CHEMISTRY (862)

Aims:

1. To foster acquisition of knowledge and understanding of terms, concepts, facts, processes, techniques and principles relating to the subject of Chemistry.

2. To develop the ability to apply the knowledge of contents and principles of Chemistry in new or unfamiliar situations.

3. To develop skills in proper handling of apparatus and chemicals.

4. To develop an ability to appreciate achievements in the field of Chemistry and its role in nature and society.

5. To develop an interest in activities involving usage of the knowledge of Chemistry.

6. To develop a scientific attitude through the study of Physical Sciences.

7. To acquaint students with the emerging frontiers and interdisciplinary aspects of the subject.

8. To develop skills relevant to the discipline.

9. To apprise students with interface of Chemistry with other disciplines of Science, such as, Physics, Biology, Geology, Engineering, etc.

CLASS XI

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. ***Some Basic Concepts of Chemistry***

   (i) Precision and Accuracy

   Quantities and their measurements in Chemistry, significant figures, SI Units.

   (ii) Dimensional Analysis

   Conversion of units, numericals and applications of units.

   (iii) The concept of atoms having fixed properties in explaining the laws of chemical combination.

Study about atoms. Dalton's atomic theory:

- *Main postulates of the theory.*
- *Its limitations.*
- *Modern atomic theory.*

Laws of chemical combinations:

- *Law of conservation of mass.*
- *Law of definite proportion.*
- *Law of multiple proportion.*
- *Law of reciprocal proportion.*
- *Gay-Lussac's law of gaseous volumes.*

Statement, explanation and simple problems based on these laws.

   (iv) Atomic and isotopic masses.

   The atomic mass unit is one of the experimentally determined unit. It is equal to 1/12 of the mass of the carbon 12 isotope.

   (v) Chemical equivalents, volumetric calculations in terms of normality. $C = 12.00$ should be taken as a standard for expressing atomic masses.

   Equivalent weight expresses the combining capacity of the elements with the standard elements such as H, Cl, O, Ag, etc.

   Variable equivalent weight. Gram equivalent weights, relationship between gram equivalent weight, gram molecular weight and valency.

   Determination of equivalent weight of acids, alkalis, salts, oxidising and reducing agents. (experimental details not required).

Terms used in volumetric calculations such as percentage (w/w and w/v), normality, molarity, molality, mole fraction, etc. should be discussed. Students are required to know the formulae.

Simple calculations on the above topics.

(vi) Relative molecular mass and mole. The following methods may be considered for the determination of relative molecular masses for the gases: the molar volume method; Victor Meyer's method (experimental details not required).

Numerical problems based on the above method and Victor Meyer's method. Mole concept, Avogadro's number and numerical problems on mole concept. Gram molecular volume.

(vii) Chemical reaction – Stoichiometric calculations based on mass-mass, mass-volume and volume-volume relationships.

Self explanatory.

2. Atomic Structure

(i) Electrons, Protons and Neutrons as fundamental particles, their charges and masses.

Concept of indivisibility of atom as proposed by Dalton does not exist. The atom consists of subatomic fundamental particles. Production of cathode rays and their properties. Production of anode rays and their properties.

Chadwick's experiment for the discovery of neutron and properties of neutron.

(ii) Rutherford's nuclear model based on the scattering experiment.

Rutherford's nuclear model of atom. Rutherford's scattering experiment. Discovery of nucleus. Defects of Rutherford model. Types of spectra. Hydrogen spectra to be done in detail.(Numericals are not required).

(iii) Bohr's atomic model.

1. Postulates of Bohr's theory – based on Planck's quantum theory.

2. Numericals on Bohr's atomic radii, velocity and energy of orbits (derivation not required).

3. Defects in the Bohr's Model.

(iv) Atomic structure: wave mechanical model- a simple mathematical treatment. Quantum numbers; shape, size and orientation of s, p and d orbitals only (No derivation). Hund's rule of maximum multiplicity. Pauli's exclusion principle, Aufbau principle, electronic configuration of elements in terms of s, p, d, f subshells.

- *Wave mechanical model - experimental verification of wave nature of electron.*
- *de Broglie's equation. Numericals.*
- *Heisenberg's uncertainity principle. Numericals.*
- *Quantum numbers – types of quantum numbers, information obtained in terms of distance of electron from the nucleus, node and nodal planes, energy of electron, number of electrons present in an orbit and an orbital.*
- *Pauli's exclusion principle. Shape, size and orientation of the s, p and d subshells.*
- *Hund's rule of maximum multiplicity.*
- *Aufbau principle, (n+l) rule.*
- *Electronic configuration of elements in terms of s, p, d, f subshells.*

3. Periodic Table

(i) Atomic number (Proton number) as the basis for classification of the elements in the Periodic Table. IUPAC nomenclature for elements with Z> 100.

Mendeleev's periodic law, defects in the Mendeleev's periodic table. Advantages and disadvantages. Modern periodic law (atomic number taken as the basis of classification of the elements). Extended and long form of periodic table. General characteristics of groups and periods. Division of periodic table as s, p, d and f blocks.

(ii) Extra nuclear structure as the basis of periodicity. Some idea of the following: ionisation enthalpy, electron gain enthalpy, atomic radius, atomic volume, electronegativity, etc must be given. The periodicity of electronic structure leading to

the periodicity of elements e.g. the relative ease of ionisation of elements.

- *Periodic properties such as valence electrons, atomic volume, atomic and ionic radii and their variation in groups and periods.*

- *The idea of ionisation enthalpy, electron gain enthalpy and electronegativity must be given and their variation in groups and periods may be discussed.*

- *The factors (atomic number, atomic volume and shielding effect, the number of electrons in the outermost orbit) which affect these periodic properties and their variation in groups and periods.*

(iii) Periodicity of elements with reference to s, p, d and f block elements.

Classification of elements on the basis of s, p, d, f block elements and also on the basis of their complete and incomplete electron shells.

Study of the periodicity of properties mentioned in point (ii) in terms of s, p, d, f blocks and the governing factors in terms of the block characteristics.

NOTE: Recommendations of the latest IUPAC for numbering of groups to be followed. Numbering 1 – 18 replacing old notation of I – VIII. Details given at the end of the syllabus.

4. **Chemical Bonding:**

Kossel-Lewis approach to Chemical Bonding**.**

Its application to electrovalent and covalent bonds.

Electrovalent Bond

(i) Electrovalent or ionic bond e.g formation of NaCl, Li_2O, MgO, CaO, MgF_2, and Na_2S.

Cause of chemical combination, Octet rule, types of chemical bonds. Electrovalent formation of NaCl, Li_2O, MgO, CaO, MgF_2, and Na_2S. Properties of ionic compounds. Electron dot structure of the following ionic compounds: NaCl, Li_2O, MgO, CaO, MgF_2, and Na_2S must be taught in detail.

(ii) Factors influencing the formation of ionic bond, e.g electron gain enthalpy, ionisation enthalpy, lattice energy and electronegativity.

The conditions necessary for the formation of ionic bonds such as:

- *low ionisation enthalpy of metals.*

- *high electron gain enthalpy of non-metals.*

- *high lattice energy.*

- *electronegativity difference between the reacting atoms should be appreciable.*

All these points must be discussed in detail.

(iii) The relation between the ionic bonding and Periodic Table.

The relationship between the formation of cations and anions of the atoms and their positions in the periodic table should be discussed.

Correlate the periodic property and the position of the elements in the periodic table to show the ease of formation of anions and cations and electrovalent and covalent compounds.

(iv) Variable electrovalency and its causes.

Variable electrovalency; reasons for variable electrovalency i.e, due to inert electron pair effect, by using suitable examples. Calculation of lattice enthalpy (Born-Haber cycle).

Covalent Bond

(i) Covalent bond, sigma and pi bonds e.g. formation of ammonia, nitrogen, ethene, ethyne, and carbon dioxide. Resonance.

Definition of covalent bonding, conditions for formation of covalent bonds, types of covalent bonds i.e single, double and triple bonds. Sigma and pi bonds. H_2, O_2, N_2. Classification of covalent bonds based on electronegativity of atoms - polar and non polar covalent bond, dipole moment, formation of CH_4, H_2O, NH_3, ethane, ethene, ethyne and CO_2, etc. and their electron dot structure or Lewis structure. Characteristics of covalent compounds. Comparison in electrovalency and covalency. Resonance in simple inorganic molecules like ozone, carbon dioxide, carbonate ion and nitrate ion.

(ii) Variable valency: chlorine exhibits the valency of 1,3,5 & 7.

Variable valency, cause of variable covalency e.g. chlorine exhibits the valency 1, 3, 5 and 7. Discuss in terms of atomic structure.

Variable covalency of phosphorus and sulphur may be discussed. Discuss in terms of atomic structure.

(iii) Deviation from Octet rule and Fajan's rules.

Definition of Octet rule.

Failure of Octet rule, due to either incomplete octet or exceeding of Octet with suitable examples.

Fajan's rules: Statements. Conditions for electrovalency and covalency must be discussed. Polar and non polar bonds should be correlated with Fajan's rules.

(iv) 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, ammonium ion, hydronium ion, nitric acid, ozone – structural formulae of the above molecules based on co-ordinate bonding.

(v) 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. Intramolecular hydrogen bonding.

(vi) 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.

(vii) Valence Shell Electron Pair Repulsion Theory; Hybridization and shapes of molecules: hybridization 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.

Hybridization and molecular shapes – definition, hybridization of orbitals involving s, p and d orbitals (examples: ethane, ethene, ethyne, PCl_5 and SF_6).

(viii) Molecular orbital theory, Qualitative treatment of homonuclear diatomic molecules of first two periods (Hydrogen to Neon). Energy level diagrams, bonding, antibonding molecular orbitals, bond order, paramagnetism of O_2 molecule. Relative stabilities of O_2, O_2^-, O_2^{2-}, O_2^+ and N_2, N_2^+, N_2^-, N_2^{2-}.

Self-explanatory.

5. **The Gaseous State**

(i) The gas laws, kinetic theory treated qualitatively.

Characteristics of gases, comparison between solid, liquid and gas. Properties of gases on the basis of kinetic theory of gases. Laws of gases – Boyle's Law, Charles' Law, Absolute Temperature, Pressure Temperature Law, Avogadro's Law. Simple numerical problems based on the above laws.

Postulates of Kinetic Theory must be discussed to explain gas laws. Concept of average, root mean square and most probable velocities (No numericals).

(ii) PV = nRT or PV= (w/M)RT and the application of this equation of state.

Ideal gas equation PV = nRT; its application in calculation of relative molecular mass and in the calculation of the value of R.

(iii) Non ideal behaviour of gases and van der Waals' equation.

Non ideal behaviour of gases i.e. deviation from gas laws may be discussed at low and at high temperature and pressure.

van der Waals' equation $(P + a/V^2)$ $(V-b)$ = RT for one mole of a gas. (Numericals not required)

The pressure correction and volume correction may be explained.

(iv) Dalton's law, the Avogadro's constant, the mole, Graham's law of diffusion, simple numerical problems on the above.

- *Dalton's Law of partial pressure.*

- *Application of Dalton's Law.*

- *Numerical problems based on the above law.*

- *Avogadro's constant.*

- *Relationship between the mole and Avogadro number. Graham's Law of diffusion and its application.*

- *Simple numerical problems on the above.*

6. Surface Chemistry

(i) Adsorption

Factors affecting adsorption of gases on solids, Freundlich and Langmuir adsorption isotherms.

(ii) Colloidal State: Preparation and properties of colloids, both lyophilic and lyophobic colloids. Precipitation as evidence that the colloidal particles are charged. Idea of gold number is required, but application of gold number is not required. The importance of large surface area in adsorption should also be appreciated.

- *Thomas Graham classified the substances as crystalloid and colloid.*

- *Classification of substances on the basis of the particle size i.e. true solution, sol and suspension.*

- *Colloidal system is heterogeneous. Lyophilic and lyophobic colloids.*

- *Classification of colloidal solutions as micro, macro and associated colloids.*

- *Preparation of lyophilic colloids. Preparation of lyophobic colloids by colloid mill, peptisation, Bredig's arc method (procedural details not required) by oxidation, reduction, double decomposition and exchange of solvent method should be discussed.*

- *Purification of colloids (dialysis, ultra filtration, and ultracentrifugation).*

- *Properties of colloidal solutions such as Brownian movement, Tyndall effect, coagulation should be discussed.*

- *Protection of colloids, Gold number and Hardy Schulze rule.*

- *Application of colloids in life.*

- *Electrophoresis (movement of dispersed phase).*

- *Emulsions, surfactants, micelles (only definition and examples).*

(iii) Chromatography

Principle and its application (details not required).

7. Chemical Kinetics

Rate of a chemical reaction, basic idea of order and molecularity of a reaction.

Rate of a chemical reaction; Relation between order and the stoichiometric coefficients in the balanced equation; Meaning of molecularity. Differences between the order and molecularity of the reaction. (Numericals are not required).

8. 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 surroundings.

(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 surroundings.

(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 surroundings at constant temperature.

(d) Meaning of heat absorbed by the system and by the surroundings 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 surroundings.

(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 surroundings.

(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.*
* *Relationship between C_p and C_v.*

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

* *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) Third Law of Thermodynamics – statement only.
  Self explanatory.

(vi) 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.

SECTION B

9. **Study of Representative Elements**: Group 1, 2, 13, 14, 15 - The following should be included:
a) Occurrence, (b) Physical State, (c) Electronic Configuration, (d) Atomic and Ionic radii, (e) Common oxidation state, (f) Electropositive / Electronegative character, (g) Ionisation enthalpy, (h) Reducing/oxidising nature, (i) Distinctive behaviour of first member of each group (namely Lithium, Beryllium, Boron, Carbon, Nitrogen), (j) Nature of oxides, hydroxides, hydrides, carbonates, nitrates, chlorides, sulphates, wherever applicable.

s-Block elements:

Group 1 – Lithium, Sodium: General characteristics in terms of physical and chemical properties.

Group 2 – Beryllium, Magnesium and Calcium: General characteristics in terms of physical and chemical properties.

p-Block elements:

Group 13 – Boron, Aluminium: General characteristics in terms of physical and chemical properties; Boron's Lewis acid character; amphoteric nature of aluminium.

Group 14 – Carbon, Silicon, Germanium, Tin and Lead: General characteristics in terms of physical and chemical properties, property of catenation; structure of diamond, graphite and fullerene; stability of +2 oxidation state down the group in terms of inert pair effect.

Group 15 – Nitrogen, Phosphorus: General trends in group; unreactive nature of nitrogen; difference in the physical state of nitrogen and phosphorus in terms of bonding; allotropes of phosphorus (white, red) - nature and uses.

10. **Preparation, properties and uses of Compounds of Groups 1, 2, 13, 14, 15.**

Only brief qualitative treatment is required for preparation. Main emphasis must be given to the chemistry of preparation, chemical properties and uses of the given compounds. Biological importance of magnesium, sodium, calcium and potassium.

Group 1: Sodium chloride, Sodium hydroxide, Sodium carbonate, Sodium bicarbonate, Sodium thiosulphate; Group 2: Magnesium chloride hexahydrate, Calcium oxide, Plaster of Paris, Cement; Group 13: Borax, Borax Bead Test, Boric acid, Alums; Group 14: Carbon monoxide, Carbon dioxide, Silicon dioxide, Silicon carbide, Silicones; Group 15: Oxides of nitrogen, Phosphorus trichloride, Phosphorus pentachloride, Oxoacids of phosphorus.

Group 1:

  (i) *Sodium chloride - Isolation. Uses.*

  (ii) *Sodium hydroxide - only the principle of preparation by Castner-Kellner cell.*

  (iii) *Sodium carbonate - equation of Solvay's process. Uses.*

(iv) *Sodium bicarbonate - preparation from sodium carbonate. Uses.*

(v) *Sodium thiosulphate - preparation from sodium sulphite and its reaction with iodine, dilute acids and silver nitrate. Uses.*

Group 2:

(i) *Magnesium chloride hexahydrate - preparation from magnesium oxide. Effect of heat.*

(ii) *Calcium oxide - preparation from limestone; reaction with water, carbon dioxide and silica.*

(iii) *Plaster of Paris - preparation from gypsum. Uses.*

(iv) *Manufacture of cement.*

Group 13:

(i) *Borax- reaction with water and action of heat on hydrated compound (preparation not required).*

(ii) *Borax Bead Test.*

(iii) *Boric acid – preparation and action of heat.*

(iv) *Alums – preparation and uses.*

Group 14:

(i) *Carbon monoxide - preparation from incomplete combustion of carbon. Hazards of CO. Reducing nature of CO.*

(ii) *Carbon dioxide - preparation from limestone and carbon, limewater test. Uses.*

(iii) *Silicon dioxide - structure, comparison with carbon dioxide. Uses.*

(iv) *Silicon carbide - preparation from silica. Uses.*

(v) *Silicones - general method of preparation. Uses.*

(vi) *Silicates – structure and uses.*

(vii) *Zeolites – formula and use.*

Group 15:

(i) *Oxides of nitrogen (N_2O, NO, N_2O_3, N_2O_4, N_2O_5) - preparation, structure and uses.*

(ii) *Ammonia– Preparation and manufacture. Properties: reaction with oxygen, copper oxide, chlorine, HCl, formation of complexes. Uses.*

(iii) *Nitric Acid - Preparation and manufacture. Properties: reaction with copper (dilute and concentrated HNO_3), carbon and sulphur. Uses.*

(iv) *Phosphorus trichloride - Preparation from phosphorous. Uses.*

(v) *Phosphorus pentachloride - preparation from PCl_3. Thermal dissociation and hydrolysis. Uses.*

(vi) *Phosphine – preparation from phosphorus and properties: reaction with halo acids).*

(vii) *Oxoacids of phosphorus (structure only).*

11. Redox Reactions

− *Concept of oxidation and reduction in terms of oxygen, hydrogen, electrons.*

− *Redox reactions – examples.*

− *Oxidation number: Rules for calculation, simple calculations of oxidation state in molecules and ions like $K_2\underline{C}r_2O_7$, $\underline{S}_2O_3^{2-}$, etc.*

− *Oxidation and reduction in terms of change in oxidation number.*

− *Balancing of redox reactions in acidic and basic medium by oxidation number and ion-electron method.*

SECTION C

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

12. Introduction to Organic Chemistry

(i) The unique nature of carbon atom and catenation.

Introduction to organic chemistry:

- *Vital force theory.*

- *Reason for separate study of organic chemistry and its importance.*

- *Characteristics of carbon atoms (tetra valency).*

- *Reasons for large number of organic compounds:*

  (a) *Catenation.*

  (b) *Isomerism and multiple bonding, etc.*

(ii) Classification of organic compounds and homologous series.

Classification of organic compounds: (definition and examples)

   (a) Open chain.

   (b) Closed chain.

   (c) Homocyclic.

   (d) Hetrocyclic.

   (e) Aromatic.

   (f) Alicyclic compounds.

   (g) Homologous series and its characteristics.

   (h) Functional groups.

   (i) Nomenclature of organic compounds; hydrocarbons and other simple compounds.

   (j) IUPAC rules for naming organic compounds.

(iii) Detection of carbon, hydrogen, sulphur, nitrogen and halogen.

Analysis of organic compounds:

Detection of elements (qualitative analysis) such as carbon, hydrogen, nitrogen, halogens and sulphur should be considered by using Lassaigne's test and reactions involved in it.

(iv) Estimation of carbon, hydrogen, nitrogen, halogens, sulphur and phosphorous.

Estimation of carbon and hydrogen. Estimation of nitrogen by Kjeldahl's method; halogens by Carius' method. Estimation of sulphur and phosphorous. Numericals included.

13. 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, syn and anti.

   (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.

14. Types of Chemical Reactions and their Mechanisms

(i) Substitution, addition and elimination reactions.

Substitution, addition and elimination reactions – definition and examples.

(ii) Homolytic and heterolytic fission.

Homolytic and heterolytic fission – definition and examples.

(iii) Electrophiles and nucleophiles.

Electrophiles and nucleophiles – definition and examples (including neutral electrophiles and nucleophiles).

(iv) Inductive, mesomeric, electromeric effects and hyperconjugation.

Inductive, electromeric, mesomeric effect and hyperconjugation – definition, examples and their reactivities.

(v) Free radicals and polar mechanisms (in terms of fission of the bonds and formation of the new bonds) including S_N1, S_N2, E_1 and E_2 mechanisms. (S_N1 and S_N2, E_1 and E_2 mechanisms are to be taught at this point).

Free radical: its formation due to the fission of the bonds.

- *Meaning of S.*
- *Meaning of N.*
- *Meaning of 1 and 2.*

Explain with relevant examples and conditions.

15. Aliphatic and Aromatic Hydrocarbons

(i) Alkanes: General methods of preparation, Properties of alkanes.

- *General formula of alkanes.*
- *Homologous series.*
- *Naming of alkanes.*
- *Isomerism of alkanes.*
- *Occurrence.*
- *Conformation (Sawhorse and Newman projections of ethane).*

General methods of preparation:

- *From sodium salts of carboxylic acids (decarboxylation and Kolbe's electrolytic method).*
- *From alcohols.*
- *From alkyl halides (Wurtz reaction).*
- *From aldehydes.*

Physical and chemical properties of alkanes.

Physical properties:

- *State of existence.*
- *Freezing point.*
- *Melting point.*
- *Boiling point.*
- *Density.*

Chemical properties:

- *Combustibility.*
- *Reaction with chlorine (free radical mechanism).*
- *Reaction with oxygen in presence of catalyst (formation of alcohol, aldehyde, and carboxylic acid).*

Uses of alkanes.

(ii) Alkenes: general methods of preparation and properties of alkenes.

- *General formula of alkenes.*
- *Nomenclature of alkenes.*
- *General methods of preparation – dehydration of alcohols, dehydrohalogenation of alkyl halides and Kolbe's electrolytic method.*
- *Physical and Chemical properties.*
- *Markownikoff's rule and Anti-Markownikoff's rule with mechanism. Explain by using suitable examples.*
- *Saytzeff's rule.*

(iii) Alkynes: methods of preparation (including manufacture), properties and uses of ethyne.

- *General formula of alkynes.*
- *Nomenclature of the alkynes.*
- *General methods of preparations of alkynes. Manufacture of ethyne by calcium carbide and from natural gas. Dehydrohalogenation and Kolbe's electrolytic method.*
- *Physical and chemical properties of alkynes – addition reactions, formation of acetylides.*
- *Uses.*
- *Distinguishing test between Alkane, Alkene and Alkyne.*

(iv) Benzene: Coal tar as an important source of aromatic compounds; preparation of benzene from sodium benzoate, properties and uses of benzene; resonance model of benzene; directive influence of substituents in the benzene ring.

- *Coal tar as an important source of aromatic compounds – a general study.*
- *Benzene: Preparation from sodium benzoate. Physical properties and uses.*

Resonance structures (Kekule's) of benzene.

Directive influence (o-, p-, and m-) of substituents in electrophilic and nucleophilic substitutions.

Chemical properties:

- *Oxidation (formation of maleic anhydride).*

- *Pyrolysis (formation of bi-phenyl).*

- *Addition reactions with hydrogen, chlorine, bromine.*

- *With ozone.*

- *Substitution reaction (halogenation, nitration and sulphonation).*

- *Alkylation, acetylation – Friedel Craft's reaction.*

- *Carcinogenicity and toxicity of benzene may be discussed.*

16. **Applications of Chemicals**

(i) In medicine: antipyretics, analgesics, tranquillisers, antiseptics, disinfectants, anti-microbials, anti-fertility drugs, antihistamines, antibiotics, antacids.
Definition, common examples, uses.
Structure not required. Differences between antiseptics and disinfectants to be specified.

(ii) Soaps and Detergents: classification, structure and some important examples.
Soaps and Detergents – advantage of detergents over soaps, classification of detergents into anionic, cationic and non-ionic.

17. **Environmental Chemistry**

(i) Energy: Non-renewable and renewable sources, use of diesel and petrol in trains buses, cars and other vehicles, use of LPG, use of CNG and their role in pollution control.
Future sources of energy – hydrogen, alcohol, fuel cells and bio-fuels. Brief explanation.
Methods of saving energy in homes and institutions – use of energy saving bulbs, solar cooker, bio-gas pipeline.
Self explanatory.

(ii) Pollution: Environmental pollution: atmospheric pollution and water pollution
Gaseous pollutants: oxides of nitrogen, carbon, sulphur, hydrocarbons; their sources, harmful effects and prevention; Green house effect and global warming; acid rain;
Particulate pollutants: smoke, dust, smog, fumes, mist; their sources, harmful effects and prevention.
Water pollutants: pathogens, organic waste, chemical pollutants; their harmful effects and prevention.

PAPER II

PRACTICAL WORK- 20 Marks

Candidates are required to complete the following experiments:

1. Basic laboratory techniques:

   − Cutting a glass tube.

   − Bending a glass tube.

   − Drawing out a glass jet.

   − Boring a cork.

2. Titration: acid-base titration involving molarity.

   Titrations involving:

   ▪ *Sodium carbonate solution/ dil H_2SO_4 or dil. HCl using methyl orange indicator.*

   ▪ *NaOH or KOH solution/ dil H_2SO_4 or dil. HCl using methyl orange indicator.*

   ▪ *Calculations involving molarity, concentration in grams l^{-1}/ number of ions, water of crystallisation and percentage purity.*

NOTE: Calculation of molarity must be upto 4 decimal places at least, in order to avoid error.

3. 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+}.

Formal analytical procedure required.

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:

- **More than one radical will not be given from the same group of anions and cations.**
- **For wet test of anions, sodium carbonate extract must be used (except for carbonate).**

(Insoluble salts excluded)

4. Preparation of inorganic compounds

   (i) Preparation of potash alum/Mohr's salt.

   (ii) Preparation of crystalline $FeSO_4$/$CuSO_4$.

5. Paper Chromatography

   Preparation of chromatogram, separation of pigments from extracts of leaves and flowers/ink mixtures; determination of R_f value.

PROJECT WORK AND PRACTICAL FILE -

10 Marks

Project Work – 7 Marks

The candidate is to creatively execute one project/assignment on a selected topic of Chemistry. Teachers may assign or students may choose **any one** project of their choice.

Suggested Evaluation criteria for Project Work:

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

Practical File – 3 Marks

Teachers are required to assess students on the basis of the Chemistry Practical file maintained by them during the academic year.

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.

<u>Part I (20 marks)</u> 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 IInd 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