HYDROGEN

Occurrence: Most abundant in universe.

Preparation:

- Laboratory Method:

$Zn+2H^+ \longrightarrow Zn^{2+}+H_2$

$Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2$

-Commercial Method:

$2H_2O(l) \xrightarrow[\text{Traces of acid/base}]{\text{Electrolysis}} 2H_2(g) + O_2(g)$

By electrolysing warm aqueous barium hydroxide Solution between Ni electrodes.

$C_nH_{2n+2}+nH_2O \xrightarrow[Ni]{1270\ K} nCO+(2n+1)\ H_2$

$-CO + H_2$ is called water gas

-Coal Gasification : $C_{(s)}+H_2O_{(g)} \xrightarrow{1270\ K} CO_{(g)}+H_{2(g)}$

Water-gas shift reaction :

$CO(g)+H_2O_{(g)} \xrightarrow{673\ K} CO_{2(g)}+H_{2(g)}$

Physical Properties:

Colourlers, odourless, tasteless and combustible
Lighter than air, insoluble in water.

Chemical Properties:

$H_{2(g)}+X_{2(g)} \longrightarrow 2HX_{(g)}(X=F,Cl,Br,I)$

$2H_{2(g)}+O_{2(g)} \xrightarrow[\text{Heating}]{\text{Catalyst or}} 2H_2O(l)\ \Delta H^0=-285.9\ kJmol^{-1}$

$3H_{2(g)}+N_{2(g)} \xrightarrow[Fe]{673K,200atm} 2NH_{3(g)}\ \Delta H^0=-92.6\ kJmol^{-1}$

$H_{2(g)}+2M_{(g)} \longrightarrow 2MH_{(s)}$ Where M=alkali metal

$H_{2(g)}+Pd^{2+}_{(aq)} \longrightarrow Pd_{(s)}+2H^+_{(aq)}$

$H_2+CO+RCH=CH_2 \longrightarrow RCH_2CH_2CHO$

$H_2+RCH_2CH_2CHO \longrightarrow RCH_2CH_2CH_2OH$

Uses:

- Synthesis of ammonia.
- In manufacture of vanaspati fat.
- In manufacture of bulk organic chemicals.
- For manufacture of metal hydrides
- Preparation of HCl
- In metallurgical processes.
- As a rocket fuel.
- In fuel cells

HEAVY WATER

Preparation

By exhaustive electrolysis of water

Uses

- As a moderator in nuclear reactors.
- In exchange reactions for the study of reaction mechanisms.

ISOTOPES

Protium: Predominant form. (^1_1H)

Deuterium: (^2_1H)

Tritium : Radioactive (^3_1H)

PROPERTIES

- Resembles alkali metals (lose one e^- to form unipositive ions)
- Resembles halogens (gain one e^- to form uninegative ion)
- Forms oxides, halides and sulphides
- Very high ionization enthalpy
- Does not possess metallic characters under normal conditions
- Forms diatomic molecules.

HYDRIDES

TYPES

(i) Ionic/saline/salt-like
Stoichiometric compounds of dihydrogen formed with s-block elements

(ii) Metallic/non-stoichiometric/interstitial
Formed by d-block & f-block elements

(iii) Covalent/molecular
Formation of molecular compounds from dihydrogen and p-block elements

a) Electron deficient (Group 13 hydrides)
b) Electron Precise (Group 14 hydrides)
c) Electron rich (Group 15,16,17 hydrides)

DIHYDROGEN

Physical properties

Colourless, miscible with water.
Structure : Non-Planar

Chemical Properties

1) Oxidising action in acidic medium

$2Fe^{2+}_{(aq)}+2H^+_{(aq)}+H_2O_{2(aq)} \longrightarrow 2Fe^{3+}_{(aq)}+2H_2O_{(l)}$

$PbS_{(s)}+4H_2O_{2(aq)} \longrightarrow PbSO_{4(s)}+4H_2O_{(l)}$

2) Reducing action in acidic medium

$2MnO_4^-+6H^+ +5H_2O_2 \longrightarrow 2Mn^{2+}+8H_2O+5O_2$

$HOCl+H_2O_2 \longrightarrow H_3O^++Cl^-+O_2$

3) Oxidising action in basic medium

$2Fe^{2+}+H_2O_2 \longrightarrow 2Fe^{3+}+2OH^-$

$Mn^{2+}+H_2O_2 \longrightarrow Mn^{4+}+2OH^-$

4) Reducing action in basic medium

$I_2+H_2O_2+2OH^- \longrightarrow 2I^-+2H_2O+O_2$

$2MnO_4^-+ 3H_2O_2 \longrightarrow 2MnO_2+3O_2+2H_2O+2OH^-$

HYDROGEN PEROXIDE

Uses

- As hair bleach,disinfectant
- Manufacture of chemicals used in detergents.
- In industries as bleaching agent
- In environmental chemistry

WATER

Temporary hardness
Removed by boiling, Clark's method.(Due to presence of magnesium and calcium hydrogen carbonates)

Permanent hardness
Removed by treatment with washing soda, Calgon's method, Ion exchange method, synthetic resins methods.
(Due to presence of soluble salts of Mg & Ca in the form of chlorides and sulphate)

Preparation

1) $BaO_2\ .8H_2O_{(s)}+H_2SO_{4(aq)} \longrightarrow BaSO_{4(s)}+H_2O_{2(aq)}+8H_2O_{(l)}$

2) $2HSO^-_{4(aq)} \xrightarrow{\text{Electrolysis}} HO_3SOOSO_3H(aq) \xrightarrow{\text{hydrolysis}} 2HSO^-_{4(aq)}+ 2H^+_{(aq)}+ H_2O_{2(aq)}$

3) 2-ethylanthraquinol $\underset{H_2/Pd}{\overset{O_2(air)}{\rightleftharpoons}}$ H_2O_2 + Oxidised Product