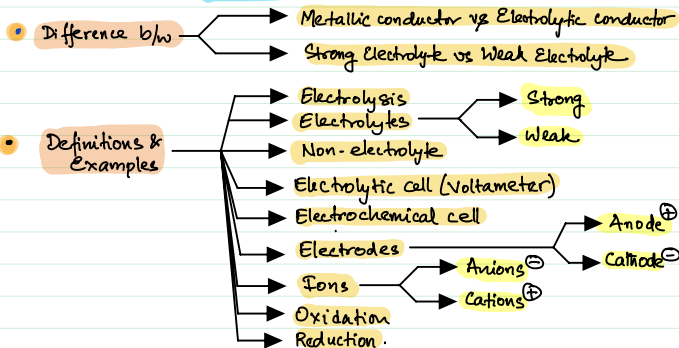
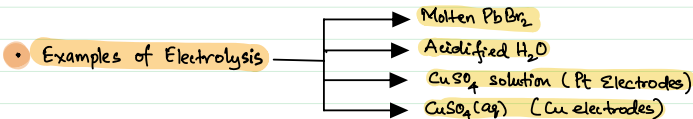


ELECTROLYSIS



- Theory of electrolytic dissociation
- Characteristics of Electrolytes
- Electrolytic dissociation vs Ionisation.
- Electrochemical series & selective discharge of ions.



- Electrodes** : Metal plates or wires or graphite/carbon rods through which electricity enters and leaves the electrolyte.
Anode (+): Connected to the terminal
Cathode (-): Connected to -ve terminal.

Anode	Cathode
1. It is the electrode connected to positive terminal of the battery.	1. It is the electrode connected to negative terminal of the battery.
2. Anions migrate to anode.	2. Cations migrate to cathode.
3. It is an oxidising electrode. Oxidation takes place at anode.	3. It is a reducing electrode. Reduction takes place at cathode.

ANODE : **An Ox**
Anode / Oxidation



CATHODE : **Red Cat**
Reduction / Cathode



- Ions**: Atoms or groups of atoms with a (+ve) or (-ve) charge

+vely charged ions : Cations

-vely charged ions : Anions

Ions	ELECTRODE	REACTION
Anions ⁻	Anode ⁺	Oxidation
Cations ⁺	Cathode ⁻	Reduction

Cations	Anions
1. Are positively charged ions.	1. Are negatively charged ions.
2. Migrate to the cathode during electrolysis.	2. Migrate to the anode during electrolysis.
3. Gain electron(s) from the cathode and get reduced to become a neutral atom.	3. Lose electrons to the anode and get oxidised to become a neutral atom.
Examples : Cations : Na^+ , Ca^{2+} , Al^{3+}	Examples : Anions : PO_4^{3-} , Cl^- , SO_4^{2-} , OH^-

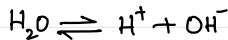
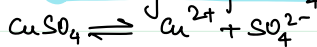
Preferential or Selective Discharge of ions at Electrodes

- Selective discharge of ions : When two or more ions of same charge are present in an electrode, only one of them gets preferentially discharged. This is known as Selective or preferential discharge of ions.
- Selective discharge of ions depends on 3 factors
 - (i) Position in Electrochemical series.
 - (ii) Relative concentration of ions.
 - (iii) Nature of electrodes.

(i) Position of ion in Electrochemical Series

- Ions which are lower in the Electrochemical Series, are discharged first.

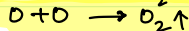
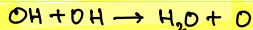
Ex: Electrolysis of CuSO_4 (aq.) ie $\text{CuSO}_4 + \text{H}_2\text{O}$



Anions : SO_4^{2-} , OH^-

Cations : Cu^{2+} , H^+

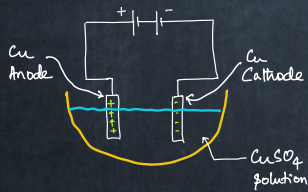
At Anode : $\text{OH}^- - e^- \rightarrow \text{OH}$ (discharged first)



At Cathode : $\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$ (discharged first)

Electrolysis of CuSO_4 Soln. with Copper Electrodes

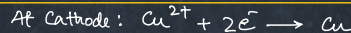
Improves Conductivity
joel samuel
9182099001
www.joelsamuelacademy.in



- **Electrolyte** : $\text{CuSO}_4(\text{aq})$ with small amount of dilute H_2SO_4
- **Electrodes** :
 - Anode - **Copper**
 - Cathode - **Copper**
- **Dissociation reaction** :
$$\text{CuSO}_4 \rightleftharpoons \text{Cu}^{2+} + \text{SO}_4^{2-}$$
$$\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$$
- **Ions present** : Cu^{2+} , H^+ , SO_4^{2-} , OH^-

Due to active Cu Anode, neither OH^- nor SO_4^{2-} are discharged. Cu Anode itself loses electrons to release Cu^{2+} ions into the electrolyte solution.

- **Electrode reactions** : At Anode: $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$



Cu^{2+} is preferred over H^+ , since it is lower in the series

- **Observations** : (i) Pink or reddish brown Cu is deposited at Cathode.
(ii) Cu Anode gets thinner with time.
(iii) Blue solution remains blue as Anode supplies lost Cu^{2+} ions.
- **Note** 1. During electrolysis, for every Cu^{2+} ion lost at Cathode, a Cu^{2+} ion is released by the Anode, such that the total number of Cu^{2+} ions in the solution remains unchanged. Hence the solution retains its blue colour.

Spectator Ions

H^+ , OH^- and SO_4^{2-} ions do not participate in the electrolytic reactions, and hence are called **spectator ions**.

a) Extraction of Potassium

Electrolyte - Fused KBr

Cathode - Iron ;

Anode - Graphite

Dissociation: $\text{KBr} \rightleftharpoons \text{K}^+ + \text{Br}^-$

At Anode : $2\text{Br}^- \rightarrow 2\text{Br} + 2\text{e}^-$



At Cathode : $2\text{K}^+ + 2\text{e}^- \rightarrow 2\text{K}$

b) Extraction of Sodium

Electrolyte - Fused NaCl

Cathode - Iron ;

Anode - Graphite

Dissociation: $\text{NaCl} \rightleftharpoons \text{Na}^+ + \text{Cl}^-$

At Anode : $2\text{Cl}^- \rightarrow 2\text{Cl} + 2\text{e}^-$



At Cathode : $2\text{Na}^+ + 2\text{e}^- \rightarrow 2\text{Na}$

c) Extraction of Calcium

Electrolyte - Fused CaCl_2

Cathode - Iron ;

Anode - Graphite

Dissociation: $\text{CaCl}_2 \rightleftharpoons \text{Ca}^{2+} + 2\text{Cl}^-$

At Anode : $2\text{Cl}^- \rightarrow 2\text{Cl} + 2\text{e}^-$



At Cathode : $\text{Ca}^{2+} + 2\text{e}^- \rightarrow \text{Ca}$

d) Extraction of Aluminium.

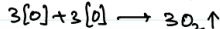
Electrolyte - Fused Al_2O_3

Cathode - Gas carbon

Anode - Thick carbon rods

Dissociation: $\text{Al}_2\text{O}_3 \rightleftharpoons 2\text{Al}^{3+} + 3\text{O}^{2-}$

At Anode : $3\text{O}^{2-} \rightarrow 3[\text{O}] + 6\text{e}^-$



At Cathode : $2\text{Al}^{3+} + 6\text{e}^- \rightarrow 2\text{Al}$

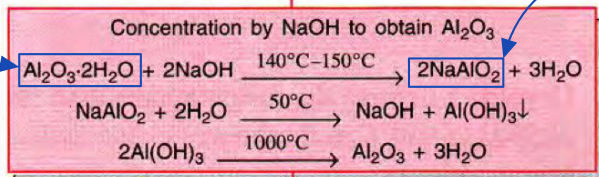
(C) Extraction of Aluminium

Flow Chart for extraction of aluminium

Bauxite (ore)

ORE - Bauxite $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$

Sodium meta
aluminate



Al_2O_3

Na_3AlF_6

CaF_2

Electrolytic reduction of alumina

Electrolyte : Alumina, cryolite, fluorspar (1 : 3 : 1)

Cathode : $4\text{Al}^{3+} + 12\text{e}^- \rightarrow 4\text{Al}$

Anode : $6\text{O}^{2-} - 12\text{e}^- \rightarrow 3\text{O}_2$

$\text{C} + \text{O}_2 \rightarrow \text{CO}_2$

Purification by electrolysis

Cathode : $\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$

Anode : $\text{Al} - 3\text{e}^- \rightarrow \text{Al}^{3+}$

Methods of making alloys

- **Melting and Mixing** -
 - Most common method
 - Metals are melted in a furnace & mixed.
 - The molten mix is poured into a mold to solidify.
- **Powder metallurgy** -
 - Used to make alloys of metals which have high melting point.
 - Metals are finely powdered & mixed.
 - The mixture is pressed into a mold & heated to high temp.
 - This causes the powders to sinter or fuse together forming an alloy.

Alloys are solid solutions in which the metal with higher concentration is the solvent, while the other metals are solute.

Ex: Brass is a solid solution of zinc (solute) in copper (solvent.)