68. By the Decomposition of Water by Sodium or Potassium.

Exp. 1.—Boil some water ten or fifteen minutes, that all the air may be expelled from it; let it cool, and fill a saucer and a large and strong test-tube with it; close the mouth of the test-tube with the thumb and insert it under the water in the saucer. Should the mouth of the test-tube be too wide to be closed by the thumb, place a small watch glass, or a piece of thick blotting paper under it and rapidly insert it in the saucer. Support the test-tube with its mouth just under the water by means of a copper wire twisted tightly round a cork fitted on to a retort stand. Now place on the end of a wire a piece of sodium, not larger than a small pea, and thrust it rapidly under the mouth of the tube. The metal frees itself from the wire, and as it is lighter than water, ascends into the tube, floating there with a rotary motion. A gas is evolved from the water and collects in the upper part of the tube. When the tube is full, place a glass plate under it and raise it from the water, invert it and rapidly apply a light to its mouth; the gas will burn with a pale blue flame—as in Exp. 19, Art. 19—and is readily recognized as hydrogen. Add reddened litmus to some of the water in the saucer, and it will immediately become blue, showing that the water now contains an *alkali*. On evaporating the water in the saucer, this alkali is found to be sodium hydrate, NaOH, The sodium must, therefore, have replaced one-half of the hydrogen in the water, in the manner shown in the following equation:—

$$\underset{\text{Water.}}{2H_2O} + \underset{\text{Sodium.}}{Na_2} = \underset{\text{Sodium hydrate.}}{2NaOH} + \underset{\text{Hydrogen.}}{H_2}.$$

Exp. 2.—Lay a piece of blotting paper on the surface of the water in the saucer, and throw upon it a small piece of sodium; an energetic decomposition of the water takes place, and in a few seconds the sodium will apparently burst into flame, and burn with a bright golden color. The apparent combustion of the sodium is really due to the burning of the hydrogen set free by the metal, which is inflamed by the intense heat which accompanies its evolution. This experiment differs only from the preceding one inasmuch as in the former case the hydrogen is collected, while in the latter it is burnt as it is liberated. The sodium hydrate may be rendered evident as before by the addition of reddened litmus solution to the water.

If potassium had been used instead of sodium in the preceding experiment, the blotting paper might have been dispensed with. The potassium glides about with a hissing noise, decomposing the water much more violently than sodium, the hydrogen evolved burning with a violet flame, potassium hydrate, KOH, remaining in solution in the water.

In these experiments care must be taken not to hold the face too near when the flame has ceased; for there remains a globule of the metal, which is in a melted state, and when it cools down to such a temperature as to permit the water to come in contact with it, steam is rapidly generated, and the melted metal blown out of the water.

69. By the action of Zinc on Dilute Sulphuric Acid.

Exp. 3.—The most convenient mode of preparing hydrogen gas for ordinary use, where absolute purity is not requisite, is by the action of dilute sulphuric acid on zinc. Take a strong flask, with a flat bottom, of about 250 (10 oz.) cubic centimetres capacity, fit it to a good sound cork which has been previously well soaked in melted paraffine. Take a funnel-tube and a piece of glass tubing bent once at right angles, and bore in the cork two holes of such a size as to fit them, taking care not to make the holes too near the edge of the cork nor too near each other. Fit the funnel-tube into one of these holes so that it may reach nearly to the bottom of the flask, and join to the other tube, by means of a short piece of india-rubber tubing, a bent delivery-tube. Put 30 grams (10 oz.) of granulated zinc* or zinc clippings into the flask, inclining it to one side, and gently sliding the zinc down the neck, taking care that it does not fall heavily against the bottom. Fit the cork into the neck of the flask and arrange the apparatus so that the delivery-tube may be under the shelf of the trough. A straight tube, to the upper end of which a small funnel is united by a cork, may be used instead of a funnel tube. Pour through the funnel enough water to cover the zinc to the depth of about one centimetre, and try whether the joints are tight by blowing through the delivery tube till the water rises in the funnel, then pressing the connecting india-rubber with the fingers, and observing if the water remains in the funnel or descends very slowly. If it descends rapidly wet the cork and push it still farther into the flask; if there is still leakage it may be detected by the bubbling of the water through the cork and may be stopped by a little sealing wax, or more conveniently by a mixture of equal parts of bees-wax and turpentine, with a little Venetian red to give it color. Now pour through the funnel-tube sulphuric acid in small quantities at a time. The disengagement of the gas commences immediately, and when it slackens it may be invigorated by a little more acid. Great care must be taken not to add too much acid or the liquid in the flask will froth over. Should it exhibit a tendency to do so, pour some water down the funnel to dilute and cool the acid. If the zinc happens to be very pure the sulphuric acid will act upon it very slowly. In that case a few drops of copper sulphate will at once cause energetic action. Fill two bottles with the mixture of air and hydrogen which first escapes from the flask and reject it. This precaution is important as it will be shown that air forms with hydrogen a mixture which explodes upon contact with a light. As soon as the bottle is filled place a glass plate or small saucer under it, lift it out of the trough, and place it on the table mouth downwards. It is only necessary to collect one or two bottles of the gas at first, as the collection may go on while the experiments are being performed.

One ounce of zinc is sufficient to liberate from the acid about 2½ gallons of gas; or 30 grams will furnish about 10 litres.

Scraps of iron may be substituted for zinc; but is this case the gas is less pure It has a disagreeable odor, due to the presence of compounds of carbon and hydrogen, but these may be removed by passing the gas through tubes filled with fragments of wood-charcoal.

(To be continued.)

* Zinc may be *granulated* by melting it in an iron ladle and pouring it into a pail of water. If the melted metal is poured from the height of a yard or more above the surface of the water, the granules are spongy and very thin, presenting a large surface compared with their weight; whilst solid heavy granules are obtained if the zinc is poured at a distance of a few inches only above the water. The former kind is most convenient when a rapid current of hydrogen is required.