# Selected Articles.

## LECTURES OF SPECTRUM ANALYSIS.

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In our lecture last Saturday afternoon we investigated the properties of white solar light. We saw that the sunlight which produces upon our eye the impression of whiteness is, in reality, composed of an infinite number of different coloured lights; and we obtained, when we passed this white solar light through a triangular piece of glass, that which we called the solar spectrum—a broad band of variously coloured rays differing from one another in their refrangibility. But we noticed that this solar spectrum is not continuous,—that it is intersected by dark lines which run through the whole length of the spectrum, and which occur always in sunlight. We noticed that these bands occur not only in direct sunlight, but also in reflected sunlight—in the light of the planets, and that these same bands do not occur in starlight. Hence Fraunhofer, as early as the year 1814, stated that these lines observed in the spectra of the sun and planet-light must in some way have their origin in the sun. We then proceeded to notice the properties of the light given off by artificially heated bodies. We saw that, with the exception of phosphorescence, light is given off only when a body becomes heated; and we divided artificial light as given off from heated substances into two great classes,—namely, that kind of light which is given off when a solid or a liquid is heated, and that kind of light which is given off when a gas is heated. We saw that when a solid or a liquid body becomes luminous it gives off light of every kind between certain limits—that its spectrum is continuous; whereas the light given off by a glowing gas is not of every kind—that such light produces a broken spectrum; and thus we learnt that it was possible to distinguish, by examining the light given off by such glowing gases, between the kinds of gas which were made to glow, but that we could not in the case of liquids or solids decide by the examination of the light what substance was heated; and thus we arrived at a knowledge of the possibility of founding the science of spectrum analysis, a science which will teach us what the chemical nature of a substance is by simply looking at the kind of light given off by its glowing vapour.

I propose in this lecture to notice—for I cannot do more than notice—some of the applications of the principles which we laid down in the last lecture, to the analysis of terrestrial matter; for we find that we obtain, by the application of these principles to the examination of the matter which composes our globe, a knowledge which is as perfectly unlooked for and novel as it is interesting—information concerning the properties and chemical composition of the matter constituting the globe which we inhabit.

We must remember that what we require to do in order to obtain such a knowledge of the constitution of terrestrial matter, is to obtain this terrestrial matter in the condition of a glowing gas. Now, we may divide, for the sake of illustration, the matter composing the globe into three classes,—that matter which is made gaseous and which becomes luminous near the temperature of the coal-gas flame: that matter, in the second place, which is volatile at a much lower temperature than that; and thirdly, that matter which is volatilised, and becomes luminous at a much higher temperature than that of the gas flame.

Thus, for instance, if I place a piece of clean platinum wire in this gas flame for a few moments we shall observe that it does not impart any colour to the colourless flame. For a moment it does impart a colour, for a reason which I shall have to explain. The platinum itself does not give any colour to the gas flame because it is not volatile at the temperatare of the flame, and we do not get any platinum gas. But if I place another substance in the flame; for instance, a piece of common salt, we shall see that this flame is coloured of a peculiar tint, owing to the fact that the sodium is here volatilised, and that it becomes luminous, and gives off its peculiar and characteristic kind of light, namely, yellow. Now, by heating the platinum to a much higher temperature, we can get the peculiar light which it gives off. Thus, for instance, I have here a platinum pole, and by passing an intense electric spark through this, I obtain the platinum, as we shall see in a subsequent part of the lecture, in a state of luminous vapour, and then we find that the platinum also gives out the light which is peculiar and characteristic for platinum alone, and which no other body gives off.

That peculiar chemical substances produce in the flame peculiar colours has long been known, and this fact is used by the chemist as a means of detecting such substances. Thus, for instance, I will here show you a number of such differently coloured flames; here we can produce the luminous vapour of a number of these substances. I can here produce the characteristic yellow flame of sodium. If I bring the salts of potash into this flame I can produce the peculiar colour given by all those salts—a peculiar purple colour. Here I have the peculiar colour which is produced by a very interesting body with which we shall have to do in a subsequent part of the lecture—one of the new alkaline metals discovered by Bunsen, *rubidium;* and this is the flame coloured by the other new alkaline metal, *cæsium*, also discovered by Bunsen. Here we have lithium, which produces this magnificent red colour. Here we have the green produced by barium. All the salts of barium tint the flame of this beautiful green colour. Here we have the red produced by strontium. Here we have the orange produced by calcium, and here I will produce a peculiar blue flame by a substance which differs entirely from these in properties—the non metallic element selenium. If I bring selenium into the flame, we shall see that this body imparts to the flame a very peculiar and beautiful blue colour. It is extremely volatile, and only lasts for a few seconds. Further on we have the peculiar blue colours communicated to the flame by copper and by boracic acid.

I can show you the same thing in various ways. Here, for instance, I can produce a much larger flame, and show you the colour of the same salts. [A large gas flame was produced from a perforated jet of about three inches in diameter, and urged by a strong current of air. Pumice-stone dipped