The Examination and the Examinee in Elementary Science.

By John Waddell, Ph. D., D. Sc., School of Mining, Kingston, Ontario.

[The following article from the pen of Dr. Waddell was written for the Review and the N. Y. *School Journal*. It appeared in the *Journal* of October 11th. Dr. Waddell will, we are glad to say, contribute other articles to the Review during the course of the year.—Editor].

The average examinee considers examinations as an ordeal which he must pass in order to obtain a certain certificate. He looks upon the examiner as a man whom he must try to convince of his knowledge of the subject, and if he can do this without excessive study so much the better. No doubt the examiner has largely himself to blame if the examinee can pass the examination without a reasonable amount of study. The examination should not be of the kind that can be crammed for, but should require thoughtful application on the part of the student. It must not be of such a character that a candidate having accumulated a number of undigested facts without any knowedge of their relationships may be able to present a good appearance. If definitions are asked for care should be taken to ascertain that the definitions mean something to the examinee as well as to the examiner. The words may be exact, the idea expressed may be perfectly correct, and yet the candidate may have no more conception of what is meant than if he had committed to memory a list of words taken from an unknown language. For instance, the statement of Avogadro's law that equal volumes of different gases under the same conditions of temperature, and pressure contain equal numbers of molecules, may be given correctly, and yet the candidate might be entirely at sea if asked what volume of hydrogen would contain five million million of molecules, provided that under the same conditions of temperature and pressure one litre of nitrogen contains a million million of molecules.

Not that I consider the memorizing of definitions useless. The strengthening of the memory has some value, but I think that storing the mind with gems of literature is preferable to accumulating a stock of definitions. Definitions accurately and exactly learned may doubtless be of use in later life when their meaning is understood, and in this respect the learning of a definition is better than the learning of a series of words in a dictionary or of a page in a table of logarithms. I refer to the learning of definitions without understanding their meaning. The learning of a definition, when the value of each clause and word is appreciated, is quite a different matter, and is, in the highest degree, educative.

The pupil beginning the study of science should realize from the very first the necessity of accuracy and exactness. He should learn that his knowledge, while necessarily limited, should be definite and distinct. A hazy idea of principles and facts is most unsatisfactory. The term *science* denotes *knowledge*, and knowledge should be exact and not of a general and indistinct kind. General knowledge has been wittily described as definite and dense ignorance, and it must be admitted that many examination papers exhibit on the part of the examinees a great deal of general knowledge.

Accuracy of observation is one of the essentials of any scientific training, and any training is to that extent scientific in which accuracy of observation is insisted upon. If leaves are being examined their shape should be accurately observed, the character of their margin, the texture, the surface, and other peculiarities, so that the pupil will realize that he *knows* something about the leaves he has studied. If flowers are examined their peculiarities should be noted, and whatever object is looked at the observation should be accurate so far as it goes. An examination paper can test such accuracy of observation. Taking an illustration from elementary chemistry instead of botany such a question as the following may be asked, "What did you see when a piece of sodium was placed upon water?" The answer might involve the fact that sodium takes a globular form and moves about on the surface of the water; it might be that a yellow flame was seen; but that hydrogen was produced by the action of sodium on water, or that caustic soda was produced is not a thing visible in the experiment suggested. It is very important for the pupil to distinguish between what he sees and what he infers, and, still more important, to distinguish between what he sees and what *somebody* else infers. Unfortunately most of our science students learn too much of what somebody else has inferred, usually without a knowledge of the facts from which the inference is drawn, and this inference, which we call a theory, is considered the fundamental fact, and the things observed are supposed to hang upon it rather than it upon them. Such a theory is the atomic theory. Examinees in elementary chemistry when asked to describe a chemical phenomenon, are all too apt to describe it in terms of atoms and molecules and in such wise as to show plainly that their knowledge is of the general kind mentioned above.