

either the endowment of universities, or the partial support of high schools and colleges, pays by reason of their influence in promoting the best interests of all classes, so long they may continue to sanction the appropriations on the ground of expediency. The people may do what they please with their own. But it is none the less clear that the moment we reach a class of institutions whose advantages are, in the nature of the case, absolutely above the reach of the great majority of citizens, that moment the ground on which the appropriation of public funds to such institutions can be justified is shifted. The wonder to our mind often is that while it is a notorious fact that the chief work of the State universities is to train young men for the learned professions to which they aspire for the sake of their own personal benefit, the great body of the people are so willing to find the money. It is not unlikely that the day will come in every Democratic country when the masses of the citizens will decree that those who expect to profit directly by the higher institutions of learning must found and support them. We have such faith in the operation of the voluntary principle that we are inclined to believe the coming of that day will prove helpful rather than otherwise to the interests of sound learning and broad culture.

Special.

ELEMENTARY CHEMISTRY.

CHAPTER III.

Combination of Elements Already Studied.

Having considered the preparation and properties of the four elementary bodies, oxygen hydrogen, nitrogen, and carbon, we will proceed to study some of those more important compounds with each other. From the following diagram it will be seen that, leaving out of consideration the proportions of each element in the different compounds, ten sets are formed in which occur every possible combination of the four elements, taking two, three, and four together, with one exception. The brackets show which elements are united together in each set, and at the top of each bracket is placed the name of some body which serves as an example of the class to which it belongs in the arrangement. —

	1. Water, H_2O .	2. Ammonia, NH_3 .	3. Marsh gas, CH_4 .	4. Carbon dioxide, CO_2 .	5. Cyanogen, CN .	6. Laughing gas, N_2O .	7. Nitric Acid, HNO_3 .	8. Prussic Acid, HCN .	9. Alcohol, C_2H_6O .	10.	11. Tea or Coffee, $C_8H_{10}N_4O_2$.
HYDROGEN..	—	—	—	—	—	—	—	—	—	—	—
OXYGEN	—	—	—	—	—	—	—	—	—	—	—
NITROGEN..	—	—	—	—	—	—	—	—	—	—	—
CARBON	—	—	—	—	—	—	—	—	—	—	—

Observe that the tenth bracket has no name above it; no compound has yet been discovered which consists of oxygen, nitrogen, and carbon. We shall find that more than one compound belongs to each class. For instance in the fourth class, besides carbon dioxide, there is another oxide of carbon, called carbon monoxide, CO , which contains just half as much oxygen. So in the sixth class, besides N_2O , there are four other oxides of nitrogen.

For convenience we will discuss these subjects in the following order:—

1. Compounds of carbon and oxygen (4).
2. " " " and hydrogen (7).
3. " " " nitrogen and " (6).
4. " " " nitrogen and hydrogen (2).
5. " " " hydrogen and oxygen (1).
6. A mixture of several of these substances, the atmosphere.
7. Compounds of carbon and hydrogen (3).
8. A mixture of these or coal gas. Combustion.

CARBON DIOXIDE.

Symbol, CO_2 . Molecular Weight, 44.

Carbonates. 100 parts by weight of calcium carbonate, chalk, or marble consists of—

Calcium.....	40 Ca.
Carbon.....	12 C.
Oxygen.....	48 O_3 .

From these and other considerations it is inferred that a molecule of calcium carbonate is denoted by the formula $CaCO_3$. If we compare this formula with the formula of carbonic acid, H_2CO_3 (Art. 44.), we see that the two formulæ are identical, except in the one case we have Ca, the symbol for calcium, and in the other we have H_2 . The former may be considered as derived from the latter by the replacement of H_2 by Ca. Compounds formed by replacing the hydrogen of carbonic acid by a metal are called CARBONATES. Most of the common metals, such as zinc, copper, mercury, act like calcium, one atom of the metal replacing two atoms of hydrogen. These metals are called *dyads*. Others, such as potassium, sodium, and silver, replace the hydrogen atom for atom. These are called *monads*.

Bicarbonates.—When only half the hydrogen of the acid is replaced by a metal the resulting compound is called a *bicarbonate*. Thus, Na_2CO_3 is sodium carbonate, and $NaHCO_3$ is sodium bicarbonate.

SYSTEMATIC NAME.	COMMON NAME.	FORMULA.
Calcium Carbonate.....	Chalk, marble, limestone..	$CaCO_3$.
Sodium ".....	Barilla, washing-soda....	Na_2CO_3 .
Hydrogen Sodium Carbonate....	Bicarbonate of soda, baking soda....	$NaHCO_3$.
Potassium Carbonate.....	Potash, pearlash.....	K_2CO_3 .
Hydrogen Potassium Carbonate.	Selaratus.....	$KHCO_3$.
Ammonium Carbonate.....	Smelling salts.....	$(NH)_2CO_3$.
Magnesium Carbonate.....	Magnesia.....	$MgCO_3$.
Lead Carbonate.....	White lead.....	$PbCO_3$.

Properties of Carbonates.

(1) All carbonates are insoluble in water except potassium carbonate, K_2CO_3 ; sodium carbonate, Na_2CO_3 , and ammonium carbonate $(NH_4)_2CO_3$.