

Master Resource Book in

# **Chemistry**

## **JEE Main**

Joint Entrance Examination



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# Chemistry

## JEE Main

Joint Entrance Examination

SANJAY SHARMA



ARIHANT PRAKASHAN, MEERUT



# ARIHANT PRAKASHAN, MEERUT

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# PREFACE

In sync with the recent changes in the test pattern and format of **JEE Main** (Joint Engineering Entrance), it is my pleasure to introduce **Master Resource Book in Chemistry for JEE Main**, for the Students aspiring a seat in a reputed Engineering College. JEE Main is a gateway examination for candidates expecting to seek admission in Bachelor in Engineering (BE), Bachelor of Technology (B.Tech) and Bachelor of Architecture (B.Arch) at Indian Institutes of Information Technology (IITs), National Institutes of Technology (NITs), Delhi Technological University and other Centrally Funded Technical Institutes (CFTIs).

JEE Main is also an examination which is like screening examination for **JEE Advanced** (The gateway examination to India's most reputed Technical Institutes, Indian Institutes of Technology IITs). Only the top 1.5 lacs students passed in JEE Main will be able to attempt JEE Advanced.

Gradually, the number of students aspiring for the seat in the Engineering College has increased rapidly in the last 5 Years or so. This year nearly 14 lacs students appeared for JEE Main and only a few were able to reserve a seat in the college of their choice, so there is a cut throat competition among the aspirants. Thus, it calls for a systematic mastery of all the subjects of the test with paramount importance to problem-solving. Most of the books now in the market have become repetitive with scant respect to the needs of true and effective learning. This book has been designed to fulfill the perceived needs of the students as such.

- This book comprehensively covers all the topics of JEE Main Chemistry syllabus. The chapters have been sequenced according to the syllabus of class 11<sup>th</sup> & 12<sup>th</sup>. Each chapter has essential theoretical discussion of the related concepts with sufficient number of solved examples, practice problems and other solved problems. In each chapter previous years' questions of AIEEE and JEE Main have been included to help students know the difficulty levels and nature of questions asked in competitive exams at this level.*
- All types of questions have been included in this book: Single Correct Answer Types, Multiple Correct Answer Types, Reasoning Types, Matches, Passage-based Questions etc.*
- This is the only book which has its subject matter divided as per class 11<sup>th</sup> & 12<sup>th</sup> syllabus. It covers almost all questions of NCERT Textbook & NCERT Exemplar problems.*

It is hoped this new effort will immensely benefit the students in their goal to secure a seat in the prestigious engineering college, and would be convenient to teachers in planning their teaching programmes. Suggestions for further improvement are welcome from the students and teachers.

*Wish You Success*

**Sanjay Sharma**

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# ANALYSIS OF **JEE Main**

JEE Main Entrance Exam for admission into various engineering courses in different engineering colleges and institutes in the country has hit the imagination of the school-going students more than any other entrance test conducted at this level.

Without argument, you need to be well-versed with the pattern as well as the level of the questions asked in the exam. A Chapter-wise analysis of previous years' questions is called for here, with this objective in mind, we are giving below the chapter-wise analysis (break-up) of the questions asked in last 9 years' of AIEEE & JEE Main 2015 in Chemistry.

# CHEMISTRY

S.N.	Chapters	Years									
		15	14	13	12	11	10	09	08	07	
1.	Mole Concept	1	2	1	1	1	1	1	1	1	
2.	Acid-Base Titrations										
3.	Redox Reactions	1	1	1						1	
4.	Gaseous State	1	1	2	1	1	2	1		1	
5.	Thermochemistry		1				2	1	1		
6.	Thermodynamics				1	1	1	1	1	3	
7.	Atomic Structure	1	1	2	1	1	1	2	2		
8.	Chemical Bonding	1	2	1	2	3	2		1	2	
9.	Chemical Equilibrium	2	1		1	1				1	
10.	Ionic Equilibrium		1	1	1		2	4	1	3	
11.	Electrochemistry	1	3		1	1	1	1	1	2	
12.	Chemical Kinetics	1	1	1	1	1	1	2	1	1	
13.	Solution and Colligative Properties	1	1	2	2	3	2	2	2	3	
14.	Solid State	1	1	1	1	1	1	2	1	1	
15.	Surface Chemistry	1			1				1	1	
16.	General Organic Chemistry		1	2			1	2	2	2	
17.	Stereochemistry	1		1		1		1	2	1	
18.	Hydrocarbons		1	1	2	1	1	1		3	
19.	Alkyl Halides	1	1		1			1	1	1	
20.	Alcohols and Ethers				1		1	2		1	
21.	Aldehydes and Ketones	1	1		1	2				1	
22.	Carboxylic Acids and Their Derivatives		1	1		2				1	
23.	Amines	1	2	2						2	
24.	Carbohydrates, Amino Acids and Polymers	3	3	1	3	1	2	2	2	2	
25.	Aromatic Compounds	1		1	2	2	3	1	1	2	
26.	Qualitative Analysis	1		1							
27.	Transition Elements and Co-ordination Chemistry	4	3	3	2	4	2	3	4	3	
28.	Periodic Table and Representative Elements	4	1	3	3	4	3	1	4	3	
29.	Metallurgy	1			1					1	
30.	Nuclear Chemistry			1						2	
31.	Environmental Chemistry			1	1		1			1	
	<b>Total No. of Questions</b>	<b>30</b>	<b>35</b>	<b>40</b>							

# Analysis for JEE MAIN 2015

## CHEMISTRY

Majority of the questions in the Chemistry part of the **JEE Main 2015** are in the range of easy to moderate. The overall difficulty level of this part in this year exam is less as compared to last year. Usually, application level questions are expected from Physical and Organic chemistry areas, but this year questions from these two areas were quite straight in nature. However, one question from Inorganic Chemistry was based on practical part and it can be rated difficult to answer. Moreover, this year's contribution from Inorganic Chemistry was more compared to previous years.

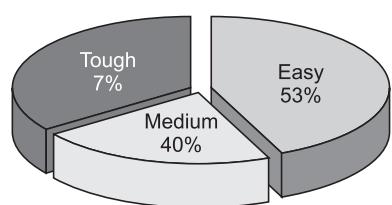
**Class XI<sup>th</sup> & XII<sup>th</sup> Wise Analysis**

	Organic Chemistry	Inorganic Chemistry	Physical Chemistry	Total
Easy	6	5	5	16
Medium	4	5	4	13
Tough	-	-	1	1
<b>Total</b>	10	10	10	30
<b>%age</b>	33.33	33.33	33.33	<b>100.00</b>

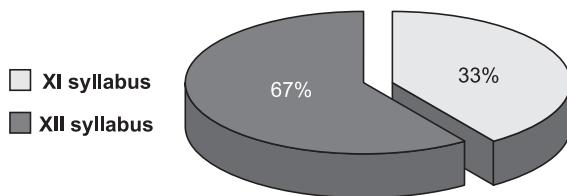
  

XI syllabus	10	XII syllabus	20
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**Chemistry - JEE Main Difficulty Level Analysis**



**Percentage Portion asked from Syllabus of Class XI & XII**



# SUBJECT-WISE & TOPIC-WISE

## Allocation of Marks

### CHEMISTRY

Unit & Topic Name	No. of Questions	Total Marks	% Weightage
<b>Inorganic Chemistry-I</b>	8	28	23.33%
• Chemical Bonding	1	4	3.33%
• <i>p</i> -block	5	20	16.66%
• Reaction Mechanism	2	8	6.66%
<b>Inorganic Chemistry-II</b>	4	16	13.33%
• <i>d</i> -block & <i>f</i> -block	2	8	6.66%
• Transition Elements & Coordination Chemistry	2	8	6.66%
<b>Organic Chemistry-I</b>			
• General Organic Chemistry- II			
<b>Atomic Compound</b>			
• Organic Chemistry II	4	16	13.33%
• Carbohydrates, Amino Acids and Polymers	3	12	10.00%
• Carboxylic Acid and their Derivatives			
• Practical Organic Chemistry	1	4	3.33%
<b>Physical Chemistry-I</b>	5	20	16.66%
• Atomic Structure	1	4	3.33%
• Gaseous State	1	4	3.33%
• Ionic Equilibrium	2	8	6.66%
• Mole Concept	1	4	3.33%
• Thermodynamics and Thermochemistry			
<b>Physical Chemistry-II</b>	5	20	16.66%
• Chemical Kinetics	1	4	3.33%
• Electrochemistry	1	4	3.33%
• Solid State	1	4	3.33%
• Solution	1	4	3.33%
• Surface Chemistry	1	4	3.33%
<b>Grand Total</b>	30	120	100%

# FOCUS TOPICS FOR JEE Main

1. **Some Basic Concepts in Chemistry** Analysis of last 5 years examination papers clearly reveals that sometimes question may be from this unit. The question, if asked may be based on 'stoichiometry' or 'Mole Concept'.
2. **States of Matter** On the basis of last 5 years examination papers, it can be clearly said that every year 2 to 3 questions are from this unit. This unit is covered in two chapters : Gaseous and Liquid State, Solid State. The questions are generally based on two topics. Like the first topic is 'Compressibility factor and van der Waals' equation, the second topic is 'calculations involving unit cell parameter' and the third topic is molecular velocities'.
3. **Atomic Structure** On the basis of previous 5 years examination papers, it can be clearly said that there are 3 main topics from which questions are asked regularly. The first topic is 'Bohr theory and spectra of Hydrogen', the second topic is 'Quantum numbers' and the third one is 'Heisenberg's uncertainty principle'.
4. **Chemical Bonding and Molecular Structure** If we go through previous 5 years examination papers, we find that from this unit mainly there are 3 topics from which questions are asked regularly. The first topic is 'Molecular Orbital Theory', second one is 'Hybridisation and Geometry (VSEPR theory)' and third one is 'Fajan's rule'.
5. **Chemical Thermodynamics** On analyzing last 5 years examination papers, we find that there are 2 main topics from which questions are asked regularly. These topics are 'Enthalpy change (for different process)' and  $\Delta G$  of the system as criteria for spontaneity'.
6. **Solutions** A minute analysis of previous 5 years examination papers clearly reveals that there are 3 main topics from which questions are seen regularly. The first topic is 'Molality'. The second topic is 'Depression in Freezing point' and the third one is 'Lowering of vapour pressure'.
7. **Equilibrium** On the basis of last 5 years examination papers, it can be clearly said that there are 3 topics from this unit from which questions are asked regularly. The first topic is 'Equilibrium constants and their significance'. The second topic is 'pH and Ionisation Constant' and the third topic is 'Solubility product'.
8. **Redox Reactions and Electrochemistry** According to the syllabus of XI and XII, this is divided into two chapters. Redox reactions and Electrochemistry. The first one is kept in part I and second one in part II. Analysis of previous 5 years examination papers clearly shows that there are 2 main topics from which questions are asked regularly. The first topic is 'Equivalent and molar conductivity'. The second topic is 'Electrode potential and Nernst equation'.
9. **Chemical Kinetics** A minute analysis of last 5 years examination papers clearly shows that there is no specific topic in this unit from which questions are asked regularly. The question may be from order of reaction, reaction mechanism, Arrhenius equation etc.
10. **Surface Chemistry** If we go through last 5 years examination papers, we find that it is not an important unit and questions are rarely asked from this unit. The question, if asked, may be based on adsorption.
11. **Classification of Elements and Periodicity in Properties** On the basis of last 5 years examination papers, it can be clearly said that there are 2 main topics from which questions are asked regularly. The first topic is 'ionic radius' and the second topic is 'electron gain enthalpy'.

12. **General Principles and Processes** of Isolation of Metals Analysis of previous 5 years examination papers clearly shows that generally no question is asked from this unit.
13. **Hydrogen** Analysis of last 5 years examination papers clearly reveals that the questions are rarely asked from this unit but, if asked , belongs to the topic methods of preparation of hydrogen.
14. **s-Block Elements** (Alkali and alkaline earth metals) A minute analysis of last 5 years examinations papers clearly shows that the questions are asked rarely from this unit but, it asked; belongs to the 'chemical properties of alkali metals'.
15. **p-Block Elements** According to the syllabus of class XI and XII, this chapter is divided into two parts; p-Block elements-I and p-Block elements II. p-Block elements-I is given in part-I and p-Block elements-III is given in part-II. Analysis of last 5 years examination papers clearly shows that the topics from which questions are asked vary year to year. However boron compounds, properties of hydrides and silicones are more important topics of the unit.
16. **d and f-block Elements** Analysis of last 5 years examination papers clearly shows that there are 3 main topics from which questions are asked regularly. The first topic is 'Oxidation state' second topic is 'Lanthanoid Contraction' and third topic is oxidation state of lanthanoid and actinoids'.
17. **Coordination Compounds** If we go through last 5 years examination papers analysis, we find that there are topics from which questions are seen regularly. The first topic is 'Bonding in Complexes' second topic is 'isomerism' and third topic is Nomenclature.'
18. **Environmental Chemistry** Analysis of last 5 years examination papers clearly shows that questions are asked rarely from this unit but, if asked, it generally belongs to 'consequences of air pollution.'
19. **Purification and Characterisation of Organic Compounds** From the analysis of last 5 years examination papers, it is clear that questions are asked rarely from this unit. The question, if asked may belong to 'quantitative analysis of nitrogen'.
20. **Some Basic Principles of Organic Chemistry** On analyzing last 5 years examination papers, it is found that there is not any specific topic from which question is asked regularly. However, stereo isomerism, tautomerism and nucleophilicity are some important topics for the examination.
21. **Hydrocarbons** On the basis of last 5 years examination papers, it can be clearly said that there are 3 topics from which questions are asked regularly. The first topic is 'ozonolysis, second one is acidic property of alkynes and third one is halogenation of alkanes'.
22. **Organic Compounds Containing Halogens** A minute analysis of last 5 years examination papers clearly reveals that there are 2 main topics from which questions are asked regularly. The first topic is  $S_N$  reactions' and second topic is 'Elimination reactions'.
23. **Organic Compounds Containing Oxygen** If we go through last 5 years examination papers, we find that there are 4 topics form which questions are asked regularly. The first topic is phenol. The second one is 'acidity order of acids.' The third topic is 'Dehydration of alcohols and Lucas test and' the fourth topic is 'Cannizzaro reaction'.
24. **Organic Compounds Containing Nitrogen** On analyzing last 5 years examination papers, we find that there are 2 topics from which questions are asked regularly. The first topic is 'Basicity of amines' and second one is 'diazonium salts'.
25. **Polymers** If we go through last 5 years examination papers, we find that there is not any specific topic from which questions are asked regularly.
26. **Biomolecules** On the basis of last 5 years examination papers, it can be clearly shown that there is no specific topic from which question is asked regularly. However, proteins and carbohydrates are some what more important.
27. **Chemistry in Everyday Life** A minute analysis of last 5 years examination papers clearly shows that no question is asked generally from this unit.

# SYLLABUS for JEE MAIN

**Note:** The syllabus contains two Sections - A & B. Section A pertains to the Theory Part, having 80% weightage, while Section B contains Practical Component (Experimental Skills) having 20% weightage.

## Physical Chemistry

### Unit I Some Basic Concepts in Chemistry

Matter and its nature, Dalton's atomic theory; Concept of atom, molecule, element and compound; Physical quantities and their measurements in Chemistry, precision and accuracy, significant figures, S.I. Units, dimensional analysis; Laws of chemical combination; Atomic and molecular masses, mole concept, molar mass, percentage composition, empirical and molecular formulae; Chemical equations and stoichiometry.

### Unit II States of Matter

Classification of matter into solid, liquid and gaseous states. Gaseous State Measurable properties of gases; Gas laws Boyle's law, Charle's law, Graham's law of diffusion, Avogadro's law, Dalton's law of partial pressure; Concept of Absolute scale of temperature; Ideal gas equation, Kinetic theory of gases (only postulates); Concept of average, root mean square and most probable velocities; Real gases, deviation from Ideal behaviour, compressibility factor, van der Waals' equation, liquefaction of gases, critical constants.

Liquid State Properties of liquids - vapour pressure, viscosity and surface tension and effect of temperature on them (qualitative treatment only).

Solid State Classification of solids: molecular, ionic, covalent and metallic solids, amorphous and crystalline solids (elementary idea); Bragg's Law and its applications, Unit cell and lattices, packing in solids (fcc, bcc and hcp lattices), voids, calculations involving unit cell parameters, imperfection in solids; electrical, magnetic and dielectric properties.

### Unit III Atomic Structure

Discovery of sub-atomic particles (electron, proton and neutron); Thomson and Rutherford atomic models and their limitations; Nature of electromagnetic radiation, photoelectric effect; spectrum of hydrogen atom, Bohr model of hydrogen atom - its postulates, derivation of the relations for energy of the electron and radii of the different orbits, limitations of Bohr's model; dual nature of matter, de-Broglie's relationship, Heisenberg uncertainty principle.

Elementary ideas of quantum mechanics, quantum mechanical model of atom, its important features,  $\psi$  and  $\psi^2$ , concept of atomic orbitals as one electron wave functions; Variation of  $\psi$  and  $\psi^2$  with  $r$  for 1s and 2s orbitals;

various quantum numbers (principal, angular momentum and magnetic quantum numbers) and their significance; shapes of s, p and d - orbitals, electron spin and spin quantum number; rules for filling electrons in orbitals – aufbau principle, Pauli's exclusion principle and Hund's rule, electronic configuration of elements, extra stability of half-filled and completely filled orbitals.

### Unit IV Chemical Bonding and Molecular Structure

Kossel Lewis approach to chemical bond formation, concept of ionic and covalent bonds.

Ionic Bonding Formation of ionic bonds, factors affecting the formation of ionic bonds; calculation of lattice enthalpy.

Covalent Bonding Concept of electronegativity, Fajan's rule, dipole moment; Valence Shell Electron Pair Repulsion (VSEPR) theory and shapes of simple molecules.

Quantum mechanical approach to covalent bonding Valence bond theory - Its important features, concept of hybridization involving s, p and d orbitals; Resonance.

Molecular Orbital Theory Its important features, LCAOs, types of molecular orbitals (bonding, antibonding), sigma and pi-bonds, molecular orbital electronic configurations of homonuclear diatomic molecules, concept of bond order, bond length and bond energy.

Elementary idea of metallic bonding. Hydrogen bonding and its applications.

### Unit V Chemical Thermodynamics

Fundamentals of thermodynamics System and surroundings, extensive and intensive properties, state functions, types of processes.

First law of thermodynamics Concept of work, heat internal energy and enthalpy, heat capacity, molar heat capacity, Hess's law of constant heat summation; Enthalpies of bond dissociation, combustion, formation, atomization, sublimation, phase transition, hydration, ionization and solution.

Second law of thermodynamics Spontaneity of processes;  $\Delta S$  of the universe and  $\Delta G$  of the system as criteria for spontaneity,  $\Delta G^\circ$  (Standard Gibb's energy change) and equilibrium constant.

### Unit VI Solutions

Different methods for expressing concentration of solution molality, molarity, mole fraction, percentage (by volume and mass both), vapour pressure of solutions and Raoult's Law Ideal and non-ideal solutions, vapour pressure - composition plots for ideal and non-ideal solutions.

Colligative properties of dilute solutions - relative lowering of vapour pressure, depression of freezing point, elevation of boiling point and osmotic pressure; Determination of molecular mass using colligative properties; Abnormal value of molar mass, van't Hoff factor and its significance.

## **Unit VII Equilibrium**

Meaning of equilibrium, concept of dynamic equilibrium. Equilibria involving physical processes Solid -liquid, liquid gas and solid - gas equilibria, Henry's law, general characteristics of equilibrium involving physical processes.

Equilibria involving chemical processes Law of chemical equilibrium, equilibrium constants ( $K$  and  $K'$ ) and their significance, significance of  $\Delta G$  and  $\Delta G^\circ$  in chemical equilibria, factors affecting equilibrium concentration, pressure, temperature, effect of catalyst; Le - Chatelier's principle.

Ionic equilibrium Weak and strong electrolytes, ionization of electrolytes, various concepts of acids and bases (Arrhenius, Bronsted - Lowry and Lewis) and their ionization, acid-base equilibria (including multistage ionization) and ionization constants, ionization of water, pH scale, common ion effect, hydrolysis of salts and pH of their solutions, solubility of sparingly soluble salts and solubility products, buffer solutions.

## **Unit VIII Redox Reactions and Electrochemistry**

Electronic concepts of oxidation and reduction, redox reactions, oxidation number, rules for assigning oxidation number, balancing of redox reactions.

Electrolytic and metallic conduction, conductance in electrolytic solutions, specific and molar conductivities and their variation with concentration: Kohlrausch's law and its applications.

Electrochemical cells - Electrolytic and Galvanic cells, different types of electrodes, electrode potentials including standard electrode potential, half - cell and cell reactions, emf of a Galvanic cell and its measurement; Nernst equation and its applications; Relationship between cell potential and Gibbs' energy change; Dry cell and lead accumulator; Fuel cells; Corrosion and its prevention.

## **Unit IX Chemical Kinetics**

Rate of a chemical reaction, factors affecting the rate of reactions concentration, temperature, pressure and catalyst; elementary and complex reactions, order and molecularity of reactions, rate law, rate constant and its units, differential and integral forms of zero and first order reactions, their characteristics and half - lives, effect of temperature on rate of reactions - Arrhenius theory, activation energy and its calculation, collision theory of bimolecular gaseous reactions (no derivation).

## **Unit X Surface Chemistry**

Adsorption - Physisorption and chemisorption and their characteristics, factors affecting adsorption of gases on solids- Freundlich and Langmuir adsorption isotherms, adsorption from solutions.

Catalysis Homogeneous and heterogeneous, activity and selectivity of solid catalysts, enzyme catalysis and its mechanism.

Colloidal state distinction among true solutions, colloids and suspensions, classification of colloids - lyophilic, lyophobic; multi molecular, macromolecular and associated colloids (micelles), preparation and properties of colloids Tyndall effect, Brownian movement, electrophoresis, dialysis, coagulation and flocculation; Emulsions and their characteristics.

# **Inorganic Chemistry**

## **Unit XI Classification of Elements and Periodicity in Properties**

Periodic Law and Present Form of the Periodic Table, s, p, d and f Block Elements, Periodic Trends in Properties of Elements atomic and Ionic Radii, Ionization Enthalpy, Electron Gain Enthalpy, Valence, Oxidation States and Chemical Reactivity.

reactions and uses of hydrogen peroxide; Classification of hydrides - ionic, covalent and interstitial; Hydrogen as a fuel.

## **Unit XII General Principles and Processes of Isolation of Metals**

Modes of occurrence of elements in nature, minerals, ores; steps involved in the extraction of metals - concentration, reduction (chemical and electrolytic methods) and refining with special reference to the extraction of Al, Cu, Zn and Fe; Thermodynamic and electrochemical principles involved in the extraction of metals.

## **Unit XIV s - Block Elements (Alkali and Alkaline Earth Metals)**

### **Group 1 and 2 Elements**

General introduction, electronic configuration and general trends in physical and chemical properties of elements, anomalous properties of the first element of each group, diagonal relationships.

Preparation and properties of some important compounds sodium carbonate, sodium chloride, sodium hydroxide and sodium hydrogen carbonate; Industrial uses of lime, limestone, Plaster of Paris and cement; Biological significance of Na, K, Mg and Ca.

## **Unit XIII Hydrogen**

Position of hydrogen in periodic table, isotopes, preparation, properties and uses of hydrogen; physical and chemical properties of water and heavy water; Structure, preparation,

## **Unit XV p - Block Elements Group 13 to Group 18 Elements**

General Introduction Electronic configuration and general trends in physical and chemical properties of elements across

the periods and down the groups; unique behaviour of the first element in each group.

#### **Group wise study of the p – block elements**

**Group 13** Preparation, properties and uses of boron and aluminium; structure, properties and uses of borax, boric acid, diborane, boron trifluoride, aluminium chloride and alums.

**Group 14** Tendency for catenation; Structure, properties and uses of allotropes and oxides of carbon, silicon tetrachloride, silicates, zeolites and silicones.

**Group 15** Properties and uses of nitrogen and phosphorus; Allotropic forms of phosphorus; Preparation, properties, structure and uses of ammonia, nitric acid, phosphine and phosphorus halides, ( $\text{PCl}_3$ ,  $\text{PCl}_5$ ); Structures of oxides and oxoacids of nitrogen and phosphorus.

**Group 16** Preparation, properties, structures and uses of dioxygen and ozone; Allotropic forms of sulphur; Preparation, properties, structures and uses of sulphur dioxide, sulphuric acid (including its industrial preparation); Structures of oxoacids of sulphur.

**Group 17** Preparation, properties and uses of chlorine and hydrochloric acid; Trends in the acidic

nature of hydrogen halides; Structures of Interhalogen compounds and oxides and oxoacids of halogens.

**Group 18** Occurrence and uses of noble gases; Structures of fluorides and oxides of xenon.

#### **Unit XVI d – and f – Block Elements**

Transition Elements General introduction, electronic configuration, occurrence and characteristics, general trends in properties of the first row transition elements - physical properties, ionization enthalpy, oxidation states, atomic radii, colour, catalytic behaviour, magnetic properties, complex formation, interstitial compounds, alloy formation;

Preparation, properties and uses of  $\text{K}_2\text{Cr}_2\text{O}_7$  and  $\text{KMnO}_4$ .

#### **Inner Transition Elements**

**Lanthanoids** - Electronic configuration, oxidation states, chemical reactivity and lanthanoid contraction.

**Actinoids** - Electronic configuration and oxidation states.

#### **Unit XVII Coordination Compounds**

Introduction to coordination compounds, Werner's theory; ligands, coordination number, denticity, chelation; IUPAC nomenclature of mononuclear coordination compounds, isomerism; Bonding Valence bond approach and basic ideas of Crystal field theory, colour and magnetic properties; importance of coordination compounds (in qualitative analysis, extraction of metals and in biological systems).

#### **Unit XVIII Environmental Chemistry**

Environmental pollution Atmospheric, water and soil.

Atmospheric pollution - Tropospheric and stratospheric.

Tropospheric pollutants Gaseous pollutants: Oxides of carbon, nitrogen and 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.

Stratospheric pollution Formation and breakdown of ozone, depletion of ozone layer - its mechanism and effects.

Water pollution Major pollutants such as, pathogens, organic wastes and chemical pollutants their harmful effects and prevention.

Soil pollution Major pollutants such as: Pesticides (insecticides, herbicides and fungicides), their harmful effects and prevention.

Strategies to control environmental pollution.

## **Organic Chemistry**

#### **Unit XIX Purification & Characterisation of Organic Compounds**

Purification Crystallization, sublimation, distillation, differential extraction and chromatography principles and their applications.

Qualitative analysis Detection of nitrogen, sulphur, phosphorus and halogens.

Quantitative analysis (basic principles only) Estimation of carbon, hydrogen, nitrogen, halogens, sulphur, phosphorus.

Calculations of empirical formulae and molecular formulae; Numerical problems in organic quantitative analysis.

Homologous series; Isomerism - structural and stereoisomerism.

Nomenclature (Trivial and IUPAC)

Covalent bond fission Homolytic and heterolytic free radicals, carbocations and carbanions; stability of carbocations and free radicals, electrophiles and nucleophiles.

Electronic displacement in a covalent bond Inductive effect, electromeric effect, resonance and hyperconjugation.

Common types of organic reactions Substitution, addition, elimination and rearrangement.

#### **Unit XXI Hydrocarbons**

Classification, isomerism, IUPAC nomenclature, general methods of preparation, properties and reactions.

Alkanes Conformations: Sawhorse and Newman projections (of ethane); Mechanism of halogenation of alkanes.

Alkenes Geometrical isomerism; Mechanism of electrophilic

#### **Unit XX Some Basic Principles of Organic Chemistry**

Tetravalency of carbon; Shapes of simple molecules hybridization (s and p); Classification of organic compounds based on functional groups:  $-\text{C}=\text{C}-$ ,  $-\text{C}=\text{C}-$  and those containing halogens, oxygen, nitrogen and sulphur,

addition: addition of hydrogen, halogens, water, hydrogen halides (Markownikoff's and peroxide effect); Ozonolysis, oxidation, and polymerization.

Alkynes acidic character; addition of hydrogen, halogens, water and hydrogen halides; polymerization.

Aromatic hydrocarbons Nomenclature, benzene structure and aromaticity; Mechanism of electrophilic substitution: halogenation, nitration, Friedel – Craft's alkylation and acylation, directive influence of functional group in mono-substituted benzene.

## **Unit XXII Organic Compounds Containing Halogens**

General methods of preparation, properties and reactions; Nature of C—X bond; Mechanisms of substitution reactions. Uses/environmental effects of chloroform, iodoform, freons and DDT.

## **Unit XXIII Organic Compounds Containing Oxygen**

General methods of preparation, properties, reactions and uses.

Alcohols, Phenols and Ethers

Alcohols Identification of primary, secondary and tertiary alcohols; mechanism of dehydration.

Phenols Acidic nature, electrophilic substitution reactions: halogenation, nitration and sulphonation, Reimer - Tiemann reaction.

Ethers: Structure.

Aldehyde and Ketones Nature of carbonyl group;

Nucleophilic addition to  $>\text{C}=\text{O}$  group, relative reactivities of aldehydes and ketones; Important reactions such as - Nucleophilic addition reactions (addition of HCN,  $\text{NH}_3$  and its derivatives), Grignard reagent; oxidation; reduction (Wolff Kishner and Clemmensen); acidity of  $\alpha$  - hydrogen, aldol condensation, Cannizzaro reaction, Haloform reaction; Chemical tests to distinguish between aldehydes and Ketones.

Carboxylic Acids Acidic strength and factors affecting it.

## **Unit XXIV Organic Compounds Containing Nitrogen**

General methods of preparation, properties, reactions and uses.

Amines Nomenclature, classification, structure basic character and identification of primary, secondary and tertiary amines and their basic character.

Diazonium Salts Importance in synthetic organic chemistry.

## **Unit XXV Polymers**

General introduction and classification of polymers, general methods of polymerization-addition and condensation, copolymerization; Natural and synthetic rubber and

vulcanization; some important polymers with emphasis on their monomers and uses - polythene, nylon, polyester and bakelite.

## **Unit XXVI Biomolecules**

General introduction and importance of biomolecules.

Carbohydrates Classification: aldoses and ketoses; monosaccharides (glucose and fructose), constituent monosaccharides of oligosaccharides (sucrose, lactose, maltose) and polysaccharides (starch, cellulose, glycogen).

Proteins Elementary Idea of  $\alpha$ -amino acids, peptide bond, . polypeptides; proteins: primary, secondary, tertiary and quaternary structure (qualitative idea only), denaturation of proteins, enzymes.

Vitamins Classification and functions.

Nucleic Acids Chemical constitution of DNA and RNA. Biological functions of Nucleic acids.

## **Unit XXVII Chemistry in Everyday Life**

Chemicals in medicines Analgesics, tranquilizers, antiseptics, disinfectants, antimicrobials, antifertility drugs, antibiotics, antacids, antihistamines - their meaning and common examples.

Chemicals in food Preservatives, artificial sweetening agents - common examples.

Cleansing agents Soaps and detergents, cleansing action.

## **Unit XXVIII Principles Related to Practical Chemistry**

- Detection of extra elements (N, S, halogens) in organic compounds; Detection of the following functional groups: hydroxyl (alcoholic and phenolic), carbonyl (aldehyde and ketone), carboxyl and amino groups in organic compounds.
- Chemistry involved in the preparation of the following
- Inorganic compounds Mohr's salt, potash alum.
- Organic compounds Acetanilide, p-nitroacetan ilide, aniline yellow, iodoform.
- Chemistry involved in the titrimetric excercises - Acids bases and the use of indicators, oxali-acid vs  $\text{KMnO}_4$ , Mohr's salt vs  $\text{KMnO}_4$ .
- Chemical principles involved in the qualitative salt analysis
- Cations —  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Al}^{3+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Mg}^{2+}$   $\text{NH}_4^+$ . Anions —  $\text{CO}_3^{2-}$ ,  $\text{S}^{2-}$ ,  $\text{SO}_4^{2-}$ ,  $\text{NO}_2$ ,  $\text{NO}_3^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$  (Insoluble salts excluded).
- Chemical principles involved in the following experiments
  1. Enthalpy of solution of  $\text{CuSO}_4$
  2. Enthalpy of neutralization of strong acid and strong base.
  3. Preparation of lyophilic and lyophobic sols.
  4. Kinetic study of reaction of iodide ion with hydrogen peroxide at room temperature.