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Title: Hydrogen

Hydrogen

Hydrogen in the Periodic Table

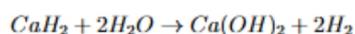
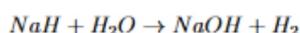
Hydrogen occupies a unique place in the periodic table. It can form both H^+ and H^- ions, showing resemblance to alkali metals and halogens, hence not assigned a fixed group.

Laboratory Preparation of Dihydrogen (H_2)

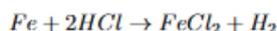
- With reactive metals and water:



- Using metal hydrides:



- With acids:



- From zinc and dilute acid:



Pure Hydrogen Production

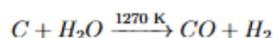
- Using pure Mg and dilute H_2SO_4 :



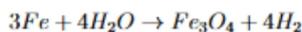
- Electrolysis of warm $Ba(OH)_2$ using Ni electrodes

Industrial Methods of Hydrogen Production

- Bosch Process (from water gas):



- Lane's Process:

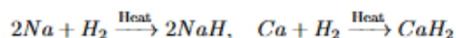


Physical Properties of Hydrogen

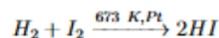
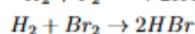
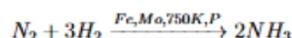
Colorless, odorless, and tasteless gas.

Chemical Behavior of Hydrogen

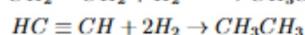
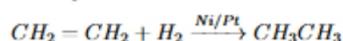
- With Metals:



- With Non-metals:



- Addition to unsaturated hydrocarbons:



- With CO: Produces methanol.



- **With metal oxides:** Forms metals.



- **Organic reductions:**

- Vegetable oil → solid ghee
- Aldehydes/ketones → alcohols
- Nitriles → amines

Hydrides Classification

- **Ionic (Saline):** S-block (except Be, Mg)
- **Covalent (Molecular):** p-block
- **Metallic:** d- and f-block (non-stoichiometric)

Water (H_2O)

Structure: Bent, sp^3 hybridization, bond angle 104.5°

Properties:

- Amphoteric
- Involved in redox and hydrolysis
- Forms hydrates
- High boiling point due to hydrogen bonding

Hard vs Soft Water

Hard Water: Contains Ca^{2+} and Mg^{2+} salts. Prevents soap lathering.

Soft Water: Free from Ca^{2+}/Mg^{2+} salts. Lathers easily.

Types:

- **Temporary:** Due to bicarbonates. Removed by boiling or Clark's method.
- **Permanent:** Due to sulphates/chlorides. Removed by washing soda, Calgon, ion exchange, or synthetic resins.

Hydrogen Peroxide (H_2O_2)

Preparation: From BaO_2 , electrolysis of H_2SO_4 , auto-oxidation of 2-ethylanthraquinol.

Structure: Open book, non-planar.

Properties: Acts as oxidizing and reducing agent.

Uses: Bleaching, antiseptic, propellant in rockets.

Heavy Water (D_2O)

Preparation: By extended electrolysis of normal water.

Properties: Higher melting/boiling point than H_2O .

Uses: Moderator in reactors, tracer in chemical studies.