# NATURE STUDY No. XXXVI.

## THE FOUNDATIONS OF CHEMISTRY AS SEEN IN NATURE STUDY. (FOR TEACHERS ESPECIALLY.)

BY JOHN BRITTAIN, Woodstock, N.B.

### Chemical Union.

In order to teach effectively we must distinguish carefully between the trivial and the important—between the accidental and the essential. We are apt to spend too much of the precious school-time over the details which have little significance—the lifeless husks which enclose and conceal the living germ-thoughts. We think that we must do this in order to be thorough; but we deserve no credit for thoroughness in doing things which should not be done at all or which should be done elsewhere or at another time. Let us rather devote our skill and patience to the development, in natural and logical sequence, of the great facts and principles of nature and of life. Practice and the habit of observation will ensure a sufficient knowledge of details.

At the basis of all the natural forms we see—organic and inorganic—lies the fact of chemical union or combination. To learn to distinguish it, by its effects, from mere mechanical mixture, it is not necessary for the learners to wait until they have become acquainted with the molecular and atomic theories. Only very simple apparatus and cheap material are required for the experiments which follow.

Each member of the class is supplied with a small stick of *dry* white wood. The sticks are held for a few seconds in the flame of a spirit lamp. At once a soft black substance appears in the heated part of the stick—a substance which will mark on paper and which will be found to be insoluble in water. The pupils recognize this as charcoal which they may be told is a form of carbon. Now the question is, where was the charcoal before the stick was heated? We could not see it before that was done.

It will be found, by holding the hand above the flame of the lamp that no charcoal issues from *it*—nor does it come out of the surrounding air. Hence it must have been in the stick at first. But why did the charcoal not then make the stick black?

Heat slowly and carefully a little of the wood, cut into small pieces, in the bottom of a closed test-tube. Clear drops of a tasteless liquid like water form on the inside of the tube above the wood; and as the water gathers, the charcoal appears. The water evidently comes out of the dry wood and leaves the charcoal behind.

It can easily be shown, by means of a hand balance, that a piece of charcoal (from a stove) weighs less than a piece of the dry wood, equal in size, from which the charcoal was obtained.

It is plain then that *dry* white wood contains both charcoal and water, and that when the water is driven out by the heat, the charcoal can be seen. And so it appears that the water in the wood hides the charcoal, else the wood would look black, and the charcoal conceals the water, else the wood would feel wet.

It may now be stated that when two substances—as charcoal and water in this case—are so united together that they conceal each other's properties, the two substances are said to be chemically united or combined; and the substance they form by their union is called a chemical compound. Thus dry wood may be regarded as a chemical compound of carbon and water.

Next mix together, in a bottle, water and powdered charcoal. Do they unite chemically? They do not conceal each other's properties. The black charcoal can still be *seen* and the water *felt*. They now form, not a chemical compound, but a chemical or physical mixture. But how can the charcoal and water be got to unite chemically? They must have been chemically separate before they united to form wood; but *we* don't know, at present, how to compel them to combine to form wood.

Put finely divided wood, to the depth of about an inch, into a test-tube loosely closed with a cork or the thumb,—and apply heat until the tube is filled with smoky gas; then without withdrawing the heat remove the cork or thumb, and try with a match until you succeed, to set fire to the gas in the tube. How do you account for this combustible "wood-gas"? Since this gas will burn, it cannot be water-gas (steam); so we must conclude, since chemists find that pure wood is composed entirely of carbon and water, that this gas was formed in some way from these two substances in the wood. It should be noted here that the water set free by the heat soon becomes colored by some other liquid, and that a mass of charcoal remains in the tube after the water and the combustible gas has been all expelled. It will

be found upon trial that this charcoal residue, although it will not burn with a flame like the gas, will slowly burn away with a *glow* when held by a wire in the flame of the lamp.

It seems from this experiment that when wood is heated in a closed space, it breaks up into other substances besides charcoal and water. This will explain too in part, the manufacture of charcoal and wood alcohol by the destructive distillation of wood, that is by heating wood in closed vessels, and the production of coke (carbon) and coal gas from bituminous coal by destructive distillation.

Let the children char small samples of starch and sugar—try whether they contain water—and whether combustible gases are formed when they are decomposed by heat. The last experiment may be performed by heating a little

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On page 90, line 26, for "Chemical or physical mixture" read "Mechanical or physical mixture."

similar composition, are called carbohydrates. The fitness of this name should be shown from its derivation.

In all this work, the teacher is supposed to act only as the director of experiments and as the referee in deciding the validity of the arguments and inferences. His skill is measured by the success he has had in inducing each pupil to do his own observing and thinking independently.

After a careful review of the whole ground, the children should retain a good working idea of chemical union—will see that heat tends to separate substances that have been chemically united—will understand what agricultural lecturers mean by carbohydrates—will know that when carbohydrates are heated in a closed place until they decompose they break up into carbon, water, and other substances liquid and gaseous—will see that

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The children will now be able to describe the results of their experiments with sugar and starch and to state and justify their conclusions as to the composition of both. They will doubtless conclude that, like wood, starch and sugar are probably composed of charcoal and water chemically united. They may then be told that sugar, starch and wood and several other substances of similar composition, are called carbohydrates. The fitness of this name should be shown from its derivation.

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a flame is a burning gas and that a solid, as carbon, burns without a flame—and will be able to form an intelligent conception of many processes in nature and the arts which would otherwise be quite inexplicable.

The main topic in these lessons—for this work covers several lessons—is *chemical union*; but the other topics discussed are important and all of them help in making clearer the idea of chemical union. And this illustrates another method of making our teaching more effective and saving time in the process. I mean that while we keep in view one principal topic we should always associate it with others which are significant and worth teaching in themselves and at the same time are so related to the central topic that they can be used effectively in enforcing it.

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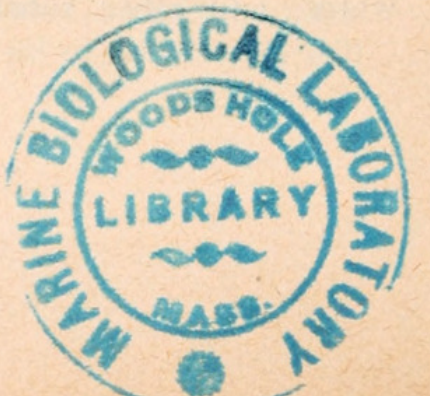
## OTTAWA SUMMER SCHOOL OF SCIENCE.

Last year a most successful and enjoyable three weeks' session Summer School was held at the Normal School, Ottawa, under the direction of Dr. J. F. White and Mr. J. H. Putman, assisted by Mr. A. E. Attwood and others. The school was well attended by teachers and other students to the number of 160.

We are glad to hear that it has been decided to hold a similar school this summer. The lectures will be given in the Normal school and in the field. The course will open on July 3 and last for three weeks. The arrangements have been handed over to Mr. J. H. Putman whose addresses were so acceptable to all in attendance last year. Mr. Putman will give an Elementary Course in Botany. Mr. A. E. Attwood will help in the field work and will lecture on Animal Biology and Mineralogy. Mr. F. E. Perney will give addresses on Physical Geography. Mr. J. F. Sullivan will help in the botanical field work. Mr. J. S. Harterre will have charge of the Manual Training classes and Miss Gallup of Sewing. Mr. J. A. Dobbie will take charge of the Art work. The course will embrace Nature Study, Domestic Science, Manual Training, Drawing and Colour Work.

In addition to the above, two lectures will be given on Insects and two on Birds, by Dr. Fletcher, and one on Fish and Fish-life by Prof. E. E. Prince.



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