

XVII. "On the Vapour Densities of Potassium and Sodium."

By Professor JAMES DEWAR, M.A., F.R.S., and ALEXANDER SCOTT, B.A. Received June 12, 1879.

The ingenious method of determining the vapour densities of volatile bodies invented by Professor Meyer* suggested the revision of work done by one of us in connexion with Professor Dittmar,† on the vapour density of potassium. The new method possesses several advantages over that formerly employed, and seemed to be especially fitted to simplify the difficulties of working with substances having the chemical characters of the alkali metals. The fact that a constant temperature need not be maintained unless for a short time, and that all absolute determinations of temperature are unnecessary during the course of the experiments, renders Professor Meyer's system the simplest when the boiling point of the substance is above a white heat.

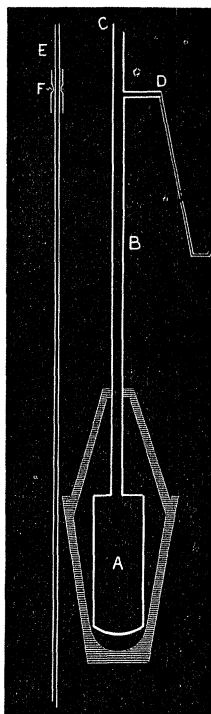
The apparatus used was simply a reproduction in wrought iron of Professor Meyer's glass one, on a somewhat larger scale. The bottle A had a capacity of 160—180 cub. centims. The tube B was about 2 feet long and in diameter about .5 inch. A and a considerable part of B was coated with a glaze of borax and then fitted between two crucibles as in figure, and the crucibles filled with fine sand as completely as possible.

This apparatus kept a tolerably constant temperature for a considerable time even when the furnace temperature varied considerably, as it was only slowly affected, owing to the mass of the crucibles and sand surrounding it. The chief difficulty at first was the diffusion of the furnace gases, especially carbonic oxide, through the hot iron. This, however, seems to be completely prevented by the borax glaze. To ensure success, especially in the cases of potassium and sodium, it was found to be essential to clean the apparatus by treatment with dilute hydrochloric acid to remove the larger part of the oxide of iron, then to fuse in it some caustic potash, and thus get rid of the silica, &c., used in the welding in of the tube and bottom of A, after boiling several times with water to dissolve out the potash, it was again treated with dilute hydrochloric acid, and then thoroughly washed and dried. The crucibles were arranged of such a height that the iron was in no place exposed to the gases of the furnace. The fuel used was gas carbon broken into pieces the size of walnuts, this gave a very constant temperature, and the furnace fed with it on more than one occasion fused the bottle A.

* "Deut. Chem. Ges. Ber.," vol. xi, 2253.

† "Proc. Roy. Soc.," vol. xxi.

After the apparatus had been placed in the furnace and had risen to a dull red heat, the tube E was inserted into it and made airtight at C by the india-rubber tubing F, the point of the tube reaching almost to the bottom of A. Hydrogen was now passed into the apparatus by D, and a current kept up until the apparatus was thoroughly reduced; by this time the temperature had risen sufficiently for the experiments



to be proceeded with. The apparatus was now filled with nitrogen, which was likewise passed in at D, the tube E withdrawn, and an india-rubber stopper inserted into C, and the end of D immersed in water or mercury. The weighed substance was then dropped in at C, and the gas expelled, collected in a graduated jar in the usual manner.

The substances whose vapour densities are to be determined, were placed, after weighing, in small iron capsules and kept in them by a plug of wire gauze. This was done in order to ensure their reaching the bottom of the apparatus, and the wire gauze plug also had the advantage of moderating the rate at which the gas came off. The potassium and sodium were placed in tared iron capsules and weighed in dry carbonic acid, and then the plug of wire gauze inserted.

To test the apparatus cadmium was tried and gave very good

results. Zinc was next used, but with very slight success, owing, we believe, to the formation of an alloy of zinc and iron, even although the temperature was far above the boiling point of zinc. This was shown by the wire gauze plug and capsule becoming very brittle, so that the wire gauze might be rubbed to pieces between the fingers. An approach to approximate results was once got with an apparatus which had not been reduced by hydrogen, the coating of oxide of iron and silica having protected the iron from the zinc. Mercury gave good results in this apparatus. With potassium and sodium greater difficulties stood in the way of exact results, as the correct weight of the pieces inserted could not be ascertained, and both metals seemed to have a tendency to behave in the same manner as zinc, viz., to form an alloy with the iron; because the vapour evolved after a few minutes was absorbed completely in spite of all precautions to prevent oxidation. Both of these sources of error tend to make the numbers found for potassium and sodium too high. The mean error due to the weighing of the metals was found by measuring the hydrogen given off by their action on water, and the action of the iron was partially overcome by raising the temperature as much as possible, so as to induce rapid volatilization.

After each experiment the metallic vapours were blown out by a strong current of hydrogen, by inserting (as before in reducing the apparatus) the tube E, and passing the hydrogen in at D, refilling with nitrogen, and proceeding as before.

The following molecular weights are calculated by finding the weight of metal in milligrams required to give 22·34 cub. centims. of vapour at 0° C. + 760 millims. pressure.

Cadmium.

0·106	grm.	gave	22·0	c.c.	at	0° + 760	mm.	∴	mol. wt.	=	107·7
0·103	„		19·4		„	„	„	„			109·6
0·106	„		20·8		„	„	„	„			113·2
0·100	„		19·2		„	„	„	„			116·3
0·105	„		20·4		„	„	„	„			115·0
0·102	„		20·7		„	„	„	„			110·1
0·102	„		20·9		„	„	„	„			109·0
0·106	„		21·1		„	„	„	„			114·0
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											894·9

Mean molecular weight. 111·86

Mercury.

0·198	grm.	gave	22·8	c.c.	at	0° C. + 760	mm.	∴	mol. wt.	=	194
0·210	„		23·8		„	„	„	„			199·6

Potassium.

0.065	gram.	gave 18.8 c.c. at 0°C. + 760 mm. ∴ mol. wt. =	77.2
0.083	„	22.4 „ „ „	82.7
0.077	„	19.6 „ „ „	87.7
0.075	„	18.5 „ „ „	90.5
0.077	„	20.0 „ „ „	86.0
0.070	„	20.0 „ „ „	78.2
0.077	„	22.6 „ „ „	76.1
0.087	„	26.1 „ „ „	74.4
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			652.8
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Mean molecular weight.			81.6

Sodium.

0.043	gram.	gave 15.1 c.c. at 0°C. + 760 mm. ∴ mol. wt. =	63.6
0.067	„	23.9 „ „ „	62.6
0.047	„	19.2 „ „ „	54.7
0.040	„	17.6 „ „ „	50.7
0.059	„	28.6 „ „ „	46.0
0.040	„	20.4 „ „ „	43.8
0.045	„	23.36 „ „ „	43.0
0.037	„	20.2 „ „ „	40.9
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			405.3
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Mean molecular weight.			50.66

Four pieces of potassium weighed in iron capsules and thrown into water, gave 84.2 as a mean molecular weight, calculated from the hydrogen evolved. Four pieces of sodium similarly treated, gave 49.8 as a mean. The above experiments show that no great accuracy in the determination of the vapour density of sodium and potassium can be attained by this method of working when vessels of wrought iron are employed. The results are, however, conclusive as regards the *normal character of their respective vapour densities.*

XVIII. "The Physical Properties of Liquid Acetylene." By GERRARD ANSDELL, F.C.S., Chemical Assistant to the Royal Institution of Great Britain. Communicated by J. DEWAR, F.R.S., Professor of Chemistry, Royal Institution. Received June 12, 1879.

The hydrocarbon acetylene, being the only one of its numerous class which can be formed synthetically by the direct union of its

