Special.

ELEMENTARY CHEMISTRY.

CHAPTER III.—(*Continued.*)

80. The Hydrogen Harmonicum.

Exp. 13.—Take a glass tube, open at both ends, about one centimetre wide and 30 centimetres long, and slowly pass the jet up into it, the flame is seen suddenly to elongate and a musical note results. The note emitted depends on the diameter and length of the tube, consequently tubes varying in these particulars may be used to produce different sounds. By raising or depressing the tube, the intensity of the sounds may be greatly varied. Ordinary wide mouthed bottles may be used instead of tubes. These musical notes are really a succession of detonations due to the periodic combination of the atmospheric oxygen with the issuing jet of hydrogen, and succeeding each other with such swiftness as to prevent the ear observing the intervals between them. They may be produced by any combustible gas burned in the same way.

81. Reducing action of Hydrogen.

Exp. 14.—Take a hard-glass tube, about 20 centimetre long and 1 centimetre in diameter, and draw out one end to a moderately wide jet. Place midway in it a thin layer of copper oxide, CuO, connect it by a cork and glass tube with the drying tube, which is itself joined to the generating flask. Generate hydrogen as usual and keep up a steady current through the apparatus. When all the air has been expelled, apply heat to the tube so as to raise the temperature of the copper oxide to a low red heat. The oxide soon begins to glow, and steam issues from the end of the tube, and may be condensed in a cold flask. The lamp may be removed, and when the glowing ceases, the tube is seen to contain a red body, easily identified as metallic copper. The change is expressed by the following equation:—

$$\underset{\text{Copper oxide.}}{CuO} + \underset{\text{Hydrogen.}}{H_2} = \underset{\text{Metallic copper.}}{Cu} + \underset{\text{Water.}}{H_2O}$$

This reaction has been employed to determine the composition of water by weight.

Iron rust, Fe_2O_3, may be substituted for the copper oxide. Metallic iron will be left in the tube, and in a very fine state of division, in which condition the metal easily takes fire when scattered out of the tube into the air, so rapidly does it combine with the oxygen again. The reaction is expressed by the equation—

$$\underset{\text{Ferric oxide.}}{Fe_2O_3} + \underset{\text{Hydrogen.}}{3H_2} = \underset{\text{Iron.}}{2Fe} + \underset{\text{Water.}}{3H_2O}$$

OTHER METHODS OF PREPARING HYDROGEN.

82. By the action of Zinc on Dilute Hydrochloric Acid.

Exp. 15.—Add to a few pieces of granulated zinc, contained in a test-tube, some dilute hydrochloric acid till there is a brisk effervescence. Apply a light to the mouth of the tube, the sharp explosion and the well-known lambent flame show the presence of hydrogen. The reaction is expressed by the equation:—

$$2HCl + Zn = ZnCl_2 + H_2$$

83. By the action of Zinc on a strong Solution of Potash.

Exp. 16.—Add a little granulated zinc to a strong aqueous solution of caustic potash in a test-tube, to which adapt a cork and delivery-tube. On boiling, a gas will be slowly given off, which may be collected over water in the usual way. Some steam will pass over, but this will condense. On applying a light to a test-tube full of the gas, it will give the well-known flame of hydrogen. The following equation expresses the reaction:—

$$\underset{\text{Zinc.}}{Zn} + \underset{\text{Potassium hydrate.}}{2KOH} = \underset{\text{Zinc potassate.}}{Zn(HK)_2} + \underset{\text{Hydrogen.}}{H_2}$$

This method is interesting from its theoretical bearing rather than from any practical utility. But if iron filings are added with the zinc, hydrogen is given off without the application of heat. The zinc dissolves, as above, but not the iron, which forms a galvanic circuit, and thus hastens the solution of the zinc. By this process very pure hydrogen may be prepared.

84. From the Decomposition of Water by Iron at a red heat.

Clean iron turnings or filings, free from rust, are placed in a piece of clean gas-piping, and are heated to low redness in a furnace. The cheapest furnace for this purpose is an ordinary plumber's furnace with holes pierced through its sides. Steam generated from a flask of boiling water is then conducted through the tube, and the liberated hydrogen is collected over water in the usual way. The reaction is—

$$\underset{\text{Iron.}}{3Fe} + \underset{\text{Water.}}{4H_2O} = \underset{\text{Magnetic oxide of Iron.}}{Fe_3O_4} + \underset{\text{Hydrogen.}}{4H_2}$$

The magnetic oxide of iron produced in this experiment is adherent, and a protection from further rust. Barff's process for preventing articles from rusting, is an application of this principle.

85. From the decomposition of Water by Magnesium.

The preceding experiment, though interesting, is quite a troublesome one. By substituting magnesium for iron the experiment may be conducted in a glass tube, and will be much more satisfactory.

Exp. 17.—Place about 3 feet of magnesium ribbon, in folds, in a hard-glass tube in such a way that the metal touches the glass in a number of points. Draw out one end of the tube to a pretty wide jet, and attach the other to a flask of water. Boil the water in the flask and allow the steam to flow until the air is expelled. Heat the tube sufficiently to prevent condensation at the mouth of the jet. Then heat the metal strongly at the extreme end. After a few moments it takes fire, burning brilliantly, and the escaping hydrogen may be lighted at the jet. It is best to keep the metal quite hot throughout. The reaction is:—

$$\underset{\text{Magnesium.}}{Mg} + \underset{\text{Water.}}{H_2O} = \underset{\text{Magnesia.}}{MgO} + \underset{\text{Hydrogen.}}{H_2}$$

SUMMARY AND ADDITIONAL FACTS.

86. History.—Hydrogen was probably known as early as the sixteenth century, but its true nature was first ascertained by Cavendish in 1766. It was named hydrogen by Lavoisier. It was liquified almost simultaneously and independently by two distinguished physicists, M. Cailletet, of Chatillon-sur-