steam is decomposed by red-hot iron all of the hydrogen is set free and all of the oxygen is retained by the iron. But when sodium acts on water all of the hydrogen of the decomposed water is not set free—half of it only is set free; the other half, together with all of the oxygen, unites with the sodium, and when the water that has not been acted on is evaporated by heating the solution, a white substance, caustic soda, consisting of sodium, oxygen and hydrogen, is left behind, the amount of hydrogen in the caustic soda being equal to the amount that was set free. The hydrogen in caustic soda may be liberated by fusing the caustic soda with additional sodium, sodium oxide being formed at the same time. This experiment shows that the hydrogen of water can be divided into two equal parts. The oxygen of water has never been divided. In every operation in which oxygen is taken from water all of the oxygen holds together. The simplest way of representing these facts is by the formula H_2O, for this shows the possibility of separating the hydrogen into two parts and indicates the impossibility of dividing the oxygen.

The second argument is based on Avogadro's Law, and is a little more theoretical than the first. Avogadro's Law is that equal volumes of different gases, under the same conditions of temperature and pressure, contain equal numbers of molecules; that is, if a certain volume contains 100,000,000 molecules of hydrogen it would contain 100,000,000 molecules of nitrogen, or ammonia, or marsh gas, or water vapor. We do not know the volume of 100,000,000 molecules, and we cannot adapt our volume to contain any specified number of molecules. But we can choose a liter as our standard volume, and if Avogadro's Law is true a liter would contain the same number of molecules of every gas, and the weight of a liter of the different gases would give the relative weight of the molecules. A liter of hydrogen weighs .09 grams, a liter of nitrogen fourteen times as much, of ammonia eight and a half times, of marsh gas eight times, and of water vapor nine times. But these numbers, which would all be fractions, are not very convenient and have no very evident connection with the formula of the gases or with the weights of the various constituents of the gases; and instead of taking a liter of hydrogen as the standard, it might be better to take the volume of hydrogen that would weigh a gram. This volume is a little over eleven liters and it contains 14 grms. of nitrogen, 8½ grms. of ammonia, 8 grms. of marsh gas and 9 grms. of water vapor. The same volume would contain 18.25 grms. of hydrochloric acid, of which one-half gram would be hydrogen and 17.75 grms. chlorine.

If possible, however, it is best to adopt such a standard volume that the formula will represent volume as well as weight. It has not been found possible to decompose hydrochloric acid in any way so as to divide the hydrogen into two parts or the chlorine into two parts, and hence the most satisfactory formula is HCl. If we are to make the formula represent grams we have the gram formula weight, or, as it is usually called, the gram molecular weight. The symbol H must then stand for one gram of hydrogen and the symbol Cl for 35.5 grams of chlorine. Now, 36.5 grams of hydrochloric acid occupy the volume 22.4 liters (approximately), so this volume is the most convenient to use.

There are many gaseous compounds of hydrogen, and not one of them contains less than a gram of hydrogen in 22.4 liters. A number contain exactly one gram, some two, some three, some four, etc. In the same way the volume 22.4 liters contains 35.5 grams of chlorine, or some whole multiple of 35.5 grams, but never less. Similarly, no compound of oxygen in the gaseous condition contains less than sixteen grams of oxygen, no compound of nitrogen, less than fourteen grams of nitrogen.

If, then, 22.4 liters be taken as the standard volume, the weight of the various elements that it contains will be once, twice, three times, or some other multiple of the atomic weight. Twenty-two and four-tenths liters of ammonia contain 14 grams of nitrogen, and as no gaseous compound of nitrogen contains less than fourteen grams in this volume, it is reasonable to represent fourteen grams by the symbol N. There are three grams of hydrogen in this volume of ammonia, and so ammonia is represented by the formula NH_3. Water vapor contains two grams of hydrogen and sixteen grams of oxygen in 22.4 liters. No compound of oxygen contains less than sixteen grams of oxygen in this volume, hence the formula of water is written H_2O. If any new gas were discovered containing eight grams only of oxygen in 22.4 liters, eight grams would require to be represented by the symbol O, and the formula of water would be H_2O_2. Hitherto no such gas has been discovered, and it would be strange if among all the compounds known none should have the minimum quantity of oxygen.

Expressed in terms of the atomic hypothesis, it would be strange if among all the compounds of oxygen known, none should have less than two atoms of oxygen in the molecule, and still further that none should have an odd number of atoms.

It is hoped that this article may be of use to teachers in their endeavor to help pupils to understand the real meaning of chemical formulæ.

One of the most beneficent features of our modern educational work is that of the school gardens. Through pleasant outdoor occupation it brings the children into delightful contact with nature. It gives them something interesting to do and to think about. It improves them mentally, morally and physically, and is one of the most potent of instruments for expanding their minds and their souls by casting the light of understanding upon some of the mysteries of life and growth.—*Boston Herald.*