

(10) *Phosphorus*.—Occurs, in minerals, in an oxidized condition only, *i.e.*, as phosphoric acid (or anhydride) in the group of phosphates.* As first pointed out by Fuchs, these bodies, when moistened with sulphuric acid, impart a green coloration to the flame-border, and many produce this reaction *per se*. A closely similar coloration, however, is communicated to the flame by borates (when moistened with sulphuric acid), as well as by bodies containing barium, copper, &c. It only serves, therefore, as a probable indication of the presence of phosphoric acid. The readiest and most certain method of detect-

* It is assumed to be in this condition simply because phosphates give the known reactions of phosphoric acid or phosphoric anhydride, although these reactions may, of course, be modified to some extent by the presence of other bodies. In like manner, when iron is present in an oxidized body, we assume that it is present in the condition of FeO if the substance give the known reactions of that compound, and increase in weight on ignition; and that it is present as Fe₂O₃ if the reactions of sesquioxide of iron be given by the substance. As to the *actual conditions*, either physical or chemical, of bodies in combination, we know absolutely nothing, but we have a certain knowledge of the secondary components of most bodies. We are able to examine these components apart, and to form more complex bodies by their union. Thus, from a piece of limestone or calcite we can obtain two well known compounds, lime and carbonic acid (or carbonic anhydride); and with these compounds we can readily produce limestone or its equivalent. Hence, the simplest and most practically useful way of stating, either verbally or by symbols, the composition of limestone and other mineral bodies, is surely that which makes known to us at once the components into which the body readily splits up or decomposes, or which characterize it directly by their reactions. This method, therefore, is adhered to in the present handbook. It may be urged that a formula of the kind represented by CaO, CO₂ asserts too much, and that consequently the more modern Ca CO₃ is preferable. But rightly considered, the old formulæ need not be assumed to make any assertions regarding the actual condition of bodies in combination, but only to indicate clearly the well known simple compounds into which (in the great majority of cases) substances may be more or less readily decomposed, and the reactions which substances exhibit. As a strict matter of fact, moreover, the new formulæ are not free from assertion. They carry upon their face, at least, a seeming assertion that the elementary bodies in compounds are present in an absolutely free, separate and independent state; or that unknown problematical compounds, as CO₃, SiO₄, SiO₅, SiO₆, etc., etc., are present in the substances to which these formulæ refer. To take another illustration. A student has two minerals before him: one he finds to be the well known mineral, corundum, and consequently Al₂O₃ (alumina); and the second he finds to be ordinary quartz, and consequently SiO₂ (silica), according to the commonly received formula. He has also before him a third mineral, one that gives the reactions of alumina and silica, and yields these separate bodies on analysis. Naturally, therefore, he writes the formula (assuming the two components to be in equal atomic proportions) Al₂O₃, SiO₂. But, to his bewilderment, he finds it given in modern books as Al₂SiO₅. Practically, we do not want to know how much aluminium, silicic acid and oxygen, are present in a body of this kind, but how much alumina and silica; and the first formula shews us this, or enables us to determine it at once. Were only simple elements and their complex combinations known to us, the new views, carried out properly to their full conception, might pass without opposition; but the question becomes entirely altered by the occurrence of simple binary compounds so abundantly in the free state. In mineral analysis, and in the practical study of minerals, it is not possible to ignore these binary formulæ without great inconsistency. Among other works, they are retained essentially, we are glad to find, in the standard and very copious "Handwörterbuch der Chemie," now being published under the editorship of Dr. Von Fehling of Stuttgart. See also Von Kobell's remarks on this subject in the 5th edition of his "Mineralogie;" 1878.