XXII.—*On Phosphide of Magnesium.*

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As this substance does not appear to have been previously described, some account of its preparation and properties may prove interesting. The most practicable method of preparing it seemed to consist in heating the metal to redness in an atmosphere of phosphorus vapour. For this purpose an apparatus of the following form was used:—

A tube of glass, of difficult fusibility, was selected; two boats of a similar material were constructed, of such size as readily to enter the tube; one of these was filled with filings of magnesium, the other with fragments of phosphorus; both were then introduced into the tube, which was afterwards attached, by means of a plug of caoutchouc, to an apparatus for the evolution of carbonic acid dried by passing through sulphuric acid. The whole was so arranged that the stream of gas might pass over the phosphorus towards the magnesium. When the air was judged to have been expelled from the apparatus, the boat containing the magnesium was heated to strong redness by means of a Bunsen's burner. A gentle heat was then applied to the phosphorus, until it began to volatilize. The vapour was carried by the stream of gas over the heated magnesium, and at the moment when it reached the ignited metal, the latter burst into vivid combustion. In the first experiment the apparatus was allowed to cool immediately, and the product removed. The results obtained with it were anomalous. On treating a portion with dilute hydrochloric acid, a copious evolution of phosphoretted hydrogen (not spontaneously inflammable) took place. When the action had ceased, however, a black flocculent substance remained, upon which the dilute acid produced no action in the cold, nor was it dissolved to any extent upon boiling the liquid. This substance, as it afterwards appeared, was the true phosphide.

The evolution of phosphoretted hydrogen, however, was the cause of some perplexity, until an examination of the original substance suggested the following explanation:—The latter appeared to consist of a black powder (the pure phosphide), mixed with unaltered magnesium. It seemed probable, therefore, that

the intimate contact between these two bodies would produce a galvanic arrangement, in which, upon the addition of an acid, hydrogen would tend to attach itself, not to the unchanged metal, but to the phosphide. It would then, by virtue of the powerful affinities derived from its nascent condition, appropriate the phosphorus of the latter, and thus be converted into phosphoretted hydrogen. The truth of the above explanation was subsequently tested by making an intimate mixture of the pure phosphide, upon which dilute acids had been proved to exert no solvent action with metallic magnesium. Upon adding dilute hydrochloric acid, a copious evolution of phosphoretted hydrogen took place, as was expected.

A second operation, conducted in the manner already described, proved that, in order to prepare the phosphide in a state of moderate purity, it was only necessary to ensure the expulsion of air from the apparatus before heating the metal, and to continue the application of heat for a short time after the first appearance of combustion, maintaining at the same time the supply of phosphorus vapour. A minute proportion of unchanged metal, however, generally remains. When thus formed, phosphide of magnesium appears as a slightly coherent black mass, readily separated into a flocculent powder strongly resembling lamp-black, both in its appearance and physical properties. Its stability is most remarkable. It has been preserved unchanged for some weeks in moderately dilute hydrochloric acid; it has been boiled for some time with a mixture of equal parts of strong sulphuric acid and water, without apparent solution; and it is only with considerable difficulty that it can be dissolved in boiling nitro-hydrochloric acid, in which it has been boiled for hours without completely disappearing. It may be heated to redness without change, if air be excluded; in the presence of a current of air, however, oxidation takes place, and magnesia is gradually formed.

In order to ascertain the composition of this substance, the method of synthesis was adopted, the apparatus used being a slight modification of that above described. The metal, in fine filings, was introduced into a tube of hard glass, between two plugs of asbetos, the tube and plugs having been previously weighed. A second weighing, after the introduction of the magnesium, gave the quantity of the latter to be acted upon. The tube was now attached to a carbonic acid apparatus, and a bulb containing phosphorus. The rest of the operation was then con-

ducted as before, care being taken to expel the excess of phosphorus vapour from the tube as far as possible by continuing the stream of carbonic acid after the completion of the reaction. The tube was now detached and weighed, the increase of weight showing, of course, the amount of phosphorus absorbed by the known weight of magnesium. In every case a small quantity of metal escaped the action of the phosphorus, as was evidenced by the evolution of a few bubbles of phosphoretted hydrogen upon the addition of hydrochloric acid. The last and most successful operation, in which the evolution of gas was very small, gave a composition for the substance, approximating closely to the formula Mg'_3P . The quantity of metal used was 2.40 grains. The phosphide formed weighed 4.40 grains, giving thus a percentage composition of—

Magnesium.....	54.54	theory requiring	53.74 Mg'_3
Phosphorus.....	45.46		46.26 P.

It seems likely that an investigation, conducted on similar principles to the above, might dispel the uncertainty which at present rests upon the composition of the phosphide of calcium.