**Electrochemistry**

**Electrochemical**

**Cells**

**CBSC SEM – 4**

**electrochemistry: electrochemical Cells**

**CBCS Syllabus:** Quantitative aspects of Faraday’s laws of electrolysis, rules of oxidation/reduction of ionsbased on half-cell potentials

Chemical cells, reversible and irreversible cells with examples; Electromotive force of a celland its measurement, Nernst equation; Standard electrode (reduction) potential and itsapplication to different kinds of half-cells; Application of EMF measurements in determining(i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pHvalues, using hydrogen, quinone-hydroquinone, glass and SbO/Sb2O3 electrodes

Concentration cells with and without transference, liquid junction potential; determination ofactivity coefficients and transference numbers; Qualitative discussion of potentiometrictitrations (acid-base, redox, precipitation); Applications of electrolysis in metallurgy andindustry

***Contents*** —

1. **Basics of Electrochemistry**
   1. Oxidation and Reduction — 01
   2. Redox reactions — 03
   3. Oxidising and reducing agents — 04
   4. Oxidising agents with reduction half-reactions — 05
   5. Reducing agents with oxidation half-reactions — 07
2. **Electrolysis and Electrolytic conduction**
   1. Basics and working of an electrolytic cell — 10
   2. Factors affecting electrolytic conduction — 10
   3. Quantitative aspects of Faraday’s law of electrolysis — 11
      1. Faraday’s First law of Electrolysis — 11
      2. Equivalent mass and electrochemical equivalent — 12
      3. Numerical Solved Problems based on Faraday’s 1st law — 13
      4. Faraday’s Second law of Electrolysis — 17
      5. Chemical equivalent and electrochemical equivalent — 18
      6. Numerical Solved Problems based on Faraday’s 2nd law — 18
3. **Electrochemical Cells**
   1. Definition and Classification — 20
   2. Electrolytic Cells— 21
   3. **Galvanic** Cells — 22
      1. Danilel Cell — 22
      2. Zinc-Acid Cell — 23
      3. Copper-Silver Cell — 23
      4. Working of a Galvanic Cell — 23
      5. Difference between Galvanic and Electrolytic Cells — 24
4. **Half Reactions**
   1. For redox reactions and **redox couple** — 24
   2. For non-redox reactions — 25
   3. Reactions at electrodes — 26
   4. **Types of electrodes** 
      1. Metal/ Metal-ion electrodes — 27
      2. Gas Electrodes — 27
      3. Metal/ Insoluble-Salt Electrodes — 27
         1. Lead-Lead Sulphate electrode — 27
         2. Calomel Electrode — 28
      4. Redox Electrodes or Oxidation-Reduction Electrodes — 28
5. **Liquid Junction Potential** 
   1. Definition — 28
   2. Derivation of formula for Liquid Junction Potential — 29
   3. Elimination of Liquid Junction Potential — 30
6. **Notation of Cells**
   1. Simple Galvanic cells without Liquid Junction Potential — 30
   2. Cells with Liquid Junction Potential — 30
   3. Cells without Liquid Junction Potential — 30
      1. Fick’s law of ion transport — 14
7. **The Cell Reactions**
   1. Introduction — 30
   2. Cell potential or emf of the Cell — 31
   3. Relation between **cell Potential and Gibbs free energy** — 31
   4. Numerical **Solved problems** based on emf data — 33
   5. Important conclusions regarding Galvanic Cells — 35
   6. Numerical **Solved problems** based on emf data — 36
   7. Measurement of Cell emf — 43
8. **The Nernst Equation**
   1. Derivation of Nernst equation — 44
9. **Standard Electrode Potentials ()**
   1. Definition and representation — 45
   2. **Cell Diagram and IUPAC Convention** — 46
   3. **Standard potential in terms of Reduction Potentials** — 46
   4. Solved Numerical Problems based on standard reduction potentials — 47
   5. The **composition dependence of Individual Potentials** — 50
   6. Solved Numerical Problems based on Composition — 51
10. **The Electrochemical Series**
    1. The electrochemical series — 52
    2. Conclusions derived from electrochemical series — 53
    3. Applications of electrochemical series (or **standard Red potentials**) — 53
    4. In aqueous solution - is the strongest reducing agent — 55
    5. Reducing power of halogens and halide ions — 56
    6. Solved Numerical Problems based on Electrochemical Series — 56
11. **The Pressure Dependence of Potential**
    1. Explanation by problem solving — 60
12. **Classification of Galvanic (Concentration) Cells**
    1. Introduction and Classification — 62
    2. Electrode concentration cells or Amalgam cells — 63
    3. Electrolytic concentration cells — 63
       1. Concentration cells without Transference or transport — 63
       2. Concentration cells with Transference or transport — 64
    4. **EMF of Concentration cells without Transference** or transport — 64
    5. **EMF of Concentration cells with Transference** or transport — 65
    6. Solved Numerical Problems based on Concentration Cells — 66
13. **Application of EMF Measurements OR Applications of Concentration Cells**
    1. **Determination of Activity and Activity Coefficients of Electrolytes** — 67
    2. Solved Numerical Problems based on Activity — 68
    3. **Determination of Transport Numbers of the Ions of the Electrolyte** — 63
    4. **Determination of Valency of the Ions in Doubtful cases** — 69
    5. **Determination of the Solubility Product of the Electrolyte** — 69
    6. Solved Numerical Problems based on Solubility Product — 70
    7. **Determination of of the Electrolyte** — 72
       1. **Determination of by using - Electrode** — 72
       2. **Determination of by using - Electrode** — 72
          1. Advantages of using - Electrode— 73
          2. Limitations of using - Electrode— 74
          3. Solved Numerical Problems based on - determination — 74
       3. **Determination of by using - Electrode** — 74
          1. Construction of Glass- Electrode — 74
          2. Advantages of using - Electrode— 75
          3. Limitations of using - Electrode— 75
       4. **Determination of by using -- oxide Electrode** — 75
          1. Electrode Reaction — 75
          2. Advantages of using **-- oxide** Electrode— 76
          3. Limitations of using **-- oxide** Electrode— 76
          4. Solved Numerical Problems based on - determination — 76
14. **Potentiometric Titrations** 
    1. Principle of Potentiometric Titrations — 77
    2. Acid-Base Titrations — 77
    3. Oxidation-Reduction (Redox) Titrations — 78
    4. Precipitation Titrations — 79
    5. Advantages of Potentiometric Titrations — 80
15. **Applications of Electrolysis in Metallurgy & Industry** 
    1. **Electrolysis in Metallurgy** — 80
       1. Electrometallurgy — 81
       2. Electro-refining — 81
    2. **Electrolysis in Industry** — 82
       1. Electroplating — 82
       2. Electro-synthesis — 83
       3. Electro-typing — 83
       4. Electro-forming — 83
16. **Commercial Cells** 
    1. Classification — 83
    2. Primary Cells — 83
    3. Secondary Cells or Batteries — 84

XXXXX#XXXXXX