Electrochemistry Important Questions

Here are the key points for each of the important questions related to **Electrochemistry** in Class 12:

Short Answer Questions (2-3 Marks)

1. **Electrochemical Cells:**
   - A device that converts chemical energy into electrical energy or vice versa.
   - Consists of two half-cells connected via a salt bridge.
   - Example: Galvanic cells (spontaneous), Electrolytic cells (non-spontaneous).
2. **Differences Between Electrolytic and Galvanic Cells:**
   - **Galvanic Cell:** Converts chemical energy to electrical energy, spontaneous reaction.
   - **Electrolytic Cell:** Uses electrical energy to drive a non-spontaneous reaction.
   - In a galvanic cell, the anode is negative, and the cathode is positive, while in an electrolytic cell, the anode is positive, and the cathode is negative.
3. **Faraday's Laws of Electrolysis:**
   - **First Law:** The amount of substance deposited or liberated at an electrode is directly proportional to the quantity of electricity passed through the electrolyte.
   - **Second Law:** The amount of different substances liberated by the same quantity of electricity is proportional to their equivalent weights.
4. **Conductance and Its Units:**
   - **Conductance (G):** The ability of an electrolyte to conduct electricity. It is the inverse of resistance.
   - **Units:** Siemens (S) or ohm^{-1}.
5. **Kohlrausch's Law and Applications:**
   - States that at infinite dilution, each ion contributes a definite value to the molar conductivity of the electrolyte, independent of the other ions.
   - **Applications:**
     - To determine the limiting molar conductivities of weak electrolytes.
     - To calculate the degree of dissociation and ion concentration.
6. **Nernst Equation:**
   - $E_{\text{cell}} = E^\circ_{\text{cell}} - \left(\frac{RT}{nF}\right) \ln Q$
   - Where:
     - E_{cell} is the cell potential.
     - E°_{cell} is the standard cell potential.
     - R is the gas constant, T is the temperature, n is the number of moles of electrons, F is the Faraday constant, and Q is the reaction quotient.

Numerical Problems (2-5 Marks)

1. **Standard Cell Potential Calculation:**
   - Use the equation: $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$.
   - Apply standard electrode potentials from tables and subtract the anode from the cathode potential.
2. **Molar Conductivity and Degree of Dissociation:**

- $\Lambda_m = \frac{\kappa}{c}$, where Λ_m is molar conductivity, κ is conductivity, and c is concentration.
- Degree of dissociation $\alpha = \frac{\Lambda_m}{\Lambda_m^\circ}$.

3. **Nernst Equation for Emf Calculation:**
   - Use the Nernst equation to calculate the emf under non-standard conditions.
4. **Faraday's Laws:**
   - For calculating substance deposition: $m = \frac{ZIt}{F}$, where Z is the equivalent weight, I is current, and t is time.

Long Answer Questions (5 Marks)

1. **Lead-Acid Battery Working:**
   - Consists of lead (Pb) and lead dioxide (PbO_2) as electrodes and sulfuric acid (H_2SO_4) as the electrolyte.
   - Cell reactions: $\mathrm{Pb} + \mathrm{SO}_4^{2-} \rightarrow \mathrm{PbSO}_4$ (at the anode) and $\mathrm{PbO_2} + \mathrm{SO}_4^{2-} + 4H^+ + 2e^- \rightarrow \mathrm{PbSO}_4 + 2H_2O$ (at the cathode).
   - Provides electrical energy during discharge and is recharged by reversing the reaction.
2. **Relation Between Gibbs Free Energy and Cell Potential:**
   - $\Delta G = -nFE_{\text{cell}}$, where ΔG is Gibbs free energy, n is the number of moles of electrons, F is Faraday's constant, and E_{cell} is the cell potential.
   - This shows how spontaneity of a reaction is linked to the cell potential.
3. **Corrosion:**
   - **Definition:** The degradation of metals due to chemical reactions with the environment.
   - **Prevention Methods:**
     - Coating with paint or other metals (galvanization).
     - Using corrosion inhibitors or sacrificial anodes (cathodic protection).

Application-Based Questions

1. **Electrolysis of Molten Sodium Chloride:**
   - Inert electrodes (like platinum) are used because they do not react with the products of electrolysis.
   - Sodium metal is produced at the cathode, and chlorine gas at the anode.
2. **Importance of Salt Bridge:**
   - Maintains electrical neutrality by allowing the exchange of ions.
   - Prevents the mixing of electrolytes while completing the circuit.
3. **Arrhenius Theory and Weak Electrolytes:**
   - Arrhenius theory doesn't explain the partial dissociation of weak electrolytes at different concentrations.
   - Degree of dissociation varies with concentration, which requires Kohlrausch's law for explanation.

Tips for Numerical Problems:

- Memorize standard values like the gas constant R, Faraday constant F, and electrode potentials for common electrodes.
- Practice applying the Nernst equation and Faraday's laws in different scenarios.
- Understand the steps to derive formulas like conductivity, molar conductance, and the relation between free energy and cell potential.

These key points will help you build a strong conceptual understanding and also be prepared to tackle numerical and long-answer questions effectively.