132. *Physical Properties and Chemical Constitution. Part XV. The Phenyl Group.*

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New measurements of the parachors and of the refractivities for the C, D, F, and G′ lines at 20° of a number of alkyl benzoates, phenylacetates, and β-phenylpropionates and of monohalogeno-benzenes are recorded. The experimental data, in conjunction with those in Parts XIII and XIV (preceding papers), have been employed in the calculation of the constants for the phenyl group by the following methods: (1) $C_6H_5{\cdot}CO_2R - 0{\cdot}5(CO_2R)_2$; (2) $C_6H_5{\cdot}CH_2{\cdot}CO_2R - 0{\cdot}5(CH_2{\cdot}CO_2R)_2$; (3) $C_6H_5{\cdot}CH_2{\cdot}CH_2{\cdot}CO_2R - 0{\cdot}5(CH_2{\cdot}CH_2{\cdot}CO_2R)_2$; (4) $C_6H_5X - X$ (X = Cl, Br and I). The results are in reasonable agreement and lead to the following mean values for the phenyl group:

	P.	R_C.	R_D.	R_F.	$R_{G'}$.	$Mn_D^{20°}$.
C_6H_5	188·3	25·239	25·463	26·036	26·057	121·89

Preliminary figures for the α-naphthyl group have been computed from measurements upon α-methyl-, α-chloro-, and α-bromo-naphthalene.

THE primary object of this investigation was the determination of the parachor and the refractivities for the C, D, F, and G′ lines of the phenyl group. Apart from its own intrinsic value, it is hoped, with the aid of the constants for hydrogen (Part IX, *J.*, 1946, 133) to employ the refractivities in the calculation of the bond refractions $C_{ar.}$–$C_{ar.}$ which will be compared with

TABLE I.

Parachor and refractivities of the phenyl group.

	P.	R_C.	R_D.	R_F.	$R_{G'}$.	$Mn_D^{20°}$.
From alkyl benzoates, $C_6H_5{\cdot}CO_2R$.						
R = Me	188·6	25·43	25·67	26·32	26·83	123·40
R = Et	187·9	25·53	25·79	26·43	26·96	122·99
R = Pr^n	187·9	25·50	25·74	26·38	26·93	122·98
R = Bu^n	188·2	25·55	25·80	26·44	26·98	122·89
From alkyl phenylacetates, $C_6H_5{\cdot}CH_2{\cdot}CO_2R$.						
R = Me	189·1	25·13	25·34	25·89	26·33	122·56
R = Et	188·8	25·19	25·40	25·95	26·40	122·17
R = Pr^n	189·5	25·18	25·39	25·95	26·38	121·87
R = Bu^n	188·1	25·22	25·44	25·98	26·44	121·69
From alkyl β-phenylpropionates, $C_6H_5{\cdot}CH_2{\cdot}CH_2{\cdot}CO_2R$.						
R = Me	188·6	25·21	25·43	25·98	26·44	122·39
R = Et	187·9	25·16	25·37	25·92	26·39	122·00
R = Pr^n	187·0	25·18	25·40	25·94	26·41	121·89
R = Bu^n	187·1	25·22	25·43	25·99	26·46	121·64
From halogenobenzenes, C_6H_5X.						
X = Cl	188·0	25·08	25·30	25·83	26·25	121·22 *
X = Br	188·3	25·04	25·25	25·79	26·22	126·88 *
X = I	188·9	24·97	25·20	25·75	26·19	134·33 *
Mean	188·3	25·239	25·463	26·036	26·507	121·89 *
Mean (excluding alkyl benzoates)	188·3	25·136	25·359	25·906	26·356	122·03 *

* Values marked with an asterisk were omitted in the calculation of the mean.

the figures deduced from other data (*e.g.*, Part X, this vol., p. 607). New measurements of the parachors and the refractivities have accordingly been made upon the compounds mentioned above. The constants for the phenyl group have been computed by the four methods indicated above. The results are collected in Table I. It will be observed that the results by all methods are in reasonably good agreement, although the refractivities derived from the alkyl benzoates appear to be slightly higher than those from the other series. Whether these differences possess real significance cannot at present be decided, but as a first approximation the constants for the phenyl group have been taken as the arithmetical mean of all the values. It must be pointed out that the experimental data for the dialkyl oxalates lead to constants for CO·O which are higher than the mean figures derived from other carboxylic esters (Part XIII, *loc. cit.*), yet they give reasonable figures for the contribution of the phenyl group. The second set of mean constants for C_6H_5 do not include the data for the alkyl benzoates and are probably more trustworthy.

The experimental results for benzyl chloride (XIV, **281**) (which are not of the same order of accuracy as the other measurements because of the properties of the compound) lead to the following figures for phenyl $\{C_6H_5 = C_6H_5{\cdot}CH_2Cl - (CH_2 + Cl)\}$: *P*, 189·3, R_C 25·32, R_D 25·53, R_F 26·11, R_G 26·56, $Mn_D^{20°}$ 123·81.

Some preliminary results for the α-naphthyl group, calculated from new experimental measurements upon α-methyl-, α-chloro-, and α-bromo-naphthalene are given in Table II.

TABLE II.

Parachor and refractivities of the α-naphthyl group.

	P.	R_C.	R_D.	R_F.	$R_{G'}$.	$Mn_D^{20°}$.
$C_{10}H_7{}^{\alpha}{\cdot}CH_3$	293·6	42·50	43·00	44·27	—	210·68
$C_{10}H_7{}^{\alpha}Cl$	293·3	—	42·89	—	—	215·08
$C_{10}H_7{}^{\alpha}Br$	292·6	—	42·66	—	—	225·29

EXPERIMENTAL.

Preparation of Materials.—Methyl benzoate. From A.R. benzoic acid, m. p. 122—123° (1 mol.), absolute methyl alcohol (10 mols.), and concentrated sulphuric acid (5% of weight of the alcohol); b. p. 199°/775 mm.

Ethyl benzoate. From A.R. benzoic acid, absolute ethyl alcohol, and concentrated sulphuric acid, as for the methyl ester; b. p. 213·5°/775 mm.

n-*Propyl benzoate.* From 30·5 g. of A.R. benzoic acid, 30 g. of pure *n*-propyl alcohol, 50 ml. of sodium-dried A.R. benzene, and concentrated sulphuric acid; the mixture was refluxed for 35 hours and then poured into water, etc. The yield was 37 g.; b. p. 229·5°/766 mm.

n-*Butyl benzoate.* From 30·5 g. of A.R. benzoic acid, 37 g. of pure *n*-butyl alcohol, 50 ml. of sodium-dried A.R. benzene, and 10 g. of concentrated sulphuric acid; refluxed for 35 hours. The yield of ester was 36 g., b. p. 120°/11 mm.

Methyl phenylacetate. From phenylacetic acid, m. p. 77—78°, absolute ethyl alcohol, and concentrated sulphuric acid, as for methyl benzoate; b. p. 215°/760 mm.

Ethyl phenylacetate. From phenylacetic acid, absolute ethyl alcohol, and concentrated sulphuric acid; b. p. 228°/753 mm.

n-*Propyl phenylacetate.* From 34 g. of phenylacetic acid, 30 g. of *n*-propyl alcohol, 50 ml. of sodium-dried A.R. benzene, and 10 g. of concentrated sulphuric acid; refluxed for 24 hours. The yield of ester, b. p. 240°/753 mm., was 43 g.

n-*Butyl phenylacetate.* From 34 g. of phenylacetic acid, 37 g. of pure *n*-butyl alcohol, 50 ml. of sodium-dried A.R. benzene, and 10 g. of concentrated sulphuric acid. The yield of ester, b. p. 257°/753 mm., was 45 g.

Methyl β-phenylpropionate. β-Phenylpropionic acid was prepared by reduction of purified ethyl cinnamate in moist ethereal solution with aluminium amalgam (Vogel, *J.*, 1927, 597); the resulting ethyl ester, b. p. 248—250°/760 mm., was hydrolysed with alcoholic potassium hydroxide solution and, after recrystallisation from water or from dilute methyl alcohol, the acid had m. p. 49—50°. The methyl ester was prepared from this acid, excess of absolute methyl alcohol, and concentrated sulphuric acid; b. p. 231·5—232·5°/755 mm.

Ethyl β-phenylpropionate. From 25 g. of the acid, 23 g. of absolute ethyl alcohol, 100 ml. of dry benzene, and 4 g. of concentrated sulphuric acid; refluxed for 16·5 hours. The yield of ester, b. p. 123°/11 mm., was 26 g.

n-*Propyl β-phenylpropionate.* From 25 g. of the acid, 30 g. of *n*-propyl alcohol, 100 ml. of dry benzene, and 4 g. of concentrated sulphuric acid; refluxed for 16·5 hours. The yield of ester, b. p. 126°/9 mm., was 27 g.

n-*Butyl β-phenylpropionate.* From 25 g. of the acid, 37 g. of *n*-butyl alcohol, 100 ml. of dry benzene, and 4 g. of concentrated sulphuric acid; refluxed for 18 hours. The yield of n-*butyl* ester, b. p. 138°/6 mm., was 34 g. (Found: C, 75·9; H, 9·0. $C_{13}H_{18}O_2$ requires C, 75·7; H, 8·8%).

Chlorobenzene. This was prepared from A.R. aniline by an adaptation of the method given for *o*-chlorotoluene (*Org. Synth.*, 1923, **3**, 35); the crude product was washed with sodium hydroxide solution, cold concentrated sulphuric acid (to remove traces of azo-compounds), and then water until neutral, dried, and distilled; b. p. 131·5°/765 mm.

Bromobenzene. This was prepared from A.R. aniline (see details for *p*-bromotoluene in *Org. Synth.*, 1925, **5**, 21) and purified as for chlorobenzene; treatment with one-third of the volume of concentrated sulphuric acid produced a very dark solution and the product was therefore poured into excess of water to separate the bromobenzene. The latter was washed with dilute sodium hydroxide solution and water, dried, and distilled: the product boiled constantly at 155°/755 mm. and was extremely pale yellow in colour.

A second sample was prepared by washing a pure commercial product (obviously prepared directly from benzene) with sodium hydrogen carbonate solution and water, dried, and distilled: this boiled at 155°/760 mm., was perfectly colourless, and had identical physical properties with the preparation from aniline.

Iodobenzene. This was prepared from A.R. aniline (*Org. Synth.*, 1939, **19**, 55) and boiled at 186°/750 mm. as a yellow liquid. Redistillation gave a colourless product, b. p. 58°/6 mm.

α-*Methylnaphthalene.* A pure commercial product was washed three times with one-third of its bulk of 10% sodium hydroxide solution, then with water until the washings were neutral, and dried ($MgSO_4$) and twice distilled over sodium; b. p. 240·5°/760 mm.

α-*Chloronaphthalene.* A pure commercial product was washed successively with 10% sodium hydroxide solution and water, dried, and twice fractionated under reduced pressure; b. p. 106·5°/5 mm.

α-*Bromonaphthalene.* A pure commercial product was purified as for α-chloronaphthalene; b. p. 125·5°/5 mm.

Physical Measurements.—All liquids were redistilled immediately before use; the b. p.s are given below.

313. *Methyl benzoate.* B. p. 199°/775 mm.; M 136·14; n_C 1·51213, n_D 1·51701, n_F 1·52970, $n_{G'}$ 1·53992; R_C 37·51, R_D 37·81, R_F 38·59, $R_{G'}$ 39·20; $Mn_D^{20°}$ 205·86. Densities determined: $d_{4°}^{20°}$ 1·0894, $d_{4°}^{41·1°}$ 1·0690, $d_{4°}^{60·7°}$ 1·0505, $d_{4°}^{85·5°}$ 1·0280. Apparatus *A*.

(These headings apply to corresponding columns in all the following tables.)

t.	H.	$d_{4°}^{t°}$.	γ.	P.	t.	H.	$d_{4°}^{t°}$.	γ.	P.
15·3°	18·69	1·0949	38·32	309·4	61·8°	16·65	1·0494	32·72	310·3
20·3	18·54	1·0891	37·81	309·9	87·3	15·60	1·0263	29·98	310·4
41·1	17·60	1·0690	35·23	310·3				Mean	310·1

314. *Ethyl benzoate.* B. p. 213·5°/775 mm.; M 150·17; n_C 1·50064, n_D 1·50519, n_F 1·51689, $n_{G'}$ 1·52654; R_C 42·24, R_D 42·57, R_F 43·40, $R_{G'}$ 44·07; $Mn_D^{20°}$ 226·04. Densities determined: $d_{4°}^{20°}$ 1·0467, $d_{4°}^{41·5°}$ 1·0276, $d_{4°}^{61·6°}$ 1·0099, $d_{4°}^{86·3°}$ 0·9876. Apparatus *D*.

15·8°	13·67	1·0504	35·46	348·9	41·9°	12·88	1·0272	32·67	349·5
21·1	13·56	1·0457	35·02	349·3	62·1	12·21	1·0095	30·44	349·4
24·8	13·43	1·0424	34·57	349·3	88·1	11·47	0·9860	27·93	350·1
								Mean	349·4

315. n-*Propyl benzoate.* B. p. 229·5°/766 mm.; M 164·20; n_C 1·49598, n_D 1·50031, n_F 1·51134, $n_{G'}$ 1·52043; R_C 46·88, R_D 47·22, R_F 48·10, $R_{G'}$ 48·82; $Mn_D^{20°}$ 246·35. Densities determined: $d_{4°}^{20°}$ 1·0232, $d_{4°}^{41·1°}$ 1·0049, $d_{4°}^{60·4°}$ 0·9878, $d_{4°}^{87·5°}$ 0·9647. Apparatus *A*.

16·0°	18·12	1·0267	35·09	389·2	61·6°	16·15	0·9868	29·84	388·9
23·5	17·73	1·0202	33·87	388·3	87·6	15·12	0·9646	27·31	389·1
41·5	17·03	1·0046	32·04	388·9				Mean	388·9

316. n-*Butyl benzoate.* B. p. 120°/11 mm.; M 178·22; n_C 1·49306, n_D 1·49720, n_F 1·50780, $n_{G'}$ 151631; R_C 51·53, R_D 51·90, R_F 52·83, $R_{G'}$ 53·58; $Mn_D^{20°}$ 266·83. Densities determined: $d_{4°}^{20°}$ 1·0052, $d_{4°}^{41·3°}$ 0·9880, $d_{4°}^{60·1°}$ 0·9725, $d_{4°}^{86·7°}$ 0·9502. Apparatus *A*.

20·8°	17·83	1·0045	33·54	427·0	61·4°	16·31	0·9714	29·67	428·2
26·9	17·71	0·9995	33·15	427·8	87·2	15·30	0·9496	27·21	428·6
41·9	17·01	0·9875	31·45	427·4				Mean	427·8

317. *Methyl phenylacetate.* B. p. 215°/760 mm.; M 150·17; n_C 1·50277, n_D 1·50686, n_F 1·51715 $n_{G'}$ 1·52553; R_C 41·55, R_D 41·84, R_F 42·56, $R_{G'}$ 43·13; $Mn_D^{20°}$ 226·29. Densities determined: $d_{4°}^{20°}$ 1·0679, $d_{4°}^{41·3°}$ 1·0479, $d_{4°}^{60·5°}$ 1·0303, $d_{4°}^{86·7°}$ 1·0065. Apparatus *D*.

18·1°	14·55	1·0697	38·44	349·4	61·5°	13·10	1·0294	33·30	350·4
41·4	13·70	1·0478	35·45	349·7	85·8	12·26	1·0073	30·49	350·3
								Mean	350·0

318. *Ethyl phenylacetate.* B. p. 228°/753 mm.; M 164·18; n_C 1·49347, n_D 1·49734, n_F 1·50705, $n_{G'}$ 1·51492; R_C 46·25, R_D 46·55, R_F 47·33, $R_{G'}$ 47·94; $Mn_D^{20°}$ 245·83. Densities determined: $d_{4°}^{20°}$ 1·0325, $d_{4°}^{42·0°}$ 1·0131, $d_{4°}^{61·5°}$ 0·9948, $d_{4°}^{85·0°}$ 0·9743. Apparatus *D*.

16·7°	13·97	1·0355	35·74	387·6	61·0°	12·50	0·9953	30·72	388·4
20·0	13·86	1·0325	35·34	387·7	84·7	11·77	0·9746	28·33	388·6
41·2	13·22	1·0138	33·10	388·4				Mean	388·1

319. n-*Propyl phenylacetate.* B. p. 240°/753 mm.; M 178·22; n_C 1·48882, n_D 1·49250, n_F 1·50187 $n_{G'}$ 1·50924; R_C 50·89, R_D 51·22, R_F 52·05, $R_{G'}$ 52·69; $Mn_D^{20°}$ 265·99. Densities determined: $d_{4°}^{20}$ 1·0103, $d_{4°}^{41·5°}$ 0·9920, $d_{4°}^{62·0°}$ 0·9743, $d_{4°}^{85·2°}$ 0·9540. Apparatus *A*.

$t.$	$H.$	$d_{4°}^{t°}$.	$\gamma.$	$P.$	$t.$	$H.$	$d_{4°}^{t°}$.	$\gamma.$	$P.$
15·7°	18·33	1·0140	34·80	426·9	60·9°	16·46	0·9752	30·06	427·9
20·9	18·10	1·0095	34·21	427·0	86·3	15·50	0·9532	27·67	428·8
41·2	17·26	0·9923	32·07	427·4				Mean	427·6

320. n-*Butyl phenylacetate.* B. p. 257°/753 mm.; M 192·25; n_C 1·48581, n_D 1·48940, n_F 1·49842, $n_{G'}$ 1·50562; R_C 55·54, R_D 55·89, R_F 56·76, $R_{G'}$ 57·45; $Mn_D^{20°}$ 286·34. Densities determined: $d_{4°}^{20°}$ 0·9935, $d_{4°}^{42·1°}$ 0·9755, $d_{4°}^{59·1°}$ 0·9614, $d_{4°}^{86·1°}$ 0·9389. Apparatus *D*.

22·3°	13·52	0·9916	33·11	465·1	62·0°	12·33	0·9590	29·20	466·0
43·1	12·91	0·9747	31·08	465·7	85·2	11·63	0·9396	26·99	466·3
								Mean	465·8

321. *Methyl β-phenylpropionate.* B. p. 232°/755 mm.; M 164·20; n_C 1·49903, n_D 1·50297, n_F 1·51297, $n_{G'}$ 1·52089; R_C 46·22, R_D 46·53, $R_{F'}$ 47·31, $R_{G'}$ 47·92; $Mn_D^{20°}$ 246·79. Densities determined: $d_{4°}^{20°}$ 1·0432, $d_{4°}^{41·0°}$ 1·0254, $d_{4°}^{60·6°}$ 1·0077, $d_{4°}^{87·3°}$ 0·9841. Apparatus *D*.

13·9°	14·72	1·0485	38·12	389·1	41·2°	13·86	1·0252	35·09	389·8
16·2	14·64	1·0465	37·84	389·2	61·3	13·16	1·0071	32·73	390·0
22·6	14·44	1·0409	37·12	389·4	87·1	12·33	0·9843	29·97	390·3
								Mean	389·6

322. *Ethyl β-phenylpropionate.* B. p. 123°/11 mm.; M 178·22; n_C 1·49086, n_D 1·49460, n_F 1·50401, $n_{G'}$ 1·51158; R_C 50·82, R_D 51·14, R_F 51·97, $R_{G'}$ 52·63; $Mn_D^{20°}$ 266·37. Densities determined: $d_{4°}^{20°}$ 1·0155, $d_{4°}^{41·0°}$ 0·9980, $d_{4°}^{59·6°}$ 0·9815, $d_{4°}^{85·2°}$ 0·9616. Apparatus *D*.

25·5°	13·80	1·0109	34·45	427·1	62·3°	12·65	0·9792	30·59	428·0
28·8	13·73	1·0081	34·18	427·5	86·7	11·88	0·9603	28·17	427·6
40·9	13·31	0·9981	32·81	427·3				Mean	427·5

323. n-*Propyl β-phenylpropionate.* B. p. 126°/9 mm.; M 192·17; n_C 1·48769, n_D 1·49131, n_F 1·50041, $n_{G'}$ 1·50774; R_C 55·46, R_D 55·81, R_F 56·68, $R_{G'}$ 57·38; $Mn_D^{20°}$ 286·73. Densities determined: $d_{4°}^{20°}$ 0·9983, $d_{4°}^{42·5°}$ 0·9797, $d_{4°}^{61·4°}$ 0·9638, $d_{4°}^{86·8°}$ 0·9424. Apparatus *A*.

25·0°	18·06	0·9941	33·62	465·7	62·7°	16·48	0·9627	29·71	466·3
32·3	17·84	0·9880	33·00	466·4	87·4	15·43	0·9417	27·21	466·3
42·0	17·33	0·9801	31·80	465·9				Mean	466·1

324. n-*Butyl β-phenylpropionate.* B. p. 138°/6 mm.; M 206·27; n_C 1·48512, n_D 1·48864, n_F 1·49743, $n_{G'}$ 1·50441; R_C 60·11, R_D 60·48, R_F 61·41, $R_{G'}$ 62·14; $Mn_D^{20°}$ 307·05. Densities determined: $d_{4°}^{20°}$ 0·9836, $d_{4°}^{40·4°}$ 0·9676, $d_{4°}^{61·5°}$ 0·9506, $d_{4°}^{86·8°}$ 0·9304. Apparatus *D*.

19·3°	13·79	0·9842	33·52	504·3	43·5°	13·12	0·9651	31·27	505·4
22·0	13·74	0·9820	33·32	504·7	62·6	12·56	0·9497	29·46	506·0
29·4	13·56	0·9762	32·69	505·2	87·4	11·86	0·9298	27·23	506·8
								Mean	505·4

325. *Chlorobenzene.* B. p. 131·5°/765 mm.; M 112·56; n_C 1·51998, n_D 1·52481, n_F 1·53716, $n_{G'}$ 1·54672; R_C 30·90, R_D 31·14, R_F 31·75, $R_{G'}$ 32·22; $Mn_D^{20°}$ 171·63. Densities determined: $d_{4°}^{20°}$ 1·1074, $d_{4°}^{41·3°}$ 1·0845, $d_{4°}^{61·0°}$ 1·0640, $d_{4°}^{80·6°}$ 1·0432. Apparatus *B*.

16·7°	12·71	1·1109	33·11	243·1	63·4°	11·18	1·0625	28·11	243·4
42·4	11·83	1·0833	30·05	243·3	87·6	10·33	1·0358	25·09	243·2
								Mean	243·2

326. *Bromobenzene.* B. p. 155°/755 mm.; M 157·02; n_C 1·55455, n_D 1·55998, n_F 1·57387, $n_{G'}$ 1·58498; R_C 33·72, R_D 33·99, R_F 34·68, $R_{G'}$ 35·23; $Mn_D^{20°}$ 244·95. Densities determined: $d_{4°}^{20°}$ 1·4939, $d_{4°}^{40·9°}$ 1·4676, $d_{4°}^{60·1°}$ 1·4424, $d_{4°}^{85·2°}$ 1·4093. Apparatus *B*.

19·0°	10·26	1·4952	35·97	257·2	62·5°	9·13	1·4393	30·81	257·0
41·2	9·70	1·4672	33·37	257·2	86·5	8·53	1·4076	28·16	257·0
								Mean	257·1

327. *Iodobenzene.* B. p. 186°/750 mm. and 58°/6 mm.; M 204·02; n_C 1·61342, n_D 1·62040, n_F 1·63842, $n_{G'}$ 1·65350; R_C 38·80, R_D 39·15, R_F 40·06, $R_{G'}$ 40·81; $Mn_D^{20°}$ 330·60. Densities determined: $d_{4°}^{20°}$ 1·8313, $d_{4°}^{41·1°}$ 1·8016, $d_{4°}^{60·9°}$ 1·7725, $d_{4°}^{87·5°}$ 1·7331. Apparatus *A* and apparatus *B*.*

18·4°	11·47	1·8336	39·38	278·7	41·6° *	8·78	1·8009	37·08	279·5
41·3	10·96	1·8013	36·97	279·3	64·4 *	8·21	1·7675	34·03	278·8
62·2	10·49	1·7706	34·78	279·8	90·0 *	7·74	1·7295	31·39	279·2
								Mean	279·2

[Sugden (*J.*, 1924, **125**, 1172 and 1182) finds P for bromobenzene and iodobenzene 260·6 and 282·3, respectively; these values are about 3 units high.]

328. α-*Methylnaphthalene.* B. p. 240·5°/763 mm.; M 142·19; n_C 1·60137, n_D 1·60923, n_F 1·63030; R_C 48·14, R_D 48·65, R_F 49·99; $Mn_D^{20°}$ 228·81. Densities determined: $d_{4°}^{20°}$ 1·0123, $d_{4°}^{41·0°}$ 0·9979, $d_{4°}^{59·7°}$ 0·9847, $d_{4°}^{85·4°}$ 0·9660. Apparatus *A*.

t.	*H.*	$d_{4°}^{t°}$.	γ.	*P.*	*t.*	*H.*	$d_{4°}^{t°}$.	γ.	*P.*
18·3°	20·16	1·0135	38·26	348·9	61·6°	18·57	0·9834	34·20	349·8
25·8	19·87	1·0082	37·51	349·2	87·2	17·61	0·9647	31·81	350·0
40·9	19·37	0·9980	36·20	349·7				Mean	349·5

329. α-*Chloronaphthalene.* B. p. 106·5°/5 mm.; M 162·62; n_D 1·63255; R_D 48·75; $Mn_D^{20°}$ 265·49. Densities determined: $d_{4°}^{20°}$ 1·1908, $d_{4°}^{41·4°}$ 1·1741, $d_{4°}^{62·8°}$ 1·1572, $d_{4°}^{85·0°}$ 1·1394. Apparatus *D*.

15·9°	14·59	1·1941	43·03	348·8	61·0°	13·27	1·1586	37·97	348·4
25·5	14·18	1·1864	41·55	348·0	86·4	12·60	1·1383	35·42	348·5
40·5	13·87	1·1748	40·24	348·6				Mean	348·5

330. α-*Bromonaphthalene.* B. p. 125·5°/5 mm.; M 207·08; n_D 1·65805, R_D 51·40; $Mn_D^{20°}$ 343·36. Densities determined: $d_{4°}^{20°}$ 1·4839, $d_{4°}^{40·5°}$ 1·4659, $d_{4°}^{60·2°}$ 1·4470, $d_{4°}^{86·0°}$ 1·4225. Apparatus *D*.

16·2°	12·32	1·4874	45·26	361·1	60·4°	11·44	1·4468	40·88	361·9
27·0	12·11	1·4775	44·19	361·4	86·7	10·79	1·4219	37·89	361·3
41·0	11·89	1·4654	43·03	361·9				Mean	361·5

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