

6.0 HYDROGEN - HYDRIDE - HALOGEN FAMILY

Carvendish discovered hydrogen because he was the first in 1766 to prepare it in the pure state. He describe it properties and recorgnized it as an element. He found that the gas was flammable and that it burned in air to produce water. Therefore, Lavoisier named it Hydrogen, meaning water-former

6.1 OCCURRENCE

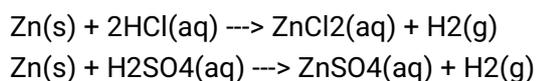
Hydrogen make up approximately 1% of the earth's crust. it is found free only in very small amounts (0.01%) in the atmosphere and in volcanic gases, although recent spectroscopic studies show that the large amount are present in the sun and the star. Hydrogen is widely distributed in combination with other element. It make up one ninth by mass of water and is an important constituent of all acids and alkalis. Combined with carbon, hydrogen is found in natural gas, kerosene, and other petroleum products.

6.2 LABORATORY PREPARATION

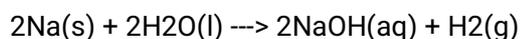
Hydrogen is liberated when certain metals react with dilute minerals acid, water or steam. it is also given off when tin, zinc or aluminium reacts with hot concentrated solutions of sodium or potassium hydroxide. The three method commonly used for preparation of hydrogen in the laboratory are as follows

[A.] Action of zinc on acid: Dilute hydrochlroic or tetraoxosulphate(vi)acid attack mettalic zinc with the liberation of hydrogcn gas, No heating is necessary

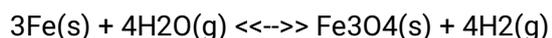
hydrogen gas preparation



[B.] Action of sodium on cold water: Sodium liberates hydrogen from cold water. This reaction is very vigorously and should be carried out with extreme care using only a small piece of sodium.



[C.] Action of iron on steam: Iron, at red heat liberate hydrogen from steam. Iron(II) diiron(III); oxide Fe_3O_4 formed at the same time, the reaction is reversible.



6.3 HYDROGEN AND THE ACTIVITY SERIES

In the laboratory preparation of hydrogen, we saw that some metals could displace hydrogen from water and acids. However; other metals like copper and silver cannot displace hydrogen from water or acids. We can regard metals which displace hydrogen from water and acid as more active than hydrogen, while those that do not as less active.

Activity series of metals in tabular form

---->> Increasing electropositivity

Lithium (Li) , Potassium (K) , Sodium (Na) , Calcium (Ca) , Magnesium (Mg) , Aluminium (Al) , Zinc (Zn) , Iron (Fe) , Tin (Sn) , Lead (Pb) , Hydrogen (H) , Copper (Cu) , Mercury (Hg) , Silver (Ag) , Platinum (Pt) , Gold (Au).

<<---- Decreasing chemical activity

Lithium (Li) , Potassium (K) , Sodium (Na) , Calcium (Ca) , Magnesium (Mg) , Aluminium (Al) , Zinc (Zn) , Iron (Fe) , Tin (Sn) , Lead (Pb) , Hydrogen (H) , Copper (Cu) , Mercury (Hg) , Silver (Ag) , Platinum (Pt) , Gold (Au).

6.4 PHYSICAL PROPERTIES OF HYDROGEN

- [1] Hydrogen is colourless, odourless and tasteless gas.
- [2] Hydrogen is neutral to moist litmus paper.
- [3] Hydrogen is relatively insoluble in water.
- [4] Hydrogen is lightest known substance, 14.4 times lesser than air.
- [5] Hydrogen has very low boiling point of -253 degree Celsius.

6.5 CHEMICAL PROPERTIES OF HYDROGEN

- [1] Hydrogen is an unusual element.
- [2] Hydrogen has single valency electron like Group 1 alkali metals
- [3] Hydrogen is clearly a gas with non-metallic properties like Group 7 halogen.

- [4] Hydrogen is usually in Group 1 in periodic table.
- [5] Hydrogen accept an electron from another atom to form negative hydride ion.
- [6] Hydrogen forms a covalent bond by sharing its lone electron. (H-H).

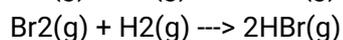
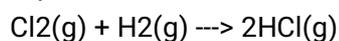
6.6 COMBINATION REACTION OF HYDROGEN

Hydrogen combines with certain metals and non metals to form electrovalent and covalent hydrides respectively. In both instances, the hydrogen atom gains an extra electron to achieve the stable electronic configuration of helium.

[a.] With Metals: Hydrogen combines directly with several of the more active metals to form ionic hydrides, i.e. compounds which contain the hydride ion. For example $2\text{Na(s)} + \text{H}_2\text{(g)} \rightarrow 2\text{NaH(s)}$

[b.] With Oxygen: Pure hydrogen burns with a pale blue flame as it combines with oxygen to produce steam. For example $2\text{H}_2\text{(g)} + \text{O}_2\text{(g)} \rightarrow 2\text{H}_2\text{O(g)}$

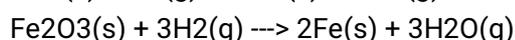
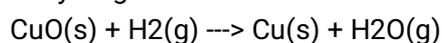
[c.] With Halogens: Hydrogen combines directly with the halogens to produce halides. For example



The reaction between hydrogen and chlorine is spontaneous in bright sunlight but slower in diffused light. The combination of hydrogen with bromine and with iodine is much less vigorous.

6.7 REDUCING ACTION

Hydrogen is a strong reducing agent. It reduces the oxides of copper, lead, iron, and zinc to the respective metals when they are heated in a stream of the gas. At the same time, the hydrogen itself is oxidized to form water.



N.B: Hydrogen has three isotopes (protium, deuterium and tritium)

6.8 TEST FOR HYDROGEN

Insert a light splinter into a test-tube containing the unknown gas. If the gas is hydrogen, it will burn with a pop sound, since it will invariably mix with air as soon as the test-tube is unstoppered. This test should be carried out with small quantities of the gas.

USES OF HYDROGEN

- [1] It is used in ammonia, hydrochloric acid and methanol.
- [2] Under high pressure it is passed through vegetable oil (e.g palm oil)
- [3] It is used for filling balloons.
- [4] It is highly flammable nature.
- [5] It gives out lot of heat when it burns
- [6] It is a constituent of many gaseous fuels

REVISION EXERCISE

- [1] Who discovered Hydrogen ?
- [2] In what year hydrogen was discovered ?
- [3] Who named the element Hydrogen ?
- [4] How can hydrogen be prepared in the Lab ?
- [5] Uses of hydrogen ?
- [6] What is the physical properties of hydrogen ?
- [7] What is the chemical properties of hydrogen ?
- [8] Explain how hydrogen react with metals
- [9] Explain how hydrogen react with Oxygen & Halogen
- [10] How can we test for hydrogen ?

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