to the quantitative relations of organic bodies and to the importance of the methods of ascertaining these relations with facility and precision.

In this and in the next lecture I intend to describe to you briefly the methods which are at present used for determining the composition of organic substances. It is by no means my intention to instruct you in organic analysis,—to accomplish this, laboratory practice is indispensable;—my object is to put you in possession of principles. I will therefore avoid entering into details as far as possible, confining myself to an account of the more important processes which are actually in use Enabled as I am to illustrate these processes by actual experiment, I hope they will be sufficiently interesting. But, after I have shown you the methods of analysing, I shall have to claim your attention to a few calculations, which, simple though they be, may to many be not acceptable; I have to explain to you how from such experiments we proceed to establish a chemical formula. Now I consider this a most important point, the very basis of all our future discussions; and I earnestly entreat you to give me a patient hearing. I hope to convince you that the apprehension of these formulæ, which are dreaded by some, as much as they are cherished by others, requires no mathematical attainments whatever.

In estimating the quantities of the constituent elements of organic compounds, it might appear to be the simplest method to separate the several elements, and to weigh them in the isolated state. In fact, such attempts have been made, but they were confined to the earliest stages of organic analysis. An isolation of the elements is generally attended with very considerable, if not insurmountable difficulties. In one case only, viz., in that of nitrogen, the separation as such is easy; but even nitrogen is not usually estimated in the isolated state.

The principle universally adopted in organic analysis consists in the conversion of the elements into compounds of salient properties, the composition of which is accurately established, and which may be readily produced, collected, and weighed. For this purpose, both the carbon and hydrogen are oxidized; the former being converted into carbonic acid, the latter into water; while the nitrogen, provided it is not determined in the free state, is made to unite with hydrogen, and estimated in the form of ammonia. The oxygen is never directly determined; but, the quantities of carbon, hydrogen, and nitrogen being ascertained, the remainder of the substance is inferred to be oxygen.

In order to proceed from the simpler to the more complicated case, let us assume that we have to analyse a substance containing carbon, hydrogen, and oxygen, but no nitrogen. Such a substance would yield, when heated in atmospheric air, or, better still, in pure oxygen, carbonic acid and water The formation of these products presents no difficulty, but how are we to collect them? The method which originally suggested itself, viz., to perform this combustion in vessels containing free oxygen, has been altogether superseded by using instead of (or at all events together with) free oxygen, an oxygen-compound as the agent of combustion, which is capable of giving up its oxygen with ease at a comparatively low temperature. Such a substance is the common black oxide of copper To convince you of the facility with which this compound yields its oxygen, I will introduce this Florence flask (the outer surface of which has been covered with a thin layer of this oxide) into the flame of an ordinary gas-burner The very moment the oxide comes in contact with the combustible substances in the interior portion of the flame, it is deprived of its oxygen,—it is reduced (as we call it); and you now observe the brilliant lustre of metallic copper If I remove it from the flame, the hot copper, coming in contact with the oxygen of the air, is oxidised again; showing that copper absorbs oxygen with the same facility with which it loses it.

But the following experiment may illustrate this point even in a more conspicuous manner In this mortar I mix a small quantity of sugar, with finely-divided black oxide of copper The intimate mixture is now introduced into a little retort, which is fitted into a tubulated receiver provided with a