

U. S. DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS

THE OPTICAL ROTATION OF LIQUIDS
ITS VARIATION WITH WAVE LENGTH
TEMPERATURE, SOLVENT
AND CONCENTRATION

By T. MARTIN LOWRY

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PREFACE

The compilation of the available data on this topic, as presented in the following pages, was made in conjunction with work undertaken for the International Critical Tables and covers, with the exceptions noted below, the literature preceding January 1, 1923. No attempt has been made to include fragmentary data. Data for the sodium *D*-line at ordinary temperatures and in the common solvents will be found in International Critical Tables.¹ The common sugars have also been omitted from the present compilation, since they have been covered in the saccharimetry section of International Critical Tables.²

¹ Int. Crit. Tables, 7, pp. 355-489. McGraw-Hill Book Co., New York; 1931.

² Int. Crit. Tables, 2, pp. 334-355. McGraw-Hill Book Co., New York; 1927.

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THE OPTICAL ROTATION OF LIQUIDS, ITS VARIATION WITH WAVE LENGTH, TEMPERATURE, SOLVENT, AND CONCENTRATION¹

By T. MARTIN LOWRY

I. ARRANGEMENT

Arrangement is by classes defined as follows:

CARBON COMPOUNDS²

- I. None of the asymmetric carbon atoms forms part of a ring.
 - II. At least one asymmetric carbon atom forms part of a ring.
 - III. The compound contains no asymmetric carbon atom or contains at least one asymmetric or dissymmetric atom other than carbon.
 - IV. Substances of unknown, doubtful, or complex structure.
- Classes I to IV are subdivided according to the number and nature of the asymmetric atoms as follows:
- A_n The molecule contains n asymmetric atoms which are attached each to only one other carbon atom.
 - B_n The molecule contains n asymmetric atoms which are attached each to two other carbon atoms.
 - C_n The molecule contains n asymmetric atoms which are attached each to three other carbon atoms.
 - D_n The molecule contains n asymmetric atoms which are attached each to four other carbon atoms.

For substances which fall within two or more of the above subdivisions the higher (in the order D, C, B, A) division receives preference in deciding the arrangement. Within a subdivision the arrangement is in accordance with the value of n in the order 1, 2, 3, etc.

¹ This section includes data and bibliography to January 1, 1924.

² Sugars and their derivatives are classed as open chain compounds. In general, derivatives are listed under the parent compound, even when they contain additional asymmetric atoms

II. SYMBOLS AND ABBREVIATIONS

- t Temperature in degrees centigrade ($^{\circ}\text{C}$).
 λ Wave length of light expressed in Angstrom units; that is, in tenths of a millimicron ($\frac{1}{10} \mu\mu$) unless otherwise indicated.
 D A wave length of 5893 A.
 α_{λ}^t Observed rotation at the given values for t .
 $[\alpha]_{\lambda}^t$ Specific rotation at the given values for t .
 $[M]_{\lambda}^t$ Molecular rotation at the given values for t ($=M \times [\alpha]_{\lambda}^t / 100$).
 c Concentration in grams per 100 cm^3 of solution.
 p Concentration in grams per 100 g of solution ($= \text{Wt. per cent}$). (Values in italics when column heading is " c " or " p ").
 d d_4^t = density at the given value for t referred to water at 4°C ., unless otherwise indicated.
 2 per cent NaOH (etc.) 2 per cent of solution of NaOH in water.
 2 per cent NaOH MeOH 2 per cent of solution of NaOH in methyl alcohol.
 M Moles.
 N NaOH Normal aqueous solution of NaOH ($=1$ equivalent/liter).
 s Solvent.

SYMBOLS FOR SOLVENTS AND RADICALS

A	$\equiv$ The acid radical under which it is used.	Ph	$\equiv$ (C_6H_5) Phenyl.
Ac	$\equiv$ (CH_3CO) Acetyl.	pn	$\equiv$ ($\text{C}_3\text{H}_{10}\text{N}_2$) α , β -Propylene-diamine.
Bu	$\equiv$ (C_4H_9) Butyl.	Pr	$\equiv$ (C_3H_7) Propyl.
en	$\equiv$ ($\text{C}_2\text{H}_5\text{N}_2$) α , β -Ethylene-diamine.	Py	$\equiv$ ($\text{C}_5\text{H}_5\text{N}$) Pyridine.
Et	$\equiv$ (C_2H_5) Ethyl.	tr	$\equiv$ ($\text{C}_3\text{H}_{10}\text{N}_2$) α , γ -Diaminopropane (trimethylene-diamine).
Me	$\equiv$ (CH_3) Methyl.		

III. Class I.—ORGANIC SUBSTANCES IN WHICH THE ASYMMETRIC CARBON ATOM DOES NOT FORM PART OF A RING

IB. THE MOLECULE CONTAINS 1 CARBON ATOM ATTACHED TO 4 DIFFERENT ATOMS OR GROUPS

$\text{CH}_5\text{ClINO}_3\text{S}$, ammonium chloridomethanesulphonate (176)

		$[\alpha]_{\lambda}^{20}$		
s	c	5,461	5,781	5,893
H_2O	1.000	15.8	13.3	12.3
H_2O	1.674	16.0	13.4	12.4
H_2O	3.402	15.7	13.2	12.2
EtOH	1.671	19.5	16.8	15.7

NOTE.—Throughout this paper, black-face figures in parentheses refer to correspondingly numbered citations in the bibliography, p. 101.

IB, THE ASYMMETRIC CARBON ATOM IS ATTACHED TO 2 OTHER CARBON ATOMS

1. AMINES

Sec-butylamine (= Am) and derivatives (171) $[\alpha]_{\lambda}^{20}$

$s = H_2O$	Sulphonyl=Su	λ c	5,893	5,780	5,461
$C_6H_{11}N$	<i>l</i> -Am.....	4.70	-5.00	-5.22	-5.75
$C_6H_{11}ClN$	<i>l</i> -Am hydrochloride.....	3.40	.88	.96	1.25
$C_{11}H_{15}NO$	Benzoyl- <i>d</i> -Am.....	1.00	30.7	32.2	37.1
$C_{10}H_{13}NO_2S$	Benzene-Su- <i>d</i> -Am.....	3.01	2.40	2.49	2.49
$C_{11}H_{17}NO_2S$	<i>p</i> -Toluene-Su- <i>d</i> -Am.....	3.03	.81	.81	.81
$C_{14}H_{17}NO_2S$	Naphthalene- α -Su- <i>l</i> -Am.....	2.73	-5.40	-5.40	-5.58

 $C_{15}H_{15}NO$, benzoyl-*l*- α -phenylethylamine (174; cf. 131)

	$[\alpha]_{\lambda}^{20}$				$[M]_{\lambda}^{20}$
s	λ c	5,893	5,780	5,461	5,461
C_6H_5	3.004	-40.1	-41.9	-48.3	-137
C_6H_5	2.384	-43.7	-45.7	-52.6	-149
C_6H_5	.795	-52.5	-55.7	-64.2	-182

2. MONOHYDROXY ALCOHOLS, THEIR ETHERS AND ESTERS

Specific rotation $[\alpha]_D^t$ of carbinols

(161; cf. 81)	Methyl carbinol ¹	$[\alpha]_D^{20}$	$[\alpha]_D^{50}$	$[\alpha]_D^{90}$	<i>d</i> -Methylethyl carbinol (164)					<i>d</i> -Methyl- <i>n</i> -hexyl carbinol (164)				
					s	c	$[\alpha]_D^2$	5,893	5,461	4,358	c	5,893	$[\alpha]_D^2$	5,461	4,358
C ₂ H ₆ O-----	-Ethyl-----	13.87	12.48	11.84	Py-----	5.26	18.42	18.42	21.61	37.00	5.04	10.31	11.70	20.22
C ₃ H ₈ O-----	- <i>n</i> -Propyl-----	13.70	12.89	12.56	CS ₂ -----	5.59	17.21	17.21	20.46	34.86	5.25	13.34	13.34	-----
C ₄ H ₁₀ O-----	- <i>n</i> -Butyl-----	11.57	11.02	10.90	EtOAc-----	5.45	16.78	16.78	19.72	33.29	5.06	12.34	12.34	-----
C ₅ H ₁₂ O-----	- <i>n</i> -Amyl-----	10.32	9.89	9.60	Me ₂ CO-----	4.98	16.39	16.39	18.79	31.79	5.04	10.51	10.51	-----
C ₆ H ₁₄ O-----	- <i>n</i> -Hexyl-----	9.76	9.17	8.99	AcOH-----	5.04	16.28	16.28	18.66	31.77	5.27	10.81	10.81	-----
C ₇ H ₁₆ O-----	- <i>n</i> -Heptyl-----	8.99	8.55	8.30	EtOH-----	5.38	14.60	14.60	16.89	28.28	5.46	9.79	9.79	-----
C ₈ H ₁₈ O-----	- <i>n</i> -Octyl-----	8.68	8.14	7.80	C ₂ H ₆ -----	5.60	14.54	14.54	17.31	28.17	5.51	12.44	12.44	-----
C ₉ H ₂₀ O-----	- <i>n</i> -Nonyl-----	8.13	7.66	7.28	C ₂ H ₄ Br ₂ -----	4.96	11.82	11.82	13.93	23.55	-----	-----	-----	-----
C ₁₀ H ₂₂ O-----	- <i>n</i> -Decyl-----	7.78	7.27	6.89	Phenetole-----	-----	-----	-----	-----	-----	5.52	12.67	12.67	-----
C ₁₁ H ₂₄ O-----	- <i>n</i> -Undecyl-----	7.22	6.67	6.39	C ₆ H ₅ Cl-----	-----	-----	-----	-----	-----	5.34	12.26	12.26	-----
-----	-----	-----	-----	-----	CCl ₄ -----	-----	-----	-----	-----	-----	5.04	12.29	12.29	-----
-----	-----	-----	-----	-----	CHCl ₃ -----	-----	-----	-----	-----	-----	5.17	9.00	9.00	-----

¹ These substances are stated to show simple dispersion. A 1-term Drude dispersion expression fits the data accurately (126).
² t=about 20°.

Ethyl carbinols (163; cf. 126)		$[\alpha]_D^{20}$	$[\alpha]_{5,461}^{20}$	$[M]_D^{20}$	$[M]_D^{60}$	$[M]_D^{100}$	$[M]_D^{140}$
C ₄ H ₁₀ O-----	Methyl-----	13.87	16.09	10.02	8.73	-----	-----
C ₅ H ₁₂ O-----	Ethyl-----			Optically inactive.			
C ₆ H ₁₄ O-----	Propyl-----	1.97	2.24	2.01	2.12	2.32	-----
C ₇ H ₁₆ O-----	Butyl-----	8.13	9.58	9.43	9.58	9.78	10.06
C ₈ H ₁₈ O-----	Amyl-----	8.22	9.64	10.69	10.95	11.14	11.24
C ₉ H ₂₀ O-----	Hexyl-----	7.38	8.63	10.63	11.10	11.15	11.04
C ₁₀ H ₂₂ O-----	Heptyl-----	6.68	7.76	10.55	10.66	10.64	10.49
C ₁₁ H ₂₄ O-----	Octyl-----	6.25	7.23	10.74	10.96	11.00	11.10
C ₁₂ H ₂₆ O-----	Nonyl-----	5.97	6.92	11.09	10.33	10.21	10.33
C ₁₃ H ₂₈ O-----	Decyl-----	6.23	7.21	12.44	12.28	12.13	12.11
C ₁₄ H ₃₀ O-----	Undecyl-----	5.87	6.80	12.56	12.28	12.19	12.16
C ₁₅ H ₃₂ O-----	Dodecyl-----	5.53	6.40	12.61	12.26	12.13	12.20
C ₁₆ H ₃₄ O-----	Tridecyl-----	5.11	5.92	12.38	12.34	12.11	11.76
C ₁₇ H ₃₆ O-----	Pentadecyl-----	4.77	5.49	12.87	12.80	12.72	12.63

Isopropyl carbinols (126, 162)		$[\alpha]_D^{20}$	$[M]_D^{20}$	$[M]_D^1$
C ₆ H ₁₄ O-----	Methyl-----	4.85	4.3	3.7
C ₇ H ₁₆ O-----	Ethyl-----	15.06	15.4	12.4
C ₈ H ₁₈ O-----	<i>n</i> -Propyl-----	21.25	24.7	21.9
C ₉ H ₂₀ O-----	<i>n</i> -Butyl-----	25.64	33.3	29.1
C ₁₀ H ₂₂ O-----	<i>n</i> -Amyl-----	22.84	32.9	28.7
C ₁₁ H ₂₄ O-----	<i>n</i> -Hexyl-----	21.46	33.9	29.2
C ₁₂ H ₂₆ O-----	<i>n</i> -Octyl-----	18.55	34.5	29.0
C ₁₄ H ₃₀ O-----	<i>n</i> -Decyl-----	16.15	34.5	29.0

¹ At boiling point.

Specific rotation [α_D^{25}] *of carbinols* (165; cf. 126)

	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358
	$C_{10}H_{18}O$ <i>d</i> -Methyl- <i>tert</i> -butyl			$C_{10}H_{18}O$ <i>d</i> -Methylphenyl			$C_8H_{16}O$ <i>l</i> -Ethylphenyl			$C_8H_{16}O$ <i>d</i> -Methylbenzyl			$C_{10}H_{18}O$ <i>l</i> -Methyl- α -naphthyl		
10.....	7.71	9.09	15.55	41.77	49.85	86.64	25.86	32.91	54.95	32.19	59.03	28.11	9.79	-14.89	-40.25
20.....	6.84	8.18	14.08	41.51	49.40	85.82	30.24	36.02	60.40	33.42	61.22	29.28	-14.53	-2.05	-12.75
40.....	5.94	7.25	12.52	41.18	48.97	84.61	32.82	38.71	65.16	34.43	62.70	30.45	-26.51	13.85	16.92
60.....	5.27	6.35	11.07	40.64	48.22	83.05	34.46	40.83	68.82	34.73	63.36	31.44	-29.80	26.89	40.41
80.....	4.58	5.60	10.00	40.12	47.56	81.39	36.31	42.01	70.84	34.41	62.94	32.32	-34.46	37.47	58.96
100.....													-37.59	44.37	72.96
120.....				39.31	46.66	79.60	35.51	42.11	71.03	33.83	61.98	32.28	-38.99	46.78	82.58
140.....				38.48	45.77	77.94	35.28	41.56	70.34	33.17	60.57		-39.25	51.34	87.26
160.....							34.37	40.76	69.07	32.14	59.07		-38.88	43.82	89.82
180.....										31.07	57.41		-38.51	44.13	90.86
200.....													-37.83	51.06	86.26

	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358
	$C_{10}H_{18}O$ <i>d</i> -Methyl- <i>tert</i> -butyl			$C_{10}H_{18}O$ <i>d</i> -Methylphenyl			$C_8H_{16}O$ <i>l</i> -Ethylphenyl			$C_8H_{16}O$ <i>d</i> -Methylbenzyl			$C_{10}H_{18}O$ <i>l</i> -Methyl- α -naphthyl		
EtOH.....	4.87	5.86	10.54	41.04	49.04	86.26	32.48	38.59	65.06	16.13	36.29	38.89	65.37	80.02	140.8
CH_3OH	3.31	3.89	7.78	48.88	57.93	90.22	40.05	47.78	79.16	41.82	50.82	42.70	74.67	89.97	156.7
CH_3OH	5.59	7.79	1.87	54.13	65.18	113.2	45.46	53.67	92.23	39.02	46.72	34.40	64.76	78.03	136.2
CS_2	2.18	2.70	5.32	58.33	70.01	123.8	45.83	54.26	93.09	73.57	89.60	52.65	60.15	108.5	124.8
Py.....	2.28	2.74	5.02	70.66	84.22	146.9	49.66	71.39	122.7	47.88	58.02	34.18	55.29	50.58	87.24
												$s = CO_2Me$	71.48	86.54	155.5
												$s = C_2H_5Br$	54.46	64.00	115.0

The following are approximately 5 per cent solutions at room temperature (102, 165)

t	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500	520	540	560	580	600	620	640	660	680	700	720	740	760	780	800	820	840	860	880	900	920	940	960	980	1000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
λ	4.338	4.361	4.386	4.411	4.436	4.461	4.486	4.511	4.536	4.561	4.586	4.611	4.636	4.661	4.686	4.711	4.736	4.761	4.786	4.811	4.836	4.861	4.886	4.911	4.936	4.961	4.986	5.011	5.036	5.061	5.086	5.111	5.136	5.161	5.186	5.211	5.236	5.261	5.286	5.311	5.336	5.361	5.386	5.411	5.436	5.461	5.486	5.511	5.536	5.561	5.586	5.611	5.636	5.661	5.686	5.711	5.736	5.761	5.786	5.811	5.836	5.861	5.886	5.911	5.936	5.961	5.986	6.011	6.036	6.061	6.086	6.111	6.136	6.161	6.186	6.211	6.236	6.261	6.286	6.311	6.336	6.361	6.386	6.411	6.436	6.461	6.486	6.511	6.536	6.561	6.586	6.611	6.636	6.661	6.686	6.711	6.736	6.761	6.786	6.811	6.836	6.861	6.886	6.911	6.936	6.961	6.986	7.011	7.036	7.061	7.086	7.111	7.136	7.161	7.186	7.211	7.236	7.261	7.286	7.311	7.336	7.361	7.386	7.411	7.436	7.461	7.486	7.511	7.536	7.561	7.586	7.611	7.636	7.661	7.686	7.711	7.736	7.761	7.786	7.811	7.836	7.861	7.886	7.911	7.936	7.961	7.986	8.011	8.036	8.061	8.086	8.111	8.136	8.161	8.186	8.211	8.236	8.261	8.286	8.311	8.336	8.361	8.386	8.411	8.436	8.461	8.486	8.511	8.536	8.561	8.586	8.611	8.636	8.661	8.686	8.711	8.736	8.761	8.786	8.811	8.836	8.861	8.886	8.911	8.936	8.961	8.986	9.011	9.036	9.061	9.086	9.111	9.136	9.161	9.186	9.211	9.236	9.261	9.286	9.311	9.336	9.361	9.386	9.411	9.436	9.461	9.486	9.511	9.536	9.561	9.586	9.611	9.636	9.661	9.686	9.711	9.736	9.761	9.786	9.811	9.836	9.861	9.886	9.911	9.936	9.961	9.986	10.011	10.036	10.061	10.086	10.111	10.136	10.161	10.186	10.211	10.236	10.261	10.286	10.311	10.336	10.361	10.386	10.411	10.436	10.461	10.486	10.511	10.536	10.561	10.586	10.611	10.636	10.661	10.686	10.711	10.736	10.761	10.786	10.811	10.836	10.861	10.886	10.911	10.936	10.961	10.986	11.011	11.036	11.061	11.086	11.111	11.136	11.161	11.186	11.211	11.236	11.261	11.286	11.311	11.336	11.361	11.386	11.411	11.436	11.461	11.486	11.511	11.536	11.561	11.586	11.611	11.636	11.661	11.686	11.711	11.736	11.761	11.786	11.811	11.836	11.861	11.886	11.911	11.936	11.961	11.986	12.011	12.036	12.061	12.086	12.111	12.136	12.161	12.186	12.211	12.236	12.261	12.286	12.311	12.336	12.361	12.386	12.411	12.436	12.461	12.486	12.511	12.536	12.561	12.586	12.611	12.636	12.661	12.686	12.711	12.736	12.761	12.786	12.811	12.836	12.861	12.886	12.911	12.936	12.961	12.986	13.011	13.036	13.061	13.086	13.111	13.136	13.161	13.186	13.211	13.236	13.261	13.286	13.311	13.336	13.361	13.386	13.411	13.436	13.461	13.486	13.511	13.536	13.561	13.586	13.611	13.636	13.661	13.686	13.711	13.736	13.761	13.786	13.811	13.836	13.861	13.886	13.911	13.936	13.961	13.986	14.011	14.036	14.061	14.086	14.111	14.136	14.161	14.186	14.211	14.236	14.261	14.286	14.311	14.336	14.361	14.386	14.411	14.436	14.461	14.486	14.511	14.536	14.561	14.586	14.611	14.636	14.661	14.686	14.711	14.736	14.761	14.786	14.811	14.836	14.861	14.886	14.911	14.936	14.961	14.986	15.011	15.036	15.061	15.086	15.111	15.136	15.161	15.186	15.211	15.236	15.261	15.286	15.311	15.336	15.361	15.386	15.411	15.436	15.461	15.486	15.511	15.536	15.561	15.586	15.611	15.636	15.661	15.686	15.711	15.736	15.761	15.786	15.811	15.836	15.861	15.886	15.911	15.936	15.961	15.986	16.011	16.036	16.061	16.086	16.111	16.136	16.161	16.186	16.211	16.236	16.261	16.286	16.311	16.336	16.361	16.386	16.411	16.436	16.461	16.486	16.511	16.536	16.561	16.586	16.611	16.636	16.661	16.686	16.711	16.736	16.761	16.786	16.811	16.836	16.861	16.886	16.911	16.936	16.961	16.986	17.011	17.036	17.061	17.086	17.111	17.136	17.161	17.186	17.211	17.236	17.261	17.286	17.311	17.336	17.361	17.386	17.411	17.436	17.461	17.486	17.511	17.536	17.561	17.586	17.611	17.636	17.661	17.686	17.711	17.736	17.761	17.786	17.811	17.836	17.861	17.886	17.911	17.936	17.961	17.986	18.011	18.036	18.061	18.086	18.111	18.136	18.161	18.186	18.211	18.236	18.261	18.286	18.311	18.336	18.361	18.386	18.411	18.436	18.461	18.486	18.511	18.536	18.561	18.586	18.611	18.636	18.661	18.686	18.711	18.736	18.761	18.786	18.811	18.836	18.861	18.886	18.911	18.936	18.961	18.986	19.011	19.036	19.061	19.086	19.111	19.136	19.161	19.186	19.211	19.236	19.261	19.286	19.311	19.336	19.361	19.386	19.411	19.436	19.461	19.486	19.511	19.536	19.561	19.586	19.611	19.636	19.661	19.686	19.711	19.736	19.761	19.786	19.811	19.836	19.861	19.886	19.911	19.936	19.961	19.986	20.011	20.036	20.061	20.086	20.111	20.136	20.161	20.186	20.211	20.236	20.261	20.286	20.311	20.336	20.361	20.386	20.411	20.436	20.461	20.486	20.511	20.536	20.561	20.586	20.611	20.636	20.661	20.686	20.711	20.736	20.761	20.786	20.811	20.836	20.861	20.886	20.911	20.936	20.961	20.986	21.011	21.036	21.061	21.086	21.111	21.136	21.161	21.186	21.211	21.236	21.261	21.286	21.311	21.336	21.361	21.386	21.411	21.436	21.461	21.486	21.511	21.536	21.561	21.586	21.611	21.636	21.661	21.686	21.711	21.736	21.761	21.786	21.811	21.836	21.861	21.886	21.911	21.936	21.961	21.986	22.011	22.036	22.061	22.086	22.111	22.136	22.161	22.186	22.211	22.236	22.261	22.286	22.311	22.336	22.361	22.386	22.411	22.436	22.461	22.486	22.511	22.536	22.561	22.586	22.611	22.636	22.661	22.686	22.711	22.736	22.761	22.786	22.811	22.836	22.861	22.886	22.911	22.936	22.961	22.986	23.011	23.036	23.061	23.086	23.111	23.136	23.161	23.186	23.211	23.236	23.261	23.286	23.311	23.336	23.361	23.386	23.411	23.436	23.461	23.486	23.511	23.536	23.561	23.586	23.611	23.636	23.661	23.686	23.711	23.736	23.761	23.786	23.811	23.836	23.861	23.886	23.911	23.936	23.961	23.986	24.011	24.036	24.061	24.086	24.111	24.136	24.161	24.186	24.211	24.236	24.261	24.286	24.311	24.336	24.361	24.386	24.411	24.436	24.461	24.486	24.511	24.536	24.561	24.586	24.611	24.636	24.661	24.686	24.711	24.736	24.761	24.786	24.811	24.836	24.861	24.886	24.911	24.936	24.961	24.986	25.011	25.036	25.061	25.086	25.111	25.136	25.161	25.186	25.211	25.236	25.261	25.286	25.311	25.336	25.361	25.386	25.411	25.436	25.461	25.486	25.511	25.536	25.561	25.586	25.611	25.636	25.661	25.686	25.711	25.736	25.761	25.786	25.811	25.836	25.861	25.886	25.911	25.936	25.961	25.986	26.011	26.036	26.061	26.086	26.111	26.136	26.161	26.186	26.211	26.236	26.261	26.286	26.311	26.336	26.361	26.386	26.411	26.436	26.461	26.486	26.511	26.536	26.561	26.586	26.611	26.636	26.661	26.686	26.711	26.736	26.761	26.786	26.811	26.836	26.861	26.886	26.911	26.936	26.961	26.986	27.011	27.036	27.061	27.086	27.111	27.136	27.161	27.186	27.211	27.236	27.261	27.286	27.311	27.336	27.361	27.386	27.411	27.436	27.461	27.486	27.511	27.536	27.561	27.586	27.611	27.636	27.661	27.686	27.711	27.736	27.761	27.786	27.811	27.836	27.861	27.886	27.911	27.936	27.961	27.986	28.011	28.036	28.061	28.086	28.111	28.136	28.161	28.186	28.211	28.236	28.261	28.286	28.311	28.336	28.361	28.386	28.411	28.436	28.461	28.486	28.511	28.536	28.561	28.586	28.611	28.636	28.661	28.686	28.711	28.736	28.761	28.786	28.811	28.836	28.861	28.886	28.911	28.936	28.961	28.986	29.011	29.036	29.061	29.086	29.111	29.136	29.161	29.186	29.211	29.236	29.261	29.286	29.311	29.336	29.361	29.386	29.411	29.436	29.461	29.486	29.511	29.536	29.561	29.586	29.611	29.636	29.661	29.686	29.711	29.736	29.761	29.786	29.811	29.836	29.861	29.886	29.911	29.936	29.961	29.986	30.011	30.036	30.061	30.086	30.111	30.136	30.161	30.186	30.211	30.236	30.261	30.286	30.311	30.336	30.361	30.386	30.411	30.436	30.461	30.486	30.511	30.536	30.561	30.586	30.611	30.636	30.661	30.686	30.711	30.736	30.761	30.786	30.811	30.836	30.861	30.886	30.911	30.936	30.961	30.986	31.011	31.036	31.061	31.086	31.111	31.136	31.161	31.186	31.211	31.236	31.261	31.286	31.311	31.336	31.361	31.386	31.411	31.436	31.461	31.486	31.511	31.536	31.561	31.586	31.611	31.636

Specific rotation $[\alpha]_{\lambda}^t$ of ethers of *d*-benzylmethyl carbinol (159)

$t=17^{\circ}$	$s=EtOH$				CS_2			
	λ c	5, 893	5, 461	4, 358	λ c	5, 893	5, 461	4, 358
Methyl.....	5.00	2.8	4.9	7.3	5.00	36.2	39.5	81.3
Ethyl.....	4.95	19.7	24.4	41.1	5.01	44.4	51.4	94.3
Propyl.....	5.01	21.1	24.0	41.3	5.00	42.8	52.1	93.2
Butyl.....	5.00	25.3	30.6	49.4	4.98	42.7	53.0	95.2
Amyl.....	4.91	25.6	31.1	51.1	5.01	41.5	48.1	89.1
Hexyl.....	5.04	25.5	30.7	50.3	4.99	41.2	49.9	90.3
Heptyl.....	5.07	24.8	29.8	49.3	4.87	38.1	47.2	82.1
Octyl.....	4.95	24.2	29.8	49.0	5.05	37.9	45.6	81.9
Nonyl.....	5.04	24.4	29.7	48.6	4.96	37.5	44.6	80.6

Specific rotation of *d*- β -octyl ethers

<i>d</i> - β -Octyl ether		$[\alpha]_{\lambda}^{20}$							$[\alpha]_{\lambda}^{120}$						
		(100)													
		6, 438	5, 461	5, 086	4, 800	4, 678	4, 358		6, 438	5, 461	5, 086	4, 800	4, 678	4, 358	
$C_9H_{20}O$	Methyl.....	6.42	8.63	10.20	11.66	12.23	13.79	-----	3.02	4.52	5.80	6.70	7.18	8.35	-----
$C_{10}H_{22}O$	Ethyl.....	14.68	20.35	24.13	26.95	28.46	32.56	-----	10.79	14.73	17.15	19.54	20.32	23.04	-----
$C_{11}H_{24}O$	<i>n</i> -Propyl.....	-----	20.51	-----	-----	-----	32.92	-----	-----	15.78	-----	-----	-----	25.65	-----
$C_{12}H_{26}O$	<i>n</i> -Butyl.....	16.63	22.46	26.13	29.64	31.01	36.13	-----	12.34	17.61	19.61	21.83	23.19	27.32	-----
$C_{13}H_{28}O$	<i>n</i> -Amyl.....	13.03	18.19	22.09	23.83	25.42	29.06	-----	10.34	14.19	16.56	18.92	19.86	22.87	-----
$C_{14}H_{30}O$	<i>n</i> -Hexyl.....	11.68	16.29	18.68	21.05	22.45	25.95	-----	8.65	12.36	14.39	15.68	16.97	19.54	-----
$C_{15}H_{32}O$	<i>n</i> -Heptyl.....	13.18	18.41	21.58	24.11	25.72	29.75	-----	10.42	14.62	16.48	19.05	19.73	22.85	-----
$C_{16}H_{34}O$	<i>n</i> -Octyl.....	10.80	15.33	17.59	19.96	20.84	24.77	-----	7.95	11.29	12.88	14.47	14.98	18.11	-----
$C_{17}H_{36}O$	<i>n</i> -Nonyl.....	10.98	15.45	18.41	20.26	21.35	24.60	-----	8.98	12.43	14.52	15.96	16.70	19.82	-----
	c	$s=CS_2 [\alpha]_{\lambda}^{20}$							c	$s=EtOH [\alpha]_{\lambda}^{120}$					
$C_9H_{20}O$	4.97.....	12.31	20.44	24.31	28.10	29.10	35.95	19.60	6.37	7.52	8.92	9.80	10.07	12.24	
$C_{10}H_{22}O$	4.73.....	24.27	32.68	41.50	45.85	47.93	58.16	24.75	13.94	17.65	22.22	25.35	26.57	30.00	
$C_{11}H_{24}O$	5.47.....	-----	31.42	-----	-----	-----	56.26	25.50	-----	17.24	-----	-----	-----	28.99	
$C_{12}H_{26}O$	4.56.....	24.58	33.79	39.60	45.86	48.71	57.81	22.65	15.67	19.86	24.06	26.93	28.03	33.36	
$C_{13}H_{28}O$	3.53.....	19.00	25.42	30.62	34.16	36.61	43.81	24.05	12.37	15.50	18.82	21.12	21.84	25.28	
$C_{14}H_{30}O$	3.17.....	17.97	23.96	27.51	33.16	34.99	40.83	17.60	12.91	13.85	18.59	20.01	21.85	24.69	
$C_{15}H_{32}O$	4.26.....	19.15	26.20	32.90	37.71	39.50	45.23	24.20	13.22	17.66	20.96	23.13	24.99	27.88	
$C_{16}H_{34}O$	3.41.....	16.14	20.00	25.98	29.20	30.09	35.52	14.65	10.26	14.02	15.73	17.78	18.46	21.37	
$C_{17}H_{36}O$	3.30.....	-----	21.50	-----	-----	-----	27.40	21.05	-----	14.97	-----	-----	-----	25.35	

¹ t =room temperature.

Specific rotation $[\alpha]_{\lambda}^t$ of alkyl esters at various temperatures (164, 166)

	5, 461	5, 893	5, 461	5, 893	5, 461	5, 893	5, 461	5, 893	5, 461	5, 983	5, 461	5, 893	5, 461	5, 893
	Acetate $C_2H_3O_2$		Propionate $C_3H_5O_2$		n-Butyrate $C_4H_7O_2$		n-Valerate $C_5H_9O_2$		Caproate $C_6H_{11}O_2$		Enanthate $C_7H_{13}O_2$		Caprylate $C_8H_{15}O_2$	
<i>d</i> -Butyl esters														
20-----	30.17	25.43	28.19	23.85	25.96	21.97	24.53	20.72	22.07	18.66	20.48	17.37	19.04	16.14
40-----	28.15	23.69	26.47	22.37	24.19	20.44	23.10	19.50	20.53	17.18	19.22	16.24	17.97	15.13
60-----	26.29	22.14	24.74	20.91	22.61	19.09	21.65	18.27	19.16	16.15	18.00	15.19	16.82	14.22
80-----	24.79	20.85	23.33	19.71	21.50	18.18	20.22	17.10	18.02	15.17	16.99	14.32	15.83	13.33
100-----	23.40	19.66	-----	-----	20.35	17.18	18.94	16.00	17.04	14.44	16.03	13.54	14.84	12.52
120-----	-----	-----	-----	-----	19.36	16.33	17.90	15.13	16.04	13.53	15.03	12.71	13.99	11.84
140-----	-----	-----	-----	-----	-----	-----	17.02	14.40	15.26	12.90	14.30	12.04	13.30	12.24
160-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	13.76	11.60	12.75	10.77
<i>d</i> -Butyl esters														
20-----	17.80	15.03	15.81	13.42	15.03	12.69	13.42	11.34	12.12	10.25	11.14	9.39	-----	-----
40-----	16.73	14.14	14.83	12.48	14.11	11.91	12.70	10.69	11.44	9.65	10.47	8.83	-----	-----
60-----	15.75	13.31	13.97	11.73	13.22	11.13	11.95	10.07	10.81	9.12	9.86	8.32	-----	-----
80-----	14.82	12.51	13.13	11.09	12.39	10.43	11.26	9.50	10.23	8.61	9.32	7.89	-----	-----
100-----	13.96	11.76	12.40	10.47	11.69	9.83	10.55	8.91	9.62	8.10	8.89	7.48	-----	-----
120-----	13.11	11.10	11.81	9.98	11.15	9.41	9.95	8.41	9.11	7.68	8.45	7.12	-----	-----
140-----	12.51	10.59	11.26	9.45	10.57	8.92	9.44	7.95	8.67	7.29	8.01	6.75	-----	-----
160-----	12.25	10.33	10.69	8.99	10.07	8.50	9.03	7.65	-----	-----	7.66	6.48	-----	-----
<i>d</i> -Amyl esters														
20-----	20.27	17.16	19.29	16.43	18.42	15.77	18.77	16.01	22.48	18.74	-----	-----	-----	-----
40-----	18.44	15.67	17.85	15.24	16.89	14.46	17.13	14.70	20.27	16.87	-----	-----	-----	-----
60-----	17.04	14.50	16.44	14.03	15.46	13.23	15.98	13.63	18.19	15.04	-----	-----	-----	-----
80-----	15.58	13.26	15.26	13.00	14.09	12.08	14.84	12.71	16.19	13.48	-----	-----	-----	-----
100-----	14.54	12.36	14.25	12.15	13.29	11.34	13.98	11.95	-----	-----	-----	-----	-----	-----
120-----	13.87	11.85	13.47	11.49	12.69	10.86	13.27	11.32	-----	-----	-----	-----	-----	-----
140-----	-----	-----	-----	-----	-----	-----	12.62	10.80	-----	-----	-----	-----	-----	-----
<i>d</i> -Hexyl esters														
20-----	11.80	10.13	11.41	9.76	12.66	10.83	13.05	11.16	12.66	10.84	12.12	10.36	-----	-----
40-----	10.30	8.85	10.17	8.73	11.47	9.76	11.97	10.26	11.69	9.96	11.11	9.50	-----	-----
60-----	8.92	7.68	9.06	7.80	10.32	8.81	10.92	9.39	10.69	9.16	10.18	8.73	-----	-----
80-----	7.67	6.58	8.06	6.91	9.32	7.94	9.87	8.48	9.85	8.41	9.28	7.96	-----	-----
100-----	6.53	5.59	7.19	6.16	8.33	7.13	9.08	7.74	9.03	7.74	8.56	7.31	-----	-----
120-----	5.66	4.88	-----	-----	7.65	6.53	8.27	7.08	8.32	7.14	7.94	6.78	-----	-----
140-----	-----	-----	-----	-----	7.02	5.98	7.61	6.52	7.66	6.60	7.43	6.31	-----	-----
<i>d</i> -Hexyl esters														
20-----	10.96	9.38	9.75	8.35	9.34	7.99	8.66	7.40	8.10	6.87	7.21	6.16	-----	-----
40-----	10.09	8.61	8.97	7.67	8.53	7.27	7.84	6.70	7.44	6.31	6.44	5.52	-----	-----
60-----	9.26	7.87	8.17	7.00	7.75	6.64	7.18	6.14	6.84	5.87	5.88	5.02	-----	-----
80-----	8.46	7.19	7.56	6.48	7.11	6.09	6.60	5.62	6.26	5.37	5.43	4.65	-----	-----
100-----	7.77	6.63	7.02	6.02	6.52	5.60	6.09	5.21	5.81	4.97	5.03	4.31	-----	-----
120-----	7.24	6.21	6.49	5.55	6.01	5.16	5.66	4.84	5.51	4.70	4.68	4.02	-----	-----
140-----	6.73	5.84	5.99	5.15	5.64	4.82	5.29	4.53	5.31	4.55	4.40	3.78	-----	-----
160-----	-----	-----	-----	-----	-----	-----	5.03	4.30	-----	-----	4.21	3.58	-----	-----

Specific rotation $[\alpha]_D^{25}$ of alkyl esters in various solvents (5 per cent concentration) (164)

$t =$ Room temp. $\lambda =$	$s =$																			
	Ethyl alcohol					Pyridine														
Ester	Ethyl alcohol					Benzene					Carbon disulphide					Ethyl alcohol				
	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358		
β -Butyl esters																			β -Hexyl esters	
Acetate.....	25.87	30.45	50.06	18.56	21.78	35.13	21.92	26.10	43.73	15.62	18.31	27.53	6.94	7.66	11.64	6.94	7.66	11.64		
Propionate.....	24.69	29.10	47.48	17.22	20.22	32.80	21.92	26.10	43.73	15.62	18.31	27.53	7.47	7.99	12.56	7.47	7.99	12.56		
<i>n</i> -Butyrate.....	22.80	26.40	44.69	16.29	18.49	29.49	21.92	26.10	43.73	15.62	18.31	27.53	9.11	10.28	16.46	9.11	10.28	16.46		
<i>n</i> -Valerate.....	21.40	25.04	40.90	14.42	16.29	27.52	14.42	16.29	27.52	8.92	10.00	15.58	10.34	11.42	18.40	10.34	11.42	18.40		
Caproate.....	19.28	22.78	37.36	12.80	14.92	23.18	13.49	15.91	26.51	8.92	10.00	15.58	10.05	10.86	18.23	10.05	10.86	18.23		
Enanthate.....	18.03	21.15	34.99	12.80	14.92	23.18	13.49	15.91	26.51	8.92	10.00	15.58	9.82	11.38	17.74	9.82	11.38	17.74		
Caprylate.....	16.95	19.83	32.95	12.09	13.44	21.77	11.93	13.93	23.12	8.40	10.01	15.01	8.99	10.09	16.24	8.99	10.09	16.24		
Pelargonate.....	15.82	18.33	30.19	11.42	13.04	21.22	11.93	13.93	23.12	8.40	10.01	15.01	8.99	10.09	16.24	8.99	10.09	16.24		
Undecylate.....	14.38	16.51	27.79	10.03	12.90	19.03	11.93	13.93	23.12	7.03	8.81	12.20	8.99	10.09	16.24	8.99	10.09	16.24		
Laurate.....	13.79	16.01	26.47	7.55	8.92	14.86	9.47	11.13	18.39	6.32	7.46	10.77	6.63	7.46	10.77	6.63	7.46	10.77		
Myristate.....	12.09	14.30	23.56	7.55	8.92	14.86	7.89	9.37	15.09	5.55	6.47	9.71	6.63	7.46	10.77	6.63	7.46	10.77		
Palmitate.....	11.01	13.02	21.46	7.55	8.92	14.86	7.89	9.37	15.09	5.55	6.47	9.71	6.63	7.46	10.77	6.63	7.46	10.77		
Stearate.....	10.30	11.80	19.56	7.55	8.92	14.86	7.89	9.37	15.09	5.55	6.47	9.71	6.63	7.46	10.77	6.63	7.46	10.77		
β -Heptyl esters																			$s =$ Benzene	
Acetate.....	5.02	5.72	8.13	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10		
Propionate.....	5.71	6.32	9.27	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10		
<i>n</i> -Butyrate.....	8.06	9.26	14.71	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10		
<i>n</i> -Valerate.....	8.92	9.88	15.72	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10		
Caproate.....	8.20	9.78	15.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10		
Enanthate.....	8.43	10.29	17.18	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10		
Caprylate.....	8.53	9.82	15.18	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10		
Pelargonate.....	8.32	8.92	14.25	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10		
Undecylate.....	7.36	8.25	13.80	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10		
Laurate.....	7.08	8.11	13.80	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10		
Myristate.....	6.59	7.19	11.72	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10		
Palmitate.....	6.19	6.63	10.58	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10		
Stearate.....	5.90	6.63	10.58	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10	2.13	2.84	6.10		

s = Benzene

	β -Octyl esters												$s = \text{CS}_2$		
	3.28	3.86	5.50	-3.80	-4.83	-10.69	-0.84	-1.12	-3.63	-8.96	-11.45	-22.13	-4.70	-6.60	-14.76
Acetate.....	3.66	4.94	6.33			-10.69	-4.01	-4.90	-10.52	11.42	15.36	32.00	7.45	10.10	20.31
Propionate.....	7.00	8.26	12.72			-10.69	-1.49	-2.19	-4.29	8.08	10.62	21.13	5.82	7.80	16.94
n-Butyrate.....	7.61	9.39	13.95			-10.69	.73	1.22	2.92	7.72	10.00	20.33	5.38	7.72	16.34
n-Pentanoate.....	7.62	8.68	13.05			-10.69				6.01	7.88	17.74	4.01	5.20	11.74
Caproate.....	7.87	8.53	14.10			-10.69				6.36	8.23	17.00	3.79	5.30	12.03
Enanthate.....	7.27	8.30	13.05			-10.69	-3.88	-5.1	-2.11	5.80	7.34	15.38	3.41	4.62	10.44
Caprylate.....	7.65	8.54	13.85			-10.69				5.18	6.80	13.09	3.03	3.33	10.47
Pelargonate.....	7.40	7.89	13.12			-10.69				4.74	6.16	13.36	2.08	3.12	7.50
Laurate.....	6.37	7.08	11.62			-10.69				4.40	5.62	11.96	2.09	3.22	7.55
Myristate.....	6.02	7.04	11.39			-10.69				4.32	5.38	11.03	2.43	3.50	5.73
Palmitate.....	5.27	6.53	10.24			-10.69				4.49	5.15	10.03			
Stearate.....						-10.69									

	β -Undecyl esters										$s = \text{CS}_2$								
	5.893	5.461	4.358	5.893	5.461	4.358	5.893	5.461	4.358	5.893	5.461	4.358							
Acetate.....	2.32	2.42	2.62	-2.43	-2.91	-6.67	-8.53	-11.10	-21.28	Butan- β -ol.....	25.87	30.45	50.06	13.79	16.01	26.47	15.62	18.31	27.53
Propionate.....	2.84	2.99	3.79	-5.32	-6.28	-12.09	11.45	14.52	28.21	Pentan- β -ol.....	15.41	7.66	11.64	10.53	6.94	8.11	4.70	-6.60	-14.76
n-Butyrate.....	5.92	6.92	10.93				9.46	11.45	24.72	Hexan- β -ol.....	6.04	5.72	8.13	7.08	8.11	13.80	8.52	-10.28	-22.93
n-Pentanoate.....	6.07	6.86	8.84	-2.07	-3.45	-5.30	8.04	10.30	20.69	Heptan- β -ol.....	5.02	4.15	6.00	6.47	7.31	8.11	8.96	-11.45	-20.16
Caprylate.....	6.61	7.05	12.76				7.73	10.18	19.09	Octan- β -ol.....	3.52	2.82	3.02	6.47	7.31	8.11	9.13	-12.14	-23.50
Enanthate.....	6.60	7.65	11.62	-87	-1.16	-3.66	6.54	8.60	17.09	Nonan- β -ol.....	2.73	2.62	2.71	6.02	7.31	8.11	9.13	-12.14	-23.50
Pelargonate.....	5.78	6.41	10.51	-72	.95	-1.07	5.95	7.66	14.72	Decan- β -ol.....	2.54	2.42	2.71	6.02	7.31	8.11	9.13	-12.14	-23.50
Undecyrate.....							5.40	7.08	13.38	Undecan- β -ol.....	2.32	2.42	2.22	6.01	6.21	6.21	8.53	-11.10	-21.28
Myristate.....	5.78	6.72					4.90	6.43	12.48	Dodecan- β -ol.....	1.76	1.58	1.32	5.50	6.21	6.21	8.53	-11.10	-21.28
										Tridecan- β -ol.....							7.90	-10.00	-19.39

Specific rotation $[\alpha]_D^{25}$ of alkyl esters in various solvents (5 per cent concentration) (164)—Continued

$t = \text{Room temp. } \lambda =$	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358
$s =$	$\beta\text{-Octyl acetate}$			$\beta\text{-Octyl stearate}$			$\beta\text{-Octyl enanthate}$			$\beta = \text{Octyl hydrogen phthalate}$		
None.....	6.84	8.01	12.45	5.71	6.68	14.50	8.59	9.97	16.10	25.43	30.17	49.52
$\text{C}_6\text{H}_5\text{Br}$	9.79	11.11	17.42	7.43	8.50	14.50	11.39	13.00	21.76	26.80	31.96	52.84
$\beta\text{-O}_2\text{HCl}$	5.91	6.84	9.53	5.48	6.52	10.17	9.09	10.16	16.66	25.61	30.31	49.87
$\text{OH}_2\text{CO}_2\text{H}$	5.56	5.83	8.55	5.31	5.86	9.68	8.50	9.70	15.89	25.75	30.00	49.20
OH_2NO_2	5.25	5.83	8.55	4.57	5.11	8.07	7.76	8.68	13.40	23.07	29.56	49.34
EtOAc	5.18	5.83	8.55	5.27	6.53	10.24	7.87	8.53	14.10	25.87	30.45	50.06
CHCl_3	3.78	4.15	6.00	3.32	4.00	10.63	3.00	4.00	10.63	21.92	26.10	43.73
AcOH	3.65	4.15	6.00	3.27	4.00	10.63	3.00	4.00	10.63	21.92	26.10	43.73
EtOH	3.52	4.15	6.00	3.27	4.00	10.63	3.00	4.00	10.63	21.92	26.10	43.73
CO_2H	3.50	4.15	6.00	3.27	4.00	10.63	3.00	4.00	10.63	21.92	26.10	43.73
C_6H_6	-0.84	-1.12	-3.63	0.32	±0.00	-0.63	±0.00	-0.51	-2.11	42.83	52.41	98.72
Phenetole.....	-1.39	-1.12	-3.63	0.32	±0.00	-0.63	±0.00	-0.51	-2.11	42.83	52.41	98.72
$\text{C}_6\text{H}_5\text{Cl}$	-3.10	-4.83	-10.69	0.27	±0.00	-0.73	-0.90	-1.54	-3.88	18.56	21.78	35.16
Py.....	-3.80	-4.83	-10.69	0.27	±0.00	-0.73	-0.90	-1.54	-3.88	18.56	21.78	35.16
OS_2	-8.96	-11.45	-22.13	-4.49	-5.15	-10.03	-6.36	-8.23	-17.00	15.62	18.31	27.53

Influence of concentration on rotatory power at laboratory temperature (164)

λ	5,893	5,461	4,358	λ	5,893	5,461	4,358	λ	5,893	5,461	4,358
p	$d\text{-}\beta\text{-Butyl acetate } s = \text{CS}_2$			p	$d\text{-}\beta\text{-Octyl acetate } s = \text{CS}_2$			p	$d\text{-}\beta\text{-Octyl acetate } s = \text{C}_6\text{H}_6$		
7.56	16.02	18.33	28.15	4.56	-9.11	-10.46	-22.18	9.77	-0.64	-0.88	-2.86
21.40	19.04	22.17	35.52	15.37	-5.14	-6.27	-13.95	29.39	+4.49	+3.33	-1.51
29.87	20.21	23.63	38.23	32.07	-1.07	-1.52	-4.77	46.69	1.69	1.80	1.73
60.15	22.40	26.43	43.21	44.33	+1.72	+1.79	+1.05	62.91	3.15	3.54	4.68
66.45	23.84	28.16	46.22	47.90	+1.72	+1.79	+1.05	71.05	3.96	4.44	6.22
100.00	25.43	30.17	49.51	60.85	3.47	3.92	5.06	100.00	7.05	8.22	12.47
				72.49	4.80	5.53	7.85				
				100.00	7.05	8.22	12.47				

Specific rotation $[\alpha]_D^{25}$ of esters of acetic acid (99)

$\lambda \rightarrow$	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358
$\downarrow$	$C_{10}H_{18}O_2$ <i>d</i> - γ -Hexyl acetate			$C_{10}H_{18}O_2$ <i>d</i> - γ -Heptyl acetate			$C_{10}H_{18}O_2$ <i>d</i> - γ -Octyl acetate			$C_{11}H_{20}O_2$ <i>l</i> - γ -Decyl acetate		
20-----	0.55	0.05	0.71	-4.68	-5.66	-10.44	-4.30	-5.08	-9.03	4.40	5.11	9.38
40-----	.54	.63	.70	-4.73	-5.73	-10.52	-4.37	-5.15	-9.75	4.40	5.14	9.44
60-----	.52	.61	.68	-4.78	-5.80	-10.63	-4.46	-5.24	-9.88	4.42	5.20	9.49
80-----	.51	.60	.67	-4.83	-5.88	-10.73	-4.54	-5.34	-10.02	4.45	5.24	9.55
100-----	.50	.58	.65	-4.88	-5.94	-10.83	-4.61	-5.43	-10.16	4.47	5.28	9.62
120-----	.48	.56	.63	-4.93	-6.01	-10.95	-4.71	-5.54	-10.30	4.50	5.33	9.69
140-----	.46	.54	.61	-4.98	-6.08	-11.07	-4.77	-5.63	-10.43	4.53	5.37	9.72
160-----	-----	-----	-----	-5.03	-6.16	-11.20	-4.86	-5.73	-10.59	4.57	5.35	9.80
180-----	-----	-----	-----	-----	-----	-----	-4.96	-5.85	-10.79	4.58	5.48	9.88
200-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	4.59	5.40	9.95
$\downarrow$	$C_{11}H_{20}O_2$ <i>l</i> - γ -Tridecyl acetate			$C_{11}H_{20}O_2$ <i>l</i> - γ -Tetradecyl acetate			$C_{11}H_{20}O_2$ <i>l</i> - γ -Pentadecyl acetate			$C_{12}H_{22}O_2$ <i>l</i> - γ -Hexadecyl acetate		
20-----	3.83	4.61	8.49	3.69	4.44	8.17	3.68	4.42	8.08	3.19	3.90	7.20
40-----	3.88	4.64	8.53	3.70	4.46	8.22	3.67	4.43	8.10	3.21	3.97	7.25
60-----	3.90	4.69	8.56	3.73	4.49	8.27	3.68	4.43	8.12	3.24	3.99	7.28
80-----	3.93	4.71	8.60	3.76	4.51	8.33	3.69	4.45	8.15	3.26	3.99	7.30
100-----	3.97	4.73	8.66	3.79	4.56	8.38	3.70	4.47	8.18	3.31	3.90	7.35
120-----	4.00	4.75	8.72	3.82	4.58	8.44	3.70	4.49	8.21	3.35	3.91	7.39
140-----	4.03	4.78	8.78	3.86	4.61	8.52	3.70	4.51	8.23	3.38	3.92	7.44
160-----	4.08	4.84	8.89	3.91	4.64	8.59	3.71	4.53	8.30	3.40	3.93	7.50
180-----	4.13	4.91	9.03	3.95	4.68	8.66	3.71	4.52	8.37	3.44	3.97	7.59
200-----	4.17	4.94	9.14	3.99	4.71	8.75	3.71	4.56	8.40	3.47	4.00	7.69
$\downarrow$	$C_{12}H_{22}O_2$ <i>l</i> - γ -Dodecyl acetate			$C_{13}H_{24}O_2$ <i>l</i> - γ -Undecyl acetate			$C_{13}H_{24}O_2$ <i>l</i> - γ -Octadecyl acetate			$C_{14}H_{26}O_2$ <i>l</i> - γ -Dodecyl acetate		
20-----	-----	-----	-----	-----	-----	-----	2.98	3.72	6.63	-----	-----	-----
40-----	-----	-----	-----	-----	-----	-----	3.01	3.53	6.65	-----	-----	-----
60-----	-----	-----	-----	-----	-----	-----	3.00	3.53	6.67	-----	-----	-----
80-----	-----	-----	-----	-----	-----	-----	3.02	3.56	6.71	-----	-----	-----
100-----	-----	-----	-----	-----	-----	-----	3.05	3.56	6.75	-----	-----	-----
120-----	-----	-----	-----	-----	-----	-----	3.06	3.58	6.79	-----	-----	-----
140-----	-----	-----	-----	-----	-----	-----	3.08	3.58	6.85	-----	-----	-----
160-----	-----	-----	-----	-----	-----	-----	3.11	3.60	6.89	-----	-----	-----
180-----	-----	-----	-----	-----	-----	-----	3.14	3.63	6.93	-----	-----	-----
200-----	-----	-----	-----	-----	-----	-----	3.16	3.63	6.99	-----	-----	-----

Specific rotation $[\alpha]_D^{20}$ of alkyl esters in solution (99)

c=5 per cent	s	Acetates						Enanthates					
		EtOH			CS ₂			EtOH			CS ₂		
		5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358
λ													
<i>d</i> -sec-Butyl.....	25.87	30.45	50.06	27.53	15.62	18.31	27.53	18.03	21.15	34.99	8.16	9.53	14.46
<i>d</i> -Pentyl.....	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
<i>d</i> - γ -Hexyl.....	-34	-43	-60	-3.60	-2.07	-2.34	-3.60	+ .08	+ .16	+ .32	2.07	2.04	5.17
<i>d</i> - γ -Heptyl.....	-8.01	-8.96	-16.28	-33.06	-14.96	-18.10	-33.06	-3.19	-3.44	-6.46	-10.64	-12.98	-23.86
<i>d</i> - γ -Octyl.....	-7.41	-8.69	-15.42	-33.60	-15.27	-18.32	-33.60	-2.70	-3.15	-5.84	-10.79	-13.33	-24.47
<i>d</i> - γ -Nonyl.....	-8.12	-9.57	-16.90	-33.62	-17.89	-21.31	-33.62	-3.67	-4.32	-7.61	-13.40	-16.10	-28.30
<i>l</i> - γ -Decyl.....	7.24	8.87	15.58	34.43	15.28	18.16	34.43						
<i>l</i> - γ -Undecyl.....	7.12	8.45	14.86	32.63	14.24	17.13	32.63						
<i>l</i> - γ -Dodecyl.....	6.02	7.42	13.64	29.25	13.10	15.44	29.25						
<i>l</i> - γ -Tridecyl.....	6.77	8.19	14.46	31.12	14.12	16.90	31.12	-2.40	-2.70	-5.09	-10.50	-12.00	-22.90
<i>l</i> - γ -Tetradecyl.....	6.69	8.11	14.97	31.03	13.92	16.85	31.03	+2.45	-2.94	-5.96	+10.88	+13.25	+24.75
<i>l</i> - γ -Pentadecyl.....	6.61	8.31	15.08	29.84	13.38	16.01	29.84	+2.69	+3.41	+6.20	+10.69	+13.12	+23.81
<i>l</i> - γ -Hexadecyl.....	6.56	7.60	13.27	28.39	12.39	15.20	28.39	2.10	2.54	5.51	10.21	11.98	22.75
<i>l</i> - γ -Octadecyl.....	5.96	7.06	12.25	25.23	11.54	13.59	25.23	1.94	2.31	4.64	8.46	10.14	19.15

* Inactive.

Specific rotatory power $[\alpha]_{\lambda}^t$ of d - β -octyl alkyl esters of the dicarboxylic acids (78)

t ↓		C ₁₁ H ₂₃ O ₄ Octyl methyl oxalate			C ₁₁ H ₂₃ O ₄ Octyl ethyl oxalate			C ₁₁ H ₂₃ O ₄ Octyl ethyl malonate			C ₁₁ H ₂₃ O ₄ L - β -Octyl methyl succinate		
		5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358
20	λ →	14.22	16.64	25.91	13.98	16.33	24.94	9.27	10.83	17.40	-3.54	-3.97	-5.85
40	-----	13.32	15.24	24.25	13.05	15.13	23.56	8.10	9.28	15.19	3.39	3.83	5.42
60	-----	12.72	14.42	22.96	12.54	14.17	22.08	7.36	8.41	13.74	3.30	3.71	5.42
80	-----	12.22	13.77	21.96	12.48	13.72	21.04	6.67	7.73	12.89	3.12	3.56	5.20
100	-----	11.79	13.21	21.01	12.38	13.44	20.08	6.13	7.17	11.61	2.94	3.38	5.00
120	-----	11.39	12.68	20.19	12.37	13.36	19.21	5.66	6.72	10.81	2.77	3.17	4.78

t ↓		C ₁₄ H ₂₉ O ₄ Octyl ethyl succinate			C ₁₄ H ₂₉ O ₄ Octyl oxalate			C ₁₄ H ₂₉ O ₄ Octyl malonate		
		6,438	5,461	5,086	5,893	5,461	4,358	6,438	5,461	5,086
20	λ →	2.44	3.67	3.96	22.72	26.57	40.66	9.19	12.83	14.79
40	-----	2.29	3.48	3.78	21.56	24.93	38.77	8.08	11.33	12.88
60	-----	2.25	3.39	3.65	20.60	23.72	37.15	7.09	10.18	11.44
80	-----	2.20	3.35	3.59	19.86	22.83	35.95	6.42	9.17	10.24
100	-----	2.20	3.30	3.55	19.32	22.26	34.92	5.95	8.40	9.53
120	-----	2.20	3.30	3.53	18.98	21.77	34.00	5.51	7.76	8.52

t ↓		C ₁₆ H ₃₃ O ₄ Octyl succinate			C ₁₆ H ₃₃ O ₄ Octyl glutarate			C ₁₆ H ₃₃ O ₄ Octyl adipate		
		6,438	5,461	5,086	6,438	5,461	5,086	6,438	5,461	4,358
20	λ →	4.08	5.54	6.00	7.12	10.35	11.63	12.77	13.39	15.35
40	-----	3.93	5.32	5.77	6.33	9.18	10.17	11.14	11.89	13.40
60	-----	3.77	5.21	5.60	5.70	8.25	9.06	9.95	10.60	11.93
80	-----	3.63	5.10	5.49	5.22	7.47	8.28	9.04	9.61	10.99
100	-----	3.55	5.05	5.45	4.87	6.91	7.72	8.43	8.96	10.25
120	-----	3.53	5.03	5.43	4.60	6.46	7.20	7.99	8.47	9.59

Specific rotatory power $[\alpha]_D^{25}$ of *d*- β -octyl alkyl esters of the dicarboxylic acids (78)—Continued

t $\lambda \rightarrow$	$C_{22}H_{44}O_4$ Octyl pimelate					$C_{22}H_{46}O_4$ Octyl suberate					$C_{22}H_{48}O_4$ Octyl azelate				
	6,438	5,461	5,086	4,800	4,678	4,353	5,893	5,461	4,353	6,438	5,461	5,086	4,800	4,678	4,353
20.....	9.53	13.18	15.33	17.22	18.25	20.64	11.01	12.95	19.59	9.02	12.76	14.69	16.36	17.10	19.54
40.....	8.49	11.52	13.34	14.10	16.10	17.94	9.89	11.59	17.97	8.37	11.58	13.51	14.99	15.60	17.59
60.....	7.72	10.31	11.83	13.39	14.16	15.91	8.85	10.47	16.77	7.75	10.68	12.36	13.69	14.23	16.12
80.....	7.13	9.42	10.80	12.28	12.99	14.40	8.03	9.54	15.79	7.16	9.85	11.33	12.57	13.07	14.84
100.....	6.76	8.83	10.14	11.62	12.21	13.48	7.35	8.93	14.84	6.64	9.17	10.40	11.50	12.01	13.84
120.....	6.53	8.44	9.66	11.26	11.79	12.94	6.85	8.46	13.88	6.23	8.58	9.89	10.60	11.05	12.93
	$C_{20}H_{40}O_4$ Octyl sebacate					$C_{21}H_{42}O_4$ Octyl <i>n</i> -nonane- <i>i</i> -dicarboxylate					$C_{23}H_{44}O_4$ Octyl <i>n</i> -decane- <i>k</i> -dicarboxylate				
	6,438	5,461	5,086	4,800	4,678	4,353	5,893	5,461	4,353	5,893	5,461	4,353	5,893	5,461	4,353
20.....	8.45	12.04	14.16	15.80	16.75	18.87	10.37	11.77	18.30	10.36	11.29	16.98	9.25	11.12	17.47
40.....	7.64	10.84	12.75	14.03	14.86	16.86	9.39	10.54	16.05	9.25	10.22	15.37	8.77	10.35	16.02
60.....	6.95	9.76	11.43	12.48	13.35	15.04	8.63	9.66	14.65	8.42	9.40	14.32	8.48	9.75	14.79
80.....	6.39	8.83	10.36	11.29	12.08	13.51	7.84	8.87	13.43	7.67	8.70	13.42	8.27	9.33	13.78
100.....	5.95	8.03	8.40	10.34	11.10	12.26	7.08	8.05	12.33	7.02	8.02	12.56	8.02	8.93	12.83
120.....	5.62	7.45	8.72	9.61	10.31	11.29	6.29	7.13	11.27	6.52	7.44	11.70	7.89	8.74	11.99

Specific rotatory power $[\alpha]_D^t$ of the preceding esters in approximately 5 per cent solution

Esters	s=Ethyl alcohol					Carbon disulphide				
	c	t	5,893	5,461	4,358	c	t	5,893	5,461	4,358
<i>d</i> - β -C ₁₁ H ₂₂ O ₄	4.95	20	13.14	16.28	24.36	4.57	20	11.48	12.47	18.27
<i>d</i> - β -C ₁₂ H ₂₄ O ₄	4.99	18	13.61	18.03	25.64	5.01	18	9.98	12.08	18.47
<i>d</i> - β -C ₁₃ H ₂₆ O ₄ malonate.....	5.04	21	7.34	8.14	13.70	5.06	19.5	-5.04	-7.01	-14.62
<i>l</i> - β -C ₁₃ H ₂₆ O ₄ succinate.....	5.05	20	-1.29	-2.18	-2.97	5.06	20	12.66	16.02	31.54
<i>d</i> - β -C ₁₄ H ₂₈ O ₄	5.07	18	1.87	2.66	4.73	4.99	17	-13.34	-14.94	-31.09
<i>d</i> - β -C ₁₅ H ₃₀ O ₄	4.99	18	23.73	27.54	43.66	4.97	16	10.37	13.79	17.22
<i>d</i> - β -C ₁₆ H ₃₂ O ₄	5.04	18	9.63	10.52	16.97	4.99	17	-13.13	-15.14	-30.17
<i>d</i> - β -C ₁₇ H ₃₄ O ₄	5.10	18	1.77	1.67	-.29	5.03	17	-21.18	-24.97	-49.82
<i>d</i> - β -C ₁₈ H ₃₆ O ₄	5.07	18	8.39	9.43	14.51	5.05	17	-11.69	-13.67	-27.33
<i>d</i> - β -C ₁₉ H ₃₈ O ₄	5.03	18	9.45	10.35	16.72	5.11	17	-10.95	-13.10	-26.70
<i>d</i> - β -C ₂₀ H ₄₀ O ₄	5.04	18	9.43	11.03	17.98	5.09	18	-8.85	-11.90	-22.81
<i>d</i> - β -C ₂₁ H ₄₂ O ₄	5.03	19	8.95	10.74	17.70	5.01	18	-9.59	-11.29	-20.48
<i>d</i> - β -C ₂₂ H ₄₄ O ₄	5.15	19	9.22	10.86	16.11	5.03	18	-7.86	-9.75	-20.19
<i>d</i> - β -C ₂₃ H ₄₆ O ₄	5.00	18	8.71	10.41	16.81	4.96	18	-8.06	-10.28	-20.34
<i>d</i> - β -C ₂₄ H ₄₈ O ₄	5.04	18	8.93	10.12	16.36	4.97	18	-7.75	-9.46	-20.22
<i>d</i> - β -C ₂₅ H ₅₀ O ₄	5.01	19	9.29	9.98	16.58	4.97	18	-7.65	-9.36	-18.94
<i>d</i> - β -C ₂₆ H ₅₂ O ₄	4.62	19	9.41	10.06	15.15	4.71	18	-6.26	-7.85	-15.50

Alkylisopropylcarbinyl hydrogen phthalates (62)	CHCl ₃ c=5		EtOH c=5	
	$[\alpha]_D$	$[M]_D$	$[\alpha]_D$	$[M]_D$
C ₁₁ H ₁₈ O ₄ <i>d</i> -Methyl ¹	37.9	89.3	41.4	97.7
C ₁₄ H ₂₂ O ₄ <i>d</i> -Ethyl ¹	-5	-1.2	-4.0	-10.1
C ₁₅ H ₂₄ O ₄ <i>d</i> -Propyl.....	-7.8	20.9	8.4	22.1
C ₁₆ H ₂₆ O ₄ <i>l</i> - <i>n</i> -Propyl.....	-7.8	.....	-8.0	.....
C ₁₆ H ₂₆ O ₄ <i>d</i> - <i>n</i> -Butyl.....	13.9	38.7	12.8	35.5
C ₁₆ H ₂₆ O ₄ <i>l</i> - <i>n</i> -Butyl.....	-13.8	.....	-12.9	.....
C ₁₇ H ₂₈ O ₄ <i>d</i> - <i>n</i> -Amyl.....	13.5	39.3	15.1	44.1
C ₁₈ H ₃₀ O ₄ <i>d</i> - <i>n</i> -Hexyl.....	11.8	36.1	17.0	52.1
C ₂₀ H ₃₄ O ₄ <i>d</i> - <i>n</i> -Octyl.....	16.9	56.3	17.2	57.3
C ₂₂ H ₃₈ O ₄ <i>d</i> - <i>n</i> -Decyl.....	13.9	50.3	16.8	61.0

¹ Not recrystallized, being very soluble in organic media.

α , β -Dichloropropionates¹ (67)

C ₄ H ₄ Cl ₂ O ₂ Methyl		C ₅ H ₅ Cl ₂ O ₂ Ethyl		C ₇ H ₁₃ Cl ₂ O ₂ Isobutyl		C ₁₀ H ₁₉ Cl ₂ O ₂ Heptyl	
t	$[\alpha]_D$	t	$[\alpha]_D$	t	$[\alpha]_D$	t	$[\alpha]_D$
3.5	0.95	12.0	-1.96	14.5	-3.73	12.0	-1.84
13.5	1.47	20.0	-1.79	20.0	-3.62	20.0	-1.73
20.0	1.70	39.5	-1.40	40.5	-3.31	40.0	-1.62
43.5	2.35	56.5	-.97	68.0	-2.91	53.0	-1.54
54.5	2.54	.....	.....	.....	.....	99.0	-1.26

¹ Prepared from corresponding *l*-glycerates, possibly partly racemized.

Specific rotation $[\alpha]_D^t$ of *d*- γ -nonyl esters in solution (99) t = Temperature of laboratory

Ester	c	Ethyl alcohol			c	Carbon disulphide		
	$\lambda =$	5,893	5,461	4,358	$\lambda =$	5,893	5,461	4,358
Acetate.....	4.495	-8.12	-9.57	-16.90	5.115	-17.89	-21.31	-38.62
Propionate.....	5.240	-8.77	-20.68	-17.97	5.430	-20.72	-25.59	-44.01
<i>n</i> -Butyrate.....	5.195	-5.69	-6.65	-11.55	5.175	-17.10	-24.80	-36.74
<i>n</i> -Valerate.....	5.095	-4.91	-5.59	-9.61	5.050	-15.36	-19.42	-34.48
Caproate.....	4.885	-4.19	-4.93	-8.84	5.255	-14.55	-17.51	-31.49
Enanthate.....	5.170	-3.67	-4.32	-7.61	5.005	-13.40	-16.10	-28.30
Caprylate.....	5.035	-3.07	-3.52	-6.05	5.435	-12.51	-15.37	-26.22
Pelargonate.....	5.260	-2.76	-3.48	-5.42	5.295	-11.90	-14.73	-24.93
Caprate.....	5.720	-2.62	-3.32	-6.03	5.720	-10.75	-13.63	-24.04
Undecylate.....	5.440	-2.42	-2.84	-5.26	5.745	-10.35	-12.61	-23.31
Laurate.....	5.090	-2.36	-2.86	-4.47	4.995	-10.30	-12.51	-22.02
Myristate.....	4.755	-2.31	-2.48	-3.85	4.925	-9.75	-11.68	-20.31
Palmitate.....	4.735	-2.40	-2.69	-3.36	5.140	-9.15	-10.51	-18.78
Stearate.....	4.755	-2.30	-2.49	-3.33	5.245	-8.67	-10.49	-17.93

Specific rotation of *d*- γ -nonyl acetate (99)

Py.....	4.820	-13.39	-16.08	25.72	-----	-----	-----
C ₆ H ₆	4.831	-12.42	-14.87	25.50	-----	-----	-----
CHCl ₃	4.615	-8.73	-9.55	16.25	-----	-----	-----
AcOEt.....	4.996	-5.91	-7.00	12.21	-----	-----	-----
Me ₂ CO.....	4.684	-6.08	-7.15	12.06	-----	-----	-----
C ₂ H ₅ Br.....	4.898	-3.74	-4.49	8.13	-----	-----	-----

C ₆ H ₉ O ₂ Methyl <i>l</i> -lactate (148; cf., 66, 221)						
(66; cf., 221)		s=PhNO ₂		C ₂ H ₂ Cl ₄		
<i>t</i>	[α] _D ^{<i>t</i>}	<i>t</i>	[α] _D ^{<i>t</i>}	<i>t</i>	[α] _D ^{<i>t</i>}	
−75.0	5.48	<i>p</i> = 9.877	16.0	<i>p</i> = 9.937	−7.8	−7.66
−51.0	5.84		36.2		39.7	−2.53
16.7	8.10		56.5		94.3	1.96
35.4	8.68		104.5		120.0	3.74
78.8	9.98		141.0		10.95	
125.0	11.13					
C ₈ H ₁₀ O ₄ Methyl <i>l</i> -α-acetoxypropionate						
−7.4	54.26	<i>p</i> = 10.14	0.3	<i>p</i> = 10.035	17.6	47.56
43.0	54.20		19.2		54.7	47.32
83.2	54.03		65.0		91.3	47.34
141.0	54.08		141.0		139.3	47.80
C ₈ H ₁₀ O ₃ Methyl <i>l</i> -α-methoxypropionate						
−16.6	103.3	<i>p</i> = 9.802	16.6	<i>p</i> = 10.062	16.7	73.69
16.4	97.16		41.7		39.8	72.52
51.1	91.81		70.5		77.0	70.52
78.4	88.28		92.8		101.0	69.40
130.0	84.16		119.0		119.0	68.21

Esters of methylbenzyl carbinol in various solvents (5 per cent solution) at laboratory temperature (101)

Ester.....	$\int \lambda \rightarrow$	s=EtOH				$\int \lambda \rightarrow$	CS ₂			
		5,893	5,700	5,461	4,358		5,893	5,700	5,461	4,358
Acetate.....	5.805	8.01	8.61	9.47	15.72	5.060	-8.17	-8.36	-10.42	-22.55
Propionate.....	5.315	7.24	7.62	8.56	14.11	5.165	-13.78	-14.62	-16.85	-34.57
Butyrate.....	5.145	12.14	12.74	14.48	24.01	5.405	-7.77	-8.42	-9.17	-22.29
Valerate.....	5.630	14.70	15.75	17.20	29.23	5.645	-4.61	-4.86	-6.11	-14.21
Caproate.....	5.605	14.55	15.53	16.96	28.57	5.020	-3.26	-3.98	-4.62	-10.95
Enanthate.....	5.240	15.09	15.38	17.67	29.98	5.040	-1.80	-2.25	-2.80	-8.12
Caprylate.....	5.360	14.66	15.03	17.18	29.32	5.540	-.90	-.98	-1.15	-5.57
Pelargonate.....	5.550	14.34	15.24	17.50	28.85	5.500	-.36	-.45	-.73	-4.45
Caprate.....	5.525	14.32	15.13	16.93	28.72	5.450	-.33	-.50	-1.00	-3.92
Undecylate.....	5.250	13.61	14.19	16.19	27.71	5.270	.00	-.19	-.28	-3.51
Laurate.....	5.180	13.02	13.50	15.71	26.23	5.560	.08	-.08	-.33	-2.70
Myristate.....	5.455	12.28	13.20	14.48	24.75	5.255	.26	.00	-.17	-1.82
Palmitate.....	5.425	11.25	11.98	13.55	23.23	5.270	.38	.19	-.09	-1.71
Stearate.....	5.025	10.45	10.95	12.74	21.19	5.915	.54	.31	.23	-1.31

Specific rotation $[\alpha]_D^{25}$ of esters of methylbenzyl carbinol (101)

$\lambda \rightarrow$	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358
$\downarrow$	$C_{11}H_{14}O_2$ Acetate				$C_{12}H_{16}O_2$ Propionate				$C_{13}H_{18}O_2$ n-Butyrate			
20	6.41	6.71	7.54	12.12	4.81	5.06	5.58	8.69	8.48	8.94	10.14	16.41
40	3.27	3.49	6.11	9.64	3.89	4.09	4.47	6.76	7.57	7.95	8.93	14.53
60	4.10	4.30	4.78	7.32	3.04	3.25	3.50	6.14	6.92	7.24	8.14	13.21
80	3.05	3.27	3.71	5.45	2.33	2.51	2.67	3.79	6.40	6.70	7.53	12.04
100	2.31	2.44	2.76	3.78	1.83	1.96	2.13	2.73	6.00	6.30	7.01	11.04
120	1.56	1.65	1.76	2.18	1.48	1.56	1.65	1.96	5.54	6.80	6.49	10.06
140	.92	.90	.92	.87	1.20	1.20	1.20	1.20	5.22	5.41	6.04	9.30
160	.38	.26	.17	-.37	.99	.93	.87	.58	4.96	5.14	5.76	8.77
180	-.06	-.15	-.27	-1.47	.83	.72	.66	±.00	4.87	4.96	5.56	8.29
200	-.37	-.56	-.67	-2.18	.73	.67	.49	-.48	4.91	5.03	5.56	7.99
$\downarrow$	$C_{14}H_{20}O_2$ Caproate				$C_{15}H_{22}O_2$ Enanthate				$C_{17}H_{26}O_2$ Caprylate			
20	10.46	11.21	12.46	20.91	10.69	11.34	12.72	21.26	10.67	11.36	12.76	21.42
40	9.58	10.20	11.41	18.84	9.98	10.45	11.80	19.53	9.85	10.53	11.86	19.95
60	8.88	9.45	10.62	17.34	9.33	9.76	11.03	18.28	9.20	9.81	11.00	18.49
80	8.46	8.82	10.01	16.31	8.86	9.21	10.32	17.00	8.69	9.25	10.42	17.31
100	8.09	8.43	9.55	15.54	8.39	8.69	9.63	15.90	8.14	8.76	9.82	16.30
120	7.77	8.13	9.16	14.89	8.00	8.29	9.19	15.11	7.74	8.27	9.34	15.42
140	7.47	7.79	8.76	14.19	7.62	7.92	8.82	14.60	7.59	8.00	8.97	14.90
160	7.18	7.50	8.31	13.55	7.31	7.63	8.48	14.10	7.44	7.82	8.72	14.40
180	7.05	7.29	8.02	13.06	7.10	7.46	8.26	13.60	7.31	7.67	8.46	14.02
200	6.95	7.19	7.88	12.66	7.08	7.39	8.17	13.14	7.25	7.67	8.30	13.83
$\downarrow$	$C_{14}H_{20}O_2$ Polargonate				$C_{14}H_{20}O_2$ Polargonate				$C_{14}H_{20}O_2$ Polargonate			
20	10.50	10.96	12.41	20.90	10.50	10.96	12.41	20.90	10.50	10.96	12.41	20.90
40	9.84	10.34	11.65	19.63	9.84	10.34	11.65	19.63	9.84	10.34	11.65	19.63
60	9.16	9.64	10.85	18.22	9.16	9.64	10.85	18.22	9.16	9.64	10.85	18.22
80	8.62	8.99	10.22	17.05	8.62	8.99	10.22	17.05	8.62	8.99	10.22	17.05
100	8.21	8.49	9.61	16.08	8.21	8.49	9.61	16.08	8.21	8.49	9.61	16.08
120	8.00	8.21	9.26	15.38	8.00	8.21	9.26	15.38	8.00	8.21	9.26	15.38
140	7.77	8.01	8.96	14.71	7.77	8.01	8.96	14.71	7.77	8.01	8.96	14.71
160	7.56	7.80	8.71	14.17	7.56	7.80	8.71	14.17	7.56	7.80	8.71	14.17
180	7.28	7.56	8.38	13.61	7.28	7.56	8.38	13.61	7.28	7.56	8.38	13.61
200	7.04	7.23	8.08	13.17	7.04	7.23	8.08	13.17	7.04	7.23	8.08	13.17

Specific rotation $[\alpha]_D^{20}$ of esters of methylbenzyl carbinol (101)

$\lambda \rightarrow$	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,385	5,893	5,700	5,461	4,358
$C_{19}H_{30}O_2$ Caprate												
20	10.13	10.74	12.20	20.31	9.92	10.51	11.81	20.01	9.66	10.11	11.38	19.39
40	9.44	10.10	11.47	19.11	9.31	9.90	11.19	18.69	9.11	9.44	10.60	18.04
60	8.81	9.50	10.88	17.92	8.80	9.26	10.48	17.39	8.45	8.84	9.96	16.80
80	8.23	8.85	10.21	16.76	8.23	8.73	9.69	16.36	8.02	8.37	9.39	15.90
100	7.78	8.32	9.55	15.63	7.76	8.30	9.16	15.51	7.55	7.88	8.90	15.13
120	7.43	7.92	9.04	14.79	7.37	7.84	8.80	14.79	7.17	7.49	8.44	14.28
140	7.27	7.63	8.70	14.30	7.03	7.48	8.40	14.08	6.85	7.15	8.11	13.54
160	7.20	7.53	8.49	13.90	6.81	7.18	8.07	13.53	6.60	6.89	7.82	12.84
180	7.18	7.46	8.29	13.61	6.69	7.06	7.93	12.94	6.45	6.61	7.58	12.40
200	7.19	7.44	8.27	13.46	6.69	7.07	7.83	12.76	6.30	6.48	7.30	12.13
$C_{23}H_{44}O_2$ Palmitate												
20	8.44	9.04	10.04	17.10	7.92	8.37	9.44	15.99	C_6H_5 ----- C_6H_5 ----- $CHCl_3$ ----- $EtOH$ ----- $AcOEt$ ----- Py ----- CS_2 -----			
40	8.01	8.35	9.36	16.04	7.37	7.78	8.62	14.72				
60	7.55	7.87	8.75	15.00	6.95	7.26	7.99	13.59				
80	7.02	7.31	8.23	13.81	6.47	6.71	7.62	12.68				
100	6.60	6.89	7.74	13.05	6.11	6.40	7.27	12.10				
120	6.31	6.60	7.35	12.32	5.82	6.12	6.92	11.49	s			
140	6.03	6.33	6.97	11.74	5.61	5.84	6.71	11.05				
160	5.80	6.10	6.73	11.36	5.44	5.72	6.46	10.69				
180	5.66	5.85	6.51	11.12	5.32	5.57	6.38	10.59				
200	5.52	5.73	6.28	11.09	5.30	5.59	6.43	10.66				
$C_{27}H_{54}O_2$ Stearate												
20	8.44	9.04	10.04	17.10	7.92	8.37	9.44	15.99	C_6H_5 ----- C_6H_5 ----- $CHCl_3$ ----- $EtOH$ ----- $AcOEt$ ----- Py ----- CS_2 -----			
40	8.01	8.35	9.36	16.04	7.37	7.78	8.62	14.72				
60	7.55	7.87	8.75	15.00	6.95	7.26	7.99	13.59				
80	7.02	7.31	8.23	13.81	6.47	6.71	7.62	12.68				
100	6.60	6.89	7.74	13.05	6.11	6.40	7.27	12.10				
120	6.31	6.60	7.35	12.32	5.82	6.12	6.92	11.49	c			
140	6.03	6.33	6.97	11.74	5.61	5.84	6.71	11.05				
160	5.80	6.10	6.73	11.36	5.44	5.72	6.46	10.69				
180	5.66	5.85	6.51	11.12	5.32	5.57	6.38	10.59				
200	5.52	5.73	6.28	11.09	5.30	5.59	6.43	10.66				
$C_{31}H_{64}O_2$ d-Methylbenzylcarbinyl acetate												
20	8.44	9.04	10.04	17.10	7.92	8.37	9.44	15.99	C_6H_5 ----- C_6H_5 ----- $CHCl_3$ ----- $EtOH$ ----- $AcOEt$ ----- Py ----- CS_2 -----			
40	8.01	8.35	9.36	16.04	7.37	7.78	8.62	14.72				
60	7.55	7.87	8.75	15.00	6.95	7.26	7.99	13.59				
80	7.02	7.31	8.23	13.81	6.47	6.71	7.62	12.68				
100	6.60	6.89	7.74	13.05	6.11	6.40	7.27	12.10				
120	6.31	6.60	7.35	12.32	5.82	6.12	6.92	11.49	s			
140	6.03	6.33	6.97	11.74	5.61	5.84	6.71	11.05				
160	5.80	6.10	6.73	11.36	5.44	5.72	6.46	10.69				
180	5.66	5.85	6.51	11.12	5.32	5.57	6.38	10.59				
200	5.52	5.73	6.28	11.09	5.30	5.59	6.43	10.66				
$C_{35}H_{70}O_2$ Myristate												
20	8.44	9.04	10.04	17.10	7.92	8.37	9.44	15.99	C_6H_5 ----- C_6H_5 ----- $CHCl_3$ ----- $EtOH$ ----- $AcOEt$ ----- Py ----- CS_2 -----			
40	8.01	8.35	9.36	16.04	7.37	7.78	8.62	14.72				
60	7.55	7.87	8.75	15.00	6.95	7.26	7.99	13.59				
80	7.02	7.31	8.23	13.81	6.47	6.71	7.62	12.68				
100	6.60	6.89	7.74	13.05	6.11	6.40	7.27	12.10				
120	6.31	6.60	7.35	12.32	5.82	6.12	6.92	11.49	c			
140	6.03	6.33	6.97	11.74	5.61	5.84	6.71	11.05				
160	5.80	6.10	6.73	11.36	5.44	5.72	6.46	10.69				
180	5.66	5.85	6.51	11.12	5.32	5.57	6.38	10.59				
200	5.52	5.73	6.28	11.09	5.30	5.59	6.43	10.66				

Specific rotation $[\alpha]_D^{25}$ of homologous esters of *d*- α -naphthyl-*n*-hexyl carbinol (102)

$\lambda \rightarrow$	$C_{10}H_{18}O_2$ Acetate					$C_{12}H_{20}O_2$ Propionate					$C_{14}H_{24}O_2$ n-Butyrate					$C_{16}H_{28}O_2$ n-Pentanoate					$C_{18}H_{34}O_2$ n-Hexanoate					$C_{20}H_{40}O_2$ n-Heptanoate					$C_{22}H_{46}O_2$ n-Octanoate					$C_{24}H_{52}O_2$ n-Nonanoate					$C_{26}H_{58}O_2$ n-Decanoate					$C_{28}H_{64}O_2$ n-Undecanoate																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
t	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700	5, 461	4, 358	5, 893	5, 700

Specific rotation of the above esters in 5 per cent solutions at room temperature

<i>d</i> - α -Naphthyl- <i>n</i> -hexyl carbinyI	<i>s</i> =EtOH				CS ₂ (102)			
	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358
Acetate.....	33.80	35.38	40.84	75.88	111.5	117.3	137.0	268.2
Propionate.....	36.31	37.88	43.88	80.52	122.8	129.1	150.7	298.6
<i>n</i> -Butyrate.....	32.18	33.66	38.77	71.76	113.1	119.5	139.3	273.2
<i>n</i> -Valerate.....	27.21	29.32	33.01	61.80	102.7	108.1	126.6	247.3
Caproate.....	26.52	27.33	31.23	59.89	99.10	102.7	119.8	240.4
Enanthate.....	23.26	24.68	27.91	51.58	89.74	94.99	110.3	217.4
Caprylate.....	25.27	26.27	30.16	56.76	86.64	91.07	106.2	207.9
Pelargonate.....	22.01	22.87	26.32	49.53	84.06	88.54	104.6	203.8
Caprate.....	19.54	20.64	23.00	46.00	78.36	82.35	96.20	199.6
Undecylate.....	17.99	18.88	21.46	42.74	74.22	78.05	90.99	183.1

	C ₂₅ H ₂₆ O ₄ hydrogen phthalic ester in various solvents (102)			C ₂₅ H ₂₅ O ₄ Na sodium phthalic ester in EtOH (102)		
	<i>t</i> =room temperature			<i>c</i> =5 g in 100 cc		
	5,893	5,461	4,358	5,893	5,461	4,358
CS ₂	75.26	90.72	170.0	29.35	35.52	63.24
AcOH.....	25.25	29.66	47.94	-----	-----	-----
CHCl ₃	17.50	20.80	32.33	-----	-----	-----
C ₆ H ₆	5.00	4.74	1.00	-----	-----	-----
Py.....	-1.30	-3.13	-11.14	-----	-----	-----
EtOH.....	-22.46	-28.63	-61.02	-----	-----	-----

Specific rotation of C₁₄H₁₄O₂ l-methyl- α -naphthyl carbinyI acetate

<i>t</i>	5,893	5,461	4,358
20.....	-32.28	-38.90	-73.79
40.....	39.51	47.47	88.04
60.....	44.58	54.04	101.51
80.....	49.18	59.39	113.02
100.....	52.85	64.21	121.57
120.....	55.22	67.07	126.02
140.....	56.78	68.68	129.82
160.....	58.11	70.33	132.62
180.....	59.29	71.83	135.39
<i>l</i> -methyl- α -naphthyl carbinyI hydrogen phthalate (102, 165)			
Approximately 5 per cent solutions at room temperature			
$\frac{s}{\lambda} \rightarrow$	5,893	5,461	4,358
CHCl ₃	-43.67	-53.47	-109.6
EtOH.....	-69.68	-84.80	-171.7

Specific rotation $[\alpha]_D^{25}$ of esters of benzoic and naphthoic acids with secondary alcohols (105)

	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358
	$C_{11}H_{14}O_2$ δ - β -Butyl benzoate				$C_{11}H_{12}O_2$ δ - β -Octyl benzoate				$C_{11}H_{10}O_2$ δ - β -Undecyl benzoate			
20-----	+39.23	+41.06	+46.59	+78.13	+35.38	+36.99	+42.20	+72.23	+27.55	+28.89	+32.92	+56.99
40-----	37.62	39.39	44.64	75.24	34.93	36.55	41.69	71.52	27.45	28.75	32.77	56.94
60-----	36.26	37.78	42.83	72.34	34.52	36.09	41.15	70.32	27.33	28.61	32.61	56.90
80-----	34.86	36.24	41.15	69.37	34.09	35.60	40.58	70.13	27.18	28.42	32.41	56.79
100-----	33.52	34.86	39.45	66.70	33.62	35.07	40.01	69.36	27.10	28.30	32.28	56.72
120-----	32.22	33.55	38.05	64.29	33.17	34.61	39.56	68.65	26.94	28.12	32.11	56.40
140-----	31.20	32.41	36.93	62.40	32.73	34.32	39.10	67.94	26.72	27.90	32.03	55.01
160-----	30.25	31.43	35.88	61.16	32.21	33.87	38.58	67.19	26.49	27.79	31.66	55.64
180-----	29.61	30.67	34.88	-----	31.75	33.40	38.14	66.31	26.25	27.46	31.37	55.14
	$C_{11}H_{14}O_2$ δ - γ -Nonyl benzoate				$C_{11}H_{10}O_2$ δ -Benzylmethylcarbinyl benzoate				$C_{11}H_{10}O_2$ δ - β -Butyl α -naphthoate			
0-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
10-----	+6.84	+7.27	+8.39	+15.95	+65.07	+68.14	+78.84	+144.54	+28.40	+29.82	+34.00	+60.03
20-----	7.88	8.21	9.59	17.92	62.73	65.68	75.77	139.75	27.44	28.76	32.80	57.98
40-----	8.70	9.16	10.57	19.55	60.46	63.45	73.24	134.82	26.42	27.68	31.59	55.85
60-----	9.33	9.86	11.39	21.07	58.32	61.38	70.72	129.06	25.38	26.69	30.47	53.97
80-----	-----	-----	-----	-----	56.41	59.36	68.24	125.10	24.48	25.72	29.42	52.29
100-----	10.00	10.52	12.02	22.34	54.64	57.41	66.20	121.70	23.65	24.95	28.40	50.85
120-----	10.59	11.18	12.88	23.68	53.23	55.77	64.46	118.72	22.97	24.16	27.48	49.56
140-----	11.10	11.84	13.48	24.75	52.08	54.47	62.91	116.25	22.42	23.46	26.68	48.44
160-----	11.60	12.24	13.92	25.60	51.00	53.29	61.45	115.25	21.90	22.98	26.01	47.35
180-----	12.03	12.74	14.50	26.37	-----	-----	-----	-----	-----	-----	-----	-----
	$C_{11}H_{14}O_2$ δ - β -Hexyl α -naphthoate				$C_{11}H_{10}O_2$ δ - β -Hexyl α -naphthoate				$C_{11}H_{10}O_2$ δ - β -Hexyl α -naphthoate			
0-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
10-----	+2.96	+3.53	+4.85	+9.13	+3.06	+3.53	+4.85	+9.13	+3.06	+3.53	+4.85	+9.13
20-----	4.84	5.87	7.48	15.53	4.84	5.87	7.48	15.53	4.84	5.87	7.48	15.53
40-----	6.08	7.52	9.40	16.90	6.08	7.52	9.40	16.90	6.08	7.52	9.40	16.90
60-----	8.55	10.48	12.37	20.86	8.55	10.48	12.37	20.86	8.55	10.48	12.37	20.86
80-----	10.32	12.37	13.82	23.95	10.32	12.37	13.82	23.95	10.32	12.37	13.82	23.95
100-----	11.54	13.82	15.10	26.40	11.54	13.82	15.10	26.40	11.54	13.82	15.10	26.40
120-----	12.53	15.10	16.03	28.53	12.53	15.10	16.03	28.53	12.53	15.10	16.03	28.53
140-----	13.37	14.88	16.98	30.53	13.37	14.88	16.98	30.53	13.37	14.88	16.98	30.53
160-----	14.14	15.22	17.81	32.32	14.14	15.22	17.81	32.32	14.14	15.22	17.81	32.32
180-----	14.84	-----	-----	-----	14.84	-----	-----	-----	14.84	-----	-----	-----

Specific rotation $[\alpha]_D^{25}$ of esters of benzoic and naphthoic acids with secondary alcohols (105)—Continued

	$C_{18}H_{18}O_2$ <i>d</i> - β -Heptyl α -naphthoate				$C_{18}H_{18}O_2$ <i>d</i> - β -Octyl α -naphthoate				$C_{21}H_{22}O_2$ <i>d</i> - β -Decyl α -naphthoate				$C_{22}H_{22}O_2$ <i>d</i> - β -Undecyl α -naphthoate			
	+1.40	+1.29	+1.04	-2.30	-1.90	-2.11	-2.77	-9.36	-1.57	-1.67	-2.36	-9.14	+0.19	+1.63	+0.19	-3.37
0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
10	3.90	4.19	4.45	4.86	+1.67	+1.07	+1.47	-4.48	-0.01	-0.01	-0.40	-3.66	+1.63	+1.63	+0.19	-3.37
20	6.27	6.63	7.44	10.71	4.18	4.18	4.48	+3.88	+1.41	+1.38	+1.30	-0.02	3.78	4.23	3.78	+4.45
40	8.39	8.71	9.88	15.52	8.01	8.14	6.97	11.34	6.78	5.95	4.29	+5.86	5.63	5.79	5.63	6.14
60	9.96	10.28	11.83	19.63	8.02	8.14	9.23	15.75	7.49	7.73	8.70	15.03	6.33	6.44	7.32	10.47
80	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	14.36
100	11.25	11.61	13.53	23.13	9.56	9.97	11.28	19.68	9.04	9.40	10.61	18.91	8.87	9.16	8.87	18.15
120	12.57	13.00	14.97	26.64	10.93	11.49	13.06	23.26	10.48	12.33	12.33	22.30	10.14	10.55	10.14	21.42
140	13.67	14.19	16.18	29.43	12.17	12.74	14.46	26.16	11.71	12.23	13.88	25.48	11.16	11.71	11.16	23.19
160	14.42	15.05	17.12	31.69	13.19	13.77	15.72	28.97	12.75	13.30	15.15	28.55	12.10	12.74	12.10	26.62
180	15.11	15.84	17.97	33.82	14.20	14.76	16.90	31.25	13.40	14.22	16.22	31.53	12.90	13.93	12.90	28.77
	$C_{20}H_{20}O_2$ <i>d</i> - γ -Nonyl α -naphthoate				$C_{20}H_{20}O_2$ <i>d</i> -Benzylmethylcarbinyl α -naphthoate				$C_{15}H_{18}O_2$ <i>d</i> - β -Butyl β -naphthoate				$C_{17}H_{20}O_2$ <i>d</i> - β -Hexyl β -naphthoate			
	-22.23	-23.34	-27.29	-51.39	+29.10	+30.74	+35.56	+68.67	+50.04	+52.62	+60.32	+109.82	+57.11	+60.00	+60.16	+127.44
20	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
40	-18.62	-19.63	-22.64	-41.94	29.63	31.35	36.14	70.24	45.82	47.88	56.44	101.62	55.30	58.22	66.97	123.81
60	-15.30	-16.36	-18.86	-34.80	30.10	31.84	36.69	71.46	43.75	45.80	52.74	94.33	53.60	56.38	64.69	119.84
80	-12.45	-13.26	-15.27	-28.18	30.55	32.28	37.18	72.51	40.78	42.87	49.20	88.61	51.82	54.48	62.36	113.71
100	-9.86	-10.47	-12.22	-21.88	30.91	32.61	37.62	73.38	38.57	40.47	46.59	84.45	50.19	52.57	60.28	111.25
120	-7.65	-8.02	-9.50	-16.25	31.31	32.86	38.01	74.10	36.87	38.78	44.47	80.74	48.75	50.82	58.36	106.98
140	-5.74	-5.98	-7.05	-12.13	31.58	33.09	38.28	74.67	35.13	37.00	42.32	76.67	47.54	49.53	56.92	103.90
160	-3.98	-4.18	-5.12	-8.47	31.80	33.33	38.53	75.14	33.68	35.37	40.51	75.36	46.03	48.57	55.95	102.64
180	-2.53	-2.78	-3.51	-5.51	32.05	33.58	38.77	75.60	32.62	34.13	39.12	-----	45.62	47.81	55.16	102.00
	$C_{10}H_{14}O_4$ <i>d</i> - β -Octyl β -naphthoate				$C_{27}H_{30}O_2$ <i>d</i> - β -Undecyl β -naphthoate				$C_{30}H_{32}O_2$ <i>d</i> - γ -Nonyl β -naphthoate				$C_{30}H_{32}O_2$ <i>d</i> -Benzylmethylcarbinyl β -naphthoate			
	+56.25	+63.99	+68.11	+125.84	+50.03	+52.66	+60.72	+112.36	+19.14	+20.04	+23.30	+44.54	+122.83	+129.04	+149.82	+290.2
20	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
40	55.17	57.82	66.80	123.25	49.54	52.10	60.08	110.99	20.33	21.48	24.91	46.93	117.71	123.54	143.32	278.2
60	54.30	56.87	65.66	120.86	49.03	51.50	59.37	109.62	21.68	22.79	26.46	50.22	112.98	118.90	137.94	267.5
80	53.51	55.99	64.60	118.85	48.45	50.86	58.63	108.24	22.84	23.92	27.68	52.91	109.38	114.90	133.66	259.1
100	52.77	55.20	63.49	116.91	47.89	50.24	57.87	106.77	23.68	24.83	28.65	54.62	105.81	111.62	129.42	251.2
120	51.97	54.46	62.48	115.06	47.29	49.55	57.09	105.31	24.37	25.61	29.53	55.99	102.82	108.13	125.51	243.1
140	51.33	53.68	61.78	113.77	46.84	49.13	56.46	104.48	25.00	26.39	30.89	57.21	99.94	105.23	122.28	235.7
160	50.71	52.92	61.03	112.81	46.47	48.71	55.94	104.44	25.06	26.86	30.89	58.20	97.51	102.49	119.40	229.7
180	49.37	51.41	59.42	109.00	46.00	48.18	55.42	-----	25.92	27.32	31.49	59.21	95.41	100.56	116.44	225.0

Specific rotation of the above esters in approximately 5 per cent solution at laboratory temperature (105°)

S ↓ γ→	<i>d</i> -β-Butyl benzoate				<i>d</i> -Benzylmethylcarbinyl benzoate				<i>d</i> -Benzylmethylcarbinyl β-naphthoate				<i>d</i> -γ-Nonyl benzoate			
	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358
EtOH.....	+40.23	42.18	+48.04	+80.54	+70.49	+74.89	+86.86	+156.8	+127.9	+133.6	+155.4	+298.2	+12.01	+13.21	+14.85	+26.63
CS ₂	40.38	42.13	48.11	81.94	69.49	73.08	85.09	158.0	131.3	138.1	160.3	315.4	1.25	1.63	1.83	3.46
	<i>d</i> -β-Hexyl benzoate				<i>d</i> -Benzylmethylcarbinyl α-naphthoate				<i>d</i> -γ-Nonyl β-naphthoate				<i>d</i> -γ-Nonyl α-naphthoate			
	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358
EtOH.....	+40.98	+42.91	+49.11	+84.33	+36.02	+37.59	+42.70	+79.39	+26.71	+28.49	+32.59	+63.23	-2.69	-3.07	-3.07	-7.29
CS ₂	31.93	33.28	38.14	64.39	44.71	46.71	54.34	107.70	22.76	23.92	28.09	54.76	-15.00	-15.34	-18.07	-31.00
	<i>d</i> -β-Octyl benzoate				<i>d</i> -β-Octyl α-naphthoate				<i>d</i> -β-Octyl α-naphthoate							
	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358
Py.....	+25.43	+26.96	+31.23	+52.40	+8.72	+9.35	+10.61	+20.50	50.03	52.76	60.87	112.57	-----	-----	-----	-----
C ₆ H ₆	28.21	29.74	34.22	58.40	7.92	7.97	9.40	18.80	53.08	56.26	64.63	119.40	-----	-----	-----	-----
CS ₂	29.68	31.31	35.44	61.34	10.90	11.50	12.70	25.49	55.89	58.88	67.93	127.94	-----	-----	-----	-----
CHCl ₃	34.74	36.40	41.27	70.78	16.28	17.17	19.52	34.72	48.93	50.80	58.61	107.04	-----	-----	-----	-----
EtOH.....	39.26	41.09	47.35	82.54	18.90	20.27	22.70	40.47	43.38	48.00	53.35	101.24	-----	-----	-----	-----
AcOEt.....	42.51	44.31	51.31	88.22	19.61	20.89	23.42	40.85	58.95	62.03	71.44	130.05	-----	-----	-----	-----

3. AMINO ACIDS

$C_{10}H_{11}NO_2$ N-Benzoylalanine ¹			$[\alpha]_{\lambda}^{20}$ (170)		
	s	c	5,893	5,780	5,461
<i>d</i> -Acid.....	H ₂ O.....	1.022	2.4	2.7	3.2
<i>l</i> -Acid.....	H ₂ O.....	1.025	-2.4	-2.7	-3.2
<i>d</i> -Acid.....	(EtOH.....	1.069	10.5	10.9	12.7
	(Me ₂ O.....	1.016	24.9	26.1	30.2

$C_4H_8N_2O_3$ <i>l</i> -Asparagine (47; cf. 18, 210)				
$s = H_2O$		$[\alpha]_{\lambda}^t$		
<i>t</i>	p	5,893	5,461	4,358
34.....	1.961	-6.7	-7.5	-14.7
40.....	1.961	-7.7	-8.3	-17.7
60.....	1.961	-10.5	-11.3	-22.4
38.....	7.407	-6.4	-6.9	-13.2
52.....	7.407	-8.3	-9.3	-18.3
68.....	7.407	-10.5	-11.7	-23.5

$C_4H_7NO_4$ <i>l</i> -Aspartic acid. (47; cf. 18, 50, 140, 141)				
$s = H_2O$		$[\alpha]_{\lambda}^t$		
<i>t</i>	p	5,893	5,461	4,358
14.....	0.990	5.1	7.1	15.2
35.....	0.990	2.5	5.1	12.7
48.....	0.990	1.3	3.1	9.2
48.....	1.961	2.3	4.0	9.3
68.....	1.961	0.0	1.3	4.5
78.....	1.961	-1.5	-0.3	2.3

¹ The effect of KOH on the specific rotation is also given in the article.

Specific rotation $[\alpha]_{\lambda}^{20}$ of aminoglutaric acid and some derivatives (98)

Formula	Substance	s	$\frac{\gamma}{c}$	6,563	6,260	5,893	5,000	5,403	5,270	5,165	4,990	4,861	4,780
$C_6H_9NO_4$	<i>d</i> - α -Aminoglutaric acid + 3 mols NaOH	(Cl. 4) dil. NaOH	16.4 ²	8.05	9.17	10.62	11.76	12.96	14.10	14.86	16.23	17.53	---
$C_7H_{11}NO_4$	Ethyl pyroglutamate	H ₂ O	11.4	-3.40	-3.21	-2.08	-2.04	-1.59	-1.89	-2.22	16.23	17.53	---
$C_8H_7ClO_4$	<i>l</i> - α -Chloroglutaric acid	AcOEt	5.08	18.26	20.06	22.67	25.26	26.81	28.76	30.18	32.67	34.07	---
	<i>l</i> - α -Chloroglutaric acid (from zinc hydroxyglutarate)	---	16.5	22.75	24.78	27.14	29.63	30.48	32.71	34.28	---	---	---
$C_8H_9O_4$	<i>d</i> - α -Hydroxyglutaric acid	H ₂ O + HCl	15.8	-2.00	-1.64	-1.34	-97	-67	-31	10.00	31	67	---
$AgC_8H_9O_4$	Silver <i>d</i> -butyrolactone- γ -carboxylate	H ₂ O	1.08	5.67	7.31	8.69	9.78	9.14	11.52	10.88	9.23	13.16	12.07
$C_8H_9O_4$	<i>d</i> -butyrolactone- γ -carboxylic acid (from zinc hydroxyglutarate)	---	1.89	1.11	1.80	2.14	2.42	2.83	3.25	3.39	3.53	3.66	---
$Zn(C_8H_7O_6)_2$	{(from silver butyrolactonecarboxylate)}	do	.69	---	1.50	2.67	3.00	3.33	3.67	3.84	4.00	4.17	4.34
$C_4H_7NO_4$	Zinc α -hydroxyglutarate	do	.62	4.24	5.69	6.65	7.71	8.24	8.82	9.39	---	---	---
$C_4H_7NO_4$	<i>d</i> -Aspartic acid + 3 mols NaOH	dil. NaOH	.566	-3.54	-2.76	-2.48	-2.28	-2.13	-1.91	-1.61	-1.18	---	---
$C_8H_{16}NO_4$	Diethyl <i>d</i> -aspartate	EtOH	4.58	.98	1.25	1.73	2.08	2.25	2.53	2.78	2.98	3.38	---
$C_4H_6ClO_4$	<i>l</i> -Chlorosuccinic acid	H ₂ O	5.15	-15.04	-16.79	-18.92	-21.36	-22.90	-24.98	-26.17	-28.48	-30.90	---

* Values in italics are expressed in per cent.

Amino-acids and derivatives (222) [α] $_{\lambda}^{20}$

Formula	Substance	s	t	p	6,563	6,260	5,893	5,675	5,463	5,270
$C_6H_9N_3O_7$	L-3, 5-Dinitrotyrosine	$\{HCl\} \cdot H_2O$	15	1.45	7.81	9.40	11.45	13.17	14.30	16.48
$C_6H_9N_3O_7$	L-3-Nitrotyrosine	$\{N K OH\}$	15	1.773	2.58	5.6	1.54	17.22	15.47	---
$C_6H_9N_3O_7$	L-Tyrosine	$HCl \cdot H_2O$	15	1.93	1.31	2.36	3.21	3.82	3.97	---
$C_6H_{11}N_3O_7$	L-3, 4-Dihydroxyphenylalanine	do	15	3.773	-10.27	-11.30	-12.30	-13.14	-13.76	-14.61
$C_6H_{12}N_3O_7$	L-3-Aminotyrosine	do	15	3.81	-11.44	-11.80	-12.74	-13.53	-14.02	---
$C_6H_{12}N_3O_7$	L-3, 4-Diaminotyrosine	do	15	3.9	-3.69	-3.69	-3.61	-3.56	-3.54	---
$C_6H_{12}N_3O_7$	L-Hexahydrotyrosine	$H_2O \cdot H_2O$	20	3.36	.00	1.02	1.02	1.66	1.18	---
$C_6H_{12}N_3O_7$	L-Tyrosine-3-diazonium chloride	$HCl \cdot H_2O$	20	4.13	10.16	11.83	13.18	14.37	15.70	17.16
$C_6H_8ClN_2O_3$	---	do	20	2.52	7.81	9.50	11.87	14.37	(7.02 at $\lambda = 6,615$)	---

† 15.47 at $\lambda = 5,600$.
‡ 4.13 g in 100 cc.

$CaH_{12}NO_2$, Leucine (232)				$C_6H_9NO_4$, Glutamic acid				$C_6H_7NO_4$, Aspartic acid			
HCl		NaOH		HCl		NaOH		HCl		NaOH	
r ¹	[α] _D	r ¹	[α] _D	r ¹	[α] _D	r ¹	[α] _D	r ¹	[α] _D	r ¹	[α] _D
0	-9.84	0	4.60	0	12.02	0	12.02	0	5.87	0	5.87
.55	1.70	.54	6.74	.54	23.04	.40	3.00	.29	9.00	.42	-3.54
.87	6.50	.69	4.90	.82	26.88	.74	-4.0	.39	11.8	.86	-14.7
1.06	7.83	.83	4.93	.84	28.84	1.27	-4.73	.50	14.1	1.08	-14.5
1.34	11.20	.86	4.42	1.01	27.91	1.09	-3.97	.94	18.4	1.53	-9.9
2.21	12.65	.99	4.00	1.55	30.94	1.32	-4.0	1.28	19.0	2.17	-5.1
2.82	11.23	1.30	7.51	2.26	31.10	1.60	4.50	1.44	21.0	2.80	-3.77
5.11	12.14	1.63	4.28	4.53	32.36	2.47	10.22	2.80	22.8	4.06	-3.47
7.51	11.36	1.75	5.39	1.47	13.00	5.96	10.90	3.04	23.0	6.21	-3.47
8.02	12.88	1.97	4.37	3.92	13.86	---	---	4.90	23.9	---	---

s = $CH_2Cl \cdot CO_2H$

† Ratio of the number of moles of the acid or base to the number of moles of the amino acid.

Molecular rotation $[M]_D^t$

Substance (25, 14, 15, 16)	s	c	$t^\circ \lambda =$	6,770	6,570	6,380	6,210	6,050	5,890	5,740	5,510	5,300	5,130	4,980	4,850
$C_4H_9O_5S$ <i>l-n</i> - α -sulphobutyric acid	H ₂ O	18.15	(?)	-24.8	-20.7	-29.7	-7.2	-32.2	-7.8	-35.4	-38.2	-9.3			
Copper <i>d-n</i> - α -sulphobutyrate	H ₂ O	1.75	(?)	(-15 at 4,730)		+6.5	0	0	-34.0	-35.4	-6.5	-41.0			
Copper <i>l-n</i> - α -sulphobutyrate	H ₂ O	1.3	(?)	+20.7	+20.7	+20.7	+25.3	+27.0	0	+29.3	+31.6	+33.3	-11	-11	-13
Nickel <i>l-n</i> - α -sulphobutyrate	H ₂ O	2.27	(?)	+20.7	+20.7	+25.8		+29.2	+28.2		+34.8	+35.6	+35.6	+37.9	+40.2
Cobalt <i>l-n</i> - α -sulphobutyrate	EtOH	1.16	(?)	+8		+8		+6.5	+31.4	+32.6	± 0 (positive at 4,790)	+35.9	+40.4	+44.9	(*)
$C_{10}H_{19}NO_5S$ Anilido- <i>l</i> - α -sulphobutyric acid	H ₂ O	2.54	(?)				-9.7		-11.0	Neg.		-13.6			
Nickel anilido- <i>l</i> - α -sulphobutyrate	H ₂ O	1.6	(?)	(-77 at 4,730)		-25.5	-20.5	-29	-30	-34	-39.5	-49	-60		
EtOH	EtOH	1.45	(?)	-119.5		-121.5	-122.5	-122.5	-123.5	-123.5	-123.5	-132	-138	-144	
Copper anilido- <i>l</i> - α -sulphobutyrate	H ₂ O	.80	(?)	-20.5		-24.5		-32.5	-31.5	-34.5	-41	-48	-55	-55	-58
EtOH	EtOH	.7	(?)	-16.5		-23.5		-27.5	-31.5	-35	-41	-48			
Cobalt anilido- <i>l</i> - α -sulphobutyrate	H ₂ O	1.09	(?)	-53		-22	-58	-27.5	-31.5	-38.5	-52	-64.5	-82.5	-85	-96
EtOH	EtOH	.87	(?)			-53		-63	-78	-99	-109	-34	+27		-41
Barium anilido- <i>l</i> - α -sulphobutyrate	H ₂ O	$\lambda =$	5,220	5,130	5,050	4,910	4,790	4,730							
		$[\alpha]$	0	+27	0	-34	-68	-82	-34			-51			
$C_{10}H_{19}N_3O_5S$ <i>d</i> -Benzimidazole-2-propylsulphonic acid		3.65													
Barium <i>d</i> -Benzimidazole-2-propylsulphonate	H ₂ O	2.6					+31	+24	+34	+26	+20.5	+39	+30		
Cobalt <i>d</i> -Benzimidazole-2-propylsulphonate	H ₂ O	1.88		+20		+22.5	+23.2		+25			+30	+30		

* Temperature not stated, but presumably that of the laboratory.

* +50 ($\lambda = 4,620$).* 0.485 N .* 0.09734 M .

IB₂. THE MOLECULE CONTAINS 2 ASYMMETRIC CARBON ATOMS
WHICH ARE ATTACHED EACH TO 2 OTHER CARBON ATOMS

4. TARTARIC ACID AND ITS ESTERS

Specific rotation $[\alpha]_{\lambda}^{20}$ of *d*-tartaric acid in aqueous solution¹ (121)

<i>d</i>	1.2987	1.2658	1.2352	1.2052	1.1760	1.1476	1.1201	1.0942	1.0692	1.0448	1.0211
λ ↓ <i>p</i> →	55.0	50.0	45.0	40.0	35.0	30.0	25.0	20.0	15.0	10.0	5.0
6,438.....	6.004	6.734	7.421	8.073	8.728	9.336	9.886	10.457	11.047	11.645	12.209
5,893.....	6.501	7.366	8.219	9.010	9.799	10.500	11.207	11.949	12.642	13.304	14.070
5,790.....	6.566	7.466	8.331	9.162	9.975	10.752	11.481	12.197	12.948	13.687	14.527
5,769.....	6.577	7.487	8.346	9.184	10.014	10.786	11.535	12.246	12.980	13.687	14.527
5,461.....	6.613	7.653	8.645	9.594	10.532	11.417	12.237	13.061	13.925	14.740	15.609
5,086.....	6.235	7.479	8.668	9.784	10.876	11.927	12.904	13.899	14.855	15.856	17.040
4,800.....	5.348	6.781	8.150	9.430	10.714	11.859	13.032	14.162	15.297	16.446	17.922
4,678.....	4.739	6.241	7.707	9.056	10.427	11.660	12.969	14.051	15.359	16.558	18.150
4,358.....	1.848	3.631	5.421	7.025	8.637	10.131	11.570	13.023	14.486	15.952	17.791

¹ In fused and supercooled states: (28). In various solvents: (10, 11, 83, 90, 93, 117, 184, 211, 213, 229, 230).

Rotatory dispersion in aqueous solutions of d-tartaric acid at 20°; constants and anomalies (121)

$$(\text{Range } \lambda = 6,438-4,358) [M] = \frac{k_1}{10^{-8}(\lambda^2 - \lambda_1^2)} - \frac{k_2}{10^{-8}(\lambda^2 - \lambda_2^2)} \quad (10^{-8}\lambda_1^2 = 0.03) \quad (10^{-8}\lambda_2^2 = 0.074)$$

<i>p</i>	<i>k</i> ₁	<i>k</i> ₂	$10^{-4}\lambda^1$ (Inflection)	$10^{-4}\lambda$ (Maximum)	$10^{-4}\lambda^1$ (Reversal)
55.0	17.127	12.093	<i>0.6571</i>	0.5527	<i>0.4229</i>
54.1	17.188	12.080	.6533	.5485	.4220
50.0	17.485	12.043	.6376	.5373	.4140
45.0	17.686	11.877	.6197	.5232	.4050
41.25	17.960	11.869	.6092	.5150	.3997
40.0	18.053	11.865	.6058	.5123	.5980
35.0	18.367	11.812	.5929	.5022	.5915
30.0	18.709	11.799	.5822	.4937	.5861
25.0	18.936	11.714	.5722	.4859	.5812
20.0	19.160	11.624	.5623	.4785	.5767
15.0	19.485	11.605	.5543	.4720	.5726
10.0	19.657	11.475	.5458	.4653	.5684
5.0	19.592	11.108	.5341	.4562	.5628

¹ All values which lie outside the range of observations are in italics.

$C_6H_{12}O_6$ specific rotation $[\alpha]_{\lambda}^{20}$ of dimethyl *d*-tartrate (120; cf., 6, 51, 167, 228)

$$[\alpha]_{\lambda}^t = \frac{K_1}{10^{-8}(\lambda^2 - \lambda_1^2)} - \frac{K_2}{10^{-8}(\lambda^2 - \lambda_2^2)} \quad (10^{-8}\lambda_1^2 = 0.030)$$

<i>s</i>	<i>c</i>	<i>k</i> ₁	<i>k</i> ₂	$10^{-8}\lambda_1^2$	Range λ	$\lambda=6,708$	6,438
Nil.....	-----	22.576	20.079	0.056	6,708-3,741	+2.79	+2.65
Nil at 100.5° C.....	-----	24.762	21.193	.052	6,708-4,135	+5.69	+5.80
H ₂ O.....	25	17.145	9.979	.065	6,438-4,358	-----	+16.04
CHONH ₂	25	17.049	10.640	.070	6,708-4,137	+12.65	+13.41
C ₂ H ₄ Cl ₂	25	20.360	22.202	.058	6,708-4,236	-8.16	-9.31
(CH ₃) ₂ CO.....	25	27.425	24.000	.054	6,708-3,750	+4.59	+4.67
C ₆ H ₅ N Pyridine.....	20	19.448	6.683	.082	6,438-4,800	-----	+30.48
C ₇ H ₈ O Anisole.....	20	42.828	43.581	.047	6,438-4,358	-----	-7.20
C ₈ H ₇ N Quinoline.....	21.5	37.555	33.211	.058	6,438-4,800	-----	+4.47

<i>s</i>	$\lambda=5,893$	5,780	5,461	5,086	4,800	4,678	4,358
Nil.....	+2.22	+2.05	+1.28	-0.39	-2.47	-----	-8.93
Nil at 100.5° C.....	+6.27	+6.29	+6.25	+5.68	+4.74	+4.07	+1.26
H ₂ O.....	-----	+19.28	+21.17	+23.44	+25.23	+25.86	+27.33
CHONH ₂	+15.39	+15.80	+16.96	+18.14	+18.74	+18.87	+17.85
C ₂ H ₄ Cl ₂	-----	-13.50	-16.51	-21.53	-27.09	-30.12	-40.92
(CH ₃) ₂ CO.....	+4.62	+4.50	+4.01	+2.73	+0.87	-----	-----
C ₆ H ₅ N Pyridine.....	+36.32	+37.44	+41.60	+47.15	+52.01	-----	-----
C ₇ H ₈ O Anisole.....	-----	-11.00	-13.80	-23.68	-----	-----	-37.08
C ₈ H ₇ N Quinoline.....	+3.56	+3.19	+1.73	-1.35	-5.24	-----	-----

$C_8H_{14}O_6$ Diethyl *d*-tartrate $[\alpha]_{\lambda}^t$ (146)

λ	6,708	6,234	5,769	5,461	4,960	4,358
<i>t</i>	<i>s</i> =C ₆ H ₅ N Pyridine. <i>p</i> =19.263					
0.0	34.74	39.50	46.75	52.06	62.48	78.63
15.7	32.26	36.63	43.23	48.11	57.63	72.06
58.6	26.38	29.90	35.03	38.70	45.89	59.90
100.0	21.99	25.19	29.50	32.63	38.41	46.51
<i>t</i>	<i>s</i> =C ₇ H ₈ O Benzaldehyde. <i>p</i> =10.335					
17.0	-----	39.12	42.35	47.33	57.26	¹ 73.3
86.7	-----	26.49	¹ 30.5	33.93	¹ 39.8	¹ 49.4
135.5	-----	22.66	26.52	29.18	34.07	41.93
λ	6,708	6,234	5,790	5,461	4,960	4,358
<i>t</i>	<i>s</i> =C ₇ H ₈ O ₂ Salicylaldehyde. <i>p</i> =20.214					
19.8	20.34	23.88	27.36	30.39	35.73	43.52
32.1	¹ 20.0	¹ 23.54	¹ 27.0	¹ 30.0	¹ 35.3	¹ 42.6
61.1	19.81	22.97	¹ 26.2	¹ 29.1	34.43	40.93
79.5	19.13	22.36	25.55	28.32	33.29	39.34
114.2	18.23	21.23	24.21	26.74	31.57	37.09
<i>t</i>	<i>s</i> =C ₈ H ₇ N Quinoline. <i>p</i> =4.972					
19.8	38.25	30.3	35.07	38.25	44.00	49.46
60.3	¹ 20.0	¹ 22.4	25.94	27.73	31.2	¹ 32.3
82.0	18.13	20.57	23.50	25.15	27.75	31.26
99.0	17.47	19.5	22.35	24.08	27.27	29.20
<i>t</i>	<i>s</i> =C ₈ H ₇ N Quinoline. <i>p</i> =13.601					
-13.0	¹ 34.4	¹ 39.0	¹ 46.0	50.93	60.86	¹ 73.3
0.0	31.13	35.23	41.20	45.42	53.77	63.63
16.8	-----	30.29	35.26	38.70	45.18	52.06
44.5	31.60	24.54	28.00	30.60	35.17	38.78
65.	19.19	21.55	24.48	26.76	30.41	32.58
116.0	18.21	20.36	22.92	25.14	-----	-----

¹ These values have been interpolated by the compiler from the author's data.

$C_2H_{14}O_6$, Diethyl *d*-tartrate¹ (152)

$s = C_2H_4Br_2 + PhNO_2$					
p	p of $PhNO_2$	$[\alpha]_D^{20}$	p	p of $PhNO_2$	$[\alpha]_D^{20}$
19.925	100.00	25.9	19.926	33.35	6.06
17.105	61.92	15.95	13.391	15.55	-1.70
19.922	49.95	11.50	19.942	.00	-7.56
15.022	35.63	7.01	12.061	.00	-10.72
14.928	35.03	6.80			

¹ In other solvents see (149, 150, 152). $C_8H_{14}O_6$, Diethyl tartrate (123, 124)

$a = \frac{k_1}{10^{-8}(\lambda^2 - \lambda_1^2)} - \frac{k_2}{10^{-8}(\lambda^2 - \lambda_2^2)} \quad (10^{-8}\lambda_1^2 = 0.030)$				
t	k_1	k_2	$10^{-8}\lambda_2^2$	Range λ
¹ 20.0	25.005	20.678	0.056	6,708-3,860
20.0	25.22	21.05	.055	6,708-3,879
64.3	22.941	17.670	.057	6,708-3,923
98.7	24.091	18.284	.055	6,708-4,358
^s CHONH ₂	$(c=25)$			
	19.62	9.46	.07	6,708-3,960
C ₂ H ₄ Br ₂	18.08	19.335	.061	6,708-4,154

¹ The ester used for these determinations was specially purified by distillation and freezing and had a setting point of 18.7° C.Specific rotatory power $[\alpha]_{\lambda}^{20}$ of diethyl tartrate (123, 124)

s	λ c	6,708	5,893	5,780	5,461	4,358
NHl at 20°		6.87	7.82	7.88	7.87	¹ 1.98
NHl at 64.3°		6.69	7.45	7.52	7.50	1.62
NHl at 98.7°		9.64	11.44	11.66	12.28	10.42
		11.09	13.35	13.70	14.64	15.13
H ₂ O ¹	20	18.23	23.39	24.46	27.06	38.18
	25	18.59	23.74	24.60	27.19	37.89
CCl ₄	20	.20	-1.34	-1.73	-3.11	-17.17
CHBr ₃	20	1.84	.83	.63	-.30	---
CHONH ₂	5	22.80	29.38	30.50	33.73	46.75
	10	22.75	28.99	30.01	33.20	46.30
	20	21.87	27.80	28.76	31.86	43.89
	25	21.81	27.73	28.72	31.70	43.68
C ₂ H ₅ Br ₄	23	-6.30	---	-11.33	-13.95	-35.36
C ₂ H ₅ Cl ₄	5	-10.35	-15.17	-16.20	-19.55	-45.17
	10	-9.54	-14.31	-15.26	-18.48	-43.57
	20	-8.13	-12.41	-13.30	-16.33	-39.70
C ₂ H ₄ Br ₂	5	-10.90	-16.60	-17.11	-20.73	-48.70
	10	-9.60	-14.26	-15.23	-18.65	-44.76
	20	-7.40	-11.52	-12.35	-15.23	-38.76
	25	-6.66	-10.56	-11.33	-14.11	-36.77
C ₂ H ₄ Cl ₂	5	-1.71	---	-4.63	-6.40	-23.80
	10	-1.55	-3.76	-4.24	-6.09	-23.11
	20	-1.36	-3.63	-4.11	-5.88	-22.39
C ₂ H ₅ Br ₂	20	-1.50	-3.40	-4.40	-6.40	-23.35
C ₂ H ₅ OH	40	9.38	11.09	11.30	11.88	10.00
	5	10.73	12.80	13.23	13.97	11.37
Me ₂ CO	10	10.10	12.28	12.63	13.24	10.99
	20	9.90	11.66	11.93	12.46	9.52
C ₆ H ₅ NO ₂	20	19.32	24.45	26.02	29.01	---

¹ The ester used for these determinations was specially purified by distillation and freezing and had a setting point of 18.7° C. Specific rotations for other wave lengths are as follows:

$\lambda =$	6,438	6,362	5,782	5,700	5,218	5,153	5,105	5,086	4,810	4,800
$[\alpha]_{\lambda}^{20} =$	7.38	7.43	7.87	7.88	7.61	7.48	7.36	7.34	6.25	6.22
$\lambda =$	4,722	4,678	4,603	4,475	4,415	4,359	4,315	4,271	4,240	4,210
$[\alpha]_{\lambda}^{20} =$	5.75	5.45	4.9	3.5	2.8	2.1	1.4	0.7	0	-0.7
$\lambda =$	4,148	4,119	4,071	4,005	3,967	3,900	3,889	3,872	3,868	3,860
$[\alpha]_{\lambda}^{20} =$	-2.1	-2.8	-4.2	-6.2	-7.7	-10.3	-11.1	-11.5	-11.8	-12.2

² The data for water are uncertain, on account of hydrolysis; but they serve to show the general character of the dispersion in this solvent.

$C_8H_{14}O_6$ Diethyl tartrate ¹ $[\alpha]_D^t$ (231)

$t \downarrow$ $p \rightarrow$	s=H ₂ O					
	100	75.05	50.23	25.03	10.08	5
20	7.67	11.81	17.51	23.69	25.98	26.52
30	8.72	12.38	17.34	23.13	25.52	26.28
40	9.72	12.90	17.18	22.55	25.00	25.78
50	10.60	13.37	17.04	21.97	24.41	25.17
60	11.31	13.65	16.90	21.40	23.76	24.52
70	11.94	13.90	16.77	20.81	23.08	23.89
80	12.50	14.14	16.65	20.23	22.39	23.25
90	13.01	14.40	16.53	19.65	-----	-----
100	13.47	14.65	16.42	19.06	-----	-----
s=MeOH						
$t \downarrow$ $p \rightarrow$	100	75	50	25	10	5
20	7.67	9.13	10.45	11.20	11.45	11.51
30	8.72	10.10	11.34	12.07	12.30	12.37
40	9.72	11.00	12.15	12.80	13.10	13.10
50	10.60	11.80	12.82	13.48	13.48	13.74
s=EtOH						
$t \downarrow$ $p \rightarrow$	100	60	50	25	10	5
20	7.67	7.60	7.90	8.37	8.55	8.75
30	8.72	8.70	9.00	9.52	9.60	9.75
40	9.72	9.63	10.02	10.46	10.62	10.75
s=CHCl ₃						
$t \downarrow$ $p \rightarrow$	100	79.95	60.04	39.91	19.12	9.0
20	7.67	3.84	0.70	1.56	2.80	2.80
30	8.72	5.23	2.32	.32	.89	.89
40	9.72	6.46	3.83	2.05	.82	.79
50	10.60	7.67	5.26	3.61	2.50	2.30

¹ For dispersion (light-filter sources only) see (228, 229); for influence of solvents, concentration, and temperature see (6, 74, 151, 167).

C₈H₁₄O₆, Diethyl tartrate (231)

<i>s</i> = CHONH ₂ Formamide			<i>s</i> = C ₂ H ₄ Br ₂ Ethylene bromide		
<i>p</i>	<i>d</i> ₄ ²⁰	[<i>α</i>] _D ²⁰	<i>p</i>	<i>d</i> ₄ ²⁰	[<i>α</i>] _D ²⁰
74.67	1.1986	16.00	69.60	1.3867	2.62
51.10	1.1806	22.55	44.47	1.5899	−1.94
25.69	1.1577	27.60	22.49	1.8297	−6.99
8.86	1.1425	29.74	11.58	1.9814	−10.79
5.35	1.1396	30.13	5.53	2.0788	−14.16
1.90	1.1365	30.3	2.31	2.1362	−16.72
			1.20	2.1567	−17.3
			.42	2.1713	−18.7

*C₁₂H₂₂O₆ Diisobutyl tartrate [*α*]_λ^t (146)*

<i>t</i> ↓ λ→	6,716	6,234	5,790	5,461	4,960	4,358
73.0	15.86	17.94	20.50	22.77	26.14	29.69
99.0	16.33	18.51	21.17	23.34	27.19	31.40
132.0	16.42	18.73	21.43	23.64	27.75	32.33
171.7	16.02	18.31	20.94	23.14	27.34	32.10
193.0	15.64	17.93	20.56	22.71	26.86	31.73
226.3	15.28	17.30	19.79	21.97	26.03	30.96
<i>s</i> = C ₂ H ₂ Cl ₄ <i>p</i> = 33.362						
0.0	5.46	5.82	5.97	5.81	4.56	−0.26
16.4	7.47	8.23	8.89	9.15	8.84	5.63
44.0	10.19	11.39	12.58	13.43	14.32	13.31
68.0	11.90	13.34	14.91	16.01	17.84	18.24
99.4	13.26	14.92	16.84	18.35	20.78	22.56
<i>s</i> = C ₂ H ₂ Cl ₄ <i>p</i> = 48.15						
24.8	9.29	10.44	11.50	12.20	12.74	11.04
42.2	10.85	12.24	13.58	14.57	15.83	15.30
67.0	12.39	14.07	15.82	17.21	19.25	20.08
99.7	13.78	15.59	17.60	19.28	22.06	24.26
<i>s</i> = C ₉ H ₇ N Quinoline. <i>p</i> = 20.066						
0.0	54.49	63.29	73.72	83.36	103.44	133.63
39.35	39.40	45.63	62.56	59.45	72.50	91.47
69.75	32.67	37.69	52.79	48.15	58.62	73.26
99.5	28.35	32.48	42.99	41.87	50.61	62.28
147.5	23.93	28.30	¹ 37.63	¹ 36.9	42.94	¹ 52.9

¹ These values have been interpolated by the compiler from the author's data.

C₁₆H₂₆O₈ Diisobutyl diacetyl-d-tartrate (146)

t ↓ $\lambda \rightarrow$	6,742	6,234	5,790	5,461	4,960	4,358
-21.0	¹ 16.2	¹ 16.5	18.63	20.33	23.34	25.92
0.0	13.53	15.29	17.34	18.95	21.63	23.86
14.0	12.86	14.69	16.58	18.15	20.74	22.92
17.25	12.83	14.54	16.42	17.96	-----	-----
42.25	12.21	13.94	15.75	17.09	19.75	21.93
75.2	11.92	13.61	15.45	16.94	19.60	22.22
98.9	11.94	13.80	15.69	17.30	20.14	23.32
200.0	14.28	16.51	19.00	21.26	-----	31.45
$s = C_2H_2Cl_4$. $p = 20.034$						
t ↓ $\lambda \rightarrow$	6,716	6,234	5,790	5,461	4,960	4,358
0.0	10.62	11.75	13.06	14.25	15.87	16.51
16.9	9.86	11.10	¹ 12.5	¹ 13.5	14.93	¹ 15.4
43.0	9.49	10.57	11.87	12.82	14.29	14.65
57.5	¹ 9.4	10.49	¹ 11.6	12.68	14.26	¹ 14.8
76.85	9.35	10.40	11.70	12.73	14.41	15.49
99.75	9.63	10.80	12.12	13.24	15.27	16.78
$s = C_7H_7NO_2$ o-Nitrotoluene. $p = 58.86$						
0.0	3.38	2.96	2.11	0.91	-3.52	-18.30
46.7	5.18	5.31	5.22	4.81	2.52	-6.21
99.1	7.48	8.15	8.80	9.17	8.97	² 9.34
147.0	9.61	10.93	12.27	13.19	14.16	-----
$s = C_7H_7NO_2$ o-Nitrotoluene. $p = 24.694$						
0.0	-3.08	-4.60	-7.20	-10.19	-19.41	² -42.85
17.0	¹ -1.4	¹ -2.8	-4.83	-7.36	¹ -14.9	² -33.22
49.8	1.65	0.71	-0.49	-1.94	-7.14	-----
73.7	3.74	2.99	2.47	1.62	-1.93	-----
150.0	7.68	8.31	8.83	9.00	9.11	-----
$s = C_8H_7N$ Quinoline. $p = 74.96$						
t ↓ $\lambda \rightarrow$	6,742	6,234	5,790	5,461	4,960	4,358
0.0	15.51	17.81	20.32	22.44	26.22	30.54
16.6	14.64	16.73	19.17	21.09	24.55	28.65
59.75	13.23	15.15	17.26	19.06	22.22	25.70
100.0	12.89	14.77	-----	18.75	22.02	-----
$s = C_8H_7N$ Quinoline. $p = 20.476$						
0.0	33.53	39.32	46.48	52.79	65.26	89.54
17.0	-----	34.35	¹ 40.5	¹ 46.1	57.41	76.59
36.7	-----	29.94	¹ 35.2	¹ 39.8	49.56	66.04
76.75	21.37	24.37	¹ 28.5	¹ 32.2	39.22	51.00
103.2	19.49	¹ 22.1	¹ 25.8	¹ 29.2	35.35	-----

¹ These values have been interpolated by the compiler from the author's data.² These readings were difficult to make and are, therefore, less accurate.

Rotatory dispersion of tartrates (65)

$[\alpha]_{\lambda}^t \quad t=2 \text{ dm}$												
$\text{C}_{12}\text{H}_{22}\text{O}_6$, <i>n</i> -Dibutyl <i>d</i> -tartrate												
t	λ d_1^t	6,708	6,563	6,147	5,893	5,769	5,679	5,568	5,461	5,219	4,861	4,662
9.0	1.1044	7.44	7.68	8.32	8.67	8.82	8.92	9.04	9.13	9.26	8.7	8.1
21.5	1.0934	8.55	8.80	9.63	10.20	10.45	10.61	10.81	11.00	11.25	11.23	11.0
41.5	1.0759	9.93	10.22	11.27	11.92	12.27	12.50	-----	13.08	13.61	14.19	14.1
72.5	1.0492	11.31	11.73	13.06	13.91	14.36	14.65	15.05	15.44	16.26	17.4	17.9
98.0	1.0269	12.11	12.54	13.99	14.95	15.45	15.83	16.29	16.75	17.87	19.43	20.2
118.0	1.0099	12.39	12.83	14.36	15.35	15.89	16.30	16.82	17.26	18.39	20.21	20.9
128.0	1.0011	12.4	12.91	14.51	15.53	16.08	16.46	16.97	17.53	18.65	20.4	-----
140.0	.9906	12.44	13.00	14.54	15.65	16.23	16.62	17.15	17.63	18.88	20.76	21.4
151.0	.981	12.54	12.97	14.54	15.69	16.19	16.57	17.04	17.66	18.77	20.51	21.6
165.0	.969	12.52	12.99	14.58	15.69	16.25	16.67	17.16	17.67	18.97	20.60	21.9
$\text{C}_{18}\text{H}_{34}\text{O}_6$, <i>n</i> -Diheptyl <i>d</i> -tartrate												
44.5	0.9952	7.66	7.92	8.70	9.17	9.43	9.64	9.84	10.03	10.44	10.77	10.6
79.0	.9685	8.87	9.20	10.16	10.88	11.23	11.49	11.78	12.08	12.73	13.69	14.1
100.0	.9520	9.27	9.59	10.71	11.43	11.81	12.12	12.44	12.79	13.60	14.76	15.2
125.2	.9328	9.66	10.00	11.16	11.96	12.38	12.71	13.09	13.48	14.46	15.78	16.5
149.0	.914	9.78	10.17	11.35	12.14	12.60	12.88	13.33	13.71	14.77	16.18	16.9
168.0	.8995	9.68	10.06	11.30	12.12	12.59	12.88	13.29	13.69	14.63	16.20	16.8
$\text{C}_{20}\text{H}_{38}\text{O}_6$, <i>n</i> -Dioctyl <i>d</i> -tartrate												
45.0	0.9817	7.14	7.35	8.05	8.51	8.73	8.88	9.08	9.29	9.71	9.98	9.9
79.0	.9551	8.32	8.59	9.54	10.18	10.51	10.75	11.05	11.32	12.02	12.72	13.0
89.0	.9473	8.54	8.84	9.86	10.53	10.86	11.13	11.44	11.76	12.53	13.40	13.8
112.0	.9292	8.90	9.26	10.35	11.06	11.44	11.73	12.07	12.42	13.32	14.50	15.0
132.0	.9140	9.04	9.39	10.51	11.26	11.65	11.93	12.30	12.68	13.57	14.96	15.6
145.0	.9035	8.06	9.41	10.58	11.34	11.73	12.01	12.40	12.73	13.66	15.07	15.8
165.0	.887	9.05	9.41	10.54	11.33	11.74	12.06	12.45	12.80	13.74	15.04	16.0

d-Tartrates (128, 145; cf. 6, 167, 228, 229)

$C_{10}H_{14}O_6$ t	Diallyl $[\alpha]_D^t$	$C_{12}H_{22}O_6$ t	Diisobutyl $[\alpha]_D^t$	$C_{20}H_{38}O_6$ t	Di- <i>d</i> - β -octyl $[\alpha]_D^t$
15.6	15.28	20.0	17.75	16.4	10.25
20.0	15.52	69.1	19.83	20.0	10.45
33.2	16.23	80.6	20.03	41.0	11.38
71.5	17.95	97.5	20.44	74.4	12.54
				107.5	13.31
106.6	18.66	$C_{14}H_{26}O_6$ Ethyl octyl		133.0	13.58
131.6	18.82			159.0	13.75
148.2	18.75			173.0	13.67
168.0	18.44			179.0	13.64
$C_{10}H_{18}O_6$ Di- <i>n</i> -propyl		16.0	7.63	$C_{22}H_{34}O_6$ Ethyl octyl dibenzoyl	
		21.5	7.83		
16.5	12.22	41.5	9.36	10.8	49.41
20.0	12.54	50.0	10.13	24.2	49.31
45.5	14.52	62.0	10.89	38.0	49.16
77.7	16.48	71.0	11.43	47.5	48.81
111.2	17.44	98.0	12.72	54.0	48.64
		$C_{18}H_{30}O_6$ Ethyl octyl diacetyl		67.0	48.39
123.0	17.62			79.0	47.12
133.2	17.72	18.5	4.20	88.0	46.18
147.2	17.82	44.0	4.63	99.0	44.88
161.0	17.77	61.0	5.37		
173.0	17.70	81.5	6.43		
$C_{10}H_{18}O_6$ Diisopropyl		100.0	7.23		
15.3	20.55				
20.0	20.90				
49.7	22.66				
73.0	23.67				
118.0	24.69				
136.0	24.82				
144.5	24.79				
155.0	24.77				
173.0	24.63				

$C_{20}H_{38}O_6$ Di- β -octyl tartrates $[\alpha]_D^{17}$ (161)			
	<i>d</i> -Tartrate	<i>l</i> -Tartrate	<i>r</i> -Tartrate
Di- <i>d</i> - β -octyl.....	24.06	2.06	14.12
Di- <i>l</i> - β -octyl.....	-1.93	-24.20	-14.03
Di- <i>dl</i> - β -octyl.....	11.02	-11.00	0.00

*d-Tartrates of organic bases in water*¹

Neutral salts (87)	c =	2.5 [α] _D ²⁰	5.0 [α] _D ²⁰	5.0 [M] _D ²⁰
C ₄ H ₆ O ₆ <i>d</i> -Tartaric acid.....		14.44	14.02	21.0
C ₁₂ H ₂₈ N ₂ O ₆ <i>n</i> -Butylamine.....		17.40	17.86	52.9
C ₁₄ H ₁₆ N ₂ O ₆ Pyridine.....		18.72	19.30	59.5
C ₁₄ H ₂₈ N ₂ O ₆ Piperidine.....		16.80	17.12	54.8
C ₁₀ H ₂₀ N ₂ O ₆ Aniline.....		16.12	16.58	55.7
C ₁₆ H ₂₄ N ₂ O ₆ Benzylamine.....		17.40	18.28	66.5
C ₉ H ₁₀ N ₂ O ₆ Quinoline.....		12.80	13.22	54.0
C ₂₂ H ₂₆ N ₂ O ₆ Tetrahydroquinoline.....		12.80	13.42	55.8
Acid salts (39)	c	[α] _D ²⁰	[M] _D ²⁰	
C ₄ H ₆ O ₆ <i>d</i> -Tartaric acid.....	1.50	15.0	22.5	
C ₆ H ₉ NO ₆ Ammonia.....	1.67	25.55	42.7	
C ₈ H ₁₁ NO ₆ Methylamine.....	1.81	23.4	42.35	
C ₈ H ₁₇ NO ₆ Diethylamine.....	2.23	18.98	42.35	
C ₈ H ₁₁ NO ₆ Pyridine.....	2.29	18.5	42.35	
C ₁₀ H ₁₃ NO ₆ Aniline.....	2.43	17.42	42.35	
C ₁₀ H ₁₃ NO ₆ <i>p</i> -Aminophenol.....	2.59	16.2	42.0	
C ₁₁ H ₁₅ NO ₆ <i>o</i> -Toluidine.....	2.57	16.34	42.0	
C ₁₁ H ₁₅ NO ₆ <i>m</i> -Toluidine.....	2.57	16.47	42.35	
C ₁₁ H ₁₅ NO ₆ <i>p</i> -Toluidine.....	2.57	16.60	42.7	
C ₁₁ H ₁₅ NO ₆ Benzylamine.....	2.57	16.60	42.7	
C ₁₁ H ₁₅ NO ₆ <i>p</i> -Anisidine.....	2.73	15.4	42.0	
C ₁₂ H ₁₇ NO ₆ <i>p</i> -Phenetidine.....	2.87	14.75	42.4	
C ₁₃ H ₁₃ NO ₆ Quinoline.....	2.79	14.95	41.7	
C ₁₃ H ₁₃ NO ₆ Pseudocumidine.....	1.14	14.92	42.5	
Neutral salts (30)				
C ₄ H ₁₂ N ₂ O ₆ Ammonia.....	1.84	34.6	63.7	
C ₆ H ₁₆ N ₂ O ₆ Methylamine.....	2.12	29.7	63.1	
C ₁₂ H ₂₈ N ₂ O ₆ Diethylamine.....	2.96	21.1	62.6	
C ₁₄ H ₁₆ N ₂ O ₆ Pyridine.....	3.08	19.2	59.2	
C ₁₀ H ₂₀ N ₂ O ₆ Aniline.....	3.36	17.1	57.5	
C ₁₀ H ₂₀ N ₂ O ₆ <i>o</i> -Toluidine.....	3.64	15.6	56.7	
C ₁₁ H ₁₄ N ₂ O ₆ <i>m</i> -Toluidine.....	3.64	15.8	57.6	
C ₁₁ H ₁₄ N ₂ O ₆ <i>p</i> -Toluidine.....	3.64	15.85	57.7	
C ₁₆ H ₂₄ N ₂ O ₆ Benzylamine.....	3.64	17.4	63.4	
C ₁₂ H ₂₀ N ₂ O ₆ Quinoline.....	4.08	13.5	55.0	

¹ For effects of different ratios of acids to amines see (135).

d-Tartrates of organic bases in water—Continued

s	c, p, or d	(157, 180, 181) [α] _D ²⁰	[M] _D ²⁰
C ₆ H ₁₀ O ₆ Dimethyl <i>d</i> -tartrate			
Nil.....	1.3284	2.14	3.8
H ₂ O.....	<i>1.6.0231</i>	20.04	35.7
C ₈ H ₁₄ O ₆ Diethyl <i>d</i> -tartrate			
Nil.....	1.2059	7.62	15.7
<i>n</i> -BuOH (1,594).....	<i>5.5251</i>	8.47	-----
	<i>23.106</i>	7.46	-----
	<i>43.653</i>	6.97	-----
	<i>59.440</i>	6.86	-----
	<i>80.990</i>	7.07	-----
<i>iso</i> -BuOH (1,594).....	<i>4.510</i>	7.10	-----
	<i>27.273</i>	6.01	-----
	<i>50.516</i>	5.55	-----
	<i>65.573</i>	5.85	-----
	<i>83.960</i>	6.64	-----
C ₆ H ₆	<i>5.6479</i>	6.75	+13.9
	<i>10.7539</i>	6.29	+13.0
	<i>21.0627</i>	6.12	+12.6
C ₁₀ H ₁₈ O ₆ Dipropyl <i>d</i> -tartrate			
Nil.....	1.1344	12.31	28.81
H ₂ O.....	<i>4.8206</i>	26.67	62.4
C ₆ H ₆	<i>5.6205</i>	19.62	45.9
	<i>11.1266</i>	20.34	47.6
	<i>22.2112</i>	18.31	42.8
Dimethoxysuccinates			
C ₈ H ₁₄ O ₆ Dimethyl			
Nil ¹	1.1317	² 82.52	² 170.0
H ₂ O.....	19.9988	78.71	162.1
	10.0315	78.45	161.6
	5.0319	78.50	161.7
MeOH.....	<i>6.2593</i>	81.04	166.9
	<i>12.0806</i>	76.32	157.2
	<i>23.0151</i>	78.90	162.5
C ₆ H ₆	20.0036	101.63	209.4
	10.0128	104.66	215.6
	5.0060	105.47	217.3
C ₁₀ H ₁₈ O ₆ Diethyl			
Nil ¹	² 1.0556	² 85.39	² 199.8
H ₂ O.....	1.0961	89.96	210.6
	5.3752	89.11	208.5
	<i>6.0569</i>	87.66	205.1
MeOH.....	<i>9.7365</i>	87.41	204.5
	<i>19.0407</i>	87.27	204.2
	<i>5.5130</i>	104.93	245.5
C ₆ H ₆	<i>10.1117</i>	104.14	243.7
	<i>19.5137</i>	102.65	240.2
C ₁₂ H ₂₂ O ₆ Dipropyl			
Nil ¹	² 1.0237	² 81.06	² 212.5
H ₂ O.....	1.0612	84.92	222.4
	<i>6.6571</i>	84.99	222.7
MeOH.....	<i>12.3697</i>	84.50	221.4
	<i>23.7085</i>	85.79	224.8
	<i>5.6932</i>	101.26	265.3
C ₆ H ₆	<i>11.4730</i>	101.00	264.6
	<i>21.5619</i>	99.24	260.0

¹ The *p* values are in italics.² At *t* = 60° C.

d-Tartrates of organic bases in water—Continued

C ₁₀ H ₁₆ Cl ₂ O ₈ , Dimethyl di- <i>o</i> -chlorobenzoyltartrate			C ₂₀ H ₁₁ Cl ₂ O ₈ , Dimethyl di- <i>m</i> -chlorobenzoyltartrate		
<i>t</i> or <i>p</i> ¹	<i>d</i> ₄ ^t (64)	[<i>α</i>] _D ^t	<i>t</i> or <i>p</i> ¹	<i>d</i> ₄ ^t (64)	[<i>α</i>] _D ^t
13.1	1.3793	—48.83	s=EtOH. <i>c</i> =1.961		
20.6	1.3719	—49.22	20	0.7975	86.66
46.8	1.3467	—49.79	C ₂₀ H ₁₆ Cl ₂ O ₈ , Dimethyl di- <i>p</i> -chlorobenzoyltartrate		
69.8	1.3246	—48.94	11.8	1.3660	—122.20
83.1	1.3117	—47.95	23.9	1.3536	—118.79
87.5	1.3075	—47.51	30.4	1.3470	—117.03
99.2	1.2962	—46.80	35.9	1.3414	—115.50
s=EtOH. <i>p</i> =1.606			64.1	1.3127	—103.23
20	0.7964	—51.99	98.0	1.2784	—98.30
C ₂₀ H ₁₆ Br ₂ O ₈ , Dimethyl di- <i>o</i> -bromobenzoyltartrate			s=EtOH. <i>p</i> =1.621.		
27	1.602	—34.29	20	0.7964	—103.1
38	1.587	—34.74	s=EtOH. <i>t</i> =20°		
60	1.559	—34.23	1.033	0.7777	—72.19
75	1.543	—33.79	1.3057	.7941	—71.85
93	1.524	—32.89	1.2592	.7929	—71.38
s=EtOH. <i>t</i> =20°			C ₂₀ H ₁₆ Br ₂ O ₈ , Dimethyl di- <i>p</i> -bromobenzoyltartrate		
1.486	0.8009	—37.39	21.7	1.5832	—112.2
.9996	.7951	—36.51	44	1.5565	—107.2
s=Py. <i>t</i> =20°			68.5	1.5290	—100.7
1.408	0.9860	—33.12	74.6	1.5228	—99.1
1.121	.9831	—33.61	s=EtOH. <i>t</i> =20°		
C ₂₀ H ₁₆ Br ₂ O ₈ , Dimethyl di- <i>m</i> -bromobenzoyltartrate			1.822	0.7982	—101.8
4	1.620	—83.26	1.766	.7979	—101.5
16	1.605	—82.05	C ₂₀ H ₁₆ I ₂ O ₈ , Dimethyl di- <i>o</i> -iodobenzoyltartrate		
23	1.595	—81.33	14.1	1.8104	—13.23
40	1.573	—79.19	20.0	1.8037	—13.82
75	1.531	—73.80	45.7	1.7746	—16.00
C ₁₀ H ₁₆ Cl ₂ O ₈ , Dimethyl di- <i>m</i> -chlorobenzoyltartrate			74.7	1.7420	—16.72
16.2	1.3556	—92.09	99.0	1.7145	—16.47
26.0	1.3463	—91.00	C ₂₀ H ₁₆ I ₂ O ₈ , Dimethyl di- <i>m</i> -iodobenzoyltartrate		
35.4	1.3375	—89.67	17.8	1.7866	—80.90
42.4	1.3307	—88.61	35.1	1.7665	—79.18
52.6	1.3213	—86.84	63.0	1.7335	—74.88
79.3	1.2963	—81.79	98.5	1.6918	—67.86
99.0	1.2779	—77.53			

¹ *p* values are in italics.

Rotatory dispersion of d-tartrates in aqueous solutions at 20° C. (121)

λ ↓	c ↔	$K_2C_4H_4O_6 \cdot \frac{1}{2}H_2O$ 4.329 K_2O 0.403	$Na_2C_4H_4O_6 \cdot 2H_2O$ 20.178 Na_2O 0.220	$H_2C_4H_4O_6$ 15.0 As_2O_3 Sat. at B. P.	For further data on these and other metallic salts of tartaric acid see (83, 107, 113, 114, 115, 143, 144, 208, 218); also the main table.
6,438	-----	-2.62	-14.32	34.68	
5,893	-----	-2.71	-----	41.55	
5,780	-----	-2.71	-19.17	42.87	
5,461	-----	-3.71	-22.55	47.83	
5,086	-----	-5.52	-27.75	54.33	
4,800	-----	-7.24	-33.11	60.35	
4,678	-----	-8.96	-35.85	63.02	
4,358	-----	-12.12	-46.14	70.62	

$$\text{Drude's equation } [M]_{\lambda}^t = \frac{k_1}{10^{-8}(\lambda^2 - \lambda_1^2)} - \frac{k_2}{10^{-8}(\lambda^2 - \lambda_2^2)}$$

Solute	c	Moles	k_1	k_2	$10^{-8}\lambda_1^2$	$10^{-8}\lambda_2^2$	Range λ
(1) $H_2C_4H_4O_6$	7.5	0.05					
H_3BO_3	4.65	.075	24.08		0.0246		6,708-4,100
(2) $H_2C_4H_4O_6$	15.0	.10					
H_3BO_3	6.2	.10	25.7	1.249	.03	.065	6,708-4,046
$H_2C_4H_4O_6$	2.5	.0167					
As_2O_3	1.65	.0167					
KOH	14.0	.25	20.148		.017		6,438-4,259
$H_2C_4H_4O_6$	2.5	.0167					
(4) $Bi(OH)_3$	2.16	.0083					
KOH	14.0	.25		37.414		.0645	6,438-4,249
(5) $(NH_4)_2C_4H_4O_6$	37.075	-----	38.676	17.117	.038	.060	6,438-3,919
(6) $Na_2C_4H_4O_6$	4.6	.02	18.56		.060		6,438-4,242
$NaOH$	4.7	.02	17.298		.013		6,438-4,242
$K_2C_4H_4O_6$	25.72	-----	37.445	18.025	.038	.060	6,708-4,005
KOH	41.97	-----	37.108	18.348	.038	.060	6,438-3,874
(9) $Na_2C_4H_4O_6$	41.647	-----	41.750	19.255	.038	.060	6,708-4,046
(10) $K_2C_4H_4O_6$	40.255	-----	41.108	18.886	.038	.060	6,438-4,251
(11) -----	55.938	-----	38.513	18.066	.038	.060	6,438-4,055
(12) $KNaC_4H_4O_6 \cdot 4H_2O$	5.516	-----	142.78		.0494		6,708-3,984
(13) $K(SbO)C_4H_4O_6 \cdot \frac{1}{2}H_2O$	5.53	.0167					
(14) $K(SbO)C_4H_4O_6 \cdot \frac{1}{2}H_2O$	11.2	.20		89.48		.0627	6,708-4,358

Molecular rotations of the preceding solutions

	6,708	6,438	5,893	5,780	5,461	5,086	4,800	4,678	4,358
(1)	55.9	61.3	74.8	77.8	88.1	103.1	117.2	124.1	145.4
(2)	57.8	63.0	76.7	79.9	90.6	105.9	120.5	128.1	150.2
(3)	-----	51.0	-----	63.3	72.2	83.8	95.5	99.0	114.9
(4)	-----	-106.4	-132.2	-138.8	-159.9	-192.6	-225.5	-243.4	-298.4
(5)	-----	54.24	65.43	63.05	76.77	89.10	100.51	106.11	122.83
(6)	-----	43.6	-----	55.5	62.4	71.7	80.5	84.0	98.7
(7)	-----	42.7	-----	53.9	61.4	70.8	79.4	84.0	97.3
(8)	45.05	49.00	58.45	60.55	68.23	79.65	89.36	94.51	107.74
(9)	-----	47.04	56.10	58.35	65.58	75.88	85.04	89.99	103.04
(10)	51.92	56.51	67.96	70.81	79.61	92.39	104.06	109.63	126.61
(11)	-----	55.79	67.20	69.86	78.69	91.26	102.81	108.68	125.22
(12)	-----	51.49	61.72	64.29	72.16	83.72	94.41	99.44	114.45
(13)	358.1	389.9	481.0	500.45	573.7	682.2	789.2	842.5	1,015.8
(14)	-229.0	-253.8	-313.7	-330.05	-380.4	-457.8	-534.3	-574.3	-702.0

C₈H₁₄O₆ Diethyl d-tartrate (153, 154, 155)

	<i>s</i>	<i>p</i>	$[\alpha]_D^{20}$	<i>t</i>	$[\alpha]_D^t$	<i>t</i>	$[\alpha]_D^t$	<i>t</i>	$[\alpha]_D^t$
<i>C₂H₅NS</i>	Nil	100	7.58						
	Methyl thiocyanate	60.63	9.87						
	Methyl isothiocyanate	61.40	7.95						
	Acetaldehyde	49.09	17.02						
<i>C₂H₅NS</i>	Ethyl thiocyanate	9.98	11.7						
	Ethyl isothiocyanate	10.17	1.37						
	Acetone	10.01	12.2	13	11.7	36.7	13.4	46	13.9
<i>C₂H₅O</i>		25.06	11.9	11.5	11.3		12.8	36	13.0
<i>C₂H₅O</i>	<i>n</i> -Propyl alcohol	25.0	6.73						
<i>C₂H₅O</i>	<i>n</i> -Butyl alcohol	12.04	+9.2						
	Isobutyl alcohol	10.00	5.7						
	<i>sec</i> -Butyl alcohol	11.88	5.7						
	<i>tert</i> -Butyl alcohol	12.13	3.5						
<i>C₂H₅O₂S</i>	Diethyl sulphite	9.38	7.9						
	Ethyl ethylsulphonate	8.66	4.3						
<i>C₂H₅O₂</i>		10.21	11.3	15.3	10.9	35.1	12.2	54	13.2
	Methyl acetoacetate	25.23	10.6	16.9	10.4	35.1	11.7	57.3	12.8
		50.46	9.40	15.6	9.0	37.4	10.9	56.2	12.1
<i>C₂H₅NS</i>	Isobutyl thiocyanate	10.59	6.2						
	Isobutyl isothiocyanate	10.67	-1.0						
	Diethyl ketone	11.79	10.5						
<i>C₂H₅O</i>	Methyl propyl ketone	11.88	10.9						
<i>C₂H₅O₂</i>	Diethyl carbonate	10.11	6.5						
<i>C₂H₅O</i>	Allyl alcohol	28.27	11.95	8.6	11.2	35.3	13.2	55.5	14.2
		49.81	10.70	11.5	10.0	34.2	11.9	53.0	13.1
		23.89		60.1	16.2	81.4	16.9	112.2	17.66
<i>C₂H₅NO₂</i>	<i>o</i> -Nitrophenol	51.12		56.8	14.31	78.2	15.35	97.3	16.08
		74.95		43.4	12.14	87.3	14.38	115.1	14.21
		89.3	112.0	14.4	11.6	38.6	13.5		
<i>C₂H₅N₂O₂</i>	<i>o</i> -Nitroaniline	89.43	111.8	36.6	13.1	48.6	13.8		
	<i>m</i> -Nitroaniline	90.02	17.8	34.8	18.0	41.6	18.2		
	<i>p</i> -Nitroaniline								
<i>C₂H₅O</i>		14.79	38.5	30.75	35.47	52.3	30.96	92.4	26.85
		23.85	34.2	53.5	29.55	96.9	25.7	130.4	23.65
		48.2	23.94	65.2	22.62	92.3	21.83	140.6	20.54
	Phenol	64.78	17.05	64.9	18.38	100.3	18.78	126	18.52
		74.39	13.82	53.5	15.60	76.5	16.38	89.7	16.76
		79.24	12.37	55.5	14.62	87.1	15.90	117.2	16.62
<i>C₂H₇N</i>	Aniline	7.66	37.7	34.7	36.5	59.3	34.2	70.7	33.3
		23.98	35.2	38.1	33.6	55.6	31.3	81.8	29.5
		66.29	21.3	43.2	21.8	75.2	20.8	86.1	20.6
<i>C₂H₅O₂</i>	Ethyl acetoacetate	10.47	8.9	14	8.0	51	11.7	71.5	13.1
		25.08	8.1	14	7.5	40.5	10.0	50.5	10.8
		50.19	7.7	15.2	7.1	43.1	10.0	54.2	10.9
<i>C₂H₅O₂</i>	Paracetaldehyde	49.99	3.93	33.1	6.2	57	9.1	67.5	10.0
<i>C₂H₇NO₂</i>	<i>o</i> -Nitroanisole	9.79	30.6	34.5	29.5	53.2	28.3	62.8	27.7
		21.17	25.3	29.1	25.4	39.3	25.1	55.8	24.8
	<i>p</i> -Nitroanisole	53.84	12.5	35.1	13.63	44.4	14.23	57.6	14.91
<i>C₂H₅O</i>	Anisole	9.99	4.5	27.3	5.34	35.2	6.25		
		24.62	6.8	33.2	8.20	52.9	10.15	72.8	12.41
		49.85	8.1	30.6	9.12				
<i>C₂H₅O</i>		10.0	28.0	46.9	26.1				
	Benzyl alcohol	23.38	26.2	45.1	25.2	75.6	23.9	101.1	23.0
	<i>o</i> -Cresol	9.61	33.2						
	<i>m</i> -Cresol	9.64	42.6						
	<i>p</i> -Cresol	9.59	46.9						
<i>C₂H₅N</i>	Methylaniline	9.94	23.6	31.7	23.1	49.8	22.8	65.0	22.5
		30.89	17.6	19.4	17.5	15.7	17.3	15.3	17.3
		10.93	30.5	38.2	29.4	47.4	28.3		
	<i>o</i> -Toluidine	25.10	27.4	45.7	25.7	58.0	25.2		
		50.3	21.1	34.6	20.7	50.5	20.4		
	<i>m</i> -Toluidine	11.66	48.5	29.7	46.1	43.2	42.2		
		24.96	42.4	32.9	39.4	48.0	36.4	64.3	33.9
<i>C₂H₅N</i>	<i>p</i> -Toluidine	24.92	42.3	35.7	39.4	46.8	37.7	67.8	33.6
		49.98	31.4	34.7	29.8	46.3	28.6	58.2	27.5
<i>C₂H₅O₂</i>	Ethyl methylacetoacetate	10.23	8.5	13	7.8	30	9.5	41	10.5
<i>C₂H₅NO₂</i>	<i>o</i> -Nitrophenetole	25.09	19.2	30.6	19.7	53.3	20.4	65.5	20.6
		39.43	15.75	29.1	16.27	42.0	17.06		
		9.99	+7.75	27.1	8.41	36.5	9.58		
<i>C₂H₅O</i>	Phenetole	24.96	+7.32	31.6	8.79	43.5	10.14	60.5	10.92
		51.73	6.86	31.0	8.05	18.2	6.72		

¹ See footnote at end of table.

C₈H₁₄O₆ Diethyl d-tartrate (153, 154, 155)—Continued

	<i>s</i>	<i>p</i>	$[\alpha]_D^{20}$	<i>t</i>	$[\alpha]_D^{10}$	<i>t</i>	$[\alpha]_D^{10}$	<i>t</i>	$[\alpha]_D^{10}$
<i>C₈H₈O₂</i>	Phenyl acetate.....	24.96	¹ 5.28	28.2	¹ 5.33	39.3	¹ 5.40	44.4	¹ 5.37
<i>C₈H₁₀O</i>	<i>β</i> -Phenylethyl alcohol.....	26.30	¹ 4.48	27.8	¹ 4.52	40.7	¹ 4.55	-----	-----
	<i>o</i> -Cresol methyl ether.....	10.06	8.8	-----	-----	-----	-----	-----	-----
<i>C₈H₁₀O</i>	<i>m</i> -Cresol methyl ether.....	10.17	4.9	-----	-----	-----	-----	-----	-----
	<i>p</i> -Cresol methyl ether.....	10.04	7.0	-----	-----	-----	-----	-----	-----
<i>C₈H₁₁N</i>	Dimethylaniline.....	{ 9.4	4.2	26.6	5.6	43.0	7.7	33.9	6.6
		{ 24.84	5.1	30.9	6.6	47.3	8.5	50.9	9.4
<i>C₈H₁₂O₄</i>	Ethyl <i>C</i> -acetylacetoacetate.....	9.02	10.0	-----	-----	-----	-----	-----	-----
	Ethyl <i>O</i> -acetylacetoacetate.....	9.38	14.0	-----	-----	-----	-----	-----	-----
<i>C₈H₁₄O₃</i>	Ethyl ethylacetoacetate.....	62.93	6.72	-----	-----	-----	-----	-----	-----
	Ethyl <i>β</i> -ethoxycrotonate.....	62.96	4.86	-----	-----	-----	-----	-----	-----
	Ethyl dimethylacetoacetate.....	{ 10.28	8.8	11.9	8.2	35.8	10.1	-----	-----
		{ 25.17	8.0	13.2	7.1	38.4	9.8	57.1	11.3
		{ 50.31	6.83	12.6	6.5	32.2	8.7	51.0	10.5
<i>C₉H₁₀O₂</i>	Benzyl acetate.....	24.89	¹ 4.68	31.8	¹ 4.72	43.7	¹ 4.75	51.7	¹ 4.82
<i>C₉H₁₂O</i>	<i>γ</i> -Phenylpropyl alcohol.....	24.83	¹ 3.63	28.7	¹ 3.73	42.0	¹ 3.87	-----	-----
<i>C₉H₂₀O₄</i>	Benzyl ethyl ether.....	20.78	¹ 2.26	13.0	¹ 2.18	36.3	¹ 2.57	42.5	¹ 2.83
<i>C₉H₂₀O₄</i>	Ethyl orthocarbonate.....	10.80	4.0	-----	-----	-----	-----	-----	-----
<i>C₁₄H₁₄O</i>	Dibenzyl ether.....	24.84	¹ 3.07	16.4	3.0	32.2	¹ 3.35	40.9	¹ 3.54

¹ These are values of $[\alpha]_D^{10}$ for 10-cm tubes; the specific rotations are not given by the author.

IC₁. THE MOLECULE CONTAINS 1 ASYMMETRIC CARBON ATOM ATTACHED TO 3 OTHER CARBON ATOMS

5. CITRONELLAL DERIVATIVES

Derivatives of citronellal (187; cf. 188, 196) $[\alpha]_\lambda^{20}$

		6,563	5,893	5,270	4,861
<i>C₁₁H₂₀</i>	2, 6-Dimethyl- Δ^2 , 7-nonadiene.....	-8.12	-10.37	-12.29	-16.17
<i>C₁₂H₂₂</i>	2, 6-Dimethyl- Δ^2 , 7-decadiene.....	-----	-6.64	-----	-----
<i>C₁₃H₂₄</i>	2, 6-Dimethyl- Δ^2 , 8-undecadiene.....	-5.22	-6.68	-7.98	-10.55
<i>C₁₃H₂₄</i>	2, 6-Dimethyl- Δ^2 , 8, 10-undecatriene.....	-7.87	-10.12	-12.34	-16.92
<i>C₁₈H₂₈</i>	2, 6-Dimethyl- Δ^2 , 8-octadiene-8-cyclohexane.....	-5.03	-6.40	-7.65	-----
<i>C₁₆H₂₂</i>	2, 6-Dimethyl- Δ^2 , 7-octadiene-8-benzene.....	-48.07	-63.24	-77.35	-108.10
<i>C₁₆H₂₄</i>	2, 6-Dimethyl- Δ^2 -octene-8-benzene.....	-----	-7.26	-----	-----
<i>C₁₇H₂₄</i>	2, 6-Dimethyl- Δ^2 , 8-nonadiene-9-benzene.....	-----	-3.33	-----	-----
<i>C₁₈H₂₆</i>	2, 6-Dimethyl- Δ^2 , 8-decadiene-10-benzene.....	-4.54	-5.76	-6.84	-8.90

6. AMYLACETONE DERIVATIVES

Derivatives of amylacetone $[\alpha]_\lambda^{20}$ (204)

<i>p</i> =10	<i>s</i>	6,563	5,893	5,270	4,861	$[M]_D$
<i>C₈H₁₆O</i> <i>l</i> -Amylacetone ¹	{ <i>C₆H₆</i> EtOH	{ 6.41 5.4	{ 8.20 7.34	{ 9.52 8.5	{ 12.42 12.5	{ 10.49 9.4
<i>C₁₀H₁₈O₂</i> Acetyl- <i>l</i> -amylacetone.....	{ <i>C₆H₆</i>	{ 6.2	{ 8.0	{ 9.0	{ 13.0	{ 10.3
	{ <i>C₆H₆</i>	{ 7.54	{ 9.80	{ 11.65	{ 15.78	{ 16.66
<i>C₁₁H₂₀O₃</i> Ethyl <i>l</i> -amylacetoacetate.....	{ <i>C₆H₆</i>	{ 6.12	{ 8.0	{ 9.5	{ 14.0	{ 14.1
	{ <i>C₆H₆</i>	{ 10.62	{ 13.66	{ 16.23	{ 21.72	{ 27.32
<i>C₁₃H₂₀O</i> Benzylidene- <i>l</i> -amylacetone.....	{ <i>C₆H₆</i>	{ 10.4	{ 14.1	{ 16.7	{ 23.7	{ 28.2
	{ <i>C₆H₆</i>	{ 7.8	{ 10.8	{ 12.2	{ 20.0	{ 23.3
<i>C₁₃H₂₀O₂</i> Benzoyl- <i>l</i> -amylacetone.....	{ <i>C₆H₆</i>	{ 7.28	{ 9.41	{ 11.34	{ 15.72	{ 21.83
	{ NaOH	{ 5.1	{ 6.0	{ 8.11	{ 11.94	{ 15.9
<i>C₁₆H₂₂O₂</i> Anisylidene- <i>l</i> -amylacetone.....	{ <i>C₆H₆</i>	{ 6.4	{ 8.93	{ 10.6	{ 15.05	{ 20.7
	{ <i>C₆H₆</i>	{ 5.9	{ 8.62	{ 10.52	{ 16.6	{ 21.2

¹ These derivatives of *l*-amyl alcohol are dextrorotatory.

IV. Class II. ORGANIC SUBSTANCES, AT LEAST ONE ASYMMETRIC CARBON ATOM OF WHICH FORMS PART OF A RING

II B. THE MOLECULE CONTAINS ASYMMETRIC CARBON ATOMS ATTACHED TO 2 OTHER CARBON ATOMS

7. TETRAHYDRONAPHTHOL AND DERIVATIVES

Specific rotation $[\alpha]_{\lambda}^t$ of *d*- and *l*-ac-tetrahydro- β -naphthol and derivatives (103)

<i>t</i>	$C_{10}H_{12}O$ <i>d</i> -ac-tetrahydro- β -naphthol			$C_{15}H_{20}O_2$ <i>l</i> -ac-tetrahydro- β -naphthyl <i>n</i> -valerate		
	$[\alpha]_{5,893}^t$	$[\alpha]_{5,461}^t$	$[\alpha]_{4,358}^t$	$[\alpha]_{5,893}^t$	$[\alpha]_{5,461}^t$	$[\alpha]_{4,358}^t$
20	75.68	90.26	162.16	-46.80	-56.23	-99.97
40	71.85	86.72	155.51	-45.77	-55.34	-98.40
60	68.35	82.62	148.98	-44.71	-54.43	-96.74
80	65.36	79.16	142.05	-43.62	-53.50	-95.13
100	62.56	75.39	135.65	-42.48	-52.52	-93.40
120	59.94	72.33	130.13	-41.30	-51.54	-91.60
140	57.50	69.82	125.88	-40.05	-50.56	-89.80
160	55.26	67.36	121.04	-38.79	-49.53	-87.96
180	52.96	64.66	116.10	-37.43	-48.45	-85.95
200	50.86	62.47	112.15	-----	-----	-----

<i>s</i>	<i>c</i>	$[\alpha]_{5,893}^t$	$[\alpha]_{5,461}^t$	$[\alpha]_{4,358}^t$	<i>s</i>	<i>c</i>	$[\alpha]_{5,893}^t$	$[\alpha]_{5,461}^t$	$[\alpha]_{4,358}^t$
$C_{10}H_{20}O$ <i>d</i> -ac-tetrahydro- β -naphthol					$C_{15}H_{20}O_2$ <i>l</i> -ac-tetrahydro- β -naphthyl <i>n</i> -valerate				
Py.....	5.0815	75.97	91.54	164.6	CHCl ₃ ..	4.9355	-41.01	-49.57	-87.34
EtOH....	5.1565	75.56	90.88	161.4	EtOH....	5.0335	-41.21	-49.45	-88.49
CHCl ₃ ..	4.9840	67.32	80.71	143.2	C ₆ H ₆	4.1395	-53.63	-64.63	-115.1
CS ₂	5.1030	62.30	75.13	134.3	CS ₂	5.1460	-63.86	-77.36	-140.0
C ₆ H ₆	4.8265	61.50	73.98	131.6	$C_{15}H_{16}O_4$ <i>l</i> -ac-tetrahydro- β -naphthyl hydrogen phthalate				
$C_{15}H_{15}O_4Na$ Sodium <i>l</i> -ac-tetrahydro- β -naphthyl phthalate					Py.....	5.2985	-15.87	-19.99	-34.23
H ₂ O... {	0.5117	$\pm 0^\circ$	0.87	5.65	EtOH....	4.9150	-9.72	-11.28	-17.11
	1.0332	$\pm 0^\circ$	.75	4.84	CHCl ₃ ..	5.1060	-13.71	-17.27	-29.40
	1.5280	-1.24	-1.02	1.10	C ₆ H ₆	2.2115	-27.54	-33.30	-59.61
	1.9660	-2.54	-2.71	-2.49	$C_{15}H_{16}O_4$ <i>d</i> -ac-tetrahydro- β -naphthyl hydrogen phthalate				
EtOH... {	.9423	-18.05	-21.59	-34.26	CHCl ₃ ...	1.0718	13.57	16.03	28.84

8. AMINES

 $C_{10}H_{14}N_2$ Nicotine (97)

t	d_4^t	$[\alpha]_D^t$
20.0	1.0093	168.20
29.5	1.0017	168.71
41.5	.9924	169.09
52.0	.9840	169.51
62.0	.9760	169.74
69.6	.9699	169.94
86.4	.9567	169.73
92.0	.9521	169.71
$s=H_2O$		
	p	
20.0	6.638	76.82
85.0	6.638	95.29
20.0	88.338	124.16
90.0	88.338	150.34
20.0	89.471	138.73
20.0	81.842	121.48
20.0	69.202	100.47
20.0	60.773	94.02
20.0	50.134	89.03
20.0	40.237	85.09
20.0	30.973	82.48
20.0	20.726	80.06
20.0	10.012	78.66
20.0	2.505	83.15
$s=CHONH_2$ (231)		
p	d_4^{20}	$[\alpha]_D^{20}$
100	-----	-163.9
61.54	1.0610	-122.65
38.33	1.0889	-102.38
17.60	1.1139	-82.77
11.32	1.1220	-73.74
$s=C_2H_4Br_2$ (231)		
58.12	1.3009	-172.64
36.29	1.5310	-176.55
17.42	1.8096	-179.31
10.14	1.9467	-179.90

Specific rotation $[\alpha]_{\lambda}^t$ of nicotine at various temperatures (135)

t	$[\alpha]_{4,800}^t$	t	$[\alpha]_{5,893}^t$
22.3	251.81	22.7	149.97
81.5	223.67	-71.5	135.02
	$[\alpha]_{5,086}^t$	-82.1	131.73
22.4	216.08	-89.0	129.40
81.5	191.27		$[\alpha]_{6,438}^t$
	$[\alpha]_{5,461}^t$		
22.4	180.7	22.5	121.38
5.0	179.40	-71.2	109.51
-5.0	178.20	-80.7	106.98
-15.0	176.90		$[\alpha]_{6,708}^t$
-30.0	174.42	22.5	110.43
-45.0	171.54	-72.2	99.23
-72.5	162.85	-81.6	96.98
-81.5	159.24		
-89.7	156.61		

Specific rotation $[\alpha]_{\lambda}^{20}$ of derivatives of *l*-tetrahydroquinaldine (177; cf. 108)

s	Benzoyl $C_{17}H_{17}NO$				o-Nitrobenzoyl $C_{17}H_{15}N_2O_3$			
	c	5,893	5,780	5,461	c	5,893	5,780	5,461
EtOH.....	1.6890	326.7	342.2	397.3	1.8332	17.11	13.4	-2.05
C_6H_6	1.3396	246.7	258.3	299.9	1.7644	-58.5	-66.8	-99.0
Me_2CO	1.3265	318.1	333.3	389.0	2.1108	9.60	4.5	-12.4
AcOH.....	1.3309	364.5	382.8	445.2	1.8484	30.0	27.5	+14.5
	<i>m</i> -Nitrobenzoyl $C_{17}H_{15}N_2O_3$				<i>p</i> -Nitrobenzoyl $C_{17}H_{15}N_2O_3$			
EtOH.....	1.7303	241.6	252.8	292.6	1.3376	369.9	388.2	459.2
C_6H_6	1.6752	229.6	241.4	278.8	1.3317	320.7	337.9	396.5
Me_2CO	1.7930	250.7	262.9	306.5	1.3317	353.0	371.7	440.1
AcOH.....	1.7456	250.2	263.4	306.5	1.3402	379.6	401.8	473.9
	<i>p</i> -Toluy $C_{18}H_{19}NO$				Toluene- <i>p</i> -sulphonyl $C_{17}H_{18}NO_2S$			
EtOH.....	1.3369	333.2	347.2	404.5	1.3207	-137.2	-143.1	-163.9
C_6H_6	1.3333	251.5	264.4	305.5	1.3029	-134.2	-141.9	-162.7
Me_2CO	1.3426	323.6	338.9	393.7	1.3349	-128.8	-135.2	-155.1
AcOH.....	1.3472	370.7	388.6	452.0	1.3179	-122.0	-127.1	-145.9
	Nitrobenzene- <i>m</i> -sulphonyl $C_{18}H_{18}N_2O_4S$				2-Nitrotoluene-4-sulphonyl $C_{17}H_{18}N_2O_4S$			
EtOH.....	0.7770	-85.2	-91.7	-103.3	0.6781	-48.7	-49.8	-54.0
C_6H_6	1.4096	-124.2	-130.0	-148.3	1.3212	-21.2	-20.4	-18.9
Me_2CO	1.1664	-100.7	-107.2	-123.9	1.2585	-53.1	-54.4	-60.8
AcOH.....	1.5098	-96.9	-101.9	-116.9	1.2909	-27.1	-28.1	-30.0

Specific rotation $[\alpha]_{\lambda}^{20}$ of derivatives of *l*-tetrahydroquinaldine (177; cf. 108)—Con.

s	α -Naphthoyl $C_{11}H_9NO$				β -Naphthoyl $C_{11}H_9NO$			
	c	5, 893	5, 780	5, 461	c	5, 893	5, 780	5, 461
EtOH.....	1.3336	359.9	416.2	490.0	0.3562	339.3	359.5	415.5
C_6H_6	1.3192	338.5	354.9	421.7	2.0434	256.1	268.8	311.5
Me_2CO	1.3479	385.8	406.6	478.0	.3376	330.3	347.3	405.1
AcOH.....	1.3342	397.2	420.3	491.9	2.0334	374.0	393.8	457.2
s	Naphthalene- α -sulphonyl $C_{20}H_{19}NO_2S$				Naphthalene- β -sulphonyl $C_{20}H_{19}NO_2S$			
	c	5, 893	5, 780	5, 461	c	5, 893	5, 780	5, 461
EtOH.....	0.7949	103.8	110.0	134.9	1.2570	-225.0	-237.3	-276.1
C_6H_6	1.3465	75.0	80.7	98.4	1.3303	-231.7	-243.1	-234.3
Me_2CO	1.6371	90.9	94.7	114.5	.6638	-216.9	-227.1	-264.4
AcOH.....	1.3596	89.0	95.1	114.7	1.3522	-206.5	-216.5	-252.5

Specific rotation $[\alpha]_{\lambda}^{20}$ of tetrahydroquinaldinomethylene camphors,¹ $C_{21}H_{27}NO$

$C_{21}H_{27}NO$	s	c	5, 893	5, 780	5, 461	4, 482	4, 359
<i>d</i> -T- <i>d</i> -C ¹	EtOH.....	0.1114	-133	-145	-183	-----	-598
<i>d</i> -T- <i>d</i> -C.....	EtOH.....	.5020	-133	-143	-182	M. P.=81.0°	-----
<i>d</i> -T- <i>d</i> -C (A).....	AcOH.....	.1052	-95.5	-105	-136	-----	-----
<i>d</i> -T- <i>d</i> -C.....	AcOH.....	.5009	-142	-153	-196	-----	-----
<i>l</i> -T- <i>l</i> -C.....	EtOH.....	.1108	+134	+144	+182	M. P.=81.0°	-----
<i>d</i> -T- <i>l</i> -C.....	EtOH.....	.1030	-627	-667	-803	M. P.=111.5°	-----
<i>d</i> -T- <i>l</i> -C.....	EtOH.....	.5017	-734	-780	-945	-----	-----
<i>d</i> -T- <i>l</i> -C (B).....	AcOH.....	.1535	-671	-715	-868	-----	-----
<i>l</i> -T- <i>d</i> -C.....	EtOH.....	.1109	+741	+787	+951	+1,946	+2,519
<i>l</i> -T- <i>d</i> -C.....	EtOH.....	.5008	+734	+780	+945	M. P.=111.5°	-----
<i>d</i> -T- <i>dl</i> -C.....	EtOH.....	.1016	-440	-475	-577	-----	-1,575
<i>d</i> -T- <i>dl</i> -C (C).....	AcOH.....	.1062	-384	-412	-504	-----	-----
<i>l</i> -T- <i>dl</i> -C.....	EtOH.....	.1006	+444	+471	+574	M. P.=83.5°	-----
<i>dl</i> -T- <i>d</i> -C.....	EtOH.....	.1066	+307	+326	+391	M. P.=113.0°	-----
<i>dl</i> -T- <i>l</i> -C.....	EtOH.....	.1016	-307	-326	-390	-----	-975
<i>dl</i> -T- <i>l</i> -C (D).....	AcOH.....	.1018	-300	-313	-381	M. P.=113.0°	-----

¹ T and C represent, respectively, the tetrahydroquinaldinomethylene, $C_{11}H_{13}N$, and the camphor, $C_{10}H_{16}O$, radicals.

NOTE.—Tetrahydroquinaldinomethylene camphors exhibit mutarotation in acetic acid solution. All observations recorded in the above table were made after mutarotation was complete.

Mutarotation of the (A), (B), (C), and (D) substances in the preceding table is given below:

Time (in hours)	(A)	(B)	(C)	(D)
	$\alpha_{5,461}$	$\alpha_{5,461}$	$\alpha_{5,461}$	$\alpha_{5,461}$
$\frac{1}{2}$	-2.54	-19.60	-8.15	-5.44
$1\frac{1}{2}$	-2.00	-18.25	-7.39	-5.34
$2\frac{1}{2}$	-1.91	-17.88	-7.25	-5.26
$6\frac{1}{2}$	-----	-17.77	-7.20	-5.18
24.....	-----	-----	-7.13	-----
48.....	-1.91	-----	-----	-----

Data for other smaller concentrations given in the original paper; influence of concentration is negligible.

Salts and derivatives of hydroxyhydrindamine (173; cf. 172)

B=1-hydroxy-2-hydrindamine.
A=α-bromocamphor-α-sulphonic acid.
A'=camphor-β-sulphonic acid.

Substance	s	λ c	[α] _λ ²⁰			[M] _{5,461} ²⁰
			5,893	5,780	5,461	
d-B-l-A ¹	H ₂ O.....	1.510	-45.2	-47.7	-56.3	-274
(After 98 hours)*.....	Me ₂ CO.....	.413	-30.9	-32.7	-40.6	-198
d-B-d ₂	H ₂ O.....	1.592	+68.3	71.9	84.5	389
.....	Me ₂ CO (95 per cent).....	.779	+76.7	81.2	95.3	439
d-B-d-A'.....	H ₂ O.....	1.382	+31.7	33.1	38.5	147
.....	Me ₂ CO.....	.686	+69.2	73.2	85.2	325
l-B-d-A'.....	H ₂ O.....	2.271	-2.5	-2.4	-1.5	-5.9
(30 minutes)*.....	Me ₂ CO.....	.801	-6.5	-6.5	-7.2	-27.3
(48 hours)*.....	Me ₂ CO.....	.....	-5.3	-5.6	-6.2	-23.7
d-B.....	H ₂ O.....	1.103	+22.9	24.3	27.9	41.6
(122 hours).....	Me ₂ CO.....	1.053	+27.5	289	334	498
(104 hours).....	EtOH.....	.518	+39.1	41.1	47.3	70.6
d-B-HCl.....	H ₂ O.....	.642	+32.3	33.9	38.9	72.2
l-B-HCl.....	H ₂ O.....	.606	-32.2	-33.8	-38.8	-72.0
l-B-HBr.....	H ₂ O.....	.502	-26.4	-27.4	-31.9	-73.3
d-B-1/2 (H ₂ SO ₄).....	H ₂ O.....	1.345	+29.2	30.7	35.3	70.0
(17 hours)*.....	Me ₂ CO (70 per cent).....	.344	+33.4	34.9	40.7	80.6
-B-HNO ₃	H ₂ O.....	.718	-27.8	-29.2	-33.8	-71.6
(19 hours)*.....	Me ₂ CO (93 per cent).....	.341	-52.1	-56.5	-65.3	-138
d-B-1/2 (H ₂ CO ₃).....	H ₂ O.....	.319	+30.7	33.1	38.0	68.4
d-B-1/2 (H ₂ PtCl ₆).....	H ₂ O.....	1.200	+16.0	17.3	19.4	68.6
d-B picrate.....	Me ₂ CO.....	.432	.....	.....	.....	.....
(30 minutes)*.....	Me ₂ CO.....	.432	+3.5	+2.9	±0.0	±0.0
(19 hours)*.....	Me ₂ CO.....	.432	-2.9	-4.1	-8.1	-31.0
(43 hours)*.....	Me ₂ CO.....	.432	-4.6	-5.8	-10.4	-39.0
d-B acetate.....	H ₂ O.....	.682	+28.2	30.1	34.5	72.1
(96 hours)*.....	Me ₂ CO.....	.690	+169	177.0	203	425.0
l-B benzoate*.....	H ₂ O.....	.473	-22.2	-23.2	-26.9	-73.0
(107 hours)*.....	Me ₂ CO.....	.486	-122	-128	-148	-401
l-B salicylate*.....	H ₂ O.....	.455	-21.4	-22.0	-25.3	-73
(30 minutes)*.....	Me ₂ CO.....	.582	.....	.....	.....	.....
(378 hours)*.....	Me ₂ CO.....	.582	-61.0	-63.5	-73.8	-212
.....	Me ₂ CO.....	.582	-31.8	-34.3	-39.9	-115
C ₁₈ H ₁₅ NO ₂ l-1-hydroxy-2-benzo- ylhydrindamine.....	Me ₂ CO.....	.258	-58.1	-60.1	-68.8	-174
C ₁₈ H ₁₅ NO d-1-hydroxy-2-benzyl- idenehydrindamine.....	EtOH.....	.355	+90.1	95.7	111.0	+262
C ₁₆ H ₁₂ N ₂ O ₂ d-1-hydroxy-2-carba- midohydrindene.....	AcOH.....	.386	-4.5	-4.5	-4.5	-8.7
.....	HCl (conc.).....	.422	+59.2	+61.6	+71.7	+138

		s	c	λ	[α] _λ ²⁰
C ₉ H ₁₂ N ₂ O.....	l-1-Hydroxy-2-hydrazinohydrindene (156).....	H ₂ O.....	0.375	5,893	-14.0
C ₁₀ H ₁₃ N ₃ O ₂	l-1-Hydroxy-2-semicarbazinohydrindene.....	EtOH.....	0.510	5,780	-17.6
				5,461	-22.0
				5,461	-14.7

NOTE.—Solutions marked with an asterisk (*) exhibit mutarotation, the final rotation being given for each substance. The form of the rotation-time curve is not simple and a maximum is observed in some cases. Thus the rotations for the dextro-base (α_{5,461}) in acetone are:

30 minutes.....	14.03	42 minutes.....	14.51	100 minutes.....	14.73	23 hours.....	14.34
34 minutes.....	14.23	55 minutes.....	14.65	190 minutes.....	14.69	122 hours.....	14.07
38 minutes.....	14.40	70 minutes.....	14.71	6 hours.....	14.60	240 hours.....	14.07

II B₃

(172)			$[\alpha]_{\lambda}^{18}$			$[M]_{\lambda}^{18}$
C ₁₈ H ₁₉ NO ₂ Dihydroxydihydrindamine	s	$\frac{c}{d}$ $\lambda \rightarrow$	5,893	5,780	5,461	5,461
<i>l</i> hydrochloride	(H ₂ O)	¹ 0.330	83.3	86.4	100.0	+28.1
<i>d</i> hydrochloride	(H ₂ O)	¹ 2.007	81.3	84.4	98.1	27.6
<i>d</i> -chloroplatinate	(H ₂ O)	¹ 3.46	-83.2	-86.1	-99.8	+28.1
	(EtOH)	.503	46.3	47.2	55.7	27.1

Name	s	c	[α] _D ^t	Lit.
C ₁₇ H ₁₃ NO ₂	d-Hyoscyamine.....	50 per cent EtOH.....	4.0	21.0 (29)
.....	l-Hyoscyamine.....	50 per cent EtOH.....	2.165	-25.8 (17)
.....	.....	CHCl ₃	4.0	-23.7 (29)

t=room temperature.

¹ Concentration calculated on free base.

² Molecular rotatory power calculated on one equivalent of base.

II. THE MOLECULE CONTAINS ASYMMETRIC CARBON ATOMS ATTACHED EACH TO 3 OTHER CARBON ATOMS

9. METHYLCYCLOHEXANE DERIVATIVES (158)

$C_8H_{13}BrCl$, *d*-4-Chloro-1-methyl-4-chlorobromomethylcyclohexane

s	c	$\frac{t}{\lambda} \rightarrow$	4,359	5,780	5,893
EtOH.....	3.21	17.0	0.39	0.35	0.35

$C_8H_{13}Br$ *d*-1-Methyl-4-bromomethylenecyclohexane ¹

Ligroin.....	9.01	16.0	-59.37	-52.34	-50.39
EtOH.....	3.05	16.0	-62.24	-55.38	-50.40

l-1-Methyl-4-bromomethylenecyclohexane ¹

Ligroin.....	9.17	16.0	59.11	52.17	50.18
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$C_8H_{13}BrO_2$ *l*-1-Methylcyclohexylidene-4-bromoacetic acid ¹

EtOH.....	{	1.47	19.0	-12.4	-11.0	-10.4
		2.67	16.0	-12.1	-10.6	-10.3

$C_8H_{13}BrClO_2$ *l*-4-Chloro-1-methylcyclohexyl-4-chlorobromoacetic acid

EtOH.....	3.79	17.0	-1.32	-1.12	-1.05
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$C_8H_{14}Br_2O_2$ *d*- β -Dibromo-1-methylcyclohexyl-4-acetic acid

EtOAc.....	{	1.59	16.0	2.3	2.0	2.4
		1.37	17.0	29.0	25.1	24.3
C_6H_6		1.50	17.0	29.6	25.6	-24.3
		2.70	17.0	28.2	24.5	23.8

$C_8H_{14}Br_2O_2$ *l*- β -Dibromo-1-methylcyclohexyl-4-acetic acid

EtOAc.....	{	3.29	16.0	-2.3	-1.9	-2.3
		1.49	16.0	-29.2	-25.2	-24.5
C_6H_6		3.01	16.0	-28.2	-24.7	-23.9

$C_8H_{14}Br_2O_2$ *l*- α -Dibromo-1-methylcyclohexyl-4-acetic acid ¹

C_6H_6	{	1.51	16.0	10.3	9.3	8.6
		3.05	16.0	9.5	8.4	7.6
		3.00	16.0	4.9	4.3	3.9

$C_8H_{14}O_2$ *d*-1-Methylcyclohexylidene-4-acetic acid ¹

EtOH.....	0.78	18.0	95.8	83.7	81.1
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¹ These compounds are centrosymmetric.

² The rotatory powers of the α -dibromides are opposite in sign to those of the parent acids.

10. DIMETHYLTETRAHYDROQUINOLINE AND DERIVATIVES

 $C_{11}H_{13}N$ 2, 4-DIMETHYLTETRAHYDROQUINOLINE (216)

	t	$d_4^{t \text{ or } s}$	$[\alpha]_D^t$	$[M]_D^t$		t	$d_4^{t \text{ or } s}$	$[\alpha]_D^t$	$[M]_D^t$
d -.....	20	1.0009	60.13	97.1	$C_{13}H_{15}NO$ Benzoyl- d -compound				
l -.....	20	1.00078	-57.24	-92.15	C_6H_5 -.....	{ 18	0.678	-312.5	-828.0
d -Iso-.....	15	1.0044	18.23	29.52	EtOH-.....	{ 18	1.211	-313.7	-831.0
l -Iso-.....	15	1.0063	-18.03	-29.05		{ 18	.501	-379.7	-1,006.0
s d -Compound						{ 18	1.124	-378.9	-1,004.0
EtOH-.....	{ 18	1.473	57.0	91.8	Me ₂ CO-.....	{ 18	.418	-374.5	-992.0
	{ 18	3.675	56.7	91.3	CHCl ₃ -.....	{ 18	1.162	-377.0	-999.0
l -Compound						{ 18	.426	-373.6	-990.0
EtOH-.....	{ 18	1.270	-56.2	-90.6		{ 18	.822	-378.1	-1,002.0
	{ 18	2.625	-56.0	-90.2	AcOEt-.....	{ 18	.392	-397.7	-1,054.0
d -Iso-Compound						{ 18	.768	-392.8	-1,041.0
EtOH-.....	{ 17	2.102	18.5	29.7	AcOH-.....	{ 18	.494	-418.2	-1,109.0
	{ 17	2.768	18.5	29.7		{ 18	.814	-420.6	-1,114.0
l -Iso-Compound					Benzoyl- l -compound				
EtOH-.....	{ 18	0.951	-17.6	-23.2	C_6H_5 -.....	{ 19	0.486	314.1	832.3
	{ 18	2.548	-17.9	-28.8		{ 19	.395	314.7	833.7
$C_{11}H_{16}ClN$ d -Hydrochloride						{ 19	.809	313.5	830.3
H ₂ O-.....	{ 18	0.462	84.4	167.0	EtOH-.....	{ 18	.363	377.6	1,000.6
EtOH-.....	{ 18	.908	83.1	164.5	AcOH-.....	{ 19	.356	420.0	1,113.0
	{ 19	.422	91.4	181.0	EtOAc-.....	{ 19	.182	401.7	1,063.0
l -Hydrochloride					Benzoyl- l -Iso-compound				
H ₂ O-.....	{ 18	0.583	-81.5	-161.2	EtOH-.....	{ 18	-----	0.0	0.0
EtOH-.....	{ 18	.891	-80.8	-159.8	$C_{21}H_{30}BrNO_4S$ d -2, 4-Dimethyltetrahydroquinoline d - α -bromocamphor- π -sulphonate				
	{ 18	.541	-91.4	-180.5	H ₂ O-.....	{ 18	0.416	86.2	407.0
	{ 18	.146	-93.2	-184.5		{ 18	.821	84.9	401.0
d -Iso-Hydrochloride						{ 18	1.236	85.0	401.0
H ₂ O-.....	{ 18	1.085	5.1	10.1		{ 18	1.640	86.5	408.0
l -Iso-Hydrochloride					d -Iso- l -compound				
H ₂ O-.....	{ 18	1.505	-5.1	-10.1	H ₂ O-.....	{ 18	1.286	-55.2	-261.0
						{ 18	1.341	-54.8	-259.0
						{ 18	.886	-55.4	-262.0
						{ 18	.456	-55.5	-262.0
					l - l -compound				
					H ₂ O-.....	{ 18	0.450	-85.5	-404.0
						{ 18	.854	-86.1	-407.0
						{ 18	1.913	-84.7	-400.0
					l -Iso- d -compound				
					H ₂ O-.....	{ 18	1,034	55.7	263.0

11. MYRTENOL ESTERS

(188) Esters of myrtenol $[\alpha]_{\lambda}^{20}$

Formula	Name	6,563	5,893	5,463	4,861
$C_{10}H_{16}O$	Myrtenol.....	36.83	46.49	55.04	71.81
$C_{14}H_{20}O_2$	Myrtenyl crotonate.....	32.39	40.97	48.66	63.75
$C_{14}H_{22}O_2$	Myrtenyl butyrate.....	26.99	34.13	40.51	53.01
$C_{16}H_{22}O_2$	Myrtenyl $\Delta^1,4$ pentadiene- α -carboxylate.....	29.25	36.97	43.96	57.36
$C_{16}H_{24}O_2$	Myrtenyl <i>n</i> -hexoate.....	23.95	30.30	35.96	47.13
$C_{17}H_{20}O_2$	Myrtenyl benzoate.....	29.01	36.67	43.51	56.90
$C_{18}H_{22}O_2$	Myrtenyl phenylacetate.....	20.31	25.68	30.35	39.42
$C_{19}H_{24}O_2$	Myrtenyl β -phenylpropionate.....	20.77	26.30	31.22	40.81

12. MENTHONE

Specific rotation $[\alpha]_{\lambda}^t$ of menthone $C_{10}H_{18}O$ at different temperatures (104)

λ t	5,893	5,780	5,461	4,358	λ t	5,893	5,780	5,461	4,358
20	-26.74	-27.84	-32.07	-57.15	120	-31.41	-32.88	-38.18	-71.83
40	-27.65	-28.89	-33.29	-59.92	140	-31.63	-33.13	-38.63	-72.13
60	-28.36	-29.79	-34.38	-62.61	160	-31.48	-33.06	-38.43	-71.48
80	-29.32	-30.67	-35.48	-65.55	180	-31.77	-33.09	-38.37	-71.52
100	-30.43	-31.77	-36.82	-68.84					

*Anomalous rotatory dispersion of mixtures of $C_{10}H_{18}O$ *l*- and *d*-menthone (36; cf. 13, 19, 20, 21, 69)*

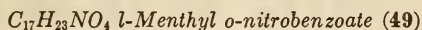
<i>l</i> -Menthone <i>p</i>	<i>d</i> -Menthone <i>p</i>	$[\alpha]_{\lambda}^{20}$			
		6,563	5,893	5,270	4,861
100	-----	-22.44	-28.84	-37.75	-46.47
	100	19.33	26.83	38.66	52.45
46.29	53.71	.085	1.00	3.04	6.03
40.21	59.79	2.37	4.05	7.22	11.43
51.76	48.24	-1.94	-1.70	-.69	1.18
59.24	40.76	-4.73	-5.41	-5.77	-5.41

II CB. THE MOLECULE CONTAINS 2 OR MORE ASYMMETRIC ATOMS ATTACHED RESPECTIVELY TO 2 AND 3 OTHER CARBON ATOMS

13. MENTHOL, ISOPULEGOL, AND DERIVATIVES



$\begin{array}{c} \diagdown \\ p \end{array}$ s-	Phenol C_6H_5OH	Eugenol $C_{10}H_{12}O_2$	$\begin{array}{c} \diagdown \\ p \end{array}$ s-	Phenol C_6H_5OH	Eugenol $C_{10}H_{12}O_2$
10	-----	-48.96	35	-46.51	-47.84
15	-----	-48.52	40	-46.44	-47.73
25	-47.16	-48.13	45	-46.39	-47.63
30	-46.74	-47.98	50	-46.36	-47.56



	d'	$[\alpha]_D^t$	t	d'	$[\alpha]_D^t$
100	1.050	-121.2	$p\text{-Ester}$		
80	1.058	-125.0			
70	1.073	-124.6			
65	1.078	-124.8			
$m\text{-Ester}$			100	1.045	-75.48
			80	1.058	-76.21
			70	1.070	-76.54
			65	1.077	-76.94
100	1.049	-82.04			
80	1.056	-82.92			
70	1.071	-82.54			
65	1.081	-82.06			
40	1.097	-82.17			
20	1.118	-82.52			

Esters of l-Isopulegol $[\alpha]_D^{25}$ (160)

Formula	Name	t°	6, 438	5, 461	5, 086	4, 800	4, 359
$C_{10}H_{18}O$ -----	<i>l</i> -Isopulegol-----	20	-18.23	-25.90	-30.31	-34.51	-43.07
		40	18.61	26.46	31.01	35.43	44.30
		60	18.98	27.05	31.74	36.37	45.55
		80	19.39	27.65	32.47	37.35	46.86
		100	19.83	28.28	33.25	38.37	48.22
		120	20.26	28.95	34.08	39.45	49.67
		140	20.73	29.66	34.95	40.57	51.16
		160	21.22	30.38	35.83	41.74	52.71
$C_{12}H_{20}O_2$ -----	<i>l</i> -Isopulegyl acetate-----	20	-9.58	-12.22	-13.61	-14.57	-15.65
		40	-11.61	-15.32	-17.18	-18.71	-21.24
		60	-13.65	-18.34	-20.74	-22.83	-26.38
		80	-15.82	-21.23	-24.16	-26.95	-31.56
$C_{14}H_{22}O_2$ -----	<i>l</i> -Isopulegyl propionate-----	($s=EtOH, c=5$)-----	20	-16.66	-20.66	-23.95	-26.55
			20	-8.19	-10.13	-11.06	-11.63
			40	-10.17	-13.49	-14.60	-16.12
			60	-12.22	-16.58	-18.51	-20.36
			80	-14.33	-19.63	-22.21	-24.68
		($s=EtOH, c=5$)-----	20	-15.81	-19.64	-22.87	-25.08
$C_{16}H_{24}O$ -----	<i>l</i> -Isopulegyl <i>n</i> -butyrate-----	20	-5.53	-6.46	-7.02	-6.93	-6.28
		40	-7.78	-9.99	-10.98	-11.77	-12.34
		60	-9.87	-13.32	-14.69	-16.13	-18.10
		80	-11.87	-16.24	-18.35	-19.88	-23.41
		100	-14.12	-19.39	-22.41	-24.65	-29.09
		120	-16.31	-22.40	-26.00	-28.77	-34.59
		140	-18.21	-25.54	-29.34	-32.96	-39.86
		160	-20.12	-28.60	-32.77	-37.20	-45.24
$C_{18}H_{26}O_2$ -----	<i>l</i> -Isopulegyl <i>n</i> -valerate-----	($s=EtOH, c=5$)-----	20	-14.11	-16.50	-19.19	-20.67
			20	-6.28	-7.57	-8.28	-8.63
			40	-8.39	-10.87	-11.99	-12.87
			60	-10.32	-13.78	-15.47	-17.12
			80	-12.19	-16.51	-18.79	-20.95
		($s=EtOH, c=5$)-----	20	-14.28	-16.79	-19.71	-21.62
$C_{10}H_{18}O_2$ -----	<i>l</i> -Isopulegyl caproate-----	20	-5.19	-5.95	-6.19	-6.30	-5.84
		40	-7.45	-9.04	-9.84	-10.46	-11.46
		60	-9.33	-11.93	-13.31	-14.55	-16.66
		80	-11.06	-14.86	-16.77	-18.41	-21.47
		($s=EtOH, c=5$)-----	20	-11.37	-14.36	-17.12	-18.79
$C_{12}H_{20}O_2$ -----	<i>l</i> -Isopulegyl enanthate-----	20	-4.84	-5.48	-5.76	-5.83	-5.50
		40	-6.71	-8.45	-9.44	-10.07	-10.74
		60	-8.43	-11.27	-12.57	-13.82	-15.41
		80	-10.17	-13.88	-15.68	-17.53	-20.00
		($s=EtOH, c=5$)-----	20	-10.81	-13.82	-15.92	-17.12
$C_{14}H_{22}O_2$ -----	<i>l</i> -Isopulegyl caprylate-----	20	-4.60	-5.23	-5.68	-5.86	-5.26
		40	-6.58	-7.92	-8.84	-9.68	-10.10
		60	-8.28	-10.52	-11.88	-13.23	-14.82
		80	-9.78	-13.09	-14.84	-16.69	-19.07
		($s=EtOH, c=5$)-----	20	-10.30	-13.50	-15.10	-16.81
$C_{16}H_{24}O_2$ -----	<i>l</i> -Isopulegyl pelargonate-----	20	-4.36	-4.98	-5.38	-5.51	-4.94
		40	-6.20	-7.64	-8.43	-9.22	-9.47
		60	-7.72	-10.24	-11.39	-12.64	-13.94
		80	-9.20	-12.57	-14.06	-15.62	-18.12
		($s=EtOH, c=5$)-----	20	-10.21	-13.01	-14.81	-16.31
$C_{18}H_{26}O_2$ -----	<i>l</i> -Isopulegyl caprate-----	20	-4.15	-4.93	-5.20	-5.35	-5.15
		40	-5.78	-7.52	-8.19	-8.71	-9.66
		60	-7.41	-9.75	-11.10	-12.23	-13.54
		80	-9.02	-11.92	-13.69	-15.20	-17.38
		($s=EtOH, c=5$)-----	20	-9.77	-12.47	-14.16	-15.65
$C_{20}H_{28}O_2$ -----	<i>l</i> -Isopulegyl undecylate-----	20	-4.31	-4.98	-5.29	-5.54	-5.54
		40	-5.94	-7.35	-8.21	-8.94	-9.41
		60	-7.31	-9.48	-10.83	-11.82	-13.18
		80	-8.65	-11.48	-13.02	-14.52	-16.44
		($s=EtOH, c=5$)-----	20	-9.86	-11.87	-13.68	-15.39
$C_{22}H_{30}O_2$ -----	<i>l</i> -Isopulegyl laurate-----	20	-3.84	-4.42	-4.83	-4.98	-4.65
		40	-5.35	-6.69	-7.60	-8.23	-8.57
		60	-6.89	-8.88	-10.14	-11.18	-12.27
		80	-8.32	-11.01	-12.47	-13.75	-15.93
		($s=EtOH, c=5$)-----	20	-9.44	-11.90	-13.56	-15.04
$C_{24}H_{34}O_2$ -----	<i>l</i> -Isopulegyl myristate-----	20	-3.81	-4.23	-4.68	-4.84	-4.48
		40	-5.30	-6.30	-7.05	-7.62	-8.07
		60	-6.63	-8.32	-9.38	-10.28	-11.44
		80	-7.82	-10.33	-11.69	-13.00	-15.02
		($s=EtOH, c=5$)-----	20	-9.24	-10.95	-12.76	-14.16

Menthol and related compounds in solution $[a]_D^{20}$ (104; cf. 12, 71, 136, 185, 191)

t = approximately 20°

Formula	Name	s	c	5,893	5,780	5,461	4,358
$C_{10}H_{18}O$ -----	<i>l</i> -Menthone-----	$\{C_6H_6$ -----	5.01	16.73	17.13	19.83	35.17
		$\{EtOH$ -----	5.49	23.19	24.02	27.66	47.31
		$\{CS_2$ -----	5.47	23.95	24.86	29.07	58.68
$C_{10}H_{20}O$ -----	<i>l</i> -Menthol-----	$\{EtOH$ -----	5.16	-49.46	-51.80	-59.14	-97.09
		$\{CS_2$ -----	5.28	47.03	49.11	55.64	93.19
		$\{C_6H_6$ -----	5.53	44.60	46.52	52.78	86.78
$C_{12}H_{22}O_2$ -----	<i>l</i> -Menthyl acetate-----	$\{CS_2$ -----	5.18	77.01	81.27	91.20	150.58
		$\{EtOH$ -----	5.79	85.23	89.02	100.93	167.50
$C_{17}H_{21}O_4$ -----	<i>l</i> -Menthyl hydrogen succinate (Cf. 12).-----	$\{C_6H_6$ -----	5.08	59.43	62.24	70.47	116.27
		$\{CHCl_3$ -----	5.09	65.65	68.50	78.05	128.91
$C_{17}H_{22}BrClO_2$ -----	<i>l</i> -Menthyl 2-chloro-6-bromobenzoate.-----	CS_2 -----	4.77	15.69	16.74	19.04	33.88
$C_{17}H_{22}ClNO_4$ -----	<i>l</i> -Menthyl 4-chloro-2-nitrobenzoate.-----	CS_2 -----	4.12	144.64	152.76	181.74	447.38
$C_{17}H_{22}ClNO_4$ -----	<i>l</i> -Menthyl 4-chloro-3-nitrobenzoate.-----	Py -----	4.60	72.57	75.19	85.41	155.39
$C_{17}H_{22}ClNO_4$ -----	<i>l</i> -Menthyl 5-chloro-2-nitrobenzoate.-----	$\{CS_2$ -----	4.52	151.53	161.25	193.97	516.14
		$\{C_6H_6$ -----	4.86	169.38	180.86	217.30	566.79
		$\{CHCl_3$ -----	5.46	153.71	162.40	195.23	505.03
$C_{17}H_{22}N_2O_4$ -----	<i>l</i> -Menthyl 2, 6-dinitrobenzoate.-----	C_6H_6 -----	4.72	184.05	196.83	237.49	644.60
$C_{17}H_{22}N_2O_4$ -----	<i>l</i> -Menthyl 3, 5-dinitrobenzoate.-----	$CHCl_3$ -----	4.64	80.39	83.32	96.03	173.83
$C_{17}H_{22}N_2O_6$ -----	<i>l</i> -Menthyl 2, 4-dinitrobenzoate.-----	$\{Py$ -----	4.73	116.0	122.6	145.0	347.62
		$\{CS_2$ -----	4.83	133.3	141.2	167.9	403.11
		$\{CHCl_3$ -----	4.94	135.9	144.0	170.9	403.76
		$\{C_6H_6$ -----	4.80	138.1	146.1	173.6	425.68
$C_{17}H_{22}ClO_2$ -----	<i>l</i> -Menthyl <i>m</i> -chlorobenzoate.-----	CS_2 -----	5.67	85.19	89.07	100.13	171.80
$C_{17}H_{22}FO_2$ -----	<i>l</i> -Menthyl <i>p</i> -fluorobenzoate.-----	$\{Py$ -----	5.31	81.45	84.94	96.14	160.58
		$\{CHCl_3$ -----	4.84	81.70	85.41	96.56	159.87
		$\{EtOH$ -----	4.73	84.37	87.62	99.33	165.57
		$\{CS_2$ -----	4.55	90.24	93.33	106.72	181.38
		$\{C_6H_6$ -----	4.82	86.80	90.74	102.86	173.09
$C_{17}H_{22}IO_2$ -----	<i>l</i> -Menthyl <i>o</i> -iodobenzoate.-----	CS_2 -----	5.17	58.59	61.76	70.34	124.49
$C_{17}H_{22}IO_2$ -----	<i>l</i> -Menthyl <i>m</i> -iodobenzoate.-----	$\{Py$ -----	5.28	58.38	62.37	68.96	115.20
		$\{CS_2$ -----	6.19	63.97	66.24	74.80	127.77
$C_{17}H_{22}IO_2$ -----	<i>l</i> -Menthyl <i>p</i> -iodobenzoate.-----	$\{AcOEt$ -----	6.06	57.36	59.91	67.72	111.61
		$\{C_6H_6$ -----	5.71	69.69	72.14	82.13	139.73
$C_{17}H_{22}NO_4$ -----	<i>l</i> -Menthyl <i>o</i> -nitrobenzoate.-----	$\{Py$ -----	5.07	138.91	146.90	175.00	435.52
		$\{CHCl_3$ -----	5.15	154.01	162.01	170.67	461.97
		$\{EtOH$ -----	4.92	156.78	165.52	195.57	466.90
		$\{CS_2$ -----	5.57	162.76	172.27	208.08	513.34
		$\{C_6H_6$ -----	4.19	182.40	193.47	230.27	560.18
$C_{17}H_{22}NO_4$ -----	<i>l</i> -Menthyl <i>m</i> -nitrobenzoate.-----	$\{Py$ -----	5.87	81.75	85.67	97.76	173.34
$C_{17}H_{24}O_2$ -----	<i>l</i> -Menthyl benzoate-----	$\{CS_2$ -----	7.11	88.97	92.83	106.48	186.09
		$\{C_6H_6$ -----	5.20	90.38	96.01	106.70	178.60
		$\{CHCl_3$ -----	5.18	86.61	90.66	102.24	169.75
$C_{17}H_{22}NO_2$ -----	<i>l</i> -Menthyl phenylcarbamate.-----	$CHCl_3$ -----	4.96	76.91	80.04	91.83	153.22
$(C_{18}H_{23}O_4)_2Mg$ -----	Magnesium <i>l</i> -menthyl phthalate.-----	$EtOH$ -----	3.76	55.23	57.62	65.06	108.88
$C_{18}H_{23}O_4Na$ -----	Sodium <i>l</i> -menthyl phthalate.-----	H_2O -----	5.29	60.74	63.42	72.52	123.79
$C_{18}H_{24}O_4$ -----	<i>l</i> -Menthyl hydrogen phthalate.-----	$CHCl_3$ -----	4.97	93.74	97.86	113.15	205.19
$C_{18}H_{26}O_2$ -----	<i>l</i> -Menthyl phenylacetate.-----	C_6H_6 -----	5.07	64.43	67.39	76.26	128.45
$C_{18}H_{26}O_2$ -----	<i>l</i> -Menthyl <i>m</i> -toluate.-----	C_6H_6 -----	5.03	88.47	92.17	104.99	176.63
$C_{20}H_{30}O_3$ -----	<i>l</i> -Menthyl <i>o</i> -propoxybenzoate.-----	CS_2 -----	4.89	59.82	62.37	70.34	115.45
$C_{20}H_{30}O_3$ -----	<i>l</i> -Menthyl <i>p</i> -isopropoxybenzoate.-----	C_6H_6 -----	4.78	79.56	83.22	94.58	161.41
$C_{20}H_{38}O_3S$ -----	<i>di-l</i> -Menthyl sulphite.-----	$EtOH$ -----	4.92	78.81	81.75	93.22	155.90
$C_{22}H_{28}O_3$ -----	<i>l</i> -Menthyl 2-methoxynaphthoate.-----	$\{CS_2$ -----	4.95	46.89	49.32	56.39	89.33
		$\{C_6H_6$ -----	5.02	51.16	53.43	60.75	99.79
		$\{EtOH$ -----	5.27	97.86	101.84	115.57	192.12
		$\{CS_2$ -----	4.79	82.08	85.82	96.68	157.99
		$\{C_6H_6$ -----	4.92	98.18	102.55	116.25	192.81
$C_{22}H_{38}O_4$ -----	<i>l</i> -Dimenthyl oxalate.-----	$\{Py$ -----	4.74	93.69	97.43	110.83	183.84
		$\{C_6H_6$ -----	4.74	93.69	97.43	110.83	183.84
$C_{24}H_{28}NO_4$ -----	Pyridinium <i>l</i> -menthyl phthalate.-----	Py -----	6.57	70.92	74.57	86.30	159.74

Menthylamine derivatives $[\alpha]_{\lambda}^t$ (104; cf., 12, 71, 136, 185, 191) t = approximately 20°

Formula	Name	s	c	5, 893	5, 780	5, 461	4, 358
C ₁₀ H ₂₂ ClN	<i>l</i> -Menthylamine hydrochloride	{H ₂ O	5.12	36.29	37.45	42.60	69.85
C ₁₃ H ₂₅ NO ₂	Ethyl <i>l</i> -menthylcarbamate	{CHCl ₃	4.98	45.72	49.86	54.14	89.82
C ₁₄ H ₂₅ NO ₂	Allyl <i>l</i> -menthylcarbamate	{CHCl ₃	3.94	68.52	71.31	81.58	137.0
C ₁₄ H ₂₉ N ₃ O	<i>n</i> -Propyl <i>l</i> -menthylcarbamide	{EtOH	4.35	67.33	70.08	79.86	135.98
C ₁₅ H ₂₉ NO ₂	<i>n</i> -Butyl <i>l</i> -menthylcarbamate	{CHCl ₃	2.77	66.94	69.47	79.20	133.17
C ₁₅ H ₂₇ NO ₂	<i>m</i> -Tolyl <i>l</i> -menthylcarbamate	{CHCl ₃	4.42	64.18	66.74	76.19	128.76
C ₁₅ H ₂₇ NO ₂	<i>p</i> -Tolyl <i>l</i> -menthylcarbamate	{CHCl ₃	2.93	56.14	59.20	66.70	115.35
C ₁₅ H ₂₇ NO ₂	<i>m</i> -Tolyl <i>l</i> -menthylcarbamide	{CHCl ₃	1.96	56.49	58.52	66.92	112.98
C ₁₅ H ₂₉ N ₃ O	<i>m</i> -4-Xylenyl <i>l</i> -menthylcarbamate	{Py	2.23	80.67	85.06	97.03	171.32
C ₁₉ H ₂₉ NO ₂	1-Naphthyl <i>l</i> -menthylcarbamate	{CHCl ₃	3.85	53.91	55.67	63.57	108.05
C ₂₁ H ₂₇ NO ₂	2-Naphthyl <i>l</i> -menthylcarbamate	{EtOH	3.10	43.66	51.86	59.64	100.20
C ₂₁ H ₂₉ N ₃ O	<i>l</i> -Menthyl <i>l</i> -menthylcarbamate	{CHCl ₃	1.13	64.68	67.89	76.72	136.18
C ₂₁ H ₂₉ NO ₂	<i>l</i> -Menthyl <i>l</i> -menthylcarbamate	{CHCl ₃	4.74	90.02	93.60	106.34	178.26
C ₂₁ H ₄₀ N ₂ O	di- <i>l</i> -Menthylcarbamide	{CHCl ₃	4.68	91.26	95.53	108.02	181.25

Rotatory dispersion of some menthyl esters (197; cf., 38)

Formula	Name	s	t	p or c	6, 563	5, 893	5, 461	4, 861
C ₁₂ H ₂₁ NO ₂	<i>l</i> -Menthyl cyanoacetate	C ₆ H ₆	20	10	-64.15	-80.92	-95.21	-123.57
C ₁₆ H ₂₄ O ₄	<i>l</i> -Menthyl acetylacetoacetate	{Nil			-61.49	-79.56	-96.34	-131.32
C ₁₆ H ₂₄ O ₄	<i>l</i> -Menthyl ethylacetoacetate	{C ₆ H ₆		10	-40.39	-50.77	-59.46	-76.50
C ₁₆ H ₂₄ O ₄	<i>l</i> -Menthyl ethylacetoacetate	{C ₆ H ₆		10	-50.59	-63.85	-75.60	-98.39
C ₁₇ H ₂₀ O ₃	<i>l</i> -Menthyl isopropylacetoacetate	{Nil	20		-48.69	-61.53	-72.91	-95.05
C ₁₈ H ₂₆ O ₂	Menthyl <i>o</i> -toluate (33)	{C ₆ H ₆	20	10	-47.32	-59.74	-70.53	-91.70
C ₁₉ H ₂₄ O ₃	<i>l</i> -Menthyl phenylpropiolate	{Nil	20		-66.54	-84.58	-108.84	-131.72
C ₁₉ H ₂₆ O ₃	<i>l</i> -Menthyl benzoylacetate	{C ₆ H ₆	20	10	-50.95	-64.39	-76.15	-99.89
C ₂₁ H ₂₆ O ₄	<i>l</i> -Menthyl benzylideneacetate (cf. 82)	{C ₆ H ₆		10	-8.17	-10.97	-13.66	-21.27
C ₂₁ H ₂₆ O ₄	<i>l</i> -Menthyl <i>l</i> -benzylacetoacetate	{C ₆ H ₆	20	10	-94.05	-121.21	-145.67	-196.73
C ₂₁ H ₂₆ O ₄	<i>l</i> -Menthyl <i>dl</i> -benzylacetoacetate	{C ₆ H ₆	20	10	-43.43	-55.10	-65.20	-85.85
C ₂₅ H ₃₀ O ₄	<i>l</i> -Menthyl benzoylphenylacetate	{C ₆ H ₆	20	10	13.73	21.10	28.58	49.91
C ₂₅ H ₃₀ O ₄	<i>l</i> -Menthyl benzoylphenylacetate	{EtOH	20	{ 10+1 dropy	-43.89	-58.91	-75.08	-93.57
C ₂₆ H ₃₀ O ₄	<i>l</i> -Menthyl benzoylbenzylideneacetate	{C ₆ H ₆	20	10	-61.75	-78.62	-93.69	-123.84
C ₂₇ H ₃₄ O ₃	<i>l</i> -Menthyl <i>d</i> -diphenylmethylacetoacetate	{C ₆ H ₆		10	-33.83	-41.94	-48.18	-60.00
C ₂₇ H ₃₄ O ₃	<i>l</i> -Menthyl <i>l</i> -diphenylmethylacetoacetate	{C ₆ H ₆		10	-51.13	-65.15	-78.04	-103.94
C ₂₇ H ₃₄ O ₃	<i>l</i> -Menthyl <i>dl</i> -diphenylmethylacetoacetate	{C ₆ H ₆		10	-42.62	-53.69	-63.31	-82.43
C ₂₈ H ₃₄ O ₃	<i>l</i> -Menthyl <i>l</i> -benzoylcinnamylacetate	{C ₆ H ₆	20	10	-67.41	-86.08	-102.18	-135.71
C ₃₀ H ₃₄ O ₂	<i>l</i> -Menthyl triphenylacetate (33)	{PhMe	20	1	26.17	-3.04	-3.44	-3.67
C ₃₀ H ₃₄ O ₂	<i>l</i> -Menthyl triphenylacetate (33)	{CS ₂	20	1	19.22	-9.94	-13.79	-19.65
C ₃₀ H ₃₄ O ₂	<i>l</i> -Menthyl triphenylacetate (33)	{Me ₂ CO	20	1	12.89	-1.58	-1.58	-1.28
C ₃₀ H ₃₄ O ₂	<i>l</i> -Menthyl triphenylacetate (33)	{CHCl ₃	20	1	13.12	-3.81	-4.39	-4.83

¹ For this compound $c = g/100$ cc.

67316°—32—5 °

Menthol and menthyl esters $[\alpha]_D^{20}$

Formula	Name	<i>p</i>	<i>s</i>	6,563	5,893	5,463	4,861	Lit.
C ₁₀ H ₂₀ O	<i>l</i> -Menthol		C ₆ H ₆	37.01	46.58	54.78	70.84	188
C ₁₃ H ₂₁ NO ₂	<i>l</i> -Menthyl cyanoacetate	10	C ₆ H ₆	-64.15	80.92	95.21	123.57	197
			Nil	-54.92	-69.21	-81.98	-109.35	188
C ₁₄ H ₂₄ O ₃	<i>l</i> -Menthyl acetoacetate	10	C ₆ H ₆	-55.71	-69.32	-82.15	-105.78	204
			C ₆ H ₆		-68.03			188
			EtOH		-70.26			188
C ₁₄ H ₂₆ O ₂	<i>l</i> -Menthyl butyrate		Nil	55.39	69.66	82.13	106.16	188
C ₁₅ H ₂₈ O ₂	<i>l</i> -Menthyl isovalerate		Nil	51.88	65.18	76.95	99.09	188
C ₁₆ H ₂₈ O ₄	<i>l</i> -Menthyl acetylacetoacetate	10	Nil	61.49	-79.56	-96.34	-131.32	197
			C ₆ H ₆	-51.84	-66.88	-80.68	-110.64	
C ₁₆ H ₂₈ O ₃	<i>l</i> -Menthyl ethylacetoacetate		Nil	-50.59	-63.85	-75.60	-98.39	188, 197
C ₁₇ H ₂₄ O ₂	<i>l</i> -Menthyl benzoate		C ₆ H ₆	72.41	91.10	107.76	139.30	188
C ₁₇ H ₃₀ O ₃	<i>l</i> -Menthyl isopropylacetoacetate		Nil	-48.69	-61.53	-72.91	-95.05	188, 197
C ₁₈ H ₂₆ O ₂	<i>l</i> -Menthyl <i>o</i> -toluate	10	C ₆ H ₆	-47.32	-59.74	-70.58	-91.70	
	<i>l</i> -Menthyl ethyl acetylsuccinate (α -ester)		Nil	-44.76	-56.67	-67.24	-87.97	38, 197
			C ₆ H ₆	-45.59	-57.80	-67.99	-89.38	
	<i>l</i> -Menthyl ethyl acetylsuccinate (β -ester)		Nil	-38.77	-48.80	-57.45	-74.02	188, 197
			C ₆ H ₆	-40.94	-51.59	-60.68	-78.29	
C ₁₈ H ₃₂ O ₃	<i>l</i> -Menthyl diethylacetoacetate		Nil	-44.35	-55.68	-65.53	-84.35	188, 197
			C ₆ H ₆	-40.89	-50.77	-59.46	-76.50	
C ₁₈ H ₂₄ O ₂	<i>l</i> -Menthyl phenylpropionate	10	C ₆ H ₆	-57.31	-72.56	-85.90	-111.92	188, 197
C ₁₈ H ₂₈ O ₂	<i>l</i> -Menthyl cinnamate		C ₆ H ₆	59.94	75.80	89.75	117.42	188
C ₁₉ H ₂₆ O ₂	<i>l</i> -Menthyl benzoylacetate	10	C ₆ H ₆	-50.95	-64.39	-76.15	-99.89	197
C ₁₉ H ₃₄ O ₃	<i>l</i> -Menthyl <i>l</i> -amylacetoacetate		Nil	-32.40	40.48	47.66	61.01	204
C ₂₀ H ₂₈ O ₂	<i>l</i> -Menthyl α -methylcinnamate		C ₆ H ₆	49.99	62.26	72.95	92.65	188
C ₂₀ H ₂₈ O ₂	<i>l</i> -Menthyl β -methylcinnamate		C ₆ H ₆	53.13	66.35	78.01	99.61	188
C ₂₁ H ₂₆ O ₃	<i>l</i> -Menthyl benzylideneacetoacetate	10	C ₆ H ₆	-8.17	-10.97	-13.66	-21.27	188, 197
C ₂₁ H ₃₀ O ₃	<i>l</i> -Menthyl <i>l</i> -benzylacetoacetate	10	C ₆ H ₆	-94.05	-121.21	-145.67	-196.75	188, 197
C ₂₁ H ₃₀ O ₃	<i>dl</i> -Menthyl <i>dl</i> -benzylacetoacetate	10	C ₆ H ₆	-43.43	-55.10	-65.20	-85.85	197
C ₂₂ H ₃₂ O ₃	<i>l</i> -Menthyl α -phenylethylacetoacetate	10	C ₆ H ₆	-84.25	108.2	131.3	177.75	204
	<i>l</i> -Menthyl <i>d</i> -benzoylphenylacetate	10	C ₆ H ₆	13.73	21.10	28.58	49.91	197
C ₂₂ H ₃₀ O ₃	<i>l</i> -Menthyl <i>dl</i> -benzoylphenylacetate	10	EtOH ¹	-43.89	-58.91	-75.08	-93.57	197
C ₂₆ H ₃₀ O ₃	<i>l</i> -Menthyl benzoylbenzylideneacetate	10	C ₆ H ₆	-61.75	-78.62	-93.69	-123.84	197
C ₂₆ H ₃₀ O ₄	<i>l</i> -Menthyl dibenzoylacetate		C ₆ H ₆	-49.53	-64.07	-76.88	-104.18	188, 197
C ₂₇ H ₃₄ O ₃	<i>l</i> -Menthyl <i>d</i> -diphenylmethylacetoacetate	10	C ₆ H ₆	-33.83	-41.94	-48.18	-60.00	197
C ₂₇ H ₃₄ O ₃	<i>l</i> -Menthyl <i>l</i> -diphenylmethylacetoacetate	10	C ₆ H ₆	-51.13	-65.15	-78.04	-103.94	197
C ₂₇ H ₃₄ O ₃	<i>l</i> -Menthyl <i>dl</i> -diphenylmethylacetoacetate	10	C ₆ H ₆	-42.62	-53.69	-63.31	-82.43	188, 197
C ₂₈ H ₃₄ O ₃	<i>l</i> -Menthyl <i>l</i> -benzoylcinnamate		C ₆ H ₆	-67.41	-86.08	-102.18	-135.71	197
C ₂₈ H ₄₂ O ₅	<i>l</i> -Menthyl dibenzoylacetate		C ₆ H ₆	42.79	53.94	63.30	80.35	188

¹ With one drop of piperidine.

Mutarotation of l-menthyl esters of keto-acids (186)

$C_{14}H_{21}O_3$ <i>l</i> -Menthyl acetoacetate		$C_{19}H_{29}O_3$ <i>l</i> -Menthyl benzoylacetate		$C_{23}H_{33}O_3$ <i>l</i> -Menthyl phenylacetoacetate	
$s = C_6H_5$. $p = 10.02$		$s = C_6H_5$. $p = 10.04$		$s = C_6H_5$. $p = 10.04$	
Hours	$[\alpha]_D^{20}$	Hours	$[\alpha]_D^{20}$	Hours	$[\alpha]_D^{20}$
0	-64.0	0	-55.4	0	+28.7
1	-64.2	1	-58.4	80	-25.1
19	-64.5	3	-61.7	104	-31.3
68	-65.5	5	-62.5	144	-38.5
96	-5.9			245	-49.4
$s = EtOH$. $p = 0.88$		7	-63.2	319	-53.5
		9	-63.2	464	-60.7
		23	-63.9	628	-62.1
		50	64.0	800	-64.9
		$s = EtOH$. $p = 9.93$		1,303	-66.0
0	-71.4	0	-56.4	1,615	-67.2
0.75	-71.0	0.75	-56.6	$s = EtOH$. $p = 10.01$	
1.5	-70.8	3	-56.8	0	-28.3
2.25	-70.7	6	-56.9	2	-37.9
3.0	-70.2			5	-49.4
				9	-58.0
				12	-61.5
				24	-65.5
				47	-67.1
				$C_{25}H_{35}O_3$ <i>l</i> -Menthyl phenylbenzoylacetate	
				$s = EtOH$. $p = 1.25$	
				0	-12
				2	-16
				17	-39
				25	-45
				89	-63

 $C_{20}H_{31}O_4S$ *l*-Menthyl *d*- β -camphorsulphonate $[\alpha]_{\lambda}^{20}$ (35)

s	λ c	656 $\mu\mu$	589 $\mu\mu$	527 $\mu\mu$	486 $\mu\mu$	472 $\mu\mu$	457 $\mu\mu$
PhMe.....	9.76	-12.04	-13.45	-13.95	-12.86	-12.04	-----
Me ₂ CO.....	7.54	-15.38	-17.57	-19.08	-18.73	-18.03	-----
CHCl ₃	9.66	-17.87	-20.63	-22.92	-23.30	-22.76	-21.46

l-Menthyl *l*- β -camphorsulphonate

PhMe.....	9.70	-57.9	-74.7	-98.3	-122.0	-131.3	-----
Me ₂ CO.....	11.05	-57.3	-74.1	-97.8	-121.4	-----	-----

¹ In the presence of one drop of piperidine this value is reached in eight minutes.

Mutarotation of *l*-menthyl esters of keto-acids (186)—Continued

C ₁₅ H ₂₃ OS ₂ (40) Methyl <i>l</i> -menthyl- xanthate (superfused)		C ₁₅ H ₂₃ OS ₂ (42) Benzyl <i>l</i> -menthyl- xanthate		C ₁₅ H ₁₉ O ₂ S ₄ (42) Meth- ylene di- <i>l</i> -menthyl- xanthate—Contd.	
$d=1.037$		$s=\text{PhMe. } c=9.994$		$s=\text{CS}_2. \quad c=7.069$	
λ	$[\alpha]_{\lambda}^{20}$	λ	$[\alpha]_{\lambda}^{20}$	λ	$[\alpha]_{\lambda}^{20}$
657 $\mu\mu$	-56.4	657	-32.0	657	-9.70
589	-64.8	590	-35.1	590	-2.00
553	-67.7	553	-36.9	559	5.56
527	-67.9	528	-36.0	547	9.90
517	-67.1	508	-33.8		
		500	-32.0	523	19.8
508	-65.7	486	-28.2	503	33.5
500	-63.8			509	41.6
492	-61.4			486	58.7
486	-58.5				
473	-49.1				
$s=\text{PhMe. } c=5.788$		C ₂₇ H ₂₅ O ₂ S ₃ (33) <i>l</i> -Menthylxanthic thioanhydride		C ₂₄ H ₂₉ NOS ₂ (39, 41) 1,2-Diphenyl- <i>l</i> -men- thylimido-xanthide (<i>l</i> -Menthyl phenyl- thiobenzoylthioure- thane, Ph.CS.N Ph. CS.OC ₁₀ H ₁₉)	
673	-62.3	$s=\text{PhMe. } c=5.657$		$s=\text{PhMe. } c=0.138$	
657	-65.1	684	-48.5	622	-192
622	-70.9	657	-49.8	603	-272
590	-76.6	622	-49.6	590	-338
560	-81.4	603	-48.4	582	-449
		589	-46.5		
542	-83.9	548	-34.3	573	-536
528	-85.3			559	-594
522	-85.8	527	-21.3	547	-507
517	-85.8	516	-11.8	536	-260
508	-85.6	506	-2.2		
		498.5	+5.0	528	0
500	-85.0	491	+11.8	508	580
486	-82.2			492	870
473	-76.5			478	1,160
452	-56.7				
C ₁₅ H ₂₁ OS ₂ (40) Ethyl <i>l</i> -menthyl- xanthate (liquid)		C ₂₇ H ₂₅ O ₂ S ₄ (34; cf., 33) <i>l</i> -Menthyl dixanthide		$s=\text{Me}_2\text{CO. } c=0.138$	
$d=1.020$		$s=\text{PhMe. } c=9.404$		657	-33
657	-52.4	656	-182.8	622	-105
589	-60.3	589	-225.1	603	-183
553	-63.0	527	-271.0	590	-301
527	-63.4	486	-293.3	582	-348
517	-62.6				
		478	-293.4	573	-507
508	-61.4	472	-292.0	559	-579
500	-59.8	466	-288.0	547	-594
486	-55.3	461	-281.9	536	-522
473	-47.0			528	-261
$s=\text{PhMe. } c=9.442$		C ₂₇ H ₂₅ O ₂ S ₄ (42) Meth- ylene di- <i>l</i> -menthyl- xanthate		$s=\text{PhMe. } c=0.9876$	
657	-59.7	$s=\text{PhMe. } c=10.18$		687	-51
589	-70.4	683	1.37	663	-80
553	-75.7	657	3.35	642	-116
527	-78.6	622	7.66	622	-167
517	-78.9	590	13.9		
508	-78.9	553	24.8		
500	-78.3	528	37.5		
486	-75.5	508	51.6		
478	-73.3	486	75.4		
473	-70.1				

Mutarotation of *l*-menthyl esters of keto-acids (186)—Continued

C ₂₄ H ₃₂ NO ₂ S (39) <i>l</i> -Menthyl monothiourethane (<i>l</i> -menthyl phenylthiobenzoylurethane, Ph. CS. N Ph. CO. OC ₁₀ H ₁₉)		C ₂₄ H ₄₂ O ₂ S ₄ (42) Ethylene di- <i>l</i> -menthylxanthate [CH ₂ . S.C S.OC ₁₀ H ₁₉] ₂		C ₂₅ H ₄₁ O ₂ S ₄ (42) Trimethylene di- <i>l</i> -menthylxanthate	
s = PhMe. c = 0.131		s = PhMe. c = 7.506		s = PhMe. c = 6.49	
λ	[α] _λ ²⁰	λ	[α] _λ ²⁰	λ	[α] _λ ²⁰
696	-31	657	-56.1	675	-54.9
657	-35	622	-61.1	657	-57.2
641	-39	590	-65.4	622	-62.7
622	-47	553	-69.3	559	-67.1
603	-57	536	-70.3	553	-71.7
590	-78	528	-70.4	536	-72.7
573	-110	508	-69.3	523	-73.0
560	-162	500	-67.9	522	-73.2
547	-230	492	-66.0	517	-73.0
C ₂₄ H ₃₀ OS ₂ (42) Diphenylcarbinyl <i>l</i> -menthylxanthate		486	-63.9	508	-72.6
		478	-58.0	500	-71.7
s = EtOH				486	-68.6
657	-53.4			478	-65.0
589	-65.3	C ₃₀ H ₃₄ OS ₂ (42) Triphenylcarbinyl <i>l</i> -menthylxanthate		s = PhMe. c = 4.395	
528	-77.6			657	-72.8
486	-82.4			589	-96.9
478	-82.9			527	-127.5
472	-83.3			456	-159.2
466	-81.3			472	-175.0

(43) [α]_λ^t

C ₁₂ H ₂₂ OS ₂ Methyl <i>l</i> -menthylxanthate					C ₂₃ H ₄₀ O ₂ S ₄ Methylene di- <i>l</i> -menthylxanthate				
s = PhMe. p = 10.18					s = PhMe. p = 4.89				
λ t	656 μμ	589 μμ	527 μμ	486 μμ	λ t	656 μμ	589 μμ	527 μμ	436 μμ
-36.6	-64.3	-75.4	-83.3	-79.3	-22.0	17.4	32.4	63.7	108.8
-31.8	-64.6	-75.7	-83.6	-79.8	0.0	10.8	23.4	51.4	93.3
0.0	-65.1	-76.8	-85.1	-81.6	22.0	2.8	12.0	36.6	74.3
17.4	-65.3	-76.8	-85.3	-82.4	50.4	-8.7	-2.4	16.2	47.9
47.5	-65.8	-77.4	-86.0	-82.8	80.4	-20.3	-17.5	-5.0	20.8
80.6	-66.1	-77.5	-86.2	-83.8	C ₂₂ H ₃₈ O ₂ S ₂ <i>l</i> -Menthylxanthic thioanhydride				
s = AcOEt. p = 4.33					s = PhMe. p = 1.06				
-47.6	-66.6	-78.9	-87.7	-86.2	-34.6	-22.6	1.0	+85.3	+285.
0.0	-67.7	-80.9	-90.7	-89.2	19.8	-51.3	-48.0	-20.7	+23.4
20.5	-68.4	-81.9	-91.5	-90.2	80.2	-76.0	-94.7	-127.5	-----
49.2	-69.3	-82.7	-93.2	-92.0					

IIDC. THE MOLECULE CONTAINS 2 OR MORE ASYMMETRIC ATOMS ATTACHED RESPECTIVELY TO 3 OR 4 OTHER CARBON ATOMS

14. CAMPHORIC AND CAMPHOLYTIC ACIDS AND DERIVATIVES

$C_{10}H_{16}O_4$ Camphoric acid and normal camphorates (87)

Formula	Organic base (s=EtOH) $[\alpha]_D^{20}$	c=2.5	5.0
$C_{10}H_{16}O_4$	Nil.....	47.72	48.02
$C_{18}H_{32}N_2O_4$	<i>n</i> -Butylamine.....	11.16	10.96
$C_{20}H_{36}N_2O_4$	Pyridine.....	27.12	25.90
$C_{20}H_{38}N_2O_4$	Piperidine.....	14.36	14.24
$C_{22}H_{30}N_2O_4$	Aniline.....	31.84	32.5
$C_{24}H_{34}N_2O_4$	Benzylamine.....	17.16	16.92
$C_{28}H_{40}N_2O_4$	Quinoline.....	18.76	19.16
$C_{28}H_{38}N_2O_4$	Tetrahydroquinoline.....	17.28	17.56
$C_{20}H_{24}N_2O_4$	α -Naphthylamine.....	18.00	18.12
$C_{20}H_{24}N_2O_4$	β -Naphthylamine.....	18.72	18.64
$C_{20}H_{42}N_2O_4$	<i>ac</i> -Tetrahydro- β -naphthylamine.....	14.32	14.38
$C_{20}H_{42}N_2O_4$	<i>ar</i> -Tetrahydro- α -naphthylamine.....	16.76	16.92

Derivatives of camphoric acid

s	c	$[\alpha]_D^{13}$	s	c	$[\alpha]_D^{13}$	s	c	$[\alpha]_D^{13}$
$C_{10}H_{14}BrNO_2$ <i>d</i> -Camphorbromimide (52)			$C_{11}H_{17}NO_2$ <i>d</i> -Camphormethylimide			$C_{17}H_{20}N_2O_4$ <i>d</i> -Camphor <i>p</i> -nitrobenzylimide		
C_6H_6	$\left\{ \begin{array}{l} 1.9412 \\ 2.3840 \\ 3.0828 \end{array} \right.$	$\left\{ \begin{array}{l} 12.0 \\ 11.2 \\ 12.0 \end{array} \right.$	$EtOH$	$\left\{ \begin{array}{l} 2.4352 \\ 3.1372 \\ 3.5548 \end{array} \right.$	$\left\{ \begin{array}{l} 11.1 \\ 11.0 \\ 11.4 \end{array} \right.$	Me_2CO	$\left\{ \begin{array}{l} 2.0284 \\ 2.7180 \\ 3.1392 \end{array} \right.$	$\left\{ \begin{array}{l} 11.8 \\ 12.3 \\ 12.3 \end{array} \right.$
$CHCl_3$	$\left\{ \begin{array}{l} 1.6644 \\ 2.7372 \\ 2.8640 \end{array} \right.$	$\left\{ \begin{array}{l} 13.6 \\ 13.0 \\ 12.8 \end{array} \right.$	Me_2CO	$\left\{ \begin{array}{l} 4.2428 \\ 2.8280 \\ 4.1460 \end{array} \right.$	$\left\{ \begin{array}{l} 11.3 \\ 8.0 \\ 8.0 \end{array} \right.$	C_6H_6	$\left\{ \begin{array}{l} 2.2520 \\ 3.9712 \end{array} \right.$	$\left\{ \begin{array}{l} 2.6 \\ 2.8 \end{array} \right.$
$C_{10}H_{14}INO_2$ <i>d</i> -Camphoriodimide			$C_{12}H_{18}NO_2$ <i>d</i> -Camphorethylimide			$C_{17}H_{21}NO_2$ <i>d</i> -Camphorbenzylimide		
C_6H_6	$\left\{ \begin{array}{l} 1.6220 \\ 1.7532 \\ 1.5408 \end{array} \right.$	$\left\{ \begin{array}{l} 16.0 \\ 16.0 \\ 15.2 \end{array} \right.$	$EtOH$	$\left\{ \begin{array}{l} 2.0864 \\ 2.1480 \\ 3.0352 \end{array} \right.$	$\left\{ \begin{array}{l} 12.4 \\ 12.6 \\ 12.5 \end{array} \right.$	$EtOH$	$\left\{ \begin{array}{l} 1.8156 \\ 2.3104 \\ 3.2128 \end{array} \right.$	$\left\{ \begin{array}{l} 12.7 \\ 12.1 \\ 12.1 \end{array} \right.$
$CHCl_3$	$\left\{ \begin{array}{l} 2.0520 \\ 2.5792 \\ 2.9872 \end{array} \right.$	$\left\{ \begin{array}{l} 15.3 \\ 15.7 \\ 15.7 \end{array} \right.$	Me_2CO	$\left\{ \begin{array}{l} 3.9028 \\ 2.3544 \\ 2.9392 \\ 4.7560 \end{array} \right.$	$\left\{ \begin{array}{l} 12.5 \\ 8.4 \\ 8.8 \\ 8.5 \end{array} \right.$	Me_2CO	$\left\{ \begin{array}{l} 2.9552 \\ 3.3444 \\ 3.9392 \end{array} \right.$	$\left\{ \begin{array}{l} 11.9 \\ 12.0 \\ 11.9 \end{array} \right.$
						C_6H_6	$\left\{ \begin{array}{l} 2.1904 \\ 3.8228 \end{array} \right.$	$\left\{ \begin{array}{l} 5.2 \\ 4.8 \end{array} \right.$

Derivatives of campholic and camphoric acids

Formula	Name	<i>p</i>	<i>s</i>	$[\alpha]_\lambda^{20}$				Lit.
				6,563	5,893	5,463	4,861	
$C_{10}H_{18}O$	1, 2, 2, 3-Tetramethylcyclopentane-1-aldehyde.	10	C_6H_6	68.48	89.26	108.00	148.65	196, 198
$C_{10}H_{18}O_2$	Campholic acid.....		C_6H_6	47.48	59.26	69.36	88.33	198, 196
$C_{10}H_{20}O$	1, 2, 2, 3-Tetramethylcyclopentane-1-carbinol.		C_6H_6	53.36	67.18	79.42	102.74	198, 198
$C_{11}H_{18}O_3$	1-Acetyl-1, 2, 2-trimethylcyclopentane-3-carboxylic acid.	5	C_6H_6	84.29	109.98	116.07	185.71	196
$C_{11}H_{20}O$	1, 2, 2, 3-Tetramethylcyclopentane-1-methyl ketone.		(Nil).....	51.27	63.67	74.17	93.32	198, 196
			(C_6H_6)	53.89				196
$C_{12}H_{20}O_2$	1, 2, 2, 3-Tetramethylcyclopentane-1-acrylic acid.	10	C_6H_6	52.06	66.82	79.90	107.39	198
$C_{12}H_{20}O_2$	Ethyl 1, 2, 2-trimethyl-3-methylenecyclopentane-1-carboxylate.		(Nil).....	20.62	¹ 26.73	31.57	41.24	195
			(C_6H_6)	12.99	¹ 16.38	18.97	25.41	195

¹ In (196) these figures are quoted for the methyl ester.

Derivatives of campholic and camphoric acids—Continued

Formula	Name	p	s	$[\alpha]_{\lambda}^{20}$				Lit.
				6,563	5,893	5,463	4,861	
C ₁₂ H ₂₀ O ₃ ----	Methyl 1-acetyl-1, 2, 2-trimethylcyclopentane-3-carboxylate.	{	Nil-----	-10.53	-14.02	-14.08	-24.99	196
			C ₆ H ₅ -----	14.46	-19.17	-20.18	-33.41	196
C ₁₂ H ₂₂ O ₂ ----	1, 2, 2, 3-Tetramethylcyclopentane-1-ethyl ketone.	{	Nil-----	50.64	63.15	73.89	94.08	198, 196
			C ₆ H ₅ -----		54.83			196
C ₁₂ H ₂₂ O ₂ ----	Ethyl campholate.	{	Nil-----		40.49			196
			C ₆ H ₅ -----		39.79			196
C ₁₂ H ₂₂ O ₃ ----	1, 2, 2, 3-Tetramethylcyclopentane-1-propionic acid.	10	C ₆ H ₅ -----	38.21	48.38	57.20	75.29	198
C ₁₄ H ₂₄ O ₂ ----	Ethyl 1, 2, 2, 3-tetramethylcyclopentane-1-acrylate.	{	Nil-----	44.91	57.51	68.80	91.93	198
			C ₆ H ₅ -----	44.47	57.11	68.19	91.60	198
C ₁₄ H ₂₆ O ₂ ----	Ethyl 1, 2, 2, 3-tetramethylcyclopentane-1-propionate.	{	Nil-----	32.32	40.95	48.09	63.15	198
			C ₆ H ₅ -----	32.94	41.66	49.14	64.54	198
C ₁₆ H ₂₂ O-----	1, 2, 2, 3-Tetramethylcyclopentane-1 phenyl ketone.	{	Nil-----	5.72	-1.21	-12.42	-50.54	196
			C ₆ H ₅ -----	2.70	-11.47	-23.96	-66.49	196
			EtOH-----	21.74	21.68	17.51	-3.73	196
C ₁₇ H ₂₄ O-----	1, 2, 2, 3-Tetramethylcyclopentane-1 benzyl ketone.	{	Nil-----	26.46	32.16	36.40	42.56	196
			C ₆ H ₅ -----	21.51	25.91	28.05	33.34	196
C ₁₈ H ₂₄ O-----	1, 2, 2, 3-Tetramethyl-1-cyclopentane cinnamyl ketone.				54.29			196
C ₁₇ H ₂₄ O ₂ ----	1, 2, 2, 3-Tetramethylcyclopentane-1-carbinyl benzoate.	10	C ₆ H ₅ -----	37.75	47.81	56.63	73.83	198
C ₁₈ H ₂₆ O-----	1, 2, 2, 3-Tetramethylcyclopentane-1 β -phenylethyl ketone.	{	Nil-----	18.96	23.71	27.68	35.43	196
			C ₆ H ₅ -----	14.32	18.15	20.86	27.40	196
			C ₆ H ₅ -----	-41.95	-60.52	-80.21	-132.25	196
C ₂₀ H ₂₄ O-----	1, 2, 2, 3-Tetramethylcyclopentane-1 α -naphthyl ketone.	5	EtOH-----	-12.23	-19.97	-29.45	-58.16	196

(112)	C ₁₀ H ₁₄ O ₂ Camphorquinone	C ₁₀ H ₁₅ NO ₂ Isonitrosocamphor	
$p=0.2 \text{ to } 0.6 \left[\alpha \right]_{\lambda}^t$ $t=\text{laboratory temperature}$			
$\lambda \diagdown s$	=MeOH	C ₆ H ₆	EtOH
6,850	-----	38	-----
6,680	-----	41	146.9
6,260	42.7	48	-----
5,940	53	60.8	192.6
5,660	80	75	222
5,430	85	100	240.8
5,240	122.6	144	-----
5,060	151	227	291.4
5,000	256	-----	-----
4,930	341	368	318
4,860	389	-----	-----
4,800	293.7	240	351.7
4,740	144	-----	-----
4,690	102	-----	-----

Derivatives of camphorquinonehydrazoxime (Q) (61)

Formula	Name	s	c	$[\alpha]_D$
$C_{16}H_{17}N_3O$ -----	Q (from α -isonitrosocamphor)-----	(CHCl ₃ ----- 2 per cent NaOH-----	1.0388-----	-52.4 0.0
$C_{11}H_{18}N_4O_2$ -----	Q-carbamide-----	CHCl ₃ -----	1.0576-----	52.8
$C_{13}H_{21}N_3O$ -----	Isopropylidene-Q-----	CHCl ₃ -----	1.0184-----	-40.1
$C_{17}H_{21}N_3O$ -----	Benzylidene-Q-----	CHCl ₃ -----	1.0164-----	-73.8
$C_{20}H_{32}N_4O_2$ -----	bis-Isonitrosocamphanazine-----	CHCl ₃ -----	1.0336-----	-254.2
$C_{16}H_{17}N_3O$ -----	Q (from β -isonitrosoepicamphor)-----	(CHCl ₃ ----- 2 per cent NaOH-----	1.0372----- 1.0548-----	149.0 103.8
$C_{11}H_{18}N_4O_2$ -----	Q-carbamide-----	2 per cent NaOH-----	1.0568-----	135.6
$C_{14}H_{21}N_3O_3$ -----	Diacetyl-Q-----	(CHCl ₃ ----- 2 per cent NaOH-----	.8224----- .8552-----	177.0 87.7
$C_{17}H_{21}N_3O$ -----	Benzylidene-Q-----	CHCl ₃ -----	1.040-----	94.5
$C_{17}H_{21}N_3O_2$ -----	Benzoyl-Q-----	EtOH-----	.8420-----	130.5
$C_{24}H_{27}N_5O_3$ -----	Phenylcarbaminoxyphenylurethane-Q-----	CHCl ₃ -----	.920-----	137.7

15. LIMONENE

$C_{10}H_{16}$ <i>d</i> -Limonene (135; Cf., 26)		$C_{10}H_{16}$ <i>d</i> -Limonene (135; Cf., 26)		$C_{10}H_{16}$ <i>d</i> -Limonene (135; Cf., 26)	
	$[\alpha]_{4,359}^t$		$[\alpha]_{5,461}^t$		$[\alpha]_{6,703}^t$
22.2	232.5	20.5	135.7	21.0	85.1
-4	241.0	-5	140.2	4.0	87.1
-22.5	249.3	-20.5	144.5	-9.0	89.2
-47.0	259.3	-40.8	148.8	-24.2	91.2
-66.0	266.2	-54.0	152.1	-41.0	93.6
				-61.0	96.5
-80.6	274.3	-67.0	155.0		
-92.0	277.8	-79.7	159.0	-82.0	100.4
-102.0	282.7	-89.7	163.0	-102.0	105.6
-115.0	289.3	-116.4	172.0	-108.0	106.5
-123.0	292.9	-124.5	176.0	-120.7	109.4
				-123.5	109.5
	$[\alpha]_{4,916}^t$		$[\alpha]_{5,893}^t$		
22.0	174.6	22.2	115.9		
-12.2	184.3	.0	120.0		
-30.4	188.4	-18.0	124.0		
-51.0	194.5	-64.0	132.1		
-74.5	201.1	-76.4	135.0		
-85.0	204.1	-89.0	137.7		
-104.0	210.7	-103.7	141.4		
-120.8	214.6	-114.0	143.2		
		-118.0	143.8		
		-123.0	145.4		
		-125.7	146.4		
		-128.0	146.3		

16. CAMPHOR AND DERIVATIVES

Specific rotation of camphor in various solvents

C ₁₀ H ₁₆ O camphor (231)			C ₁₀ H ₁₆ O camphor (231)			C ₁₀ H ₁₆ O camphor (231)		
<i>p</i>	<i>d</i> ₄ ²⁰	[<i>α</i>] _D ²⁰	<i>p</i>	<i>d</i> ₄ ²⁰	[<i>α</i>] _D ²⁰	<i>p</i>	<i>d</i> ₄ ²⁰	[<i>α</i>] _D ²⁰
<i>s</i> = C ₆ H ₆			<i>s</i> = CHCl ₃ —continued			<i>s</i> = AcOH		
34.91	0.9066	44.20	4.03	1.4452	41.10	33.26	1.0174	45.66
6.44	.8835	39.90	2.19	1.4586	41.23	3.98	1.0458	42.33
5.36	.8827	40.07	1.15	1.4664	41.7	3.15	1.0467	41.81
4.12	.8817	39.75	<i>s</i> = C ₂ H ₄ Br ₂			2.15	1.0478	41.3
3.14	.8809	39.90				1.13	1.0483	40.7
1.97	.8800	39.2						
<i>s</i> = CHCl ₃			36.23	1.4929	56.93			
			3.87	2.0758	58.83			
			2.99	2.0983	58.93			
35.27	1.2476	45.76	1.86	2.1279	60.1			
5.31	1.4361	41.00	1.60	2.1513	60.1			

<i>p</i> (157)	[<i>α</i>] _D ²⁵	<i>p</i> (157)	[<i>α</i>] _D ²⁵	<i>p</i> (157)	[<i>α</i>] _D ²⁵
C ₁₀ H ₁₆ O camphor		C ₁₀ H ₁₆ O camphor		C ₁₀ H ₁₅ BrO (cf. 226) α-Bromocamphor	
<i>s</i> = EtOH		<i>s</i> = C ₆ H ₆		<i>s</i> = EtOH	
0.7643	41.4	0.4472	38.4	0.5078	133.4
3.050	43.8	.928	38.8	4.978	135.9
7.538	43.5	2.722	40.3	9.765	136.5
14.82	44.1	4.550	41.4	14.32	137.0
24.230	45.2	9.097	42.4	18.73	138.3
37.83	46.1	22.470	43.4	<i>s</i> = Me ₂ CO	
50.72	47.4	35.480	45.6		
<i>s</i> = Me ₂ CO		52.373	47.8	0.7693	138.1
		<i>s</i> = PhCl		7.351	143.2
0.7962	50.1	0.7255	41.3	22.93	144.2
3.054	50.6	5.509	41.2	34.72	145.4
5.037	50.2	18.643	43.2	48.58	146.3
9.992	50.6	30.35	44.9	<i>s</i> = EtOAc	
24.27	51.2	59.25	45.7		
37.83	51.9	<i>s</i> = <i>iso</i> -BuOH		0.4572	139.1
50.73	52.5			4.394	141.5
66.94	53.3	0.9796	40.1	20.76	142.9
<i>s</i> = EtOAc		4.9447	43.7	31.89	144.3
1.119	52.9	23.984	46.2	38.90	144.7
2.671	51.5	46.143	48.2	<i>s</i> = C ₆ H ₆	
8.882	52.0	56.654	48.9		
22.09	52.5			0.4665	116.2
34.85	52.5			4.512	120.4
51.69	53.4			21.21	125.1
				32.50	128.3
				46.12	132.9

The interpolation formula for calculating the specific rotation applied to ($C_{10}H_{16}O$) camphor in various solvents (72)

s	Limits of p		$[\alpha]_D^{20} = A + Bp + Cp^2$
C_6H_6	11.30	54.28	39.942+0.1627 p .
C_6H_6	11.07	54.20	39.097+0.1583 p ($t=18.5$).
$MeOH$	12.34	56.66	40.979+0.03835 p +0.0009196 p^2 .
$EtOH$	12.32	56.79	42.004+0.04968 p +0.001006 p^2 .
$PrOH$	12.19	56.37	43.805+0.036331 p +0.0008996 p^2 .
HCO_2H	8.44	46.54	19.856+0.3023 p .
$AcOH$	9.64	49.89	41.811+0.1327 p .
$EtCO_2H$	10.12	50.96	46.020+0.0938 p .

$C_{10}H_{16}O$ Camphor in Me_2CO (130)

t	d_4^t	c	$[\alpha]_D^t$	t	d_4^t	c	$[\alpha]_D^t$
13.7	0.87507	40.7410	50.549	14.3	0.81346	3.8695	49.211
13.7	.85355	27.5673	49.665	14.8	.81100	2.6196	49.511
13.7	.83880	18.6984	49.133	17.0	.80887	2.1344	49.639
13.7	.82864	12.5190	48.773	17.4	.80708	1.7758	49.695
14.3	.82166	8.4604	48.709	17.0	.80633	1.1914	49.960
14.3	.81709	5.7394	48.900	25.2	.79763	1.0684	50.070

$C_{10}H_{16}O$ Camphor (72; cf. 9, 10, 19, 54, 55, 63, 80, 91, 109, 111, 116, 182, 206, 226, 227)

$s = C_6H_6$. $t=20$		$s = EtOH$. $t=20$		$s = AcOH$. $t=20$	
p	$[\alpha]_D^t$				
		12.32	42.769	8.50	43.36
		24.10	43.930	16.42	43.87
		35.57	45.020	19.22	44.24
11.30	40.780	46.25	46.248	29.60	45.93
22.34	43.581	56.79	48.070	34.35	46.60
33.18	44.331			38.84	47.20
43.82	46.075			52.75	49.37
54.28	47.772				
$t=18.5$		$s = PrOH$. $t=20^\circ$ (?)		$s = EtCO_2H$. $t=20$	
		12.19	41.381		
		23.90	45.145		
11.07	40.786	35.10	46.188	13.60	48.34
21.87	42.548	45.93	47.397	23.06	48.98
33.28	44.387	56.37	48.711	30.60	49.70
43.70	45.950			39.08	50.53
54.20	47.638				
$s = MeOH$. $t=20$		$s = CH_2O_2$. $t=20$			
		20.44	26.03		
12.34	41.592	24.05	26.91		
24.14	42.495	34.38	29.85		
35.46	43.495	42.32	32.33		
46.25	44.738	50.89	35.08		
56.66	46.104	64.11	39.93		

Simple derivatives of camphor (37) $[\alpha]_\lambda^{20}$

Formula	Name	s	c	6,563	5,893	5,270	4,861
$C_{10}H_{16}O$	Camphor.....	$MeOH$	9.97	29.37	40.56	58.64	78.94
		CS_2	12.10	31.86	44.75	64.99	89.24
	β -Camphor (epicamphor).....	$MeOH$	9.66	-32.84	-45.53	-66.40	-90.51
$C_{10}H_{14}Br_2O$		CS_2	8.47	-45.59	-63.23	-91.57	-124.33
	α, α -Dibromocamphor.....	CS_2	10.02	28.44	40.52	61.97	89.42
		C_6H_6	10.85	27.50	39.20	59.55	85.86
$C_{10}H_{14}I_2O$	α, β -Dibromocamphor.....	C_6H_6	9.70	61.16	80.45	109.50	140.1
		CS_2	5.25	20.7	30.3	48.6	70.8
	α, α -Diiodocamphor.....	C_6H_6	5.02	20.7	30.5	48.6	70.8
$C_{10}H_{15}ClO$		CS_2	9.36	69.7	91.8	125.2	161.0
	α -Chlorocamphor.....	C_6H_6	9.24	54.20	71.10	96.40	122.30
		CS_2	9.98	107.5	141.8	193.6	248.2
$C_{10}H_{15}BrO$	α -Bromocamphor.....	$MeOH$	4.58	98.8	129.3	174.7	222.0
$C_{10}H_{15}IO$	α -Iodocamphor (cf.79).....	$MeOH$	9.40	112.3	147.3	198.3	252.9
$C_{10}H_{15}BrNO_4S$	$NH_4 \alpha$ -Bromo- π -camphorsulphonate.	H_2O	5.25	63.6	85.1	117.4	152.0

Mutarotation of $C_{10}H_{15}NO_3$ nitrocamphor in various solvents
(119; cf. 19, 31, 32, 56, 118, 119, 122, 127, 168)

s	c	t	[α] _D		Period
			Initial	Final	
C_6H_6	5	15	-124	-104	4 days.
PhMe.....	5	20	-106	-87	½ day.
$C_6H_5Me_2$	5	20	-99	-75	4 days.
$PhCO_2Et$	5	17	-50	-28	½ day.
CS_2	5	17	-53	-68	2 days.
$CHCl_3$	5	13	-27	-15	1 week.
Et_2O	5	18	-37	-18	2 hours.
$AcOEt$	5	14	-13	-2	2 hours.
Me_2CO	5	20	-7	8	¼ hour.
$MeOH$	5	16	-31	-12	3 hours.
$EtOH$	5	15	-26	-9	5 hours.
$PrOH$	5	17	-24	-10	2 hours.
HCO_2H	5	15	± 0	12	3 hours.
$AcOH$	5	13	-3	8	5 hours.
$EtCO_2H$	5	14	-5	5	2 hours.

Mutarotation of $C_{10}H_{14}BrNO_3$

π -Bromonitrocamphor (119)

s = C_6H_6 p = 3.3	
Pseudo form	
Time	α_t
<i>Hours</i>	
0	(188.4)
0.5	184.0
1.0	179.7
1.5	175.0
3.5	158.2
5.0	145.2
7.0	129.5
8.7	116.0
27.0	25.7
29.0	18.7
31.7	10.7
48.6	-17.5
99.3	-38.0
Limit.	
Normal form	
0	(-51.4)
1	-50.7
25	-47.2
48	-43.7
72	-42.7
118	-40.0
144	-37.5
Limit.	
t = 13 to 15° C.	

C₁₀H₁₆O₄S *d*-Camphor- β -sulphonic acid, salts, and derivatives $s = \text{H}_2\text{O}$ (73)

Salts	λ c	$[\alpha]_{\lambda}^{20}$			[M] _D
		5,461	5,780	5,893	
ZnA ₂ .6H ₂ O-----	2	20.75	16.84	15.83	100.7
	4	20.90	16.89	15.79	100.5
	8	20.74	16.75	15.80	100.5
MgA ₂ .6H ₂ O-----	2	22.22	17.92	16.88	100.4
	4	22.12	18.02	16.92	100.7
	8	22.20	17.92	16.82	100.1
CdA ₂ .6H ₂ O-----	2	19.37	15.72	14.74	100.7
	4	19.38	15.65	14.80	101.0
	8	19.37	15.63	14.66	100.1
	16	19.34	15.60	14.70	100.4
CaA ₂ .4H ₂ O-----	2	22.76	18.47	17.22	98.94
	4	22.67	18.32	17.15	98.50
	8	22.35	18.00	16.91	97.15
	16	22.06	17.77	16.65	95.67
BaA ₂ .3H ₂ O-----	2	20.00	16.34	15.08	98.58
	4	19.89	16.11	14.98	98.00
	8	19.57	15.77	14.77	96.64
	16	19.23	15.49	14.53	95.04
NH ₄ A-----	1	26.68	21.70	20.21	50.38
	2	26.70	21.71	20.24	50.45
	4	27.01	21.79	20.46	51.00
	8	26.99	21.81	20.46	51.00
	16	27.43	22.20	20.79	51.85
C ₆ H ₁₁ NA-----	2	20.83	17.04	15.97	50.70
	4	21.37	17.30	16.12	51.18
	8	21.63	17.56	16.50	52.38
	16	22.29	18.07		

Camphor- β -sulphonyl salts $s = \text{CHCl}_3$ (73: Cf. 7)

	λ c	5,461	5,780	5,893	[M]
C ₁₀ H ₁₆ ClO ₃ S-----	3.6	40.08	33.91	32.17	80.62
C ₁₀ H ₁₆ NO ₂ S-----	2.3	38.56	34.37	33.79	72.07
C ₁₃ H ₂₅ NO ₃ S-----	.57	42.58	35.91	33.45	100.15
(Piperidide)-----	.97	42.46	35.88	33.38	99.90
C ₆ H ₁₁ NA-----	1.6	41.40	34.94	32.37	102.8
	.92	40.54	34.06	32.08	101.9

$C_{10}H_{18}BrO_4S.3H_2O$ *d*- α -Bromocamphor- β -sulphonic acid and salts $s=H_2O$ (175; Cf. 106, 132)

	λ c	5,461	5,780	5,893	$[M]_D$
C Acid $3H_2O$	0.521	120.8	103.6	98.3	305.8
C.....	3.130	121.6	104.1	99.1	308.2
C $BaA_2.6\frac{1}{2}H_2O$	.391	85.7	73.5	69.7	305.0
C.....	1.570	85.2	73.0	69.3	303.0
D NH_4A	.523	88.4	75.0	71.2	233.5
D.....	3.017	88.8	75.4	71.5	235.0
D.....	$\left\{ \begin{array}{l} 0.5\% \\ (EtOH) \end{array} \right\}$	99.7	81.7	81.1	266
B.....	.503	53.7	44.8	41.8	137.0
C.....	.498	113.0	97.0	91.4	300.0
K $A.H_2O(?)$	.522	102.1	87.2	83.4	292.0
D.....	3.180	103.1	88.0	84.1	295.0
C.....	.299	109.0	91.9	86.0	300.0
D $C_2H_5NH_2A$	.504	90.2	77.3	72.9	259.0
D.....	2.561	91.3	77.9	73.6	262.0
C $AgA.1\frac{1}{2}H_2O$	.688	85.4	73.0	69.0	310.0
C.....	3.048	83.2	71.3	67.7	304.0
C $ZnA_2.5\frac{1}{2}H_2O$	.686	94.4	80.2	76.5	300.0
D.....	.581	97.3	82.2	77.9	267.0

NOTE. The salts of this acid exist in two stereoisomeric forms, one of low rotatory power and high dispersion (C) and another of high rotatory power and low dispersion (B). Both of these are converted into an equilibrium-mixture (D) in the presence of traces of ammonia.

$C_{10}H_{17}O_4S$ Camphor- π -sulphonic acid and its salts (87)

Formula	Organic base ($s=CHCl_3$) $[\alpha]_D^{20}$	$c=2.5$	5.0	$[M]_D^{20}$
$C_{10}H_{16}O_4S$	Nil.....	24.04	24.82	57.6
$C_{14}H_{27}NO_4S.H_2O$	<i>n</i> -Butylamine.....	20.44	20.36	62.1
$C_{15}H_{21}NO_4S$	Pyridine.....	31.72	31.42	97.7
$C_{15}H_{27}NO_4S$	Piperidine.....	21.40	22.94	72.7
$C_{16}H_{23}NO_4S$	Aniline.....	23.32	23.28	75.7
$C_{17}H_{25}NO_4S$	Benzylamine.....	21.36	22.00	74.6
$C_{19}H_{23}NO_4S$	Quinoline.....	26.96	27.90	100.7
$C_{19}H_{27}NO_4S$	Tetrahydroquinoline.....	25.36	25.98	94.8
$C_{20}H_{25}NO_4S$	α -Naphthylamine.....	20.92	21.38	80.2
$C_{20}H_{25}NO_4S$	β -Naphthylamine.....	20.80	21.54	80.8
$C_{20}H_{29}NO_4S$	<i>ac</i> -Tetrahydro- β -naphthylamine.....	17.36	17.36	65.8
$C_{20}H_{29}NO_4S$	<i>ar</i> -Tetrahydro- α -naphthylamine.....	19.80	19.92	75.5

$C_{11}H_{18}O_2$. Hydroxymethylenecamphor and derivatives (174)

Formula	Name	Time	s	$c_{\lambda \rightarrow}$	$[\alpha]_{\lambda}^{20}$		
					5,893	5,750	5,461
$C_{11}H_{18}O_2$	<i>d</i> -Hydroxymethylenecamphor.....	Hours					
		$\frac{1}{2}$	EtOH*.....	1.009	198	209	242
	<i>l</i> -Hydroxymethylenecamphor.....	20	EtOH†.....	1.009	228	198	187
		$\frac{1}{2}$	EtOH*.....	1.008	-195	207	239
$C_{11}H_{18}BrO_2$	<i>d</i> -Bromohydroxymethylenecamphor.....	20	EtOH†.....	1.008	-185	196	226
		$\frac{1}{2}$	EtOH*.....	1.188	73.2	76.4	85.7
		48	EtOH†.....	1.188	71.6	74.3	82.9
		48	EtOH†.....	3.367	73.6	76.4	86.0
$C_{19}H_{23}NO_2$	<i>l</i> -Hydroxyhydrindamino- <i>d</i> -methylenecamphor.....		C_6H_5	.850	80.6	83.0	92.4
		72	EtOH*†.....	.497	145	167	185
	<i>d</i> -Hydroxyhydrindamino- <i>d</i> -methylenecamphor.....	48	C_6H_5 *†.....	.517	99.1	107	131
		18	AcOH*†.....	.391	102	108	128
$C_{19}H_{23}NO_2$	<i>d</i> -Hydroxyhydrindamino- <i>d</i> -methylenecamphor.....	54	C_6H_5 *†.....	.512	153	164	190
		72	EtOH*†.....	.518	302	335	376

NOTE.—Solutions marked with asterisk (*) exhibit mutarotation, the final value is given for each substance and marked with the dagger (†).

Divalent metallic salts of hydroxymethylenecamphor and of nitrocamphor							
	$d\text{-C}_{11}\text{H}_{15}\text{O}_2 = \text{oca}$		$d\text{-C}_{10}\text{H}_{14}\text{NO}_3 = \text{nica}$		(112) $[\alpha]_D$		
s	CHCl ₃	CHCl ₃	CHCl ₃	CHCl ₃	EtOH	CHCl ₃	CHCl ₃
p	-----	-----	5	5	5	5	5
Salt	Co.oca ₂	Ni.oca ₂	UO ₂ .oca ₂	[Cu.oca ₂ (H.oca) ₂]		Cu.oca ₂	Co.nica ₂
6,840	178	-----	70	-----	-----	-----	-----
6,650	185	140	84	-----	-----	119.7	190
6,450	200	-----	-----	-----	-----	147.3	-----
6,250	223	167	100	37.7	87	156.6	232
6,100	233	-----	-----	-----	98	128.9	-----
5,940	247	200	122	18.3	106	101	276
5,780	268	-----	-----	-----	-----	-----	-----
5,650	286	235	145	9.4	120	55.3	324
5,430	333	280	175	34	140	18.4	370
5,240	353	322	221	56.5	146	0	432
5,075	412	355	267	75.3	160	-----	456
4,940	-----	415	320	-----	170	-----	-----
4,800	-----	465	-----	-----	-----	-----	-----
4,690	-----	515	-----	-----	-----	-----	-----

Tervalent metallic salts of hydroxymethylenecamphor

Salt	Cr.oca ₃		Al.oca ₃ H.oca ¹		Salt	Cr.oca ₃		Al.oca ₃ H.oca ¹	
s	C ₆ H ₆	EtOH	EtOH	EtOH	s	C ₆ H ₆	EtOH	EtOH	EtOH
p	0.1	0.51	0.5-1	1	p	0.1	0.51	0.5-1	1
6,840	-----	218.5	475	136	5,330	-----	218.5	-----	-----
6,650	215	256.5	499	146	5,240	24	133	1,011.8	266
6,450	-----	294.5	-----	-----	5,150	-----	114	-----	-----
6,250	311	342	581	170	5,075	155.5	95	1,138.6	292
6,100	-----	427.5	-----	-----	5,000	-----	137.8	-----	-----
5,940	622	503	675.8	193	4,940	84	180	1,271	318
5,650	730	589	779.5	213	4,800	59.8	204?	1,413	345
5,540	-----	484	-----	-----	4,690	-----	-----	1,566.7	375
5,430	407	361	892.8	240	4,580	-----	-----	1,730	402

¹ See (174) and hydroxymethylenecamphor, p. 73

Dispersion data. Alkyl and alkylidene derivatives of camphor [α]_D²⁰

Formula	Name	s	<i>p</i> or <i>d</i>	6,563	5,893	5,461	5,270	4,861	Lit.
$C_{11}H_{17}NO$	α -Aminomethylenecamphor	EtOH	9.98	191.37	257.32	323.41	---	477.19	200
$C_{12}H_{19}NO$	β -Aminomethylenecamphor	EtOH	9.97	236.57	313.76	388.23	---	553.99	200
		EtOH	9.870	154.0	208.4	---	252.1	352.6	180
	Ethylidenecamphor	C_6H_6	9.99	136.37	178.58	---	219.31	308.49	194
		$(Ni)^1$	9.9497	112.18	140.18	185.30	---	267.40	192
		Ni^2	9.9553	55.71	73.26	89.70	---	126.19	192
		C_6H_6	5	17.47	22.67	27.73	---	37.81	192
	Propylidenecamphor	Ni^1	9.9448	131.39	172.95	---	212.96	301.48	194
		EtOH	9.99	130.72	171.26	---	210.60	296.48	194
		C_6H_6	10.06	119.07	157.44	---	195.25	276.96	194
		C_6H_6	10	24.11	32.31	40.05	---	57.28	192
	Methylenecamphorpropionic acid	Py	5.26	149.42	198.52	245.11	---	347.35	201
$C_{14}H_{21}NO_3$	α -Methylenecamphorethylurethane	Py	5.26	145.93	197.17	247.62	---	366.69	192
	β -Methylenecamphorethylurethane	Py	9.989	71.61	94.58	117.13	---	168.54	192
$C_{14}H_{23}O$	<i>n</i> -Butylidenecamphor	Ni^1	9.9880	124.51	161.93	---	200.07	283.83	194
	$\Delta^{4,5}$ Pentylidenecamphor	C_6H_6	9.56	112.57	149.32	---	185.40	264.75	194
$C_{15}H_{25}O$	4-Butene-1-methylenecamphor	Ni^1	9.9475	108.47	144.23	178.78	---	257.48	192
		Ni^1	9.9275	118.67	156.69	---	193.40	275.90	194
$C_{15}H_{27}O$	Isoamylidenecamphor	C_6H_6	9.98	109.55	145.04	---	179.05	254.12	194
$C_{15}H_{29}O$	<i>n</i> -Amylidenecamphor	Ni^1	9.9332	88.94	116.48	146.18	---	209.95	192
		Ni^1	9.9197	50.19	66.78	---	82.57	120.17	194
$C_{15}H_{29}O$	Isoamylcamphor	C_6H_6	10.06	31.29	42.34	---	53.40	78.14	194
$C_{16}H_{29}O$	<i>n</i> -Hexylidenecamphor	Ni^1	9.9252	106.05	141.13	175.05	---	251.88	192
	Isobutylidenecamphor	Ni^1	9.9202	100.85	133.84	165.68	---	237.80	192
$C_{17}H_{31}O$	Benzylidenecamphor	C_6H_6	10.01	322.48	426.55	---	530.40	741.87	194
$C_{17}H_{33}O$	Hexahydrobenzylidenecamphor	C_6H_6	9.99	97.64	128.13	---	157.36	216.08	194
$C_{17}H_{35}O_3$	α -Methylenecamphor- α -isobutyric acid	C_6H_6	---	82.34	103.74	133.23	---	187.49	192
$C_{18}H_{21}NO_3$	α -Benzoylaminomethylenecamphor	Py	5.26	166.44	228.20	292.67	---	453.11	200
	β -Benzoylaminomethylenecamphor	Py	5.26	164.28	219.29	273.15	---	393.06	200
$C_{18}H_{29}O$	Phenylethylidenecamphor	Ni^1	1.0250	97.87	129	---	159.26	226.50	194
		C_6H_6	9.97	87.78	115.72	---	143.39	203.31	194
$C_{18}H_{29}O$	Phenylethylcamphor	EtOH	9.93	98.29	129.83	---	160.40	227.02	194
$C_{18}H_{29}O$	Phenylethylcamphor ketone	C_6H_6	10.00	16.56	22.82	---	29.22	46.19	194
		Ni^1	0.9368	40.82	51.17	58.91	---	76.34	193
		C_6H_6	10.0	38.19	48.24	56.32	---	70.41	---
$C_{18}H_{29}O$	Phenylpropylidenecamphor	Ni^1	1.0104	95.81	126.92	157.35	---	226.66	192
		Ni^1	1.0094	96.61	127.99	---	157.97	225.20	194
$C_{18}H_{29}O$	Phenylpropylcamphor	C_6H_6	9.97	89.32	117.70	---	145.52	206.69	194
$C_{21}H_{33}NO$	α -Naphthylmethylenecamphor	C_6H_6	9.97	30.19	52.37	---	64.75	93.51	194
		C_6H_6	10.00	263.17	353.62	---	443.94	634.54	194

1 $t = 20^\circ$.2 $t = 30^\circ$.

Camphor, methylcamphor, and derivatives

Formula	Name	<i>p</i>	<i>s</i>	$[\alpha]_D^{20}$				Lit.
				6,563	5,893	5,463	4,861	
$C_{10}H_{16}O$	Camphor	-----	C_6H_5	30.94	43.01	55.32	86.75	188
$C_{11}H_{18}O$	Methylcamphor	-----	C_6H_5	15.82	23.25	30.76	50.84	188
$C_{11}H_{18}O_2$	Camphorylcarbinol ¹	-----	Nil	46.31	62.11	77.67	113.48	188
$C_{12}H_{18}O_2$	Camphorylacetic acid	-----	C_6H_5	16.01	23.40	31.02	50.83	cf. 189
$C_{12}H_{18}O_2$	Camphorylacetic acid	-----	C_6H_5	27.56	38.06	47.99	73.33	203
$C_{13}H_{20}O_2$	Camphorylacetone	{ 10	Nil	36.99	49.25	61.08	87.60	203
$C_{13}H_{20}O_2$	Camphorylacetone		C_6H_5	45.91	60.73	74.42	105.52	cf. 189
$C_{13}H_{20}O_2$	Camphorylcarbinyl acetate	-----	Nil	40.46	53.78	66.77	96.36	188
$C_{14}H_{22}O_2$	Ethyl camphorylacetate	{ 10	Nil	51.01	67.53	83.38	119.23	203
$C_{14}H_{22}O_2$	Ethyl camphorylacetate		C_6H_5	27.07	37.18	46.96	70.77	203
$C_{15}H_{26}O$	Isoamylcamphor	-----	Nil	50.19	66.78	82.57	120.17	194
$C_{17}H_{28}O$	Camphorylphenylmethane	-----	C_6H_5	31.29	42.34	53.40	79.14	cf. 188
$C_{18}H_{24}O$	α -Camphoryl- β -phenylethane	-----	Nil	92.56	123.35	153.34	220.90	188
$C_{19}H_{26}O$	α -Camphoryl- γ -phenylpropane	-----	C_6H_5	16.56	22.82	29.22	45.19	194
$C_{19}H_{26}O$	α -Camphoryl- γ -phenylpropane	-----	C_6H_5	39.19	52.37	64.75	93.51	194
$C_{20}H_{24}O_2$	Camphorylbenzylidene-3-acetone	10	C_6H_5	35.41	47.37	58.54	83.57	203
$C_{20}H_{24}O_2$	Camphoryl-3-acetylacetophenone	10	C_6H_5	45.38	62.52	78.31	118.59	203
$C_{21}H_{24}NO_2$	Methylenecamphor- α -aminocamphor	2.48	C_6H_5	90.51	121.8	151.7	211.4	200
$C_{22}H_{24}O_2$	α, β -Diacamphorylethane	5	C_6H_5	44.99	60.37	75.29	110.33	188

¹ In this table "camphoryl" is used for the radical $C_{10}H_{15}O$ of camphor, and not for the radical $C_{10}H_{15}O_2$ of camphoric acid.

17. CAMPHORCARBOXYLIC ACID AND DERIVATIVES

$C_{11}H_{16}O_3$ Amine salts of camphorcarboxylic acid (rotation calculated on the concentration of the acid)

<i>c</i> = 7.84 (133)		$\frac{M \text{ amine}}{M \text{ acid}}$		$[\alpha]_D^{13}$	
Amine		H ₂ O	EtOH	H ₂ O	EtOH
$C_{14}H_{25}NO_3$ Propylamine	-----	{ 1 17	{ 1 4.8	90.4 90.2	81.7 78.5
$C_{15}H_{27}NO_3$ Butylamine	-----	{ 1 13.7	{ 1 5	91 92.3	81.7 78.8
$C_{15}H_{27}NO_3$ Diethylamine	-----	{ 1 1.98 13.7	{ 1 5 45	92.5 92.5 92.5	73.1 82.3 85
$C_{17}H_{31}NO_3$ Triethylamine	-----	{ 1 9.53	{ 1 5 45	92.5 92.5 92.5	85.5 82 85.5

$C_{11}H_{16}O_3$ Camphorcarboxylic acid + C_6H_7N aniline							
<i>M C₆H₇N</i>	<i>(c of acid = 2.61)</i>			$[\alpha]_D^{13}$ (133)			
<i>s</i>	EtOH	Et ₂ O	C_6H_5	PhMe	$C_6H_4Me_2$	Me ₂ CO	PhNH ₂
0	63.2	55.8	33.2	39.6	44.3	57.7	27.4
1	62.5	55.8	33.8	39.6	44.3	57.7	-----
5	57.4	-----	-----	-----	-----	-----	-----
45	34.1	-----	-----	-----	-----	-----	-----
70	27.4	-----	-----	-----	-----	-----	-----

Influence of bases on rotatory power of $C_{11}H_{16}O_3$ camphorcarboxylic acid (27)

Formula	Base ($s=C_6H_5Me_2$)	c	Mols of base to 1 of acid	t_1	$[\alpha]_D^{t_1}$	t_2	$[\alpha]_D^{t_2}$
$C_{11}H_{16}O_3$	Nil.....	0.18	-----	32	44.2	57	46.2
		.18	-----	22	42.1	50	45.2
$C_{14}H_{21}NO_3$	Pyridine.....	.5	1.2	23	34.5	48	39.2
		.5	10.4	-----	-----	49	33.0
$C_{14}H_{21}NO_3$	Piperidine.....	.13	1.4	25	61.7	47	60.0
		.13	3.0	25	61.7	48	60.0
$C_{14}H_{21}NO_3$	Isoamylamine.....	.12	1.0	19	65.3	48	63
		.12	2.0	22	65.7	48	63
$C_{17}H_{23}NO_3$	α -Picoline.....	.74	1.0	22	33.3	49	38.7
		.74	5.1	27	30.3	48	34.2
$C_{14}H_{21}NO_3$	Benzylamine.....	.02	1.5	22	49.2	48	49.2
		.02	3.0	30	49.4	48	49.6
$C_{14}H_{21}NO_3$	m -Toluidine.....	.20	1.9	18	42.5	48	45
$C_{19}H_{27}NO_3$	Collidine.....	.39	1.02	21	36	48	40
		.39	4.5	22	31.8	48	35.8
$C_{19}H_{27}NO_3$	Dimethylaniline.....	.39	5.5	19	32.5	48	36.2
		.28	1.2	19	41.2	48	44.5
$C_{19}H_{27}NO_3$	Diisobutylamine.....	.18	1.04	22	65.7	48	62.8
		.17	2.15	25	67.2	47	64.7
$C_{20}H_{29}NO_3$	Quinoline.....	.84	1.3	22	36.3	48.5	40.3
		.84	4.1	21	29.2	48	36.7
		.84	7.3	22	27.5	49	33.7
$C_{20}H_{27}NO_3$	Tripropylamine.....	.13	1.0	22	40.3	48	41.8
		.13	1.5			48	
		1.4	1.7			48	
$C_{21}H_{29}NO_3$	Quinaldine.....	1.4	4.1	24	25.4	48	33.0
		1.4	5.7	22	23	49	31.7
$C_{22}H_{31}NO_3$	Diethylbenzylamine.....	.32	1.02	19	37.5	47	40.8
		.41	2.0	26	36.7	48	40.0
$C_{22}H_{31}NO_3$	Triisobutylamine.....	.17	1.3	20	43.0	48	45

Dispersion data, camphorcarboxylic acid derivatives

Formula	Name	s	$c \backslash \lambda$	6,708	6,438	5,893	5,461	5,086
$C_{11}H_{16}BrNO_2$	α, α' -Bromocamphorcarboxamide.	EtOH	5	29.4	-----	38.4	45.8	-----
$C_{16}H_{24}BrNO_2$	α, α' -Bromocamphorpiperide.	EtOH	-----	-54.5	-58.5	-71.2	-86	-102.3

Formula	Name	s	$c \backslash \lambda$	4,800	4,678	4,359	Lit.
$C_{11}H_{16}BrNO_2$	α, α' -Bromocamphorcarboxamide.....	EtOH	5	-----	-----	82.6	-----
$C_{16}H_{24}BrNO_2$	α, α' -Bromocamphorpiperide.....	EtOH	-----	-118.0	-126.0	-150.9	79

Derivatives of camphorcarboxylic acid $c=5$ (125)

Time	$[\alpha]_{D,40}$	Time	$[\alpha]_{D,40}$	Time	$[\alpha]_{D,40}$
$C_{11}H_{17}NO_2$ Mutarotation of camphorcarboxamide		$C_{11}H_{17}NO_2$ Mutarotation of camphorcarboxamide		$C_{15}H_{23}NO_2$ Mutarotation of camphorcarboxypiperide	
$s = EtOH$		$s = C_6H_6$		$s = C_6H_6$	
<i>Hours</i>		<i>Hours</i>		<i>Hours</i>	
0.1	-0.2	0.1	1.5	0.5	24.7
.2	.1	.2	2.0	.7	24.7
.3	.2	.4	2.9	1.0	24.7
.4	.3	.6	3.6	1.5	24.7
.5	.4	.8	4.7	2.0	25.0
.6	.6	1.0	5.5	2.3	25.3
.8	1.1	2.0	10.1	2.5	25.3
1.0	1.4	3.0	15.0	3.0	25.4
1.5	2.5	4.0	19.9	3.5	25.6
2.0	3.7	5.0	24.1	4.0	25.8
2.5	4.8	6.0	28.7	4.5	25.7
3.0	5.9	7.0	32.6	5.0	25.6
3.5	7.1	8.0	36.5	5.5	25.6
4.0	8.2	10.0	43.4	6.5	25.8
4.5	9.4	12.0	49.2	8.0	26.3
5.0	10.4	13.3	52.4	9.0	26.5
8.0	17.2	23.0	67.4	10.0	26.6
9.0	19.0	25.0	68.0	11.0	27.0
10.0	21.0	28.4	69.7	12.0	27.1
11.0	23.3	31.0	71.0	13.0	27.5
12.4	25.8	36.0	70.9	22.0	28.0
14.2	29.3	48.0	72.7	28.0	29.0
22.0	43.4	61.0	73.8	30.0	29.2
26.0	50.3	96.0	74.4	33.1	29.6
30.0	56.4			36.0	30.0
33.0	60.7	$C_{15}H_{23}NO_2$ Mutarotation of camphorcarboxypiperide		46.8	30.9
34.0	62.3	$s = C_6H_6$		54.0	31.3
36.0	64.8	<i>Hours</i>		59.0	31.6
48.0	81.1	0.1 25.8		70.0	32.4
50.0	84.0	.4 25.5		73.0	32.6
51.0	85.4	2.0 25.5		78.0	33.3
52.0	86.5	9.0 25.3		84.0	33.7
53.0	88.3	12.0 25.6		94.0	34.4
54.5	90.3	24.0 27.7		102.0	35.4
56.0	91.8	30.0 28.7			
58.0	93.8	36.0 29.9			
59.4	94.7	48.0 32.9			
61.0	96.0	54.0 34.2			
71.0	99.6	61.0 36.2			
83.0	100.4	72.0 39.1			
Final	100.8	78.0 40.6			
		84.0 42.2			
		96.0 44.2			
		108.0 46.5			
		132.0 49.8			
		<i>Days</i>			
		6.0 51.2			
		6.5 51.2			
		7.0 52.9			
		7.5 54.3			
		8.0 54.7			
		8.5 54.8			
		9.0 54.8			
		10.0 55.6			
		15.0 56.3			
		21.0 56.9			
		40.0 56.7			

18. BORNEOL AND RELATED COMPOUNDS

Borneol and isoborneol (104)

Formula	Name	s	c	$[\alpha]_D^{20}$	$[\alpha]_D^{17}$	$[\alpha]_D^{15}$	$[\alpha]_D^{14}$
$C_{10}H_{18}O$	<i>l</i> -Borneol.....	EtOH.....	5.51	36.79	39.10	44.54	76.05
	<i>d</i> -Isoborneol.....	EtOH.....	5.16	33.89	35.38	39.61	65.31
		$CHCl_3$	4.99	20.33	20.92	23.33	37.05
		C_6H_6	4.73	42.72	45.02	51.93	91.70
$C_{18}H_{22}O_4$	<i>d</i> -Bornyl hydrogen phthalate.....	CS_2	1.65	46.06	47.28	51.82	96.96
	<i>l</i> -Isobornyl hydrogen phthalate.....	EtOH.....	5.18	56.72	59.71	68.39	123.60
		$CHCl_3$	5.33	77.47	80.74	92.76	163.34
		EtOH.....	5.19	81.62	85.27	97.97	173.71

Specific rotation $[\alpha]_{\lambda}^{20}$ of $C_{12}H_{20}O_2$ *l*-bornyl acetate at different temperatures (104)

t $\downarrow \lambda \rightarrow$	5,893	5,780	5,461	4,358
20	-42.43	-44.16	-50.18	-84.33
40	-40.75	-42.49	-48.19	-80.98
60	-39.06	-40.71	-46.18	-77.49
80	-37.64	-39.22	-44.52	-74.56
100	-36.44	-38.08	-43.16	-72.40
120	-35.22	-36.84	-41.60	-70.04
140	-34.00	-35.58	-40.46	-67.79
160	-33.04	-34.47	-39.09	-65.55
180	-32.30	-33.55	-37.67	-63.43

$[\alpha]_D^{20}$ (174; cf. 57, 58, 59, 60)

Formula	Name	s	c $\downarrow \lambda \rightarrow$	5,893	5,780	5,461
$C_{10}H_{19}BrN$	<i>d</i> -Bornylamine hydrobromide.....	H_2O	2.465	17.6	18.5	20.7
		H_2O	1.023	17.6	18.6	20.8
		EtOH.....	4.931	18.9	19.8	22.3
		EtOH.....	1.644	18.6	19.5	21.9
		$CHCl_3$	.673	26.0	26.8	32.0
$C_{17}H_{23}NO$	Benzoyl- <i>d</i> -bornylamine.....	EtOH.....	4.027	-21.6	-22.7	-26.3
$C_{10}H_{19}N$	<i>d</i> -Neobornylamine ¹	EtOH.....	1.005	-20.6	-22.1	-25.6
		EtOH.....	4.413	-38.0	-39.5	-44.4
		EtOH.....	4.0	-43.7		
$C_{10}H_{20}BrN$	<i>d</i> -Neobornylamine hydrobromide ¹	H_2O	2.470	-31.4	32.5	37.0
		H_2O	1.001	-31.2	32.7	37.0
		EtOH.....	1.637	-33.0	34.5	39.4
		$CHCl_3$	0.671	-37.3	39.9	44.4
$C_{17}H_{23}NO$	Benzoyl- <i>d</i> -neobornylamine ¹	EtOH.....	1.8	-44.7		

¹ Probably not quite pure.

² These values were determined by Forster, and probably refer to the pure substance.

Derivatives of borneol

λ	$[\alpha]_{\lambda}^t$	λ	$[\alpha]_{\lambda}^t$	λ	$[\alpha]_{\lambda}^t$
$C_{12}H_{20}OS_2$ (39) Methyl <i>d</i> -bornylxanthate		$C_{22}H_{34}O_2S$ (33, 39, 40) <i>l</i> -Bornyldixanthide [S.CS.O.Bor] ₂ (superfused)		$C_{25}H_{32}NOS_2$ (41) 1-Phenyl-2- <i>o</i> -tolyl-3- <i>d</i> -bornylimidoxanthide Ph.-CS.N(C ₇ H ₇).CS.O.Bor	
$s = \text{PhMe. } c = 5.95$		$c = 10.47$		$s = \text{PhMe. } c = 0.1390$	
675 $\mu\mu$	31.4	656	-37.3	657	119
657	32.7	589	-43.0	622	255
622	35.5	553	-44.8	590	417
589	37.7	527	-44.6	573	417
559	39.8	517	-43.5	559	331
542	40.5	508	-42.1	547	158
527	40.5	486	-35.0	$s = \text{Me}_2\text{CO. } c = 0.1424$	
508	39.5	466	-20.5	657	77
500	38.5	451	1.3	622	190
486	35.6	$C_{22}H_{30}O_2S_4$ (42) Methylene <i>l</i> -bornylxanthate $\text{CH}_2(\text{S.CS.O.Bor})_2$		590	337
472	30.7	$s = \text{PhMe. } c = 5.23$		573	351
451	15.3	685	-1.1	559	323
$C_{18}H_{22}OS_2$ (39) Ethyl <i>d</i> -bornylxanthate		675	-0.8	547	182
$s = \text{PhMe. } c = 5.881$		657	.4	$C_{25}H_{32}OS_2$ (41) 1-Phenyl-2- <i>p</i> -tolyl-3- <i>d</i> -bornylimidoxanthide Ph.-CS.N(C ₇ H ₇).CS.O.Bor	
657	28.8	622	3.1	$s = \text{PhMe. } c = 0.1390$	
621	31.6	590	5.9	657	173
589	33.4	553	12.0	603	425
548	35.1	528	18.9	590	489
537	35.4	500	31.7	582	504
527	34.9	486	39.8	578	489
516	34.5	$C_{24}H_{27}NOS_2$ (41) 1, 2-Diphenyl- <i>d</i> -bornyl imidoxanthide Ph.CS.NPh.CS.O.Bor.		573	474
506	33.5	$s = \text{PhMe. } c = 0.1468$		559	417
498	32.6	622	242	$s = \text{Me}_2\text{CO. } c = 0.1424$	
486	28.9	603	340	657	140
$C_{22}H_{34}O_2S$ (33, 39, 40) <i>l</i> -Bornyldixanthide [S.CS.O.Bor] ₂ (superfused)		590	399	590	380
$s = \text{PhMe. } c = 5.95$		582	405	578	420
657	-49.8	578	408	573	450
589	-58.9	559	327	559	435
553	-63.2	547	129	553	365
527	-65.3	536	-82	547	310
517	-65.3	528	-279	$C_{30}H_{42}OS_2$ (42) Triphenylmethyl <i>l</i> -bornylxanthate $\text{CPh}_3\text{S.CS.O.Bor}$	
508	-65.0	492	-1,290	$s = \text{EtOH}$	
500	-64.3	478	-1,500	657	-25.5
486	-61.0	$s = \text{Me}_2\text{CO. } c = 0.1456$		589	-34.3
472	-54.5	603	309	553	-40.6
$s = \text{PhMe. } c = 4.154$		578	385	528	-46.4
657	-36.6	573	412	508	-52.6
589	-42.4	559	412	500	-56.2
548	-44.1	547	275	486	-64.0
527	-43.8	536	164		
498	-39.0				
485	-33.7				
478	-29.6				
466	-19.5				
451	2.7				
446	11.3				

Influence of temperature on dispersion of methyl l-bornylxanthate

$C_{12}H_{20}OS_2$ (43) $[\alpha]_{\lambda}^t$				
s=PhMe. $p=10.04$				
$\begin{array}{c} \lambda \\ t \end{array}$	656 $\mu\mu$	589	527	586
-36.6	-39.6	-46.7	-51.3	-47.8
-31.8	-39.3	-46.0	-50.0	-46.7
0	-35.5	-41.1	-44.4	-40.2
+20	-32.9	-38.1	-40.7	-35.6
+46.4	-30.2	-34.8	-36.1	-30.5
+80.2	-26.4	-30.4	-30.2	-23.6
s=AcOEt $p=4.86$				
-49.5	-48.5	-57.7	-65.7	-67.2
0	-39.2	-46.0	-51.1	-50.4
20.5	-36.3	-42.2	-45.8	-43.1
50.2	-31.2	-36.4	-38.7	-34.7

19. FENCHYL ALCOHOL DERIVATIVES

Derivatives of fenchyl alcohol

$C_{12}H_{14}O_2S_2$ (41) Fenchylxanthic thioanhydride $[\alpha]_{\lambda}^t$				
s=PhMe. $p=2.09$. (43)				
$\begin{array}{c} t \\ \lambda \end{array}$	0	22.4	50.9	81.5
674	36.2	35.4	35.4	33.8
656	35.7	33.8	34.5	33.8
589	26.0	24.4	24.6	23.7
527	33.5	34.9	35.4	39.1
508	89.8	-----	93.7	¹ 94.1(?)

¹ The query is in the original paper.

Derivatives of fenchyl alcohol—Continued

[α] _{λ} s=PhMe. c=6.004		C ₂₁ H ₃₄ O ₂ S ₄ (42) Methylene fenchyl- xanthate, CH ₂ (S.CS.O.Fen) ₂		C ₂₄ H ₂₇ NOS ₂ (39, 41) 1,2-Diphenylfenchyl- imidoxanthide, Ph.CS.NPh.CS.O.Fen	
687	-36.0	s=PhMe. c=7.77		s=Me ₂ CO. c=0.1302	
670	-36.0				
657	-36.1				
641	-35.2				
631	-34.3				
622	-33.3	657	-40.8	657	150
612	-31.6	590	-51.2	622	430
600	-29.2	553	-57.8	603	630
589	-25.6	523	-63.0	590	799
570	-18.1	500	-68.0	582	829
559	-9.6	486	-70.3	578	876
547	1.9	478	-70.5	573	814
536	16.7	C ₂₄ H ₂₇ NOS ₂ (39, 41) 1,2-Diphenylfenchyl- imidoxanthide, Ph.CS.NPh.CS.O.Fen		566	783
527	34.1			559	630
s=Me ₂ CO. c=5.95				553	461
				547	246
				528	-829
s=PhMe. c=1.416					
		701	-52.6		
		682	-55.2		
		656	-57.3		
		631	-57.9		
612	-57.2	696	75		
588	-53.8	687	109		
553	-38.0	663	225		
527	-6.3	642	338		
517	42.3	634	436		
508	57.8	s=PhMe. c=0.1304			
504	73.9				
496	87.3				
C ₂₂ H ₃₁ O ₂ S ₄ (42) Fenchyl dixanthide [S.CS.O.Fen] ₂					
s=PhMe. c=4.35					
657	74.2	622	630		
589	98.9	603	900		
527	136.3	590	1,050		
486	181.4	582	1,040		
479	191.5	578	1,000		
473	203.7	573	930		
467	215.6	566	770		
462	227.6	559	560		
457	240.2	553	290		
		547	15		
		542	-315		
		536	-640		
		523	-1,590		
		508	-2,440		
		500	-2,940		
		492	-3,160		
		486	-3,340		
		478	-3,530		

20. TERESANTALIC AND ISOTERESANTALIC ACIDS

Dispersion data. Other acids derived from camphor (202)

Formula	Name	[α] _{λ} ²⁰					
		s	p or d	6,563	5,893	5,463	4,861
C ₁₁ H ₁₆ O ₂ ----	Methyl teresantalate.....	{Nil.....	1.0305	-48.19	-60.79	-71.79	-93.04
	Methyl isoteresantalate.....	{C ₆ H ₅	10.0	-50.43	-63.57	-75.36	-97.82
C ₁₀ H ₁₄ O ₂ ----	Teresantalic acid.....	{Nil.....	1.0269	-84.51	-108.75	-130.34	-174.31
	Isoteresantalic acid.....	{C ₆ H ₅	10.0	-60.84	-76.60	-91.70	-117.76
C ₁₁ H ₁₇ ClO ₂ ..	Isoteresantalic acid.....	{C ₆ H ₅	10.0	-99.29	-127.58	-152.41	-204.52
	Methyl hydrochloroteresantalate.....	{C ₆ H ₅	10.0	7.22	9.22	10.45	14.33

V. Class III. COMPOUNDS CONTAINING NO ASYMMETRIC CARBON ATOM, OR CONTAINING AN ASYMMETRIC OR DISSYMMETRIC ATOM OF SOME OTHER ELEMENT

(a) COMPOUNDS CONTAINING ASYMMETRIC ATOMS OF S, P, ETC.

21. METHYLETHYLPHENACYLTHETINE DERIVATIVES

(a) Compounds containing asymmetric atoms of S, P, etc.

Salts of methylethylphenacylthetine, $C_{11}H_{19}O_2S$ (=MOH)

(215)		$[\alpha]_{\lambda}^{20}$			(215)		$[\alpha]_{\lambda}^{20}$		
s	$c \lambda \rightarrow$	4,359	5,781	5,893	s	$c \lambda \rightarrow$	4,359	5,781	5,893
$C_{27}H_{27}BrO_2S_2$ d-M d- α -bromocamphor- τ -sulphonate					$C_{17}H_{17}N_3O_2S$ l-M picrate				
H_2O	$\left\{ \begin{array}{l} 0.603 \\ .610 \\ .945 \end{array} \right.$	$\left\{ \begin{array}{l} 72.5 \\ 70.9 \\ 71.4 \end{array} \right.$	$\left\{ \begin{array}{l} 61.3 \\ 61.1 \\ 60.8 \end{array} \right.$	$\left\{ \begin{array}{l} 59.7 \\ 59.0 \\ 59.2 \end{array} \right.$	Me_2CO	$\left\{ \begin{array}{l} 0.480 \\ .948 \\ 2.289 \end{array} \right.$	$\left\{ \begin{array}{l} -16.7 \\ -15.8 \\ -16.2 \end{array} \right.$	$\left\{ \begin{array}{l} -14.1 \\ -14.0 \\ -13.8 \end{array} \right.$	$\left\{ \begin{array}{l} -13.0 \\ -12.4 \\ -12.6 \end{array} \right.$
$EtOH$	$\left\{ \begin{array}{l} .807 \\ 1.034 \end{array} \right.$	$\left\{ \begin{array}{l} 83.9 \\ 83.6 \end{array} \right.$	$\left\{ \begin{array}{l} 70.6 \\ 70.8 \end{array} \right.$	$\left\{ \begin{array}{l} 67.2 \\ 66.2 \end{array} \right.$	$C_{17}H_{17}N_3O_2S$ d-M styphnate				
$C_{27}H_{27}BrO_2S_2$ l-M d- α -bromocamphor- τ -sulphonate					Me_2CO	$\left\{ \begin{array}{l} 0.625 \\ .908 \end{array} \right.$	$\left\{ \begin{array}{l} 11.6 \\ 11.6 \end{array} \right.$	$\left\{ \begin{array}{l} 10.0 \\ 10.2 \end{array} \right.$	$\left\{ \begin{array}{l} 9.2 \\ 9.1 \end{array} \right.$
H_2O	$\left\{ \begin{array}{l} 0.260 \\ .484 \\ .760 \\ 1.190 \end{array} \right.$	$\left\{ \begin{array}{l} 56.9 \\ 56.2 \\ 57.2 \\ 57.6 \end{array} \right.$	$\left\{ \begin{array}{l} 48.3 \\ 47.4 \\ 48.0 \\ 47.5 \end{array} \right.$	$\left\{ \begin{array}{l} 46.3 \\ 46.4 \\ 46.0 \\ 46.9 \end{array} \right.$	$C_{17}H_{17}N_3O_2S$ l-M styphnate				
$EtOH$	$\left\{ \begin{array}{l} .192 \\ .320 \\ .387 \end{array} \right.$	$\left\{ \begin{array}{l} 72.9 \\ 71.1 \\ 71.8 \end{array} \right.$	$\left\{ \begin{array}{l} 61.2 \\ 60.9 \\ 60.8 \end{array} \right.$	$\left\{ \begin{array}{l} 57.3 \\ 56.2 \\ 56.9 \end{array} \right.$	Me_2CO	$\left\{ \begin{array}{l} 0.684 \\ 1.009 \end{array} \right.$	$\left\{ \begin{array}{l} -12.1 \\ -12.3 \end{array} \right.$	$\left\{ \begin{array}{l} -10.6 \\ -10.7 \end{array} \right.$	$\left\{ \begin{array}{l} -9.9 \\ -10.0 \end{array} \right.$
$C_{17}H_{17}N_3O_2S$ d-M picrate									
Me_2CO	$\left\{ \begin{array}{l} 0.575 \\ .713 \\ 1.464 \end{array} \right.$	$\left\{ \begin{array}{l} 15.7 \\ 15.8 \\ 15.9 \end{array} \right.$	$\left\{ \begin{array}{l} 13.5 \\ 13.7 \\ 13.6 \end{array} \right.$	$\left\{ \begin{array}{l} 12.2 \\ 11.9 \\ 12.2 \end{array} \right.$					

22. BROMOCAMPHOR- AND CAMPHORSULPHONATES PHOSPHONIUM SALTS

$s = H_2O$ (169)				$[\alpha]_{\lambda}^{15}$		
(a)	d- α -Bromocamphor- τ -sulphonates	$c \lambda \rightarrow$	4,359	5,781	5,893	
$C_{16}H_{15}BrNO_4S$	Ammonium salt.....	0.488	104.0	87.9	84.0	
$C_{31}H_{34}BrO_4PS$	dl-Phenyl-p-tolylbenzylmethylphosphonium salt.....	.836	53.9	45.85	43.74	
(b)	d-Camphor- β -sulphonates					
$C_{16}H_{15}NO_4S$	Ammonium salt.....	.498	26.6	21.6	20.1	
$C_{31}H_{37}O_4PS$	dl-Phenyl-p-tolylbenzylmethylphosphonium salt.....	1.058	12.3	9.9	9.2	

(b) COMPOUNDS CONTAINING DISSYMMETRIC METALLIC ATOMS
(Co, Cr, Rh, Ir, Pt, Etc.)

en=ethylenediamine, $H_2N \cdot CH_2 \cdot CH_2 \cdot NH_2$.
 pn=propylenediamine, $H_2N \cdot CH(CH_3)CH_2 \cdot NH_2$.
 tr=trimethylenediamine $H_2N \cdot CH_2 \cdot CH_2 \cdot CH_2 \cdot NH_2$.

23. COBALT COMPLEXES

Trialkylenediamminecobaltic salts				
I=[Co. pn ₃]Br ₃ . 2H ₂ O. II=[Co. en ₃]Br ₃ . 2H ₂ O				
s=H ₂ O p=0.1 (212) [M] _λ ¹				
λ	I (d-pn)	I (l-pn)	II (d-salt)	II (l-salt)
6,615	-175	+173	0 (?)	0 (?)
6,435	-120	+122	+82	-82
6,260	0	0	+232	-227
6,075	+111	-111	+376	-374
5,893	+223	-223	+603	-603
5,740	+459	-457	+868	-863
5,600	+836	-824	+1,257	-1,250
5,475	+1,379	-1,370	+1,841	-1,830
5,270	+2,508	-2,479	+3,100	-3,095
5,075	+1,114	-1,114	+2,477	-2,477
5,035	0	0		
4,990	-1,114	+1,114	+1,452	-1,452
4,920			0	0
4,850			-937	+927

¹ The largest value of α was 1.2°; the last figure in each number is therefore uncertain.

(94)

s=H₂O. p=60

λ	[M] _λ ¹⁵	λ	[M] _λ ¹⁵	λ	[M] _λ ¹⁵
6,750	165	6,265	394	5,760	828
6,600	228	6,100	513	5,595	1,069
6,425	306	5,910	638		

¹ p=1.91.

(95)

λ	$[M]_{\lambda}$	λ	$[M]_{\lambda}$	λ	$[M]_{\lambda}$
$s=\text{H}_2\text{O}$. $p=0.5$ to 7.3		$\text{Co. en}_3(\text{CNS})_3$		$[\text{Co}(\text{C}_2\text{O}_4)_2]\text{K}_3, 3\frac{1}{2}\text{H}_2\text{O}$	
6, 750	± 165	$s=\text{H}_2\text{O}$ $d\text{-salt}, c=0.68$ $l\text{-salt}, c=0.81$		$s=\text{H}_2\text{O}$. $c=0.41$	
6, 600	± 216	5, 420	± 133	4, 740	± 389
6, 425	± 290	5, 595	± 781	4, 780	± 402
6, 265	± 375	5, 760	± 616	4, 870	± 418
6, 100	± 448	5, 910	± 491	4, 945	± 441
5, 910	± 599	6, 100	± 401	5, 020	± 465
5, 760	± 790	6, 265	± 267	5, 105	± 492
5, 595	± 931	6, 425	± 179	5, 180	± 511
5, 420	$\pm 1, 399$	$[\text{Co. en}_3]\text{I}_3 \cdot \text{H}_2\text{O}$		5, 260	± 552
5, 260	$\pm 1, 903$	$s=\text{H}_2\text{O}$ $d\text{-salt}, c=0.59$ $l\text{-salt}, c=0.55$		5, 340	± 596
5, 085	$\pm 2, 377$	5, 085	$\pm 2, 158$	5, 420	± 640
4, 920	$\pm 2, 705$	5, 260	$\pm 1, 843$	5, 515	± 705
$[\text{Co. en}_3](\text{ClO}_4)_3$		5, 420	$\pm 1, 435$	5, 610	± 786
$s=\text{H}_2\text{O}$. $c=0.57$		5, 595	$\pm 1, 072$	5, 700	± 869
5, 085	$\pm 2, 592$	5, 760	± 774	5, 800	± 974
5, 260	$\pm 1, 804$	5, 910	± 599	5, 910	$\pm 1, 135$
5, 420	$\pm 1, 407$	6, 100	± 470	6, 020	$\pm 1, 266$
5, 595	± 999	6, 265	± 357	6, 140	± 839
5, 760	± 743	6, 425	± 274	6, 260	∓ 18
5, 910	± 513	6, 600	± 211	6, 380	∓ 543
6, 100	± 444			6, 520	∓ 422
6, 265	± 407			6, 660	∓ 174
6, 425	± 327			6, 800	∓ 34
6, 600	± 212			6, 940	∓ 19

¹ Mean values for *d*- and *l*-salts.

(269, 224)		
$d\text{- and } l\text{-}[\text{C}_6\text{H}_7\text{O}_2\text{Co.en}_2] \text{ X}$		$[M]_{D^1}$
Acetylacetonatodiethylenediamine salts		
$s=\text{H}_2\text{O}$. $c=0.1$ $[M]_D$		
X	<i>d</i> -	<i>l</i> -
Cl_2	+2, 107	-2, 134
Br_2	+2, 102	-2, 102
I_2	+2, 204	-2, 204
$(\text{ClO}_4)_2$	+2, 107	-2, 107
$(\text{NO}_3)_2$	+2, 217	-2, 217
$(\text{SCN})_2$	+2, 107	-2, 107
S_2O_8	+2, 040	-2, 261
$d\text{- and } l\text{-}[\text{C}_6\text{H}_5\text{O}_2\text{Co.en}_2] \text{ X}$		
Propionylacetonatodiethylenediamine salts		
$s=\text{H}_2\text{O}$. $c=0.1$		
X	<i>d</i> -	<i>l</i> -
$(\text{ClO}_4)_2$	+2, 476	-2, 436
$(\text{NO}_3)_2$	+2, 481	-2, 460
S_2O_8	+2, 311	-2, 383

¹ The last figures in these numbers are uncertain.

<i>d</i> - and <i>l</i> -[C ₆ H ₅ O ₂ .Co.en ₂] I ₂ Propionylacetонатodiethylenediamine-cobaltic iodide			<i>d</i> - and <i>l</i> -[C ₆ H ₅ O ₂ .Co.en ₂] I ₂ Propionylacetонатodiethylenediamine-cobaltic iodide		
<i>s</i> =H ₂ O. <i>c</i> =0.1			<i>s</i> =H ₂ O. <i>c</i> =0.1		
λ	[α] _{λ}		λ	[α] _{λ}	
	<i>d</i> -	<i>l</i> -		<i>d</i> -	<i>l</i> -
6,440	+115	-135	5,540	650	-672
6,260	186	-190	5,475	600	-623
6,075	276	-268	5,425	554	-584
5,893	402	-390	5,370	440	-480
5,750	518	-535	5,320	360	-388
5,600	630	-645			

24. CHROMIUM COMPLEXES

[Cr(C ₂ O ₄) ₃] K ₃ .3H ₂ O (95)		[Cr(C ₂ O ₄) ₃] K ₃ .3H ₂ O (95)		[Cr(C ₂ O ₄) ₃] K ₃ .3H ₂ O (95)	
<i>s</i> =H ₂ O		<i>s</i> =H ₂ O		<i>s</i> =H ₂ O	
λ	[M] _{λ}	λ	[M] _{λ}	λ	[M] _{λ}
4,600	-1,550	5,400	-2,100	5,950	1,960
4,800	-1,710	5,500	-1,400	6,200	600
5,000	-2,100	5,600	-900	6,340	0
5,200	-2,300	5,700	0	6,400	-100
5,300	-2,200	5,800	+1,750	6,500	-200

<i>d</i> - and <i>l</i> -[Cr.en ₃] I ₃ . H ₂ O		<i>d</i> - and <i>l</i> -[Cr.en ₃] I ₃ . H ₂ O		<i>d</i> - and <i>l</i> -[Cr.en ₃] I ₃ . H ₂ O	
(95; <i>cf.</i> , 96)		(95; <i>cf.</i> , 96)		(95; <i>cf.</i> , 96)	
Values for <i>d</i> -salts are +, for <i>l</i> -salts -		Values for <i>d</i> -salts are +, for <i>l</i> -salts -		Values for <i>d</i> -salts are +, for <i>l</i> -salts -	
<i>s</i> =H ₂ O <i>p</i> =1.01-0.03 <i>t</i> =15°-18°		<i>s</i> =H ₂ O <i>p</i> =1.01-0.03 <i>t</i> =15°-18°		<i>s</i> =H ₂ O <i>p</i> =1.01-0.03 <i>t</i> =15°-18°	
4,260	2,826	5,260	965	6,020	291
4,420	2,538	5,430	763	6,260	233
4,640	2,205	5,610	574	6,520	195
4,860	1,761	5,860	409	6,660	182
5,100	1,171				

25. RHODIUM COMPLEXES

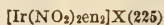
λ	$[M]_{\lambda}$	λ	$[M]_{\lambda}$	λ	$[M]_{\lambda}$
<i>d</i> - and <i>l</i> - Rhodiumtriethylenediamines		<i>d</i> - and <i>l</i> - Rhodiumtriethylenediamines		<i>d</i> - and <i>l</i> - Rhodiumtriethylenediamines	
$[\text{Rh.en}_3]\text{Br}_3 \cdot 2\text{H}_2\text{O}$ (95)		$[\text{Rh.en}_3](\text{NO}_3)_3$ (95)		$[\text{Rh}(\text{C}_3\text{H}_2\text{O}_4)_3]\text{K}_3 \cdot 1\frac{1}{2}\text{H}_2\text{O}$ Malonate (95)	
$s=\text{H}_2\text{O}$. $p=7.31$		$s=\text{H}_2\text{O}$. $p=3.37$		$s=\text{H}_2\text{O}$. $p=0.804$ and 1.503	
6,780	-244	6,840	-240	5,340	± 261
6,640	-251	6,660	260	5,420	$^1 \pm 263$
6,520	-260	6,520	265	5,515	± 267
6,380	-278	6,380	284	5,610	$^1 \pm 276$
6,260	-296	6,260	298		
				5,700	± 280
6,140	-309	6,140	319	5,800	$^1 \pm 284$
6,030	-328	6,063	334	5,910	± 271
5,890	-346	5,890	300	6,020	$^1 \pm 258$
5,700	-372	5,800	370		
		5,700	386	6,140	± 250
5,510	-400			6,260	$^1 \pm 246$
5,340	-425	5,605	402	6,380	± 241
5,180	-446	5,510	420	6,520	$^1 \pm 236$
5,100	-458	5,420	430		
		5,340	440		
4,860	-481				
4,710	-495	5,260	456		
4,310	-508	5,180	463		
4,150	-509	5,100	472		
		4,945	495		
$[\text{Rh.en}_3]\text{I}_3 \cdot \text{H}_2\text{O}$ (95)		4,780	518		
$s=\text{H}_2\text{O}$. $p=4.53$		4,650	536		
		4,480	550		
		4,310	562		
		$[\text{Rh}(\text{C}_2\text{O}_4)_3]\text{K}_3 \cdot \text{H}_2\text{O}$ (95)			
		$s=\text{H}_2\text{O}$. $p=10.96-0.5$			
6,840	± 205	4,860	1,724		
6,660	218	4,950	1,419		
6,520	232	5,020	1,225		
6,380	247	5,100	997		
6,260	255	5,180	833		
6,140	273	5,260	686		
6,030	293	5,340	553		
5,890	302	5,420	411		
5,800	312	5,510	325		
5,700	326	5,605	225		
5,605	335	5,700	146		
5,510	347	5,800	79		
5,420	359	5,890	30		
5,340	366	5,900	25		
5,260	380	5,970	0		
5,180	387	6,030	-22		
5,100	396	6,140	-56		
5,020	405	6,260	-82		
4,945	411	6,380	-102		
4,860	420	6,520	-114		
		6,660	-121		
4,780	428	6,800	-126		
4,710	434	6,946	-133		
4,650	442				
4,560	447				
4,480	450				
4,420	454				
4,310	455				
4,260	456				
4,150	457				
4,060	458				
4,010	459				
3,940	460				
3,880	402				
3,820	366				
3,780	340				
3,740	323				
3,700	322				

 $^1 p=0.511$.

26. IRIIDIUM COMPLEXES

d-Triethylenediamine salts (225)

X	$\begin{matrix} p \\ \downarrow \\ \lambda \rightarrow \end{matrix}$	6,563	5,893	5,270
I.....	0.25	30	42	56
NO ₃	.25	41.2	57.2	75.2
ClO ₄	.2	34.5	48.5	64.0

d-Dinitritodiethylenediamine salts

s = H ₂ O		p = 0.25		[α] _{λ}	
$\begin{matrix} X \\ \downarrow \end{matrix}$	$\lambda \rightarrow$	6,563	5,893	5,270	
Br.....		17.2	26.0	40.0	
ClO ₄		16.4	24.8	38.4	
NO ₂		18.0	27.2	41.2	

27. PLATINUM COMPLEXES

Platinum complexes containing d- and l-propylenediamine (212)

s = H ₂ O	c = 0.5	[M] _{6,563}	[M] _{5,893}	[M] _{5,270}
<i>l</i> -[Pt. d-pn ₃]Cl ₄ .H ₂ O.....		-844	-1,013	-1,419
<i>d</i> -[Pt. l-pn ₃]Cl ₄ .H ₂ O.....		+839	+1,035	+1,413
<i>l</i> -[Pt. d-pn ₃]Br ₄		-833	-1,024	-1,422
<i>d</i> -[Pt. l-pn ₃]Br ₄		+840	+1,031	+1,429
<i>l</i> -[Pt. d-pn ₃]I ₄		-851	-1,054	-1,433
<i>d</i> -[Pt. l-pn ₃]I ₄		+832	+1,036	+1,424

Complex metallic salts containing l-propylenediamine (44)

s = H ₂ O	p	[M] _D
[Pt. pn ₃]Cl ₂	16.6	+192
[Pt. pn. 2NH ₃]Cl ₂	17.5	+94
[Pt. en. pn]Cl ₂	19.1	+96
[Pt. pn. tr]Cl ₂	13.1	+98
[Pd. pn ₃]Cl ₂	17.7	+258
[Ni. pn ₃]Cl ₂ .H ₂ O.....	11.0	+55

28. MOLYBDENYL AND TUNGSTYL DERIVATIVES OF MALIC AND TARTARIC ACIDS

 $(\text{MoO}_3)(\text{C}_4\text{H}_4\text{O}_5\text{Na}_2)$ Sodium molybdenylmalate [M]_D. (77, cf. 75)

$\begin{matrix} p \\ t \end{matrix}$	11.020	6.046	3.175	1.633	0.827	0.416
15	190.2	189.0	188.2	187	185	181
30	178.7	177.5	176.8	175	173	170
45	163.6	162.4	162.0	160	158	155
60	146.0	144.8	144.0	142	140	136
75	125.9	124.6	123.2	122	120	115
90	102.8	101.2	99.7	98	96	93

p = per cent of malic acid: the solutions are N/1, 2, 4, 8, 16, 32.

$(\text{MoO}_3)_2(\text{C}_4\text{H}_4\text{O}_5\text{Na}_2)$ *Sodium dimolybdenylmalate* $[M]_D$. (77 cf. 75)

$\begin{smallmatrix} p \\ t \end{smallmatrix}$	5.748	3.094	1.608	0.821	0.414	0.208
15	958.5	951.5	945	935	920	905
30	954.7	946.8	938	922	903	881
45	947.0	937.7	928	903	876	828
60	934.1	915.9	895	860	795	717
75	913.0	884.4	849	777	672	509
90	877.6	832.5	766	661	496	218

p = per cent of malic acid: the solutions are $N/2$, 4, 8, 16, 32, 64.

$\text{MoO}_2(\text{C}_4\text{H}_4\text{O}_5\text{Na})_2$ *Sodium molybdenyldimalate* $[M]_D$. (77; cf. 75)

$\begin{smallmatrix} p \\ t \end{smallmatrix}$	11.792	6.275	3.241
10	-121.4	-119.8	-114.2
20	125.8	122.9	115.7
30	128.7	124.7	116.5
40	130.4	125.8	117.1
50	¹ 131.6	¹ 126.8	¹ 117.6
60	131.5	125.0	114.4
70	130.9	123.3	110.6
80	129.9	120.0	105.6
90	127.6	115.1	98.6
95	125.9	111.6	93.1

¹ Maximum.

p = Per cent of malic acid: the solutions are $N/1$, 2, 4.

$\text{MoO}_2(\text{C}_4\text{H}_5\text{O}_5\text{K})_2$ *Potassium molybdenyldimalate* $[M]_D$. (75)

$\begin{smallmatrix} p \\ t \end{smallmatrix}$	6.975	3.619	1.843
20	+382.2	+379.3	+377
45	381.4	378.3	374
70	380.1	374.6	365
95	372.6	359.4	342

p = Per cent of malic acid.

$\text{MoO}_2(\text{C}_4\text{H}_4\text{O}_5\text{NH}_4)_2$ *Ammonium molybdenyldimalate* $[M]_D$. (77; cf. 75)

$\begin{smallmatrix} p \\ t \end{smallmatrix}$	12.107	6.367	3.270	1.658	0.835
10	-122.0	-121.4	-120.2	-109	-103
20	125.7	125.1	123.7	112	107
30	128.7	128.0	125.2	113	109
35	¹ 129.5	¹ 128.7	¹ 125.8	¹ 114	¹ 110
40	129.3	128.2	125.6	113	109
50	129.1	128.2	123.7	109	103
60	128.6	126.2	120.6	103	94
70	126.5	123.6	115.9	96	81
80	123.8	120.3	109.6	86	67
90	120.7	116.5	102.5	75	52
95	118.9	114.8	99.6	71	45

¹ Maximum.

p = per cent of malic acid: the solutions are $N/1$, 2, 4, 8, 16.

MoO₃(C₄H₄O₆Na₂) Sodium molybdenyltartrate [M]_D. (76)

$\begin{smallmatrix} p \\ t \end{smallmatrix}$	12.308	6.781	3.569	1.831	0.928	0.467	0.234	0.117
20	832.4	813.8	787.6	750	629	695	538	421
40	815.4	797.6	769.1	729	602	671	509	386
70	791.8	778.6	717.0	704	561	636	443	300
90	767.7	758.6	722.5	676	502	600	363	225

p=per cent of tartaric acid; the solutions are N/1, 2, 4, 8, 16, 32, 64, 128.

(MoO₃)₂(C₄H₄O₆Na₂) Sodium dimolybdenyltartrate [M]_D. (76)

$\begin{smallmatrix} p \\ t \end{smallmatrix}$	6.403	3.461	1.803	0.920	0.465	0.233
15	1324.9	1223	1039	802	662	592
30	1188.7	1098	918	710	592	524
45	1037.7	926	785	611	514	450
60	894.9	777	668	516	443	382
75	771.0	651	566	434	379	320
90	666.2	565	484	375	323	270

p=per cent of tartaric acid; the solutions are N/2, 4, 8, 16, 32, 64.

MoO₂(C₄H₄O₆K)₂ Potassium molybdenylditartrate [M]_D. (76)

$\begin{smallmatrix} p \\ t \end{smallmatrix}$	6.975	3.619	1.843	0.929	0.467	0.235
20	382.2	379.3	377	372	362	365
45	381.4	378.3	374	368	361	353
70	380.1	374.6	365	351	338	320
95	371.6	359.4	342	316	283	246

p=per cent of tartaric acid; the solutions are N/2, 4, 8, 16, 32, 64.

WO₃(C₄H₄O₅Na₂) Sodium tungstylmalate [M]_D. (77)

$\begin{smallmatrix} p \\ t \end{smallmatrix}$	10.202	5.792	3.107	1.601	0.822	0.415
10	28.0	+29.2	+32.2	+56	+91	+124
30	28.6	31.2	38.5	64	98	131
50	30.3	36.7	51.6	81	116	139
70	33.8	45.6	66.3	103	137	150
95	37.3	57.8	82.2	124	159	162

p=per cent of malic acid; the solutions are N/1, 2, 4, 8, 16, 32.

WO₂(C₄H₄O₅Na)₂ Sodium tungstyltrimalate [M]_D. (77)

$\begin{smallmatrix} p \\ t \end{smallmatrix}$	12.268	6.134	3.211	1.640
10	-99.6	-98.5	-97.1	-91
20	104.3	102.7	100.9	93
30	107.6	105.4	102.8	94
40	110.1	107.7	103.2	95 Max.
50	112.0	109.0	104.1 Max.	94
60	113.4	110.1 Max.	103.8	93
70	113.7 Max.	108.5	101.9	91
80	113.4	108.1	98.0	88
90	112.8	106.2	93.8	82
95	112.4	105.0	91.2	77

p=per cent of malic acid; the solutions are N/1, 2, 4, 8.

$WO_3(C_4H_4O_6Na_2)$ Sodium tungstylltartrate $[M]_D$. (76)

$\frac{p}{t}$	11.390	6.486	3.484	1.409	0.922	0.465
20	482.8	463.5	442.4	420	395	360
40	476.1	455.7	432.8	405	378	344
70	466.7	447.2	421.3	390	354	316
90	459.3	437.5	411.9	381	336	291

p = per cent of tartaric acid: the solutions are N/1, 2, 4, 8, 16, 32.

 $(WO_3)_2(C_4H_4O_6Na_2)$ Sodium ditungstylltartrate $[M]_D$. (76)

$\frac{p}{t}$	5.833	3.233	1.751	0.906	0.461	0.232
10	220.2	203.1	197	191	183	179
20	213.6	203.0	191	186	178	171
30	208.1	198.3	186	182	174	163
40	203.2	194.1	182	178	170	155
50	198.7	190.3	179	175	166	150
60	194.8	186.8	175	172	163	145
70	191.4	183.7	172	170	159	141
80	188.7	180.7	169	168	158	139
90	186.6	177.8	167	166	157	137
95	185.8	176.6	167	164	156	134

p = per cent of tartaric acid: the solutions are N/2, 4, 8, 16, 32, 64.

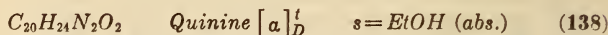
 $WO_2(C_4H_4O_6Na)_2$ Sodium tungstylditartrate $[M]_D$. (76)

$\frac{p}{t}$	12.582	6.845	3.580	1.832	0.927
10	242.4	242.7	243.5	247	256
20	245.9	247.2	248.2	252	262
30	248.5	249.9	251.7	255	264
40	250.9	252.4	254.3	257	265
50	253.0	254.4	255.9	258	264
60	255.0	256.1	257.2	258	263
70	256.4	257.6	257.0	256	261
80	257.5	257.4	256.3	254	256
90	257.9	256.6	254.7	251	248
95	258.1	256.0	252.8	250	244

p = per cent of tartaric acid: the solutions are N/1, 2, 4, 8, 16.

VI. Class IV. SUBSTANCES OF UNKNOWN, DOUBTFUL, OR COMPLEX STRUCTURE

29. ALKALOIDS AND DERIVATIVES



$\begin{smallmatrix} c \\ t \end{smallmatrix}$	1	2	3	4	5	6
0	-171.4	-169.6	-167.9	-166.1	-164.2	-162.4
5	-170.5	-168.7	-167.0	-165.2	-163.4	-161.6
10	-169.6	-167.8	-166.1	-164.4	-162.7	-160.9
15	-168.9	-167.1	-165.4	-163.7	-162.1	-160.4
20	-168.2	-166.6	-164.8	-163.2	-161.6	-159.8



s = H ₂ O + EtOH		s = H ₂ O + EtOH	
c = 2. t = 15°		c = 2. t = 15°	
Per cent EtOH	$[\alpha]_D$	Per cent EtOH	$[\alpha]_D$
97	-143.86	60	-187.75
90	-160.75	50	-187.50
85	-168.25	40	-182.82
80	-174.75	20	-166.59
70	-182.27	0	-138.75



Formula	Name	c =	2.5	5.0
		s	$[\alpha]_D^{25}$	$[\alpha]_D^{20}$
$C_{19}H_{22}N_2O$	Cinchonine.....	EtOH.....	224.5	(c = 0.5)
$C_{23}H_{26}N_2O_4$	Myristate.....	CHCl ₃	134.2	133.5
$C_{25}H_{28}N_2O_4$	Palmitate.....	CHCl ₃	126.3	127.8
$C_{27}H_{30}N_2O_4$	Stearate.....	CHCl ₃	121.4	122.3

Derivatives of cinchonine and cinchonidine (87)

s = CHCl ₃ c = 2.0		Cinchonine	Cinchonidine
Formula	Name	$[\alpha]_D^{25}$	$[\alpha]_D^{25}$
$C_{21}H_{24}N_2O_2$	Acetyl.....	108.5	12.90
$C_{23}H_{26}N_2O_2S$	Benzenesulphonyl.....	62.15	11.43
$C_{25}H_{28}N_2O_2$	Benzoyl.....	-27.80	98.65

(C₂₃H₂₉N₃O₄) Brucine salts, s = CHCl₃ (85, 86, 87, 89)

Formula	Name	c=2.5	c=5.0
		[M] _D ¹⁵	[M] _D ¹⁵
C ₂₅ H ₃₀ N ₂ O ₆	Acetate.....	260.6	258.0
C ₂₆ H ₃₂ N ₂ O ₆	Propionate.....	252.3	248.1
C ₂₇ H ₃₄ N ₂ O ₆	n-Butyrate.....	251.2	247.4
C ₂₈ H ₃₆ N ₂ O ₆	n-Valerate.....	251.6	247.4
C ₂₉ H ₃₈ N ₂ O ₆	n-Caproate.....	252.8	246.8

t=14.5–20° C.		[M] _D	[M] _D
C ₂₃ H ₂₈ N ₂ O ₄	Brucine.....	121.0	121.5
C ₂₅ H ₃₀ N ₂ O ₅	Glyoxylate.....	–61.3	–60.7
C ₂₆ H ₃₀ N ₂ O ₇	Pyruvate.....	–86.2	–85.2
C ₂₇ H ₃₂ N ₂ O ₇	Acetoacetate.....	–53.7	–54.7
C ₂₈ H ₃₄ N ₂ O ₇	Levulinat.....	–177.9	–175.5
C ₂₉ H ₃₄ N ₂ O ₈	Sorbate.....	–120.6	–130.0
C ₂₉ H ₃₆ N ₂ O ₆	β, γ-Dihydrosorbate.....	–214.2	–227.2
C ₃₀ H ₃₂ N ₂ O ₆	Benzoate.....	–129.0	–131.1
C ₃₁ H ₃₂ N ₂ O ₇	Phenylglyoxylate.....	–33.4	–32.6
C ₃₂ H ₃₄ N ₂ O ₇	Phenylpyruvate.....	+18.5	+20.4
C ₃₃ H ₃₄ N ₂ O ₇	Benzoylacetate.....	–188.8	–180.0
C ₃₃ H ₃₆ N ₂ O ₇	β-Benzoylpropionate.....	–182.4	–184.1
C ₃₃ H ₃₄ N ₂ O ₈	Benzoylpyruvate.....	+66.1	+60.1
C ₃₂ H ₃₆ N ₂ O ₇	Benzylpyruvate.....	–55.5	–54.9
C ₃₅ H ₃₆ N ₂ O ₈	Piperate.....	–28.6	–30.7
C ₃₅ H ₃₈ N ₂ O ₈	α, β-Dihydropiperate.....	–154.3	–154.1
C ₃₅ H ₃₈ N ₂ O ₈	β, γ-Dihydropiperate.....	–179.1	–178.5
C ₃₅ H ₄₀ N ₂ O ₈	Piperonylbutyrate.....	–170.5	–174.1
C ₃₇ H ₃₄ N ₂ O ₈	Myristate.....	246.7	246.8
C ₃₈ H ₃₈ N ₂ O ₈	Palmitate.....	248.4	247.5
C ₄₁ H ₆₂ N ₂ O ₈	Stearate.....	247.7	247.4

Dibrucine salts

C ₄₈ H ₅₈ N ₄ O ₁₄	Mesoxalate.....	–191.9	–189.1
C ₅₀ H ₅₈ N ₄ O ₁₂	Oxalacetate.....	–357.0	–362.4
C ₅₁ H ₅₈ N ₄ O ₁₃	Acetonedicarboxylate.....	–428.2	–428.2
C ₄₉ H ₅₄ N ₄ O ₁₂	Oxalate.....	–24.6	–26.3
C ₄₉ H ₅₆ N ₄ O ₁₂	Malonate.....	–470.6	–470.6
C ₅₀ H ₅₈ N ₄ O ₁₂	Succinate.....	–580.9	–591.6
C ₅₁ H ₆₀ N ₄ O ₁₂	Glutarate.....	–464.4	–465.8
C ₅₂ H ₅₈ N ₄ O ₁₂	Muconate.....	–90.4	–88.5
C ₅₂ H ₆₀ N ₄ O ₁₂	α, β-Dihydromuconate.....	–359.0	–354.6
C ₅₂ H ₆₀ N ₄ O ₁₂	β, γ-Dihydromuconate.....	365.5	–358.8
C ₅₂ H ₆₂ N ₄ O ₁₂	Adipate.....	397.8	399.2
C ₅₃ H ₆₄ N ₄ O ₁₂	Pimelate.....	417.9	405.2
C ₅₄ H ₆₆ N ₄ O ₁₂	Suberate.....	457.5	439.6
C ₅₅ H ₆₈ N ₄ O ₁₂	Azelate.....	444.2	440.8
C ₅₆ H ₇₀ N ₄ O ₁₂	Sebacate.....	479.5	477.5
C ₅₈ H ₆₂ N ₄ O ₁₂	Cinnamylidenemalonate.....	98.99	.....
C ₅₈ H ₆₄ N ₄ O ₁₂	α, β-Dihydrocinnamylidenemalonate.....	439.5	–444.2
C ₅₈ H ₆₄ N ₄ O ₁₂	β, γ-Dihydrocinnamylidenemalonate.....	505.2	–509.2

VII. Class V. INFLUENCE OF SALTS AND OTHER SUBSTANCES ON ROTATORY POWER

Influence of salts on rotatory power (48)

(a) $C_3H_5O_3$ *l*-lactic acid (containing 8 per cent *d*-lactic acid)

$s = H_2O$ $t = 15^\circ C.$

Salt	c of salt	p	d_{15}^0	$[\alpha]_{5,461}^{15}$
Nil.....		10.73	1.027	-2.2
NaCl.....	23.4	8.71	1.162	-7.6
NaBr.....	41.2	7.65	1.293	-8.0
BaBr ₂	59.2	6.79	1.485	-17.7

(b) $C_4H_7O_3$ Methyl *l*-lactate (containing 5 per cent methyl *d*-lactate)

s	p	d_{15}^0	$[\alpha]_{5,461}^{20}$
Nil.....	100	1.093	8.4
H ₂ O.....	10.0	1.012	1.4
N NaCl.....	10.0	1.050	.5
1/4 N NaCl.....	10.37	1.150	-2.1
N NaBr.....	10.0	1.080	.5
N KCl.....	10.0	1.054	.5
N NH ₄ Cl.....	10.0	1.027	.9
N CaCl ₂	10.0	1.054	-1.0
N BaCl ₂	10.0	1.094	-1.3
1/4 N BaBr ₂	9.81	1.456	-9.1

(c) $C_3H_5O_4$ *d*-Glyceric acid

$s = H_2O$

Salt	c of salt	p	d_{15}^0	$[\alpha]_{5,461}^{20}$
Nil.....		2.40	1.01	0.0
NaCl.....	23.4	1.84	1.17	4.9
BaBr ₂	20.8	1.90	1.22	6.9

(d) $C_3H_7NO_2$ *d*-Alanine

s	c	$[\alpha]_{5,461}^{15}$
H ₂ O.....	10.0	2.9
N KCl.....	10.0	3.0
N NaCl.....	10.0	3.3
N BaCl ₂	10.0	3.5
1/4 N BaBr ₂	10.0	4.8
1.5 M HCl.....	5.78	17.8

(e) $C_5H_9NO_4$ *d*-Glutamic acid

s	p	d_{15}^0	$[\alpha]_{5,461}^{25}$
H ₂ O.....	1.50	1.003	13.3
N NaCl.....	1.50	1.043	14.4
1/4 N NaCl.....	1.51	1.152	15.8
N KCl.....	1.53	1.050	14.8
N BaCl ₂	1.53	1.092	14.4
1/4 N BaBr ₂	1.51	1.500	18.1
M NaOH.....	12.25	1.075	-3.6
2M NaOH.....	6.55	1.050	11.7
1.5M HCl.....	8.75		37.4

Influence of salts on rotatory power (48)—Continued

(f) Influence of NaBr

$s = \text{MeOH}$		$c = 10 \quad +N \text{ NaBr}$	
		$[\alpha]_{5,461}^{15}$	$[\alpha]_{5,461}^{15}$
$\text{C}_4\text{H}_6\text{O}_5$	<i>l</i> -Malic acid.....	-5.9	21.8
$\text{C}_4\text{H}_6\text{O}_5$	<i>d</i> -Tartaric acid.....	2.6	-9.0
$\text{C}_4\text{H}_6\text{O}_5$	Methyl <i>l</i> -lactate.....	5.4	-5.8
$\text{C}_5\text{H}_8\text{O}_6$	Dimethyl <i>l</i> -malate.....	-9.4	9.1
$\text{C}_5\text{H}_8\text{O}_6$	Dimethyl <i>d</i> -tartrate.....	2.7	-12.6
$\text{C}_{10}\text{H}_{14}\text{O}_8$	Dimethyl <i>d</i> -diacetoxysuccinate ($c=4$).....	-18.3	-12.2
$\text{C}_{12}\text{H}_{18}\text{O}_8$	Diethyl <i>d</i> -diacetoxysuccinate ($c=5$).....	3.6	7.6

(g) Influence of sodium halides

Formula	Name	s	c	t	$[\alpha]_{5,461}^t$
$\text{C}_9\text{H}_{10}\text{O}_3$	<i>d</i> - β -Phenyllactic acid.....	H_2O	2.505	20	25.5
		<i>N</i> NaCl.....	.665	20	13.5
		MeOH.....	10.0	20	21.0
		<i>N</i> NaBr in MeOH.....	10.0	20	-2.0
$\text{C}_{10}\text{H}_{12}\text{O}_3$	Methyl <i>d</i> - β -phenyllactate.....	MeOH.....	10.0	18	-4.5
		<i>N</i> NaBr in MeOH.....	10.0	18	-22.3

(h) $\text{C}_8\text{H}_{15}\text{NO}_4$ Ethyl *l*-aspartate

s	c	$[\alpha]_{5,461}^{15}$
Nil.....		-11.7
C_2H_5	10.92	-12.6
CHCl_3	11.02	-9.7
Me_2CO^1	20.0	-8.8
H_2O	21.7	4.2
	12.25	4.2
$\frac{1}{2}$ <i>N</i> NaCl.....	10.81	6.7
$\frac{1}{2}$ <i>N</i> BaBr ₂	14.50	11.5
$\frac{5}{8}$ <i>N</i> CaCl ₂	13.21	14.5
<i>N</i> HCl.....	11.37	12.0
MeOH.....	20.0	-0.5
<i>N</i> NaBr in MeOH.....	20.0	4.3

¹ Ethyl *l*-aspartate reacts with Me_2CO ; $\alpha_{\text{Et}} = -3.50$ to -56.6 ($c=20$) in 15 hours

(i) Effect of temperature

(1) $\text{C}_3\text{H}_6\text{O}_3$ *l*-Lactic acid in aqueous solution (containing 8 per cent *d*-lactic acid) $p=10.73$

t	15	18	36	52	62	70
d^t	1.03	1.03	1.02	1.01	1.01	1.00
$[\alpha]_{5,461}^t$	-2.2	-2.0	-0.7	± 0.0	0.4	0.7

Influence of salts on rotatory power (48)—Continued(2) $C_4H_5O_2$ Methyl *l*-lactate (containing 5 per cent methyl *d*-lactate)

s=Nil				
<i>t</i>	<i>d^t</i>	$[a]_{5,893}^t$	$[a]_{5,461}^t$	$[a]_{4,078}^t$
15	1.097	7.26	8.25	10.89
20	1.093	7.46	8.39	11.21
s=H ₂ O				
<i>p</i>	<i>d²⁰</i>	$[a]_{5,893}^{20}$	$[a]_{5,461}^{20}$	$[a]_{4,078}^{20}$
100	1.093	7.46	8.39	11.21
80.0	1.086	4.1	4.4	4.5
50.9	1.063	2.1	2.5	1.0
20.0	1.026	1.8	1.8	-0.2
10.0	1.012	1.3	1.4	-0.5
5.36	1.005	1.3	1.4	-0.9

Effect of salts on the rotatory power of C₃H₇NO₂ d-alanine (48)

s	c	$[a]_{4,359}^{15}$
H ₂ O.....	10.0	2.9
N KCl.....	10.0	3.0
N NaCl.....	10.0	3.3
N BaCl ₂	10.0	3.5
N BaBr ₂	10.0	4.8
1.5 M HCl.....	5.78	17.8

*Influence of inorganic salts on the rotation of C₄H₅O₅, malic acid*s=H₂O, n=number of gram equivalents of salt added to 500 g of 20 per cent malic acid solution. (214; cf., 8, 53, 182, 183, 207, 214, 223)Δ=Change in $[α]_D$ due to the presence of the salt

Salt	<i>d</i> ₄ ²⁰	n	Δ	Salt	<i>d</i> ₄ ²⁰	n	Δ
NH ₄ Cl.....	1.086	1/4	1.16	Ca(NO ₃) ₂	1.1155	0.2998	4.37
	1.103	1	3.28		1.1917	1	12.07
(NH ₄) ₂ SO ₄	1.0965	1/4	.65	BaCl ₂	1.1256	1/4	5.58
	1.1418	1	1.98		1.2566	1	17.23
NH ₄ NO ₃	1.0938	1/4	1.11	Ba(NO ₃) ₂	1.133	1/4	4.83
	1.131	1	3.00		1.091	1/4	.73
AlCl ₃	1.0985	1/4	.60	LiCl.....	1.123	1	2.84
	1.1547	1	2.63	NaCl.....	1.0993	1/4	1.67
Al ₂ (SO ₄) ₃	1.1075	1/4	.40		1.153	1	5.39
	1.1105	1/4	.56	Na ₂ SO ₄	1.1103	1/4	1.14
ZnCl ₂	1.1915	1.015	2.55		1.181	3/8	3.38
	1.118	1/4	.00	NaNO ₃	1.107	1/4	1.61
ZnSO ₄	1.2247	0.998	1.06		1.180	1	4.64
	1.119	1/4	.55		1.0905	1/4	1.04
Zn(NO ₃) ₂	1.2283	1	2.81		1.1013	1/4	1.95
	1.1291	1/4	.73	KCl.....	1.123	1/4	3.49
Cd(NO ₃) ₂	1.267	1	3.11		1.1618	1	5.57
	1.126	1/8	.36	KBr.....	1.1215	1/4	2.11
HgCl ₂	1.1495	1/4	-3.36		1.2363	1	6.00
Hg(NO ₃) ₂	1.3472	1	-3.58	KI.....	1.1397	1/4	2.39
	1.0995	1/4	.77		1.3015	1	6.79
MgCl ₂	1.1556	1	2.82	K ₂ SO ₄	1.1126	1/4	1.48
	1.1095	1/4	.34	KNO ₃	1.1095	1/4	1.88
MgSO ₄	1.1935	1	1.51		1.882	1	4.51
	1.107	1/4	.81	RbCl.....	1.1223	1/4	1.95
Mg(NO ₃) ₂	1.1817	1	2.65		1.2417	1	5.08
	1.1018	1/4	3.95	CsCl.....	1.1442	1/4	1.94
CaCl ₂	1.166	1.019	14.81		1.3185	1	4.66

C₄H₆O₆ Tartaric acid, effect of metallic salts on rotation (129)

Salt	c		[α] _{5,780} For acid alone	λ→ t ↓	[α] _λ			
	Of salt	Of acid			5,780	5,461	4,920	4,359
NaCl.....	24.8	39.1	9.1	17	-3.2	-4.4	-8.0	-17.5
CaCl ₂	42.7	30.2	10.2	17	-42.5	-49.0	-64.9	-95.0
SrCl ₂	41	25.8	10.9	19	-16.3	-19.4	-27.1	-43.2
BaCl ₂	28	47.0	8.2	17	-11.2	-13.5	-19.0	-33.8
MgCl ₂	25	19.1	11.9	17	7.4	7.5	6.8	3.8
ZnCl ₂	22	24.4	11.0	18	9.6	9.9	9.9	8.0
NaNO ₃	36	21.8	11.3	18	0.2	-0.6	-3.0	-10.5
Ca(NO ₃) ₂	40	21.8	11.3	20	-14.0	-17.0	-24.1	-38.9
Sr(NO ₃) ₂	32	21.8	11.3	20	-5.4	-7.0	-12.0	-22.5
Ba(NO ₃) ₂	8	21.8	11.3	18	5.2	4.9	-3.7	-1.0

Influence of sodium and barium halides on the rotatory power of derivatives of succinic acid in aqueous solution (45, 46)

Formula	Name	p	s	t	[α] _D
C ₄ H ₅ O ₄	Malic acid.....	16.67	H ₂ O.....	25	-1.55
		13.95	4 M ¹ NaCl.....	25	4.80
		11.15	2 M BaBr ₂	25	21.8
C ₄ H ₆ O ₆	Tartaric acid.....	16.67	H ₂ O.....	25	12.98
		15.2	2 M NaCl.....	25	7.62
		14.22	2 M NaBr.....	25	7.03
		13.33	2 M NaI.....	25	5.11
		14.20	1 M BaCl ₂	25	-1.58
		13.36	1 M BaBr ₂	25	-2.34
		11.15	2 M BaBr ₂	25	-8.83
C ₅ H ₉ O ₆	Methyl hydrogen tartrate.....	19.67	H ₂ O.....	25	14.8
		20.05	5 M NaCl.....	25	3.7
		19.6	2.5 M BaBr ₂	25	-8.37
C ₆ H ₁₀ O ₆	Dimethyl malate.....	50.0	H ₂ O.....	25	-8.58
		43.62	5 M NaCl.....	25	-1.65
		36.4	2.5 M BaBr ₂	25	9.00
C ₆ H ₁₀ O ₆	Dimethyl tartrate.....	49.77	H ₂ O.....	16.7	² 14.71
		43.62	5 M NaCl.....	16.0	.73
		36.45	2.5 M BaBr ₂	17.0	-12.02
C ₆ H ₁₄ O ₆	Diethyl tartrate.....	50.0	H ₂ O.....	19.9	³ 17.34
		43.62	5 M NaCl.....	17.0	2.19
		36.45	2.5 M BaBr ₂	15.0	-7.93

¹ Moles of salt per 1000 g of water, throughout the table.² See (143).³ See (143).*Effect of the addition of various salts on the rotation of C₈H₁₆O₆ Diethyl tartrate. (147)*c=11.84¹

s	[d] ₄ ²⁶	[α] _D ²⁶	s	[d] ₄ ²⁶	[α] _D ²⁶
H ₂ O.....	1.021	26.37	M NaBr.....	1.127	19.86
M NH ₄ Cl.....	1.046	22.56	M KBr.....	1.151	18.41
M NaCl.....	1.088	20.32	M (NH ₄) ₂ SO ₄	1.129	18.73
M KCl.....	1.097	19.59	M KCNS.....	1.091	17.28
M NH ₄ NO ₃	1.068	22.50			
M NaNO ₃	1.110	19.06	M NaClO ₄	1.132	18.78
M KNO ₃	1.119	19.34	M NaC ₂ H ₃ O ₂	1.087	18.25
M NaI.....	1.201	16.26	M CO(NH ₂) ₂	1.053	27.29
M KI.....	1.211	16.69	M BaCl ₂	1.127	13.94

¹ The concentrations of ester and of salt are relative to 100 g. of water.

Effect of inactive substances on the rotation of tartaric acid

1. Inorganic and organic acids (23, 110, 178, 217).
2. Organic bases (178, 179).
3. Organic halide and nitro compounds (179).
4. Alcohols (22, 110, 178).
5. Benzene and homologues (179).
6. Boric acid (24, 139).
7. Alkalies (3, 219).
8. Alkali salts (113, 208, 218).

Influence of acid, alkali, and salts on the rotatory power and rotatory dispersion of aspartic acid and asparagine (47)

 $(C_4H_7NO_4)$ *L*-Aspartic acid

s	Moles of acid or alkali per mole of substance	p	t	$[\alpha]_{D, 5893}$	$[\alpha]_{D, 5461}$	$[\alpha]_{D, 4358}$
H ₂ O.....		0.990	25	3.8	6.0	14.0
-----		1.961	48	2.3	4.0	9.3
-----		1.961	68	± 0.0	1.3	4.5
-----		1.961	78	-1.5	-3	2.3
NHCl.....	1.5	7.984	25	25.0	29.9	63.5
0.2 N NaOH.....	1.0	2.584	25	-17.3	-19.3	-33.6
N NaOH.....	1.0	11.30	25	-6.0	-6.9	-9.4
2 N NaOH.....	1.0	19.76	25	.5	1.5	5.5
N NaOH.....	2.0	6.0	25	-2.4	-2.1	1.8
0.2 N NaOH.....	2.0	1.303	25	-6.9	-4.8	-1.5
2 N NaOH.....	2.0	11.02	25	-.7	-.3	4.3
N NaCl.....		1.011	25	9.5	12.7	28.6
4 N NaCl.....		.944	25	18.4	21.5	47.9
N BaCl ₂		1.047	25	13.7	16.7	33.7
4 N BaCl ₂		1.007	25	21.2	25.4	50.3

 $(C_4H_5N_2O_3)$ *L*-Asparagine

H ₂ O.....		1.961	34	-6.7	-7.5	-14.7
-----		1.961	40	-7.7	-8.3	-17.7
-----		1.961	60	-10.5	-11.3	-22.4
-----		7.407	52	-8.3	-9.3	-18.3
NHCl.....	1.5	8.942	25	27.9	33.7	70.4
N NaOH.....	1.0	12.44	25	-8.8	-10.0	-19.9

$C_4H_5N_2O_3$, Asparagine, effect of dilute acids on rotation of 1 mole asparagine+300 moles H₂O (18)

M HCl	$[\alpha]_D^{20}$	M H ₂ SO ₄	$[\alpha]_D^{20}$	M AcOH	$[\alpha]_D^{20}$
1	26.4	0.5	23.1	1	-3.49
1.5	30.4	0.75	27.3	2	-3.10
2	31.5	1	29.5	5	-1.45
3	31.9	3	32.0	7	-0.59
5	32.3	5	34.3	10	0.00
10	33.3	10	35.5	15	1.11
15	33.7			20	2.63
20	34.3				

Influence of acid, alkali and salts on rotatory power of C₅H₉NO₄ d-glutamic acid (48)

s	p	$[\alpha]_{D, 589}$	s	p	$[\alpha]_{D, 589}$
H ₂ O.....	1.50	13.3	4 N BaBr ₂	1.51	18.1
N NaCl.....	1.50	14.4	1 M NaOH.....	12.25	-3.6
4 N NaCl.....	1.51	15.8	2 M NaOH.....	6.55	11.7
N KCl.....	1.53	14.8	1.5 M HCl.....	8.75	37.4
N BaCl ₂	1.53	14.4			

Influence of boric acid on $C_6H_{14}O_6$ mannitol

(a) with H_3BO_3 (62)		s=EtOH. c=10		(b) with NaOH (137)	
s= H_2O . c=10		$\frac{M H_3BO_3}{M C_6H_{14}O_6}$	$[\alpha]_D^{18}$	$\frac{M C_6H_{14}O_6}{M H_3BO_3}$	$[\alpha]_D^{15}$
$\frac{M H_3BO_3}{M C_6H_{14}O_6}$	$[\alpha]_D^{18}$	2.0	17.3	10	-0.37
0.8	3.1	2.6	21.1	9	-0.47
1.5	4.3	3.0	22.9	8	-0.70
2.0	5.2	3.5	24.6	7	-0.83
s= H_2O . c=15		s=EtOH. c=12		6	-0.86
0.4	1.5	2.2	20.2	5	-1.04
.8	3.6	3.0	25.2	4	-1.30
1.0	4.5	4.0	28.7	3	-1.95
1.3	5.4	s= H_2O . c=3.555		2	-2.59
1.5	5.9	$\frac{M C_6H_{14}O_6}{M H_3BO_3}$	$[\alpha]_D^{15}$ (137)	1	-3.43
s=EtOH. c=6		$\frac{M C_6H_{14}O_6}{M H_3BO_3}$	$[\alpha]_D^{15}$ (137)	(c) with $NaBO_2$ (137)	
1.8	13.9	6	-0.73	$\frac{M C_6H_{14}O_6}{M NaBO_2}$	$[\alpha]_D^{15}$
2.0	15.6	5	.38	20	-0.078
3.0	19.7	4	1.69	17	.004
4.0	23.9	3	1.83	15	.397
5.0	25.4	2	2.03	13	.873
6.0	27.2	1	2.25	11	1.357
		.5	3.77	9	1.737
		.333	5.57	7	2.193
		.25	6.76	5	3.439
				3	5.169
				1	19.746

Influence of boric acid on derivatives of mannitol (92) s= H_2O N/2 H_3BO_3

Formula	Name	c	$[\alpha]_D^{20}$	$[\alpha]_D^{20}$
$C_6H_{14}O_6$	Mannitol	-----	-0.25	28.3
$C_8H_{18}O_8$	ϵ , ζ -Dimethylmannitol	N/4	-7.35	-3.88
$C_{10}H_{22}O_{10}$	γ , δ , ϵ , ζ -Tetramethylmannitol	N/8	-13.02	-6.72
$C_{12}H_{26}O_{12}$	β , γ , ϵ , ζ -Tetramethylmannitol	N/8	38.54	40.64
$C_8H_{18}O_8$	Mannitolmonoacetone	N/4	30.61	29.50
$C_{11}H_{21}O_9$	Pentamethylmannitol	N/2	7.54	8.25
$C_{12}H_{22}O_9$	Mannitoldiacetone	N/8	23.04	22.43

The influence of papaverine on the optical activity of narcotine in acid solution (5)

c		Length of tube=2 cm.	
$C_{22}H_{23}NO_7$	$C_{20}H_{21}NO_4$	$[\alpha]_{D,461}^{21}$	
Narcotine	Papaverine	in 1 per cent H_2SO_4	in 1 per cent HCl
2.0	0.0	2.61	2.23
.0	.5	.02	0.02
2.0	.5	2.24	1.76
2.0	.0	2.59	-----
2.0	.5	2.19	-----
2.0	1.0	2.00	-----
2.0	2.0	1.69	-----
2.0	3.0	1.49	-----
2.0	4.0	1.45	-----
s=PhMe			
1.333	0.00	-4.83	-----
0.00	.50	± 0.00	-----
1.333	.50	-4.82	-----
1.333	1.00	-4.84	-----

Specific rotation of $C_{21}H_{23}NO_7$, narcotine (5)					
s	PhMe	90 per cent EtOH	$CHCl_3$	1 per cent H_2SO_4	1 per cent HCl
c	2	0.4	2.0	2.0	1.0
t	32	31	33	32	29
$[\alpha]_{D,893}^{25}$ -----	-148.75	-----	-198.0	57.25	50.0
$[\alpha]_{D,780}^{25}$ -----	-154.5	-----	-206.5	-----	52.2
$[\alpha]_{D,461}^{25}$ -----	-182	-203.75°	-242.3	65.2	56.5

Rotatory power of liquid crystals

For a layer 1 mm. thick; $\lambda=5,893$			(220)
(a) Esters of $C_{27}H_{45}O$ cholesterol			
$C_{27}H_{45}Cl$ -----	Chloride-----		-120
$C_{27}H_{45}O_2$ -----	Acetate-----		-200
$C_{30}H_{50}O_2$ -----	Propionate-----		5
$C_{31}H_{50}O_2$ -----	Crotonate-----		1180
$C_{31}H_{50}O_2$ -----	<i>n</i> -Butyrate-----		50
$C_{32}H_{52}O_2$ -----	Allylacetate-----		-190
$C_{33}H_{52}O_2$ -----	Sorbate-----		480
$C_{34}H_{49}NO_4$ -----	<i>o</i> -Nitrobenzoate-----		70
	<i>m</i> -Nitrobenzoate-----		100
	<i>p</i> -Nitrobenzoate-----		-1,700
$C_{34}H_{49}O_2$ -----	Benzoate-----		+80
$C_{35}H_{50}O_2$ -----	Phenylpropiolate-----		30
$C_{35}H_{51}NO_4$ -----	<i>p</i> -Nitrocinnamate-----		-6,200
$C_{35}H_{52}O_2$ -----	Cinnamate-----		-1,400
$C_{36}H_{54}O_2$ -----	Hydrocinnamate-----		-900
$C_{72}H_{102}N_2O_4$ -----	<i>p</i> -Azocinnamate-----		10,500

¹ Sign uncertain.

(b) Esters of active amyl alcohol		
$C_{23}H_{25}NO_2$ -----	Cinnamylideneaminocinnamate-----	9,500.
$C_{21}H_{22}N_2O_4$ -----	<i>p</i> -Nitrobenzylideneaminocinnamate-----	6,000.
$C_{22}H_{22}N_2O_2$ -----	Cyanobenzylideneaminocinnamate-----	8,000 to 13,000.
$C_{22}H_{23}NO_3$ -----	Anisylideneaminocinnamate-----	6,000 to 8,000.
$C_{23}H_{27}NO_3$ -----	Anisylideneamino- α -methylcinnamate-----	4,000 to 5,000.

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