

Electrolysis

Define:

Electrolysis

Cathode

Anode

Electrolyte

Which electrodes do *Cations* and *Anions* move to?

Do they gain or lose electrons?

Are they oxidised or reduced?

What is produced at the cathode and anode?

Write half equations.

Definitions:

***Electrolysis:** The breakdown of a molten or aqueous **ionic** compound by **electricity**

Cathode: The electrode connected to the **negative** terminal of the battery

Anode: The electrode connected to the **positive** terminal of the battery

Electrolyte: A liquid that contains ions and therefore conducts electricity

Movement of Ions:

Cations (positive ions), e.g. metals and hydrogen:

- move to the cathode (negative electrode)
- **gain** electrons (they are reduced)

Anions (negative ions), e.g. non-metals:

- move to the anode (positive electrode)
- **lose** electrons (they are oxidised)

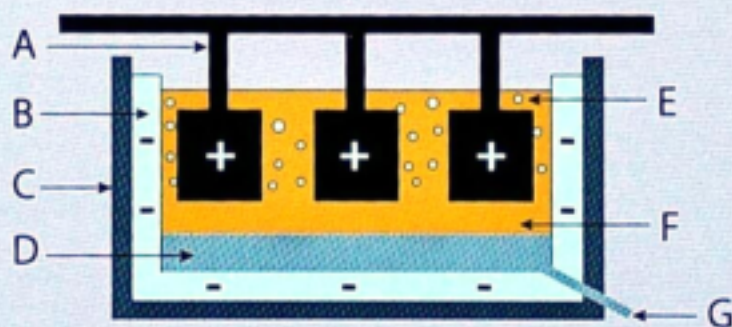
Products of Electrolysis:

	Produced at Cathode	Produced at Anode
Molten ionic compounds e.g. FeCl ₂	Metal, e.g. $\text{Fe}_{(l)}^{2+} + 2e^{-} \longrightarrow \text{Fe}_{(s)}$	Non-metal, e.g. $2\text{Cl}_{(l)}^{-} \longrightarrow \text{Cl}_{2(g)} + 2e^{-}$
Aqueous solutions (which also contain H ⁺ and OH ⁻ ions):		
Metals more reactive than hydrogen e.g. Na, K, Mg	Hydrogen gas $2\text{H}_{(aq)}^{+} + 2e^{-} \longrightarrow \text{H}_{2(g)}$	X
Metal less reactive than hydrogen e.g. Ag, Cu	Metal, e.g. $\text{Cu}_{(aq)}^{2+} + 2e^{-} \longrightarrow \text{Cu}_{(s)}$	
Dilute halide solution (or no halide ions) e.g. CuSO ₄	X	Oxygen gas $4\text{OH}_{(aq)}^{-} \longrightarrow \text{O}_{2(g)} + 2\text{H}_2\text{O}_{(l)} + 4e^{-}$
Concentrated halide solution e.g. conc. NaCl		Halogen, e.g. $2\text{Cl}_{(aq)}^{-} \longrightarrow \text{Cl}_{2(g)} + 2e^{-}$
If anode is made out of metal (<i>other than platinum</i>), e.g. copper		Metal ions, e.g. $\text{Cu}_{(s)} \longrightarrow \text{Cu}_{(aq)}^{2+} + 2e^{-}$

Aluminium

What form is aluminium found in naturally?

Label the following diagram of the apparatus used to extract aluminium:



Explain why cryolite is used.

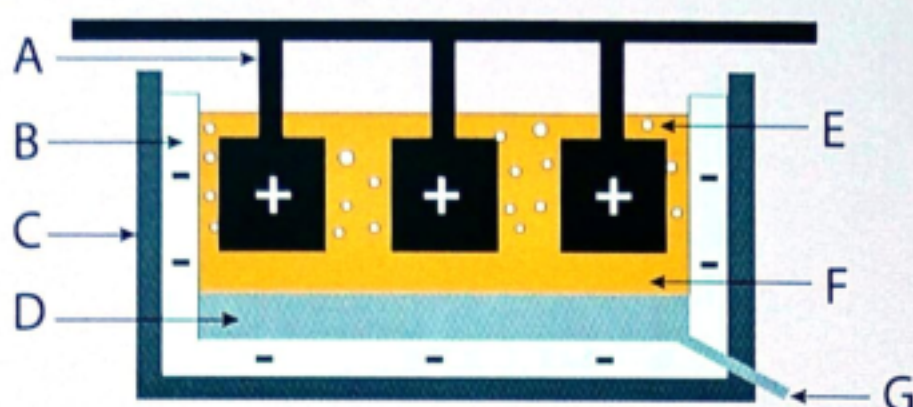
Give equations for the reactions at the electrodes.

Give uses of aluminium, stating the properties which make it useful for each purpose.

Extraction:

Ore: Bauxite (which is mostly aluminium oxide)

Electrolysis apparatus:



A: carbon anode

B: carbon cathode

C: steel cell

D: molten aluminium

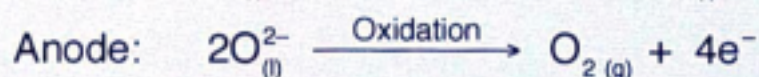
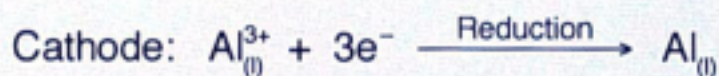
E: oxygen bubbling off

F: alumina (aluminium oxide) dissolved in molten cryolite (at about 1000°C)

G: molten aluminium exit channel

Cryolite: Alumina has a melting point of over 2000°C, so it is dissolved in cryolite to reduce the melting point and save energy

Equations:



Uses of Aluminium:

- Manufacturing aircraft (it has a high strength and low density)
- Overhead electricity cables (it has good electrical conductivity and low density)
- Making food containers (it does not corrode easily and is non-toxic)

Electrolysis of Brine

What is *Brine*?

State the products of brine electrolysis, giving half equations and an overall equation.

Give uses for the 3 products.

Electroplating

What is *Electroplating*?

Explain how it is done.

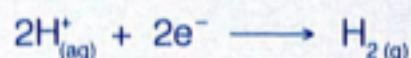
Give uses.

Electrolysis of Brine:

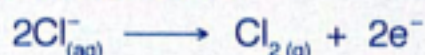
Brine: A concentrated solution of sodium chloride, $\text{NaCl}_{(\text{aq})}$

Products:

Hydrogen gas is formed at the cathode:

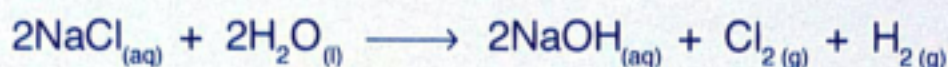


Chlorine gas is formed at the anode:



This leaves **Sodium Hydroxide** (Na^+ and OH^- ions are left in solution)

Overall Equation:



Uses of Products:

Chlorine	Hydrogen	Sodium Hydroxide
Killing bacteria (<i>in drinking water and swimming pools</i>) For Making: Hydrochloric acid Bleach, PVC (<i>plastic</i>) Solvents, paints Medicines Weed killers, pesticides	Fuel (for rockets and for hydrogen fuel cells) For Making: Margarine (<i>by hardening vegetable oils</i>) Ammonia (<i>Haber process</i>) Refrigerants	For Making: Soaps Detergents Oven cleaner Biodiesel Paper Textiles Dyes

Electroplating:

Description: Using electricity to coat one metal with another

Method: To coat Metal A with Metal B, pass electricity through the following cell:

Cathode: Metal A

Anode: Metal B

Electrolyte: a solution of a soluble compound of Metal B

Uses:

- To make a cheaper metal look better (e.g. coating silver onto jewellery made from cheap metal)
- To prevent corrosion (e.g. tin on steel food cans, chromium on car bumpers)