

# ISC Chemistry

**BOOK I**

**FOR CLASS XI**



**Dr. R.D. MADAN  
B.S. BISHT**

Strictly according to the Latest Syllabus for ISC (Class XI) prescribed by the  
Council for Indian School Certificate Examination, New Delhi

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# ISC CHEMISTRY

BOOK-I

FOR CLASS XI

ACCORDING TO THE NEW SYLLABUS FOR CLASS XI

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# Preface to the Revised Edition

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The present edition of ISC Chemistry, Book I (For Class XI) has been thoroughly revised according to the syllabus prescribed by the **COUNCIL FOR THE INDIAN SCHOOL CERTIFICATE EXAMINATIONS, NEW DELHI** for the years 2015 on words.

The main features of the latest edition are given below:

- (i) Each chapter at the end contains.
  - (a) Summary of the topic.
  - (b) Important relations and the formulae to be used in solving the numerical problems where ever relevant.
  - (c) Questions asked in Previous ISC examinations as well as questions on the pattern of ISC examinations.
  - (d) Additional questions for practice.
  - (e) Questions for the competitive examinations with their solutions.
  - (f) Solved numerical problems where ever relevant.
- (ii) Many chapters at the end contain study material required in addition to the material covered in the chapter, for the preparation of various medical and engineering examinations.
- (iii) Each chapter at the end contains multiple choice questions with answers
- (iv) Appendices containing useful information have been given at the end of the book.

We hope that the book will be of immense help to both students and teachers keeping in views above mentioned unique features of the present edition of this book.

There may be some omissions on errors despite our best efforts in preparing the manuscript of the present edition.

We shall be highly obliged, if the errors or omissions are brought to our notice and constructive and logical suggestions are communicated to the authors or the publisher for the improvement of the book.

## ACKNOWLEDGMENTS

We wish to put on record our sincere thanks to **Mrs. Nirmala Gupta**, Chief Managing Director, **Mr. Amit Gupta**, CEO & **Mr. Navin Joshi**, Executive Vice-President (Publishing) and Mr. S. Bhatnagar for the encouragement and guidance we have received from them during the publication of this book.

Last but not the least we put on record our sincere thanks to Mr. Sanjay Joshi, branch manager Lucknow branch and also the entire staff of Lucknow branch for providing the necessary material for preparing the manuscript.

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# Preface to the First Edition

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We are happy to present this book to the students of class XI preparing for the Indian School Certificate Examinations (I.S.C.). It is intended to meet the requirements of the latest syllabus in Chemistry prescribed by the Council for the Indian School Certificate Examinations, New Delhi. The main feature of this book is that all the three branches of Chemistry (organic, inorganic and physical) have been compiled in one to make it handy. The main aim of the book is to guide the beginners towards a better understanding of fundamental principles and applications of Chemistry. Much care has been taken to explain the abstract ideas and theories of Chemistry, which often elude comprehension. The treatment of various topics in physical, inorganic and organic, is exhaustive, yet illustrative and to the point.

In view of the rapid progress of the subject, it is important that the book should reflect the modern outlook. Thus stress has been laid on structure and reactions of compounds. The authors have laid special emphasis on the discussion of the position of each element in the periodic table in reference to the other elements present in the same group.

It is a common experience that a comprehensive approach is needed for a student to conceive the problems involved. A fairly detailed study of the subject matter enables the students to appreciate the problems. Too short an account as given in most of the books, usually leaves the impression that everything works according to the rigid plan. This is undesirable for those who are expected to learn to think for themselves, especially the beginners.

The subject matter has been organised in such a manner as to fit into the exact requirement of class XI syllabus prescribed by the Council for the I.S.C. Examinations, New Delhi. Each chapter has been concluded with a number of relevant questions.

The authors sincerely hope that the textbook will prove a boon to students and help the beginners develop a sound conceptual understanding of the subject. If it does that, we shall feel amply rewarded, for the pains we have taken.

Despite our best efforts there may be certain errors and we shall feel highly obliged if these are brought to our notice. Any suggestions for improvement of the book will be gratefully acknowledged.

Last, but not the least, we wish to put on record our sincere thanks to Mr. Rajendra Kumar Gupta, Managing Director, Mr. Ravindra Kumar Gupta, Director, Mr. T.N. Goel, Manager, S. Chand & Co. Ltd. for their keen interest in the publication of this book and Mr. Navin Joshi, Branch Manager, Lucknow Branch for encouragement, and for providing necessary material for preparing the manuscript.

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# NEW SYLLABUS

## 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.

<b>Paper I : Theory</b>	3 hours	70 marks
<b>Paper II : Practical</b>	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 the 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. Structure of the Atom

- (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 the don 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 non-mathematical treatment. Quantum numbers; shape, size, and orientation of *s* and *p* orbitals only. 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 uncertainty principle. Numericals.
  - Quantum numbers – types of quantum numbers, information obtained in terms of distance of electron from the nucleus, energy of electron, number of electrons present in an orbit and an orbital.
  - Pauli's exclusion principle. Shape, size and orientation of the *s* and *p* subshells.
  - Hund's rule of maximum multiplicity.
  - Aufbau principle, (*n*+1) 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<sub>2</sub>O, MgO, CaO, MgF<sub>2</sub> and Na<sub>2</sub>S.  
*Cause of chemical combination, Octet rule, types of chemical bonds. Electrovalent formation of NaCl, Li<sub>2</sub>O, MgO, CaO, MgF<sub>2</sub>, and Na<sub>2</sub>S. Properties of ionic compounds. Electron dot structure of the following ionic compounds: NaCl, Li<sub>2</sub>O, MgO, CaO, MgF<sub>2</sub>, and Na<sub>2</sub>S 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 and sigma and pi-bonds H<sub>2</sub>SO<sub>2</sub>, N<sub>2</sub>. Classification of covalent bonds based on electronegativity of atoms - polar and non polar covalent bond, dipole moment, formation of ammonia, water, methane, ethyne, ethane, ethene and carbon dioxide, 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 and 7 respectively.  
*Variable valency, cause of variable covalency e.g. chlorine exhibits the valency 1, 3, 5 and 7 respectively. 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 rule.  
*Definition of Octet rule. Failure of Octet rule, due to either incomplete octet or expansion 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; Hybridisation and shapes of molecules: hybridisation involving s, p and d orbitals only; sigma and pi bonds.  
*Concept of electron-pair repulsion and shapes of molecules taking methane, ammonia and water as examples.*  
*Hybridisation and molecular shapes-definition, hybridization of orbitals involving s, p and d orbitals (examples : ethane, ethene, ethyne,  $PCl_5$  and  $SF_6$ ).*
- (viii) Molecular orbital theory, Qualitative treatment of homonuclear diatomic molecules of first two periods. Energy level diagrams, bonding, antibonding molecular orbitals, bond order, paramagnetism of  $O_2$  molecule. Relative stabilities of  $O_2$ ,  $O_2^-$ ,  $O_2^{2-}$ ,  $O_2^+$  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 Waal's 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 (Numerical not required). The pressure correction and volume correction may be explained.
- (iv) Dalton's law, the Avogadro 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.

(viii)

## 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 and protection (protective colloids), 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 (Thermodynamics)

(i) Introduction.

- Scope of thermodynamics-characteristics of thermodynamics.*
- Types of system-ideal system, real system, isolated system, closed system, open system.*
- Meaning of surrounding.*
- Properties of the system: macroscopic, intensive and extensive properties of the system.*
- State of the system.*
- Main processes the system undergoes: reversible, irreversible, adiabatic, isothermal, isobaric, isochoric, cyclic.*
- Meaning of thermodynamic equilibrium.*
- Meaning of thermodynamic process.*

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

- Idea of conservation of energy-total energy of the system and the surrounding.*
- Meaning of internal energy of the system and change in internal energy of the system.*
- Meaning of work done by the system and by the surrounding at constant temperature.*
- Meaning of heat absorbed by the system and by the surrounding at constant temperature.*
- The sign convention for change in internal energy, heat given out or gained, work done by the system or by the surrounding.*
- State function and path function-meaning with examples.*
- Internal energy change, work done and heat absorbed in a cyclic process.*
- Internal energy change in an isolated system and in non isolated system.*
- Total internal energy change of a system and surrounding.*
- Significance of first law of thermodynamics.*
- Chemical change and internal energy.*
- Need for enthalpy-constant pressure or open vessel processes.*
- Enthalpy a thermodynamic property-state function.*
- 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—Entropy, Free Energy. Spontaneity of a chemical change.  $\Delta G^\circ = -2,303 RT \log K_{eq}$ ; reversible and irreversible changes, isobaric, isochoric adiabatic processes.
- Ideas about reversible (recapitulation), Spontaneous and non spontaneous processes.
  - Inadequacy of first law and need for second law.
  - Meaning of entropy—derived from 2nd law—statement of 2nd 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 the Elements 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, 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, 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, structures 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  $K_2Cr_2O_7$ ,  $S_2O_3^{2-}$  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) Heterocyclic.  
(e) Aromatic.  
(f) Alicyclic compounds.  
(g) Homologous series and its characteristics.  
(h) Functional groups.  
(i) Nomenclature of organic compounds. Simple hydrocarbons and 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.

(xii)

### 13. Isomerism

Definiton. Classification of isomerism.

- (i) *Structure 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. Tyupes 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 and electromeric effects.  
Inductive, electromeric and mesomeric effect 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 progections 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 acetylation).
  - Alkylation, acetylation.
  - Friedel Craft's reaction.
  - Carcinogenicity and toxicity of benzene may be discussed.

## 16. Applications of Chemicals

- (i) **In medicine:** Antipyretics, analgesics, tranquilisers, antiseptics, disinfectants, antimicrobials, 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.*



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