

509

THE ELEMENTS OF INORGANIC CHEMISTRY

For use in Schools and Colleges

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be converted into the other. Moreover, if equal weights of red and common phosphorus be burnt separately in excess of oxygen, equal weights of phosphoric oxide will be produced.

Red phosphorus is largely used in the composition placed on the boxes of safety matches. The heads of these matches are composed chiefly of antimony sulphide, chlorate of potassium, and glue; the composition on the boxes consists of red phosphorus with oxide of manganese, or sulphide of antimony, and glue. Common matches are tipped with a paste containing white phosphorus. The use of these latter is to be discouraged, as the fumes of the phosphorus are very injurious to the health of the 'dippers.'

If phosphorus be dissolved in molten lead, it separates, on cooling, in dark crystals, which are isomorphous with those of arsenic, antimony, and bismuth. Its density in this form is 2.34, and it may be separated from the lead by dissolving the latter in diluted nitric acid.

247. Phosphorus an element. When phosphorus enters into combination with oxygen, it produces one or more oxides, but any one of these oxides can be converted into the others by increasing or reducing the proportion of phosphorus. In no case does it behave like marsh gas when it is oxidized, or when it combines with other elements (see 122); and we know no class of compounds resembling phosphorus. Therefore it is considered to be an element.

248. The sources and manufacture of phosphorus. Phosphorus exists, as phosphate, in many of the older rocks, and is found in the soil formed by their disintegration. From the soil it is absorbed by the roots of plants, and thence passes into the bodies of animals. It is present, in greater or less quantity, in most animal tissues, and earthy phosphates constitute the chief part of the mineral components of bone. The student may easily extract calcium phosphate from fragments of bone by digesting them in solution of hydrochloric acid. After a few hours a stiff gelatinous mass (ossein) will remain, and if the liquid be decanted and neutralized with ammonia the calcium phosphate will be precipitated. The residue is used for making glue.

Bones, apatite (phosphate of calcium), redonda phosphate (aluminium phosphate), and coprolites are the chief sources of phosphorus.

Phosphorus was discovered, in 1669, by Brand. To obtain it, bones *

* Mineral phosphates, such as apatite, are often substituted for bone-ash.

are either burnt, or extracted with superheated water to remove the ossein, which is sent to the glue-makers. The residue is ground to a powder and digested with sulphuric acid, which liberates phosphoric acid :—



The acid solution is decanted, or strained, from the insoluble sulphate of calcium, concentrated, and mixed intimately with charcoal. The mixture is then heated to whiteness in clay retorts *A* (Fig. 96), which are connected with iron pipes *B*, dipping into warm water in *D*.

The heat first dehydrates the phosphoric acid, forming metaphosphoric acid (HPO_3), and the latter is reduced by the carbon at higher temperatures :—

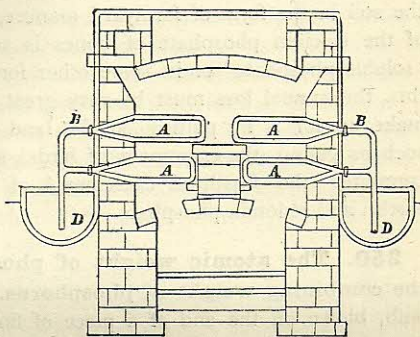
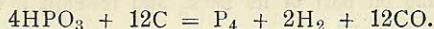


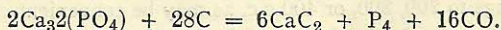
Fig. 96.



The crude phosphorus from *D* is melted under water, strained through bags of wash-leather, and run into tubes, where it is allowed to solidify. It may be further purified by shaking it, when melted, with a mixture of potassium bichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) and strong sulphuric acid.

Pure phosphorus is *almost* colourless, and translucent; but it gradually becomes covered by an opaque crust, which seems to consist of amorphous phosphorus, especially if it be not protected from light.

Since the introduction of the electric furnace it has been found possible to decompose calcium phosphate directly by the action of carbon. The following reaction is said to occur :—



249. The waste of phosphates by civilized communities.

Under the conditions of modern life, a great part of the phosphates and other soluble matters removed from the soil by plants and afterwards consumed by men are not returned to the soil, as they