Electrolysis

Electrolysis
It is the process of decomposition of a chemical compound in aqueous solution or in a molten state, accompanied by a chemical change using direct current.

Electrolyte
It is an ionic compound which in the fused state or in the aqueous solution allows the passage of an electric current and is decomposed by it.

Strong Electrolytes
The compounds which in their aqueous solution or in the fused state are almost completely ionised are called strong electrolytes.
Examples: Mineral acids, alkalis and salts

Weak Electrolytes
The compounds which in their fused state or aqueous solution are feebly ionised and are poor conductors of electricity are called weak electrolytes.
Examples: Acetic acid, oxalic acid

Non-electrolytes
The compounds which neither in solution nor in the molten state allow an electric current to pass through them are called non-electrolytes.
Examples: Kerosene, carbon disulphide

Electrolytic Cell
It is a device used to convert electrical energy into chemical energy.

Electrochemical Cell
It is a device used to convert chemical energy into electrical energy.

Electrodes
The graphite, metal plates or gas carbon rods immersed in the electrolyte through which current enters and leaves the electrolytic cell are called electrodes.

Cathode
The electrode connected to the negative terminal of the battery is called a cathode.

Anode
The electrode connected to the positive terminal of the battery is called an anode.

Ions
The atoms or groups of atoms which carry a positive or negative charge are known as ions.

Cations
Atoms which carry a positive charge are called cations.

Anions
Atoms which carry a negative charge are called anions.

Oxidation
It is a chemical process which involves the addition of oxygen or the removal of hydrogen.

Oxidising Agents
It is a substance which oxidises other substances either by accepting electrons or by providing oxygen or an electronegative ion.

Reduction
It is a chemical process which involves the removal of oxygen or the addition of hydrogen.

Reducing Agent
It is a substance which reduces other substances by providing electrons, hydrogen or an electropositive ion.

Dissociation
The process due to which an ionic compound dissociates into ions in the fused state or in the aqueous solution is called electrolytic dissociation.
Example: Electrovalent compound such as NaCl.

$NaCl \rightarrow Na^{+} + Cl^{-}$

Ionisation
The process by which polar covalent compounds are converted into ions in water solution is called ionisation.

$HCl \rightleftharpoons H^{+} + Cl^{-}$

Electrochemical Series
It is a series in which metals are arranged based on the ease with which atoms of metals lose electrons to form positively charged ions.

Cation			Anion
K^{+}	Discharged with most difficulty	Discharged with most difficulty	SO_4^{2-}
Ca^{2+}			NO_3^{1-}
Na^{+}			
Mg^{2+}			Cl^{1-}
Al^{3+}			
Zn^{2+}			Br^{1-}
Fe^{2+}			
Pb^{2+}			I^{1-}
H^{+}			
Cu^{2+}			
Hg^{2+}			
Ag^{+}	Discharged most easily	Discharged most easily	OH^{1-}

Selective Discharge of Ions

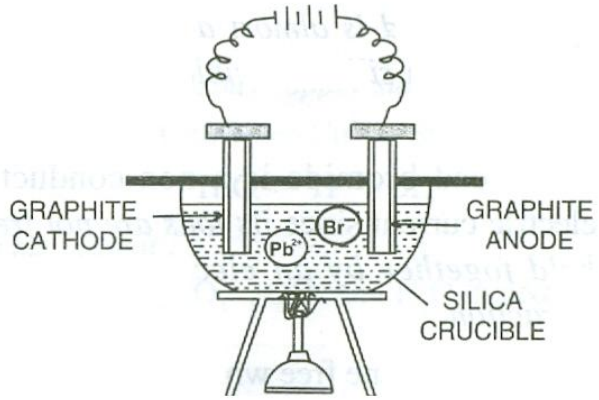
The preferential discharge of ions present in an electrolyte at the respective electrodes is known as selective discharge of ions.

It depends on the following factors:

i. Relative position of ions in an electrochemical series
ii. Concentration of the ions
iii. Nature of the electrode

Electrolysis of Fused Lead Bromide

Electrolyte: Molten lead bromide ($PbBr_2$)



Anode: Graphite
Cathode: Graphite

Overall reaction: $PbBr_2 \longrightarrow Pb^{2+} + 2Br^-$

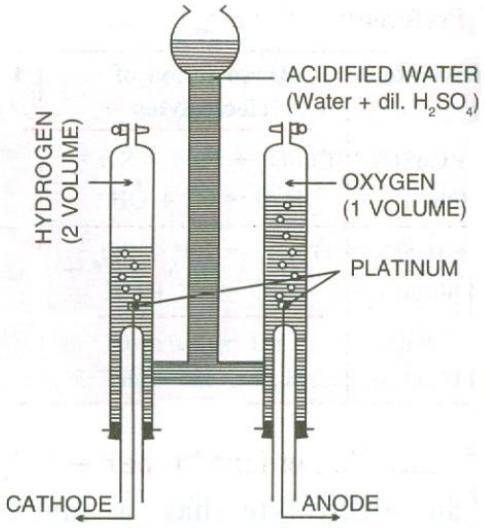
Reaction at the cathode: $Pb^{2+} + 2e^- \longrightarrow Pb$

Reaction at the anode: $Br^- - e^- \longrightarrow Br$

$Br + Br \longrightarrow Br_2$

Electrolysis of Acidified Water

Electrolyte: Acidified water



Anode: Platinum
Cathode: Platinum
Ionisation of acidified water: $H_2O \rightleftharpoons H^+ + OH^-$

$H_2SO_4 \rightleftharpoons 2H^+ + SO_4^{2-}$

Ions present: H^+, SO_4^{2-}, OH^-

Reaction at the cathode: $H^+ + e^- \longrightarrow H$

$H + H \longrightarrow H_2$ (Hydrogen molecule)

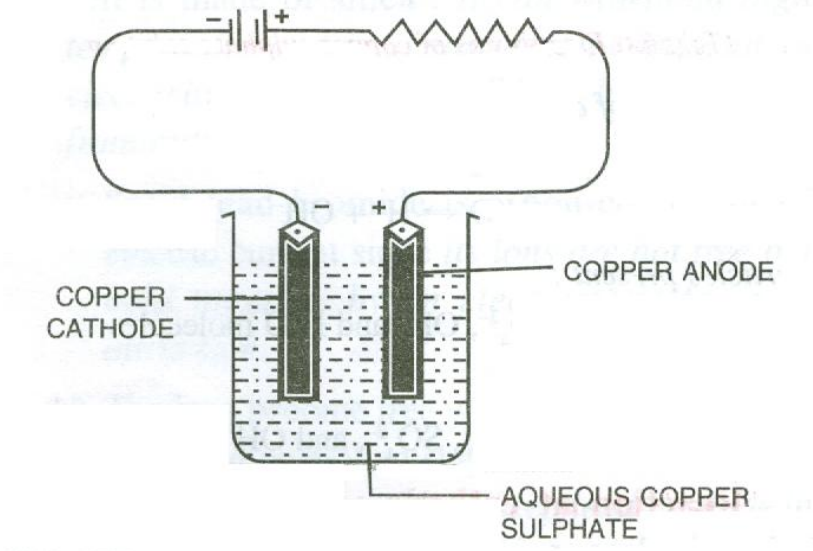
Reaction at the anode: $OH^- - e^- \longrightarrow OH \times 4$

OH^- ion discharge in preference to SO_4^{2-}

$4OH \longrightarrow 2H_2O + O_2$ (Oxygen molecule)

Electrolysis of Aqueous Copper Sulphate

Electrolyte: Aqueous copper sulphate solution



Anode: Copper
Cathode: Copper
Dissociation of aqueous copper sulphate:

$CuSO_4 \rightleftharpoons Cu^{2+} + SO_4^{2-}$

$H_2O \rightleftharpoons H^+ + OH^-$

Reaction at the cathode: $Cu^{2+} + 2e^- \longrightarrow Cu$

Cu being lower in the electrochemical series.

Reaction at the anode: $Cu - 2e^- \longrightarrow Cu^{2+}$

SO_4^{2-} and OH^- are not discharged.

Applications of Electrolysis

i. Electroplating with metals
ii. Electrorefining of metals
iii. Extraction of metals

Electroplating

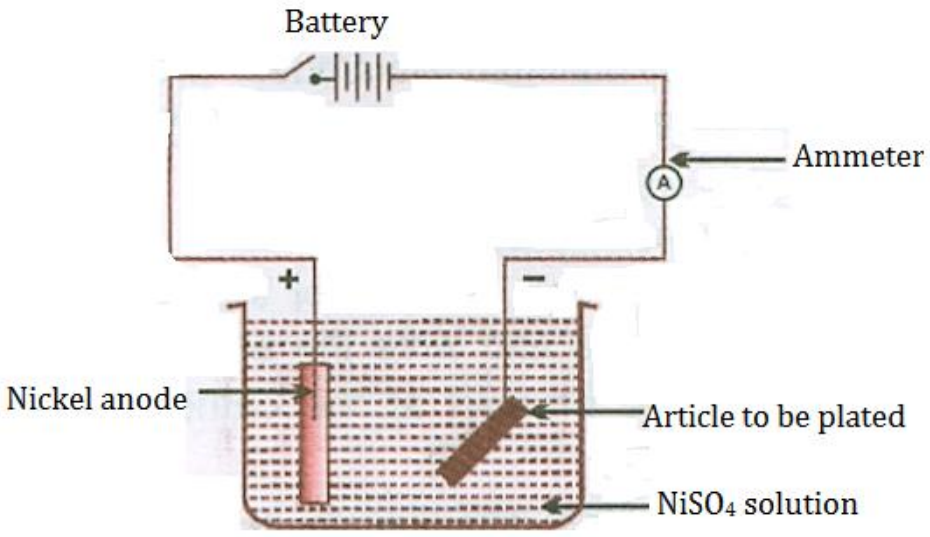
It is a process in which a thin film of a metal, such as gold, silver or nickel, gets deposited on another metallic article with the help of electricity.

Reasons for Electroplating

i. Decoration purposes
ii. To protect from rusting and corrosion

Electroplating with Nickel

Electrolyte: Aqueous solution of nickel sulphate



Dissociation: $NiSO_4 \rightleftharpoons Ni^{2+} + SO_4^{2-}$

$H_2O \rightleftharpoons H+ + OH^-$

Cathode: Article to be electroplated
Anode: Block of pure nickel
Reaction at cathode: $Ni^{2+} + 2e^- \rightarrow Ni$ (deposited)
Reaction at anode: $Ni - 2e^- \rightarrow Ni^{2+}$
Note: Article to be electroplated is always kept at the cathode.

Electrolytic refining of metals

It is a process by which metals containing impurities are purified electrolytically to give a pure metal.

Electrolytic refining of copper

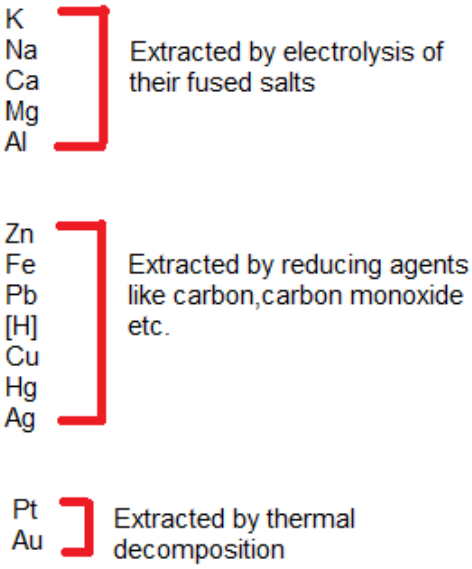
Electrolyte: Copper sulphate solution and dil. sulphuric acid

Cathode: Thin strip of pure copper
Anode: Impure copper
Reaction at cathode: $Cu^{2+} + 2e^- \rightarrow Cu$
Reaction at anode: $Cu - 2e^- \rightarrow Cu^{2+}$

Electrometallurgy

It is the process of extraction of metals by electrolysis.

Activity Series



Acids, Bases and Salts as Electrolytes

They can be classified as strong or weak electrolytes depending on the degree of dissociation.

$$\text{Degree of dissociation} = \frac{\text{Number of molecules dissociated}}{\text{Total number of molecules}} \times 100$$