

Chapter7: Hydrogen

Hydrogen (H_2) is the lightest and most abundant element in the universe. It is highly reactive and has various industrial applications.

1. Preparation of Hydrogen

a) From Water – Electrolysis

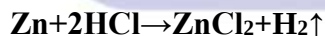
- **Electrolysis** is the process of passing electricity through water to break it down into hydrogen and oxygen.
- **Key Terms:**
 - **Electrode:** The solid conductor through which electricity enters or leaves a solution.
 - **Electrolyte:** A substance that conducts electricity when dissolved in water.
 - **Electrolysis:** The process of chemical decomposition using electricity.
- **Reaction:**



- Hydrogen is collected at the **cathode (-)** and oxygen at the **anode (+)**.

b) Laboratory Preparation of Hydrogen

- Hydrogen is prepared by reacting **zinc (Zn)** with **dilute acids** such as **HCl** or **H_2SO_4** .
- **Reaction:**



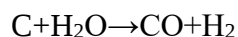
- **Why is Zinc Preferred?**
 - ✓ It reacts moderately, producing hydrogen at a **manageable rate**.
 - ✓ It is **cheaper** and easily available.
 - ✓ It does not form a protective layer of oxide like aluminum.
 - **Why Not Dilute Nitric Acid (HNO_3)?**
 - ✗ **HNO_3 is a strong oxidizing agent** and converts H_2 into water instead of releasing it as a gas.
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2. Bosch's Process (Industrial Preparation of Hydrogen)

Bosch's process is used for large-scale production of hydrogen from **water gas (CO + H₂)**.

Steps:

1. Water Gas Formation:



2. Water Gas Shift Reaction (CO is removed):



3. Removal of CO₂: Passed through **alkali solution** to absorb CO₂, leaving pure **H₂**.

3. Properties of Hydrogen

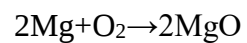
Physical Properties	Chemical Properties
Lightest gas, colorless, odorless.	Burns in oxygen to form water: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$.
Insoluble in water.	Reacts with metals to form metal hydrides .
Highly flammable.	Acts as a reducing agent , removing oxygen from compounds.

4. Uses of Hydrogen

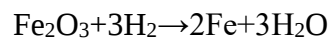
- ✓ Used in the manufacture of **ammonia (NH₃)** for fertilizers.
 - ✓ Used in **hydrogenation of vegetable oils** to make margarine.
 - ✓ Used as a **rocket fuel** due to its high energy.
 - ✓ Potential future **clean fuel** in hydrogen fuel cells.
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5. Oxidation and Reduction

- **Oxidation: Addition of oxygen or removal of hydrogen.**
 - Example: **Magnesium burning in oxygen**



- **Reduction:** Addition of hydrogen or removal of oxygen.
 - Example: **Iron oxide reduced to iron**



- **Redox Reaction:** A reaction where oxidation and reduction occur together.

