

Electrochemical Cell

An Electrochemical Cell is a device capable of either generating electrical energy from chemical reactions or using electrical energy to cause chemical reactions. It consists of two electrodes (Anode and Cathode) in contact with an electrolyte.

2. Types of Cells

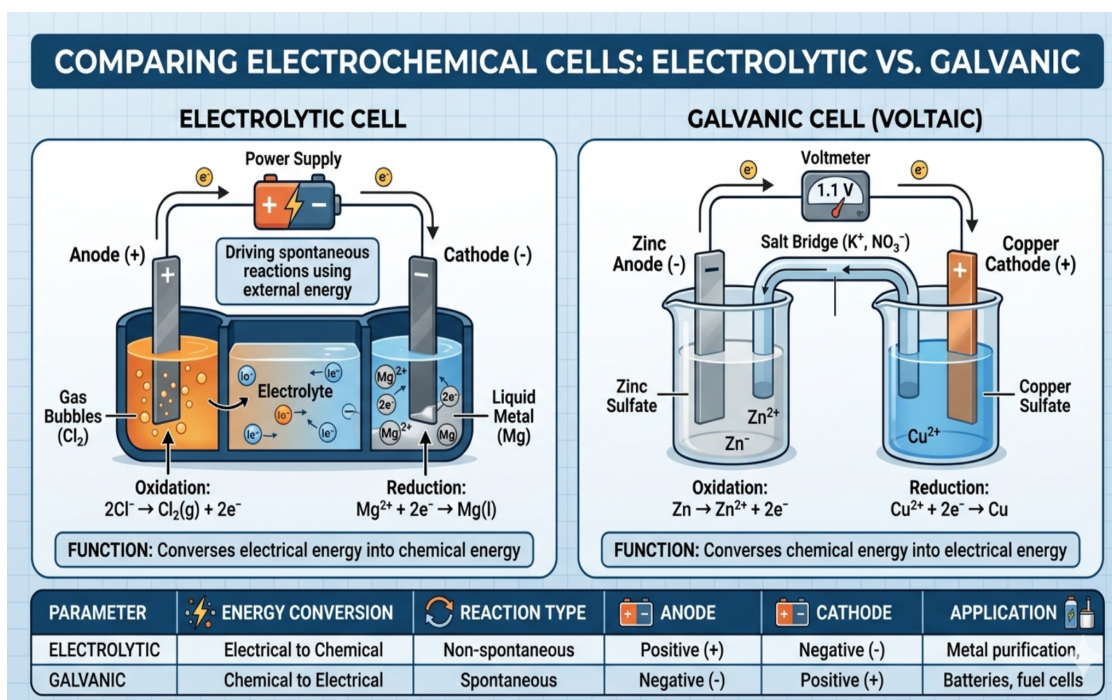
A. Galvanic (Voltaic) Cell

Definition: A cell that converts Chemical Energy into Electrical Energy via spontaneous redox reactions.

Anode: The electrode where Oxidation occurs. It is negatively charged.

Cathode: The electrode where Reduction occurs. It is positively charged.

Salt Bridge: A U-tube containing an inert electrolyte (like KCl) that maintains electrical neutrality and completes the circuit.



B. Electrolytic Cell

Definition: A cell that uses Electrical Energy to drive a non-spontaneous chemical reaction (Electrolysis).

Anode: Connected to the positive terminal (Oxidation).

Cathode: Connected to the negative terminal (Reduction).

3. Key Differences

Feature	Galvanic Cell	Electrolytic Cell
Energy Conversion	Chemical → Electrical	Electrical → Chemical
Spontaneity	Spontaneous ($E^\circ_{\text{cell}} > 0$)	Non-spontaneous ($E^\circ_{\text{cell}} < 0$)
Anode Charge	Negative	Positive
Cathode Charge	Positive	Negative

4. Core Equations & Reactions

Cell Potential: $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$

Nernst Equation: $E_{\text{cell}} = E^\circ_{\text{cell}} - (0.0591/n) \log Q$

Thermodynamic Relation: $\Delta G = -nFE_{\text{cell}}$; If E_{cell} is positive, ΔG is negative (Spontaneous).

5. Advanced Concepts for JEE

Concentration Cells: Cells where both electrodes are of the same material, but the electrolyte concentrations differ (E_{cell} depends on concentration).

Reference Electrodes: Specifically the SHE (Standard Hydrogen Electrode), which is assigned a potential of 0 V to measure other electrodes.

Faraday's First Law: The mass (m) of a substance deposited is proportional to the charge (Q) passed.

$$m = ZQ$$

- (where Z is the Electrochemical Equivalent).