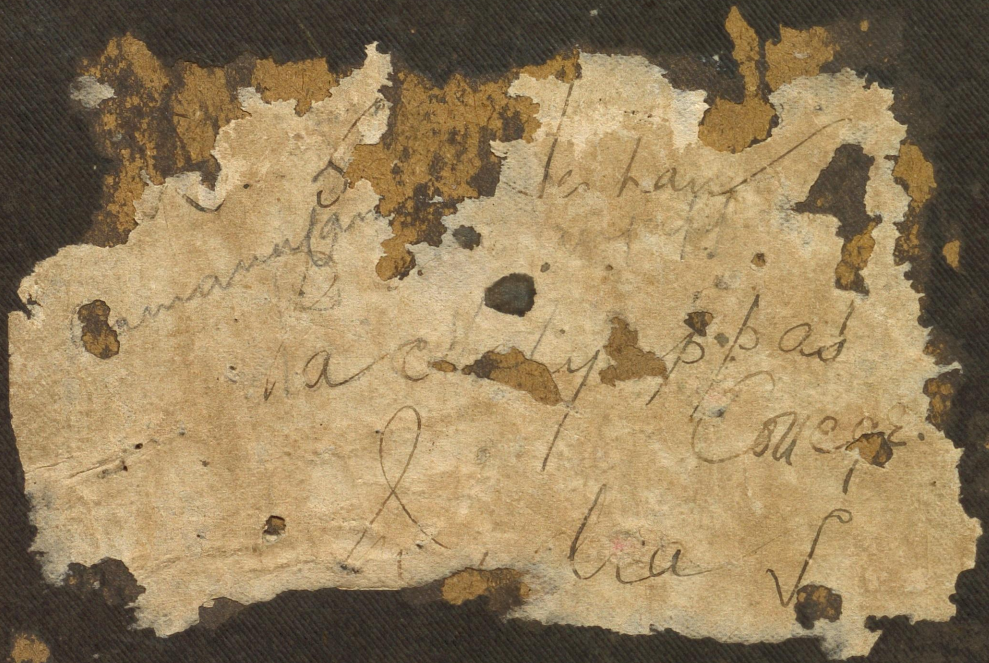

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Calculation of the Kerr const. for gases and vapours from the depolarisation factor by using Gans's formula

$$B = \frac{\beta (n^2-1)(n^2+2)(K-1)(K+2)}{24\pi n \lambda} \cdot \frac{\rho}{6-7\rho}.$$

For gases and vapours which are sufficiently rare that Boyle's law holds $\beta = \frac{1}{p}$.

$$= \frac{1}{1{\cdot}0132 \times 10^6} \quad \text{for atm. pressure.}$$

and $n^2-1 = 2(n-1)$

$n^2+2 = 3 \qquad K+2 = 3.$

$$\therefore B = \frac{18\,(n-1)(K-1)}{1{\cdot}0132 \times 10^6 \times 24\pi\lambda \cdot n} \cdot \frac{\rho}{6-7\rho}$$

$$= \text{antilog } \bar{3}{\cdot}6023 \cdot \frac{(n-1)(K-1)}{n} \cdot \frac{\rho}{6-7\rho}.$$

List of vapours and gases.

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CO_2

n_0 (for D line) from Landolt-Tables
$= 1.0_3449.$

$n_{17.5^\circ} - 1 = \frac{.0_3449}{1 + 17.5\alpha}$ where $\alpha = .0_2367$

$= .0_3422.$

K_0 from Landolt-Tables $= 1.0_3989.$

$K_{17.5} - 1 = \frac{.0_3989}{1 + 17.5\alpha} = .0_3929.$

$\therefore B = \text{antilog. } \bar{3}.6023 \times \frac{.0_3422 \times .0_3989}{1.0_34} \times \frac{\rho}{6 - 7\rho}$

using R and R's value for $\rho = .106$

$B = .32 \times 10^{-10}$ per atm

using Rayleigh's value .117

$B_{17.5-D} = .38 \times 10^{-10}$ per atm

Sziveßy's value for $B_{17.5-D\text{ line}} = .24 \times 10^{-10}$
(Zeit. f. Phys. 26, 323, 1924).

Lyon however [Zeits. f. Physik. 28, 286, 1924]
gets $B = .78 \times 10^{-11}$ per atm. for Li line 610.4 mμ at 18° C.

Handau's value $= .23 \times 10^{-10}$.

O_2

n_0 for D line = 1.0_3271 (Landolt-Zebbs)

$$n_{20^\circ} - 1 = \frac{.0_3271}{1.0734} = .0_3252.$$

K_0 from Landolt Zebbs = 1.0_3547.

$$K_{20^\circ} - 1 = \frac{.0_3547}{1.0734} = .0_3509_5$$

$$\therefore B = \text{anti log } \bar{3}.6023 \times \frac{.0_3252 \times .0_3509_5}{1.0_3252} \times \frac{\rho}{6-7\rho}.$$

using Rayleigh's value 9.4

$$B = .090 \times 10^{-10}$$

using R + R's value 8.4

$$B = .080 \times 10^{-10}$$

H_2

n_0 for the D line $= 1 \cdot 0_3 140$ (Landolt Tables)

$$n_{20} - 1 = \frac{\cdot 0_3 140}{1 \cdot 0734} = 1 \cdot 0_3 130$$

K_{20} from Landolt Tables $= 1 \cdot 0_3 273$.

$$\therefore B = \text{anti log } \bar{3} \cdot 6023 \times \frac{\cdot 0_3 130 \times \cdot 0_3 273}{1 \cdot 0_3 130} \times \frac{\rho}{6 - 7\rho}$$

Taking $\rho = -\cdot 037$ [Raman & Rao 3.6, Rayleigh 3.83].

$$B = \cdot 0089 \times 10^{-10}$$

N_2

$\rho = \cdot 0406$ (Rayleigh)

$n_0 = 1 \cdot 0_3 2987$ from Landolt Tables.

$\therefore n_{20} - 1 = \dfrac{\cdot 0_3 297}{1 + 20\alpha} = \cdot 0_3 277.$

$K_{20} = 1 \cdot 0_3 5581$ (Landolt Tables)

$\therefore$ B:

$$B = \text{anti log } \bar{3} \cdot 6023 \times \frac{\cdot 0_3 277 \times \cdot 0_3 5581}{1 \cdot 0_3 277} \times \frac{\cdot 0406}{5 \cdot 7158}$$

$$= \cdot 046 \times 10^{-10}.$$

" "

N_2O

$\rho = \cdot 157$ (Rayleigh)
$\cdot 143$ (R+R).

B - n_0 from Landolt-Tables = $1 \cdot 0_3 516$.

$\therefore n_{20} - 1 = \cdot 0_3 4851$

K_0 from Landolt-Tables = $1 \cdot 0_2 1129$.

$K_{20} - 1 = \cdot 001052$.

$\therefore B = \text{anti log } \bar{3} \cdot 6023 \times \frac{\cdot 0_3 4851 \times \cdot 0_2 1052}{1 \cdot 0_3 5} \times \frac{\rho}{6 - 7\rho}$

using Rayleigh's value $B = \cdot 65 \times 10^{-10}$.

using R+R's value $B = \cdot 58 \times 10^{-10}$.

Hansen's value = ~~·615~~ $\cdot 48 \times 10^{-10}$.

CO.

$\rho = \cdot 034$ (Ramsay – quoted by K.R.R.)

$n_0 = 1 \cdot 0_3 335.$

$n_{20} - 1 = \cdot 0_3 312.$

$K_0 = 1 \cdot 0_3 692$

$K_{20} - 1 = \cdot 0_3 645.$

$$B = \text{antilog } \bar{3} \cdot 6023 \times \frac{\cdot 0_3 312 \times \cdot 0_3 645}{1 \cdot 0_3 3} \times \frac{\cdot 034}{5 \cdot 762}$$

$$= \cdot 048 \times 10^{-10}$$

CS_2 see next page.

ρ = ·120 Rayleigh
·167 Gansan

$n_0 = 1·0_2 1481$ (Landolt's Tables.

$n_{20°} - 1 = ·001380.$

$K_0 = 1·00290.$ (Landolt's Tables)

$K_{20°} - 1 = ·00270$

using Rayleigh's value

$$B = \text{antilog } \bar{3}·6023 \times \frac{·0_2 1380 \times ·0_2 270}{1·0014} \times \frac{·120}{5·16}$$

$$= 3·47 \times 10^{-10}$$

using Gansan's value $= 5·15 \times 10^{-10}$.

B is always referred to the Sodium line and 1 atm press at 20° C.
ie B for $CS_2 = 5·5 \times 10^{-10}$ per atm. at 20° C

$\rho = \cdot 120$ (Rayleigh)

$\cdot 167$ (Gaussian at 55°).

$n_0 = 1 \cdot 001481$ from Landolt Tables.

$$\therefore n_{55^\circ} - 1 = \frac{\cdot 001481}{1 + 55\alpha} = \cdot 001232.$$

$K_{0^\circ} = 1 \cdot 00290$ (Landolt Tables)

$K_{55^\circ} - 1 = \cdot 00241$

$$\therefore B_{55^\circ} = \text{antilog.}\ \bar{3} \cdot 6023 \times \frac{\cdot 0_2 1232 \times \cdot 0_2 241}{1 \cdot 0012} \times \frac{\rho}{6 - 7\rho}.$$

using Rayl's value $B = 2 \cdot 76_5 \times 10^{-10}$

" Gaussian " $B = 4 \cdot 11 \times 10^{-10}$

at 55° C. per atmosphere.

CCl_4.

$\rho = \cdot 019$ [Gausan 90°.]

$n_0 = 1 \cdot 001779$ (From Landolt-Table)

$n_{90^\circ} - 1 = \frac{\cdot 001779}{1 + 90\alpha} = \cdot 001338.$

$K_{110^\circ} = 1 \cdot 00304$ [Bädeker – Landolt Table]

$\alpha_{110^\circ} = 1 \cdot 3 \times 10^{-5}$. "

$K_{90^\circ} = 1 \cdot 0033.$

$\therefore B = \text{anti log } \overline{3} \cdot 6023 \times \frac{\cdot 0_2 1338 \times \cdot 0_2 330}{1 \cdot 0013} \times \frac{\cdot 019}{5 \cdot 867}.$

$= \cdot 571 \times 10^{-10}$ at 90° per atm.

Octane

$\rho_1 = \cdot 027$ [Ramsay 135°].

No data for ref. index or K for vapour, Molec. refractivity for the liquid for the D line = 39·16.

$$\frac{n^2-1}{n^2+2} = \frac{39 \cdot 16}{22390 \times 1 \cdot 4953}$$

$n = 1 \cdot 001756$ putting $K = n^2$

$$B = \text{a.l.}\ \bar{3} \cdot 6023 \times \frac{\cdot 001756^2}{1 \cdot 00176} \times \frac{\cdot 054}{5 \cdot 811}$$

$= 1 \cdot 14_5 \times 10^{-10}$ per atm.

C_6H_6

$\rho = \cdot 066$ (Gausau — at 100°C)
$\cdot 068$ (R.R.) adopt — ·066.

$K_{110°} = 1\cdot 00292$ (Bädeker – Landolt Tables)
$\alpha_{110} = 1\cdot 1 \times 10^{-5}$.
$K_{100°} = 1\cdot 00303$.

$n_0 = 1\cdot 001700$ Prytz
$1\cdot 001823$ ... Mercart } Landolt Tables

Taking Prytz's value

$$n_{100°} - 1 = \frac{\cdot 001700}{1 + 100\,\alpha} = \cdot 001244.$$

$$\therefore B = \text{anti log. } \bar{3}\cdot 6023 \times \frac{\cdot 0_2 1244 \times \cdot 0_2 303}{1\cdot 0012.} \times \frac{\cdot 066}{5\cdot 538}$$

$= 1\cdot 79_5 \times 10^{-10}$ at 100° per atm.

Heptane

$\rho = .031$ (Ramsay at 110°)

no data for refractive indices. — the molec. refractivity ~~calculated from atomic refractivity for CH_2 and refractivity for hexane~~ = wh might be taken as the mean of the values for hexane & octane = 34·52. Molec wt = 100·13.

$\frac{n^2-1}{n^2+2}$ for vapour at 110° $= \frac{34 \cdot 53}{22390 \times 1 \cdot 4037}$

$n^2 = 1 \cdot 003300 \qquad n = 1 \cdot 001650$

putting $K = n^2$

$P_2 = a.l. \; \overline{3} \; 6023 \times \frac{\cdot 001650^2}{1 \cdot 0016_5} \times \frac{\cdot 062}{5 \cdot 783}$

$= 1 \cdot 17 \times 10^{-10}$ per atm.

Pentane

$\rho = .034$ at $45°$ (Ganesan)

$n_0 = 1.001711$

$n_{45°} - 1 = \frac{.001711}{1 + 45\alpha} = .0014469.$

no data for K available.
assuming $K = n^2$ (since the molec is not polar)

$B = \text{anti log } \bar{3}.6023 \cdot \frac{(n-1)^2}{n} \cdot \frac{2\rho}{6-7\rho}.$

$: \text{a.l } \bar{3}.6023 \times \frac{.0014469^2}{1.0015} \times \frac{.068}{5.762}$

$= 1.02 \times 10^{-10}$ per atm.

Hexane

$\rho = .033$ (Ganesan at 80°C)

we have ~~no~~ no data for n or K for the vapour. However the molecular refractivity for the D line calculated from the observed value of the ref index for the liquid [see Landolt Tables] = 29.88.

molec. wt = 86·12 and Δ for the vapour at 80°C = $\frac{86 \cdot 12}{22390 \times (1 + 80\alpha)}$

where $\alpha = \cdot 00367$

$$\frac{n^2 - 1}{n^2 + 2} = k = 29 \cdot 88 \times \frac{\Delta}{M}$$

$$= \frac{29 \cdot 88}{22390 \times 1 \cdot 2936}$$

$\therefore n^2_{80^\circ} = 1 \cdot 003098$ $\quad n = 1 \cdot 001549$

putting $k = n^2$

$$B = a.l\ \overline{3} \cdot 6023 \times \frac{\cdot 0_2 1549^2}{1 \cdot 001155} \times \frac{\cdot 066}{5 \cdot 769}$$

$= 1 \cdot 10 \times 10^{-10}$ per atm.

Amylene

$\rho = \cdot 061$ (Gaussian) at 45°.

$n_0 = 1\cdot 001693$ (Marcart – Landolt Tables)

$$n_{45^\circ} - 1 = \frac{\cdot 001693}{1 + 45\alpha} = \cdot 001453.$$

assuming as before $K = n^2$

$$B = \text{al.}\bar{3}\cdot 6023 \times \frac{\cdot 001453^2}{1\cdot 001_5} \times \frac{\cdot 122}{5\cdot 573}$$

$$= \underline{\underline{1\cdot 85 \times 10^{-10}}} \text{ per atm at } 45^\circ$$

methyl acetate

$\rho = \cdot 048$ (Gaussan. – at 70°C.)

$n_0 = 1\cdot 001138$ Marcart } Landolt Tables.
$\quad\;\; 1\cdot 001189$ Grytz. }

$$n_{70^\circ} - 1 = \frac{\cdot 001189}{1 + 70\alpha} = \cdot 000946.$$

$K_{100^\circ} = 1\cdot 0077$ Lebedew. Landolt Tables.

$$K_{70^\circ} - 1 = \cdot 0077 \times \frac{1\cdot 367}{1\cdot 257} = \cdot 0084.$$

$$\therefore B = \text{anti log } \bar{3}\cdot 6023 \times \frac{\cdot 0_3 946 \times \cdot 0_2 84}{1\cdot 001} \times \frac{\cdot 048}{5\cdot 664}$$

$$= 2\cdot 68_5 \times 10^{-10} \text{ at } 70^\circ \text{ per atm.}$$

Ethyl acetate.

$\rho = .034$. (Gaussan at ~~85°~~)

$n_0 = 1.001582$ Lorent
1.001408 Mascart } Landolt Tabb

$n_{85°} - 1 = \dfrac{.001582}{1 + 85\alpha} = .001206.$

assume $K = n^2$

$\therefore B = \text{an log. } \bar{3}.6023 \times \dfrac{.001206^2}{1.001} \times \dfrac{.068}{5.762}.$

$= .69 \times 10^{-10}$ ~~$\mu\mu$~~ $\mu\mu$ ahm at ~~85°~~.

Argon

$\rho = \cdot 0046$ (Rayleigh.)

$n_0 = 1 \cdot 0_3 284.$

$n_{20^\circ} - 1 = \dfrac{\cdot 0_3 284}{1 + 20\alpha} = \cdot 0_3 264_5.$

no data for K.

Assuming $K = n^2$

$P_2 = \text{antilg } \overline{3} \cdot 6023 \times \dfrac{\cdot 0_3 264_5^{\,2}}{1 \cdot 0_3 3.} \times \dfrac{\cdot 0092}{5 \cdot 9678}$

$= \cdot 004 \times 10^{-10}$ gr-atm at 20°

NH_3.

Here we shall calculate ρ from B since we have no reliable data for ρ while we have for B.

$$\rho = \frac{48\pi n \lambda B}{\frac{6\times(n-1)(K-1)}{1\cdot0132\times10^6} + 56\pi n\lambda B}.$$

Sziversy's value for $B_{17\cdot9^\circ} = \cdot59\times10^{-10}$

n_0 from Landolt Tables $= 1\cdot0_3377$.

$$n_{19\cdot9^\circ} - 1 = \frac{1\cdot0_3377}{1+17\cdot9\alpha} = \cdot0_3354$$

$K_{20^\circ} = 1\cdot00718 \qquad \alpha_{20^\circ} = 5\cdot45\times10^{-5}$.

$$K_{17\cdot9} = K_{20^\circ} + 5\cdot45\times2\cdot1\times10^{-5} = 1\cdot00730.$$

$$\rho = \frac{48\pi\times\cdot589\times10^{-7}\times1\cdot0_34\times\cdot59\times10^{-10}}{\frac{6\times\cdot0_3354\times\cdot0_2730}{1\cdot0132\times10^6} + 56\pi n\lambda B}.$$

$$= \frac{48 \text{ anti log. } \overline{14}\cdot0383}{\text{anti log. } \overline{11}\cdot1849 + 56 \text{ anti log. } \overline{14}\cdot0383}.$$

$$Dr = \frac{\cdot0_{10}1531}{\cdot0_{10}0061} \Big/ 15^2$$

$\therefore \rho = \cdot033$.

Observed value $\cdot010$ (K.R.R)

SO_2.

Sziversy's value for $B_{17.3} = 1.67 \times 10^{-10}$

$n_0 = 1.0_3661$ (Calibration — Landolt-Zebb)

$$n_{17.3} - 1 = \frac{.0_3661}{1 + 17.3\alpha} = .0_3622$$

$K_0 = 1.00993$
$\alpha_0 = 6.19 \times 10^{-5}$
$\beta_0 = 1.86 \times 10^{-7}$
} Landolt-Zebb.

$\therefore K_{17.3} = 1.00892.$

$$\therefore \rho = \frac{\cdot 48\pi \cdot 1.0_3 62 \times 589 \times 10^{-7} \times 1.67 \times 10^{-10}}{\frac{6 \times .0_3622 \times .0_2892}{1.0132 \times 10^6} + 56\pi - \lambda B.}$$

$$= \frac{48 \text{ anti log } \overline{14}.4901}{\text{anti log } \overline{11} + 5168 + 56 \text{ anti log } \overline{14}.4901}$$

$$\Delta r = \frac{.0_{10}3287}{.0_{10}0173} \quad \therefore \rho = .043.$$
$$3460$$

Obsd. value = .049 (K.R.R. ? Greenlight to prevent formation of clouds.)

Vapour.	Elec. moment μ $\times 10^{18}$ C.G.S.	Authority
HCl	2.15	Falkenhagen
H_2S	1.02	Smyth
NH_3	1.53	Jona
CH_4	< .048	Riegger
SO_2	1.76	Jona
	1.87	Falkenh.
CH_3OH	1.61	Jona
	~~1.87~~	Smyth from same data but
~~H_2O~~	1.78	by a diff. cal. calcn.
H_2O	2-1	J. J. T.
	1.87	Jona
	2.35	Bädeker
CO_2	.142	Falkenh.
liquid CO_2	< .132 ± ~~.007~~	Riegger
liquid air	< .026	"
" H_2	< .043	
" CO_2	< .128 ± .007	"

Falkenhagen. Phys Zeits. 23, 87, 1922.; Smyth Phil mag. 45 849, 1923; ibid 47, 530, 1924.; Jona Phys Zeits 20, 14, 1919 Riegger Ann der Phys. 59, 753, 1919.

Intensity & polarisation measurements at different temperatures.

I Liquid CS_2 K.R.R (unpublished)

t	ρ.	after plotting & smoothing	
28	·67	30°	·67
90	·59	100°	·545
103	·524	150	·42
118	·509	180	·325
166	·37	200	·26
209	·222	210.	·225
212	·218		

II

.45

04, 1919

Heptane

To calculate the value of the depolarisation factor for the liquid at different temps. from Ganesan's value for the vapour $\rho_1 = .031$ by using Ramanathan's formula

$$\rho = \frac{6\rho_1}{\gamma(6-7\rho_1) + 7\rho_1}$$

where $\gamma = \frac{RT\beta}{N} n_0 \left(\frac{n^2+2}{3}\right)^2$

and

$R = 8.315 \times 10^7$

$N = 6.062 \times 10^{23}$.

directly from Tables

n_0 = no. of molecs. per c.c.

$= \frac{1.008}{1.66 \times 10^{-24}} \times \frac{\Delta}{M}$: 100.16.

$\frac{n_0}{N}$ directly $= \frac{\Delta}{M}$

where Δ is the density and M is the molecular

n : ref. index β : isoth. compress.

and to compare with the observed values of Martin and Lehrman. (Journal Phys Chem. 27, 558, 1923.)

So we require Δ, n and β at different temps. In the following table Δ is taken directly from Young's data in Landolt Bornstein Tables. p 275.

n for diff^t temps. is calculated from the Lorentz Mossotti relation

$$\frac{n^2-1}{n^2+2} = \frac{\text{Molecular refraction}}{\text{Molec. wt}} \times \Delta.$$

We have no exptal data for molecular refraction of γ heptane; but we have for hexane = 30.45 [for the F line] and for Octane = 39.70 so that we may take the value for heptane to be equal to 35.08 - and the Molec. wt = 100.16 so that

$$\frac{n^2-1}{n^2+2} = \frac{35.08}{100.16} \times \Delta = K \text{ say.}$$

$$n^2 = \frac{1+2K}{1-K}. \quad \text{whence } n.$$

t°	Δ n	n^2	β.
20°	·6836	1·945	
100°	·6124	1·820	
200°	·4952	1·629	
225	·4515	1·563	
240	·4177	1·515	
250	·3877	1·472	
260.	·3457.	1·414	

We have no data at higher temps for the compressibility of the liquid. However since Martin & Lehmann have determined the Intensity of the transverse scattered light for

these temperatures Δ assuming Smoluchowski formula with the correction factor $\frac{6(1+\rho)}{6-7\rho}$ to be true where ρ is the observed value of the depolarization factor at the corresponding temp. we have

$$\beta = C \cdot \frac{T}{T\,(n^2-1)^2(n^2+2)^2} \cdot \frac{6-7\rho}{1+\rho}$$

~~which has~~ where C is a const. which is easily evaluated from the known value of β at 20°

$$= \frac{130 \times 10^{-6}}{1.0132 \times 10^{6}} \text{ ~~per~~ dyn cm}^2$$

C = anti log. ~~$\bar{T}.0613$~~ $\bar{T}.0613$.

t	I	ρ	n^2	β × 10 [illegible] per dyne cm²
20	1·00	·127	1·945	128 ~~[illegible]~~ (from tables)
100	1·30	·100	1·820	196
200	3·97	·038	1·629	1024
225	6·8	·026	1·563	2321
240	10·1	·020	1·515	3976
250	13·4	·017	1·472	6356
260	16·8	·0165	1·414	10520

$\frac{A}{B}$	t	ρ calcd.	ρ obsd.	$\frac{A}{B}$
~~1·21$_6$~~	20	·435	·127	1·22
~~1·21$_4$~~	100	·330	·100	1·21$_5$
~~1·25~~	200	·098	·038	1·25
~~1·30$_5$~~	225	·050	·026	1·30
~~1·32~~	240	·032	·020	1·31
~~1·36~~	250	·022	·017	1·36
~~1·43~~	260	·015	·0165	1·43$_5$

recalculate

$\frac{A}{B}$ for vapour = 1·59

$\frac{A}{B}$ for vapour = 1·59

$P_1 = .034$ (Ramsay) Pentane

data taken from Venkatrwaran's paper (Trans. Chem. Soc. 121, 2655, 1922). ~~expected~~ The values of Δ have been interpolated between the values given by Young. [Landolt p. 279]

The exptal value for molecular refraction for D line = 25.28 [mean of the 2 values given in Landolt Tables] and molecular wt = 72.10.

$$\frac{n^2-1}{n^2+2} = \frac{25.28}{72.10} \cdot \Delta = K \text{ (say)}$$

$$n^2 = \frac{1+2K}{1-K}.$$

t	Δ	n^2
36·5	·6098	1·816
86·6	·5544	1·726
103·8	·5292	1·683
117·0	·5149	1·662
148·6	·4630	1·581
156·8	·4461	1·556

t	T	P	$\beta \times 10^{12}$
36·5	1·61	·072	
86·6	2·84	·067	
103·8	3·40	·059₅	
117·0	4·25	·052	
148·6	8·18	·017	
156·8	8·75	·015	
	9·10		

In order to calculate β we might have done so from the pressure volume data of Rose-Innes and Young (Phil mag (vi) 47, 355, 1899) ~~However so~~ as has been done by Mr Venkatswaran. However since the reference is not available ~~β has been~~ and since Venkatswaran himself does not give the values from which he calculated the $\bar{I}$, we have calculated β back from his calculated values for the intensity by using the formula as before

$$\beta = C \frac{\bar{I}}{T(n^2-1)^2(n^2+2)^2} \cdot \frac{6-7\rho}{1+\rho}$$

In order to calculate β

Grimaldi's values given in Landolt Tables 0 to 100° seem to be too high as tested by Gay's values (calculated from adiabatic compressibilities) Further Grimaldi is differently quoted by Landolt, Kaye and Laby, Cohen Schut and Winkelman. So that the compressibilities were not used for lower temps. For temps above 130° - the press vol. curve was drawn from data of Rose Innes and Young - Phil mag Ser 47, 355, 1899. ~~and then~~ for the different temps separately And for each temp a tangent was drawn at the pt corresponding to the vapour press. at that partr. temp. (Young Journ. Chem. Soc. 71, 446, 1897) and β thus calculated. Then a curve connecting β with temp was drawn from wh the values in the table ~~were~~ were read off directly. β for 30° is from my notebook.

t	Δ	n^2	$\beta \times 10^{12}$	calcd.	obsd.
30°	·6165	1·827.	235	·286	·072
122°	·5077	1·649.	1150	·081	·052
151°	·4583	1·574	2140	·049	·017
159°	·4415	1·550	2800	·038	·015
173°	·4073.	1·500	6230.	·019s.	·015.

verify

Rosse Jones and Young. data for p–v.

	p. mm.	v.c.c.
130°	7023	2·022
	8194	2·018
	11430	2·008
	15100	1·998
	18610	1·989
140°	8507	2·094
	9927	89
	10580	85
	13230	75
	15730	2·066
150°	11380	2·172
	14680	53
	18770	33
	22830	14
	27840	2·095
160°	14060	2·272
	14330	68
	16670	49
	19250	29
	22000	2·210
170°	16560	2·398
	17520	84
	19020	64
	20660	45
	22520	2·326
180°	19340	2·580
	20110	57
	20770	38
	21570	19
	22470	2·500

Young.

t	130°	140°	150°	160°	170°	180°
vap pres.	8187	9892	11805	14060	16540	19345.

From the graphs

t	130°	140°	150°	160°	170°	180°
$\beta \times 10^{12}$	1230	1520	2090	2930	4940	10,100.

Calculating the anisotropy $\frac{A}{B}$ ~~at~~ from depolarisation for liquid at diff. temp.

t	$\frac{A}{B}$
30°	1·23
122°	1·39 (?)
151°	1·28.
159°	1·28.
173	1·41
from vapour	1·62

Venkatswaran's value ~~does not~~ = ·052 for this temp ~~does not~~ seems to be too high - and does not plot into a smooth curve with the other values

Ether.

observed data for the depolarisation at different temperatures are taken from Ramanathan's paper [P.R.S.A 102, 151, 1922]

The values of Δ have been interpolated betw Young's values given in Landolt Tables —. From the ~~Table~~ same Tables

n_F at 20° = 1·3607 and Δ at 20° = ·7135

M = 74·10.

∴ molecular refractivity $= \frac{n^2-1}{n^2+2} \cdot \frac{M}{\Delta}$

$= \underline{22 \cdot 79}$ -

∴ n at any other temp given by

$\frac{n^2-1}{n^2+2} = \frac{22 \cdot 79}{74 \cdot 10} \Delta$ and the

values in the table were thus calculated.

Table I

t (°C)	Δ	n^2
33	·6981$_5$	1·820.
61	·6645$_5$	1·770.
80	·6402	1·736.
91	·6235$_5$	1·712.
100	·6105	1·693.
150	·5179.	1·568.
175	·4455	1·477.
185	·4018	1·423
190	·3663.	1·380.

Table II

t	I (Cals)	ρ	n^2	$\beta \cdot x10^{12}$
33	1·00	·08	1·820	203.
61	1·34	·079	1·770	~~216$_5$~~. 290
80	1·65	·076	1·736	~~230~~. 379.$_5$
91	1·83	·074	1·712	~~242~~ 443.
100	2·13	·07$\frac{1}{5}$	1·693	~~254~~ 541
150	8·2	·024	1·568	3245.
175	14·1	·015	1·477	8020.
185	27·2	·014	1·423	19,900.
190	73.	·013.	1·380	67,300.

as for β we cd have calculated from Ramsay and Young's data as Ramanathan has done. However since he has given us calculated values of $\frac{I}{T}$ (by using Einstein Smoluchowski formula) and it is easier to calculate β back from these values we have used them.

Thus β

$$= C \frac{\frac{I}{T}}{(n^2-1)^2(n^2+2)^2} \frac{6-7\rho}{1+\rho}$$

Amagat's values adopted by Ramanathan for temps below 100° are certainly too low (as referred to Tyrer's values available upto 35°) However we shall assume Amagat for the present.

$$\beta_{33°} = \frac{206 \times 10^{-12}}{1.0132} \text{ per dyne cm}^2.$$

$\therefore C = \text{al.} \overline{7} \cdot 0836.$

Table III

t	ρ obsd.	ρ calcd.
33	·080	·282.
61	·079	·217
80	·076	·176.
91	·074	·157
100	·071$_5$	·134.
150	·024	·058
175	·015	·013$_5$
185	·014	·006
190	·013.	·003.

See p 67

t	Δ	β × 10^{12} per dyn/cm^2	n^2	ρ	A/B.
33°	·6981$_5$				
60°	·6658				
80	·6250 ~~·6402~~				
100	·6105				
150° ~~120~~	·5179	3280			
175° ~~135~~	·4455	7940			
185° ~~145~~	·4018	20,000			
190° ~~165~~	·3663.	$\frac{1}{14.5} \times 10^6$			
~~189~~		=			

For vapour.

In the above liquids—heptane pentane and ether the calculated value of f is always higher than the obsd value right up to the critical pt. The fact that in the case of ether very near the critical pt the calculated value is smaller than the obsd is not of much significance since measurements of depolarisation of the order of 1%. are extremely difficult. Thus in all the above case we may reasonably assume that the effective anisotropy of the molecs. in the liquid state is different from the anisotropy in the gaseous state. probably due to the grouping of the molecs. in the liquid state; and this grouping or aggregation of the molecs. persists up to the critical pt.

However we can verify this

latter plate in a slightly different way by calculating the anisotropy imperfection for the liquid state at different temps. up to the critical pt from the known value of the depolarisation at the room temperature.

Heptane

By Ramanathans formula

$$\rho = \frac{2f}{\gamma\left(\frac{A+B+C}{3}\right)^2 + \frac{7}{8}f} \quad \text{---(1)}$$

where ρ has the significance already mentioned and $f = \frac{1}{15}\left(A^2+B^2+C^2-AB-BC-CA\right)$

Let the same letters with subscript 1. refer to the same liquid under different conditions. Then

$$\rho_1 = \frac{2f}{\gamma_1\left(\frac{A+B+C}{3}\right)^2 + \frac{7}{8}f} \quad \text{--(2)}$$

Eliminating f & $(A+B+C)^2$ between (1) and (2)

we have

$$\rho = \frac{6\gamma_1\rho_1}{\gamma(6-7\rho_1)+7\gamma_1\rho_1}.$$

Now supposing the letters with subscripts to refer to Heptane at 20° c.

$\rho_1 = \cdot 127$. Striking out common factors.

~~and~~ $\gamma_1 = \frac{8.315\times10^{7}\times293\times128\times10^{-12}}{}$

$$= \frac{6K_1\rho_1}{K(6-7\rho_1)+7K_1\rho_1}$$

where $K = T\beta^{\times10^{12}}\Delta\,(n^2+2)^2$

$K_1\rho_1 = 293\times128\times\cdot6836\times3.945^2\times\cdot127$

$= 5.066\times10^4$.

$$\rho = \frac{\text{anti log } 5.4829}{\text{a.l.}\cdot7085\cdot T\beta^{\times10^{12}}\Delta(n^2+2)^2 + 35.462\times10^4}$$

Heptane (normal)

t	ρ calcd. (ρ_{20} reference)	ρ obsd
100°	·086.	·100
200°	·018.	·038
225°	·009	·026
240°	·006.	·020
250°	·004.	·017
260°	·003	·016$_5$

Pentane

Extending the above method to pentane and taking the data for 30° C as reference

$$K_1\rho_1 = 303 \times 235 \times \cdot 6165 \times 3\cdot 827^2 \times \cdot 072$$

$$= 4\cdot 630 \times 10^4.$$

$$\therefore \rho = \frac{\text{anti log. } 5\cdot 4438}{\text{a.l } \cdot 7401 \times T\beta \times 10^{12}\Delta(n^2+2)^2 + 3\cdot 241 \times 10^5}$$

Pentane (Venkateswaran)

t	ρ (calc) from ρ at 30°C	ρ (obsd)
122°	·016	·052
151°	·009$_4$	·017
159°	·007$_5$	·015
173°	·003$_6$	·015

Ether

Calculating from for Ether from known value for ρ at 33°C

$$K_1\rho_1 = 306 \times 203 \times \cdot 6981_5 \times 3\cdot820^2 \times \cdot08$$
$$= 5\cdot064 \times 10^4$$

$$\rho = \frac{\text{anti log } 5\cdot4827}{\text{a.l. } \cdot7356 \times T\beta \times 10^{12}\Delta(n^2+2)^2 + 3\cdot545 \times 10^5}$$

ether (Ramanathan)

t.	ρ (calc. from ρ at 33°C)	ρ (obsd.)
61	·057	~~·08~~ ·079
80	·044	·076
91	·038$_5$	·074
100	·032	·0715
150	·006.	·024
175	·003.	·015
183	·001	·014
190	·000$_4$	·013.

Ether cont'd.

t	Δ	β × 10^{12} per dyne cm^2	n^2	ρ	A/B
35°	·6~~8~~57	215/1·0132	1·816	·080.	1·25.
60	·6658	~~440~~ 290/ "	1·772	·079	1·28.
90	·6250	~~839~~ 440/ "	1·714	·074	1·32
100	·6105	539 ~~380~~ "	1·693	·0715	1·34
150	·5179	3280 ~~7940~~ "	1·568	·024	1·44
175	·4453	~~7940~~ ~~20,000~~ "	1·477	·015	1·49.
185	·4018	20,000	1·423	·014	1·76.
190	·3663	$\frac{1}{14·5} \times 10^6$	1·380.	·013	2·53

$\frac{A}{B}$ from vapour = 1·60.

Recalculation of some of the values calculated by Raman & Ramanathan in their paper on CO_2 at high Press. (Proc. R. S. A. 104, 357, 1923).

Table I (p 362 loc. cit.)

(a) Scattering by undistorted vapour at press. p and 30°C in terms of the scattering of CO_2 at 0°C & 760 mm. press.

Press in atms.	ρ observed p 366 loc cit	Density Scattering (Einstein formula)	Density Scatty R's latter formula [taken from his paper]	Density Scatty corrected for anisotropy Later formula.	Observed Scatty.
30	·09	49	59	60.	54 ~~32~~
40	·08	65·2	77	78.	83 ~~29~~
50	·06	123	144	140.	140
60	·045	276	315	305 ~~347~~	307
65	·04	514	576.	561	665

Table II (p 363)

(b) Saturated vapour.

Temp.	ρ obsd. p. 361	Density Scatter (Einstein formula)	Density Scatter Corrected for anisotrop. 4 R's cubic formula	Density Scatter Corrected for anisotrop. late formula.	Observed Scattering.
15°	·058	300	340	340·5	347
20°	·04	560	620	611	567
25°	·03	970	1067	1035	1190
30°	·015	5100	5500	5270.	8000.

Table III p 363.

(c) Liquid in equilibrium with vapour.

10°	·14	480	600	654	463 Bulb 500 cylinder
15°	·10	618	760	771 ~~707~~	630 Bulb 730 cylinder
20°	·08	905	1086	1077	980 Bulb 1000 cylinder
25°	·05	1540.	1786	1718	1880 bulb.

Imperfection of polarisation

Table VII. p 366.

i unsaturated vapour at 30° C. (T = 303)

p in atms.	Density.	Compressibility $\beta \times 10^{8}$	n^2	ρ calcd by later formula	ρ calcd by R's earlier formula	ρ (obsd)
30	·06348	4·29	1·029	·070 ~~·102~~	·08	·09
40	·09294	3·36	1·042	·061 ~~·059~~	·06	·08
50	·1276	3·13	1·059	·048 ~~·045~~	·049	·06
60	·1774	3·54	1·083	·031 ~~·028~~	·031	·045
65	·2155	4·31	1·102	·021 ~~·019~~	·02	·04

The values for density in the 2nd were obtained by multiplying the values for $\frac{\text{density}}{\text{density at N.T.P}}$ in Ramanathan's Table I by ·0019769.

The values of β are from ~~Ram~~ the values for the reciprocals in Ramanathan's Table. reduced to dyn cm².

n^2 for the different densities was calculated from the empirical expression given in Phillips's paper (foot of p. 236)

$$\frac{n^2-1}{n^2+2} = \frac{\rho}{6.5581 + .1130\,\rho^2} = K \text{ say}$$

the value of the denominator was obtained by extrapolation from the value in Phillips' tables.

n^2: $\dfrac{1+2K}{1-K}$ for λ: 5461×10^{-8}

$$\rho = \frac{6\rho_1}{\gamma(6-7\rho_1) + 7\rho_1}.$$

ρ_1 used in Ramanathan's paper = .106.

$$\rho = \frac{\text{anti log. } \bar{1}.8035}{\text{anti log } \bar{2}.0437 \times T\beta\times 10^8 \times \Delta\,(n^2+2)^2 + .742}$$

But $T = 303$.

$$\therefore \rho = \frac{\text{anti log } \bar{1}.8035}{\text{anti log } .5251 \times \beta\times 10^8 \Delta (n^2+2)^2 + .742}.$$

Table VII contd (p 366)

ii ~~[illegible]~~ Saturated vapour.

Temp	Density	$\beta \times 10^8$	n^2	ρ calc new formula	ρ calc old for.	ρ obs.
15	·1582	4·71	1·074.	·027	·026	·058
20	·1899	5·01	1·089	·021	·021	·04
25	·2448	6·58	1·116.	·012	·012	·03
30	·3342	16·73.	1·160.	·003.	·003	·015

The calculation of the diff. columns done as already indicated.

$$\rho = \frac{\text{antilog. } \bar{1}\cdot 8035}{\text{antilog } \bar{2}\cdot 0437 \cdot T \cdot \beta \cdot 10^8 \cdot \Delta (n^2+2)^2 + \cdot 742.}$$

Table VII (contd) p 367.

iii Liquid in equilibrium with vapour.

Temp	Density	$\beta \times 10^9$	n^2	ρ calcd new for.	ρ calcd old form.	ρ (obs)
10	·8543.	1·86	1·441	·096	·105	·14
15	·8127	2·65	1·418	1·073	·07	·10
20	·7652	4·49	1·390	·047	·06	·08
25	·7020.	8·97	1·355	·021	·038	·05
					·044	

ρ given by the same expn as before.

The marked discrepancy betn the obsd value of the depolarisation of the light scattered by the liquid and the value calculated by Ramanathan's formula from the depolarisation for the vapour indicates that the effective anisotropy ~~in the gas of the~~ molec. in the ~~gas~~ liquid state is less than the anisotropy in the gaseous state. Gans's theory is not in any way concerned with the question whether the anisotropy in the liquid state is different from the anisotropy in the gaseous state. ∴ in Gans's expression the anisotropy of the medium enters thro' the factor B (Kerr const.); and ~~since~~ as he uses only the observed value of B (observed under the same conditions under wh the depolarisation measurements are made) it is only

the effective anisotropy of the molec. that is taken into a/c. There is fair agreement between the obsd & calcd values in Gans's method.

If the above supposition is correct then there ought be as much discrepancy between the observed value of the Kerr const. for the liquid and the value calculated from the Kerr const. for the same vapour & using Langevin's molecular formula as there is between the observed value of the depolarisation and the value calculated from the depolarisation for the vapour calculated according to Ramanathan's formula.

We should have some data which might be useful in this connection

Pentane

Values of the Kerr constant B for the vapour at 45° calculated for alm. by different methods.

(1) Gansan's value of the depolarisation of the light scattered by the vapour at 45° C = ·034. By using Gans's formula B_{45}. for vapour calculated comes out to be 1.02×10^{-10} for alm

(2) The value of ρ for liquid at 20° C = ·075 [mean of Martin's and my readings.]. By means of Ramanathan's formula

$$\rho_{vapour} = \frac{6\gamma\rho_{liq.}}{6 + 7\rho_{liq.}(\gamma - 1)}$$

ρ for vapour can be calculated.

$$\gamma = \frac{8.315\times10^{7}\times293\times10^{-12}\times1.008}{9\times1.0132\times6.062\times10^{23}\times1.66\times10^{-24}}\,\frac{\Delta}{M}\,\beta\times10^{12}(n^2+2)^2$$

$$= \text{antilog}\,\bar{3}.4276\cdot\frac{\beta\times10^{12}\cdot\Delta\times(n^2+2)^2}{M}$$

for pentane $\beta = 215$

$\Delta = .6263$

$n^2+2 = 3.839$

$M = 72.12$

$\therefore \gamma = \cdot0736_5$

ρ vapour $= .00575$

using this value of ρ for vapour by Gans's formula

$$B = \text{antilog}\,\bar{3}.6023\times\frac{.001469^2}{1.0015}\times\frac{.0115}{5.960}$$

$$= \underline{\underline{.166\times10^{-10}}} \text{ per atm}$$

(3) The value of the Kerr constant for liquid at 20° C = $\cdot 05_8 \times 10^{-7}$. Calculate the Kerr constant for the vapour at 45° C from this by means of Langevin's formula we have

$$B_{vap} = B_{liq.} \times \frac{293}{318} \times \frac{n_{liq.}}{n_{vap.}} \times \frac{(n^2_{vap.}+2)^2 (K_{vap}+2)^2}{(n^2_{liq}+2)^2 (K_{liq}+2)^2} \times \frac{d_{vap.}}{d_{liq.}}$$

Since we have no data for K either for vapour or liquid we shall take them = n^2 [as is the case with other substances for which we have data]

$$= \cdot 050 \times 10^{-7} \times \frac{293}{318} \times \frac{1.356}{1.0015} \times \frac{3.003^4}{3.839^4} \times \frac{72.12}{\cdot 6263 \times 22390 \times 1.1644}$$

$$= \cdot 103 \times 10^{-10} \text{ per atm.}$$

Ethyl acetate.

Value of B for ~~liquid~~ vapour at 85° calc'd by different methods

(1) Gans's value for the depolarisation of the light scattered by the vapour at 85° = ·034. The value of B for vapour calculated from this by Gans's formula

$$= \cdot 69 \times 10^{-10} \text{ per atm.}$$

(2) The value of ρ for the liquid = ·230 (mean of martin's and my readings). ρ_1 for vapour by Ramanathan's formula

$$= \frac{6\gamma\rho}{6 - 7\rho(1-\gamma)}$$

$$\gamma = \frac{\text{anti log } \overline{3}\cdot 4276 \times \beta \times 10^{-6} \times \Delta \times (n^2+2)^2}{M}$$

For Ethyl acetate

$\beta = 114\cdot 7$ $\qquad M = 88\cdot 06$

$\Delta = \cdot 9007.$

$n^2+2 = 3\cdot 885$ $\qquad \therefore \gamma = \cdot 0474$

$\therefore \rho = \cdot 0146.$

From this calculate B for vapour at 85° by Lamb's formula we have

$$B = a.l\ \bar{3}\cdot 6023 \times \frac{\cdot 001206^2}{1\cdot 001} \times \frac{\cdot 0292}{5\cdot 8978}$$

$$= \cdot 29 \times 10^{-10} \text{ per atm.}$$

(3) B. for liquid 20° $= 1\cdot 68 \times 10^{-7}$.

$\therefore$ B. for vapour calculated by Langevin's formula.

$$= 1\cdot 68 \times 10^{-7} \times \frac{293}{358} \times \frac{1\cdot 3726}{1\cdot 0012} \times \frac{3\cdot 0024^4}{3\cdot 885^2 \times 8\cdot 11^2} \times \frac{88\cdot 06}{\cdot 9007 \times 22390 \times 1\cdot 312}$$

$$= \cdot 51 \times 10^{-10}.$$

But if in (3) instead of using the observed value of B for the liquid at 20° C we had used the value calculated from the depolarisation viz $B = 1.38 \times 10^{-7}$

B for vapour by Langevin's formula

$$= .42 \times 10^{-10}$$

CS_2

(1) Calculation of the Kerr const. for the vapour at 55° C by diff. methods

(1) Ganesan's value for the depolarisation of the light scattered by the vapour at 55° C = ·167.

The Kerr const. for vapour

$= 4 \cdot 11 \times 10^{-10}$ per atm.

using Rayleigh's value ·120 for the depolarisation in the vapour

$B = 2 \cdot 76_5 \times 10^{-10}$.

(2) By Ramanathan's formula ρ_1 for vapour from ρ for liquid is given by the formula

$$\rho_1 = \frac{6\gamma\rho}{6 - 7\rho(1-\gamma)}$$

$$\gamma = \frac{\text{anisotropy } 3 \cdot 4276 \times \beta \times \Delta \times (n^2+2)^2}{M}$$

For CS_2 $\beta = 93.8$

$\Delta = 1.292 \times 1.0236$

$n^2+2 = 4.646.$

$M = 76.12_5.$

~~using my value~~ $\rho =$

$\therefore \gamma = .0941$.

using my value .69 for the depolar of the liquid

$\rho_1 = .240.$

using Gauss's value for $\rho = .64$

$\rho_1 = .186.$

$$B = \text{antilog } \bar{3}.6023 \times \frac{.0_2 1232 \times .0_2 241}{1.0012} \times \frac{\rho}{6-7\rho}.$$

Δ (K.S.K.) $= 6.59 \times 10^{-10}$ per atm

(Gauss) $= 4.70 \times 10^{-10}$ "

(3) B. for liquid at 20° = 3.226×10^{-7}

By Langevin's formula B for vap

$$= 3.226 \times 10^{-7} \times \frac{293}{328} \times \frac{1.627}{1.0012} \times \frac{3.0025^2 \times 3.0024^2}{4.646^2 \times 4.593^2} \times \frac{76.12}{1.292 \times 1.0236 \times 22390 \times 1.2012}$$

$$= = 1.75 \times 10^{-10} \text{ per atm.}$$

Benzene

Values of the Kerr const. for the vapour at 100° calculated by diff. methods.

(1) Gaussian value for ρ_1 for vapour at 100° C = ·066. wh gives

$B = 1.79_5 \times 10^{-10}$ per atm.

(2) ρ for liquid at 20° = ·47.

$$\therefore \rho_1 = \frac{6\gamma\rho}{6 - 7\rho(1-\gamma)}$$

$$\gamma = \text{anti log.}\,\bar{3}\cdot4276 \times \frac{\beta \cdot \Delta \cdot (n^2+2)^2}{M}$$

for benzene $\beta = 95.65$

$\Delta = \cdot8784$ $\quad M = 78.08$

$n^2+2 = 4.254$.

$\therefore \gamma = \cdot0521$

$\therefore \rho_1 = \cancel{\cdot0258}.\ \cdot0510.$

$$B = \text{a.l.}\ \bar{3}\cdot6023 \times \frac{\cdot0_2 1244 \times \cdot0_2 303}{1\cdot0012} \times \frac{\cdot0510}{5\cdot643}$$

$$= 1\cdot36 \times 10^{-10}$$

(3) R_{20} for liquid : $\cdot 593 \times 10^{-7}$

$$\therefore B = \cdot 593 \times 10^{-7} \times \frac{293}{373} \times \frac{1 \cdot 5014}{1 \cdot 0012_5} \times \frac{3 \cdot 0025^2 \times 3 \cdot 003^2}{4 \cdot 254^2 \times 4 \cdot 284^2} \times \frac{78 \cdot 08}{\cdot 8784 \times 22390 \times 1 \cdot 0367}$$

$$= \cdot 655 \times 10^{-10} \text{ per atm}$$

Part if we use instead of the published value of B for liquid the value calculated from depolarisation $\cdot 72 \times 10^{-7}$

$$B = \cdot 795 \times 10^{-10} \text{ per atm.}$$

CCl_4

(1) Value of the Kerr const B_2 for the vapour at 90° calculated by different methods.

(1) Gans's value for $\rho = .019$.
Whence B_2 for vapour by Gauss formula
$= .571 \times 10^{-10}$ per atm.

(2) ρ for liquid $= .053$ [mean of Gans's and my readings].
By Ramanathan's for—

$$\rho_1 = \frac{6\gamma\rho}{6 - 7\rho(1-\gamma)}$$

$$\gamma = a.l.\,\bar{3}.4276\ \frac{\beta \cdot \Delta \cdot (n^2+2)^2}{M.}$$

$\beta = 106.$
$\Delta = 1.5939.$
$n^2+2 = 4.134$
$M. = 153.8.$
$\therefore \gamma = .0503.$

$\therefore \rho_1 = .00285.$

$$B = \text{al.}\bar{3}.6023 \times \frac{\cdot 0_2 1338 \times \cdot 0_2 330}{1 \cdot 00013} \times \frac{\cdot 00283}{5 \cdot 980}$$

$$\cdot 083 \times 10^{-10}$$

(3) B for liquid $= \cdot 074 \times 10^{-7}$ which gives by Langevin's formula for vapour.

$$B = \cdot 074 \times 10^{-7} \times \frac{293}{363} \times \frac{1 \cdot 4607}{1 \cdot 0013} \times \frac{3 \cdot 0027^2 \times 3 \cdot 0033^2}{4 \cdot 134^2 \times 4 \cdot 19^2} \times \frac{153 \cdot 8}{1 \cdot 5939 \times 22390 \times 1 \cdot 3303}$$

$$\doteq \cdot 076 \times 10^{-10}$$

collected results

Substance	Temperature °C	Kerr const. B for vapour per atm: Calcd from imperfection for vapour (Gauss's form)	from Imperfection for liquid (Ramsay's & Gauss's formulae)	from B for liquid (Langevin's form)
Pentane	45°	1.02×10^{-10}	0.166×10^{-10}	0.103×10^{-10}
Ethyl acetate	85°	0.69×10^{-10}	0.29×10^{-10}	0.51×10^{-10} 0.42×10^{-10}
CS_2	55°	Gauss 4.11×10^{-10} Rayl. 2.76×10^{-10}	KSK 6.59×10^{-10} Gauss. 4.70×10^{-10}	1.75×10^{-10}
Benzene	100°	1.795×10^{-10}	1.36×10^{-10}	0.655×10^{-10} 0.795×10^{-10}
CCl_4	90°	0.571×10^{-10}	0.083×10^{-10}	0.076×10^{-10}
Hexane	80°	1.10×10^{-10}	0.174×10^{-10}	Schmidt 0.089×10^{-10} Leiser 0.111×10^{-10}
Heptane	110°	1.17×10^{-10}	0.175×10^{-10}	Sch 0.119×10^{-10} Lei 0.176×10^{-10}
Octane	135°	$1.14_5 \times 10^{-10}$	0.193×10^{-10}	Sch 0.088×10^{-10} Lei 0.156×10^{-10}

Hexane

Calculation of the Kerr const. B for the vapour at 80° C by different methods.

(1) Ganesan's value for ρ_1 for the vapour at 80° C = ·033 which gives, according to Ganes's formula, the value for B

$$B = 1{\cdot}10 \times 10^{-10} \text{ per atm}$$

(2) The value of ρ for the liquid at 20° C = ·100. By R's formula ρ_1 for vapour = $\dfrac{6\gamma\rho}{6 - 7\rho(1-\gamma)}$

γ = anisotropy $= \dfrac{\bar{3}\cdot 4276 \times \beta \cdot \Delta \cdot (n^2+2)^2}{M}$.

For hexane $\beta = 155$

$\Delta = ·6595.$

$n = 1{\cdot}3754 \quad n^2+2 = 3{\cdot}891$

$M = 86{\cdot}12.$

$\therefore \gamma = ·0481$

$\therefore \rho_1 = ·00541.$

using this value of ρ_1, B for vapour by Keen's formula

$$= a.l\ \bar{3}.6023 \times \frac{\cdot 0_2 15^{-}49^{2}}{1\cdot 00155^{-}} \times \frac{\cdot 01082}{5\cdot 962}.$$

$$= 0\cdot 174 \times 10^{-10} \text{ per atm}$$

(3) Schmidt's value for Kerr const. for liquid $= \cdot 045^{-} \times 10^{-7}$. By Langevin's formula B for vapour at 80° C.

$$= \cdot 045^{-} \times 10^{-7} \times \frac{293}{353} \times \frac{1\cdot 375_4}{1\cdot 00915^{-}} \times \frac{3\cdot 0031^{4}}{3\cdot 891^{2} \times 3\cdot 729^{2}} \times \frac{86\cdot 12}{\cdot 6595 \times 22390 \times 1\cdot 2936}$$

$$= \cdot 348 \times 10^{-10} \text{ per atm}$$

using Jeser's value $\cdot 056 \times 10^{-7}$ for B for the liquid we get—

$$B = \cdot 433 \times 10^{-10} \text{ per atm}$$

using again the value calculated from depolarisation

$$B_2 = \cdot 344 \times 10^{-10} \text{ per atm}$$

$= 0.0894 \times 10^{-10}$ per atm.

using Leiser's value ·056 for the liquid at 20°C B for vapour comes out to be

0.111×10^{-10} per atm.

Heptane

Calculation of molar const. B for the vapour at 110° at ~~diff temperatures~~. by diff. methods.

(1) Ganesan's value for ρ_1 at 110° = ·031 from which by Gans's formula we have

$B = 1.17 \times 10^{-10}$ per atm.

(2) ρ for liquid at 20° C = ·114. By R's formula ρ_1 for vapour

$$= \frac{6\gamma\rho}{6 - 7\rho(1-\gamma)}$$

$$\gamma = \text{ant log. } \overline{3}\cdot 4276 \times \frac{\beta \times \Delta \times (n^2+2)^2}{M}$$

$\beta = 130$

$n = 1.386 \quad n^2+2 = 3.932$.

$M = 100.13$

$\Delta = .6836$.

$\therefore \gamma = .0367 \qquad \rho_1 = .00480$.

$\therefore B_2 : a.l.\ \bar{3}\cdot 6023 \times \frac{\cdot 001650^2}{1\cdot 0016_5} \times \frac{\cdot 0096}{5\cdot 966}$.

$= 0\cdot 175 \times 10^{-10}$ per atm.

(3) B_2 for liquid at 20° C accdg to Schmidt

$= \cdot 071 \times 10^{-7}$. wh gives for the vapour by Langevin's formula

$$B = \cdot 071 \times 10^{-7} \times \frac{293}{383} \times \frac{1\cdot 386}{1\cdot 0016_5} \times \frac{3\cdot 0033^4}{3\cdot 932^4} \times \frac{100\cdot 13}{\cdot 6836 \times 22390 \times 1\cdot 4037}.$$

$= 0\cdot 119 \times 10^{-10}$ per atm.

using however Leiser's value for B_2 for the liquid $= \cdot 105 \times 10^{-7}$

B_2 for vapour $= 0\cdot 176 \times 10^{-10}$

Octane

The values of the Kerr const- B for the vapour at 135° calculated by different- methods.

(1) Gans's value for ρ_1 for the vapour at 135° C = ·027 which gives for B

$$1 \cdot 14_5 \times 10^{-10} \text{ per atm.}$$

(2) Obsd value of ρ for the liquid at- 20° = ·129 which gives accord^g to Ramanathan's formula

$$\rho_1 = \frac{6\gamma\rho}{6 - 7\rho(1-\gamma)}$$

$$\gamma = \text{anti log } \overline{3} \cdot 4216 \times \frac{\beta \times \Delta \times (n^2+2)^2}{M}$$

$\beta = 118$
$\Delta = \cdot 7022$
$n = 1 \cdot 397 \quad n^2+2 = 3 \cdot 953.$
$M = 112 \cdot 1$
$\gamma = \cdot 0309$

~~$\rho_1 = \cdot 00861$~~

$\rho_1 = \cdot 00467$

∴ B by Gans's formula

$$= \text{anti log } \bar{3}\cdot 6023 \times \frac{\cdot 0_2 1756^2}{1\cdot 00176} \times \cancel{\frac{\cdot 0_3 861}{5\cdot 994}} \cancel{\cdot 0_2 467}$$

$$\times \frac{\cdot 0_2 934}{5\cdot 967}$$

$$= 0.193 \times 10^{-10} \text{ per atm.}$$

(3) Schmidt's value for B for liquid at 20°C = $\cdot 077 \times 10^{-7}$. Using this value by Langevin's formula

$$B = \cdot 077 \times 10^{-7} \times \frac{293}{408} \times \frac{1\cdot 397}{1\cdot 00176} \times \frac{3\cdot 0035^4}{3\cdot 953^2 \times 3\cdot 945^2} \times \frac{112\cdot 1}{\cdot 7022} \times 22390 \times 1\cdot 495_5.$$

$$= \underline{\underline{0.088 \times 10^{-10}}} \text{ per atm.}$$

Using Leiser's value for B for the liquid ($= \cdot 136 \times 10^{-7}$)

$$B = \underline{\underline{0.156 \times 10^{-10}}} \text{ per atm}$$

According to Einstein Smoluchowski formula

$$\frac{\Sigma v^2}{EV} = \frac{\pi^2 R T \beta (n^2-1)^2 (n^2+2)^2}{18 N \lambda^4} \cdot \frac{6(1+\rho)}{6-7\rho}$$

For air

$$= \frac{\pi^2 \times 8.315 \times 10^7 \times 300 \times 212 \times 10^{-12} \times \cdot 827^2 \times 3.827^2 \times 6 \times 1.080}{18 \times 6.062 \times 10^{23} \times 4.358^4 \times 10^{-20} \times 5.44}$$

$$= 1.58 \times 10^{-5}$$

According to Knig's formula

$$= 9.72 \times 10^{-6}$$

Real value (Martin's) $= 9.2 \times 10^{-6}$.

values of $\frac{I r^2}{EV}$. For water

(1) according to Einstein Smoluchowski formula

$= 3.0 \times 10^{-6}$

(2) according to King's $= 1.89 \times 10^{-6}$

(3) ~~Acco~~ Obsd value King's $= 1.77 \times 10^{-6}$

Absolute determinations.

(1) Martin — Ether — Supports King's

(2) Ramanathan — Ether liquid with both saturated vapour and vapor above c. Temp

Supports Einstein Smoluchowski

(3) Raman & Rao. ~~liquid Sec~~ determination of Avogadro const

(4) Ram & Rama. CO_2 at high pressures.

n-Pentane

Anisotropy at diff. temps. from r (Venkateswaran)

t°C	r	$\beta \times 10^{12}$	Δ	n^2	Ra	$\delta \times 10^3$ Kerr gas.
30°	·072	2352	·6165	1·827	5·2	3·2
			·5107	1·655		
120°	·048	1120	·4991	1·636	12·0	8·1
			·4787			
140°	·023	1520	·4642	1·605	7·0	4·8
			·4604			
150	·017$_5$	2090	·4445	1·578	6·9	4·8
			·4394			
160	·015	2930	·4206	1·546	7·7	5·6
			·4162			
170	·014	4940	·3914	1·513	11·3	8·2

Critical $\mu = 197 \cdot 2$.

δ from vapour = 23

n^2 calculated from the molec. refraction 25·28

$$\therefore \frac{n^2-1}{n^2+2} \cdot R \text{ say} = \frac{25 \cdot 28}{72 \cdot 10} \times \Delta$$

$$n^2 = \frac{1+2k}{1-k}$$

$$\delta_R = \text{antilog. } \bar{4} \cdot 2736 \times \Delta \cdot \beta \times 10^{12} \times (n^2+2)^2 \frac{r^2}{6-7r}$$

Venkateswaran's values were plotted and smoothed.

n Heptane Martin & Lehman

t	Δ	$\beta \times 10^{12}$ using Kings expression	n^2	r	$\delta \times 10^3$ Calcd Raman	King Gans
20	·6836	128.	1·945	·127	4·6	2·6.
100	·6124	184 ~~190~~.	1·820	·100	4·2	2·6.
200	·4952	867 ~~942~~	1·629	·038	5·1	3·5
225	·4515	1893 ~~2096~~	1·563	·026	6·6	4·6
240	·4177	3157 ~~3543~~.	1·515	·020	7·5	5·5.
250	·3877	4203 ~~5582~~	1·472	·017	8·6	6·4.
260	·3457	7881 ~~9105~~.	1·414	·0165	12·0	9·3

266·85 critical temp.

δ from vapour = 27.

δ_R = Anti log $\bar{4}$·1309 ×

$\Delta = \beta \times 10^{12} \times (n^2+2) \times \frac{r}{6-7r}$.

Benzene. (Martin & Lehrman)

	t° C.	r	Δ	n^2 –	β × 10⁶ per atm		δ × 10³ Ramn.	δ × 10³ King Gans
					I			
293	20	·485	~~·9001~~ ~~·9001~~ ·8790	2·290	I/= 1·00	95.65	49.	24
373	100	·394	·7927	2·115.	1·33	177	50.	26.
473	200	·154	·6605	1·876	2·40	750	40.	24
523	250	·061	·5609	1·713	6·0	3153	46	30
533	260	·045	·5328	1·669	10·7	6491	63.	42
543	270	·025	·4984	1·616	19·4	14230	68	47
553	280	·015	·4514	1·549	62·0.	57460 ~~57890~~	142	102 ~~129~~.
critical μ^- = 288·5							δ from vapour = 61 × 10⁻³	

$$K = \frac{n^2-1}{n^2+2} = \frac{26.70}{78.05}\,\Delta \quad \text{whence } n^2.$$

$$\beta = C \times \frac{I}{T\,(n^2-1)^2}\;\frac{6-7r}{1+r}$$

where C (from $\beta_{20°}$ = 95.65 per atm) = anti log $\bar{4}.4248$.

$$\delta = \text{anti log}\ \bar{4}.2335 \times \Delta\,\beta \times 10^6 \text{ per atm} \times (n^2+2)^2\,\frac{r}{6-7r}.$$

CS_2. (Ramsay & Shields)

$\frac{T}{T_c}$	t° c.	x	Δ	x^2
·555	30	·67		
·683	100	·545		
·775	150	·42		
·830	180	·325		
·866	200	·26		
·884	210	·225		

We have no data for Δ at higher temps. — If we use the values of critical expansion obtained by Thorpe for lower temps, we get $\frac{\Delta}{T_c} = ·737$ as against the Ord value ·441, so that the values of critical expansion can not be used for higher temps.

52
12
64

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	1204
Thopu advance	100
	1304
Tax (for Revenue given by peria)	200
Deivasikamaniyan etc	92
Sent for brother	150
Marriage	200
Arama Sam	30
Kerosene ~~[illegible]~~ x vettu	9
Chen Chami	100
Cash on the 22nd	463½
	1244½
bao for vettu	
Cash 463½	
11 Rs	20
4	1

[illegible] 20
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(6) Aug 3rd — The diffusion of light in liquids — A chosen of the formulae of obtained by Verdet — King, Ramanathan & Gaus.
by J. Rocard

(7) Aug 17th The diffusion of light & ratio of the absolute retardation in Kerr's phenomenon
by Rocard.

(1) The influence of atomic arrangement on ref. index — by W. L. Bragg. Proc. R. S.

(2) The electrical double refraction of Limonene by R. de Mallemann Ac. of Sciens Paris May 18th

(3) " June 29th The determination of Avogadro's const. by means of the light diffused by C_2H_5Cl $N = (6.5 \pm .65)\ 10^{23}$ — by Pierre Daure

(4) " June 29th — "The diffusion of light and Kerr's const" by R. de Mallemann

(5) " July 20th The calculation of rotatory power starting with the molecular structure by Mallemann

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Intensity of the Scattered light

The fraction of the incident unpolarised light scattered transversely per unit volume per unit solid angle

$$I = \frac{\pi^2 R T \beta}{18 N \lambda^4} (\nu^2 - 1)^2 (\nu^2 + 2)^2 \frac{6(1+r)}{6-7r} \quad (1)$$

according to Ramanathan and Gans

and

$$= \frac{\pi^2 R T \beta}{2 N \lambda^4} (\nu^2 - 1)^2 \frac{6(1+r)}{6-7r} \quad (2)$$

according to King.

The values are calculated in the following pages relative to the Scattering by Ethyl Ether; ~~F line~~ ref indices refer to the F line and 30° C —.

Calculation of anisotropy

I from r for vapour

$$r = \frac{2f}{\left(\frac{A+B+C}{3}\right)^2 + \frac{7}{3}f} = \frac{\frac{2}{15}\left(\Sigma A^2 - \Sigma AB\right)}{\frac{(\Sigma A)^2}{9} + \frac{7}{45}\left(\Sigma A^2 - \Sigma AB\right)}$$

$$= \frac{6\left(\Sigma A^2 - \Sigma AB\right)}{5\left(\Sigma A\right)^2 + 7\left(\Sigma A^2 - \Sigma AB\right)}$$

$$= \frac{6\delta}{5 + 7\delta}$$

where δ (the anisotropy) $= \dfrac{\Sigma A^2 - \Sigma AB}{(A+B+C)^2}$

$$\therefore \delta = \frac{5r}{6-7r}$$

~~[illegible]~~ If r_p is the ratio with incid polarised light (direction of obs. $\perp$ to elec. vector of incid light & to direction of propagation of the light)

$$r_p = \frac{r}{2-r} \quad ; \quad r = \frac{2r_p}{1+r_p}$$

II from ν for liquid

According to Ramanathan's formula

$$\nu = \frac{6\delta}{\frac{5RT\beta}{N} n \left(\frac{\nu^2+2}{3}\right)^2 + 7\delta}.$$

do with $\delta_2 = \frac{5RT\beta}{N} n \left(\frac{\nu^2+2}{3}\right)^2 \frac{\nu}{6-7\nu}$.

$$= 5 \times 8.315 \times 10^7 \times 293 \times \frac{\beta' \times 10^{-12}}{1.0132} \times \frac{\Delta}{M} \left(\frac{\nu^2+2}{3}\right)^2 \cdot \frac{\nu}{6-7\nu}$$

$$\text{i } \delta_R = \text{anti log } \bar{2}.1259 \times \frac{\Delta \beta' \left(\nu^2+2\right)^2}{M} \frac{\nu}{6-7\nu}$$

where $\beta' = \beta \times 10^6$ per atm.

$$\delta_{\text{liq}} = \text{anti log } \bar{2}.1259 \times \frac{\Delta \beta' 9}{M} \frac{\nu}{6-7\nu}.$$

Since the anisotropy calculated from ν liquid has to be used with anisotropy from β liquid and since most of the measurements on β liquid are for the D line and 20° C we calculate δ from liquid for the same temp + wavelength.

III δ from Kerr const- for the liquid

when the molecules are non polar

$$B = \frac{(K-1)(K+2)(\nu^2-1)(\nu^2+2)\,M}{120\pi RT\Delta\lambda\nu}\,\delta$$

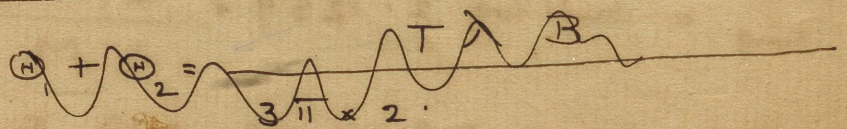
So that

$$\delta = \frac{120\pi RT\Delta\lambda\nu}{M(K-1)(K+2)(\nu^2-1)(\nu^2+2)}\,B$$

$$= \frac{120\pi \times 8.315\times10^7 \times 293 \times 5.893\times10^{-5}\times10^{-7}}{M(K-1)(K+2)(\nu^2-1)(\nu^2+2)}\,\Delta\nu B\times10^7$$

$$= \text{anti log } 7.7334 + \frac{\Delta\nu B\times10^7}{M(K-1)(K+2)(\nu^2-1)(\nu^2+2)}$$

IV δ from Kerr const- for the liquid:- Polar molecules



$$H_1 + H_2 = \frac{27\nu\lambda M B}{\pi N \Delta (\nu^2+2)^2 (\delta+2)^2} \quad \cdots(1)$$

ν = ref index ; Δ = density δ = observed dielec const.

M = molec. wt-

$$H_1 = \frac{2}{45RT}\,\frac{\frac{K-1}{K+2}}{\frac{\nu^2-1}{\nu^2+2}}\,\Sigma(A-B)^2\left[\Sigma A^2 - \Sigma AB\right]$$

$$\textcircled{H}_2 = \frac{1}{45 R^2 T^2} \varepsilon \left[(\omega_A^2 - \omega_B^2)(A - B) \right]$$

r = ratio of weak compt to strong compt

p = % of polarisation

$= \frac{1-r}{1+r} \times 100$

	$A=B=C$	$B=C=0$ $A\neq 0$		$A=B\neq 0$ $C=0$	
Incid light-	r	p	r	p	r	p
unpolarised	0	100	1/2	$33\frac{1}{3}\%$	2/9	$63\frac{7}{11}$
						$\frac{7}{11}\times 100$
polarised	0	100	1/3	50%	1/8	$77\frac{7}{9}$
						$\frac{7}{9}\times 100$

for $A=B=C\neq 0$

$r=0$ $\quad p=100$

n - Pentane

$r = \cdot 078$ (K.S.K) ; $\cdot 072$ (M.L.) adopt $\cdot 075$.

$n_{F-30^\circ} = 1 \cdot 353$ $\beta = 235 \times 10^{-6}$ per atm.

$\therefore$ $\overline{I}_{\text{Raw Gas}} = 1 \cdot 11$

$\overline{I}_{\text{King}} = 1 \cdot 11$ } obsd $1 \cdot 14$. (K)

calculation of $\delta = \dfrac{\Sigma A^2 - \Sigma AB}{(A+B+C)^2}$

(1) from r_{vapour}.

$r_v = \cdot 012$ Rayl.
$\cdot 012$ Cabannes + Gaudit } adopt $\cdot 012$.

$\delta = 10 \cdot 1 \times 10^{-3}$.

$r_v = \cdot 028$ R.R
$\cdot 025$ Venkatesw. } adopt $\cdot 027$

$\delta = 23 \cdot 2 \times 10^{-3}$.

(2) δ from κ liquid.

$\kappa = \cdot 075 \qquad \Delta_{20^\circ} = \cdot 6263 \qquad \beta'_{20^\circ} = 215$

$M = 72 \cdot 10 \qquad \mathfrak{D}_{D-20^\circ} = 1 \cdot 356$

$\nu^2 + 2 = 3 \cdot 839$

$$\therefore \delta_R = \text{am.log } \bar{2} \cdot 1259 \times \frac{\cdot 6263 \times 215 \times 3 \cdot 839^2}{72 \cdot 10} \times \frac{\cdot 075}{5 \cdot 475}$$

$$= 5 \cdot 04 \times 10^{-3}$$

$$\delta_{\text{knig}} = 3 \cdot 08 \times 10^{-3}$$

(3) δ from B liquid $\qquad B = \cdot 050 \times 10^{-7}$ (Leiser) 1·55 relative to $CS_2 = 100$

no data for κ Assume $\kappa = \nu^2$

$$\delta = \text{antilog } 1 \cdot 7334 \times \frac{\cdot 6263 \times \cdot 050 \times 1 \cdot 356}{72 \cdot 10 \times \cdot 839^2 \times 3 \cdot 839^2}$$

$$= 3 \cdot 07 \times 10^{-3}.$$

Isopentane

$r_{\mathfrak{R}} = \cdot 056$ (K.S.K)

$n_{F-30^\circ} = 1.352$ $\beta_{30^\circ} = 238 \times 10^{-6}$ per atm

$\therefore$ $I_{R\,G.} = 1.06$
$I_{King.} = 1.06$ } obsd = 1.06 (K)

Calculation of δ

(1) ~~no data for~~ $r_{vapour.} = \cdot 012$ Cabanes & Gauzit

$\therefore \delta = 10.1 \times 10^{-3}$

(2) δ from $r_{liquid.}$

$r = \cdot 056$ $\Delta_{20^\circ} = \cdot 6196$ $\beta'_{20^\circ} = 218$

$M = 72.10$ $\nu_{D-20^\circ} = 1.353$

$\nu^2 + 2 = 3.831$

$$\therefore \delta_R = \text{anti log } \bar{2}\cdot 1259 \cdot \frac{\cdot 6196 \times 218 \times 3\cdot 831^2}{72\cdot 10} \times \frac{\cdot 056}{5\cdot 608}$$

$$= 3\cdot 67 \times 10^{-3}$$

$$\delta_{\text{Kerr}} = 2\cdot 25 \times 10^{-3}.$$

(3) δ from B_{liquid} no data for IC

assume $= n^2$.

The value quoted in Kaufmann's tables is 1·55 ($CS_2 = 100$) which gives $B = \cdot 050 \times 10^{-7}$

$$\therefore \delta = \text{anti log } 1\cdot 7334 \times \frac{\cdot 6196 \times \cdot 050 \times 1\cdot 353}{72\cdot 10 \times \cdot 831^2 \times 3\cdot 831^2}$$

$$= 3\cdot 11 \times 10^{-3}.$$

Hexane

$r = \cdot 100$ (M.L) $\cdot 099$ (K.S.K) — adopt $\cdot 100$

$n_{F-30^\circ} = 1 \cdot 374$ $\beta_{30^\circ} = 169 \times 10^{-6}$ per atm.

$I_{R.G} = \cdot 99$
$I_{King} = \cdot 96$
} obsd = 1·00 K
1·13 M.L.

Calculation of δ

(1) from r_{vapour}.

$r_v = \cdot 021$ Ramanathan $\delta = 18 \cdot 0 \times 10^{-3}$

$= \cdot 015$ Cabannes + Gaulit $\delta = 12 \cdot 7 \times 10^{-3}$.

(2) δ from r liquid

$r = \cdot 100$ $\Delta_{20^\circ} = \cdot 6595$ $\beta'_{20^\circ} = 155$

$M = 86 \cdot 11$ $\nu_{D-20^\circ} = 1 \cdot 3754$

$\nu^2 + 2 = 3 \cdot 891$.

$$\therefore \delta_R = \text{anlog}\ \bar{2}\cdot1259 \times \frac{\cdot6595 \times 155 \times 3\cdot891^2}{86\cdot11} \times \frac{\cdot10}{5\cdot3}$$

$$\left.\begin{aligned} &= 4\cdot53 \times 10^{-3} \\ \delta_{\text{Kuig}} &= 2\cdot69 \times 10^{-3} \end{aligned}\right\}.$$

(3) δ from B_{liquid}

$K_{20^\circ} = 1\cdot729$. $B' = \cdot045$ [from ~~Sag~~ Schmidt's value 1·4 relative to $CS_2 = 100$]

$$\therefore \delta = \text{an log}\ 1\cdot7334 \times \frac{\cdot6595 \times \cdot045 \times 1\cdot3754}{86\cdot11 \times \cdot729 \times 3\cdot729 \times \cdot891 \times 3\cdot891}$$

$$= \underline{2\cdot72 \times 10^{-3}}$$

Assuming Seiser's relative value for the Kerr const 1·73 wh gives $B' = \cdot056$ we have

$$\underline{\delta = 3\cdot39 \times 10^{-3}}$$

Cyclohexane

~~cal~~

Calculation of δ

(1) Vapour $r = 0.0086$ (Cabannes and Granier).

wh gives $\delta = 7.2 \times 10^{-3}$.

(2) liquid $r = 0.08$ (Martin and Lehrman)

$\Delta_{20^\circ} = 0.779$ $n_{20^\circ} = 1.427_3$ $M = 84.09$.

$\beta'_{25^\circ} = 110.8$ Let us assume $\beta'_{20^\circ} = 110$

$n^2 = 2.038$.

$$\delta_R = \text{an log } \bar{2}.1259 \times \frac{.779 \times 110 \times 4.038^2}{84.09} \times \frac{.08}{5.44}$$

$$= 3.3 \times 10^{-3}$$

$$\delta_K = 1.8 \times 10^{-3}.$$

Heptane

$r = \cdot 127$ M.L. $\cdot 100$ K adopt $\cdot 114$

$n_{F-30^\circ} = 1 \cdot 387$ $\beta_{30^\circ} = 142 \times 10^{-6}$ per atm.

$$\left.\begin{aligned} I_{R-G} &= \cdot 95 \\ I_{King} &= \cdot 90 \end{aligned}\right\} \text{Obsd} = 1 \cdot 00.$$

Calculation of δ

(1) from r_{vapour}

$r_v = \cdot 031$ (Gausau) $\delta = 27 \times 10^{-3}$.

(2) δ from r_{liquid}

$r = \cdot 114$ $\Delta_{20^\circ} = \cdot 6836$ $\beta'_{20^\circ} = 130$.

$M = 100 \cdot 13$ $\nu_{D-20^\circ} = 1 \cdot 386$ $\nu^2 + 2 = 3 \cdot 932$.

$$\therefore \delta_R = \text{an log } \bar{2}\cdot1259 \times \frac{\cdot6836 \times 130 \times 3\cdot932^2}{100\cdot13} \times \frac{\cdot114}{5\cdot202}$$

$$= 4\cdot02 \times 10^{-3}$$

$$\delta_{Knig} = 2\cdot34 \times 10^{-3}.$$

(3) δ from B liquids.

assume $K = \nu^2$

For B Schmidt's value 2·2 gives $B' = \cdot071$

$$\therefore \delta = \text{an log } 1\cdot7334 \times \frac{\cdot6836 \times 1\cdot386 \times \cdot071}{100\cdot13 \times \cdot932^2 \times 3\cdot932^2}$$

$$= 2\cdot71 \times 10^{-3}$$

using Heisen's value 3·26 which gives

$$B' = \cdot105$$

$$\delta = 4\cdot01 \times 10^{-3}.$$

Octane $CH_3(CH_2)_6CH_3$

$r = \cdot 129$ (K) $\quad n_{F-30^\circ} = 1\cdot 396$

$\beta_{30^\circ} = 128 \times 10^{-6}$ per atm.

$$\therefore \left.\begin{array}{l} I_{R-G} = \cdot 94 \\ I_{Knig} = \cdot 89 \end{array}\right\} \text{ Ded} = \cdot 96 \text{ (K)}$$

Calculation of δ

(1) from r_{vapour}

$r_v = \cdot 027$ (Gausan) $\qquad \delta = 23\cdot 2 \times 10^{-3}$.

(2) δ from r_{liquid}

$r = \cdot 129 \quad \Delta_{20^\circ} = \cdot 7022 \quad \beta'_{20^\circ} = 118$

$M = 114\cdot 14 \quad \nu_{D-20^\circ} = 1\cdot 397 \quad \nu^2_{+2} = 3\cdot 953$.

$$\delta_R = \text{an log } \bar{2}.1259 \times \frac{.7022 \times 118 \times 3.953^2}{114.14} \times \frac{.129}{5.097}$$

$$= 3.84 \times 10^{-3}$$

$$\delta_{King} = 2.21 \times 10^{-3}$$

(3) δ from B_{liquid}

$K_{20^\circ} = 1.945$

Schmidt's value 2.4 gives $B = .077 \times 10^{-7}$

$$\therefore \delta = \text{an log } 1.7334 \times \frac{.7022 \times 1.397 \times .077}{114.14 \times .945 \times 3.945 \times .953 \times 3.953}$$

$$= 2.55 \times 10^{-3}$$

Kaiser's value 4.21 gives $B = .136 \times 10^{-7}$

$$\therefore \delta = \text{an } 4.51 \times 10^{-3}$$

β-iso amylene $(CH_3)_2C:CH\cdot CH_3$.

$r = \cdot 258$ (K) $n_{F-30^\circ} = 1.381$ $\beta_{30^\circ} = 199 \times 10^{-6}$ per cm

$\therefore$ $I_{R-G} = 1.78$
$I_K = 1.71$
} $\delta = 1.54$ (K)

Calculation of δ

(1) from r_{vapour}

$r_v = \cdot 061$ (Gans) $\delta = 55 \times 10^{-3}$.

(2) δ from r_{liquid}

$r = \cdot 258$ $\Delta_{20^\circ} = \cdot 6476$ $\beta'_{20^\circ} = 177$

$M = 70.08$ $\nu^2 + 2 = 3.892$.

$$\therefore \delta_R = \text{anti log } \bar{2}\cdot 1259 \times \frac{\cdot 6476 \times 177 \times 3\cdot 892^2}{70\cdot 08} \times \frac{\cdot 258}{4\cdot 194}.$$

$$= 20\cdot 4 \times 10^{-3}$$

$$\delta_{Kmg} = 12\cdot 1 \times 10^{-3}$$

Ethyl bromide C_2H_5Br.

$r = \cdot 250$ (K)

$n_{F-30^\circ} = 1 \cdot 423$ $\beta = 144 \times 10^{-6}$ per atm.

$$\left.\begin{aligned} I_{R-G} &= 1 \cdot 71 \\ I_{King} &= 1 \cdot 55 \end{aligned}\right\} \text{obsd} = 1 \cdot 58 \text{ (K)}$$

Calculation of δ

(1) from r_{vapour}

$r_v = \cdot 032$ (Ramanathi) $\delta = 28 \times 10^{-3}$.

(2) δ from r_{liquid}

$r = \cdot 250$ $$\Delta_{20^\circ} = \frac{1 \cdot 4982}{1 + \cdot 0_2 1338 \times 20 + \cdot 0_5 150 \times 20^2 + \cdot 0_7 17 \times 20^3}$$

$= 1 \cdot 456$.

$M = 108.96 \qquad n^2+2 = 4.028 \qquad \beta'_{20} = 131.$

$$\delta_R = \text{an.log } \bar{2}.1259 \times \frac{1.456 \times 131 \times 4.028^2}{108.96} \times \frac{.25}{4.25}$$

$$\left.\begin{aligned} &= 22.3 \times 10^{-3} \\ \delta_{King} &= 12.4 \times 10^{-3} \end{aligned}\right\}.$$

Propyl chloride

$r = 0.163 \qquad n_{D-20} = 1.3886. \quad n^2 = 1.929.$

$M = 78.51 \qquad \Delta = .890.$

To calculate β'. $\quad I \ (\text{Ethyl} = 1) = 1.34$

$$1.34 = \frac{\beta'}{189} \times \frac{.929^2}{.832^2} \times \frac{\frac{1.163}{4.859}}{\frac{1.08}{5.44}}$$

$$\therefore \beta' = \frac{1.34 \times 189 \times .832^2 \times 1.08 \times 4.859}{5.44 \times .929^2 \times 1.163} = 168.5.$$

To calculate δ from r_{liquid}

$$\delta_R = \text{an.log. } \bar{2}.1259 \times \frac{.890 \times \beta' \times 3.929^2}{78.51} \times \frac{.163}{4.859}$$

$$= 13.2 \times 10^{-3}$$

$$\delta_{King} = \underline{\underline{7.70 \times 10^{-3}}}.$$

Methylene chloride

$r = 0.31$ $\quad n_{D\text{-}20} = 1.4237$ $\quad n^2 = 2.027$.

$\Delta_{20} = 1.336$ $\quad M = 84.93$.

no data for β'_{20} Calculated from mi Arrow intensity relative to Ether

$$1.24 = \frac{\beta'_{20}}{189} \cdot \frac{1.027^2}{0.832^2} \times \frac{\frac{1.31}{3.83}}{\frac{1.08}{5.44}}$$

$$\therefore \beta' = 89.3.$$

$$\delta_R = \text{antilog } \bar{2}.1259 \times \frac{1.336 \times 89.3 \times 4.027^2}{84.93} \times \frac{.31}{3.83}$$

$$= 24.7 \times 10^{-3}$$

$$\delta_{Knig} = 13.7 \times 10^{-3}.$$

Ethylene chloride

$$\begin{array}{l} CH_2Cl \\ | \\ CH_2Cl \end{array}$$

$r = \cdot 36$ (K) $n_{F-30^\circ} = 1\cdot 445$ $\beta = 87 \times 10^{-6}$ per atm

$$\left.\begin{array}{l} I_{R-G} = 1\cdot 60 \\ I_{Kriq} = 1\cdot 40 \end{array}\right\} \quad \text{Rod} = 1\cdot 44 \text{ (K)}$$

calculation of δ

(1) no data for r_{vapour}.

(2) δ from r_{liquid}

$r = \cdot 36$. $\Delta_{20^\circ} = 1\cdot 251$ $\beta'_{20^\circ} = 80\cdot 7$

$M = 98\cdot 95$ $\chi_{D-20^\circ} = 1\cdot 4444$ $\chi^2 + 2 = 4\cdot 086$.

$$\delta_R = \text{anti log } \bar{2}\cdot 1259 \times \frac{1\cdot 251 \times 80\cdot 7 \times 4\cdot 076^2}{98\cdot 95} \times \frac{\cdot 36}{3\cdot 48}.$$

$$= 23\cdot 6 \times 10^{-3}.$$

$$\delta_{\text{Knig}} = 12\cdot 7 \times 10^{-3}.$$

Chloroform $CHCl_3$.

$n_{F-30} = 1.4446$. $\beta = 110 \times 10^{-6}$ per atm.

$\rho = .238$ Gans
$.242$ K
adopt $.240$.

$\underline{I}_{R-G} = 1.49$
$\underline{I}_{Kuig} = 1.31$

$\rho = .150$ Raman + Kao
$.150$. Martin
adopt $.150$

$\underline{I}_{R-G} = 1.21$
$\underline{I}_{Kuig} = 1.06$

Mean $\underline{I} = 1.26$.

Calculation of δ

(1) from ν_{vapour}

$\nu_v = .030$ Rayl.
$.032$ Gans.
adopt $.031$ $\delta = 27 \times 10^{-3}$.

(2) δ from r_{liquid}.

$\Delta_{20^\circ} = 1.490 \quad \beta'_{20^\circ} = 101 \quad M = 119.4$

$\nu_{20^\circ - D} = 1.4467 \quad \nu^2 + 2 = 4.093.$

(a) using the value $\underline{r = .240}$

$$\delta_R = \text{an. log } \bar{2}.1259 \times \frac{1.490 \times 101 \times 4.093^2}{119.4} \times \frac{.24}{4.32}$$

$$\left.\begin{aligned} &= 15.7 \\ \delta_{King} &= 8.42 \end{aligned}\right\} \times 10^{-3}.$$

(b) using the value $\underline{r = .150}$

$$\left.\begin{aligned} \delta_R &= 8.55 \times 10^{-3} \\ \delta_{King} &= 4.59 \times 10^{-3} \end{aligned}\right\}.$$

Carbon tetrachloride - CCl_4.

$r = .045$ (Gans) ~~.061~~ $.061$ (K) Adopt $.053$.

$n_{F-30°} = 1.462$; $\beta = 114$.

$I_{R-G} = 1.12$
$I_{King} = .96$ } Obsd $I = 1.02$ (K)

Calculation of δ

(1) from r_{vapour}

$r_v = .019$ Gn $\delta = 16.2 \times 10^{-3}$.

(2) from r_{liquid}

$r = .053$; $\Delta_{20°} = 1.594$; $\beta'_{20} = 106$

$M = 153.84$ $\nu^2_{D-20°} + 2 = 4.134$.

$$\delta_R = \text{an.log } \bar{2}.1259 \cdot \frac{1.594 \times 106 \times 4.134^2}{153.84} \times \frac{1.053}{5.629}.$$

$$= 2.36 \times 10^{-3}.$$

$$\delta_{\text{Ising}} = 1.24 \times 10^{-3}$$

(3) δ from B_{liquid}

The value quoted in Kauffmann's work 2.3 gives $B = .074 \times 10^{-7}$.

$K_{20} = 2.1900$. $\quad n_D = 1.4607$

$$\therefore \delta = \text{an log } 1.7334 \times \frac{1.594 \times .074 \times 1.4607}{153.84 \times 1.134 \times 4.134 \times 1.19 \times 4.19}$$

$$= 2.59 \times 10^{-3}$$

Carbon bi sulphide

r = ·685 (K) ; ·71 (M.L) ; ·70 (Raman & Rao

·70 (Ganesan) ·70 (J.C.K Rao)

adopt ·685.

$n_{F-30'} = 1.642$ $\beta = 101 \times 10^{-6}$ per atm

$\therefore I_{R-G} = 21.3$

$I_{King} = 14.1$

using Gans's value $r = .64$

$I_{RG} = 16.4$

$I_{King} = 10.9$

$I_{obsd} = 12.8$ M.L, 13.0 K.

Calculation of δ

(1) from r_{vapour}

r_v = ·120 Rayl, ·167 Ganes., ·143 Ramth. } adopt ·143 $\delta = 143 \times 10^{-3}$.

(2) δ from ν liquid.

$\Delta_{20^\circ} = 1.2632$; $\beta_{20^\circ} = 93.8$; $M = 76.14$

$\nu^2_{D-20^\circ} + 2 = 4.646.$

(a) using the value $\nu = .685$

$$\delta_R = \text{an. log } \bar{2}.1259 \cdot \frac{1.2632 \times 93.8 \times 4.646^2}{76.14} \times \frac{.685}{1.205}$$

$= 255 \times 10^{-3}$

$\delta_{\text{Kmig}} = 106 \times 10^{-3}$

(b) using $\nu = .64$

$\delta_R = 189 \times 10^{-3}$

$\delta_{\text{Kmig}} = 78.8 \times 10^{-3}$.

(3) δ from β liquid

Chaumont's value for $\beta = 3.226 \times 10^{-7}$.

$K_{20^\circ} = 2.593$ $\quad$ $\nu_{D-20^\circ} = 1.627.$

$$\therefore \delta = \text{an log } 1.7334 \times \frac{1.2632 \times 3.226 \times 1.627}{76.14 \times 1.593 \times 4.593 \times 4.646 \times 4.646}$$

$= 84.2 \times 10^{-3}$

Acetic acid $CH_3 \cdot COOH$

$\nu = .439$ (Lyons) $.47$ (K) Adopt $.455$.

$\nu_{F-30°} = 1.373$ $\beta = 98.5 \times 10^{-6}$ per atm.

$\left.\begin{aligned} I_{R-G} &= 1.43 \\ I_{Knig} &= 1.39 \end{aligned}\right\}$ Mean $I = 1.19$.

Calculation of δ

(1) no data for ν vapour.

δ from ν liquid

$\Delta_{20°} = 1.049$. $\beta'_{20°} = 92$ $M = 60.03$.

$n_{D\,20°} = 1.3718$. $n_D^2 = 1.881$.

$$\delta_R = \text{am log. } \bar{2}.1259 \times \frac{1.049 \times 92 \times 3.881^2}{60.03} \times \frac{.455}{2.815}$$

$$= 52.1 \times 10^{-3}$$

$$\delta_{Knig} = 31.1 \times 10^{-3}$$

Propionic acid.

$r = 0.41 \quad n_{D.20} = 1.3868 \quad n^2_{D.20} = 1.923.$

$M = 74.05 \quad \Delta = .99\cancel{46}2.$

To calculate β' $\quad$ I (relative to ether) $= 1.24.$

$$1.24 = \frac{\beta'}{189} \times \frac{.923^2}{.832^2} \times \frac{\frac{1.41}{3.13}}{\frac{1.08}{5.44}}$$

$$\therefore \beta' = \frac{1.24 \times 189 \times .832^2 \times 1.08 \times 3.13}{5.44 \times .923^2 \times 1.41} = \cancel{77.5}\ 83.9.$$

To calculate δ. from r_{liquid}.

$$\delta_R = \text{an log. } \bar{2}.1259 \times \frac{.992 \times \beta' \times 3.923^2}{74.05} \times \frac{.41}{3.13}$$

$$= \cancel{28.0}\ 30.3 \times 10^{-3}.$$

$$\delta_{Kuj} = \cancel{16.55}\ 17.7 \times 10^{-3}.$$

Ethyl Ether $(CH_3 \cdot CH_2)_2 O$

γ = ·080 (K) ; ·100 (M.L) ; ·082 (R-R)

·089 (Gans) ·084 (Ganesan) ·080 (Ramanathan)

Adopted ·080.

$n_{F-30^\circ} = 1.352$ $\beta_{30^\circ} = 212 \times 10^{-6}$.

$$\therefore (n^2-1)^2 (n^2+2)^2 . \beta \times 10^6 \times \frac{1+\gamma}{6-7\gamma} = 421.6.$$

$$(n^2-1)^2 \beta \times 10^6 \frac{1+\gamma}{6-7\gamma} = 28.78.$$

Calculation of absolute intensity

(1) According to Ramanathan Gans formula the fraction of the incident unpolarised light scattered per unit vol per unit solid $\angle^e$

$$\frac{I}{R} = \frac{\pi^2 R T \beta (n^2-1)^2 (n^2+2)^2}{18 N \lambda^4} \cdot \frac{6(1+\gamma)}{6-7\gamma}.$$

for $\lambda = 4358$ Å, and 20° C

~~$\frac{\pi^2 \times 8.315 \times 10^7 \times 293 \times}{}$~~

$T = 293$ $\beta_{20^\circ} = \frac{189 \times 10^{-12}}{1.0132}$

n [interpolated between values of Landolt-1·36071 for (G') 4341 Å and 1·35720 for F (4861 Å)] = 1·3606.

$\therefore n^2 = 1.851.$

whence $I_R = 14.6 \times 10^{-6}$
and $I_{King} = 8.85 \times 10^{-6}$ }.

The value obtained exptally by Martin and Lehrman $= 9.2 \times 10^{-6}$ supporting King's formula

Calculation of δ

(1) from r_{vapour}.

$r_v = \left.\begin{matrix} .032 \text{ Gm} \\ .030 \text{ Ru.} \end{matrix}\right\}$ adopt .031 $\quad \delta = 27 \times 10^{-3}$

(2) δ from r_{liquid}

$r = .080$; $\Delta_{20^\circ} = .7135$; $\beta'_{20^\circ} = 189$.

$M = 74.08 \qquad \nu^2_{D-20^\circ} + 2 = 3.832$.

$$\delta_R = \text{an log } \bar{2}.1259 \times \frac{.7135 \times 189 \times 3.832^2}{74.08} \times \frac{.080}{5.44}.$$

$$= 5.25 \times 10^{-3}$$

$$\delta_{King} = 3.22 \times 10^{-3}$$

In Debye's formula for dielec const $P_0 = a + bT$

$a = 4400$ $\quad b = 38.$

But optical extrapolation gives a much smaller value P for D line being only 22.8.

$\mu = .84 \times 10^{-18}$

Benzene

γ = ·484 (M.L.) ·485 (M. temp variation paper)
·398 (R.R.) ·480 (Ganesan) ·43 Ramathi
·444 (Ganes) ·47 (K)
Adopt ·47.

$n_{F-30'}$ = 1.507 $\beta = 103 \times 10^{-6}$ per atm.

$\underline{I}_{R-Gr}$ = 3·90.
$\underline{I}_{knig}$ = 3·13

Adopt $\underline{I}$ = 2·82 (M.L)
3·64 (R.R)
3·15 (K)
3·2 (Ramanathan)

Calculation of δ

(1) from γ_{vapour}

γ_v = ·068 R.R
·066 Gn.
·067 Rn.

adopt ·067 $\delta = 61 \times 10^{-3}$

(2) γ = ·044 $\delta = 38.7 \times 10^{-3}$.

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(2) δ from π liquid

$\pi = \cdot 47 \quad \Delta_{20^\circ} = \cdot 8790 \; ; \quad \beta'_{20^\circ} = 95 \cdot 65^-$

$M = 78 \cdot 05 \qquad \nu^2_{D-20^\circ} + 2 = 4 \cdot 254.$

$$\delta_R = \text{an log } \bar{2} \cdot 1259 \times \frac{\cdot 8790 \times 95 \cdot 65 \times 4 \cdot 254^2}{78 \cdot 05} \times \frac{\cdot 47}{2 \cdot 71}$$

$$= 45 \cdot 2 \times 10^{-3}$$

$$\delta_{Kiq} = 22 \cdot 6 \times 10^{-3}$$

90.

Taking Cabannes' value $\pi = \cdot 42$

$\delta_R = 35 \cdot 8 \times 10^{-3}.$

$\delta_K = 17 \cdot 8 \times 10^{-3}$

(3) δ from B liquid

Mc Combs value for $B = \cdot 593 \times 10^{-7}$

$K_{20^\circ} = 2 \cdot 284 \qquad \nu_{D-20^\circ} = 1 \cdot 501_4$

$$\delta = \text{an log } 1 \cdot 7334 \times \frac{\cdot 8990 \times \cdot 593 \times 1 \cdot 501_4}{78 \cdot 05 \times 1 \cdot 284 \times 4 \cdot 284 \times 1 \cdot 254 \times 4 \cdot 254}$$

$$= 18 \cdot 5 \times 10^{-3}.$$

To calculate the absolute intensity of the light scattered by liquid benzene.

~~Recently~~ The light scattered per unit vol per unit solid angle

$$\frac{I}{R} = \frac{\pi^2 R T \beta (n^2-1)^2 (n^2+2)^2}{18 N \lambda^4} \cdot \frac{6(1+r)}{6-7r}$$

For $\lambda = 5440$ Å and $T = 273 + 15 = 288°$ C.

$n = 1.508$ $\quad n^2 = 2.273$. $\quad r = 0.41$ Cabannes

$\therefore \frac{I}{R}$ $\quad \beta = 92 \times 10^{-6}$ per atm.

$$\therefore \frac{I}{R} = \frac{\pi^2 \times 1.370 \times 10^{-16} \times 288 \times 92 \times 10^{-12} \times 1.273^2 \times 4.273^2 \times 6 \times 1.41}{1.0132 \times 18 \times 5.44^4 \times 10^{-20} \times 3.13}$$

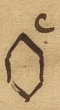
$$= \frac{18.0 \times 10^{-6}}{}$$

$$F_{Kuiq} = 8.85 \times 10^{-6}$$

The observed value $= (10.7 \pm 0.55) \times 10^{-6}$

(Cabannes and Daure, Comptes Rend 184, 520, 28th Feb 1927.)

Toluene.



r = ·490 (M.L) ·400 (R.R) ·522 (Ramsay)
·55 (J.C.IC.Rao) ·507 (Ramsay) ·52$_5$ (IC)
adopt- ·51

$n_{F-30°}$ = 1·501 β = 97 × 10^{-6} per atm.

I_{R-G} = 4·06
I_{Kuig} = 3·29.

Mod I = 3·21 (M.L)
3·45 (R.R)
3·53 (K)

Calculation of δ

(1) from r_{vapour}.

r_{vap} = ·064 Ramsay $\delta = 58 \times 10^{-3}$.

(2) δ from r_{liquid}

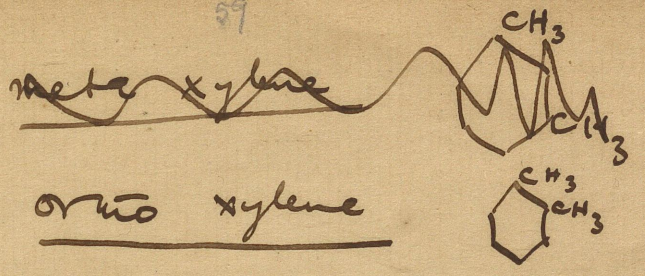
$r = \cdot 51 \qquad \Delta_{20^\circ} = \cdot 8659 \; ; \; \beta'_{20^\circ} = 90 \cdot 8$

$M = 92 \cdot 06 \qquad \nu_{D-20^\circ} = 1 \cdot 496 \qquad \nu^2 + 2 = 4 \cdot 239$

$$\therefore \delta_R = \text{an log } \bar{2} \cdot 1259 \times \frac{\cdot 8659 \times 90 \cdot 8 \times 4 \cdot 239^2}{92 \cdot 06} \times \frac{\cdot 51}{2 \cdot 43}$$

$$\left.\begin{aligned} &= 43 \cdot 0 \times 10^{-3} \\ \delta_{Kring} &= 21 \cdot 6 \times 10^{-3} \end{aligned}\right\}.$$

with $r = \cdot 430 \qquad \delta_K = 14 \cdot 8 \times 10^{-3}$



Meta xylene

Ortho xylene

$r = .40$ (K)

$n_{F\cdot 30^\circ} = 1.511$ $\quad \beta_{30^\circ} = 86 \times 10^{-6}$ per atm.

$\Delta_{30^\circ} = .8633$ $\quad \beta'_{30^\circ} = 80$ $\quad n_{D\cdot 20^\circ} = 1.505$

$M = 106.08$. $\quad \nu^2 + 2 = 4.265$.

$\therefore$ δ from r_{liquid} according to Ramanadhan

$$= \text{an log } \bar{2}.1259 \times \frac{.8633 \times 80 \times 4.265^2}{106.08} \times \frac{.40}{3.20}.$$

$$= 20.3 \times 10^{-3}$$

$$\delta_{Kuig} = 9.79 \times 10^{-3}.$$

δ from β_{liquid}.

Schmidt's value 41.0 gives $\beta = 1.32 \times 10^{-7}$

while Keiser's 41.2 gives $\beta = 1.33 \times 10^{-7}$.

$K_{20^\circ} = 2.561$.

$$\delta = \text{an log } \frac{1.7334}{106.08} \times \frac{.8633 \times 1.33 \times 1.505}{1.265 \times 4.265 \times 1.561 \times 4.561}.$$

$$= 23.0 \times 10^{-3}.$$

$$\delta_R = \text{am log } \bar{2}.1259 \times \frac{.8658 \times 85.7 \times 4.242^2}{106.08} \times \frac{.57}{2.01}$$

$$= 47.7 \times 10^{-3}$$

$$\delta_{King} = 23.9 \times 10^{-3}$$

(3) δ from B_{liquid}

Becker's values for $B = .858$ for $\lambda = 586$.

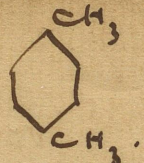
$K_{20} = 2.392$

$$\delta = \text{am log } 1.7334 \times \frac{.8658 \times .858 \times 1.497}{106.08 \times 1.392 \times 4.392 \times 1.242 \times 4.242}$$

$= 17.6 \times 10^{-3}$. Really in the calculation we ought to have used $\lambda = 586 \times 10^{-5}$ instead of 5.896×10^{-5} and also the corresponding ν's so that the calculated value will be slightly lower. However adopt-

$\delta = 17.5 \times 10^{-3}$

para Xylene



ν = ·583 (Rams) ·6h (IC) adopt ·583.

$n_{F-30'}$ = 1·501 β = 94 × 10^{-6} per atm.

$\bar{I}_{R.R.}$ = 5·22
$\bar{I}_{King}$ = 4·23 } do $\bar{I}$ = 4·61.

Calculation of δ

(1) no data for ν_{vapour}.

(2) δ from ν_{liquid}.

ν = ·583. $\Delta_{20'}$ = ·8611 ; $\beta'_{20'}$ = 87

M = 106·08 ; $\nu_{D\cdot 20'}$ = 1·496 ; ν^2+2 = 4·239

$$\therefore \delta_R = \text{antilog } \bar{2}\cdot 1259 \times \frac{\cdot 8611 \times 87 \times 4\cdot 239^2}{106\cdot 08} \times \frac{\cdot 583}{1\cdot 919}$$

= ~~27·8 × 10⁻³~~ 51·5 × 10^{-3}

δ_{King} = ~~13·9 × 10⁻³~~ 25·8 × 10^{-3}

(3). δ from B_{liquid}

Schmidt's value 22.9 gives $B = .74 \times 10^{-7}$

while Leiser's 22.6 gives $B = .73 \times 10^{-7}$

adopt $B = .73 \times 10^{-7}$.

$K_{20^\circ} = 2.15$.

$$\therefore \delta = \text{an. log } 1.7334 \times \frac{.8611 \times 1.496 \times .73}{106.08 \times 1.15 \times 4.15 \times 1.239 \times 4.239}$$

$= 19.1 \times 10^{-3}$

$= .$

Benzyl chloride $C_6H_5 \cdot CH_2Cl$

$r = 0.56$ $\quad n_{D-20^\circ} = 1.539$ $\quad n^2 = 2.368$

$\Delta_{20^\circ} = 1.102$ $\quad M = 126.5$.

But we have no data for β. We shall however calculate the same from the intensity of the scattered light using King's formula.

$I_{\text{ether}=1} = 3.50$ for ether $r = .080$. $n_D^2 = 1.832$. $\beta' = 189$

$$\therefore 3.50 = \frac{\beta'}{189} \times \frac{1.368^2}{0.832^2} \times \frac{\frac{1.56}{2.08}}{\frac{1.08}{5.44}}$$

$$\therefore \beta' = \frac{3.50 \times 189 \times 0.832^2 \times 1.08 \times 2.08}{5.44 \times 1.368^2 \times 1.56} = 64.8 \times 10^{-6} \text{ per atm.}$$

$$\therefore \delta_{King} = \text{an log. } \bar{2}.1259 \times \frac{\cancel{1.539}\ 1.102 \times 64.8 \times 9}{126.5} \times \frac{0.56}{2.08}$$

$= 1.83 \times 10^{-2}$ $\qquad \delta_R = 38.8 \times 10^{-3}$

Benzal chloride $C_6H_5 \cdot CHCl_2$

$\gamma = 0.52$ $\quad M = 161.0$ $\quad \Delta_{16^\circ} = 1.295.$

no data for n. molecular refractivity calculated from the refractivity of $C_6H_5 \cdot CH_2Cl$ and the atomic refractivity of Cl and H $= \dfrac{35.72}{5.97} - 1.10 = 40.59$

$$\frac{n^2-1}{n^2+2} \cdot \frac{161.0}{1.295} = 40.59 \qquad \therefore n^2_{16^\circ} = 2.455 \qquad n_{16^\circ} = 1.567$$

We shall calculate β' as before.

$$3.21 = \frac{\beta'}{189} \times \frac{1.455^2}{0.832^2} \times \frac{\frac{1.52}{2.36}}{\frac{1.08}{5.44}}$$

$$\therefore \beta' = \frac{3.21 \times 189 \times 0.832^2 \times 1.08 \times 2.36}{5.44 \times 1.455^2 \times 1.52} = 61.1$$

i.e. $\beta = 61.1 \times 10^{-6}$ per atm.

$$\therefore \delta_{Kuig} = \text{an log } \bar{2}.1259 = \frac{1.295 \times 61.1 \times 9}{161.0} \cdot \frac{0.52}{2.36}$$

$$= 13.0 \times 10^{-3}. \qquad \delta_R = 28.9 \times 10^{-3}$$

Chlorobenzene



r = ·58 (K) ; Eyans (·579) (M.L. ·539)

Adopt ·58

$n_{F\text{-}30^\circ}$ = 1·531 ; β = 80 × 10^{-6} per cm

$\overline{I}_{R-G}$ = 5·27

$\overline{I}_{Knig}$ = 4·09

$\overline{I}$ Blood = 4·11 (M.L) / 4·10 (IC)

Calculation of δ

(1) from r_{vapour}

r_v = ·078 Eyr. $\quad \delta = 72 \times 10^{-3}$

(2) δ from r_{liquid}

$r = \cdot 58 \quad \Delta_{20^\circ} = 1\cdot1064 \; ; \; \beta'_{20^\circ} = 75\cdot2$

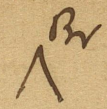
$M = 112\cdot5 \quad W_{D-W} = 1\cdot5248 \quad \nu^2 + 2 = 4\cdot325.$

$$\therefore \delta_R = \text{anti log } \bar{2}\cdot1259 \times \frac{1\cdot1064 \times 75\cdot2 \times 4\cdot325^2}{112\cdot5} \times \frac{\cdot58}{1\cdot94}$$

$$= 55\cdot3 \times 10^{-3}$$

$$\delta_{\text{Lenig}} = 26\cdot6 \times 10^{-3}$$

Bromobenzene



$r = \cdot 618$ (Gans) $\cdot 65$ (K) adopt $\cdot 635$

$n_{F-30^\circ} = 1\cdot 568$; $\beta = 72 \times 10^{-6}$ per atm.

$$\left.\begin{aligned} I_{R-G} &= 7\cdot 59 \\ I_{Kuig} &= 5\cdot 59 \end{aligned}\right\} \quad I.(\text{obsd}) = 4\cdot 92.$$

Calculation of δ

(1) from r_{vapour}.

$r_v = \cdot 078$ (Gn) $\qquad \underline{\delta = 72 \times 10^{-3}}$.

(2) δ from ν_{liquid}

$\nu = \cdot 635 \quad \Delta_{20^\circ} = 1 \cdot 4953 \quad \beta'_{20^\circ} = 67$

$M = 156 \cdot 96 \quad \nu_{D-20^\circ} = 1 \cdot 560 \quad \nu^2 + 2 = 4 \cdot 433.$

$$\delta_R = \text{anhog } \overline{2} \cdot 1259 \times \frac{1 \cdot 4953 \times 67 \times 4 \cdot 433^2}{156 \cdot 96} \times \frac{\cdot 635}{1 \cdot 555}$$

$$= 68 \cdot 5 \times 10^{-3}$$

$$\delta_{Kuig} = 31 \cdot 4 \times 10^{-3}$$

Ethyl benzoate

$\tau = 0.55$ (Martin) $\quad n_{D\text{-}20^\circ} = 1.506 \quad n^2 =$

$n_{F\text{-}20^\circ}$ Estimated $= 1.517$

no data for β. Let us calculate from intensity relative to toluene. $\underline{I} = 1.55$.

For toluene $\tau = 0.51 \quad \beta' = 90.8 \quad n_{F\text{-}20^\circ} = 1.507$.

$$1.55 = \frac{\beta'}{90.8} \times \frac{1.301^2}{1.271^2} \times \frac{\frac{1.55}{2.15}}{\frac{1.51}{2.43}}$$

$$\beta' = \frac{1.55 \times 90.8 \times 1.271^2 \times 1.51 \times 2.15}{2.43 \times 1.301^2 \times 1.55} = 116$$

ie $\beta = 116 \times 10^{-6}$ per atm.

To calculate δ $\quad \Delta_{20^\circ} = 1.047 \quad M = 150.1$

$$\therefore \delta_{Kerr} = \text{antilog } \bar{2}.1259 \times \frac{1.047 \times 116 \times 9}{150.1} \times \frac{.55}{2.15}$$

$$= 24.9 \times 10^{-3}$$

Nitrobenzene Λ^{NO_2}

$r = \cdot 74$ (K) $\cdot 733$ (Gans)

adopt $\cdot 74$.

$n_{D-30^\circ} = 1.548$; $\beta = 53 \times 10^{-6}$ per atm.

$$\left.\begin{array}{l} I_{R-G} = 10.0 \\ I_{King} = 7.6 \end{array}\right\} I_{obsd} = 10.5.$$

Calculation of δ

(1) from r_{vapour}.

$r_v = \cdot 056$ (Ramanathan) $\underline{\delta = 50 \times 10^{-3}}$.

(2) δ from r_{liquid}

$r = .74 \quad \Delta_{20^\circ} = 1.2032 \quad \beta'_{20^\circ} = 50.0$

$M = 123.05 \quad \nu_{D-20^\circ} = 1.553 \quad V^2 + 2 = 4.411.$

$$\delta_R = \text{an log } \overline{2}.1259 \times \frac{1.2032 \times 50.0 \times 4.411^2}{123.05} \times \frac{.74}{.82}$$

$$= 115 \times 10^{-3}$$

$$\delta_{liq} = 53.1 \times 10^{-3}.$$

Aniline $\bigcirc^{NH_2}$.

$r = .60$ (K)

$n_F = 1.599$ $\quad \beta = 48 \times 10^{-6}$ per atm.

$\left.\begin{matrix} \overline{I}_{R-G} = 5.10 \\ \overline{I}_{Ring} = 3.59 \end{matrix}\right\}$ $\overline{I}$ obs $= 3.42$.

Calculation of δ

(1) from r_{vapour}

$r_v = .049$ (Ru) $\quad \underline{\delta = 43 \times 10^{-3}}$.

(2) δ from r_{liquid}

$r = .60 \quad \Delta_{20^\circ} = 1.0216 \quad \beta = 45.9$

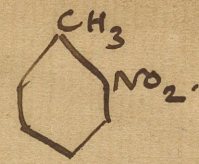
$M = 93.06 \quad n_{D\text{-}20^\circ} = 1.5863 \quad \nu^2 + 2 = 4.518$

$$\delta_R = \text{am log } \bar{2}.1259 \times \frac{1.0216}{1.5863} \times 45.9 \times 4.518^2 \times \frac{.60}{93.06} \times \frac{.60}{1.8}$$

$= 45.8 \times 10^{-3}$

$\delta_{Knig} = 20.2 \times 10^{-3}$

Ortho nitrotoluene



$r = \cdot 82.$

$n_{D-30^\circ} = 1\cdot 547_5$ $\quad \beta = \cancel{49 \times 10^{-6}}$ per atm. $\cancel{51\cdot 3 \times 10^{-6}}$ per atm. $51\cdot 3 \times 10^{-6}$

$$\therefore \left.\begin{aligned} I_{R-G} &= 32 \\ I_{King} &= 24 \end{aligned}\right\} \quad \text{Obs} = 9\cdot 40.$$

Calculation of δ

from r liquid.

$r = 0\cdot 82 \quad \Delta_{20^\circ} = 1\cdot 1623 \quad \beta' = 49$

$M = 137\cdot 06 \quad \nu_{D-20^\circ} = 1\cdot 5475 \quad \nu^2 + 2 = 4\cdot 394.$

$$\delta_R = \text{an log } \bar{2}\cdot 1259 \times \frac{1\cdot 1623 \times 49 \times 4\cdot 394^2}{137\cdot 06} \times \frac{\cdot 82}{\cdot 26}$$

$$= \underline{338 \times 10^{-3}}$$

$$\delta_{King} = \underline{\underline{177 \times 10^{-3}}}$$

α- chloronaphthalene

$r = 0.78$ (Martin) $\quad n_{D-20^\circ} = 1.633 \quad n^2 = 2.667$

To calculate β.

Σ(units respect to toluene = 1) $= 4.30$.

$$\therefore 4.30 = \frac{\beta'}{90.8} \times \frac{1.667^2}{1.239^2} \times \frac{\frac{1.78}{.54}}{\frac{1.51}{2.43}}$$

$$\therefore \beta' = \frac{4.30 \times 90.8 \times 1.239^2 \times 1.51 \times .54}{2.43 \times 1.667^2 \times 1.78} = 40.7$$

i.e. $\beta = 40.7 \times 10^{-6}$ per atm.

To calculate δ

$\Delta_{20^\circ} = 1.191$; $\quad M = 162.5$

$$\therefore \delta_{\text{kg.}} = \text{antilog } \bar{2}.1259 \times \frac{1.191 \times 40.7 \times 9}{162.5} \times \frac{.78}{.54}$$

$$= 51.8 \times 10^{-3}.$$

Methyl alcohol CH_3OH.

r = ~~.082~~ .060 (K) ; .070 (M) .125 (R.R) .625 Gans

adopt ~~.082~~ .060

$n_{F-30^\circ} = 1.329$ $\beta = 131 \times 10^{-6}$ per atm.

$\therefore I_{R-G} = .49$ } Obs M.L = .54
$I_{King} = .51$ } R.R = .58
K = .78 ?

Calculation of δ

(1) from r_{vapour}

$r_v = .027$ (Gm) $\delta = 23.2 \times 10^{-3}$.

(2) δ from r_{liquid}

$r = .060$. $\Delta_{20'} = .7915$ $\beta'_{20'} = 123$

$M = 32.03$ $\nu_{D-20'} = 1.330$ $\nu^2 + 2 = 3.769$.

$$\delta_R = \text{antilog } \bar{2}.1259 \times \frac{.7915 \times 123 \times 3.769^2}{32.03} \times \frac{.060}{5.58}$$

$$= 6.21 \times 10^{-3}$$

$$\delta_{Knig} = 3.93 \times 10^{-3}$$

(3) From B for liquid

$\mu = 1.61 \times 10^{-18}$ (Jona)

B =

Ethyl alcohol. $CH_3 \cdot CH_2 \cdot OH$

$r = \cdot 053$. (K)

$n_{\beta - 30^\circ} = 1 \cdot 363$; $\beta = 121 \times 10^{-6}$ per atm.

$I_{R-G} = \cdot 59$
$I_{King} = \cdot 58$

obsd I = $\cdot 56$ M.L
$\cdot 72$ R.R
$\cdot 58$ K.

Calculation of δ

(1) from r_{vapour}.

$r_v = \cdot 017$ (Gm) $\qquad \delta = 14 \cdot 5 \times 10^{-3}$

(2) δ from r_{liquid}.

$r = \cdot 053$; $\Delta_{20^\circ} = \cdot 7894$; $\beta'_{20^\circ} = 113$

$M = 46 \cdot 06$; $\nu_{D-20^\circ} = 1 \cdot 3623$; $\nu^2 + 2 = 3 \cdot 856$

$$\therefore \delta_R = \text{antilog } \bar{2} \cdot 1259 \times \frac{\cdot 7894 \times 113 \times 3 \cdot 856^2}{46 \cdot 06} \times \frac{\cdot 053}{5 \cdot 629}$$

$$= 3 \cdot 62 \times 10^{-3}$$

$$\delta_{Kuig} = 2 \cdot 19 \times 10^{-3}$$

Propyl alcohol $CH_3(CH_2)_2OH$.

$r = .085$ (M.L) ; $.0784$ (G) $.071$ (K)

adopt- $.071$

$n_{F-30^\circ} = 1.385$ $\beta = 105 \times 10^{-6}$ per atm.

$\overline{I}_{R-G} = .643$
$\overline{I}_{Kenig} = .60$
$\Big\}$ $\overline{I}_{obs.} = .73$ M.L $= .62$ K.

Calculation of δ

(1) from r_{vapour}

$r_v = .020$ (from) $\delta = 17.1 \times 10^{-3}$

(2) δ from r_{liquid}

$r = \cdot 071$; $\Delta_{20^\circ} = \cdot 8035$ $\beta'_{20^\circ} = 98 \cdot 5$.

$M = 60 \cdot 06$ $\nu_{D-20^\circ} = 1 \cdot 3854$ $\nu^2 + 2 = 3 \cdot 920$

$$\therefore \delta_R = \text{antilog } \bar{2} \cdot 1259 \times \frac{\cdot 8035 \times 98 \cdot 5 \times 3 \cdot 920^2}{60 \cdot 06} \times \frac{\cdot 071}{5 \cdot 503}$$

$$= 3 \cdot 49 \times 10^{-3}$$

$$\delta_{Kenig} = 2 \cdot 05 \times 10^{-3}$$

Isopropyl alcohol $(CH_3)_2CH\,OH$

$\nu = \cdot 050.$ (K)

$n_{F-30^\circ} = 1.380$; $\beta = 112 \times 10^{-6}$ per cm.

$I_{R-G} = \cdot 62$
$I_{Kuig} = \cdot 59.$
} I obs. $= \cdot 60$ (K)

Calculation of δ

(1) from ν_{vapour}

$\nu_v = \cdot 019$ (Lyn) $\qquad \delta = 16.2 \times 10^3$

(2) δ from r_{liquid}.

$r = \cdot 050$; $\Delta_{20^\circ} = \cdot 7887$; $\beta'_{20^\circ} = 105$

$M = 60 \cdot 06$; $\nu_{D-20^\circ} = 1 \cdot 378$; $\nu^2 + 2 = 3 \cdot 900$.

$$\therefore \delta_R = \text{an log } \bar{2} \cdot 1259 \times \frac{\cdot 7887 \times 105 \times 3 \cdot 900^2}{60 \cdot 06} \times \frac{\cdot 050}{5 \cdot 65}.$$

$$\left.\begin{aligned} &= 2 \cdot 48 \times 10^{-3} \\ \delta_{Knig} &= 1 \cdot 47 \times 10^{-3} \end{aligned}\right\}.$$

n - Butyl alcohol $CH_3(CH_2)_3OH$.

$\tau = \cdot 093$ (K)

$n_{F-30^\circ} = 1.400$ $\quad \beta = 97 \times 10^{-6}$ per atm

$\overline{I}_{R-G} = \cdot 68$
$\overline{I}_{Knig.} = \cdot 64$
} $\overline{I}_{obser.} = \cdot 65$ (K)

Calculation of δ

(1) from τ_{vapour}

$\tau_v = \cdot 020$ (Km) $\quad \delta = 17 \cdot 1 \times 10^{-3}$.

(2) δ from r_{liquid}

$r = .093$; $\Delta_{20}^{\cdot} = .8042$; $\beta'_{20^\cdot} = 92$; $M = 74.08$.

$\nu_{D-20^\cdot} = 1.3992 \quad \nu^2 + 2 = 3.958$.

$$\delta_R = \text{antilog } \bar{2}.1259 \times \frac{.8042 \times 92 \times 3.958^2}{74.08} \times \frac{.093}{5.349}$$

$$= 3.64 \times 10^{-3}$$

$$\delta_{liq} = 2.09 \times 10^{-3}$$

Isobutyl alcohol $(CH_3)_2CHCH_2OH$.

$r = \cdot 085$ M.L ; $\cdot 099$ G ; $\cdot 073$ (K)

adopt $r = \cdot 073$.

$n_{F-30^\circ} = 1\cdot 397$; $\beta = 105 \times 10^{-6}$ per atm.

$$\left.\begin{array}{l} I_{R-G} = \cdot 69 \\ I_{King} = \cdot 65 \end{array}\right\} \quad I_{obs} = \left\{\begin{array}{l} \cdot 79 \text{ (M.L.)} \\ \cdot 74 \text{ (K)} \end{array}\right.$$

Calculation of δ

(1) from r_{vapour}.

$r_v = \cdot 019$ (Gauss.) $\quad \underline{\delta = 16\cdot 2 \times 10^3}$

(2) δ from ν_{liquid}

$\nu = \cdot 073$; $\Delta_{20^\circ} = \cdot 798$; $\beta'_{20^\circ} = 99 \cdot 5$

$M = 74 \cdot 08$; $\underset{D-20^\circ}{\nu} = 1 \cdot 396$ $\quad \nu^2 + 2 = 3 \cdot 949$

$$\delta_R = \text{antilog } \bar{2} \cdot 1259 \times \frac{\cdot 798 \times 99 \cdot 5 \times 3 \cdot 949^2}{74 \cdot 08} \times \frac{\cdot 073}{5 \cdot 489}$$

$$= 2 \cdot 97 \times 10^{-3}$$

$$\delta_{King} = 1 \cdot 71 \times 10^{-3}$$

Tertiary butyl alcohol $(CH_3)_3COH$.

$\gamma = .041$ (IC)

$n_{F-30^\circ} = 1.388$; $\beta = 120 \times 10^{-6}$ per atm.

$\frac{1}{T}$ R-G $= .69$

$\frac{1}{T}$ Kuig $= .66$

$\left.\begin{matrix} \\ \\ \end{matrix}\right\}$ $\frac{1}{T}$ Std $= .69$ (K)

Calculation of δ

(1) from γ_{vapour}.

$\gamma_v =$

Amyl alcohol (inactive) $(CH_3)_2CH \cdot CH_2 \cdot CH_2OH$.

$r = \cdot 090$ M.L. $\cdot 098$ (K) adopt $\cdot 098$.

$n_{F-30^\circ} = 1 \cdot 408$; $\beta = 110 \times 10^{-6}$ per atm.

$$\left.\begin{array}{l} I_{R-G} = \cdot 82 \\ I_{King} = \cdot 76 \end{array}\right\} I \text{ obsd} = \left\{\begin{array}{l} \cdot 84 \text{ (M.L)} \\ \cdot 74 \text{ (K)} \end{array}\right.$$

Calculation of δ from r_{liquid}.

$r = \cdot 098$. $\Delta = \cdot 817$

$\beta' = {}^{*}100$ $M = 88 \cdot 09$

$n = 1 \cdot 407$ $n^2 = 1 \cdot 980$.

$$\delta_K = \text{an log } \bar{2} \cdot 1259 \times \frac{\cdot 817 \times 100 \times 9}{88 \cdot 09} \times \frac{\cdot 098}{5 \cdot 314}$$

$$= 2 \cdot 06 \times 10^{-3}.$$

Allyl alcohol $CH_2:CH\cdot CH_2OH$

$\gamma = .296$ (IC)

$n_{F-30^\circ} = 1.419$; $\beta = 100 \times 10^{-6}$ per atm.

$\underline{I}_{R-G} = 1.29.$

$\underline{I}_{Knig} = 1.18$

$\underline{I}_{obs} = 1.22.$ (K)

Calculation of δ

(1) from γ_{vapour}.

$\gamma_v = .052$ (Gm) $\quad \delta = 46 \times 10^{-3}$

(2) δ from r_{liquid}

$\delta = .296$; $\Delta_{20^\circ} = .8549$; $\beta'_{20^\circ} = 95$; $M = 58.05$

molecular refrn. $= 17.11$ (from atomic refrns)

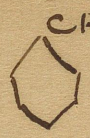
$\therefore \nu_{D-20^\circ}^2 + 2 = 4.010$

$$\delta_R = \text{an. log } \bar{2}.1259 \times \frac{.8549 \times 95 \times 4.010^2}{58.05} \times \frac{.296}{3.928}$$

$$= 22.7 \times 10^{-3}$$

$$\delta_{Kmig} = 12.7 \times 10^{-3}$$

Benzyl alcohol.



$r = .62$ (1C)

$n_{F-30'} = 1.547$; $\beta = 55 \times 10^{-6}$ per atm.

$I_{R-G} = 5.20$

$I_{Kuig} = 3.95$

I obs $= 2.93$ (K)

δ from r_{liquid} $\quad r = 0.62. \quad \beta' = 55$

$n_D = 1.5493 \quad n_0^2 + 2 = 4.369. \quad M = 108.06$

$\Delta = 1.046.$

$$\delta_R = \text{anlog } .\bar{2}.1259 \times \frac{1.046 \times 55 \times 4.369^2}{108.06} \times \frac{.62}{1.66.}$$

$= 50.8 \times 10^{-3}.$

$\delta_{Kuig} = 23.9 \times 10^{-3}.$

Ethyl formate.

$r = 0.213.$ $M. = 74.05$ $\Delta_{20^\circ} = .906.$

n_{20° for F line $= 1.3642.$ $n^2_{20^\circ} = 1.861$

n_{20° for D line $= 1.3597$ $n^2_{20\,D} = 1.8488.$

no data for β_{20° now I with respect to Ethyl = 1.00.

$$\therefore 1.00 = \frac{\beta'}{189} \times \frac{.861^2}{.832^2} \times \frac{\frac{1.213}{4.509}}{\frac{1.08}{5.44}}$$

$$\therefore \beta' = \frac{189 \times .832^2 \times 1.08 \times 4.509}{5.44 \times .861^2 \times 1.213} = 130 \text{ at } 20^\circ.$$

$$\delta_R = \text{anti log. } \bar{2}.1259 \times \frac{.906 \times 130 \times 3.861^2}{74.05} \times \frac{.213}{4.509}.$$

$$= 15.0 \times 10^{-3}$$

$$\delta_{\text{Kopp}} = 9.0 \times 10^{-3}.$$

Propyl formate $H \cdot COO(CH_2)_2 CH_3$.

$r = \cdot 210$ (K)

$n_{F-30^\circ} = 1.379$; $\beta = 120 \times 10^{-6}$ per atm.

$\overline{I}_{R-G} = \cdot 94$

$\overline{I}_{Liq} = \cdot 91$

} $\overline{I}$ obs $= \cdot 94$

Calculation of δ

(1) from r_{vapour}.

$r_v = \cdot 035$ (Gm) $\quad \delta = 30 \times 10^{-3}$

(2) δ from ν_{liquid}

$\nu = \cdot 210$; $\Delta_{20^\circ} = \cdot 9058$; $\beta'_{20^\circ} = 100$

$M = 88 \cdot 06$.

molec. refr. M_D for ethyl formate $= 17 \cdot 92$

$\therefore$ M_D for propyl " $= \frac{+4 \cdot 62}{22 \cdot 54}$

whence $\nu^2_{D-20^\circ} + 2 = 3 \cdot 905$.

$$\delta_R = \text{an log } \bar{2} \cdot 1259 = \frac{\cdot 9058 \times 100 \times 3 \cdot 905^2}{88 \cdot 06} \cdot \frac{\cdot 210}{4 \cdot 53}$$

$$= 9 \cdot 71 \times 10^{-3}$$

$$\delta_{Lorenz} = 5 \cdot 73 \times 10^{-3}$$

Propyl formate $H \cdot COO(CH_2)_2CH_3$.

$r = \cdot 210$ (K)

$n_{F-30^\circ} = 1 \cdot 379$; $\beta = 120 \times 10^{-6}$ per atm.

$I_{R-G} = \cdot 94$

$I_{Kinq} = \cdot 91$

I ~~ohsd~~ $= \cdot 94$

Calculation of δ

(1) from r_{vapour}.

$r_v = \cdot 035$ (Gm) $\quad \delta = 30 \times 10^{-3}$

(2) δ from ν_{liquid}

$\nu = \cdot 210$; $\Delta_{20^\circ} = \cdot 9058$; $\beta'_{20^\circ} = 100$

$M = 88 \cdot 06$.

mole. refr. M_D for ethyl formate $= 17 \cdot 92$

$\therefore$ M_D for Propyl " $= \frac{+4 \cdot 62}{22 \cdot 54}$

whence $\nu^2_{D-20^\circ} + 2 = 3 \cdot 905$.

$$\delta_R = \text{an log } \bar{2} \cdot 1259 \times \frac{\cdot 9058 \times 100 \times 3 \cdot 905^{-1}}{88 \cdot 06} \times \frac{\cdot 210}{4 \cdot 53}$$

$$= 9 \cdot 71 \times 10^{-3}$$

$$\delta_{Lorenz} = 5 \cdot 73 \times 10^{-3}$$

Ethyl acetate $CH_3COO\,CH_2CH_3$.

$r = \cdot 228$ (M) $\cdot 233$ (K) Adopt $\cdot 230$.

$n_{F-30^\circ} = 1\cdot 372$; $\beta = 125 \times 10^{-6}$ per atm.

$$\left.\begin{array}{l} I_{R-G} = \cdot 97 \\ I_{King} = \cdot 95 \end{array}\right\} I_{obsd} = \cdot 98 \text{ (K)}$$

Calculation of δ

(1) from r_{vapour}.

$r_v = \cdot 034$ $\delta = 29\cdot 5 \times 10^{-3}$.

(2) δ from r_{liquid}.

$r = .230$; $\Delta_{20^\circ} = .9005$; $\beta'_{20^\circ} = 114.7$

$M = 88.06$; $\nu^2_{D-20^\circ} + 2 = 3.885$.

$$\delta_R = \text{an.log}\ \bar{2}.1259 \times \frac{.9005 \times 114.7 \times 3.885^2}{88.06} \cdot \frac{.23}{4.39}$$

$$= 12.4 \times 10^{-3}$$

$$\delta_{King} = 7.39 \times 10^{-3}$$

(3) δ from B_{liquid}

The value given in Kauffmann's book 52 gives $B = 1.68 \times 10^{-7}$.

Acetone

$$\begin{matrix} CH_3 \\ CH_3 \end{matrix} \!\!> C = O$$

r = ·170 gm ·236 K. adopt ·20.

$n_{F-30°}$ = 1·358 ; $\beta = 130 \times 10^{-6}$ per atm.

$$\left.\begin{array}{l} I_{R-Ge.} = \cdot 85 \\ I_{King} = \cdot 84 \end{array}\right\} \quad I \text{ obsd} = \cancel{1\cdot 06}\ \cdot 81.$$

Calculation of δ

(1) from r_{vapour}.

r_v = ·048 (gm) $\quad \delta = 42 \times 10^{-3}$

(2) δ from γ_{liquid}

$r = .200$; $\Delta_{20^\circ} = .7920$; $\beta'_{20^\circ} = 120.$

$M = 58.05$; $\nu_{D-20^\circ} = 1.3593$; $\nu^2 + 2 = 3.848.$

$$\delta_R = \text{antilog } \bar{2}.1259 \cdot \frac{.7920 \times 120 \times 3.848^2}{58.05} \times \frac{.200}{4.60}.$$

$$= 14.1 \times 10^{-3}$$

$$\delta_{knig} = 8.6 \times "$$

Diethyl Ketone.

$$\left.\begin{matrix} C_2H_5 \\ C_2H_5 \end{matrix}\right\rangle C=O$$

γ = ~~·196~~. ·180 K.

n_{F-30° = 1·392 ; β = 110 × 10^{-6} per atm.

$$\left.\begin{matrix} I_{R-G} = \cdot 88 \\ I_{King} = \cdot 84 \end{matrix}\right\} \quad I_{obsd} = 1\cdot 06.$$

Chlorine.

Liquid at -20° C.

$\Delta_{\#} = 1.408$ $\beta' = 123$ (Richards + Stull extrapolated)

$M = 70.92$. $n_{D\text{-}20} = 1.385$

$\gamma = 0.24$ (Martin and Cole)

$$\therefore \delta_{liq} = \text{antilog } \bar{2}.1259 \times \frac{1.408 \times 123 \times 9}{70.92} \times \frac{.24}{4.32}$$

$$= \underline{16.3 \times 10^{-3}}$$

δ from γ_{vapour}.

$\gamma_{vap} = 0.041$ (Martin + Cole)

$$\therefore \delta = \frac{.205}{5.713} = \underline{35.9 \times 10^{-3}}.$$

Water

$r = \cdot 085$ K.

$n_{F-30^\circ} = 1 \cdot 336$; $\beta = 45 \times 10^{-6}$ per atm

$$\left.\begin{array}{l} I_{R-G} = \cdot 19 \\ I_{King} = \cdot 19 \end{array}\right\} \quad I \text{ obsd} = \begin{array}{l} \cdot 19 \text{ M.L} \\ \cdot 19 \text{ R.R} \\ \cdot 21 \text{ K.} \end{array}$$

To calculate δ

from r_{liquid} $\quad r = 0 \cdot 085 \quad \Delta_{20^\circ} \cdot 9982$

$\beta'_{20^\circ} = 46 \cdot 45$. $\quad M = 18 \cdot 016 \quad n_D = 1 \cdot 333 \quad n_D^2 + 2 = 3 \cdot 777$

$$\delta_R = \text{antlog.}\ \bar{2} \cdot 1259 \times \frac{\cdot 9982 \times 46 \cdot 45 \times 3 \cdot 777^2}{18 \cdot 016} \times \frac{\cdot 085}{5 \cdot 405}$$

$$= \underline{\underline{7 \cdot 71 \times 10^{-3}}}.$$

$$\delta_{King} = \underline{\underline{4 \cdot 87 \times 10^{-13}}}$$

CO_2.

(1) anisotropy from r.

r = ·117 Rayl.
·106 R.R
·098 Cabanes & Gr.
} adopt mean ·107.

$\therefore \delta = \cdot 102$

(2) δ from Kerr const.

$B = \cdot 24 \times 10^{-10}$ Sziversy for D line at 17.5°C.

$\cdot 23 \times 10^{-10}$ Hauden.

adopt $\cdot 24 \times 10^{-10}$

$$\delta = \frac{1820\,\pi\, k\, \lambda\, \text{no. of mole. per cc at } 0^\circ \times B}{(k-1)(n-1)}$$

$$n_{17.5} - 1 = \frac{\cdot 0_3 449}{1 + 17.5\alpha} \quad (\alpha = \cdot 0_2 367) = \cdot 0_3 422$$

$$k_{17.5} - 1 = \frac{\cdot 0_3 989}{1 + 17.5\alpha} = \cdot 0_3 929.$$

$\therefore \delta = \cdot 077$.

N_2O

(1) δ from r

r = ·154 Rayl.
·143 Ram Rao
·122 Cab. & Gra.

} adopt mean ·140.

δ = ·139

(2) δ from Kerr const.

$B = \cdot 48 \times 10^{-10}$ for D line and room temp. sq 20°. (Hansen's value)

$n_{20°} - 1 = \cdot 0_3 481$

$K_{20°} - 1 = \cdot 0_2 1052$

δ as before = ·119.