented computing system; Self-teaching; Statistical analysis; Automatic printing; Bessel functions; *TN552.*

Data analysis; Equations of state; Model discrimination; Surface fitting; Curve fitting; *J.75A No. 5, 441-453 (1971).*

Data analysis; Flux density; Intercomparisons; Least squares; Standards; Thermal neutrons; *12048.*

Data base; Data retrieval; Data structure; Information storage and retrieval; Language extension; Preprocessor; Programming language; *TN590.*

Data base; Document processing; Information retrieval; Document storage and retrieval; Text; Text processing; Bibliographic system; Computer package; *TN599.*

Data codes; Data elements; Data processing systems standards; Federal information processing standards; Management information systems; United States Government; *FIPS PUB 19.*

Data collection; Group dynamics; Interpersonal relationships; Management research; Opinion survey; Brainstorming; Cybernetic technique; *12364.*

Data communication; Data interchange; Data processing; Federal Information Processing Standards; Graphic character subsets; Graphic subsets; Information interchange; Information processing; Standards; Subsets; *FIPS PUB 15.*

Data communications; Data interchange; Data processing; Electric accounting machine; EAM cards; Federal Information Processing Standard; Hollerith punched cards; Information interchange; Information processing; Punched cards; Rectangular holes; *FIPS PUB 13.*

Data communications; Data interchange; Data processing; Electric accounting machine; EAM cards; Federal Information Processing Standard; Hollerith punched card code; Hollerith punched cards; Information interchange; Information processing; *FIPS PUB 14.*

Data communications equipment; Data processing terminal equipment; Data transmission; Federal information processing standards; Serial-by-bit; Serial-by-character; Telecommunications: Teleprocessing; *FIPS PUB 16.*

Data dissemination; Data processing; Maintenance; Operational readiness; Performance monitoring; Testing; Data acquisition; *SP336*, pp. 549-568.

Data elements; Data processing systems standards; Federal information processing standards; Management information systems; United States Government; Data codes; *FIPS PUB 19.*

Data for decision; Standards laboratory management; Test equipment records; Use, storage, or surplus; *SP335*, pp. 95-98.

Data interchange; Data processing; Electric accounting machine; EAM cards; Federal Information Processing Standard; Hollerith punched cards; Information interchange; Information processing; Punched cards; Rectangular holes; *FIPS PUB 13.*

Data interchange; Data processing; Electric accounting machine; EAM cards; Federal Information Processing Standard; Hollerith punched card code; Hollerith punched cards; Information interchange; Information processing; Punched cards; *FIPS PUB 14.*

Data interchange; Data processing; Federal Information Processing Standards; Graphic character subsets; Graphic subsets; Information interchange; Information processing; Standards; Subsets; *FIPS PUB 15.*

Data management; Data structures; File organization; Information retrieval; Information systems; Programming languages; *12008.*

Data manipulation; Easy and effective programming in English; List of instructions; Matrix operations; Numerical analysis; OMNITAB II user oriented computing system; Self-teaching; Statistical analysis; Automatic printing; Bessel functions; Data analysis; *TN552.*

Data processing; Electric accounting machine; EAM cards; Federal Information Processing Standard; Hollerith punched cards; Information interchange; Information processing; Punched cards; Rectangular holes; *FIPS PUB 13.*

Data processing; Electric accounting machine; EAM cards; Federal Information Processing Standard; Hollerith punched card code; Hollerith punched cards; Information interchange; Information processing; Punched cards; *FIPS PUB 14.*

Data processing; Federal Information Processing Standards; Graphic character subsets; Graphic subsets; Information interchange; Information processing; Standards; Subsets; American Standard Code for Information Interchange; ASCII; *FIPS PUB 15.*

Data processing; Federal Information Processing Standards Publication; National government; Representations and codes; Standard Metropolitan Statistical Areas; Computers; *FIPS PUB 8-1.*

Data processing; Maintenance; Operational readiness; Performance monitoring; Testing; Data acquisition; Data dissemination; *SP336*, pp. 549-568.

Data processing systems; Federal Information Processing Standards; International Organization for Standardization; Management information systems; Standards; U.S. Government; American National Standards; Computers, data elements and codes; *FIPS PUB 12.*

Data processing systems standards; Federal information processing standards; Management information systems; United States Government; Data codes; Data elements; *FIPS PUB 19.*

Data processing terminal equipment; Data transmission; Federal information processing standards; Serial-by-bit; Serial-by-character; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; Communications; *FIPS PUB 16.*

Data retrieval; Data structure; Information storage and retrieval; Language extension; Preprocessor; Programming language; Data base; *TN590.*

Data structure; Information storage and retrieval; Language extension; Preprocessor; Programming language; Data base; Data retrieval; *TN590.*

Data structures; File organization; Information retrieval; Information systems; Programming languages; Data management; *12008.*

Data support; Fixed calibration interval; Instrument reliability; Statistical validity; Two-method optimization; *SP335*, pp. 73-79.

Data tables; Distorted wave calculations; Exact quantum mechanical calculations; Inelastic transition probabilities; K matrix calculation; KWIC Index; Mass values; Numerical calculations; One-dimensional collisions; *NBS-OSRDB-70-3 (AD705110).*

Data transmission; Federal information processing standards; Serial-by-bit; Serial-by-character; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; Communications; Data communications equipment; *FIPS PUB 16.*

Data transmission; Federal information processing standards; Serial-by-bit; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; Character structure; Character parity sense; Communications; *FIPS PUB 17.*

Data transmission; Federal information processing standards; Parallel-by-bit; Parity sense; Serial-by-character; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; Character structure; *FIPS PUB 18.*

Dataway; Digital; Instrumentation; Modules; Nuclear; Standards; CAMAC; Data; *12142.*

Daylight fluorescent lamp; Heterochromatic photometry; Integrating sphere; Intercomparison; Luminous flux;

Photometry; Spectroradiometry; Barnes colorimeter; Chromaticity coordinate; Color correction; Cool white fluorescent lamp; *TN559.*

Dc potentiometer test set; Dual channel system; Modulated subcarrier; Ratio transformer test set; Small attenuation measurement; Small insertion loss measurement; Small reflection coefficient measurements; Stainless steel waveguide; Comparison of results; *11917.*

Deactivation; Ethane; Ion-molecule reactions; Mass spectrometry; Radiolysis; Charge transfer; *12129.*

Deactivation; Ion-molecule reactions; Photoionization; Radiolysis; Unimolecular ion fragmentation; *11905.*

Decaborane; Electrodeposition of magnesium; Lithium deposition; Nonaqueous electroplating; Organometallic compound; *12027.*

Deceleration; Human kinematics; Human tests; Restraint geometry; Restraint systems; Seat belt; Sled tests; Webbing abrasion; Webbing degradation; Anthropomorphic dummies; Auto seat tests; *11850.*

Decomposition; Degassing; Environment; Evaporation; Outgassing; Simulation; Sublimation; Thermal conduction; Thermal vacuum tests; Volatile constituents; Volatilization; Absorption; Adsorption; "bake out"; Components; *SP336,* pp. 473-485.

Deep impurities; Germanium; Infrared; Photoconductivity; Photoresponse; Semiconductors; Silicon; *TN570.*

Deep probes; Emission; Occupied bands; Soft x ray; Band structure; Cu; *11952.*

Deep submergence; Fracture; Fracture energy; Glass; High pressure; Strength; *12188.*

Defect; Deformation; Disclination; Dislocation; Dualism; Elasticity; Incompatibility; Motor calculus; Plasticity; Burgers vector; Compatibility; Continuum; Contortion; Cosserat; Couple-stress; *SP317,* pp. 651-673.

Defect annealing; Impurities; Silicon; Space simulation; *SP336,* pp. 313-321.

Defect dipoles; Dielectric relaxation; ESR line broadening; Gadolinium; Orientational relaxation; Calcium fluoride; *11956.*

Defect equilibria; Electron paramagnetic resonance; Point defects; Calcium fluoride; *12237.*

Defect motion; Interstitial motion; Jump frequency; Lattice model; Migration energy; Migration entropy; Molecular dynamics; Random-walk theory; Vacancy motion; Atomic diffusion; *12022.*

Defect pairs; Dielectric relaxation; Relaxation modes; Reorientation; Anelastic relaxation; Calcium fluoride; *12357.*

Defect phonon; Emission; Excitation; Lifetime; $^4T_2$ state; Absorption; *12319.*

Defects in harmonic crystal; Functional equation; Many-body problem; Multiple scattering; Statistical physics; Transmission coefficient; *12375.*

Definition of second; Flicker noise; Frequency; Frequency stability; Lasers; Length standards; Measurement standards; Spectral density; Speed of light; Standard frequency broadcasts; Statistics of time/frequency measurements; Time; *SP350.*

Deflection; Equilibrium; Load eccentricity; Masonry; Section cracking; Stability; Stress distribution; Unreinforced concrete; Buckling; Compression members, concrete; *12298.*

Deflection; Loads (forces); Masonry; Moments; Slenderness ratio; Stability; Structural engineering; Walls; Bricks; Buckling; *12227.*

Deformation; Disclination; Dislocation; Dualism; Elasticity; Incompatibility; Motor calculus; Plasticity; Burgers vector; Compatibility; Continuum; Contortion; Cosserat; Couple-stress; Defect; *SP317,* pp. 651-673.

Deformation; Lead; Roof; Washington Cathedral; "1921"; Cathedral; *12377.*

Degassing; Environment; Evaporation; Outgassing; Simulation; Sublimation; Thermal conduction; Thermal vacuum tests; Volatile constituents; Volatilization; Absorption; Adsorption; "bake out"; Components; Decomposition; *SP336,* pp. 473-485.

Degradation mechanising; Electron bombardment; Electron degradation; Polymeric perfluorinated ethylenepropylene; Proton bombardment; Thermal control coatings; *SP336,* pp. 359-382.

Densitometer; Microdensitometer; Radiochromic dye films; Spectral transmission density; **J.75C** *No. 1, 23-27 (1971).*

Density; Dielectric constant; Enthalpy; Entropy; Equation of state; Fixed points; Heat transfer coefficients; Index of refraction; Joule-Thomson; Latent heat; Melting point; Prandtl number; Oxygen; Specific heat; Speed of sound; Surface tension; *TN384.*

Density; Dilatometric measurements; High pressure; Liquids; Ultrasonics; 2-methylbutane; Bulk modulus; Compressibility; **J.75A** *No. 2, 121-127 (1971).*

Density; Dilatometric measurements; High pressure; Liquids; Solids; Ultrasonics; Bulk modulus; *SP326,* pp. 11-22.

Density; Glasses; Hardness; Laser; Optical homogeneity; Photoelasticity; Refractive index; Thermal conductivity; Thermo-optic properties; Transmittance; Chemical composition; **J.75A** *No. 3, 163-174 (1971).*

Density; Liquids; Nitrogen; P,V,T; phase boundary; Saturation density; Vapor pressure; *12186.*

Density; Solvable groups; 2-generator groups; *12001.*

Density dependence; Liquid state; Simple fluids; Temperature dependence; Thermal conductivity; Transport properties; Viscosity; *11879.*

Density of states; Diffusion; Glass; High temperature materials; Laser damage; Laser degradation; Laser glass; Laser materials; Mass transport; Neodymium glass; Optical properties; Opto-elastic properties; Oxides; Ruby; Rutile; Titanium; *TN565.*

Dental amalgam; Environment; Hazards; Hygiene; Mercury; Vapor; Contamination; *12254.*

Dental restorative materials; EBA cements; Plastic reinforced restoratives; Restorative materials; Temporary dental cements; *11996.*

Denture base; Protective; Resilient liners; Temporary expedients; Tissue bearing; *12250.*

Denture base materials; Dentures; Dimensional stability; Foreign bodies; Prosthetics; Radiopacity; Silane bonding; Composites; *12310.*

Denture base materials; Diagnosis; Light translucency; Physical properties; Radiopacity; Bonding; Composites; *12232.*

Denture base materials; Physical properties; Prosthetic materials; Radiopacity-radiopaque; Composite materials; *12309.*

Denture foreign bodies: type, cause, prevention; Prosthetic materials: radiopaquing agents; Radiopaque denture base materials; *12233.*

Dentures; Dimensional stability; Foreign bodies; Prosthetics; Radiopacity; Silane bonding; Composites; Denture base materials; *12310.*

Dentures; Epoxy; Expansion; Hard rubber; Retention; Serviceability; Stability; Adaption; Acrylic; Contraction; *12189.*

Dentures; Tensile strength; Acrylic teeth; Adhesion; Autoadhesion; Bonding; Cold-curing methyl methacrylate; *12340.*

Department of Defense; International System of Units; Metric conversion; Metric system; Metrication; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; *SP345-9.*

Depolarization; Dielectric; Dilution refrigerator; Glass ceramic; Phase transition; Strontium titanate; Thermometer; Capacitor; *12368.*

Description of experiments; Evaluation of data; Numerical data;

Publication standards; Titles; Abstracts; Chemistry; Content of articles; Data; *11806*.

Design criteria; Dynamics; Gust factors; Smoke stacks; Structural failure; Wind loads; Buildings; *BSS30*, pp. 5-8.

Design criteria; Port-vane geometry; Vacuum vane gauge; *11931*.

Designing to specification; Fabrication of balances; Legal metrology; Mass standards; NPL of India; *SP335*, pp. 121-124.

Designs; Incidence matrices; Invariant factors; Smith normal form; *12338*.

Desorption; Electron reflection; Electron stimulated desorption; Gallium arsenide; Work function; Adsorption; Cesium; *12108*.

Desorption; Electron stimulated desorption; Hydrogen; Nickel; Nitrogen; Oxygen; Surface; Tungsten; Adsorption; Chemisorption; Cross section; *12332*.

Desorption; Field emission; Monoxide; Rhenium; Ruthenium; Surface migration; Carbon monoxide; *11819*.

Desorption; Ions; Outgassing; Quartz crystal microbalance; Solar panels; Space; Sputtering; Surface contamination; Cleaning; *SP336*, pp. 113-127.

Detachment; Dissociation; Ionization; Photoabsorption; Photoabsorption theory; Total absorption cross sections; Absorption and ionization coefficients; Cross section data; *NBS-OSRDB-70-4 (COM-71-00025)*.

Detection limits; Differential method; Flame emission; Nonaqueous media; Precision; Sensitivity; Tables; Accuracy; Atomic absorption; *12111*.

Detector; Energy; Laser; Power; Ruby; Calorimeter; *12011*.

Detector; Gas chromatography; Spectroscopy; Vacuum ultraviolet; Analytical; Atomic emission; *12267*.

Detector noise; Electron fluence; Electrons radiation damage; Front and rear contact; Leakage current; Silicon surface-barrier detector; Alpha particles counting response; Capacitance; *12107*.

Detector response functions; Dosimetry; Electron-energy deposition; Gray medal; Ionization; Bragg-Gray principle; Cavity; *12297*.

Detectors; Infrared; Josephson effect; Lasers; Superconductivity; *12166*.

Detergent; Hydrophobic bonding; Krafft point; Long chain compounds; Micelle; Paraffin chain salts; Selected values; Soap; Solubilization; Standard values; Surface active agents; Surface chemistry; Surface tension; Surfactant; *NSRDS-NBS36*.

Determinant; Generalized matrix function; Invariants; Matrices; Rank; **J.75B** *Nos. 3 and 4, 109-115 (1971)*.

Determination; Electron-transfer; Inosose; Oxidation; Quantitative; Radical; Reagent; *12151*.

Deuteranope; Protanope; Color blindness; Color vision; *11824*.

Deuterium; Dissociation; Electron; Hydrogen; Molecule; *12058*.

Deuterium; Isotope effect; Ketene; Kinetics; Methylene; Abstraction; *12331*.

Development; Interdisciplinary team; Management science; Model building; Organization; Search and rescue; Simulation; Team development; Coast Guard; *12243*.

Deviations from geometric mean rule; Interaction energy parameters; Ionization potentials; Binary fluid mixtures; Correlation; *11962*.

Device fabrication; Environmental testing; Integrated circuits; Measurement methods; Microcircuits; Silicon; *SP336*, pp. 449-455.

Device processing; Diffusion; Epitaxy; Junctions; Resistivity; Surface preparation; Analysis; *SP337*.

Dew point; Hygrometry; Meterology; Moisture measurement in gases; Psychrometry; *11991*.

Dew point temperature; Humidity; Hygrometer; Mixing ratio; Moist gas; Psychrometer; Vapor pressure; Adiabatic saturation; **J.75C** *No. 2, 69-78 (1971)*.

$(d+s)^n p$, SU_3; Casimir operator; Checking parameters; **J.75B** *Nos. 1 and 2, 31-47 (1971)*.

ΔH-ΔS correlation; Heat of vaporization; Least squares fits; Second and third heats; *12014*.

Diagnosis; Light translucency; Physical properties; Radiopacity; Bonding; Composites; Denture base materials; *12232*.

Diagnosis; Physical properties of fillings; X-ray opaque; Clinical research (dental); Composite restorations; *11944*.

Diagnostics; Gears; Reliability; Signature analysis; Vibration; Bearings; *SP336*, pp. 407-448.

Diamagnetism; Electron in a magnetic field; Coherent states; *11808*.

Diamagnetism; Knight shift; NaTl; Polarization; V_3Ga; $AuGa_2$; BiIn; Bismuth; *12085*.

Diamond lattice; Dislocation-electron interactions; Semiconductors; Band structures; Charged dislocations; *SP317*, pp. 1231-1253.

Diamond lattice; $DyPO_4$; Ising system; Low temperature; Magnetic susceptibility; Metamagnetism; Optical absorption; Critical phenomena; *12126*.

Diazomethane; Heat of formation; Vacuum ultraviolet; Bond dissociation energy; *12367*.

Dichlorides of Ca, Sc, Ti, V, Cr, Mn, Fe, Ni; Geometry; Infrared spectra of species; Matrix isolation; $ScCl_3$; $TiCl_3$; $TiCl_4$; *12281*.

Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; *TN702*.

Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Resistivity; Semiconductor devices; *TN560*.

Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; *TN571*.

Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; *TN592*.

Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; *TN598*.

Dielectric; Dilution refrigerator; Glass ceramic; Phase transition; Strontium titanate; Thermometer; Capacitor; Depolarization; *12368*.

Dielectric constant; Enthalpy; Entropy; Equation of state; Fixed points; Heat transfer coefficients; Index of refraction; Joule-Thomson; Latent heat; Melting point; Prandtl number; Oxygen; Specific heat; Speed of sound; Surface tension; *TN384*.

Dielectric constant; Oxygen; Polarizability; Saturated liquid; Clausius-Mossotti function; *11844*.

Dielectric constant; Stable capacitance; Temperature variation of capacitance; Capacitance; *11935*.

Dielectric liquids; Electric field measurements; Electrooptical measurements; High voltage measurements; Kerr cell; Laser applications; Pulse measurements; *12306*.

Dielectric relaxation; ESR line broadening; Gadolinium; Orientational relaxation; Calcium fluoride; Defect dipoles; *11956*.

Dielectric relaxation; Relaxation modes; Reorientation; Anelastic relaxation; Calcium fluoride; Defect pairs; *12357*.

Diene polymerization; Fluorodienes; Intermediates; Polymerization; Purity; Synthesis; Telomerization; Cyclic inter-intramolecular mechanism; **J.75A** *No. 1, 41-56 (1971).*

Differential cross sections; Elastic scattering; Electron; H_2 (hydrogen molecule); Rotational excitation; Close coupling calculation; *12163.*

Differential equations; Self-adjoint equations; Sturm-Liouville systems; Boundary value problems; Coupled equations; *J.75B Nos. 3 and 4, 125-138 (1971).*

Differential method; Flame emission; Nonaqueous media; Precision; Sensitivity; Tables; Accuracy; Atomic absorption; Detection limits; *12111.*

Differential thermal analysis; Ion exchange; Organic acid; Oxycellulose; Stability; Sulfuric acid; Thermogravimetric analysis; Alum; Aluminum; Apparent activation energy; Calcium; Cellulose; Crosslinking; *12218.*

Diffraction; Molecular structure; Neutron; Nuclear reactor; Radiation; Scattering; Crystal structure; *TN567.*

Diffraction; X ray; Absorption correction; *12053.*

Diffraction profiles; Dislocation diffraction; Kinematic x-ray diffraction; Statistical methods for dislocations; *SP317,* pp. 1195-1221.

Diffraction scattering; Glauber model; He^4-He^4 elastic scattering; High energy Coulomb effects; High energy scattering; *12031.*

Diffraction shrinkage; High energy; Pomeranchuck theorem; Asymptotics; Cross section; *11870.*

Diffraction theory; Lattice constants; Measurements; X-ray interferometry; Wave optics; *12285.*

Diffuse density measurement; Linear microdensitometer; Microdensitometry; *12362.*

Diffusion; Epitaxy; Junctions; Resistivity; Surface preparation; Analysis; Device processing; *SP337.*

Diffusion; Glass; High temperature materials; Laser damage; Laser degradation; Laser glass; Laser materials; Mass transport; Neodymium glass; Optical properties; Opto-elastic properties; Oxides; Ruby; Rutile; Titanium; Titanium dioxide; *TN565.*

Diffusion; High-pressure; Phase-diagram; Vanadium; Alloys; Aluminum; *11832.*

Diffusion; Light scattering; Neutron scattering; Plastic crystal; Rotational; Spherical molecules; *11953.*

Diffusion; Random alloy; Vacancies; Activation analysis; Concentrated alloys; Correlation factor; *12167.*

Diffusion effects; Free radicals; Polymer decomposition; Polymer depolymerization; Polymer irradiation; Polymer pyrolysis; *11955.*

Diffusion equation; Diffusion of gases; Flow reactor; Gas mixing; Mixing by diffusion; Relaxation methods; *12091.*

Diffusion of gases; Flow reactor; Gas mixing; Mixing by diffusion; Relaxation methods; Diffusion equation; *12091.*

Digital; Instrumentation; Modules; Nuclear; Standards; CAMAC; Data; Dataway; *12142.*

Digital; Logic gating; Quasi-sinusoid; *11876.*

Digital counters; Digital voltmeters; Exchange program on costs; Oscilloscopes; Calibration and maintenance manhours; *SP335,* pp. 51-55.

Digital filters; Flicker noise; Fractional integration; Recursive digital filters; Analog noise simulation; Computer noise simulation; *TN604.*

Digital logic; Image processing; Microscope; Microspectrophotometry; Pattern recognition; Computers; *11990.*

Digital simulation; Radar beacon system; Air traffic control; Beacon code assignment; *TN568.*

Digital voltmeters; Exchange program on costs; Oscilloscopes; Calibration and maintenance manhours; Digital counters; *SP335,* pp. 51-55.

Dilatation centers; Lattice statics; Non-local theories; Solid mechanics; Wave propagation; *SP317,* pp. 729-736.

Dilatometric measurements; High pressure; Liquids; Ultrasonics; 2-methylbutane; Bulk modulus; Compressibility; Density; **J.75A** *No. 2, 121-127 (1971).*

Dilatometric measurements; High pressure; Liquids; Solids; Ultrasonics; Bulk modulus; Density; *SP326,* pp. 11-22.

Dilution refrigerator; Fermi-Dirac statistics; Heat exchangers; Helium-3; Helium-4; Liquid helium; Mixtures; Quantum fluid; Thermodynamic properties; Cryogenics; *11981.*

Dilution refrigerator; Glass ceramic; Phase transition; Strontium titanate; Thermometer; Capacitor; Depolarization; Dielectric; *12368.*

Dimensional stability; Foreign bodies; Prosthetics; Radiopacity; Silane bonding; Composites; Denture base materials; Dentures; *12310.*

Dimethacrylates; Phthalate monomers; Purification methods; Resins for composites; Ternary eutectic; Thermosetting monomers; Biomaterials; *11802.*

Dimethyl beryllium; Magnesium, electrodeposition of; Nonaqueous plating baths; Grignard reagents; Organic plating baths; Triethylboron; Beryllium, electrodeposition of; Beryllium azide; Beryllium thiocyanate, decaborane; *12304.*

Dimethylacetylene; Internal rotation; Rotational constants; Spectrum; Vibration-rotation; *12170.*

Dipole; Gas; Intermolecular potential function; Polar; Second virial coefficient; Stockmayer; **J.75A** *No. 4, 337-385 (1971).*

Dipole moment; Epoxy cyclopentene; Microwave spectrum; Ring conformation; Rotational constants; Cyclopentene oxide; *11970.*

Dipole moment; Ethynyldifluoroborane; Microwave spectrum; Molecular structure; Stark effect; Rotational spectrum; *12328.*

Dipole moment; Microwave spectrum; Reactive species; Rotational spectra; Thioformaldehyde; Structure; *12325.*

Dipole system; Low temperature; Paramagnetic salt; Specific heat; Susceptibility; Thermometer scale; Cerous magnesium nitrate; *11822.*

Dipole-dipole interaction; Neodymium ethyl sulphate; Shape dependent; Specific heat; Cerous magnesium nitrate; Cesium titanium alum; *11909.*

Directional coupler; Directivity; Impedance measurements; Power measurements; Coupler; *11893.*

Directional coupler; Directivity; Impedance measurements; Power measurements; Coupler; *12070.*

Directional coupler; High power; Measurement; Microwave; Accurate; Calibration; **J.75C** *Nos. 3 and 4, 181-186 (1971).*

Directional effects; Grain morphology; Preferred orientation; Stress corrosion; Aluminum alloy; Corrosion; *11839.*

Directivity; Impedance measurements; Power measurements; Coupler; Directional coupler; *11893.*

Directivity; Impedance measurements; Power measurements; Coupler; Directional coupler; *12070.*

Disclination; Dislocation; Dualism; Elasticity; Incompatibility; Motor calculus; Plasticity; Burgers vector; Compatibility; Continuum; Contortion; Cosserat; Couple-stress; Defect; Deformation; *SP317,* pp. 651-673.

Disclination; Internal stresses; Quasidisclination; Affine connexions; Continuum mechanics; Curvature tensor; *SP317,* pp. 637-649.

Disclinations; Screw disclinations; Crystal surface imperfections; *SP317,* pp. 593-606.

Discrete; Forbidden; Transition probability; Allowed; Atomic; *SP320. Suppl. 1.*

Disinfestation; Dosimetry; Dyes; Gamma rays; Insect sterilization; Shelf-life extension; Sprouting inhibition; Chemical dosimeter; *12193.*

Disk; Pressure fluctuations; Stagnation point; Turbulence; *TN563.*

Dislocation; Dualism; Elasticity; Incompatibility; Motor calculus; Plasticity; Burgers vector; Compatibility; Continuum; Contortion; Cosserat; Couple-stress; Defect; Deformation; Disclination; *SP317,* pp. 651-673.

Dislocation; Elasticity; Non-linear elasticity; Anisotropic elasticity; Dislocation dynamics; *SP317*, pp. 877-905.

Dislocation arrangements; Distribution of impurities; Precipitate particles; Thermomechanical treatment; Cavities; Cellular solidification; Constitutional supercooling; Copper (99.999%); *12239*.

Dislocation core structure; Interatomic potentials; Iron; Computer simulation; *SP317*, pp. 305-308.

Dislocation damping; Dislocation resonance; Internal friction; *SP317*, pp. 419-421.

Dislocation damping; Dislocation-electron interactions; Electroresistivity; *SP317*, pp. 1303-1322.

Dislocation diffraction; Kinematic x-ray diffraction; Statistical methods for dislocations; Diffraction profiles; *SP317*, pp. 1195-1221.

Dislocation dissociation; Lattice shuffling; Partial dislocations; Twinning; Zonal dislocations; *SP317*, pp. 495-529.

Dislocation distributions; Mechanical properties; Plane blending; *SP317*, pp. 925-941.

Dislocation distributions; Micromorphic dislocations; Micropolar dislocations; Continuum mechanics; *SP317*, pp. 1023-1040.

Dislocation drag; Dislocation-phonon interactions; Electroresistivity; Kink motion; Phonon scattering; *SP317*, pp. 397-401.

Dislocation dynamics; Dislocation; Elasticity; Non-linear elasticity; Anisotropic elasticity; *SP317*, pp. 877-905.

Dislocation dynamics; Dislocation stability; Anisotropic elasticity; Cerenkov waves; *SP317*, pp. 23-33.

Dislocation dynamics; Dislocation-electron interactions; Phonons; *SP317*, pp. 1291-1292.

Dislocation dynamics; Dislocations; Green's tensors; Anisotropic elasticity; *SP317*, pp. 977-996.

Dislocation dynamics; Interface dislocations; Supersonic dislocation; *SP317*, pp. 71-82.

Dislocation dynamics; Non-linear elasticity; Anisotropic elasticity; Anisotropic plasticity dislocations; Constitutive relations; *SP317*, pp. 837-876.

Dislocation dynamics; Statistical theory of dislocation; Thermal acceleration; Arrhenius rate theory; *SP317*, pp. 1065-1076.

Dislocation dynamics; Ultrasonics; Anharmonic properties; *SP317*, pp. 427-445.

Dislocation field theory; Oriented media; Continuum mechanics; Cosserat continua; *SP317*, pp. 817-829.

Dislocation field theory; Statistical methods; Continuum mechanics; *SP317*, pp. 785-816.

Dislocation geometry; Dislocations; Kinks; Pipe diffusion; Vacancies in dislocations; *SP317*, pp. 563-576.

Dislocation geometry; Stacking faults; Shockley partials; *SP317*, pp. 47-55.

Dislocation geometry; Twinning; Zonal dislocations; *SP317*, pp. 479-493.

Dislocation kinematics; Dislocations; Oriented media; Thermodynamics and dislocation motion; Constitutive relations; Continuum mechanics; *SP317*, pp. 1041-1052.

Dislocation kinetics; Mobile dislocations, stress rates; *SP317*, pp. 1099-1106.

Dislocation loops; Elasticity; Finite bodies; *SP317*, pp. 35-45.

Dislocation mobility; Dislocation-phonon interactions; Nonlinear elasticity; Phonons; Thermal conductivity; *SP317*, pp. 363-389.

Dislocation motion; Kink relaxation; Mechanical properties; Thermal activation; Bordoni-peaks; *SP317*, pp. 1137-1156.

Dislocation motion; Mechanical properties; Precipitation hardening; Computer simulation; *SP317*, pp. 1083-1098.

Dislocation multipoles; Dislocation networks; Dislocation nodes; Dislocations; Electron microscopy; Hexagonal alloys; Silver-tin alloys; *12072*.

Dislocation networks; Dislocation nodes; Dislocations; Electron microscopy; Hexagonal alloys; Silver-tin alloys; Dislocation multipoles; *12072*.

Dislocation nodes; Dislocation ribbons; Dislocations; Faulted dislocation dipoles; Stacking fault energy; Stacking fault tetrahedra; *11828*.

Dislocation nodes; Dislocations; Electron microscopy; Hexagonal alloys; Silver-tin alloys; Dislocation multipoles; Dislocation networks; *12072*.

Dislocation nodes; Dislocation-surface interactions; Dislocations—image series; Line tension of dislocations; *SP317*, pp. 11–22.

Dislocation observations; Dislocation theory; Status and problems; *SP317*, pp. 5-9.

Dislocation pileups; Grain boundaries; Anisotropic elasticity; Dislocations-elasticity; *SP317*, pp. 163-171.

Dislocation pileups; Moutier cycle; Stress concentrations; *SP317*, pp. 147-150.

Dislocation pileups; Phase boundaries; Dislocations-elasticity; *SP317*, pp. 135-146.

Dislocation radiation; Dispersion relations; Internal friction; *SP317*, pp. 423-426.

Dislocation resonance; Internal friction; Dislocation damping; *SP317*, pp. 419-421.

Dislocation ribbons; Dislocations; Faulted dislocation dipoles; Stacking fault energy; Stacking fault tetrahedra; Dislocation nodes; *11828*.

Dislocation stability; Anisotropic elasticity; Cerenkov waves; Dislocation dynamics; *SP317*, pp. 23-33.

Dislocation stacking faults; Peierls-Nabarro model; *SP317*, pp. 1157-1161.

Dislocation structure; Pair-potential; Point defects; Computer simulation; Copper; *SP317*, pp. 273-283.

Dislocation surface; Interactions; Dislocations; Elastic interactions; Finite elasticity; *SP317*, pp. 1179-1189.

Dislocation surface interactions; Finite elasticity; Inhomogeneities; Dislocations-elasticity; *SP317*, pp. 57-69.

Dislocation theory; Status and problems; Dislocation observations; *SP317*, pp. 5-9.

Dislocation velocity; High speed dislocations; Impact stress pulse; Piezoelectric stress gauge; Quartz; Slip bands; *SP336*, pp. 487-508.

Dislocation vibration; Internal friction; Localized modes; Dislocation-phonon interactions; *SP317*, pp. 315-357.

Dislocation-electron interactions; Electroresistivity; Dislocation damping; *SP317*, pp. 1303-1322.

Dislocation-electron interactions; Fermi energy; Semiconductors; Band structure; Covalent-ionic solids; *SP317*, pp. 1293-1302.

Dislocation-electron interactions; Interatomic potentials; Stacking faults; *SP317*, pp. 1259-1277.

Dislocation-electron interactions; Phonons; Dislocation dynamics; *SP317*, pp. 1291-1292.

Dislocation-electron interactions; Semiconductors; Band structures; Charged dislocations; Diamond lattice; *SP317*, pp. 1231-1253.

Dislocation-electron interactions; Slater-Koster method; Stacking fault; *SP317*, pp. 1279-1288.

Dislocation-interstitial interaction; Interatomic potentials; Lattice defects; Carbon in iron; Computer simulation; *SP317*, pp. 299-303.

Dislocation-phonon interaction; Frenkel-Kontorowa model; Computer simulation; *SP317*, pp. 403-414.

Dislocation-phonon interactions; Dispersion relations; Lattice of dynamics; Localized modes; *SP317*, pp. 205-217.

Dislocation-phonon interactions; Dislocation vibration; Internal friction; Localized modes; *SP317*, pp. 315-357.

Dislocation-phonon interactions; Electroresistivity; Kink motion; Phonon scattering; Dislocation drag; *SP317*, pp. 397-401.

Dislocation-phonon interactions; Nonlinear elasticity; Phonons; Thermal conductivity; Dislocation mobility; *SP317*, pp. 363-389.

Dislocations; Elastic interactions; Finite elasticity; Dislocation surface; Interactions; *SP317*, pp. 1179-1189.

Dislocations; Elasticity; Electron-dislocation interactions; Lattice defects; Phonon-dislocation interactions; Solid-state; Theoretical physics; Thermally activated processes; Twinning; Conference; Continuum mechanics; Crystal physics, disclinations; *SP317*.

Dislocations; Elasticity; Statistical methods; *SP317*, pp. 1191-1193.

Dislocations; Electron microscopy; Hexagonal alloys; Silver-tin alloys; Dislocation multipoles; Dislocation networks; Dislocation nodes; *12072*.

Dislocations; Electron microscopy; Iron alloys; Stacking fault energy; Temperature; *12105*.

Dislocations; Faulted dislocation dipoles; Stacking fault energy; Stacking fault tetrahedra; Dislocation nodes; Dislocation ribbons; *11828*.

Dislocations; Grain boundaries; Interfaces; Twinning; *SP317*, pp. 465-477.

Dislocations; Green's tensor; Incompatibility; Internal stress; Source kernels; Stress functions; Anisotropic elasticity; *SP317*, pp. 89-124.

Dislocations; Green's tensors; Anisotropic elasticity; Dislocation dynamics; *SP317*, pp. 977-996.

Dislocations; Inhomogeneous elastic bodies; Constitutive relations; Continuum mechanics; *SP317*, pp. 907-924.

Dislocations; Kinks; Pipe diffusion; Vacancies in dislocations; Dislocation geometry; *SP317*, pp. 563-576.

Dislocations; Liquid metal embrittlement; Surface; Surface active agent; Complex-ion embrittlement; *11972*.

Dislocations; Oriented media; Thermodynamics and dislocation motion; Constitutive relations; Continuum mechanics; Dislocation kinematics; *SP317*, pp. 1041-1052.

Dislocations and thermodynamics; Entropy; Specific heat; Thermal expansion; Thermodynamics and expansions; Bulk modulus; *SP317*, pp. 1223-1225.

Dislocations in biophysics; Protein structure; Surface crystals; Surface dislocations; *SP317*, pp. 579-592.

Dislocations in lattices; Peierls stress; Zero point motion; Anharmonicity; *SP317*, pp. 253-272.

Dislocations-elasticity; Dislocation surface interactions; Finite elasticity; Inhomogeneities; *SP317*, pp. 57-69.

Dislocations-elasticity; Dislocation pileups; Phase boundaries; *SP317*, pp. 135-146.

Dislocations-elasticity; Dislocation pileups; Grain boundaries; Anisotropic elasticity; *SP317*, pp. 163-171.

Dislocations-elasticity; Internal stresses; Crack nucleation; *SP317*, pp. 151-162.

Dislocation-surface interactions; Dislocations—image series; Line tension of dislocations; Dislocation nodes; *SP317*, pp. 11-22.

Dislocations—image series; Line tension of dislocations; Dislocation nodes; Dislocation-surface interactions; *SP317*, pp. 11-22.

Disordered one-dimensional crystal; Multiple scattering; Statistical physics; Thermal conductivity; Transport properties; *12376*.

Dispersion relations; Internal friction; Dislocation radiation; *SP317*, pp. 423-426.

Dispersion relations; Lattice of dynamics; Localized modes; Dislocation-phonon interactions; *SP317*, pp. 205-217.

Displacement reaction; Hydrogen; Single crystal; Tungsten; Work function; Carbon monoxide; Chemisorption; Co-adsorption; *12261*.

Dissemination; Frequency; Frequency synthesizers; Linear phase comparators; Television color subcarrier; Time; *12234*.

Dissociation; Electron; Hydrogen; Molecule; Deuterium; *12058*.

Dissociation; Equilibrium; Phase relations; SrO:IrO$_2$ compounds; SrO-IrO$_2$-Ir system; *J.*75A *No. 3, 185-196 (1971)*.

Dissociation; Ionization; Photoabsorption; Photoabsorption theory; Total absorption cross sections; Absorption and ionization coefficients; Cross section data; Detachment; *NBS-OSRDB-70-4 (COM-71-00025)*.

Dissociation energy; Ionization energy; Mass spectrometry; Photoionization; Vacuum ultraviolet; Chlorine monofluoride; *12064*.

Dissociative electron attachment; Electron energy; Angular distribution of O$_2$; *12057*.

Dissociative ionization; Fluorine; Heats of formation; Hot bands; Hydrogen fluoride; Ion pairs; Mass spectrometry; Molecular ionization; Photoionization; Vacuum ultraviolet; Chlorine monofluoride; *12148*.

Distorted wave calculations; Exact quantum mechanical calculations; Inelastic transition probabilities; K matrix calculation; KWIC Index; Mass values; Numerical calculations; One-dimensional collisions; Oscillator force constants; *NBS-OSRDB-70-3 (AD705110)*.

Distribution; Gyration; Polymer; Radius; Two segments; *11947*.

Distribution of impurities; Precipitate particles; Thermomechanical treatment; Cavities; Cellular solidification; Constitutional supercooling; Copper (99.999%); Dislocation arrangements; *12339*.

Disturbed soil; Instantaneous rate; Pit depth; Pitting factor; Polarization; Steel piling; Undisturbed soil; Weight loss; Corrosion; Corrosion rate; *J.*75C *No. 2, 107-121 (1971)*.

Divider; Inductive voltage divider; Ratio; Voltage divider; Voltage ratio; *11894*.

Divider; Measurement system; Ratio; Ratio standard; Resistive divider; Voltage ratio; *12150*.

Diving; Hyperbaric; Neutral buoyancy; Simulation; Space; *SP336*, pp. 651-659.

Divinylbenzene; Infrared; Styrene; Copolymers; Crosslinking; *11884*.

Document processing; Information retrieval; Document storage and retrieval; Text; Text processing; Bibliographic system; Computer package; Data base; *TN599*.

Document storage and retrieval; Microform-microfilm systems; *11938*.

Document storage and retrieval; Text; Text processing; Bibliographic system; Computer package; Data base; Document processing; Information retrieval; *TN599*.

Documentation; Error checking; Machine independent; OMNITAB II operating system subprograms; OMNITAB II source listing; Programming techniques; Transportable; User-oriented computing system; Accuracy; Algorithms; ANSI FORTRAN; *SP339*.

Door units, wood; Hinged door units, interior; Prefabricated door units; Wood door units; *PS32-70*.

Doors, steel bi-fold; Steel bi-fold doors; Bi-fold doors, steel; Closet doors, steel bi-fold; *PS38-70*.

Doppler broadening; Escape probability; Planetary nebula; Spectral line formation; *12180*.

Dose distribution; Electron beams; Holography; Interferometry; Pulsed beams; Radiation; Absorbed dose; Calorimetry; *12100*.

Dosimetry; Dyes; Gamma rays; Insect sterilization; Shelf-life extension; Sprouting inhibition; Chemical dosimeter; Disinfestation; *12193*.

Dosimetry; Electron-energy deposition; Gray medal; Ionization; Bragg-Gray principle; Cavity; Detector response functions; *12297*.

of a rigid body; Rotation group; Spatial rotation; Angular velocity; **J.75B** *Nos. 3 and 4, 179-186 (1971).*

Effects impurity; Ion-molecule reactions; Mass spectrometry; Radiolysis; Cyclohexane; *11928.*

Efficiency; Sliding short; Adaptor; Connector; **J.75C** *Nos. 3 and 4, 173-180 (1971).*

Eigenvalues; Linear inequalities; Singular values; **J.75B** *Nos. 3 and 4, 117-124 (1971).*

Elastic; Electron impact; Helium; Inelastic; Absolute differential cross section; Born; *12029.*

Elastic; Experiment; Finite-element analysis; Force transducer; Stiffness matrix; Structural analysis; Axisymmetric; **J.75C** *Nos. 3 and 4, 155-161 (1971).*

Elastic interactions; Finite elasticity; Dislocation surface; Interactions; Dislocations; *SP317,* pp. 1179-1189.

Elastic modulus; Resonance frequency; Shear modulus; Standard reference material; Young's modulus; Alumina; **J.75A** *No. 3, 155-162 (1971).*

Elastic scattering; Electron; H_2 (hydrogen molecule); Rotational excitation; Close coupling calculation; Differential cross sections; *12163.*

Elastic scattering; Electron; Molecule; Atom; Cross section; *12283.*

Elasticity; Electron-dislocation interactions; Lattice defects; Phonon-dislocation interactions; Solid-state; Theoretical physics; Thermally activated processes; Twinning; Conference; Continuum mechanics; Crystal physics, disclinations; Dislocations; *SP317.*

Elasticity; Finite bodies; Dislocation loops; *SP317,* pp. 35-45.

Elasticity; Green's tensor; Anisotropy; Cubic materials; *SP317,* pp. 125-134.

Elasticity; Incompatibility; Motor calculus; Plasticity; Burgers vector; Compatibility; Continuum; Contortion; Cosserat; Couple-stress; Defect; Deformation; Disclination; Dislocation; Dualism; *SP317,* pp. 651-673.

Elasticity; Non-linear elasticity; Anisotropic elasticity; Dislocation dynamics; Dislocation; *SP317,* pp. 877-905.

Elasticity; Statistical methods; Dislocations; *SP317,* pp. 1191-1193.

Electric accounting machine; EAM cards; Federal Information Processing Standard; Hollerith punched cards; Information interchange; Information processing; Punched cards; Rectangular holes; American Standard Code for Information Interchange: *FIPS PUB 13.*

Electric accounting machine; EAM cards; Federal Information Processing Standard; Hollerith punched card code; Hollerith punched cards; Information interchange; Information processing; Punched cards; *FIPS PUB 14.*

Electric field measurements; Electrooptical measurements; High voltage measurements; Kerr cell; Laser applications; Pulse measurements; Dielectric liquids; *12306.*

Electric transition; Electrodisintegration; Few nucleon systems; Long wavelength; Cross section; *12279.*

Electrical conductivity; Iron alloys; Nickel alloys; Titanium alloys; Aluminium alloys; Copper alloys; Cryogenics; *11873.*

Electrical discharge; Interstellar medium; Microwave spectroscopy; Rotational spectrum; Thioformaldehyde; Astronomically important; *11965.*

Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; *TN702.*

Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Resistivity; Semiconductor devices; *TN560.*

Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; *TN571.*

Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; *TN592.*

Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; *TN598.*

Electrical resistance; Soft materials; Strain extensometer; Cryostat; *11825.*

Electrical resistivity; Electrolytic iron; Lorenz ratio; Seebeck effect; Thermal conductivity; Transport properties; Cryogenics; *SP260-31.*

Electrical resistivity; Emittance; Heat capacity; High-speed measurements; High temperature; Thermal radiation properties; Thermodynamics; Tungsten; **J.75A** *No. 4, 283-290 (1971).*

Electrical resistivity; Emittance; Heat capacity; High-speed measurements; High temperature; Niobium; Thermal radiation properties; Thermodynamics; **J.75A** *No. 6, 565-571 (1971).*

Electrical resistivity; Emittance; Heat capacity; High-speed measurements; High temperature; Tantalum; Thermal radiation properties; Thermodynamics; **J.75A** *No. 1, 1-13 (1971).*

Electrical resistivity; Grain boundaries; Solute segregation; Super-purity metals; Aluminum; *11818.*

Electrical resistivity; High-speed methods; High temperature; Melting point; Metals; Molybdenum; Premelting; Thermodynamics; *12231.*

Electrical resistivity; Lorenz ratio; Nickel alloys; Seebeck effect; Thermal conductivity; Titanium alloy; Transport properties; Aluminum alloy; Cryogenics; **J.75A** *No. 4, 269-277 (1971).*

Electrode monitoring; Industrial monitoring; Ion-selective electrodes; Pollutant monitoring; *11999.*

Electrode potential of paints; Photo degradation; Thermal control coatings; Ultraviolet degradation; Alkaline paint; Conduction of paints during ultraviolet exposure; *SP336,* pp. 393-402.

Electrodeposited copper; Impurity content; Properties of mechanical structure; Annealing-electrolylic copper; *12041.*

Electrodeposition; Hexafluoroacetylacetone; Rhenium coatings; Trifluorophosphine; Carbonyl; Chemical vapor deposition; *11942.*

Electrodeposition of magnesium; Lithium deposition; Nonaqueous electroplating; Organometallic compound; Decaborane; *12027.*

Electrodisintegration; Few nucleon systems; Long wavelength; Cross section; Electric transition; *12279.*

Electroformed sieves; Microscopic size measurement; Particle size measurement; Air elutriation; Air permeability; Andreasen pipette; Calibrated glass beads; Coulter counter; *11895.*

Electrolytic iron; Lorenz ratio; Seebeck effect; Thermal conductivity; Transport properties; Cryogenics; Electrical resistivity; *SP260-31.*

Electrolytic protection; Hydrazine; Maraging steel; Metallic coatings; Missiles; Rocket-fuel tanks; Compatibility tests; *11934.*

Electrometric study of silver adsorption; Silver adsorption; Silver ion-selective electrode; Trace silver determination; *12353.*

Electromotive force; Saturated standard cells; Standard cells; Unsaturated standard cells; *12037.*

Multichannel analyzer; Proportional counters; Quantitative analysis; Solid state counters; Tests; X-ray spectra; X-ray spectrometers; Electron diffraction; *12251.*

Electron probes; Evaluation; Metallography; Microscopy; Polarized electromagnetic radiation; Color photography; Electron microscopy; *11994.*

Electron produced; High intensity; Monochromatic yields; Purity; X-ray beams; Beryllium to gold; *12214.*

Electron reflection; Electron stimulated desorption; Gallium arsenide; Work function; Adsorption; Cesium; Desorption; *12108.*

Electron scatter; Energy curve; Local potential; N_2; Resonance width; Shape resonance; Spectroscopic constant; Valence orbital; *11899.*

Electron scattering; Form factor; Helium; Hydrogen; Sum rule; Correlation; *11916.*

Electron scattering; Magnetoresistance; Resistance; Aluminum; *12278.*

Electron scattering; Momentum transfer; Pair correlation; Shell model; Spurious; Sum rule; *12043.*

Electron scattering; Pseudo-state expansion; Close coupling calculation; *12098.*

Electron scattering; Pseudo-state expansion; Close coupling calculation; *12155.*

Electron spectroscopy; NO_2; Photoelectron spectroscopy; Rydberg series; *12065.*

Electron spin resonance; Evaluation; Gel; Mechanical properties; Optical properties; Plastic films; Poly(ethylene terephtalate); Proton damage; Proton energy; Radiation effect; Radiation intensity; Recovery; Solubility; *SP336*, pp. 323-344.

Electron stimulated desorption; Gallium arsenide; Work function; Adsorption; Cesium; Desorption; Electron reflection; *12108.*

Electron stimulated desorption; Hydrogen; Nickel; Nitrogen; Oxygen; Surface; Tungsten; Adsorption; Chemisorption; Cross section; Desorption; *12332.*

Electron temperature; Line-blanketing; Mechanical heating; Radiation quality; Radiation quantity; *12097.*

Electron-dislocation interactions; Lattice defects; Phonon-dislocation interactions; Solid-state; Theoretical physics; Thermally activated processes; Twinning; Conference; Continuum mechanics; Crystal physics, disclinations; Dislocations; Elasticity; *SP317.*

Electron-energy deposition; Gray medal; Ionization; Bragg-Gray principle; Cavity; Detector response functions; Dosimetry; *12297.*

Electronic energy; $OCCl_2$; Photodissociation; Vacuum ultraviolet; Absorption coefficient; Cl_2; Emission; *12289.*

Electronic specific heat; Specific heat; 0.48 to 10 K; Clustering; $Co_{0.6}Ni_{0.4}$ alloy; *11843.*

Electronic spectrum; Flash photolysis; Free radicals; Matrix isolation; Molecular orbitals; Vibrational spectrum; *11823.*

Electronic transitions; Rotational analysis; Vibrational analysis; Vibrational and rotational constants; Absorption spectrum; CO; **J.75A** *No. 5, 455-467 (1971).*

Electronic transport; $LaCoO_3$; Magnetic ordering; Transition metal oxides; *11809.*

Electrons; Gamma rays; Ge(Li) detectors; Germanium gamma-ray spectrometers; Holes; Lifetime; Theoretical model; Trapping; Charge carriers; *12255.*

Electrons; Single crystal faces of tungsten; Spin-orbit split bands; Tungsten; *12049.*

Electrons radiation damage; Front and rear contact; Leakage current; Silicon surface-barrier detector; Alpha particles counting response; Capacitance; Detector noise; Electron fluence; *12107.*

Electron-transfer; Inosose; Oxidation; Quantitative; Radical; Reagent; Determination; *12151.*

Electrooptic effect; Index of refraction; Nonlinear optics; Transmission; Crystal growth; $CsCuCl_3$; *12032.*

Electrooptical measurements; High voltage measurements; Kerr cell; Laser applications; Pulse measurements; Dielectric liquids; Electric field measurements; *12306.*

Electroresistivity; Dislocation damping; Dislocation-electron interactions; *SP317*, pp. 1303-1322.

Electroresistivity; Kink motion; Phonon scattering; Dislocation drag; Dislocation-phonon interactions; *SP317*, pp. 397-401.

Electrostrictive; Glass; Lasers; Photoelasticity; *12223.*

Element determined; Literature file; Matrix analyzed; Technique used; Activation analysis; Bibliography; *TN467, Part 1.*

Element determined; Literature file; Matrix analyzed; Technique used; Activation analysis; Bibliography; *TN467, Part 2.*

Elementary divisors; Multilinear functional; Isometry; *12079.*

Ellipsometry; Refractive index; Tungsten; Absorption; *12270.*

Elution volume; Flow; Gel permeation chromatography; Hydrodynamic volume; Polymer; Polymer separation; Chromatography; *12149.*

EMF-temperature relationship; Furnace; High temperature; Refractory metals; Thermocouple; Thermoelements; Sensor; Ultra high vacuum; W-Re alloys; **J.75C** *No. 2, 99-106 (1971).*

Emission; Electronic energy; $OCCl_2$; Photodissociation; Vacuum ultraviolet; Absorption coefficient; Cl_2; *12289.*

Emission; Excitation; Lifetime; $^4T_2$ state; Absorption; Defect phonon; *12319.*

Emission; Occupied bands; Soft x-ray; Band structure; Cu; Deep probes; *11952.*

Emission coefficient; Hydrogen; Hydrogen continuum; LTE; Spectral radiance standard; Stark-broadening; **J.75A** *No. 4, 291-333 (1971).*

Emission spectroscopy; Wavelengths; Zinc; Atomic spectra; *11907.*

Emissivity; Flashing light; Flux measurement; Irradiance; Material properties; Photometry; Projectors; Radiance; Radiometry; Reflectometry; *SP300. Vol. 7*

Emittance; Heat capacity; High-speed measurements; High temperature; Thermal radiation properties; Thermodynamics; Tungsten; Electrical resistivity; **J.75A** *No. 4, 283-290 (1971).*

Emittance; Heat capacity; High-speed measurements; High temperature; Niobium; Thermal radiation properties; Thermodynamics; Electrical resistivity; **J.75A** *No. 6, 565-571 (1971).*

Emittance; Heat capacity; High-speed measurements; High temperature; Tantalum; Thermal radiation properties; Thermodynamics; Electrical resistivity; **J.75A** *No. 1, 1-13 (1971).*

Emittance; High-speed measurements; Melting; Normal spectral emittance; Tantalum; Thermal radiation properties; *12307.*

Emulsions; Homogeneity; Ions; Mass; Platinum; Precision; Replicate; Spark; Spectrometry; Accuracy; Circumvention; *11847.*

End standard of length; Accelerometer round robin; Computer program for Youden diagrams; Correlation effect; *SP335*, pp. 39-40.

End-fixity; Reinforced concrete; Slenderness; Strength; Structural analysis; Walls; Axial load (force); Bending moment; Building codes; *11933.*

Energy; Free energy; Gibbs energy; Helmholtz energy; *12128.*

Energy; Laser; Power; Ruby; Calorimeter; Detector; *12011*

Energy curve; Local potential; N_2; Resonance width; Shape resonance; Spectroscopic constant; Valence orbital; Electron scatter; *11899.*

Energy deposition; Silicon detectors; Surface layers; Absorbed dose; Absorbed-energy distributions; Electron beams; *12063.*

Energy levels; gas laser; HCN, hydrogen cyanide; Infrared; Spectra; Rotational constants; Vibrational constants; Absorption; *12044.*

Energy levels; Hydrogen maser; Hyperfine interaction; Rubidium gas cell; Transition probability; Atomic frequency standards; Cesium beam; *TN399.*

Energy levels; Ionization potential; Nickel; Spectral series; Spectroscopy; Wavelength; J.75A *No. 4, 335-336 (1971).*

Energy levels of Gd^{+++} in Al_2O_3; Quadrupole transitions; Spin Hamiltonian; Transition probabilities; Ultrasonic (paramagnetic) resonance; Ultrasonic transition probabilities; Wave functions of Gd^{+++}; Corundum; J. 75A *No. 5, 493-523 (1971).*

Energy levels of Tm III; Radial energy integrals of Tm III; Spectrum of Tm III; Doubly ionized thulium; *11836.*

Energy per pulse; Laser; Peak power; Repetitively pulsed lasers; Average power; *TN398.*

Energy transfer; Eu and Nd doped glass; Fluorescence; Fluorescence decay times; Fluorescence quenching; Laser glass; Rare earth glass; *11831.*

Energy transfer; Excitation; Lifetime; Photoluminescence; Cr^{3+}; *12318.*

Engen microcalorimeter; Rf coaxial impedance standards; Attenuation measurement; Automatic data correction; Auxiliary receiver for microwave measurements; Dual admittance Woods bridge; *SP335*, pp. 117-119.

Engineering standards; International standards; International System of Units; Metric conversion; Metric system; Metrication; Metrication and engineering standards; SI; Standards; U.S. Metric Study; *SP345-11.*

Engineering standards, index of; Index of standards, recommended practices, specifications, and test methods; Key-Word-In-Context index of voluntary standards; Standards, voluntary, index of; *SP329.*

Enthalpy; Entropy; Equation of state; Fixed points; Heat transfer coefficients; Index of refraction; Joule-Thomson; Latent heat; Melting point; Prandtl number; Oxygen; Specific heat; Speed of sound; Surface tension; Thermal conductivity; *TN384.*

Enthalpy; Entropy; Gibbs energy of formation; Beryllium compounds; Magnesium compounds; Calcium compounds; Strontium compounds; Barium compounds; Radium compounds; *TN270-6.*

Enthalpy; Entropy; Gibbs energy of formation; Hafnium compounds; Heat of formation; Niobium compounds; Scandium compounds; Tantalum compounds; Titanium compounds; Vanadium compounds; Yttrium compounds; Zirconium compounds; *TN270-5.*

Enthalpy; Heat capacity standard; Specific heat; Standard reference material; Synthetic sapphire; Thermodynamic functions; Alumina; Aluminum oxide; Corundum; Drop calorimetry; J.75A *No. 5, 401-420 (1971).*

Enthalpy; Operational limits; Stagnation pressure; Arc currents; Arc heaters; Constricted arc; *SP336*, pp. 879-892.

Enthalpy of formation; Heat of formation; Ketene; Methylene; Bond energy; *12252.*

Entire function; Exponential type; Maximum modulus; Bounded index; J.75B *Nos. 3 and 4, 149-156 (1971).*

Entrance control; Hydraulics; Inlets; Culverts; *12359.*

Entropy; Equation of state; Fixed points; Heat transfer coefficients; Index of refraction; Joule-Thomson; Latent heat; Melting point; Prandtl number; Oxygen; Specific heat; Speed of sound; Surface tension; Thermal conductivity; Thermal diffusivity; *TN384.*

Entropy; Gibbs energy of formation; Beryllium compounds; Magnesium compounds; Calcium compounds; Strontium compounds; Barium compounds; Radium compounds; Enthalpy; *TN270-6.*

Entropy; Gibbs energy of formation; Hafnium compounds; Heat of formation; Niobium compounds; Scandium compounds; Tantalum compounds; Titanium compounds; Vanadium compounds; Yttrium compounds; Zirconium compounds; Enthalpy; *TN270-5.*

Entropy; Hard sphere; Liquid state; Neon; Percus-Yevick equation; Configuration entropy; Correlation function; *12370.*

Entropy; Open system; Potentials of mean force; Activity derivatives; Closed system; Correlation functions; *12373.*

Entropy; Specific heat; Thermal expansion; Thermodynamics and expansions; Bulk modulus; Dislocations and thermodynamics; *SP317*, pp. 1223-1225.

Environment; Evaporation; Outgassing; Simulation; Sublimation; Thermal conduction; Thermal vacuum tests; Volatile constituents; Volatilization; Absorption; Adsorption; "bake out"; Components; Decomposition; Degassing; *SP336*, pp. 473-485.

Environment; Hazards; Hygiene; Mercury; Vapor; Contamination; Dental amalgam; *12254.*

Environment; Ion pumping; Low pressure; Low temperature; Pumping; Ultraclean; Vacuum; Anti-migration traps; Cold shrouding; Contamination; *SP336*, pp. 661-668.

Environment; Standard Reference Material; Activation analysis; Biological; Botanical; *12334.*

Environmental samples; Standard Reference Material; Tissue standard; Trace analysis; Biological standards; Blood standard; Botanical standards; *12132.*

Environmental testing; Integrated circuits; Measurement methods; Microcircuits; Silicon; Device fabrication; *SP336*, pp. 449-455.

Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; *TN702.*

Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Resistivity; Semiconductor devices; Semiconductor materials; *TN560.*

Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; *TN571.*

Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; *TN592.*

Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; *TN598.*

Epitaxy; Junctions; Resistivity; Surface preparation; Analysis; Device processing; Diffusion; *SP337.*

Epoxy; Expansion; Hard rubber; Retention; Serviceability; Stability; Adaption; Acrylic; Contraction; Dentures; *12189.*

Epoxy cyclopentene; Microwave spectrum; Ring conformation; Rotational constants; Cyclopentene oxide; Dipole moment; *11970.*

Epoxy polymer; Parting agents; Poisson's ratio; Release agents; Stress-strain curve; Volume dilation; Composite materials; Coupling agents; *12379.*

Epoxy-novolac; Erosion; Phenolic carbon; Silicone rubber; Ablation; Aerodynamic shear; Carbon; Char; Cork; *SP336*, pp. 837-851.

EPR; Exponential temperature dependence; Intra-molecular relaxation; Jahn-Teller effect; Tris(2,2.-dipyridine)copper(II); Aqueous solutions; *12116.*

EPR; *g*-factors; Hyperfine interaction; Quadrupole coupling; Rutile; Titanium dioxide; Copper; *11804.*

Federal Information Processing Standard; Hollerith punched card code; Hollerith punched cards; Information interchange; Information processing; Punched cards; American Standard Code for Information Interchange; ASCII; Card punch; *FIPS PUB 14.*

Federal Information Processing Standards; Graphic character subsets; Graphic subsets; Information interchange; Information processing; Standards; Subsets; American Standard Code for Information Interchange; ASCII; Coded character subsets; *FIPS PUB 15.*

Federal information processing standards; Serial-by-bit; Serial-by-character; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; Communications; Data communications equipment; *FIPS PUB 16.*

Federal information processing standards; Serial-by-bit; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; Character structure; Character parity sense; Communications; Data transmission; *FIPS PUB 17.*

Federal information processing standards; Parallel-by-bit; Parity sense; Serial-by-character; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; Character structure; Communications; *FIPS PUB 18.*

Federal Information Processing Standards Publication; National government; Representations and codes; Standard Metropolitan Statistical Areas; Computers; Data processing; *FIPS PUB 8-1.*

Federal Information Processing Standards; International Organization for Standardization; Management information systems; Standards; U.S. Government; American National Standards; Computers, data elements and codes; Data processing systems; *FIPS PUB 12.*

Federal libraries; Federal Library Committee (FLC); Library automation; System design for libraries; Task Force on Automation; Automatic data processing; Automation of library functions; *12004.*

Federal Library Committee (FLC); Library automation; System design for libraries; Task Force on Automation; Automatic data processing; Automation of library functions; Federal libraries; *12004.*

Feedthrough; High pressure; Leads; Closure; *12039.*

Fees for testing; Test fee schedule; Test procedures; Calibration services; *SP250, 1970 Edition.*

Fe(III)-β-isopropyltropolone (HIPT) complex; First order in Fe(III) and in HIPT; Kinetics; *12115.*

FEP heat-shrinkable tubing; Fluorocarbon plastic heat-shrinkable tubing; Plastic tubing, fluorocarbon; PTFE heat-shrinkable tubing; Tubing, heat-shrinkable fluorocarbon plastic; *PS47-71.*

FEP lined pipe; Fluorinated ethylene-propylene plastic lined pipe; Pipe and fittings, steel, plastic lined; Plastic lined steel pipe; Steel pipe and fittings, plastic lined; *PS34-70.*

FEP tubing; Fluorocarbon plastic tubing; Plastic tubing, fluorinated ethylene-propylene; Tubing, FEP-fluorocarbon; Chemical, mechanical, and electrical tubing; *PS43-71.*

Fermi energy; Semiconductors; Band structure; Covalent-ionic solids; Dislocation-electron interactions; *SP317,* pp. 1293-1302.

Fermi-Dirac statistics; Heat exchangers; Helium-3; Helium-4; Liquid helium; Mixtures; Quantum fluid; Thermodynamic properties; Cryogenics; Dilution refrigerator; *11981.*

Ferric; Graphical; Least squares computer calculations; Vanadyl; β-isopropyltropolone; Chelate; Equilibrium constants; Extraction method; *12110.*

Ferric ions; Fricke dosimeter; Radiation dosimeter; Radiation dosimetry; Spectrophotometry; Spectrophotometric measurements; Chemical dosimeter; Chemical dosimetry, ferrous sulfate; Ferrous sulfate dosimeter; *12174.*

Ferrites; Hyperfine fields; Iron; Isomer shift; Lithium; Mössbauer effect; Recoilless fraction; Antimony; *12205.*

Ferroelectric materials; Glass; Laser damage; Lasers; *SP341.*

Ferrous sulfate dosimeter; Ferric ions; Fricke dosimeter; Radiation dosimeter; Radiation dosimetry; Spectrophotometry; Spectrophotometric measurements; Chemical dosimeter; Chemical dosimetry, ferrous sulfate; *12174.*

Few nucleon systems; Long wavelength; Cross section; Electric transition; Electrodisintegration; *12279.*

Fe-3Si alloy; Homogeneity testing; Metallography; Microprobe analysis; Spectrometric analysis; Standard Reference Materials; *SP260-22.*

Fiberglass; Friction; Steel; Titanium; Ultrahigh vacuum; Adhesion; Basalt; *SP336,* pp. 225-244.

Field emission; Monoxide; Rhenium; Ruthenium; Surface migration; Carbon monoxide; Desorption; *11819.*

Field emission; Surface physics; Tunneling; Attenuation length; Electron gas theory; *12154.*

Field emission; Surfaces; Tunneling; *12192.*

Field standard measuring flasks; Specification; Tolerances; Weights and measures inspection; Accurate measurements of volume of liquids; *H105-2.*

Field standard; Metal volumetric field standards; Provers; Specifications; Test measures; Tolerances; Weights and measures inspection; Accurate measurements of volumes; *H105-3.*

Field-ion microscope; Hydrogen; Ion; Liquid nitrogen temperature; *11911.*

Figure of merit; Frequency accuracy; Frequency multiplier; Frequency precision; NBS-III; NBS-5; Phase noise; Quartz crystal oscillator; Ramsey cavity; Slave oscillator; Atomic frequency standard; Cesium beam; *11959.*

File organization; Information retrieval; Information systems; Programming languages; Data management; Data structures; *12008.*

Film, plastic; Orientation release stress; Plastic heat-shrinkable film; Retraction ratio; Shrink film, plastic; Balanced and unbalanced film; *PS29-70.*

Filter permanence; Limit filters; Railroad signals; Signal colors; Signal standards; Spectral transmittance of glass filters; Traffic signals; Aircraft signals; Color standards; *TN564.*

Fine-grain ceramic; Ion bombardment; Magnesia; MgO; Microstructure; Rock; Zirconia; Alumina; Al_2O_3; Ceramics; Electron microscopy; *12083.*

Fine-structure; Perovskites; X ray; Absorption; *11919.*

Finishing; Operative dentistry; Polishing instruments; Surface finish; Composite restorative materials; *12308.*

Finite bodies; Dislocation loops; Elasticity; *SP317,* pp. 35-45.

Finite elasticity; Dislocation surface; Interactions; Dislocations; Elastic interactions; *SP317,* pp. 1179-1189.

Finite elasticity; Inhomogeneities; Dislocations-elasticity; Dislocation surface interactions; *SP317,* pp. 57-69.

Finite-element analysis; Force transducer; Stiffness matrix; Structural analysis; Axisymmetric; Elastic; Experiment; J.75C *Nos. 3 and 4, 155-161 (1971).*

Fire control; Fire spread; Smoke movement; Building design; Dampers; Ducts; *12347.*

Fire spread; Smoke movement; Building design; Dampers; Ducts; Fire control; *12347.*

Fire station; Simulation model; Systems analysis; Urban analysis; East Lansing, Mich.; Facility location; *12018.*

Fire tests; Interlaboratory tests; Optical density; Round robin; Smoke; Smoke density chamber; Statistical analysis; Building materials; *TN708.*

First order in Fe(III) and in HIPT; Kinetics; Fe(III)-β-isopropyltropolone (HIPT) complex; *12115.*

Fischer inequality; Hadamard determinant theorem; Permanent;

Positive definite hermitian matrix; **J.75B** *Nos. 1 and 2, 77-80 (1971).*

Fission cross sections; Fission neutron spectra; Integral measurements; *12363.*

Fission neutron spectra; Integral measurements; Fission cross sections; *12363.*

Fission tracks; Kale; Orchard leaves; Uranium; Alpha tracks; Boron; Botanical material; *12269.*

Fixed calibration interval; Instrument reliability; Statistical validity; Two-method optimization; Data support; *SP335,* pp. 73-79.

Fixed point; Freezing point; Furnaces; High temperature; IPTS-68; Platinum resistance thermometer; Temperature scale; Thermocouple; Triple point; Calibration; *12354.*

Fixed points; Heat transfer coefficients; Index of refraction; Joule-Thomson; Latent heat; Melting point; Prandtl number; Oxygen; Specific heat; Speed of sound; Surface tension; Thermal conductivity; Thermal diffusivity; Vapor pressure; Viscosity; *TN384.*

Fixed points; High pressure; High-pressure equipment; Instrumentation; Pressure scale; Shock wave technique; Temperature; Accurate measurement; Equation-of-state; *SP326.*

Flame emission; Nonaqueous media; Precision; Sensitivity; Tables; Accuracy; Atomic absorption; Detection limits; Differential method; *12111.*

Flame spectra; Line shapes; Carbon monoxide; Collision parameters; Equivalent width;**J.75A** *No. 5, 469-479 (1971).*

Flame-resistant; Paper and paperboard; Paper, paperboard, flame-resistant; Paperboard, paper, flame-resistant; *PS46-71.*

Flammability; Flammability reduction; Mattresses; Research; Small carpets and rugs; Standards; Test development; Annual report to Congress; Blankets; Carpets and rugs; Children's sleepwear; Cooperation; *TN596.*

Flammability reduction; Mattresses; Research; Small carpets and rugs; Standards; Test development; Annual report to Congress; Blankets; Carpets and rugs; Children's sleepwear; Cooperation; Flammability; *TN596.*

Flash desorption; Hydrogen; Nitrogen; Tungsten; Tungsten (100) plane; Work function; Chemisorption;*12125.*

Flash photolysis; Free radicals; Matrix isolation; Molecular orbitals; Vibrational spectrum; Electronic spectrum; *11823.*

Flashing light; Flux measurement; Irradiance; Material properties; Photometry; Projectors; Radiance; Radiometry; Reflectometry; Emissivity; *SP300. Vol. 7*

Flashlamp-pumped dye laser; Mode-locking; Subnanosecond pulses; Acousto-optic modulator; *TN603.*

Flat roofs; Heat transfer; Moisture transfer; Thermal insulation; *BSS37.*

Flexural strength; Masonry; Mortar; Slenderness effects; Standards; Structural stability; Walls; Brick; Cavity walls; Composite walls; Compressive strength; Concrete block; *BSS34.*

Flicker noise; Fractional integration; Recursive digital filters; Analog noise simulation; Computer noise simulation; Digital filters; *TN604.*

Flicker noise; Frequency; Frequency stability; Lasers; Length standards; Measurement standards; Spectral density; Speed of light; Standard frequency broadcasts; Statistics of time/frequency measurements; Time; Time/frequency dissemination; *SP350.*

Flicker noise; Frequency stability; Frequency standards; Hydrogen maser; Long baseline interferometry; Quartz crystal oscillators; Time standards; Atomic frequency standards; Cesium beam; *11888.*

Flip-chip; Magnetic pickup; Microelectronic interconnections; Spider bonding; Ultrasonic bonding; Wire bonding; Capacitor microphone; *TN573.*

Flow; Flowmeters; Liquid nitrogen; Measurement; Positive displacement; Cryogenic; *TN605.*

Flow; Gel permeation chromatography; Hydrodynamic volume; Polymer; Polymer separation; Chromatography; Elution volume; *12149.*

Flow facility; Liquid nitrogen; Measurement; Accuracy statement; Cryogenic; *TN606.*

Flow measurement; Weirs, broad-crested; *12366.*

Flow rate tests; High speed movies; Particle velocities; Vacuum tests; Water jet; *SP336,* pp. 905-914.

Flow reactor; Gas mixing; Mixing by diffusion; Relaxation methods; Diffusion equation; Diffusion of gases; *12091.*

Flow stress; Impurity softening; Lattice solution; Lower yield stress; Nitrogen; Polycrystals; Solution hardening; Upper yield point; Zone-refined iron; *11946.*

Flowmeters; Instrumentation; Liquefied natural gas (LNG); Methane; Properties data; *11821.*

Flowmeters; Liquid nitrogen; Measurement; Positive displacement; Cryogenic; Flow; *TN605.*

Fluctuating pressure; Gust factors; Walls; Wind damage; Wind loads; Buildings; *BSS30,* pp. 9-18.

Fluctuations; Homogeneity; Ion sensitive emulsion; Mass spectrometry; Precision; Quantitative analysis; Solids; Spark source; Trace elements; *12127.*

Fluid dynamic force; Microorganisms; Optical properties; Planetary quarantine; Polymers; Shock force; Space simulation; Testing; Volatile products; Absorption; Condensation; Contamination control; Evaluation; Far infrared; *SP336,* pp. 51-77.

Fluid measure; Labeling; Net quantity; Principal display panel; Regulations; Weights and measures; Consumer package; Exemption; *H108.*

Fluid mechanics; Hydraulic engineering; Hydraulic research; Hydraulics; Hydrodynamics; Model studies; Research summaries; *SP346.*

Fluorescence; Fluorescence decay times; Fluorescence quenching; Laser glass; Rare earth glass; Energy transfer; Eu and Nd doped glass; *11831.*

Fluorescence; H atom; Propylene; Reaction kinetics; Absolute rate constant; Activation energy; *12212.*

Fluorescence; HNCO; NCO $A^2\Sigma$; NH $A^3\pi$, $c^1\pi$; Photodissociation; Vacuum ultraviolet; Bond dissociation energy; *12012.*

Fluorescence; Infrared; Laser; Nitrous oxide; Q-switching; Vibrational relaxation; *11858.*

Fluorescence analysis; Gamma rays; Photons; Röntgen; X rays; Absorption corrections; Attenuation coefficient; Conference; Crystallography; Electron microprobe; *11814.*

Fluorescence decay times; Fluorescence quenching; Laser glass; Rare earth glass; Energy transfer; Eu and Nd doped glass; Fluorescence; *11831.*

Fluorescence filters Tl(I), Ce(III), Pb(II); Glass filters (SRM 930); Mercury in botanical; Quantum efficiencies; Aluminum in steel; Bilirubin; DTA standards; *TN584.*

Fluorescence quenching; Laser glass; Rare earth glass; Energy transfer; Eu and Nd doped glass; Fluorescence; Fluorescence decay times; *11831.*

Fluorescence spectrum; Free radical; Infrared spectrum; Matrix isolation; Photolysis; Ultraviolet spectrum; ClCF; Chlorofluoromethane; Chlorofluoromethane-d_2; *12219.*

Fluorescence yield; Fluorine; *K*-shell; Magnesium; ω_K; Beryllium; Boron; Carbon; *11950.*

Fluorides; Alkaline earth; Color centers; F^- centers; *12301.*

Fluorinated ethylene-propylene plastic lined pipe; Pipe and fittings, steel, plastic lined; Plastic lined steel pipe; Steel pipe and fittings, plastic lined; FEP lined pipe; *PS34-70.*

Fluorine; Heats of formation; Hot bands; Hydrogen fluoride; Ion pairs; Mass spectrometry; Molecular ionization; Photoionization; Vacuum ultraviolet; Chlorine monofluoride; Dissociative ionization; *12148.*

Fluorine; *K*-shell; Magnesium; ω_K; Beryllium; Boron; Carbon; Fluorescence yield; *11950.*

Fluorine; Latent heats of vaporization; Saturated liquid densi-

Gamma rays; Insect sterilization; Shelf-life extension; Sprouting inhibition; Chemical dosimeter; Disinfestation; Dosimetry; Dyes; *12193*.

Gamma rays; Photocurrents; Radiation; Radiation detector; Radiation dosimetry; Silicon radiation detector; Temperature dependence; X rays; **J.75A** *No. 6, 579-589 (1971)*.

Gamma rays; Photons; Röntgen; X rays; Absorption corrections; Attenuation coefficient; Conference; Crystallography; Electron microprobe; Fluorescence analysis; *11814*.

Gamma rays, angular distribution of; Hyperfine field in iron; Nuclear orientation; Transition mixing ratios; ^{192}Ir, magnetic moment of; Beta rays, angular distribution of; *12005*.

Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; *TN702*.

Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; *TN560*.

Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; *TN571*.

Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; *TN592*.

Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; *TN598*.

Gamma-ray transport; Moment method; Neutron transport; Polynomial truncation errors; Sievert function; Biorthogonal polynomials; **J.75B** *Nos. 1 and 2, 1-16 (1971)*.

Gas; Gas, compressibility factor of; Gas, *PVT* properties of; Measurements; Second virial coefficient; Adsorption, gas on metal; Argon, compressibility factor of; Burnett data reduction; **J.75C** *Nos. 3 and 4, 163-172 (1971)*.

Gas; Gas law correction; Imperfect gas; Second virial coefficient; Adsorption; Correction for gas; *12330*.

Gas; Infrared; Methyl iodide; Molecular geometry; Molecular structure; Spectra; Absorption; *11973*.

Gas; Intermolecular potential; Potential function; Scattering; Second virial; Viscosity; *12162*.

Gas; Intermolecular potential function; Polar; Second virial coefficient; Stockmayer; Dipole; **J.75A** *No. 4, 337-385 (1971)*.

Gas; Model dependency; Nonlinear; PVT; Statistical; Burnett; *11932*.

Gas chromatography; Group separation; Mercuric nitrate; Olefins; Silver nitrate; Surface effect; Aliphatics; Aromatics; Complexing effects; *12024*.

Gas chromatography; Interactive gels; Liquid chromatography design; Nitrilotriacetic acid; Clinical Standard Reference Materials; Fraction collecting; *TN589*.

Gas chromatography; Isotope dilution; Olefins; Water analysis; Aromatics; *12023*.

Gas chromatography; Ketene; Methyl ketene; Analysis; *12164*.

Gas chromatography; Spectroscopy; Vacuum ultraviolet; Analytical; Atomic emission; Detector; *12267*.

Gas, compressibility factor of; Gas, *PVT* properties of; Measurements; Second virial coefficient; Adsorption, gas on metal; Argon, compressibility factor of; Burnett data reduction; **J.75C** *Nos. 3 and 4, 163-172 (1971)*.

Gas flow; Lithium; Microanalysis; Multichannel analyzer; Proportional counters; Quantitative analysis; Solid state counters; Tests; X-ray spectra; X-ray spectrometers; Electron diffraction; Electron probes; Evaluation; *12251*.

Gas kinetics; Olefins; Singlet oxygen; Air pollution; Chemical kinetics; Chemistry; *12158*.

Gas laser; HCN, hydrogen cyanide; Infrared; Spectra; Rotational constants; Vibrational constants; Absorption; Energy levels; *12044*.

Gas laser; Line widths; Power output; Theory; Tuning curves; Collisions; *11811*.

Gas law correction; Imperfect gas; Second virial coefficient; Adsorption; Correction for gas; Gas; *12330*.

Gas mixing; Mixing by diffusion; Relaxation methods; Diffusion equation; Diffusion of gases; Flow reactor; *12091*.

Gas phase; Hydrocarbons; Ion-molecule reactions; Mass spectrometry; Photoionization; Rate constants; **J.75A** *No. 3, 147-153 (1971)*.

Gas phase; Nitrogen; Nitrogen oxides; Oxygen; Ozone; Bibliography; Chemical kinetics; *NBS-OSRDB-71-2 (COM-71-00841)*.

Gas phase; Potential energy surfaces; Recombination; Review; Unimolecular decomposition; Atom-transfer reaction; Chemical activation; Chemical kinetics; Chemi-excitation; *11943*.

Gas, *PVT* properties of; Measurements; Second virial coefficient; Adsorption, gas on metal; Argon, compressibility factor of; Burnett data reduction; Carbon dioxide, second virial coefficient of; **J.75C** *Nos. 3 and 4, 163-172 (1971)*.

Gas solubility; Hard-sphere model; Liquefied gases; Phase equilibria; Predicted thermodynamic parameters; *11989*.

Gas stream blower; GN temperature conditioning; Solar array; Solar cell; Thermal cycle vacuum testing; Thermal shroud; Gaseous nitrogen heater; *SP336*, pp. 669-682.

Gaseous nebulae; Non-LTE thermodynamics; Solar physics; Transition probabilities; Atomic energy levels; *SP353*.

Gaseous nitrogen heater; Gas stream blower; GN temperature conditioning; Solar array; Solar cell; Thermal cycle vacuum testing; Thermal shroud; *SP336*, pp. 669-682.

Gases; Mass action; Non-linear search; Chemical equilibrium; Chemical reactions; Equilibrium; *12244*.

Gas-liquid chromatography; Infrared spectrometry; Mass spectrometry; Quartz crystal oscillator mass monitors; Radiometry; Reflectometry; Space environment simulation chambers; Contamination collection units; *SP336*, pp. 25-49.

Gas-liquid chromatography; Rare sugars; Rearrangement; 1,3-dioxolane rings; Fructose; *11866*.

Gaussian primes; Indexing; Measurement; Performance; Prime; Program; Test; Assessment; Complex; Composite; Computer; Criteria; Evaluation; *TN572*.

Gaussian quadrature; Integration; Optimal quadrature; Quadrature; Analytical functions; Approximation; **J.75B** *Nos. 1 and 2, 85-88 (1971)*.

$GdAsO_4$; Heat capacity; Heisenberg; Ising model; Low temperature; Antiferromagnetism; Exchange interactions; *12202*.

Gears; Reliability; Signature analysis; Vibration; Bearings; Diagnostics; *SP336*, pp. 407-448.

Gel; Mechanical properties; Optical properties; Plastic films; Poly(ethylene terephtalate); Proton damage; Proton energy; Radiation effect; Radiation intensity; Recovery; Solubility; Space simulation; Temperature effect; Tests; *SP336*, pp. 323-344.

Gel filtration; Gel permeation chromatography; Macromolecules; Separation by flow; Chromatography; *12003*.

Gel permeation chromatography; Hydrodynamic volume; Polymer; Polymer separation; Chromatography; Elution volume; Flow; *12149*.

Gel permeation chromatography; Macromolecules; Separation by flow; Chromatography; Gel filtration; *12003.*

Ge(Li) detectors; Germanium gamma-ray spectrometers; Holes; Lifetime; Theoretical model; Trapping; Charge carriers; Electrons; Gamma rays; *12255.*

General Conference of Weights and Measures; International Committee of Weights and Measures; International System of Units; SI; Système International des Unités; Units of measurement; *SP330.*

General Overhauser effect; Internuclear double resonance; Long-range coupling; Magnetic equivalence factoring; Spin-tickling; Transient nutations; 6-Deoxy-α-D-glucofuranose derivative; *12272.*

Generalized matrix function; Invariants; Matrices; Rank; Determinant; **J.75B** *Nos. 3 and 4, 109-115 (1971).*

Generalized techniques; Historical review; Isothermal; Isoconversional and isokinetic methods; Kinetic parameters; Thermogravimetric analysis; Applied nonisothermal kinetics; *12356.*

Geometry; Infrared spectra of species; Matrix isolation; $ScCl_3$; $TiCl_3$; $TiCl_4$; Dichlorides of Ca, Sc, Ti, V, Cr, Mn, Fe, Ni; *12281.*

Geophysics; Laser strainmeter; Seismograph; Earth strain; Earth tide; *11865.*

Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; *TN560.*

Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; *TN571.*

Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; *TN592.*

Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; *TN702.*

Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; *TN598.*

Germanium; Infrared; Photoconductivity; Photoresponse; Semiconductors; Silicon; Deep impurities; *TN570.*

Germanium gamma-ray spectrometers; Holes; Lifetime; Theoretical model; Trapping; Charge carriers; Electrons; Gamma rays; Ge(Li) detectors; *12255.*

g-factors; Hyperfine interaction; Quadrupole coupling; Rutile; Titanium dioxide; Copper; EPR; *11804.*

Giant resonance; Hydrodynamic model; Isospin; Nuclear structure; Charge distribution; Collective model; *12287.*

Giant resonance; Isobaric spin splitting; Photonuclear; Boron eleven; *11890.*

Gibbs energy; Helmholtz energy; Energy; Free energy; *12128.*

Gibbs energy of formation; Beryllium compounds; Magnesium compounds; Calcium compounds; Strontium compounds; Barium compounds; Radium compounds; Enthalpy; Entropy; *TN270-6.*

Gibbs energy of formation; Hafnium compounds; Heat of formation; Niobium compounds; Scandium compounds; Tantalum compounds; Titanium compounds; Vanadium compounds; Yttrium compounds; Zirconium compounds; Enthalpy; Entropy; *TN270-5.*

Girling scale dynamometer; Inertia brake dynamometer; Vehicle road tests; Brake friction materials; Coefficient of friction; Friction assessment screening test machine; Friction materials test machine; *12051.*

Glaserite; α-$Ca_3(PO_4)_2$; Calcium magnesium phosphate; Single crystal x-ray diffraction; Cation vacancies; *12274.*

Glaserite; Hydroxyapatite; Single crystal x-ray diffraction; Calcium phosphate; Calcium phosphate-calcium silicate solid solution; Calcium phosphosilicates; Calcium silicates; Crystal structures; *12273.*

Glass; Heat capacity; Monoclinic crystal; Low temperature; Planar molecular structure; Spherical shell molecules; Vitreous state; Arsenious oxide; Arsenolite; Claudetite; Crystal transition; Cubic crystal; *12311.*

Glass; High pressure; Strength; Deep submergence; Fracture; Fracture energy; *12188.*

Glass; High temperature materials; Laser; Oxides; Oxygen diffusion; Pure materials; Sapphire; Al_2O_3; Crystal growth; Damage threshold; *TN703.*

Glass; High temperature materials; Laser damage; Laser degradation; Laser glass; Laser materials; Mass transport; Neodymium glass; Optical properties; Opto-elastic properties; Oxides; Ruby; Rutile; Titanium; Titanium dioxide; Transition metal; *TN565.*

Glass; High temperature materials; Laser; Oxides; Oxygen diffusion; Pure materials; Sapphire; Al_2O_3; Crystal growth; Damage threshold; *TN574.*

Glass; Hydrated antimony pentoxide (HAP); Radiochemical separations; Sodium; Trace elements; Activation analysis; *12000.*

Glass; Immiscibility; Phase-separation; Viscosity; Viscosity-drift; *12238.*

Glass; Laser damage; Lasers; Ferroelectric materials; *SP341.*

Glass; Laser damage; Surface; *12239.*

Glass; Lasers; Photoelasticity; Electrostrictive; *12223.*

Glass; Static fatigue; Stress corrosion; Crack propagation; Fracture; *11992.*

Glass; Strength; Surface; Crack healing; Fracture; *11993.*

Glass ceramic; Phase transition; Strontium titanate; Thermometer; Capacitor; Depolarization; Dielectric; Dilution refrigerator; *12368.*

Glass chromatography; Immiscibility and courses of crystallization; Immiscibility and practical applications; Immiscibility and thermodynamics; Immiscibility in oxides; Liquid immiscibility; $Ln_2O_3-B_2O_3$ phase diagrams; *11902.*

Glass filters (SRM 930); Mercury in botanical; Quantum efficiencies; Aluminum in steel; Bilirubin; DTA standards; Fluorescence filters Tl(I), Ce(III), Pb(II); *TN584.*

Glass temperature; High pressure; Radiation-induced; Tetrafluoroethylene; 3,3,4,4,5,5,5-heptafluoropentene-1; Amorphous polymer; Copolymerization; Fluoropolymers; *11868.*

Glass thermometers, clinical; Mercury-in-glass thermometers; Thermometers, self-registering, clinical; Clinical thermometers; *PS39-70.*

Glass transformation; Heat capacity; Natural rubber; Normal and supercooled liquid; Rubber, natural; Thermal diffusivity; Thermodynamic properties; Annealed and quenched glass; Calorimetry; *cis*-1,4-polyisoprene; **J.75A** *No. 2, 113-120 (1971).*

Glasses; Hardness; Laser; Optical homogeneity; Photoelasticity; Refractive index; Thermal conductivity; Thermo-optic properties; Transmittance; Chemical composition; Density; **J.75A** *No. 3, 163-174 (1971).*

Glasses; Interferometry; Optics; Refractive index; Fused silica; **J.75A** *No. 4, 279-281 (1971).*

Glauber model; He^4-He^4 elastic scattering; High energy Coulomb effects; High energy scattering; Diffraction scattering; *12031*.

Glazing; Hailstones; Masonry; Mobile homes; Roofs; Structural engineering; Wind load; Anchorage; Building performance; *TN558*.

Glide propagation; Grain boundaries; Virtual dislocations; Boundary dislocations; *SP317*, pp. 531-545.

Gloss; Porcelain enamel; Weather resistance; Acid resistance; Color; *BSS38*.

Glyoxal; Methyl sulfoxide; Oxygen; Radical-anion; Bis(phenylhydrazone); E.s.r.; **J.75A** *No. 6, 573-577 (1971)*.

GN temperature conditioning; Solar array; Solar cell; Thermal cycle vacuum testing; Thermal shroud; Gaseous nitrogen heater; Gas stream blower; *SP336*, pp. 669-682.

Gold; Inelastic electron scattering; Multiple scattering; 0.1 to 3.0 MeV; Carbon; Copper; Experimental cross sections; *12113*.

Gold-cadmium alloy; Martensite; Phase transformation; Twinning; Crystallography; *12006*.

Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; *TN560*.

Gold-doped silicon; Metallization; Method of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; *TN571*.

Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; *TN592*.

Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; *TN702*.

Gold-doped silicon; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; *TN598*.

Gradient; Matrices; Matrix calculus; Partial differentiation; Product rule; Tensor function; Trace; Chain rule; Continuum mechanics; **J.75B** *Nos. 3 and 4, 97-107 (1971)*.

Grading; Rating; Test method; Tread wear; Automobile tires; *12200*.

Grading charts, women's size; Pattern size, women's; Size designations, women's; Span charts, women's sizing; Apparel, women's; Body measurements, women's; Classifications, women's size; *PS42-70*.

Grain boundaries; Anisotropic elasticity; Dislocations-elasticity; Dislocation pileups; *SP317*, pp. 163-171.

Grain boundaries; Interfaces; Twinning; Dislocations; *SP317*, pp. 465-477.

Grain boundaries; Solute segregation; Super-purity metals; Aluminum; Electrical resistivity; *11818*.

Grain boundaries; Virtual dislocations; Boundary dislocations; Glide propagation; *SP317*, pp. 531-545.

Grain morphology; Preferred orientation; Stress corrosion; Aluminum alloy; Corrosion; Directional effects; *11839*.

Gram-Schmidt orthogonalization; Householder transformations; Iterative refinement; Least squares; Linear equations; Orthogonalization; Orthogonal polynomials; Regression; Rounding error; Stepwise regression; Computer programs; Curve fitting; *12184*.

Graph; Hamiltonian; Power of a graph; **J.75B** *Nos. 1 and 2, 63-66 (1971)*.

Graphic character subsets; Graphic subsets; Information interchange; Information processing; Standards; Subsets; American Standard Code for Information Interchange; ASCII; Coded character subsets; Codes; Data communication; Data interchange; *FIPS PUB 15*.

Graphic subsets; Information interchange; Information processing; Standards; Subsets; American Standard Code for Information Interchange; ASCII; Coded character subsets; Codes; Data communication; Data interchange; Data processing; *FIPS PUB 15*.

Graphical; Least squares computer calculations; Vanadyl; β-isopropyltropolone; Chelate; Equilibrium constants; Extraction method; Ferric; *12110*.

Graphite arc; High-speed measurements; High temperatures; Pyrometry; Radiance; Standards; *12201*.

Graphite electrode; High energy density cell; Lithium deposition; Organic electrolyte; *12088*.

Gravitational red shift; Stark broadening; Stark-induced red shift; White dwarf spectra; Balmer lines H_α, H_β, and H_γ; *12226*.

Gray medal; Ionization; Bragg-Gray principle; Cavity; Detector response functions; Dosimetry; Electron-energy deposition; *12297*.

Green olives, package quantities of; Olives, green, package quantities of; Package quantities of green olives; *PS40-70*.

Green's tensor; Anisotropy; Cubic materials; Elasticity; *SP317*, pp. 125-134.

Green's tensor; Hooke's elasticity; Non-local elasticity; Solid mechanics; *SP317*, pp. 737-746.

Green's tensor; Incompatibility; Internal stress; Source kernels; Stress functions; Anisotropic elasticity; Dislocations; *SP317*, pp. 89-124.

Green's tensor; Non-local elasticity; Solid mechanics; Surface waves; *SP317*, pp. 747-759.

Green's tensors; Anisotropic elasticity; Dislocation dynamics; Dislocations; *SP317*, pp. 977-996.

Green's tensors; Interatomic potential; Lattice studies; Peierl's energy; Screw dislocation; Computer simulation; *SP317*, pp. 291-298.

Grid; Intermittency; Isotropy; Moments; Probability-distributions; Turbulence; Velocity-gradients; Computer; Correlations; *12316*.

Grignard reagents; Organic plating baths; Triethylboron; Beryllium, electrodeposition of; Beryllium azide; Beryllium thiocyanate, decaborane; Dimethyl beryllium; Magnesium, electrodeposition of; Nonaqueous plating baths; *12304*.

Grüneisen; *n*-alkanes; Normal mode; Polyethylene; Quasiharmonic specific heat; String of beads; Thermal expansion; Thermal properties; Volume; Bulk modulus; *12305*.

Ground motion; Infrasonic microphones; Seismic response; Compensation; **J.75C** *No. 1, 41-45 (1971)*.

Group additivity method; Peroxyacetyl nitrate; Peroxybenzoyl nitrate; Thermochemical properties; Bond additivity method; *12204*.

Group dynamics; Interpersonal relationships; Management research; Opinion survey; Brainstorming; Cybernetic technique; Data collection; *12364*.

Group separation; Mercuric nitrate; Olefins; Silver nitrate; Surface effect; Aliphatics; Aromatics; Complexing effects; Gas chromatography; *12024*.

Group theory; Inversion splitting; Methane; Molecular-beam data; Ortho-para transitions; Radio frequency; *12323*.

Growth mechanisms; Morphological stability; Nucleation; Phase changes; Transport processes; Crystal; Crystal growth; Crystallization; *11918*.

Growth technique; N-eicosane; Single crystal; Unit cell; *11875*.

Gust factor; Mode shape; Probability theory; Wind loads; Buildings; Dynamics; *BSS30*, pp. 93-104.

error function; **J.75A** *No. 4, 261-268 (1971).*

Heat exchangers; Helium-3; Helium-4; Liquid helium; Mixtures; Quantum fluid; Thermodynamic properties; Cryogenics; Dilution refrigerator; Fermi-Dirac statistics; *11981.*

Heat of formation; Ketene; Methylene; Bond energy; Enthalpy of formation; *12252.*

Heat of formation; Niobium compounds; Scandium compounds; Tantalum compounds; Titanium compounds; Vanadium compounds; Yttrium compounds; Zirconium compounds; Enthalpy; Entropy; Gibbs energy of formation; Hafnium compounds; *TN270-5.*

Heat of formation; Vacuum ultraviolet; Bond dissociation energy; Diazomethane; *12367.*

Heat of hydration; Portland cements; Shrinkage; Statistical evaluation; Strength; Sulfate expansion; Trace elements; Alkalies; Concrete; Durability; *11863.*

Heat of vaporization; Least squares fits; Second and third heats; ΔH-ΔS correlation; *12014.*

Heat protection; Reentry; Test facility; Ballistic missiles; *SP336,* pp. 893-904.

Heat shields; Heat transfer; Planetary entry; Radiation; Ablation; Evaluation; *SP336,* pp. 751-812.

Heat transfer; Isotherm; Kinetics; Mass transfer; Adsorbent-reaction; Adsorption; *11898.*

Heat transfer; Moisture transfer; Thermal insulation; Flat roofs; *BSS37.*

Heat transfer; Planetary entry; Radiation; Ablation; Evaluation; Heat shields; *SP336,* pp. 751-812.

Heat transfer coefficients; Index of refraction; Joule-Thomson; Latent heat; Melting point; Prandtl number; Oxygen; Specific heat; Speed of sound; Surface tension; Thermal conductivity; Thermal diffusivity; Vapor pressure; Viscosity; Volume; *TN384.*

Heat transmission; Infrared scanning; Mars environmental simulation; Outgassing; Thermal insulation; Thermal-vacuum chambers; Evacuating; *SP336,* pp. 725-748.

Heat transmission; Thermal contact; Cryogenics; Equipment design; *11816.*

Heats; *n*-hexatricontane; *n*-pristane; *n*-tetracosane; *n*-tetranonacontane; Vaporization; Alkanes; *11840.*

Heats of formation; Hot bands; Hydrogen fluoride; Ion pairs; Mass spectrometry; Molecular ionization; Photoionization; Vacuum ultraviolet; Chlorine monofluoride; Dissociative ionization; Fluorine; *12148.*

Heats of immersion; Heats of immersion of tooth structure; Reactivity of anorganic whole tooth; Reactivity of dentin; *12230.*

Heats of immersion of tooth structure; Reactivity of anorganic whole tooth; Reactivity of dentin; Heats of immersion; *12230.*

Heats of sublimation (second and third law); Interlaboratory measurements; Silver; Standard errors; Standard reference materials; Vapor pressure; Cadmium; Components of error (within- and between-laboratory); *SP260-21.*

Heats of vaporization; Methane; Orthobaric densities; Specific heats of the saturated liquid; Thermofunctions for ideal gas states; Thermophysical properties; **J.75A** *No. 1, 15-21 (1971).*

Heavy metal halides; Infrared spectra; Matrix isolation; Molecular geometries; *12157.*

HeH_2^+; Proton transfer; Activation energy; Configuration interaction; Correlation energy surface; Hartree-Fock; H_3^+; H_3; H_3^-; H_4; LiH_2; LiHF; HNO; *11969.*

Heisenberg; Ising model; Low temperature; Antiferromagnetism; Exchange interactions; $GdAsO_4$; Heat capacity; *12202.*

Heisenberg paramagnet; Specific heat; Spin-diffusion; Susceptibility; Ultrasonic attenuation; Frequency shift; *12265.*

Helium; Hydrogen; Sum rule; Correlation; Electron scattering; Form factor; *11916.*

Helium; Inelastic; Absolute differential cross section; Born; Elastic; Electron impact; *12029.*

Helium; Mixture adsorption; Nitrogen methane; Breakthrough time; *12160.*

Helium; Nitrogen; Pump; Pump design; Pump performance; Centrifugal; *12176.*

Helium; Second virial coefficient; Speed of sound in gases; Acoustic thermometry; Equation of state; Equilibrium gas properties; *12061.*

Helium; Wavelength measurement; Atomic energy levels; Atomic theory; Autoionization; *12380.*

Helium negative glow discharge; Microwave cavity; Plasma density; Collision frequency; *TN607.*

Helium resonance radiation; Hydrocarbons; Inorganic molecules; Ionization efficiency; Ionization quantum yield; Neon resonance radiation; Absorption coefficient; **J.75A** *No. 5, 481-485 (1971).*

Helium-3; Helium-4; Liquid helium; Mixtures; Quantum fluid; Thermodynamic properties; Cryogenics; Dilution refrigerator; Fermi-Dirac statistics; Heat exchangers; *11981.*

Helium-3; Photonuclear; Radiative capture; Angular distribution; Cross section; *11886.*

Helium-4; Liquid helium; Mixtures; Quantum fluid; Thermodynamic properties; Cryogenics; Dilution refrigerator; Fermi-Dirac statistics; Heat exchangers; Helium-3; *11981.*

Helmholtz energy; Energy; Free energy; Gibbs energy; *12128.*

Hemacytometer; Interferometry; Planarity; Cover glass, test method for; *TN579.*

Heterochromatic photometry; Integrating sphere; Intercomparison; Luminous flux; Photometry; Spectroradiometry; Barnes colorimeter; Chromaticity coordinate; Color correction; Cool white fluorescent lamp; Correlated color temperature; *TN559.*

Heteropolymolybdate; X-ray crystal structure; *11979.*

Hexachloromolybdate complex ion; Molten salt; Transference numbers; *11971.*

Hexafluoroacetylacetone; Rhenium coatings; Trifluorophosphine; Carbonyl; Chemical vapor deposition; Electrodeposition; *11942.*

Hexagonal alloys; Silver-tin alloys; Dislocation multipoles; Dislocation networks; Dislocation nodes; Dislocations; Electron microscopy; *12072.*

Hexahalogenated benzenes; Raman; Laser; Vibrational assignment; C_6F_6; C_6Cl_6; C_6Br_6; C_6I_6; *12299.*

He^3-He^4 dilution refrigerator; Mass spectrometer leak detector; Mechanical pump; Shaft seal; Closed pumping system; *12235.*

He^4-He^4 elastic scattering; High energy Coulomb effects; High energy scattering; Diffraction scattering; Glauber model; *12031.*

High cirrus; Fourier spectroscopy; Submillimeter waves; Water vapor; *11885.*

High density; High temperature; Pairwise potentials; Redlich Kwong; Second virial coefficient; Thermodynamics; Compressibility factors; Equation of state; *11887.*

High energy; Pomeranchuck theorem; Asymptotics; Cross section; Diffraction shrinkage; *11870.*

High energy Coulomb effects; High energy scattering; Diffraction scattering; Glauber model; He^4-He^4 elastic scattering; *12031.*

High energy density cell; Lithium deposition; Organic electrolyte; Graphite electrode; *12088.*

High energy scattering; Diffraction scattering; Glauber model; He^4-He^4 elastic scattering; High energy Coulomb effects; *12031.*

High flux; Irradiation; Neutron diffraction; Research reactor; Split core; Cold neutron source; *12351.*

High frequency; Low frequency; Standard frequencies; Time signals; Very low frequency; Broadcast of standard frequencies; *SP236, 1971 Edition.*

High intensity; Monochromatic yields; Purity; X-ray beams; Beryllium to gold; Electron produced; *12214*.

High momentum components; Many-body clusters; Nuclei; Quarks; Coherent production; Cosmic rays; *12144*.

High power; Measurement; Microwave; Accurate; Calibration; Directional coupler; **J.75C** *Nos. 3 and 4, 181-186 (1971)*.

High precision coulometry; Accurate analysis; Boric acid; Coulometric titration; High-precision acidimetry; **J.75A** *No. 5, 421-428 (1971)*.

High pressure; High-pressure equipment; Instrumentation; Pressure scale; Shock wave technique; Temperature; Accurate measurement; Equation-of-state; Fixed points; *SP326*.

High pressure; Leads; Closure; Feedthrough; *12039*.

High pressure; Liquids; Solids; Ultrasonics; Bulk modulus; Density; Dilatometric measurements; *SP326*, pp. 11-22.

High pressure; Liquids; Ultrasonics; 2-methylbutane; Bulk modulus; Compressibility; Density; Dilatometric measurements; **J.75A** *No. 2, 121-127 (1971)*.

High pressure; Radiation-induced; Tetrafluoroethylene; 3,3,4,4,5,5,5-heptafluoropentene-1; Amorphous polymer; Copolymerization; Fluoropolymers; Glass temperature; *11868*.

High pressure; Single crystal; X-ray diffraction; Anisotropic compressibility; Azides; Compressibility; *12025*.

High pressure; Strength; Deep submergence; Fracture; Fracture energy; Glass; *12188*.

High pressure; Subject index; Author index; Bibliography; *NBS-OSRDB-70-1-V1 (PB191174)*.

High pressure; Subject index; Author index; Bibliography; *NBS-OSRDB-70-1-V2 (PB191175)*.

High speed dislocations; Impact stress pulse; Piezoelectric stress gauge; Quartz; Slip bands; Dislocation velocity; *SP336*, pp. 487-508.

High speed movies; Particle velocities; Vacuum tests; Water jet; Flow rate tests; *SP336*, pp. 905-914.

High temperature; Infrared; Matrix; NaOD; NaOH; RbOD; RbOH; Vibrational assignment; Alkali hydroxides; *11845*.

High temperature; Infrared; Matrix isolations; Barium; Barium oxides; **J.75A** *No. 1, 23-25 (1971)*.

High temperature; IPTS-68; Platinum resistance thermometer; Temperature scale; Thermocouple; Triple point; Calibration; Fixed point; Freezing point; Furnaces; *12354*.

High temperature; Melting point; Metals; Molybdenum; Premelting; Thermodynamics; Electrical resistivity; High-speed methods; *12231*.

High temperature; Niobium; Thermal radiation properties; Thermodynamics; Electrical resistivity; Emittance; Heat capacity; High-speed measurements; **J.75A** *No. 6, 565-571 (1971)*.

High temperature; Pairwise potentials; Redlich Kwong; Second virial coefficient; Thermodynamics; Compressibility factors; Equation of state; High density; *11887*.

High temperature; Platinum; Thermal expansion; High-speed measurements; *12139*.

High temperature; Refractory metals; Thermocouple; Thermoelements; Sensor; Ultra high vacuum; W-Re alloys; EMF-temperature relationship; Furnace; **J.75C** *No. 2, 99-106 (1971)*.

High temperature; Tantalum; Thermal radiation properties; Thermodynamics; Electrical resistivity; Emittance; Heat capacity; High-speed measurements; **J.75A** *No. 1, 1-13 (1971)*.

High temperature; Tantalum; Thermodynamics; Heat capacity; High-speed measurements; *11871*.

High temperature; Thermal radiation properties; Thermodynamics; Tungsten; Electrical resistivity; Emittance; Heat capacity; High-speed measurements; **J.75A** *No. 4, 283-290 (1971)*.

High temperature materials; Laser; Oxides; Oxygen diffusion; Pure materials; Sapphire; Al_2O_3; Crystal growth; Damage threshold; Glass; *TN703*.

High temperature materials; Laser; Oxides; Oxygen diffusion; Pure materials; Sapphire; Al_2O_3; Crystal growth; Damage threshold; Glass; *TN574*.

High temperature materials; Laser damage; Laser degradation; Laser glass; Laser materials; Mass transport; Neodymium glass; Optical properties; Opto-elastic properties; Oxides; Ruby; Rutile; Titanium; Titanium dioxide; Transition metal; *TN565*.

High temperature matrix isolation; Infrared; Uranium monoxide; Uranium oxides; Vibrational frequency; *12262*.

High temperature species; Stability structure; *11961*.

High temperatures; Pyrometry; Radiance; Standards; Graphite arc; High-speed measurements; *12201*.

High temperatures; Thermodynamics; Thermophysical properties; High-speed measurement methods; *12028*.

High temperatures; Thermodynamics; Thermophysical properties; High-speed measurements; **J.75C** *No. 1, 7-18 (1971)*.

High vacuum; Solar cells; Space radiation; Space simulation; Thermal control; *SP336*, pp. 935-947.

High voltage measurements; Kerr cell; Laser applications; Pulse measurements; Dielectric liquids; Electric field measurements; Electrooptical measurements; *12306*.

High-precision acidimetry; High precision coulometry; Accurate analysis; Boric acid; Coulometric titration; **J.75A** *No. 5, 421-428 (1971)*.

High-pressure; Naphthalene; Polymorphism; Anthracene; Benzene; *11800*.

High-pressure; Phase-diagram; Vanadium; Alloys; Aluminum; Diffusion; *11832*.

High-pressure; Polymorph; Single crystal; X-ray diffraction; Cesium; Gallium; *12187*.

High-pressure equipment; Instrumentation; Pressure scale; Shock wave technique; Temperature; Accurate measurement; Equation-of-state; Fixed points; High pressure; *SP326*.

High-pressure furnaces; High-temperature, high-pressure research; Power dissipation; Temperature distribution, steady-state; Temperature gradients; Temperature irregularities; Temperature variation; Thermal conductivity; **J.75C** *No. 2, 79-83 (1971)*.

High-speed measurement methods; High temperatures; Thermodynamics; Thermophysical properties; *12028*.

High-speed measurements; High temperatures; Pyrometry; Radiance; Standards; Graphite arc; *12201*.

High-speed measurements; High temperature; Thermal radiation properties; Thermodynamics; Tungsten; Electrical resistivity; Emittance; Heat capacity; **J.75A** *No. 4, 283-290 (1971)*.

High-speed measurements; High temperature; Niobium; Thermal radiation properties; Thermodynamics; Electrical resistivity; Emittance; Heat capacity; **J.75A** *No. 6, 565-571 (1971)*.

High-speed measurements; High temperature; Tantalum; Thermodynamics; Heat capacity; *11871*.

High-speed measurements; High temperature; Platinum; Thermal expansion; *12139*.

High-speed measurements; High temperature; Tantalum; Thermal radiation properties; Thermodynamics; Electrical resistivity; Emittance; Heat capacity; **J.75A** *No. 1, 1-13 (1971)*.

High-speed measurements; High temperatures; Thermodynamics; Thermophysical properties; **J.75C** *No. 1, 7-18 (1971)*.

High-speed measurements; Melting; Normal spectral emittance; Tantalum; Thermal radiation properties; Emittance; *12307*.

High-speed measurements; Optical attenuator; Photometry; Radiance; **J.75C** *No. 2, 85-88 (1971)*.

High-speed methods; High temperature; Melting point; Metals; Molybdenum; Premelting; Thermodynamics; Electrical resistivity; *12231*.

High-speed methods; Light attenuator; Photometry; Radiance modulation; Radiation; *J.75C No. 1, 29-32 (1971).*

High-speed photography; Indicating instruments; Indicator characteristics; Loading rate; Loads (forces); Motion picture cameras; Photographic equipment; Static loads; Test equipment; Compression tests; Dynamic loads; *12080.*

High-temperature, high-pressure research; Power dissipation; Temperature distribution, steady-state; Temperature gradients; Temperature irregularities; Temperature variation; Thermal conductivity; Analytic solutions; *J.75C No. 2, 79-83 (1971).*

Highways; Hospital; Housing; Mobile home; Seismic; Standards; Structural engineering; Bridge; Building; Codes; Dams; Earthquake damage; Earthquakes; Foundation geology; *BSS40.*

Hinged door units, interior; Prefabricated door units; Wood door units; Door units, wood; *PS32-70.*

Historical review; Isothermal; Isoconversional and isokinetic methods; Kinetic parameters; Thermogravimetric analysis; Applied nonisothermal kinetics; Generalized techniques; *12356.*

HNCO; NCO $A^2\Sigma$; NH $A^3\pi$, $c^1\pi$; Photodissociation; Vacuum ultraviolet; Bond dissociation energy; Fluorescence; *12012.*

HNO; HeH_2^+; Proton transfer; Activation energy; Configuration interaction; Correlation energy surface; Hartree-Fock; H_3^+; H_3; H_3^-; H_4; LiH_2; LiHF; *11969.*

Hole centers; Optical absorption; Shared holes; $SrTiO_3$; Color centers; EPR; *11805.*

Hole pressure; Nonlinear rheology; Normal stresses; Pressure error; Second order fluid; *11966.*

Holes; Lifetime; Theoretical model; Trapping; Charge carriers; Electrons; Gamma rays; Ge(Li) detectors; Germanium gamma-ray spectrometers; *12255.*

Hollerith punched card code; Hollerith punched cards; Information interchange; Information processing; Punched cards; American Standard Code for Information Interchange; ASCII; Card punch; Card reader; Data communications; Data interchange; *FIPS PUB 14.*

Hollerith punched cards; Information interchange; Information processing; Punched cards; Rectangular holes; American Standard Code for Information Interchange; ASCII; Card punch; Card reader; Data communications; Data interchange; *FIPS PUB 13.*

Hollerith punched cards; Information interchange; Information processing; Punched cards; American Standard Code for Information Interchange; ASCII; Card punch; Card reader; Data communications; Data interchange; Data processing; *FIPS PUB 14.*

Holography; Interferometry; Pulsed beams; Radiation; Absorbed dose; Calorimetry; Dose distribution; Electron beams; *12100.*

Homogeneity; Ion sensitive emulsion; Mass spectrometry; Precision; Quantitative analysis; Solids; Spark source; Trace elements; Fluctuations; *12127.*

Homogeneity; Ions; Mass; Platinum; Precision; Replicate; Spark; Spectrometry; Accuracy; Circumvention; Emulsions; *11847.*

Homogeneity; Matrix scanner; Microanalysis; Quantitative analysis; Standard reference materials; X-ray emission; Alloys; Corrections; Electron probe; *SP260-28.*

Homogeneity testing; Metallography; Microprobe analysis; Spectrometric analysis; Standard Reference Materials; Fe-3Si alloy; *SP260-22.*

Homotopy; Convex functions; Convex sets; *J.75B Nos. 1 and 2, 49-61 (1971).*

Hooke's elasticity; Non-local elasticity; Solid mechanics; Green's tensor; *SP317*, pp. 737-746.

Hospital; Housing; Mobile home; Seismic; Standards; Structural engineering; Bridge; Building; Codes; Dams; Earthquake damage; Earthquakes; Foundation geology; Highways; *BSS40.*

Hot bands; Hydrogen fluoride; Ion pairs; Mass spectrometry; Molecular ionization; Photoionization; Vacuum ultraviolet; Chlorine monofluoride; Dissociative ionization; Fluorine; Heats of formation; *12148.*

Hot saline water corrosion; Oxide films; Precipitates; Transmission microscopy; Aluminum alloys; *12315.*

Householder transformations; Iterative refinement; Least squares; Linear equations; Orthogonalization; Orthogonal polynomials; Regression; Rounding error; Stepwise regression; Computer programs; Curve fitting; Gram-Schmidt orthogonalization; *12184.*

Housing; Mobile home; Seismic; Standards; Structural engineering; Bridge; Building; Codes; Dams; Earthquake damage; Earthquakes; Foundation geology; Highways; Hospital; *BSS40.*

Housing; Precast concrete; Production capacity; Production management; Production methods; Standardization; United Soviet Socialist Republics; Building economics; Building systems; Construction industry; *SP334.*

Human engineering; Kinematics; Occupant restraint systems; Seat; Seat belts; Acceleration (mechanical); Biodynamics; Biomechanics; *11851.*

Human factors; Mail handling; Mail processing; Mail sorting; Methodology; *11948.*

Human kinematics; Human tests; Restraint geometry; Restraint systems; Seat belt; Sled tests; Webbing abrasion; Webbing degradation; Anthropomorphic dummies; Auto seat tests; Deceleration; *11850.*

Human tests; Restraint geometry; Restraint systems; Seat belt; Sled tests; Webbing abrasion; Webbing degradation; Anthropomorphic dummies; Auto seat tests; Deceleration; Human kinematics; *11850.*

Humidity; Hygrometer; Mixing ratio; Moist gas; Psychrometer; Vapor pressure; Adiabatic saturation; Dew point temperature; *J.75C No. 2, 69-78 (1971).*

Hurricanes; Mobile homes; Roofs; Structural engineering; Tides; Wind; Buildings; Failure; *TN569.*

Hydrate; Ion pairs; Mineralization; Calcification; Calcium carbonate; Crystal structure; *11951.*

Hydrated antimony pentoxide (HAP); Radiochemical separations; Sodium; Trace elements; Activation analysis; Glass; *12000.*

Hydraulic engineering; Hydraulic research; Hydraulics; Hydrodynamics; Model studies; Research summaries; Fluid mechanics; *SP346.*

Hydraulic research; Hydraulics; Hydrodynamics; Model studies; Research summaries; Fluid mechanics; Hydraulic engineering; *SP346.*

Hydraulics; Hydrodynamics; Model studies; Research summaries; Fluid mechanics; Hydraulic engineering; Hydraulic research; *SP346.*

Hydraulics; Inlets; Culverts; Entrance control; *12359.*

Hydraulics; Measurement; Open-channel flow; Standards; Calibration; Current meters (fluids); *12358.*

Hydrazine; Maraging steel; Metallic coatings; Missiles; Rocket-fuel tanks; Compatibility tests; Electrolytic protection; *11934.*

Hydrocarbons; Inorganic molecules; Ionization efficiency; Ionization quantum yield; Neon resonance radiation; Absorption coefficient; Helium resonance radiation; *J.75A No. 5, 481-485 (1971).*

Hydrocarbons; Ion-molecule reactions; Photoionization; Radiolysis; Rate constants; Theory; *11853.*

Hydrocarbons; Ion-molecule reactions; Mass spectrometry; Photoionization; Proton transfer; Water; *11927.*

Hydrocarbons; Ion-molecule reactions; Mass spectrometry; Photoionization; Rate constants; Gas phase; *J.75A No. 3, 147-153 (1971).*

Hydrodynamic equations; Quantum fluids; Quantum mechanical density distribution; Quantum statistical mechanics; Conservation equations; Equation of motion; *11923.*

Hydrodynamic model; Isospin; Nuclear structure; Charge distribution; Collective model; Giant resonance; *12287.*

Hydrodynamic volume; Polymer; Polymer separation; Chromatography; Elution volume; Flow; Gel permeation chromatography; *12149.*

Hydrodynamics; Model studies; Research summaries; Fluid mechanics; Hydraulic engineering; Hydraulic research; Hydraulics; *SP346.*

Hydrofluoric acid; Ionization constant; Lanthanum fluoride electrode; Least squares procedure; Potentiometric measurements; **J.75A** *No. 3, 205-211 (1971).*

Hydrogen; Hydrogen continuum; LTE; Spectral radiance standard; Stark-broadening; Emission coefficient; **J.75A** *No. 4, 291-333 (1971).*

Hydrogen; Ion; Liquid nitrogen temperature; Field-ion microscope; *11911.*

Hydrogen; Molecule; Deuterium; Dissociation; Electron; *12058.*

Hydrogen; Nickel; Nitrogen; Oxygen; Surface; Tungsten; Adsorption; Chemisorption; Cross section; Desorption; Electron stimulated desorption; *12332.*

Hydrogen; Nitrogen; Tungsten; Tungsten (100) plane; Work function; Chemisorption; Flash desorption; *12125.*

Hydrogen; Single crystal; Tungsten; Work function; Carbon monoxide; Chemisorption; Co-adsorption; Displacement reaction; *12261.*

Hydrogen; Sum rule; Correlation; Electron scattering; Form factor; Helium; *11916.*

Hydrogen atoms; Nitrogen atoms; $O_2(^1\Delta_g)$; Oxygen atoms; Quenching reactions; Upper atmosphere; *12090.*

Hydrogen bond; Infrared; Isotope dilution; Lattice mode; Raman; Sodium bifluoride; Stretching vibration; Bending vibration; *11983.*

Hydrogen bonding; Infrared spectrum; Matrix isolation; Ultraviolet spectrum; Vacuum-ultraviolet photolysis; Bichloride anion; ClHCl free radical; Electron attachment; HCl dimer; *11975.*

Hydrogen bonding; Titrations; Acid-base behavior; Acidity and basicity scales; Aprotic organic solvents; *11997.*

Hydrogen continuum; LTE; Spectral radiance standard; Stark-broadening; Emission coefficient; Hydrogen; **J.75A** *No. 4, 291-333 (1971).*

Hydrogen cyanide; Infrared; Microwave; Molecular structure; Rotational constants; Spectra; Bond distances; *12342.*

Hydrogen extraction; Nuclear evaporation calculations; Photonuclear reactions; 90 MeV bremsstrahlung; ^{64}Cu, ^{61}Cu, ^{11}C activation monitor yields; Absolute tritium yields; *12143.*

Hydrogen fluoride; Ion pairs; Mass spectrometry; Molecular ionization; Photoionization; Vacuum ultraviolet; Chlorine monofluoride; Dissociative ionization; Fluorine; Heats of formation; Hot bands; *12148.*

Hydrogen hyperfine transition; Hydrogen maser; Hydrogen storage; Hydrogen wall collisions; NBS-III; Teflon; Universal time; Frequency shift; Frequency stability; *12069.*

Hydrogen isotopes; Low temperatures; Olefins; Orientation; Quantum tunneling; Atom addition; *12040.*

Hydrogen lines; Line wings; One-electron theory; Stark broadening; Unified theory; Classical path; *12084.*

Hydrogen lines; Line wings; Stark broadening; Theory; Unified classical path; *12222.*

Hydrogen lines; Line wings; Stark broadening; Unified theory; Classical path; *Monogr. 120.*

Hydrogen maser; Atomic beam tube; Cavity pulling; Frequency stability; Frequency standard; *11891.*

Hydrogen maser; Hydrogen storage; Hydrogen wall collisions; NBS-III; Teflon; Universal time; Frequency shift; Frequency stability; Hydrogen hyperfine transition; *12069.*

Hydrogen maser; Hyperfine interaction; Rubidium gas cell; Transition probability; Atomic frequency standards; Cesium beam; Energy levels; *TN399.*

Hydrogen maser; Long baseline interferometry; Quartz crystal oscillators; Time standards; Atomic frequency standards; Cesium beam; Flicker noise; Frequency stability; Frequency standards; *11888.*

Hydrogen maser; NBS frequency standard; Time scale; Allan variance; Cesium beam; Frequency stability; *11922.*

Hydrogen maser; Wall shift; Frequency accuracy; *11892.*

Hydrogen peroxide; Cation exchanger; Chromium; *12019.*

Hydrogen storage; Hydrogen wall collisions; NBS-III; Teflon; Universal time; Frequency shift; Frequency stability; Hydrogen hyperfine transition; Hydrogen maser; *12069.*

Hydrogen wall collisions; NBS-III; Teflon; Universal time; Frequency shift; Frequency stability; Hydrogen hyperfine transition; Hydrogen maser; Hydrogen storage; *12069.*

Hydrophobic bonding; Krafft point; Long chain compounds; Micelle; Paraffin chain salts; Selected values; Soap; Solubilization; Standard values; Surface active agents; Surface chemistry; Surface tension; Surfactant; Association colloid; *NSRDS-NBS36.*

Hydroxyapatite; Single crystal x-ray diffraction; Calcium phosphate; Calcium phosphate-calcium silicate solid solution; Calcium phosphosilicates; Calcium silicates; Crystal structures; Glaserite; *12273.*

Hygiene; Mercury; Vapor; Contamination; Dental amalgam; Environment; Hazards; *12254.*

Hygrometer; Mixing ratio; Moist gas; Psychrometer; Vapor pressure; Adiabatic saturation; Dew point temperature; Humidity; **J.75C** *No. 2, 69-78 (1971).*

Hygrometry; Meterology; Moisture measurement in gases; Psychrometry; Dew point; *11991.*

Hyperbaric; Neutral buoyancy; Simulation; Space; Diving; *SP336*, pp. 651-659.

Hyperfine field in iron; Nuclear orientation; Transition mixing ratios; ^{192}Ir, magnetic moment of; Beta rays, angular distribution of; Gamma rays, angular distribution of; *12005.*

Hyperfine fields; Iron; Isomer shift; Lithium; Mössbauer Effect; Recoilless fraction; Antimony; Ferrites; *12205.*

Hyperfine interaction; Quadrupole coupling; Rutile; Titanium dioxide; Copper; EPR; *g*-factors; *11804.*

Hyperfine interaction; Rubidium gas cell; Transition probability; Atomic frequency standards; Cesium beam; Energy levels; Hydrogen maser; *TN399.*

Hyperons; Resonances; Rotations; SU(6) × 0(3); Baryons; Configuration mixing; *11912.*

Hypervelocity; Impact damage; Micrometeoroid; Particle detectors; *SP336*, pp. 915-933.

Hypervelocity impact; Meteorid penetration; Oxidative detonation; Oxidative flash; Oxygen atmosphere; Spacecraft; Blast over-pressure; Combustion front; *SP336*, pp. 569-585.

Hypo; Microfilm; Permanent record film; Archival film; **J.75C** *No. 1, 19-22 (1971).*

H_2 (hydrogen molecule); Rotational excitation; Close coupling calculation; Differential cross sections; Elastic scattering; Electron; *12163.*

H_2CCl; Infrared spectrum; Matrix isolation; Photolysis; Ultraviolet spectrum; CCl; CCl_2; Force constants; Free radical; HCCl; $HCCl_2$; *11964.*

H_2O; NH_3; N_2O; Photoelectrons; Photoionization.; Spectroscopy; C_2H_2; Franck-Condon principle; *12118.*

H_2O laser; Magnetic resonance; OH; Spectroscopy; Astronomical OH emission; *11954.*

H_2O lasers; Infrared lasers; Variable laser coupling; HCN lasers; *12207.*

H_2O lasers; Infrared lasers; Variable coupling lasers; HCN Lasers; *TN395.*

H_2S; Rate constant; Resonance fluorescence; Vacuum-uv; Activation energy; H atoms; *12074.*

Index; Information; Knight shifts; NMR; Soft x ray; Alloy data; Bibliography; *SP324.*

Index of plastics standards; Plastics standards, world index; Standards, plastics; *SP352.*

Index of refraction; Joule-Thomson; Latent heat; Melting point; Prandtl number; Oxygen; Specific heat; Speed of sound; Surface tension; Thermal conductivity; Thermal diffusivity; Vapor pressure; Viscosity; Volume; Density; Dielectric constant; *TN384.*

Index of refraction; Nonlinear optics; Transmission; Crystal growth; $CsCuCl_3$; Electrooptic effect; *12032.*

Index of standards, recommended practices, specifications, and test methods; Key-Word-In-Context index of voluntary standards; Standards, voluntary, index of; Engineering standards, index of; *SP329.*

Indexing; Measurement; Performance; Prime; Program; Test; Assessment; Complex; Composite; Computer; Criteria; Evaluation; Gaussian primes; *TN572.*

Indicating instruments; Indicator characteristics; Loading rate; Loads (forces); Motion picture cameras; Photographic equipment; Static loads; Test equipment; Compression tests; Dynamic loads; High-speed photography; *12080.*

Indicator characteristics; Loading rate; Loads (forces); Motion picture cameras; Photographic equipment; Static loads; Test equipment; Compression tests; Dynamic loads; High-speed photography; Indicating instruments; *12080.*

Indirect valleys; *n*-type gallium arsenide; Photoluminescence; Temperature dependence; Band tailing; Gallium arsenide; *12343.*

Indium; Semiconductors; $SrTiO_3$; Strontium titanate; Superconductivity; Surface potential barrier; Tunneling; *11925.*

Inductive ratio divider; Josephson effect; NPL of UK; Potential-divider resistor; Quantum standard of voltage; Solder-drop Josephson junctions; Superconductivity; *SP335,* pp. 111-115.

Inductive voltage divider; Ratio; Voltage divider; Voltage ratio; Divider; *11894.*

Industrial monitoring; Ion-selective electrodes; Pollutant monitoring; Electrode monitoring; *11999.*

Inelastic; Absolute differential cross section; Born; Elastic; Electron impact; Helium; *12029.*

Inelastic electron scattering; Multiple scattering; 0.1 to 3.0 MeV; Carbon; Copper; Experimental cross sections; Gold; *12113.*

Inelastic electron scattering; Nitrous oxide; Oscillator strengths; Far uv absorption; *12225.*

Inelastic electron scattering; Ultraviolet absorption; Formaldehyde; *12224.*

Inelastic transition probabilities; K matrix calculation; KWIC Index; Mass values; Numerical calculations; One-dimensional collisions; Oscillator force constants; Potential values; Transition probabilities vs. energy values; *NBS-OSRDB-70-3 (AD705110).*

Inelastic-electron scattering; Metal-insulator transition; Plasmon energy losses; Tungsten; Adsorbed atomic layers; Cesium; *11920.*

Inert gas fusion; One ppm of oxygen and nitrogen in steel; Research Associate Program; Simultaneous determination of oxygen and nitrogen; Standard Reference Material for oxygen; *SP260-26.*

Inertia brake dynamometer; Vehicle road tests; Brake friction materials; Coefficient of friction; Friction assessment screening test machine; Friction materials test machine; Girling scale dynamometer; *12051.*

Information; Knight shifts; NMR; Soft x ray; Alloy data; Bibliography; Index; *NBS-OSRDB-70-2 (COM-71-00722).*

Information; Knight shifts; NMR; Soft x ray; Alloy data; Bibliography; Index; *SP324.*

Information center; Interferometric measurements; Optical materials; Physical property changes; Space environment; *SP336,* pp. 949-959.

Information exchange; NBS; Operations research/systems analysis studies; OR users and producers; Planning; Conference proceedings; Contract research; Federal government; *SP347.*

Information interchange; Information processing; Punched cards; Rectangular holes; American Standard Code for Information Interchange; ASCII; Card punch; Card reader; Data communications; Data interchange; Data processing; *FIPS PUB 13.*

Information interchange; Information processing; Punched cards; American Standard Code for Information Interchange; ASCII; Card punch; Card reader; Data communications; Data interchange; Data processing; Electric accounting machine; *FIPS PUB 14.*

Information interchange; Information processing; Standards; Subsets; American Standard Code for Information Interchange; ASCII; Coded character subsets; Codes; Data communication; Data interchange; Data processing; *FIPS PUB 15.*

Information processing; Languages; Man-machine relationships; Teleprocessing; Communication; *12021.*

Information processing; Punched cards; Rectangular holes; American Standard Code for Information Interchange; ASCII; Card punch; Card reader; Data communications; Data interchange; Data processing; Electric accounting machine; EAM cards; *FIPS PUB 13.*

Information processing; Punched cards; American Standard Code for Information Interchange; ASCII; Card punch; Card reader; Data communications; Data interchange; Data processing; Electric accounting machine; EAM cards; *FIPS PUB 14.*

Information processing; Standards; Subsets; American Standard Code for Information Interchange; ASCII; Coded character subsets; Codes; Data communication; Data interchange; Data processing; Federal Information Processing Standards; *FIPS PUB 15.*

Information retrieval; Document storage and retrieval; Text; Text processing; Bibliographic system; Computer package; Data base; Document processing; *TN599.*

Information retrieval; Information systems; Programming languages; Data management; Data structures; File organization; *12008.*

Information storage and retrieval; Language extension; Preprocessor; Programming language; Data base; Data retrieval; Data structure; *TN590.*

Information systems; Programming languages; Data management; Data structures; File organization; Information retrieval; *12008.*

Information theory; Markov process; Probability theory; Ring theory; Stochastic process; **J.75B** *Nos. 3 and 4, 139-148 (1971).*

Infrared; Integrating sphere; Mars; Reflectance; Scattering; Simulation; Spectral; Absorbing; Anomalous dispersion; Carbon dioxide; Cryodeposit; Cryogenics; Frost; *SP336,* pp. 165-183.

Infrared; Isotope dilution; Lattice mode; Raman; Sodium bifluoride; Stretching vibration; Bending vibration; Hydrogen bond; *11983.*

Infrared; Josephson effect; Lasers; Superconductivity; Detectors; *12166.*

Infrared; Laser; Nitrous oxide; Q-switching; Vibrational relaxation; Fluorescence; *11858.*

Infrared; Matrix; NaOD; NaOH; RbOD; RbOH; Vibrational assignment; Alkali hydroxides; High temperature; *11845.*

Infrared; Matrix isolations; Barium; Barium oxides; High temperature; **J.75A** *No. 1, 23-25 (1971).*

Infrared; Methyl iodide; Molecular geometry; Molecular structure; Spectra; Absorption; Gas; *11973.*

Infrared; Microwave; Molecular structure; Rotational constants; Spectra; Bond distances; Hydrogen cyanide; *12342.*

Infrared; Photoconductivity; Photoresponse; Semiconductors; Silicon; Deep impurities; Germanium; *TN570.*

Infrared; Piezoelectricity; Polymers; Polyvinylfluoride; Pyroelectricity; *12352.*

Infrared; Rf-dc; Thermopile radiation; Ammeter; Coax; *12198.*

Infrared; Spectra; Rotational constants; Vibrational constants; Absorption; Energy levels; Gas laser; HCN, hydrogen cyanide; *12044.*

Infrared; Styrene; Copolymers; Crosslinking; Divinylbenzene; *11884.*

Infrared; Uranium monoxide; Uranium oxides; Vibrational frequency; High temperature matrix isolation; *12262.*

Infrared analysis; Internal reflection spectroscopy; Mercury-arc irradiation; Organic coatings; Photodegradation; Surface degradation; Volatile degradation products; Xenon-arc irradiation; Atmospheric exposure; ATR spectroscopy; *SP336,* pp. 299-312.

Infrared analysis; Ion exchange; Liquid chromatography; Purification; Separation; Styrene/divinylbenzene; Zeolites; Air pollution; Bilirubin; *TN549.*

Infrared detectors; Lasers; Whisker diode; Antenna theory; *12168.*

Infrared lasers; Variable coupling lasers; HCN Lasers; H_2O lasers; *TN395.*

Infrared lasers; Variable laser coupling; HCN lasers; H_2O lasers; *12207.*

Infrared scanning; Mars environmental simulation; Outgassing; Thermal insulation; Thermal-vacuum chambers; Evacuating; Heat transmission; *SP336,* pp. 725-748.

Infrared spectra; Matrix isolation; Molecular geometries; Heavy metal halides; *12157.*

Infrared spectra of species; Matrix isolation; $ScCl_3$; $TiCl_3$; $TiCl_4$; Dichlorides of Ca, Sc, Ti, V, Cr, Mn, Fe, Ni; Geometry; *12281.*

Infrared spectrometry; Mass spectrometry; Quartz crystal oscillator mass monitors; Radiometry; Reflectometry; Space environment simulation chambers; Contamination collection units; Gas-liquid chromatography; *SP336,* pp. 25-49.

Infrared spectrum; Isolated SH; Low temperature; Matrix; SH; Ultraviolet; *11846.*

Infrared spectrum; Matrix isolation; Photolysis; Ultraviolet spectrum; ClCF; Chlorofluoromethane; Chlorofluoromethane-d_2; Fluorescence spectrum; Free radical; *12219.*

Infrared spectrum; Matrix isolation; Photoionization; Vacuum ultraviolet photolysis; CCl_3^+; Chloroform; Electron attachment; $HCCl_2^+$; $HCCl_2^-$; $HCCl_3^-$; *12242.*

Infrared spectrum; Matrix isolation; Molecular orbitals; SO_2^- anion; Sulfur dioxide; Alkali metal reactions; Charge transfer; Electron capture; *12336.*

Infrared spectrum; Matrix isolation; Molecular rotation; Vacuum-ultraviolet photolysis; Vibrational potential function; Alkali metal reactions; $BrHBr^-$; Charge transfer; $ClHCl^-$ Electron attachment; *12369.*

Infrared spectrum; Matrix isolation; Photolysis; Ultraviolet spectrum; CCl; CCl_2; Force constants; Free radical; HCCl; $HCCl_2$; H_2CCl; *11964.*

Infrared spectrum; Matrix isolation; Ultraviolet spectrum; Vacuum-ultraviolet photolysis; Bichloride anion; ClHCl free radical; Electron attachment; HCl dimer; Hydrogen bonding; *11975.*

Infrared spectrum; Matrix isolation; O-atom reaction; Structure; Ultraviolet spectrum; Vacuum-ultraviolet photolysis; CO_2; CO_3; Force constants; *12101.*

Infrared spectrum; Matrix isolation; Reaction of OH with CO; Stereoisomers; Vacuum-ultraviolet photolysis; CHO_2 free radical; Force constants; *12112.*

Infrasonic microphones; Seismic response; Compensation; Ground motion; *J.*75C *No. 1, 41-45 (1971).*

Inhomogeneities; Dislocations-elasticity; Dislocation surface interactions; Finite elasticity; *SP317,* pp. 57-69.

Inhomogeneous elastic bodies; Constitutive relations; Continuum mechanics; Dislocations; *SP317,* pp. 907-924.

Inlets; Culverts; Entrance control; Hydraulics; *12359.*

Inorganic coordination complex; Octahedral coordination; Pyrazole; Trigonal symmetry; X-ray structure determination; *11826.*

Inorganic molecules; Ionization efficiency; Ionization quantum yield; Neon resonance radiation; Absorption coefficient; Helium resonance radiation; Hydrocarbons; *J.*75A *No. 5, 481-485 (1971).*

Inorganic polymer; Pyrazine ligand; X-ray structure determination; Coordination complex; *12054.*

Inosose; Oxidation; Quantitative; Radical; Reagent; Determination; Electron-transfer; *12151.*

Insect sterilization; Shelf-life extension; Sprouting inhibition; Chemical dosimeter; Disinfestation; Dosimetry; Dyes; Gamma rays; *12193.*

Inside diameters; Small-bore tubes; Standard hole; Wringing; Capacitance probe; Cylindrical gauge blocks; *12277.*

Instant mashed potatoes, package quantities of; Mashed potatoes, instant, package quantities of; Package quantities of instant mashed potatoes; Potatoes, instant mashed, package quantities of; *PS41-70.*

Instant nonfat dry milk; Nonfat dry milk, package quantities of; Package quantities of dry milk; Dry milk package quantities; *PS37-70.*

Instantaneous rate; Pit depth; Pitting factor; Polarization; Steel piling; Undisturbed soil; Weight loss; Corrosion; Corrosion rate; Disturbed soil; *J.*75C *No. 2, 107-121 (1971).*

Instrument calibration; Metrology; Research materials; Standard reference materials; SRM's; Standard Reference Materials Program; Agriculture; Air and water pollution; Biology; Botany; Health and medicine; *12349.*

Instrument calibration procedures; Instrument performance testing; Pulse technology; Time domain testing; Automatic measuring devices; Automatic performance test; Computer control systems; *SP335,* pp. 23-28.

Instrument performance testing; Pulse technology; Time domain testing; Automatic measuring devices; Automatic performance test; Computer control systems; Instrument calibration procedures; *SP335,* pp. 23-28.

Instrument reliability; Instrument standardization; Calibration data system; Calibration interval adjustment method; *SP335,* pp. 99-104.

Instrument reliability; Statistical validity; Two-method optimization; Data support; Fixed calibration interval; *SP335,* pp. 73-79.

Instrument standardization; Calibration data system; Calibration interval adjustment method; Instrument reliability; *SP335,* pp. 99-104.

Instrumental evaluation; Porcelain enamel direct-to-steel; Adherence; *12138.*

Instrumentation; Josephson effect; Magnetometry; Superconductivity; Cardiography; *12190.*

Instrumentation; Liquefied natural gas (LNG); Methane; Properties data; Flowmeters; *11821.*

Instrumentation; Modules; Nuclear; Standards; CAMAC; Data; Dataway; Digital; *12142.*

Instrumentation; Overturning moments; Wind loads; Wind tunnel modeling; Boundary layer; Buildings; Pressure fluctuations; *BSS30,* pp. 45-59.

Instrumentation; Pressure scale; Shock wave technique; Temperature; Accurate measurement; Equation-of-state; Fixed points; High pressure; High-pressure equipment; *SP326.*

Instrumentation; Standard reference materials; Automated analysis; Clinical chemistry; *12047.*

Instrumentation; Tower interference; Transducers; Wind vanes;

Wind loads; Anemometers; *BSS30*, p. 21.

Integral equation of first kind; Shifting operators; Slit correction; Slit weighting-function; Small-angle x-ray scattering; Strong numerical instability; Conditions for convergence of solutions; **J.75B** *Nos. 3 and 4, 187-207 (1971).*

Integral measurements; Fission cross sections; Fission neutron spectra; *12363.*

Integrated circuits; Measurement methods; Microcircuits; Silicon; Device fabrication; Environmental testing; *SP336*, pp. 449-455.

Integrated circuits; Microelectronics; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; ASTM standards; *11869.*

Integrated intensities; Lattice constants; Peak intensities; Powder patterns; Reference intensities; Standard; X-ray diffraction; Crystal structure; *Monogr. 25, Section 9.*

Integrating sphere; Intercomparison; Luminous flux; Photometry; Spectroradiometry; Barnes colorimeter; Chromaticity coordinate; Color correction; Cool white fluorescent lamp; Correlated color temperature; Daylight fluorescent lamp; *TN559.*

Integrating sphere; Mars; Reflectance; Scattering; Simulation; Spectral; Absorbing; Anomalous dispersion; Carbon dioxide; Cryodeposit; Cryogenics; Frost; Infrared; *SP336*, pp. 165-183.

Integration; Optimal quadrature; Quadrature; Analytical functions; Approximation; Gaussian quadrature; **J.75B** *Nos. 1 and 2, 85-88 (1971).*

Interaction; Nonadditivity; Principal components; Surface fitting; Two-way arrays; Factorial experiments; *12109.*

Interaction; Resonant structure; Atomic absorption; Close coupling; Configuration; *12094.*

Interaction energy; LiHe; NaHe; Transition probabilities; Hartree-Fock; *12326.*

Interaction energy parameters; Ionization potentials; Binary fluid mixtures; Correlation; Deviations from geometric mean rule; *11962.*

Interaction zone; Adherence; Aluminum; Electron microprobe; Electron microscope; *12130.*

Interactions; Dislocations; Elastic interactions; Finite elasticity; Dislocation surface; *SP317*, pp. 1179-1189.

Interactive gels; Liquid chromatography design; Nitrilotriacetic acid; Clinical Standard Reference Materials; Fraction collecting; Gas chromatography; *TN589.*

Inter-atomic; One-electron potentials; Pseudopotentials; Band structure; Cohesion; Core-core interactions; Electron density; *SP317*, pp. 179-200.

Interatomic potential; Krypton; Atomic calculation; *SP317*, pp. 285-289.

Interatomic potential; Lattice studies; Peierl's energy; Screw dislocation; Computer simulation; Green's tensors; *SP317*, pp. 291-298.

Interatomic potentials; Iron; Computer simulation; Dislocation core structure; *SP317*, pp. 305-308.

Interatomic potentials; Lattice defects; Carbon in iron; Computer simulation; Dislocation-interstitial interaction; *SP317*, pp. 299-303.

Interatomic potentials; Stacking faults; Dislocation-electron interactions; *SP317*, pp. 1259-1277.

Interband transition theory; Optical absorption; Potassium; Pseudopotential; Sodium; *11921.*

Intercomparison; Luminous flux; Photometry; Spectroradiometry; Barnes colorimeter; Chromaticity coordinate; Color correction; Cool white fluorescent lamp; Correlated color temperature; Daylight fluorescent lamp; Heterochromatic photometry; *TN559.*

Intercomparisons; Least squares; Standards; Thermal neutrons; Data analysis; Flux density; *12048.*

Interdisciplinary team; Management science; Model building; Organization; Search and rescue; Simulation; Team development; Coast Guard; Development; *12243.*

Interface dislocations; Supersonic dislocation; Dislocation dynamics; *SP317*, pp. 71-82.

Interfaces; Twinning; Dislocations; Grain boundaries; *SP317*, pp. 465-477.

Interference fringes; Interferometry; Pulsed beams; Refractive-index holography; Temperature profile; Absorbed dose; Calorimetry; Electron beams; *12324.*

Interfering reactions; Laser; Nondestructive analysis; Ruby; Trace elements; Activation analysis; Al_2O_3; **J.75A** *No. 5, 429-433 (1971).*

Interferometer; Standard reference material; Thermal expansion; Components of error (within and between samples); Copper; *12036.*

Interferometric measurements; Optical materials; Physical property changes; Space environment; Information center; *SP336*, pp. 949-959.

Interferometry; Optics; Refractive index; Fused silica; Glasses; **J.75A** *No. 4, 279-281 (1971).*

Interferometry; Planarity; Cover glass, test method for; Hemacytometer; *TN579.*

Interferometry; Pulsed beams; Radiation; Absorbed dose; Calorimetry; Dose distribution; Electron beams; Holography; *12100.*

Interferometry; Pulsed beams; Refractive-index holography; Temperature profile; Absorbed dose; Calorimetry; Electron beams; Interference fringes; *12324.*

Interferometry; Wavefront shearing interferometer; Coherence; Coherence measurement; *12321.*

Interlaboratory evaluation; Round robin; Single classification; Statistics; Variance components; Weighting; Analysis of variance; Average (weighted); *11906.*

Interlaboratory measurements; Silver; Standard errors; Standard reference materials; Vapor pressure; Cadmium; Components of error (within- and between-laboratory); Heats of sublimation (second and third law); *SP260-21.*

Interlaboratory testing; Precision; Repeatability; Reproducibility; Test methods, evaluation of; *12333.*

Interlaboratory tests; Optical density; Round robin; Smoke; Smoke density chamber; Statistical analysis; Building materials; Fire tests; *TN708.*

Intermediates; Polymerization; Purity; Synthesis; Telomerization; Cyclic inter-intramolecular mechanism; Diene polymerization; Fluorodienes; **J.75A** *No. 1, 41-56 (1971).*

Intermetallic compounds; Magnetic susceptibility; Superconductors; Atomic ordering; *12300.*

Intermittency; Isotropy; Moments; Probability-distributions; Turbulence; Velocity-gradients; Computer; Correlations; Grid; *12316.*

Intermolecular potential; Potential function; Scattering; Second virial; Viscosity; Gas; *12162.*

Intermolecular potential; Pressure broadening; Strong collision; Classical path approximation; *12033.*

Intermolecular potential function; Polar; Second virial coefficient; Stockmayer; Dipole; Gas; **J.75A** *No. 4, 337-385 (1971).*

Internal friction; Dislocation damping; Dislocation resonance; *SP317*, pp. 419-421.

Internal friction; Dislocation radiation; Dispersion relations; *SP317*, pp. 423-426.

Internal friction; Kink motion; Peierl's stress; *SP317*, pp. 447-458.

Internal friction; Localized modes; Dislocation-phonon interactions; Dislocation vibration; *SP317*, pp. 315-357.

Internal reflection spectroscopy; Mercury-arc irradiation; Organic coatings; Photodegradation; Surface degradation; Volatile degradation products; Xenon-arc irradiation; Atmospheric exposure; ATR spectroscopy; Clear and pigmented films; *SP336*, pp. 299-312.

Internal rotation; Rotational constants; Spectrum; Vibration-rotation; Dimethylacetylene; *12170*.

Internal standard; Mössbauer spectrometry; Stannic oxide; Alloys; Analysis; *11978*.

Internal Stark effect; KCl; Optical phonons; Polarizable ion model; Semicontinuum polaron model; CaF_2; CaO; *F* center; *12134*.

Internal stress; Source kernels; Stress functions; Anisotropic elasticity; Dislocations; Green's tensor; Incompatibility; *SP317*, pp. 89-124.

Internal stresses; Crack nucleation; Dislocations-elasticity; *SP317*, pp. 151-162.

Internal stresses; Quasidisclination; Affine connexions; Continuum mechanics; Curvature tensor; Disclination; *SP317*, pp. 637-649.

International Committee of Weights and Measures; International System of Units; SI; Système International des Unités; Units of measurement; General conference of weights and measures; *SP330*.

International Organization for Standardization; Management information systems; Standards; U.S. Government; American National Standards; Computers, data elements and codes; Data processing systems; Federal Information Processing Standards; *FIPS PUB 12*.

International standards; International System of Units; Metric conversion; Metric system; Metrication; Metrication and engineering standards; SI; Standards; U.S. Metric Study; Engineering standards; *SP345-11*.

International System of Units; Manufacturing industry; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; Metric conversion; Metric system; Metric usage; SI; U.S. Metric Study; *SP345-4*.

International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Federal Government; *SP345-2*.

International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Commercial weights and measures; *SP345-3*.

International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; Nonmanufacturing businesses; SI; U.S. Metric Study; *SP345-5*.

International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Education; *SP345-6*.

International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; SI; U.S. Metric Study; *SP345-7*.

International System of Units; Metric conversion; Metric conversion, effect on foreign trade; Metric system; Metric usage; Metric usage, effect on foreign trade; Metrication; Metrication, impact of on foreign trade; SI; U.S. Metric Study; *SP345-8*.

International System of Units; Metric conversion; Metric system; Metrication; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Department of Defense; *SP345-9*.

International System of Units; Metric conversion; Metric system; Metrication; Metrication and engineering standards; SI; Standards; U.S. Metric Study; Engineering standards; International standards; *SP345-11*.

International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; SI; U.S. Metric Study; *SP345-12*.

International System of Units; SI; Système International des Unités; Units of measurement; General conference of weights and measures; International Committee of Weights and Measures; *SP330*.

Internuclear double resonance; Long-range coupling; Magnetic equivalence factoring; Spin-tickling; Transient nutations; 6-Deoxy-α-D-glucofuranose derivative; General Overhauser effect; *12272*.

Interpersonal relationships; Management research; Opinion survey; Brainstorming; Cybernetic technique; Data collection; Group dynamics; *12364*.

Interstate; Intra-state; "National Conference of States on Building and Standards"; Uniformity; *12081*.

Interstellar medium; Microwave spectroscopy; Rotational spectrum; Thioformaldehyde; Astronomically important; Electrical discharge; *11965*.

Interstitial motion; Jump frequency; Lattice model; Migration energy; Migration entropy; Molecular dynamics; Random-walk theory; Vacancy motion; Atomic diffusion; Defect motion; *12022*.

Intervals; Procedures; Recall; Reliability; Traceability; Calibration records; Calibration system specification; *SP335*, pp. 47-50.

Intra-molecular relaxation; Jahn-Teller effect; Tris(2,2.-dipyridine)copper(II); Aqueous solutions; EPR; Exponential temperature dependence; *12116*.

Intra-state; "National Conference of States on Building and Standards"; Uniformity; Interstate; *12081*.

Intrinsic vector; Kinematics of a rigid body; Rotation group; Spatial rotation; Angular velocity; Effective axis and angle of rotation; **J.75B** *Nos. 3 and 4, 179-186 (1971)*.

Invariant factors; Principal ideal rings; Smith normal form; **J.75B** *Nos. 1 and 2, 81-84 (1971)*.

Invariant factors; Smith normal form; Designs; Incidence matrices; *12338*.

Invariants; Matrices; Rank; Determinant; Generalized matrix function; **J.75B** *Nos. 3 and 4, 109-115 (1971)*.

Inversion splitting; Methane; Molecular-beam data; Ortho-para transitions; Radio frequency; Group theory; *12323*.

Ion; Liquid nitrogen temperature; Field-ion microscope; Hydrogen; *11911*.

Ion activity standards; Ionic activity; Ion selective electrodes; Single ion; Activity coefficients; Activity scales of high concentrations; Activity standard scales; Chloride activity convention; *11859*.

Ion beam deflection; Ion optics; Mass separator; Proton source; Solar wind simulator; *SP336*, pp. 279-296.

Ion bombardment; Magnesia; MgO; Microstructure; Rock; Zirconia; Alumina; Al_2O_3;Ceramics; Electron microscopy; Fine-grain ceramic; *12083*.

Ion exchange; Liquid chromatography; Purification; Separation; Styrene/divinylbenzene; Zeolites; Air pollution; Bilirubin; Infrared analysis; *TN549*.

Ion exchange; Organic acid; Oxycellulose; Stability; Sulfuric acid; Thermogravimetric analysis; Alum; Aluminum; Apparent activation energy; Calcium; Cellulose; Crosslinking; Differential thermal analysis; *12218*.

Ion exchangers; Oleum; Sulfonation; Cation exchangers; *11957*.

Ion mobility; O_3^-; Photodetachment; Photodetachment rate measurement; Sunlight; *12268*.

Ion molecule reactions; Mass spectrometry; Neopentane; Photoionization; Proton affinity; Rate constants; **J.75A** *No. 5, 487-493 (1971)*.

Ion optics; Mass separator; Proton source; Solar wind simulator; Ion beam deflection; *SP336*, pp. 279-296.

Ion optics; Mass separators; Proton sources; Solar wind; Sput-

Liquid metal embrittlement; Surface; Surface active agent; Complex-ion embrittlement; Dislocations; *11972.*

Liquid nitrogen; Liquid oxygen; Neutral buoyancy; Space simulation; Cryogenics; Liquid air; *SP336,* pp. 623-649.

Liquid nitrogen; Measurement; Accuracy statement; Cryogenic; Flow facility; *TN606.*

Liquid nitrogen; Measurement; Positive displacement; Cryogenic; Flow; Flowmeters; *TN605.*

Liquid nitrogen temperature; Field-ion microscope; Hydrogen; Ion; *11911.*

Liquid oxygen; Neutral buoyancy; Space simulation; Cryogenics; Liquid air; Liquid nitrogen; *SP336,* pp. 623-649.

Liquid state; Neon; Percus-Yevick equation; Configuration entropy; Correlation function; Entropy; Hard sphere; *12370.*

Liquid state; Simple fluids; Temperature dependence; Thermal conductivity; Transport properties; Viscosity; Density dependence; *11879.*

Liquid-gas phase transition; Parametric form; Scaling; Thermodynamic properties; Coexistence curve; Critical point; *12156.*

Liquid-gas transition; Phase boundary; Phase transition; Thermodynamic scaling; Critical region; Equation of state; *J.***75A** *No. 2, 103-107 (1971).*

Liquids; Nitrogen; *P,V,T;* phase boundary; Saturation density; Vapor pressure; Density; *12186.*

Liquids; Solids; Ultrasonics; Bulk modulus; Density; Dilatometric measurements; High pressure; *SP326,* pp. 11-22.

Liquids; Ultrasonics; 2-methylbutane; Bulk modulus; Compressibility; Density; Dilatometric measurements; High pressure; *J.***75A** *No. 2, 121-127 (1971).*

List of instructions; Matrix operations; Numerical analysis; OMNITAB II user oriented computing system; Self-teaching; Statistical analysis; Automatic printing; Bessel functions; Data analysis; Data manipulation; Easy and effective programming in English; *TN552.*

Literature; Mössbauer Spectroscopy; Review; Chemical applications; *12147.*

Literature file; Matrix analyzed; Technique used; Activation analysis; Bibliography; Element determined; *TN467, Part 1.*

Literature file; Matrix analyzed; Technique used; Activation analysis; Bibliography; Element determined; *TN467, Part 2.*

Lithium; Microanalysis; Multichannel analyzer; Proportional counters; Quantitative analysis; Solid state counters; Tests; X-ray spectra; X-ray spectrometers; Electron diffraction; Electron probes; Evaluation; Gas flow; *12251.*

Lithium; Mössbauer Effect; Recoilless fraction; Antimony; Ferrites; Hyperfine fields; Iron; Isomer shift; *12205.*

Lithium deposition; Nonaqueous electroplating; Organometallic compound; Decaborane; Electrodeposition of magnesium; *12027.*

Lithium deposition; Organic electrolyte; Graphite electrode; High energy density cell; *12088.*

Lithium vapor; Two electron excitation; Absorption spectroscopy; Autoionization; Configuration interaction; K electron excitation; *12034.*

$Ln_2O_3-B_2O_3$ phase diagrams; Mechanism of phase separation; Metastable liquid immiscibility; Microphase separation; Phase diagrams of metastable immiscibility; Spinodal; Structural interpretation of immiscibility; *11902.*

Load cell; Viscoelastic damping; Dynamic force; *12050.*

Load eccentricity; Masonry; Section cracking; Stability; Stress distribution; Unreinforced concrete; Buckling; Compression members, Concrete; Deflection; equilibrium; *12298.*

Loading rate; Loads (forces); Motion picture cameras; Photographic equipment; Static loads; Test equipment; Compression tests; Dynamic loads; High-speed photography; Indicating instruments; Indicator characteristics; *12080.*

Loads (forces); Masonry; Moments; Slenderness ratio; Stability; Structural engineering; Walls; Bricks; Buckling; Deflection; *12227.*

Loads (forces); Motion picture cameras; Photographic equipment; Static loads; Test equipment; Compression tests; Dynamic loads; High-speed photography; Indicating instruments; Indicator characteristics; Loading rate; *12080.*

Local moments; Mössbauer effect; Nickel; Alloys; Clustering; Copper; Iron; *12199.*

Local potential; N_2^-; Resonance width; Shape resonance; Spectroscopic constant; Valence orbital; Electron scatter; Energy curve; *11899.*

Localized modes; Dislocation-phonon interactions; Dispersion relations; Lattice of dynamics; *SP317,* pp. 205-217.

Localized modes; Dislocation-phonon interactions; Dislocation vibration; Internal friction; *SP317,* pp. 315-357.

Logic gating; Quasi-sinusoid; Digital; *11876.*

Long baseline interferometry; Quartz crystal oscillators; Time standards; Atomic frequency standards; Cesium beam; Flicker noise; Frequency stability; Frequency standards; Hydrogen maser; *11888.*

Long chain compounds; Micelle; Paraffin chain salts; Selected values; Soap; Solubilization; Standard values; Surface active agents; Surface chemistry; Surface tension; Surfactant; Association colloid; Bibliography; CMC; Colloid; *NSRDS-NBS36.*

Long wavelength; Cross section; Electric transition; Electrodisintegration; Few nucleon systems; *12279.*

Longitudinal; Polyethylene terephthlate; Polypyromelitimide; Relative creep; Thermoelastic; Transverse; *12165.*

Longitudinal and shear sound waves; Solids sound speed accuracy; Speed of sound; Transient pulse-acoustical; Acoustical pulse; *J.***75C** *No. 1, 33-40 (1971).*

Long-range coupling; Magnetic equivalence factoring; Spin-tickling; Transient nutations; 6-Deoxy-α-D-glucofuranose derivative; General Overhauser effect; Internuclear double resonance; *12272.*

Loops; Polymer adsorption; Surface layer; Θ-point; Trains; Configurations; Excluded volume effect; *12240.*

Lorenz ratio; Nickel alloys; Seebeck effect; Thermal conductivity; Titanium alloy; Transport properties; Aluminum alloy; Cryogenics; Electrical resistivity; *J.***75A** *No. 4, 269-277 (1971).*

Lorenz ratio; Seebeck effect; Thermal conductivity; Transport properties; Cryogenics; Electrical resistivity; Electrolytic iron; *SP260-31.*

Lossy uniform transmission lines; Oscilloscope errors; Pulse generators; Standard waveforms; *12045.*

Low frequency; Standard frequencies; Time signals; Very low frequency; Broadcast of standard frequencies; High frequency; *SP236, 1971 Edition.*

Low pressure; Low temperature; Pumping; Ultraclean; Vacuum; Anti-migration traps; Cold shrouding; Contamination; Environment; Ion pumping; *SP336,* pp. 661-668.

Low temperature; Antiferromagnetism; Exchange interactions; $GdAsO_4$; Heat capacity; Heisenberg; Ising model; *12202.*

Low temperature; Magnetic susceptibility; Metamagnetism; Optical absorption; Critical phenomena; Diamond lattice; $DyPO_4$; Ising system; *12126.*

Low temperature; Magnetometer; Martensite; Nondestructive; Fatigue monitor; *TN613.*

Low temperature; Matrix; SH; Ultraviolet; Infrared spectrum; Isolated SH; *11846.*

Low temperature; Mechanical property equipment; Stainless steel; Cryostat; Fatigue; Impact; *J.***75C** *No. 2, 95-98 (1971).*

Low temperature; Mechanical property equipment; Stainless steel; Fatigue; Fracture; Impact; *TN609.*

Low temperature; Paramagnetic salt; Specific heat; Susceptibility; Thermometer scale; Cerous magnesium nitrate; Dipole system; *11822.*

Low temperature; Planar molecular structure; Spherical shell molecules; Vitreous state; Arsenious oxide; Arsenolite; Claudetite; Crystal transition; Cubic crystal; Glass; Heat capacity; Monoclinic crystal; *12311*.

Low temperature; Pumping; Ultraclean; Vacuum; Anti-migration traps; Cold shrouding; Contamination; Environment; Ion pumping; Low pressure; *SP336*, pp. 661-668.

Low temperature physics; Cryogenics; *11963*.

Low temperature viscosity; Automotive hydraulic brake fluids; Brake fluids performance; Braking systems; *12052*.

Low temperatures; Olefins; Orientation; Quantum tunneling; Atom addition; Hydrogen isotopes; *12040*.

Lower yield stress; Nitrogen; Polycrystals; Solution hardening; Upper yield point; Zone-refined iron; Flow stress; Impurity softening; Lattice solution; *11946*.

Low-temperature; Magnetometer; Piezoelectric; Vibrating-sample magnetometer; Bimorph; Cryogenic; *12046*.

LTE; Spectral radiance standard; Stark-broadening; Emission coefficient; Hydrogen; Hydrogen continuum; **J.75A** *No. 4, 291-333 (1971)*.

Luminance; Model; Neutral; Perception; Vision; Achromatic; Appearance; Brightness; Chromatic adaptation; Chromaticity; Color; Least squares; *11813*.

Luminous flux; Photometry; Spectroradiometry; Barnes colorimeter; Chromaticity coordinate; Color correction; Cool white fluorescent lamp; Correlated color temperature; Daylight fluorescent lamp; Heterochromatic photometry; Integrating sphere; *TN559*.

Lumped parameter system; Mechanical impedance; Random vibration; Test; Transfer impedance; Transmissivity equalization; Vibration; Acceleration response; Evaluation; Fatigue life; *SP336*, pp. 509-524.

Lunar samples; Lunar simulation; Lunar thermal history; Meteorites; Scanning electron microscopy; Electron probe microanalysis; *11810*.

Lunar samples; Microanalysis; Minerals; Rocks; Analysis; Electron probe; *11995*.

Lunar simulation; Lunar thermal history; Meteorites; Scanning electron microscopy; Electron probe microanalysis; Lunar samples; *11810*.

Lunar soil; Metal inclusions; Meteorite; Microstructure; SEM; *12131*.

Lunar thermal history; Meteorites; Scanning electron microscopy; Electron probe microanalysis; Lunar samples; Lunar simulation; *11810*.

Lyman-α; Stark-broadening; Time-ordering; Unified theory; *12208*.

Lyman-α; Stark-broadening; Time-ordering; Unified theory; *Monogr. 121*.

M

Machine independent; OMNITAB II operating system subprograms; OMNITAB II source listing; Programming techniques; Transportable; User-oriented computing system; Accuracy; Algorithms; ANSI FORTRAN; Documentation; Error checking; *SP339*.

Macromolecules; Optical mixing spectroscopy; Review; Air pollution; Brillouin spectroscopy; Lasers; Light scattering; *12361*.

Macromolecules; Separation by flow; Chromatography; Gel filtration; Gel permeation chromatography; *12003*.

Magnesia; MgO; Microstructure; Rock; Zirconia; Alumina; Al_2O_3; Ceramics; Electron microscopy; Fine-grain ceramic; Ion bombardment; *12083*.

Magnesium; ω_K; Beryllium; Boron; Carbon; Fluorescence yield; Fluorine; *K*-shell; *11950*.

Magnesium compounds; Calcium compounds; Strontium compounds; Barium compounds; Radium compounds; Enthalpy; Entropy; Gibbs energy of formation; Beryllium compounds; *TN270-6*.

Magnesium, electrodeposition of; Nonaqueous plating baths; Grignard reagents; Organic plating baths; Triethylboron; Beryllium, electrodeposition of; Beryllium azide; Beryllium thiocyanate, decaborane; Dimethyl beryllium; *12304*.

Magnetic; Nucleon potentials; Repulsive core; ^{3}He; ^{3}H; Charge; Form factor; *12056*.

Magnetic dipole-dipole coupling; Specific heats; Cesium titanium alum; Critical temperature; Face centered cubic lattice; *12077*.

Magnetic domains; Scanning electron microscope; Electron detector; Image contrast; *12346*.

Magnetic equivalence factoring; Spin-tickling; Transient nutations; 6-Deoxy-α-D-glucofuranose derivative; General Overhauser effect; Internuclear double resonance; Long-range coupling; *12272*.

Magnetic field; Maxwellian distribution; Scattering; Semiconductor; *12078*.

Magnetic field; Solenoid; Toroid; Transformer; Vector potential; *12372*.

Magnetic field; Toroid; Transformer; Vector potential; Leakage flux; *12371*.

Magnetic moments; Mössbauer effect; Ni; Alloys; Clustering; Cold work; Cu; Fe; *11838*.

Magnetic ordering; Transition metal oxides; Electronic transport; $LaCoO_3$; *11809*.

Magnetic pickup; Microelectronic interconnections; Spider bonding; Ultrasonic bonding; Wire bonding; Capacitor microphone; Flip-chip; *TN573*.

Magnetic resonance; OH; Spectroscopy; Astronomical OH emission; H_2O laser; *11954*.

Magnetic resonance; Relaxation times; Rotational diffusion; Spherical-top molecules; Angular relaxation; ClO_3F; *12195*.

Magnetic susceptibility; Metamagnetism; Optical absorption; Critical phenomena; Diamond lattice; $DyPO_4$; Ising system; Low temperature; *12126*.

Magnetic susceptibility; Optical absorption coefficient; Radiation damage; Ruby; Concentration determination; *12348*.

Magnetic susceptibility; Superconductors; Atomic ordering; Intermetallic compounds; *12300*.

Magnetic tape; Master standard; Saturation curves; Secondary standard; Signal level calibration; Standard reference materials; Unrecorded reference; Average signal peak level; Computer amplitude reference; *SP260-29*.

Magnetism; Mo; Mössbauer Effect; Nb; Alloys; *12220*.

Magnetometer; Martensite; Nondestructive; Fatigue monitor; Low temperature; *TN613*.

Magnetometer; Piezoelectric; Vibrating-sample magnetometer; Bimorph; Cryogenic; Low-temperature; *12046*.

Magnetometry; Superconducting devices; Josephson effect; *11936*.

Magnetometry; Superconductivity; Cardiography; Instrumentation; Josephson effect; *12190*.

Magnetoresistance; Aluminum; Copper; *12152*.

Magnetoresistance; Copper; *12153*.

Magnetoresistance; Resistance; Aluminum; Electron scattering; *12278*.

Magnetosphere; Plasma theory; Shock wave; Solar wind; Earth magnetic field; Earth tail; *SP336*, p. 297.

Mail handling; Mail processing; Mail sorting; Methodology; Human factors; *11948*.

Mail processing; Mail sorting; Methodology; Human factors; Mail handling; *11948*.

Mail sorting; Methodology; Human factors; Mail handling; Mail processing; *11948*.

Maintainability prediction; Microbiology; Microflora shift; Physiology; Psychology; Space station simulator; Submersible; Closed ecological system; Habitability; *SP336*, pp. 599-621.

Maintenance; Operational readiness; Performance monitoring;

Testing; Data acquisition; Data dissemination; Data processing; *SP336*, pp. 549-568.

Management information systems; Standards; U.S. Government; American National Standards; Computers, data elements and codes; Data processing systems; Federal Information Processing Standards; International Organization for Standardization; *FIPS PUB 12*.

Management information systems; United States Government; Data codes; Data elements; Data processing systems standards; Federal information processing standards; *FIPS PUB 19*.

Management research; Opinion survey; Brainstorming; Cybernetic technique; Data collection; Group dynamics; Interpersonal relationships; *12364*.

Management science; Model building; Organization; Search and rescue; Simulation; Team development; Coast Guard; Development; Interdisciplinary team; *12243*.

Managerial breakthrough techniques; Personnel selection for metrology; Steady control versus sudden change; *SP335*, pp. 85-88.

Manganese dioxide; Polycrystalline; Structure; Surface; Adsorption; Amorphour; Free-radical; Ionic; *12314*.

Manganous sulfate bath; Neutron source absorption; Neutron source calibration; Thermal neutron absorption; *12177*.

Manganous sulfate bath calibration of neutron sources; Neutron; Neutron standards; *TN576*.

Man-machine relationships; Teleprocessing; Communication; Information processing; Languages; *12021*.

Man-machine system; Man-rated centrifuge; Simulation research; Combined environmental stress; Dynamic environment simulator; *SP336*, pp. 587-598.

Man-rated centrifuge; Simulation research; Combined environmental stress; Dynamic environment simulator; Man-machine system; *SP336*, pp. 587-598.

Manufacturing industry; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; Metric conversion; Metric system; Metric usage; SI; U.S. Metric Study; International System of Units; *SP345-4*.

Many-body clusters; Nuclei; Quarks; Coherent production; Cosmic rays; High momentum components; *12144*.

Many-body problem; Multiple scattering; Statistical physics; Transmission coefficient; Defects in harmonic crystal; Functional equation; *12375*.

Maraging steel; Metallic coatings; Missiles; Rocket-fuel tanks; Compatibility tests; Electrolytic protection; Hydrazine; *11934*.

Markov process; Probability theory; Ring theory; Stochastic process; Information theory; **J.75B** *Nos. 3 and 4, 139-148 (1971)*.

Markov renewal process; Runway; Airport; Air traffic control; Capacity concept; *11960*.

Mars; Reflectance; Scattering; Simulation; Spectral; Absorbing; Anomalous dispersion; Carbon dioxide; Cryodeposit; Cryogenics; Frost; Infrared; Integrating sphere; *SP336*, pp. 165-183.

Mars atmosphere exploration; Planetary atmosphere-surface interaction; Planetary meteorology; Research facility; Simulation techniques; Space research; Convective processes; *SP336*, pp. 699-723.

Mars environmental simulation; Outgassing; Thermal insulation; Thermal-vacuum chambers; Evacuating; Heat transmission; Infrared scanning; *SP336*, pp. 725-748.

Martensite; Crystallographic theory; Iron-nickel alloy; *11820*.

Martensite; Nondestructive; Fatigue monitor; Low temperature; Magnetometer; *TN613*.

Martensite; Phase transformation; Twinning; Crystallography; Gold-cadmium alloy; *12006*.

Maser oscillator; Metrology; Quantum electronics; Saturated absorption; Slave oscillators; Accurate frequency standards; Accurate length standards; Accurate time standards; Accurate voltage standards; Ion storage; Laser stabilization; *12099*.

Maser oscillator; Metrology; Saturated absorption; Slave oscillators; Quantum electronics; Ion storage; Laser stabilization; *12068*.

Mashed potatoes, instant, package quantities of; Package quantities of instant mashed potatoes; Potatoes, instant mashed, package quantities of; Instant mashed potatoes, package quantities of; *PS41-70*.

Masonry; Mobile homes; Roofs; Structural engineering; Wind load; Anchorage; Building performance; Glazing; Hailstones; *TN558*.

Masonry; Moments; Slenderness ratio; Stability; Structural engineering; Walls; Bricks; Buckling; Deflection; Loads (forces); *12227*.

Masonry; Mortar; Slenderness effects; Standards; Structural stability; Walls; Brick; Cavity walls; Composite walls; Compressive strength; Concrete block; Flexural strength; *BSS34*.

Masonry; Section cracking; Stability; Stress distribution; Unreinforced concrete; Buckling; Compression members, concrete; Deflection; Equilibrium; Load eccentricity; *12298*.

Mass; Platinum; Precision; Replicate; Spark; Spectrometry; Accuracy; Circumvention; Emulsions; Homogeneity; Ions; *11847*.

Mass absorption coefficient derivation; Strontium 90 wall-thickness measurement gage; Thin-wall mensuration; Attenuation of betas; Beta-transmission phenomenology; Counting geometry; *SP335*, pp. 11-21.

Mass action; Non-linear search; Chemical equilibrium; Chemical reactions; Equilibrium; Gases; *12244*.

Mass comparisons of 1969; Systematic and random weighing errors; Within-group variance; Between-group variance; *SP335*, pp. 41-45.

Mass formulae; Nuclei; Particle-hole energy; Quartet structure; Rearrangement; Binding energy; *12145*.

Mass measurements; Metrology; Standards; State laboratories; Volume measurements; Length measurements; *SP335*, pp. 89-94.

Mass separator; Proton source; Solar wind simulator; Ion beam deflection; Ion optics; *SP336*, pp. 279-296.

Mass separators; Proton sources; Solar wind; Sputtering; Ultrahigh vacuum systems; Charge exchange; Charge neutralization; Ion optics; *SP336*, pp. 261-277.

Mass spectrometer leak detector; Mechanical pump; Shaft seal; Closed pumping system; He^3-He^4 dilution refrigerator; *12235*.

Mass spectrometry; Molecular ionization; Photoionization; Vacuum ultraviolet; Chlorine monofluoride; Dissociative ionization; Fluorine; Heats of formation; Hot bands; Hydrogen fluoride; Ion pairs; *12148*.

Mass spectrometry; Molten salt halides; Thermodynamics; Complex molecules; *12280*.

Mass spectrometry; Neopentane; Photoionization; Proton affinity; Rate constants; Ion molecule reactions; **J.75A** *No. 5, 487-493 (1971)*.

Mass spectrometry; Photoionization; Rate constants; Alkanes; Excited states; Ion-molecule reactions; *11829*.

Mass spectrometry; Photoionization; Protonated dimer ions; Alkane dimer ions; Ethane; Ion-molecule reactions; *11830*.

Mass spectrometry; Photoionization; Proton transfer; Water; Hydrocarbons; Ion-molecule reactions; *11927*.

Mass spectrometry; Photoionization; Vacuum ultraviolet; Chlorine monofluoride; Dissociation energy; Ionization energy; *12064*.

Mass spectrometry; Photoionization; Propane; Radiation chemistry; Ion-molecule reaction; Kinetics; *12175*.

Mass spectrometry; Photoionization; Rate constants; Gas phase; Hydrocarbons; Ion-molecule reactions; **J.75A** *No. 3, 147-153 (1971)*.

Mass spectrometry; Precision; Quantitative analysis; Solids;

Measurement; Performance; Prime; Program; Test; Assessment; Complex; Composite; Computer; Criteria; Evaluation; Gaussian primes; Indexing; *TN572*.

Measurement; Positive displacement; Cryogenic; Flow; Flowmeters; Liquid nitrogen; *TN605*.

Measurement; Ratio transformer; Ratio transformer bridge; Bridge; Impedance; Impedance bridge; *12172*.

Measurement methods; Microcircuits; Silicon; Device fabrication; Environmental testing; Integrated circuits; *SP336*, pp. 449-455.

Measurement standards; Spectral density; Speed of light; Standard frequency broadcasts; Statistics of time/frequency measurements; Time; Time/frequency dissemination; Time scales; Timing (HF, LF, satellite, TV, VLF); Wavelength standards; WWV; *SP350*.

Measurement system; Ratio; Ratio standard; Resistive divider; Voltage ratio; Divider; *12150*.

Measurement techniques; Metrology; Education for metrology; Measurements; *11900*.

Measurement uncertainty; Reliability of working instruments; Calibration intervals; Economy in adjusting quality level; *SP335*, pp. 57-64.

Measurements; Measurement techniques; Metrology; Education for metrology; *11900*.

Measurements; Second virial coefficient; Adsorption, gas on metal; Argon, compressibility factor of; Burnett data reduction; Carbon dioxide, second virial coefficient of; Compressibility factor; Gas; **J.75C** *Nos. 3 and 4, 163-172 (1971)*.

Measurements; X-ray interferometry; Wave optics; Diffraction theory; Lattice constants; *12285*.

Mechanical heating; Radiation quality; Radiation quantity; Electron temperature; Line-blanketing; *12097*.

Mechanical impedance; Random vibration; Test; Transfer impedance; Transmissivity equalization; Vibration; Acceleration response; Evaluation; Fatigue life; Lumped parameter system; *SP336*, pp. 509-524.

Mechanical properties; Misfit strain; Precipitation hardening; Activation energy; Cross slip; *SP317*, pp. 1115-1134.

Mechanical properties; Optical properties; Plastic films; Poly(ethylene terephtalate); Proton damage; Proton energy; Radiation effect; Radiation intensity; Recovery; Solubility; Space simulation; Temperature effect; Tests; *SP336*, pp. 323-344.

Mechanical properties; Outgassing; Pressure measurements; Rock mechanics; Space environment simulation; Ultrahigh vacuum; Anisotropy; Compression tests; Mass spectroscopy; *SP336*, pp. 209-223.

Mechanical properties; Phonon scattering; Thermal resistivity; Cottrell atmospheres; *SP317*, pp. 391-394.

Mechanical properties; Plane blending; Dislocation distributions; *SP317*, pp. 925-941.

Mechanical properties; Plastic deformation; Sapphire; Strength; Alumina; Fracture; *12282*.

Mechanical properties; Precipitation hardening; Thermal activation; Arrhenius law; *SP317*, pp. 1077-1082.

Mechanical properties; Precipitation hardening; Computer simulation; Dislocation motion; *SP317*, pp. 1083-1098.

Mechanical properties; Pressure; Properties; Standards; Standard Reference Materials; Temperature; Thermal; Ceramics; Chemical composition; *12181*.

Mechanical properties; Thermal activation; Bordoni-peaks; Dislocation motion; Kink relaxation; *SP317*, pp. 1137-1156.

Mechanical property equipment; Stainless steel; Cryostat; Fatigue; Impact; Low temperature; **J.75C** *No. 2, 95-98 (1971)*.

Mechanical property equipment; Stainless steel; Fatigue; Fracture; Impact; Low temperature; *TN609*.

Mechanical pump; Shaft seal; Closed pumping system; He^3-He^4 dilution refrigerator; Mass spectrometer leak detector; *12235*.

Mechanical reliability; Accelerated testing; Cumulative damage; Failure; Life testing; *SP336*, pp. 457-471.

Mechanism of adsorption; Solution adsorption; Adsorption from solution; Calcium phosphate; Composite adsorption; Isotopic exchange; Kinetics of adsorption; *12249*.

Mechanism of phase separation; Metastable liquid immiscibility; Microphase separation; Phase diagrams of metastable immiscibility; Spinodal; Structural interpretation of immiscibility; Super-duty silica brick; Glass chromatography; *11902*.

Melting; Normal spectral emittance; Tantalum; Thermal radiation properties; Emittance; High-speed measurements; *12307*.

Melting point; Metals; Molybdenum; Premelting; Thermodynamics; Electrical resistivity; High-speed methods; High temperature; *12231*.

Melting point; Prandtl number; Oxygen; Specific heat; Speed of sound; Surface tension; Thermal conductivity; Thermal diffusivity; Vapor pressure; Viscosity; Volume; Density; Dielectric constant; Enthalpy; Entropy; Equation of state; Fixed points; *TN384*.

Melting point of Al_2O_3; Melting point standards; Al_2O_3; Alumina; IUPAC; *11924*.

Melting point standards; Al_2O_3; Alumina; IUPAC; Melting point of Al_2O_3; *11924*.

Melting points; Phase equilibria; System tantalum oxide-tantalum tungstate; *12017*.

Mercuric nitrate; Olefins; Silver nitrate; Surface effect; Aliphatics; Aromatics; Complexing effects; Gas chromatography; Group separation; *12024*.

Mercury; Mercury vapor levels; Threshold limit; Amalgam condensation; *12092*.

Mercury; Vapor; Contamination; Dental amalgam; Environment; Hazards; Hygiene; *12254*.

Mercury in botanical; Quantum efficiencies; Aluminum in steel; Bilirubin; DTA standards; Fluorescence filters Tl(I), Ce(III), Pb(II); Glass filters (SRM 930); *TN584*.

Mercury vapor levels; Threshold limit; Amalgam condensation; Mercury; *12092*.

Mercury-arc irradiation; Organic coatings; Photodegradation; Surface degradation; Volatile degradation products; Xenon-arc irradiation; Atmospheric exposure; ATR spectroscopy; Clear and pigmented films; Infrared analysis; *SP336*, pp. 299-312.

Mercury-in-glass thermometers; Thermometers, self-registering, clinical; Clinical thermometers; Glass thermometers, clinical; *PS39-70*.

Mesons; Reactions; Structure; $SU(6)_W$; Symmetry; Exotic; *11974*.

Mesons; Resonances; Spectroscopy; SU(3); $SU(6)_W$; A_2; *12009*.

Metal coatings; Micrometers; Microscopes; Optical equipment; Optical microscopes; Thickness; Thickness gages; *12215*.

Metal inclusions; Meteorite; Microstructure; SEM; Lunar soil; *12131*.

Metal-insulator transition; Plasmon energy losses; Tungsten; Adsorbed atomic layers; Cesium; Inelastic-electron scattering; *11920*.

Metal volumetric field standards; Provers; Specifications; Test measures; Tolerances; Weights and measures inspection; Accurate measurements of volumes; Field standard; *H105-3*.

Metallic coatings; Missiles; Rocket-fuel tanks; Compatibility tests; Electrolytic protection; Hydrazine; Maraging steel; *11934*.

Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; *TN560*.

Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; *TN571*.

Metallization; Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; *TN592*.

Metallizing; Ultrasonic; Vacuum; Boron nitride; Ceramic; *11883*.

Metallography; Metallurgical analysis; Microscopy; Photogrammetry; Evaluation; Measurement; *11977*.

Metallography; Microprobe analysis; Spectrometric analysis; Standard Reference Materials; Fe-3Si alloy; Homogeneity testing; *SP260-22*.

Metallography; Microscopy; Polarized electromagnetic radiation; Color photography; Electron microscopy; Electron probes; Evaluation; *11994*.

Metallurgical analysis; Microscopy; Photogrammetry; Evaluation; Measurement; Metallography; *11977*.

Metals; Molybdenum; Premelting; Thermodynamics; Electrical resistivity; High-speed methods; High temperature; Melting point; *12231*.

Metamagnetism; Optical absorption; Critical phenomena; Diamond lattice; $DyPO_4$; Ising system; Low temperature; Magnetic susceptibility; *12126*.

Metamerism; Color-match classification; Color; Isomerism; *12196*.

Metastable liquid immiscibility; Microphase separation; Phase diagrams of metastable immiscibility; Spinodal; Structural interpretation of immiscibility; Super-duty silica brick; Glass chromatography; Immiscibility and courses of crystallization; *11902*.

Meteoroid penetration; Oxidative detonation; Oxidative flash; Oxygen atmosphere; Spacecraft; Blast over-pressure; Combustion front; Hypervelocity impact; *SP336*, pp. 569-585.

Meteorite; Microstructure; SEM; Lunar soil; Metal inclusions; *12131*.

Meteorites; Scanning electron microscopy; Electron probe microanalysis; Lunar samples; Lunar simulation; Lunar thermal history; *11810*.

Meteorology; Spatial correlation; Turbulence; Wind observations; Wind profiles; Climatology; *BSS30*, pp. 23-25.

Meterology; Moisture measurement in gases; Psychrometry; Dew point; Hygrometry; *11991*.

Methacrylates; Polymerization; Resins; Synthesis; Accelerators; Amines; Color-stable composites; *12302*.

Methane; Molecular-beam data; Ortho-para transitions; Radio frequency; Group theory; Inversion splitting; *12323*.

Methane; Orthobaric densities; Specific heats of the saturated liquid; Thermofunctions for ideal gas states; Thermophysical properties; Heats of vaporization; **J.75A** *No. 1, 15-21 (1971)*.

Methane; Properties data; Flowmeters; Instrumentation; Liquefied natural gas (LNG); *11821*.

Methane; Saturated absorption; Coherence; Laser stabilization; Length; *12296*.

Methane; Saturated absorption; Zeeman effect; Lasers; *12179*.

Methodology; Human factors; Mail handling; Mail processing; Mail sorting; *11948*.

Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; *TN702*.

Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; *TN560*.

Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; *TN571*.

Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; *TN592*.

Methods of measurement; Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; *TN598*.

Methylcylopropane; Photoionization; Photolysis; Radiolysis; Butene; Cyclobutane; Ion structure; Isomerization; **J. 75A**, *No. 6, 591-605 (1971)*.

Methyl iodide; Molecular geometry; Molecular structure; Spectra; Absorption; Gas; Infrared; *11973*.

Methyl ketene; Analysis; Gas chromatography; Ketene; *12164*.

Methyl radicals; Methylene; Spectroscopy; Vacuum UV; Oscillator strengths; *12290*.

Methyl sulfoxide; Oxygen; Radical-anion; Bis(phenylhydrazone); E.s.r.; Glyoxal; **J.75A** *No. 6, 573-577 (1971)*.

Methylene; Abstraction; Deuterium; Isotope effect; Ketene; Kinetics; *12331*.

Methylene; Bond energy; Enthalpy of formation; Heat of formation; Ketene; *12252*.

Methylene; Spectroscopy; Vacuum UV; Oscillator strengths; Methyl radicals; *12290*.

Metric conversion; Metric conversion, effect on foreign trade; Metric system; Metric usage; Metric usage, effect on foreign trade; Metrication; Metrication, impact of on foreign trade; SI; U.S. Metric Study; Foreign trade; *SP345-8*.

Metric conversion; Metric system; Metric usage; Metrication; Public Law 90-472; U.S. Metric Study; *SP345*.

Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Federal Government; International System of Units; *SP345-2*.

Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Commercial weights and measures; International System of Units; *SP345-3*.

Metric conversion; Metric system; Metric usage; SI; U.S. Metric Study; International System of Units; Manufacturing industry; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; *SP345-4*.

Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; Nonmanufacturing businesses; SI; U.S. Metric Study; International System of Units; *SP345-5*.

Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Education; International System of Units; *SP345-6*.

Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; SI; U.S. Metric Study; Consumers; *SP345-7*.

Metric conversion; Metric system; Metrication; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Department of Defense; International System of Units; *SP345-9*.

Metric conversion; Metric system; Metrication; Metrication and engineering standards; SI; Standards; U.S. Metric Study; Engineering standards; International standards; International System of Units; *SP345-11*.

Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; SI; U.S. Metric Study; International System of Units; *SP345-12*.

Metric conversion, effect on foreign trade; Metric system; Metric usage; Metric usage, effect on foreign trade; Metrication; Metrication, impact of on foreign trade; SI; U.S. Metric Study; Foreign trade; International System of Units; *SP345-8*.

Metric system; Metric usage; Metrication; Public Law 90-472; U.S. Metric Study; Metric conversion; *SP345*.

Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Federal Government; International System of Units; Metric conversion; *SP345-2*.

Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Commercial weights and measures; International System of Units; Metric conversion; *SP345-3*.

Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; Nonmanufacturing businesses; SI; U.S. Metric Study; International System of Units; Metric conversion; *SP345-5*.

Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Education; International System of Units; Metric conversion; *SP345-6*.

Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; SI; U.S. Metric Study; Consumers; International System of Units; *SP345-7*.

Metric system; Metric usage; Metric usage, effect on foreign trade; Metrication; Metrication, impact of on foreign trade; SI; U.S. Metric Study; Foreign trade; International System of Units; Metric conversion; *SP345-8*.

Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; SI; U.S. Metric Study; International System of Units; Metric conversion; *SP345-12*.

Metric system; Metric usage; SI; U.S. Metric Study; International System of Units; Manufacturing industry; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; Metric conversion; *SP345-4*.

Metric system; Metrication; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Department of Defense; International System of Units; Metric conversion; *SP345-9*.

Metric system; Metrication; Metrication and engineering standards; SI; Standards; U.S. Metric Study; Engineering standards; International standards; International System of Units; Metric conversion; *SP345-11*.

Metric system; Weights and measures; *SP345-10*.

Metric usage; Metric usage, effect on foreign trade; Metrication; Metrication, impact of on foreign trade; SI; U.S. Metric Study; Foreign trade; International System of Units; Metric conversion; Metric conversion, effect on foreign trade; *SP345-8*.

Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Federal Government; International System of Units; Metric conversion; Metric system; *SP345-2*.

Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Commercial weights and measures; International System of Units; Metric conversion; Metric system; *SP345-3*

Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; Nonmanufacturing businesses; SI; U.S. Metric Study; International System of Units; Metric conversion; Metric system; *SP345-5*.

Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Education; International System of Units; Metric conversion; Metric system; *SP345-6*.

Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; SI; U.S. Metric Study; Consumers; International System of Units; Metric conversion; *SP345-7*.

Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; SI; U.S. Metric Study; International System of Units; Metric conversion; Metric system; *SP345-12*.

Metric usage; Metrication; Public Law 90-472; U.S. Metric Study; Metric conversion; Metric system; *SP345*.

Metric usage; SI; U.S. Metric Study; International System of Units; Manufacturing industry; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; Metric conversion; Metric system; *SP345-4*.

Metric usage, effect on foreign trade; Metrication; Metrication, impact of on foreign trade; SI; U.S. Metric Study; Foreign trade; International System of Units; Metric conversion; Metric conversion, effect on foreign trade; Metric system; *SP345-8*.

Metrication; Metrication and engineering standards; SI; Standards; U.S. Metric Study; Engineering standards; International standards; International System of Units; Metric conversion; Metric system; *SP345-11*.

Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Federal Government; International System of Units; Metric conversion; Metric system; Metric usage; *SP345-2*.

Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Commercial weights and measures; International System of Units; Metric conversion; Metric system; Metric usage; *SP345-3*.

Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; Metric conversion; Metric system; Metric usage; SI; U.S. Metric Study; International System of Units; Manufacturing industry; *SP345-4*.

Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; Nonmanufacturing businesses; SI; U.S. Metric Study; International System of Units; Metric conversion; Metric system; Metric usage; *SP345-5*.

Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Education; International System of Units; Metric conversion; Metric system; Metric usage; *SP345-6*.

Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; SI; U.S. Metric Study; Consumers; International System of Units; Metric conversion; Metric system; *SP345-7*.

Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; SI; U.S. Metric Study; International System of Units; Metric conversion; Metric system; Metric usage; *SP345-12*.

Metrication; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Department of Defense; International System of Units; Metric conversion; Metric system; *SP345-9*.

Metrication; Metrication, impact of on foreign trade; SI; U.S. Metric Study; Foreign trade; International System of Units; Metric conversion; Metric conversion, effect on foreign trade; Metric system; Metric usage; *SP345-8*.

Metrication; Public Law 90-472; U.S. Metric Study; Metric conversion; Metric system; Metric usage; *SP345*.

Metrication and engineering standards; SI; Standards; U.S. Metric Study; Engineering standards; International standards; International System of Units; Metric conversion; Metric system; Metrication; *SP345-11*.

Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Federal Government; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; *SP345-2*.

Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Commercial weights and measures; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; *SP345-3*.

Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; Metric conversion; Metric system; Metric usage; SI; U.S. Metric Study; International System of Units; Manufacturing industry; Metrication; *SP345-4*.

Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; Nonmanufacturing businesses; SI; U.S. Metric Study; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; *SP345-5*.

Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Education; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; *SP345-6*.

Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; SI; U.S. Metric Study; Consumers; International System of Units; Metric conversion; Metric system; Metric usage; *SP345-7*.

Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; SI; U.S. Metric Study; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; *SP345-12*.

Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Federal Government; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; *SP345-2*.

Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Commercial weights and measures; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; *SP345-3*.

Metrication, costs and benefits of; Metrication, impact of; Metric conversion; Metric system; Metric usage; SI; U.S. Metric Study; International System of Units; Manufacturing industry; Metrication; Metrication, attitudes toward; *SP345-4*.

Metrication, costs and benefits of; Metrication, impact of; Nonmanufacturing businesses; SI; U.S. Metric Study; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; *SP345-5*.

Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Education; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; *SP345-6*.

Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; SI; U.S. Metric Study; Consumers; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; *SP345-7*.

Metrication, costs and benefits of; Metrication, impact of; SI; U.S. Metric Study; Department of Defense; International System of Units; Metric conversion; Metric system; Metrication; *SP345-9*.

Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; SI; U.S. Metric Study; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; *SP345-12*.

Metrication, impact of; Metric conversion; Metric system; Metric usage; SI; U.S. Metric Study; International System of Units; Manufacturing industry; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; *SP345-4*.

Metrication, impact of; National Metric Study Conferences; SI; U.S. Metric Study; Consumers; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; *SP345-7*.

Metrication, impact of; National Metric Study Conferences; SI; U.S. Metric Study; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; *SP345-12*.

Metrication, impact of; Nonmanufacturing businesses; SI; U.S. Metric Study; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; *SP345-5*.

Metrication, impact of; SI; U.S. Metric Study; Federal Government; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; *SP345-2*.

Metrication, impact of; SI; U.S. Metric Study; Commercial weights and measures; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; *SP345-3*.

Metrication, impact of; SI; U.S. Metric Study; Education; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; *SP345-6*.

Metrication, impact of; SI; U.S. Metric Study; Department of Defense; International System of Units; Metric conversion; Metric system; Metrication; Metrication, costs and benefits of; *SP345-9*.

Metrication, impact of on foreign trade; SI; U.S. Metric Study; Foreign trade; International System of Units; Metric conversion; Metric conversion, effect on foreign trade; Metric system; Metric usage; Metric usage, effect on foreign trade; *SP345-8*.

Metrology; Education for metrology; Measurements; Measurement techniques; *11900*.

Metrology; Quantum electronics; Saturated absorption; Slave oscillators; Accurate frequency standards; Accurate length standards; Accurate time standards; Accurate voltage standards; Ion storage; Laser stabilization; Maser oscillator; *12099*.

Metrology; Research materials; Standard reference materials; SRM's; Standard Reference Materials Program; Agriculture; Air and water pollution; Biology; Botany; Health and medicine; Instrument calibration; *12349*.

Metrology; Saturated absorption; Slave oscillators; Quantum electronics; Ion storage; Laser stabilization; Maser oscillator; *12068*.

Metrology; Standards; State laboratories; Volume measurements; Length measurements; Mass measurements; *SP335*, pp. 89-94.

Metrology management; National Conference of Standards Laboratories; Physical measurement; Proceedings NCSL; *SP335*.

MgO; Microstructure; Rock; Zirconia; Alumina; Al_2O_3; Ceramics; Electron microscopy; Fine-grain ceramic; Ion bombardment; Magnesia; *12083*.

Micelle; Paraffin chain salts; Selected values; Soap; Solubilization; Standard values; Surface active agents; Surface chemistry; Surface tension; Surfactant; Association colloid; Bibliography; CMC; Colloid; Colloidal electrolyte; *NSRDS-NBS36*.

Microanalysis; Minerals; Rocks; Analysis; Electron probe; Lunar samples; *11995*.

Microanalysis; Multichannel analyzer; Proportional counters; Quantitative analysis; Solid state counters; Tests; X-ray spectra; X-ray spectrometers; Electron diffraction; Electron probes; Evaluation; Gas flow; Lithium; *12251.*

Microanalysis; Quantitative analysis; Standard reference materials; X-ray emission; Alloys; Corrections; Electron probe; Homogeneity; Matrix scanner; *SP260-28.*

Microbiology; Microflora shift; Physiology; Psychology; Space station simulator; Submersible; Closed ecological system; Habitability; Maintainability prediction; *SP336,* pp. 599-621.

Microcircuits; Silicon; Device fabrication; Environmental testing; Integrated circuits; Measurement methods; *SP336,* pp. 449-455.

Microdensitometer; Radiochromic dye films; Spectral transmission density; Densitometer; **J.75C** *No. 1, 23-27 (1971).*

Microdensitometry; Diffuse density measurement; Linear microdensitometer; *12362.*

Microelectronic interconnections; Spider bonding; Ultrasonic bonding; Wire bonding; Capacitor microphone; Flip-chip; Magnetic pickup; *TN573.*

Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; *TN702.*

Microelectronics; Microwave devices; Nuclear radiation detectors; Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; *TN560.*

Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; *TN571.*

Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; *TN592.*

Microelectronics; Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; *TN598.*

Microelectronics; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; ASTM standards; Integrated circuits; *11869.*

Microfilm; Permanent record film; Archival film; Hypo; **J.75C** *No. 1, 19-22 (1971).*

Microflora shift; Physiology; Psychology; Space station simulator; Submersible; Closed ecological system; Habitability; Maintainability prediction; Microbiology; *SP336,* pp. 599-621.

Microform-microfilm systems; Document storage and retrieval; *11938.*

Micrometeoroid; Particle detectors; Hypervelocity; Impact damage; *SP336,* pp. 915-933.

Micrometers; Microscopes; Optical equipment; Optical microscopes; Thickness; Thickness gages; Metal coatings; *12215.*

Micromorphic dislocations; Micropolar dislocations; Continuum mechanics; Dislocation distributions; *SP317,* pp. 1023-1040.

Microorganisms; Optical properties; Planetary quarantine; Polymers; Shock force; Space simulation; Testing; Volatile products; Absorption; Condensation; Contamination control; Evaluation; Far infrared; Fluid dynamic force; *SP336,* pp. 51-77.

Microphase separation; Phase diagrams of metastable immiscibility; Spinodal; Structural interpretation of immiscibility; Super-duty silica brick; Glass chromatography; Immiscibility and courses of crystallization; Immiscibility and practical applications; *11902.*

Micropolar dislocations; Continuum mechanics; Dislocation distributions; Micromorphic dislocations; *SP317,* pp. 1023-1040.

Microprobe analysis; Spectrometric analysis; Standard Reference Materials; Fe-3Si alloy; Homogeneity testing; Metallography; *SP260-22.*

Microscope; Microspectrophotometry; Pattern recognition; Biological structure; Biomedical instrumentation; Computer; Image processing; *11834.*

Microscope; Microspectrophotometry; Pattern recognition; Computers; Digital logic; Image processing; *11990.*

Microscopes; Optical equipment; Optical microscopes; Thickness; Thickness gages; Metal coatings; Micrometers; *12215.*

Microscopic size measurement; Particle size measurement; Air elutriation; Air permeability; Andreasen pipette; Calibrated glass beads; Coulter counter; Electroformed sieves; *11895.*

Microscopy; Photogrammetry; Evaluation; Measurement; Metallography; Metallurgical analysis; *11977.*

Microscopy; Polarized electromagnetic radiation; Color photography; Electron microscopy; Electron probes; Evaluation; Metallography; *11994.*

Microspectrophotometry; Pattern recognition; Biological structure; Biomedical instrumentation; Computer; Image processing; Microscope; *11834.*

Microspectrophotometry; Pattern recognition; Computers; Digital logic; Image processing; Microscope; *11990.*

Microstructure; Rock; Zirconia; Alumina; Al_2O_3; Ceramics; Electron microscopy; Fine-grain ceramic; Ion bombardment; Magnesia; MgO; *12083.*

Microstructure; SEM; Lunar soil; Metal inclusions; Meteorite; *12131.*

Microwave; Accurate; Calibration; Directional coupler; High power; Measurement; **J.75C** *Nos. 3 and 4, 181-186 (1971).*

Microwave; Molecular structure; Rotational constants; Spectra; Bond distances; Hydrogen cyanide; Infrared; *12342.*

Microwave; Oscillators; Semiconductor; Solid state; Amplifiers; Basic characteristics; *TN597.*

Microwave; Power; Self balancing; Stabilizer; Bridge; Leveler; *12042.*

Microwave; Precision; Rotary vane; Attenuator; **J.75C** *No. 1, 1-5 (1971).*

Microwave; Reflection coefficient; Return loss; Sliding short; Shorted termination; Waveguide; *TN602.*

Microwave antennas; Near-field measurements; Patterns; Gains; *11855.*

Microwave cavity; Plasma density; Collision frequency; Helium negative glow discharge; *TN607.*

Microwave current measurements; Microwave power measurements; Microwave voltage measurements; BOLOVAC; *12055.*

Microwave currents; Microwave voltages; Power measurement; Voltage measurement (HF & MW); Bolovac; Current measurement (HF & MW); (HF & MW); *11926.*

Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; *TN702.*

Microwave devices; Nuclear radiation detectors; Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; *TN560.*

Microwave devices; Nuclear radiation detectors; Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; *TN571.*

Dew point temperature; Humidity; Hygrometer; Mixing ratio; **J.75C** *No. 2, 69-78 (1971).*

Moisture measurement in gases; Psychrometry; Dew point; Hygrometry; Meterology; *11991.*

Moisture transfer; Thermal insulation; Flat roofs; Heat transfer; *BSS37.*

Molecular dynamics; Random-walk theory; Vacancy motion; Atomic diffusion; Defect motion; Interstitial motion; Jump frequency; Lattice model; Migration energy; Migration entropy; *12022.*

Molecular geometries; Heavy metal halides; Infrared spectra; Matrix isolation; *12157.*

Molecular geometry; Molecular structure; Spectra; Absorption; Gas; Infrared; Methyl iodide; *11973.*

Molecular hydrogen; Partial widths; Potential curve; Predissociation; Vibrational overlap; Born-Oppenheimer; Hartree-Fock; *12102.*

Molecular ionization; Photoionization; Vacuum ultraviolet; Chlorine monofluoride; Dissociative ionization; Fluorine; Heats of formation; Hot bands; Hydrogen fluoride; Ion pairs; Mass spectrometry; *12148.*

Molecular orbitals; SO_2^- anion; Sulfur dioxide; Alkali metal reactions; Charge transfer; Electron capture; Infrared spectrum; Matrix isolation; *12336.*

Molecular orbitals; Vibrational spectrum; Electronic spectrum; Flash photolysis; Free radicals; Matrix isolation; *11823.*

Molecular rotation; Vacuum-ultraviolet photolysis; Vibrational potential function; Alkali metal reactions; $BrHBr^-$; Charge transfer; $ClHCl^-$; Electron attachment; Infrared spectrum; Matrix isolation; *12369.*

Molecular structure; Neutron; Nuclear reactor; Radiation; Scattering; Crystal structure; Diffraction; *TN567.*

Molecular structure; Rotational constants; Spectra; Bond distances; Hydrogen cyanide; Infrared; Microwave; *12342.*

Molecular structure; Spectra; Absorption; Gas; Infrared; Methyl iodide; Molecular geometry; *11973.*

Molecular structure; Stark effect; Rotational spectrum; Dipole moment; Ethynyldifluoroborane; Microwave spectrum; *12328.*

Molecular-beam data; Ortho-para transitions; Radio frequency; Group theory; Inversion splitting; Methane; *12323.*

Molecule; Atom; Cross section; Elastic scattering; Electron; *12283.*

Molecule; Atom; Cross section; Electron; *12161.*

Molecule; Deuterium; Dissociation; Electron; Hydrogen; *12058.*

Molecule-fixed axes; Reference configuration; Constraint equations; Eckart conditions; Eulerian angles; Large amplitude vibrational coordinate; *12117.*

Molten salt; Transference numbers; Hexachloromolybdate complex ion; *11971.*

Molten salt halides; Thermodynamics; Complex molecules; Mass spectrometry; *12280.*

Molybdenum; Premelting; Thermodynamics; Electrical resistivity; High-speed methods; High temperature; Melting point; Metals; *12231.*

Moment method; Neutron transport; Polynomial truncation errors; Sievert function; Biorthogonal polynomials; Gamma-ray transport; **J.75B** *Nos. 1 and 2, 1-16 (1971).*

Moments; Probability-distributions; Turbulence; Velocity-gradients; Computer; Correlations; Grid; Intermittency; Isotropy; *12316.*

Moments; Slenderness ratio; Stability; Structural engineering; Walls; Bricks; Buckling; Deflection; Loads (forces); Masonry; *12227.*

Momentum transfer; Pair correlation; Shell model; Spurious; Sum rule; Electron scattering; *12043.*

Monitor tests; Neutron radiography; Ultrasonics; X rays; Compaction density; Eddy current measurements; Fuel rods; Impregnation density; *SP336*, p. 405.

Monochromatic yields; Purity; X-ray beams; Beryllium to gold; Electron produced; High intensity; *12214.*

Monoclinic crystal; Low temperature; Planar molecular structure; Spherical shell molecules; Vitreous state; Arsenious oxide; Arsenolite; Claudetite; Crystal transition; Cubic crystal; Glass; Heat capacity; *12311.*

Monoxide; Rhenium; Ruthenium; Surface migration; Carbon monoxide; Desorption; Field emission; *11819.*

Monte Carlo; Photon neutron; Radiation transport; Thick targets; Bremsstrahlung; Bremsstrahlung efficiency; *11799.*

Monte Carlo calculations; Semi-infinite aluminum medium; Silicon detector; Absorbed energy vs depth; Absorbed-energy distributions; Incident monoenergetic electrons; *12140.*

Monte-Carlo computations; Near-neighbor interactions; Phase transition; Stochastic matrix; Theta point; Chain partition function; *11908.*

Moon; Petrography; Rocks; Apollo 11; Electron probe analysis; Mineralogy; *11958.*

Morphological stability; Nucleation; Phase changes; Transport processes; Crystal; Crystal growth; Crystallization; Growth mechanisms; *11918.*

Morphology; Pattern recognition; Biological images; Image processing; *12284.*

Mortar; Slenderness effects; Standards; Structural stability; Walls; Brick; Cavity walls; Composite walls; Compressive strength; Concrete block; Flexural strength; Masonry; *BSS34.*

MOSFETS; Neutrons; Pu^{239}-Be; Radiation simulation; RTG; Test; Evaluation; *SP336*, pp. 129-140.

Motion picture cameras; Photographic equipment; Static loads; Test equipment; Compression tests; Dynamic loads; High-speed photography; Indicating instruments; Indicator characteristics; Loading rate; Loads (forces); *12080.*

Motor calculus; Plasticity; Burgers vector; Compatibility; Continuum; Contortion; Cosserat; Couple-stress; Defect; Deformation; Disclination; Dislocation; Dualism; Elasticity; Incompatibility; *SP317*, pp. 651-673.

Motor vehicle brake fluid; Passenger car braking systems; Brake fluids; Brake fluid standards; *12038.*

Moutier cycle; Stress concentrations; Dislocation pileups; *SP317*, pp. 147-150.

Mullions; Parapets; Roof projections; Static pressures; Wind effects; Wind tunnel modeling; Architectural features; Buildings; *BSS30*, pp. 73-86.

Multichannel analyzer; Proportional counters; Quantitative analysis; Solid state counters; Tests; X-ray spectra; X-ray spectrometers; Electron diffraction; Electron probes; Evaluation; Gas flow; Lithium; Microanalysis; *12251.*

Multichannel scaler; Nuclear instrumentation; Overflow counter; *12173.*

Multilinear functional; Isometry; Elementary divisors; *12079.*

Multiple scattering; Statistical physics; Transmission coefficient; Defects in harmonic crystal; Functional equation; Many-body problem; *12375.*

Multiple scattering; Statistical physics; Thermal conductivity; Transport properties; Disordered one-dimensional crystal; *12376.*

Multiple scattering; 0.1 to 3.0 MeV; Carbon; Copper; Experimental cross sections; Gold; Inelastic electron scattering; *12113.*

Multiplet tables, carbon spectra; Spectra, carbon; Wavelengths, carbon spectra; Atomic energy levels, carbon spectra; Atomic spectra of carbon; Carbon spectra; *NSRDS-NBS3, Section 3.*

Multiplet tables, NIV-NVII; Spectra, NIV-NVII; Wavelengths, nitrogen spectra NIV-NVII; Atomic energy levels, NIV-NVII; Nitrogen spectra, NIV-NVII; *NSRDS-NBS3, Section 4.*

Liquid nitrogen; Liquid oxygen; *SP336*, pp. 623-649.

Neutralization; Radiolysis; Unimolecular fragmentation; Ion-molecule reactions; Neopentane; *12141*.

Neutron; Neutron standards; Manganous sulfate bath calibration of neutron sources; *TN576*.

Neutron; Nuclear reactor; Radiation; Scattering; Crystal structure; Diffraction; Molecular structure; *TN567*.

Neutron diffraction; Percus-Yevick equation; Radial distribution function; Simple liquids; Superposition approximation; Three body correlation function; X-ray diffraction; *12016*.

Neutron diffraction; PH$_4$Br; Rigid-body analysis; Thermal motion; Crystal structure; *12119*.

Neutron diffraction; Research reactor; Split core; Cold neutron source; High flux; Irradiation; *12351*.

Neutron penetration; Nuclear weapons data; Structure shielding; Albedo; Civil defense; Ducts; *11988*.

Neutron radiography; Ultrasonics; X rays; Compaction density; Eddy current measurements; Fuel rods; Impregnation density; Monitor tests; *SP336*, p. 405.

Neutron scattering; Plastic crystal; Rotational; Spherical molecules; Diffusion; Light scattering; *11953*.

Neutron source absorption; Neutron source calibration; Thermal neutron absorption; Manganous sulfate bath; *12177*.

Neutron source calibration; Thermal neutron absorption; Manganous sulfate bath; Neutron source absorption; *12177*.

Neutron standards; Manganous sulfate bath calibration of neutron sources; Neutron; *TN576*.

Neutron transport; Polynomial truncation errors; Sievert function; Biorthogonal polynomials; Gamma-ray transport; Moment method; **J.75B** *Nos. 1 and 2, 1-16 (1971)*.

Neutrons; Pu^{239}-Be; Radiation simulation; RTG; Test; Evaluation; MOSFETS; *SP336*, pp. 129-140.

New antenna theorems; Antenna gain; Antenna pattern; Calculated far-field patterns; Near-field measurements; *11856*.

New technology; Performance standards; Product standards; Standardization; *12245*.

NH $A^3\pi$, $c^1\pi$; Photodissociation; Vacuum ultraviolet; Bond dissociation energy; Fluorescence; HNCO; NCO $A^2\Sigma$; *12012*.

n-hexatricontane; *n*-pristane; *n*-tetracosane; *n*-tetranonacontane; Vaporization; Alkanes; Heats; *11840*.

NH$_3$; N$_2$O; Photoelectrons; Photoionization.; Spectroscopy; C$_2$H$_2$; Franck-Condon principle; H$_2$O; *12118*.

Ni; Alloys; Clustering; Cold work; Cu; Fe; Magnetic moments; Mössbauer effect; *11838*.

Nickel; Alloys; Clustering; Copper; Iron; Local moments; Mössbauer effect; *12199*.

Nickel; Nitrogen; Oxygen; Surface; Tungsten; Adsorption; Chemisorption; Cross section; Desorption; Electron stimulated desorption; Hydrogen; *12332*.

Nickel; Spectral series; Spectroscopy; Wavelength; Energy levels; Ionization potential; **J.75A** *No. 4, 335-336 (1971)*.

Nickel alloys; Seebeck effect; Thermal conductivity; Titanium alloy; Transport properties; Aluminum alloy; Cryogenics; Electrical resistivity; Lorenz ratio; **J.75A** *No. 4, 269-277 (1971)*.

Nickel alloys; Titanium alloys; Aluminium alloys; Copper alloys; Cryogenics; Electrical conductivity; Iron alloys; *11873*.

Nickel steels; X-ray analysis; X-ray diffraction; Statistics; Computer programs; Fourier analysis; *TN600*.

Niobia; Polymorphism; Zirconia; ZrO$_2$·12Nb$_2$O$_5$; Electron microscopy; Lattice images; *12059*.

Niobium; Thermal radiation properties; Thermodynamics; Electrical resistivity; Emittance; Heat capacity; High-speed measurements; High temperature; **J.75A** *No. 6, 565-571 (1971)*.

Niobium compounds; Scandium compounds; Tantalum compounds; Titanium compounds; Vanadium compounds; Yttrium compounds; Zirconium compounds; Enthalpy; Entropy; Gibbs energy of formation; Hafnium compounds; Heat of formation; *TN270-5*.

Niobium tungsten system; Wadsley defects; Annealing equilibria; Electron microscopy; *12263*.

Nitrilotriacetic acid; Clinical Standard Reference Materials; Fraction collecting; Gas chromatography; Interactive gels; Liquid chromatography design; *TN589*.

Nitrogen; Nitrogen oxides; Oxygen; Ozone; Bibliography; Chemical kinetics; Gas phase; *NBS-OSRDB-71-2 (COM-71-00841)*.

Nitrogen; Oxygen; Photon activation analysis; Review; Sensitivities; Bremsstrahlung; Carbon; Electron accelerators; *12076*.

Nitrogen; Oxygen; Surface; Tungsten; Adsorption; Chemisorption; Cross section; Desorption; Electron stimulated desorption; Hydrogen; Nickel; *12332*.

Nitrogen; Polycrystals; Solution hardening; Upper yield point; Zone-refined iron; Flow stress; Impurity softening; Lattice solution; Lower yield stress; *11946*.

Nitrogen; Pump; Pump design; Pump performance; Centrifugal; Helium; *12176*.

Nitrogen; *P,V,T;* phase boundary; Saturation density; Vapor pressure; Density; Liquids; *12186*.

Nitrogen; Tungsten; Tungsten (100) plane; Work function; Chemisorption; Flash desorption; Hydrogen; *12125*.

Nitrogen atoms; O$_2$($^1\Delta_g$); Oxygen atoms; Quenching reactions; Upper atmosphere; Hydrogen atoms; *12090*.

Nitrogen methane; Breakthrough time; Helium; Mixture adsorption; *12160*.

Nitrogen oxides; Oxygen; Ozone; Bibliography; Chemical kinetics; Gas phase; Nitrogen; *NBS-OSRDB-71-2 (COM-71-00841)*.

Nitrogen paramagnetic; Periodic acid; Radical; Aromatic; Azines; Cleavage; Complex; *12095*.

Nitrogen spectra, N IV-N VII; Multiplet tables, N IV-N VII; Spectra, N IV-N VII; Wavelengths, nitrogen spectra N IV-N VII; Atomic energy levels, N IV-N VII; *NSRDS-NBS3, Section 4*.

Nitrous oxide; Oscillator strengths; Far uv absorption; Inelastic electron scattering; *12225*.

Nitrous oxide; Q-switching; Vibrational relaxation; Fluorescence; Infrared; Laser; *11858*.

NMR; Adsorbed water; Calorimetry; Collagen; Frozen collagen; Mobile water; *11998*.

NMR; Nuclear magnetic resonance; Phosphorus; Spectral analysis; Computer program; Isopropyl; *11897*.

Nmr; Relaxation; Scalar coupling; Sensitivity; ^{13}C; Fourier transform; *12378*.

NMR; Soft x ray; Alloy data; Bibliography; Index; Information; Knight shifts; *NBS-OSRDB-70-2 (COM-71-00722)*.

NMR; Soft x ray; Alloy data; Bibliography; Index; Information; Knight shifts; *SP324*.

Noise; Noise factor; Noise temperature; Y-factor; Amplifier noise; *12191*.

Noise; Noise measurement; Amplifier noise; *11881*.

Noise; Superconductivity; Thermometry; Josephson effect; *12159*.

Noise measurement; Amplifier noise; Noise; *11881*.

Noise measurement; Noise pollution; Noise (sound); Sound transmission; Tires; Transportation noise; Trucks; Urban planning; Acoustics; *12329*.

Noise pollution; Noise (sound); Sound transmission; Tires; Transportation noise; Trucks; Urban planning; Acoustics; Noise measurement; *12329*.

Noise (sound); Sound transmission; Tires; Transportation noise; Trucks; Urban planning; Acoustics; Noise measurement; Noise pollution; *12329*.

Noise temperature; Y-factor; Amplifier noise; Noise; Noise factor; *12191*.

Noise temperature measurement; Compensation method; Cryogenic noise generators; Mismatch error; *12182*.

Nonadditivity; Principal components; Surface fitting; Two-way arrays; Factorial experiments; Interaction; *12109*.

Nonaqueous electroplating; Organometallic compound; Decaborane; Electrodeposition of magnesium; Lithium deposition; *12027*.

Nonaqueous media; Precision; Sensitivity; Tables; Accuracy; Atomic absorption; Detection limits; Differential method; Flame emission; *12111*.

Nonaqueous plating baths; Grignard reagents; Organic plating baths; Triethylboron; Beryllium, electrodeposition of; Beryllium azide; Beryllium thiocyanate, decaborane; Dimethyl beryllium; Magnesium, electrodeposition of; *12304*.

Noncoherent scattering; Thermalization length; Formation; Line; *12071*.

Noncombinatorial method; Statistical equilibrium; Configurational thermodynamic properties; Excluded volume; Extrapolations; Lattice models; *11880*.

Nondestructive; Fatigue monitor; Low temperature; Magnetometer; Martensite; *TN613*.

Nondestructive analysis; Ruby; Trace elements; Activation analysis; Al_2O_3; Interfering reactions; Laser; *J.75A No. 5, 429-433 (1971)*.

Nonequilibrium statistical mechanics; Open systems; Thermal transport; Equations of motion; *12197*.

Nonfat dry milk, package quantities of; Package quantities of dry milk; Dry milk package quantities; Instant nonfat dry milk; *PS37-70*.

Nonlinear; PVT; Statistical; Burnett; Gas; Model dependency; *11932*.

Nonlinear; Subharmonics; *12217*.

Nonlinear behavior; Polyisobutylene; Stress relaxation; Viscosity; BKZ fluid; *J.75A No. 1, 33-40 (1971)*.

Non-linear elasticity; Anisotropic elasticity; Anisotropic plasticity dislocations; Constitutive relations; Dislocation dynamics; *SP317*, pp. 837-876.

Non-linear elasticity; Anisotropic elasticity; Dislocation dynamics; Dislocation; Elasticity; *SP317*, pp. 877-905.

Nonlinear elasticity; Phonons; Thermal conductivity; Dislocation mobility; Dislocation-phonon interactions; *SP317*, pp. 363-389.

Nonlinear optics; Optical activity; Optical properties; Second harmonic generation; Selenium; *12203*.

Nonlinear optics; Transmission; Crystal growth; $CsCuCl_3$; Electrooptic effect; Index of refraction; *12032*.

Nonlinear rheology; Normal stresses; Pressure error; Second order fluid; Hole pressure; *11966*.

Non-linear search; Chemical equilibrium; Chemical reactions; Equilibrium; Gases; Mass action; *12244*.

Non-local elasticity; Solid mechanics; Green's tensor; Hooke's elasticity; *SP317*, pp. 737-746.

Non-local elasticity; Solid mechanics; Surface waves; Green's tensor; *SP317*, pp. 747-759.

Non-local theories; Solid mechanics; Wave propagation; Dilatation centers; Lattice statics; *SP317*, pp. 729-736.

Non-LTE; Radiative-control; Temperature-control-bracket; Boundary temperature; Collisional-control; *12360*.

Non-LTE line formation; Plages; Radiative transport; Solar chromosphere; Solar spectrum; Sunspots; Wilson-Bappu effect; Ca H and K lines; *12106*.

Non-LTE radiative transfer; Resonance lines, Ca II; Solar chromosphere, physical properties; Solar chromosphere, structure; Spectral line formation; Spectroscopic diagnostics; *12247*.

Non-LTE radiative transfer; Resonance lines, Ca II; Solar chromosphere, physical properties; Spectral line formation; Spectroscopic diagnostics; *12248*.

Non-LTE thermodynamics; Solar physics; Transition probabilities; Atomic energy levels; Gaseous nebulae; *SP353*.

Nonmanufacturing businesses; SI; U.S. Metric Study; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; *SP345-5*.

Non-Riemannian geometry; Affine connection; Continuum mechanics; Kinematics; *SP317*, pp. 999-1020.

Non-Riemannian geometry; Stress; Affine connection; Continuum mechanics; *SP317*, pp. 943-962.

Non-Riemannian theories; Plasticity; Yielding; Continuum mechanics; *SP317*, pp. 761-784.

Normal and supercooled liquid; Rubber, natural; Thermal diffusivity; Thermodynamic properties; Annealed and quenched glass; Calorimetry; *cis*-1,4-polyisoprene; Glass transformation; Heat capacity; Natural rubber; *J.75A No. 2, 113-120 (1971)*.

Normal boiling point; Vapor pressure data; Vapor pressure equation; Critical point pressure; Fluorine; *11835*.

Normal hydrogen; Parahydrogen; Thermal conductivity; Critical region; *11827*.

Normal mode; Polyethylene; Quasiharmonic specific heat; String of beads; Thermal expansion; Thermal properties; Volume; Bulk modulus; Grüneisen; *n*-alkanes; *12305*.

Normal spectral emittance; Tantalum; Thermal radiation properties; Emittance; High-speed measurements; Melting; *12307*.

Normal stresses; Pressure error; Second order fluid; Hole pressure; Nonlinear rheology; *11966*.

NO_2; Photoelectron spectroscopy; Rydberg series; Electron spectroscopy; *12065*.

NPL of India; Designing to specification; Fabrication of balances; Legal metrology; Mass standards; *SP335*, pp. 121-124.

NPL of UK; Potential-divider resistor; Quantum standard of voltage; Solder-drop Josephson junctions; Superconductivity; Inductive ratio divider; Josephson effect; *SP335*, pp. 111-115.

n-pristane; *n*-tetracosane; *n*-tetranonacontane; Vaporization; Alkanes; Heats; *n*-hexatricontane; *11840*.

n-tetracosane; *n*-tetranonacontane; Vaporization; Alkanes; Heats; *n*-hexatricontane; *n*-pristane; *11840*.

n-tetranonacontane; Vaporization; Alkanes; Heats; *n*-hexatricontane; *n*-pristane; *n*-tetracosane; *11840*.

n-type gallium arsenide; Photoluminescence; Temperature dependence; Band tailing; Gallium arsenide; Indirect valleys; *12343*.

Nuclear; Pulse; Quadrupole; Resonance; Spectroscopy; Transistor; Zeeman; Current; Modulator; *12350*.

Nuclear; Standards; CAMAC; Data; Dataway; Digital; Instrumentation; Modules; *12142*.

Nuclear charge distribution; Nuclear structure; Three-fluid model; Two-fluid model; Excess neutrons; Isospin; *12114*.

Nuclear evaporation calculations; Photonuclear reactions; 90 MeV bremsstrahlung; ^{64}Cu, ^{61}Cu, ^{11}C activation monitor yields; Absolute tritium yields; Hydrogen extraction; *12143*.

Nuclear instrumentation; Overflow counter; Multichannel scaler; *12173*.

Nuclear interferences; Trace oxygen; Activation analysis; *11914*.

Nuclear magnetic; Pulsed resonance; Fourier transform; *11882*.

Nuclear magnetic resonance; Phosphorus; Spectral analysis; Computer program; Isopropyl; NMR; *11897*.

Nuclear medicine; Point kernel; Radionuclide; Absorbed dose; Beta ray; Dosimetry; *11861*.

Nuclear orientation; Nuclear Ramsauer effect; Nuclear shape; Optical-model; Total neutron cross section; ^{165}Ho; Black-nucleus model; Coupled channel calculation; *12007*.

Nuclear orientation; Superconducting solenoid; ^{3}He cryostat; ^{3}He refrigerator; *TN562*.

Nuclear orientation; Transition mixing ratios; ^{192}Ir, magnetic moment of; Beta rays, angular distribution of; Gamma rays, angular distribution of; Hyperfine field in iron; *12005*.

Nuclear quadrupole resonance; Sodium chlorate; Temperature dependence 14-90 K; ^{35}chlorine; *12258*.

Open system; Potentials of mean force; Activity derivatives; Closed system; Correlation functions; Entropy; *12373.*

Open systems; Thermal transport; Equations of motion; Nonequilibrium statistical mechanics; *12197.*

Open-channel flow; Standards; Calibration; Current meters (fluids); Hydraulics; Measurement; *12358.*

Operational limits; Stagnation pressure; Arc currents; Arc heaters; Constricted arc; Enthalpy; *SP336*, pp. 879-892.

Operational readiness; Performance monitoring; Testing; Data acquisition; Data dissemination; Data processing; Maintenance; *SP336*, pp. 549-568.

Operations research/systems analysis studies; OR users and producers; Planning; Conference proceedings; Contract research; Federal government; Information exchange; NBS; *SP347.*

Operative dentistry; Polishing instruments; Surface finish; Composite restorative materials; Finishing; *12308.*

Opinion survey; Brainstorming; Cybernetic technique; Data collection; Group dynamics; Interpersonal relationships; Management research; *12364.*

Optical absorption; Critical phenomena; Diamond lattice; $DyPO_4$; Ising system; Low temperature; Magnetic susceptibility; Metamagnetism; *12126.*

Optical absorption; Potassium; Pseudopotential; Sodium; Interband transition theory; *11921.*

Optical absorption; Shared holes; $SrTiO_3$; Color centers; EPR; Hole centers; *11805.*

Optical absorption coefficient; Radiation damage; Ruby; Concentration determination; Magnetic susceptibility; *12348.*

Optical activity; Optical properties; Second harmonic generation; Selenium; Nonlinear optics; *12203.*

Optical activity; Optical rotatory power; Verdet coefficient; $Bi_{34}Ga_2O_{54}$; $Bi_{12}eO_{20}$; $Bi_{12}SiO_{20}$; $Bi_{12}TiO_{20}$; $Bi_{14}ZnO_{22}$; Faraday effect; Modulator materials; *11807.*

Optical attenuator; Photometry; Radiance; High-speed measurements; **J.75C** *No. 2, 85-88 (1971).*

Optical character recognition; Automatic pattern recognition; Handprinted characters; OCR standards; *12020.*

Optical density; Round robin; Smoke; Smoke density chamber; Statistical analysis; Building materials; Fire tests; Interlaboratory tests; *TN708.*

Optical equipment; Optical microscopes; Thickness; Thickness gages; Metal coatings; Micrometers; Microscopes; *12215.*

Optical homogeneity; Photoelasticity; Refractive index; Thermal conductivity; Thermo-optic properties; Transmittance; Chemical composition; Density; Glasses; Hardness; Laser; **J.75A** *No. 3, 163-174 (1971).*

Optical magnetic and transport properties; Alkali halide crystal defect properties; Alkali halide dopants; Bibliography; Impurity centers; *NBS-OSRDB-71-1 (COM-71-00248).*

Optical materials; Physical property changes; Space environment; Information center; Interferometric measurements; *SP336*, pp. 949-959.

Optical microscopes; Thickness; Thickness gages; Metal coatings; Micrometers; Microscopes; Optical equipment; *12215.*

Optical mixing spectroscopy; Review; Air pollution; Brillouin spectroscopy; Lasers; Light scattering; Macromolecules; *12361.*

Optical phonons; Polarizable ion model; Semicontinuum polaron model; CaF_2; CaO; *F* center; Internal Stark effect; KCl; *12134.*

Optical properties; Opto-elastic properties; Oxides; Ruby; Rutile; Titanium; Titanium dioxide; Transition metal; Aluminum oxide; Band structure; Borides; Bulk optical properties; Chemical analysis; Chromium ions; Corundum; Crystal defects; *TN565.*

Optical properties; Planetary quarantine; Polymers; Shock force; Space simulation; Testing; Volatile products; Absorption; Condensation; Contamination control; Evaluation; Far infrared; Fluid dynamic force; Microorganisms; *SP336*, pp. 51-77.

Optical properties; Plastic films; Poly(ethylene terephtalate); Proton damage; Proton energy; Radiation effect; Radiation intensity; Recovery; Solubility; Space simulation; Temperature effect; Tests; Viscosity; Electron damage; *SP336*, pp. 323-344.

Optical properties; Second harmonic generation; Selenium; Nonlinear optics; Optical activity; *12203.*

Optical rotatory power; Verdet coefficient; $Bi_{34}Ga_2O_{54}$; $Bi_{12}GeO_{20}$; $Bi_{12}SiO_{20}$; $Bi_{12}TiO_{20}$; $Bi_{14}ZnO_{22}$; Faraday effect; Modulator materials; Optical activity; *11807.*

Optical zero phonon line; S in resonance; Statistical methods for dislocations; Line broadening; *SP317*, pp. 1169-1173.

Optical-model; Total neutron cross section; ^{165}Ho; Black-nucleus model; Coupled channel calculation; Nuclear orientation; Nuclear Ramsauer effect; Nuclear shape; *12007.*

Optics; Refractive index; Fused silica; Glasses; Interferometry; **J.75A** *No. 4, 279-281 (1971).*

Optimal quadrature; Quadrature; Analytical functions; Approximation; Gaussian quadrature; Integration; **J.75B** *Nos. 1 and 2, 85-88 (1971).*

Opto-elastic properties; Oxides; Ruby; Rutile; Titanium; Titanium dioxide; Transition metal; Aluminum oxide; Band structure; Borides; Bulk optical properties; Chemical analysis; Chromium ions; Corundum; Crystal defects; Crystal growth; *TN565.*

OR users and producers; Planning; Conference proceedings; Contract research; Federal government; Information exchange; NBS; Operations research/systems analysis studies; *SP347.*

Orchard leaves; Uranium; Alpha tracks; Boron; Botanical material; Fission tracks: Kale; *12269.*

Organic acid; Oxycellulose; Stability; Sulfuric acid; Thermogravimetric analysis; Alum; Aluminum; Apparent activation energy; Calcium; Cellulose; Crosslinking; Differential thermal analysis; Ion exchange; *12218.*

Organic coatings; Photodegradation; Surface degradation; Volatile degradation products; Xenon-arc irradiation; Atmospheric exposure; ATR spectroscopy; Clear and pigmented films; Infrared analysis; Internal reflection spectroscopy; *SP336*, pp. 299-312.

Organic electrolyte; Graphite electrode; High energy density cell; Lithium deposition; *12088.*

Organic plating baths; Triethylboron; Beryllium, electrodeposition of; Beryllium azide; Beryllium thiocyanate, decaborane; Dimethyl beryllium; Magnesium, electrodeposition of; Nonaqueous plating baths; Grignard reagents; *12304.*

Organic residues; Outgassing; Polymeric materials; Residual gas analysis; Test facility; Vacuum; Chemical analysis; Contamination; *SP336*, pp. 1-24.

Organic SRMs; Standard reference materials; Spectrophotometry SRMs; Clinical chemistry; *12194.*

Organization; Search and rescue; Simulation; Team development; Coast Guard; Development; Interdisciplinary team; Management science; Model building; *12243.*

Organoboron compounds; Tetrachlorodiborane(4); Tetrafluorodiborane(4); Boron; Boron subhalides; Halides; Haloolefins; *12292.*

Organometallic compound; Decaborane; Electrodeposition of magnesium; Lithium deposition; Nonaqueous electroplating; *12027.*

Orientation; Quantum tunneling; Atom addition; Hydrogen isotopes; Low temperatures; Olefins; *12040.*

Orientation; Ruby; Single crystal; Topography; X ray; Laser rod; *12066.*

Orientation release stress; Plastic heat-shrinkable film; Retraction ratio; Shrink film, plastic; Balanced and unbalanced film; Film, plastic; *PS29-70.*

Orientational relaxation; Calcium fluoride; Defect dipoles; Dielectric relaxation; ESR line broadening; Gadolinium; *11956.*

Oriented media; Continuum mechanics; Cosserat continua; Dislocation field theory; *SP317,* pp. 817-829.

Oriented media; Thermodynamics and dislocation motion; Constitutive relations; Continuum mechanics; Dislocation kinematics; Dislocations; *SP317,* pp. 1041-1052.

Oriented sheet; Plastic sheet; Polystyrene plastic sheet; Sheet, plastic; Impact resistance, plastic sheet; *PS31-70.*

Orthobaric densities; Specific heats of the saturated liquid; Thermofunctions for ideal gas states; Thermophysical properties; Heats of vaporization; Methane; **J.75A** *No. 1, 15-21 (1971).*

Orthogonal; Skew-symmetric; Commutator; Matrix; **J.75B** *Nos. 1 and 2, 17-21 (1971).*

Orthogonal polynomials; Regression; Rounding error; Stepwise regression; Computer programs; Curve fitting; Gram-Schmidt orthogonalization; Householder transformations; Iterative refinement; Least squares; Linear equations; Orthogonalization; *12184.*

Orthogonalization; Orthogonal polynomials; Regression; Rounding error; Stepwise regression; Computer programs; Curve fitting; Gram-Schmidt orthogonalization; Householder transformations; Iterative refinement; Least squares; Linear equations; *12184.*

Ortho-para transitions; Radio frequency; Group theory; Inversion splitting; Methane; Molecular-beam data; *12323.*

Oscillator force constants; Potential values; Transition probabilities vs. energy values; Translational-vibrational energy transfer; Atom-diatom transitions; Data tables; Distorted wave calculations; Exact quantum mechanical calculations; *NBS-OSRDB-70-3 (AD705110).*

Oscillator strength; Rydberg state; Valence state; CO; CO_2; Electron impact; Fourth positive bands; *12327.*

Oscillator strengths; Atomic lifetimes; Atomic spectra; Configuration interaction; *12123.*

Oscillator strengths; Far uv absorption; Inelastic electron scattering; Nitrous oxide; *12225.*

Oscillator strengths; Methyl radicals; Methylene; Spectroscopy; Vacuum UV; *12290.*

Oscillator strengths; Temperature in stars; Turbulence in stars; Abundances of elements in stars; Ba II stars (ζ Capricorni); Curve of growth; Equivalent widths; Identification of spectral lines; Ionization in stars; *Monogr. 119.*

Oscillators; Semiconductor; Solid state; Amplifiers; Basic characteristics; Microwave; *TN597.*

Oscilloscope errors; Pulse generators; Standard waveforms; Lossy uniform transmission lines; *12045.*

Oscilloscopes; Calibration and maintenance manhours; Digital counters; Digital voltmeters; Exchange program on costs; *SP335,* 51-55.

Oscilloscopes; RX meters; Vacuum-tube voltmeters; Calibration histories; Equal likelihood; *SP335,* pp. 81-84.

Osmotic pressure; Poly(*n*-alkyl isocyanates); Radii of gyration; Second virial coefficients; Configuration; Conformation; Kratky-Porod model; Light scattering; *12355.*

Outgassing; Polymeric materials; Residual gas analysis; Test facility; Vacuum; Chemical analysis; Contamination; Organic residues; *SP336,* pp. 1-24.

Outgassing; Pressure measurements; Rock mechanics; Space environment simulation; Ultrahigh vacuum; Anisotropy; Compression tests; Mass spectroscopy; Mechanical properties; *SP336,* pp. 209-223.

Outgassing; Quartz crystal microbalance; Solar panels; Space; Sputtering; Surface contamination; Cleaning; Desorption; Ions; *SP336,* pp. 113-127.

Outgassing; Simulation; Sublimation; Thermal conduction; Thermal vacuum tests; Volatile constituents; Volatilization; Absorption; Adsorption; "bake out"; Components; Decomposition; Degassing; Environment; Evaporation; *SP336,* pp. 473-485.

Outgassing; Thermal insulation; Thermal-vacuum chambers; Evacuating; Heat transmission; Infrared scanning; Mars environmental simulation; *SP336,* pp. 725-748.

Overflow counter; Multichannel scaler; Nuclear instrumentation; *12173.*

Overload testing; Self-balancing current comparator; Transformer; Wide-range; Calibration; Current comparator; Current transformer; *12256.*

Overturning moments; Wind loads; Wind tunnel modeling; Boundary layer; Buildings; Pressure fluctuations; Instrumentation; *BSS30,* pp. 45-59.

Oxidation; Psicose; Reduction; Ruthenium tetraoxide; Sodium borohydride; Acetals; Fructose; Ketoses; *12121.*

Oxidation; Quantitative; Radical; Reagent; Determination; Electron-transfer; Inosose; *12151.*

Oxidative detonation; Oxidative flash; Oxygen atmosphere; Spacecraft; Blast over-pressure; Combustion front; Hypervelocity impact; Meteorid penetration; *SP336,* pp. 569-585.

Oxidative flash; Oxygen atmosphere; Spacecraft; Blast overpressure; Combustion front; Hypervelocity impact; Meteorid penetration; Oxidative detonation; *SP336,* pp. 569-585.

Oxide films; Precipitates; Transmission microscopy; Aluminum alloys; Hot saline water corrosion; *12315.*

Oxide glasses; Relaxation times; Supercritical fluctuations; Ultrasonic spectroscopy; Viscous relaxation; Immiscibility; *11986.*

Oxide glasses; Viscosity; Critical phenomena; Immiscibility; *12294.*

Oxide mixtures; Viscosity anomaly; Anomaly in oxide mixtures; *11929.*

Oxide semiconductors; TiH_2; Soldering; Contact resistance; *11812.*

Oxides; Oxygen diffusion; Pure materials; Sapphire; Al_2O_3; Crystal growth; Damage threshold; Glass; High temperature materials; Laser; *TN703.*

Oxides; Oxygen diffusion; Pure materials; Sapphire; Al_2O_3; Crystal growth; Damage threshold; Glass; High temperature materials; Laser; *TN574*

Oxides; Ruby; Rutile; Titanium; Titanium dioxide; Transition metal; Aluminum oxide; Band structure; Borides; Bulk optical properties; Chemical analysis; Chromium ions; Corundum; Crystal defects; Crystal growth; Density of states; Diffusion; *TN565.*

Oxycellulose; Stability; Sulfuric acid; Thermogravimetric analysis; Alum; Aluminum; Apparent activation energy; Calcium; Cellulose; Crosslinking; Differential thermal analysis; Ion exchange; Organic acid; *12218.*

Oxygen; Ozone; Bibliography; Chemical kinetics; Gas phase; Nitrogen; Nitrogen oxides; *NBS-OSRDB-71-2 (COM-71-00841).*

Oxygen; Photon activation analysis; Review; Sensitivities; Bremsstrahlung; Carbon; Electron accelerators; Nitrogen; *12076.*

Oxygen; Polarizability; Saturated liquid; Clausius-Mossotti function; Dielectric constant; *11844.*

Oxygen; PVT; Chemical potential; Coexistence curve; Compressibility; Critical point; *12185.*

Oxygen; Radical-anion; Bis(phenylhydrazone); E.s.r.; Glyoxal; Methyl sulfoxide; **J.75A** *No. 6, 573-577 (1971).*

Oxygen; Specific heat; Speed of sound; Surface tension; Thermal conductivity; Thermal diffusivity; Vapor pressure; Viscosity; Volume; Density; Dielectric constant; Enthalpy; Entropy; Equation of state; Fixed points; Heat transfer coefficients; *TN384.*

Oxygen; Surface; Tungsten; Adsorption; Chemisorption; Cross section; Desorption; Electron stimulated desorption; Hydrogen; Nickel; Nitrogen; *12332*.

Oxygen atmosphere; Spacecraft; Blast over-pressure; Combustion front; Hypervelocity impact; Meteorid penetration; Oxidative detonation; Oxidative flash; *SP336*, pp. 569-585.

Oxygen atoms; Quenching reactions; Upper atmosphere; Hydrogen atoms; Nitrogen atoms; $O_2(^1\Delta_g)$; *12090*.

Oxygen diffusion; Pure materials; Sapphire; Al_2O_3; Crystal growth; Damage threshold; Glass; High temperature materials; Laser; Oxides; *TN703*.

Oxygen diffusion; Pure materials; Sapphire; Al_2O_3; Crystal growth; Damage threshold; Glass; High temperature materials; Laser; Oxides; *TN574*.

Ozone; Bibliography; Chemical kinetics; Gas phase; Nitrogen; Nitrogen oxides; Oxygen; *NBS-OSRDB-71-2 (COM-71-00841)*.

Ozone; Plastic material; Simulation; Solar ultraviolet radiation; Atmospheric environment; Balloon; Computer; *SP336*, pp. 245-259.

$O_2(^1\Delta_g)$; Oxygen atoms; Quenching reactions; Upper atmosphere; Hydrogen atoms; Nitrogen atoms; *12090*.

O_3^-; Photodetachment; Photodetachment rate measurement; Sunlight; Ion mobility; *12268*.

P

Package quantities of dry milk; Dry milk package quantities; Instant nonfat dry milk; Nonfat dry milk, package quantities of; *PS37-70*.

Package quantities of green olives; Green olives, package quantities of; Olives, green, package quantities of; *PS40-70*.

Package quantities of ice; Sized ice, package quantities of; Block ice, package quantities of; Crushed ice, package quantities of; Cubed ice, package quantities of; Ice, package quantities of; *PS48-71*.

Package quantities of instant mashed potatoes; Potatoes, instant mashed, package quantities of; Instant mashed potatoes, package quantities of; Mashed potatoes, instant, package quantities of; *PS41-70*.

Package quantities of toothpaste; Toothpaste, package quantities; *PS50-71*.

Packaging; Proliferation; Quantity standards; Regulations; Consumer commodities; Labeling; *12259*.

Pair correlation; Shell model; Spurious; Sum rule; Electron scattering; Momentum transfer; *12043*.

Pair-potential; Point defects; Computer simulation; Copper; Dislocation structure; *SP317*, pp. 273-283.

Pairwise potentials; Redlich Kwong; Second virial coefficient; Thermodynamics; Compressibility factors; Equation of state; High density; High temperature; *11887*.

Paper and paperboard; Paper, paperboard, flame-resistant; Paperboard, paper, flame-resistant; Flame-resistant; *PS46-71*.

Paper ice bag sizes; Bag sizes, ice; Ice bag sizes; *PS44-71*.

Paper, paperboard, flame-resistant; Paperboard, paper, flame-resistant; Flame-resistant; Paper and paperboard; *PS46-71*.

Paper research; Preservation of records; Tear reference; Testing program; Appearance properties; *11842*.

Paperboard, paper, flame-resistant; Flame-resistant; Paper and paperboard; Paper, paperboard, flame-resistant; *PS46-71*.

Paraffin chain salts; Selected values; Soap; Solubilization; Standard values; Surface active agents; Surface chemistry; Surface tension; Surfactant; Association colloid; Bibliography; CMC; Colloid; Colloidal electrolyte; *NSRDS-NBS36*.

Parahydrogen; Thermal conductivity; Critical region; Normal hydrogen; *11827*.

Parallel-by-bit; Parity sense; Serial-by-character; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; Character structure; Communications; Data transmission; *FIPS PUB 18*.

Paramagnetic salt; Specific heat; Susceptibility; Thermometer scale; Cerous magnesium nitrate; Dipole system; Low temperature; *11822*.

Parametric form; Scaling; Thermodynamic properties; Coexistence curve; Critical point; Liquid-gas phase transition; *12156*.

Parapets; Roof projections; Static pressures; Wind effects; Wind tunnel modeling; Architectural features; Buildings; Mullions; *BSS30*, pp. 73-86.

Parity sense; Serial-by-character; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; Character structure; Communications; Data transmission; Federal information processing standards; *FIPS PUB 18*.

Parsons black; Retro-reflectance; Absorptance; Black coatings; Cavity absorptance; Cavity reflectance; Laser-source reflectometer; *TN575*.

Partial; Photoabsorption cross sections; Photodissociation; Photoexcitation; Photoionization; Photon-scattering; Total; Ultraviolet cross sections; Aeronomic; Astrophysical; *NSRDS-NBS38*.

Partial differentiation; Product rule; Tensor function; Trace; Chain rule; Continuum mechanics; Gradient; Matrices; Matrix calculus; **J.75B** *Nos. 3 and 4, 97-107 (1971)*.

Partial dislocations; Twinning; Zonal dislocations; Dislocation dissociation; Lattice shuffling; *SP317*, pp. 495-529.

Partial widths; Potential curve; Predissociation; Vibrational overlap; Born-Oppenheimer; Hartree-Fock; Molecular hydrogen; *12102*.

Partially coherent imaging; Resolution; Resolving power; Tribar targets; Coherence; *12320*.

Particle detectors; Hypervelocity; Impact damage; Micrometeoroid; *SP336*, pp. 915-933.

Particle size measurement; Air elutriation; Air permeability; Andreasen pipette; Calibrated glass beads; Coulter counter; Electroformed sieves; Microscopic size measurement; *11895*.

Particle velocities; Vacuum tests; Water jet; Flow rate tests; High speed movies; *SP336*, pp. 905-914.

Particle-hole energy; Quartet structure; Rearrangement; Binding energy; Mass formulae; Nuclei; *12145*.

Particulate radiation; Re-entry; Space simulation; Thermal radiation; Vacuum; Weightlessness; Ablation; *SP336*.

Particulate sampling; Quartz crystal microbalance; Spacecraft contamination; *SP336*, pp. 105-111.

Parting agents; Poisson's ratio; Release agents; Stress-strain curve; Volume dilation; Composite materials; Coupling agents; Epoxy polymer; *12379*.

Partition function; Random walk; Adsorption; Chain polymer; Lattice model; *12374*.

Passenger car; Radial; Tires; Tire strength; Winter; Bias ply; Breaking energy; *11833*.

Passenger car braking systems; Brake fluids; Brake fluid standards; Motor vehicle brake fluid; *12038*.

Pattern recognition; Biological images; Image processing; Morphology; *12284*.

Pattern recognition; Biological structure; Biomedical instrumentation; Computer; Image processing; Microscope; Microspectrophotometry; *11834*.

Pattern recognition; Computers; Digital logic; Image processing; Microscope; Microspectrophotometry; *11990*.

Pattern size, women's; Size designations, women's; Span charts, women's sizing; Apparel, women's; Body measurements, women's; Classifications, women's size; Grading charts, women's size; *PS42-70*.

Pattern sizes, boys'; Size designations, boys'; Span charts, boys' sizing; Apparel, boys'; Body measurements, boys'; *PS36-70*.

Patterns; Gains; Microwave antennas; Near-field measurements; *11855*.

Peak intensities; Powder patterns; Reference intensities; Standard; X-ray diffraction; Crystal structure; Integrated intensities; Lattice constants; *Monogr. 25, Section 9.*

Peak power; Repetitively pulsed lasers; Average power; Energy per pulse; Laser; *TN398.*

Peak pulse power measurement; Sampling power measurement; Solid state switch; *12295.*

Peak values; Power spectra; Turbulence; Wind profiles; Atmospheric boundary layer; Gust factors; *BSS30,* pp. 27-41.

Peierl's energy; Screw dislocation; Computer simulation; Green's tensors; Interatomic potential; Lattice studies; *SP317,* pp. 291-298.

Peierl's stress; Internal friction; Kink motion; *SP317,* pp. 447-458.

Peierls stress; Zero point motion; Anharmonicity; Dislocations in lattices; *SP317,* pp. 253-272.

Peierls-Nabarro model; Dislocation stacking faults; *SP317,* pp. 1157-1161.

Perception; Vision; Achromatic; Appearance; Brightness; Chromatic adaptation; Chromaticity; Color; Least squares; Luminance; Model; Neutral; *11813.*

Percus-Yevick equation; Configuration entropy; Correlation function; Entropy; Hard sphere; Liquid state; Neon; *12370.*

Percus-Yevick equation; Radial distribution function; Simple liquids; Superposition approximation; Three body correlation function; X-ray diffraction; Neutron diffraction; *12016.*

Performance; Prime; Program; Test; Assessment; Complex; Composite; Computer; Criteria; Evaluation; Gaussian primes; Indexing; Measurement; *TN572.*

Performance; Restraints; Automobiles; Dummies; Dynamic; Impact; *11945.*

Performance monitoring; Testing; Data acquisition; Data dissemination; Data processing; Maintenance; Operational readiness; *SP336,* pp. 549-568.

Performance standards; Product standards; Standardization; New technology; *12245.*

Periodic acid; Radical; Aromatic; Azines; Cleavage; Complex; Nitrogen paramagnetic; *12095.*

Periodicities, atomic spectra; Rare-earth spectra; Regularities, atomic spectra; Solar spectra; Atomic spectra; Coronal spectra; *12288.*

Permanent; Positive definite hermitian matrix; Fischer inequality; Hadamard determinant theorem; **J.75B** *Nos. 1 and 2, 77-80 (1971).*

Permanent record film; Archival film; Hypo; Microfilm; **J.75C** *No. 1, 19-22 (1971).*

Permutation matrix decompositions; Block design; Combinatorial analysis; Configurations; König's theorem; Matrices; 0,1 matrices; Matrix equations; **J.75B** *Nos. 1 and 2, 23-30 (1971).*

Perovskites; X ray; Absorption; Fine-structure; *11919.*

Peroxyacetyl nitrate; Peroxybenzoyl nitrate; Thermochemical properties; Bond additivity method; Group additivity method; *12204.*

Peroxybenzoyl nitrate; Thermochemical properties; Bond additivity method; Group additivity method; Peroxyacetyl nitrate; *12204.*

Perrhenyl chloride; Rhenium heptaoxide; Rhenium oxytetrachloride; Chemical vapor deposition; *12062.*

Personnel selection for metrology; Steady control versus sudden change; Managerial breakthrough techniques; *SP335,* pp. 85-88.

Petrography; Rocks; Apollo 11; Electron probe analysis; Mineralogy; Moon; *11958.*

Phase boundaries; Dislocations-elasticity; Dislocation pileups; *SP317,* pp. 135-146.

Phase boundary; Phase transition; Thermodynamic scaling; Critical region; Equation of state; Liquid-gas transition; **J.75A** *No. 2, 103-107 (1971).*

Phase boundary; Saturation density; Vapor pressure; Density; Liquids; Nitrogen; *P,V,T; 12186.*

Phase changes; Transport processes; Crystal; Crystal growth; Crystallization; Growth mechanisms; Morphological stability; Nucleation; *11918.*

Phase diagram; ReO_3-type compounds; $Nb_2O_5-P_2O_5$; $NbPO_5$; $Nb_2P_4O_{15}$; Nb_9PO_{25}; $Nb_{44}P_2O_{115}$; $P_2O_5-Nb_2O_5$; *11903.*

Phase diagrams of metastable immiscibility; Spinodal; Structural interpretation of immiscibility; Super-duty silica brick; Glass chromatography; Immiscibility and courses of crystallization; Immiscibility and practical applications; Immiscibility and thermodynamics; *11902.*

Phase equilibria; Predicted thermodynamic parameters; Gas solubility; Hard-sphere model; Liquefied gases; *11989.*

Phase equilibria; System tantalum oxide-tantalum tungstate; Melting points; *12017.*

Phase noise; Quartz crystal oscillator; Ramsey cavity; Slave oscillator; Atomic frequency standard; Cesium beam; Figure of merit; Frequency accuracy; Frequency multiplier; Frequency precision; NBS-III; NBS-5; *11959.*

Phase relations; $SrO{:}IrO_2$ compounds; SrO-IrO_2-Ir system; Dissociation; Equilibrium; **J.75A** *No. 3, 185-196 (1971).*

Phase sensitive detection; Speed of sound; Ultrasonic interferometer; Ultrasonics; *12322.*

Phase transformation; Twinning; Crystallography; Gold-cadmium alloy; Martensite; *12006.*

Phase transition; Stochastic matrix; Theta point; Chain partition function; Monte-Carlo computations; Near-neighbor interactions; *11908.*

Phase transition; Strontium titanate; Thermometer; Capacitor; Depolarization; Dielectric; Dilution refrigerator; Glass ceramic; *12368.*

Phase transition; Thermodynamic scaling; Critical region; Equation of state; Liquid-gas transition; Phase boundary; **J.75A** *No. 2, 103-107 (1971).*

Phase transitions; Structural relaxation; Transport phenomena; Viscous flow; Critical point theories; Immiscibility; **J.75A** *No. 3, 175-184 (1971).*

Phase-diagram; Vanadium; Alloys; Aluminum; Diffusion; High-pressure; *11832.*

Phase-separation; Viscosity; Viscosity-drift; Glass; Immiscibility; *12238.*

Phenolic carbon; Silicone rubber; Ablation; Aerodynamic shear; Carbon; Char; Cork; Epoxy-novolac; Erosion; *SP336,* pp. 837-851.

Phonon scattering; Dislocation drag; Dislocation-phonon interactions; Electroresistivity; Kink motion; *SP317,* pp. 397-401.

Phonon scattering; Thermal resistivity; Cottrell atmospheres; Mechanical properties; *SP317,* pp. 391-394.

Phonon-dislocation interactions; Solid-state; Theoretical physics; Thermally activated processes; Twinning; Conference; Continuum mechanics; Crystal physics, disclinations; Dislocations; Elasticity; Electron-dislocation interactions; Lattice defects; *SP317.*

Phonons; Dislocation dynamics; Dislocation-electron interactions; *SP317,* pp. 1291-1292.

Phonons; Thermal conductivity; Dislocation mobility; Dislocation-phonon interactions; Nonlinear elasticity; *SP317,* pp. 363-389.

Phosphorus; Spectral analysis; Computer program; Isopropyl; NMR; Nuclear magnetic resonance; *11897.*

Photo degradation; Thermal control coatings; Ultraviolet degradation; Alkaline paint; Conduction of paints during ultraviolet exposure; Electrode potential of paints; *SP336,* pp. 393-402.

Photoabsorption; Photoabsorption theory; Total absorption cross sections; Absorption and ionization coefficients; Cross section data; Detachment; Dissociation; Ionization; *NBS-OSRDB-70-4(COM-71-00025).*

Photoabsorption; Photoionization; Photon; Atoms; Compilation; Cross section data; *12210.*

Photoabsorption cross sections; Photodis ciation; Photoexcitation; Photoionization; Photon-scattering; Total; Ultraviolet cross sections; Aeronomic; Astrophysical; Partial; *NSRDS-NBS38.*

Photoabsorption theory; Total absorption cross sections; Absorption and ionization coefficients; Cross section data; Detachment; Dissociation; Ionization; Photoabsorption; *NBS-OSRDB-70-4 (COM-71-00025).*

Photoabsorption transition elements; Rare earths; Autoionization; Exchange interaction; *12275.*

Photoconductivity; Photoresponse; Semiconductors; Silicon; Deep impurities; Germanium; Infrared; *TN570.*

Photocurrents; Radiation; Radiation detector; Radiation dosimetry; Silicon radiation detector; Temperature dependence; X rays; Gamma rays; **J.75A** *No. 6, 579-589 (1971).*

Photodegradation; Surface degradation; Volatile degradation products; Xenon-arc irradiation; Atmospheric exposure; ATR spectroscopy; Clear and pigmented films; Infrared analysis; Internal reflection spectroscopy; Mercury-arc irradiation; *SP336,* pp. 299-312.

Photodetachment; Photodetachment rate measurement; Sunlight; Ion mobility; O_3^-; *12268.*

Photodetachment rate measurement; Sunlight; Ion mobility; O_3^-; Photodetachment; *12268.*

Photodissociation; Photoex tation; Photoionization; Photon-scattering; Total; Ultraviolet cross sections; Aeronomic; Astrophysical; Partial; Photoabsorption cross sections; *NSRDS-NBS38.*

Photodissociation; Vacuum ultraviolet; Absorption coefficient; Cl_2; Emission; Electronic energy; $OCCl_2$; *12289.*

Photodissociation; Vacuum ultraviolet; Bond dissociation energy; Fluorescence; HNCO; NCO $A^2\Sigma$; NH $A^3\pi$, $c^1\pi$; *12012.*

Photoelasticity; Electrostrictive; Glass; Lasers; *12223.*

Photoelasticity; Refractive index; Thermal conductivity; Thermo-optic properties; Transmittance; Chemical composition; Density; Glasses; Hardness; Laser; Optical homogeneity; **J.75A** *No. 3, 163-174 (1971).*

Photoelectron spectroscopy; Rydberg series; Electron spectroscopy; NO_2; *12065.*

Photoelectrons; Photoionization; Spectroscopy; C_2H_2; Franck-Condon principle; H_2O; NH_3; N_2O; *12118.*

Photoexcitation; Photoionization; Photon-scattering; Total; Ultraviolet cross sections; Aeronomic; Astrophysical; Partial; Photoabsorption cross sections; Photodissociation; *NSRDS-NBS38.*

Photogrammetry; Evaluation; Measurement; Metallography; Metallurgical analysis; Microscopy; *11977.*

Photographic equipment; Static loads; Test equipment; Compression tests; Dynamic loads; High-speed photography; Indicating instruments; Indicator characteristics; Loading rate; Loads (forces); Motion picture cameras; *12080.*

Photoionization; Photolysis; Radiolysis; Butene; Cyclobutane; Ion structute; Isomerization; Methylcyclopropane; **J. 75A,** *No. 6, 591-605 (1971).*

Photoionization; Photolysis; Unimolecular-dissociation; Cyclohexene; Ion-molecule reactions; *11901.*

Photoionization; Photon; Atoms; Compilation; Cross section data; Photoabsorption; *12210.*

Photoionization; Photon-scattering; Total; Ultraviolet cross sections; Aeronomic; Astrophysical; Partial; Photoabsorption cross sections; Photodissociation; Photoexcitation; *NSRDS-NBS38.*

Photoionization; Propane; Quantum yields; Rare-gas resonance radiation; Unimolecular dissociation; Ion-molecule reaction; **J.75A** *No. 6, 607-612 (1971).*

Photoionization; Propane; Radiation chemistry; Ion-molecule reaction; Kinetics; Mass spectrometry: *12175.*

Photoionization; Proton affinity; Rate constants; Ion molecule reactions; Mass spectrometry; Neopentane; **J.75A** *No. 5, 487-493 (1971).*

Photoionization; Proton transfer; Water; Hydrocarbons; Ion-molecule reactions; Mass spectrometry; *11927.*

Photoionization; Protonated dimer ions; Alkane dimer ions; Ethane; Ion-molecule reactions; Mass spectrometry: *11830.*

Photoionization; Radiolysis; Rate constants; Theory; Hydrocarbons; Ion-molecule reactions; *11853.*

Photoionization; Radiolysis; Unimolecular ion fragmentation; Deactivation; Ion-molecule reactions; *11905.*

Photoionization; Rate constants; Alkanes; Excited states; Ion-molecule reactions; Mass spectrometry; *11829.*

Photoionization; Rate constants; Gas phase; Hydrocarbons; Ion-molecule reactions; Mass spectrometry; **J.75A** *No. 3, 147-153 (1971).*

Photoionization.; Spectroscopy; C_2H_2; Franck-Condon principle; H_2O; NH_3; N_2O; Photoelectrons; *12118.*

Photoionization; Vacuum ultraviolet photolysis; CCl_3^+; Chloroform; Electron attachment; $HCCl_2^+$; $HCCl_2^-$; $HCCl_3^-$; Infrared spectrum; Matrix isolation; *12242.*

Photoionization; Vacuum ultraviolet; Chlorine monofluoride; Dissociation energy; Ionization energy; Mass spectrometry; *12064.*

Photoionization; Vacuum ultraviolet; Chlorine monofluoride; Dissociative ionization; Fluorine; Heats of formation; Hot bands; Hydrogen fluoride; Ion pairs; Mass spectrometry; Molecular ionization; *12148.*

Photoluminescence; Cr^{3+}; Energy transfer; Excitation; Lifetime; *12318.*

Photoluminescence; Temperature dependence; Band-to-band recombination; Concentration dependence; Excitation dependence; Gallium arsenide; Impurity effects; *12216.*

Photoluminescence; Temperature dependence; Band tailing; Gallium arsenide; Indirect valleys; *n*-type gallium arsenide; *12343.*

Photolysis; Polymerization; Radiolysis; Ethylene; Free radical reactions; Ion-molecule reactions; **J.75A** *No. 3, 141-146 (1971).*

Photolysis; Primary processes; Vacuum ultraviolet; Ethane; Free radicals; Ions; *11904.*

Photolysis; Radiolysis; Butene; Cyclobutane; Ion structure; Isomerization; Methylcyclopropane; Photoionization; **J. 75A,** *No. 6, 591-605 (1971).*

Photolysis; Ultraviolet spectrum; ClCF; Chlorofluoromethane; Chlorofluoromethane-d_2; Fluorescence spectrum; Free radical; Infrared spectrum; Matrix isolation; *12219.*

Photolysis; Ultraviolet spectrum; CCl; CCl_2; Force constants; Free radical; HCCl; $HCCl_2$; H_2CCl; Infrared spectrum; Matrix isolation; *11964.*

Photolysis; Unimolecular-dissociation; Cyclohexene; Ion-molecule reactions; Photoionization; *11901.*

Photometry; Projectors; Radiance; Radiometry; Reflectometry; Emissivity; Flashing light; Flux measurement; Irradiance; Material properties; *SP300. Vol. 7*

Photometry; Radiance; High-speed measurements; Optical attenuator; **J.75C** *No. 2, 85-88 (1971).*

Photometry; Radiance modulation; Radiation; High-speed methods; Light attenuator; **J.75C** *No. 1, 29-32 (1971).*

Photometry; Spectral emissivity; Standard; Ceramic; Light; *TN595.*

Photometry; Spectroradiometry; Barnes colorimeter; Chromaticity coordinate; Color correction; Cool white fluorescent lamp; Correlated color temperature; Daylight fluorescent lamp; Heterochromatic photometry; Integrating sphere; Intercomparison; *TN559.*

Photon; Atoms; Compilation; Cross section data; Photoabsorption; Photoionization; *12210.*

Photon activation analysis; Review; Sensitivities; Bremsstrahlung; Carbon; Electron accelerators; Nitrogen; Oxygen; *12076.*

Photon neutron; Radiation transport; Thick targets; Bremsstrahlung; Bremsstrahlung efficiency; Monte Carlo; *11799.*

Photons; Röntgen; X rays; Absorption corrections; Attenuation coefficient; Conference; Crystallography; Electron microprobe; Fluorescence analysis; Gamma rays; *11814*.

Photon-scattering; Total; Ultraviolet cross sections; Aeronomic; Astrophysical; Partial; Photoabsorption cross sections; Photodissociation; Photoexcitation; Photoionization; *NSRDS-NBS38*.

Photonuclear; Boron eleven; Giant resonance; Isobaric spin splitting; *11890*.

Photonuclear; Radiative capture; Angular distribution; Cross section; Helium-3; *11886*.

Photonuclear experiments; Radioactivity monitors; *11877*.

Photonuclear reactions; 90 MeV bremsstrahlung; ^{64}Cu, ^{61}Cu, ^{11}C activation monitor yields; Absolute tritium yields; Hydrogen extraction; Nuclear evaporation calculations; *12143*.

Photoresponse; Semiconductors; Silicon; Deep impurities; Germanium; Infrared; Photoconductivity; *TN570*.

Phthalate monomers; Purification methods; Resins for composites; Ternary eutectic; Thermosetting monomers; Biomaterials; Dimethacrylates; *11802*.

Physical constants; Atomic constants; Fundamental constants; *SP344*.

Physical measurement; Proceedings NCSL; Metrology management; National Conference of Standards Laboratories; *SP335*.

Physical properties; Cement; Chemical composition; Concrete; Durability; Material properties; *BSS36*.

Physical properties; Prosthetic materials; Radiopacity-radiopaque; Composite materials; Denture base materials; *12309*.

Physical properties; Radiopacity; Bonding; Composites; Denture base materials; Diagnosis; Light translucency; *12232*.

Physical properties of fillings; X-ray opaque; Clinical research (dental); Composite restorations; Diagnosis; *11944*.

Physical property changes; Space environment; Information center; Interferometric measurements; Optical materials; *SP336*, pp. 949-959.

Physiology; Psychology; Space station simulator; Submersible; Closed ecological system; Habitability; Maintainability prediction; Microbiology; Microflora shift; *SP336*, pp. 599-621.

PH$_4$Br; Rigid-body analysis; Thermal motion; Crystal structure; Neutron diffraction; *12119*.

Picnic coolers, portable; Portable picnic coolers; Coolers, portable picnic; *PS49-71*.

Picosecond; Pulse generator bias supply; Tunnel diode; Jitter; *11849*.

Piezoelectric; Vibrating-sample magnetometer; Bimorph; Cryogenic; Low-temperature; Magnetometer; *12046*.

Piezoelectric modulus; Polymer; Polyvinylchloride; Transducer; Underwater sound; Piezoelectricity; *12276*.

Piezoelectric stress gauge; Quartz; Slip bands; Dislocation velocity; High speed dislocations; Impact stress pulse; *SP336*, pp. 487-508.

Piezoelectric vibration; Secondary extinction; Theory; X-ray diffraction; Dynamical diffraction; Imperfections; Kinematical scattering; *12073*.

Piezoelectricity; Piezoelectric modulus; Polymer; Polyvinylchloride; Transducer; Underwater sound; *12276*.

Piezoelectricity; Polymers; Polyvinylfluoride; Pyroelectricity; Infrared; *12352*.

Piezoelectricity; Polymers; Polyvinylchloride films; G modulus; *12093*.

Piezoelectricity; Polyvinylchloride; Polyvinylfluoride; *g* moduli; *12271*.

Pipe and fittings, steel, plastic lined; Plastic lined steel pipe; Polytetrafluoroethylene plastic lined pipe; PTFE lined pipe; Steel pipe and fittings, plastic lined; *PS33-70*.

Pipe and fittings, steel, plastic lined; Plastic lined steel pipe; Steel pipe and fittings, plastic lined; FEP lined pipe; Fluorinated ethylene-propylene plastic lined pipe; *PS34-70*.

Pipe and fittings, steel, plastic lined; Plastic lined steel pipe; Poly(vinylidene fluoride) plastic lined pipe; PVF$_2$ lined pipe; Steel pipe and fittings, plastic lined; *PS35-70*.

Pipe diffusion; Vacancies in dislocations; Dislocation geometry; Dislocations; Kinks; *SP317*, pp. 563-576.

Pit depth; Pitting factor; Polarization; Steel piling; Undisturbed soil; Weight loss; Corrosion; Corrosion rate; Disturbed soil; Instantaneous rate; *J.75C No. 2, 107-121 (1971)*.

Pitting factor; Polarization; Steel piling; Undisturbed soil; Weight loss; Corrosion; Corrosion rate; Disturbed soil; Instantaneous rate; Pit depth; *J.75C No. 2, 107-121 (1971)*.

Plages; Radiative transport; Solar chromosphere; Solar spectrum; Sunspots; Wilson-Bappu effect; Ca H and K lines; Non-LTE line formation; *12106*.

Planar molecular structure; Spherical shell molecules; Vitreous state; Arsenious oxide; Arsenolite; Claudetite; Crystal transition; Cubic crystal; Glass; Heat capacity; Monoclinic crystal; Low temperature; *12311*.

Planarity; Cover glass, test method for; Hemacytometer; Interferometry; *TN579*.

Plane blending; Dislocation distributions; Mechanical properties; *SP317*, pp. 925-941.

Planetary atmosphere-surface interaction; Planetary meteorology; Research facility; Simulation techniques; Space research; Convective processes; Mars atmosphere exploration; *SP336*, pp. 699-723.

Planetary entry; Radiation; Ablation; Evaluation; Heat shields; Heat transfer; *SP336*, pp. 751-812.

Planetary meteorology; Research facility; Simulation techniques; Space research; Convective processes; Mars atmosphere exploration; Planetary atmosphere-surface interaction; *SP336*, pp. 699-723.

Planetary nebula; Spectral line formation; Doppler broadening; Escape probability; *12180*.

Planetary nebulae; Stellar atmospheres; Transfer equation; *11815*.

Planetary quarantine; Polymers; Shock force; Space simulation; Testing; Volatile products; Absorption; Condensation; Contamination control; Evaluation; Far infrared; Fluid dynamic force; Microorganisms; Optical properties; *SP336*, pp. 51-77.

Planning; Conference proceedings; Contract research; Federal government; Information exchange; NBS; Operations research/systems analysis studies; OR users and producers; *SP347*.

Plasma density; Collision frequency; Helium negative glow discharge; Microwave cavity; *TN607*.

Plasma theory; Shock wave; Solar wind; Earth magnetic field; Earth tail; Magnetosphere; *SP336*, p. 297.

Plasmon energy losses; Tungsten; Adsorbed atomic layers; Cesium; Inelastic-electron scattering; Metal-insulator transition; *11920*.

Plastic crystal; Rotational; Spherical molecules; Diffusion; Light scattering; Neutron scattering; *11953*.

Plastic deformation; Sapphire; Strength; Alumina; Fracture; Mechanical properties; *12282*.

Plastic films; Poly(ethylene terephtalate); Proton damage; Proton energy; Radiation effect; Radiation intensity; Recovery; Solubility; Space simulation; Temperature effect; Tests; Viscosity; Electron damage; Electron energy; *SP336*, pp. 323-344.

Plastic heat-shrinkable film; Retraction ratio; Shrink film, plastic; Balanced and unbalanced film; Film, plastic; Orientation release stress; *PS29-70*.

Plastic lined steel pipe; Polytetrafluoroethylene plastic lined pipe; PTFE lined pipe; Steel pipe and fittings, plastic lined; Pipe and fittings, steel, plastic lined; *PS33-70*.

Plastic lined steel pipe; Poly(vinylidene fluoride) plastic lined pipe; PVF$_2$ lined pipe; Steel pipe and fittings, plastic lined; Pipe and fittings, steel, plastic lined; *PS35-70*.

Plastic lined steel pipe; Steel pipe and fittings, plastic lined; FEP lined pipe; Fluorinated ethylene-propylene plastic lined pipe; Pipe and fittings, steel, plastic lined; *PS34-70.*

Plastic material; Simulation; Solar ultraviolet radiation; Atmospheric environment; Balloon; Computer; Ozone; *SP336,* pp. 245-259.

Plastic reinforced restoratives; Restorative materials; Temporary dental cements; Dental restorative materials; EBA cements; *11996.*

Plastic sheet; Polystyrene plastic sheet; Sheet, plastic; Impact resistance, plastic sheet; Oriented sheet; *PS31-70.*

Plastic tubing, fluorinated ethylene-propylene; Tubing, FEP-fluorocarbon; Chemical, mechanical, and electrical tubing; FEP tubing; Fluorocarbon plastic tubing; *PS43-71.*

Plastic tubing, fluorocarbon; PTFE heat-shrinkable tubing; Tubing, heat-shrinkable fluorocarbon plastic; FEP heat-shrinkable tubing; Fluorocarbon plastic heat-shrinkable tubing; *PS47-71.*

Plasticity; Burgers vector; Compatibility; Continuum; Contortion; Cosserat; Couple-stress; Defect; Deformation; Disclination; Dislocation; Dualism; Elasticity; Incompatibility; Motor calculus; *SP317,* pp. 651-673.

Plasticity; Yielding; Continuum mechanics; Non-Riemannian theories; *SP317,* pp. 761-784.

Plastics standards, world index; Standards, plastics; Index of plastics standards; *SP352.*

Platinum; Precision; Replicate; Spark; Spectrometry; Accuracy; Circumvention; Emulsions; Homogeneity; Ions; Mass; *11847.*

Platinum; Stress components; Thermoelastic theory; Antimony; Heat conduction; Laser materials; Nd-doped glass; **J.75A** *No. 4, 247-260 (1971).*

Platinum; Stress components; Thermoelastic theory; Antimony; Heat conduction; Laser materials; Nd-doped glass; *12133.*

Platinum; Thermal expansion; High-speed measurements; High temperature; *12139.*

Platinum resistance thermometer; Temperature scale; Thermocouple; Triple point; Calibration; Fixed point; Freezing point; Furnaces; High temperature; IPTS-68; *12354.*

Point defects; Calcium fluoride; Defect equilibria; Electron paramagnetic resonance; *12237.*

Point defects; Computer simulation; Copper; Dislocation structure; Pair-potential; *SP317,* pp. 273-283.

Point defects; Schottky pairs; Computer simulation; Kansaki method; Lattice statics; *SP317,* pp. 219-245.

Point kernel; Radionuclide; Absorbed dose; Beta ray; Dosimetry; Nuclear medicine; *11861.*

Poiseuille flow; Standard; Viscosity; Viscous flow; Absolute measurement; Calculation of bounds; Calibration; **J.75A** *No. 6, 553-560 (1971).*

Poisson's ratio; Release agents; Stress-strain curve; Volume dilation; Composite materials; Coupling agents; Epoxy polymer; Parting agents; *12379.*

Polar; Second virial coefficient; Stockmayer; Dipole; Gas; Intermolecular potential function; **J.75A** *No. 4, 337-385 (1971).*

Polarizability; Saturated liquid; Clausius-Mossotti function; Dielectric constant; Oxygen; *11844.*

Polarizable ion model; Semicontinuum polaron model; CaF_2; CaO; *F* center; Internal Stark effect; KCl; Optical phonons; *12134.*

Polarization; Radiation; Spectrometer; Azimuthal angle; Compton-Raman interaction; Hamiltonian; *12345.*

Polarization; Steel piling; Undisturbed soil; Weight loss; Corrosion; Corrosion rate; Disturbed soil; Instantaneous rate; Pit depth; Pitting factor; **J.75C** *No. 2, 107-121 (1971).*

Polarization; V_3Ga; $AuGa_2$; BiIn; Bismuth; Diamagnetism; Knight shift; NaTl; *12085.*

Polarized electromagnetic radiation; Color photography; Electron microscopy; Electron probes; Evaluation; Metallography; Microscopy; *11994.*

Polishing instruments; Surface finish; Composite restorative materials; Finishing; Operative dentistry; *12308.*

Pollutant monitoring; Electrode monitoring; Industrial monitoring; Ion-selective electrodes; *11999.*

Polycrystalline; Structure; Surface; Adsorption; Amorphour; Free-radical; Ionic; Manganese dioxide; *12314.*

Polycrystals; Solution hardening; Upper yield point; Zone-refined iron; Flow stress; Impurity softening; Lattice solution; Lower yield stress; Nitrogen; *11946.*

Polyethylene; Quasiharmonic specific heat; String of beads; Thermal expansion; Thermal properties; Volume; Bulk modulus; Grüneisen; *n*-alkanes; Normal mode; *12305.*

Poly(ethylene terephtalate); Proton damage; Proton energy; Radiation effect; Radiation intensity; Recovery; Solubility; Space simulation; Temperature effect; Tests; Viscosity; Electron damage; Electron energy; *SP336,* pp. 323-344.

Polyethylene terephthlate; Polypyromelitimide; Relative creep; Thermoelastic; Transverse; Longitudinal; *12165.*

Polyisobutylene; Stress relaxation; Viscosity; BKZ fluid; Nonlinear behavior; **J.75A** *No. 1, 33-40 (1971).*

Polymer; Polymer separation; Chromatography; Elution volume; Flow; Gel permeation chromatography; Hydrodynamic volume; *12149.*

Polymer; Polyvinylchloride; Transducer; Underwater sound; Piezoelectricity; Piezoelectric modulus; *12276.*

Polymer; Radius; Two segments; Distribution; Gyration; *11947.*

Polymer adsorption; Surface layer; Θ-point; Trains; Configurations; Excluded volume effect; Loops; *12240.*

Polymer characterization; Polymer identification; Pyrolysis-gas chromatography of polymers; Pyrolytic techniques; Chromatographic analysis of degradation products; *11798.*

Polymer crystals; Polymer morphology; Polyoxymethylene crystals; Post irradiation heat treatment; α-particle initiation; Chain folded crystals; Crystal growth mechanisms; Electron diffraction of polymers; Electron microscopy of polymers; *12030.*

Polymer decomposition; Polymer depolymerization; Polymer irradiation; Polymer pyrolysis; Diffusion effects; Free radicals; *11955.*

Polymer depolymerization; Polymer irradiation; Polymer pyrolysis; Diffusion effects; Free radicals; Polymer decomposition; *11955.*

Polymer identification; Pyrolysis-gas chromatography of polymers; Pyrolytic techniques; Chromatographic analysis of degradation products; Polymer characterization; *11798.*

Polymer irradiation; Polymer pyrolysis; Diffusion effects; Free radicals; Polymer decomposition; Polymer depolymerization; *11955.*

Polymer morphology; Polyoxymethylene crystals; Post irradiation heat treatment; α-particle initiation; Chain folded crystals; Crystal growth mechanisms; Electron diffraction of polymers; Electron microscopy of polymers; Polymer crystals; *12030.*

Polymer pyrolysis; Diffusion effects; Free radicals; Polymer decomposition; Polymer depolymerization; Polymer irradiation; *11955.*

Polymer separation; Chromatography; Elution volume; Flow; Gel permeation chromatography; Hydrodynamic volume; Polymer; *12149.*

Polymeric materials; Residual gas analysis; Test facility; Vacuum; Chemical analysis; Contamination; Organic residues; Outgassing; *SP336,* pp. 1-24.

Polymeric perfluorinated ethylenepropylene; Proton bombardment; Thermal control coatings; Degradation mechanising; Electron bombardment; Electron degradation; *SP336,* pp. 359-382.

Polymerization; Pressure; 3,3,4,4,5,5,5-heptafluoropentene-1; Irradiation; *12089.*

Polymerization; Purity; Synthesis; Telomerization; Cyclic inter-intramolecular mechanism; Diene polymerization; Fluorodienes; Intermediates; **J.75A** *No. 1, 41-56 (1971).*

Power spectra; Pressure fluctuations; Subcritical flow; Supercritical flow; Transcritical flow; Turbulence; Circular cylinders; *BSS30*, pp. 87-91.

Power spectra; Turbulence; Wind profiles; Atmospheric boundary layer; Gust factors; Peak values; *BSS30*, pp. 27-41.

Prandtl number; Oxygen; Specific heat; Speed of sound; Surface tension; Thermal conductivity; Thermal diffusivity; Vapor pressure; Viscosity; Volume; Density; Dielectric constant; Enthalpy; Entropy; Equation of state; Fixed points; *TN384*.

Praseodymium; Spectra; Wavelengths; *12257*.

Precast concrete; Production capacity; Production management; Production methods; Standardization; United Soviet Socialist Republics; Building economics; Building systems; Construction industry; Housing; *SP334*.

Precipitate particles; Thermomechanical treatment; Cavities; Cellular solidification; Constitutional supercooling; Copper (99.999%); Dislocation arrangements; Distribution of impurities; *12339*.

Precipitates; Transmission microscopy; Aluminum alloys; Hot saline water corrosion; Oxide films; *12315*.

Precipitation hardening; Activation energy; Cross slip; Mechanical properties; Misfit strain; *SP317*, pp. 1115-1134.

Precipitation hardening; Computer simulation; Dislocation motion; Mechanical properties; *SP317*, pp. 1083-1098.

Precipitation hardening; Thermal activation; Arrhenius law; Mechanical properties; *SP317*, pp. 1077-1082.

Precision; Quantitative analysis; Solids; Spark source; Trace elements; Fluctuations; Homogeneity; Ion sensitive emulsion; Mass spectrometry; *12127*.

Precision; Repeatability; Reproducibility; Test methods, evaluation of; Interlaboratory testing; *12333*.

Precision; Replicate; Spark; Spectrometry; Accuracy; Circumvention; Emulsions; Homogeneity; Ions; Mass; Platinum; *11847*.

Precision; Rotary vane; Attenuator; Microwave; **J.75C** *No. 1, 1-5 (1971)*.

Precision; Sensitivity; Tables; Accuracy; Atomic absorption; Detection limits; Differential method; Flame emission; Nonaqueous media; *12111*.

Precision Measurement Equipment Laboratories (PMEL); Technician skills; U.S. Air Force; Audit examinations; Audit package; *SP335*, pp. 105-109.

Precision measurements; Fundamental constants; Least squares adjustments; *12221*.

Precision measurements; Fundamental constants; Least squares adjustments; *SP343*.

Precoordination; Standards; Building; Components; *BSS32*.

Predicted thermodynamic parameters; Gas solubility; Hard-sphere model; Liquefied gases; Phase equilibria; *11989*.

Predictive testing; Structures; Combined environments; Components; Material performance; *SP336*, pp. 403-404.

Predissociation; Vibrational overlap; Born-Oppenheimer; Hartree-Fock; Molecular hydrogen; Partial widths; Potential curve; *12102*.

Prefabricated door units; Wood door units; Door units, wood; Hinged door units, interior; *PS32-70*.

Preferred orientation; Stress corrosion; Aluminum alloy; Corrosion; Directional effects; Grain morphology; *11839*.

Premelting; Thermodynamics; Electrical resistivity; High-speed methods; High temperature; Melting point; Metals; Molybdenum; *12231*.

Preprocessor; Programming language; Data base; Data retrieval; Data structure; Information storage and retrieval; Language extension; *TN590*.

Preservation of records; Tear reference; Testing program; Appearance properties; Paper research; *11842*.

Pressure; Properties; Standards; Standard Reference Materials; Temperature; Thermal; Ceramics; Chemical composition; Mechanical properties; *12181*.

Pressure; 3,3,4,4,5,5,5-heptafluoropentene-1; Irradiation; Polymerization; *12089*.

Pressure broadening; Strong collision; Classical path approximation; Intermolecular potential; *12033*.

Pressure error; Second order fluid; Hole pressure; Nonlinear rheology; Normal stresses; *11966*.

Pressure fluctuations; Instrumentation; Overturning moments; Wind loads; Wind tunnel modeling; Boundary layer; Buildings; *BSS30*, pp. 45-59.

Pressure fluctuations; Stagnation point; Turbulence; Disk; *TN563*.

Pressure fluctuations; Subcritical flow; Supercritical flow; Transcritical flow; Turbulence; Circular cylinders; Power spectra; *BSS30*, pp. 87-91.

Pressure fluctuations; Wind loads; Wind tunnel modeling; Buildings; Full-scale tests; Power spectra; *BSS30*, pp. 61-71.

Pressure measurements; Rock mechanics; Space environment simulation; Ultrahigh vacuum; Anisotropy; Compression tests; Mass spectroscopy; Mechanical properties; Outgassing; *SP336*, pp. 209-223.

Pressure profile; Steam; Venturi; Water; Critical flow; *TN608*.

Pressure scale; Shock wave technique; Temperature; Accurate measurement; Equation-of-state; Fixed points; High pressure; High-pressure equipment; Instrumentation; *SP326*.

Primary processes; Vacuum ultraviolet; Ethane; Free radicals; Ions; Photolysis; *11904*.

Prime; Program; Test; Assessment; Complex; Composite; Computer; Criteria; Evaluation; Gaussian primes; Indexing; Measurement; Performance; *TN572*.

Principal components; Surface fitting; Two-way arrays; Factorial experiments; Interaction; Nonadditivity; *12109*.

Principal display panel; Regulations; Weights and measures; Consumer package; Exemption; Fluid measure; Labeling; Net quantity; *H108*.

Principal ideal rings; Smith normal form; Invariant factors; **J.75B** *Nos. 1 and 2, 81-84 (1971)*.

Probability theory; Ring theory; Stochastic process; Information theory; Markov process; **J.75B** *Nos. 3 and 4, 139-148 (1971)*.

Probability theory; Wind loads; Buildings; Dynamics; Gust factor; Mode shape; *BSS30*, pp. 93-104.

Probability theory; Wind loads; Buildings; Dynamics; Gust loads; Matrix analysis; Mode shape; *BSS30*, pp. 145-149.

Probability-distributions; Turbulence; Velocity-gradients; Computer; Correlations; Grid; Intermittency; Isotropy; Moments; *12316*.

Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; *TN702*.

Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; *TN571*.

Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; *TN592*.

Probe techniques (a-c); Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; *TN598*.

Procedures; Recall; Reliability; Traceability; Calibration records; Calibration system specification; Intervals; *SP335*, pp. 47-50.

Proceedings NCSL; Metrology management; National Conference of Standards Laboratories; Physical measurement; *SP335.*

Product rule; Tensor function; Trace; Chain rule; Continuum mechanics; Gradient; Matrices; Matrix calculus; Partial differentiation; **J.75B** *Nos. 3 and 4, 97-107 (1971).*

Product Standards; Standard; Voluntary Product Standards; Editorial format; Format: *PS0-70.*

Product standards; Standardization; New technology; Performance standards; *12245.*

Production capacity; Production management; Production methods; Standardization; United Soviet Socialist Republics; Building economics; Building systems; Construction industry; Housing; Precast concrete; *SP334.*

Production management; Production methods; Standardization; United Soviet Socialist Republics; Building economics; Building systems; Construction industry; Housing; Precast concrete; Production capacity; *SP334.*

Production methods; Standardization; United Soviet Socialist Republics; Building economics; Building systems; Construction industry; Housing; Precast concrete; Production capacity; Production management; *SP334.*

Program; Test; Assessment; Complex; Composite; Computer; Criteria; Evaluation; Gaussian primes; Indexing; Measurement; Performance; Prime; *TN572.*

Programming language; Data base; Data retrieval; Data structure; Information storage and retrieval; Language extension; Preprocessor; *TN590.*

Programming languages; Data management; Data structures; File organization; Information retrieval; Information systems; *12008.*

Programming techniques; Transportable; User-oriented computing system; Accuracy; Algorithms; ANSI FORTRAN; Documentation; Error checking; Machine independent; OMNITAB II operating system subprograms; OMNITAB II source listing; *SP339.*

Projectors; Radiance; Radiometry; Reflectometry; Emissivity; Flashing light; Flux measurement; Irradiance; Material properties; Photometry; *SP300. Vol. 7*

Proliferation; Quantity standards; Regulations; Consumer commodities; Labeling; Packaging; *12259.*

Propane; Quantum yields; Rare-gas resonance radiation; Unimolecular dissociation; Ion-molecule reaction; Photoionization; **J.75A** *No. 6, 607-612 (1971).*

Propane; Radiation chemistry; Ion-molecule reaction; Kinetics; Mass spectrometry; Photoionization; *12175.*

Properties; Standards; Standard Reference Materials; Temperature; Thermal; Ceramics; Chemical composition; Mechanical properties; Pressure; *12181.*

Properties data; Flowmeters; Instrumentation; Liquefied natural gas (LNG); Methane; *11821.*

Properties of mechanical structure; Annealing-electrolylic copper; Electrodeposited copper; Impurity content; *12041.*

Proportional counters; Quantitative analysis; Solid state counters; Tests; X-ray spectra; X-ray spectrometers; Electron diffraction; Electron probes; Evaluation; Gas flow; Lithium; Microanalysis; Multichannel analyzer; *12251.*

Propylene; Reaction kinetics; Absolute rate constant; Activation energy; Fluorescence; H atom; *12212.*

Prosthetic materials; Radiopacity-radiopaque; Composite materials; Denture base materials; Physical properties; *12309.*

Prosthetic materials: radiopaquing agents; Radiopaque denture base materials; Denture foreign bodies: type, cause, prevention; *12233.*

Prosthetics; Radiopacity; Silane bonding; Composites; Denture base materials; Dentures; Dimensional stability; Foreign bodies; *12310.*

Protanope; Color blindness; Color vision; Deuteranope; *11824.*

Protective; Resilient liners; Temporary expedients; Tissue bearing; Denture base; *12250.*

Protein structure; Surface crystals; Surface dislocations; Dislocations in biophysics; *SP317*, pp. 579-592.

Proton affinity; Rate constants; Ion molecule reactions; Mass spectrometry; Neopentane; Photoionization; **J.75A** *No. 5, 487-493 (1971).*

Proton bombardment; Thermal control coatings; Degradation mechanising; Electron bombardment; Electron degradation; Polymeric perfluorinated ethylenepropylene; *SP336*, pp. 359-382.

Proton damage; Proton energy; Radiation effect; Radiation intensity; Recovery; Solubility; Space simulation; Temperature effect; Tests; Viscosity; Electron damage; Electron energy; Electron spin resonance; Evaluation; Gel; *SP336*, pp. 323-344.

Proton degradation; Silver coated teflon; Teflon film; Ultraviolet degradation; Aluminum coated teflon; Electron degradation; *SP336*, pp. 345-358.

Proton energy; Radiation effect; Radiation intensity; Recovery; Solubility; Space simulation; Temperature effect; Tests; Viscosity; Electron damage; Electron energy; Electron spin resonance; Evaluation; Gel; Mechanical properties; *SP336*, pp. 323-344.

Proton magnetic resonance; Pyranoid ring; Spectroscopy; 1,2:4,6-di-*O*-benzylidene-α-D-glucopyranoses; Conformations; Coupling constants; Iterative analysis; *m*-dioxane ring; *11874.*

Proton source; Solar wind simulator; Ion beam deflection; Ion optics; Mass separator; *SP336*, pp. 279-296.

Proton sources; Solar wind; Sputtering; Ultrahigh vacuum systems; Charge exchange; Charge neutralization; Ion optics; Mass separators; *SP336*, pp. 261-277.

Proton transfer; Activation energy; Configuration interaction; Correlation energy surface; Hartree-Fock; H_3^+; H_3; H_3^-; H_4; LiH_2; LiHF; HNO; HeH_2^+; *11969.*

Proton transfer; Water; Hydrocarbons; Ion-molecule reactions; Mass spectrometry; Photoionization; *11927.*

Protonated dimer ions; Alkane dimer ions; Ethane; Ion-molecule reactions; Mass spectrometry; Photoionization; *11830.*

Provers; Specifications; Test measures; Tolerances; Weights and measures inspection; Accurate measurements of volumes; Field standard; Metal volumetric field standards; *H105-3.*

Pseudopotential; Sodium; Interband transition theory; Optical absorption; Potassium; *11921.*

Pseudopotentials; Band structure; Cohesion; Core-core interactions; Electron density; Inter-atomic; One-electron potentials; *SP317*, pp. 179-200.

Pseudo-state expansion; Close coupling calculation; Electron scattering; *12155.*

Psicose; Reduction; Ruthenium tetraoxide; Sodium borohydride; Acetals; Fructose; Ketoses; Oxidation; *12121.*

Psychology; Space station simulator; Submersible; Closed ecological system; Habitability; Maintainability prediction; Microbiology; Microflora shift; Physiology; *SP336*, pp. 599-621.

Psychrometer; Vapor pressure; Adiabatic saturation; Dew point temperature; Humidity; Hygrometer; Mixing ratio; Moist gas; **J.75C** *No. 2, 69-78 (1971).*

Psychrometry; Dew point; Hygrometry; Meterology; Moisture measurement in gases; *11991.*

PTFE heat-shrinkable tubing; Tubing, heat-shrinkable fluorocarbon plastic; FEP heat-shrinkable tubing; Fluorocarbon plastic heat-shrinkable tubing; Plastic tubing, fluorocarbon; *PS47-71.*

PTFE lined pipe; Steel pipe and fittings, plastic lined; Pipe and fittings, steel, plastic lined; Plastic lined steel pipe; Polytetrafluoroethylene plastic lined pipe; *PS33-70.*

Public Law 90-472; U.S. Metric Study; Metric conversion; Met-

sion; Alloys; Corrections; Electron probe; Homogeneity; Matrix scanner; Microanalysis; *SP260-28*.

Quantitative microscopy; SRM; X-ray fluorescence analysis; Austenite in ferrite; Electron microprobe; Powder metallurgy; *SP260-25*.

Quantity standards; Regulations; Consumer commodities; Labeling; Packaging; Proliferation; *12259*.

Quantum corrections; Second virial coefficient; Statistical mechanics; Thermodynamics; Lennard-Jones gas; (m-6) intermolecular potential; **J.75A** *No. 1, 57-89 (1971)*.

Quantum corrections; Statistical mechanics; Viscosity; Boltzmann gas; Cross-section for viscosity; Hard sphere gas; *12303*.

Quantum efficiencies; Aluminum in steel; Bilirubin; DTA standards; Fluorescence filters Tl(I), Ce(III), Pb(II); Glass filters (SRM 930); Mercury in botanical; *TN584*.

Quantum electric standards; Radio-frequency standards; Absolute measurements; Basic electrical standards; *SP335*, pp. 129-132.

Quantum electronics; Ion storage; Laser stabilization; Maser oscillator; Metrology; Saturated absorption; Slave oscillators; *12068*.

Quantum electronics; Saturated absorption; Slave oscillators; Accurate frequency standards; Accurate length standards; Accurate time standards; Accurate voltage standards; Ion storage; Laser stabilization; Maser oscillator; Metrology; *12099*.

Quantum fluid; Thermodynamic properties; Cryogenics; Dilution refrigerator; Fermi-Dirac statistics; Heat exchangers; Helium-3; Helium-4; Liquid helium; Mixtures; *11981*.

Quantum fluids; Quantum mechanical density distribution; Quantum statistical mechanics; Conservation equations; Equation of motion; Hydrodynamic equations; *11923*.

Quantum mechanical density distribution; Quantum statistical mechanics; Conservation equations; Equation of motion; Hydrodynamic equations; Quantum fluids; *11923*.

Quantum standard of voltage; Solder-drop Josephson junctions; Superconductivity; Inductive ratio divider; Josephson effect; NPL of UK; Potential-divider resistor; *SP335*, pp. 111-115.

Quantum statistical mechanics; Conservation equations; Equation of motion; Hydrodynamic equations; Quantum fluids; Quantum mechanical density distribution; *11923*.

Quantum tunneling; Atom addition; Hydrogen isotopes; Low temperatures; Olefins; Orientation; *12040*.

Quantum yields; Rare-gas resonance radiation; Unimolecular dissociation; Ion-molecule reaction; Photoionization; Propane; **J.75A** *No. 6, 605-610 (1971)*.

Quarks; Coherent production; Cosmic rays; High momentum components; Many-body clusters; Nuclei; *12144*.

Quartet structure; Rearrangement; Binding energy; Mass formulae; Nuclei; Particle-hole energy; *12145*.

Quartets; Rotational states; Vibrational states; Collective correlations; Four particle-four hole states; Light nuclei; *12146*.

Quartz; Slip bands; Dislocation velocity; High speed dislocations; Impact stress pulse; Piezoelectric stress gauge; *SP336*, pp. 487-508.

Quartz crystal microbalance; Solar panels; Space; Sputtering; Surface contamination; Cleaning; Desorption; Ions; Outgassing; *SP336*, pp. 113-127.

Quartz crystal microbalance; Spacecraft contamination; Particulate sampling; *SP336*, p. 105-111.

Quartz crystal oscillator; Ramsey cavity; Slave oscillator; Atomic frequency standard; Cesium beam; Figure of merit; Frequency accuracy; Frequency multiplier; Frequency precision; NBS-III; NBS-5; Phase noise; *11959*.

Quartz crystal oscillator mass monitors; Radiometry; Reflectometry; Space environment simulation chambers; Contamination collection units; Gas-liquid chromatography; Infrared spectrometry; Mass spectrometry; *SP336*, pp. 25-49.

Quartz crystal oscillators; Time standards; Atomic frequency standards; Cesium beam; Flicker noise; Frequency stability; Frequency standards; Hydrogen maser; Long baseline interferometry; *11888*.

Quasidisclination; Affine connexions; Continuum mechanics; Curvature tensor; Disclination; Internal stresses; *SP317*, pp. 637-649.

Quasiharmonic specific heat; String of beads; Thermal expansion; Thermal properties; Volume; Bulk modulus; Grüneisen; n-alkanes; Normal mode; Polyethylene; *12305*.

Quasi-sinusoid; Digital; Logic gating; *11876*.

Quenching reactions; Upper atmosphere; Hydrogen atoms; Nitrogen atoms; $O_2(^1\Delta_g)$; Oxygen atoms; *12090*.

R

Radar beacon system; Air traffic control; Beacon code assignment; Digital simulation; *TN568*.

Radial; Tires; Tire strength; Winter; Bias ply; Breaking energy; Passenger car; *11833*.

Radial distribution function; Simple liquids; Superposition approximation; Three body correlation function; X-ray diffraction; Neutron diffraction; Percus-Yevick equation; *12016*.

Radial energy integrals of Tm III; Spectrum of Tm III; Doubly ionized thulium; Energy levels of Tm III; *11836*.

Radial integrals; Sack correction; Ytterbium; *11837*.

Radiance; High-speed measurements; Optical attenuator; Photometry; **J.75C** *No. 2, 85-88 (1971)*.

Radiance; Radiometry; Reflectometry; Emissivity; Flashing light; Flux measurement; Irradiance; Material properties; Photometry; Projectors; *SP300. Vol. 7*

Radiance; Standards; Graphite arc; High-speed measurements; High temperatures; Pyrometry; *12201*.

Radiance modulation; Radiation; High-speed methods; Light attenuator; Photometry; **J.75C** *No. 1, 29-32 (1971)*.

Radiation; Ablation; Evaluation; Heat shields; Heat transfer; Planetary entry; *SP336*, pp. 751-812.

Radiation; Absorbed dose; Calorimetry; Dose distribution; Electron beams; Holography; Interferometry; Pulsed beams; *12100*.

Radiation; High-speed methods; Light attenuator; Photometry; Radiance modulation; **J.75C** *No. 1, 29-32 (1971)*.

Radiation; Radiation detector; Radiation dosimetry; Silicon radiation detector; Temperature dependence; X rays; Gamma rays; Photocurrents; **J.57A** *No. 6, 579-589 (1971)*.

Radiation; Scattering; Crystal structure; Diffraction; Molecular structure; Neutron; Nuclear reactor; *TN567*.

Radiation; Spectrometer; Azimuthal angle; Compton-Raman interaction; Hamiltonian; Polarization; *12345*.

Radiation chemistry; Ion-molecule reaction; Kinetics; Mass spectrometry; Photoionization; Propane; *12175*.

Radiation damage; Radiation testing; *SP336*, pp. 525-534.

Radiation damage; Ruby; Concentration determination; Magnetic susceptibility; Optical absorption coefficient; *12348*.

Radiation detector; Radiation dosimetry; Silicon radiation detector; Temperature dependence; X rays; Gamma rays; Photocurrents; Radiation; **J.75A** *No. 6, 579-589 (1971)*.

Radiation dosimeter; Radiation dosimetry; Spectrophotometry; Spectrophotometric measurements; Chemical dosimeter; Chemical dosimetry, ferrous sulfate; Ferrous sulfate dosimeter; Ferric ions; Fricke dosimeter; *12174*.

Radiation dosimetry; Silicon radiation detector; Temperature dependence; X rays; Gamma rays; Photocurrents; Radiation; Radiation detector; **J. 75A** *No. 6, 579-589 (1971)*.

Radiation dosimetry; Spectrophotometry; Spectrophotometric measurements; Chemical dosimeter; Chemical dosimetry, ferrous sulfate; Ferrous sulfate dosimeter; Ferric ions; Fricke dosimeter; Radiation dosimeter; *12174*.

Radiation effect; Radiation intensity; Recovery; Solubility; Space simulation; Temperature effect; Tests; Viscosity; Electron damage; Electron energy; Electron spin resonance; Evaluation; Gel; Mechanical properties; *SP336*, pp. 323-344.

Radiation intensity; Recovery; Solubility; Space simulation; Temperature effect; Tests; Viscosity; Electron damage; Electron energy; Electron spin resonance; Evaluation; Gel; Mechanical properties; Optical properties; Plastic films; *SP336*, pp. 323-344.

Radiation quality; Radiation quantity; Electron temperature; Line-blanketing; Mechanical heating; *12097*.

Radiation quantity; Electron temperature; Line-blanketing; Mechanical heating; Radiation quality; *12097*.

Radiation simulation; RTG; Test; Evaluation; MOSFETS; Neutrons; Pu^{239}-Be; *SP336*, pp. 129-140.

Radiation testing; Radiation damage; *SP336*, pp. 525-534.

Radiation transport; Thick targets; Bremsstrahlung; Bremsstrahlung efficiency; Monte Carlo; Photon neutron; *11799*.

Radiation-induced; Tetrafluoroethylene; 3,3,4,4,5,5,5-heptafluoropentene-1; Amorphous polymer; Copolymerization; Fluoropolymers; Glass temperature; High pressure; *11868*.

Radiative capture; Angular distribution; Cross section; Helium-3; Photonuclear; *11886*.

Radiative correction; Anomalous moment; Back scattering; Electron; *11801*.

Radiative transport; Solar chromosphere; Solar spectrum; Sunspots; Wilson-Bappu effect; Ca H and K lines; Non-LTE line formation; Plages; *12106*.

Radiative-control; Temperature-control-bracket; Boundary temperature; Collisional-control; Non-LTE; *12360*.

Radical; Aromatic; Azines; Cleavage; Complex; Nitrogen paramagnetic; Periodic acid; *12095*.

Radical; Reagent; Determination; Electron-transfer; Inosose; Oxidation; Quantitative; *12151*.

Radical-anion; Bis(phenylhydrazone); E.s.r.; Glyoxal; Methyl sulfoxide; Oxygen; **J.75A** *No. 6, 573-577 (1971)*.

Radii of gyration; Second virial coefficients; Configuration; Conformation; Kratky-Porod model; Light scattering; Osmotic pressure; Poly(*n*-alkyl isocyanates); *12355*.

Radio frequency; Group theory; Inversion splitting; Methane; Molecular-beam data; Ortho-para transitions; *12323*.

Radioactivity monitors; Photonuclear experiments; *11877*.

Radiochemical separations; Sodium; Trace elements; Activation analysis; Glass; Hydrated antimony pentoxide (HAP); *12000*.

Radiochromic dye films; Spectral transmission density; Densitometer; Microdensitometer; **J.75C** *No. 1, 23-27 (1971)*.

Radiofrequency power measurement; Self-balancing Wheatstone bridge; Automated dc substitution; Bolometer calibration; *SP335*, pp. 35-37.

Radio-frequency standards; Absolute measurements; Basic electrical standards; Quantum electric standards; *SP335*, pp. 129-132.

Radiolysis; Butene; Cyclobutane; Ion structure; Isomerization; Methylcyclopropane; Photoionization; Photolysis; **J. 75A**, *No. 6, 591-605 (1971)*.

Radiolysis; Charge transfer; Deactivation; Ethane; Ion-molecule reactions; Mass spectrometry; *12129*.

Radiolysis; Cyclohexane; Effects impurity; Ion-molecule reactions; Mass spectrometry; *11928*.

Radiolysis; Ethylene; Free radical reactions; Ion-molecule reactions; Photolysis; Polymerization; **J.75A** *No. 3, 141-146 (1971)*.

Radiolysis; Rate constants; *t*-butyl ion; Carbonium ions; Ion-molecule reactions; Neopentane; *11854*.

Radiolysis; Rate constants; Theory; Hydrocarbons; Ion-molecule reactions; Photoionization; *11853*.

Radiolysis; Unimolecular fragmentation; Ion-molecule reactions; Neopentane; Neutralization; *12141*.

Radiolysis; Unimolecular ion fragmentation; Deactivation; Ion-molecule reactions; Photoionization; *11905*.

Radiometric standards; Radiometry; Spectral irradiance; Spectral radiance; Irradiance; *SP336*, pp. 185-187.

Radiometry; Reflectometry; Emissivity; Flashing light; Flux measurement; Irradiance; Material properties; Photometry; Projectors; Radiance; *SP300. Vol. 7*

Radiometry; Reflectometry; Space environment simulation chambers; Contamination collection units; Gas-liquid chromatography; Infrared spectrometry; Mass spectrometry; Quartz crystal oscillator mass monitors; *SP336*, pp. 25-49.

Radiometry; Spectral irradiance; Spectral radiance; Irradiance; Radiometric standards; *SP336*, pp. 185-187.

Radionuclide; Absorbed dose; Beta ray; Dosimetry; Nuclear medicine; Point kernel; *11861*.

Radiopacity; Bonding; Composites; Denture base materials; Diagnosis; Light translucency; Physical properties; *12232*.

Radiopacity; Silane bonding; Composites; Denture base materials; Dentures; Dimensional stability; Foreign bodies; Prosthetics; *12310*.

Radiopacity-radiopaque; Composite materials; Denture base materials; Physical properties; Prosthetic materials; *12309*.

Radiopaque denture base materials; Denture foreign bodies: type, cause, prevention; Prosthetic materials: radiopaquing agents; *12233*.

Radiopaquing agents; Radiopaque denture base materials; Dental foreign bodies; Type, cause, prevention; Prosthetic materials; *12233*.

Radium compounds; Enthalpy; Entropy; Gibbs energy of formation; Beryllium compounds; Magnesium compounds; Calcium compounds; Strontium compounds; Barium compounds; *TN270-6*.

Radius; Two segments; Distribution; Gyration; Polymer; *11947*.

Railroad signals; Signal colors; Signal standards; Spectral transmittance of glass filters; Traffic signals; Aircraft signals; Color standards; Filter permanence; Limit filters; *TN564*.

Raman; Laser; Vibrational assignment; C_6F_6; C_6Cl_6; C_6Br_6; C_6I_6; Hexahalogenated benzenes; *12299*.

Raman; Sodium bifluoride; Stretching vibration; Bending vibration; Hydrogen bond; Infrared; Isotope dilution; Lattice mode; *11983*.

Ramsey cavity; Slave oscillator; Atomic frequency standard; Cesium beam; Figure of merit; Frequency accuracy; Frequency multiplier; Frequency precision; NBS-III; NBS-5; Phase noise; Quartz crystal oscillator; *11959*.

Random alloy; Vacancies; Activation analysis; Concentrated alloys; Correlation factor; Diffusion; *12167*.

Random vibration; Test; Transfer impedance; Transmissivity equalization; Vibration; Acceleration response; Evaluation; Fatigue life; Lumped parameter system; Mechanical impedance; *SP336*, pp. 509-524.

Random walk; Adsorption; Chain polymer; Lattice model; Partition function; *12374*.

Random-walk theory; Vacancy motion; Atomic diffusion; Defect motion; Interstitial motion; Jump frequency; Lattice model; Migration energy; Migration entropy; Molecular dynamics; *12022*.

Rank; Determinant; Generalized matrix function; Invariants; Matrices; **J.75B** *Nos. 3 and 4, 109-115 (1971)*.

Rare earth glass; Energy transfer; Eu and Nd doped glass; Fluorescence; Fluorescence decay times; Fluorescence quenching; Laser glass; *11831*.

Rare earths; Autoionization; Exchange interaction; Photoabsorption transition elements; *12275*.

Rare sugars; Rearrangement; 1,3-dioxolane rings; Fructose; Gas-liquid chromatography; *11866*.

Rare-earth spectra; Regularities, atomic spectra; Solar spectra; Atomic spectra; Coronal spectra; Periodicities, atomic spectra; *12288*.

Rare-earth spectra; Solar spectra; Spectra, atomic; Spectra, rare-earth; Atomic spectra; Coronal spectra; *11987*.

squares; Linear equations; Orthogonalization; Orthogonal polynomials; *12184*.

Regularities; Review; Atomic transition probabilities; Beam foil spectroscopy; Lifetimes; *12124*.

Regularities, atomic spectra; Solar spectra; Atomic spectra; Coronal spectra; Periodicities, atomic spectra; Rare-earth spectra; *12288*.

Regulations; Consumer commodities; Labeling; Packaging; Proliferation; Quantity standards; *12259*.

Regulations; Weights and measures; Consumer package; Exemption; Fluid measure; Labeling; Net quantity; Principal display panel; *H108*.

Reinforced concrete; Slenderness; Strength; Structural analysis; Walls; Axial load (force); Bending moment; Building codes; End-fixity; *11933*.

Relative creep; Thermoelastic; Transverse; Longitudinal; Polyethylene terephthlate; Polypyromelitimide; *12165*.

Relaxation; Scalar coupling; Sensitivity; ^{13}C; Fourier transform; Nmr; *12378*.

Relaxation methods; Diffusion equation; Diffusion of gases; Flow reactor; Gas mixing; Mixing by diffusion; *12091*.

Relaxation modes; Reorientation; Anelastic relaxation; Calcium fluoride; Defect pairs; Dielectric relaxation; *12357*.

Relaxation times; Rotational diffusion; Spherical-top molecules; Angular relaxation; ClO_3F; Magnetic resonance; *12195*.

Relaxation times; Supercritical fluctuations; Ultrasonic spectroscopy; Viscous relaxation; Immiscibility; Oxide glasses; *11986*.

Release agents; Stress-strain curve; Volume dilation; Composite materials; Coupling agents; Epoxy polymer; Parting agents; Poisson's ratio; *12379*.

Reliability; Signature analysis; Vibration; Bearings; Diagnostics; Gears; *SP336*, pp. 407-448.

Reliability; Traceability; Calibration records; Calibration system specification; Intervals; Procedures; Recall; *SP335*, pp. 47-50.

Reliability of working instruments; Calibration intervals; Economy in adjusting quality level; Measurement uncertainty; *SP335*, pp. 57-64.

Reliability, systems effectiveness, tradeoffs; Calibration intervals; Exponential distribution; *SP335*, pp. 65-72.

Renaissance bronzes; Widener collection; Art restoration; Cellini; Chemical microscopy; National Gallery of Art; *11984*.

Reorientation; Anelastic relaxation; Calcium fluoride; Defect pairs; Dielectric relaxation; Relaxation modes; *12357*.

ReO_3-type compounds; $Nb_2O_5-P_2O_5$; $NbPO_5$; $Nb_2P_4O_{15}$; Nb_9PO_{25}; $Nb_{44}P_2O_{115}$; $P_2O_5-Nb_2O_5$; Phase diagram; *11903*.

Repeatability; Reproducibility; Test methods, evaluation of; Interlaboratory testing; Precision; *12333*.

Repetitively pulsed lasers; Average power; Energy per pulse; Laser; Peak power; *TN398*.

Replicate; Spark; Spectrometry; Accuracy; Circumvention; Emulsions; Homogeneity; Ions; Mass; Platinum; Precision; *11847*.

Representations and codes; Standard Metropolitan Statistical Areas; Computers; Data processing; Federal Information Processing Standards Publication; National government; *FIPS PUB 8-1*.

Reproducibility; Test methods, evaluation of; Interlaboratory testing; Precision; Repeatability; *12333*.

Repulsive core; ^3He; ^3H; Charge; Form factor; Magnetic; Nucleon potentials; *12056*.

Research; Small carpets and rugs; Standards; Test development; Annual report to Congress; Blankets; Carpets and rugs; Children's sleepwear; Cooperation; Flammability; Flammability reduction; Mattresses; *TN596*.

Research Associate Program; Simultaneous determination of oxygen and nitrogen; Standard Reference Material for oxygen; Inert gas fusion; One ppm of oxygen and nitrogen in steel; *SP260-26*.

Research facility; Simulation techniques; Space research; Convective processes; Mars atmosphere exploration; Planetary atmosphere-surface interaction; Planetary meteorology; *SP336*, pp. 699-723.

Research management principles embodied in government-university collaboration in the Joint Institute for Laboratory Astrophysics; *11940*.

Research materials; Standard reference materials; SRM's; Standard Reference Materials Program; Agriculture; Air and water pollution; Biology; Botany; Health and medicine; Instrument calibration; Metrology; *12349*.

Research reactor; Split core; Cold neutron source; High flux; Irradiation; Neutron diffraction; *12351*.

Research summaries; Fluid mechanics; Hydraulic engineering; Hydraulic research; Hydraulics; Hydrodynamics; Model studies; *SP346*.

Research techniques; Corrosion; Electron diffraction; Electron microscopy; *12104*.

Residual gas analysis; Test facility; Vacuum; Chemical analysis; Contamination; Organic residues; Outgassing; Polymeric materials; *SP336*, pp. 1-24.

Residual gas analysis computer simulation; Residual gas analysis data reduction; Space vacuum system gas; Mass spectrometry; *SP336*, pp. 151-164.

Residual gas analysis data reduction; Space vacuum system gas; Mass spectrometry; Residual gas analysis computer simulation; *SP336*, pp. 151-164.

Residual stress; Titanium bearing steels; Chromium diffusion coating; Columnar grains; Fatigue crack initiation; Fatigue crack propagation; *12087*.

Resilient liners; Temporary expedients; Tissue bearing; Denture base; Protective; *12250*.

Resins; Synthesis; Accelerators; Amines; Color-stable composites; Methacrylates; Polymerization; *12302*.

Resins for composites; Ternary eutectic; Thermosetting monomers; Biomaterials; Dimethacrylates; Phthalate monomers; Purification methods; *11802*.

Resistance; Aluminum; Electron scattering; Magnetoresistance; *12278*.

Resistance thermometers; Resistor intercomparison; Standard cell surveillance; Computer automation; *SP335*, pp. 29-33.

Resistive divider; Voltage ratio; Divider; Measurement system; Ratio; Ratio standard; *12150*.

Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; *TN702*.

Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Carrier lifetime; Die attachment; *TN560*.

Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; *TN571*.

Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; *TN592*.

Resistivity; Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; *TN598*.

Resistivity; Surface preparation; Analysis; Device processing; Diffusion; Epitaxy; Junctions; *SP337*.

Resistor intercomparison; Standard cell surveillance; Computer automation; Resistance thermometers; *SP335*, pp. 29-33.

Resolution; Resolving power; Tri-bar targets; Coherence; Partially coherent imaging; *12320*.

Resolving power; Tri-bar targets; Coherence; Partially coherent imaging; Resolution; *12320*.

Resonance; Spectroscopy; Transistor; Zeeman; Current; Modulator; Nuclear; Pulse; Quadrupole; *12350*.

Resonance; Standards; Frequency; *11857*.

Resonance fluorescence; Vacuum-uv; Activation energy; H atoms; H_2S; Rate constant; *12074*.

Resonance frequency; Shear modulus; Standard reference material; Young's modulus; Alumina; Elastic modulus; **J.75A** *No. 3, 155-162 (1971)*.

Resonance line shape; Cavity phase shift; Cesium beam tube; Frequency accuracy; Frequency modulation; Frequency standard; Power shift; *12365*.

Resonance lines, Ca II; Solar chromosphere, physical properties; Solar chromosphere, structure; Spectral line formation; Spectroscopic diagnostics; Non-LTE radiative transfer; *12247*.

Resonance lines, Ca II; Solar chromosphere, physical properties; Spectral line formation; Spectroscopic diagnostics; Non-LTE radiative transfer; *12248*.

Resonance width; Shape resonance; Spectroscopic constant; Valence orbital; Electron scatter; Energy curve; Local potential; N_2; *11899*.

Resonances; Rotations; SU(6) 04 × 0(3); Baryons; Configuration mixing; Hyperons; *11912*.

Resonances; Spectroscopy; SU(3); $SU(6)_W$; A_2; Mesons; *12009*.

Resonant detector; Conversion electrons; Iron; Mössbauer spectroscopy; *TN541*.

Resonant structure; Atomic absorption; Close coupling; Configuration; Interaction; *12094*.

Restorative materials; Temporary dental cements; Dental restorative materials; EBA cements; Plastic reinforced restoratives; *11996*.

Restraint geometry; Restraint systems; Seat belt; Sled tests; Webbing abrasion; Webbing degradation; Anthropomorphic dummies; Auto seat tests; Deceleration; Human kinematics; Human tests; *11850*.

Restraint systems; Seat belt; Sled tests; Webbing abrasion; Webbing degradation; Anthropomorphic dummies; Auto seat tests; Deceleration; Human kinematics; Human tests; Restraint geometry; *11850*.

Restraints; Automobiles; Dummies; Dynamic; Impact; Performance; *11945*.

Result computation; Spectral resolution; Activation analysis; Component identification; *12344*.

Retention; Serviceability; Stability; Adaption; Acrylic; Contraction; Dentures; Epoxy; Expansion; Hard rubber; *12189*.

Retraction ratio; Shrink film, plastic; Balanced and unbalanced film; Film, plastic; Orientation release stress; Plastic heat-shrinkable film; *PS29-70*.

Retro-reflectance; Absorptance; Black coatings; Cavity absorptance; Cavity reflectance; Laser-source reflectometer; Parsons black; *TN575*.

Return loss; Sliding short; Shorted termination; Waveguide; Microwave; Reflection coefficient; *TN602*.

Review; Air pollution; Brillouin spectroscopy; Lasers; Light scattering; Macromolecules; Optical mixing spectroscopy; *12361*.

Review; Atomic transition probabilities; Beam foil spectroscopy; Lifetimes; Regularities; *12124*.

Review; Chemical applications; Literature; Mössbauer Spectroscopy; *12147*.

Review; Sensitivities; Bremsstrahlung; Carbon; Electron accelerators; Nitrogen; Oxygen; Photon activation analysis; *12076*.

Review; Unimolecular decomposition; Atom-transfer reaction; Chemical activation; Chemical kinetics; Chemi-excitation; Gas phase; Potential energy surfaces; Recombination; *11943*.

Rf coaxial impedance standards; Attenuation measurement; Automatic data correction; Auxiliary receiver for microwave measurements; Dual admittance Woods bridge; Engen microcalorimeter; *SP335*, pp. 117-119.

Rf-dc; Thermopile radiation; Ammeter; Coax; Infrared; *12198*.

Rhenium; Rhenium coatings; Rhenium oxychlorides; Chemical vapor deposition; *11848*.

Rhenium; Ruthenium; Surface migration; Carbon monoxide; Desorption; Field emission; Monoxide; *11819*.

Rhenium coatings; Rhenium oxychlorides; Chemical vapor deposition; Rhenium; *11848*.

Rhenium coatings; Trifluorophosphine; Carbonyl; Chemical vapor deposition; Electrodeposition; Hexafluoroacetylacetone; *11942*.

Rhenium heptaoxide; Rhenium oxytetrachloride; Chemical vapor deposition; Perrhenyl chloride; *12062*.

Rhenium oxychlorides; Chemical vapor deposition; Rhenium; Rhenium coatings; *11848*.

Rhenium oxytetrachloride; Chemical vapor deposition; Perrhenyl chloride; Rhenium heptaoxide; *12062*.

Rigid-body analysis; Thermal motion; Crystal structure; Neutron diffraction; PH_4Br; *12119*.

Ring conformation; Rotational constants; Cyclopentene oxide; Dipole moment; Epoxy cyclopentene; Microwave spectrum; *11970*.

Ring theory; Stochastic process; Information theory; Markov process; Probability theory; **J.75B** *Nos. 3 and 4, 139-148 (1971)*.

Röntgen; X rays; Absorption corrections; Attenuation coefficient; Conference; Crystallography; Electron microprobe; Fluorescence analysis; Gamma rays; Photons; *11814*.

Rock; Zirconia; Alumina; Al_2O_3; Ceramics; Electron microscopy; Fine-grain ceramic; Ion bombardment; Magnesia; MgO; Microstructure; *12083*.

Rock mechanics; Space environment simulation; Ultrahigh vacuum; Anisotropy; Compression tests; Mass spectroscopy; Mechanical properties; Outgassing; Pressure measurements; *SP336*, pp. 209-223.

Rocket-fuel tanks; Compatibility tests; Electrolytic protection; Hydrazine; Maraging steel; Metallic coatings; Missiles; *11934*.

Rocks; Analysis; Electron probe; Lunar samples; Microanalysis; Minerals; *11995*.

Rocks; Apollo 11; Electron probe analysis; Mineralogy; Moon; Petrography; *11958*.

Roof; Washington Cathedral; "1921"; Cathedral; Deformation; Lead; *12377*.

Roof projections; Static pressures; Wind effects; Wind tunnel modeling; Architectural features; Buildings; Mullions; Parapets; *BSS30*, pp. 73-86.

Roofs; Structural engineering; Tides; Wind; Buildings; Failure; Hurricanes; Mobile homes; *TN569*.

Roofs; Structural engineering; Wind load; Anchorage; Building performance; Glazing; Hailstones; Masonry; Mobile homes; *TN558*.

Rotary vane; Attenuator; Microwave; Precision; **J.75C** *No. 1, 1-5 (1971)*.

Rotation group; Spatial rotation; Angular velocity; Effective axis and angle of rotation; Intrinsic vector; Kinematics of a rigid body; **J. 75B** *Nos. 3 and 4, 179-186 (1971)*.

Rotational; Spherical molecules; Diffusion; Light scattering; Neutron scattering; Plastic crystal; *11953*.

Rotational analysis; Vibrational analysis; Vibrational and rotational constants; Absorption spectrum; CO; Electronic transitions; **J.75A** *No. 5, 455-467 (1971)*.

Rotational constants; Cyclopentene oxide; Dipole moment; Epoxy cyclopentene; Microwave spectrum; Ring conformation; *11970*.

Rotational constants; Spectra; Bond distances; Hydrogen cya-

Scandium compounds; Tantalum compounds; Titanium compounds; Vanadium compounds; Yttrium compounds; Zirconium compounds; Enthalpy; Entropy; Gibbs energy of formation; Hafnium compounds; Heat of formation; Niobium compounds; *TN270-5*.

Scanning electron microscope; Electron detector; Image contrast; Magnetic domains; *12346*.

Scanning electron microscope; X-ray spectrometer shield; Increased sensitivity of touch alarm; *12060*.

Scanning electron microscopy; Electron probe microanalysis; Lunar samples; Lunar simulation; Lunar thermal history; Meteorites; *11810*.

Scattering; Crystal structure; Diffraction; Molecular structure; Neutron; Nuclear reactor; Radiation; *TN567*.

Scattering; Second virial; Viscosity; Gas; Intermolecular potential; Potential function; *12162*.

Scattering; Semiconductor; Magnetic field; Maxwellian distribution; *12078*.

Scattering; Simulation; Spectral; Absorbing; Anomalous dispersion; Carbon dioxide; Cryodeposit; Cryogenics; Frost; Infrared; Integrating sphere; Mars; Reflectance; *SP336*, pp. 165-183.

ScCl$_3$; TiCl$_3$; TiCl$_4$ Dichlorides of Ca, Sc, Ti, V, Cr, Mn, Fe, Ni; Geometry; Infrared spectra of species; Matrix isolation; *12281*.

Schottky pairs; Computer simulation; Kansaki method; Lattice statics; Point defects; *SP317*, pp. 219-245.

Scientists' use of literature; Weeding a scientific library; Weeding criteria; *12178*.

Screw disclinations; Crystal surface imperfections; Disclinations; *SP317*, pp. 593-606.

Screw dislocation; Computer simulation; Green's tensors; Interatomic potential; Lattice studies; Peierl's energy; *SP317*, pp. 291-298.

Search and rescue; Simulation; Team development; Coast Guard; Development; Interdisciplinary team; Management science; Model building; Organization; *12243*.

Seat; Seat belts; Acceleration (mechanical); Biodynamics; Biomechanics; Human engineering; Kinematics; Occupant restraint systems; *11851*.

Seat belt; Sled tests; Webbing abrasion; Webbing degradation; Anthropomorphic dummies; Auto seat tests; Deceleration; Human kinematics; Human tests; Restraint geometry; Restraint systems; *11850*.

Seat belts; Acceleration (mechanical); Biodynamics; Biomechanics; Human engineering; Kinematics; Occupant restraint systems; Seat; *11851*.

Second and third heats; ΔH-ΔS correlation; Heat of vaporization; Least squares fits; *12014*.

Second harmonic generation; Selenium; Nonlinear optics; Optical activity; Optical properties; *12203*.

Second order fluid; Hole pressure; Nonlinear rheology; Normal stresses; Pressure error; *11966*.

Second virial; Viscosity; Gas; Intermolecular potential; Potential function; Scattering; *12162*.

Second virial coefficient; Adsorption; Correction for gas; Gas; Gas law correction; Imperfect gas; *12330*.

Second virial coefficient; Adsorption, gas on metal; Argon, compressibility factor of; Burnett data reduction; Carbon dioxide, second virial coefficient of; Compressibility factor; Gas; Gas, compressibility factor of; **J.75C** *Nos. 3 and 4, 163-172 (1971)*.

Second virial coefficient; Speed of sound in gases; Acoustic thermometry; Equation of state; Equilibrium gas properties; Helium; *12061*.

Second virial coefficient; Statistical mechanics; Thermodynamics; Lennard-Jones gas; (m-6) intermolecular potential; Quantum corrections; **J.75A** *No. 1, 57-89 (1971)*.

Second virial coefficient; Stockmayer; Dipole; Gas; Intermolecular potential function; Polar; **J.75A** *No. 4, 337-385 (1971)*.

Second virial coefficient; Thermodynamics; Compressibility factors; Equation of state; High density; High temperature; Pairwise potentials; Redlich Kwong; *11887*.

Second virial coefficients; Configuration; Conformation; Kratky-Porod model; Light scattering; Osmotic pressure; Poly(n-alkyl isocyanates); Radii of gyration; *12355*.

Secondary extinction; Theory; X-ray diffraction; Dynamical diffraction; Imperfections; Kinematical scattering; Piezoelectric vibration; *12073*.

Secondary standard; Signal level calibration; Standard reference materials; Unrecorded reference; Average signal peak level; Computer amplitude reference; Magnetic tape; Master standard; Saturation curves; *SP260-29*.

Section cracking; Stability; Stress distribution; Unreinforced concrete; Buckling; Compression members, concrete; Deflection; Equilibrium; Load eccentricity; Masonry; *12298*.

Seebeck effect; Thermal conductivity; Titanium alloy; Transport properties; Aluminum alloy; Cryogenics; Electrical resistivity; Lorenz ratio; Nickel alloys; **J.75A** *No. 4, 269-277 (1971)*.

Seebeck effect; Thermal conductivity; Transport properties; Cryogenics; Electrical resistivity; Electrolytic iron; Lorenz ratio; *SP260-31*.

Seismic; Standards; Structural engineering; Bridge; Building; Codes; Dams; Earthquake damage; Earthquakes; Foundation geology; Highways; Hospital; Housing; Mobile home; *BSS40*.

Seismic loads; Structural engineering; Wind loads; Vibrations; Buildings; Climatology; *BSS30*, pp. 129-131.

Seismic response; Compensation; Ground motion; Infrasonic microphones; **J.75C** *No. 1, 41-45 (1971)*.

Seismograph; Earth strain; Earth tide; Geophysics; Laser strainmeter; *11865*.

Selected values; Soap; Solubilization; Standard values; Surface active agents; Surface chemistry; Surface tension; Surfactant; Association colloid; Bibliography; CMC; Colloid; Colloidal electrolyte; Critical concentration; *NSRDS-NBS36*.

Selection of hearing aids; Speech communication; Audition; Communications; Hearing; Hearing aids; *C154*.

Selenium; Nonlinear optics; Optical activity; Optical properties; Second harmonic generation; *12203*.

Self balancing; Stabilizer; Bridge; Leveler; Microwave; Power; *12042*.

Self-adjoint equations; Sturm-Liouville systems; Boundary value problems; Coupled equations; Differential equations; **J. 75B** *Nos. 3 and 4, 125-138 (1971)*.

Self-balancing current comparator; Transformer; Wide-range; Calibration; Current comparator; Current transformer; Overload testing; *12256*.

Self-balancing Wheatstone bridge; Automated dc substitution; Bolometer calibration; Radiofrequency power measurement; *SP335*, pp. 35-37.

Self-nucleation; Steady-state; Cilia; Conformational entropy; Free energy; Nucleation rate; Rate constants; *12293*.

Self-teaching; Statistical analysis; Automatic printing; Bessel functions; Data analysis; Data manipulation; Easy and effective programming in English; List of instructions; Matrix operations; Numerical analysis; OMNITAB II user oriented computing system; *TN552*.

SEM; Lunar soil; Metal inclusions; Meteorite; Microstructure; *12131*.

Semiconductor; Magnetic field; Maxwellian distribution; Scattering; *12078*.

Semiconductor; Solid state; Amplifiers; Basic characteristics; Microwave; Oscillators; *TN597*.

Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; *TN702*.

Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; ASTM standards; Integrated circuits; Microelectronics; *11869*.

Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Carrier lifetime; Die attachment; *TN560*.

Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; *TN571*.

Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; *TN592*.

Semiconductor devices; Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; *TN598*.

Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; *TN702*.

Semiconductor materials; Semiconductor process control; Silicon; ASTM standards; Integrated circuits; Microelectronics; Semiconductor devices; *11869*.

Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Carrier lifetime; Die attachment; Electrical properties; *TN560*.

Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; *TN571*.

Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; *TN592*.

Semiconductor materials; Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; *TN598*.

Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; *TN702*.

Semiconductor process control; Silicon; ASTM standards; Integrated circuits; Microelectronics; Semiconductor devices; Semiconductor materials; *11869*.

Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; *TN560*.

Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; *TN571*.

Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; *TN592*.

Semiconductor process control; Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; *TN598*.

Semiconductors; Band structure; Covalent-ionic solids; Dislocation-electron interactions; Fermi energy; *SP317*, pp. 1293-1302.

Semiconductors; Band structures; Charged dislocations; Diamond lattice; Dislocation-electron interactions; *SP317*, pp. 1231-1253.

Semiconductors; Silicon; Deep impurities; Germanium; Infrared; Photoconductivity; Photoresponse; *TN570*.

Semiconductors; SrTiO$_3$; Strontium titanate; Superconductivity; Surface potential barrier; Tunneling; Indium; *11925*.

Semicontinuum polaron model; CaF$_2$; CaO; *F* center; Internal Stark effect; KCl; Optical phonons; Polarizable ion model; *12134*.

Semi-infinite aluminum medium; Silicon detector; Absorbed energy vs depth; Absorbed-energy distributions; Incident monoenergetic electrons; Monte Carlo calculations; *12140*.

Sensitivities; Bremsstrahlung; Carbon; Electron accelerators; Nitrogen; Oxygen; Photon activation analysis; Review; *12076*.

Sensitivity; Tables; Accuracy; Atomic absorption; Detection limits; Differential method; Flame emission; Nonaqueous media; Precision; *12111*.

Sensitivity; ^{13}C; Fourier transform; Nmr; Relaxation; Scalar coupling; *12378*.

Sensitivity and gamma-ray spectra of the elements; 3-MeV neutron activation analysis; Absolute flux; Cockcroft-Walton neutron generator; Sample attenuation corrections; *11913*.

Sensor; Ultra high vacuum; W-Re alloys; EMF-temperature relationship; Furnace; High temperature; Refractory metals; Thermocouple; Thermoelements; *J.75C No. 2, 99-106 (1971)*.

Separation; Styrene/divinylbenzene; Zeolites; Air pollution; Bilirubin; Infrared analysis; Ion exchange; Liquid chromatography; Purification; *TN549*.

Separation by flow; Chromatography; Gel filtration; Gel permeation chromatography; Macromolecules; *12003*.

Serial-by-bit; Serial-by-character; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; Communications; Data communications equipment; Data processing terminal equipment; Data transmission; *FIPS PUB 16*.

Serial-by-bit; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; Character structure; Character parity sense; Communications; Data transmission; Federal information processing standards; *FIPS PUB 17*.

Serial-by-character; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; Communications; Data communications equipment; Data processing terminal equipment; Data transmission; *FIPS PUB 16*.

Serial-by-character; Telecommunications; Teleprocessing; American Standard Code for Information Interchange; ASCII; Character structure; Communications; Data transmission; Federal information processing standards; Parallel-by-bit; *FIPS PUB 18*.

Serviceability; Stability; Adaption; Acrylic; Contraction;

Dentures; Epoxy; Expansion; Hard rubber; Retention; *12189.*

Set reduction; Structure search; Substructure search; Ambiguity; Binary matrices; Bond adjacency; Chemical information; Computer; Control vector; *12337.*

SH; Ultraviolet; Infrared spectrum; Isolated SH; Low temperature; Matrix; *11846.*

Shaft seal; Closed pumping system; He^3-He^4 dilution refrigerator; Mass spectrometer leak detector; Mechanical pump; *12235.*

Shape dependent; Specific heat; Cerous magnesium nitrate; Cesium titanium alum; Dipole-dipole interaction; Neodymium ethyl sulphate; *11909.*

Shape resonance; Spectroscopic constant; Valence orbital; Electron scatter; Energy curve; Local potential; N_2; Resonance width; *11899.*

Shared holes; $SrTiO_3$; Color centers; EPR; Hole centers; Optical absorption; *11805.*

Shear modulus; Standard reference material; Young's modulus; Alumina; Elastic modulus; Resonance frequency; **J. 75A** *No. 3, 155-162 (1971).*

Sheet, plastic; Impact resistance, plastic sheet; Oriented sheet; Plastic sheet; Polystyrene plastic sheet; *PS31-70.*

Shelf-life extension; Sprouting inhibition; Chemical dosimeter; Disinfestation; Dosimetry; Dyes; Gamma rays; Insect sterilization; *12193.*

Shell model; Spurious; Sum rule; Electron scattering; Momentum transfer; Pair correlation; *12043.*

Shifting operators; Slit correction; Slit weighting-function; Small-angle x-ray scattering; Strong numerical instability; Conditions for convergence of solutions; Integral equation of first kind; **J. 75B** *Nos. 3 and 4, 187-207 (1971).*

Shock compression; Shock wave; Thermal relaxation; Equation of state of solids; Lattice dynamics; *SP326,* pp. 105-122.

Shock force; Space simulation; Testing; Volatile products; Absorption; Condensation; Contamination control; Evaluation; Far infrared; Fluid dynamic force; Microorganisms; Optical properties; Planetary quarantine; Polymers; *SP336,* pp. 51-77.

Shock wave; Solar wind; Earth magnetic field; Earth tail; Magnetosphere; Plasma theory; *SP336,* p. 297.

Shock wave; Thermal relaxation; Equation of state of solids; Lattice dynamics; Shock compression; *SP326,* pp. 105-122.

Shock wave technique; Temperature; Accurate measurement; Equation-of-state; Fixed points; High pressure; High-pressure equipment; Instrumentation; Pressure scale; *SP326.*

Shockley partials; Dislocation geometry; Stacking faults; *SP317,* pp. 47-55.

Shorted termination; Waveguide; Microwave; Reflection coefficient; Return loss; Sliding short; *TN602.*

Shortite; Single-crystal x-ray diffraction; Calcium sodium carbonate; Crystal structure; **J.75A** *No. 2, 129-135 (1971).*

Shrink film, plastic; Balanced and unbalanced film; Film, plastic; Orientation release stress; Plastic heat-shrinkable film; Retraction ratio; *PS29-70.*

Shrinkage; Statistical evaluation; Strength; Sulfate expansion; Trace elements; Alkalies; Concrete; Durability; Heat of hydration; Portland cements; *11863.*

SI; Standards; U.S. Metric Study; Engineering standards; International standards; International System of Units; Metric conversion; Metric system; Metrication; Metrication and engineering standards; *SP345-11.*

SI; Système International des Unités; Units of measurement; General conference of weights and measures; International Committee of Weights and Measures; International System of Units; *SP330.*

SI; U.S. Metric Study; Commercial weights and measures; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; *SP345-3.*

SI; U.S. Metric Study; Consumers; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; *SP345-7.*

SI; U.S. Metric Study; Department of Defense; International System of Units; Metric conversion; Metric system; Metrication; Metrication, costs and benefits of; Metrication, impact of; *SP345-9.*

SI; U.S. Metric Study; Education; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; *SP345-6.*

SI; U.S. Metric Study; Federal Government; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; *SP345-2.*

SI; U.S. Metric Study; Foreign trade; International System of Units; Metric conversion; Metric conversion, effect on foreign trade; Metric system; Metric usage; Metric usage, effect on foreign trade; Metrication; *SP345-8.*

SI; U.S. Metric Study; International System of Units; Manufacturing industry; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; Metric conversion; Metric system; Metric usage; *SP345-4.*

SI; U.S. Metric Study; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; Nonmanufacturing businesses; *SP345-5.*

SI; U.S. Metric Study; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; *SP345-12.*

Siemens-Halske AEG; Wandel & Goltermann; Automatic noise-level recorders; Calibration of carrier-frequency filters; Microwave transmission lines; *SP335,* pp. 125-127.

Sievert function; Biorthogonal polynomials; Gamma-ray transport; Moment method; Neutron transport; Polynomial truncation errors; **J.75B** *Nos. 1 and 2, 1-16 (1971).*

Signal colors; Signal standards; Spectral transmittance of glass filters; Traffic signals; Aircraft signals; Color standards; Filter permanence; Limit filters; Railroad signals; *TN564.*

Signal level calibration; Standard reference materials; Unrecorded reference; Average signal peak level; Computer amplitude reference; Magnetic tape; Master standard; Saturation curves; Secondary standard; *SP260-29.*

Signal standards; Spectral transmittance of glass filters; Traffic signals; Aircraft signals; Color standards; Filter permanence; Limit filters; Railroad signals; Signal colors; *TN564.*

Signature analysis; Vibration; Bearings; Diagnostics; Gears; Reliability; *SP336,* pp. 407-448.

Silane bonding; Composites; Denture base materials; Dentures; Dimensional stability; Foreign bodies; Prosthetics; Radiopacity; *12310.*

Silicon; ASTM standards; Integrated circuits; Microelectronics; Semiconductor devices; Semiconductor materials; Semiconductor process control; *11869.*

Silicon; Deep impurities; Germanium; Infrared; Photoconductivity; Photoresponse; Semiconductors; *TN570.*

Silicon; Device fabrication; Environmental testing; Integrated circuits; Measurement methods; Microcircuits; *SP336,* pp. 449-455.

Silicon; Space simulation; Defect annealing; Impurities; *SP336,* pp. 313-321.

Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; *TN702.*

Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Carrier lifetime; Die attachment; Electrical properties; epitaxial silicon; Gamma-ray detectors; Germanium; *TN560.*

Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; *TN571.*

Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; *TN592.*

Silicon; Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; *TN598.*

Silicon detector; Absorbed energy vs depth; Absorbed-energy distributions; Incident monoenergetic electrons; Monte Carlo calculations; Semi-infinite aluminum medium; *12140.*

Silicon detectors; Surface layers; Absorbed dose; Absorbed-energy distributions; Electron beams; Energy deposition; *12063.*

Silicon radiation detector; Temperature dependence; X rays; Gamma rays; Photocurrents; Radiation; Radiation detector; Radiation dosimetry; ***J. 75A*** *No. 6, 579-589 (1971).*

Silicon spectra in the sun's atmosphere; Spectra of silicon, atomic and ionic in the sun; Sun, silicon in the; *12010.*

Silicon surface-barrier detector; Alpha particles counting response; Capacitance; Detector noise; Electron fluence; Electrons radiation damage; Front and rear contact; Leakage current; *12107.*

Silicone rubber; Ablation; Aerodynamic shear; Carbon; Char; Cork; Epoxy-novolac; Erosion; Phenolic carbon; *SP336,* pp. 837-851.

Silver; Silver-tin alloys; Stacking fault probability; X-ray diffraction data; *11915.*

Silver; Standard errors; Standard reference materials; Vapor pressure; Cadmium; Components of error (within- and between-laboratory); Heats of sublimation (second and third law); Interlaboratory measurements; *SP260-21.*

Silver adsorption; Silver ion-selective electrode; Trace silver determination; Electrometric study of silver adsorption; *12353.*

Silver coated teflon; Teflon film; Ultraviolet degradation; Aluminum coated teflon; Electron degradation; Proton degradation; *SP336,* pp. 345-358.

Silver ion-selective electrode; Trace silver determination; Electrometric study of silver adsorption; Silver adsorption; *12353.*

Silver nitrate; Surface effect; Aliphatics; Aromatics; Complexing effects; Gas chromatography; Group separation; Mercuric nitrate; Olefins; *12024.*

Silver-tin alloys; Dislocation multipoles; Dislocation networks; Dislocation nodes; Dislocations; Electron microscopy; Hexagonal alloys; *12072.*

Silver-tin alloys; Stacking fault probability; X-ray diffraction data; Silver; *11915.*

Simple fluids; Temperature dependence; Thermal conductivity; Transport properties; Viscosity; Density dependence; Liquid state; *11879.*

Simple liquids; Superposition approximation; Three body correlation function; X-ray diffraction; Neutron diffraction; Percus-Yevick equation; Radial distribution function; *12016.*

Simulation; Solar ultraviolet radiation; Atmospheric environment; Balloon; Computer; Ozone; Plastic material; *SP336,* pp. 245-259.

Simulation; Space; Diving; Hyperbaric; Neutral buoyancy; 36, pp. 651-659.

Simulation; Space systems; System test bed; *SP336,* pp. 535-547.

Simulation; Spectral; Absorbing; Anomalous dispersion; Carbon dioxide; Cryodeposit; Cryogenics; Frost; Infrared; Integrating sphere; Mars; Reflectance; Scattering; *SP336,* pp. 165-183.

Simulation; Sublimation; Thermal conduction; Thermal vacuum tests; Volatile constituents; Volatilization; Absorption; Adsorption; "bake out"; Components; Decomposition; Degassing; Environment; Evaporation; Outgassing; *SP336,* pp. 473-485.

Simulation; Team development; Coast Guard; Development; Interdisciplinary team; Management science; Model building; Organization; Search and rescue; *12243.*

Simulation model; Systems analysis; Urban analysis; East Lansing, Mich.; Facility location; Fire station; *12018.*

Simulation research; Combined environmental stress; Dynamic environment simulator; Man-machine system; Man-rated centrifuge; *SP336,* pp. 587-598.

Simulation techniques; Space research; Convective processes; Mars atmosphere exploration; Planetary atmosphere-surface interaction; Planetary meteorology; Research facility; *SP336,* pp. 699-723.

Simultaneous determination of oxygen and nitrogen; Standard Reference Material for oxygen; Inert gas fusion; One ppm of oxygen and nitrogen in steel; Research Associate Program; *SP260-26.*

Simultaneous determination of vanadium and iron; Spectrophotometric determination of vanadium; Analysis of steel samples; Extraction with β-isopropyltropolone; *12335.*

Single classification; Statistics; Variance components; Weighting; Analysis of variance; Average (weighted); Interlaboratory evaluation; Round robin; *11906.*

Single crystal; Crystal growth; Cuprous oxide; *12137.*

Single crystal; Topography; X ray; Laser rod; Orientation; Ruby; *12066.*

Single crystal; Tungsten; Work function; Carbon monoxide; Chemisorption; Co-adsorption; Displacement reaction; Hydrogen; *12261.*

Single crystal; Unit cell; Growth technique; N-eicosane; *11875.*

Single crystal; X-ray diffraction; Anisotropic compressibility; Azides; Compressibility; High pressure; *12025.*

Single crystal; X-ray diffraction; Cesium; Gallium; High-pressure; Polymorph; *12187.*

Single crystal faces of tungsten; Spin-orbit split bands; Tungsten; Electrons; *12049.*

Single crystal x-ray diffraction; Aragonite; Barium calcium carbonate; Calcium carbonate; Crystal structure; ***J.75A*** *No. 3, 197-203 (1971).*

Single crystal x-ray diffraction; Calcium phosphate; Calcium phosphate-calcium silicate solid solution; Calcium phosphosilicates; Calcium silicates; Crystal structures; Glaserite; Hydroxyapatite; *12273.*

Single crystal x-ray diffraction; Cation vacancies; Glaserite; α-$Ca_3(PO_4)_2$; Calcium magnesium phosphate; *12274.*

Single crystal x-ray diffraction; Calcium carbonates; Carbonates; Crystal structure; ***J.75A*** *No. 1, 27-32 (1971).*

Single ion; Activity coefficients; Activity scales of high concentrations; Activity standard scales; Chloride activity convention; Ion activity standards; Ionic activity; Ion selective electrodes; *11859.*

Single-crystal x-ray diffraction; Calcium sodium carbonate; Crystal structure; Shortite; ***J.75A*** *No. 2, 129-135 (1971).*

Singlet oxygen; Air pollution; Chemical kinetics; Chemistry; Gas kinetics; Olefins; *12158.*

Singlet-triplet transitions; Spin forbidden transitions; Transition calculations; Asymmetric rotors; Matrix elements; Rotational line intensities; *12313.*

Singular values; Eigenvalues; Linear inequalities; **J. 75B** *Nos. 3 and 4, 117-124 (1971).*

Siping; Stability; Stopping distance; Tires; Traction; Tractionizing; *TN566.*

Size designations, boys'; Span charts, boys' sizing; Apparel, boys'; Body measurements, boys'; Pattern sizes, boys'; *PS36-70.*

Size designations, women's; Span charts, women's sizing; Apparel, women's; Body measurements, women's; Classifications, women's size; Grading charts, women's size; Pattern size, women's; *PS42-70.*

Sized ice, package quantities of; Block ice, package quantities of; Crushed ice, package quantities of; Cubed ice, package quantities of; Ice, package quantities of; Package quantities of ice; *PS48-71.*

Skew-symmetric; Commutator; Matrix; Orthogonal; *J.***75B** *Nos. 1 and 2, 17-21 (1971).*

Slater-Koster method; Stacking fault; Dislocation-electron interactions; *SP317,* pp. 1279-1288.

Slave oscillator; Atomic frequency standard; Cesium beam; Figure of merit; Frequency accuracy; Frequency multiplier; Frequency precision; NBS-III; NBS-5; Phase noise; Quartz crystal oscillator; Ramsey cavity; *11959.*

Slave oscillators; Accurate frequency standards; Accurate length standards; Accurate time standards; Accurate voltage standards; Ion storage; Laser stabilization; Maser oscillator; Metrology; Quantum electronics; Saturated absorption; *12099.*

Slave oscillators; Quantum electronics; Ion storage; Laser stabilization; Maser oscillator; Metrology; Saturated absorption; *12068.*

Sled tests; Webbing abrasion; Webbing degradation; Anthropomorphic dummies; Auto seat tests; Deceleration; Human kinematics; Human tests; Restraint geometry; Restraint systems; Seat belt; *11850.*

Slenderness; Strength; Structural analysis; Walls; Axial load (force); Bending moment; Building codes; End-fixity; Reinforced concrete; *11933.*

Slenderness effects; Standards; Structural stability; Walls; Brick; Cavity walls; Composite walls; Compressive strength; Concrete block; Flexural strength; Masonry; Mortar; *BSS34.*

Slenderness ratio; Stability; Structural engineering; Walls; Bricks; Buckling; Deflection; Loads (forces); Masonry; Moments; *12227.*

Sliding short; Adaptor; Connector; Efficiency; *J.***75C** *Nos. 3 and 4, 173-180 (1971).*

Sliding short; Shorted termination; Waveguide; Microwave; Reflection coefficient; Return loss; *TN602.*

Slip bands; Dislocation velocity; High speed dislocations; Impact stress pulse; Piezoelectric stress gauge; Quartz; *SP336,* pp. 487-508.

Slit correction; Slit weighting-function; Small-angle x-ray scattering; Strong numerical instability; Conditions for convergence of solutions; Integral equation of first kind; Shifting operators; **J. 75B** *Nos. 3 and 4, 187-207 (1971).*

Slit weighting-function; Small-angle x-ray scattering; Strong numerical instability; Conditions for convergence of solutions; Integral equation of first kind; Shifting operators; Slit correaction; **J. 75B** *Nos. 3 and 4, 187-207 (1971).*

Small attenuation measurement; Small insertion loss measurement; Small reflection coefficient measurements; Stainless steel waveguide; Comparison of results; Dc potentiometer test set; Dual channel system; Modulated subcarrier; Ratio transformer test set; *11917.*

Small carpets and rugs; Standards; Test development; Annual report to Congress; Blankets; Carpets and rugs; Children's sleepwear; Cooperation; Flammability; Flammability reduction; Mattresses; Research; *TN596.*

Small insertion loss measurement; Small reflection coefficient measurements; Stainless steel waveguide; Comparison of results; Dc potentiometer test set; Dual channel system; Modulated subcarrier; Ratio transformer test set; Small attenuation measurement; *11917.*

Small reflection coefficient measurements; Stainless steel waveguide; Comparison of results; Dc potentiometer test set; Dual channel system; Modulated subcarrier; Ratio transformer test set; Small attenuation measurement; Small insertion loss measurement; *11917.*

Small-angle x-ray scattering; Strong numerical instability; Conditions for convergence of solutions; Integral equation of first kind; Shifting operators; Slit correction; Slit weighting-function; **J. 75B** *Nos. 3 and 4, 187-207 (1971).*

Small-bore tubes; Standard hole; Wringing; Capacitance probe; Cylindrical gauge blocks; Inside diameters; *12277.*

Smectic crystals; Cholesteric crystals; Faulted ribbon; Liquid crystals; Nematic crystals; *SP317,* pp. 607-636.

Smith normal form; Designs; Incidence matrices; Invariant factors; *12338.*

Smith normal form; Invariant factors; Principal ideal rings; *J.***75B** *Nos. 1 and 2, 81-84 (1971).*

Smoke; Smoke density chamber; Statistical analysis; Building materials; Fire tests; Interlaboratory tests; Optical density; Round robin; *TN708.*

Smoke density chamber; Statistical analysis; Building materials; Fire tests; Interlaboratory tests; Optical density; Round robin; Smoke; *TN708.*

Smoke movement; Building design; Dampers; Ducts; Fire control; Fire spread; *12347.*

Smoke stacks; Structural failure; Wind loads; Buildings; Design criteria; Dynamics; Gust factors; *BSS30,* pp. 5-8.

Soap; Solubilization; Standard values; Surface active agents; Surface chemistry; Surface tension; Surfactant; Association colloid; Bibliography; CMC; Colloid; Colloidal electrolyte; Critical concentration; Critical micelle concentration; *NSRDS-NBS36.*

Sodium; Interband transition theory; Optical absorption; Potassium; Pseudopotential; *11921.*

Sodium; Trace elements; Activation analysis; Glass; Hydrated antimony pentoxide (HAP); Radiochemical separations; *12000.*

Sodium bifluoride; Stretching vibration; Bending vibration; Hydrogen bond; Infrared; Isotope dilution; Lattice mode; Raman; *11983.*

Sodium borohydride; Acetals; Fructose; Ketoses; Oxidation; Psicose; Reduction; Ruthenium tetraoxide; *12121.*

Sodium chlorate; Temperature dependence 14-90 K; ^{35}chlorine; Nuclear quadrupole resonance; *12258.*

Soft materials; Strain extensometer; Cryostat; Electrical resistance; *11825.*

Soft x ray; Alloy data; Bibliography; Index; Information; Knight shifts; NMR; *NBS-OSRDB-70-2 (COM-71-00722).*

Soft x ray; Alloy data; Bibliography; Index; Information; Knight shifts; NMR; *SP324.*

Soft x-ray; Band structure; Cu; Deep probes; Emission; Occupied bands; *11952.*

Software; Test problems; Accuracy; ANSI FORTRAN; Computer system implementation; Examples; OMNITAB II; *TN551.*

Solar array; Solar cell; Thermal cycle vacuum testing; Thermal shroud; Gaseous nitrogen heater; Gas stream blower; GN temperature conditioning; *SP336,* pp. 669-682.

Solar cell; Thermal cycle vacuum testing; Thermal shroud; Gaseous nitrogen heater; Gas stream blower; GN temperature conditioning; Solar array; *SP336,* pp. 669-682.

Solar cells; Space radiation; Space simulation; Thermal control; High vacuum; *SP336,* pp. 935-947.

Solar chromosphere; Solar spectrum; Sunspots; Wilson-Bappu effect; Ca H and K lines; Non-LTE line formation; Plages; Radiative transport; *12106.*

Solar chromosphere, physical properties; Solar chromosphere, structure; Spectral line formation; Spectroscopic diagnostics; Non-LTE radiative transfer; Resonance lines, Ca II; *12247*.

Solar chromosphere, physical properties; Spectral line formation; Spectroscopic diagnostics; Non-LTE radiative transfer; Resonance lines, Ca II; *12248*.

Solar chromosphere, structure; Spectral line formation; Spectroscopic diagnostics; Non-LTE radiative transfer; Resonance lines, Ca II; Solar chromosphere, physical properties; *12247*.

Solar panels; Space; Sputtering; Surface contamination; Cleaning; Desorption; Ions; Outgassing; Quartz crystal microbalance; *SP336*, pp. 113-127.

Solar photosphere; Solar ultraviolet spectrum; H_3^+; Opacity, continuous; *12246*.

Solar physics; Transition probabilities; Atomic energy levels; Gaseous nebulae; Non-LTE thermodynamics; *SP353*.

Solar spectra; Atomic spectra; Coronal spectra; Periodicities, atomic spectra; Rare-earth spectra; Regularities, atomic spectra; *12288*.

Solar spectra; Spectra, atomic; Spectra, rare-earth; Atomic spectra; Coronal spectra; Rare-earth spectra; *11987*.

Solar spectrum; Sunspots; Wilson-Bappu effect; Ca H and K lines; Non-LTE line formation; Plages; Radiative transport; Solar chromosphere; *12106*.

Solar ultraviolet radiation; Atmospheric environment; Balloon; Computer; Ozone; Plastic material; Simulation; *SP336*, pp. 245-259.

Solar ultraviolet spectrum; H_3^+; Opacity, continuous; Solar photosphere; *12246*.

Solar wind; Earth magnetic field; Earth tail; Magnetosphere; Plasma theory; Shock wave; *SP336*, p. 297.

Solar wind; Sputtering; Ultrahigh vacuum systems; Charge exchange; Charge neutralization; Ion optics; Mass separators; Proton sources; *SP336*, pp. 261-277.

Solar wind simulator; Ion beam deflection; Ion optics; Mass separator; Proton source; *SP336*, pp. 279-296.

Solder-drop Josephson junctions; Superconductivity; Inductive ratio divider; Josephson effect; NPL of UK; Potential-divider resistor; Quantum standard of voltage; *SP335*, pp. 111-115.

Soldering; Contact resistance; Oxide semiconductors; TiH_2; *11812*.

Solenoid; Toroid; Transformer; Vector potential; Magnetic field; *12372*.

Solid mechanics; Green's tensor; Hooke's elasticity; Non-local elasticity; *SP317*, pp. 737-746.

Solid mechanics; Surface waves; Green's tensor; Non-local elasticity; *SP317*, pp. 747-759.

Solid mechanics; Wave propagation; Dilatation centers; Lattice statics; Non-local theories; *SP317*, pp. 729-736.

Solid state; Amplifiers; Basic characteristics; Microwave; Oscillators; Semiconductor; *TN597*.

Solid state counters; Tests; X-ray spectra; X-ray spectrometers; Electron diffraction; Electron probes; Evaluation; Gas flow; Lithium; Microanalysis; Multichannel analyzer; Proportional counters; Quantitative analysis; *12251*.

Solid state switch; Peak pulse power measurement; Sampling power measurement; *12295*.

Solids; Spark source; Trace elements; Fluctuations; Homogeneity; Ion sensitive emulsion; Mass spectrometry; Precision; Quantitative analysis; *12127*.

Solids; Ultrasonics; Bulk modulus; Density; Dilatometric measurements; High pressure; Liquids; *SP326*, pp. 11-22.

Solids sound speed accuracy; Speed of sound; Transient pulse-acoustical; Acoustical pulse; Longitudinal and shear sound waves; *J.75C No. 1, 33-40 (1971)*.

Solid-state; Theoretical physics; Thermally activated processes; Twinning; Conference; Continuum mechanics; Crystal physics, disclinations; Dislocations; Elasticity; Electron-dislocation interactions; Lattice defects; Phonon-dislocation interactions; *SP317*.

Solubility; Space simulation; Temperature effect; Tests; Viscosity; Electron damage; Electron energy; Electron spin resonance; Evaluation; Gel; Mechanical properties; Optical properties; Plastic films; Poly(ethylene terephtalate); *SP336*, pp. 323-344.

Solubilization; Standard values; Surface active agents; Surface chemistry; Surface tension; Surfactant; Association colloid; Bibliography; CMC; Colloid; Colloidal electrolyte; Critical concentration; Critical micelle concentration; Detergent; *NSRDS-NBS36*.

Solute; Stability; Surface tension; Aqueous solutions; Cylinder; Ice; *11889*.

Solute segregation; Super-purity metals; Aluminum; Electrical resistivity; Grain boundaries; *11818*.

Solution adsorption; Adsorption from solution; Calcium phosphate; Composite adsorption; Isotopic exchange; Kinetics of adsorption; Mechanism of adsorption; *12249*.

Solution hardening; Upper yield point; Zone-refined iron; Flow stress; Impurity softening; Lattice solution; Lower yield stress; Nitrogen; Polycrystals; *11946*.

Solvable groups; 2-generator groups; Density; *12001*.

Sound transmission; Tires; Transportation noise; Trucks; Urban planning; Acoustics; Noise measurement; Noise pollution; Noise (sound); *12329*.

Source kernels; Stress functions; Anisotropic elasticity; Dislocations; Green's tensor; Incompatibility; Internal stress; *SP317*, pp. 89-124.

SO_2^- anion; Sulfur dioxide; Alkali metal reactions; Charge transfer; Electron capture; Infrared spectrum; Matrix isolation; Molecular orbitals; *12336*.

Space; Diving; Hyperbaric; Neutral buoyancy; Simulation; 36, pp. 651-659.

Space; Sputtering; Surface contamination; Cleaning; Desorption; Ions; Outgassing; Quartz crystal microbalance; Solar panels; *SP336*, pp. 113-127.

Space environment; Information center; Interferometric measurements; Optical materials; Physical property changes; *SP336*, pp. 949-959.

Space environment simulation; Ultrahigh vacuum; Anisotropy; Compression tests; Mass spectroscopy; Mechanical properties; Outgassing; Pressure measurements; Rock mechanics; *SP336*, pp. 209-223.

Space environment simulation chambers; Contamination collection units; Gas-liquid chromatography; Infrared spectrometry; Mass spectrometry; Quartz crystal oscillator mass monitors; Radiometry; Reflectometry; *SP336*, pp. 25-49.

Space radiation; Space simulation; Thermal control; High vacuum; Solar cells; *SP336*, pp. 935-947.

Space research; Convective processes; Mars atmosphere exploration; Planetary atmosphere-surface interaction; Planetary meteorology; Research facility; Simulation techniques; *SP336*, pp. 699-723.

Space simulation; Cryogenics; Liquid air; Liquid nitrogen; Liquid oxygen; Neutral buoyancy; *SP336*, pp. 623-649.

Space simulation; Defect annealing; Impurities; Silicon; *SP336*, pp. 313-321.

Space simulation; Temperature effect; Tests; Viscosity; Electron damage; Electron energy; Electron spin resonance; Evaluation; Gel; Mechanical properties; Optical properties; Plastic films; Poly(ethylene terephtalate); *SP336*, pp. 323-344.

Space simulation; Testing; Volatile products; Absorption; Condensation; Contamination control; Evaluation; Far infrared; Fluid dynamic force; Microorganisms; Optical properties; Planetary quarantine; Polymers; Shock force; *SP336*, pp. 51-77.

Space simulation; Thermal control; High vacuum; Solar cells; Space radiation; *SP336*, pp. 935-947.

Space simulation; Thermal radiation; Vacuum; Weightlessness; Ablation; Particulate radiation; Re-entry; *SP336*.

Space simulation chamber; Vacuum; Cryopumping; Ion pump; Pumping speed; *SP336*, pp. 683-698.

Space station simulator; Submersible; Closed ecological system; Habitability; Maintainability prediction; Microbiology; Microflora shift; Physiology; Psychology; *SP336*, pp. 599-621.

Space systems; System test bed; Simulation; *SP336*, pp. 535-547.

Space vacuum system gas; Mass spectrometry; Residual gas analysis computer simulation; Residual gas analysis data reduction; *SP336*, pp. 151-164.

Spacecraft; Blast over-pressure; Combustion front; Hypervelocity impact; Meteorid penetration; Oxidative detonation; Oxidative flash; Oxygen atmosphere; *SP336*, pp. 569-585.

Spacecraft; Contamination; Mass transfer; *SP336*, pp. 79-103.

Spacecraft contamination; Particulate sampling; Quartz crystal microbalance; *SP336*, pp. 105-111.

Span charts, boys' sizing; Apparel, boys'; Body measurements, boys'; Pattern sizes, boys'; Size designations, boys'; *PS36-70*.

Span charts, women's sizing; Apparel, women's; Body measurements, women's; Classifications, women's size; Grading charts, women's size; Pattern size, women's; Size designations, women's; *PS42-70*.

Spark; Spectrometry; Accuracy; Circumvention; Emulsions; Homogeneity; Ions; Mass; Platinum; Precision; Replicate; *11847*.

Spark source; Trace elements; Fluctuations; Homogeneity; Ion sensitive emulsion; Mass spectrometry; Precision; Quantitative analysis; Solids; *12127*.

Spatial correlation; Turbulence; Wind observations; Wind profiles; Climatology; Meteorology; *BSS30*, pp. 23-25.

Spatial rotation; Angular velocity; Effective axis and angle of rotation; Intrinsic vector; Kinematics of a rigid body; Rotation group; **J.75B** *Nos. 3 and 4, 179-186 (1971)*.

Special functions; Error functions; Indefinite integrals; **J.75B** *Nos. 3 and 4, 157-178 (1971)*.

Specific heat; Cerous magnesium nitrate; Cesium titanium alum; Dipole-dipole interaction; Neodymium ethyl sulphate; Shape dependent; *11909*.

Specific heat; Speed of sound; Surface tension; Thermal conductivity; Thermal diffusivity; Vapor pressure; Viscosity; Volume; Density; Dielectric constant; Enthalpy; Entropy; Equation of state; Fixed points; Heat transfer coefficients; *TN384*.

Specific heat; Spin-d fusion; Susceptibility; Ultrasonic attenuation; Frequency shift; Heisenberg paramagnet; *12265*.

Specific heat; Standard reference material; Synthetic sapphire; Thermodynamic functions; Alumina; Aluminum oxide; Corundum; Drop calorimetry; Enthalpy; Heat capacity standard; **J.75A** *No. 5, 401-420 (1971)*.

Specific heat; Susceptibility; Thermometer scale; Cerous magnesium nitrate; Dipole system; Low temperature; Paramagnetic salt; *11822*.

Specific heat; Thermal expansion; Thermodynamics and expansions; Bulk modulus; Dislocations and thermodynamics; Entropy; *SP317*, pp. 1223-1225.

Specific heat; 0.48 to 10 K; Clustering; $Co_{0.6}Ni_{0.4}$ alloy; Electronic specific heat; *11843*.

Specific heats; Cesium titanium alum; Critical temperature; Face centered cubic lattice; Magnetic dipole-dipole coupling; *12077*.

Specific heats of the saturated liquid; Thermofunctions for ideal gas states; Thermophysical properties; Heats of vaporization; Methane; Orthobaric densities; **J.75A** *No. 1, 15-21 (1971)*.

Specification; Tolerances; Weights and measures inspection; Accurate measurements of volume of liquids; Field standard measuring flasks; *H105-2*.

Specifications; Technical requirements; Tolerances; Commercial weighing and measuring devices; *H44*.

Specifications; Test measures; Tolerances; Weights and measures inspection; Accurate measurements of volumes; Field standard; Metal volumetric field standards; Provers; *H105-3*.

Spectra; Absorption; Gas; Infrared; Methyl iodide; Molecular geometry; Molecular structure; *11973*.

Spectra; Absorption; Laser; *12253*.

Spectra; Bond distances; Hydrogen cyanide; Infrared; Microwave; Molecular structure; Rotational constants; *12342*.

Spectra; Rotational constants; Vibrational constants; Absorption; Energy levels; Gas laser; HCH, hydrogen cyanide; Infrared; *12044*.

Spectra; Wavelengths; Praseodymium; *12257*.

Spectra, atomic; Spectra, rare-earth; Atomic spectra; Coronal spectra; Rare-earth spectra; Solar spectra; *11987*.

Spectra, carbon; Wavelengths, carbon spectra; Atomic energy levels, carbon spectra; Atomic spectra of carbon; Carbon spectra; Multiplet tables, carbon spectra; *NSRDS-NBS3, Section 3*.

Spectra, NIV-NVII; Wavelengths, nitrogen spectra NIV-NVII; Atomic energy levels, NIV-NVII; Nitrogen spectra, NIV-NVII; Multiplet tables, NIV-NVII; *NSRDS-NBS3, Section 4*.

Spectra of silicon, atomic and ionic in the sun; Sun, silicon in the; Silicon spectra in the sun's atmosphere; *12010*.

Spectra, rare-earth; Atomic spectra; Coronal spectra; Rare-earth spectra; Solar spectra; Spectra, atomic; *11987*.

Spectral; Absorbing; Anomalous dispersion; Carbon dioxide; Cryodeposit; Cryogenics; Frost; Infrared; Integrating sphere; Mars; Reflectance; Scattering; Simulation; *SP336*, pp. 165-183.

Spectral analysis; Computer program; Isopropyl; NMR; Nuclear magnetic resonance; Phosphorus; *11897*.

Spectral density; Speed of light; Standard frequency broadcasts; Statistics of time/frequency measurements; Time; Time/frequency dissemination; Time scales; Timing (HF, LF, satellite, TV, VLF); Wavelength standards; WWV; WWVB; WWVH; WWVL; *SP350*.

Spectral density; Variance; Allan variance; Frequency; Frequency stability; Sample variance; *12228*.

Spectral emissivity; Standard; Ceramic; Light; Photometry; *TN595*.

Spectral irradiance; Spectral radiance; Irradiance; Radiometric standards; Radiometry; *SP336*, pp. 185-187.

Spectral line formation; Doppler broadening; Escape probability; Planetary nebula; *12180*.

Spectral line formation; Spectroscopic diagnostics; Non-LTE radiative transfer; Resonance lines, Ca II; Solar chromosphere, physical properties; Solar chromosphere, structure; *12247*.

Spectral line formation; Spectroscopic diagnostics; Non-LTE radiative transfer; Resonance lines, Ca II; Solar chromosphere, physical properties; *12248*.

Spectral radiance; Irradiance; Radiometric standards; Radiometry; Spectral irradiance; *SP336*, pp. 185-187.

Spectral radiance standard; Stark-broadening; Emission coefficient; Hydrogen; Hydrogen continuum; LTE; **J.75A** *No. 4, 291-333 (1971)*.

Spectral resolution; Activation analysis; Component identification; Result computation; *12344*.

Spectral series; Spectroscopy; Wavelength; Energy levels; Ionization potential; Nickel; **J.75A** *No. 4, 335-336 (1971)*.

Spectral transmission density; Densitometer; Microdensitometer; Radiochromic dye films; **J.75C** *No. 1, 23-27 (1971)*.

Spectral transmittance of glass filters; Traffic signals; Aircraft signals; Color standards; Filter permanence; Limit filters; Railroad signals; Signal colors; Signal standards; *TN564*.

Spectrometer; Azimuthal angle; Compton-Raman interaction;

materials; Standard reference materials; *12349*.

SrO:IrO$_2$ compounds; SrO-IrO$_2$-Ir system; Dissociation; Equilibrium; Phase relations; *J.*75A *No. 3, 185-196 (1971)*.

SrO-IrO$_2$-Ir system; Dissociation; Equilibrium; Phase relations; SrO:IrO$_2$ compounds; *J.*75A *No. 3, 185-196 (1971)*.

SrTiO$_3$; Color centers; EPR; Hole centers; Optical absorption; Shared holes; *11805*.

SrTiO$_3$; Strontium titanate; Superconductivity; Surface potential barrier; Tunneling; Indium; Semiconductors; *11925*.

Stability; Adaption; Acrylic; Contraction; Dentures; Epoxy; Expansion; Hard rubber; Retention; Serviceability; *12189*.

Stability; Stress distribution; Unreinforced concrete; Buckling; compression members, Concrete; Deflection; Equilibrium; Load eccentricity; Masonry; Section cracking; *12298*.

Stability; Stopping distance; Tires; Traction; Tractionizing; Siping; *TN566*.

Stability; Structural engineering; Walls; Bricks; Buckling; Deflection; Loads (forces); Masonry; Moments; Slenderness ratio; *12227*.

Stability; Sulfuric acid; Thermogravimetric analysis; Alum; Aluminum; Apparent activation energy; Calcium; Cellulose; Crosslinking; Differential thermal analysis; Ion exchange; Organic acid; Oxycellulose; *12218*.

Stability; Surface tension; Aqueous solutions; Cylinder; Ice; Solute; *11889*.

Stability structure; High temperature species; *11961*.

Stabilization; Techniques; Time standard; Frequency; Laser; Laser frequency measurement; *12135*.

Stabilizer; Bridge; Leveler; Microwave; Power; Self balancing; *12042*.

Stable capacitance; Temperature variation of capacitance; Capacitance; Dielectric constant; *11935*.

Stacking fault; Dislocation-electron interactions; Slater-Koster method; *SP317*, pp. 1279-1288.

Stacking fault energy; Stacking fault tetrahedra; Dislocation nodes; Dislocation ribbons; Dislocations; Faulted dislocation dipoles; *11828*.

Stacking fault energy; Temperature; Dislocations; Electron microscopy; Iron alloys; *12105*.

Stacking fault probability; X-ray diffraction data; Silver; Silver-tin alloys; *11915*.

Stacking fault tetrahedra; Dislocation nodes; Dislocation ribbons; Dislocations; Faulted dislocation dipoles; Stacking fault energy; *11828*.

Stacking faults; Dislocation-electron interactions; Interatomic potentials; *SP317*, pp. 1259-1277.

Stacking faults; Shockley partials; Dislocation geometry. *SP317*, pp. 47-55.

Stagnation point; Turbulence; Disk; Pressure fluctuations; *TN563*.

Stagnation pressure; Arc currents; Arc heaters; Constricted arc; Enthalpy; Operational limits; *SP336*, pp. 879-892.

Stainless steel; Cryostat; Fatigue; Impact; Low temperature; Mechanical property equipment; *J.*75C *No. 2, 95-98 (1971)*.

Stainless steel; Fatigue; Fracture; Impact; Low temperature: Mechanical property equipment; *TN609*.

Stainless steel waveguide; Comparison of results; Dc potentiometer test set; Dual channel system; Modulated subcarrier; Ratio transformer test set; Small attenuation measurement; Small insertion loss measurement; Small reflection coefficient measurements; *11917*.

Standard; Ceramic; Light; Photometry; Spectral emissivity; *TN595*.

Standard; Torsional pendulum; Viscosity; Absolute measurement; Calibration; *J.*75A *No. 6, 541-551 (1971)*.

Standard; Viscosity; Viscous flow; Absolute measurement; Calculation of bounds; Calibration; Poiseuille flow; *J.*75A *No. 6, 553-560 (1971)*.

Standard; Voluntary Product Standards; Editorial format; Format; Product Standards: *PS0-70*.

Standard; X-ray diffraction; Crystal structure; Integrated intensities; Lattice constants; Peak intensities; Powder patterns; Reference intensities; *Monogr. 25, Section 9*.

Standard cell surveillance; Computer automation; Resistance thermometers; Resistor intercomparison; *SP335*, pp. 29-33.

Standard cells; Unsaturated standard cells; Electromotive force; Saturated standard cells; *12037*.

Standard errors; Standard reference materials; Vapor pressure; Cadmium; Components of error (within- and between-laboratory); Heats of sublimation (second and third law); Interlaboratory measurements; Silver; *SP260-21*.

Standard frequencies; Time signals; Very low frequency; Broadcast of standard frequencies; High frequency; Low frequency; *SP236, 1971 Edition*.

Standard frequency broadcasts; Statistics of time/frequency measurements; Time; Time/frequency dissemination; Time scales; Timing (HF, LF, satellite, TV, VLF); Wavelength standards; WWV; WWVB; WWVH; WWVL; Atomic clocks; Atomic standards; *SP350*.

Standard hole; Wringing; Capacitance probe; Cylindrical gauge blocks; Inside diameters; Small-bore tubes; *12277*.

Standard Metropolitan Statistical Areas; Computers; Data processing; Federal Information Processing Standards Publication; National government; Representations and codes; *FIPS PUB 8-1*.

Standard reference data; *12096*.

Standard Reference Material; Activation analysis; Biological; Botanical; Environment; *12334*.

Standard reference material; Synthetic sapphire; Thermodynamic functions; Alumina; Aluminum oxide; Corundum; Drop calorimetry; Enthalpy; Heat capacity standard; Specific heat; *J.*75A *No. 5, 401-420 (1971)*.

Standard reference material; Thermal expansion; Components of error (within and between samples); Copper; Interferometer; *12036*.

Standard Reference Material; Tissue standard; Trace analysis; Biological standards; Blood standard; Botanical standards; Environmental samples; *12132*.

Standard reference material; Young's modulus; Alumina; Elastic modulus; Resonance frequency; Shear modulus; *J.*75A *No. 3, 155-162 (1971)*.

Standard Reference Material for oxygen; Inert gas fusion; One ppm of oxygen and nitrogen in steel; Research Associate Program; Simultaneous determination of oxygen and nitrogen; *SP260-26*.

Standard reference materials; Automated analysis; Clinical chemistry; Instrumentation; *12047*.

Standard Reference Materials; Fe-3Si alloy; Homogeneity testing; Metallography; Microprobe analysis; Spectrometric analysis; *SP260-22*.

Standard reference materials; Spectrophotometry SRMs; Clinical chemistry; Organic SRMs; *12194*.

Standard reference materials; SRM's; Standard Reference Materials Program; Agriculture; Air and water pollution; Biology; Botany; Health and medicine; Instrument calibration; Metrology; Research materials; *12349*.

Standard reference materials; Standard samples; USSR standards; Standards in Russia: *SP260-30*.

Standard Reference Materials; Temperature; Thermal; Ceramics; Chemical composition; Mechanical properties; Pressure; Properties; Standards; *12181*.

Standard reference materials; Unrecorded reference; Average signal peak level; Computer amplitude reference; Magnetic tape; Master standard; Saturation curves; Secondary standard; Signal level calibration; *SP260-29*.

Standard reference materials; Vapor pressure; Cadmium; Components of error (within- and between-laboratory); Heats of sublimation (second and third law); Interlaboratory measurements; Silver; Standard errors; *SP260-21*.

Standard reference materials; X-ray emission; Alloys; Corrections; Electron probe; Homogeneity; Matrix scanner; Microanalysis; Quantitative analysis; *SP260-28.*

Standard Reference Materials Program; Agriculture; Air and water pollution; Biology; Botany; Health and medicine; Instrument calibration; Metrology; Research materials; Standard reference materials; SRM's; *12349.*

Standard samples; USSR standards; Standards in Russia; Standard reference materials; *SP260-30.*

Standard values; Surface active agents; Surface chemistry; Surface tension; Surfactant; Association colloid; Bibliography; CMC; Colloid; Colloidal electrolyte; Critical concentration; Critical micelle concentration; Detergent; *NSRDS-NBS36.*

Standard waveforms; Lossy uniform transmission lines; Oscilloscope errors; Pulse generators; *12045.*

Standardization; New technology; Performance standards; Product standards; *12245.*

Standardization; United Soviet Socialist Republics; Building economics; Building systems; Construction industry; Housing; Precast concrete; Production capacity; Production management; Production methods; *SP334.*

Standards; Building; Components; Precoordination; *BSS32.*

Standards; Calibration; Current meters (fluids); Hydraulics; Measurement; Open-channel flow; *12358.*

Standards; CAMAC; Data; Dataway; Digital; Instrumentation; Modules; Nuclear; *12142.*

Standards; Frequency; Resonance; *11857.*

Standards; Graphite arc; High-speed measurements; High temperatures; Pyrometry; Radiance; *12201.*

Standards; Standard Reference Materials; Temperature; Thermal; Ceramics; Chemical composition; Mechanical properties; Pressure; Properties; *12181.*

Standards; State laboratories; Volume measurements; Length measurements; Mass measurements; Metrology; *SP335,* pp. 89-94.

Standards; Structural engineering; Bridge; Building; Codes; Dams; Earthquake damage; Earthquakes; Foundation geology; Highways; Hospital; Housing; Mobile home; Seismic; *BSS40.*

Standards; Structural stability; Walls; Brick; Cavity walls; Composite walls; Compressive strength; Concrete block; Flexural strength; Masonry; Mortar; Slenderness effects; *BSS34.*

Standards; Subsets; American Standard Code for Information Interchange; ASCII; Coded character subsets; Codes; Data communication; Data interchange; Data processing; Federal Information Processing Standards; Graphic character subsets; *FIPS PUB 15.*

Standards; Substitution weighing; Transposition weighing; True mass; Uncertainty; Value; Balance; Buoyancy; Calibration; *TN577.*

Standards; Test development; Annual report to Congress; Blankets; Carpets and rugs; Children's sleepwear; Cooperation; Flammability; Flammability reduction; Mattresses; Research; Small carpets and rugs; *TN596.*

Standards; Thermal neutrons; Data analysis; Flux density; Intercomparisons; Least squares; *12048.*

Standards; Time; Time standards, universal time; Atomic time; *12264.*

Standards; U.S. Government; American National Standards; Computers, data elements and codes; Data processing systems; Federal Information Processing Standards; International Organization for Standardization; Management information systems; *FIPS PUB 12.*

Standards; U.S. Metric Study; Engineering standards; International standards; International System of Units; Metric conversion; Metric system; Metrication; Metrication and engineering standards; SI; *SP345-11.*

Standards for audiometers; Threshold of hearing; Audiometry; Earphones; NBS 9-A coupler; Reference threshold sound pressure levels; *12260.*

Standards in Russia; Standard reference materials; Standard samples; USSR standards; *SP260-30.*

Standards laboratory management; Test equipment records; Use, storage, or surplus; Data for decision; *SP335,* pp. 95-98.

Standards, plastics; Index of plastics standards; Plastics standards, world index; *SP352.*

Standards, voluntary, index of; Engineering standards, index of; Index of standards, recommended practices, specifications, and test methods; Key-Word-In-Context index of voluntary standards; *SP329.*

Stannic oxide; Alloys; Analysis; Internal standard; Mössbauer spectrometry; *11978.*

Stark broadening; Stark-induced red shift; White dwarf spectra; Balmer lines H_α, H_β, and H_γ; Gravitational red shift; *12226.*

Stark broadening; Theory; Unified classical path; Hydrogen lines; Line wings; *12222.*

Stark broadening; Unified theory; Classical path; Hydrogen lines; Line wings; One-electron theory; *12084.*

Stark broadening; Unified theory; Classical path; Hydrogen lines; Line wings; *Monogr. 120.*

Stark effect; Rotational spectrum; Dipole moment; Ethynyldifluoroborane; Microwave spectrum; Molecular structure; *12328.*

Stark-broadening; Emission coefficient; Hydrogen; Hydrogen continuum; LTE; Spectral radiance standard; **J.75A** *No. 4, 291-333 (1971).*

Stark-broadening; Time-ordering; Unified theory; Lyman-α; *12208.*

Stark-broadening; Time-ordering; Unified theory; Lyman-α; *Monogr. 121.*

Stark-induced red shift; White dwarf spectra; Balmer lines H_α, H_β, and H_γ; Gravitational red shift; Stark broadening; *12226.*

State laboratories; Volume measurements; Length measurements; Mass measurements; Metrology; Standards; *SP335,* pp. 89-94.

Static fatigue; Stress corrosion; Crack propagation; Fracture; Glass; *11992.*

Static loads; Test equipment; Compression tests; Dynamic loads; High-speed photography; Indicating instruments; Indicator characteristics; Loading rate; Loads (forces); Motion picture cameras; Photographic equipment; *12080.*

Static pressures; Wind effects; Wind tunnel modeling; Architectural features; Buildings; Mullions; Parapets; Roof projections; *BSS30,* pp. 73-86.

Statistical; Burnett; Gas; Model dependency; Nonlinear; PVT; *11932.*

Statistical analysis; Automatic printing; Bessel functions; Data analysis; Data manipulation; Easy and effective programming in English; List of instructions; Matrix operations; Numerical analysis; OMNITAB II user oriented computing system; Self-teaching; *TN552.*

Statistical analysis; Building materials; Fire tests; Interlaboratory tests; Optical density; Round robin; Smoke; Smoke density chamber; *TN708.*

Statistical analysis; Structural engineering; Wind loads; Wind tunnel modeling; Aeroelasticity; Buildings; Dynamics; *BSS30,* pp. 107-114.

Statistical equilibrium; Configurational thermodynamic properties; Excluded volume; Extrapolations; Lattice models; Noncombinatorial method; *11880.*

Statistical evaluation; Strength; Sulfate expansion; Trace elements; Alkalies; Concrete; Durability; Heat of hydration; Portland cements; Shrinkage; *11863.*

Statistical mechanics; Thermodynamics; Lennard-Jones gas; (*m*-6) intermolecular potential; Quantum corrections; Second virial coefficient; **J.75A** *No. 1, 57-89 (1971).*

Statistical mechanics; Viscosity; Boltzmann gas; Cross-section for viscosity; Hard sphere gas; Quantum corrections; *12303.*

Statistical methods; Continuum mechanics; Dislocation field theory; *SP317,* pp. 785-816.

Statistical methods; Dislocations; Elasticity; *SP317,* pp. 1191-1193.

Statistical methods for dislocations; Line broadening; Optical zero phonon line; Spin resonance; *SP317*, pp. 1169-1173.

Statistical methods for dislocations; Diffraction profiles; Dislocation diffraction; Kinematic x-ray diffraction; *SP317*, pp. 1195-1221.

Statistical physics; Thermal conductivity; Transport properties; Disordered one-dimensional crystal; Multiple scattering; *12376*.

Statistical physics; Transmission coefficient; Defects in harmonic crystal; Functional equation; Many-body problem; Multiple scattering; *12375*.

Statistical theory of dislocation; Thermal acceleration; Arrhenius rate theory; Dislocation dynamics; *SP317*, pp. 1065-1076.

Statistical validity; Two-method optimization; Data support; Fixed calibration interval; Instrument reliability; *SP335*, pp. 73-79.

Statistics; Computer programs; Fourier analysis; Nickel steels; X-ray analysis; X-ray diffraction; *TN600*.

Statistics; Variance components; Weighting; Analysis of variance; Average (weighted); Interlaboratory evaluation; Round robin; Single classification; *11906*.

Statistics of time/frequency measurements; Time; Time/frequency dissemination; Time scales; Timing (HF, LF, satellite, TV, VLF); Wavelength standards; WWV; WWVB; WWVH; WWVL; Atomic clocks; Atomic standards; Clock dissemination; *SP350*.

Status and problems; Dislocation observations; Dislocation theory; *SP317*, pp. 5-9.

Steady control versus sudden change; Managerial breakthrough techniques; Personnel selection for metrology; *SP335*, pp. 85-88.

Steady-state; Cilia; Conformational entropy; Free energy; Nucleation rate; Rate constants; Self-nucleation; *12293*.

Steam; Thermodynamic anomalies; Vapor pressure; Argon; Carbon dioxide; Classical equation; Coexistence curve; Critical exponents; Critical point; Lattice gas; Power laws; Rectilinear diameter; *11985*.

Steam; Venturi; Water; Critical flow; Pressure profile; *TN608*.

Steam; Virial coefficients; Clausius-Clapeyron equation; Saturation vapor pressure over water; Vapor pressure; Vapor pressure of water; Water vapor; **J.75A** *No. 3, 213-230 (1971)*.

Steel; Titanium; Ultrahigh vacuum; Adhesion; Basalt; Fiberglass; Friction; *SP336*, pp. 225-244.

Steel bi-fold doors; Bi-fold doors, steel; Closet doors, steel bi-fold; Doors, steel bi-fold; *PS38-70*.

Steel piling; Undisturbed soil; Weight loss; Corrosion; Corrosion rate; Disturbed soil; Instantaneous rate; Pit depth; Pitting factor; Polarization; **J.75C** *No. 2, 107-121 (1971)*.

Steel pipe and fittings, plastic lined; Pipe and fittings, steel, plastic lined; Plastic lined steel pipe; Polytetrafluoroethylene plastic lined pipe; PTFE lined pipe; *PS33-70*.

Steel pipe and fittings, plastic lined; FEP lined pipe; Fluorinated ethylene-propylene plastic lined pipe; Pipe and fittings, steel, plastic lined; Plastic lined steel pipe; *PS34-70*.

Steel pipe and fittings, plastic lined; Pipe and fittings, steel, plastic lined; Plastic lined steel pipe; Poly(vinylidene fluoride) plastic lined pipe; PVF_2 lined pipe; *PS35-70*.

Stellar atmospheres; Transfer equation; Planetary nebulae; *11815*.

Stepwise regression; Computer programs; Curve fitting; Gram-Schmidt orthogonalization; Householder transformations; Iterative refinement; Least squares; Linear equations; Orthogonalization; Orthogonal polynomials; Regression; Rounding error; *12184*.

Stereoisomers; Vacuum-ultraviolet photolysis; CHO_2 free radical; Force constants; Infrared spectrum; Matrix isolation; Reaction of OH with CO; *12112*.

Stiffness matrix; Structural analysis; Axisymmetric; Elastic; Experiment; Finite-element analysis; Force transducer; **J.75C** *Nos. 3 and 4, 155-161 (1971)*.

Stochastic matrix; Theta point; Chain partition function; Monte-Carlo computations; Near-neighbor interactions; Phase transition; *11908*.

Stochastic process; Information theory; Markov process; Probability theory; Ring theory; **J.75B** *Nos. 3 and 4, 139-148 (1971)*.

Stockmayer; Dipole; Gas; Intermolecular potential function; Polar; Second virial coefficient; **J.75A** *No. 4, 337-385 (1971)*.

Stoichiometry; Tricalcium phosphate; Whitlockite; Ca/P ratio; Pyrolysis; Pyrophosphate; *12183*.

Stoichiometry; Uranium; Absolute isotopic abundance; Ignition procedure; Isotopic standards, mass spectrometry; *SP260-27*.

Stopping distance; Tires; Traction; Tractionizing; Siping; Stability; *TN566*.

Strain extensometer; Cryostat; Electrical resistance; Soft materials; *11825*.

Strength; Alumina; Fracture; Mechanical properties; Plastic deformation; Sapphire; *12282*.

Strength; Deep submergence; Fracture; Fracture energy; Glass; High pressure; *12188*.

Strength; Structural analysis; Walls; Axial load (force); Bending moment; Building codes; End-fixity; Reinforced concrete; Slenderness; *11933*.

Strength; Sulfate expansion; Trace elements; Alkalies; Concrete; Durability; Heat of hydration; Portland cements; Shrinkage; Statistical evaluation; *11863*.

Strength; Surface; Crack healing; Fracture; Glass; *11993*.

Stress; Affine connection; Continuum mechanics; Non-Riemannian geometry; *SP317*, pp. 943-962.

Stress components; Thermoelastic theory; Antimony; Heat conduction; Laser materials; Nd-doped glass; Platinum; **J.75A** *No. 4, 247-260 (1971)*.

Stress components; Thermoelastic theory; Antimony; Heat conduction; Laser materials; Nd-doped glass; Platinum; *12133*.

Stress concentrations; Dislocation pileups; Moutier cycle; *SP317*, pp. 147-150.

Stress corrosion; Aluminum alloy; Corrosion; Directional effects; Grain morphology; Preferred orientation; *11839*.

Stress corrosion; Crack propagation; Fracture; Glass; Static fatigue; *11992*.

Stress distribution; Unreinforced concrete; Buckling; Compression members, concrete; Deflection; Equilibrium; Load eccentricity; Masonry; Stability; Section cracking; *12298*.

Stress functions; Anisotropic elasticity; Dislocations; Green's tensor; Incompatibility; Internal stress; Source kernels; *SP317*, pp. 89-124.

Stress relaxation; Viscosity; BKZ fluid; Nonlinear behavior; Polyisobutylene; **J.75A** *No. 1, 33-40 (1971)*.

Stress-strain curve; Volume dilation; Composite materials; Coupling agents; Epoxy polymer; Parting agents; Poisson's ratio; Release agents; *12379*.

Stretching vibration; Bending vibration; Hydrogen bond; Infrared; Isotope dilution; Lattice mode; Raman; Sodium bifluoride; *11983*.

String of beads; Thermal expansion; Thermal properties; Volume; Bulk modulus; Grüneisen; *n*-alkanes; Normal mode; Polyethylene; Quasiharmonic specific heat; *12305*.

Strong collision; Classical path approximation; Intermolecular potential; Pressure broadening; *12033*.

Strong numerical instability; Conditions for convergence of solutions; Integral equation of first kind; Shifting operators; Slit correction; Slit weighting-function; Small-angle x-ray scattering; **J.75B** *Nos. 3 and 4, 187-207 (1971)*.

Strontium compounds; Barium compounds; Radium compounds; Enthalpy; Entropy; Gibbs energy of formation; Beryllium compounds; Magnesium compounds; Calcium compounds; *TN270-6*.

Strontium titanate; Superconductivity; Surface potential barrier; Tunneling; Indium; Semiconductors; $SrTiO_3$; *11925*.

Strontium titanate; Thermometer; Capacitor; Depolarization;

Dielectric; Dilution refrigerator; Glass ceramic; Phase transition; *12368.*

Strontium 90 wall-thickness measurement gage; Thin-wall mensuration; Attenuation of betas; Beta-transmission phenomenology; Counting geometry; Mass absorption coefficient derivation; *SP335,* pp. 11-21.

Structural analysis; Axisymmetric; Elastic; Experiment; Finite-element analysis; Force transducer; Stiffness matrix; **J.75C** *Nos. 3 and 4, 155-161 (1971).*

Structural analysis; Walls; Axial load (force); Bending moment; Building codes; End-fixity; Reinforced concrete; Slenderness; Strength; *11933.*

Structural design; Turbulence; Wind effects; Wind loads; Aerodynamic forces; Atmospheric boundary layer; *BSS30.*

Structural engineering; Bridge; Building; Codes; Dams; Earthquake damage; Earthquakes; Foundation geology; Highways; Hospital; Housing; Mobile home; Seismic; Standards; *BSS40.*

Structural engineering; Tides; Wind; Buildings; Failure; Hurricanes; Mobile homes; Roofs; *TN569.*

Structural engineering; Towers; Vortex shedding; Wind loads; Aeroelasticity; Buildings; Circular cylinders; Gust factors; Masts; *BSS30,* pp. 115-128.

Structural engineering; Walls; Bricks; Buckling; Deflection; Loads (forces); Masonry; Moments; Slenderness ratio; Stability; *12227.*

Structural engineering; Wind load; Anchorage; Building performance; Glazing; Hailstones; Masonry; Mobile homes; Roofs; *TN558.*

Structural engineering; Wind loads; Wind tunnel modeling; Aeroelasticity; Buildings; Dynamics; Statistical analysis; *BSS30,* pp. 107-114.

Structural engineering; Wind loads; Vibrations; Buildings; Climatology; Seismic loads; *BSS30,* pp. 129-131.

Structural engineering; Wind loads; Wind profile; Buildings; Climatology; Extreme value theory; Gust factors; *BSS30,* pp. 151-164.

Structural failure; Wind loads; Buildings; Design criteria; Dynamics; Gust factors; Smoke stacks; *BSS30,* pp. 5-8.

Structural interpretation of immiscibility; Super-duty silica brick; Glass chromatography; Immiscibility and courses of crystallization; Immiscibility and practical applications; Immiscibility and thermodynamics; Immiscibility in oxides; Liquid immiscibility; *11902.*

Structural relaxation; Transport phenomena; Viscous flow; Critical point theories; Immiscibility; Phase transitions; **J.75A** *No. 3, 175-184 (1971).*

Structural relaxation; Ultrasonic spectroscopy; Critical transport; Critical viscosity; Critical viscous flow; *12120.*

Structural stability; Walls; Brick; Cavity walls; Composite walls; Compressive strength; Concrete block; Flexural strength; Masonry; Mortar; Slenderness effects; Standards; *BSS34.*

Structural testing; Universal testing machine; Force calibration; Large test facilities; *SP355.*

Structure; Dipole moment; Microwave spectrum; Reactive species; Rotational spectra; Thioformaldehyde; *12325.*

Structure; Surface; Adsorption; Amorphous; Free-radical; Ionic; Manganese dioxide; Polycrystalline; *12314.*

Structure; $SU(6)_W$; Symmetry; Exotic; Mesons; Reactions; *11974.*

Structure; Ultraviolet spectrum; Vacuum-ultraviolet photolysis; CO_2; CO_3; Force constants; Infrared spectrum; Matrix isolation; O-atom reaction; *12101.*

Structure search; Substructure search; Ambiguity; Binary matrices; Bond adjacency; Chemical information; Computer; Control vector; Set reduction; *12337.*

Structure shielding; Albedo; Civil defense; Ducts; Neutron penetration; Nuclear weapons data; *11988.*

Structures; Combined environments; Components; Material performance; Predictive testing; *SP336,* pp. 403-404.

Sturm-Liouville systems; Boundary value problems; Coupled equations; Differential equations; Self-adjoint equations; **J.75B** *Nos. 3 and 4, 125-138 (1971).*

Styrene; Copolymers; Crosslinking; Divinylbenzene; Infrared; *11884.*

Styrene/divinylbenzene; Zeolites; Air pollution; Bilirubin; Infrared analysis; Ion exchange; Liquid chromatography; Purification; Separation; *TN549.*

Subcritical flow; Supercritical flow; Transcritical flow; Turbulence; Circular cylinders; Power spectra; Pressure fluctuations; *BSS30,* pp. 87-91.

Subharmonics; Nonlinear; *12217.*

Subject index; Author index; Bibliography; High pressure; *NBS-OSRDB-70-1-V1 (PB191174).*

Subject index; Author index; Bibliography; High pressure; *NBS-OSRDB-70-1-V2 (PB191175).*

Sublimation; Thermal conduction; Thermal vacuum tests; Volatile constituents; Volatilization; Absorption; Adsorption; "bake out"; Components; Decomposition; Degassing; Environment; Evaporation; Outgassing; Simulation; *SP336,* pp. 473-485.

Submersible; Closed ecological system; Habitability; Maintainability prediction; Microbiology; Microflora shift; Physiology; Psychology; Space station simulator; *SP336,* pp. 599-621.

Submillimeter waves; Water vapor; High-cirrus; Fourier spectroscopy; *11885.*

Subnanosecond pulses; Acousto-optic modulator; Flashlamp-pumped dye laser; Mode-locking; *TN603.*

Subsets; American Standard Code for Information Interchange; ASCII; Coded character subsets; Codes; Data communication; Data interchange; Data processing; Federal Information Processing Standards; Graphic character subsets; *FIPS PUB 15.*

Substitution weighing; Transposition weighing; True mass; Uncertainty; Value; Balance; Buoyancy; Calibration; Standards; *TN577.*

Substructure heating; Surface cracks; Ablation; Catastrophic ablation; *SP336,* pp. 853-877.

Substructure search; Ambiguity; Binary matrices; Bond adjacency; Chemical information; Computer; Control vector; Set reduction; Structure search; *12337.*

Sulfate expansion; Trace elements; Alkalies; Concrete; Durability; Heat of hydration; Portland cements; Shrinkage; Statistical evaluation; Strength; *11863.*

Sulfates; Tutton salts; Chromates; Langbeinites; Lattice constants; **J.75A** *No. 5, 435-439 (1971).*

Sulfonation; Cation exchangers; Ion exchangers; Oleum; *11957.*

Sulfur dioxide; Alkali metal reactions; Charge transfer; Electron capture; Infrared spectrum; Matrix isolation; Molecular orbitals; SO_2^- anion; *12336.*

Sulfuric acid; Thermogravimetric analysis; Alum; Aluminum; Apparent activation energy; Calcium; Cellulose; Crosslinking; Differential thermal analysis; Ion exchange; Organic acid; Oxycellulose; Stability; *12218.*

Sum rule; Correlation; Electron scattering; Form factor; Helium; Hydrogen; *11916.*

Sum rule; Electron scattering; Momentum transfer; Pair correlation; Shell model; Spurious; *12043.*

Sun, silicon in the; Silicon spectra in the sun's atmosphere; Spectra of silicon, atomic and ionic in the sun; *12010.*

Sunlight; Ion mobility; O_3^-; Photodetachment; Photodetachment rate measurement; *12268.*

Sunspots; Wilson-Bappu effect; Ca H and K lines; Non-LTE line formation; Plages; Radiative transport; Solar chromosphere; Solar spectrum; *12106.*

Superconducting devices; Josephson effect; Magnetometry; *11936.*

Superconducting solenoid; ^3He cryostat; ^3He refrigerator; Nuclear orientation; *TN562.*

Superconductivity; Cardiography; Instrumentation; Josephson effect; Magnetometry; *12190.*

Superconductivity; Detectors; Infrared; Josephson effect; Lasers; *12166*.

Superconductivity; Inductive ratio divider; Josephson effect; NPL of UK; Potential-divider resistor; Quantum standard of voltage; Solder-drop Josephson junctions; *SP335*, pp. 111-115.

Superconductivity; Josephson effect; *12082*.

Superconductivity; Surface potential barrier; Tunneling; Indium; Semiconductors; SrTiO$_3$; Strontium titanate; *11925*.

Superconductivity; Thermometry; Josephson effect; Noise; *12159*.

Superconductivity; Transition elements; Atomic ordering; Binary A-15 compounds; *11864*.

Superconductivity; Transition temperatures; Vanadium carbides; Band structure of solids; Cryogenics; *12266*.

Superconductors; Atomic ordering; Intermetallic compounds; Magnetic susceptibility; *12300*.

Supercritical flow; Transcritical flow; Turbulence; Circular cylinders; Power spectra; Pressure fluctuations; Subcritical flow; *BSS30*, pp. 87-91.

Supercritical fluctuations; Ultrasonic spectroscopy; Viscous relaxation; Immiscibility; Oxide glasses; Relaxation times; *11986*.

Super-duty silica brick; Glass chromatography; Immiscibility and courses of crystallization; Immiscibility and practical applications; Immiscibility and thermodynamics; Immiscibility in oxides; Liquid immiscibility; *11902*.

Superhyperfine interaction; Ytterbium; Cadmium fluoride; EPR; *12312*.

Superposition approximation; Three body correlation function; X-ray diffraction; Neutron diffraction; Percus-Yevick equation; Radial distribution function; Simple liquids; *12016*.

Superposition of configurations; Electron affinity; Electron correlation; Ionization potential; *12086*.

Super-purity metals; Aluminum; Electrical resistivity; Grain boundaries; Solute segregation; *11818*.

Supersonic dislocation; Dislocation dynamics; Interface dislocations; *SP317*, pp. 71-82.

Surface; Adsorption; Amorphous; Free-radical; Ionic; Manganese dioxide; Polycrystalline; Structure; *12314*.

Surface; Crack healing; Fracture; Glass; Strength; *11993*.

Surface; Glass; Laser damage; *12239*.

Surface; Surface active agent; Complex-ion embrittlement; Dislocations; Liquid metal embrittlement; *11972*.

Surface; Tungsten; Adsorption; Chemisorption; Cross section; Desorption; Electron stimulated desorption; Hydrogen; Nickel; Nitrogen; Oxygen; *12332*.

Surface active agent; Complex-ion embrittlement; Dislocations; Liquid metal embrittlement; Surface; *11972*.

Surface active agents; Surface chemistry; Surface tension; Surfactant; Association colloid; Bibliography; CMC; Colloid; Colloidal electrolyte; Critical concentration; Critical micelle concentration; Detergent; Hydrophobic bonding; Krafft point; *NSRDS-NBS36*.

Surface chemistry; Surface tension; Surfactant; Association colloid; Bibliography; CMC; Colloid; Colloidal electrolyte; Critical concentration; Critical micelle concentration; Detergent; Hydrophobic bonding; Krafft point; Long chain compounds; *NSRDS-NBS36*.

Surface contamination; Cleaning; Desorption; Ions; Outgassing; Quartz crystal microbalance; Solar panels; Space; Sputtering; *SP336*, pp. 113-127.

Surface cracks; Ablation; Catastrophic ablation; Substructure heating; *SP336*, pp. 853-877.

Surface crystals; Surface dislocations; Dislocations in biophysics; Protein structure; *SP317*, pp. 579-592.

Surface degradation; Volatile degradation products; Xenon-arc irradiation; Atmospheric exposure; ATR spectroscopy; Clear and pigmented films; Infrared analysis; Internal reflection spectroscopy; Mercury-arc irradiation; Organic coatings; *SP336*, pp. 299-312.

Surface dislocations; Dislocations in biophysics; Protein structure; Surface crystals; *SP317*, pp. 579-592.

Surface effect; Aliphatics: Aromatics; Complexing effects; Gas chromatography; Group separation; Mercuric nitrate; Olefins; Silver nitrate; *12024*.

Surface finish; Composite restorative materials; Finishing; Operative dentistry; Polishing instruments; *12308*.

Surface fitting; Curve fitting; Data analysis; Equations of state; Model discrimination; **J.75A** *No. 5, 441-453 (1971)*.

Surface fitting; Two-way arrays; Factorial experiments; Interaction; Nonadditivity; Principal components; *12109*.

Surface layer; Θ-point; Trains; Configurations; Excluded volume effect; Loops; Polymer adsorption; *12240*.

Surface layers; Absorbed dose; Absorbed-energy distributions; Electron beams; Energy deposition; Silicon detectors; *12063*.

Surface migration; Carbon monoxide; Desorption; Field emission; Monoxide; Rhenium; Ruthenium; *11819*.

Surface physics; Adsorption; Electron gas; Impurities; *12035*.

Surface physics; Chemisorption; Impurities; *12317*.

Surface physics; Tunneling; Attenuation length; Electron gas theory; Field emission; *12154*.

Surface potential barrier; Tunneling; Indium; Semiconductors; SrTiO$_3$; Strontium titanate; Superconductivity; *11925*.

Surface preparation; Analysis; Device processing; Diffusion; Epitaxy; Junctions; Resistivity; *SP337*.

Surface temperature; Temperature measurement; Temperature-sensitive phosphor; Thermographic phosphor; Transistor-chip temperature; *TN591*.

Surface tension; Aqueous solutions; Cylinder; Ice; Solute; Stability; *11889*.

Surface tension; Surfactant; Association colloid; Bibliography; CMC; Colloid; Colloidal electrolyte; Critical concentration; Critical micelle concentration; Detergent; Hydrophobic bonding; Krafft point; Long chain compounds; Micelle; *NSRDS-NBS36*.

Surface tension; Thermal conductivity; Thermal diffusivity; Vapor pressure; Viscosity; Volume; Density; Dielectric constant; Enthalpy; Entropy; Equation of state; Fixed points; Heat transfer coefficients; Index of refraction; Joule-Thomson; *TN384*.

Surface waves; Green's tensor; Non-local elasticity; Solid mechanics; *SP317*, pp. 747-759.

Surfaces; Tunneling; Field emission; *12192*.

Surfactant; Association colloid; Bibliography; CMC; Colloid; Colloidal electrolyte; Critical concentration; Critical micelle concentration; Detergent; Hydrophobic bonding; Krafft point; Long chain compounds; Micelle; Paraffin chain salts; *NSRDS-NBS36*.

Susceptibility; Thermometer scale; Cerous magnesium nitrate; Dipole system; Low temperature; Paramagnetic salt; Specific heat; *11822*.

Susceptibility; Ultrasonic attenuation; Frequency shift; Heisenberg paramagnet; Specific heat; Spin-diffusion; *12265*.

SU(3); SU(6)$_W$; A$_2$; Mesons; Resonances; Spectroscopy; *12009*.

SU(6) 04 × 0(3); Baryons; Configuration mixing; Hyperons; Resonances; Rotations; *11912*.

SU(6)$_W$; A$_2$; Mesons; Resonances; Spectroscopy; SU(3); *12009*.

SU(6)$_W$; Symmetry; Exotic; Mesons; Reactions; Structure; *11974*.

Symmetry; Exotic; Mesons; Reactions; Structure; SU(6)$_W$; *11974*.

Symmetry class of tensors; Full linear group; Irreducible character; *12213*.

Synthesis; Accelerators; Amines; Color-stable composites; Methacrylates; Polymerization; Resins; *12302*.

Synthesis; Telomerization; Cyclic inter-intramolecular mechanism; Diene polymerization; Fluorodienes; Intermediates; Polymerization; Purity; **J.75A** *No. 1, 41-56 (1971)*.

Synthetic sapphire; Thermodynamic functions; Alumina; Aluminum oxide; Corundum; Drop calorimetry; Enthalpy; Heat

Temperature gradients; Temperature irregularities; Temperature variation; Thermal conductivity; Analytic solutions; Boundary conditions; Computation, temperature distribution; Furnaces, high-pressure; High-pressure furnaces; **J.75C** *No. 2, 79-83 (1971).*

Temperature in stars; Turbulence in stars; Abundances of elements in stars; Ba II stars (ζ Capricorni); Curve of growth; Equivalent widths; Identification of spectral lines; Ionization in stars; Oscillator strengths; *Monogr. 119.*

Temperature irregularities; Temperature variation; Thermal conductivity; Analytic solutions; Boundary conditions; Computation, temperature distribution; Furnaces, high-pressure; High-pressure furnaces; **J.75C** *No. 2, 79-83 (1971).*

Temperature measurement; Temperature-sensitive phosphor; Thermographic phosphor; Transistor-chip temperature; Surface temperature; *TN591.*

Temperature profile; Absorbed dose; Calorimetry; Electron beams; Interference fringes; Interferometry; Pulsed beams; Refractive-index holography; *12324.*

Temperature scale; Thermocouple; Triple point; Calibration; Fixed point; Freezing point; Furnaces; High temperature; IPTS-68; Platinum resistance thermometer; *12354.*

Temperature variation; Thermal conductivity; Analytic solutions; Boundary conditions; Computation, temperature distribution; Furnaces, high-pressure; High-pressure furnaces; High-temperature, high-pressure research; **J.75C** *No. 2, 79-83 (1971).*

Temperature variation of capacitance; Capacitance; Dielectric constant; Stable capacitance; *11935.*

Temperature-control-bracket; Boundary temperature; Collisional-control; Non-LTE; Radiative-control; *12360.*

Temperature-sensitive phosphor; Thermographic phosphor; Transistor-chip temperature; Surface temperature; Temperature measurement; *TN591.*

Temporary dental cements; Dental restorative materials; EBA cements; Plastic reinforced restoratives; Restorative materials; *11996.*

Temporary expedients; Tissue bearing; Denture base; Protective; Resilient liners; *12250.*

Tensile strength; Acrylic teeth; Adhesion; Autoadhesion; Bonding; Cold-curing methyl methacrylate; Dentures; *12340.*

Tensor function; Trace; Chain rule; Continuum mechanics; Gradient; Matrices; Matrix calculus; Partial differentiation; Product rule; **J.75B** *Nos. 3 and 4, 97-107 (1971).*

Ternary eutectic; Thermosetting monomers; Biomaterials; Dimethacrylates; Phthalate monomers; Purification methods; Resins for composites; *11802.*

Test; Assessment; Complex; Composite; Computer; Criteria; Evaluation; Gaussian primes; Indexing; Measurement; Performance; Prime; Program; *TN572.*

Test; Evaluation; MOSFETS; Neutrons; Pu^{239}-Be; Radiation simulation; RTG; *SP336,* pp. 129-140.

Test; Transfer impedance; Transmissivity equalization; Vibration; Acceleration response; Evaluation; Fatigue life; Lumped parameter system; Mechanical impedance; Random vibration; *SP336,* pp. 509-524.

Test development; Annual report to Congress; Blankets; Carpets and rugs; Children's sleepwear; Cooperation; Flammability; Flammability reduction; Mattresses; Research; Small carpets and rugs; Standards; *TN596.*

Test equipment; Compression tests; Dynamic loads; High-speed photography; Indicating instruments; Indicator characteristics; Loading rate; Loads (forces); Motion picture cameras; Photographic equipment; Static loads; *12080.*

Test equipment records; Use, storage, or surplus; Data for decision; Standards laboratory management; *SP335,* pp. 95-98.

Test facility; Ballistic missiles; Heat protection; Reentry; *SP336,* pp. 893-904.

Test facility; Vacuum; Chemical analysis; Contamination; Organic residues; Outgassing; Polymeric materials; Residual gas analysis; *SP336,* pp. 1-24.

Test fee schedule; Test procedures; Calibration services; Fees for testing; *SP250, 1970 Edition.*

Test measures; Tolerances; Weights and measures inspection; Accurate measurements of volumes; Field standard; Metal volumetric field standards; Provers; Specifications; *H105-3.*

Test method; Tread wear; Automobile tires; Grading; Rating; *12200.*

Test methods, evaluation of; Interlaboratory testing; Precision; Repeatability; Reproducibility; *12333.*

Test problems; Accuracy; ANSI FORTRAN; Computer system implementation; Examples; OMNITAB II; Software; *TN551.*

Test procedures; Calibration services; Fees for testing; Test fee schedule; *SP250, 1970 Edition.*

Testing; Data acquisition; Data dissemination; Data processing; Maintenance; Operational readiness; Performance monitoring; *SP336,* pp. 549-568.

Testing; Volatile products; Absorption; Condensation; Contamination control; Evaluation; Far infrared; Fluid dynamic force; Microorganisms; Optical properties; Planetary quarantine; Polymers; Shock force; Space simulation; *SP336,* pp. 51-77.

Testing program; Appearance properties; Paper research; Preservation of records; Tear reference; *11842.*

Tests; Viscosity; Electron damage; Electron energy; Electron spin resonance; Evaluation; Gel; Mechanical properties; Optical properties; Plastic films; Poly(ethylene terephtalate); Proton damage; Proton energy; Radiation effect; *SP336,* pp. 323-344.

Tests; X-ray spectra; X-ray spectrometers; Electron diffraction; Electron probes; Evaluation; Gas flow; Lithium; Microanalysis; Multichannel analyzer; Proportional counters; Quawtitative analysis; Solid state counters; *12251.*

Tetrachlorodiborane(4); Tetrafluorodiborane(4); Boron; Boron subhalides; Halides; Haloolefins; Organoboron compounds; *12292.*

Tetrafluorodiborane(4); Boron; Boron subhalides; Halides; Haloolefins; Organoboron compounds; Tetrachlorodiborane(4); *12292.*

Tetrafluoroethylene; 3,3,4,4,5,5,5-heptafluoropentene-1; Amorphous polymer; Copolymerization; Fluoropolymers; Glass temperature; High pressure; Radiation-induced; *11868.*

Text; Text processing; Bibliographic system; Computer package; Data base; Document processing; Information retrieval; Document storage and retrieval; *TN599.*

Text processing; Bibliographic system; Computer package; Data base; Document processing; Information retrieval; Document storage and retrieval; Text; *TN599.*

Theoretical model; Trapping; Charge carriers; Electrons; Gamma rays; Ge(Li) detectors; Germanium gamma-ray spectrometers; Holes; Lifetime; *12255.*

Theoretical physics; Thermally activated processes; Twinning; Conference; Continuum mechanics; Crystal physics, disclinations; Dislocations; Elasticity; Electron-dislocation interactions; Lattice defects; Phonon-dislocation interactions; Solid-state; *SP317.*

Theory; Hydrocarbons; Ion-molecule reactions; Photoionization; Radiolysis; Rate constants; *11853.*

Theory; Tuning curves; Collisions; Gas laser; Line widths; Power output; *11811.*

Theory; Unified classical path; Hydrogen lines; Line wings; Stark broadening; *12222.*

Theory; X-ray diffraction; Dynamical diffraction; Imperfections; Kinematical scattering; Piezoelectric vibration; Secondary extinction; *12073.*

Thermal; Ceramics; Chemical composition; Mechanical properties; Pressure; Properties; Standards; Standard Reference Materials; Temperature; *12181.*

Thermal acceleration; Arrhenius rate theory; Dislocation dynamics; Statistical theory of dislocation; *SP317,* pp. 1065-1076.

Thermal activation; Arrhenius law; Mechanical properties; Precipitation hardening; *SP317*, pp. 1077-1082.

Thermal activation; Bordoni-peaks; Dislocation motion; Kink relaxation; Mechanical properties; *SP317*, pp. 1137-1156.

Thermal conduction; Thermal vacuum tests; Volatile constituents; Volatilization; Absorption; Adsorption; "bake out"; Components; Decomposition; Degassing; Environment; Evaporation; Outgassing; Simulation; Sublimation; *SP336*, pp. 473-485.

Thermal conductivity; Analytic solutions; Boundary conditions; Computation, temperature distribution; Furnaces, high-pressure; High-pressure furnaces; High-temperature, high-pressure research; Power dissipation; **J.75C** *No. 2, 79-83 (1971)*.

Thermal conductivity; Critical region; Normal hydrogen; Parahydrogen; *11827*.

Thermal conductivity; Dislocation mobility; Dislocation-phonon interactions; Nonlinear elasticity; Phonons; *SP317*, pp. 363-389.

Thermal conductivity; Thermal diffusivity; Vapor pressure; Viscosity; Volume; Density; Dielectric constant; Enthalpy; Entropy; Equation of state; Fixed points; Heat transfer coefficients; Index of refraction; Joule-Thomson; Latent heat; *TN384*.

Thermal conductivity; Thermo-optic properties; Transmittance; Chemical composition; Density; Glasses; Hardness; Laser; Optical homogeneity; Photoelasticity; Refractive index; **J.75A** *No. 3, 163-174 (1971)*

Thermal conductivity; Titanium alloy; Transport properties; Aluminum alloy; Cryogenics; Electrical resistivity; Lorenz ratio; Nickel alloys; Seebeck effect; **J.75A** *No. 4, 269-277 (1971)*.

Thermal conductivity; Transport properties; Disordered one-dimensional crystal; Multiple scattering; Statistical physics; *12376*.

Thermal conductivity; Transport properties; Cryogenics; Electrical resistivity; Electrolytic iron; Lorenz ratio; Seebeck effect; *SP260-31*.

Thermal conductivity; Transport properties; Viscosity; Density dependence; Liquid state; Simple fluids; Temperature dependence; *11879*.

Thermal conductivity; Vacuum effect; Ablation material; *SP336*, pp. 197-208.

Thermal contact; Cryogenics; Equipment design; Heat transmission; *11816*.

Thermal control; High vacuum; Solar cells; Space radiation; Space simulation; *SP336*, pp. 935-947.

Thermal control coatings; Degradation mechanising; Electron bombardment; Electron degradation; Polymeric perfluorinated ethylenepropylene; Proton bombardment; *SP336*, pp. 359-382.

Thermal control coatings; Ultraviolet degradation; Vacuum UV; Alzak; *SP336*, pp. 383-392.

Thermal control coatings; Ultraviolet degradation; Alkaline paint; Conduction of paints during ultraviolet exposure; Electrode potential of paints; Photo degradation; *SP336*, pp. 373-402.

Thermal cycle vacuum testing; Thermal shroud; Gaseous nitrogen heater; Gas stream blower; GN temperature conditioning; Solar array; Solar cell; *SP336*, pp. 669-682.

Thermal diffusivity; Thermodynamic properties; Annealed and quenched glass; Calorimetry; *cis*-1,4-polyisoprene; Glass transformation; Heat capacity; Natural rubber; Normal and supercooled liquid; Rubber, natural; **J.75A** *No. 2, 113-120 (1971)*.

Thermal diffusivity; Vapor pressure; Viscosity; Volume; Density; Dielectric constant; Enthalpy; Entropy; Equation of state; Fixed points; Heat transfer coefficients; Index of refraction; Joule-Thomson; Latent heat; Melting point; Prandtl number; *TN384*.

Thermal expansion; Components of error (within and between samples); Copper; Interferometer; Standard reference material; *12036*.

Thermal expansion; High-speed measurements; High temperature; Platinum; *12139*.

Thermal expansion; Thermal properties; Volume; Bulk modulus; Grüneisen; *n*-alkanes; Normal mode; Polyethylene; Quasiharmonic specific heat; String of beads; *12305*.

Thermal expansion; Thermodynamics and expansions; Bulk modulus; Dislocations and thermodynamics; Entropy; Specific heat; *SP317*, pp. 1223-1225.

Thermal functions; Thermodynamic properties of materials; Thermodynamics; Evaluated data; *NSRDS-NBS37*.

Thermal insulation; Flat roofs; Heat transfer; Moisture transfer; *BSS37*.

Thermal insulation; Thermal-vacuum chambers; Evacuating; Heat transmission; Infrared scanning; Mars environmental simulation; Outgassing; *SP336*, pp. 725-748.

Thermal motion; Crystal structure; Neutron diffraction; PH_4Br; Rigid-body analysis; *12119*.

Thermal neutron absorption; Manganous sulfate bath; Neutron source absorption; Neutron source calibration; *12177*.

Thermal neutrons; Data analysis; Flux density; Intercomparisons; Least squares; Standards; *12048*.

Thermal properties; Volume; Bulk modulus; Grüneisen; *n*-alkanes; Normal mode; Polyethylene; Quasiharmonic specific heat; String of beads; Thermal expansion; *12305*.

Thermal radiation; Vacuum; Weightlessness; Ablation; Particulate radiation; Re-entry; Space simulation; *SP336*.

Thermal radiation properties; Emittance; High-speed measurements; Melting; Normal spectral emittance; Tantalum; *12307*.

Thermal radiation properties; Thermodynamics; Tungsten; Electrical resistivity; Emittance; Heat capacity; High-speed measurements; High temperature; **J.75A** *No. 4, 283-290 (1971)*.

Thermal radiation properties; Thermodynamics; Electrical resistivity; Emittance; Heat capacity; High-speed measurements; High temperature; Niobium; **J.75A** *No. 6, 565-571 (1971)*.

Thermal radiation properties; Thermodynamics; Electrical resistivity; Emittance; Heat capacity; High-speed measurements; High temperature; Tantalum; **J.75A** *No. 1, 1-13 (1971)*.

Thermal relaxation; Equation of state of solids; Lattice dynamics; Shock compression; Shock wave; *SP326*, pp. 105-122.

Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; *TN702*.

Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; *TN560*.

Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; *TN571*.

Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; *TN592*.

Thermal resistance; Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; *TN598*.

Thermal resistivity; Cottrell atmospheres; Mechanical properties; Phonon scattering; *SP317*, pp. 391-394.

Thermal shroud; Gaseous nitrogen heater; Gas stream blower; GN temperature conditioning; Solar array; Solar cell; Thermal cycle vacuum testing; *SP336*, pp. 669-682.

Thermal transport; Equations of motion; Nonequilibrium statistical mechanics; Open systems; *12197*.

Thermal vacuum tests; Volatile constituents; Volatilization; Absorption; Adsorption; "bake out"; Components; Decomposition; Degassing; Environment; Evaporation; Outgassing; Simulation; Sublimation; Thermal conduction; *SP336*, pp. 473-485.

Thermalization length; Formation; Line; Noncoherent scattering; *12071*.

Thermally activated processes; Twinning; Conference; Continuum mechanics; Crystal physics, disclinations; Dislocations; Elasticity; Electron-dislocation interactions; Lattice defects; Phonon-dislocation interactions; Solid-state; Theoretical physics; *SP317*.

Thermal-vacuum chambers; Evacuating; Heat transmission; Infrared scanning; Mars environmental simulation; Outgassing; Thermal insulation; *SP336*, pp. 725-748.

Thermochemical properties; Bond additivity method; Group additivity method; Peroxyacetyl nitrate; Peroxybenzoyl nitrate; *12204*.

Thermocouple; Thermoelements; Sensor; Ultra high vacuum; W-Re alloys; EMF-temperature relationship; Furnace; High temperature; Refractory metals; **J.75C** *No. 2, 99-106 (1971)*.

Thermocouple; Triple point; Calibration; Fixed point; Freezing point; Furnaces; High temperature; IPTS-68; Platinum resistance thermometer; Temperature scale; *12354*.

Thermodynamic anomalies; Vapor pressure; Argon; Carbon dioxide; Classical equation; Coexistence curve; Critical exponents; Critical point; Lattice gas; Power laws; Rectilinear diameter; Steam; *11985*.

Thermodynamic functions; Alumina; Aluminum oxide; Corundum; Drop calorimetry; Enthalpy; Heat capacity standard; Specific heat; Standard reference material; Synthetic sapphire; **J.75A** *No. 5, 401-420 (1971)*.

Thermodynamic properties; Annealed and quenched glass; Calorimetry; *cis*-1,4-polyisoprene; Glass transformation; Heat capacity; Natural rubber; Normal and supercooled liquid; Rubber, natural; Thermal diffusivity; **J.75A** *No. 2, 113-120 (1971)*.

Thermodynamic properties; Coexistence curve; Critical point; Liquid-gas phase transition; Parametric form; Scaling; *12156*.

Thermodynamic properties; Cryogenics; Dilution refrigerator; Fermi-Dirac statistics; Heat exchangers; Helium-3; Helium-4; Liquid helium; Mixtures; Quantum fluid; *11981*.

Thermodynamic properties of materials; Thermodynamics; Evaluated data; Thermal functions; *NSRDS-NBS37*.

Thermodynamic scaling; Critical region; Equation of state; Liquid-gas transition; Phase boundary; Phase transition; **J.75A** *No. 2, 103-107 (1971)*.

Thermodynamics; Calorimetry; Laser calorimetry; Lasers; *11841*.

Thermodynamics; CODATA; Key values; **J.75A** *No. 2, 97-101 (1971)*.

Thermodynamics; Complex molecules; Mass spectrometry; Molten salt halides; *12280*.

Thermodynamics; Compressibility factors; Equation of state; High density; High temperature; Pairwise potentials; Redlich Kwong; Second virial coefficient; *11887*.

Thermodynamics; Electrical resistivity; High-speed methods; High temperature; Melting point; Metals; Molybdenum; Premelting; *12231*.

Thermodynamics; Electrical resistivity; Emittance; Heat capacity; High-speed measurements; High temperature; Niobium; Thermal radiation properties; **J.75A** *No. 6, 565-571 (1971)*.

Thermodynamics; Electrical resistivity; Emittance; Heat capacity; High-speed measurements; High temperature; Tantalum; Thermal radiation properties; **J.75A** *No. 1, 1-13 (1971)*.

Thermodynamics; Evaluated data; Thermal functions; Thermodynamic properties of materials; *NSRDS-NBS37*.

Thermodynamics; Heat capacity; High-speed measurements; High temperature; Tantalum; *11871*.

Thermodynamics; Lennard-Jones gas; (m-6) intermolecular potential; Quantum corrections; Second virial coefficient; Statistical mechanics; **J.75A** *No. 1, 57-89 (1971)*.

Thermodynamics; Thermophysical properties; High-speed measurement methods; High temperatures; *12028*.

Thermodynamics; Thermophysical properties; High-speed measurements; High temperatures; **J.75C** *No. 1, 7-18 (1971)*.

Thermodynamics; Tungsten; Electrical resistivity; Emittance; Heat capacity; High-speed measurements; High temperature; Thermal radiation properties; **J.75A** *No. 4, 283-290 (1971)*.

Thermodynamics and dislocation motion; Constitutive relations; Continuum mechanics; Dislocation kinematics; Dislocations; Oriented media; *SP317*, pp. 1041-1052.

Thermodynamics and expansions; Bulk modulus; Dislocations and thermodynamics; Entropy; Specific heat; Thermal expansion; *SP317*, pp. 1223-1225.

Thermoelastic; Transverse; Longitudinal; Polyethylene terephthlate; Polypyromelitimide; Relative creep; *12165*.

Thermoelastic theory; Antimony; Heat conduction; Laser materials; Nd-doped glass; Platinum; Stress components; **J.75A** *No. 4, 247-260 (1971)*.

Thermoelastic theory; Antimony; Heat conduction; Laser materials; Nd-doped glass; Platinum; Stress components; *12133*.

Thermoelement; Transfer voltmeter, voltage measurements; AC DC difference; Comparator; **J.75C** *Nos. 3 and 4, 145-153 (1971)*.

Thermoelements; Sensor; Ultra high vacuum; W-Re alloys; EMF-temperature relationship; Furnace; High temperature; Refractory metals; Thermocouple; **J.75C** *No. 2, 99-106 (1971)*.

Thermofunctions for ideal gas states; Thermophysical properties; Heats of vaporization; Methane; Orthobaric densities; Specific heats of the saturated liquid; **J.75A** *No. 1, 15-21 (1971)*.

Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; *TN702*.

Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; *TN560*.

Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; *TN571*.

Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; *TN592*.

Thermographic measurements; Ultrasonic bonder; Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; *TN598*.

Thermographic phosphor; Transistor-chip temperature; Surface temperature; Temperature measurement; Temperature-sensitive phosphor; *TN591*.

Thermogravimetric analysis; Alum; Aluminum; Apparent activation energy; Calcium; Cellulose; Crosslinking; Differential thermal analysis; Ion exchange; Organic acid; Oxycellulose; Stability; Sulfuric acid; *12218*.

Thermogravimetric analysis; Applied nonisothermal kinetics; Generalized techniques; Historical review; Isothermal; Isoconversional and isokinetic methods; Kinetic parameters; *12356*.

Thermomechanical treatment; Cavities; Cellular solidification; Constitutional supercooling; Copper (99.999%); Dislocation arrangements; Distribution of impurities; Precipitate particles; *12339*.

Thermometer; Capacitor; Depolarization; Dielectric; Dilution refrigerator; Glass ceramic; Phase transition; Strontium titanate; *12368*.

Thermometer scale; Cerous magnesium nitrate; Dipole system; Low temperature; Paramagnetic salt; Specific heat; Susceptibility; *11822*.

Thermometers, self-registering, clinical; Clinical thermometers; Glass thermometers, clinical; Mercury-in-glass thermometers; *PS39-70*.

Thermometry; Josephson effect; Noise; Superconductivity; *12159*.

Thermo-optic properties; Transmittance; Chemical composition; Density; Glasses; Hardness; Laser; Optical homogeneity; Photoelasticity; Refractive index; Thermal conductivity; **J.75A** *No. 3, 163-174 (1971)*.

Thermophysical properties; Heats of vaporization; Methane; Orthobaric densities; Specific heats of the saturated liquid; Thermofunctions for ideal gas states; **J.75A** *No. 1, 15-21 (1971)*.

Thermophysical properties; High-speed measurement methods; High temperatures; Thermodynamics; *12028*.

Thermophysical properties; High-speed measurements; High temperatures; Thermodynamics; **J.75C** *No. 1, 7-18 (1971)*.

Thermopile radiation; Ammeter; Coax; Infrared; Rf-dc; *12198*.

Thermosetting monomers; Biomaterials; Dimethacrylates; Phthalate monomers; Purification methods; Resins for composites; Ternary eutectic; *11802*.

Theta point; Chain partition function; Monte-Carlo computations; Near-neighbor interactions; Phase transition; Stochastic matrix; *11908*.

Thick targets; Bremsstrahlung; Bremsstrahlung efficiency; Monte Carlo; Photon neutron; Radiation transport; *11799*.

Thickness; Thickness gages; Metal coatings; Micrometers; Microscopes; Optical equipment; Optical microscopes; *12215*.

Thickness gages; Metal coatings; Micrometers; Microscopes; Optical equipment; Optical microscopes; Thickness; *12215*.

Thin-wall mensuration; Attenuation of betas; Beta-transmission phenomenology; Counting geometry; Mass absorption coefficient derivation; Strontium 90 wall-thickness measurement gage; *SP335*, pp. 11-21.

Thioformaldehyde; Astronomically important; Electrical discharge; Interstellar medium; Microwave spectroscopy; Rotational spectrum; *11965*.

Thioformaldehyde; Structure; Dipole moment; Microwave spectrum; Reactive species; Rotational spectra; *12325*.

Three body correlation function; X-ray diffraction; Neutron diffraction; Percus-Yevick equation; Radial distribution function; Simple liquids; Superposition approximation; *12016*.

Three-fluid model; Two-fluid model; Excess neutrons; Isospin; Nuclear charge distribution; Nuclear structure; *12114*.

Threshold limit; Amalgam condensation; Mercury; Mercury vapor levels; *12092*.

Threshold of hearing; Audiometry; Earphones; NBS 9-A coupler; Reference threshold sound pressure levels; Standards for audiometers; *12260*.

TiCl$_3$; TiCl$_4$; Dichlorides of Ca, Sc, Ti, V, Cr, Mn, Fe, Ni; Geometry; Infrared spectra of species; Matrix isolation; ScCl$_3$; *12281*.

TiCl$_4$; Dichlorides of Ca, Sc, Ti, V, Cr, Mn, Fe, Ni; Geometry; Infrared spectra of species; Matrix isolation; ScCl$_3$; TiCl$_3$; *12281*.

Tides; Wind; Buildings; Failure; Hurricanes; Mobile homes; Roofs; Structural engineering; *TN569*.

TiH$_2$; Soldering; Contact resistance; Oxide semiconductors; *11812*.

Time; Dissemination; Frequency; Frequency synthesizers; Linear phase comparators; Television color subcarrier; *12234*.

Time; Frequency and time code; Television; *11878*.

Time; Time standards, universal time; Atomic time; Standards; *12264*.

Time; Time/frequency dissemination; Time scales; Timing (HF, LF, satellite, TV, VLF); Wavelength standards; WWV; WWVB; WWVH; WWVL; Atomic clocks; Atomic standards; Clock dissemination; Crystal oscillators; Definition of second; *SP350*.

Time; Timing accuracy; ATS satellite; LES-6 satellite; NBS satellite timing; Satellites; TACSAT satellite; *12103*.

Time domain testing; Automatic measuring devices; Automatic performance test; Computer control systems; Instrument calibration procedures; Instrument performance testing; Pulse technology; *SP335, pp. 23-28*.

Time scale; Allan variance; Cesium beam; Frequency stability; Hydrogen maser; NBS frequency standard; *11922*.

Time scales; Timing (HF, LF, satellite, TV, VLF); Wavelength standards; WWV; WWVB; WWVH; WWVL; Atomic clocks; Atomic standards; Clock dissemination; Crystal oscillators; Definition of second; Flicker noise; Frequency; Frequency stability; *SP350*.

Time signals; Very low frequency; Broadcast of standard frequencies; High frequency; Low frequency; Standard frequencies; *SP236, 1971 Edition*.

Time standard; Frequency; Laser; Laser frequency measurement; Stabilization; Techniques; *12135*.

Time standards; Atomic frequency standards; Cesium beam; Flicker noise; Frequency stability; Frequency standards; Hydrogen maser; Long baseline interferometry; Quartz crystal oscillators; *11888*.

Time standards, universal time; Atomic time; Standards; Time; *12264*.

Time/frequency dissemination; Time scales; Timing (HF, LF, satellite, TV, VLF); Wavelength standards; WWV; WWVB; WWVH; WWVL; Atomic clocks; Atomic standards; Clock dissemination; Crystal oscillators; Definition of second; Flicker noise; *SP350*.

Time-ordering; Unified theory; Lyman-α; Stark-broadening; *12208*.

Time-ordering; Unified theory; Lyman-α; Stark-broadening; *Monogr. 121*.

Timing accuracy; ATS satellite; LES-6 satellite; NBS satellite timing; Satellites; TACSAT satellite; Time; *12103*.

Timing (HF, LF, satellite, TV, VLF); Wavelength standards; WWV; WWVB; WWVH; WWVL; Atomic clocks; Atomic standards; Clock dissemination; Crystal oscillators; Definition of second; Flicker noise; Frequency; Frequency stability; Lasers; *SP350*.

Tire strength; Winter; Bias ply; Breaking energy; Passenger car; Radial; Tires; *11833*.

Tires; Tire strength; Winter; Bias ply; Breaking energy; Passenger car; Radial; *11833*.

Tires; Traction; Tractionizing; Siping; Stability; Stopping distance; *TN566*.

Tires; Transportation noise; Trucks; Urban planning; Acoustics; Noise measurement; Noise pollution; Noise (sound); Sound transmission; *12329*.

Tissue bearing; Denture base; Protective; Resilient liners; Temporary expedients; *12250*.

Tissue standard; Trace analysis; Biological standards; Blood standard; Botanical standards; Environmental samples; Standard Reference Material; *12132*.

Titanium; Titanium dioxide; Transition metal; Aluminum oxide; Band structure; Borides; Bulk optical properties; Chemical

Ultrasonics; Phase sensitive detection; Speed of sound; Ultrasonic interferometer; *12322.*

Ultrasonics; X rays; Compaction density; Eddy current measurements; Fuel rods; Impregnation density; Monitor tests; Neutron radiography; *SP336*, p. 405.

Ultrasonics; 2-methylbutane; Bulk modulus; Compressibility; Density; Dilatometric measurements; High pressure; Liquids; **J.75A** *No. 2, 121-127 (1971).*

Ultraviolet; Infrared spectrum; Isolated SH; Low temperature; Matrix; SH; *11846.*

Ultraviolet absorption; Formaldehyde; Inelastic electron scattering; *12224.*

Ultraviolet cross sections; Aeronomic; Astrophysical; Partial; Photoabsorption cross sections; Photodissociation; Photoexcitation; Photoionization; Photon-scattering; Total; *NSRDS-NBS38.*

Ultraviolet degradation; Alkaline paint; Conduction of paints during ultraviolet exposure; Electrode potential of paints; Photo degradation; Thermal control coatings; *SP336*, pp. 373-402.

Ultraviolet degradation; Aluminum coated teflon; Electron degradation; Proton degradation; Silver coated teflon; Teflon film; *SP336*, pp. 345-358.

Ultraviolet degradation; Vacuum UV; Alzak; Thermal control coatings; *SP336*, pp. 383-392.

Ultraviolet spectrum; CCl; CCl_2; Force constants; Free radical; HCCl; $HCCl_2$; H_2CCl; Infrared spectrum; Matrix isolation; Photolysis; *11964.*

Ultraviolet spectrum; ClCF; Chlorofluoromethane; Chlorofluoromethane-d_2; Fluorescence spectrum; Free radical; Infrared spectrum; Matrix isolation; Photolysis; *12219.*

Ultraviolet spectrum; Vacuum-ultraviolet photolysis; Bichloride anion; ClHCl free radical; Electron attachment; HCl dimer; Hydrogen bonding; Infrared spectrum; Matrix isolation; *11975.*

Ultraviolet spectrum; Vacuum-ultraviolet photolysis; CO_2; CO_3; Force constants; Infrared spectrum; Matrix isolation; O-atom reaction; Structure; *12101.*

Uncertainty; Value; Balance; Buoyancy; Calibration; Standards; Substitution weighing; Transposition weighing; True mass; *TN577.*

Uncertainty of viscosity measurements; Absolute measurement of viscosity; Accuracy of viscosity measurement; Calibration of viscometers; Viscosity; **J.75A** *No. 6, 535-540 (1971).*

Underwater sound; Piezoelectricity; Piezoelectric modulus; Polymer; Polyvinylchloride; Transducer; *12276.*

Undisturbed soil; Weight loss; Corrosion; Corrosion rate; Disturbed soil; Instantaneous rate; Pit depth; Pitting factor; Polarization; Steel piling; **J.75C** *No. 2, 107-121 (1971).*

Unified classical path; Hydrogen lines; Line wings; Stark broadening; Theory; *12222.*

Unified theory; Classical path; Hydrogen lines; Line wings; One-electron theory; Stark broadening; *12084.*

Unified theory; Classical path; Hydrogen lines; Line wings; Stark broadening; *Monogr. 120.*

Unified theory; Lyman-α; Stark-broadening; Time-ordering; *12208.*

Unified theory; Lyman-α; Stark-broadening; Time-ordering; *Monogr. 121.*

Uniformity; Interstate; Intra-state; "National Conference of States on Building and Standards"; *12081.*

Unimolecular decomposition; Atom-transfer reaction; Chemical activation; Chemical kinetics; Chemi-excitation; Gas phase; Potential energy surfaces; Recombination; Review; *11943.*

Unimolecular-dissociation; Ion-molecule reaction; Photoionization; Propane; Quantum yields; Rare-gas resonance radiation; **J.75A** *No. 6, 607-612 (1971).*

Unimolecular fragmentation; Ion-molecule reactions; Neopentane; Neutralization; Radiolysis; *12141.*

Unimolecular ion fragmentation; Deactivation; Ion-molecule reactions; Photoionization; Radiolysis; *11905.*

Unimolecular-dissociation; Cyclohexene; Ion-molecule reactions; Photoionization; Photolysis; *11901.*

Unit cell; Growth technique; N-eicosane; Single crystal; *11875.*

United Soviet Socialist Republics; Building economics; Building systems; Construction industry; Housing; Precast concrete; Production capacity; Production management; Production methods; Standardization; *SP334.*

United States Government; Data codes; Data elements; Data processing systems standards; Federal information processing standards; Management information systems; *FIPS PUB 19.*

Units of measurement; General conference of weights and measures; International Committee of Weights and Measures; International System of Units; SI; Système International des Unités; *SP330.*

Universal testing machine; Force calibration; Large test facilities; Structural testing; *SP355.*

Universal time; Frequency shift; Frequency stability; Hydrogen hyperfine transition; Hydrogen maser; Hydrogen storage; Hydrogen wall collisions; NBS-III; Teflon; *12069.*

Unrecorded reference; Average signal peak level; Computer amplitude reference; Magnetic tape; Master standard; Saturation curves; Secondary standard; Signal level calibration; Standard reference materials; *SP260-29.*

Unreinforced concrete; Buckling; Compression members, concrete; Deflection; Equilibrium; Load eccentricity; Masonry; Stability; Section cracking; Stress distribution; *12298.*

Unsaturated standard cells; Electromotive force; Saturated standard cells; Standard cells; *12037.*

Upper atmosphere; Hydrogen atoms; Nitrogen atoms; $O_2(^1\Delta_g)$; Oxygen atoms; Quenching reactions; *12090.*

Upper yield point; Zone-refined iron; Flow stress; Impurity softening; Lattice solution; Lower yield stress; Nitrogen; Polycrystals; Solution hardening; *11946.*

Uranium; Absolute isotopic abundance; Ignition procedure; Isotopic standards, mass spectrometry; Stoichiometry; *SP260-27.*

Uranium; Alpha tracks; Boron; Botanical material; Fission tracks; Kale; Orchard leaves; *12269.*

Uranium monoxide; Uranium oxides; Vibrational frequency; High temperature matrix isolation; Infrared; *12262.*

Uranium oxides; Vibrational frequency; High temperature matrix isolation; Infrared; Uranium monoxide; *12262.*

Urban analysis; East Lansing, Mich.; Facility location; Fire station; Simulation model; Systems analysis; *12018.*

Urban planning; Acoustics; Noise measurement; Noise pollution; Noise (sound); Sound transmission; Tires; Transportation noise; Trucks; *12329.*

U.S. Air Force; Audit examinations; Audit package; Precision Measurement Equipment Laboratories (PMEL); Technician skills; *SP335*, pp. 105-109.

U.S. Government; American National Standards; Computers, data elements and codes; Data processing systems; Federal Information Processing Standards; International Organization for Standardization; Management information systems; Standards; *FIPS PUB 12.*

U.S. Metric Study; Commercial weights and measures; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; *SP345-3.*

U.S. Metric Study; Consumers; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; *SP345-7.*

U.S. Metric Study; Department of Defense; International System of Units; Metric conversion; Metric system; Metrication; Metrication, costs and benefits of; Metrication, impact of; SI; *SP345-9.*

U.S. Metric Study; Education; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; *SP345-6*.

U.S. Metric Study; Engineering standards; International standards; International System of Units; Metric conversion; Metric system; Metrication; Metrication and engineering standards; SI; Standards; *SP345-11*.

U.S. Metric Study; Federal Government; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; SI; *SP345-2*.

U.S. Metric Study; Foreign trade; International System of Units; Metric conversion; Metric conversion, effect on foreign trade; Metric system; Metric usage; Metric usage, effect on foreign trade; Metrication; Metrication, impact of on foreign trade; *SP345-8*.

U.S. Metric Study; International System of Units; Manufacturing industry; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; Metric conversion; Metric system; Metric usage; SI; *SP345-4*.

U.S. Metric Study; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; Nonmanufacturing businesses; SI; *SP345-5*.

U.S. Metric Study; International System of Units; Metric conversion; Metric system; Metric usage; Metrication; Metrication, attitudes toward; Metrication, costs and benefits of; Metrication, impact of; National Metric Study Conferences; SI; *SP345-12*.

U.S. Metric Study; Metric conversion; Metric system; Metric usage; Metrication; Public Law 90-472; *SP345*.

Use, storage, or surplus; Data for decision; Standards laboratory management; Test equipment records; *SP335*, pp. 95-98.

User-oriented computing system; Accuracy; Algorithms; ANSI FORTRAN; Documentation; Eror checking; Machine independent; OMNITAB II operating system subprograms; OMNITAB II source listing; Programming techniques; Transportable; *SP339*.

USSR standards; Standards in Russia; Standard reference materials; Standard samples; *SP260-30*.

V

Vacancies; Activation analysis; Concentrated alloys; Correlation factor; Diffusion; Random alloy; *12167*.

Vacancies in dislocations; Dislocation geometry; Dislocations; Kinks; Pipe diffusion; *SP317*, pp. 563-576.

Vacancy motion; Atomic diffusion; Defect motion; Interstitial motion; Jump frequency; Lattice model; Migration energy; Migration entropy; Molecular dynamics; Random-walk theory; *12022*.

Vacuum; Anti-migration traps; Cold shrouding; Contamination; Environment; Ion pumping; Low pressure; Low temperature; Pumping; Ultraclean; *SP336*, pp. 661-668.

Vacuum; Boron nitride: Ceramic; Metallizing; Ultrasonic; *11883*.

Vacuum; Chemical analysis; Contamination; Organic residues; Outgassing; Polymeric materials; Residual gas analysis; Test facility; *SP336*, pp. 1-24.

Vacuum; Cryopumping; Ion pump; Pumping speed; Space simulation chamber; *SP336*, pp. 683-698.

Vacuum; Weightlessness; Ablation; Particulate radiation; Reentry; Space simulation; Thermal radiation; *SP336*.

Vacuum effect; Ablation material; Thermal conductivity; *SP336*, pp. 197-208.

Vacuum gauge calibration; Reference transfer method; *SP336*, pp. 141-150.

Vacuum system; Apparatus; Beam diagnostic; Ion source; Ion transportation; Laboratory space simulation; *SP336*, pp. 189-196.

Vacuum tests; Water jet; Flow rate tests; High speed movies; Particle velocities; *SP336*, pp. 905-914.

Vacuum ultraviolet; Absorption coefficient; Cl_2; Emission; Electronic energy; $OCCl_2$; Photodissociation; *12289*.

Vacuum ultraviolet; Analytical; Atomic emission; Detector; Gas chromatography; Spectroscopy; *12267*.

Vacuum ultraviolet; Bond dissociation energy; Diazomethane; Heat of formation; *12367*.

Vacuum ultraviolet; Bond dissociation energy; Fluorescence; HNCO; NCO $A^2\Sigma$; NH $A^3\pi$, $c^1\pi$; Photodissociation; *12012*.

Vacuum ultraviolet; Chlorine monofluoride; Dissociation energy; Ionization energy; Mass spectrometry; Photoionization; *12064*.

Vacuum ultraviolet; Chlorine monofluoride; Dissociative ionization; Fluorine; Heats of formation; Hot bands; Hydrogen fluoride; Ion pairs; Mass spectrometry; Molecular ionization; Photoionization; *12148*.

Vacuum ultraviolet; Ethane; Free radicals; Ions; Photolysis; Primary processes; *11904*.

Vacuum ultraviolet photolysis; CCl_3^+; Chloroform; Electron attachment; $HCCl_2^+$; $HCCl_2^-$; $HCCl_3^-$; Infrared spectrum; Matrix isolation; Photoionization; *12242*.

Vacuum UV; Alzak; Thermal control coatings; Ultraviolet degradation; *SP336*, pp. 383-392.

Vacuum UV; Oscillator strengths; Methyl radicals; Methylene; Spectroscopy; *12290*.

Vacuum vane gauge; Design criteria; Port-vane geometry; *11931*.

Vacuum-tube voltmeters; Calibration histories; Equal likelihood; Oscilloscopes; RX meters; *SP335*, pp. 81-84.

Vacuum-ultraviolet photolysis; Bichloride anion; ClHCl free radical; Electron attachment; HCl dimer; Hydrogen bonding; Infrared spectrum; Matrix isolation; Ultraviolet spectrum; *11975*.

Vacuum-ultraviolet photolysis; CHO_2 free radical; Force constants; Infrared spectrum; Matrix isolation; Reaction of OH with CO; Stereoisomers; *12112*.

Vacuum-ultraviolet photolysis; CO_2; CO_3; Force constants; Infrared spectrum; Matrix isolation; O-atom reaction; Structure; Ultraviolet spectrum; *12101*.

Vacuum-ultraviolet photolysis; Vibrational potential function; Alkali metal reactions; $BrHBr^-$; Charge transfer; $ClHCl^-$; Electron attachment; Infrared spectrum; Matrix isolation; Molecular rotation; *12369*.

Vacuum-uv; Activation energy; H atoms; H_2S; Rate constant; Resonance fluorescence; *12074*.

Valence orbital; Electron scatter; Energy curve; Local potential; N_2; Resonance width; Shape resonance; Spectroscopic constant; *11899*.

Valence state; CO; CO_2; Electron impact; Fourth positive bands; Oscillator strength; Rydberg state; *12327*.

Value; Balance; Buoyancy; Calibration; Standards; Substitution weighing; Transposition weighing; True mass; Uncertainty; *TN577*.

Vanadium; Alloys; Aluminum; Diffusion; High-pressure; Phase-diagram; *11832*.

Vanadium carbides; Band structure of solids; Cryogenics; Superconductivity; Transition temperatures; *12266*.

Vanadium compounds; Yttrium compounds; Zirconium compounds; Enthalpy; Entropy; Gibbs energy of formation; Hafnium compounds; Heat of formation; Niobium compounds; Scandium compounds; Tantalum compounds; Titanium compounds; *TN270-5*.

Vanadyl; β-isopropyltropolone; Chelate; Equilibrium constants; Extraction method; Ferric; Graphical; Least squares computer calculations; *12110*.

Vapor; Contamination; Dental amalgam; Environment; Hazards; Hygiene; Mercury; *12254*.

Vapor crystal growth; Aluminum oxide; Bicrystals; Crystal growth; *12013.*

Vapor pressure; Adiabatic saturation; Dew point temperature; Humidity; Hygrometer; Mixing ratio; Moist gas; Psychrometer; *J.***75C** *No. 2, 69-78 (1971).*

Vapor pressure; Argon; Carbon dioxide; Classical equation; Coexistence curve; Critical exponents; Critical point; Lattice gas; Power laws; Rectilinear diameter; Steam; Thermodynamic anomalies; *11985.*

Vapor pressure; Cadmium; Components of error (within- and between-laboratory); Heats of sublimation (second and third law); Interlaboratory measurements; Silver; Standard errors; Standard reference materials; *SP260-21.*

Vapor pressure; Critical point; Fluorine; Latent heats of vaporization; Saturated liquid densities; Saturated vapor densities; *11980.*

Vapor pressure; Density; Liquids; Nitrogen; *P,V,T;* phase boundary; Saturation density; *12186.*

Vapor pressure; Vapor pressure of water; Water vapor; Steam; Virial coefficients; Clausius-Clapeyron equation; Saturation vapor pressure over water; *J.***75A** *No. 3, 213-230 (1971).*

Vapor pressure; Viscosity; Volume; Density; Dielectric constant; Enthalpy; Entropy; Equation of state; Fixed points; Heat transfer coefficients; Index of refraction; Joule-Thomson; Latent heat; Melting point; Prandtl number; Oxygen; *TN384.*

Vapor pressure data; Vapor pressure equation; Critical point pressure; Fluorine; Normal boiling point; *11835.*

Vapor pressure equation; Critical point pressure; Fluorine; Normal boiling point; Vapor pressure data; *11835.*

Vapor pressure of water; Water vapor; Steam; Virial coefficients; Clausius-Clapeyron equation; Saturation vapor pressure over water; Vapor pressure; *J.***75A** *No. 3, 213-230 (1971).*

Vaporization; Alkanes; Heats; *n*-hexatricontane; *n*-pristane; *n*-tetracosane; *n*-tetranonacontane; *11840.*

Variable coupling lasers; HCN Lasers; H_2O lasers; Infrared lasers; *TN395.*

Variable laser coupling; HCN lasers; H_2O lasers; Infrared lasers; *12207.*

Variance; Allan variance; Frequency; Frequency stability; Sample variance; Spectral density; *12228.*

Variance components; Weighting; Analysis of variance; Average (weighted); Interlaboratory evaluation; Round robin; Single classification; Statistics; *11906.*

Vector potential; Leakage flux; Magnetic field; Toroid; Transformer; *12371.*

Vector potential; Magnetic field; Solenoid; Toroid; Transformer; *12372.*

Vehicle road tests; Brake friction materials; Coefficient of friction; Friction assessment screening test machine; Friction materials test machine; Girling scale dynamometer; Inertia brake dynamometer; *12051.*

Velocity-gradients; Computer; Correlations; Grid; Intermittency; Isotropy; Moments; Probability-distributions; Turbulence; *12316.*

Venturi; Water; Critical flow; Pressure profile; Steam; *TN608.*

Verdet coefficient; $Bi_{34}Ga_2O_{54}$; $Bi_{12}GeO_{20}$; $Bi_{12}SiO_{20}$; $Bi_{12}TiO_{20}$; $Bi_{14}ZnO_{22}$; Faraday effect; Modulator materials; Optical activity; Optical rotatory power; *11807.*

Vertical interval signals; Frequency and time dissemination; Television; *11949.*

Very low frequency; Broadcast of standard frequencies; High frequency; Low frequency; Standard frequencies; Time signals; *SP236, 1971 Edition.*

Vibrating-sample magnetometer; Bimorph; Cryogenic; Low-temperature; Magnetometer; Piezoelectric; *12046.*

Vibration; Acceleration response; Evaluation; Fatigue life; Lumped parameter system; Mechanical impedance; Random vibration; Test; Transfer impedance; Transmissivity equalization; *SP336,* pp. 509-524.

Vibration; Bearings; Diagnostics; Gears; Reliability; Signature analysis; *SP336,* pp. 407-448.

Vibrational analysis; Vibrational and rotational constants; Absorption spectrum; CO; Electronic transitions; Rotational analysis; *J.***75A** *No. 5, 455-467 (1971).*

Vibrational and rotational constants; Absorption spectrum; CO; Electronic transitions; Rotational analysis; Vibrational analysis; *J.***75A** *No. 5, 455-467 (1971).*

Vibrational assignment; Alkali hydroxides; High temperature; Infrared; Matrix; NaOD; NaOH; RbOD; RbOH; *11845.*

Vibrational assignment; C_6F_6; C_6Cl_6; C_6Br_6; C_6I_6; Hexahalogenated benzenes; Raman; Laser; *12299.*

Vibrational constants; Absorption; Energy levels; Gas laser; HCN, hydrogen cyanide; Infrared; Spectra; Rotational constants; *12044.*

Vibrational frequency; High temperature matrix isolation; Infrared; Uranium monoxide; Uranium oxides; *12262.*

Vibrational overlap; Born-Oppenheimer; Hartree-Fock; Molecular hydrogen; Partial widths; Potential curve; Predissociation; *12102.*

Vibrational potential function; Alkali metal reactions; $BrHBr^-$; Charge transfer; $ClHCl^-$; Electron attachment; Infrared spectrum; Matrix isolation; Molecular rotation; Vacuum-ultraviolet photolysis; *12369.*

Vibrational relaxation; Fluorescence; Infrared; Laser; Nitrous oxide; Q-switching; *11858.*

Vibrational spectrum; Electronic spectrum; Flash photolysis; Free radicals; Matrix isolation; Molecular orbitals; *11823.*

Vibrational states; Collective correlations; Four particle-four hole states; Light nuclei; Quartets; Rotational states; *12146.*

Vibration-rotation; Dimethylacetylene; Internal rotation; Rotational constants; Spectrum; *12170.*

Vibrations; Buildings; Climatology; Seismic loads; Structural engineering; Wind loads; *BSS30,* pp. 129-131.

Virial coefficients; Clausius-Clapeyron equation; Saturation vapor pressure over water; Vapor pressure; Vapor pressure of water; Water vapor; Steam; *J.***75A** *No. 3, 213-230 (1971).*

Virtual dislocations; Boundary dislocations; Glide propagation; Grain boundaries; *SP317,* pp. 531-545.

Viscoelastic damping; Dynamic force; Load cell; *12050.*

Viscosity; Absolute measurement; Calibration; Standard; Torsional pendulum; *J.***75A** *No. 6, 541-551 (1971).*

Viscosity; BKZ fluid; Nonlinear behavior; Polyisobutylene; Stress relaxation; *J.***75A** *No. 1, 33-40 (1971).*

Viscosity; Boltzmann gas; Cross-section for viscosity; Hard sphere gas; Quantum corrections; Statistical mechanics; *12303.*

Viscosity; Critical phenomena; Immiscibility; Oxide glasses; *12294.*

Viscosity; Density dependence; Liquid state; Simple fluids; Temperature dependence; Thermal conductivity; Transport properties; *11879.*

Viscosity; Electron damage; Electron energy; Electron spin resonance; Evaluation; Gel; Mechanical properties; Optical properties; Plastic films; Poly(ethylene terephtalate); Proton damage; Proton energy; Radiation effect; *SP336,* pp. 323-344.

Viscosity; Gas; Intermolecular potential; Potential function; Scattering; Second virial; *12162.*

Viscosity; Uncertainty of viscosity measurements; Absolute measurement of viscosity; Accuracy of viscosity measurement; Calibration of viscometers; *J.***75A** *No. 6, 535-540 (1971).*

Viscosity; Viscosity-drift; Glass; Immiscibility; Phase-separation; *12238.*

Viscosity; Viscous flow; Absolute measurement; Calculation of bounds; Calibration; Poiseuille flow; Standard; J.75A *No. 6, 553-560 (1971).*

Viscosity; Volume; Density; Dielectric constant; Enthalpy;Entropy; Equation of state; Fixed points; Heat transfer coefficients; Index of refraction; Joule-Thomson; Latent heat; Melting point; Prandtl number; Oxygen; Specific heat; *TN384.*

Viscosity anomaly; Anomaly in oxide mixtures; Oxide mixtures; *11929.*

Viscosity-drift; Glass; Immiscibility; Phase-separation; Viscosity; *12238.*

Viscous flow; Absolute measurement; Calculation of bounds; Calibration; Poiseuille flow; Standard; Viscosity; J.75A *No. 6, 553-560 (1971).*

Viscous flow; Critical point theories; Immiscibility; Phase transitions; Structural relaxation; Transport phenomena; J.75A *No. 3, 175-184 (1971).*

Viscous relaxation; Immiscibility; Oxide glasses; Relaxation times; Supercritical fluctuations; Ultrasonic spectroscopy; *11986.*

Vision; Achromatic; Appearance; Brightness; Chromatic adaptation; Chromaticity; Color; Least squares; Luminance; Model; Neutral; Perception; *11813.*

Vitreous state; Arsenious oxide; Arsenolite; Claudetite; Crystal transition; Cubic crystal; Glass; Heat capacity; Monoclinic crystal; Low temperature; Planar molecular structure; Spherical shell molecules; *12311.*

ω_K; Beryllium; Boron; Carbon; Fluorescence yield; Fluorine; *K*-shell; Magnesium; *11950.*

Volatile constituents; Volatilization; Absorption; Adsorption; "bake out"; Components; Decomposition; Degassing; Environment; Evaporation; Outgassing; Simulation; Sublimation; Thermal conduction; Thermal vacuum tests; *SP336,* pp. 473-485.

Volatile degradation products; Xenon-arc irradiation; Atmospheric exposure; ATR spectroscopy; Clear and pigmented films; Infrared analysis; Internal reflection spectroscopy; Mercury-arc irradiation; Organic coatings; Photodegradation; *SP336,* pp. 299-312.

Volatile products; Absorption; Condensation; Contamination control; Evaluation; Far infrared; Fluid dynamic force; Microorganisms; Optical properties; Planetary quarantine; Polymers; Shock force; Space simulation; Testing; *SP336,* pp. 51-77.

Volatilization; Absorption; Adsorption; "bake out"; Components; Decomposition; Degassing; Environment; Evaporation; Outgassing; Simulation; Sublimation; Thermal conduction; Thermal vacuum tests: Volatile constituents; *SP336,* pp. 473-485.

Voltage divider; Voltage ratio; Divider; Inductive voltage divider; Ratio; *11894.*

Voltage measurement (HF & MW); Bolovac; Current measurement (HF & MW); (HF & MW); Microwave currents; Microwave voltages; Power measurement; *11926.*

Voltage ratio; Divider; Inductive voltage divider; Ratio; Voltage divider; *11894.*

Voltage ratio; Divider; Measurement system; Ratio; Ratio standard; Resistive divider; *12150.*

Voltage standard; Frequency-to-voltage ratio; Josephson effect; Potentiometer; *12067.*

Volume; Bulk modulus; Grüneisen; *n*-alkanes; Normal mode; Polyethylene; Quasiharmonic specific heat; String of beads; Thermal expansion; Thermal properties; *12305.*

Volume; Density; Dielectric constant; Enthalpy; Entropy; Equation of state; Fixed points; Heat transfer coefficients; Index of refraction; Joule-Thomson; Latent heat; Melting point; Prandtl number; Oxygen; Specific heat; Speed of sound; *TN384.*

Volume dilation; Composite materials; Coupling agents; Epoxy polymer; Parting agents; Poisson's ratio; Release agents; Stress-strain curve; *12379.*

Volume measurements; Length measurements; Mass measurements; Metrology; Standards; State laboratories; *SP335,* pp. 89-94.

Voluntary Product Standards: Editorial format; Format; Product Standards; Standard; *PS0-70*

Vortex shedding; Wind loads; Aeroelasticity; Buildings; Circular cylinders; Gust factors; Masts; Structural engineering; Towers; *BSS30,* pp. 115-128.

V_3Ga; $AuGa_2$; BiIn; Bismuth; Diamagnetism; Knight shift; NaTl; Polarization; *12085.*

W

Wadsley defects; Annealing equilibria; Electron microscopy; Niobium tungsten system; *12263.*

Wall shift; Frequency accuracy; Hydrogen maser; *11892.*

Walls; Axial load (force); Bending moment; Building codes; End-fixity; Reinforced concrete; Slenderness; Strength; Structural analysis; *11933.*

Walls; Brick; Cavity walls; Composite walls; Compressive strength; Concrete block; Flexural strength; Masonry; Mortar; Slenderness effects; Standards; Structural stability; *BSS34.*

Walls; Bricks; Buckling; Deflection; Loads (forces); Masonry; Moments; Slenderness ratio; Stability; Structural engineering; *12227.*

Walls; Wind damage; Wind loads; Buildings; Fluctuating pressure; Gust factors; *BSS30,* pp. 9-18.

Wandel & Goltermann; Automatic noise-level recorders; Calibration of carrier-frequency filters; Microwave transmission lines; Siemens-Halske AEG; *SP335,* pp. 125-127.

Washington Cathedral; "1921"; Cathedral; Deformation; Lead; Roof; *12377.*

Water; Critical flow; Pressure profile; Steam; Venturi; *TN608.*

Water; Hydrocarbons; Ion-molecule reactions; Mass spectrometry; Photoionization; Proton transfer; *11927.*

Water analysis; Aromatics; Gas chromatography; Isotope dilution; Olefins; *12023.*

Water jet; Flow rate tests; High speed movies; Particle velocities; Vacuum tests; *SP336,* pp. 905-914.

Water vapor; High cirrus; Fourier spectroscopy; Submillimeter waves; *11885.*

Water vapor; Steam; Virial coefficients; Clausius-Clapeyron equation; Saturation vapor pressure over water; Vapor pressure; Vapor pressure of water; J.75A *No. 3, 213-230 (1971).*

Wave functions of Gd^{+++}; Corundum; Energy levels of Gd^{+++} in Al_2O_3; Quadrupole transitions; Spin Hamiltonian; Transition probabilities; Ultrasonic (paramagnetic) resonance; Ultrasonic transition probabilities; J. 75A *No. 5, 493-523 (1971).*

Wave optics; Diffraction theory; Lattice constants; Measurements; X-ray interferometry; *12285.*

Wave propagation; Dilatation centers; Lattice statics; Non-local theories; Solid mechanics; *SP317,* pp. 729-736.

Wavefront shearing interferometer; Coherence; Coherence measurement; Interferometry; *12321.*

Waveguide; Microwave; Reflection coefficient; Return loss; Sliding short; Shorted termination; *TN602.*

Wavelength; Energy levels; Ionization potential; Nickel; Spectral series; Spectroscopy; J.75A *No. 4, 335-336 (1971).*

Wavelength measurement; Atomic energy levels; Atomic theory; Autoionization; Helium; *12380.*

Wavelength standards; WWV; WWVB; WWVH; WWVL; Atomic clocks; Atomic standards; Clock dissemination; Crystal oscillators; Definition of second; Flicker noise; Frequency; Frequency stability; Lasers; Length standards; Measurement standards; *SP350.*

Wavelengths; Praseodymium; Spectra; *12257.*

Wavelengths; Zinc; Atomic spectra; Emission spectroscopy; *11907.*

Wavelengths, carbon spectra; Atomic energy levels, carbon spectra; Atomic spectra of carbon; Carbon spectra; Multiplet tables, carbon spectra; Spectra, carbon; *NSRDS-NBS3, Section 3.*

Wavelengths, nitrogen spectra N IV-N VII; Atomic energy levels, N IV-N VII; Nitrogen spectra, N IV-N VII; Multiplet tables, N IV-N VII; Spectra, N IV-N VII; *NSRD NBS3, Section 4.*

Weather resistance; Acid resistance; Color; Gloss; Porcelain enamel; *BSS38.*

Webbing abrasion; Webbing degradation; Anthropomorphic dummies; Auto seat tests; Deceleration; Human kinematics; Human tests; Restraint geometry; Restraint systems; Seat belt; Sled tests; *11850.*

Webbing degradation; Anthropomorphic dummies; Auto seat tests; Deceleration; Human kinematics; Human tests; Restraint geometry; Restraint systems; Seat belt; Sled tests; Webbing abrasion; *11850.*

Weeding a scientific library; Weeding criteria; Scientists' use of literature; *12178.*

Weeding criteria; Scientists' use of literature; Weeding a scientific library; *12178.*

Weight loss; Corrosion; Corrosion rate; Disturbed soil; Instantaneous rate; Pit depth; Pitting factor; Polarization; Steel piling; Undisturbed soil; *J.75C No. 2, 107-121 (1971).*

Weighting; Analysis of variance; Average (weighted); Interlaboratory evaluation; Round robin; Single classification; Statistics; Variance components; *11906.*

Weightlessness; Ablation; Particulate radiation; Re-entry; Space simulation; Thermal radiation; Vacuum; *SP336.*

Weights and measures; Consumer package; Exemption; Fluid measure; Labeling; Net quantity; Principal display panel; Regulations; *H108.*

Weights and measures; Metric system; *SP345-10.*

Weights and measures; Weights and measures—history; Weights and measures—law; Weights and measures—regulations; Weights and measures—technical requirements; Conference; *SP342.*

Weights and measures inspection; Accurate measurements of volume of liquids; Field standard measuring flasks; Specification; Tolerances; *H105-2.*

Weights and measures inspection; Accurate measurements of volumes; Field standard; Metal volumetric field standards; Provers; Specifications; Test measures; Tolerances; *H105-3.*

Weights and measures—history; Weights and measures—law; Weights and measures—regulations; Weights and measures—technical requirements; Conference; Weights and measures; *SP342.*

Weights and measures—law; Weights and measures—regulations; Weights and measures—technical requirements; Conference; Weights and measures; Weights and measures—history; *SP342.*

Weights and measures—regulations; Weights and measures—technical requirements; Conference; Weights and measures; Weights and measures—history; Weights and measures—law; *SP342.*

Weights and measures—technical requirements; Conference; Weights and measures; Weights and measures—history; Weights and measures—law; Weights and measures—regulations; *SP342.*

Weirs, broad-crested; Flow measurement; *12366.*

Whisker diode; Antenna theory; Infrared detectors; Lasers; *12168.*

White dwarf spectra; Balmer lines H_α, H_β, H_γ; Gravitational red shift; Stark broadening; Stark-induced red shift; *12226.*

Whiting; Calcium carbonate; Calcium sulfate; Chalk; Chroma; Toxicity; *PS30-70.*

Whitlockite; Ca/P ratio; Pyrolysis; Pyrophosphate; Stoichiometry; Tricalcium phosphate; *12183.*

Widener collection; Art restoration; Cellini; Chemical microscopy; National Gallery of Art; Renaissance bronzes; *11984.*

Wide-range; Calibration; Current comparator; Current transformer; Overload testing; Self-balancing current comparator; Transformer; *12256.*

Wilson-Bappu effect; Ca H and K lines; Non-LTE line formation; Plages; Radiative transport; Solar chromosphere; Solar spectrum; Sunspots; *12106.*

Wind; Buildings; Failure; Hurricanes; Mobile homes; Roofs; Structural engineering; Tides; *TN569.*

Wind damage; Wind loads; Buildings; Fluctuating pressure; Gust factors; Walls; *BSS30*, pp. 9-18.

Wind effects: Wind loads; Aerodynamic forces; Atmospheric boundary layer; Structural design; Turbulence; *BSS30.*

Wind effects; Wind tunnel modeling; Architectural features; Buildings; Mullions; Parapets; Roof projections; Static pressures; *BSS30*, pp. 73-86.

Wind load; Anchorage; Building performance; Glazing; Hailstones; Masonry; Mobile homes; Roofs; Structural engineering; *TN558.*

Wind loads; Aerodynamic forces; Atmospheric boundary layer; Structural design; Turbulence; Wind effects; *BSS30.*

Wind loads; Aeroelasticity; Buildings; Circular cylinders; Gust factors; Masts; Structural engineering; Towers; Vortex shedding; *BSS30*, pp. 115-128.

Wind loads; Anemometers; Instrumentation; Tower interference; Transducers; Wind vanes; *BSS30*, p. 21.

Wind loads; Buildings; Design criteria; Dynamics; Gust factors; Smoke stacks; Structural failure; *BSS30*, pp. 5-8.

Wind loads; Buildings; Dynamics; Gust factor; Mode shape; Probability theory; *BSS30*, pp. 93-104.

Wind loads; Buildings; Dynamics; Gust loads; Matrix analysis; Mode shape; Probability theory; *BSS30*, pp. 145-149

Wind loads; Buildings; Fluctuating pressure; Gust factors; Walls; Wind damage; *BSS30*, pp. 9-18.

Wind loads; Vibrations; Buildings; Climatology; Seismic loads; Structural engineering; *BSS30*, pp. 129-131.

Wind loads; Wind profile; Buildings; Climatology; Extreme value theory; Gust factors; Structural engineering; *BSS30*, pp. 151-164.

Wind loads; Wind tunnel modeling; Aeroelasticity; Buildings; Dynamics; Statistical analysis; Structural engineering; *BSS30*, pp. 107-114.

Wind loads; Wind tunnel modeling; Boundary layer; Buildings; Pressure fluctuations; Instrumentation; Overturning moments; *BSS30*, pp. 45-59.

Wind loads; Wind tunnel modeling; Buildings; Full-scale tests; Power spectra; Pressure fluctuations; *BSS30*, pp. 61-71.

Wind observations; Wind profiles; Climatology; Meteorology; Spatial correlation; Turbulence; *BSS30*, pp. 23-25.

Wind profile; Buildings; Climatology; Extreme value theory; Gust factors; Structural engineering; Wind loads; *BSS30*, pp. 151-164.

Wind profiles; Atmospheric boundary layer; Gust factors; Peak values; Power spectra; Turbulence; *BSS30*, pp. 27-41.

Wind profiles; Climatology; Meteorology; Spatial correlation; Turbulence; Wind observations; *BSS30*, pp. 23-25.

Wind tunnel modeling; Aeroelasticity; Buildings; Dynamics; Statistical analysis; Structural engineering; Wind loads; *BSS30*, pp. 107-114.

Wind tunnel modeling; Architectural features; Buildings; Mullions; Parapets; Roof projections; Static pressures; Wind effects; *BSS30*, pp. 73-86.

Wind tunnel modeling; Boundary layer; Buildings; Pressure fluctuations; Instrumentation; Overturning moments; Wind loads; *BSS30*, pp. 45-59.

Wind tunnel modeling; Buildings; Full-scale tests; Power spectra; Pressure fluctuations; Wind loads; *BSS30*, pp. 61-71.

Wind vanes; Wind loads; Anemometers; Instrumentation; Tower interference; Transducers; *BSS30*, p. 21.

Winter; Bias ply; Breaking energy; Passenger car; Radial; Tires; Tire strength; *11833*.

Wire bonding; Capacitor microphone; Flip-chip; Magnetic pickup; Microelectronic interconnections; Spider bonding; Ultrasonic bonding; *TN573*.

Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; *TN702*.

Wire bonds; Alpha-particle detectors; Aluminum wire; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; Microelectronics; *TN560*.

Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; *TN571*.

Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Metallization; Methods of measurement; *TN592*.

Wire bonds; Alpha-particle detectors; Aluminum wire; Base transit time; Carrier lifetime; Die attachment; Electrical properties; Epitaxial silicon; Gamma-ray detectors; Germanium; Gold-doped silicon; Methods of measurement; Microelectronics; *TN598*.

Within-group variance; Between-group variance; Mass comparisons of 1969; Systematic and random weighing errors; *SP335*, pp. 41-45.

Wood door units; Door units, wood; Hinged door units, interior; Prefabricated door units; *PS32-70*.

Work function; Adsorption; Cesium; Desorption; Electron reflection; Electron stimulated desorption; Gallium arsenide; *12108*.

Work function; Carbon monoxide; Chemisorption; Co-adsorption; Displacement reaction; Hydrogen; Single crystal; Tungsten; *12261*.

Work function; Chemisorption; Flash desorption; Hydrogen; Nitrogen; Tungsten; Tungsten (100) plane; *12125*.

Wringing; Capacitance probe; Cylindrical gauge blocks; Inside diameters; Small-bore tubes; Standard hole; *12277*.

WWV; WWVB; WWVH; WWVL; Atomic clocks; Atomic standards; Clock dissemination; Crystal oscillators; Definition of second; Flicker noise; Frequency; Frequency stability; Lasers; Length standards; Measurement standards; Spectral density; *SP350*.

WWVB; WWVH; WWVL; Atomic clocks; Atomic standards; Clock dissemination; Crystal oscillators; Definition of second; Flicker noise; Frequency; Frequency stability; Lasers; Length standards; Measurement standards; Spectral density; Speed of light; *SP350*.

WWVH; WWVL; Atomic clocks; Atomic standards; Clock dissemination; Crystal oscillators; Definition of second; Flicker noise; Frequency; Frequency stability; Lasers; Length standards; Measurement standards; Spectral density; Speed of light; *SP350*.

WWVL; Atomic clocks; Atomic standards; Clock dissemination; Crystal oscillators; Definition of second; Flicker noise; Frequency; ·Frequency stability; Lasers; Length standards; Measurement standards; Spectral density; Speed of light; *SP350*.

W-Re alloys; EMF-temperature relationship; Furnace; High temperature; Refractory metals; Thermocouple; Thermoelements; Sensor; Ultra high vacuum; **J. 75C** *No. 2, 99–106 (1971)*.

X

X ray; Absorption; Fine-structure; Perovskites; *11919*.

X ray; Absorption correction; Diffraction; *12053*.

X ray; Laser rod; Orientation; Ruby; Single crystal; Topography; *12066*.

X rays; Absorption corrections; Attenuation coefficient; Conference; Crystallography; Electron microprobe; Fluorescence analysis; Gamma rays; Photons; Röntgen; *11814*.

X rays; Compaction density; Eddy current measurements; Fuel rods; Impregnation density; Monitor tests; Neutron radiography; Ultrasonics; *SP336*, p. 405.

X rays; Gamma rays; Photocurrents; Radiation; Radiation detector; Radiation dosimetry; Silicon radiation detector; Temperature dependence; *J.***75A** *No. 6, 578-588 (1971)*.

Xenon-arc irradiation; Atmospheric exposure; ATR spectroscopy; Clear and pigmented films; Infrared analysis; Internal reflection spectroscopy; Mercury-arc irradiation; Organic coatings; Photodegradation; Surface degradation; *SP336*, pp. 299-312.

X-ray analysis; X-ray diffraction; Statistics; Computer programs; Fourier analysis; Nickel steels; *TN600*.

X-ray beams; Beryllium to gold; Electron produced; High intensity; Monochromatic yields; Purity; *12214*.

X-ray crystal structure; Heteropolymolybdate; *11979*.

X-ray diffraction; Anisotropic compressibility; Azides; Compressibility; High pressure; Single crystal; *12025*.

X-ray diffraction; Cesium; Gallium; High-pressure; Polymorph; Single crystal; *12187*.

X-ray diffraction; Crystal structure; Integrated intensities; Lattice constants; Peak intensities; Powder patterns; Reference intensities; Standard; *Monogr. 25, Section 9*.

X-ray diffraction; Dynamical diffraction; Imperfections; Kinematical scattering; Piezoelectric vibration; Secondary extinction; Theory; *12073*.

X-ray diffraction; Neutron diffraction; Percus-Yevick equation; Radial distribution function; Simple liquids; Superposition approximation; Three body correlation function; *12016*.

X-ray diffraction; Statistics; Computer programs; Fourier analysis; Nickel steels; X-ray analysis; *TN600*.

X-ray diffraction data; Silver; Silver-tin alloys; Stacking fault probability; *11915*.

X-ray emission; Alloys; Corrections; Electron probe; Homogeneity; Matrix scanner; Microanalysis; Quantitative analysis; Standard reference materials; *SP260-28*.

X-ray emission; X-ray satellites; Electron excitation; Neon *K* emission spectrum; *12286*.

X-ray fluorescence analysis; Austenite in ferrite; Electron microprobe; Powder metallurgy; Quantitative microscopy; SRM; *SP260-25*.

X-ray interferometry; Wave optics; Diffraction theory; Lattice constants; Measurements; *12285*.

X-ray opaque; Clinical research (dental); Composite restorations; Diagnosis; Physical properties of fillings; *11944*.

X-ray satellites; Electron excitation; Neon *K* emission spectrum; X-ray emission; *12286*.

X-ray spectra; X-ray spectrometers; Electron diffraction; Electron probes; Evaluation; Gas flow; Lithium; Microanalysis; Multichannel analyzer; Proportional counters; Quantitative analysis; Solid state counters; Tests; *12251*.

X-ray spectrometer shield; Increased sensitivity of touch alarm; Scanning electron microscope; *12060*.

X-ray spectrometers; Electron diffraction; Electron probes; Evaluation; Gas flow; Lithium; Microanalysis; Multichannel analyzer; Proportional counters; Quantitative analysis; Solid state counters; Tests; X-ray spectra; *12251*.

X-ray structure analysis; *Bis*-[μ-(tri-,1,2,4-triazolo-N^1,N^2)-triaquonickel] nickel hexanitrate dihydrate; Trinuclear nickel(II) complex; *12291*.

X-ray structure determination; Coordination complex; Inorganic polymer; Pyrazine ligand; *12054*.

APPENDIX A. LIST OF DEPOSITORY LIBRARIES IN THE UNITED STATES

ALABAMA

- Alexander City: Alexander City State Junior College Library (1967).
- Auburn: Auburn University, Ralph Brown Draughon Library (1907).
- Birmingham:
  - Birmingham Public Library (1895).
  - Birmingham-Southern College, M. Paul Phillips Library (1932).
  - Samford University, Harwell G. Davis Library (1884).
- Enterprise: Enterprise State Junior College Library (1967).
- Florence: Florence State College, Collier Library (1932).
- Gadsden: Gadsden Public Library (1963).
- Huntsville: University of Alabama, Huntsville Campus Library (1964).
- Jacksonville: Jacksonville State University, Ramona Wood Library (1929).
- Maxwell AF Base: Air University Library (1963).
- Mobile:
  - Mobile Public Library (1963).
  - Spring Hill College, Thomas Byrne Memorial Library (1937).
  - University of South Alabama Library (1968).
- Montgomery:
  - Alabama State Department of Archives and History Library (1884).
  - Alabama Supreme Court Library (1884).
- Normal: Alabama Agricultural and Mechanical College, Drake Memorial Library (1963).
- St. Bernard: St. Bernard College Library (1962).
- Troy: Troy State College Library (1963).
- Tuskegee Institute: Tuskegee Institute, Hollis Burke Frissell Library (1907).
- University:
  - University of Alabama Law Library (1967).
  - University of Alabama Library (1860) – REGIONAL.

ALASKA

- Anchorage:
  - Anchorage Community College Library (1961).
  - Anchorage Methodist University Library (1963).
- College: University of Alaska Library (1922).
- Juneau: Alaska State Library (1964).

ARIZONA

- Flagstaff: Northern Arizona University Library (1937).
- Phoenix:
  - Department of Library and Archives (unknown) – REGIONAL.
  - Phoenix Public Library (1917).
- Prescott: Prescott College Library (1968).
- Tempe: Arizona State University, Matthews Library (1944).
- Thatcher: Eastern Arizona Junior College Library (1963).
- Tucson: University of Arizona Library (1907) – REGIONAL.
- Yuma: Yuma City-County Library (1963).

ARKANSAS

- Arkadelphia: Ouachita Baptist University, Riley Library (1963).
- Batesville: Arkansas College Library (1963).
- Clarksville: College of the Ozarks Library (1925).
- College Heights: Arkansas Agricultural and Mechanical College Library (1956).
- Conway: Hendrix College, O. C. Bailey Library (1903).
- Fayetteville: University of Arkansas Library (1907).
- Little Rock:
  - Arkansas Supreme Court Library (1962).
  - Little Rock Public Library (1953).
- Magnolia: Southern State College, J. M. Peace Library (1956).
- Russellville: Arkansas Polytechnic College, Tomlinson Library (1925).
- Searcy: Harding College, Beaumont Memorial Library (1963).
- State College: Arkansas State University, Dean B. Ellis Library (1913).
- Walnut Ridge: Southern Baptist College, Felix Goodson Library (1967).

CALIFORNIA

- Anaheim: Anaheim Public Library (1963).
- Arcata: Humboldt State College Library (1963).
- Bakersfield: Kern County Library.
- Berkeley:
  - University of California, General Library (1907).
  - University of California, Law Library, Earl Warren Legal Center (1963).
- Chico: Chico State College Library (1962).
- Claremont: Pomona College Documents Collection, Honnold Library (1913).
- Culver City: Culver City Library (1966).
- Davis: University of California Library (1953).
- Downey: Downey City Library (1963).
- Fresno:
  - Fresno County Free Library (1920).
  - Fresno State College Library (1962).
- Fullerton: California State College at Fullerton Library (1963).
- Gardena: Gardena Public Library (1966).
- Hayward: California State College at Hayward Library (1963).
- Inglewood Public Library (1963).
- Irvine: University of California at Irvine Library (1963).
- La Jolla: Univeristy of California, San Diego, University Library (1963).
- Lancaster: Lancaster Regional Library (1967).
- Long Beach:
  - California State College at Long Beach Library (1962).
  - Long Beach Public Library (1933).
- Los Angeles:
  - California State College at Los Angeles, John F. Kennedy Memorial Library (1956).
  - Los Angeles County Law Library (1963).
  - Los Angeles Public Library (1891).
  - Loyola University of Los Angeles Library (1933).
  - Occidental College, Mary Norton Clapp Library (1941).
  - Pepperdine College Library (1963).
  - University of California at Los Angeles Library (1932).
  - University of California, School of Law Library (1958).
  - University of Southern California Library (1933).
- Lynwood: Lynwood Library (1966).
- Marysville: Yuba College Library (1963).
- Menlo Park: Department of the Interior, Geological Survey Library (1962).
- Montebello: Montebello Library (1966).
- Monterey: Naval Postgraduate School Library (1963).

Monterey Park: Bruggemeyer Memorial Library (1964).
Newhall: Newhall Library of Los Angeles County Public Library System (1967).
Northridge: San Fernando Valley State College Library (1958).
Oakland:
  Mills College Library (1966).
  Oakland Public Library (1923).
Orange: Orange County Public Library (1963).
Pasadena:
  California Institute of Technology Library (1933).
  Pasadena Public Library (1963).
Pleasant Hill: Contra Costa County Library (1964).
Redding: Shasta County Library (1956).
Redlands: University of Redlands Library (1933).
Redwood City: Redwood City Public Library (1966).
Reseda: West Valley Regional Branch Library (1966).
Richmond: Richmond Public Library (1943).
Riverside:
  Riverside Public Library (1947).
  University of California at Riverside Library (1963).
Sacramento:
  California State Library (1895)—REGIONAL.
  Sacramento City Library (1880).
  Sacramento County Law Library (1963).
  Sacramento State College Library (1963).
San Bernardino: San Bernardino County Free Library (1964).
San Diego:
  San Diego County Library (1966).
  San Diego Public Library (1895).
  San Diego State College Library (1962).
  University of San Diego Law Library (1967).
San Francisco:
  Mechanics' Institute Library (1889).
  San Francisco Public Library (1889).
  San Francisco State College, Social Science and Business Library (1955).
  University of San Francisco, Richard A. Gleeson Library (1963).
San Jose: San Jose State College Library (1962).
San Leandro: San Leandro Community Library Center (1961).
Santa Ana: Santa Ana Public Library (1959).
Santa Barbara: University of California at Santa Barbara Library (1960).
Santa Clara: University of Santa Clara, Orradre Library (1963).
Santa Cruz: University of California at Santa Cruz Library (1963).
Santa Rosa: Santa Rosa-Sonoma County Public Library (1896).
Stanford: Stanford University Libraries (1895).
Stockton: Public Library of Stockton and San Joaquin County (1884).
Thousand Oaks: California Lutheran College Library (1964).
Torrance: Torrance Public Library (1969).
Turlock: Stanislaus State College Library (1964).
Visalia: Tulare County Free Library (1967).
Walnut: Mount San Antonio College Library (1966).
West Covina: West Covina Library (1966).
Whittier: Whittier College, Wardman Library (1963).

CANAL ZONE

Balboa Heights: Canal Zone Library-Museum (1963).

COLORADO

Alamosa: Adams State College Library (1963).
Boulder: University of Colorado Libraries (1879)—REGIONAL.
Colorado Springs: Colorado College, Charles Leaming Tutt Library (1880).
Denver:
  Colorado State Library (unknown).
  Denver Public Library (1884)—REGIONAL.
  Department of Interior, Bureau of Reclamation Library (1962).
  Regis College, Dayton Memorial Library (1915).
  University of Denver, Mary Reed Library (1909).
Fort Collins: Colorado State University Library (1907).
Golden:
  Colorado School of Mines, Arthur Lakes Library (1939).
  Jefferson County Public Library (1968).
Greeley: Colorado State College Library (1966).
Gunnison: Western State College, Leslie J. Savage Library (1932).
La Junta: Otero Junior College, Wheeler Library (1963).
Pueblo:
  McClelland Public Library (1893).
  Southern Colorado State College Library (1965).
U.S. Air Force Academy: Academy Library (1956).

CONNECTICUT

Bridgeport: Bridgeport Public Library (1884).
Danbury: Western Connecticut State College Library (1967).
Hartford:
  Connecticut State Library (unknown)—REGIONAL.
  Hartford Public Library (1945).
  Trinity College Library (1895).
Middletown: Wesleyan University, Olin Library (1906).
Mystic: Mystic Seaport Library (1964).
New Haven:
  Southern Connecticut State College Library (1968).
  Yale University Library (1859).
New London:
  Connecticut College Library (1926).
  U.S. Coast Guard Academy Library (1939).
Pomfret: Pomfret School Library (1968).
Storrs: University of Connecticut, Wilbur Cross Library (1907).
Thompsonville: Enfield Public Library (1967).
Waterbury: Silas Bronson Library (1869).

DELAWARE

Dover:
  Delaware State College, William C. Jason Library (1962).
  State Law Library in Kent County (unknown).
Georgetown: Delaware Technical and Community College, Southern Branch Library (1968).
Newark: University of Delaware, Morris Library (1907).
Wilmington: Wilmington Institute Free Library (1861).

DISTRICT OF COLUMBIA

Washington:
  Bureau of the Budget Library, Executive Office of the President (1965).
  Civil Service Commission Library (1963).
  Department of Commerce Library (1955).
  Department of Health, Education, and Welfare Library (1954).
  Department of the Interior Central Library (1895).
  Department of the Interior, Geological Survey Library (1962).
  Department of Justice, Main Library (1895).
  Department of State Library (1895).
  Department of State, Office of Legal Advisor, Law Library (1966).
  Department of Transportation, National Highway Safety Bureau Library (1968).

District of Columbia Public Library (1943).
Georgetown University Library (1969).
Indian Claims Commission Library (1968).
National Agricultural Library (1895).
National War College Library (1895).
Navy Department Library (1895).
Navy Department, Office of Judge Advocate General Library (1963).
Post Office Department Library (1895).
Treasury Department Library (1895).
Veterans Administration, Medical and General Reference Library (1967).

FLORIDA

Boca Raton: Florida Atlantic University Library (1963).
Coral Gables: University of Miami Library (1939).
Daytona Beach: Volusia County Public Libraries (1963).
De Land: Steston University, DuPont-Ball Library (1887).
Fort Lauderdale:
  Fort Lauderdale Public Library (1967).
  Nova University Library (1967).
Gainesville: University of Florida Libraries (1907)–REGIONAL.
Jacksonville:
  Haydon Burns Library (1914).
  Jacksonville University, Swisher Library (1962).
Lakeland: Lakeland Public Library (1928).
Leesburg: Lake-Sumter Junior College Library (1963).
Melbourne: Florida Institute of Technology Library (1963).
Miami:
  Miami Dade Junior College, North Campus Library (1967).
  Miami Public Library (1952).
Milton: Aeronautical Systems Library (1969).
Opa Locka: Biscayne College Library (1966).
Orlando: Florida Technological University Library (1966).
Palatka: St. Johns River Junior College Library (1963).
Pensacola: University of West Florida Library (1966).
St. Petersburg: St. Petersburg Public Library (1965).
Tallahassee:
  Florida Agricultural and Mechanical University, Coleman Memorial Library (1936).
  Florida State Library (1929).
  Florida State University, R. M. Strozier Library (1941).
Tampa:
  Tampa Public Library (1965).
  University of South Florida Library (1962).
  University of Tampa Library (1953).
Winter Park: Rollins College, Mills Memorial Library (1909).

GEORGIA

Albany: Albany Public Library (1964).
Americus: Georgia Southwestern College, Wade Lott Memorial Library (1966).
Athens: University of Georgia Libraries (1907).
Atlanta:
  Atlanta Public Library (1880).
  Atlanta University, Trevor Arnett Library (1962).
  Emory University, Asa Griggs Candler Library (1928).
  Emory University, School of Law Library (1968).
  Georgia Institute of Technology, Price Gilbert Memorial Library (1963).
  Georgia State Library (unknown).
Augusta: Augusta College Library (1962).
Brunswick: Brunswick Public Library (1965).
Carrollton: West Georgia College, Sanford Library (1962).
Dahlonege: North Georgia College Library (1939).
Gainesville: Chestatee Regional Library (1968).
Macon: Mercer University Library (1964).
Marietta: Kennesaw Junior College Library (1968).
Milledgeville: Georgia College at Milledgeville, Ina Dillard Russell Library (1950).
Savannah: Savannah Public and Chatham-Effingham-Liberty Regional Library (1857).
Statesboro: Georgia Southern College, Rosenwald Library (1939).
Valdosta: Valdosta State College, Richard Holmes Powell Library (1956).

GUAM

Agana: Nieves M. Flores Memorial Library (1962).

HAWAII

Hilo: University of Hawaii, Hilo Campus Library (1962).
Honolulu:
  Chaminade College of Honolulu Library (1965).
  Hawaii Medical Library, Inc. (1968).
  Hawaii State Library (1929).
  Municipal Reference Library of the City and County of Honolulu (1965).
  University of Hawaii Library (1907).
Laie: Church College of Hawaii Library (1964).
Lihue: Kauai Public Library (1967).
Pearl City: Leeward Community College Library (1967).
Wailuku: Maui Public Library (1962).

IDAHO

Boise:
  Boise State College Library (1966).
  Boise Public Library (1929)
  Idaho State Law Library (unknown).
Caldwell: College of Idaho, Terteling Library (1930).
Moscow: University of Idaho Library (1907)–REGIONAL.
Pocatello: Idaho State University Library (1908).
Rexburg: Ricks College, David O. McKay Library (1946).

ILLINOIS

Bloomington: Illinois Wesleyan University Libraries (1964).
Carbondale: Southern Illinois University Library (1932).
Carlinville: Blackburn College Library (1954).
Champaign: University of Illinois Law Library, College of Law (1965).
Charleston: Eastern Illinois University, Booth Library (1962).
Chicago:
  Chicago Natural History Museum Library (1963).
  Chicago Public Library (1876).
  Chicago State College Library (1954).
  John Crerar Library (1909).
  Loyola University, E. M. Cudahy Memorial Library (1966).
  Newberry Library (1890).
  Northeastern Illinois State College Library (1961).
  University of Chicago Law Library (1964).
  University of Chicago Library (1897).
  University of Illinois, Chicago Circle Campus Library (1957).
Decatur: Decatur Public Library (1954).
De Kalb: Northern Illinois University, Swen Franklin Parson Library (1960).
Edwardsville: Southern Illinois University, Lovejoy Memorial Library (1959).
Elsah: Principia College, Marshall Brooks Library (1957).
Evanston: Northwestern University Library (1876).
Freeport: Freeport Public Library (1905).

- Galesburg: Galesburg Public Library (1896).
- Jacksonville: MacMurry College, Henry Pfeiffer Library (1929).
- Kankakee: Olivet Nazarene College, Memorial Library (1946).
- Lake Forest: Lake Forest College, Donnelley Library (1962).
- Lebanon: McKendree College, Holman Library (1968).
- Lisle: St. Procopius College Library (1911).
- Lockport: Lewis College of Science and Technology Library (1952).
- Macomb: Western Illinois University Memorial Library (1962).
- Monmouth: Monmouth College Library (1860).
- Normal: Illinois State University, Milner Library (1877).
- Oak Park: Oak Park Public Library (1963).
- Peoria:
  - Bradley University Library (1963).
  - Peoria Public Library (1883).
- River Forest: Rosary College Library (1966).
- Rock Island: Rock Island Public Library (1950).
- Rockford: Rockford Public Library (unknown).
- Springfield: Illinois State Library (unknown) – REGIONAL.
- Urbana: University of Illinois Library (1907).
- Wheaton: Wheaton College Library (1964).
- Woodstock: Woodstock Public Library (1963).

INDIANA

- Anderson: Anderson College, Charles E. Wilson Library (1959).
- Bloomington: Indiana University Library (1881).
- Crawfordsville: Wabash College, Lilly Library (1906).
- Evansville:
  - Evansville and Vanderburgh County Public Library (1928).
  - Indiana State University, Evansville Campus Library (1969).
- Fort Wayne:
  - Indiana-Purdue Universities, Regional Campus Library (1965).
  - Public Library of Fort Wayne and Allen County (unknown).
- Gary:
  - Gary Public Library (1943).
  - Indiana University, Northwest Campus Library (1966).
- Greencastle: DePauw University, Roy O. West Library (1879).
- Hammond: Hammond Public Library (1964).
- Hanover: Hanover College Library (1892).
- Huntington: Huntington College Library (1964).
- Indianapolis:
  - Butler University, Irwin Library (1965).
  - Indiana State Library (unknown) – REGIONAL.
  - Indiana University, Law Library (1967).
  - Indianapolis Public Library (1906).
- Jeffersonville: Indiana University, Southeastern Campus Library (1965).
- Kokomo: Indiana University, Kokomo Regional Campus Library (1969).
- Lafayette: Purdue University Library (1907).
- Muncie:
  - Ball State University Library (1959).
  - Muncie Public Library (1906).
- Notre Dame: University of Notre Dame, Memorial Library (1883).
- Rensselaer: St. Joseph's College Library (1964).
- Richmond:
  - Earlham College, Lilly Library (1964).
  - Morrison-Reeves Library (1906).
- South Bend: Indiana University, South Bend-Mishawaka Campus Library (1965).
- Terre Haute: Indiana State University, Cunningham Memorial Library (1906).
- Valparaiso: Valparaiso University, Moellering Memorial Library (1930).

IOWA

- Ames: Iowa State University of Science and Technology Library (1907).
- Cedar Falls: University of Northern Iowa Library (1946).
- Council Bluffs: Free Public Library (1885).
- Denison: Midwestern College Library (1967).
- Des Moines:
  - Drake University, Cowles Library (1966).
  - Iowa State Traveling Library (unknown).
  - Public Library of Des Moines (1888).
- Dubuque:
  - Carnegie-Stout Public Library (unknown).
  - Loras College Wahlert Memorial Library (1967).
- Fairfield: Parsons College Library Branch of Fairfield Public Library (1862).
- Grinnell: Grinnell College Library (1874).
- Iowa City:
  - University of Iowa, Law Library (1968).
  - University of Iowa Library (1884) – REGIONAL.
- Lamoni: Graceland College, Frederick Madison Smith Library (1927).
- Mount Vernon: Cornell College, Russell D. Cole Library (1896).
- Sioux City: Sioux City Public Library (1894).

KANSAS

- Atchison: St. Benedict's College, the Abbey Library (1965).
- Baldwin City: Baker University Library (1908).
- Colby: Colby Community Junior College Library (1968).
- Emporia: Kansas State Teachers College, William Allen White Library (1909).
- Hays: Fort Hays Kansas State College, Forsyth Library (1926).
- Hutchinson: Hutchinson Public Library (1963).
- Lawrence: University of Kansas, Watson Library (1869).
- Manhattan: Kansas State University, Farrell Library (1907).
- Pittsburg: Kansas State College of Pittsburg, Porter Library (1952).
- Salina: Kansas Wesleyan University Library (1930).
- Topeka:
  - Kansas State Historical Society Library (1877).
  - State Libraries of Kansas (unknown).
- Wichita: Wichita State University Library (1901).

KENTUCKY

- Ashland: Ashland Public Library (1946).
- Barbourville: Union College, Abigail E. Weeks Memorial Library (1958).
- Bowling Green: Western Kentucky University, Margie Helm Library (1934).
- Danville: Centre College, Grace Doherty Library (1884).
- Frankfort:
  - Kentucky Department of Libraries (1967).
  - State Law Library (unknown).
- Lexington:
  - University of Kentucky, Law Library (1968).
  - University of Kentucky, Margaret I. King Library (1907) – REGIONAL.
- Louisville:
  - Louisville Free Public Library (1904).
  - University of Louisville Library (1925).
- Morehead: Morehead State University, Johnson Camden Library (1955).
- Murray: Murray State University Library (1924).
- Owensboro: Kentucky Wesleyan College Library (1966).
- Pikeville: Pikeville College Library (1947).

Richmond: Eastern Kentucky University, John Grant Crabbe Library (1966).

LOUISIANA

Baton Rouge:
  Louisiana State University Law Library (1929).
  Louisiana State University Library (1907)—REGIONAL.
  Southern University Library (1952).
Eunice: Louisiana State University at Eunice, LeDoux Library (1969).
Hammond: Southeastern Louisiana College, Sims Memorial Library (1966).
Lafayette: University of Southwestern Louisiana Library (1938).
Lake Charles: McNeese State College, Frazar Memorial Library (1941).
Monroe: Northeast Louisiana State College, Sandel Library (1963).
Natchitoches: Northwestern State College of Louisiana, Russell Library (1887).
New Orleans:
  Isaac Delgado College, Moss Technical Library (1968).
  Law Library of Louisiana (unknown).
  Louisiana State University in New Orleans Library (1963).
  Loyola University Library (1942).
  New Orleans Public Library (1883).
  Southern University in New Orleans Library (1962).
  Tulane University, Howard-Tilton Memorial Library (1942).
Pineville: Louisiana College, Richard W. Norton Memorial Library (1969).
Ruston: Louisiana Polytechnic Institute Library (1896)—REGIONAL.
Shreveport:
  Louisiana State University at Shreveport Library (1967).
  Shreve Memorial Library (1923).
Thibodaux: Francis T. Nicholls State College, Leonidas Polk Library (1962).

MAINE

Augusta: Maine State Library (unknown)
Bangor: Bangor Public Library (1884).
Brunswick: Bowdoin College, Hawthorne-Longfellow Library (1884).
Lewiston: Bates College Library (1883).
Orono: University of Maine, Raymond H. Fogler Library (1907)—REGIONAL.
Portland:
  Portland Public Library (1884).
  University of Maine Law Library (1964).
Springvale: Nasson College Library (1961).
Waterville: Colby College Library (1884).

MARYLAND

Annapolis:
  Maryland State Library (unknown).
  U.S. Naval Academy Library (1895).
Baltimore:
  Enoch Pratt Free Library (1887).
  Johns Hopkins University, Milton S. Eisenhower Library (1882).
  Morgan State College Library (1940).
Bel Air: Harford Junior College Library (1967).
Bethesda: Montgomery County Department of Public Libraries (1951).
Chestertown: Washington College, George Avery Bunting Library (1891).
College Park: University of Maryland, McKeldin Library (1925)—REGIONAL.
Frostburg: Frostburg State College, Jerome Frampton Library (1967).
Germantown: Atomic Energy Commission Library (1963).
Patuxent River: Naval Air Station Library (1968).
Salisbury: Salisbury State College, Blackwell Library (1965).
Towson: Goucher College, Julia Rogers Library (1966).
Westminster: Western Maryland College Library (1896).

MASSACHUSETTS

Amherst:
  Amherst College Library (1884).
  University of Massachusetts, Goodell Library (1907)
Belmont: Belmont Memorial Library (1968).
Boston:
  Boston Athenaeum Library (unknown).
  Boston College, Bapst Library (1963).
  Boston Public Library (1859).
  Northeastern University, Dodge Library (1962).
  State Library of Massachusetts (unknown)—REGIONAL.
Brookline: Public Library of Brookline (1925).
Cambridge:
  Harvard College Library (1860).
  Massachusetts Institute of Technology Libraries (1946).
Chicopee: Our Lady of the Elms College Library (1969).
Lowell: Lowell Technological Institute Library (1952).
Lynn: Lynn Public Library (1953).
Medford: Tufts University Library (1899).
New Bedford: New Bedford Free Public Library (1858).
North Dartmouth: Southeastern Massachusetts Technological Institute Library (1965).
North Easton: Stonehill College, Cushing-Martin Library (1962).
Springfield: Springfield City Library (1966).
Waltham: Brandeis University, Goldfarb Library (1965).
Wellesley: Wellesley College Library (1943).
Wenham: Gordon College, Winn Library (1963).
Williamstown: Williams College Library (unknown).
Worcester:
  American Antiquarian Society Library (1814).
  Worcester Public Library (1859).

MICHIGAN

Albion: Albion College, Stockwell Memorial Library (1966).
Allendale: Grand Valley State College Library (1963).
Alma: Alma College, Monteith Library (1963).
Ann Arbor: University of Michigan, General Library (1884).
Battle Creek: Willard Library (1876).
Benton Harbor: Benton Harbor Public Library (1907).
Bloomfield Hills: Granbrook Institute of Science Library (1940).
Dearborn: Henry Ford Community College Library (1957).
Detroit:
  Detroit Public Library (1868)—REGIONAL.
  Marygrove College Library (1965).
  Mercy College of Detroit Library (1965).
  University of Detroit Library (1884).
  Wayne County Public Library (1957).
  Wayne State University Library (1937).
East Lansing: Michigan State University Library (1907).
Escanaba: Michigan State Library, Upper Peninsula Branch (1964).
Farmington: Martin Luther King Learning Resources Center, Oakland Community College (1968).

Flint:
    Charles Stewart Mott Library (1959).
    Flint Public Library (1967).
Grand Rapids:
    Grand Rapids Public Library (1876).
    Knollcrest Calvin Library (1967).
Houghton: Michigan Technological University Library (1876).
Jackson: Jackson Public Library (1965).
Kalamazoo:
    Kalamazoo Library System (1907).
    Western Michigan University, Dwight B. Waldo Library (1963).
Lansing: Michigan State Library (unknown)—REGIONAL.
Livonia: Schoolcraft College Library (1962).
Marquette: Northern Michigan University, Olsen Library (1963).
Mt. Clemens: Macomb County Library (1968).
Mt. Pleasant: Central Michigan University Library (1958).
Muskegon: Hackley Public Library (1894).
Petoskey: North Central Michigan College Library (1962).
Port Huron: Saint Clair County Library System (1876).
Rochester: Oakland University, Kresge Library (1964).
Saginaw: Hoyt Public Library (1890).
Traverse City: Northwestern Michigan College, Mark Osterlin Library (1964).
University Center: Delta College Library (1963).
Ypsilanti: Eastern Michigan University Library (1965).

MINNESOTA

Bemidji: Bemidji State College Library (1963).
Collegeville: St. John's University, Alcuin Library (1954).
Duluth: Duluth Public Library (1909).
Mankato: Mankato State College Library (1962).
Minneapolis:
    Minneapolis Public Library (1893).
    University of Minnesota, Wilson Library (1907)—REGIONAL.
Moorhead: Moorhead State College Library (1956).
Morris: University of Minnesota at Morris Library (1963).
Northfield:
    Carleton College Library (1930).
    St. Olaf College, Rolvaag Memorial Library (1930).
St. Cloud: St. Cloud State College Library (1962).
St. Paul:
    Minnesota Historical Society Library (1867).
    Minnesota State Law Library (unknown).
    St. Paul Public Library (1914).
Saint Peter: Gustavus Adolphus College Library (1941).
Stillwater: Stillwater Public Library (1893).
Willmar: Kandiyohi County-Willmar Library (1958).
Winona: Winona State College, Maxwell Library (1969).

MISSISSIPPI

Columbus: Mississippi State College for Women, J. C. Fant Memorial Library (1929).
Hattiesburg: University of Southern Mississippi Library (1935).
Jackson:
    Jackson State College Library (1968).
    Millsaps College, Millsaps-Wilson Library (1963).
    Mississippi Library Commission (1947).
    Mississippi State Law Library (unknown).
State College: Mississippi State University, Mitchell Memorial Library (1907).
University:
    University of Mississippi Library (1883).
    University of Mississippi, School of Law Library (1967).

MISSOURI

Cape Girardeau: Southeast Missouri State College, Kent Library (1916).
Columbia: University of Missouri Library (1862).
Fayette: Central Methodist College Library (1962).
Fulton: Westminster College, Reeves Library (1875).
Hannibal: Hannibal Free Public Library (1909).
Jefferson City:
    Lincoln University, Inman E. Page Library (1944).
    Missouri State Library (1963).
    Missouri Supreme Court Library (unknown).
Joplin: Missouri Southern State College Library (1966).
Kansas City:
    Kansas City Public Library (1881).
    Rockhurst College Library (1917).
    University of Missouri at Kansas City, General Library (1938).
Kirksville: Northeast Missouri State Teachers College, Pickler Memorial Library (1966).
Liberty: William Jewell College Library (1900).
Rolla: University of Missouri at Rolla Library (1907).
St. Joseph: St. Joseph Public Library (1891).
St. Louis:
    St. Louis Public Library (1866).
    St. Louis University, Law Library (1967).
    St. Louis University, Pius XII Memorial Library (1866).
    University of Missouri at St. Louis Library (1966).
    Washington University, John M. Olin Library (1906).
Springfield:
    Drury College Library (1874).
    Southwest Missouri State College Library (1963).
Warrensburg: Central Missouri State College, Ward Edwards Library (1914).

MONTANA

Billings: Eastern Montana College Library (1924).
Bozeman: Montana State University Library (1907).
Butte: Montana College of Mineral Science and Technology Library (1901).
Helena:
    Montana Historical Society Library (unknown).
    Montana State Library (1966).
Missoula: University of Montana Library (1909)—REGIONAL.

NEBRASKA

Blair: Dana College Library (1924).
Crete: Doane College, Whitin Library (1944).
Fremont: Midland Lutheran College Library (1924).
Kearney: Kearney State College, Calvin T. Ryan Library (1962).
Lincoln:
    Nebraska State Library (unknown).
    University of Nebraska, Don L. Love Memorial Library (1907).
Omaha:
    Creighton University, Alumni Library (1964).
    Omaha Public Library (1880).
    University of Omaha, Gene Eppley Library (1939).
Scottsbluff: Scottsbluff Public Library (1925).

NEVADA

Carson City: Nevada State Library (unknown).
Las Vegas: Nevada Southern University, James R. Dickinson Library (1959).
Reno: University of Nevada Library (1907)—REGIONAL.

NEW HAMPSHIRE

Concord: New Hampshire State Library (unknown).
Durham: University of New Hampshire Library (1907).
Hanover: Dartmouth College, Baker Library (1884).
Henniker: New England College Library (1966).
Manchester:
    Manchester City Library (1884).
    St. Anselm's College, Geisel Library (1963).

NEW JERSEY

Atlantic City: Atlantic City Free Public Library (1908).
Bayonne: Bayonne Free Public Library (1909).
Bloomfield: Free Public Library of Bloomfield (1965).
Bridgeton: Cumberland County Library (1966).
Camden: Rutgers Library in South Jersey (1966).
Convent Station: College of St. Elizabeth, Santa Maria Library (1938).
East Orange: East Orange Public Library (1966).
Elizabeth: Free Public Library of Elizabeth (1895).
Glassboro: Glassboro State College, Savitz Library (1963).
Hackensack: Johnson Free Public Library (1966).
Irvington: Free Public Library of Irvington (1966).
Jersey City:
    Jersey City Free Public Library (1879).
    Jersey City State College, Forrest A. Irwin Library (1963).
Madison: Drew University, Rose Memorial Library (1939).
Mount Holly: Burlington County Area Library (1966).
New Brunswick:
    Free Public Library (1908).
    Rutgers University Library (1907).
Newark:
    Newark Public Library (1906) – REGIONAL.
    Rutgers – The State University, John Cotton Dana Library (1966).
Passaic: Passaic Public Library (1964).
Princeton: Princeton University Library (1884).
Rutherford: Fairleigh Dickinson University, Periodicals Library (1953).
Shrewsbury: Monmouth County Library (1968).
South Orange: Seton Hall University Library (1947).
Teaneck: Fairleigh Dickinson University, Teaneck Campus Library (1963).
Toms River: Ocean County College Library (1966).
Trenton:
    New Jersey State Library, Law and Reference Bureau, Department of Education (unknown).
    Trenton Free Public Library (1902).
Upper Montclair: Montclair State College, Harry A. Sprague Library (1967).
West Long Branch: Monmouth College, Guggenheim Memorial Library (1963).
West New York: West New York Free Public Library (1963).
Woodbridge: Free Public Library of Woodbridge (1965).

NEW MEXICO

Albuquerque: University of New Mexico, Zimmerman Library (1896) – REGIONAL.
Hobbs: New Mexico Junior College, Pannell Library (1969).
Las Cruces: New Mexico State University Library (1907).
Las Vegas: New Mexico Highlands University, Donnelly Library (1913).
Portales: Eastern New Mexico University Library (1962).
Santa Fe:
    New Mexico State Library (1960) – REGIONAL.
    Supreme Court Law Library (unknown).

NEW YORK

Albany:
    New York State Library (unknown) – REGIONAL.
    State University of New York at Albany Library (1964).
Binghamton: State University of New York at Binghamton Library (1962).
Brockport: State University of New York, Drake Memorial Library (1967).
Bronx: Herbert H. Lehman College Library (1967).
Bronxville: Sarah Lawrence College Library (1969).
Brooklyn:
    Brooklyn College Library (1936).
    Brooklyn Public Library (1908).
    Polytechnic Institute of Brooklyn, Spicer Library (1963).
    Pratt Institute Library (1891).
    State University of New York, Downstate Medical Center Library (1958).
Buffalo:
    Buffalo and Erie County Public Library (1895).
    State University of New York at Buffalo, Lockwood Memorial Library (1963).
Canton: St. Lawrence University, Owen D. Young Library (1920).
Corning: Corning Community College, Arthur A. Houghton, Jr. Library (1963).
Cortland: State University of New York, College at Cortland, Memorial Library (1964).
Elmira: Elmira College, Hamilton Library (1956).
Farmingdale: State University of New York at Farmingdale Library (1917).
Flushing: Queens College, Paul Klapper Library (1939).
Garden City:
    Adelphia University, Swirbul Library (1966).
    Nassau Library System (1965).
Geneseo: State University College, Milne Library (1967).
Greenvale: C. W. Post College Library (1964).
Hamilton: Colgate University Library (1902).
Hempstead: Hofstra University Library (1964).
Huntington: Huntington Public Library (1966).
Ithaca:
    Cornell University Library (1907).
    New York State Colleges of Agriculture and Home Economics, Albert R. Mann Library (1943).
Jamaica:
    Queens Borough Public Library (1926).
    St. John's University Library (1956).
Kings Point: U.S. Merchant Marine Academy Library (1962).
Mount Vernon: Mount Vernon Public Library (1962).
New Paltz: State University College Library (1965).
New York City:
    City University of New York, City College Library (1884).
    College of Insurance, Ecker Library (1965).
    Columbia University Libraries (1882).
    Cooper Union Library (1930).
    Fordham University Library (1937).
    New York Law Institute Library (1909).
    New York Public Library (Astor Branch) (1907).
    New York Public Library (Lenox Branch) (1884).
    New York University Libraries (1967).
    New York University, University Heights Gould Memorial Library (1902).
    State University of New York, Maritime College Library (1947).
Newburgh: Newburgh Free Library (1909).
Oakdale: Dowling College Library (1965).
Oneonta: State University College, James M. Milne Library (1966).
Oswego: State University College, Penfield Library (1966).

Plattsburgh: State University College, Benjamin F. Feinberg Library (1967).
Potsdam:
  Clarkson College of Technology, Harriet Call Burnap Memorial Library (1938).
  State University College Library (1964).
Poughkeepsie: Vassar College Library (1943).
Purchase: State University of New York, College at Purchase Library (1969).
Rochester:
  Rochester Public Library (1963).
  University of Rochester Library (1880).
St. Bonaventure: St. Bonaventure College, Friedsam Memorial Library (1938).
Saratoga Springs: Skidmore College Library (1964).
Schenectady: Union College, Schaffer Library (1901).
Staten Island (Grymes Hill): Wagner College, Horrmann Library (1953).
Stony Brook: State University of New York at Stony Brook Library (1963).
Syracuse: Syracuse University Library (1878).
Troy: Troy Public Library (1869).
Utica: Utica Public Library (1885).
West Point: U.S. Military Academy Library (unknown).
Yonkers: Yonkers Public Library (1910).

NORTH CAROLINA

Asheville: University of North Carolina at Asheville, D. Hiden Ramsey Library (1965).
Boone: Appalachian State University, Dauphin Disco Dougherty Library (1963).
Buies Creek: Campbell College, Carrie Rich Memorial Library (1965).
Chapel Hill: University of North Carolina Library (1884)—REGIONAL.
Charlotte:
  Public Library of Charlotte and Mecklenburg County (1964).
  Queens College, Everett Library (1927).
  University of North Carolina at Charlotte, Atkins Library (1964).
Cullowhee: Western Carolina University, Hunter Library (1953).
Davidson: Davidson College, Hugh A. & Jane Grey Memorial Library (1893).
Durham: Duke University Library (1890).
Greensboro:
  North Carolina Agricultural and Technical State University, F. D. Bluford Library (1937).
  University of North Carolina at Greensboro, Walter Clinton Jackson Library (1963).
Greenville: East Carolina University, J. Y. Joyner Library (1951).
Laurinburg: St. Andrews Presbyterian College, De-Tamble Library (1969).
Mars Hill: Mars Hill College, Memorial Library (1967).
Murfreesburo: Chowan College Library (1963).
Pembroke: Pembroke State College Library (1956).
Raleigh:
  North Carolina State Library (unknown).
  North Carolina State University, D. H. Hill Library (1923).
Rocky Mount: North Carolina Wesleyan College Library (1969).
Salisbury: Catawba College Library (1925).
Wilmington: University of North Carolina at Wilmington, William M. Randall Library (1965).
Wilson: Atlantic Christian College, Clarence L. Hardy Library (1930).
Winston-Salem:
  Forsyth County Public Library System (1954).
  Wake Forest University, Z. Smith Reynolds Library (1902).

NORTH DAKOTA

Bismarck:
  North Dakota State Historical Society Library (1907).
  North Dakota State Law Library (unknown).
  Veterans Memorial Public Library (1967).
Dickinson: Dickinson State College Library (1968).
Fargo:
  Fargo Public Library (1964).
  North Dakota State University Library (1907)—REGIONAL, in cooperation with University of North Dakota, Chester Fritz Library at Grand Forks.
Grand Forks: University of North Dakota, Chester Fritz Library (1890).
Minot: Minot State College, Memorial Library (1925).
Richardton: Assumption College, Abbey Library (1965).
Valley City: State College Library (1913).

OHIO

Ada: Ohio Northern University, J. P. Taggart Law Library (1965).
Akron:
  Akron Public Library (1952).
  University of Akron Library (1963).
Alliance: Mount Union College Library (1888).
Ashland: Ashland College Library (1938).
Athens: Ohio University Library (1886).
Bluffton: Bluffton College, Musselman Library (1951).
Bowling Green: Bowling Green State University Library (1933).
Chillicothe: Ohio University at Chillicothe Library (1968).
Cincinnati:
  Public Library of Cincinnati and Hamilton County (1884).
  University of Cincinnati Library (1929).
Cleveland:
  Case Western Reserve University, Freiberger Library (1913).
  Cleveland Public Library (1886).
  Cleveland State University Library (1966).
  John Carroll University, Grasselli Library (1963).
Columbus:
  Capital University Library (1968).
  Columbus Public Library (1885).
  Ohio State Library (unknown)—REGIONAL.
  Ohio State University Library (1907).
Dayton:
  Dayton and Montgomery County Public Library (1909).
  University of Dayton, Albert Emanuel Library (1969).
  Wright State University Library (1965).
Delaware: Ohio Wesleyan University, L. A. Beeghly Library (1845).
Elyria: Elyria Public Library (1966).
Findlay: Findlay College, Shafer Library (1969).
Gambier: Kenyon College Library (1873).
Granville: Denison University Library (1884).
Hiram: Hiram College, Teachout-Price Memorial Library (1874).
Kent: Kent State University Library (1962).
Mansfield: Ohio State University, Mansfield Campus Library (1969).
Marietta: Marietta College, Dawes Memorial Library (1884).
New Concord: Muskingum College Library (1966).
Oberlin: Oberlin College Library (1858).
Oxford: Miami University, Alumni Library (1909).
Portsmouth: Portsmouth Public Library (unknown).

Rio Grande: Rio Grande College, Jeanette Albiez Davis Library (1966).
Springfield: Warder Public Library (1884).
Steubenville: Public Library of Steubenville and Jefferson County (1950).
Tiffin: Heidelberg College, Beeghly Library (1964).
Toledo:
    Toledo Public Library (1884).
    University of Toledo Library (1963).
Van Wert: Brumback Library of Van Wert County (1900).
Westerville: Otterbein College, Centennial Library (1967).
Wooster: College of Wooster, the Andrews Library (1966).
Youngstown: Public Library of Youngstown and Mahoning County (1923).

OKLAHOMA

Ada: East Central State College, Linscheid Library (1914).
Alva: Northwestern State College Library (1907).
Bartlesville: Bureau of Mines, Petroleum Research Center Library (1962).
Durant: Southeastern State College Library (1929).
Edmond: Central State College Library (1934).
Enid: Public Library of Enid and Garfield County (1908).
Langston: Langston University, G. Lamar Harrison Library (1941).
Norman: University of Oklahoma Libraries (1893).
Oklahoma City:
    Oklahoma City University Library (1963).
    Oklahoma Department of Libraries (1893) – REGIONAL.
Shawnee: Oklahoma Baptist University Library (1933).
Stillwater: Oklahoma State University Library (1907).
Tahlequah: Northeastern State College, John Vaughan Library (1923).
Tulsa:
    Tulsa City-County Library Commission (1963).
    University of Tulsa, McFarlin Library (1929).
Weatherford: Southwestern State College Library (1958).

OREGON

Ashland: Southern Oregon College Library (1953).
Corvallis: Oregon State University Library (1907).
Eugene: University of Oregon Library (1883).
Forest Grove: Pacific University Library (1897).
La Grande: Eastern Oregon College Library (1954).
McMinnville: Linfield College, Northup Library (1965).
Monmouth: Oregon College of Education Library (1967).
Portland:
    Department of the Interior, Bonneville Power Administration Library (1962).
    Lewis and Clark College Library (1967).
    Library Association of Portland (1884).
    Portland State College Library (1963).
    Reed College Library (1912).
Salem:
    Oregon State Library (unknown).
    Willamette University Library (1969).

PENNSYLVANIA

Allentown: Muhlenberg College Library (1939).
Bethlehem: Lehigh University Library (1876).
Bradford: Carnegie Public Library (1909).
Carlisle: Dickinson College Library (1947).
Cheyney: Cheyney State College, Leslie Pinckney Hill Library (1947).
Collegeville: Ursinus College Library (1963).
East Stroudsburg: East Stroudsburg State College, Kemp Library (1966).
Erie: Erie Public Library (1897).
Greenville: Thiel College, Langenheim Memorial Library (1963).
Harrisburg: Pennsylvania State Library (unknown) – REGIONAL.
Haverford: Haverford College Library (1897).
Hazleton: Hazleton Area Public Library (1964).
Indiana: Indiana University of Pennsylvania, Rhodes R. Stabley Library (1962).
Johnstown: Cambria Public Library (1965).
Lancaster: Franklin and Marshall College, Fackenthal Library (1895).
Lewisburg: Bucknell University, Ellen Clarke Bertrand Library (1963).
Mansfield: Mansfield State College Library (1968).
Meadville: Allegheny College, Reis Library (1907).
Millersville: Millersville State College, Ganser Library (1966).
Monessen: Monessen Public Library (1969).
New Castle: New Castle Free Public Library (1963).
Newtown: Bucks County Community College Library (1968).
Norristown: Montgomery County-Norristown Public Library (1969).
Philadelphia:
    Drexel Institute of Technology Library (1963).
    Free Library of Philadelphia (1897).
    Temple University Library, Serials Records Unit (1947).
    University of Pennsylvania Library (1886).
Pittsburgh:
    Bureau of Mines, Pittsburgh Research Center Library (1962).
    Carnegie Library of Pittsburgh, Allegheny Regional Branch (1924).
    Carnegie Library of Pittsburgh (1895).
    University of Pittsburgh, Hillman Library (1910).
Pottsville: Pottsville Free Public Library (1967).
Reading: Reading Public Library (1901).
Scranton: Scranton Public Library (1895).
Slippery Rock: Slippery Rock State College, Maltby Library (1965).
Swarthmore: Swarthmore College Library (1923).
University Park: Pennsylvania State University Library (1907).
Villanova: Villanova University, School of Law Library (1964).
Warren: Warren Library Association, Warren Public Library (1885).
Washington: Washington and Jefferson College, Memorial Library (1884).
Waynesburg: Waynesburg College Library (1964).
West Chester: West Chester State College, Francis Harvey Green Library (1967).
Wilkes-Barre: King's College Library (1949).
Williamsport: James V. Brown Library of Williamsport and Lycoming County (1922).
York: York Junior College Library (1963).

PUERTO RICO

Mayaguez: University of Puerto Rico, Mayaguez Campus Library (1928).
Ponce: Catholic University of Puerto Rico Library (1966).
Rio Piedras: University of Puerto Rico General Library (1928).

RHODE ISLAND

Kingston: University of Rhode Island Library (1907).
Newport: Naval War College Library (1963).
Providence:
    Brown University, John D. Rockefeller, Jr. Library (unknown).

Providence College Library (1969).
Providence Public Library (1884).
Rhode Island College Library (1965).
Rhode Island State Library (before 1895).
Warwick: Warwick Public Library (1966).
Westerly: Westerly Public Library (1909).

SOUTH CAROLINA

Charleston:
Baptist College at Charleston Library (1967).
College of Charleston Library (1869).
The Citadel Memorial Library (1962).
Clemson: Clemson University Library (1893).
Columbia:
Benedict College, Starks Library (1969).
Columbia College Library (1966).
South Carolina State Library (before 1895).
University of South Carolina, McKissick Memorial Library (1884).
Due West: Erskine College, McCain Library (1968).
Florence: Florence County Library (1967).
Greenville:
Furnam University Library (1962).
Greenville County Library (1966).
Greenwood: Lander College Library (1967).
Orangeburg: South Carolina State College Library (1953).
Rock Hill: Winthrop College Library (1896).
Spartanburg: Spartanburg County Public Library (1967).

SOUTH DAKOTA

Aberdeen: Northern State College Library (1963).
Brookings: South Dakota State University, Lincoln Memorial Library (1889).
Rapid City:
Rapid City Public Library (1963).
South Dakota School of Mines and Technology Library (1963).
Sioux Falls:
Augustana College, Mikkelsen Library and Learning Resources Center (1969).
Carnegie Free Public Library (1903).
Spearfish: Black Hills State College Library (1942).
Vermillion: University of South Dakota, I. D. Weeks Library (1889).
Yankton: Yankton College, Corliss Lay Library (1904).

TENNESSEE

Chattanooga: Chattanooga Public Library (1907).
Clarksville: Austin Peay State University Library (1945).
Jackson: Lambuth College, Luther L. Gobbel Library (1967).
Jefferson City: Carson-Newman College, Maples Library (1964).
Johnson City: East Tennessee State University, Sherrod Library (1942).
Knoxville: University of Tennessee Library (1907).
Martin: University of Tennessee at Martin Library (1957).
Memphis:
Cossitt Reference Library (1896).
Memphis State University, John W. Brister Library (1966).
Murfreesboro: Middle Tennessee State University Library (1912).
Nashville:
Fisk University Library (1965).
Joint University Libraries (1884).
Public Library of Nashville and Davidson County (1884).
Tennessee State Library and Archives, State Library Division (unknown).
Sewanee: University of the South, Jesse Ball duPont Library (1873).

TEXAS

Abilene: Hardin-Simmons University Library (1940).
Arlington: University of Texas at Arlington Library (1963).
Austin:
Texas State Library (unknown) – REGIONAL
University of Texas Library (1884).
University of Texas, Lyndon B. Johnson School of Public Affairs Library (1966).
University of Texas, School of Law Library (1965).
Beaumont: Lamar State College of Technology Library (1957).
Brownwood: Howard Payne College, Walker Memorial Library (1964).
Canyon: West Texas State University Library (1928).
College Station: Texas Agricultural and Mechanical University Library (1907).
Commerce: East Texas State University Library (1937).
Corsicana: Navarro Junior College Library (1965).
Dallas:
Bishop College, Zale Library (1966).
Dallas Baptist College Library (1967).
Dallas Public Library (1900).
Southern Methodist University, Fondren Library (1925).
Denton: North Texas State University Library (1948).
Edinburg: Pan American College Library (1959).
El Paso:
El Paso Public Library (1906).
University of Texas at El Paso Library (1966).
Fort Worth:
Fort Worth Public Library (1905).
Texas Christian University, Mary Couts Burnett Library (1916).
Freeport: Brazosport Junior College Library (1969).
Galveston: Rosenberg Library (1909).
Houston:
Houston Public Library (1884).
Rice University, Fondren Library (1967).
University of Houston Library (1957).
Huntsville: Sam Houston State College, Estill Library (1949).
Kingsville: Texas Arts and Industries University Library (1944).
Longview: Nicholson Memorial Public Library (1961).
Lubbock: Texas Technological College Library (1935) – REGIONAL.
Marshall: Wiley College, Cole Library (1962).
Nacogdoches: Stephen F. Austin State College, Paul L. Boynton Library (1965).
Plainview: Wayland Baptist College, Van Howeling Memorial Library (1963).
San Angelo: Angelo State University Library (1964).
San Antonio:
San Antonio Public Library, Business and Science Department (1899).
St. Mary's University Library (1964).
Trinity University Library (1964).
San Marcos: Southwest Texas State College Library (1955).
Sherman: Austin College, Arthur Hopkins Library (1963).
Texarkana: Texarkana College Library (1963).
Waco: Baylor University Library (1905).
Wichita Falls: Midwestern University, Moffett Library (1963).

UTAH

Cedar City: Southern Utah State College Library (1964).
Ephraim: Snow College Library (1963).

Logan: Utah State University Library (1907)—REGIONAL.
Ogden: Weber State College Library (1962).
Provo: Brigham Young University Library (1908).
Salt Lake City:
  University of Utah, Law Library (1966).
  University of Utah Library (1893).
  Utah State Library Commission, Documents Library (unknown).

VERMONT

Burlington: University of Vermont, Bailey Library (1907).
Johnson: Johnson State College, John Dewey Library (1955).
Middlebury: Middlebury College, Egbert Starr Library (1884).
Montpelier: Vermont State Library (before 1895).
Northfield: Norwich University Library (1908).
Putney: Windham College, Dorothy Culbertson Marvin Memorial Library (1965).

VIRGIN ISLANDS

Charlotte Amalie (St. Thomas): St. Thomas Public Library (1968).

VIRGINIA

Blacksburg: Virginia Polytechnic Institute, Newman Library (1907).
Bridgewater: Bridgewater College, Alexander Mack Memorial Library (1902).
Charlottesville:
  University of Virginia, Alderman Library (1910)—REGIONAL.
  University of Virginia Law Library (1964).
Danville: Danville Community College Library (1969).
Emory: Emory and Henry College (1884).
Fairfax: George Mason College of the University of Virginia Library (1960).
Fredericksburg: Mary Washington College of the University of Virginia, E. Lee Trinkle Library (1940).
Hampden-Sydney: Hampden-Sydney College, Eggleston Library (1891).
Hollins College: Hollins College, Fishburn Library (1967).
Lexington:
  Virginia Military Institute, Preston Library (1874).
  Washington and Lee University, Cyrus Hall McCormick Library (1910).
Norfolk:
  Armed Forces Staff College Library (1963).
  Norfolk Public Library (1895).
  Old Dominion College, Hughes Memorial Library (1963).
Petersburg: Virginia State College, Johnston Memorial Library (1907).
Quantico: Marine Corps Schools, James Carson Breckinridge Library (1967).
Richmond:
  University of Richmond, Boatwright Memorial Library (1900).
  Virginia State Library (unknown).
Roanoke: Roanoke Public Library (1964).
Salem: Roanoke College Library (1886).
Williamsburg: William and Mary College (1936).

WASHINGTON

Bellingham: Western Washington State College, Wilson Library (1963).
Cheney: Eastern Washington State College Library (1966).
Ellensburg: Central Washington State College Library (1962).
Everett: Everett Public Library (1914).
Olympia: Washington State Library (unknown)—REGIONAL.
Port Angeles: Port Angeles Public Library (1965).
Pullman: Washington State University Library (1907).
Seattle:
  Seattle Public Library (1908).
  University of Washington Library (1890).
  University of Washington, School of Law Library (1969).
Spokane: Spokane Public Library (1910).
Tacoma:
  Tacoma Public Library (1894).
  University of Puget Sound, Collins Memorial Library (1938).
Vancouver: Fort Vancouver Regional Library (1962).
Walla Walla: Whitman College, Penrose Memorial Library (1890).

WEST VIRGINIA

Athens: Concord College Library (1924).
Charleston:
  Kanawha County Public Library (1952).
  West Virginia Department of Archives and History Library (unknown).
Elkins: Davis and Elkins College Library (1913).
Fairmont: Fairmont State College Library (1884).
Glenville: Glenville State College, Robert F. Kidd Library (1966).
Huntington: Marshall University Library (1925).
Institute: West Virginia State College Library (1907).
Morgantown: West Virginia University Library (1907)—REGIONAL.
Salem: Salem College Library
Weirton: Mary H. Weir Public Library (1963).

WISCONSIN

Appleton: Lawrence University, Samuel Appleton Library (1869).
Beloit: Beloit College Libraries (1888).
Eau Claire: Wisconsin State University, William D. McIntyre Library (1951).
Fond du Lac: Fond du Lac Public Library (1966).
Green Bay: University of Wisconsin at Green Bay Library (1968).
La Crosse:
  La Crosse Public Library (1883).
  Wisconsin State University, Florence Wing Library (1965).
Madison:
  Department of Public Instruction, Division for Library Services, Reference and Loan Library (1965).
  Madison Public Library (1965).
  State Historical Society Library (1870)—REGIONAL, in cooperation with University of Wisconsin, Memorial Library.
  University of Wisconsin, Memorial Library (1939).
  Wisconsin State Library (unknown).
Milwaukee:
  Milwaukee County Law Library (1934).
  Milwaukee Public Library (1861)—REGIONAL.
  Mount Mary College Library (1964).
  Oklahoma Neighborhood Library (1965).
  University of Wisconsin-Milwaukee Library (1960).
Oshkosh: Wisconsin State University, Forrest R. Polk Library (1956).
Platteville: Wisconsin State University, Elton S. Karrmann Library (1964).
Racine: Racine Public Library (1898).

River Falls: Wisconsin State University, Chalmer Davee Library (1962).
Stevens Point: Wisconsin State University Library (1951).
Superior:
    Superior Public Library (1908).
    Wisconsin State University, Jam Dan Hill Library (1935).
Waukesha: Waukesha Public Library (1966).
Whitewater: Wisconsin State University, Harold Andersen Library (1963).

WYOMING

Casper: Natrona County Public Library (1929).
Cheyenne: Wyoming State Library (unknown).
Laramie: University of Wyoming, Coe Library (1907).
Powell: Northwest Community College Library (1967).
Riverton: Central Wyoming College Library (1969).
Rock Springs: Western Wyoming College Library (1969).
Sheridan: Sheridan College, Mary Brown Kooi Library (1963).

APPENDIX B. LIST OF FIELD OFFICES OF THE U.S. DEPARTMENT OF COMMERCE

ALBUQUERQUE, NEW MEXICO 87101
U.S. Courthouse – Room 316
Area Code 505 Tel. 843-2386

ANCHORAGE, ALASKA 99501
412 Hill Building
632 Sixth Avenue
Area Code 907 Tel. 272-6531

ATLANTA, GEORGIA 30309
Suite 523, 1401 Peachtree St., N.E.
Area Code 404 Tel. 516-6000

BALTIMORE, MARYLAND 21202
415 U.S. Customhouse
Gay and Lombard Streets
Area Code 301 Tel. 962-3560

BIRMINGHAM, ALABAMA 35205
Suite 200-201
908 South 20th Street
Area Code 205 Tel. 325-3327

BOSTON, MASSACHUSETTS 02203
Room 510, John F. Kennedy Federal Building
Area Code 617 Tel. 223-2312

BUFFALO, NEW YORK 14202
910 Federal Building
111 West Huron Street
Area Code 716 Tel. 842-3208

CHARLESTON, SOUTH CAROLINA 29403
Federal Building, Suite 631
334 Meeting Street
Area Code 803 Tel. 577-4171

CHARLESTON, WEST VIRGINIA 25301
3000 New Federal Office Building
500 Quarrier Street
Area Code 304 Tel. 343-6181, Ext. 375

CHEYENNE, WYOMING 82001
6022 O'Mahoney Federal Center
2120 Capitol Avenue
Area Code 307 Tel. 778-2220, Ext. 2151

CHICAGO, ILLINOIS 60604
Room 1486, New Federal Building
219 South Dearborn Street
Area Code 312 Tel. 353-4400

CINCINNATI, OHIO 45202
8028 Federal Office Building
550 Main Street
Area Code 513 Tel. 684-2944

CLEVELAND, OHIO 44114
Room 600, 666 Euclid Avenue
Area Code 216 Tel. 522-4750

DALLAS, TEXAS 75202
Room 3E7, 1100 Commerce Street
Area Code 214 Tel. 749-3287

DENVER, COLORADO 80202
Room 161, New Customhouse
19th and Stout Streets
Area Code 303 Tel. 837-3246

DES MOINES, IOWA 50309
609 Federal Building
210 Walnut Street
Area Code 515 Tel. 284-4222

DETROIT, MICHIGAN 48226
445 Federal Building
Area Code 313 Tel. 226-6088

GREENSBORO, NORTH CAROLINA 27402
258 Federal Building
West Market Street, P.O. Box 1950
Area Code 919 Tel. 275-9111

HARTFORD, CONNECTICUT 06103
Room 610-B, Federal Office Building
450 Main Street
Area Code 203 Tel. 244-3530

HONOLULU, HAWAII 96813
286 Alexander Young Building
1015 Bishop Street
Area Code 808 Tel. 546-8694

HOUSTON, TEXAS 77002
1017 Old Federal Building
201 Fannin Street
Area Code 713 Tel. 226-4231

JACKSONVILLE, FLORIDA 32202
Post Office Box 35087
400 West Bay Street
Area Code 904 Tel. 791-2796

KANSAS CITY, MISSOURI 64106
Room 1840, 601 East 12th Street
Area Code 816 Tel. 374-3141

LOS ANGELES, CALIFORNIA 90024
11201 Federal Building
11000 Wilshire Blvd.
Area Code 213 Tel. 824-7591

MEMPHIS, TENNESSEE 38103
Room 710, 147 Jefferson Avenue
Area Code 901 Tel. 534-3214

MIAMI, FLORIDA 33130
Room 821, City National Bank Building
25 West Flagler Street
Area Code 305 Tel. 350-5267

MILWAUKEE, WISCONSIN 53203
Straus Building
238 West Wisconsin Avenue
Area Code 414 Tel. 224-3473

MINNEAPOLIS, MINNESOTA 55401
306 Federal Building
110 South Fourth Street
Area Code 612 Tel. 725-2133

NEW ORLEANS, LOUISIANA 70130
909 Federal Office Building, South
610 South Street
Area Code 504 Tel. 527-6546

NEW YORK, NEW YORK 10007
41st Floor, Federal Office Building
26 Federal Plaza, Foley Square
Area Code 212 Tel. 264-0634

PHILADELPHIA, PENNSYLVANIA 19107
Jefferson Building
1015 Chestnut Street
Area Code 215 Tel. 597-2850

PHOENIX, ARIZONA 85025
5413 New Federal Building
230 North First Avenue
Area Code 602 Tel. 261-3285

PITTSBURGH, PENNSYLVANIA 15222
431 Federal Building
1000 Liberty Avenue
Area Code 412 Tel. 644-2850

PORTLAND, OREGON 97204
217 Old U.S. Courthouse
520 W.W. Morrison Street
Area Code 503 Tel. 226-3361

RENO, NEVADA 89502
2028 Federal Building
300 Booth Street
Area Code 702 Tel. 784-5203

RICHMOND, VIRGINIA 23240
2105 Federal Building
400 North 8th Street
Area Code 703 Tel. 782-2246

ST. LOUIS, MISSOURI 63103
2511 Federal Building
1520 Market Street
Area Code 314 Tel. 622-4243

SALT LAKE CITY, UTAH 84111
1201 Federal Building
125 South State Street
Area Code 801 Tel. 524-5116

SAN FRANCISCO, CALIFORNIA 94102
Federal Building Box 36013
450 Golden Gate Avenue
Area Code 415 Tel. 556-5864

SAN JUAN, PUERTO RICO 00902
Room 100, Post Office Building
Phone: 723-4640

SAVANNAH, GEORGIA 31402
235 U.S. Courthouse Post Office Bldg.
125-29 Bull Street
Area Code 912 Tel. 232-4321

SEATTLE, WASHINGTON 98104
8021 Federal Office Building
909 First Avenue
Area Code 206 Tel. 442-5615

FORM NBS-114A (1-71)

U.S. DEPT. OF COMM. **BIBLIOGRAPHIC DATA SHEET**	1. PUBLICATION OR REPORT NO. NBS-SP-305, Suppl. 3	2. Gov't Accession No.	3. Recipient's Accession No.

4. TITLE AND SUBTITLE

Publications of the National Bureau of Standards 1971 Catalog

5. Publication Date

July 1972

6. Performing Organization Code

7. AUTHOR(S)

Betty L. Oberholtzer

8. Performing Organization

9. PERFORMING ORGANIZATION NAME AND ADDRESS

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, D.C. 20234

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address

Same as 9

13. Type of Report & Period Covered

14. Sponsoring Agency Code

15. SUPPLEMENTARY NOTES

16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)

This supplement to Special Publication 305 Supplements 1 and 2 of the National Bureau of Standards lists the publications of the Bureau issued between 1 January 1971 and 31 December 1971. It includes an abstract of each publication (plus some earlier papers omitted from Special Publication 305 Supplement 2), key-word and author indexes; and general information and instructions about NBS publications.

Miscellaneous Publication 240 (covering the period July 1, 1957 through June 30, 1960) and its supplement (covering the period July 1, 1960 through June 30, 1966), Special Publication 305 (covering the period July 1966 through December 1967) and Special Publication 305 Supplement 1 (covering the period 1968-1969), and Special Publication 305 Supplement 2 (covering the period 1970), remain in effect. Two earlier lists, Circular 460 (Publications of the National Bureau of Standards, 1901 to June 1947) and its supplement (Supplementary List of Publications of the National Bureau of Standards, July 1, 1947 to June 30, 1957) are also still in effect.

17. KEY WORDS (Alphabetical order, separated by semicolons)

Abstracts, NBS publications; key words; publications.

18. AVAILABILITY STATEMENT ☒ UNLIMITED. ☐ FOR OFFICIAL DISTRIBUTION. DO NOT RELEASE TO NTIS.	19. SECURITY CLASS (THIS REPORT) UNCLASSIFIED 20. SECURITY CLASS (THIS PAGE) UNCLASSIFIED	21. NO. OF PAGES 342 22. Price $3.00

(cut here)

Announcement of New Publications of the National Bureau of Standards

Superintendent of Documents,
Government Printing Office,
Washington, D. C. 20402

Dear Sir:

Please add my name to the announcement list of new publications to be issued by the National Bureau of Standards.

Name..

Company..

Address..

City.................................... State.......................... Zip Code...............................

(Notification Key N239)

U. S. GOVERNMENT PRINTING OFFICE: 1972 OL - 453-313

EDGE INDEX