

Trilogy C6 - Electrolysis

Definition: Electrolysis is the splitting of an ionic compound using electricity. It can only happen when the ions in the compound are free to move. This only happens if the compound is a liquid, dissolved in a solution, or melted to be a molten liquid. The electric current causes the ions to move towards electrodes. Electrons move through the wire joining the electrodes. The liquid is called the electrolyte.

Electrolysis of sodium chloride solution (brine)

Sodium chloride solution (brine) is electrolysed to produce hydrogen gas, chlorine gas (which is used to make bleach and plastics) and sodium hydroxide solution (which is used to make soap).

The sodium chloride solution contains sodium ions (Na^+), chloride ions (Cl^-), hydrogen ions (H^+) and hydroxide ions (OH^-). Together, these are the electrolyte.

Both positive ions move to the negative electrode, but the less reactive hydrogen is discharged. Therefore only hydrogen gas is formed at the negative electrode. Both negative ions move to the positive electrode, but the halogen (chlorine) is discharged.

(Higher only) The reactions at the electrodes can be written as half-equations.
Negative electrode: $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ & Positive electrode: $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$

Changes at the electrodes

Electrolysis involves the use of a power source and positive and negative electrodes to separate the positive and negative ions in an electrolyte.

The electrodes should be made of an inert material e.g. **graphite or platinum** to stop them reacting.

When current is flowing, the **positive** metal ions will move to the **negative** electrode because opposites attract. The **negative** non-metal ions will move to the **positive** electrode for the same reason.

Electrolysis of aluminium

Aluminium is extracted from a molten mixture of aluminium oxide (Al_2O_3) and cryolite. Aluminium oxide is acquired from its ore, bauxite. The cryolite is added to lower the melting point of the aluminium oxide. This means less energy is needed to melt it before electrolysis can begin.

- Aluminium forms at the negative electrode.
- Oxygen forms at the positive electrode, but the hot gas reacts with the carbon electrodes, wearing them away and forming carbon dioxide and so the electrodes must be continually replaced.

Products of electrolysis

Electrolysis is very useful for extracting metals but it's expensive to do. It is usually only used for metals that are more reactive than carbon (e.g. aluminium).

Electrolysis of molten liquids

For a molten compound the electrolyte will only have two ions - the metal and the non-metal. The metal will always form at the negative electrode and the non-metal at the positive electrode.

e.g. the ions in lead bromide are Pb^{2+} and Br^- . This will form Pb (s) at the negative electrode and Br_2 (g) at the positive electrode

Aqueous solutions

This means that the compound is dissolved in water. This means that there will be four ions present, the metal, the non-metal AND hydrogen ions (H^+) and hydroxide ions (OH^-). If the metal in the compound is less reactive than hydrogen (so copper, silver, gold or platinum) then the **metal** will be formed. If the metal is more reactive than hydrogen, then hydrogen will be formed (see reactivity series)

At the **positive** electrode, if the compound contains a halogen (e.g. fluorine, chlorine or bromine) then the halogen gas F_2 , Cl_2 or Br_2 will be formed. If not then oxygen is formed.

e.g. CuCl_2 (aq) forms Cu (s) (negative electrode) and Cl_2 (positive electrode)
But MgSO_4 forms H_2 (g) (negative electrode) and O_2 (positive electrode)

