CLASS XII

There will be two papers in the subject.

***Paper I:** Theory - 3 hours ... 70 marks*

***Paper II**: Practical - 3 hours ... 20 marks*

Project Work ... 7 marks

Practical File ... 3 marks

PAPER I –THEORY – 70 Marks

There will be one paper of 3 hours duration divided into 2 parts.

***Part I (20 marks)** will consist of compulsory short answer questions, testing knowledge, application and skills relating to elementary/fundamental aspects of the entire syllabus.*

***Part II (50 marks)** will be divided into 3 Sections, A, B and C. Candidates are required to answer **two** out of **three** questions from Section A (each carrying 10 marks), **two** out of **three** questions from Section B (each carrying 5 marks) and **two** out of **three** questions from Section C (each carrying 10 marks). Therefore, a total of **six** questions are to be answered in Part II.*

SECTION A

1. Relative Molecular Mass and Mole

(i) Normality, molality, molarity, mole fraction, as measures of concentration.

Definition of the above terms with examples. Simple problems relating mass, molar mass and mole.

(ii) Raoult's law and colligative properties.

Intensive property – definition and examples.

Extensive property – definition and examples.

Colligative properties – definition and examples.

Raoult's Law – I (for volatile solutes),

– II (for non-volatile solutes).

Ideal solution, non-ideal solution. Azeotropic mixtures – definition, types and examples.

(iii) Nonvolatile, non electrolytic solute.

Explanation of non-volatile solute and non-electrolytic solute with examples.

(iv) Dissociation- Electrolytic solute.

Meaning of electrolytic solute – (if strong electrolyte) – the number of particles of the solute in solution is an exact multiple of the number of ions present in one molecule of the solute. Meaning of electrolytic solute – (if weak electrolyte) – the number of particles of the solute in solution is not an exact multiple of the number of ions present in one molecule of the solute but a part of it depending on the degree of dissociation. (This part may be taught after teaching ionic equilibria). Numericals included.

(v) Association.

The meaning of association is - the number of solute particles present in solution is less than the number of particles expected to be present because some of them group together and form one particle. Numericals included.

(vi) Relative molecular mass of non-volatile substances:

(a) By relative lowering of vapour pressure.

Determination of relative molecular mass by measurement of lowering of vapour pressure. Problems based on the above.

(b) Depression in freezing point.

Freezing point depression - molal depression constant (cryoscopic constant) – definition and mathematical expression (derivation included). Problems based on the above.

(c) Elevation in boiling point method.

Boiling point elevation – molal elevation constant or ebullioscopic constant– definition and mathematical expression (derivation included). Problems based on the above.

(d) Osmotic pressure and its application in the determination of relative molecular mass.

Osmotic pressure – definition and explanation, natural and chemical semipermeable membranes, reverse osmosis.

Van't Hoff- Boyle's Law, Van't Hoff – Charles' Law, Van't Hoff - Avogadro's law.

Problems based on the above.

(e) Van't Hoff factor.

Van't Hoff factor for the electrolytes which dissociate and the molecules which associate in solution. Modification of the formula of colligative properties based on Van't Hoff factor. Simple problems.

(f) Van't Hoff equation and its interpretation.

Self-explanatory.

(g) Simple numerical problems on different methods mentioned above for the determination of molecular masses. Abnormal molecular masses in case of electrolytes and in case of solutes which associate.

Self-explanatory.

2. Chemical Bonding

(i) Co-ordinate or dative covalent bond, e.g. formation of oxy-acids of chlorine.

Co-ordinate or dative covalent bonding: definition, formation of hypochlorous acid, chloric acid, perchloric acid – structural formulae of the above molecules based on co-ordinate bonding.

(ii) Hydrogen bonding: its essential requirements, the examples of hydrogen fluoride, water (ice), alcohol, etc may be considered.

H-bonding – definition, types, condition for hydrogen bond formation, examples of inter-molecular hydrogen bonding in detail taking hydrogen fluoride, water and ice and ethanol into account.

(iii) Metallic bonding, Van der Waals' forces.

Metallic bonding - Electron sea model and band model.

Explanation of metallic properties in terms of metallic bonding.

Van der Waals' forces and its types.

(iv) Valence Shell Electron Pair Repulsion Theory; Hybridisation and shapes of molecules: hybridisation involving s, p and d orbitals only; sigma and pi bonds.

Concept of electron-pair repulsion and shapes of molecules taking methane, ammonia and water as examples.

Hybridisation and molecular shapes – definition, hybridization of orbitals involving s, p and d orbitals (examples: ethane, ethene, ethyne, PCl_5 and SF_6). Sigma and pi bonds - definition with examples (hydrogen, oxygen, nitrogen, ethane, ethyne).

(v) Molecular orbital theory, Qualitative treatment of homonuclear diatomic molecules of first two periods. Energy level diagrams, bonding, antibonding molecular orbitals, bond order, paramagnetism of O_2 molecule. Relative stabilities of O_2, O_2^-, O_2^{--}, O_2^+, O_2^{++}

Self-explanatory.

3. States of Matters: Structure and Properties

Solid State

Crystalline and amorphous substances; lattice; unit cell; 3–D packing of atoms in a crystal lattice; relation between radius, edge length and nearest neighbour distance of atoms in a unit cell; density of a unit cell; interstitial void; imperfections in solids, ionic, metallic and atomic solids, electrical and magnetic properties.

Definition of crystal lattice, unit cell; types of unit cell (scc, fcc, bcc); calculation of the number of atoms per unit cell; packing in 3 – D; calculation of density of unit cell – formula, numericals based on it; concept of radius, edge length and nearest neighbour distance; voids – types, location, formation; point defects – F centers; electrical and magnetic properties – piezo electricity, pyroelectricity, ferromagnetic, ferrimagnetic, antiferromagnetic; crystalline and amorphous substances; characteristics of crystalline solids; ionic (NaCl), metallic (Cu), atomic (diamond and graphite); sodium chloride, copper, diamond and graphite as simple examples of lattice.

4. Chemical Energetics

(i) Introduction.

(a) Scope of thermodynamics- characteristics of thermodynamics.

(b) Types of system – ideal system, real system, isolated system, closed system, open system.

(c) Meaning of surrounding.

(d) Properties of the system: macroscopic, intensive and extensive properties of the system.

(e) State of the system.

(f) Main processes the system undergoes: reversible, irreversible, adiabatic, isothermal, isobaric, isochoric, cyclic.

(g) Meaning of thermodynamic equilibrium.

(h) Meaning of thermodynamic process.

(ii) First law of Thermodynamics and its mathematical statement.

(a) Idea of conservation of energy - total energy of the system and the surrounding.

(b) Meaning of internal energy of the system and change in internal energy of the system.

(c) Meaning of work done by the system and by the surrounding at constant temperature.

(d) Meaning of heat absorbed by the system and by the surrounding at constant temperature.

(e) The sign convention for change in internal energy, heat given out or gained, work done by the system or by the surrounding.

(f) State function and path function- meaning with examples.

(g) Internal energy change, work done and heat absorbed in a cyclic process.

(h) Internal energy change in an isolated system and in non isolated system.

(i) Total internal energy change of a system and surrounding.

(j) Significance of first law of thermodynamics.

(k) Chemical change and internal energy.

(l) Need for enthalpy – constant pressure or open vessel processes.

(m) Enthalpy a thermodynamic property – state function.

(n) Mathematical form of enthalpy at constant pressure.

(iii) Ideas about Heat, Work and Energy.

- *Heat - the energy in transit.*
- *Condition for the transfer of heat.*
- *Limitation in conversion of heat into work.*
- *Condition at which heat transfer ceases.*
- *Unit of heat.*
- *Meaning of energy – capacity to do work.*
- *Meaning of work – intensity factor and capacity factor.*
- *Types of work.*
- *Mathematical form of reversible work.*
- *Mathematical form of irreversible work.*
- *Difference between the reversible and irreversible work done – graphically.*
- *Adiabatic reversible expansion.*
- *Relationship between C_v and internal energy change.*

(iv) Second law of thermodynamics – Entropy, Free Energy. Spontaneity of a chemical change. $\Delta G^\circ = -2.303\ RT \log K_{eq}$; reversible and irreversible changes, isobaric, isochoric adiabatic processes.

- *Ideas about reversible (recapitulation), spontaneous and non spontaneous processes.*
- *Inadequacy of first law and need for second law.*
- *Meaning of entropy – derived from IInd law – statement of IInd law in terms of entropy.*
- *Physical significance of entropy*
- *State function and not path function.*
- *Relationship between adiabatic change and entropy.*

- *Entropy change of the universe and a reversible isothermal process.*
- *Entropy change of the universe and irreversible process.*
- *Meaning of thermal death.*
- *Meaning of energy content and work content (free energy) of the system – thermodynamic quantity – state function.*
- *Types of work and meaning of the two types of work.*
- *Meaning of Helmholtz's Free energy and Gibb's free energy and the change in Gibb's and Helmholtz's free energy.*
- *Relationship between Gibb's free energy and Helmholtz's free energy.*
- *Simple calculation on the change in Gibb's free energy and Helmholtz's free energy.*
- *Relationship between change in Gibb's free energy and equilibrium constant of a chemical reaction.*
- *Change in Gibb's free energy in reversible, irreversible, isobaric and isochoric processes.*
- *Based on change in Gibb's free energy, defining the criteria for the spontaneity of a change in terms of entropy and enthalpy; defining the limits for reversible chemical reactions.*

(v) Thermochemistry:

(a) Definitions.

Heat of reaction:

- *Heat of formation – standard heat of formation.*
- *Heat of solution.*
- *Heat of solution at infinite dilution.*
- *Heat of dilution.*
- *Heat of neutralization.*
- *Heat of combustion.*

(b) Constancy in the heat of neutralisation.

- *Experimental verification in case of strong acids and strong bases.*
- *Reason for that observation – ionic neutralisation and the heat evolved.*

(c) Calorific value of a fuel.

Definition of calorific value.

(d) Hess's law of constant heat summation - simple problems based on the above definitions and concepts.

Statement- explanation with example.

Simple problems.

5. Chemical Kinetics (including numericals)

Detailed study of -

(i) Collision theory.

- *Condition for a chemical change - close contact - particles should collide.*
- *Collision to be effective – optimum energy and right orientation while colliding.*
- *Energy barrier built up when the collision is about to take place.*
- *Activated complex formation.*
- *Difference in energy of the reactant and the product – exoergic and endoergic reactions – with proper graphs and labelling.*

(ii) The law of mass action.

- *Statement – meaning of active mass.*
- *The reaction impossible in the laboratory, possible on the sea shore due to mass - the production of stalactites and stalagmite.*
- *Explanation with an example – general reaction.*

(iii) Effect of concentration of the reactants on -

(a) The rate of the reaction.

- *Based on the law of mass action. Statement of the rate law. General rate equation. Rate = k (concentration of the reactant)^n where n is the order of the reaction.*
- *Relationship between the rate of the reaction, with respect to the various reactants i.e aA + bB + cC + Dd - 1/a { d [A] / d t } = - 1/b {d[B] / dt} = 1/c { d[C] / dt } = 1/d { d[D] / dt }.*

(b) The rate constant.

- *Definition of rate constant - mathematical derivation of rate equation for the first order reaction.*
- *Characteristics of first order reaction - rate constant is independent of the initial concentration. Half life period of the reaction.*
- *Problems based on the first order rate equation and half life period; relation between rate constants when different reactants and products are taken into consideration.*

(iv) Molecularity and order of the reaction.

(a) Meaning of the order of reaction.

Physical picture, relation between order and the stoichiometric coefficients in the balanced equation.

(b) Meaning of molecularity.

- *Physical picture.*
- *Relation between order, molecularity and the mechanism of the reaction.*
- *Differences between the order and molecularity of the reaction.*

(v) Mechanisms of the reactions.

- *Meaning of elementary reaction.*
- *Meaning of overall reaction.*
- *Meaning of mechanism of the reaction.*
- *Bottleneck principle and slow step.*
- *Relationship between the rate expression, order of the reactants and products at the rate determining step.*
- *Unit of rate constant – explanation with suitable example.*

(vi) Variation of rate constant with temperature. Arrhenius equation $K = Ae^{-E_A/RT}$ and related graphs.

- *Relationship between the increase in temperature and the number of collisions; increase in the rate of the reaction – not directly proportional, but dependent on the total energy content of the system and the energy possessed by the system.*
- *Effect of temperature on the rate constant of a reaction.*
  - *Arrhenius equation* $K = Ae^{-E_A/RT}$. *Meaning of the terms.*
  - *Related graph. Evaluation* E_A *and 'A' from the graph.*
  - *Experimental details not included but the results from the various experiments are taken to calculate the various quantities in Arrhenius equation.*
  - *Meaning of slope.*
  - *Conversion from exponential to log equation.*

(vii) Catalyst - Catalysis: types of catalysts, theories of catalysts, characteristics of catalyst.

Definition of a catalyst – example.

Types of catalysts:

- *In terms of the state of the reactants and the catalyst - homogenous and heterogeneous catalysts with relevant examples.*
- *In terms of the nature of the catalytic reaction – positive and negative.*

Theories of catalysts:

- *Elementary treatment of intermediate compound formation theory with examples.*
- *Adsorption theory with example - the change in the energy of activation in the activation energy curve - gas phase reaction solid catalyst is used - Van der Waals' force.*

Characteristics of catalyst:

Explain each of the following with relevant examples:

- *Qualitatively and quantitatively remains same.*
- *Quantity ratio.*
- *Promoter.*
- *Poison.*
- *Specificity.*
- *Surface area of the catalyst.*

6. Ionic Equilibria

(i) Ostwald's dilution law and its derivation. Strength of acids and bases based on their dissociation constant.

Ostwald's dilution law - statement and derivation.

Strengths of acids and bases based on their dissociation constant; problems based on the Ostwald's dilution law.

(ii) Brönsted-Lowry and Lewis concept of acids and bases.

Brönsted-Lowry concept of acids and bases with examples. Lewis concept of acids and bases with examples.

(iii) Ionic product of water, pH of solutions and pH indicators, problems.

Ionic product of water – definition, pH, pOH, pK_w of solutions; problems on the above concepts. pH indicators and their choice in titrimetry. Numericals.

(iv) Common ion effect.

Common ion effect – definition, examples (Sodium acetate and acetic acid; ammonium chloride and ammonium hydroxide), applications in salt analysis.

(v) Salt hydrolysis.

Salt hydrolysis – salts of strong acids and weak bases, weak acids and strong bases and the p H of the solutions of these salts in water with suitable examples (in detail). Numericals.

(vi) Buffer solutions.

Buffer solutions: definition, examples, action; its interpretations based on Le Chatelier's principle. Henderson's equation. Numericals.

(vii) Solubility product and its applications.

Solubility product: definition and application in qualitative salt analysis (Group II, III and IV cations). Numericals.

7. Electrochemistry

(i) Faraday's laws of Electrolysis, Coulometer.

Faraday's I^{st} law of electrolysis. Statement, mathematical form. Simple problems.

Faraday's II^{nd} law of electrolysis: Statement, mathematical form. Simple problems.

(ii) Relation between Faraday, Avogadro's number and charge on an electron. $F = N_A e$ should be given (no details of Millikan's experiment are required).

Self-explanatory.

(iii) Galvanic cells, mechanism of current production in a galvanic cell; and electrode potential, standard hydrogen electrode, electrochemical series, Nernst equation.

Galvanic cells - introduction; representation, principle – oxidation reduction. Mechanism of production of electric current in a galvanic cell. Structure and setting. Measurement of potential. Single electrode potentials. Electrical double layer.

Standard hydrogen electrode - definition, preparation, application and limitations.

(a) Standard electrode potential, measurement of standard electrode potential.

Measurement of standard electrode potential of Zn^{++} / Zn^0 half cell (using standard hydrogen electrode).

(b) Idea of heterogeneous equilibria on the surface of the electrode.

Cell notation.

(c) Factors affecting electrode potential.

Factors affecting electrode potential with explanation - main emphasis on the temperature and concentration and nature of the electrode.

(d) Electrochemical series and its explanation on the basis of standard electrode potential.

Electrochemical series. Its explanation on the basis of standard reduction potential.

Prediction of the possibility of a reaction.

(e) Numericals based on calculation of emf of a cell from the values of standard electrode potential.

(f) Nernst equation (correlation with the free energy of the reaction in thermodynamics derivation of the equation).

- *Nernst equation with suitable examples.*
- *Prediction of spontaneity of a reaction based on the cell emf.*
- *Numericals on cell emf and standard electrode potential of half-cells.*

(iv) Electrolytic conductance: specific conductance. Measuring of molar and equivalent conductance; Kohlrausch's law.

Comparison of metallic conductance and electrolytic conductance. Relationship between conductance and resistance. Specific resistance and specific conductance.

Cell constant. Measuring of cell constant. Temperature condition. Meaning of equivalent conductance. Meaning of molar conductance. General relationship between specific conductance, molar conductance and equivalent conductance.

Units, numericals, graph.

Molar conductance of a weak electrolyte at a given concentration at infinite dilution.

(v) Corrosion.

Concept, mechanism of electrochemical reaction, factors affecting it and prevention.

(vi) Batteries.

Lead storage battery and fuel cell – structure, reactions and uses.

SECTION B

8. Coordination Compounds

Concept of complexes; definition of ligands; classification of ligands, coordination number, coordination sphere; IUPAC nomenclature of coordination compounds; isomerism; magnetic characteristics of coordination compounds on the basis of valence bond theory. Stability constant; uses of coordination compounds in different fields.

- *Definition of coordination compounds / complex compounds.*
- *Differences with a double salt.*
- *Study of ligands – mono-, bi-, tri-, tetra-, penta-, hexa- and polydentate, chelating ligands.*
- *Definition of coordination number, its calculation for a complex coordination sphere.*
- *Study of oxidation state of an element in a complex, its calculation.*
- *IUPAC rules of nomenclature of coordination compounds.*
- *Isomerism – types and examples.*
- *Valence bond theory of coordination compounds – examples of formation of inner orbital $[Fe(CN)_6]^{3-}$, $[Co(NH_3)_6]^{3+}$ and outer orbital $[CoF_6]^{3-}$ complexes, prediction of magnetic character.*
- *Crystal field theory – crystal field splitting in tetra and octahedral systems. Explanation of colour and magnetic character.*
- *Stability of coordination compounds (explain stability on the basis of magnitude of K).*
- *Importance and uses.*

9. Chemistry of p-Block Elements: Group 16, 17, 18 - The following should be included:

(a)Occurrence, (b) Physical State, (c) Electronic configuration, (d) Atomic and ionic radii, (e)Common oxidation state, (f) Electronegative character, (g) Ionisation enthalpy, (h) Oxidising nature, (i) Nature of oxides, hydroxides, hydrides, carbonates, nitrates, chlorides, sulphates, wherever applicable.

Group 16: O, S, Se, Te

General Characteristics in terms of physical and chemical properties.

Oxygen – lab method of preparation, formation of oxides with metals and non-metals and their common nature.

Sulphur – extraction by Frasch process, allotropes of sulphur rhombic, monoclinic), structure of sulphur.

Group 17: F, Cl, Br, I

General characteristics in terms of physical and chemical properties.

Fluorine – electrolysis of potassium hydrogen fluoride; reaction of fluorine with hydrogen, water, hydrogen sulphide, dilute and conc. Alkalies.

Chlorine – preparation from MnO_2 and HCl, from NaCl, MnO_2 and conc. H_2SO_4 (only equations), reactions of chlorine with H_2S, NH_3, cold, dilute NaOH and hot, concentrated NaOH.

Interhalogen compounds – structure, hybridisation and shapes. XX′, XX'_3, XX'_5, XX'_7.

Group 18: Noble gases – He, Ne, Ar, Kr, Xe

General Characteristics – state, low reactivity, formation of Xenon compounds with fluorine and oxygen – equation, hybridisation, shape and structure of compounds; uses of noble gases.

10. Preparation/ Manufacture, Properties and Uses of Compounds of Groups 16, 17, – Ozone, Sulphur Dioxide, Sulphuric Acid, Hydrochloric Acid

Group 16:

Ozone:

Manufacture by Siemen's Ozoniser, thermal decomposition of ozone, its oxidising nature – reaction with lead sulphide, potassium iodide and mercury, ozonolysis of ethane, ozone layer depletion (causes and prevention), resonance in ozone structure and its uses.

Sulphur Dioxide:

Laboratory and industrial preparation from sulphites and sulphide ores, reaction of sulphur dioxide with NaOH, Cl_2 and $KMnO_4$.

Sulphuric Acid:

Manufacture by Contact Process (equations, conditions and diagram), properties - acidic nature, mode of dilution, oxidising action and dehydrating nature, uses of sulphuric acid in industry.

Group 17:

Hydrochloric acid:

Lab preparation, its acidic nature, reaction with ammonia, carbonates and sulphites, formation of aqua regia and its uses.

11. Chemistry of Transition and Inner-Transition Elements:

d-Block: 3d, 4d and 5d series

f-Block: 4f and 5f series

Study in terms of metallic character, atomic and ionic radii, ionisation enthalpy, oxidisation states, variable valency, formation of coloured compounds, formation of complexes, alloy formation.

Lanthanoid contraction, shielding effect, radioactive nature.

Metallurgy of Fe, Cu, Zn and Ag in terms of equations; electrolytic refining and uses.

Compounds –

1. Silver nitrate: equation of preparation, use in laboratory and in photography.
2. Potassium permanganate: structure, shape, equation of extraction from pyrolusite ore, its oxidising nature in acidic, basic and neutral medium, use in redox titration.
3. Potassium dichromate: equation of extraction from chromite ore, structure and shape of molecule and its use in titration.

Self-explanatory.

SECTION C

(Note: Aliphatic compounds containing upto 5 carbon atoms to be taught)

12. Alcohols and Phenols

(i) Classification, general formulae, structure and nomenclature.

Classification into monohydric, dihydric and polyhydric alcohols, general formulae, structure and nomenclature of alcohols. Difference between primary, secondary and tertiary alcohols in terms of structure, physical properties and chemical properties.

(ii) Methods of preparation, manufacture, properties and uses.

Methods of preparation:

- *Hydration of Alkenes – direct hydration, hydroboration oxidation.*
- *From Grignard's reagent.*
- *Hydrolysis of alkyl halides.*
- *Reduction of carboxylic acids.*

Manufacture of only methanol by Bosch process and ethanol by fermentation of carbohydrates, chemical equations required (only outline of the method of manufacture, detail not required).

Properties:

- *Acidity of alcohols: reaction with sodium.*
- *Esterification with mechanism.*
- *Reaction with alkyl halide.*
- *Reaction with PCl_5, PCl_3 and $SOCl_2$.*
- *Oxidation.*
- *Dehydration with mechanism.*

Uses of alcohols.

(iii) Preparation, properties and uses of ethane-1,2 diol, propane-1,2,3 triol (outline - no details).

Ethane-1,2-diol:

- *Preparation from ethene.*
- *Physical properties.*
- *Chemical properties: Oxidation to oxalic acid and reaction with HCl.*

Propane – 1,2,3-triol:

- *Preparation from soap: saponification.*
- *Physical properties.*
- *Chemical properties: Oxidation with $KMnO_4$ and reaction with oxalic acid.*

(iv) Conversion of one alcohol into another.

Self-explanatory.

(v) Distinction between primary, secondary and tertiary alcohols.

Distinction through oxidation, dehydration and Lucas' Test.

- *Phenol*

Preparation of phenol from diazonium salt, chlorobenzene (Dow's process) and from benzene sulphonic acid.

Manufacture from Cumene.

Physical properties.

Chemical properties:

- *Acidic character of phenol.*
- *Reaction with sodium hydroxide.*
- *Reaction with sodium.*
- *Reaction with zinc.*
- *Reaction with acetyl chloride.*
- *Reaction with phosphorus penta chloride.*
- *Bromination, nitration and sulphonation (Electrophilic substitution reactions).*
- *Kolbe's reaction (formation of salicylic acid).*
- *Reimer – Tiemann reaction*

Test for phenol – $FeCl_3$ test, azo dye test.

13. Ethers, Carbonyl Compounds.

(i) **Ethers:** general formula and structure. Nomenclature; preparation, properties and uses of ether (outline, no detail), with reference to diethyl ether.

Ethers: ether – structure of ethereal group.

Preparation from alcohol (Williamson's synthesis).

Physical properties.

Chemical properties:

- *Reaction with chlorine.*
- *Oxidation (peroxide formation).*
- *Reaction with HI.*
- *Reaction with PCl_5.*

Uses of ether.

(ii) **Carbonyl compounds:** methods of preparation, properties and uses of aldehydes and ketones.

Preparation:

- *From alcohol.*
- *From alkenes (ozonolysis).*
- *From alkynes (hydration).*
- *From acid chlorides (Rosenmund's reduction, reaction with dialkyl cadmium).*
- *From calcium salt of carboxylic acids.*

Physical properties.

Chemical properties:

- *Nucleophilic addition reactions.*
- *Reactions with ammonia derivatives.*
- *Oxidation reactions.*
- *Reduction: reduction to alcohol and alkanes (Clemmensen's reduction and Wolff-Kishner reduction).*
- *Base catalysed reactions: Aldol, cross Aldol condensation, Cannizzaro's reaction.*
- *Iodoform reaction.*

Uses.

Tests: distinguish between formaldehyde and acetaldehyde; aldehydes and ketones.

- *Benzaldehyde*

Lab preparation from Toluene, oxidation by chromyl chloride.

Physical properties.

Chemical properties:

- *Oxidation and reduction.*
- *Nucleophilic addition reaction (hydrogen cyanide and sodium bisulphite).*
- *Reactions with ammonia derivatives (hydroxyl amine, phenyl hydrazine).*
- *Reaction with Phosphorus pentachloride.*
- *Cannizzaro reaction.*
- *Benzoin condensation.*
- *Electrophilic substitution - Chlorination.*

Test: distinction between aromatic and aliphatic aldehydes.

Uses of benzaldehyde.

14. Carboxylic acids and Acid Derivatives

(i) **Carboxylic acids:** classification, general formulae, structure and nomenclature: monocarboxylic acids, general methods of preparation, properties and uses of acids.

Carboxylic acids: Classification of mono and di carboxylic acids with examples.

Preparation:

- *From alcohols, aldehydes.*
- *From nitriles.*
- *From Grignard reagent.*

Physical properties.

Chemical properties:

- *Acidic character: reaction with active metals, alkalies, carbonates and bicarbonates,*
- *Formation of acid derivatives.*
- *Decarboxylation (chemical and Kolbe's electrolytic reaction)*
- *HVZ reactions.*

Tests for acids: formic acid and acetic acid.

Uses of formic acid and acetic acid.

- *Oxalic acid:*

Preparation from glycol and sodium formate.

Physical properties.

Chemical properties:

- *Reaction with alkali.*
- *Esterification reaction.*
- *Reaction with PCl_5.*
- *Action of heat on oxalic acid.*
- *Oxidation by potassium permanganate.*

Test for oxalic acid.

Uses of oxalic acid.

- *Benzoic acid*

  Preparation from benzaldehyde and Toluene.

  Physical properties

  Chemical properties.

  - *With sodium hydroxide, sodium carbonate.*
  - *Esterification reaction.*
  - *With phosphorus pentachloride.*
  - *Decarboxylation.*
  - *Substitution of benzene ring (meta directive effect of carboxylic acid group) nitration and sulphonation.*

  Test for Benzoic acid.

  Uses of Benzoic acid.

(ii) **Acid derivatives**: laboratory preparation, properties and uses of acetyl chloride, acetic anhydride, acetamide, ethylacetate; urea preparation (by Wohler's synthesis), properties and uses of urea, manufacture of urea from ammonia and by cyanamide process.

Acid derivatives: general and structural formula, IUPAC nomenclature, trivial names, laboratory preparation, and uses of the following compounds:

Acetyl chloride, acetic anhydride, ethyl acetate, acetamide, urea (Wohler's synthesis).

Manufacture of Urea from ammonia and by cyanamide process.

Physical properties.

Chemical properties:

(a) Acetyl chloride:

- *Hydrolysis.*
- *Acetylation of alcohol, ammonia and amines.*
- *Rosenmund's reduction .*
- *Formation of acetic anhydride.*
- *Reaction with Grignard reagent.*

(b) Acetic anhydride

- *Hydrolysis.*
- *Acetylation of ethanol and aniline.*
- *Reaction with PCl_5 .*

(c) Acetamide

- *Acid hydrolysis.*
- *Reaction with alkalies.*
- *Hoffmann's degradation.*
- *Reaction with nitrous acid.*
- *Dehydration.*
- *Reduction.*
- *Amphoteric nature (Reaction with HCl and reaction with HgO).*

(d) Ethyl acetate

- *Acid hydrolysis.*
- *Saponification.*
- *Reaction with ammonia.*
- *Reaction with phosphorus penta chloride.*
- *Reduction.*

(e) Urea

- *Hydrolysis.*
- *Salt formation with nitric acid.*
- *Biuret reaction.*
- *Reaction with hot sodium hydroxide (formation of ammonia and carbon dioxide).*

15. Cyanide, Isocyanide, Nitro compounds and Amines

Their nomenclature, general methods of preparation, correlation of physical properties, their structure, chemical properties, their uses.

- *Cyanide, isocyanide and nitro compounds.*

  Methods of preparation:

  Cyanides:

  - *From alkyl halide.*
  - *From amide.*

Isocyanides:

- *From alkyl halide.*
- *From primary amines.*

Nitro compounds:

- *From alkyl halide.*
- *From primary amines.*

Physical properties.

Chemical properties:

Cyanides and isocyanides:

- *Hydrolysis.*
- *Reduction.*

Nitro compounds:

- *Reduction in acidic and neutral medium.*

Uses.

- *Amines*

  Nomenclature, classification with examples, general formula, methods of preparation.

  Preparation:

  - *From alcohol.*
  - *From alkyl halide.*
  - *From cyanide.*
  - *From amide (Hofmann degradation).*
  - *From nitro compounds.*

  Physical properties.

  Chemical properties:

  - *Basic character of amines.*
  - *Alkylation and acylation.*
  - *Reaction with nitrous acid.*
  - *Carbylamine reaction.*

  Distinction between primary, secondary and tertiary amines (Hinsberg's Test).

- *Nitrobenzene*

  Method of preparation (by nitration of benzene with a mixture of concentrated nitric acid and sulphuric acid).

  Physical Properties.

  Chemical properties:

  - *Electrophilic substitution (Chlorination and nitration) – meta substitution.*
  - *Reduction to aniline.*

  Uses of nitrobenzene.

- *Aniline*

  Method of preparation (by the reduction of nitrobenzene).

  Physical properties.

  Chemical properties.

  - *Reaction with HCl and H_2SO_4.*
  - *Acetylation.*
  - *Benzoylation.*
  - *Carbylamine reaction.*
  - *Diazotisation.*
  - *Electrophilic substitution (bromination and nitration).*

  Test for aniline.

  Uses of aniline.

16. Polymers

Polymerisation: the principle of addition and condensation polymerisation illustrated by reference to natural and synthetic polymers e.g. proteins, polyolefines and synthetic fibres; thermoplastics, thermosetting plastics, chemotrophs; reference should also be made to the effect of chain-length and cross-linking on physical properties of polymers.

Classification: Polythene, polypropene, PVC, PTFE, polystyrene, natural rubber, polyester, Nylon 66, Nylon 6, bakelite (to be learnt in terms of monomers). Uses.

17. Isomerism

Definition. Classification of isomerism.

(i) Structural Isomerism.

(a) Chain isomerism.

(b) Positional isomerism.

(c) Functional isomerism.

(d) Metamerism.

(e) Tautomerism.

Definitions and examples.

(ii) Stereo Isomerism.

(a) Geometric isomerism (cis and trans only).

Definitions. Conditions for compounds to exhibit geometric isomerism; examples, Types of geometric isomers – cis and trans.

(b) Optical isomerism

Definition.

Nicol Prism and plane polarised light. Polarimeter. Method of measuring angle of rotation. Specific rotation.

Conditions for optical activity.

d, l form.

External compensation - racemic mixture.

Internal compensation – meso form.

Examples – lactic acid and tartaric acid.

18 Biomolecules – carbohydrates, proteins, enzymes, vitamins and nucleic acids.

Carbohydrates: definition, classification - mono (aldose, ketose), oligo (di, tri, tetra saccharides) and poly saccharides – examples: reducing sugars and non reducing sugars – examples and uses.

Structures not required.

Test for glucose and fructose (bromine water test – no equation required).

Proteins: Amino acids – general structure, classification and zwitter ion formation. Isoelectric point. Classification of proteins on the basis of molecular shape; denaturation of proteins.

Enzymes: definition, mechanism of enzymatic action.

Vitamins A, B, C, D, E and K: classification (fat soluble and water soluble), deficiency diseases.

Nucleic acids: basic unit – purine and pyrimidine, DNA – structure (double helical), RNA (No chemical structure required).

PAPER II
PRACTICAL WORK – 20 Marks

1. Qualitative analysis

Candidates would be required to carry out tests and make deductions:

Cations: NH_4^+, Pb^{2+}, Cu^{2+}, Sn^{2+}, Al^{3+}, Fe^{2+}, Fe^{3+}, Cr^{3+}, Zn^{2+}, Ni^{2+}, Mn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}

Anions: CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-}, NO_3^-, CH_3COO^-, Cl^-, Br^-, I^-, SO_4^{2-}

A formal group analysis is required for the identification of cations and anions in a mixture that may contain two cations and two anions.

Interfering combinations will not be allowed.

2. Study of the rate of reaction

The candidates will be required, having been given full instructions, to carry out an experiment on the rate of reaction, e.g. reaction between sodium thiosulphate and hydrochloric acid.

3. Titrations

- oxidation-reduction titrations: iodine / sodium thiosulphate; potassium manganate (VII) / ammonium iron (II) sulphate; potassium manganate (VII) / oxalic acid; potassium dichromate / sodium thiosulphate; copper (II) sulphate/ sodium thiosulphate.

The candidate may be required to determine the percent purity of a compound and the number of molecules of water of crystallization in hydrated salts. In such experiments sufficient working details including recognition of the end point will be given.

4. Identification of the following compounds and functional groups based on observations

- Aliphatic compounds: formaldehyde; ethanol; acetic acid; acetone; glycerol; glucose.
- Aromatic compounds: benzoic acid; phenol; aniline (carbylamine reaction should be avoided); benzaldehyde.

*Please Note: Carbylamine reactions are not performed under ordinary laboratory conditions. Ethyl, methyl or phenyl isocynides are highly obnoxious and cause dizziness and headache.

5. **Testing of food material for adulteration which may include:**
   - pure ghee (mixed with vanaspati or animal fat).
   - butter (mixed with starch or vanaspati ghee).
   - turmeric (mixed with starch or chromate salt).
   - milk (either fat is removed or some starch is also mixed).
   - sweets (non-permissible colouring matter such as metanil yellow).
6. **Testing of vitamins A and B**

PROJECT WORK AND PRACTICAL FILE - 10 Marks

Project Work – 7 Marks

The project work is to be assessed by a Visiting Examiner appointed locally and approved by the Council.

The candidate is to creatively execute **one** project/assignment on an aspect of Chemistry. Teachers may assign or students may select a topic of their choice. Following is only a suggestive list of projects.

Suggested assignments:

1. Aminoacids: Peptides, structure and classification, proteins structure and their role in the growth of living beings.
2. Nucleic Acid: DNA and RNA – their structure. Unique nature. Importance in evolution and their characteristic features.
3. Lipids: structure, membranes and their functions.
4. Carbohydrates and their metabolism, Haemoglobin-blood and respiration.
5. Immune systems.
6. Vitamins and hormones
7. Simple idea of chemical evolution.
8. Natural polymers (any **five**)- structure, characteristics, uses.
9. Synthetic polymers (any **five)-** method of preparation, structure, characteristics and uses.
10. Thermoplastics and Thermosetting plastics - methods of preparation, characteristics and uses.
11. Types of dyes- methods of preparation, characteristics and uses.
12. Chemicals in medicines: antiseptics, antibiotics, antacids, etc. and their uses – chemical names.
13. Various rocket propellants and their characteristics.
14. Preparation of soap, alcohol, nail polish, boot polish, varnish, nail polish remover, shampoo and scents.
15. Chemical and chemical processes in forensic studies.
16. Air pollution, water pollution.
17. Insecticides, pesticides and chemical fertilisers.
18. Coal and coal tar as a source of many chemicals.
19. Ancient Indian medicines and medicinal plants.
20. Explosives - preparations and their uses.

Practical File – 3 Marks

The Visiting Examiner is required to assess students on the basis of the Chemistry Practical file maintained by them during the academic year.

NOTE: According to the recommendation of International Union of Pure and Applied Chemistry (IUPAC), the groups are numbered from 1 to 18 replacing the older notation of groups IA ….. VIIA, VIII, IB …… VIIB and 0. However, for the examination both notations will be accepted.

Old notation	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	0
New notation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18