368. *Physical Properties and Chemical Constitution. Part XXII. Some Primary, Secondary, and Tertiary Amines.*

By ARTHUR I. VOGEL.

New determinations have been made of the refractivities at 20° and the parachors of a series of primary aliphatic amines, secondary aliphatic and aromatic amines, and tertiary aliphatic and aromatic amines. By combining the new data with the constants for the alkyl groups (Part XI, this vol., p. 611) and for phenyl (Part XV, this vol., p. 654), the following new constants have been evaluated :

	P.	R_C.	R_D.	R_F.	$R_{G'}$.	$Mn_D^{20°}$.
NH_2 (primary aliphatic amine)......	44·0	4·414	4·438	4·507	4·570	22·64
NH (secondary aliphatic amine) ...	28·4	3·572	3·610	3·667	3·732	23·34
NH (secondary aromatic amine) ...	27·1	4·548	4·678	5·000	5·273	29·52
N (tertiary aliphatic amine).........	7·2	2·698	2·744	2·820	2·914	24·37
N (tertiary aromatic amine).........	?	4·085	4·243	4·675	5·155	30·23

The corresponding values for N in primary and secondary amines, deduced by subtracting the constants for H in CH_2 (Part IX, *J.*, 1946, 133), are :

	P.	R_C.	R_D.	R_F.	$R_{G'}$.	$Mn_D^{20°}$
N (primary aliphatic amine).........	12·6	2·356	2·376	2·414	2·482	27·80
N (secondary aliphatic amine)......	12·7	2·546	2·582	2·624	2·692	25·90
N (secondary aromatic amine)......	11·4	3·522	3·550	3·957	4·223	32·08

THE different contributions of nitrogen to the molecular refractivity according to the state of combination have long been recognised. For instance, Brühl (for review, see Eisenlohr, " Spektrochemie organischer Verbindungen : Molekularrefraktion und -dispersion ", Ferdinand Enke, 1912, pp. 55, 62) has computed values for nitrogen in primary, secondary, and tertiary aliphatic and aromatic amines as well as in many other states of combination. Eisenlohr (in Landolt–Börnstein, " Tabellen ", 1923, II, 985) gives the following constants for nitrogen :

	R_C.	R_D.	R_F.	$R_{G'}$.
N (in primary amines)	2·309	2·322	2·368	2·397
N (in secondary amines)	2·478	2·502	2·561	2·605
N (in tertiary amines)	2·808	2·840	2·940	3·000
N (in tertiary imides)	3·740	3·776	3·877	3·962
N (in cyanides)	3·102	3·118	3·155	3·173

In the original table of atomic and structural parachors, Sugden (*J.*, 1924, **125**, 1180) gave " N = (12·5) " and stated (*loc. cit.*, p. 1179) : " Certain figures which are deduced from one or two compounds only, or which are based on somewhat doubtful data, are enclosed in brackets and can only be regarded as provisional values ". The data from which this value was deduced are not stated, but this " provisional value " was widely employed in various tables in that paper.

Presumably the figure 12·5 was subsequently adopted but no additional evidence seems to have been published (see, *e.g.*, Sugden, Reed, and Wilkins, *J.*, 1925, **127**, 1526; Henley and Sugden, *J.*, 1929, 1060; Sugden, " The Parachor and Valency ", 1930, p. 38).

New determinations of the refractivities at 20° and the parachors of a series of primary alkylamines have now been made, and the NH_2 contributions computed by subtraction of the constants for alkyl groups (Part XI, *loc. cit.*). Only one polymethylene diamine (ethylenediamine) has so far been investigated: this, coupled with the constants for CH_2 (Part IX, *J.*, 1946, 133), provides an independent determination of the NH_2 constants. All the results are collected in Table I, and the mean values have been deduced from all the alkylamines except *sec.*-butylamine.

TABLE I.

Values for NH_2 *from primary amines.*

Amine.	*P.*	R_C.	R_D.	R_F.	$R_{G'}$.	$Mn_D^{20°}$.
NH_2Pr^n	44·1	4·46	4·48	4·56	4·61	22·81
NH_2Bu^n	43·3	4·35	4·37	4·44	4·49	22·65
NH_2Bu^i	42·8	4·34	4·36	4·42	4·56	22·64
NH_2Bu^s *	46·9	4·66	4·68	4·75	4·81	21·69
NH_2Am^n	44·5	4·44	4·47	4·53	4·58	22·56
NH_2Am^i	44·4	4·41	4·44	4·52	4·56	22·54
$NH_2·C_6H_{13}^n$	44·4	4·41	4·43	4·51	4·56	22·39
$NH_2·C_7H_{15}^n$	—	4·39	4·41	4·47	4·53	22·38
$NH_2·C_8H_{17}^n$	—	4·47	4·49	4·57	4·64	22·28
$NH_2·C_3H_5$	43·2	4·43	4·46	4·52	4·58	23·51
$NH_2·CH_2·CH_2·NH_2$	45·5	4·44	4·47	4·53	4·59	22·68
Mean NH_2 (excluding *)	44·0	4·414	4·438	4·507	4·570	22·64
$C_6H_5·NH_2$	41·8	5·13	5·20	5·40	—	25·63
$C_6H_5·CH_2·NH_2$	45·1	4·26	4·26	4·32	4·34	21·05
$C_6H_{11}·NH_2$	47·1	4·63	4·68	4·75	4·80	21·70

The figures deduced from aniline and benzylamine are given at the end of the table for purposes of comparison: the constants for phenyl were those from Part XV (this vol., p. 654) and for benzyl from $C_6H_5·CH_2Cl - Cl$ (XIV, **281**). The constants from *cyclo*hexylamine, $C_6H_{11}·NH_2$, deduced with the aid of the data for di*cyclo*hexyl (XIX, **445**), are not regarded as very trustworthy in view of the difficulties attending the manipulation of this strongly fuming compound.

The constants for the secondary amine group, >NH, have been deduced by two independent methods: (1) From dialkylamines and alkyl groups in aliphatic hydrocarbons: under this heading must be included di*cyclo*hexylamine, *i.e.*, $C_6H_{11}·NH·C_6H_{11} - C_6H_{11}·C_6H_{11}$ (XIX, **445**). (2) From ethyl *N*-alkylcarbamates and esters, *e.g.*, $CH_3·NH·CO_2C_2H_5 - CH_3·CO_2C_2H_5$ (XIII, **189**). It will be noted that the constants for CH_2 are not involved. The results are summarised in Table II; in the calculation of the mean values, the figures for secondary aliphatic amines containing secondary alkyl groups have been omitted. The values for NH computed from secondary aromatic amines C_6H_5·NHAlkyl − C_6H_5·Alkyl (Part X, this vol., p. 607) are given in Table III; the parachor contribution agrees within about 1 unit, but the refractivities are uniformly higher. The measurements of $n_{G'}$ for secondary aromatic amines with a Pulfrich refractometer are difficult because of the faintness of the line and in consequence the values for $R_{G'}$ for these compounds are somewhat less trustworthy.

TABLE II.

Values for NH *from secondary aliphatic amines.*

	P.	R_C.	R_D.	R_F.	$R_{G'}$.	$Mn_D^{20°}$.
$NHEt_2$	29·5	3·66	3·70	3·77	3·86	23·96
$NHPr_2^n$	28·0	3·57	3·62	3·66	3·72	23·68
$NHPr_2^i$	29·0	3·67	3·69	3·75	5·84	24·00
$NHBu_2^n$	28·2	3·61	3·65	3·70	3·78	23·61
$NHBu_2^i$	28·1	3·57	3·59	3·66	3·72	23·03
$NHBu_2^s$ *	31·7	3·73	3·74	3·81	3·88	21·92
$NHAm_2^n$	28·7	3·46	3·49	3·55	3·61	23·57
$NHAm_2^i$	28·4	3·58	3·63	3·69	3·74	23·30
$C_6H_{11}·NH·C_6H_{11}$	30·4	3·66	3·69	3·76	3·81	23·11
$CH_3·NH·CO_2C_2H_5$	27·6	3·44	3·49	3·55	3·60	25·44 *
$CH_3·CH_2·NH·CO_2C_2H_5$	27·0	3·60	3·63	3·69	3·75	25·19 *
Mean NH (excluding *)	28·4	3·572	3·610	3·667	3·732	23·34

TABLE III.

Values for NH *from secondary aromatic amines.*

	P.	R_C.	R_D.	R_F.	$R_{G'}$.	$Mn_D^{20°}$.
NHMePh	27·9	4·46	4·57	4·90	5·19	30·43
NHEtPh	27·2	4·56	4·70	5·02	5·24	29·50
$NHPr^nPh$	26·2	4·57	4·72	5·03	5·32	29·22
$NHBu^nPh$	27·0	4·60	4·72	5·05	5·34	28·91
Mean NH	27·1	4·548	4·678	5·000	5·273	29·52

New determinations have also been made of the refractivities at 20° and the parachors of a number of tertiary amines. The data for trialkylamines have been employed in the evaluation in the usual manner of the contributions of the N atom. The results are presented in Table IV :

TABLE IV.

Values for N *from tertiary aliphatic amines.*

	P.	R_C.	R_D.	R_F.	R_G.	Mn_D^{20}.
NEt_3	10·6	2·84	2·89	2·99	3·10	28·61
NPr_3^n	6·7	2·75	2·78	2·87	2·98	25·29
NBu_3^n	6·0	2·70	2·74	2·82	2·90	25·57
NAm_3^n	6·4	2·52	2·57	2·61	2·70	25·36
NAm_3^i	6·4	2·68	2·74	2·81	2·89	25·02
Mean N	7·2	2·698	2·744	2·820	2·914	24·37
$C_6H_5{\cdot}CH_2{\cdot}NEt_2$	7·0	2·65	2·68	2·76	2·86	22·59

the values deduced from benzyldiethylamine are also included (the constants for the benzyl group were computed from $C_6H_5{\cdot}CH_2Cl$ — Cl) and are in moderate agreement with the mean constants. For tertiary aromatic amines, $NPhAlk_2$, the constants for N have been computed by subtracting {Ph (Part XV, *loc. cit.*) + 2Alkyl (Part XI, *loc. cit.*)}. All the results are collected in Table V. It will be noted that the parachor for N appears to decrease as the molecular weight of the alkyl group increases; it is hoped to confirm the surface-tension results by the method of maximum bubble pressure in order to rule out the possibility that the decreasing parachor values are due to slight departures from zero contact angles.

TABLE V.

Values for N *from tertiary aromatic amines.*

	P.	R_C.	R_D.	R_F.	$R_{G'}$.	$Mn_D^{20°}$.
NMe_2Ph	11·5	3·99	4·15	4·50	4·95	29·48
NEt_2Ph	7·9	4·08	4·24	4·68	5·20	30·61
NPr_2^nPh	3·8	4·12	4·27	4·73	5·22	30·49
NBu_2^nPh	2·3	4·15	4·31	4·79	5·25	30·32
Mean N	?	4·085	4·243	4·675	5·155	30·23

The results deduced from ethyl nitrilotricarboxylate, $N(CO_2Et)_3$, are of interest. If the CO_2Et constants are calculated from ethyl oxalate (XIII, **236**), the following values for N are obtained : *P* 13·2; R_C 2·41; R_D 2·44; R_F 2·48; $R_{G'}$ 2·51; $Mn_D^{20°}$ 24·12. The use of the mean constants for COO (esters), deduced in Part XIII (this vol., p. 624), leads to abnormal results.

It is instructive to calculate the constants for N by subtracting the values for H in CH_2 (Part IX, *J.*, 1946, **133**) from the mean values for NH_2 and NH. The results are given below.

	P.	R_C.	R_D.	R_F.	R_G.	$Mn_D^{20°}$.
N (in primary aliphatic amines)	12·6	2·362	2·382	2·421	2·490	27·76
N (in secondary aliphatic amines)	12·7	2·546	2·582	2·624	2·692	25·90
N (in secondary aromatic amines)	11·4	3·522	3·550	3·957	4·233	32·08
N (in cyanides)	15·4	0·900	0·891	0·851	0·822	23·31

The following conclusions may be drawn from these figures : (1) The parachor for N is approximately the same in primary and in secondary amines but differs from that in tertiary amines (compare Sugden who gives, and uses, one value for N in all nitrogen compounds). (2) The refractivities for N differ according to the state of combination * and at least five values for N in amines (primary aliphatic; secondary aliphatic; secondary aromatic; tertiary aliphatic; and tertiary aromatic) are necessary. This view would agree with that originally expressed by

* A sufficient number of primary aromatic amines has not yet been investigated by the author to decide whether N in these differsf rom that in primary aliphatic amines.

Bruhl but differs from that of Eisenlohr; the refractivities deduced by Eisenlohr (compare *Z. physikal. Chem.*, 1912, **79**, 129; Landolt–Bornstein, " Tabellen ", 1923, II, 985) for N in primary, secondary, and tertiary amines, which are widely quoted (see, *e.g.*, Ostwald–Luther, " Hilfsbuch zur Ausführung physiko-chemischer Messungen ", Akad. Verlag, 5th Edition, **1931**, p. 910; Fajans, in Weissberger, " Physical Methods of Organic Chemistry ", Interscience, **1945**, I, 673), are consequently meaningless and definitely misleading. The constants for N in cyanides have been computed from CN $-$ (C $+$ $\models$, terminal) (Part XVII, this vol., p. 674).

The question of the refraction of the various electron groups involving nitrogen will form the subject of a future communication (compare Smyth, " Dielectric Constant and Molecular Structure ", Chemical Catalog Co., 1931, p. 152; Denbigh, *Trans. Faraday Soc.*, 1940, **36**, 397).

Experimental.

Primary aliphatic amines. 25—50 G. samples of the pure commercial products were dried over potassium hydroxide pellets and fractionated, with adequate precautions against the entrance of moisture, in an all-glass apparatus, and three middle fractions were collected for the physical measurements. The purified specimens were kept in Pyrex test-tubes, closed with corks covered with tin or platinum foil, and used immediately after distillation. Precautions were taken as far as possible to prevent the entrance of moisture during the measurements. The b. p.s are given under the physical measurements below. The sources of the various amines were as follows:—*n*-propyl, allyl, *n*-butyl, *iso*butyl, *sec.*-butyl, *n*-amyl, and *iso*amyl, from Eastman Kodak; *n*-hexyl, *n*-heptyl, and *n*-octyl from Sharples; *cyclo*hexyl from Light; ethylenediamine from Eastman Kodak.

Aniline. A.R. Aniline (Hopkin and Williams) was dried with potassium hydroxide pellets and distilled from an all-glass apparatus; b. p. 184·5°/750 mm.

Benzylamine. A pure B.D.H. sample was dried over potassium hydroxide pellets and twice distilled from an all-glass apparatus; b. p. 185°/767 mm.

Secondary aliphatic amines. The pure commercial products were purified and manipulated as detailed for primary aliphatic amines. Diethylamine and di-*n*-butylamine were presented by Sharples; di-*n*-propyl-, di*iso*propyl-, di*iso*butyl-, di-*sec.*-butyl-, di-*n*-amyl-, and di*iso*amyl-amine were purchased from Eastman Kodak.

Dicyclohexylamine. The commercial product (Light) was distilled, and the fraction, b. p. 251·5°/760 mm., collected; this had a very pale green colour, which was removed upon distillation under reduced pressure; b. p. 113·5°/9 mm.

N-*Nitrosomethylaniline.* This was prepared from B.D.H. pure monomethylaniline according to *Org. Synth.*, 1933, **13**, 82, except that a 1-l beaker replaced the 3-l. flask, the extraction with benzene was omitted, and the compound was dried with anhydrous calcium sulphate; the yield was not appreciably affected. The *N*-nitrosomethylaniline had b. p. 120°/13 mm. The b. p. of 135—137°/13 mm. recorded in *Organic Syntheses* would appear to be in error.

N-*Nitrosoethylaniline.* This was prepared similarly to the methyl compound from B.D.H. pure monoethylaniline; b. p. 131°/20 mm.

Monomethylaniline. 78 G. of pure *N*-nitrosomethylaniline were reduced with 150 g. of tin and 300 ml. of concentrated hydrochloric acid, affording 46 g. of pure, colourless monomethylaniline, b. p. 193°/738mm.

Monoethylaniline. 75 G. of pure *N*-nitrosoethylaniline were similarly reduced and yielded 43 g. of pure, almost colourless monoethylaniline, b. p. 202·5°/750 mm.

Mono-n-*propylaniline.* 230 G. of A.R. aniline were heated with 123 g. of *n*-propyl bromide for 8 hours and the excess of aniline was removed by precipitation with 50% zinc chloride solution (Hickinbottom, *J.*, 1930, 993). The secondary amine was isolated by several extractions with light petroleum (b. p. 60—80°), the solvent removed, and the product fractionated. The crude amine (85 g.) distilled at 218—222°. Redistillation from a little zinc dust gave pure *n*-propylaniline, b. p. 219°/758 mm., $d_{4^\circ}^{20^\circ}$ 0·9460, $n_D^{20^\circ}$ 1·54375. For the physical measurements, the compound was distilled under reduced pressure; b. p. 96°/9 mm.

Mono-n-*butylaniline.* A commercially pure sample, kindly presented by Sharples Chemicals Inc. was fractionated from a little zinc dust, and the fraction, b. p. 237—238°/760 mm., collected. Redistillation gave a colourless product, b. p. 105°/3 mm.

Ethyl N-*methylcarbamate.* This was prepared from 33% aqueous methylamine solution, ethyl chloroformate, and sodium hydroxide solution, but the product was distilled under normal pressure and not under reduced pressure (cf. *Org. Synth.*, 1932, **12**, 38). The ester distilled as a colourless liquid, b. p. 169·5°/769 mm., and there was no sign of decomposition.

Ethyl N-*ethylcarbamate.* This compound was prepared from 110 ml. of ether, 90 g. of 33% aqueous ethylamine solution, 72·5 g. of ethyl chloroformate, and 26·5 g. of A.R. sodium hydroxide dissolved in 40 ml. of water (see *Org. Synth.*, 1932, **12**, 38). The yield of pure, colourless ester, b. p. 175°/748 mm., was 64 g.

Tertiary aliphatic amines. The pure commercial products (triethylamine, tri-*n*-butylamine, and benzyldiethylamine from Sharples; tri-*n*-propylamine, tri-*n*-amylamine, and tri*iso*amylamine from Eastman Kodak) were shaken mechanically with about half the volume of A.R. potassium hydroxide pellets, filtered, and distilled from sodium in a flask with a fractionating side arm, due precautions being taken to prevent access of moisture. The b. p.s are given under the physical properties.

Ethyl nitrilotricarboxylate. This was prepared from urethane, dry ether, sodium, and ethyl chloroformate (*Org. Synth.*, 1944, **24**, 60) and was twice distilled under reduced pressure; b. p. 143°/10 mm.

Dimethylaniline. A mixture of 50 g. of A.R. dimethylaniline and 25 g. of redistilled acetic anhydride was refluxed for 3 hours and then distilled until about 10 ml. remained; the residue contained any acetyl derivatives which might have been present (compare Brand and Franz, *J. pr. Chem.*, 1927, **115**, 153). The fraction, b. p. 193—194°, was collected separately and redistilled; pure dimethylaniline was collected at 194°/760 mm. (acetanilide has b. p. 305°/760 mm.; acetomethylanilide has b. p. 253°/712 mm.).

Diethylaniline. A mixture of 50 g. of redistilled diethylaniline, b. p. 214—215°, and 30 g. of redistilled acetic anhydride was refluxed for 4 hours, and the pure diethylaniline, b. p. 214·5°/748 mm., was isolated as for dimethylaniline. This was distilled under reduced pressure for the physical measurements; b. p. 86·5°/6 mm.

*Di-*n*-propylaniline.* A mixture of 45 g. of *n*-propylaniline, b. p. 218—220°/758 mm. (mainly 219°), and 82 g. of *n*-propyl bromide was refluxed for 9 hours. The solid reaction product was rendered alkaline with sodium hydroxide solution, and the upper layer separated. This was washed with water, dried ($MgSO_4$), and distilled: the excess of *n*-propyl bromide (35 g.) passed over at 72—73°, followed by the di-*n*-propylaniline (37 g.) at 241—243°/758 mm. (mainly 242°) as a very pale yellow liquid. The colour could be completely removed by distillation from a little zinc dust. For the physical measurements, the colourless product was redistilled under reduced pressure: b. p. 95°/4 mm.

*Di-*n*-butylaniline.* A mixture of 37 g. of *n*-butylaniline, b. p. 237—238°, and 68 g. of *n*-butyl bromide was heated on a boiling water-bath for 16 hours by which time the reaction product was solid. It was treated with sodium hydroxide solution until alkaline, and ether was added to facilitate separation of the organic layer. The ethereal extract was washed with water, dried, and the solvent removed: distillation yielded 22 g. of *n*-butyl bromide, b. p. 90—110°, and 37 g. of di-*n*-butylaniline, b. p. 269—270°/760 mm. The pale colour was removed by distillation under reduced pressure: b. p. 123°/6 mm.

503. n-*Propylamine.* B. p. 48°/750 mm.; M 59·11; n_C 1·38604, n_D 1·38815, n_F 1·39339, $n_{G'}$ 1·39715; R_C 19·36, R_D 19·45, R_F 19·69, $R_{G'}$ 19·85; $Mn_D^{20°}$ 82·06. Densities determined: $d_{4°}^{20°}$ 0·7173, $d_{4°}^{40.8°}$ 0·6955. Apparatus *A*.

(These headings apply to all subsequent tables in this paper.)

t.	H.	$d_{4°}^{t°}$.	γ.	P.	t.	H.	$d_{4°}^{t°}$.	γ.	P.
19·2°	16·52	0·7181	22·21	178·9	38·0°	15·51	0·6984	20·28	180·0
26·4	16·26	0·7106	21·64	179·7	41·6	15·18	0·6947	19·75	179·8
								Mean	179·6

504. n-*Butylamine.* B. p. 77°/750 mm.; M 73·14; n_C 1·39870, n_D 1·40086, n_F 1·40613, $n_{G'}$ 1·41003; R_C 23·85, R_D 23·96, R_F 24·24, $R_{G'}$ 24·44; $Mn_D^{20°}$ 102·46. Densities determined: $d_{4°}^{20°}$ 0·7414, $d_{4°}^{41.1°}$ 0·7222, $d_{4°}^{62.0°}$ 0·7020.

19·2°	13·11	0·7421	24·03	218·2	40·8°	12·16	0·7225	21·70	218·7
27·9	12·78	0·7341	23·17	218·6	61·7	11·12	0·7023	19·29	218·7
								Mean	218·6

505. iso*Butylamine.* B. p. 67·5°/753 mm.; M 73·14; n_C 1·39485, n_D 1·39700, n_F 1·40223, $n_{G'}$ 1·40601; R_C 23·87, R_D 23·98, R_F 24·26, $R_{G'}$ 24·46; $Mn_D^{20°}$ 102·18. Densities determined: $d_{4°}^{20°}$ 0·7346, $d_{4°}^{40.7°}$ 0·7143, $d_{4°}^{60.1°}$ 0·6952. Apparatus *D*.

19·7°	12·26	0·7349	22·25	216·3	41·4°	11·31	0·7136	19·93	216·9
24·5	12·14	0·7302	21·89	216·8	61·2	10·39	0·6941	17·81	217·1
25·5	12·06	0·7290	21·71	216·7				Mean	216·6

506. sec.-*Butylamine.* B. p. 63·5°/764 mm.; M 73·14; n_C 1·39107, n_D 1·39320, n_F 1·39843, $n_{G'}$ 1·40217; R_C 23·99, R_D 24·10, R_F 24·38, $R_{G'}$ 24·59; $Mn_D^{20°}$ 101·90. Densities determined: $d_{4°}^{20°}$ 0·7246, $d_{4°}^{41.0°}$ 0·7051. Apparatus *A*.

21·0°	15·86	0·7237	21·49	217·8	41·3°	14·67	0·7048	19·36	218·3
27·4	15·56	0·7177	20·91	218·2				Mean	218·1

507. n-*Amylamine.* B. p. 104·5°/761 mm.; M 87·16; n_C 1·40928, n_D 1·41147, n_F 1·41688, $n_{G'}$ 1·42070; R_C 28·58, R_D 28·72, R_F 29·05, $R_{G'}$ 29·28; $Mn_D^{20°}$ 123·02. Densities determined: $d_{4°}^{20°}$ 0·7544, $d_{4°}^{42.0°}$ 0·7343, $d_{4°}^{62.3°}$ 0·7170, $d_{4°}^{86.0°}$ 0·6966. Apparatus *D*.

20·1°	13·53	0·7543	25·20	258·9	63·5°	11·74	0·7159	20·76	260·2
22·4	13·45	0·7524	24·99	259·0	87·1	10·68	0·6956	18·35	260·0
42·1	12·62	0·7342	22·88	259·6				Mean	259·5

508. iso*Amylamine.* B. p. 96·5—97·5°/767 mm.; M 87·16; n_C 1·40611, n_D 1·40830, n_F 1·41366, $n_{G'}$ 1·41741; R_C 28·58, R_D 28·72, R_F 29·06, $R_{G'}$ 29·28; $Mn_D^{20°}$ 122·75. Densities determined: $d_{4°}^{20°}$ 0·7491, $d_{4°}^{40.9°}$ 0·7315, $d_{4°}^{61.4°}$ 0·7129, $d_{4°}^{86.8°}$ 0·6890. Apparatus *D*

25·3°	12·67	0·7445	23·30	257·2	62·0°	11·10	0·7122	19·52	257·6
29·4	12·48	0·7403	22·82	257·3	87·6	10·03	0·6883	17·05	257·9
43·1	11·97	0·7296	21·57	257·4				Mean	257·5

509. n-*Hexylamine.* B. p. 130°/762 mm.; M 101·19; n_C 1·41579, n_D 1·41801, n_F 1·42340, $n_{G'}$ 1·42750; R_C 33·14, R_D 33·29, R_F 33·67, $R_{G'}$ 33·95; $Mn_D^{20°}$ 143·49. Densities determined: $d_{4°}^{20°}$ 0·7660, $d_{4°}^{41.3°}$ 0·7481, $d_{4°}^{60.6°}$ 0·7322, $d_{4°}^{85.6°}$ 0·7106. Apparatus *C*.

13·0°	14·69	0·7719	26·92	298·6	60·6°	12·73	0·7322	22·13	299·7
40·5	13·64	0·7488	24·25	299·9	86·6	11·54	0·7098	19·45	299·4
								Mean	299·4

510. n-*Heptylamine.* B. p. 153·5°/762 mm.; M 115·22; n_C 1·42225, n_D 1·42451, n_F 1·42994, $n_{G'}$ 1·43398; R_C 37·79, R_D 37·96, R_F 38·38, $R_{G'}$ 38·70; $Mn_D^{20^\circ}$ 164·13. Densities determined: $d_{4^\circ}^{20^\circ}$ 0·7754, $d_{4^\circ}^{40\cdot0^\circ}$ 0·7601, $d_{4^\circ}^{59\cdot5^\circ}$ 0·7443, $d_{4^\circ}^{84\cdot7^\circ}$ 0·7244.

The compound does not wet glass and erratic results were obtained in the surface-tension measurements.

511. n-*Octylamine.* B. p. 176·5°/763 mm.; M 129·24; n_C 1·42694, n_D 1·42922, n_F 1·43471, $n_{G'}$ 1·43890; R_C 42·43, R_D 42·63, R_F 43·11, $R_{G'}$ 43·47; $Mn_D^{20^\circ}$ 184·71. Density determined: $d_{4^\circ}^{20^\circ}$ 0·7819. The surface tension results were erratic.

512. *Allylamine.* B. p. 54·5°/758 mm.; M 57·10; n_C 1·41747, n_D 1·42051, n_F 1·42792, $n_{G'}$ 1·43363; R_C 18·86, R_D 18·98, R_F 19·27, $R_{G'}$ 19·50; $Mn_D^{20^\circ}$ 81·11. Densities determined: $d_{4^\circ}^{20^\circ}$ 0·7621, $d_{4^\circ}^{41\cdot3^\circ}$ 0·7407. Apparatus *A*.

t.	H.	$d_{4^\circ}^{t^\circ}$.	γ.	P.	t.	H.	$d_{4^\circ}^{t^\circ}$.	γ.	P.
24·5°	17·11	0·7576	24·27	167·4	31·1°	16·76	0·7510	23·57	167·7
28·3	16·91	0·7538	23·87	167·5	41·6	15·94	0·7404	22·10	167·5

Mean 167·5

513. *Ethylenediamine.* B. p. 117°/750 mm.; M 60·10; n_C 1·45399, n_D 1·45677, n_F 1·46344, $n_{G'}$ 1·46869; R_C 18·13, R_D 18·23, R_F 18·45, $R_{G'}$ 18·64; $Mn_D^{20^\circ}$ 87·55. Densities determined: $d_{4^\circ}^{20^\circ}$ 0·8977, $d_{4^\circ}^{40\cdot7^\circ}$ 0·8799, $d_{4^\circ}^{60\cdot6^\circ}$ 0·8615, $d_{4^\circ}^{8\cdot3^\circ}$ 0·8400. Apparatus *D*.

21·3°	18·88	0·8966	41·80	170·4	63·1°	16·92	0·8593	35·91	171·2
40·7	17·99	0·8799	39·09	170·8	86·1	15·82	0·8384	32·75	171·7

Mean 171·0

514. *Aniline.* B. p. 184·5°/750 mm.; M 93·13; n_C 1·57865, n_D 1·58547, n_F 1·60343; R_C 30·27, R_D 30·56, R_F 31·31; $Mn_D^{20^\circ}$ 147·66. Densities determined: $d_{4^\circ}^{20^\circ}$ 1·0221, $d_{4^\circ}^{40\cdot2^\circ}$ 1·0052, $d_{4^\circ}^{60\cdot1^\circ}$ 0·9889, $d_{4^\circ}^{86\cdot0^\circ}$ 0·9669. Apparatus *A*.

19·6°	20·88	1·0224	39·97	229·1	61·3°	19·23	0·9879	35·57	230·2
40·0	20·05	1·0050	37·73	229·7	85·8	18·35	0·9671	33·23	231·2

Mean 230·1

The surface-tension measurements were not altogether satisfactory and will be repeated by the method of maximum bubble pressure.

515. *Benzylamine.* B. p. 185°/767 mm.; M 107·15; n_C 1·53895, n_D 1·54380, n_F 1·55656, $n_{G'}$ 1·56656; R_C 34·20, R_D 34·45, R_F 35·12, $R_{G'}$ 35·64; $Mn_D^{20^\circ}$ 165·45. Densities determined: $d_{4^\circ}^{20^\circ}$ 0·9816, $d_{4^\circ}^{42\cdot0^\circ}$ 0·9653, $d_{4^\circ}^{61\cdot0^\circ}$ 0·9489, $d_{4^\circ}^{86\cdot6^\circ}$ 0·9272. Apparatus *D*.

21·1°	16·44	0·9807	39·82	274·4	62·4°	14·82	0·9478	34·69	274·4
41·9	15·62	0·9654	37·24	274·2	88·0	13·86	0·9261	31·70	274·5

Mean 274·4

516. cyclo*Hexylamine.* B. p. 133°/756 mm.; M 99·17; n_C 1·45665, n_D 1·45926, n_F 1·46539, $n_{G'}$ 1·47001; R_C 31·13, R_D 31·29, R_F 31·64, $R_{G'}$ 31·91; $Mn_D^{20^\circ}$ 144·72. Densities determined: $d_{4^\circ}^{20^\circ}$ 0·8671, $d_{4^\circ}^{40\cdot6^\circ}$ 0·8498, $d_{4^\circ}^{62\cdot3^\circ}$ 0·8307, $d_{4^\circ}^{85\cdot3^\circ}$ 0·8106. Apparatus *A*.

16·2°	19·80	0·8703	32·27	271·6	41·1°	18·43	0·8494	29·31	271·7
17·9	19·70	0·8689	32·05	271·6	61·2	17·20	0·8316	26·78	271·3
22·9	19·48	0·8646	31·54	271·8	87·0	15·80	0·8091	23·94	271·1

Mean 271·5

517. *Diethylamine.* B. p. 55°/756 mm.; M 73·14; n_C 1·38417, n_D 1·38637, n_F 1·39167, $n_{G'}$ 1·39560 R_C 24·18, R_D 24·30, R_F 24·60, $R_{G'}$ 24·82; $Mn_D^{20^\circ}$ 101·40. Densities determined: $d_{4^\circ}^{20^\circ}$ 0·7074, $d_{4^\circ}^{41\cdot5^\circ}$ 0·6849. Apparatus *A* *. Apparatus *D* **.

24·9°	15·14	0·7023	19·91	220·3 *	23·8°	11·59	0·7034	20·13	220·6**
41·0	14·05	0·6852	18·03	220·4 *	41·3	10·60	0·6851	17·93	220·2**
16·4	11·79	0·7114	20·71	220·1**					

Mean 220·3

518. *Di*-n-*propylamine.* B. p. 108°/751 mm.; M 101·19; n_C 1·40278, n_D 1·40499, n_F 1·41039, $n_{G'}$ 1·41425; R_C 33·36, R_D 33·51, R_F 33·91, $R_{G'}$ 34·19; $Mn_D^{20^\circ}$ 142·17. Densities determined: $d_{4^\circ}^{20^\circ}$ 0·7400, $d_{4^\circ}^{41\cdot1^\circ}$ 0·7213, $d_{4^\circ}^{59\cdot9^\circ}$ 0·7043, $d_{4^\circ}^{86\cdot1^\circ}$ 0·6798. Apparatus *A*.

16·9°	16·63	0·7428	23·13	298·8	61·7°	14·05	0·7027	18·49	298·9
24·5	16·17	0·7359	22·28	298·7	85·2	12·67	0·6806	16·15	298·7
41·3	15·38	0·7211	20·77	299·5					

Mean 298·9

519. *Di*iso*propylamine.* B. p. 83·5°/765 mm.; M 101·19; n_C 1·39021, n_D 1·39236, n_F 1·39762, $n_{G'}$ 1·40177; R_C 33·48, R_D 33·64, R_F 34·04, $R_{G'}$ 34·35; $Mn_D^{20^\circ}$ 140·90. Densities determined: $d_{4^\circ}^{20^\circ}$ 0·7169, $d_{4^\circ}^{41\cdot2^\circ}$ 0·6980, $d_{4^\circ}^{61\cdot4^\circ}$ 0·6781. Apparatus *A*.

16·0°	14·85	0·7206	20·04	297·1	41·5°	13·27	0·6977	17·34	296·3
26·3	14·35	0·7111	19·11	297·5	61·5	11·98	0·6777	15·20	295·6

Mean 296·6

520. *Di-*n*-butylamine.* B. p. 159°/761 mm.; M 129·24; n_C 1·41539, n_D 1·41766, n_F 1·42310, $n_{G'}$ 1·42725; R_C 42·61, R_D 42·82, R_F 43·30, $R_{G'}$ 43·68; $Mn_D^{20^\circ}$ 183·22. Densities determined: $d_{4^\circ}^{20^\circ}$ 0·7601, $d_{4^\circ}^{41\cdot7^\circ}$ 0·7435, $d_{4^\circ}^{61\cdot0^\circ}$ 0·7277, $d_{4^\circ}^{84\cdot9^\circ}$ 0·7081. Apparatus *A*.

t.	*H.*	$d_{4^\circ}^{t^\circ}$.	γ.	*P.*	*t.*	*H.*	$d_{4^\circ}^{t^\circ}$.	γ.	*P.*
17·7°	17·39	0·7619	24·81	378·6	60·4°	15·19	0·7282	20·71	378·6
40·9	16·24	0·7441	22·63	378·8	86·2	13·84	0·7071	18·32	378·6
								Mean	378·7

521. *Di*iso*butylamine.* B. p. 137°/742 mm.; M 129·24; n_C 1·40679, n_D 1·40900, n_F 1·41448, $n_{G'}$ 1·41831; R_C 42·63, R_D 42·83, R_F 43·34, $R_{G'}$ 43·70; $Mn_D^{20^\circ}$ 182·10. Densities determined: $d_{4^\circ}^{20^\circ}$ 0·7460, $d_{4^\circ}^{40\cdot8^\circ}$ 0·7297, $d_{4^\circ}^{62\cdot0^\circ}$ 0·7128, $d_{4^\circ}^{86\cdot3^\circ}$ 0·6906. Apparatus *D*.

15·1°	12·19	0·7499	22·58	375·7	60·2°	10·44	0·7142	18·42	374·9
23·9	11·93	0·7429	21·89	376·3	86·7	9·46	0·6903	16·13	375·2
40·8	11·26	0·7297	20·29	375·9				Mean	375·6

522. *Di-*sec.*-butylamine.* B. p. 135°/765 mm.; M 129·24; n_C 1·40875, n_D 1·41092, n_F 1·41624, $n_{G'}$ 1·42017; R_C 42·39, R_D 42·58, R_F 43·06, $R_{G'}$ 43·43; $Mn_D^{20^\circ}$ 182·34. Densities determined: $d_{4^\circ}^{20^\circ}$ 0·7534, $d_{4^\circ}^{40\cdot8^\circ}$ 0·7362, $d_{4^\circ}^{61\cdot0^\circ}$ 0·7192, $d_{4^\circ}^{85\cdot1^\circ}$ 0·6989. Apparatus *D*.

14·6°	12·41	0·7579	23·28	374·4	40·9°	11·36	0·7361	20·65	374·3
22·0	12·09	0·7518	22·45	374·2	60·6	10·49	0·7195	18·64	373·2
								Mean	374·0

523. *Di-*n*-amylamine.* B. p. 67°/4 mm.; M 157·29; n_C 1·42494, n_D 1·42722, n_F 1·43280, $n_{G'}$ 1·43679; R_C 51·74, R_D 51·99, R_F 52·58, $R_{G'}$ 53·01; $Mn_D^{20^\circ}$ 224·48. Densities determined: $d_{4^\circ}^{20^\circ}$ 0·7771, $d_{4^\circ}^{60\cdot8^\circ}$ 0·7456, $d_{4^\circ}^{86\cdot0^\circ}$ 0·7269, $d_{4^\circ}^{119\cdot8^\circ}$ 0·7018. Apparatus *A*.

14·1°	18·20	0·7816	26·64	457·2	87·4°	14·82	0·7258	20·14	459·1
25·9	17·83	0·7726	25·79	458·8	121·1	13·21	0·7008	17·34	458·0
60·4	16·04	0·7459	22·40	458·8				Mean	458·6

524. *Di*iso*amylamine.* B. p. 186—186·5°/756 mm.; M 157·29; n_C 1·42119, n_D 1·42346, n_F 1·42899, $n_{G'}$ 1·43301; R_C 51·77, R_D 52·02, R_F 52·61, $R_{G'}$ 53·04; $Mn_D^{20^\circ}$ 223·90. Densities determined: $d_{4^\circ}^{20^\circ}$ 0·7708, $d_{4^\circ}^{40\cdot7^\circ}$ 0·7552, $d_{4^\circ}^{60\cdot1^\circ}$ 0·7405, $d_{4^\circ}^{85\cdot5^\circ}$ 0·7213. Apparatus *D*.

14·2°	12·92	0·7752	24·73	452·5	60·4°	11·35	0·7403	20·75	453·5
23·3	12·76	0·7683	24·21	454·1	86·5	10·50	0·7205	18·68	453·9
40·5	12·08	0·7554	22·54	453·7				Mean	453·5

525. *Dicyclo*hexylamine.* B. p. 113·5°/9 mm.; M 181·31; n_C 1·48194, n_D 1·48454, n_F 1·49080, $n_{G'}$ 1·49560; R_C 56·65, R_D 56·91, R_F 57·54, $R_{G'}$ 58·02; $Mn_D^{20^\circ}$ 269·15. Densities determined: $d_{4^\circ}^{20^\circ}$ 0·9123, $d_{4^\circ}^{40\cdot6^\circ}$ 0·8978, $d_{4^\circ}^{60\cdot1^\circ}$ 0·8842, $d_{4^\circ}^{85\cdot3^\circ}$ 0·8662. Apparatus *A*.

15·1°	15·13	0·9157	34·22	478·9	60·5°	13·61	0·8839	29·71	478·9
20·4	14·99	0·9120	33·76	479·2	87·9	12·74	0·8644	27·20	479·0
40·4	14·32	0·8970	31·75	479·4				Mean	479·1

526. *Ethyl* N*-methylcarbamate.* B. p. 169·5°/769 mm.; M 103·18; n_C 1·41594, n_D 1·41826, n_F 1·42386, $n_{G'}$ 1·42798; R_C 25·59, R_D 25·73, R_F 26·03, $R_{G'}$ 26·25; $Mn_D^{20^\circ}$ 146·34. Densities determined: $d_{4^\circ}^{20^\circ}$ 1·0115, $d_{4^\circ}^{41\cdot2^\circ}$ 0·9924, $d_{4^\circ}^{61\cdot1^\circ}$ 0·9744, $d_{4^\circ}^{86\cdot5^\circ}$ 0·9503. Apparatus *D*.

23·0°	12·99	1·0088	32·36	242·6	61·0°	11·85	0·9745	28·52	244·7
25·4	12·92	1·0066	32·12	244·0	86·1	11·04	0·9507	25·92	244·9
40·9	12·44	0·9927	29·80	242·9				Mean	243·8

527. *Ethyl* N*-ethylcarbamate.* B. p. 175°/748 mm.; M 117·15; n_C 1·41919, n_D 1·42151, n_F 1·42713, $n_{G'}$ 1·43126; R_C 30·25, R_D 30·40, R_F 30·75, $R_{G'}$ 31·01; $Mn_D^{20^\circ}$ 166·53. Densities determined: $d_{4^\circ}^{20^\circ}$ 0·9784, $d_{4^\circ}^{41\cdot6^\circ}$ 0·9593, $d_{4^\circ}^{60\cdot4^\circ}$ 0·9425, $d_{4^\circ}^{86\cdot5^\circ}$ 0·9177. Apparatus *A*.

21·1°	16·54	0·9774	30·27	281·1	61·3°	14·91	0·9417	26·29	281·7
41·7	15·73	0·9592	28·25	281·6	86·9	14·00	0·9173	24·05	282·8
								Mean	281·7

528. N*-Nitrosomethylaniline.* B. p. 120°/13 mm.; M 136·15; n_C 1·56992, n_D 1·57764, n_F 1·59901 (line rather faint); R_C 39·54, R_D 39·97, R_F 41·18; $Mn_{4^\circ}^{20^\circ}$ 214·79. Densities determined: $d_{4^\circ}^{20^\circ}$ 1·1297 $d_{4^\circ}^{41\cdot4^\circ}$ 1·1113, $d_{4^\circ}^{61\cdot5^\circ}$ 1·0941, $d_{4^\circ}^{86\cdot9^\circ}$ 1·0722. Apparatus *D*.

18·8°	16·23	1·1307	45·32	312·4	60·9°	14·94	1·0946	40·39	313·6
41·0	15·51	1·1116	42·58	312·9	87·3	14·10	1·0719	37·33	313·9
								Mean	313·2

529. *Monomethylaniline.* B. p. 193°/738 mm.; M 107·15; n_C 1·56411, n_D 1·57094, n_F 1·58899, $n_{G'}$ 1·60447 (line very faint); R_C 35·32, R_D 35·67, R_F 36·60, $R_{G'}$ 37·38; $Mn_D^{20^\circ}$ 168·32. Densities determined: $d_{4^\circ}^{20^\circ}$ 0·9867, $d_{4^\circ}^{40\cdot2^\circ}$ 0·9707, $d_{4^\circ}^{60\cdot3^\circ}$ 0·9555, $d_{4^\circ}^{85\cdot5^\circ}$ 0·9350. Apparatus *A*.

12·2°	21·97	0·9929	40·85	272·8	60·7°	19·69	0·9558	35·24	273·1
17·7	21·82	0·9885	40·39	273·1	86·5	18·59	0·9342	32·52	273·9
40·1	20·75	0·9708	37·72	273·5				Mean	273·3

530. N-*Nitrosoethylaniline*. B. p. 131°/20 mm.; M 150·18; n_C 1·55269, n_D 1·55969, n_F 1·57894 (line rather faint); R_C 44·15, R_D 44·61, R_F 45·86; $Mn_D^{20°}$ 234·24. Densities determined: $d_{4°}^{20°}$ 1·0881, $d_{4°}^{40\cdot7°}$ 1·0704, $d_{4°}^{61\cdot9°}$ 1·0525, $d_{4°}^{86\cdot0°}$ 1·0297. Apparatus *A*.

t.	*H*.	$d_{4°}^{t°}$.	γ.	*P*.	*t*.	*H*.	$d_{4°}^{t°}$.	γ.	*P*.
12·3°	20·63	1·0947	42·29	349·8	61·2°	18·62	1·0531	36·72	351·0
18·1	20·26	1·0897	41·54	349·9	85·8	17·71	1·0299	34·15	352·5
42·4	19·44	1·0689	38·91	350·9					Mean 350·8

531. *Monoethylaniline*. B. p. 202·5°/750 mm.; M 121·18; n_C 1·54738, n_D 1·55397, n_F 1·57030, $n_{G'}$ 1·58444 (line rather faint); R_C 40·05, R_D 40·45, R_F 41·43, $R_{G'}$ 42·27; $Mn_D^{20°}$ 188·32. Densities determined: $d_{4°}^{20°}$ 0·9601, $d_{4°}^{41\cdot5°}$ 0·9431, $d_{4°}^{61\cdot7°}$ 0·9273, $d_{4°}^{86\cdot1°}$ 0·9082. Apparatus *A*.

20·5°	20·47	0·9597	36·79	311·0	62·5°	18·57	0·9267	32·22	311·6
41·3	19·62	0·9433	34·66	311·7	87·6	17·46	0·9074	29·67	311·7
									Mean 311·5

532. *Mono*-n-*propylaniline*. B. p. 219°/758 mm. and 96°/9 mm.; M 135·20; n_C 1·53596, n_D 1·54217, n_F 1·55729, $n_{G'}$ 1·56991; R_C 44·72, R_D 45·15, R_F 46·19, $R_{G'}$ 47·05; $Mn_D^{20°}$ 208·51. Densities determined: $d_{4°}^{20°}$ 0·9426, $d_{4°}^{40\cdot0°}$ 0·9276, $d_{4°}^{60\cdot1°}$ 0·9119, $d_{4°}^{85\cdot9°}$ 0·8921. Apparatus *C*.

20·9°	15·55	0·9419	34·77	348·6	61·4°	14·26	0·9109	30·84	349·8
41·0	14·87	0·9268	32·72	348·9	87·1	13·45	0·8913	28·46	350·4
									Mean 349·4

533. *Mono*-n-*butylaniline*. B. p. 237—238°/760 mm. and 105°/3 mm.; M 149·23; n_C 1·52803, n_D 1·53342, n_F 1·54750, $n_{G'}$ 1·55943; R_C 49·38, R_D 49·80, R_F 50·90, $R_{G'}$ 51·81; $Mn_D^{20°}$ 228·83. Densities determined: $d_{4°}^{20°}$ 0·9305, $d_{4°}^{40\cdot0°}$ 0·9157, $d_{4°}^{59\cdot1°}$ 0·9107, $d_{4°}^{86\cdot2°}$ 0·8812. Apparatus *C*.

20·9°	15·36	0·9298	33·90	389·1	59·5°	14·25	0·9014	30·50	389·0
40·7	14·73	0·9152	32·00	387·8	86·9	13·44	0·8807	28·10	390·0
									Mean 389·0

534. *Triethylamine*. B. p. 89·5°/759 mm.; M 101·19; n_C 1·39859, n_D 1·40101, n_F 1·40670, $n_{G'}$ 1·41099; R_C 33·62, R_D 33·79, R_F 34·23, $R_{G'}$ 34·54; $Mn_D^{20°}$ 141·77. Densities determined: $d_{4°}^{20°}$ 0·7275, $d_{4°}^{41\cdot7°}$ 0·7087, $d_{4°}^{60\cdot5°}$ 0·6912. Apparatus *C*.

22·3°	11·91	0·7255	20·51	296·8	62·0°	10·12	0·6899	16·57	296·7
42·2	10·98	0·7083	18·46	296·5					Mean 296·7

535. *Tri*-n-*propylamine*. B. p. 156·5°/760 mm.; M 143·27; n_C 141471, n_D 1·41706, n_F 1·42279, $n_{G'}$ 1·42718; R_C 47·44, R_D 47·68, R_F 48·25, $R_{G'}$ 48·69; $Mn_D^{20°}$ 203·03. Densities determined: $d_{4°}^{20°}$ 0·7558, $d_{4°}^{42\cdot0°}$ 0·7411, $d_{4°}^{62\cdot0°}$ 0·7258, $d_{4°}^{87\cdot9°}$ 0·7056. Apparatus *A*.

24·5°	15·95	0·7526	22·48	414·4	60·1°	14·16	0·7271	19·28	412·9
41·3	15·05	0·7416	20·90	413·1	84·3	12·98	0·7082	17·21	412·1
									Mean 413·1

536. *Tri*-n-*butylamine*. B. p. 212°/761 mm.; M 185·35; n_C 1·42727, n_D 1·42967, n_F 1·43547, $n_{G'}$ 1·43975; R_C 61·20, R_D 61·50, R_F 62·22, $R_{G'}$ 62·75; $Mn_D^{20°}$ 264·99. Densities determined: $d_{4°}^{20°}$ 0·7781, $d_{4°}^{41\cdot4°}$ 0·7638, $d_{4°}^{60\cdot0°}$ 0·7500, $d_{4°}^{87\cdot1°}$ 0·7300. Apparatus *B*.

22·9°	13·52	0·7761	24·60	531·9	61·8°	12·17	0·7487	21·36	532·2
42·0	12·82	0·7634	22·91	531·4	89·9	11·13	0·7280	19·00	531·6
									Mean 531·8

537. *Tri*-n-*amylamine*. B. p. 109°/5 mm.; M 227·42; n_C 1·43426, n_D 1·43665, n_F 1·44238, $n_{G'}$ 1·44666; R_C 74·94, R_D 75·31, R_F 76·16, $R_{G'}$ 76·80; $Mn_D^{20°}$ 326·73. Densities determined: $d_{4°}^{20°}$ 0·7907, $d_{4°}^{40\cdot1°}$ 0·7761, $d_{4°}^{60\cdot-°}$ 0·7614, $d_{4°}^{86\cdot8°}$ 0·7428. Apparatus *A*.

12·1°	18·01	0·7964	26·86	650·1	61·1°	15·93	0·7611	22·70	652·2
26·4	17·53	0·7861	25·80	652·0	87·5	14·77	0·7423	20·53	652·3
41·5	16·82	0·7751	24·41	652·2					Mean 651·8

538. *Tri*isoa*mylamine*. B. p. 94°/4 mm.; M 227·42; n_C 1·43066, n_D 1·43305, n_F 1·43875, $n_{G'}$ 1·44308; R_C 74·97, R_D 75·33, R_F 76·19, $R_{G'}$ 76·84; $Mn_D^{20°}$ 325·92. Densities determined: $d_{4°}^{20°}$ 0·7848, $d_{4°}^{40\cdot6°}$ 0·7700, $d_{4°}^{60\cdot5°}$ 0·7557, $d_{4}^{86\cdot7°}$ 0·7364. Apparatus *B*.

14·7°	13·44	0·7886	24·85	643·9	60·7°	11·81	0·7554	20·92	643·9
40·8	12·51	0·7699	22·58	643·9	86·5	10·99	0·7365	18·98	644·5
									Mean 644·1

539. *Benzyldiethylamine*. B. p. 209—210°/757 mm. and 125°/12 mm.; M 163·25; n_C 1·49334, n_D 1·49734, n_F 1·50736, $n_{G'}$ 1·51546; R_C 53·11, R_D 53·47, R_F 54·39, $R_{G'}$ 55·12; $Mn_D^{20°}$ 244·43. Densities determined: $d_{4°}^{20°}$ 0·8938, $d_{4°}^{40\cdot5°}$ 0·8783, $d_{4°}^{60\cdot5°}$ 0·8627, $d_{4°}^{87\cdot5°}$ 0·8416. Apparatus *F*.

18·1°	14·44	0·8953	30·10	427·1	60·3°	12·94	0·8629	26·00	427·2
19·9	14·34	0·8939	29·84	426·9	86·5	12·09	0·8424	23·77	427·6
40·9	13·52	0·8780	27·64	426·3					Mean 427·0

540. *Ethyl nitrilotricarboxylate.* B. p. 143°/10 mm.; M 233·22; n_C 1·42665, n_D 1·42897, n_F 1·43456, $n_{G'}$ 1·43877; R_C 52·53, R_D 52·88, R_F 53·38, $R_{G'}$ 53·82; $Mn_D^{20°}$ 333·51. Densities determined: $d_{4°}^{20°}$ 1·1392, $d_{4°}^{40·0°}$ 1·1198, $d_{4°}^{60·9°}$ 1·0994, $d_{4°}^{86·1°}$ 1·0749. Apparatus *E*.

t.	*H*.	$d_{4°}^{t°}$.	γ.	*P*.	*t*.	*H*.	$d_{4°}^{t°}$.	γ.	*P*.
18·9°	13·11	1·1403	34·82	496·8	60·2°	11·84	1·1101	30·35	497·3
20·5	13·03	1·1387	34·81	497·5	86·8	11·15	1·0742	27·89	498·9
40·2	12·52	1·1196	32·65	497·9				Mean	497·7

541. *Dimethylaniline.* B. p. 194°/760 mm.; M 121·18; n_C 1·55110, n_D 1·55776, n_F 1·57051, $n_{G'}$ 1·59132 (line very faint); R_C 40·40, R_D 40·81, R_F 41·84, $R_{G'}$ 42·80; $Mn_D^{20°}$ 188·77. Densities determined: $d_{4°}^{20°}$ 0·9571, $d_{4°}^{62·0°}$ 0·9255, $d_{4°}^{86·2°}$ 0·9055, $d_{4°}^{119·7°}$ 0·8783. Apparatus *B*.

19·5°	16·11	0·9575	36·17	310·4	86·8°	13·65	0·9050	28·97	310·6
66·3	14·39	0·9222	31·12	310·4	121·7	12·37	0·8768	25·43	310·4
								Mean	310·5

542. *Diethylaniline.* B. p. 214·5°/748 mm. and 86·5°/6 mm.; M 149·23; n_C 1·53578, n_D 1·54178, n_F 1·55773, $n_{G'}$ 1·57227 (line faint); R_C 49·74, R_D 50·20, R_F 51·42, $R_{G'}$ 52·52; $Mn_D^{20°}$ 230·08. Densities determined: $d_{4°}^{20°}$ 0·9353, $d_{4°}^{40·8°}$ 0·9195, $d_{4°}^{61·3°}$ 0·9042, $d_{4°}^{85·0°}$ 0·8851. Apparatus *C*.

19·9°	15·55	0·9354	34·53	386·7	60·7°	14·10	0·9047	30·28	386·9
40·9	14·81	0·9194	32·33	387·0	86·8	13·13	0·8837	27·55	386·9
								Mean	386·9

543. *Di-*n*-propylaniline.* B. p. 242°/758 mm. and 95°/4 mm.; M 177·28; n_C 1·52333, n_D 1·52873, n_F 1·54292, $n_{G'}$ 1·55539 (line very faint); R_C 59·05. R_D 59·56, R_F 60·89, $R_{G'}$ 62·05; $Mn_D^{20°}$ 271·01. Densities determined: $d_{4°}^{20°}$ 0·9176, $d_{4°}^{41·2°}$ 0·9021. $d_{4°}^{61·1°}$ 0·8879, $d_{4°}^{85·8°}$ 0·8695. Apparatus *C*.

22·0°	15·08	0·9160	32·79	463·1	60·4°	13·67	0·8884	28·83	462·4
24·3	14·95	0·9145	32·46	462·7	87·5	12·84	0·8683	26·47	463·1
42·4	14·39	0·9012	30·79	463·4				Mean	463·0

544. *Di-*n*-butylaniline.* B. p. 269—270°/760 mm.; M 205·33; n_C 1·51444, n_D 1·51929, n_F 1·53246, $n_{G'}$ 1·54349 (line very faint); R_C 68·29, R_D 68·84, R_F 70·30, $R_{G'}$ 71·51; $Mn_D^{20°}$ 311·96. Densities determined: $d_{4°}^{20°}$ 0·9058, $d_{4°}^{41·3°}$ 0·8905, $d_{4°}^{61·0°}$ 0·8763, $d_{4°}^{85·4°}$ 0·8581. Apparatus *C*.

15·1°	15·22	0·9083	32·82	541·1	61·6°	13·61	0·8759	28·30	540·7
40·7	14·35	0·8901	30·32	541·3	87·8	12·80	0·8567	26·03	541·4
								Mean	541·1

WOOLWICH POLYTECHNIC, LONDON, S.E.18.

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