NCERT CLASS XII CHEMISTRY

FORMULAS & CONCEPTS

Chapter 1: The Solid State

Key Concepts

- Crystalline vs Amorphous solids
- Unit cell, lattice parameters
- Packing efficiency
- Density of unit cell
- Voids and defects

Number of Atoms per Unit Cell

Type	Atoms
Simple cubic (SC)	1
Body-centred cubic (BCC)	2
Face-centred cubic (FCC)	4

Relation Between Edge Length (a) and Radius (r)	• SC: $a = 2r$ • BCC: $\sqrt{3}\,a = 4r$ • FCC: $\sqrt{2}\,a = 4r$
Density of Unit Cell	$\rho = \frac{Z \times M}{N_A \times a^3}$ **Where** ***Z*= number of atoms/unit cell** ***M*= molar mass** ***a*= edge length**
Packing Efficiency	• SC → 52.4% • BCC → 68% • FCC → 74%
Voids	• Tetrahedral voids = $2N$ • Octahedral voids = N
Defects	• Schottky defect → decreases density • Frenkel defect → density unchanged

Chapter 2: Solutions

Key Concepts

- Concentration terms
- Raoult's law
- Colligative properties
- Abnormal molar mass
- van't Hoff factor

Concentration Terms • **Mass %**	
Concentration Terms • **Mole fraction**	$X_A = \frac{n_A}{n_A + n_B}$
Concentration Terms • **Molarity**	$M = \frac{\text{moles of solute}}{\text{volume (L)}}$
Concentration Terms • **Molality**	$m = \frac{\text{moles of solute}}{\text{mass of solvent (kg)}}$
Raoult's Law	$P_A = X_A P_A^0$
Relative Lowering of Vapour Pressure	$\frac{P^0 - P}{P^0} = X_{\text{solute}}$
Elevation in Boiling Point	$\Delta T_b = K_b m$
Depression in Freezing Point	$\Delta T_f = K_f m$
Osmotic Pressure	$\pi = CRT$
van't Hoff Factor *Used in association/dissociation problems*	$i = \frac{\text{observed colligative property}}{\text{calculated value}}$

Chapter 3: Electrochemistry

Key Concepts

- Electrochemical cells
- EMF and electrode potential
- Nernst equation
- Conductance
- Electrolysis

Cell EMF	$E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$
Gibbs Free Energy	$\Delta G^\circ = -nFE^\circ_{\text{cell}}$
Nernst Equation	$E = E^\circ - \frac{0.0591}{n} \log Q$
Conductance	$G = \frac{1}{R}$
Specific Conductance	$\kappa = \frac{G \times l}{A}$
Molar Conductance	$\Lambda_m = \frac{\kappa \times 1000}{C}$
Kohlrausch's Law	$\Lambda^\circ_m = \lambda^+ + \lambda^-$
Faraday's Laws	$m = \frac{Q}{F} \times \frac{M}{n}$

Chapter 4: Chemical Kinetics

Key Concepts

- Rate of reaction
- Order and molecularity
- Rate law
- Integrated rate equations
- Activation energy

Rate Law	$\text{Rate} = k[A]^n$
First Order Reaction	$k = \frac{2.303}{t} \log \frac{[A]_0}{[A]}$ $t_{1/2} = \frac{0.693}{k}$
Zero order reaction	$[A] = [A]_0 - kt$ $t_{1/2} = \frac{[A]_0}{2k}$
Arrhenius Equation	$k = Ae^{-E_a/RT}$
Activation Energy	$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

Chapter 5: Surface Chemistry

Key Concepts

- Adsorption
- Colloids
- Emulsions
- Catalysis

Adsorption	• Physical adsorption → weak forces • Chemical adsorption → strong bonding
Freundlich Adsorption Isotherm	$\frac{x}{m} = kP^{1/n}$
Langmuir Isotherm	$\theta = \frac{KP}{1+KP}$
Colloids	• Lyophilic • Lyophobic
Tyndall Effect	Scattering of light by colloidal particles
Coagulation	Addition of electrolyte neutralizes charge

Chapter 6: General Principles and Processes of Isolation of Elements

Key Concepts

- Ores and minerals
- Concentration of ores
- Extraction of metals
- Thermodynamics of metallurgy
- Ellingham diagram

Important Thermodynamic Relation

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

- Negative ΔG° → reaction feasible
- Ellingham diagram plots ΔG° vs T

Gibbs Energy and Equilibrium

$$\Delta G^\circ = -RT \ln K$$

Reducing Agent Selection

- Metal lower in Ellingham diagram reduces metal oxide above it
- Carbon, CO, Al commonly used reducing agents

Electrolytic Reduction

Used for:

- Na, K, Ca, Mg, Al

(No numericals; conceptual and reasoning-based)

Chapter 7: The p-Block Elements

Key Concepts

- Group 15–18 elements
- Trends in properties
- Oxides, hydrides, halides
- Anomalous behaviour

Oxidation States

- Group 15: −3 to +5
- Group 16: −2 to +6
- Group 17: −1 to +7
- Group 18: mostly 0

Acidic Strength of Oxoacids

$$\text{Acidity} \propto \text{number of } =O \text{ bonds}$$

Hydride Stability

$$\text{Stability} \downarrow \text{ down the group}$$

Interhalogen Compounds

$$\text{Types: } XY,\ XY_3,\ XY_5,\ XY_7$$

Uses

- NH_3 (fertilizer)
- H_2SO_4 (industrial acid)
- Cl_2 (disinfectant)

(Mainly **theory + reasoning**, not numericals)

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Chapter 8: d- and f-Block Elements

Key Concepts

- Transition elements
- Lanthanoids & actinoids
- Oxidation states
- Magnetic properties

Oxidation States

- Variable due to incomplete d-subshell
- Common: +2, +3

Magnetic Moment

$$\mu = \sqrt{n(n+2)}\ \text{BM}$$

Where

n = number of unpaired electrons

Colour of Transition Metal Ions

Due to **d–d transitions**

Lanthanoid Contraction

- Gradual decrease in atomic size
- Causes similarity in elements

Catalytic Activity

Due to:

- Variable oxidation states
- Formation of intermediates

Chapter 9: Coordination Compounds

Key Concepts

- Werner theory
- Coordination number
- Ligands
- Isomerism
- Bonding theories

Coordination Number

Number of ligand donor atoms attached

Oxidation Number Calculation

$$\text{Oxidation state} = \text{Charge on complex} - \sum \text{ligand charges}$$

IUPAC Naming Rules

- Ligands named first (alphabetical)
- Metal name later
- Oxidation state in Roman numerals

Isomerism

- Structural: ionisation, linkage
- Stereoisomerism:
  - Geometrical
  - Optical

Crystal Field Splitting Energy

$$\Delta_o < \Delta_t$$

Magnetic Behaviour

- Paramagnetic → unpaired electrons
- Diamagnetic → all electrons paired

Chapter 10: Haloalkanes and Haloarenes

Key Concepts

- Nomenclature
- Physical properties
- Chemical reactions
- SN1 & SN2 mechanisms

Order of Reactivity (SN1)

$$3^\circ > 2^\circ > 1^\circ$$

Order of Reactivity (SN2)

$$1^\circ > 2^\circ > 3^\circ$$

Leaving Group Ability

$$I^- > Br^- > Cl^- > F^-$$

Rate of SN1 Reaction

$$\text{Rate} \propto [\text{haloalkane}]$$

Rate of SN2 Reaction

$$\text{Rate} \propto [\text{haloalkane}][\text{nucleophile}]$$

Finkelstein Reaction

$$RCl + NaI \rightarrow RI + NaCl$$

Wurtz Reaction

$$2RX + 2Na \rightarrow R\text{–}R + 2NaX$$

Chapter 11: Alcohols, Phenols and Ethers

Key Concepts

- Classification of alcohols
- Acidity of phenols
- Preparation methods
- Chemical reactions
- Mechanisms

Acidity Order

$$\text{Phenol} > \text{Alcohol}$$

Electron-withdrawing group ↑ → acidity ↑

Lucas Test

- 3° alcohol → immediate turbidity
- 2° alcohol → slow turbidity
- 1° alcohol → no turbidity

Dehydration of Alcohols

$$\text{Alcohol} \xrightarrow{H_2SO_4} \text{Alkene}$$

Order:

$$3^\circ > 2^\circ > 1^\circ$$

Williamson Ether Synthesis

$$RONa + R'X \rightarrow ROR' + NaX$$

(SN2 mechanism → primary halide preferred)

Reimer–Tiemann Reaction

$$\text{Phenol} \rightarrow \text{Salicylaldehyde}$$

Chapter 12: Aldehydes, Ketones and Carboxylic Acids

Key Concepts

- Nucleophilic addition
- Oxidation–reduction
- Aldol condensation
- Acidity of carboxylic acids

Tollens' Test

$$\text{Aldehyde} \rightarrow \text{Silver mirror}$$

Fehling's Test

- Aliphatic aldehydes → positive
- Aromatic aldehydes → negative

Aldol Condensation

$$2\text{Aldehydes/Ketones} \rightarrow \beta\text{-hydroxy aldehyde}$$

Acidity Order

$$\text{Carboxylic acid} > \text{Phenol} > \text{Alcohol}$$

Hell–Volhard–Zelinsky Reaction

$$\alpha\text{-halogenation of carboxylic acids}$$

Chapter 13: Amines

Key Concepts

- Classification
- Basicity
- Preparation
- Reactions
- Diazotisation

Basicity Order (Aqueous)

$$2^\circ > 1^\circ > 3^\circ > NH_3$$

Hinsberg Test

Used to distinguish:

- $1^\circ, 2^\circ, 3^\circ$ amines

Gabriel Phthalimide Synthesis

Preparation of **primary amines only**

Diazotisation Reaction

$$\text{Aniline} + NaNO_2 + HCl \rightarrow \text{Diazonium salt}$$

(0–5°C)

Sandmeyer Reaction

$$ArN_2^+Cl^- \rightarrow ArCl/Br/CN$$

Chapter 14: Biomolecules

Key Concepts

- Carbohydrates
- Proteins
- Enzymes
- Vitamins
- Nucleic acids

Carbohydrates

- Monosaccharides: glucose, fructose
- Disaccharides: sucrose, maltose
- Polysaccharides: starch, cellulose

Reducing Sugars

- Glucose, fructose → reducing
- Sucrose → non-reducing

Proteins

- Amino acids linked by **peptide bond**
- Levels: primary → quaternary

Enzymes

- Biocatalysts
- Highly specific
- Optimal pH & temperature

Nucleic Acids

- DNA → double helix
- RNA → single strand

Chapter 15: Polymers

Key Concepts

- Addition & condensation polymers
- Natural & synthetic polymers

Addition Polymerisation

$$n(CH_2 = CH_2) \rightarrow (-CH_2 - CH_2-)_n$$

Condensation Polymerisation

Involves elimination of small molecule (H_2O, HCl)

Important Polymers

- Nylon-6,6
- Teflon
- PVC
- Bakelite

Biodegradable Polymers

- PHBV
- Nylon-2-nylon-6

Chapter 16: Chemistry in Everyday Life

Key Concepts

- Drugs
- Food additives
- Cleansing agents