

tinuous form of discharge into the discontinuous agrees entirely with the results previously obtained by approaching the positive to the negative pole. If we denote as the positive direction of the glow-rays that which issues from the bright kathode-layer, many discharges occurred so long as a union of the positive electricity could take place in the negative direction with the glow-rays; but as soon as that was no longer the case, much fewer discharges occurred. Exactly the same is the case here, so long as the glow-rays have not all been deflected from the axis of the tube to the side; the positive light can still unite with them in the negative direction. But as soon as a complete deflection has taken place, we have exactly the same case as if the positive electrode were behind the bright kathode-layer, and the discharge becomes continuous.

[To be continued.]

IV. *On Molecular Latent Heat.*

By FREDERICK TROUTON, *Trinity College, Dublin*.*

ON comparing the quantities of heat necessary to evaporate at constant pressure quantities of different liquids taken in the ratio of their molecular weights, it is found that the amount of heat required by any body is approximately proportional to its absolute temperature at the point of ebullition. For example, the latent heat of bromine is 45·9, it boils at 63°, and the density of the body is 79·75. The latent heat of butyric acid is 114·7, it boils at 162°, and its density is 44. The quantities of heat required to evaporate quantities of the bodies in the ratio of their molecular weights is obtained by multiplying the latent heat by the density; and the quantities thus obtained have an approximately constant ratio to the absolute temperatures of the boiling-points, thus:—

$$\frac{45\cdot9 \times 79\cdot75}{273 + 63^\circ} = 10\cdot89, \quad \frac{114\cdot6 \times 44}{273 + 162^\circ} = 11\cdot59.$$

This ratio is nearly constant for most bodies, but is still more nearly so for those bodies which are chemically related to each other.

The relation, then, may be put into this simple form. The molecules of chemically related bodies, in changing from the gaseous to the liquid state at the same pressure, disengage quantities of heat, which may be called the molecular-latent heat, directly proportional to the absolute temperature of the point of ebullition. The similarity is very striking

* Communicated by the Author.

between this statement and Dulong and Petit's law, namely that the specific heat multiplied by the atomic weight is a constant quantity.

The following alcohols form a fairly well-defined class, with which perhaps water may be placed:—

	I.	II.	III.	IV.
Water	537	9	100°	12·95
Methyl alcohol ...	263·7	16	55	12·86
Ethyl alcohol ...	202	23	79·7	13·17
Amyl alcohol ...	121	44	134	13·08
Cetyl alcohol ...	58·7	121	350	11·40

In column I. are arranged the latent heats, in column II. the densities, in III. the boiling-points of the bodies; and in column IV. are the products of the latent heat by the density divided by the absolute temperature of the boiling-point.

In the case of the following acids the theoretic densities of the first two are too small, owing to the vapour-densities being abnormally great at temperatures approaching the boiling-point. This is corrected for in formic acid in the ratio of 2·68 to 1·62, and acetic acid in the ratio of 3·19 to 2·08. Without the correction the numbers in the fourth column would be for formic acid 7·44, for acetic acid 7·86.

	I.	II.	III.	IV.
Formic acid	120·7	23	100°	12·31
Acetic acid	101·9	30	116	12·05
Butyric acid	114·7	44	162	11·59
Valeric acid	103·5	51	175	11·78

The following are the ratios in the case of a few methyl and ethyl salts:—

	I.	II.	III.	IV.
Methyl iodide ...	46·1	71	42°	10·38
Ethyl iodide.....	46·9	78	72	10·59

	I.	II.	III.	IV.
Methyl formate...	117.1	30	33 ^o	11.48
Ethyl formate ...	105.3	37	55	11.88

	I.	II.	III.	IV.
Methyl acetate ...	110.2	37	59 ^o	12.27
Ethyl acetate.....	99.0	44	75	12.45

The constant appears to be the same for the following bodies containing chlorine:—

	I.	II.	III.	IV.
Ethyl chloride	93	32.25	10 ^o	10.59
Chloroform	61	59.75	62	10.87
Carbon tetrachloride ...	47	77.00	78	10.31
Phosphorus trichloride...	51	68.75	73.8	10.75
Arsenic chloride	46	90.75	132	10.30
Stannic chloride	30.5	130.00	114	10.24

In the case of phosphorus trichloride, as above for acetic acid, a correction must be made, for a similar reason, in the ratio of 5.0 to 4.7. Without this correction the number would be 10.11.

	I.	II.	III.	IV.
Sulphur dioxide	94.5	32	-10 ^o	11.49
Carbon disulphide	86.7	38	+43	10.42
Ethyl oxide	91.1	37	34	10.97
Amyl oxide	69.4	79	176	12.20
Acetone.....	129.7	29	56.3	11.42
Benzene.....	94.2	39	80	10.40
Methyl butyrate	87.3	51	101	11.90
Turpentine	68.7	68	161	10.76
Ethyl oxalate	72.7	73	184	11.61
Bromine	45.9	80	63	10.89
Iodine	23.9	127	200	6.41

Iodine so far seems to deviate most from the above relation; but perhaps, owing to the nature of the body in question, the determination of the latent heat by Favre and Silbermann*, as given in this table, need not be considered final. It would appear that experiments have only once been undertaken with a view to determine the latent heat of iodine. In fact even the boiling-point 200° is only approximate.

V. *On a "Speed Indicator" for Ships' Propellers.* By Sir ARCHIBALD CAMPBELL of Blythswood and W. T. GOOLDEN†.

[Plate IV.]

IN February of last year, when visiting one of H.M. Dockyards, it was pointed out to us that a very urgent need was felt of some means of indicating with certainty the speed of naval engines, especially in ships carrying twin-screws, where the engines are not only distinct, but separated from each other by iron bulk-heads which prevent any communication between the two engine-rooms. The authorities intimated also that it was desired that several indications should be made simultaneously in various parts of the ship, and that the apparatus should be as far as possible automatic, and require no trouble or attention.

There are at present one or two instruments in existence for this purpose, but their indications are found to be untrustworthy when at sea; and we were warned that no instrument in which the force of gravitation played a part would be likely to receive any attention at the Admiralty. This consideration excludes the use of ball-governors or of any device depending on the weight of a fluid column; and led us to consider whether the desired conditions could not be fulfilled by a purely mechanical arrangement founded on the ordinary equation involving angular velocity,

$$v = r\omega.$$

It was at first difficult to see how this principle could be applied to a direct measure of ω , as no simple means are known whereby the variation in the velocity v of a point moving in a straight or curved path can be continuously measured. But it was soon apparent that the variable angular velocity ω of a body A can be compared with the constant

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