

# UPSC Chemistry Syllabus 2023 Paper 1

The UPSC Chemistry Syllabus for Paper 1 in 2023 covers the following topics:

## UPSC Chemistry Syllabus for Paper 1

| Topic   | Sub Topic  |
|---|--|
| 1. Atomic Structure and Chemical Bonding      | <ul style="list-style-type: none"><li>- Atomic structure, quantum theory, and electronic configurations.</li><li>- Chemical bonding, ionic and covalent bonds, molecular orbital theory.</li></ul> |
| 2. Periodic Table and Periodic Properties     | <ul style="list-style-type: none"><li>- Periodic trends in properties of elements.</li><li>- Classification of elements, periodicity in properties.</li></ul>                                      |
| 3. Structure and Bonding in Organic Compounds | <ul style="list-style-type: none"><li>- Concepts of hybridization, resonance, and electronic effects.</li><li>- Organic reaction mechanisms and stereochemistry.</li></ul>                         |
| 4. States of Matter                           | <ul style="list-style-type: none"><li>- Gaseous state, laws, and kinetic theory.</li><li>- Liquids and solids, phase equilibria, and phase diagrams.</li></ul>                                     |

5. Chemical Thermodynamics
- Laws of thermodynamics, enthalpy, entropy, and free energy.
  - Thermochemistry, Hess's law, and calorimetry.
6. Chemical Kinetics
- Rate of reactions, order, and molecularity.
  - Activation energy, catalysis, and enzyme kinetics.
7. Electrochemistry
- Redox reactions, electrochemical cells, and Nernst equation.
  - Conductance, Kohlrausch's law, and corrosion.
8. Chemical Equilibrium
- Equilibrium constants, Le Chatelier's principle.
  - Acid-base equilibria, pH, and buffers.
9. Surface Chemistry
- Adsorption, colloids, and catalysis.
10. Organic Chemistry
- Nomenclature and types of organic reactions.
  - Organic compounds and their functional groups.

- 11. Inorganic Chemistry
  - Principles of inorganic chemistry.
  - Periodic trends, chemical reactions, and coordination compounds.
- 12. Bioinorganic Chemistry
  - Metals in biological systems, metalloproteins, and metal-based drugs.

## UPSC Chemistry Syllabus 2023 Paper 2

The UPSC Chemistry Syllabus for Paper 2 in 2023 covers a wide range of topics that are essential for a comprehensive understanding of chemistry. The UPSC Chemistry Syllabus for Paper 2 in 2023 covers the following topics:

### UPSC Chemistry Syllabus for Mains Paper 2

| Topic                        | Sub Topic   |
|------------------------------|---|
| Delocalized Covalent Bonding | General methods (both kinetic and non-kinetic) of study of mechanisms or organic reactions: isotopies, method cross-over experiment, intermediate trapping, stereochemistry; the energy of activation; thermodynamic control and kinetic control of reactions |
| Reactive intermediates       | Generation, geometry, stability, and reactions of carbonium ions and carbanions, free radicals, carbenes, benzyne, and nitrenes.  |
| Substitution reactions       | SN1, SN2, and SNi, mechanisms; neighboring group participation; electrophilic and nucleophilic reactions of aromatic compounds including heterocyclic compounds—pyrrole, furan, thiophene, and indole.  |
| Elimination reactions        | E1, E2, and E1cb mechanisms; orientation in E2 reactions—Saytzeff and Hoffmann; pyrolytic syn elimination—acetate pyrolysis, Chugaev, and Cope eliminations.  |

|  |  |
|--|--|
| Addition reactions                     | Electrophilic addition to C=C and CC; nucleophilic addition to C=O, CN, conjugated olefins, and carbonyls  |
| Reactions and Rearrangement            | Pinacol-pinacolone, Hoffmann, Beckmann, Baeyer-Villiger, Favorskii, Fries, Claisen, Cope, Stevens, and Wagner—Meerwein rearrangements  |
| Pericyclic reactions                   | Classification and examples; Woodward-Hoffmann rules—electrocyclic reactions, cycloaddition reactions [2+2 and 4+2], and sigmatropic shifts [1, 3; 3, 3 and 1, 5], FMO approach  |
| Preparation and Properties of Polymers | Organic polymers polyethylene, polystyrene, polyvinyl chloride, Teflon, nylon, terylene, synthetic and natural rubber  |
| Synthetic Uses of Reagent              | OsO <sub>4</sub> , HIO <sub>4</sub> , CrO <sub>3</sub> , Pb(OAc) <sub>4</sub> , SeO <sub>2</sub> , NBS, B <sub>2</sub> H <sub>6</sub> , Na-Liquid NH <sub>3</sub> , LiAlH <sub>4</sub> , NaBH <sub>4</sub> , n-BuLi, MCPBA |
| Photochemistry                         | Photochemical reactions of simple organic compounds, excited and ground states, singlet and triplet states, Norrish-Type I and Type II reactions   |

## Spectroscopy

Principles and applications in structure elucidation

(i) Rotational—Diatomic molecules; isotopic substitution and rotational constants.

(ii) Vibrational—Diatomic molecules, linear triatomic molecules, specific frequencies of functional groups in polyatomic molecules.

(iii) Electronic—Singlet and triplet states.  $n$  and  $\pi$  transitions; application to conjugated double bonds and conjugated carbonyls Woodward-Fieser rules; Charge transfer spectra

(iv) Nuclear Magnetic Resonance ( $^1\text{H}$  NMR): Basic principle; chemical shift and spin-spin interaction and coupling constants. (v) Mass Spectrometry:—Parent peak, base peak, metastable peak, McLafferty rearrangement.