Electrochemistry

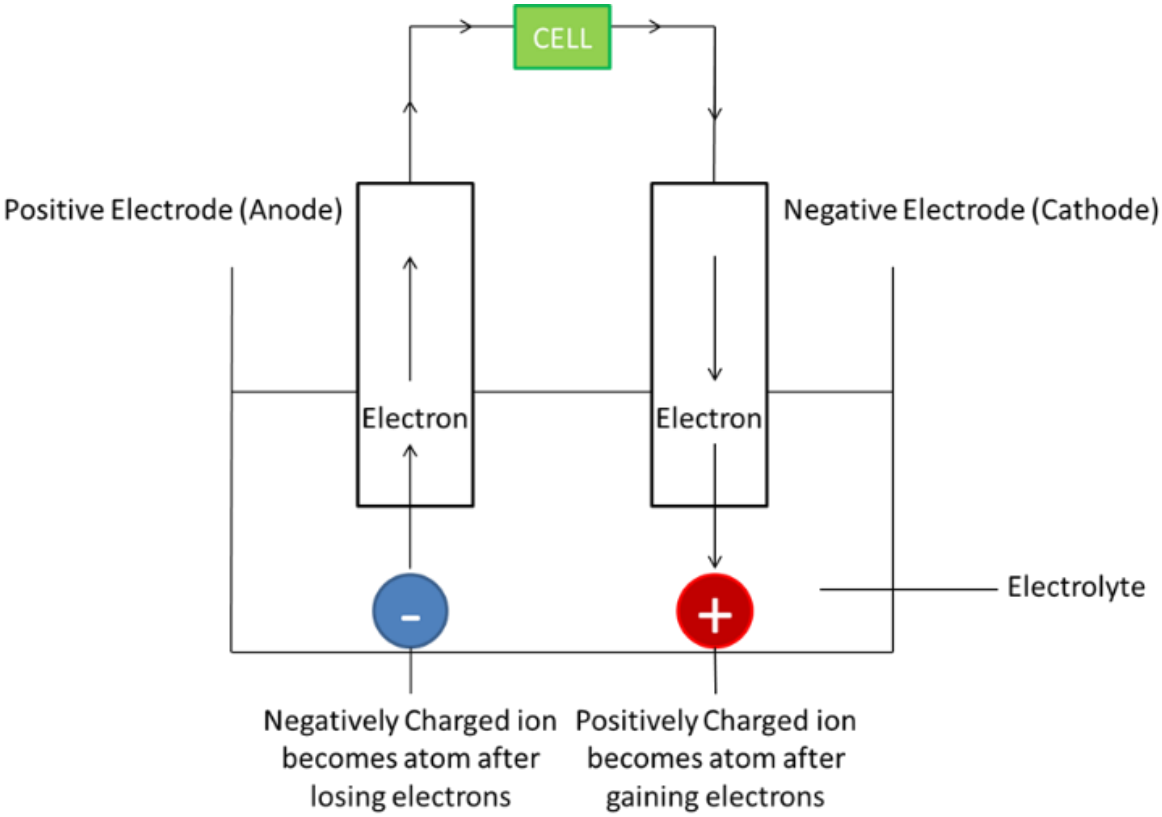
Electrolysis:

Electrolysis the decomposition of an ionic compound, when molten or aqueous solution- by passing of an electric current

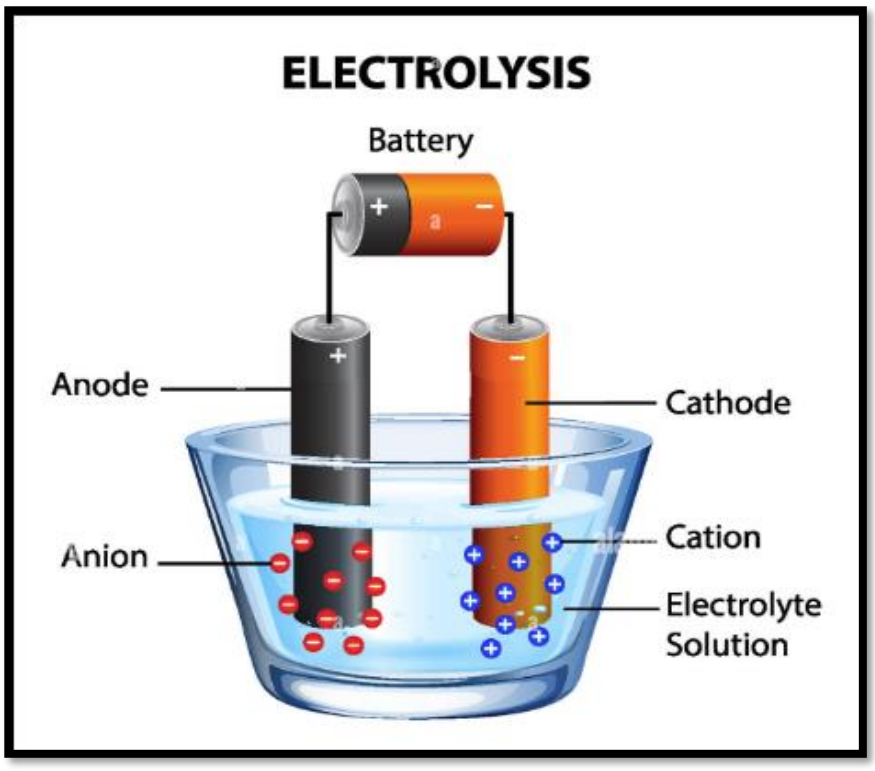
- This is possible due to the presence of **mobile electrons/free-moving ions**
- An **electrolyte** is a **molten or aqueous substance that undergoes electrolysis**

Components of Electrolysis	Definition
Electrodes	Metal or graphite rods that aid the flow of electricity in and out of the electrolyte 1. Anode: Positive electrode 2. Cathode: Negative Electrode (**PANIC**: Positive is Anode, Negative is Cathode)
Anion	Negatively charged ion that moves to anode
Cation	Positively charged ion that moves to the cathode

- Note: **Reactive** electrodes participate in the reaction,
  while **inert** electrodes (Graphite, Carbon) do not react with the cations or anions.



Interactive 3D diagram: Electrolysis

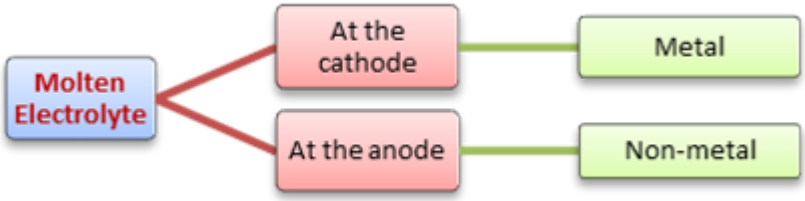


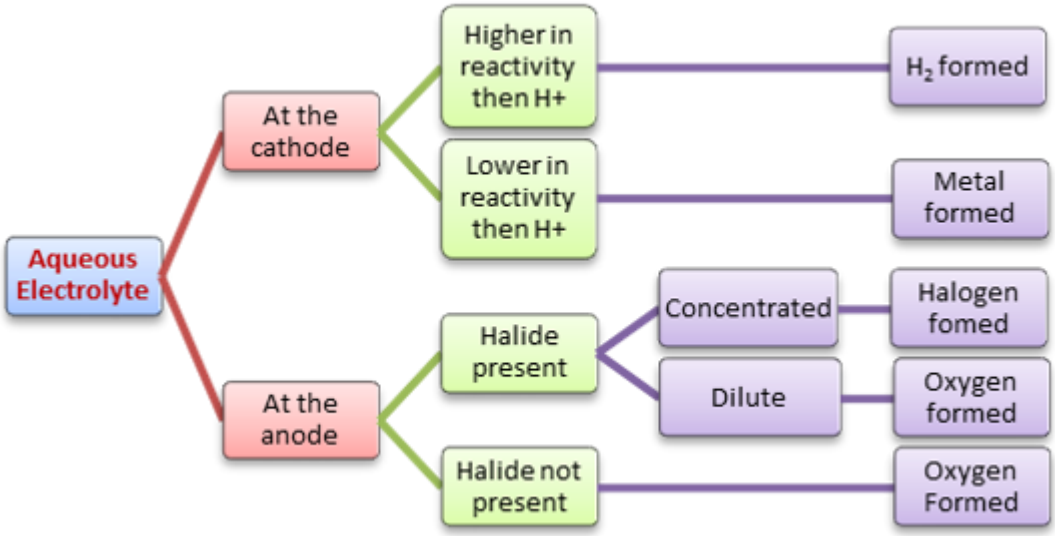
Reduction and Oxidation:

- **Reduction** of positive cations happens at the cathode
- **Oxidation** of negative anions happens at the anode

  For example (Ionic Half Equations)

  - At the anode: $2Cl^{-1} \rightarrow Cl_2 + 2e^{-1}$
  - At the cathode: $2H^{+1} + 2e^{-1} \rightarrow H_2$





Useful Acronyms

1. **REDCATANOX** (Reduction is Cathode, Anode is Oxidation)
2. **OILRIG** (Oxidation is loss, Reduction is gain)
3. **PANIC** (Positive is Anode, Negative is cathode)
4. **CMAN** (Cathode discharge Metals, Anode Discharge Non-Metals)

Observations in Electrolysis:

These are as follow:

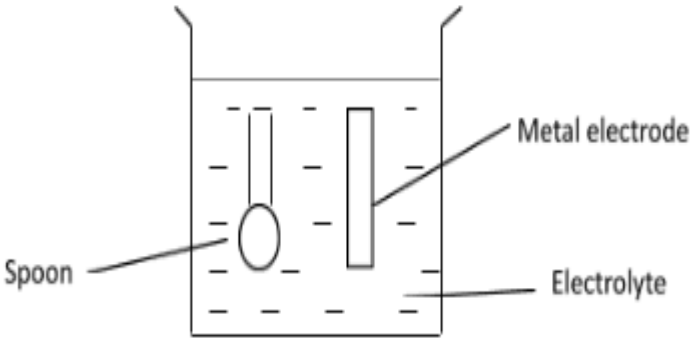
Electrolyte	At Cathode	At Anode
Molten Lead (II) Bromide	Lead	Bromine
Concentrated Hydrochloric Acid	Hydrogen	Chlorine
Concentrated Aqueous Sodium Chloride (Brine)	Hydrogen	Chlorine
Dilute Sulfuric Acid	Hydrogen	Oxygen
Aqueous Copper (II) Sulfate with Graphite Electrodes	Copper	Oxygen
Aqueous Copper (II) Sulfate with Copper Electrodes	Copper	Copper

- Blue copper (II) sulfate doesn't change as the concentration of Cu^{2+} ions remains unchanged.
- **Inert** (Unreactive electrodes) are **Platinum, Graphite or Carbon** Electrodes, so they don't **react with the ions during electrolysis.**

Electroplating

Electroplating the process of coating the surface of a metal (more reactive) with another metal (less reactive) using electrolysis.

- **Components:**
    - Anode: pure/impure metal being used for electroplating the object
    - Cathode: object being electroplated
    - Electrolyte: aqueous solution of the soluble salt of pure metal (same as anode)
- **Used to:**
    - Prevent corrosion
    - Enhance appearance



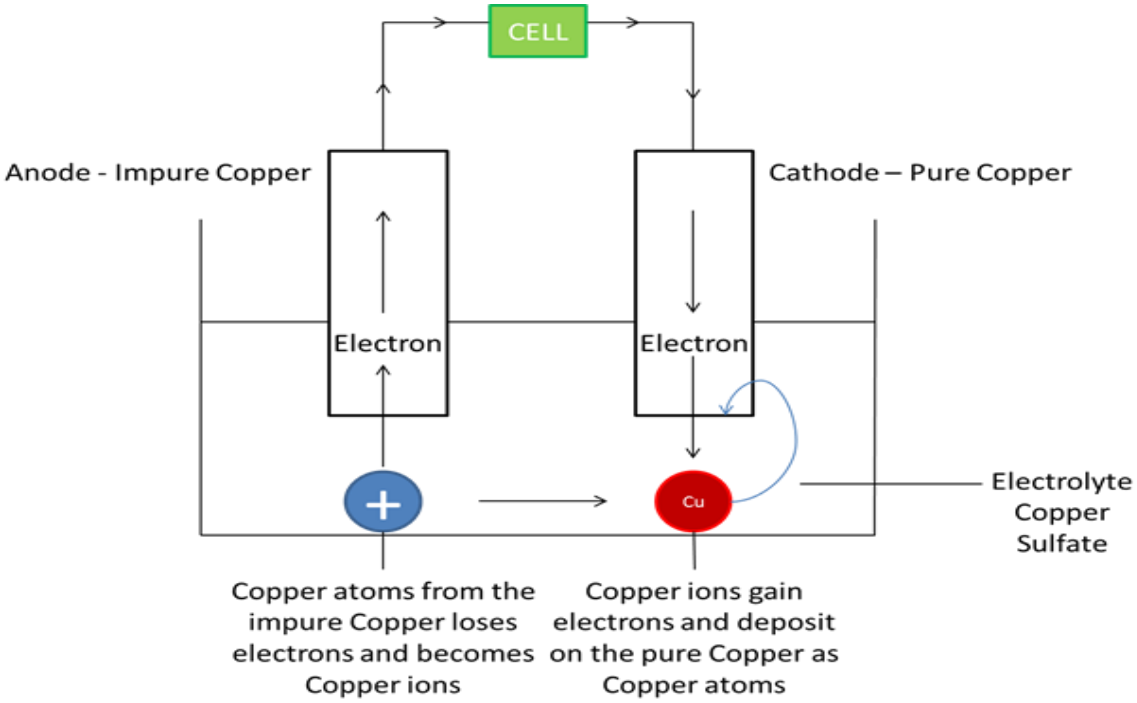
Refining Metals

- Cathode: a thin strip of pure metal
- Anode: impure metal
- Electrolyte: Aqueous Salt Solution of metal

Example:

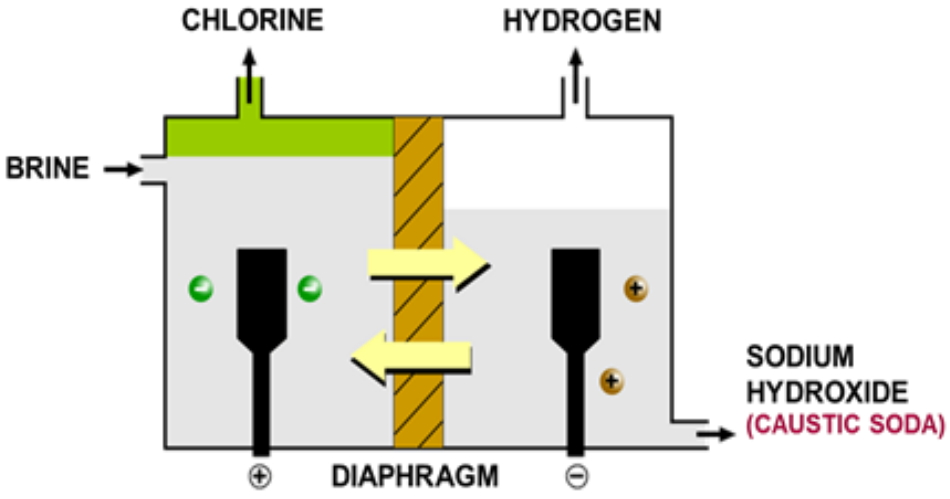
- **The refining of copper:** Impure copper as the anode and pure copper as the cathode; the aqueous copper (II) sulfate helps the copper ions move from the anode to the cathode. Here, the ions gain electrons and become copper atoms, making the pure copper cathode thicker.

1. Reaction at Anode: $Cu \rightarrow 2e + Cu^{2+}$ (**mass decreases**)
2. Reaction at Cathode: $Cu^{2+} + 2e \rightarrow Cu$ (**mass increases**)



Electrolysis of Brine:

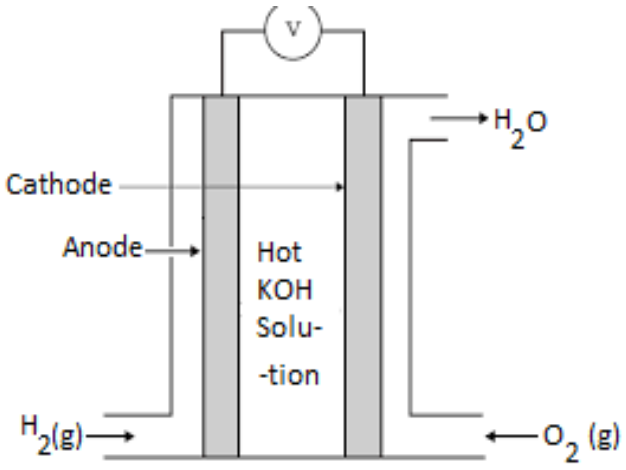
- Brine is a concentrated aqueous NaCl solution
- Ions present: Na^+, H^+, Cl^- and OH^-



At the anode	At the cathode
Made of titanium	Made of steel
Cl^- ions; Chlorine gas	Hydrogen cations reduced to H_2 molecules
Unreacted ions (Na^+, H^+ and OH^-) move through porous membranes due to differences in liquid pressure	
Left Na^+ and OH^- which form aqueous sodium hydroxide	

Hydrogen-Oxygen Fuel Cells

Hydrogen-Oxygen Fuel Cells: Uses **hydrogen and oxygen as the main reactants** to produce electricity; the only product released is **water**.



Main Chemical Equation: $2H_2 + O_2 \rightarrow 2H_2O$

Advantages of motor vehicles	Disadvantages of motor vehicles
Renewable source	Large fuel tank required
Emission Free (No carbon pollutions)	Currently expensive
Non-toxic	Lesser Hydrogen Filling stations