Special.

ELEMENTARY CHEMISTRY.

CHAPTER III.—*Continued.*

Calcium Bicarbonate.

Exp. 6.—Continue to pass carbon dioxide through the liquid in the test-tube; the turbidity disappears. The calcium carbonate combines with a molecule of carbonic acid, forming *calcium bicarbonate*, which is soluble in water; thus:—

$$\underset{\text{Calcium carbonate.}}{CaCO_3} + \underset{\text{Carbonic acid.}}{H_2CO_3} = \underset{\text{Calcium bicarbonate.}}{H_2Ca(CO_3)_2}$$

Calcium Bicarbonate, like Carbonic Acid, has never yet been isolated.

Exp. 7.—Boil the clear liquid in the test-tube, and turbidity again makes its appearance. The calcium bicarbonate is decomposed into the insoluble carbonate, carbon dioxide and water being formed; thus:—

$$\underset{\text{Calcium bicarbonate.}}{H_2Ca(CO_3)_2} = \underset{\text{Calcium carbonate.}}{CaCO_3} + \underset{\text{Water.}}{H_2O} + \underset{\text{Carbon dioxide.}}{CO_2}$$

This experiment explains the origin of the incrustation which is deposited inside kettles and steam-boilers. The calcium bicarbonate is decomposed as above, leaving the insoluble carbonate on the bottom and sides of the vessel. It may be removed from kettles by pouring in a little dilute hydrochloric acid, and may be prevented from forming in boilers by adding ammonium chloride:—

$$\underset{\text{Calcium carbonate.}}{CaCo_3} + \underset{\text{Ammonium chloride.}}{2NH_4\,1} = \underset{\text{Calcium chloride.}}{CaCl_2} + \underset{\text{Ammonium carbonate.}}{(EN_4)_2CO_3}$$

The ammonium carbonate volatilizes with the steam, and the very soluble calcium chloride remains in the boiler.

Supports Combustion of Substances that have a strong affinity for Oxygen.

Exp. 8.—Attach a piece of magnesium ribbon to the cap of the deflagrating spoon, so that its extremity may reach nearly to the bottom of a large bottle of carbon dioxide. Hold the ribbon in the flame of the spirit-lamp till it begins to burn, and then plunge it slowly into the gas; it will continue to burn brilliantly, forming white flakes of magnesium oxide, interspersed with black particles which consist of carbon. The magnesium combines with the oxygen to form magnesium oxide, setting the carbon free:—

$$\underset{\text{Carbon dioxide.}}{CO} + \underset{\text{Magnesium.}}{2Mg} = \underset{\text{Magnesium oxide.}}{2MgO} + \underset{\text{Carbon.}}{C}$$

Pour a little water into the bottle, and add a small quantity of hydrochloric acid, pour into a test-tube and heat. The magnesium oxide will disappear, while black flakes of carbon will remain floating undissolved in the clear liquid. These may be collected on a filter and shown to be carbon. *This experiment proves that carbon dioxide contains carbon.*

Decomposition of Carbon Dioxide by Plants in Sun-light.

Exp. 9.—Fill a large tumbler with water, saturated with carbon dioxide. Fill a glass funnel with fresh green leaves (mint is best). Place the funnel inverted in the tumbler, carefully displacing all the air adhering to the leaves by agitation, and close the neck of the funnel by a cork well saturated with paraffine. Pour off a portion of the water from the tumbler, and place it in direct sunlight. Soon minute bubbles will gather in the leaves and rise into the neck of the funnel. Two or three days in spring or summer, and four or five days in winter will be required. When a sufficient quantity of gas has accumulated, bring the water outside the neck to a level with that inside, remove the cork and insert a glowing splint into the gas; the splint will be rekindled, showing the gas to be oxygen. The probable reaction is—

$$\underset{\text{Carbon dioxide.}}{12CO_2} + \underset{\text{Water.}}{11H_2O} = \underset{\text{Sugar.}}{C_{12}H_{22}O_{11}} + \underset{\text{Oxygen.}}{12O_2}$$

This experiment is of great importance as it explains the natural production of oxygen from carbon dioxide and water. The plant leaf is the laboratory in which is constructed the material of which the plant consists, such as woody fibre, sugar, starch, gums, etc. All these consist essentially of carbon and water, and they differ from each other only by a certain number of molecules of water; thus:—

$$\underset{\text{Sugar.}}{C_{12}H_{22}O_{11}} + \underset{\text{Water.}}{H_2O} = \underset{\text{Glucose or fruit sugar.}}{2C_6H_{12}O_6};$$

$$\underset{\text{Fruit sugar.}}{C_6H_{12}O_6} - \underset{\text{Water.}}{H_2O} = \underset{\text{Starch.}}{C_6H_{10}O_5}.$$

Observe also that the volume of oxygen liberated is equal to the volume of carbon dioxide decomposed, so that the volume of the atmosphere remains constant.

OTHER METHODS OF OBTAINING CARBON DIOXIDE.

By boiling or heating a solution of Sodium Bicarbonate.

Exp. 10.—Dissolve a tea-spoonful of sodium bicarbonate in water in a test-tube, fitted with a cork and delivery-tube, and boil; carbon dioxide will be given off. The reaction is—

$$\underset{\text{Sodium bicarbonate.}}{2NaHCO_3} = \underset{\text{Sodium carbonate.}}{Na_2CO_3} + \underset{\text{Water.}}{H_2O} + \underset{\text{Carbon dioxide.}}{CO_2}$$

9. By the action of Hydrochloric Acid on Sodium Bicarbonate.

Exp. 11.—Pour dilute hydrochloric acid on a tea-spoonful of sodium bicarbonate in a test-tube; carbon dioxide will be rapidly given off; thus:—

$$\underset{\text{Sodium bicarbonate.}}{NaHCO_3} + \underset{\text{Hydrochloric acid.}}{HCl} = \underset{\text{Sodium chloride or common salt.}}{NaCl} + \underset{\text{Water.}}{H_2O} + \underset{\text{Carbon dioxide.}}{CO_2}$$

This reaction has been employed as a means of raising dough in the process of bread making. The escaping carbon dioxide puffs up the dough, common salt remaining in the bread. Hydrochloric acid is seldom found sufficiently pure for culinary purposes. Tartaric acid and cream of tartar, however, will answer the same purpose. Indeed, all the baking powders, and yeast powders, and the so-called self-raising flour, depend for their action on the mixture of sodium bicarbonate with some organic acid or other substance that will liberate carbon dioxide from the sodium bicarbonate.

By Combustion.

Exp. 12.—Hold a wide-mouthed bottle over the flame of a spirit-lamp for a few moments. Invert the bottle, add a little