11·2 litres of hydrogen at 0° C. and 760 mm. weigh 1 gram.
11·2 " oxygen " " " 16 "
11·2 " nitrogen " " " 14 "
11·2 " chlorine " " " 35·5 "

In *the case of compound gases*, the molecule generally occupies the same space as a molecule of hydrogen.

Thus, 11·2 litres of hydrogen and 11·2 litres of chlorine give 22·4 litres, *i.e.*, 2 (11·2)litres of HCl weighing 1 + 35·5 = 36·5 grams. Hence 11·2 litres of HCl weigh ½ of 36·5 grams = 18·25 grams, or one half the molecular weight of the gas. Again, twice 11·2 litres of hydrogen and 11·2 litres of oxygen unite to form 22·4 litres, *i.e.*, twice 11·2 litres of steam, weighing 2 + 16 = 18 grams. Hence, 11·2 litres of steam weigh ½ of 18 grams, that is one-half the molecular weight of the gas. The same thing is true of nearly every compound gas, so that it is generally stated that the density (or number of times heavier than the same volume of hydrogen) of a compound gas is equal to half its molecular weight. When we remember that the atomic weight of a compound gas is half the molecular weight, we see that the law covers compound gases as well as simple ones. The molecule of an element is composed of two atoms as $O_2$, $Cl_2$, &c., and the molecule of the compound gas occupies the same space as one of these, say the hydrogen molecule. Now it is the atom of hydrogen, not the molecule, which is taken as the unit, hence it is plain we must divide the weight of the compound molecule by 2 to compare it with the hydrogen atom. Thus carbonic oxide, CO, has two atoms in each molecule, one weighing 12 times and the other 16 times as much as the hydrogen atom. Each molecule of CO is therefore 28 times the weight of a hydrogen atom, but each molecule occupies twice the space that a hydrogen atom does. Therefore, as we compare equal volumes, the density of CO must be half of 28, or 14.

This law may be stated in several ways, but all amount to expressions of the same fact. The student should reduce the following statements to identities for himself. The weights of equal volumes of gases are identical with their atomic weights; equal volumes of gases contain the same number of molecules; the molecules of all gases occupy the same space; the densities of all gases are the same as their atomic weights; the densities of gases are half their molecular weights.

Phosphorus, arsenic, arsenic trioxide, zinc, cadmium, and mercury in the form of vapors seem to be exceptions to the law. The weight of one volume of each of the first three is the same as the weight of four volumes of hydrogen, while that of the rest is only equal to the weight of one volume of hydrogen instead of two volumes, as required by the law. These apparent anomalies may yet be explained as the science advances.

In many works the weight of one litre of hydrogen under standard conditions is called a Crith, so that 11·2 criths (nearly) = 1 gram or one crith = ·0896 gram (nearly). Also, we have 16 criths of hydrogen = 1 crith of oxygen, 14, 35·5, &c. criths of hydrogen = one of nitrogen, chlorine, &c.

It is plain that if we divide the weight of a molecule by the weight of one atom the quotient is the number of atoms in the molecule, in other words the molecular weight divided by the atomic weight gives the number of atoms. We can therefore determine the formula of a compound if we know its precentage composition.

Thus, if a compound have 72·73% of oxygen and 27 27% of carbon, we have

72 73 ÷ 16 = 4 5456
27 27 ÷ 12 = 2·2725

That is, the number of atoms of oxygen is to the number of atoms of carbon as 4·5456 : 2·2725, or, allowing for errors in experiment, as 2 : 1. Hence the formula is $CO_2$, $C_2O_4$, $C_4O_8$, or generally $C_nO_{2n}$. The simplest formula is $CO_2$, carbonic dioxide.

The process is simply the converse of finding the percentage of each ingredient when the formula is known: see previous lessons.

*(To be continued.)*

## HOW TO TEACH COMPOSITION.

BY WILL. F. SMITH.

The teacher should give instruction to children of ten years of age and upwards on this all-important branch. Take a class of pupils whose members are capable of reading with ease, extracts from second reader. The first step is familiar conversation. Take some object with which the pupils are well acquainted and get them to tell you its parts and characteristics—*e. g.* The Cow.

Question—What has a cow?
1st pupil—Horns and ears.
2nd " —Eyes.
3rd " —Tail, legs and mouth.
Question—What are the eyes for?
Whole class—To see out of.

The teacher may here give briefly the real use of the eye and other organs. Bring up simple points as to the characteristics of the animal. Give a thorough drill on the subject and then say "Tell me what you know about the cow!" They have the ideas and need only express them. By practice they will be enabled to tell intelligibly what they know. Do not at first hamper them with grammatical accuracies. If you do, you will but intimidate. Your first object is to secure, on the part of the children, self-confidence in relative conversation. Subsequently you may correct any ambiguous or loose construction, but do not be too emphatic on this score or confidence will be lost.

When the second class pupils have been promoted to the third reader, the teacher should read an extract which is expressed in simple language and on some non-abstract subject. Let it be read slowly and emphatically in order to impress the ideas upon the pupils. Then order them to produce the extract in their own language. It will be well to put the extract in their hands after it has been read, so that it will be purely a test of practical language growth. Simple subjects should always be taken at first for it is a language test required and not an inquiry into the child's knowledge or an incentive to imaginative productions. The aim is to have simple thoughts expressed in plain simple language. It will be well to place suggestive headings on the board in connection with the subject named. This will not be telling but will lead out the ideas. The direction of the stream is given and the source will thus be the more easily discovered and its affluents explored. Attention must now be given to the construction of sentences. Hand in hand with the subject of composition should go the subject and study of grammar. They are twin sisters of sensitive natures and must not be roughly treated or separated.

In most cases the only training a child gets in this important branch is by a subject assigned to be written on at home. The pupil will perhaps bring in a scrawl of ten or twelve lines of which the last two will be the startling fact that 'This is all at present." This performance occurs in most cases once a week. The teacher may glance over them and say that they must be longer next time and this is the last of the study of composition for that week. Such dallying as this will be of little avail, if any.

In teaching a third class this subject I would advise a course something like this: On your time table give this subject as much prominence as history or geography. Let there be a class in session twice a week, one subject only to be considered for the two lessons. In the first lesson commence as you would with the second class—have a familiar chit chat on the subject. Draw out the ideas of the class individually. Place on the board one or two suggestive headings and ask the class for others. Having obtained a number of distinct leaders you may now search for the branches and twigs. Get all you can out of the class first and then draw out what is necessary by hints and suggestions. This accomplished, give a thorough drill on the ground gone over, and then dismiss the class. In the second lesson the teacher will repeat what was done in the first in order to save time. He will give what he considers necessary information and then order the class to "write upon the subject."

He should superintend and assist any one that is lagging, by a hint or two, and thus stimulate the class to exertion. About fifteen minutes should be allowed for the writing of the composition and ten minutes