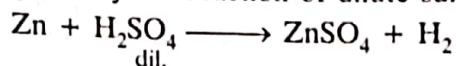


8. Laboratory Preparation of Hydrogen.

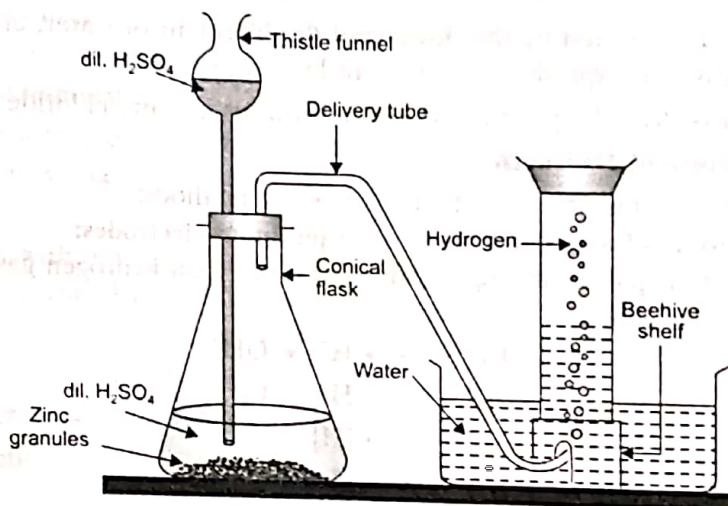
In laboratory, hydrogen is prepared by the reaction of dilute sulphuric acid with granulated zinc.



- (i) Zinc is preferred to other metals because sodium and potassium react explosively or violently with cold water or dilute acids. In calcium and magnesium, the liberation of hydrogen is so rapid that it cannot be collected.

Aluminium gets coated with the thin but tough layer of oxide which prevents the reaction of metal with water and dilute acids.

In iron, the liberation of hydrogen is very slow and as copper lies below hydrogen in activity series so, it cannot displace hydrogen from dilute acids.



Laboratory preparation of Hydrogen from Granulated zinc and dil. H_2SO_4

- (ii) The apparatus used for the preparation of hydrogen gas should be airtight. The lower end of the thistle funnel should dip in the acid otherwise the gas will escape from the thistle funnel. The apparatus should be kept away from the flame.

- (iii) Hydrogen obtained by the reaction of granulated zinc with dilute sulphuric acid is not pure, it contains the impurities of the following gases:

(a) Sulphur dioxide — SO_2

(b) Carbon dioxide — CO_2

(c) Water vapour — H_2O

(d) Hydrogen sulphide — H_2S

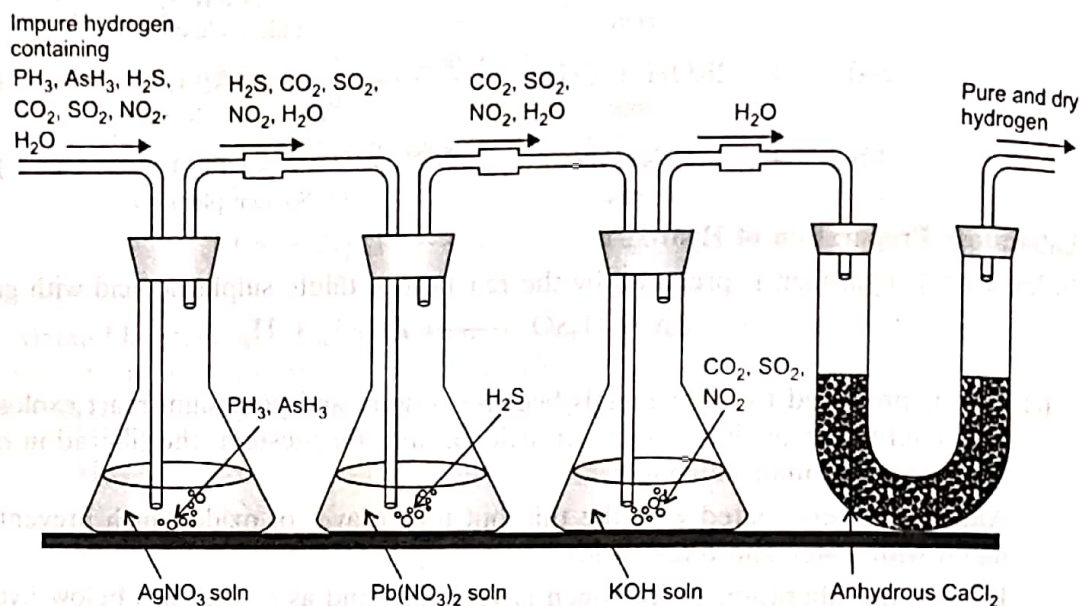
(e) Arsine — AsH_3

(f) Phosphine — PH_3

(g) Nitrogen dioxide — NO_2

Although pure hydrogen is odourless but because of the presence of the preceded mentioned gases as impurities it possesses a characteristic peculiar odour.

- (iv) For the purification of hydrogen, the impure gas is passed through
- Silver nitrate solution:** To absorb arsine and phosphine.
 - Lead nitrate solution:** To absorb hydrogen sulphide.
 - Potassium hydroxide solution:** To absorb carbon dioxide, sulphur dioxide and nitrogen dioxide.
 - Anhydrous calcium chloride:** To absorb moisture.



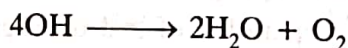
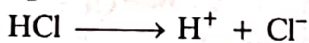
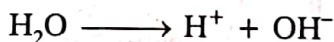
Purification of Hydrogen

- Hydrogen prepared is collected by the downward displacement of water, after first allowing the air to escape, as air forms an explosive mixture with hydrogen.
- Hydrogen collected is dried by passing through anhydrous calcium chloride.
- Industrial Manufacture of Hydrogen:**

Industrially, hydrogen is manufactured by the following methods:

- (a) **By the electrolysis of acidulated water with platinum electrodes:**

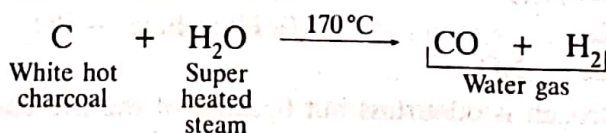
When electricity is passed through acidulated water then hydrogen gas is obtained at cathode and oxygen gas is obtained at anode.



- (b) **By Bosch Process:** This process involves the following two steps:

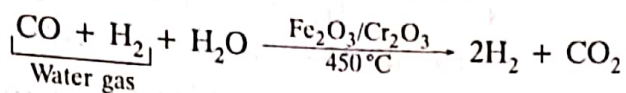
- (i) **Preparation of water gas:**

When superheated steam at a temperature of 170°C is passed over white hot charcoal, it forms equivolume mixture of carbon monoxide and hydrogen called water gas. The reaction for the formation of water gas is endothermic in nature.



(ii) **Removal of impurities (carbon monoxide) from water gas:**

Water gas formed is mixed with twice the volume of steam and passed over the catalyst, which is a mixture of ferric oxide and chromium oxide (promoter) at a temperature of 450 °C, carbon monoxide gets oxidized to carbon dioxide.



The above reaction is called the water gas shift reaction.

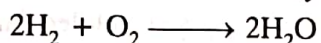
The hydrogen obtained by this process contains the impurities of carbon monoxide in traces and carbon dioxide. Carbon monoxide can be removed by passing it through ammoniacal cuprous chloride solution. Carbon dioxide can be removed by passing through cold water under pressure.

12. Physical properties of Hydrogen:

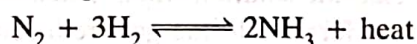
- (i) Pure hydrogen is a colourless, odourless and tasteless gas. However, impure hydrogen has fishy smell.
- (ii) Hydrogen is the lightest gas.
- (iii) Hydrogen is practically insoluble in water.

13. Chemical properties of Hydrogen:

- (i) **Combustibility:** Hydrogen is a combustible gas but it is not a supporter of combustion. It burns with pale blue flame. If hydrogen is mixed with air or oxygen and then ignited, it causes explosion.
- (ii) **Action towards litmus:** Hydrogen is neutral towards litmus. In other words, it neither turns red litmus to blue nor blue litmus to red, i.e. it is neither acidic nor basic in nature.
- (iii) **Action with non-metals:**
 - (a) **Reaction with Oxygen:** It burns silently in the atmosphere of oxygen with pale blue flame to form water, i.e. the product of oxidation of hydrogen is water.



- (b) **Reaction with Nitrogen:** The process of manufacturing or synthesis of ammonia from its elements is called Haber's process.



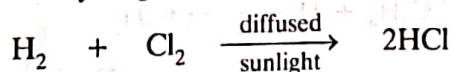
Catalyst — Finely divided Iron

Promoter — Molybdenum

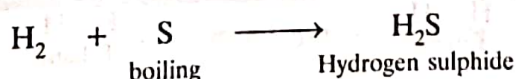
Temperature — 450–500 °C

Pressure — 200–1000 atm.

- (c) **Reaction with Chlorine:** Chlorine has maximum affinity for hydrogen. It readily reacts with hydrogen in diffused sunlight to form hydrogen chloride gas. This reaction does not take place in dark, however, in direct sunlight the reaction proceeds spontaneously with an explosion to form hydrogen chloride gas.



- (d) **Reaction with Sulphur:** When hydrogen gas is passed through boiling sulphur, it forms a gas having rotten egg smell.



**Q.1. From the list of metals given below choose the metal which fits into the description given below:
Iron, zinc, sodium, silver, magnesium, lead.**

- (i) A metal which reacts very slowly with dilute hydrochloric acid initially but after sometime reaction stops.**
- (ii) A metal that reacts reversibly with steam.**
- (iii) A metal which reacts vigorously with cold water.**
- (iv) A metal which does not react with dilute acid or water.**
- (v) A metal which reacts both with acids and alkalies to displace hydrogen.**