Special.

ELEMENTARY CHEMISTRY.

CHAPTER III.—*Continued.*

Preparation of Carbon Dioxide.

Exp. 1.—Take the apparatus used for the preparation of hydrogen, place in it some marble broken into lumps, and pour in enough of water to cover them. Fit to the flask a delivery-tube, bent at right angles, and secure the flask on the retort-stand at such a height that the longer limb of the tube may reach nearly to the table. Place the delivery-tube in a bottle, covering the mouth with a disk of cardboard with a slit in it for the delivery-tube. Pour in hydrochloric acid, HCl, in small quantities at a time, until a brisk effervescence is set up. After the lapse of half a minute, pass a lighted taper into the bottle; as it approaches the bottom it goes out. There is evidently some gas collecting there. The reaction is expressed by the following equation:—

$$\underset{\text{Calcium carbonate.}}{CaCO_3} + \underset{\text{Hydrochloric acid.}}{2HCl} = \underset{\text{Calcium chloride.}}{CaCl_2} + \underset{\text{Water.}}{H_2O} + \underset{\text{Carbon dioxide.}}{CO_2}$$

This reaction takes place in two stages. The acid first exchanges its hydrogen for the calcium, producing calcium chloride on the one hand, and carbonic acid on the other; thus:—

$$CaCO_3 + 2HCl = CaCl_2 + H_2CO_3 \ldots\ldots (1)$$

The carbonic acid, at the moment of its formation, breaks up into water and gaseous carbon dioxide, the latter of which escapes with brisk effervescence; thus:—

$$H_2CO_3 = H_2O + CO_2 \ldots\ldots (2)$$

A cubic inch of marble will yield about four gallons of the gas.

Metathesis or Double Decomposition.—The reaction expressed by equation (1) consists merely in an interchange between the hydrogen atoms of the acid and the metallic atom of the carbonate; and of the different modes of chemical action, this is by far the most frequent. It has received the name of *Metathesis or double decomposition, and consists simply in the exchange of the elements or groups of elements in one body for the elements or group of elements in another body.*

PROPERTIES.

Neither Burns nor Supports Combustion.

Exp. 1.—Plunge a lighted taper into a bottle of carbon dioxide; it is quickly and decidedly extinguished, and the gas does not burn. Its power to extinguish flame is not owing to any chemical action of the gas, but is merely owing to the exclusion of atmospheric oxygen.

This property of carbon dioxide has led to its being used to extinguish fires in mines, and in the "Chemical Fire Extinguisher" it affords a ready means of extinguishing fires in their early stages.

Heavier than Air.—The density of carbon dioxide has already been shown by the method of collecting it. It may be further shown as follows:—

Exp. 2.—Take a wide-mouthed bottle and place in it a lighted taper. Bring the mouth of a bottle of the gas close to the edge of the bottle, and pour the gas over the taper, not directly over the centre of the bottle, but at its edge, since the gas receives a forward as well as a downward impulse whilst the bottle is being inverted; the taper will be immediately extinguished, showing that the gas has been poured from one bottle into the other. The molecular weight of carbon dioxide is 44; it is therefore $\frac{44}{2} = 22$ times heavier than hydrogen (Art. 26). But hydrogen is 14·47 times lighter than air; carbon dioxide is, therefore, about $1\frac{1}{2}$ times heavier than air.

Solubility in Water.

Exp. 3.—Half fill a bottle with cold water, and fill the other half with carbon dioxide by displacement. Now tightly close the mouth of the bottle with the wetted palm of the hand, and shake it vigorously for a short time; the bottle will adhere to the hand, owing to a partial vacuum being produced by the combination of the gas with the water. The reaction is as follows:—

$$\underset{\text{Carbon dioxide.}}{CO_2} + \underset{\text{Water.}}{H_2O} = \underset{\text{Carbonic acid.}}{H_2CO_3}$$

Invert the bottle in water, and remove the hand; the water will rush in and nearly fill the bottle, showing that the whole of the carbon dioxide has been absorbed. Water, at common temperatures, absorbs its own volume of the gas, acquiring an agreeable acidulous taste, and sparkles when agitated. Its solubility increases if the temperature is diminished or the pressure increased.

Acid character.

Exp. 4.—Fill a test-tube to the depth of about two inches with a solution of blue litmus, place the delivery-tube in it, and pass a stream of carbon dioxide through it for a short time; the color is changed to a wine-red, differing entirely from the pure red produced by the action of sulphuric or hydrochloric acid upon the litmus. Boil the reddened solution; it becomes blue again, the carbon dioxide passing off with the steam. Hence, *Carbonic acid is decomposed into carbon dioxide and water by boiling.*

Action on Lime-water.

Exp. 5.—Half-fill a test-tube with clear lime-water, place the delivery-tube in it, and allow the carbon dioxide to bubble through it; the solution becomes milky. The carbon dioxide first combines with the water which holds the calcium hydrate in solution, forming carbonic acid, which then combines with the calcium hydrate, the calcium of the hydrate and the hydrogen of the carbonic acid exchanging places; thus:—

(1) $$\underset{\text{Carbon dioxide.}}{CO_2} + \underset{\text{Water.}}{H_2O} = \underset{\text{Carbon acid.}}{H_2CO_3}$$

(2) $$\underset{\text{Calcium hydrate.}}{Ca(OH)_2} + \underset{\text{Carbonic acid.}}{H_2CO_3} = \underset{\text{Calcium carbonate.}}{CaCO_3} + \underset{\text{Water.}}{2H_2O}$$

The calcium carbonate, being insoluble in water, gives the milky appearance.

(To be continued.)

Professor (to class in mineralogy:) "Can you recall a mineral occurring in the liquid form?" Philosophical student: "Milk; because it comes in quarts."—*Ex.*