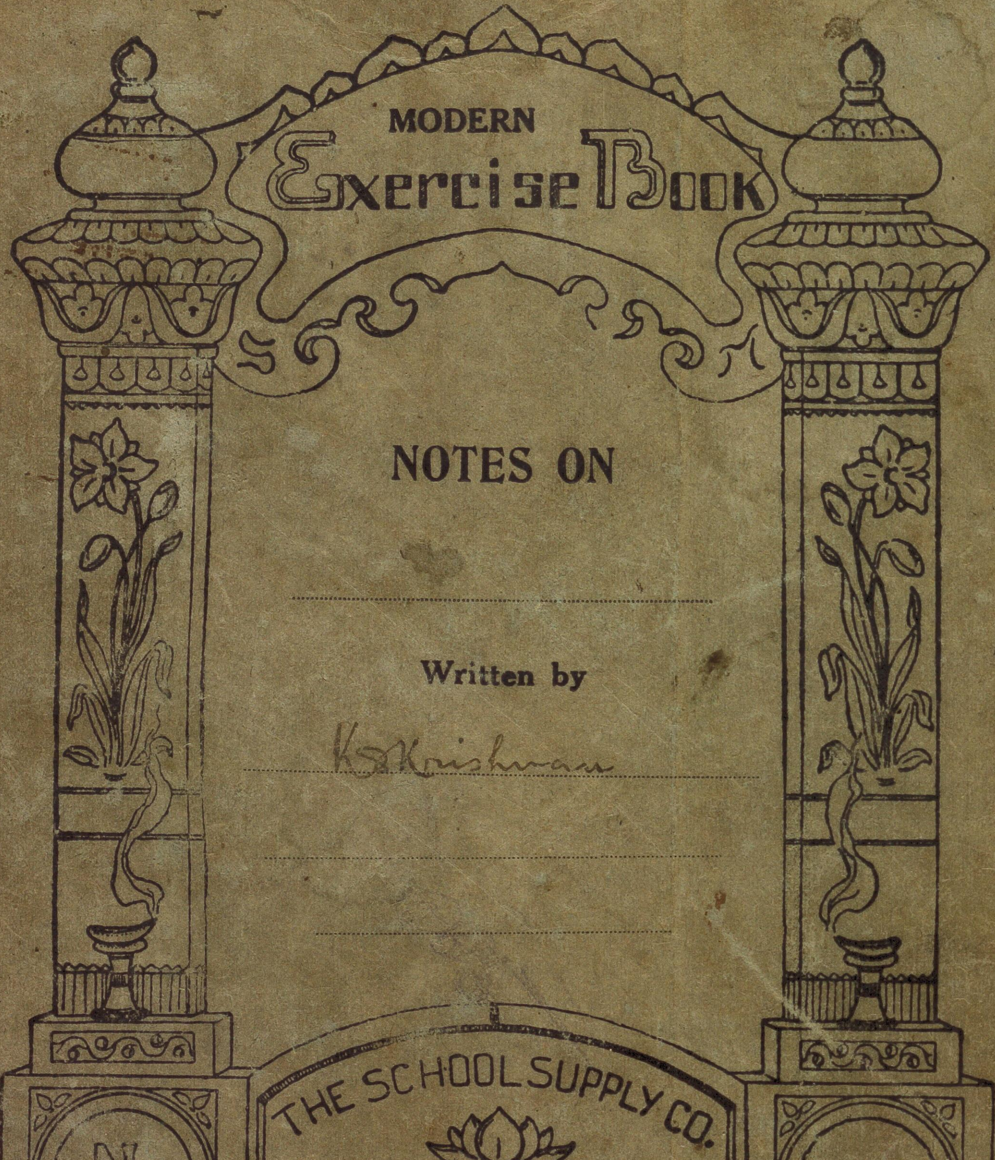


MODERN

Exercise Book

NOTES ON

Written by

K S Krishnan

THE SCHOOL SUPPLY CO.

PATUATULY, DACCA.

No

K S Krishnan
1/8/29.

4th mar, 29.

Liquid Hardener

Sodium sulphite (Na_2SO_3)	50 parts
Potash alum	25 "
Water	250 "
Glacial acetic acid	25 "

5007·05 Å

4959·02 "

3728·84

3726·10

4363·4

760)+8855(·

7th nov. 29.

Cl_2.

temp °c.	-56.8	-55	-40	-39.3	-34.5	-20	0	30°
vap. p. mm.	~~276~~ 241	276	578	592	760	1.84 atm	3.66 atm	8.7 atm.

SO_2

t °c	-25°	-10	0	33°.5
Vp. mm	374	762	1.51 atm	4.8 atm.

CCl_4.

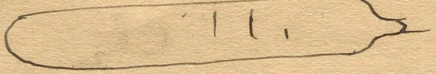
t	0	20	40	100	150	200
p. mm	33.0	89.5	211	1457	4555 ab. 6 atm	10936

NH_3 ~~[illegible]~~

t	-47	-33	0	34
p mm	360	760	4.2 atm	12.8 atm

19^{a} Mar, 29.

~~But~~



cylindrical glass bulb of ordinary soda glass fairly thickwalled 10 cms long and about 1.5 cms inner diam was partially filled with CCl_4. Exhausted and sealed Was raised to a temp. of about 220° C by ~~keeping~~ immersed in an oil bath — Did not explode ∴ stands a pressure of about 15 atms or more.

Dark room
220 plug — upper terminal -ve
and lower +ve }

<u>Negative Earthed.</u>

23rd Mar, 29 —

Infra red absn. bands of benzene liquid
(Phys Rev. Oct - 1929)

m	λ	ν (cm^{-1})
1		3030
2		5947
3		8751
4		11443
5		14023
6		16490

Anharmonic oscillator

$$\omega_m = m\omega_0 (1 - mx)$$

$$\begin{cases} \omega_0 = 3085.8 \\ x = 0.01823 \end{cases}$$

3650 — 27397

1st apr, 1929.

Thymol m.P. 51.5°C.

compressibility

temp \ $\beta \times 10^{6}$ per atm	Range of Pres 20 — 100	20 — 400 atm
28°C (under cooled)	67	57
64	69	66
100	94	80
310	416	268

G.W. Stewart + R. M. Morrow Phys Rev Sep 1927.

<u>Lauryl alcohol</u>: M.P = 19° C.

fm x ray — Spacing in solid 19°C A.U. } 35.6 4.2 3.7

Liquid 24°C } 24.7 4.6

On Atomic Properties which make an element a metal – by K.F Herzfeld – Phys. Rev. 29, May 1927

p. 701

2nd apr. 29.

Perrin, + later Wells. on Stratification in soap films

Wells gives for spacing betn adjacent planes in Potassium oleate 44 A.U.

~~D~~ de Broglie + Friedel, (Com. Rendus 176, 738 (1923). — Sur la ~~des rayo~~ diffraction des rayons x par les corps smectiques —) obtain by X-ray reflection a grating space of 43·5 A.U. for soap in excellent agreement with 44 A.U. of Perrin.

Perrin	Ann de Physique	10,	160	(1918)
Wells	"	16,	69	(1921)

3rd Apr. 29.

Dimensions of the Ellipsoidal cavity used for calculating the polarisation field

For paraffins $a > b = c$.

$$b = 4.90 \text{ A.U.}$$

ab^2 = average volume of each molec

$$= \frac{M}{\Delta \times 6.062 \times 10^{23}}$$

$$a = \frac{M}{\Delta \times 6.062 \times 10^{23} \times 4.90^2 \times 10^{-16}}$$

$$= \text{an log. } \bar{2}.8370 \times \frac{M}{\Delta}$$

	$\Delta_{30°}$	Mol. wt.	a in A.U.
Pentane	.6165	72.10	8.03
Hexane	.6505	86.11	~~8.03~~ 9.10
Heptane	.6751	100.13	~~9.10~~ 10.19
Octane	.6941	114.14	11.30

constants of the polarisation field

$4\pi = 12.57$

Liquid.	a (in A U.)	b = c (in A U.)	p_1	$p_2 = p_3$
Pentane	8.03	4.90	2.68	4.95.
Hexane	9.10	4.90	2.37	5.10 ✓
Heptane	10.19	4.90	2.09	5.24 ✓
Octane	11.29	4.90	1.86	5.36 ✓

~~Benze~~.	a = b AU	c AU.	$p_1 = p_2$	p_3
Benzene	6.2	3.2	3.03.	6.51
Cyclohexane	6.4	4.6	3.62.	5.33

Calculations of the polarisation field constants from light-scattering.

1) Optical constants for the vapours

Vapour.	$r_{vap.}$	$\frac{A}{B}$	Molec. refraction for F line	A + 2B	A	B
				×	10^{24}	
Pentane	·0132 average of Rao & Cabannes	1·355	25·52	30·14	12·16	8·99
Hexane	·0149 average of Rao & Cabannes	~~1·400~~ 1·380	30·19	35·67	14·57	10·55
Heptane	·0158	1·393	34·89 (mean of Hexane & Octane)	41·22	16·94	12·14
Octane	·0186	1·432	39·59	46·77	19·53	13·62

$$\left(\frac{A-B}{A+2B}\right) = \sqrt{\frac{5r}{6-7r}} = k, \text{ say}$$

$$\frac{A}{B} = \frac{1+2k}{1-k}$$

Again if the molec. refractivity is R

$$A + 2B = \frac{9}{4\pi N} \times R$$

$$~~= \text{anlog}\ \bar{1}\cdot 8724 \times R \times 10^{-24}~~$$

$$= \text{anlog}\ \cdot 0724\ R \times 10^{-24}$$

From the theory of light scattering

$$F = \frac{3kM}{16\pi^2 N} \times \frac{10^{-12}}{1\cdot 013} \times \frac{T \times \beta' (\mu^2-1)^2}{\Delta} \times \frac{r}{6-7r}$$

$$= \text{an log}\ \overline{54}\cdot 6277 \times \frac{M\,T\beta'(\mu^2-1)^2}{\Delta} \times \frac{r}{6-7r}$$

Pentane	= an log.	$\overline{52}\cdot 4856$
Hexane		$\overline{52}\cdot 5628$
Heptan		$\overline{52}\cdot 6283$
Octane		$\overline{52}\cdot 6852$

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

Pentane

Temp. ~~Abs.~~ °C.	r	Δ	μ^2_F	$\beta \times 10^6$ per atm	log F	μ_1	$\mu_2 = \mu_3$
30	·072	·6165	1·838	235	$\overline{49}$·5117	2·53	5·02
60	·072	·5850	1·782	437	$\overline{49}$·7849	3·25	4·66
80	·071	·5624	1·746	606	$\overline{49}$·9220	3·77 ~~3·35~~	4·40 ~~4·61~~
100	·058	·5377	1·704	830	$\overline{49}$·9567	3·93	4·32
120	·050	·5107	1·662	1120	$\overline{48}$·0098 ~~$\overline{48}$·0098~~	4·25	4·16
140	·034	·4787	1·612	1550	~~$\overline{48}$·0266~~ $\overline{49}$·9564	4·03	4·27
160	·020	·4394	1·552	2980	$\overline{49}$·9702	4·17	4·20
170	·018	·4162		5030			
180	·016			9060			
190	·012			39800			

Hexane.

Temp.	r	Δ	μ_F^2	$\beta\times10^6$ predic	log F	r_1	$r_2=r_3$.
30	·099	·6505	1·886	169	$\overline{49}.6244$	2·27	5·15
50	·098	·6318	1·854	205	$\overline{49}.7121$	2·43	5·07
70	·095	·6122	1·820	246	$\overline{49}.7803$	2·57	5·00
80	·089	·6022	1·803	275	$\overline{49}.7984$	2·59	4·99
100	·082	·5814	1·768	330	$\overline{49}.8386$	2·69	4·94
120	·062	·5588	1·731	524	$\overline{49}.9039$	2·87	4·85
140	·050	·5343	1·691	756	$\overline{49}.9556$	3·03	4·77
160	·039	·5063	1·647	1073	$\overline{49}.9804$	3·11	4·73
180	·025	·4751	1·600	1740	$\overline{49}.9715$	3·17	4·70
200°	·019	·4365	1·542	3500	$\overline{48}.1202$	3·85	4·36
220°	·013	·3810	1·462	7196	$\overline{48}.2033$		
230°	·012	·3329	1·396	42860	$\overline{48}.8775$		

Heptane

Temp °C	r	Δ	μ_F^2	$\beta \times 10^6$ per atm	log F	r_1	$r_2 = r_3$.
20°	·127	·6836	1·936	130	$\overline{49}.7122$	2·15	5·21
100°	·100	·6124	1·814	186~~186~~	$\overline{49}.7793$	2·13	5·22
200	·038	·4952	1·626	870	$\overline{49}.9624$	2·37	5·10
225	·026	·4515	1·560	1815	$\overline{48}.0763$	2·77	4·90
240	·020	·4177	1·510	3197	$\overline{48}.1707$	3·23	4·67
250	·017	·3877	1·469	4955	$\overline{48}.2566$	3·79	4·39
260	·0165	·3457	1·410	7980	$\overline{48}.3917$.		

Octane

Temp °C	r	Δ	μ_F^2	$\beta \times 10^6$ per atm	log F	μ_1	$\mu_2 = \mu_3$
30	·129	·6941	1·951	·128	$\overline{49}$·7920	1·83	5·37
40	·129	·6860	1·936	131	$\overline{49}$·8058	1·83	5·37
60	·129	·6694	1·906	135	$\overline{49}$·8290	1·83	5·37
80	·129	·6525	1·877	140	$\overline{49}$·8524	1·83	5·37
100	·125	·6351	1·848	145	$\overline{49}$·8599	1·79	5·39
120	·115	·6168	1·817	155	$\overline{49}$·8481	1·71	5·43
140	·102	·5973	1·783	168	$\overline{49}$·8227	1·59	5·49
160	·082	·5772	1·751	211	$\overline{49}$·8144	1·49	5·54
180	·051	·5556	1·716	392	$\overline{49}$·8553	1·51	5·53 ×
200	·033	·5317	1·678	738	$\overline{49}$·9225	1·59	5·49
220	·020	·5053	1·638	1180	$\overline{49}$·8887	1·39	5·59
240	·015	·4732	1·590	1845	$\overline{49}$·9335	1·39	5·59
260	·013	·4364	1·536	2783	$\overline{48}$·0171		

Benzene

$A = B > C$

$r_{vapour} = \cdot 0445$ $\frac{A}{C} = 1\cdot 983$

Molec. refrac for the F line $= 26\cdot 70$
$\times 1\cdot 037$

(Mol. wt $= 78\cdot 05$)

$$\times 1\cdot 037 \left\{ \begin{aligned} 2A + C &= 31\cdot 54 \times 10^{-24} \\ A &= 12\cdot 59 \times 10^{-24} \\ C &= 6\cdot 35 \times 10^{-24} \end{aligned} \right.$$

$A - C = 6\cdot 47 \times 10^{-24}$

$4\pi C = 82\cdot 75$

$\log \left[(A + 2C) \times 10^{24} \right]$ ~~10~~ $= 1\cdot 4187$.

Benzene.

Temp.	r	Δ	μ_F^2	$\beta \times 10^6$ pr atm	log f	$\mu_1 = \mu_2$	μ_3.
~~20~~ 10°	0·440	·8896	2·312	88·45	$\overline{48}$·3835	2·990	
20°	0·440 ·485	·8790	2·290	95·65	$\overline{48}$·4230	3·092 3·369	
30°	·478 0·440 ·433	·8683 ~~·8576~~	2·268	103·15	$\overline{48}$·4605	3·431 3·199 3·159	
40°	0·440	·8576	2·246	111·41	$\overline{48}$·4982		
60°	0·435	·8357	2·202	130·03	·5622 $\overline{48}$·~~[illegible]~~		
80°	0·420	·8145	2·158	156·5	$\overline{48}$·7164		

220	240
4·0	4·0
.5053	·4732

Pentane

Temp °C	30	60	80	100	120	140	160°
μ_1/μ_2	2.0	1.4	1.2	1.1	1.0	1.0	1.0
Δ	.6165	.5850	.5624	.5377	.5107	.4787	.4394
$n \times 10^{-21}$	5.184	4.919	4.729	4.522	4.294	4.024	3.695

Hexane

Temp	30	50	70	80	100	120	140	160	180
μ_1/μ_2	2.3	2.1	1.9	1.9	1.8	1.7	1.6	1.5	1.5
Δ	.6505	.6318	.6122	.6022	.5814	.588	.5343	.5063	.4751
$n \times 10^{21}$	4.578	4.446	4.309	4.238	4.093	3.932	3.760	3.565	3.344

Heptane

Temp	20	100	200	225	240	250	2~~60~~
μ_1/μ_2	2.4	2.4	2.2	1.8	1.4	1.2	
Δ	.6836	.6124	.4952	.4515	.4177	.3877	
$n \times 10^{21}$	4.138	3.708	2.997	2.733	2.528	2.347	

Octane

Temp	30	40	60	80	100	120	140	160	180	200
μ_1/μ_2	2.9	2.9	2.9	2.9	3.0	3.2	3.5	3.7	3.7	3.5
Δ	.6941	.6860	.6694	.6525	.6351	.6168	.5973	.5772	.5586	.5817
n										

Ch. Bouhet – C.R. vol 185 p. 53 (1927)

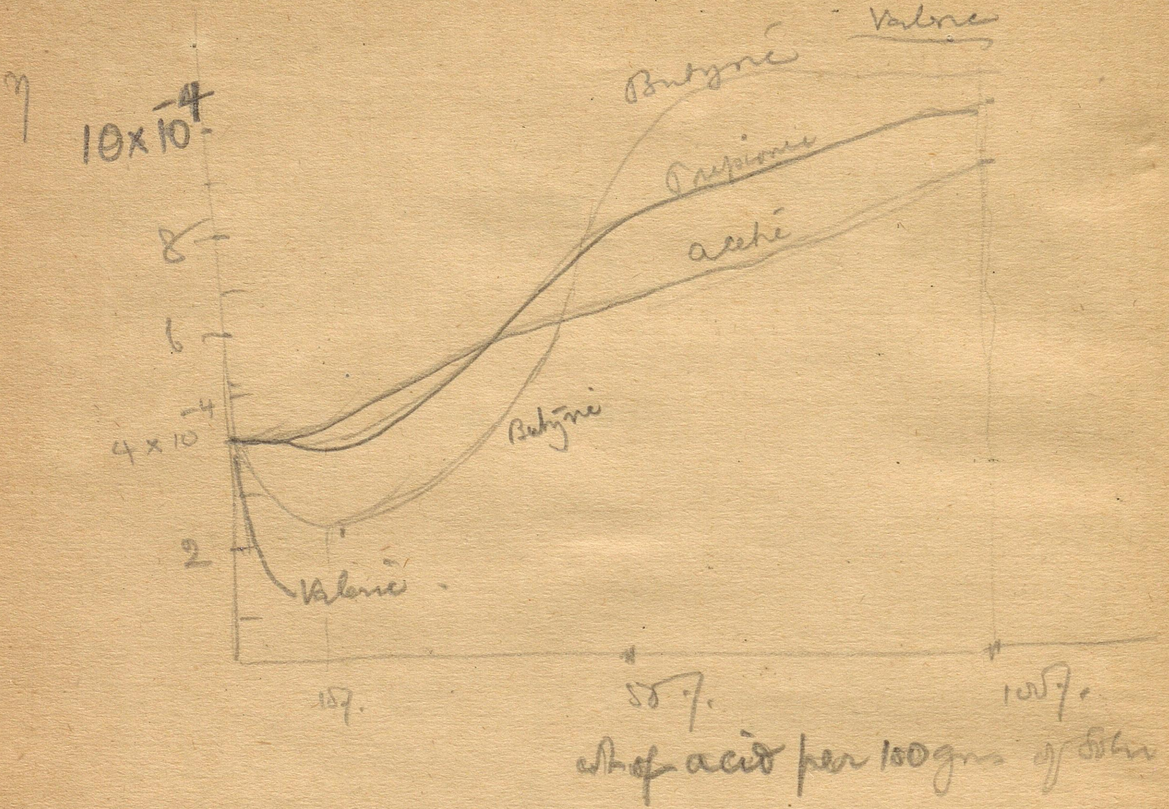
Ellipticity of light reflected ~~light~~ at Brewsterian $\angle^{le}$ from the surface of water.

$$\eta = + \cdot 000$$

for $\lambda =$

C.R. vol 185, p. 200 (1927)

Various liquids.



Ch. Bouchet — C. R ^{188} 2nd Jan 1929 p. 59

Carelli Pringsheim & Rosen. Ze. Phy.

51, 511 (1928)

NO_3^- $1040\ cm^{-1} = 9.6\ \mu$.

Schaefer & Schubert - Ann Physik 55, 577 (1918)

8th May 19

CCl_4 — Exp. started at 7-15 AM

Stopped at 10-30 "

3 h 15 hours

13th May Expe. of CCl_4 — with Fabry Perot interferometer —

				h m
13th May Expe. from	10-15 A.M.	to	9-55 P.M.	11-40
14th	6-25 "	to	10-20 "	15-55
15th	8-30 "	to	11-10 A.M.	2-40
				30-15
	1-35 P.M.	to	8-25	6-50
			Total Exp.	37-5

21st Mar. 29.

Benzene Scattg.

Depolarisation measurements

Sunlight -- filtered through Corning orange glass - G 34 M - 2.87 mm thick

Temp = 15° C

$$\begin{array}{r} 294.4 \\ 230.2 \\ \hline 64.2 \end{array} \qquad \begin{array}{r} 294.0 \\ 227.9 \\ \hline 66.1 \end{array} \qquad \begin{array}{r} 293.1 \\ 228.1 \\ \hline 65.0 \end{array}$$

$$\begin{array}{r} 294.6 \\ 227.0 \\ \hline 67.6 \end{array} \qquad \begin{array}{r} 295.7 \\ 228.1 \\ \hline 67.6 \end{array}$$

mean = 66.1.

$\tan^2 33^\circ.3'$ — 42.3

6th June, 29.

Refractivity of Benzene

Cabannes's values for r for benzene are

temp.	~~12~~ 16° C	50° C.	60°
r %	42	39.	37.5

and in a later paper gives the value of r as 41 % at 15°.

These values agree with the ~~[illegible]~~ values obtained by the Cornu method by me

We shall take the value for r at 20° at about ~~·416~~ .415 and the change of r with temp as ~~·009~~ ·010 fall per ~~ten~~ degrees rise of temperature.

or

From Rao's value for the depolarisation for the light scattered by the vapour viz. $r = \cdot 042$ which agrees ~~at~~ exactly with the value obtained by Cabannes and Granier, after correcting for the deviations from Boyle's law

$$r = \cdot 0445.$$

which gives

$$\frac{b_1}{b_3} \left(b_1 = b_2 > b_3 \right) = 1 \cdot 983 .$$

From Wasastjerna's value for the molecular Refraction for the D-line, for the vapour viz 27·20

$$2 b_1 + b_3 = 32 \cdot 14 \times 10^{-24}$$

$$b_1 = 12 \cdot 83 \times 10^{-24}$$

$$b_3 = 6 \cdot 47 \times 10^{-24}.$$

For 20°

$T = 293$ $M = 78.05$ $\beta' = 95.65$

$\Delta = .8790$ μ_D^2 calculated from the vapour on the basis of Lorentz formula

$= 2.325.$ $r = .415$

$$F = \text{an log } \overline{52}.5201 \times \frac{293 \times 95.65 \times 1.325^2}{.8790} \times \frac{.415}{3.095}$$

$$\therefore A' - C' = 6.11 \times 10^{-24}$$

$$= b_1 - b_3 + t(b_1 p_1 - b_3 p_3)$$

$$b_1 - b_3 = 6.36 \times 10^{-24}$$

$$b_1 p_1 - b_3 p_3 = -\frac{.25}{\chi} \times 10^{-24} = -\overset{2.4}{\cancel{.24}} \times 10^{-24}$$

$$12.83\, p_1 - 6.47(4\pi - 2p_1) = -\cancel{.24}\ 2.4$$

$$25.77\, p_1 = \begin{array}{r} 81.30 \\ 2.4 \\ \hline 78.9 \end{array}$$

$$p_1 = p_2 = 3.06$$

$$p_3 = 6.45.$$

$\sigma_1 = -1{\cdot}13 \qquad \sigma_2 = +2{\cdot}26$

$$\therefore \Phi = \frac{2b_1\sigma_1 + b_3\sigma_3}{3} = -\sigma_3 \; \frac{b_1 - b_3}{3}$$

$$= - \frac{2{\cdot}26 \times 6{\cdot}36 \times 10^{-24}}{3}.$$

$\nu\Phi = {\cdot}031$

i.e the Lorentz const. $\frac{\mu^2-1}{\mu^2+2} \cdot \frac{M}{\rho}$ is less than that of the vapour by 3·1 %.

Now using this value of the refr. index in the above calculation we get as a second approximation

$\nu\Phi = {\cdot}036$

i.e 3.6 % less than in the

vapour.

We may compare with this the values of Wasastjerna 27.20, & 26.18 respectively for the vapour & the liquid corresponding to a diminution of $\frac{1.02}{27.2} = 3.7_5\%$

For 20°C (contd)

Using for the refractivity in the liquid 26.18 in calculating μ^1

$\mu_1 = \mu_2 = 2.93$

$\mu_3 = 6.71$

12.57

4.19

$\sigma_1 =$

$\sigma_3 = 2.52$

For 30°C

$T = 303$ $\quad \beta' = 103{\cdot}15$. $\quad$ ~~$\Delta = \cdot 8896$.~~

$\Delta = \cdot 8683$ $\quad \mu^2 = 2{\cdot}233$ $\quad r = \cdot 406$.

$\mu_3 = 1{\cdot}495$ Assuming ~~same~~ Lorentz expression

$$F = \text{an } \overline{52}{\cdot}5201 \times \frac{303 \times 103{\cdot}15 \times 1{\cdot}233^2}{\cdot 8683} \times \frac{\cdot 406}{3{\cdot}158}$$

$$= \text{an lg } \overline{48}{\cdot}3673$$

$$A' - C' = 5{\cdot}91 \times 10^{-24}$$

$$b_1\mu_1 - b_3\mu_3 = -\frac{\cdot 45}{x} \times 10^{-24} = -4{\cdot}59$$

$$\mu_1 = \frac{\begin{array}{r} 81{\cdot}30 \\ 4{\cdot}59 \\ \hline 76{\cdot}71 \end{array}}{25{\cdot}77}$$

ie $\mu_1 = \mu_2 = 2{\cdot}98$

$\mu_3 = 6{\cdot}61$ $\qquad$ 6.61

$\begin{array}{r} 12{\cdot}57 \\ 5{\cdot}96 \end{array}$

Here of course

$$\therefore \frac{d\sigma_3}{dt} = \frac{d\rho_3}{dt} - \cancel{-.010}.$$

$$= \frac{6.61 - 6.71}{10}$$

$$= -.010.$$

At 20°C:

$$\frac{n^2-1}{n^2+2} = \nu C + \frac{n^2-1}{n^2+2} . \nu \Phi$$

where $C = \frac{4\pi}{3} . \frac{b_1 + b_2 + b_3}{3}$

$$\Phi = \frac{1}{3}\left(b_1\sigma_1 + b_2\sigma_2 + b_3\sigma_3\right)$$

$$\therefore \frac{n^2-1}{n^2+2} = \frac{\nu C}{1 - \nu\Phi}$$

$$\frac{dn}{dt} = -\frac{(n^2-1)(n^2+2)}{6n} \frac{\alpha - \nu \frac{d\Phi}{dt}}{1 - \nu\Phi}$$

We have seen that for 20° C.

$$\nu \Phi = -\cdot 036$$

$$\nu \frac{d\Phi}{dt} = -\nu \frac{b_1 - b_3}{3} \cdot \frac{d\sigma_3}{dt}$$

$$= \cdot 0_3 14$$

taking $n = 1\cdot 501_4$ $n^2 = 2\cdot 254$

$$\alpha = \cdot 0_2 1208 \qquad \cdot 0_2 107$$

$$\frac{dn}{dt} = -\frac{1\cdot 254 \times 4\cdot 254}{6 \times 1\cdot 501_4} \times \frac{\cdot 0_2 121 - \cdot 0_3 14}{1\cdot 036}$$

$= -6\cdot 12 \times 10^{-4}$ per degree C.

observed values range from $6\cdot 13$ to $6\cdot 5$
$\pm\cdot 1$

Calculated according to Lorentz formula

$$= -7\cdot 15 \times 10^{-4}.$$

$$\frac{dn}{dp} = \frac{(n^2-1)(n^2+2)}{6n} \; \frac{\beta + \nu \frac{d\bar\Phi}{dp}}{1 - \nu\bar\Phi}$$

taking $\beta = 95{\cdot}65 \times 10^{-6}$ per atm

and all the change of $\bar\Phi$ due to change of [illegible] only indirect being due to the accompanying change of density

$$\frac{\frac{d\bar\Phi}{dp}}{\frac{d\bar\Phi}{dt}} = \frac{\frac{d\bar\Phi}{d\rho} \times \frac{d\rho}{dp}}{\frac{d\bar\Phi}{d\rho} \cdot \frac{d\rho}{dt}} = -\frac{\beta}{\alpha}$$

$$\therefore \frac{dn}{dp} = 6{\cdot}12 \times 10^{-4} \times \frac{95{\cdot}65 \times 10^{-6}}{0{\cdot}0_2 121 \cancel{\times 10}}$$

$$= 4{\cdot}85 \times 10^{-5} \text{ per atm.}$$

as against the value

5.66 ~~5.82~~ $\times 10^{-5}$ calculated according to Lorentz formula.

The observed value (of Rontgen)

$= 5.06 \times 10^{-5}$ per atm.

7th June 29

$$\frac{\partial \epsilon}{\partial t} = -\frac{(\epsilon-1)(\epsilon+2)}{3} \; \frac{\alpha - \nu \frac{d\Phi}{dt}}{1 - \nu\Phi}$$

Taking the most recent and very accurate measurements of L. Hartshorn + D.A. Oliver (Proc. Roy. Soc. vol. 123, p. 664, Apr. 1929. ~~May~~ 1929.) for ϵ at 20° we

$2.282_5 \pm 5$.

$$\frac{\partial \epsilon}{\partial t} = -\frac{1.283 \times 4.283}{3} \times \frac{\cdot 0_2 107}{1.036}$$

$= - 18.9 \times 10^{-4}$ per 1°C

Observed value of Hartshorn and Oliver

$= - 19.8 \times 10^{-4}$ per 1°C.

The value calculated on the basis of Lorentz formula

$$= -22 \cdot 2 \times 10^{-4} \text{ per } 1^{\circ}\text{C.}$$

$$\frac{\partial \epsilon}{\partial p} \text{ similarly } = \frac{(\epsilon-1)(\epsilon+2)}{3} \, \frac{\beta - \nu \frac{d\Phi}{dp}}{1-\nu\Phi}$$

$$= 14 \cdot 9 \times 10^{-5} \text{ per atm.}$$

as against ~~the~~ observed value of $(1 \cdot 39 \times 10^{-10}$ per dyne per sq cm which reduces to) $14 \cdot 1 \times 10^{-5}$ per atm. obtained by Cagniard (C. R, 183, 873, (1926)

On the basis of Lorentz $= 17 \cdot 6 \times 10^{-5}$

Temp. = 20°C.	according to Lorentz formula	according to Proposed formula	Observed	authority
$\frac{dn}{dt} \times 10^4$	$-7 \cdot 15$	$-6 \cdot 12$	$-6 \cdot 13$ to $-6 \cdot 50$	
$\frac{dn}{dp} \times 10^5$	$+5 \cdot 66$ ~~$+5 \cdot 82$~~	$+4 \cdot 85$	$+5 \cdot 06$	Röntgen
$\frac{d\epsilon}{dt} \times 10^4$	$-22 \cdot 2$	$-18 \cdot 9$	$-19 \cdot 8 \pm \cdot 3$	
$\frac{d\epsilon}{dp} \times 10^5$	$+17 \cdot 6$	$+14 \cdot 9$	$+14 \cdot 1$	Ca

~~In~~ the values calculated accord'g to Lorentz given in Table are not however strictly correct. We have used for the calculation the actually observed value for the refractive index, whereas strictly speaking we ought to use the values calculated from the vapour state on the basis of Lorentz formula; (i.e. $n = 1.525$) if we do so, we get the values in Table I even higher. (about 5.8% for $\frac{dn}{dt}$ & $\frac{dn}{dp}$)

$$\left.\begin{aligned} \text{Thus}\quad \frac{\partial n}{\partial t} &= -\ 7.56 \times 10^{-4} \\ \frac{dn}{dp} &= +\ \overset{5.99}{\cancel{6.16}} \times 10^{-5} \end{aligned}\right\}\ \text{Lorentz.}$$

In the case of the calculation according to the proposed formula also we must use strictly the value

For refr. index calculated from the vapour state i.e we take for molecular refraction at 20° C i.e.,

$$\frac{n^2-1}{n^2+2} \cdot \frac{M}{\rho} = \frac{27.20}{1.036}$$

$$n^2 = 2.259 \qquad n = 1.503$$

$$\frac{dn}{dt} = -6.14 \times 10^{-4}$$

$$\frac{dn}{dp} = \cancel{4.8\,?7 \times 10^{-5}} \quad 4.87 \times 10^{-5}$$

8th June 29

The above value of Hartshorn & Oliver for ϵ viz 2·283 gives

$$\frac{\epsilon-1}{\epsilon+2} \cdot \frac{M}{\rho} = 26.61$$

$\epsilon - 1 = .00274$ per atm at 100°C

Pohrt's value gives 27·97

Ref index of Benzene liquid at 20° C.

λ	
2763	1.625
308.1	1.587
361.0	1.548
480.0	1.514
589.3	1.500

9th July, 29.

New Quartz mercury lamp.
Heraus.

Of the two ~~plugs~~ sockets intended to receive the two terminals of the **arc** the one closer to the stand is connected to the yellow wire and the other which is farther from the stand is connected to the red wire.

The ⓪ position of the switch corresponds to off and 1 position to on

Boron 11, 10 = 4·5 : 1 shorter shift more intense

(H_3BO_3)

Chlorine 35, 37 = 3·4 : 1

(ClO_3 or ClO_4.)

Bromine 79 ; 81 = 1·2 : 1

} longer shift more intense

(BrO_3 BrO_4.)

Iodine no isotopes. at wt. 126·932

Phosphorus at wt = 31·024

according to Aston 30·9825

(Phosphates)

assuming it has an isotope at wt 32

31 : 32 = 24 : 1

Arsenic At wt. = 74·96

Aston's 74·934

simil to P. 75 : 76 = [illegible]

= 37 : 1

23rd July, 29.

$NaClO_3$ Soln. (in water)

fairly saturated.

Exposure
Started at 7-53 A.M.
Stopped at 7-53 P.M.

Expr.: 12 hrs

10th Aug 1929.

Benzene

temp. °C	0	20	40	60	70
density	·90006	·8790	·8576	·8357	·8248

temp.	0	10	20	30°	40	50	60°
$\beta \times 10^6$ per atm	81·95	88·45	95·65	103·15	111·41	120·51	130·03

Tyrer – J.C.S. Trans. Vol. 105 p. 2534, (1914)

Dielec const of benzene Vapour at 110°C

= 1·00292 (Bädeker, 1901)

At 100° G Pohrt (Ann der Phys 42, 583 (1913)) gives for diele const 1·00274 ± 1/4th.

200

3125·76

100

3131·66

100

3132·02

	CO_2	H_2
3382	6	0
3281	6	0
3275	2	6
3248	3	7

1284 || 1392

H, Isnardi   Z. Phys., 9, p. 174 1922.

t °C.	ϵ	$v = 1/\rho$	$\frac{\epsilon-1}{\epsilon+2} \times \frac{1}{\rho}$.
200		1.5007 ~~1.9~~	.3520
150		1.3691	~~.166~~ .3505
100		1.2648	.3463
55		1.1886	.3416
30		1.1517	.3407
15		1.1309	.3387
11		1.1255	.3402.

W. Graffunder   Ann der Phys vol 70, p. 232 (1923)

t °C	$v = \frac{1}{\rho}$	$\frac{\epsilon-1}{\epsilon+1} \cdot \frac{1}{\rho}$.
5	1.1175	.3382
20	1.1377	.3395
40	1.1661	.3408
60	1.1964	.3414
80	1.2292	.3430.

R Sanger. Phy. Zeit.
27, p 165 (1926)

18th Dec, 25

U violet
~~Quartz~~ nicol in front of Spectrog.

Used light direct from ~~Hg~~ arc at about 60 cms in front with a ground glass plate interposed & is presumably unpolarised.

Ratio of vertical to Horizontal components in the light transmitted by the dispersing system.

λ		
5461.	4.5/6 ·75 or less.	~~6/4.5~~ 4.5/6.
4916	6.5/6 1.0 to 1.1	6/6 ~~to~~ 6.5/6
4358	~~1.2~~ 6.5/6.	6.5/6.
4109.	7/6 ?	6.5/6
39~~04~~	6.5/6.	6.5/6. to 6/6.
3650	7.5/6.	7.5/6.–
? 3341 ~~3400~~	6.5/6.	7.0/6.
Ex here w. not visible 3126 32 }.	8/6.	8/6.

19th Dec.

5460	< 4·5/6 ✓
4916	6·5/6 ✓
4358	6·3/6.
4109	~~6·4/6~~. 6·3/6
3[illegible]07	6·5/6.
3650	7·7/6.
3341	6·5/6.
3126 31	8/6.

Jan 2, 1930 Some values of magnetic susceptibilities from I. C. T. vol. VI.

Atomic group susceptibilities

Atomic group.	$-\chi \times 10^6$ per gm. atom or ion.
Ag^{+}	31.0
Al^{+++}	13.1
As^{+++}	20.9
$As^{~~+++~~++}_{5}$	43.0
Au^{++}	45.8
B^{+++}	7.3
Ba^{++}	38.2
Be^{++}	8.55
Bi^{+++}	40.6
Bi^{+++++}	69.8
Ca^{++}	15.9
Cd^{++}	20.
Cs^{+}	41.0
Cu^{+}	18.0
Hg^{++}	33.4
K^{+}	18.5

Atomic group	$-\chi \times 10^6$ per gm. ion.
Li^{+}	4.2
Mg^{++}	10.1
Na^{+}	9.2
(Pb ?) P^{+++}	10.2
Rb^{+}	27.2
Sb^{+++}	26.1
Sb^{+++++}	~~26.1~~ 66.9
Si^{+++}	~~66.9~~ 20.
Si^{++++}	~~20~~ 12.7
Sn^{++++}	30.3
Zn^{++}	13.5

Atomic gr.	$-\chi \times 10^6$ per gm ion
Br^-	30.60
Cl^-	20.10
F^-	6.30
I^-	44.60
No_3^-	14.2
So^{--} [illegible]	13.4
$S_2O_3^{--}$	43.4
$S_4O_6^{--}$	84.7
So_2^-	17.9
So_2^{--}	24.7
So_3^-	27.8

	$-\chi \times 10^6$
So_3^{--}	22.3
$S_2O_6^{--}$	56.0
So_4^-	31.4
So_4^{--}	33.6
Co_3^{--}	22.2
Po^{---}	22.3
Po_2^{---}	18.5
Po_3^{--}	~~23.8~~ 23.8
Po_3^{---}	31.3
Po_4^{---}	35.4

Specific susceptibilities

Subst.	$\chi \times 10^6$ per gm.	Substance	$\chi \times 10^6$ per gm	Substance	$\chi \times 10^6$ per gm
$(NH_4)H_2Po_4$	− ·50 (71)	$SrCo_3$	−·316		
$Pb(No_3)_2$	− ·248 (112)	$BaSo_4$	−·306 (84)		
$ZnSo_4 \cdot 7H_2O$	− ·48 (71)	$BaCo_3$	−·298		
$CuSo_4$	+ 8·6	$LiNo_3$	−·48 (23)		
$CuSo_4 \cdot H_2O$	+ 8·6 (36)	$NaCl$	−·499 (55)		
$CuSo_4 \cdot 5H_2O$	+ 5·9				
		KCl	−·516 (83)		
$MnCl_2$ temp.		$KClo_3$	−·30 (71)		
−179	+393				
24	+107·0 (55)	KBr	−·377 (32)		
55·6	+35·8	KI	−·422 (32)		
~~Mn~~ $MgCo_3$	−·51 (73)	KNo_3	−·326 (83)		
$MgCo_3 \cdot 3H_2O$	−·525 (84)	$RbNo_3$	−·281 (83)		
$MgSo_4 \cdot 7H_2O$	−·551 (84)				
$CaSo_4$	−·364 (84)				
$CaSo_4 \cdot H_2O$	−·384 (84)				
$CaCo_3$	−·382 (84)				
$SrSo_4$	−·315 (84)				

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~~(1900)~~ ~~, Phys. Zeit~~. (1899); 1, 664 (1900); Phys. Zeit.
~~[illegible]~~ 26, 51 (1925)

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174, 457, 1698, (1922)
175 1063, (1922)

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156, 323 (1913)
158 37, (1914)
29, 218 (1913)

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$FeCO_3$ siderite

specific susceptibilities are

$84{\cdot}2 \times 10^{-6}$ and $142{\cdot}6 \times 10^{-6}$.

Foex. Annales de Physique 16 174 (1921)

	χ_1	χ_2	χ_3 $\times 10^6$
$FeSO_4 \cdot 7H_2O$.	44·3	41·1	40·2
$Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$	46·2	40·9	40·5.

Finke Ann de Physik 31, 149 (1910)

Values for $MnCl_2$ aq. soln.

Cabrera & Duperier, Journ. de Physique, 6 121 (1925)

Specific susceptibilities of some ~~liquids~~ organic compounds

Substance ~~Liquid~~	$\chi \times 10^{-6}$ per gm.
Benzene	−·712 (55, 56)
Naphthalene	−·717 (82)
Anthracene	−·726 (82)
azobenzene	−·612 (82)
Diphenyl	−·677 (82)
Phenanthrene	−·718 (82)
Chrysene	−·648 (82)

(55) Ishiwara, Sc. Rep. Tohok. 3 303 (1914)
5 53 (16)
9 233 (20)

Takagi + Ishiwara. 3, 127 (14)

(56) Isnardi + Gans. Ann d. Phys. 61 585 (20)

(82) Pascal ___ .

Contd on p. . . .

13th Jan. 1930

To calculate the dispersion of optical anisotropy of the benzene molecule.

assuming the anisotropy arises wholly from the mutual electrostatic influence of ~~the~~ the 6 isotropic optical doublets of equal strength, the moment induced ~~in the~~ ~~plane of the~~ by an elec. vector ⊥r to the plane of the benzene ring

$$b_3 = 6\mu(1 - k\mu)$$

where μ is the moment induced in each isotropic unit ~~molecule~~ by unit field acting on it, and k is a const. depending on the geometry of the molecule.

moment induced in the plane

$$b_1 = b_2 = 6\mu\left(1 + \tfrac{1}{2}k\mu\right)$$

~~$\frac{b_3}{b_1} = 1 - k\mu$~~ $\qquad \frac{b_1}{b_3} = \frac{1 + \frac{1}{2}k\mu}{1 - k\mu}$.

and $\frac{1}{3}(2b_1 + b_3) = 6\mu$.

Since $\frac{1}{3}(2b_1 + b_3)$ is known from ~~[illegible]~~ the refractive index, and $\frac{b_1}{b_3}$ from scattering

μ and k are known.

k is independent of the wavelength;

~~[illegible]~~ it depends only on the geometry of disposition of the six isotropic centres.

$\frac{b_1}{b_3}$ can be calculated for any value of λ for which the refractive index of the liquid is known.

Assuming for the D lines r for scattering for benzene vapour = ·0445

$$\frac{b_1}{b_3} = \cancel{1.983} = \frac{1 + \frac{1}{2}k\mu}{1 - k\mu} \quad \text{- - - (1)}$$

$= 1\cdot983$ for D line.

$$2b_1 + b_3 = \frac{9}{4\pi}\frac{M}{N\rho}\left[\frac{n^2-1}{n^2+2}\right]' = \text{antlog}\ \overline{22}\cdot0233\ \frac{n^2-1}{n^2+2}$$

$$= 18\mu. \qquad \text{———— (2)}$$

Taking n for D line = 1·501

~~For D line~~ $2b_1 + b_3 = 31\cdot17 \times 10^{-24}$

$\therefore \mu = 1\cdot73 \times 10^{-24}$.

from (1) $k\mu = \cdot396$.

$\therefore k =$ ~~$22\cdot87 \times 10^{+24}$~~.

The following table gives the values of $\frac{b_1}{b_3}$ for different wavelengths assuming this value of k.

λ (A U)	n	$2b_1+b_3$ $\times 10^{24}$	μ. $\times 10^{24}$	b_1/b_3.
5893	1·501	31·17	1·73	1·983
4800	1·514 n^2 = 2·292	31·77	1·76	2·013
3610	1·548 n^2 = 2·396	33·51	1·86	2·113
3081	1·587 n^2 = 2·519	35·46	1·97	2·227
2763	1·625 n^2 = 2·641	37·31	2·07	2·352 $b_1 = 15\cdot39$ $b_3 = 6\cdot54$.

$$b_1' = 21\cdot 29 \times 10^{-24} \quad b_3' = 12\cdot 27 \times 10^{-24}$$

for $\lambda = 2673$. $\quad F =$ an log. ~~$\overline{4}7865$.~~ $\overline{47}\cdot 7343$.

$$\nu = \frac{N}{78\cdot 05} \times \cdot 8790.$$

$$\nu F = \cancel{27\cdot 13 \times 10^{-25}}^{\,-24}$$

$$\cancel{2\cdot 713 \times 10^{-25}}$$

$$\cdot 37 \quad \cancel{\cdot 2406} \times 10^{-6}$$

$$3kT\beta\chi^2 = \frac{3 \times 1\cdot 371 \times 10^{-16} \times 293 \times 95\cdot 65 \times 10^{-2}}{1\cdot 013 \times 10^{6}}\,\chi^2$$

$$= 1\cdot 941 \times 10^{-25}.$$

$$\cancel{r_{2673} = \frac{16\cdot 28}{1\cdot 941}}$$

$$\cancel{\begin{array}{r} 1\cdot 941 \\ 16\cdot 991 \\ \hline 18\cdot 950 \end{array}}$$

$$\frac{1\cdot 444}{1\cdot 941}$$

$$\begin{array}{r} 1\cdot 941 \\ 1\cdot 684 \\ \hline 3\cdot 625 \end{array}$$

$$\begin{array}{r} \cdot 1596 \\ \cdot 5593 \\ \hline \cdot 6003 \end{array}$$

39·8 %.

whereas for the vapour r wd be = ~~9·6%~~

as against 4·45 % for D line.

Raman frequencies of some inorganic salts in solution

	Concentration %	Raman frequencies cm^{-1}		
K_2CO_3	52	1063		
$KHCO_3$	26	1035		
$NaNO_3$	47	1050 (s)	717 (w)	
$Ca(NO_3)_2$	41	1052 (s)	723 (w)	
NH_4NO_3	52	1050 (s)	723 (w)	
K_2SO_3	52	988		
$(NH_4)_2SO_4$	43	987 (s)	624 (m)	458 (m)
$NaClO_3$	51	932 s	611 (w)	479 (m)
$NaBrO_3$	26	810 s.		367 (m)
HIO_3	45	800 (s) broad		329 (m) broad.
$HClO_4$	60	935 (s)	634 m	470. (m)

M. S. Ramachandrachari

Pyridyl derivatives of Cobaltous Chloride — Magnetic study.

I. The monopyridyl derivative $CoCl_2 \cdot Py$:

Preparation: Obtained as a light blue powder by heating the tetrapyridyl derivative ($CoCl_2 \cdot 4Py$) for about an hour at 116°–120° C, till there was no further loss of weight (or, by heating the bispyridyl derivative at 104°–106°C for about six hours) – Reitzenstein (Lieb. Ann. 282, 275, 1894).

Actually, for the above purpose Small crystals or powder is to be started with. Big crystals of $CoCl_2 \cdot 2Py$, for instance, require about 12 hours for the Pyridine evolution to be complete.

Analysis: 0.1009 gms of the light blue powder gave 0.1377 gms of AgCl.

$$\therefore \text{Cl content} = \frac{0.1377}{0.1009} \times \frac{35.46}{143.4} \times 100 = 33.77\%.$$

whereas theoretically, for $CoCl_2 \cdot Py$ it would be 33.95%.

Properties: On keeping in air, it soon turns reddish probably due to the formation of the pentahydrate $CoCl_2 : Py . 5H_2O$ — (Reitzenstein).

Mean Susceptibility measurement:

Volume Susceptibility χ_{st} of Nickel Chloride soln at 27.3° C = 10.933×10^{-6}.

$$\therefore \kappa_{CoCl_2 \cdot Py} = \frac{\Delta W_1}{\Delta W_{st}} (\kappa_{st} - \kappa_{air}) + \kappa_{air}$$

$$= \frac{0.1657}{0.0433} (10.933 - 0.029) + 0.029$$

$$= 41.759 \times 10^{-6}.$$

Density of packing of the powder $= \frac{7.4644}{8.3822}$

$$= 0.8904.$$

Mass Susceptibility $= 41.759 \times 10^{-6} \div 0.8904$

Gm. mol. Susceptibility $= \frac{41.759 \times 10^{-6} \times 208.8}{0.8904}$

$$= 9792 \times 10^{-6} \text{ CGS emu.}$$

Correction should be applied for diamagnetism of the rest of the molecule:

$$\chi_{Pyridine} = -0.623 \times 10^{-6} \times 79.05 = -49.25 \times 10^{-6}$$

$$\chi_{Cl} = -22.2 \times 10^{-6}$$

$\chi_{Py} + 2\chi_{Cl} = -93.7 \times 10^{-6} \approx -94 \times 10^{-6}$.

Corrected value of χ_M of $CoCl_2 \cdot Py = (9792 - 94) 10^{-6}$

$= 9698 \times 10^{-6}$ C.G.S. e.m.u.

We know, $\chi T = N \cdot g^2 \beta^2 / 3K$ where

the Bohr Magneton $\beta = 9.174 \times 10^{-21}$ erg/gauss.

Boltzmann Const $K = 1.371 \times 10^{-16}$ erg/degree

Avogadro number $N = 6.064 \times 10^{23}$ per mole

$$\therefore \quad g = \frac{1}{\beta}\sqrt{\frac{3K \times 9698 \times 300 \times 10^{-6}}{6.064 \times 10^{23}}}$$

$$= \underline{4.84} \text{ Bohr Magnetons.}$$

(as against 4.89 reported by Brode J.A.C.S. <u>53</u>, 2457, 1931)

II CoCl$_2$ · n Py :

Prep: Cobaltous chloride hexahydrate, dehydrated at 160° C, is treated with excess of Pyridine (corresponding to more than six molecules of Pyridine) in small quantities at a time, and is boiled up. On cooling, a red crystal-mass results (Reitzenstein)

Analysis: Estimation of Cl content in the form of AgCl, gave a molecular weight of 480 for the substance.

[Molecular Wt. of $CoCl_2 \cdot 4Py$ = 446 and that of
$CoCl_2 \cdot 6Py$ = 525]

The substance is probably a mixture of the tetrapyridyl derivative with small amounts of the hexapyridyl derivative – (Lang. Ber 21, 1588, 1888).

Mean susceptibility measurement gave volume susceptibility $\chi = 21.09 \times 10^{-6}$.

III $CoCl_2 \cdot 4Py$:

Preparation: 1) To an aqueous solution of cobaltous chloride, excess of Pyridine (Reitzenstein Z. anorg. Chem 11, 255, 1896) is added. On

b) 0·2189 gms of the crystals heated at 116–120°C lost 0·1150 gms of Pyridine (as against the theoretical loss of 0·1164 gms).

The light blue powder that remained was analysed for its Cl content.

0·1009 gms of the residual substance gave 0·1377 gm of AgCl.

$$\therefore \text{Cl content} = \frac{0{\cdot}1377}{0{\cdot}1009} \times \frac{35{\cdot}46}{143{\cdot}4} \times 100 = 33{\cdot}77\%$$

while theoretically, for $CoCl_2 \cdot Py$, it would be 33·95%.

crystallisation, peach-red well-developed crystals separate out.

Analysis: a) 0.2564 gms of the crystals yielded 0.1662 gm of AgCl.

$$\therefore \text{Cl content} = \frac{0.1662}{0.2564} \times \frac{35.46}{143.4} \times 100 = 16.03\%.$$

While, theoretically, it would be $\frac{70.92}{446.1} \times 100 = 15.90\%.$

← b)

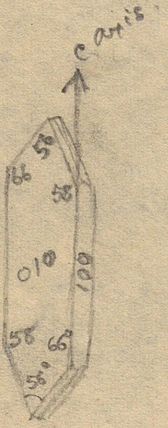
2) Finely powdered Cobaltous chloride is treated with excess of Pyridine and thoroughly stirred to make it into a paste. This is dissolved in absolute alcohol, with the aid of heat, then filtered and kept for crystallisation in a sulphuric acid desiccator. Violet red crystals obtained.

Analysis: Molecular weight of the recrystallised substance (washed with alcohol and ether) as calculated from the Cl content by estimating as AgCl — was 444.8, as against the

Magnetic measurements:

To prevent rapid decomposition of the crystals, they were given a thin coating of shellac in pyridine. This method was found quite satisfactory inasmuch as the magnetic measurements could be completed with each crystal before the whitish crust came up. The crust formation resulted in a rapid fall in anisotropy by as much as 25%.

The pole faces of the electromagnet were rectangular and measured 8" × 5" and the pole gap measured $\frac{25}{32}$ inch. The field was tested for uniformity by exploring with a pyrene crystal suitably suspended by a fine quartz fibre. In a value of 900 degrees for α_c, a variation of $\pm 3^\circ$ was noticed. The residual field was measured by a Fluxmeter and amounted to ≈ 110 Gauss.



From (1), $\psi = 90°$.

From 1 & 2,

$$\chi_3 - \chi_1 = \frac{90}{0.559} = 161.$$

[From 2, $\chi_3 - \chi_2 = 2200.$

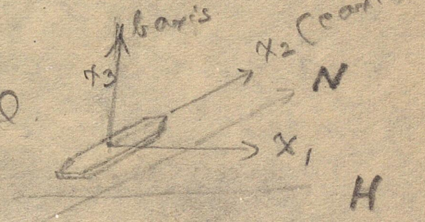
From 1, $\chi_1 - \chi_2 = 2030$

$\therefore \chi_3 - \chi_1$ should be 170]

The magnetic anisotropy was measured using the method of K. S. Krishnan and S. Banerjee (Phil Trans. Vol 234, 265, 1935). The strength of magnetic field used in these measurements was 2120 Gauss.

Anisotropy values.

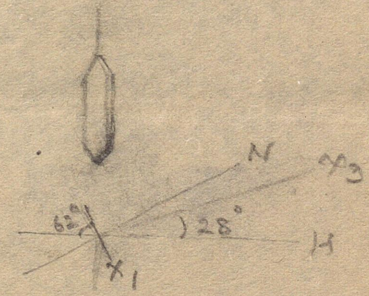
1. Suspension: b axis vertical



Orientation: c axis sets normal to field.

$\chi_1 - \chi_2 = 2030$

2. Susp: c axis vertical



Orient: (010) face sets at 62° with field

$\Delta\chi = 90$

$\therefore (\chi_3 - \chi_1)(\cos^2 28 - \sin^2 28) = 90$

3. Susp: (100) face horizontal

Orient: 'c' axis normal to field

$\Delta\chi = \chi_3 - \chi_2 = 2200$

By the Guoy method, mean susceptibility comes out to be $\chi = 8300 \times 10^{-6}$, which after correction for diamagnetism of 4 Py and 2 Cl, amounts to 8540×10^{-6}.

$$p = \frac{1}{\beta}\sqrt{\frac{3K \times 8540 \times 10^{-6}}{N}} = 4{\cdot}54 \text{ Bohr magnetons}$$

(Brode, J.A.C.S. <u>53</u>, 2457, 1931, also reported 4·54)

IV α. $CoCl_2.2Py$:

Cobalt bis pyridyl chloride is known to exist in two modifications: the alpha variety which is violet and stable at lower temperatures, and the beta variety which is blue and stable at higher temperatures.

<u>Preparation of the alpha variety</u>: 1) Hydrated cobaltous chloride is finely powdered and treated with Pyridine in small amounts, whereby blue colour appears. With a little absolute alcohol, this is boiled. On cooling, pale mauve

needles separate out, which are washed with cold alcohol and ether — (Reitzenstein — Lieb. Ann. 282, 275, 1894).

Needles of a size big enough for magnetic work were obtained by recrystallization from Chloroform solutions at room temperature.

Analysis: The Cl content of the crystals was estimated by titration of decinormal silver Nitrate solution. The molecular weight of the compound comes out to be 291 (as against the theoretical value 288).

2) The tetrapyridyl derivative is allowed to decompose in a sulphuric acid desiccator. It crumbles to a powder partially light violet and partially blue.

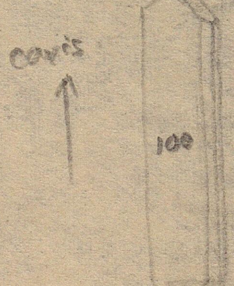
The Molecular weight of this powder, obtained by estimating the Cl content in the form of AgCl is found to be 286.5, as against the theoretical value 288, for $CoCl_2 \cdot 2Py$. Thus this powder is the bis-pyridyl derivative — (Hantzsch . . . .).

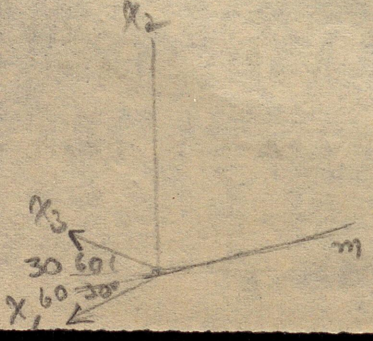
This powder is boiled with alcohol and re-crystallised (from Chloroform, solution) ~~over sulphuric acid~~, at room temperature, over sulphuric acid.

2) Method of Cox and Co-workers – J. C. S. 1556, 1937.

26 gms of hydrated cobaltous chloride are triturated with 16 gm of Pyridine and the mixture extracted with hot absolute alcohol. On cooling, pale mauve needles separate out, which are washed with cold alcohol and ether and recrystallised from chloroform solution at room temperature.

Properties: The deep violet needles are strongly dichroic (violet-red and grey axial colours), showing nearly straight extinction.


c axis
100


X_2
X_3
30
60
60
30°
X_1
m

Cox and Coworkers report these to be monoclinic, the forms in the needle zone being a {100} and m {110}, a ∧ m being 61° approx, and the axial dimensions $a = 17.2$, $b = 34.1$, $c = 3.65$ A, $\beta \approx 90°$.

They dissolve in cold water giving a red-coloured solution. On long exposure to air, the crystals slowly decompose evolving pyridine and develop a powdery crust which is blue at first and finally red. They do not change easily if placed in a desiccator over conc H_2SO_4 — (Otto Stelling: Zeits Phys Chem. 16, 303, 1932). In humid weather, the crystals absorb moisture and dissolve therein — deliquescent.

Magnetic anisotropy measurements.

	Susp.	Orient.	$\Delta\chi$
i	c axis vertical :	100 face along field	$\chi_3 - \chi_1 = 620$
ii	a (100) face horiz.	c axis normal to field	$\chi_3 - \chi_2 = 3660$.

α CoCl$_2$·2Py :

i $x_3 - x_1 = 620$.

ii $x_3 - x_2 = 3660$.

iii $x_1 - x_2 = 3030$.

$\left.\begin{matrix} x_3 - x_2 = 3660 \\ x_1 - x_2 = 3030 \end{matrix}\right] \therefore x_3 - x_1 = 630$

iv $x_1 \cos^2 30 + x_3 \sin^2 30 - x_2 = 3190$

But $x_1 - x_2 = 3030$

$\therefore (x_3 - x_1) \sin^2 30 = 160$.

$\therefore x_3 - x_1 = 640$ (exptl value 620)

v $x_1 \sin^2 30 + x_3 \sin^2 60 - x_2 = 3500$.

$x_1 - x_2 = 3030$.

$\therefore (x_3 - x_1) \cos^2 30 = 470$

$\therefore x_3 - x_1 = 470 \times \frac{4}{3} = 627$ (exptally 620).

Using $x_3 - x_2 = 3660$, & $x_1 \cos^2 30 + x_3 \sin^2 30 - x_2 = 3190$,

we get $x_3 - x_1 \cos^2 30 - x_3 \sin^2 30 = 470$.

$(x_3 - x_1) \cos^2 30 = 470$.

$\therefore x_3 - x_1 = 470 \times \frac{4}{3} = 627$

(exptl value 620)

iii a(100) face vertical. 'c' axis normal to field $\chi_1 - \chi_2 = 3030$
& c axis horiz.
(ie b axis vertical)

iv m(110) face horiz. c axis normal to field. $\Delta\chi = 3190$.
(and needle length horiz)

v m(110) face vert. " $\Delta\chi = 3500$
(needle length horiz)

Magnetic moment $p_B = 5.34$ (Barkworth & Sugden).

V β $CoCl_2 \cdot 2Py$:

Preparation: Obtained as deep blue crystals by evaporating on a water bath, a chloroform solution of the alpha variety. (Cox et al).

Analysis: Cl was estimated by titrating the aqueous solution against decinormal $AgNO_3$ soln. The molecular wt of the crystals obtained by this method was 293 (as against the theoretical value of 288).

Properties: Well developed crystals showing dichroism (deep violet and deep blue axial Colours) which soon break down to a pale blue powder on exposure to the atmosphere, eventually transforming to a violet powder, without loss of weight.

Cox and Coworkers report it to be Orthorhombic combination of a prism 'm' with a pinacoid 'a' ($a \wedge m = 65°$), the length of the prism axis being $c = 8.30$ A. this is a symmetry axis and appears to be the shortest cell dimension.

Magnetic measurements:

The crystals develop a bluish crust which soon turns light violet red. There is no resultant change in mass of the crystals. Anisotropy values, however, rapidly increased by as much as $\frac{4}{3}$ times in about 36 hours; thereafter these ~~values~~ remained stationary at the enhanced values.

1. Flat face horizontal.

Orient: Long edge makes 8° to field normal.

$$\Delta\chi = 680 \times 10^{-6}$$

2. Long edge vertical.

Orient: Flat faces set at 64° with field.

$$\Delta\chi = 235 \times 10^{-6}$$

3 Long edge horizontal and flat faces vertical.

Orient: Flat face makes 72° with field.

$$\Delta\chi = 920 \times 10^{-6}.$$

Magnetic moments: reported ~~by Barkworth & Sugden was γ_B = 4.60; and~~ by Brode that γ_B was less than 4.58; Barkworth & Sugden obtained in successive expts, 4·62 and 4·58 while they expect the true value to be slightly lower.

Approximate values for the dispersion of Hilger Quartz E_1 and E_2 Spectrographs in different regions of the spectrum.

Range in A.U.	E_1 Dispersion in mm. per 100 A.U.	per 1000 cm^{-1} (wave numbers)	E_2 Dispersion in mm per 100 A.U.	per 1000 cm^{-1}.
5,000 to 4,000	5·8	12	2·1	4·2
4,000 to 3,500	9·8	14	3·6	5·0
3500 to 3000	16·6	17	5·0	5·3
3000 to 2500	28·6	21	9·6	7·2
2500 to 2,000	56·2	28	20·6	10.

23rd Jan 1930

Regarding the Raman band of methyl alcohol at about λ 4170

$$\frac{1}{4170} + \frac{1}{\underset{5780}{\text{yellow doublet}}} = \frac{1}{2423}.$$

that due to 5461 falls on 4358 lines

due to 4358 ——— 5450.

$$\frac{1}{4170} + \frac{1}{5460} =$$

11th Mar. 30

Values for the susceptibility of Calcite

Stenger Wied. Ann. 20, 304 (1883); 35, 331 (1888)

$\chi_{\parallel} - \chi_{\perp}$ per unit vol. $= -7.9 \times 10^{-8}$ to -9.0×10^{-8} depending on the crystal specimen examined.

and König between -10.8×10^{-8} and -11.6×10^{-8}. (Wied. Ann. 31, 273 1887)

mean -11.35×10^{-8}

Taking the density of $CaCO_3$ as 2.71 the above results correspond to a gm. mole. susceptibility diffce betn ∥l + ⊥r inductions of –.

	$-\Delta\chi_{\text{per gm mol.}} \times 10^{6}$	
Stenger.	2.91 to 3.32	
König.	3.98 to 4.28	mean value 4.19 (quoted here)

Voigt & Kinoshita (Ann d. Physik 24 492. 1907)

by absolute measurement get

$\chi_{\perp} = -9.87 \times 10^{-7}$ & $\chi_{\parallel} = -11.0 \times 10^{-27}$

which corresponds to gm mole. susceptibilities

of -40.6×10^{-6} for $\chi_{\parallel}$ gm mol.

& -36.4×10^{-6} for $\chi_{\perp}$ gm mol.

$$\Delta\chi_{\text{gm mol}} = -4.2 \times 10^{-6}$$

Tyndall gets for $\frac{\chi_{\parallel}}{\chi_{\perp}}$ the value $100/91.7$

with one specimen

and assuming the absol. value of $\chi_{\parallel}$ of

Voigt

~~$\Delta\chi = 3.65 \times 10^{-6}$ for gm. molec.~~

$\Delta\chi = -3.4 \times 10^{-6}$ per gm molec.

In another expt he obtained $\chi_{\parallel}/\chi_{\parallel} = 180/90$

which gives $\Delta\chi = -4.1 \times 10^{-6}$ per gm molec.

Tyndall thinks the latter value by ~~far~~ preferable

Quartz

König

$\Delta\chi = -62 \times 10^{-10}$ per unit volume

$\rho = 2.65$
~~$M = 60.03$~~
$M = 60.0$.

$= -0.14 \times 10^{-6}$ pr gm molec.

Stenger

$$\Delta\chi = \frac{\cancel{4.5}\; 45 \times 10^{-10}}{\sin^2 88.45^\circ} \text{ pr c.c.}$$

$= -45 \times 10^{-10}$ pr cc $= -0.10 \times 10^{-6}$ pr gm mol

in another expt. -50×10^{-10} pr cc $= 0.12 \times 10^{-6}$ pr gm. mol.

Voigt & Kinoshita

abs. measurements

~~$\chi_{\parallel} = -4.66 \times 10^{-7}$~~

$$\left.\begin{array}{l} \chi_{\parallel} = -\ 28.1 \times 10^{-6} \\ \chi_{\perp} = -\ 27.8 \times 10^{-6} \end{array}\right\} \text{pr gm molec.}$$

so that the diffce ΔX comes out as

$\underline{0.3 \times 10^{-6}}$ per gm mol.

~~Bismuth~~ Bismuth

~~$\frac{\chi_{\parallel}}{\chi_{\perp}} = \frac{100}{71}$ according to Tyndall.~~

$\frac{\chi_{\parallel}}{\chi_{\perp}} = \frac{67}{100}$ Hankel (Quoted in Graetz $\overline{IV}$, 836)

$= \frac{71}{100}$ Tyndall.

For compression of powdered bis $\frac{\chi_{\text{along axis of compress.}}}{\chi_{\perp \text{ to axis of compress}}} = \frac{100}{66}$.

Starting with a cube of cryst. bismuth + compressing along axis

~~$\chi_{\perp}$~~ $\frac{\chi_{\text{along axis of compress}}}{\chi_{\perp \text{ to axis of comp}}} =$

=

Paramagnetic Crystals.

Tyndall $FeCO_3$ $\frac{\chi_{\parallel}}{\chi_{\perp}} = \frac{100}{71}$

(Sulphate of iron) $FeSO_4$? $\frac{\chi_{\parallel}}{\chi_{\perp}} = \frac{100}{85}$

Other uniaxial crystals.

Dia	Sb.	$\chi_{\parallel}/\chi_{\perp} < 1$
"	As	"
"	Ice	"

Pseudo axis of Symmetry.

Iron Sulphate $$\frac{\chi_{\parallel}}{\chi_{\perp}} = \frac{100}{85}.$$

Ref. indices of benzene

at 20°

D	·589	1·501
TR.	·535	1·506
	·3600	1·549

15   5 4   5

15   1½

·550   1·504?

3131 doublets.

The rotatory couple acting on a uniaxial magnetic crystal suspended in a ~~magnetic~~ homogeneous field, ~~with its axis~~

$$= \sigma H^2 (\chi_2 - \chi_1) \sin^2\theta \sin\psi \cos\psi$$

where σ is the volume, χ_1, χ_2 vol suscep.s.

$\theta = \angle^{le}$ betw the axis of crystal & axis of suspension

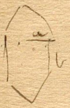
and $\psi = \angle^{le}$ betw the equitorial plane and the plane containing the axis of the crystal & that of the suspension.

20/3/30

The Ultra violet ~~absorption~~ frequency of Naphthalene molec.

= 32455 cm^{-1}

as compared with 38600 of benzene.



Cuthbertson from dispersion formula of type $\mu - 1 = \dfrac{C}{n_0^2 - n^2}$ n_0 natural frequency.

Gas.	n_0^2	$\lambda_0 \times 10^8$
O_2	12,804	838·4
N_2	17,095.	725·6
H_2	12,409	851·6

Benzene Scattering

Amalemon.

For the liquid r = 0·42 constant.

For vapour

new values for 2θ	θ	r	r. corrected for deviation from Boyle's law	A/C = B/C
23 ·55 μ	12°	·045 $\cdot 041_5$	·048 ·044	2·05
24½ ·36 μ	13°	·053 ·047	·056. ·050	2·24

Now taking the molecular refractivity for benzene as 26.36 for ·55 μ and 28·3 for ·36 μ, and assuming the anisotropy is wholly due to 6 equivalent isotropic doublets ~~in a plane~~, symmetrically distributed on a plane,

2A + C = 18 μ. ~~where μ is the moment of each doublet~~

$$C = \frac{6\mu}{1 + \theta\mu}\,, \quad A = B = \frac{6\mu}{1 - \frac{1}{2}\theta\mu}$$

where μ is the moment ~~[illegible]~~ of each doublet and θ a const. characteristic of the geometry of the molecule.

$2A + C = 18\mu$ to a 1st approximation

and $$\frac{A}{C} = \frac{1 + \theta\mu}{1 - \frac{1}{2}\theta\mu}$$

From refractivity, $\mu = 1{\cdot}73 \times 10^{-24}$ for $\lambda 5500$.

and $1{\cdot}86 \times 10^{-24}$ for $\lambda\,3600$.

Putting $$\frac{1 + 1{\cdot}73 \times 10^{-24}\,\theta}{1 - {\cdot}87 \times 10^{-24}\,\theta} = 2{\cdot}05$$

θ comes out as ${\cdot}299 \times 10^{24}$.

~~[illegible]~~ Using this value of θ the value of A/C for $\lambda 3600$ comes out as

$$\frac{1 + {\cdot}299 \times 1{\cdot}86}{1 - {\cdot}150 \times 1{\cdot}86} = \overset{2{\cdot}16}{\cancel{2{\cdot}17}}$$ which

corresponds to $r = 5{\cdot}4\%$ as against 5·6 % observed.

Coming to the liquid. (See an earlier page)

$\underline{\underline{\lambda = 5500}}$

$$F = \text{an log. } \overline{54}\cdot6277 \times \frac{MT\beta'(\mu^2-1)^2}{\Delta} \quad \frac{r}{6-7r}$$

Now from vapour scattering & ref. index, for the

λ5500 line $\quad 2A + C = 31\cdot15 \times 10^{-24}$

$$A = B \quad = 12\cdot52 \times 10^{-24}$$

$$C = 6\cdot11 \times 10^{-24}.$$

$r = \overset{\cdot141}{\cdot\cancel{142}} \qquad T = 303 \qquad M = 78\cdot05$

$\beta' = 103 \qquad \mu^2 = 2\cdot245 \qquad \Delta = \cdot8683$

$$F = \text{an log. } \overline{47}\cdot\overset{0756}{0\cancel{143}} \times (\mu^2-1)^2 \cdot \frac{r}{6-7r}.$$

$$\therefore A' - C' = 5\cdot61 \times 10^{-24}$$

$$= A - C + X\left(A\mu_1 - C\mu_3\right)$$

$$A - C = 6\cdot41 \times 10^{-24}.$$

$$A\mu_1 - C\mu_2 = -\frac{\cdot80 \times 10^{-24}}{X} = -8\cdot1\cancel{7} \times 10^{-24}$$

$$12\cdot52\,\mu_1 - 6\cdot11\left(4\pi - 2\mu_1\right) = -8\cdot1 \cancel{\times 10^{-24}}$$

$$24\cdot74\,\mu_1 = \begin{array}{r}76\cdot8\\ 8\cdot1\\ \hline 68\cdot7\end{array}$$

$$\mu_1 = \mu_2 = 2\cdot78$$

$$\mu_3 = 7\cdot01$$

$\underline{\lambda = 3600}$

$$\mu^2 = 2\cdot374.$$

$$2A + C = 33\cdot35 \times 10^{-24}$$

$A =$ ~~$13\cdot63$~~ $\times$ " $\quad 13\cdot60 \times \cdots$

$C =$ ~~$6\cdot09$~~ $\times$ ~~[illegible]~~ $\quad 6\cdot15 \times \cdots$

$$A' = 17\cdot75 \times 10^{-24}$$

$$C' = \underline{10\cdot86} \times 10^{-24}$$

$A' - C' =$ ~~$7\cdot00 \times 10^{-24}$~~. $\quad 6\cdot85 \times 10^{-24}$

$F = \frac{1}{15} \times (A' - C')^2$ ~~$= \text{antilog } \overline{46}\cdot8663.$~~

~~$\frac{r}{6-7r} = \frac{\text{antilog } \overline{46}\cdot8663}{\overline{47}\cdot0143} \times \frac{1}{1\cdot374^2}$~~

$$\frac{r}{6-7r} = \frac{49 \times 10^{-48} \times 6\cdot85^2}{15 \times \text{antilog } \overline{47}\cdot0143 \times 1\cdot374^2}$$

$= \cdot$~~168~~. $\cdot161$

whence $r = \underline{\underline{\cdot40}}$

~~whence $r = \cdot0446$~~

$=.$

Recalculation with the new values

	2θ	r	r_0
5500 A U	23°	$\cdot 041_5$	·044
3600 A U.	$24\frac{1}{2}$°	·047	·050

taking $\mu = 1{\cdot}73 \times 10^{-24}$ for λ5500.

d ~~= 1·96~~

$\frac{A}{C}$ for this line = 1·96

θ becomes $= {\cdot}280 \times 10^{24}$

whence taking μ for λ3600 = 1·86

$\frac{A}{C} = 2{\cdot}05$ $r_0 = {\cdot}048$

as against ·050 obsd.

For liquid For 5500 A U.

$2A + C = 31{\cdot}15 \times 10^{-24}$

$A/C = 1{\cdot}96$

$\therefore A = 12{\cdot}41$ $A - C = 6{\cdot}08$

$C = 6{\cdot}33$

$A' - C' = 5{\cdot}95 \times 10^{-24}$

$A\mu_1 - C\mu_2 = -\frac{0{\cdot}13}{X} \times 10^{-24}$ $= -$ ~~5·08~~ $1{\cdot}3_+ \times 10^{-24}$

where ~~$\mu_1 = \mu_2$~~ $\mu_1 = 3{\cdot}0$

~~[illegible]~~ $\mu_2 = 6{\cdot}4$

$\lambda = 3600$ $\quad \mu^2 = 2{\cdot}374$

$2A + C = 33{\cdot}35 \times 10^{-24}$

r_0 vapour $=$ $\cdot 050$ $\qquad \frac{A}{C} = 2{\cdot}09$

$A = $ ~~[illegible]~~ $13{\cdot}45 \times 10^{-24}$

$C = 6{\cdot}44 \times 10^{-24}$

$A' = $ ~~17·86~~ ~~18·26 × 10⁻²⁴~~ $17{\cdot}99 \times 10^{-24}$

$C' = $ ~~11·09 × 10⁻²⁴~~ $= 10{\cdot}92 \times$ ″

$A' - C' = $ ~~6·77 × 10⁻²⁴~~ $= 7{\cdot}06 \times 10^{-24}$

~~R = [illegible] 47·8378~~

$$\frac{r}{6-7r} = \frac{[illegible] \times 7{\cdot}06^2 \times 10^{-48}}{15 \times \text{antilog}\, \overline{47}{\cdot}0756 \times (\mu^2 - 1)^2} = \cancel{\cdot [illegible]}\ \cdot 145$$

$r =$

8

Investigate Polarisation of classical scattering for diff- wave lengths – preferably in the proximity of an absorption band.

eg C_6H_6 + CS_2 — C_6H_5-NO_2

L. F. Bates B Sc., PhD. F Inst P.
Univ. College London.

Roscoe G. Dickinson and Rober T. Dillon
Gates Chemical laboratory California
Inst. of Technology →

Infra red absn. of methyl halides —
Bennet + Meyer Phys Rev. 32, 888 (1928)

Negative absn.

H. Kopfermann & R Ladenburg – Zs. Phy Chem.
<u>139</u>, 375, 1928

molecular rays

J. Estermann Zs Phys. Chem. B 1., 161 (1928). — also 2., (4) 289 (Mar 1929)

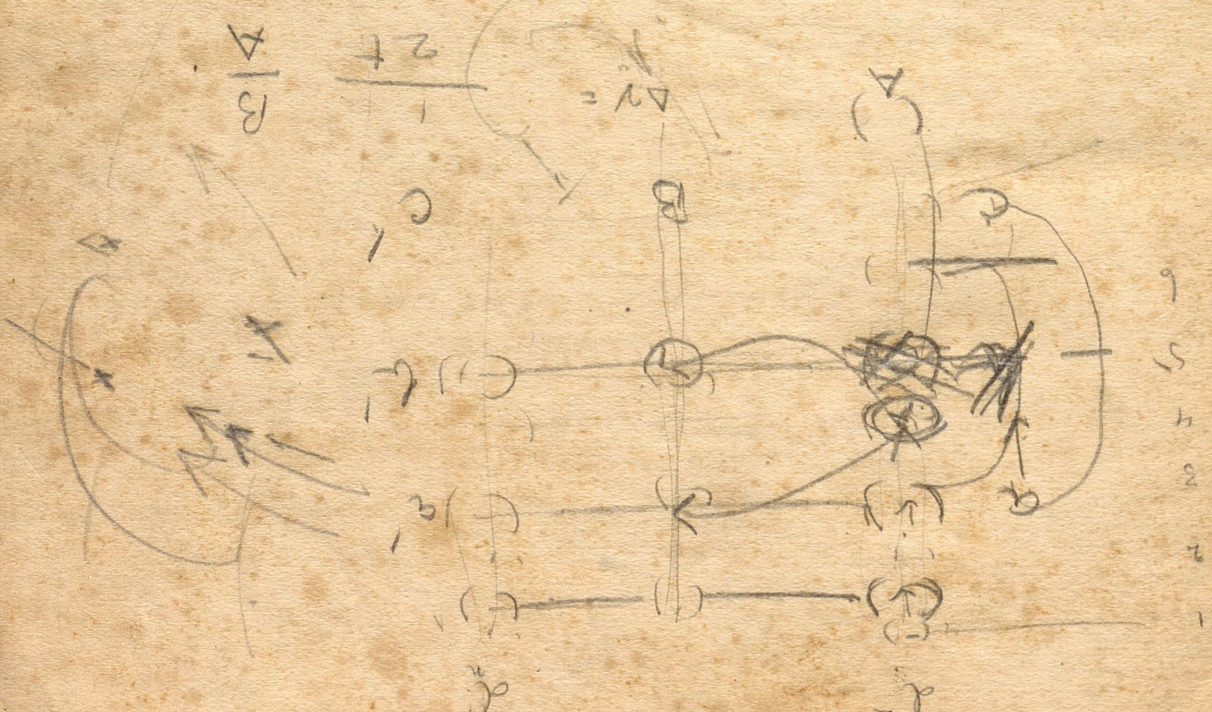
Diffractn of Electrons by Mica — S. Kikuchi

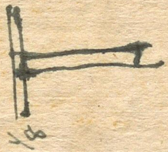
Proc. Imperial Academy of Tokyo – Oct 1928.

Diffraction by Grating – E. Rupp – Zeits. Phys. 52, 8, 1928.

Probleme der Modernen Physik – Edited by P. Debye (S. Hirzel Leipzig. [illegible], 1928) A collection of monographs dedicated to Prof. Sommerfeld on his 60th Birthday.

The Physical Review Supplement. – (Quarterly)

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