

THE APPLICATION OF THE ARCHIMEDEAN PRINCIPLE TO THE EXACT DETERMINATION OF GASEOUS DENSITIES.

BY

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THE hydrostatic method has not been used hitherto, at least for exact measurements, for the determination of the density of gases. We will describe in this article an apparatus of great precision based on the principle of Archimedes, and which avoids several inconveniences inherent to the methods generally used.

A cylindrical glass float, about 200 c.c. in volume, calibrated exactly, is suspended vertically, by a platinum wire, from the beam of a balance and balanced by a suitable counterpoise; the float is enclosed in a glass tube of slightly larger size, in which it can swing freely; at the top this tube ends in a capillary tube through which the platinum wire passes, and the gas is admitted by means of a second capillary tube fused to the lower end. The whole is kept at a constant temperature by means of a water bath, in which an accurate thermometer is immersed and it is provided with a stirrer.

The carefully purified and dried gas, is introduced into the apparatus at a speed of about 1 litre per hour; little by little it displaces the air, and the weighings may be begun some hours after starting the flow of gas, and can be repeated continuously as long as the gaseous flow lasts.

At the moment of weighing the current of gas is interrupted, the diffusion of the external air takes place very slowly on account of the apparatus used, and the equilibrium position of the balance is determined by the ordinary method of oscillations. Barometer is read simultaneously with temperature of the bath.

To calculate the pressure exerted on the float by a given gas, and from that the density of the gas, it is first necessary to know the tare, *i.e.*, the weight of the float, in a vacuum. As it is impossible to weigh it directly in a vacuum, this determination is made by the aid of two gases, oxygen and hydrogen,

whose density, or rather the mass of one litre under normal conditions is known exactly. We have thus obtained, as will be seen later, two series of very concordant measurements.

When working with a gas denser than air, oxygen for example, the interruption of the flow can be made without inconvenience during a time sufficient to observe the equilibrium position of the balance. In the case of hydrogen, on the other hand, it is no longer so, and immediately the gas stops, a progressive increase of the pressure is set up, due to the external air replacing hydrogen. We were then compelled to weigh without interrupting the flow of gas, and from that time the constancy remained perfect. A correction is necessary on account of the dynamic effect, which is actually very slight. We obtained this by the following method:

The hydrogen was prepared electrolytically, in such a way that an ampere meter placed in the electric circuit gave, in a relative measure, the exact flow of gas. Weighings were made with decreasing intensities and the values extrapolated to an intensity of zero, corresponding to the complete stoppage of the gas. Thanks to the smallness of the correction,—besides this function is almost linear to the current,—this device gave very satisfactory results.

The oxygen and hydrogen used in these researches were prepared by the electrolysis of a solution of potassium hydroxide and purified by passing through a tube heated to 350° C., containing platinized asbestos, then dried over sulphuric acid and phosphorus pentoxide.

Here is a summary of the results obtained. The numbers below represent the tare of the float in a vacuum; each is the mean of a large number of weighings. In this series the temperature varied from 15° to 16° C., and the barometric pressure between 715 mm. and 725 mm.

THE TARE DETERMINED BY MEANS OF:

OXYGEN.			HYDROGEN.
0.18260	0.18267	0.18265	0.18263 Gm.
0.18268	0.18255	0.18265	0.18264 Gm.
0.18266	0.18257	0.18258	0.18263 Gm.
0.18265	0.18264	0.18260	0.18268 Gm.
0.18256	0.18263	.....	0.18262 Gm.
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Mean (oxygen).....0.18262			Mean.....0.18264 Gm.

The agreement of the individual measurements is better in hydrogen than in oxygen, which is easily explained; in fact the pressure of hydrogen is 16 times weaker, and the errors of temperature and pressure have 16 times less influence than is the case with oxygen.

The advantage of weighing in hydrogen consist in this, that it is almost equivalent to weighing in a vacuum; the pressure of the gas in fact only amounts to hardly 2 cg., and the uncertainty as to the absolute value of the mass of a litre of hydrogen only plays an insignificant rôle.

The determinations, taken as a whole, do not then permit the calculation of the relation of the densities  $\frac{\rho}{H}$ , but they give a new confirmation of the value adopted for the mass of the normal litre of oxygen, say 1.4290 Gm., a confirmation which is correct to about one ten-thousandth.

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**Chemical Action of Ammonium Persulphate.** A. SCHULLER. (*Phot. Rundschau*, xxiv, 161.)—The ammonium persulphate penetrates the gelatin and slowly changes the silver to silver sulphate, which is converted into persulphate by the excess of ammonium persulphate. The silver persulphate is much more energetic than the ammonium persulphate and attacks the silver of the image to form silver sulphate, which is converted as before. Thus the active agent in the reduction is silver persulphate, the ammonium salt merely serving to convert the silver sulphate into silver persulphate. The action is slight in the shadows of the negative, not merely because the concentration of the silver persulphate is less there than in the denser parts of the plate, but because silver persulphate hardens the gelatin and can diffuse more rapidly into the mass of liquid where the hardening effect is slight. Hence the action of the persulphate reducer is due to the varying diffusibility of silver persulphate.

**The Corrosion of Iron.** J. N. FRIEND. (*Engineering*, lxxxviii, 531.)—Only two theories of corrosion merit attention, the acid and the electrolytic theory. Pure iron, oxygen, and water may be in contact an indefinite time without mutual action; the presence of acid is necessary to cause rusting, the acid acting as a catalyzer. Generally  $\text{CO}_2$  is the acid present. A very small quantity of  $\text{CO}_2$  forms  $\text{FeCO}_3$  or  $\text{FeH}_2(\text{CO}_3)_2$ , which is decomposed and forms rust by the oxygen of the air, setting free  $\text{CO}_2$  to begin the cycle again. The various experiments which appear to show that pure water, oxygen, and iron combine to form rust are due to the fact that the water used is not pure.