**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 (**$E^{0}$**)**
	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 $Li$- 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** $p^{H}$ **of the Electrolyte** — 72
		1. **Determination of** $p^{H}$ **by using** $Hydrogen$**- Electrode** — 72
		2. **Determination of** $p^{H}$ **by using** $Quinhydrone$**- Electrode** — 72
			1. Advantages of using $Quinhydrone$- Electrode— 73
			2. Limitations of using $Quinhydrone$- Electrode— 74
			3. Solved Numerical Problems based on $p^{H}$- determination — 74
		3. **Determination of** $p^{H}$ **by using** $Glass$**- Electrode** — 74
			1. Construction of Glass- Electrode — 74
			2. Advantages of using $Glass$- Electrode— 75
			3. Limitations of using $Glass$- Electrode— 75
		4. **Determination of** $p^{H}$ **by using** $Sb$**-**$Sb$**- oxide Electrode** — 75
			1. Electrode Reaction — 75
			2. Advantages of using $Sb$**-**$Sb$**- oxide** Electrode— 76
			3. Limitations of using $Sb$**-**$Sb$**- oxide** Electrode— 76
			4. Solved Numerical Problems based on $p^{H}$- 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