Hydrogen

→ lightest element known
→ first element of Periodic Table
→ outermost e⁻ configuration is $1s^1$
(due to which it is kept with IA metal)
However 'H' matches with halogen as well in many respect
→ high I.E
→ formation of H^- ion
→ Non-metallic character
→ existence in form of H_2
→ Most abundant element in universe
→ On earth, it is rare in free dihydrogen (H_2) form due to lower molecular wt.
However in combined form, in earth surface, in water, in hydrocarbon, organic comp. & inorganic comp., H present in large amount
* Hydrogen is most abundant element in compound.

(#) Preparation of H_2

① Lab prep^n.

(i) Active Metal + Acid / H_2O ⟶ Metal salt/hydroxide + $H_2\uparrow$

(Metal ≠ Cu, Ag, Au, Hg, Pt etc) ⟶ which lie below Hydrogen in electrochemical series.

eg:-

$$Mg + 2HCl \longrightarrow MgCl_2 + H_2 \uparrow$$

$$Na + HBr \longrightarrow NaBr + \frac{1}{2} H_2 \uparrow$$

$$Na + H_2O \longrightarrow NaOH + \frac{1}{2} H_2 \uparrow$$

(ii) By action of amphoteric metal on bases

$$Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2 \uparrow$$

$$Al + 3NaOH \longrightarrow Na_3AlO_3 + \frac{3}{2} H_2 \uparrow$$

(iii) By action of H_2O on metal hydrides is

$$LiH + H_2O \longrightarrow LiOH + H_2 \uparrow$$

$$NaH + H_2O \longrightarrow NaOH + H_2 \uparrow$$

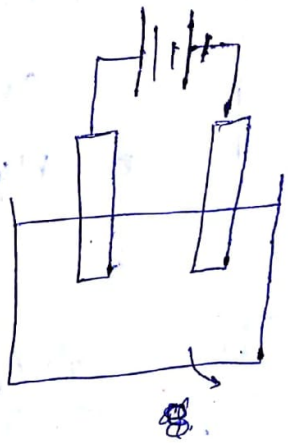
(#) Industrial Prep" is

(i) By electrolysis of H_2O containing 10 to 20 % acid or alkali.

In presence of acid H_2SO_4

$$H_2O \rightleftharpoons H^+ + OH^-$$

$$H_2SO_4 \longrightarrow 2H^+ + SO_4^{2-}$$



At Anode is

$$4OH^- \longrightarrow O_2 + 2H_2O + 4e^-$$

At cathode is

$$H^+ + e^- \longrightarrow \frac{1}{2} H_2$$

$$2H_2O \longrightarrow 2H_2 + O_2$$

In prep^n of NaOH by electrolysis of Brine (NaCl) sol^n :-

$$NaCl + H_2O \xrightarrow{\text{Electrolysis}} NaOH + \frac{1}{2}H_2 + \frac{1}{2}Cl_2$$

i) From water gas / synthetic gas - 'syngas' :-

Equimolar mixture of CO & H_2 is called water gas.

$$C(s) + H_2O \xrightarrow{1270K} \underbrace{CO(g) + H_2(g)}_{\text{water gas}}$$
(steam)

Water gas is heated over super-heated steam (180°C) in presence of catalyst like Fe_2O_3 & promoter like Cr_2O_3 at about temp. 400 - 500°C.

$$(CO + H_2) + H_2O \longrightarrow \underbrace{CO_2 + H_2}$$

CO_2 can be removed by passing with steam under high pressure.

$$CO_2 + H_2O \xrightarrow{30\ atm.} H_2CO_3$$

(iv) From Natural Gas :-

A mixture of hydrocarbon (mainly CH_4) produced in extraction of petroleum component.

$$CH_4 + H_2O \xrightarrow{1200^\circ} CO + 3H_2$$
steam

$$(CO + 3H_2) + H_2O \longrightarrow \boxed{CO_2} + 4H_2$$

CO_2 ↓ removed under high pressure

Physical Properties of H_2 :-

① Pure H_2 is colourless, odourless gas but impure H_2 has fishy smell due to presence of impurities like PH_3 & AsH_3.

② H_2 is lightest gas known.

③ H_2 has very low critical temp. & hence it can't be liquified easily. It make transportation of H_2 tough & uneconomical. So, H_2 is transported in the form of CaH_2 (Hydrolyth)

④ H_2 is highly adsorbed on metal surface like Ni, Pd, Pt.

Chemical Properties of Hydrogen :-

① It is highly combustible gas & burn with a pale blue flame.

$$2H_2 + O_2 \longrightarrow H_2O + \Delta H \text{ (very high energy)}$$

↓ non-polluting fuel

② Rea^n with X_2 :-

$$H_2 + X_2 \longrightarrow 2HX \quad \{X = Cl, Br_2\}$$

③ Rea^n with S

$$H_2 + S \text{ (boiling)} \longrightarrow H_2S$$

Rea^n with N_2 :-

$$3H_2 + N_2 \underset{\text{High P}}{\overset{Fe + Co.}{\rightleftharpoons}} 2NH_3 + \text{Energy} \quad \Delta H = -ve$$

Favorable cond^n for max^{m} yield of NH_3

(i) High Pressure
(ii) Low Temp.

(5) Rea^n with Metal :-

$$Li + \tfrac{1}{2}H_2 \longrightarrow LiH$$
$$Na + \tfrac{1}{2}H_2 \longrightarrow NaH$$

(6) H_2 has reducing property & it reduces metal oxide like CuO, SnO, PbO, Fe_2O_3

eg :- $CuO + H_2 \longrightarrow Cu + H_2O$

(#) Uses of H_2

(1) In prep^n of NH_3, HCl, CH_3OH, Gasoline.
(2) In hydrogenation of vegetable oil.
(3) As non-polluting fuel
(4) In metrological purpose.

(#) Type of Hydrogen

(1) Atomic Hydrogen :-

$$H_2 \xrightarrow[\Delta]{\text{low P \& high T}} 2H + \text{Energy}$$

$$H_2 \xrightarrow{\text{electric arc}} 2H + \text{Energy}$$

(very high amount of energy)

High amount of energy associates with H-a which make it highly energetic & reactive. It has very small life time & combine together to form H_2 producing energy so high that temp. raises to 4000°C. So Atomic H combine at metal surface, then metal surface glow with intense light. It is the principle of atomic hydrogen torch.

* Atomic H combine with all non-metal except N_2.
* Atomic H combine with metal to form metal hydrides.

(2) Nascent Hydrogen :- Hydrogen at the instant of production is called nascent H. It is more reactive than ordinary hydrogen.

eg :- $KMnO_4 + H_2 \longrightarrow X$

ordinary H_2

$KMnO_4 + (H_2SO_4 + Zn) \longrightarrow$ decolourisation of $KMnO_4$ occur

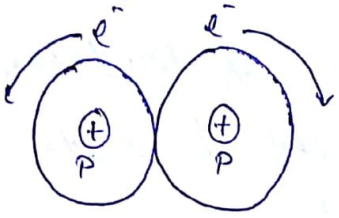
$\downarrow$

$ZnSO_4 + (H_2)$

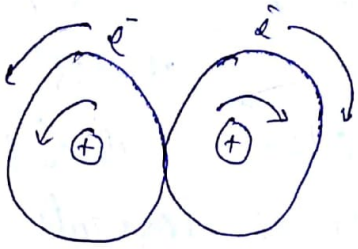
Ortho & Para H_2 :-

H_2 contain $2e^-$ & 2P

e^- will spin opp. dirⁿ acc. to pauli exclusion principle



If P moves in same dirⁿ, then it is called ortho H_2



If P moves in opp. dirⁿ, then it is called para H_2

At normal condⁿ,

stability ortho H_2 > Para H_2

(11) Isotopes of H :-

There are three isotopes of H

① ^1_1H (Protium)	② ^2_1H (Deutrium)	③ ^3_1H (Tritium)
No. of P = 1	No. of P = 1	No. of P = 1
No. of n = 0	no. of n = 1	No. of n = 2
% abundance = 99.985%	0.015 %	10^{-15} %
(stable)	(stable)	Radioactive

All has electronic conf. $1s^1$ ∴ chemical properties are identical. There is only diff. in rate of reaⁿ because heavier isotopes form slightly stronger bond.

Compounds of Hydrogen

Hydrides :- Hydrogen has ability to combine with almost all elements at diff. pressure & temps. except noble gas.

Binary compounds of hydrogen with other elements are called hydrides

General formula → ~~EH_x~~

$E_m H_y$

There are three types of hydrides

1. Ionic hydrides / Saline (salt like) hydrides
2. Covalent hydrides
3. Interstitial hydrides / Non-stoichiometric hydrides

1. Ionic hydrides :-

* formed by most electropositive elements (IA & IIA metals) except Mg, Be
* These are stoichiometric comps. in which hydrogen is present in the form of H^-
* The presence of H^- is indicated by evolution of H_2 gas at anode through oxidation.
* Such hydrides are ionic solid & hence they are non-conductor in solid state. However, in molten state or in aq. sol^n they are conductor due to presence of free ion.

Stability of Hydrides $\propto \frac{1}{\text{size of cation}}$

eg :-

(i) $LiH > NaH > KH > RbH > CsH$

→ ionic character ↑es.

← stability ↑es

(ii) $MgH_2 > CaH_2 > SrH_2 > BaH_2$

→ ionic character ↑es

← stability ↑es

(2) Covalent Hydrides :-

* Such Hydrides are formed by metals & non-metals of P-block with Be & Mg.
* These are stoichiometric compound & H is attached to element through covalent bond.
* There are three type of covalent Hydrides

(i) Electron-rich Hydrides :- That Hydride which contain lone pair of e⁻.

eg :- $\ddot{N}H_3$, $H_2\ddot{O}:$, $H_2\ddot{S}:$, $H\ddot{\underset{\cdot\cdot}{F}}:$ etc.

These are also known as lewis base.

(ii) Electron Sufficient Hydrides (electron-precise) :- The Hydrides in which all atoms have completed their octet.

eg :- CH_4, C_2H_4, C_2H_6 etc

(iii) Electron deficient hydrides :- Those hydrides which have incompleted octet.

eg :- BH_3, BeH_2, AlH_3 etc

} Such hydrides act as lewis acid }

(#) Stability of covalent hydrides $\propto \frac{1}{\text{size of atom}}$

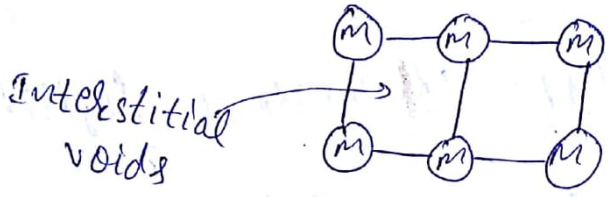
eg :- $H_2O > H_2S > H_2Se > H_2Te > H_2Po$

$HF > HCl > HBr > HI$

(3) Interstitial hydrides :-

* formed by D & f-block metals

(#) Metal → Lattice



→ H due to its small size occupies some of the interstitial sites & therefore these are known as interstitial hydrides

→ These hydrides are always non-stoichiometric i.e they will have variable composition eg :- $\underbrace{TiH_{1.5-1.8}, ZrH_{1.3-1.75}}_{\text{non-stoichiometric hydrides}}$

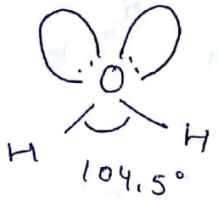
These hydrides exhibit properties similar to metal. So, they are also called metallic hydrides.

Note : Among d-block metals, metals of group 7, 8 & 9 do not form hydrides & this is known as "Hydride Gap"

(#) Water (H_2O) :

→ water is covalent hydrides of great importance

→ structure of H_2O



Bent shape

→ Capable of H-bonding, have high dielectric const.

→ water is good solvent for ionic comps.
i.e water is a universal solvent.

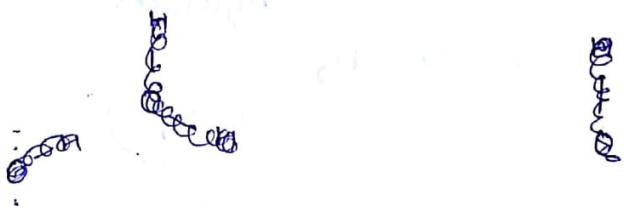
→ Ionic comps. are soluble if
$|\Delta H_{hyd}| >$ lattice energy of ionic solid

→ Covalent comps. like alcohols are soluble in H_2O due to H-bond formation.

* H_2O has f.P = 0°C , B.P = 100°C

→ $d_{ice} < d_{H_2O(l)}$

Reason :- Ice has a cage like hexagonal lattice (at normal cond^n) in which each H_2O molecule is attached to 4 other H_2O molecule through H-bond. The cage like str. of ice is responsible for its low density.



(#) Heavy water (D_2O)

→ all characteristics are almost same.

→ All physical properties of D_2O (except dielectric const.) is higher than those of H_2O

→ Chemical properties are similar. However due to stronger D-O bond than H-O bond, rate of rea^n differ. Such effect in rate due to difference in isotopic mass is called isotopic effect.

→ D_2O is harmful for small organism, however for human being, it is not harmful at all.

→ D_2O is used as moderator (to slowdown the neutron) in nuclear reactor.

Chemical properties of H_2O

Water is amphoteric in nature & hence it reacts with both acid & base

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

Acidic oxide

$$CaO + H_2O \longrightarrow Ca(OH)_2$$

Basic oxide

(2) Water also acts as oxidising as well as reducing agent.

eg:-

$$Na + \underset{O.A}{H_2O} \longrightarrow NaOH + \frac{1}{2}H_2$$

$$f_2 + \underset{R.A}{H_2O} \longrightarrow 2HF + \frac{1}{2}O_2$$

(3) **Hydrolysis of salts :-**

$$FeCl_3 + 3H_2O \longrightarrow Fe(OH)_3 + 3HCl$$

(4) **Hydrates formation**

H_2O attach itself to ionic solid & form hydrates

eg:- $CuSO_4 \cdot 5H_2O$, $MgCl_2 \cdot 6H_2O$, $Na_2CO_3 \cdot 10H_2O$

The H_2O present in hydrates are called **water of crystallisation.**

Hydrates

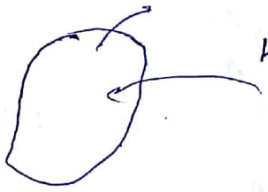
- **Cationic hydrates**: Water is attached to cation through co-ordinate bond
  eg:- $[Cr(H_2O)_6]Cl_3$
- **Anionic hydrates**: Water is attached to anion through H-bond & to cation through co-ordinate bond
  eg:- $CuSO_4 \cdot 5H_2O \rightarrow [Cu(H_2O)_4]SO_4 \cdot H_2O$
- **Lattice hydrates**: H_2O is present in interstitial space making the crystal stable

(#) Water absorber / releaser :-

* Some ionic solid absorbs H_2O from atmosphere. Such ionic solids are called Hydroscopic solid. If the water absorption occur to greater extent, then such solids are called deliquscent solids

Eg :- NaCl, $HgCl_2$

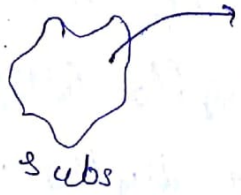
Deliquscent occurs when



V. $P_{substance} < P_{H_2O}$ in air

* Some ionic solid releases H_2O to atmosphere. Such ionic solids are called efforescent material.

Efforescent occurs when



V. $P_{substance} > P_{H_2O}$ in air

Hard water & soft water :-

Hard water is that sample of H_2O which doesn't give lather easily with soaps or detergent. Hence, hard water can't be used for laundary purpose.

* Hardness of water is due to HCO_3^-, SO_4^{2-} & Cl^- of Ca^{2+} & Mg^{2+}

Hardness

Temporary hardness (or)

presence of HCO_3^- of Ca^{2+} & Mg^{2+} causes temporary hardness

Permanent hardness.

presence of Cl^- & SO_4^{2-} of Ca^{2+} & Mg^{2+} cause permanent hardness.

⇒ Removal of hardness of H_2O :-

① Temporary hardness is removed by

(i) Boiling the water sample

$$Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3 \downarrow + CO_2 \uparrow + H_2O$$

(ii) By reacting with CaO or $Ca(OH)_2$

$$Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2CaCO_3 \downarrow + 2H_2O$$

② Permanent hardness is removed by following methods :-

(i) By reacting with Na_2CO_3

$$CaCl_2 + Na_2CO_3 \longrightarrow 2NaCl + CaCO_3 \downarrow$$

$$MgSO_4 + Na_2CO_3 \longrightarrow Na_2SO_4 + MgCO_3 \downarrow$$

(ii) If both permanent & temporary hardness are present, then hardness is removed by treating with NaOH.

$$Ca(HCO_3)_2 + NaOH \longrightarrow CaCO_3 \downarrow + Na_2CO_3 + H_2O$$

$$CaCl_2 + Na_2CO_3 \longrightarrow CaCO_3 \downarrow + 2NaCl$$

(iii) Calgon Method

Sodium hexametaphosphate: $Na_6P_6O_{18}$

$Na_2[Na_4(PO_3)_6]$

$$Na_2[Na_4(PO_3)_6] + CaCl_2 \longrightarrow Na_2[Na_2Ca(PO_3)_6] + 2NaCl$$

(iv) Zeolite Method :- (Permutit Process)

Zeolite : Sodium aluminium orthosilicate

$NaAlSiO_2 . xH_2O$

NaZe

$$2NaZe + CaSO_4 \longrightarrow CaZe_2 + Na_2SO_4$$

* Note :- $CaZe_2$ can be converted back into NaZe by treating with NaCl as

$$CaZe_2 + NaCl \longrightarrow NaZe + CaCl_2$$

By passing water through ion-exchange resin :-

Hard water → (Cation exchange resin) → (Anion exchange resin)

(Cation exchange resin)
* insoluble organic molecule containing $COOH$ & SO_3H group replaces Na^+, Ca^{2+}, Mg^{2+} by H^+

(Anion exchange resin)
* insoluble org. molecule containing $-NH_2$, $-OH^-$ group

* After passing through cation exchange resin, water sample becomes acidic

In anion exchange resin, anions like SO_4^{2-}, Cl^-, HCO_3^- are replaced by OH^- ion

$\Rightarrow \because H^+ + OH^- \longrightarrow H_2O$

So, such sample of water is free from all cation & anion called demineralized water.

(#) ## H_2O_2 (Hydrogen peroxide) :-

$(H-O-O-H)$.

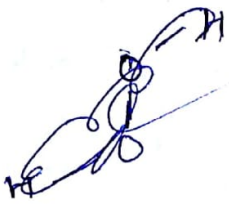
Due to peroxide bond, H_2O_2 is very unstable.

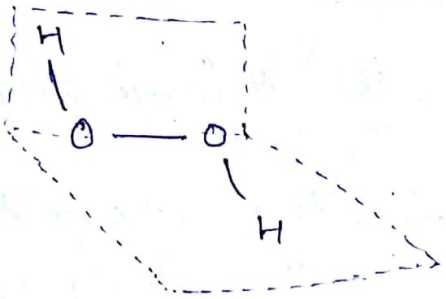
$H_2O_2 \xrightarrow{\text{light}} H_2O + \frac{1}{2}O_2 \uparrow$ ∴ explosion

So, H_2O_2 (l) is stored in dark coloured wax lined bottle to cut off the light & remove rough surface. Also small amount of glycerine, acetanalide is also added which act as anti-catalyst for decomposition

* ## Structure of H_2O_2 :-

3D structure





(3D structure
open-book structure)

(in gaseous & solid form)

Prep^{n}. of H_2O_2

Lab prep^{n}.

① $BaO_2 . 8H_2O + H_2SO_4 \longrightarrow BaSO_4 + H_2O_2$

Note :- (i) Anhydrous BaO_2 is not taken because a protective coating of $BaSO_4$ deposit on BaO_2, which prevent further rea^{n}.

(ii) H_2SO_4 act as catalyst for decomposition of H_2O_2. So, H_3PO_4 is preferred over H_2SO_4.

$BaO_2 . 8H_2O + H_3PO_4 \longrightarrow Ba_3(PO_4)_2 + H_2O_2$

H_3PO_4 act as anti-catalyst for decomposition of H_2O_2

② $Na_2O_2 + H_2SO_4 \longrightarrow \underbrace{Na_2SO_4 + H_2O_2}$

Always contain Na_2SO_4 as impurity & so each sample of H_2O_2 is used for bleaching purpose.

Industrial preparation

① By electrolysis of H_2SO_4 ~~using high~~

$$2H_2SO_4 \rightleftharpoons 2H^+ + HSO_4^-$$

At anode :

$$2HSO_4^- \longrightarrow H_2S_2O_8 + 2e^-$$

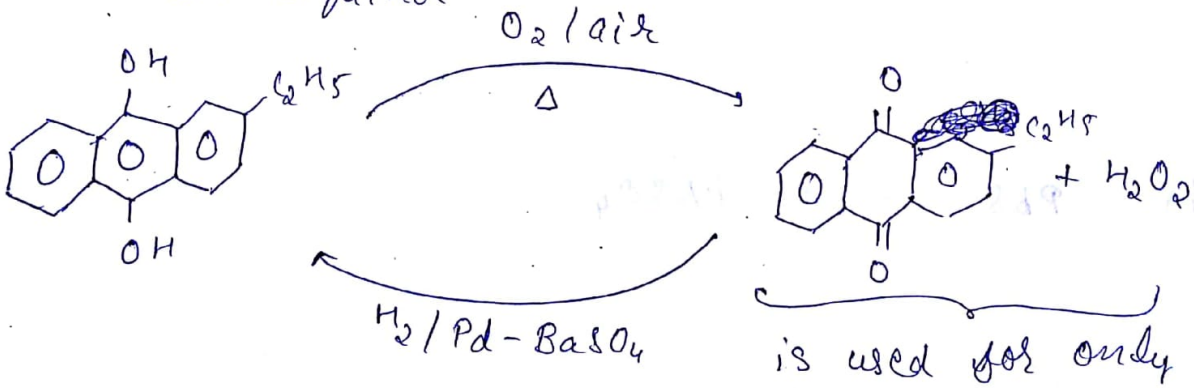
$$H_2S_2O_8 + H_2O \longrightarrow H_2SO_5 + H_2SO_4$$

$$H_2SO_5 + H_2O \longrightarrow H_2SO_4 + H_2O_2$$

At cathode :

$$2H^+ + 2e^- \longrightarrow H_2\uparrow \text{ (by product)}$$

② By cyclic oxidation-reduction of 2-ethyl anthraquinol.



is used for only prod" small conc" of H_2O_2 (about 1%)

⑪ Physical Properties

① It is pale blue oily liquid.

② It is a good polar solvent due to high dielectric ~~sol~~ const.

③ Extent of H-bonding in H_2O_2 is greater than ~~than~~ that in H_2O.

Chemical Properties :-

In H_2O_2, O is in -1 oxid^n state.

So, it acts as reducing agent & oxidising agent both in acidic & basic medium.

(#)(1) In acidic medium,

As O.A

$2H^+ + H_2O_2 + 2e^- \longrightarrow H_2O + H_2O$

$2H^+ + H_2O_2 + 2e^- \longrightarrow 2H_2O$

(i) $Fe^{2+} \longrightarrow Fe^{3+}$

(ii) $PbS \longrightarrow PbSO_4$

Reducing agent,

$H_2O_2 \longrightarrow O_2 + 2e^- + 2H^+$

(i) $Cr_2O_7^{2-} \longrightarrow Cr^{3+}$

Orange (green)

(ii) $MnO_4^- \longrightarrow Mn^{2+}$

② In basic medium,

As O.A

$H_2O + H_2O_2 + 2e^- \longrightarrow H_2O + 2OH^-$

$H_2O_2 + 2e^- \longrightarrow 2OH^-$

(i) $Fe^{2+} \longrightarrow Fe^{3+}$

(ii) $Mn^{2+} \xrightarrow{\cancel{H_2O}} Mn^{4+}$

As R. A

$$H_2O_2 + 2OH^- \longrightarrow O_2 + 2e^- + 2H_2O$$

i) $MnO_4^- \longrightarrow Mn^{2+}$

Acidic character of H_2O_2

$$H_2O_2 \longrightarrow H^+ + HO_2^-$$

→ H_2O_2 has bleaching property & is due to oxidation of H_2O_2 & hence bleaching by H_2O_2 is permanent.

Uses of H_2O_2

1. As bleaching agent for wool, clothes.
2. As anticeptic under the name of perhydrol.
3. To restore old lead painting.

Volume strength of H_2O_2

$$\boxed{H_2O_2}_{1l} \longrightarrow H_2O + \frac{1}{2}O_2$$

1 M

$\frac{M}{2} \times 22.4$

$11.2 \times M$ = volume strength

$$M = \frac{\text{volume strength}}{11.2}$$

$11.2 \times \frac{N}{2}$ = volume strength

$$N = \frac{\text{volume strength}}{5.6}$$

Problem

$N = \frac{20}{5.6}$

(#) Cal. the normality of 20 volume hydrogen peroxide sol^n.

Sol^n $3.5 = N$

(#) find the vol. strength of 1.6 N H_2O_2 sol^n.

Sol^n $N = \frac{\text{volume strength}}{5.6}$

$=$

8.96 V

(#) $LiH + AlCl_3 \rightarrow \underbrace{LiAlH_4}_{\text{Lithium aluminium hydride (LAH)}} + 3LiCl$

$2NaH + B_2H_6 \rightarrow \underbrace{2NaBH_4}_{\text{sodium borohydride}}$

Why I.E of hydrogen lies in the range of halogen?

Sol^n Hydrogen is non-metallic like halogen. They both have tendency to accept one electron to form A^- ion. So, I.E of hydrogen lie in the range of halogen.

(2) Explain, why H_2 is not produced from action of metal on H_2SO_4 or HNO_3?

Sol^n H_2SO_4 & HNO_3 are acid as well as oxidising agent. So, when metals are reacted with H_2SO_4 or HNO_3, metal oxides are formed which form a protective layer on metal. It avoids further rea^n with metal.

(3) Why for getting pure H_2, $Ba(OH)_2$ sol^n of H_2O is preferred over NaOH sol^n?

Sol^n Most of the hydroxide are contaminated with metal carbonate by absorption of CO_2 from air. However, $Ba(OH)_2$ sol^n is free from its carbonate because $BaCO_3$ is insoluble in water.

(4) How do you expect the metallic hydrides to be useful for H_2 storage? Like

Sol^n There are some metals, Pt, Pd, Ni adsorbs very high volume of H_2 gas in finely

divided state. H_2 from these metals can be easily obtained by heating, which is used in reduction purpose. So, these metals are used for H_2-storage & it is called 'Hydrogen economy'

(5) Why the fire produced in H_2 production from saline hydrides with water is not extinguished by CO_2?

Sol^n :- $NaH + H_2O \longrightarrow NaOH + H_2\uparrow + heat$

The heat produced in above H_2 production can't be extinguished by CO_2 because NaOH reacts with CO_2 which is also an exothermic rea^n. as

$$NaOH + CO_2 \longrightarrow Na_2CO_3 + H_2O + heat.$$

In this case, sand particles are used to extinguish the fire.

(6) Why only 4 H_2O molecules are removed initially when $CuSO_4.5H_2O$ is dehydrated?

Sol^n :- $CuSO_4.5H_2O$ is an anionic hydrates in which 4 H_2O molecules are attached to Cu^{2+} ion through weak co-ordinated bond & 1 H_2O molecule is attached to SO_4^{2-} ion through H-bond.

mce,

$$CuSO_4.5H_2O \xrightarrow[-4H_2O]{\Delta} CuSO_4.H_2O \xrightarrow[-H_2O]{\Delta} CuSO_4$$

(7) Arrange the bond f-f, H-H & D-D in increasing order of bond strength.

Sol^n

$$\underbrace{D-D > H-H}_{\text{Isotopic effect}} > \underbrace{f-f}_{\text{due to l.p-2 repulsion}}$$

(8) Why should a bottle of H_2O_2 be cooled before opening?

Sol^n H_2O_2 kept in a bottle is partially dissociated as,

$$H_2O_2 \longrightarrow H_2O + \tfrac{1}{2}O_2 + \text{heat}$$

To avoid this dissociation & heat produced, it is first cooled before opening.

(9) What do you expect the nature of hydrides, if formed by elements of atomic number 15, 19, 23 & 44 with dihydrogen?

Sol^n

At. No.	Nature of element	Type of hydrides
15	P (non-metal)	covalent hydrides
19	K (Metal)	Ionic hydrides
23	V (Transition metal)	metallic hydrides
44	.	

(10) In the preparation of H_2O_2, temp. is kept high & acid like H_3PO_4 is added. Explain?

Sol^n H_2O_2 dissociated in H_2O & O_2 violently at high temp., so, temp. is kept lower & anti-catalyst like H_3PO_4 is added to H_2O_2 sol^n.

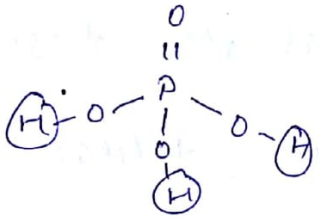
(11)

$$H_3PO_4 + D_2O \longrightarrow D_3PO_4$$

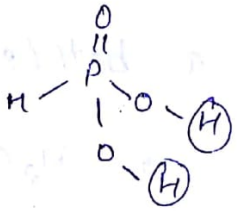
$$H_3PO_3 + D_2O \longrightarrow HD_2PO_3$$

$$H_3PO_2 + D_2O \longrightarrow H_2DPO_3$$

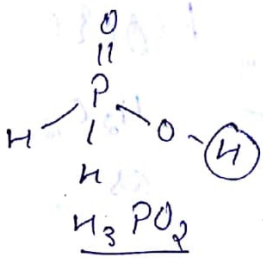
Sol^n



H_3PO_4 → All three H are acidic



H_3PO_3 Two H are acidic



H_3PO_2 one H is acidic

(12) Is rain water, distilled water, demineralised water good for drinking?

Sol^n No, because these water sample don't contain the ions which are important for human body.

(13) Which one is good bleaching agent: H_2O_2 or Cl_2?

Sol^n H_2O_2 is better bleaching agent than Cl_2, because H_2O_2 is not a pollutant ~~whereas~~ whereas Cl_2 is a pollutant.