HYDROGEN

Position in the Periodic Table

- Hydrogen shows resemblance with both Alkali metals of the first group and halogens of the 17th group.
- Like alkali metals it has one electron in the outer most shell and forms unipositive ions. Hydrogen forms oxides, halides and sulphides similar to alkali metals.
- Like halogens, it requires only one electron to complete the valence shell configuration. So it gains one electron to form uninegative ion
- . It exists as diatomic molecule, combines with metals to form hydrides and form a large number of covalent compounds with non-metals.
- At the same time it shows some differences from alkali metals and halogens.
- Unlike alkali metals it has very high ionisation enthalpy, exists as diatomic molecule and is a typical non-metal.
- Unlike halogens, it has very low reactivity and readily forms positive ions***. So eventhough Hydrogen resemblance with both alkali metals and halogens, it differs from them as well. So it is placed separately in the periodic table.***

Isotopes of Hydrogen Hydrogen has three isotopes

I. Protium
II. Deuterium
III. Tritium(***radio active)***

Preparation

1. The reaction between granulated zinc and dilute
2. Electrolysis of acidified water with platinum electrodes
3. It is obtained as a byproduct in the manufacture of NaOH and Chlorine by the electrolysis of brine solution (NaCl solution)
4. By the reaction of steam on hydrocarbons or coke at high temperature in the presence of catalyst.
   $CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$ ***The mixture of CO and H_2 is called water gas. Since it is used for the synthesis of methanol and large number hydrocarbons, it is also called synthesis gas or syn gas.***

$C(s) + H_2O(g)$ 1270K $CO(g) + H_2(g)$ (Coal Gasification)

- The production of dihydrogen can be increased by reacting carbon monoxide of syngas mixtures with steam in the presence of iron chromate as catalyst. This is called **water-gas shift reaction**.
  $CO(g) + H2O(g)$ 673K,Ni $CO_2(g) + H_2(g)$

Important Reaction Reaction

Uses of Dihydrogen

1. Dihydrogen is mainly used for the synthesis of ammonia .
2. It is used in the manufacture of vanaspati fat by the hydrogenation of vegetable oils.
3. It is widely used for the manufacture of metal hydrides
4. In metallurgical processes, it is used to reduce heavy metal oxides to metals.
5. Atomic hydrogen and oxy-hydrogen torches are used for cutting and welding purposes.
6. It is used in fuel cells for generating electrical energy.

HYDRIDES

The binary compounds of hydrogen with other elements are called Hydrides.

Ionic or saline or salt-like hydrides:

- s-block elements. They are crystalline, non-volatile solids. They are non-conductors in the solid state but conduct electricity in the molten state or in aqueous solution state.
- e.g. NaH, KH, CaH_2, BaH_2 etc.

Covalent or Molecular Hydrides:

- These are the hydrides of p-block elements.
- *(i) electron-deficient, (ii) electron-precise and (iii) electron-rich hydrides*.

Metallic Hydrides:

- These are formed by many d-block and f-block elements. However, the metals of group 7, 8 and 9 do not form this hydride. They are almost always nonstoichiometric, being deficient in hydrogen. They conduct heat and electricity.
- e.g. $LaH_{2.87}$, $YbH_{2.55}$, $VH_{0.56}$, NiH0.6–0.7, PdH0.6–0.8 etc. In these hydrides the hydrogen atom is occupied in the metal lattice. So they are also called interstitial hydrides.

WATER

Hard and soft water

Water which does not easily form lather with soap is called hard water. It is due to the presence of calcium and magnesium salts in the form chlorides, sulphates and bicarbonates.

Types of hardness of water

1. Temporary Hardness
   Hardness which can be removed by simple boiling is called temporary hardness. It is due to the presence of bicarbonate of calcium and magnesium.
   The following methods are used to remove temporary hardness.

a) Boiling

b) Clark's method:

2. Permanent Hardness

Hardness which cannot be removed by boiling is called Permanent hardness. It is due to the presence of soluble chlorides and sulphates of calcium and magnesium in water.

It can be removed by the following methods:

a) Treatment with washing soda (Sodium carbonate):

b) Calgon's method: ***Sodium hexametaphosphate ($Na_6P_6O_{18}$) is commercially called 'calgon'***.

c) Ion-exchange method: This method is also called zeolite/permutit process. Zeolite /permutit is hydrated sodium aluminium silicate which can be written as NaZ.

d) Synthetic resins method: This method is more efficient than zeolite process.

HYDROGEN PEROXIDE (H_2O_2)

Preparation

- It can be prepared by the following methoIt is prepared by acidifying barium peroxide and removing excess water by evaporation under reduced pressure.
- Industrially it is prepared by the auto-oxidation of 2- alklylanthraquinols.

Structure Hydrogen peroxide has a non-planar structure as follows:

Chemical properties : H_2O_2 acts as an oxidising as well as reducing agent in both acidic and alkaline media.

STORAGE

- H_2O_2decomposes slowly on exposure to light.
- $2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$
- In the presence of metal surfaces or traces of alkali (present in glass containers), the above reaction is catalysed.
  It is, therefore, stored in wax-lined glass or plastic vessels in dark. Urea can be added as a stabiliser. It is kept away from dust because dust can induce explosive decomposition of the compound.

Uses

1. In daily life it is used as hair bleach and as a mild disinfectant. As an antiseptic it is sold in the market as perhydrol.
2. It is used to manufacture chemicals like sodium perborate and per-carbonate, which are used in high quality detergents.
3. It is used in the synthesis of hydroquinone, tartaric acid and certain food products and pharmaceuticals.
4. It is employed in the industries as a bleaching agent for textiles, paper pulp, leather, oils, fats etc.

HEAVY WATER (D_2O)

- D_2O is called heavy water.
- It is used as a moderator in nuclear reactors and in exchange reactions for the study of reaction mechanisms. It can be prepared by exhaustive electrolysis of water or as a by-product in some fertilizer industries.
- It is used for the preparation of other deuterium compounds.