## 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. Solubility of gases in liquids – Henry's Law, simple numericals.*

(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 with respect to dimer formation. 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. Experimental details not required.*

(b) Depression in freezing point.

*Freezing point depression - molal depression constant (cryoscopic constant) – definition and mathematical expression (derivation included). Problems based on the above. Experimental details not required.*

(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. Experimental details not required.*

(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. Experimental details not required.*

(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. Calculation of degree of dissociation and association. Experimental details not required.*

(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. States of Matter: 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; concept of radius, edge length and nearest neighbour distance; calculation of density of unit cell, radius, edge length, formula of the compound – numericals based on it; voids – types, location, formation; point defects – F centers; electrical and magnetic properties – piezoelectricity, pyroelectricity, ferromagnetic, ferrimagnetic, antiferromagnetic; crystalline and amorphous substances; characteristics of crystalline solids; ionic (NaCl), metallic (Cu), atomic (diamond and graphite).*

## 3. Chemical Kinetics

Qualitative meaning of chemical kinetics, comparison with chemical dynamics; slow and fast reactions; rate of reactions; factors affecting the rate of reaction such as: concentration, temperature, nature of reactants and products, surface area of reactants, presence of catalyst and radiation; Rate constant; Rate law; Law of Mass Action; concept of energy barrier; threshold energy, activation energy; formation of activated complex; exothermic and endothermic reactions; collision theory for a chemical change; order of a reaction; rate equation of zero and first order reaction; half life period; molecularity of a reaction; mechanism of elementary and overall reaction; variation of rate constant with temperature; Arrhenius equation – $K=Ae^{-Ea/RT}$; related graphs; catalyst.

*(i) Meaning of Chemical Kinetics:*

- *Scope and importance of Kinetics of the reaction.*
- *Slow and fast reactions – explanation in terms of bonds.*

*(ii) Rate of Reaction:*

- *Definition*
- *Representation of rate of reaction in terms of reactants and products.*
- *Determination of rate of reactions graphically.*
- *Instantaneous and average rate of reaction.*

*(iii) Law of Mass Action:*

- *Statement and meaning of active mass.*
- *Explanation with an example – general reactions.*

*(iv) Effect of concentration of reactants on the rate of a reaction:*

- *Qualitative treatment.*
- *Based on the law of Mass Action. Statement of rate law.*
- *General rate equation – Rate = k(Concentration of the reactant)$^n$,*

*where k is rate constant and n is the order of the reaction.*

- *Relation between the rate of the reaction with rate constant with respect to various reactants.*

*(v) Order of a reaction:*

- *Meaning.*
- *Relation between order and stoichiometric coefficients in balanced equations.*
- *Order as an experimental quantity.*
- *Rate equation for zero order reaction and its unit.*
- *Mathematical derivation of rate equation for first order reaction.*
- *Characteristics of first order reaction – rate constant is independent of the initial concentration, units to be derived.*
- *Definition of half-life period.*
- *Derivation of expression of half-life period from first order rate equation.*
- *Problems based on first order rate equation and half life period.*

*(vi) The concept of energy:*

- *Exothermic and endothermic reactions.*
- *Concept of energy barrier.*
- *Threshold and activation energy.*
- *Formation of activated complex.*
- *Effect of catalyst on activation energy and reaction rate.*

*(vii) Collision Theory:*

- *Condition for a Chemical change – Close contact, particles should collide.*
- *Collisions to be effective – optimum energy and proper orientation during collision.*
- *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.*

*(viii)Molecularity of the reaction:*

- *Meaning – physical picture.*
- *Relation between order, molecularity and the rate of a reaction.*
- *Differences between order and molecularity of a reaction.*

*(ix) Mechanism of the reaction:*

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

*(x) Effect of temperature on the rate constant of a reaction:*

- *Arrhenius equation – $K=Ae^{-Ea/RT}$.*
- *Meaning of the symbols of Arrhenius equation.*
- *Related graph, evaluation of $E_a$ and A from the graph.*
- *Meaning of slope of the graph.*
- *Conversion from exponential to log form of the equation.*
- *Relationship between the increase in temperature and the number of collisions.*
- *Numerical based on Arrhenius equation.*

*(xi) Catalyst:*

- *Definition.*
- *Types of catalyst – positive and negative.*
- *Homogeneous and heterogeneous catalyst based on the state of the reactant and the catalyst.*
- *Elementary treatment of intermediate compound formation theory with examples; Adsorption Theory.*
- *Effect of catalyst on the rate of reaction – the change in the energy of activation in the activation energy curve.*
- *Characteristics of a catalyst – promoter, poison, specificity, surface area of a catalyst.*

**4. Chemical Equilibria**

(i) Reversible reactions and dynamic equilibrium. The concept of equilibrium constant in terms of concentration or partial pressure to indicate the composition of the equilibrium mixture. The following are the examples: the dissociation of dinitrogen tetroxide, hydrolysis of simple

esters, the Contact Process for the manufacture of sulphuric acid, the synthesis of ammonia by Haber's process.

- *Irreversible and reversible reactions.*
- *Chemical equilibrium:*
  - *Characteristics of chemical equilibrium.*
  - *The dynamic nature.*
  - *Law of mass action.*
  - *Equilibrium constant in terms of concentration* $K_c$.
  - *Gaseous reactions. Equilibrium constant in terms of partial pressures* $K_p$.
  - *Relationship between* $K_p$ *and* $K_c$ *(Derivation required).*
  - *Characteristics of equilibrium constant.*
  - *Units for equilibrium constant.*
  - *Simple calculations of equilibrium constant and concentration.*

  *The following examples should be considered to show maximum yield of products:*
  - *Synthesis of ammonia by Haber's process.*
  - *The dissociation of dinitrogen tetra oxide.*
  - *Hydrolysis of simple esters.*
  - *The Contact Process for the manufacture of sulphuric acid.*

(ii) Le Chatelier's Principle and its applications to chemical equilibria.

*Le Chatelier's Principle. Statement and explanation.*

*Factors affecting chemical and physical equilibria should be discussed in the light of Le Chatelier's Principle.*

- *Change of concentration.*
- *Change of temperature.*
- *Change of pressure.*
- *Effect of catalyst.*
- *Addition of inert gas.*

**5. 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) Arrhenius, Brönsted-Lowry and Lewis concept of acids and bases, Multistage ionization of acids and bases with examples.

*Self explanatory.*

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

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

(iv) Common ion effect.

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

(v) Salt hydrolysis.

*Salt hydrolysis – salts of strong acids and weak bases, weak acids and strong bases, weak acids and weak bases and the derivation of pH 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 on solubility product.*

**6. 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. 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 feasibility 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).

- *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: Calculation of cell constant. 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 and at infinite dilution. Kohlrausch's Law – definition and numericals.*

(v) Corrosion.

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

(vi) Batteries.

*Primary and Secondary Cells: Lead storage battery and fuel cell – structure, reactions and uses.*

**SECTION B**

**7. 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 and crystal field 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 $[CoF_6]^{3-}$, $[Fe(H_2O)_6]^{2+}$ 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.*

**8. 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 states, (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, hybridization 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, hybridization, shape and structure of compounds; uses of noble gases.*

**9. Preparation/ Manufacture, Properties and Uses of Compounds of Groups 16, 17, – Ozone, Hydrogen peroxide, 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 ethene, ozone layer depletion :causes and prevention (to be covered theoretically, no reactions are required), resonance in ozone structure and its uses.*

*Hydrogen peroxide:*

*Preparation from peroxide, structure, oxidising properties: reaction with KI, PbS, acidified $FeSO_4$,; reducing properties – reaction with acidified $KMnO_4$ and chlorine.*

*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.*

**10. 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.

**Lanthanoids:**

Lanthanoid contraction, shielding effect, radioactive nature.

Actinoids – general electronic configuration, oxidation state, comparison with lanthanoids and uses.

Metallurgy of Al, Zn, Fe, Cu and Ag in terms of equations, thermodynamics and electrochemical principles involved in the extraction of metals; 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.

   *Oxidising nature in acidic [$FeSO_4$, $(COOH)_2.2H_2O$, KI], basic (KI) and neutral ($H_2S$) mediums to be done.*
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)**

**11. Alkyl and Aryl Halides**

(i) The nomenclature of aliphatic compounds containing halogen atom.

*Naming the halogen derivatives of alkanes by using common system and IUPAC system for mono, di and tri-halo derivatives.*

(ii) Preparation, properties, uses of haloalkanes.

*Preparation from:*

- *Alkane and halogen.*
- *Alkene and hydrohalide.*
- *Alcohols with $PCl_3$, $PCl_5$ and $SOCl_2$.*

*General properties:*

- *Combustibility.*
- *Nucleophilic substitution reactions.*

  *Reaction with:*
  - *sodium nitrite.*
  - *silver nitrite.*
  - *aq. sodium hydroxide.*
  - *alcoholic potassium hydroxide.*

*Uses:*

*Uses of halogen derivatives of alkanes in day to day life and in industry may be discussed.*

(iii) Preparation, properties, and uses of the following: ethyl bromide, chloroform, iodoform, haloform reaction.

*Preparation. Properties and uses of ethyl bromide, chloroform, iodoform.*

*Haloform reaction for the preparation of chloroform and iodoform from alcohol should be discussed.*

(iv) Chlorobenzene.

*Preparation from aniline.*

*Physical properties*

*Chemical properties:*

- *Electrophilic substitution (chlorination nitration and sulphonation).*
- *Nucleophilic substitution - replacement of chlorine with -OH, $-NH_2$.*
- *Reduction to benzene.*
- *Wurtz-Fittig reaction.*
- *Fittig reaction.*
- *Addition reaction with magnesium (formation of Grignard reagent).*
- *Formula of DDT.*

(v) Organometallic compounds.

*Organometallic compounds including Grignard's reagent, preparation and their uses. Wilkinson's and Ziegler-Natta catalyst.*

## 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 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 hydrogen halides.*
- *Reaction with $PCl_5$, $PCl_3$ and $SOCl_2$.*
- *Reaction with acid chlorides and acid anhydrides*
- *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 and acetic anhydride.*
- *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: 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, hydroxylamine, hydrazine and phenyl hydrazine.*
- *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: difference 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 and its derivatives (hydroxyl amine, hydrazine and phenyl hydrazine).*
- *Reaction with phosphorus pentachloride.*
- *Cannizzaro reaction.*
- *Benzoin condensation.*
- *Electrophilic substitution - halogenation, nitration and sulphonation.*

*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's 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 (Test).*
- *Reaction with hot sodium hydroxide (formation of ammonia and carbon dioxide).*

**15. Cyanides, Isocyanides, Nitro compounds, Amines and Diazonium Salts**

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

- *Cyanides, isocyanides 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.*

- *Nitrobenzene*

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

  *Physical Properties.*

  *Chemical properties:*

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

  *Uses of nitrobenzene.*

- *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).*

- *Aniline*

  *Method of preparation (by the reduction of nitrobenzene).*

  *Physical properties.*

  *Chemical properties.*

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

  *Test for aniline.*

  *Uses of aniline.*

  - *Diazonium Salts: Preparation from aniline, importance in synthesis of other organic compounds.*
  - *Sandmeyer's reaction, Gattermann reaction and Balz – Scheimann reaction.*

**16. Polymers**

Polymerisation: the principle of addition and condensation polymerisation illustrated by reference to natural and synthetic polymers e.g. proteins, polyolefins 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. 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 for glucose and fructose (Open and cyclic).*

*Test for glucose and fructose (bromine water test with equation).*

*Proteins: Amino acids – general structure, classification and zwitter ion formation. Isoelectric point. Classification of proteins on the basis of molecular shape; primary and secondary structures of proteins – denaturation. (Definitions only. Details and diagrams are not required).*

*Enzymes: definition, mechanism of enzymatic action.*

*Vitamins A, B, C, D, E and K: classification (fat soluble and water soluble), deficiency diseases. (Chemical names and structures are not required).*

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

**PAPER II**
**PRACTICAL WORK – 20 Marks**

**Candidates are required to complete the following experiments:**

1. **Titrations**
   Oxidation-reduction titrations: potassium manganate (VII) / ammonium iron (II) sulphate; potassium manganate (VII) / oxalic acid.
   The candidate may be required to determine the percentage 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.
   *Candidates will be required to calculate:*
   - *Molarity*
   - *Concentration in grams $l^{-1}$ / molecular mass*
   - *Number of molecules of water of crystallisation/ percentage purity.*

   **NOTE: Molarity must be calculated upto 4 decimal places at least, in order to avoid error.**

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 (using different concentrations) and hydrochloric acid, magnesium and dil. sulphuric acid/ dil. hydrochloric acid (using different concentrations).

3. **Identification of the following compounds and functional groups based on observations**
   - Alcoholic group - glycerol
   - Aldehyde group- formaldehyde
   - Ketonic group – acetone
   - Carboxylic group – benzoic acid
   - Amino group - aniline

   ***Please Note: Carbylamine reaction should not be performed.**

4. **Characteristic tests of carbohydrates and proteins**
   - Carbohydrates – glucose
   - Proteins – powdered milk

5. **Experiments related to pH change using pH paper or universal indicator.**
   - Determination of pH of some solutions obtained from fruit juice, solutions of known and varied concentrations of acids, bases and salts.
   - Comparison of pH of the solutions of strong and weak acids of the same concentration.

6. **Electrochemistry**
   Setting up a simple voltaic cell.
   Variation of cell potential in $Zn/Zn^{2+}//Cu^{2+}/Cu$ with change in concentration of electrolyte ($CuSO_4$, $ZnSO_4$) at room temperature.

7. **Qualitative analysis**
   Qualitative analysis: identification of the following in a given mixture (containing two anions and two cations):

   Anions: $CO_3^{2-}$, $NO_2^-$, $S^{2-}$, $SO_3^{2-}$, $SO_4^{2-}$, $NO_3^-$, $CH_3COO^-$, $Cl^-$, $Br^-$, $I^-$, $C_2O_4^{-2}$.

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

   **More than one radical will not be given from the same group of anions and cations. (Insoluble salts excluded).**

   *Anions: Dilute acid group – $CO_3^{2-}$, $NO_2^-$, $S^{2-}$, $SO_3^{2-}$*
   *Concentrated Acid Group – $NO_3^-$, $Cl^-$, $Br^-$, $I^-$*
   *Special Group - $SO_4^{2-}$, $CH_3COO^-$, $C_2O_4^{-2}$.*
   *Cations: Group Zero: $NH_4^+$*
   *Group I: $Pb^{2+}$*
   *Group II: $Cu^{2+}$, $Pb^{2+}$*
   *Group III: $Al^{3+}$, $Fe^{3+}$*
   *Group IV: $Zn^{2+}$, $Mn^{2+}$, $Ni^{2+}$*
   *Group V: $Ba^{2+}$, $Sr^{2+}$, $Ca^{2+}$*
   *Group VI: $Mg^{2+}$*

***NOTE:***

- *Formal analytical procedure is required for Qualitative Analysis.*
- *Specific solvent for O.S. to be used;*
- *Before adding Group III reagents to the filtrate of Group II, $H_2S$ must be removed followed by boiling with conc. Nitric acid.*
- *The right order for buffer ($NH_4Cl$ and $NH_4OH$) must be used.*
- *The flame test with the precipitate obtained in Group V for $Ba^{2+}$, $Sr^{2+}$, $Ca^{2+}$ will also be accepted as a confirmatory test.*

**For wet test of anions, sodium carbonate extract must be used (except for carbonate).**

## PATTERN OF CHEMISTRY PRACTICAL PAPER

Questions in the practical paper will be set as follows:

| | |
|---|---|
| **Question 1** | **Volumetric Analysis** |
| **Question 2** | **Any one or a combination of the following experiments:** |
| | • Study of the rate of reaction. |
| | • Identification of the organic compounds and functional groups based on observations |
| | • Characteristic tests of carbohydrates and proteins. |
| | • Experiments related to pH determination using pH paper or universal indicator. |
| | • Electrochemistry. |
| **Question 3** | **Qualitative Analysis (Salt mixture).** |

## 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 Evaluation criteria for Project Work:**

- Introduction / purpose
- Contents
- Analysis/ material aid ( graph, data, structure, pie charts, histograms, diagrams, etc)
- Presentation
- Bibliography

**Suggested Assignments:**

1. Amino acids: 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, Blood - haemoglobin 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.
13. Various rocket propellants and their characteristics.
14. Preparation of soap, nail polish, boot polish, varnish, nail polish remover, shampoo and scents.
15. Chemicals 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 |