

Curve (1) gives the values of the refractive indices at temperatures between  $0^{\circ}$  and  $9^{\circ}$ , as determined by the experiments, of which an account has been given in this paper; and curve (2) the densities of water at the same temperatures as given in Lupton's 'Numerical Tables' (p. 28).

These curves show clearly that no formula representing the variation of the refractive index of water with the temperature, as a function of the density only, can be a complete expression of the facts of the case.

- IV. "On the Magnetic Rotation of the Plane of Polarisation of Light in Liquids. Part I. Carbon Bisulphide and Water." By J. W. RODGER, Assoc.R.C.S., Demonstrator of Chemistry, and W. WATSON, B.Sc., Assoc.R.C.S., Demonstrator of Physics, Royal College of Science, London. Communicated by Professor A. W. RÜCKER, F.R.S. Received June 1, 1895.

(Abstract.)

The aim of this investigation is the determination in absolute measure of the magnetic rotation of liquids at different temperatures, the effect of the chemical nature of the liquid on this property, and its correlation with other physical properties.

The present communication contains a description of the apparatus and method of experiment, and the results obtained with the standard liquids, carbon bisulphide and water, for sodium light, in a magnetic field of constant intensity, and at different temperatures between  $0^{\circ}$  and the ordinary boiling point.

The magnetic field was produced by means of a helix consisting of two separate coils, either of which, if desired, could be used separately. During the process of winding, the dimensions of each layer were carefully determined, and every precaution was taken to ensure good insulation.

The liquid under examination was contained in a glass tube closed by very thin glass plates. This tube was surrounded by a brass jacket, which passed through the coils. Observations could be made at different temperatures, and the temperature could be kept constant while making a set of readings by causing water, or the vapour of liquids boiling under different pressures, to circulate through the jacket.

Special pains were taken to obtain monochromatic light, with the result that in the case of carbon bisulphide, where the double rotation amounted to  $40^{\circ}$ , there was no trace of coloration.

The ultimate standard of current was a silver voltameter, a Kelvin deci-ampère balance being used as an intermediate standard.

In the case of carbon bisulphide three different samples were used, and identical results were obtained with three separate coils. In the following table are collected the mean values of the boiling point (b. p.), density at  $0^\circ$  ( $\rho_0$ ), and Verdet's constant at  $0^\circ$  ( $\gamma_0$ ). Verdet's constant may be defined as the rotation in minutes of arc produced in a column of liquid when the difference between the magnetic potentials at the ends of the column is equal to one C.G.S. unit.

	B. p.	$\rho_0$ .	$\gamma_0$ .
CS <sub>2</sub> No. 1 .....	46°25	1·29271	0·04348
CS <sub>2</sub> No. 2 .....	46°26	1·29282	0·04347
CS <sub>2</sub> No. 3 .....	46°26	1·29283	0·04347

It will be seen that the three different samples give practically identical values for the three physical constants.

The results obtained for the rotation of carbon bisulphide may be summed up in the following equation, where  $\gamma_t$  is the value of Verdet's constant at the temperature  $t$ ,

$$\gamma_t = 0\cdot04347 (1 - 0\cdot001696t),$$

or

$$\gamma_t = 0\cdot04347 - 0\cdot0_4 737t.$$

The expression connecting rotation and temperature is therefore linear.

In the case of water the results are best represented by

$$\gamma_t = 0\cdot01311 (1 - 0\cdot0_4 305t - 0\cdot0_6 305t^2),$$

or

$$\gamma_t = 0\cdot01311 - 0\cdot0_6 4t - 0\cdot0_7 4t^2.$$

Here the rate of change of the rotation with temperature increases as the temperature rises.

The following table gives the values of the rotation of water and carbon bisulphide at every  $10^\circ$  between  $0^\circ$  and the boiling point, as well as the values of the quotient ( $\gamma/\rho$ ), obtained by dividing the rotation by the density.

In the case of water the quotient  $\gamma/\rho$  is practically constant up to  $20^\circ$ , it then very slowly *increases*, the rate of increase between  $20^\circ$  and  $100^\circ$  being practically constant.

For carbon bisulphide the quotient  $\gamma/\rho$  *decreases* at a constant rate as the temperature rises, the rate of decrease being very much greater than the rate of increase in the case of water.

<i>t.</i>	Water.		Carbon bisulphide.	
	$\gamma$ .	$\gamma/\rho$ .	$\gamma$ .	$\gamma/\rho$ .
0	0·01311	0·01311	0·04347	0·03362
10	0·01310	0·01311	0·04273	0·03344
20	0·01309	0·01311	0·04200	0·03325
30	0·01306	0·01312	0·04126	0·03307
40	0·01303	0·01313	0·04053	0·03288
50	0·01299	0·01315		
60	0·01294	0·01316		
70	0·01289	0·01318		
80	0·01282	0·01319		
90	0·01275	0·01321		
100	0·01267	0·01322		

The measure of the molecular rotation which is usually employed in chemical investigations is

$$(M\gamma/\rho)_{\text{substance}} / (M\gamma/\rho)_{\text{water}},$$

where *M* is the molecular weight. Although the authors postpone a detailed discussion of the validity of this expression, they show that for carbon bisulphide, at any rate, its value changes with the temperature, and hence the conclusions obtained by its use regarding questions of chemical constitution, especially of tautomerism, are affected on this account.

They also point out that the above expression involves the properties of water. The only justification for the use of water in relative observations is the elimination of variations in the strength of the magnetic field in which the observations are made. If the temperature of observation is always the same, this can readily be done. If, on the other hand, the temperature varies, it is essential to know how the rotation of water alters with the temperature. In the past this alteration was unknown, and the arbitrary measure of the molecular rotation above referred to has come into use. Since an expression for the temperature variation has now been obtained it is to be hoped that observers will employ a measure of the molecular rotation which does not involve the properties of water. Indeed, other considerations make such a measure all the more desirable. Up till now the authors have made observations on eight liquids, besides water and carbon bisulphide, and in all cases except that of water the relation between rotation and temperature is linear, and the quotient, rotation divided by density, diminishes as the temperature rises. It is highly probable, therefore, that as regards magnetic rotation, as in the case of so many other properties, the

behaviour of water is exceptional, and hence it is particularly ill suited for the use to which it has been put. Again, on account of the smallness of the rotation in water, the unavoidable inaccuracies in determining its rotation, and thus estimating the strength of the magnetic field, produce a larger percentage error in the results than if a liquid, such as benzene, having a considerably higher rotation than water, were used for this purpose.

V. "The Influence of the Cerebral Cortex on the Larynx."

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(From the Pathological Laboratory of University College, London.)

(Abstract.)

This research was undertaken in order to attempt to differentiate an abductor centre in the cerebral cortex of the dog, but, as several new observations were made during the course of the investigation, similar experiments were performed in the cat in order to compare the results obtained in this animal with those obtained in the dog.

Among the preliminary considerations was the question as to what influence the condition of the peripheral laryngeal apparatus in an animal has on the effects obtained from its central nervous mechanism, and the conclusion arrived at was that the influence must be comparatively insignificant, as abduction or adduction of the vocal cords could be obtained on excitation of the appropriate area of the cerebral cortex, irrespective of whether abduction or adduction was obtained on excitation of the recurrent laryngeal nerves in the same animal.

No evidence of unilateral representation of the movements of the vocal cords in the cerebral cortex was obtained; and in testing this point one recurrent laryngeal nerve was divided transversely, when it was found possible to influence the vocal cord whose nerve was intact, with equal ease on stimulation of either cerebral hemisphere.

The question of inhibition of antagonistic muscles by electrical excitation of the cerebral cortex, on the lines adopted by Sherrington with regard to antagonistic muscles in other parts of the body, was tested by first dividing the adductor fibres in both recurrent laryngeal nerves, leaving the abductor fibres intact, and then exciting the adductor centre with strong induced currents; but no evidence of inhibition of the abductor muscles was obtained.

The major part of the paper deals with the movements of the vocal cords which could be evoked on excitation of different foci in the cerebral cortex. It was found that both in the dog and cat there