

Revision Notes on Hydrogen:

Hydrogen Element:

- Atomic number = Mass Number = 1
- Isotopes of hydrogen:
 - $^1\text{H}_1$: Protium , Most abundant in nature
 - $^2\text{H}_1$: Deuterium (D), Component of heavy water.
 - $^3\text{H}_1$: Tritium (T) , Radioactive in nature

Dihydrogen:

a. Laboratory preparation:

Reaction of metals with acids. $\text{Zn} + \text{H}^+ \rightarrow \text{Zn}^{2+} + \text{H}_2$

b. Commercial Preparation:

1. Electrolysis of acidified water
2. Electrolysis of warm aqueous $\text{Ba}(\text{OH})_2$ between nickel electrodes.
3. By-product in the manufacture of NaOH and Cl_2 by electrolysis of brine solution.
4. Reaction of steam and hydrocarbons at high temperatures

c. Properties:

- Reaction with halogen: $\text{H}_2 + \text{X}_2 \rightarrow 2\text{HX}$ [X= F, Cl, Br, I]
- Reaction with oxygen: $\text{H}_2(\text{g}) + \text{O}_2(\text{g}) + \Delta \rightarrow 2\text{H}_2\text{O}(\text{l})$ $\Delta H^0 = -285.9 \text{ kJ mol}^{-1}$
- Reaction with nitrogen: $3\text{H}_2(\text{g}) + \text{N}_2(\text{g}) + \Delta \rightarrow 2\text{NH}_3(\text{l})$ $\Delta H^0 = -92 \text{ kJ mol}^{-1}$
- Reaction with alkali metals: $3\text{H}_2(\text{g}) + 2\text{M}(\text{g}) + \Delta \rightarrow 2\text{MX}(\text{s})$

Uses of Hydrogen:

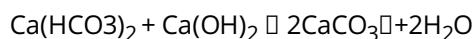
- Used for synthesis of ammonia and vanaspati fat and many other products.
- Used as rocket fuel.
- Used in hydrogen fuel cells.

Hard Water:

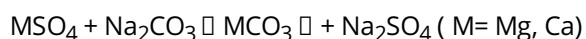
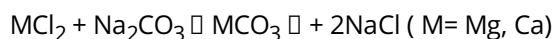
a) Water containing carbonate, chloride and sulphate salts of calcium and magnesium.

Temporary hardens is due to the presence of carbonate salts and can be removed by boiling or by

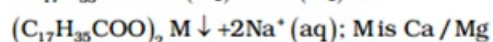
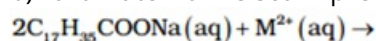
adding lime water.



Permanent hardness is due to presence of sulphate and chloride salts and can be removed by treatment with washing soda.



b) Hard water forms scum/precipitate with soap:



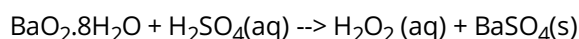
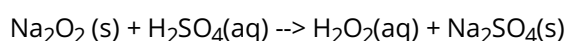
Heavy water:

- Molecular formula: D₂O
- 10.68% denser than ordinary water
- Freezing point 3.8 °C
- Unfit for drinking and causes sterility.

Hydrogen peroxide :

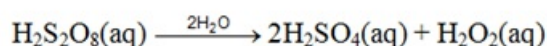
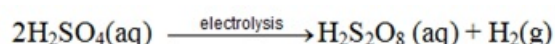
a. Preparation :

Lab Method :

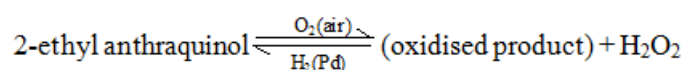


Anhydrous barium oxide is not used because the precipitated BaSO₄ forms a protective layer on the unreacted barium peroxide and thus prevents its further participation in the reaction. However it can be overcome by using phosphoric acid.

By Electrolysis:

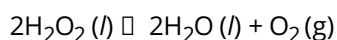


By the auto-oxidation of 2-ethyl anthraquinol. The net reaction is a catalytic union of H₂ and O₂ to yield hydrogen peroxide.



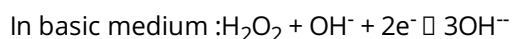
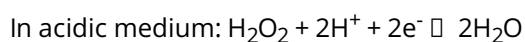
b. Properties

i) Unstable liquid, decomposes to give water and dioxygen and the reaction is slow in the absence of catalyst. It is catalysed by certain metal ions, metal powders and metal oxides.

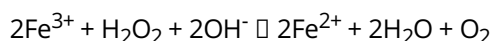
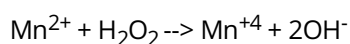
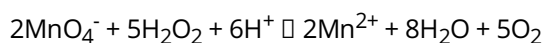
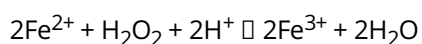
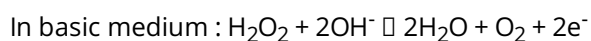
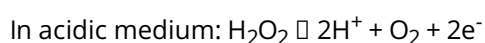


ii) It is a very powerful oxidising agent and poor reducing agent.

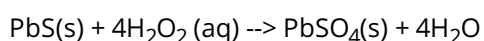
As oxidising agent



As reducing agent



The oxidising property of hydrogen peroxide is put to use in the **restoration of old paintings**, where the original white lead paint has been converted to black PbS by the H₂S in the atmosphere. Hydrogen peroxide oxidises the black PbS into white PbSO₄.



black

white

c. Tests :

- It liberates iodine from potassium iodide in presence of ferrous sulphate
- Acidified solution of dichromate ion forms a deep blue colour with H₂O₂ due to the formation of CrO₅.
$$\text{Cr}_2\text{O}_7^{2-} + 4\text{H}_2\text{O}_2 + 2\text{H}^+ \rightarrow 2\text{CrO}_5 + 5\text{H}_2\text{O}$$
- With a solution of titanium oxide in conc. H₂SO₄, it gives orange colour due to the formation of pertitanic acid.
$$\text{Ti}^{4+} + \text{H}_2\text{O}_2 + 2\text{H}_2\text{O} \rightarrow \text{H}_2\text{TiO}_4 + 4\text{H}^+$$