HYDROGEN

- This element does not fit well into any group in the periodic table.

Hydrogen was first recognised as a separate element by **Henry Cavendish** (1766). The observation that whenever it burned it produced water spurred **Lavoisier** to name it "hydrogen" which means **"water producer".**

- The element does not occur naturally in uncombined form to any appreciable extent, due to the fact that it readily combines with oxygen. Hence it occurs in compounds such as water, acids and organic substances.
- It exists in three isotopic forms: **ordinary hydrogen (H_2)**, **heavy hydrogen or deuterium (D_2)** and **tritium(T_2).** Of these isotopes, tritium is radioactive and having a half-life of twelve years.
- Hydrogen is prepared **in the laboratory** by a number of methods:
  - **Electrolysis of water** using the apparatus known as **Hoffman Voltameter**. The process involves passing electricity through acidified water causing it to decompose:

$2H_2O_{(l)} \rightarrow 2H_{2(g)} + O_{2(g)}$

  - **Displacement from water** by using a metal. The activity of the chosen metal compared to that of hydrogen is an important factor in this method. The **very active metals** high up in the activity series (eg K, Ca, Na) liberate hydrogen gas from ordinary cold water e.g.

$2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$

For moderately active metals eg mg hot water is required

$Mg(s) + 2H_2O \rightarrow Mg(OH)_{2(aq)} + H_2$

The other metals in the activity series above hydrogen (e.g. Zn, Fe, Pb) require steam to produce hydrogen. For instance heated iron reacts with **steam reversibly** to give hydrogen gas

The metals below hydrogen in the activity series are not active enough to displace hydrogen from water (cold, hot or steam).

  - **Displacement from dilute acids** by using moderately active metals (e.g. Ca, Mg, Zn). For this method, dilute H_2SO_4 and HCl are commonly used

$Zn_{(s)} + H_2SO_{4(aq)} \rightarrow ZnSO_{4(aq)} + H_{2(g)}$

Note that dil. Hno3 is not used in this method because HNO3 is a strong oxidising agent.

  - **Action of hot caustic alkalis on certain metals** (Zn, Al, and Si):

$Zn_{(s)} + 2NaOH_{(aq)} + 2H_2O_{(l)} \rightarrow Na_2Zn(OH)_{4(aq)} + H_{2(g)}$

$2Al_{(s)} + 2NaOH + 6H_2O_{(l)} \rightarrow 2NaAl(OH)_{4(aq)} + 3H_{2(g)}$

$Si_{(s)} + 2NaOH_{(aq)} + H_2O_{(l)} \rightarrow Na_2SiO_{3(aq)} + 3H_{2(g)}$