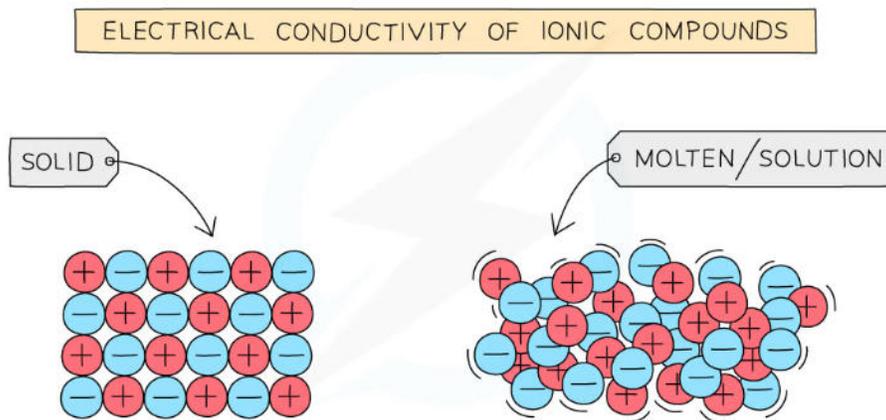


Electrolysis

Prepared by Soofia Anwer

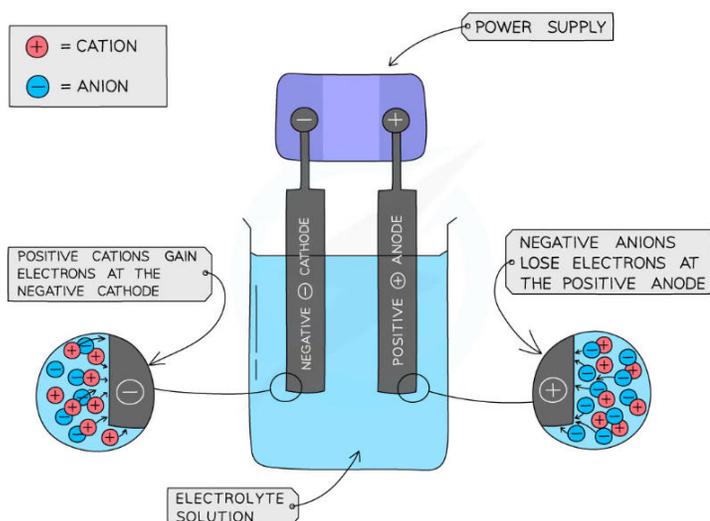
Defination: when an ionic compound in its molten or aqueous state (and an acid) decompose by an electric current.

- When an electric current is passed through a **molten ionic compound** the compound decomposes or breaks down
- The process also occurs for **aqueous solutions** of ionic compounds
- Covalent compounds cannot conduct electricity hence they do not undergo electrolysis
- Ionic compounds in the solid state cannot conduct electricity either since they have **no free ions** that can move and carry the charge



Key terms

- **Electrode** is a rod of metal or graphite through which an electric current flows into or out of an electrolyte
- **Electrolyte** is the ionic compound in molten or dissolved solution that conducts the electricity
- **Anode** is the positive electrode of an electrolysis cell
- **Anion** is a negatively charged ion which is attracted to the anode
- **Cathode** is the negative electrode of an electrolysis cell
- **Cation** is a positively charged ion which is attracted to the cathode



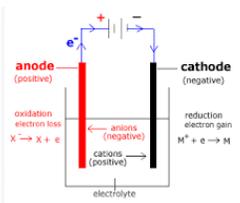
Exam Tip

Use the PANIC mnemonic to remember which electrode is the positive and which is the negative:

Positive (is) Anode Negative (is) Cathode

Electrolytic cell

This cell converts electrical energy to chemical energy and consists of two electrodes connected to a power supply by an external circuit and an electrolyte.



Electrons move from anode to cathode

Name the type of particle responsible for the conduction of electricity during electrolysis in:

the metal wires **Electrons**

the electrolyte **ions**

[2]

Anions lose electrons to the anode (oxidation)

Cations gain electrons from the cathode (reduction)

Exam Tip

AN OX RED CAT

Inert electrodes (non reactive) : graphite or platinum

The electrolysis of molten binary ionic compounds

- A binary ionic compound is one consisting of just two elements joined together by ionic bonding
- When these compounds undergo electrolysis they always produce their corresponding elements
- To predict the products made at each electrode, first identify the ions
- The **positive** ion will migrate towards the **cathode** and the **negative** ion will migrate towards the **anode**
- Therefore, the **cathode** product will always be the **metal**, and the product formed at the **anode** will always be the **non-metal**

Example: Electrolysis of molten lead(II) bromide

Method:

- Add lead(II) bromide into a beaker and heat so it will turn molten, allowing ions to be free to move and conduct an electric charge
- Add two graphite rods as the electrodes and connect this to a power pack or battery
- Turn on power pack or battery and allow electrolysis to take place
- Negative bromide ions move to the positive electrode (anode) and each loses one electron to form bromine molecules. There is bubbling at the anode as brown **bromine gas is given off**
- Positive lead ions move to the negative electrode (cathode) and gain electrons to form a **grey lead metal** which deposits on the surface of the electrode

Anode reaction:

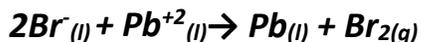


Bromide ions donate electrons to the anode (oxidation).

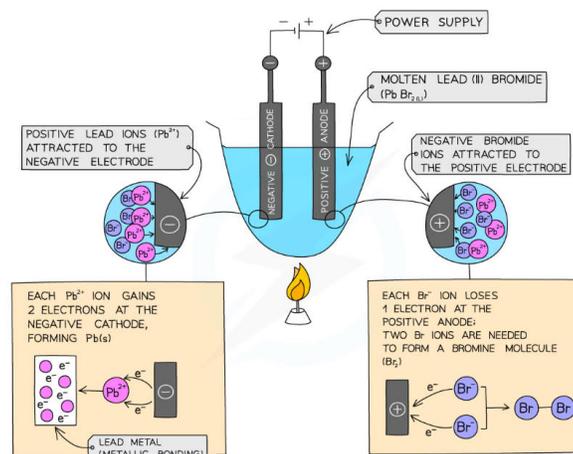
Cathode reaction:



Add the 2 half ionic equations



Observations: Brown gas at anode.
Silvery beads liquid at cathode



Electrolysis of aqueous solutions

Aqueous solutions produces **anions** and **cations** in addition to **(H⁺)** ions and **(OH⁻)** ions.



At cathode

If metal is more reactive than hydrogen, then **hydrogen gas** is produced

If metal is less reactive than hydrogen, then **the metal is formed**.

At anode

conc solutions : if halide is present then it is oxidized at the anode, if not then oxygen gas is produced

dilute solutions: oxygen gas is the only product formed by the equation:

Electrolysis of aqueous copper(II) sulfate.

1 the 4 ions present are Cu^{+2} , SO_4^{2-} , OH^- , H^+

2-the ions at the cathode could be either H^+ or Cu^{2+} (cations)

Copper being less reactive than hydrogen, therefore it will be deposited at the cathode.

3- write half ionic equation at the cathode



4-the ions at the anode would be either OH^- or SO_4^{2-} (anions)

sulfate ions do not discharge so OH^- will discharge and produce Oxygen gas.

5- half ionic equation



Solution formed : sulfuric acid (H_2SO_4)

Aqueous Solution (Ions present)	Product at Anode	Product at Cathode
Concentrated Sodium Chloride (NaCl)	Chlorine gas released	Hydrogen gas released
Dilute Sodium Chloride (NaCl)	Oxygen produced	Hydrogen gas released
Concentrated aqueous Copper (II) Sulfate ($CuSO_4$)	Oxygen gas released	Copper is lower than hydrogen in the reactivity series so copper is preferentially discharged as a metal
Concentrated aqueous Hydrochloric Acid (HCl)	Chlorine gas released	Hydrogen gas released
Dilute Hydrochloric Acid (HCl)	Oxygen produced	Hydrogen gas released
Dilute Sulfuric Acid (H_2SO_4)	Oxygen gas released. H_2O more readily gives up electrons than SO_4^{2-}	Hydrogen gas released