

thinks himself not a complete man till his understanding is beautified with the valuable furniture of knowledge, and buttressed by the immovable supports of mental culture. There is, in truth, no success without happiness, and there can be no happiness without knowledge—the richest adornment and surest safeguard of the human soul.

SCIENCE.

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EQUATIONS IN CHEMISTRY.

The value of equations in the study of chemistry is that by means of them the results of chemical reactions can be expressed concisely, and this conciseness of expression assists in enabling the student to thoroughly understand the chemical changes with which he has to deal.

When to introduce equations in a course in chemistry is a question about which there is considerable diversity of opinion, but it must be obvious that their use will be meaningless until after the members of a class have become familiar with value and application of symbols and formulas. The proper use of symbols can only be understood after the pupils have acquired some familiarity with the atomic theory and the foundation upon which this theory rests. It will thus be seen that the proper time at which to introduce equations is part of a much larger question, namely, at what stage should reference be made to the theory upon which the whole science of chemistry rests. Great differences of opinion exist on this point, and to discuss these several opinions would extend beyond the compass this short article. We shall return to it on a future occasion.

Having determined when equations should be introduced the next point that will naturally suggest itself is how to introduce them to a class. As an equation is meant to be the expression of a chemical reaction, the student must be familiar with the reaction it is intended to represent in order that the equation may have any meaning for

him; he must be thoroughly acquainted with not only the materials that enter into the reaction, but also the substances that are produced by the reaction. After having reached this point he has only to know the symbols of the materials concerned, the use and value of the algebraic signs employed, and become possessed of the idea that the same amount of each substance must appear on both sides of the sign of equality.

The dangers attendant on the use of equations are well stated in a recent number of *Science* by Prof. F. P. Venables, of the University of North Carolina. The first danger he designates the danger of methodism. By this he appears to mean the use of symbols, formulas and equations for the purpose of reducing the science to method, rather than acquiring a real knowledge of the subject.

The second danger is called the mathematical danger, and consists in the tendency to an excessive manipulation of the formulas in a purely mathematical manner, so that instead of studying chemistry the pupil is learning a special kind of arithmetic.

The third danger is called the mechanical danger, and has reference to uses that are made of formulas and equations in the graphic representation of compounds, especially organic ones, and the changes which they undergo.

The fourth danger is the danger of idolatry, that is, the danger of placing formulas and equations upon the pedestal which belongs to the science itself.