

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:

Electrolysis of acidified water

Electrolysis of warm aqueous $\text{Ba}(\text{OH})_2$ between nickel electrodes.

By-product in the manufacture of NaOH and Cl_2 by electrolysis of brine solution.

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.

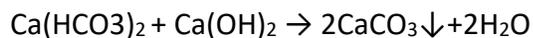
Used in hydrogen fuel cells.

Hard Water:

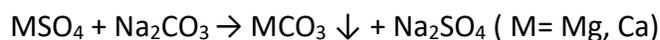
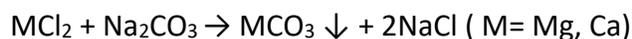
a) Water containing carbonate, chloride and sulphate salts of calcium and magnesium.

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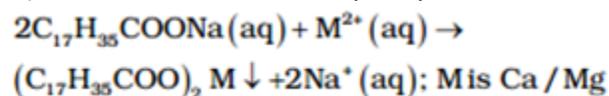
Temporary hardness is due to the presence of carbonate salts and can be removed by boiling or by adding lime water.



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

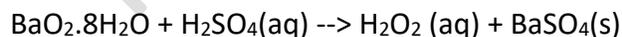
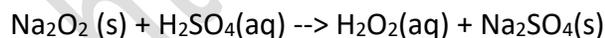
Freezing point 3.8 °C

Unfit for drinking and causes sterility.

Hydrogen peroxide :

a. Preparation :

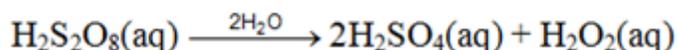
Lab Method :



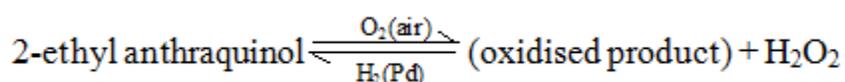
Anhydrous barium oxide is not used because the precipitated BaSO₄ forms a protective layer on the unreacted barium peroxide and thus prevents its further participation in the reaction. However it can be overcome by using phosphoric acid.

By Electrolysis:

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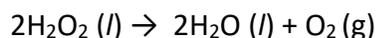


By the auto-oxidation of 2-ethyl anthraquinol. The net reaction is a catalytic union of H_2 and O_2 to yield hydrogen peroxide.



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.

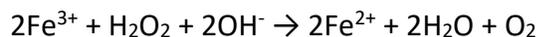
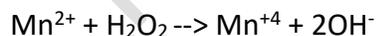
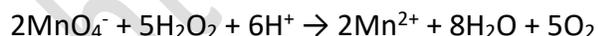
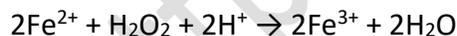
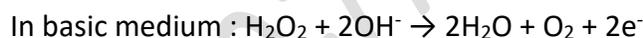


ii) It is a very powerful oxidising agent and poor reducing agent.

As oxidising agent

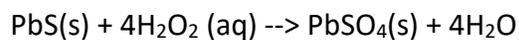


As reducing agent



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 H_2S in the atmosphere. Hydrogen peroxide oxidises the black PbS into white PbSO_4 .

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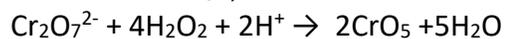
black

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 H_2O_2 due to the formation of CrO_5 ,



With a solution of titanium oxide in conc. H_2SO_4 , it gives orange colour due to the formation of pertitanic acid.

