Electrochemistry

1. Electrochemical Cells

- Galvanic Cells
  - Converts chemical energy to electrical energy.
  - Example: Daniell Cell ($Zn(s) + Cu^{2+} \rightarrow Zn^{2+} + Cu$).
  - Reactions:
    - Oxidation at anode: $Zn \rightarrow Zn^{2+} + 2e^-$.
    - Reduction at cathode: $Cu^{2+} + 2e^- \rightarrow Cu$.
- Electrolytic Cells
  - Uses electrical energy to drive non-spontaneous reactions.
  - Example: Electrolysis of water.
  - Process:
    - Anode: Oxidation.
    - Cathode: Reduction.

2. Nernst Equation

- Definition
  - Relates electrode potential to concentration.
  - Formula: $E = E^\circ - (RT/nF) * \ln([M^{n+}]/[M])$.
- Applications
  - Calculate cell potential under non-standard conditions.
  - Example: $E(cell) = 0.91V$ for a specific concentration.

3. Gibbs Energy & Equilibrium

- Gibbs Energy Relation
  - $\Delta G = -nFE(cell)$.
  - Used to calculate the maximum work of a cell.
- Equilibrium Constant
  - Formula: $\log(K) = (nFE(cell))/(2.303RT)$.
  - Example: Calculating K for Daniell Cell with $E^\circ = 1.1V$.

4. Conductance and Molar Conductivity

- Conductance (κ)
  - Measurement of ionic movement in solution.
  - Formula: $\kappa = 1/R$.
- Molar Conductivity (Λm)
  - Conductivity per mole of electrolyte.
  - Formula: $\Lambda m = \kappa/c$.
- Variation with Concentration
  - Molar conductivity increases with dilution for weak electrolytes.

5. Kohlrausch's Law

- Law of Independent Migration of Ions
  - Limiting molar conductivity ($\Lambda^\circ m$) = $\lambda^\circ_+ + \lambda^\circ_-$.
  - Applies to both strong and weak electrolytes.

6. Electrolysis and Faraday's Laws

- Faraday's First Law
  - The amount of substance deposited is proportional to the charge passed.
- Faraday's Second Law
  - The amount of substance deposited depends on its equivalent weight.
- Calculation of Charge
  - $Q = It$, where I = current and t = time.

7. Batteries and Fuel Cells

- Primary Batteries
  - Example: Leclanché dry cell.
  - Non-rechargeable.
- Secondary Batteries
  - Example: Lead storage battery.
  - Rechargeable and reusable.
- Fuel Cells
  - Converts chemical energy of fuels like hydrogen into electrical energy.

8. Corrosion

- Electrochemical Process
  - Example: Rusting of iron.
  - Occurs in the presence of water and oxygen.
- Prevention
  - Painting, sacrificial anodes, or coatings to prevent contact with air.