UPSC Chemistry Optional Syllabus 2026 for Paper 1 and Paper 2, PDF

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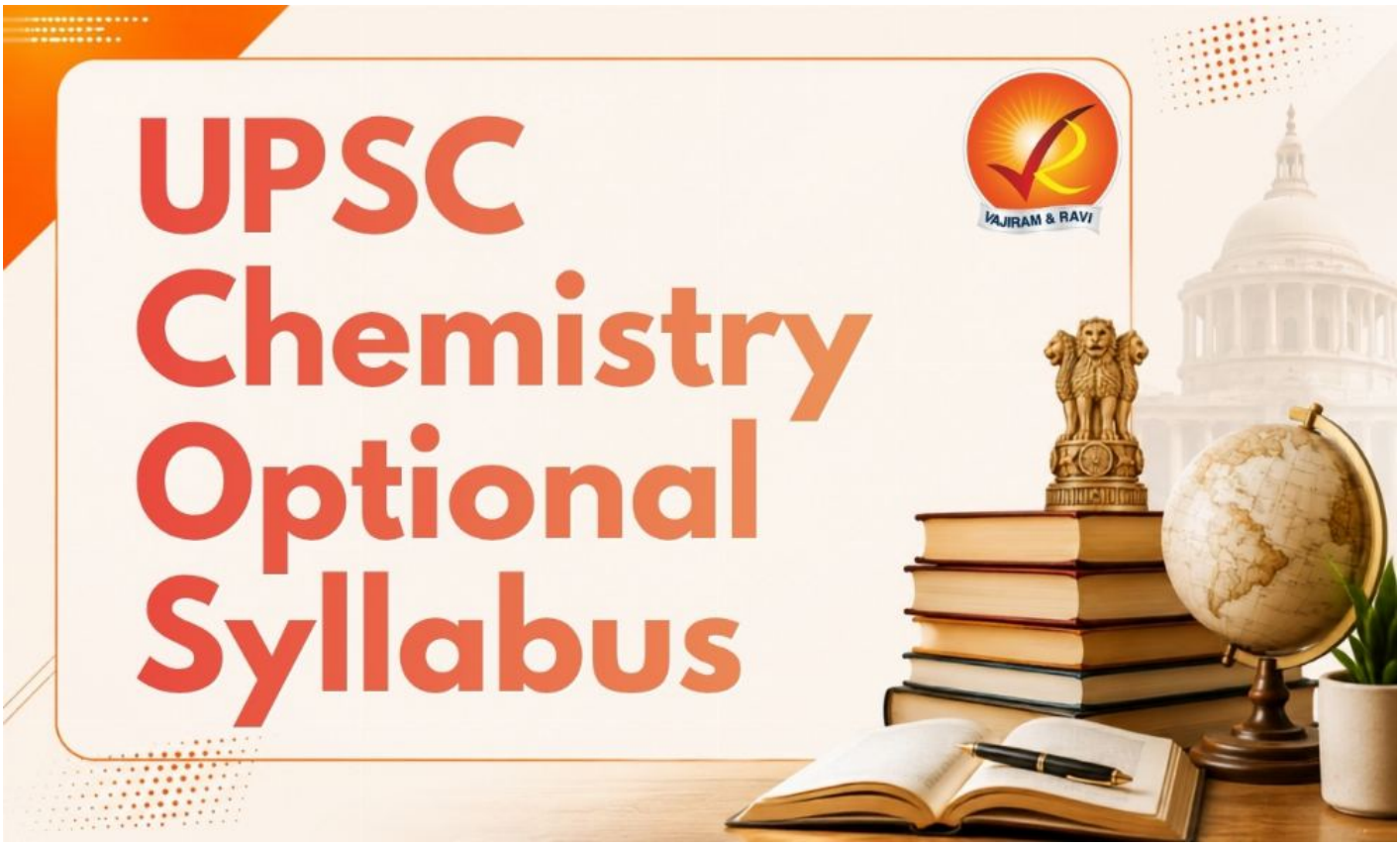

The UPSC Chemistry Syllabus for Mains is meticulously designed to assess candidates' in-depth knowledge and analytical skills in the field of chemistry. This syllabus is divided into two papers, each covering distinct aspects of the subject. Paper 1 focuses on physical and inorganic chemistry, while Paper 2 deals with organic chemistry. To excel, candidates must thoroughly understand each section, integrate fundamental concepts, and apply their knowledge to solve complex problems. Comprehensive preparation and strategic study are crucial for mastering the syllabus and achieving a high score in the UPSC Mains examination.

UPSC Chemistry Optional Syllabus

The UPSC Civil Services Mains Exam includes Chemistry as an optional subject, divided into two papers: Paper I and Paper II. The syllabus encompasses a broad spectrum of topics from Physical, Organic, and Inorganic Chemistry, reflecting the essential knowledge needed in scientific and technological contexts, as well as environmental issues. This subject not only deepens understanding in these areas but also enhances preparation for General Studies, particularly in topics related to science and technology, environmental conservation, and the impact of scientific progress on economic development.

UPSC Chemistry Syllabus for Paper 1

Paper 1 of the UPSC Chemistry syllabus focuses on Physical Chemistry, covering topics such as Thermodynamics, Quantum Chemistry, and Chemical Kinetics. It emphasizes fundamental principles and theories essential for understanding chemical processes and reactions.

Topic	Details
Atomic Structure	Heisenberg’s uncertainty principle, Schrödinger wave equation, quantum numbers, hydrogen atom wave functions, shapes of s, p, and d orbitals.
Chemical Bonding	Ionic bonds, lattice energy, Born-Haber cycle, covalent bonds, polarities, resonance, molecular orbital theory, bond order, strength, and length.
Solid State	Crystal systems, lattice structures, Bragg’s law, X-ray diffraction, close packing, radius ratio rules, structures of NaCl, ZnS, CsCl, CaF2, defects, and semiconductors.
Gaseous State and Transport Phenomenon	Equation of state for real gases, intermolecular interactions, critical phenomena, Maxwell’s distribution, thermal conductivity, and viscosity.
Liquid State	Kelvin equation, surface tension, surface energy, wetting, contact angle, interfacial tension, and capillary action.
Thermodynamics	First and second laws, entropy, free energy functions, Maxwell relations, temperature, volume, pressure dependence, J-T effect, equilibrium, and Nernst heat theorem.
Phase Equilibria and Solutions	Clausius-Clapeyron equation, phase diagram, binary systems, partial molar quantities, excess thermodynamic functions.
Electrochemistry	Debye-Hückel theory, galvanic and concentration cells, electrochemical series, electrode processes, rate of charge transfer, electroanalytical techniques.
Chemical Kinetics	Rate equations for various orders, reactions, temperature and pressure effects, fast reaction methods, collisions, and transition state theories.
Photochemistry	Light absorption, decay of excited states, photochemical reactions, quantum yields.
Surface Phenomena and Catalysis	Adsorption isotherms, surface area determination, reaction mechanisms on heterogeneous catalysts.
Bioinorganic Chemistry	Metal ions in biological systems, ion-transport, oxygen-uptake proteins, cytochromes, and ferredoxins.
Coordination Chemistry	Bonding theories, isomerism, nomenclature, stereochemistry, chelate effect, trans effect, substitution reactions, stability, metal carbonyls, and metal-aromatic complexes.

Main Group Chemistry	Boranes, borazines, phosphazenes, silicates, silicones, interhalogen compounds, sulfur-nitrogen compounds, noble gas compounds.
General Chemistry of ‘f’ Block Elements	Lanthanides and actinides: separation, oxidation states, magnetic and spectral properties, lanthanide contraction.

UPSC Chemistry Syllabus for Paper 2

Paper 2 of the UPSC Chemistry syllabus deals with Organic and Inorganic Chemistry, including the study of Organic Reaction Mechanisms, Coordination Chemistry, and Transition Metals. It integrates the study of organic compounds and inorganic substances, with a focus on their applications and properties.

Topic	Details
Atomic Structure	Heisenberg’s uncertainty principle, Schrödinger wave equation (time independent), wave function interpretation, particle in a one-dimensional box, quantum numbers, hydrogen atom wave functions, shapes of s, p, and d orbitals.
Chemical Bonding	Ionic bonds, characteristics of ionic compounds, lattice energy, Born-Haber cycle, covalent bonds, bond polarities, valence bond theory, resonance, molecular orbital theory (LCAO method), bond order, strength, and length.
Solid State	Crystal systems, lattice structures, unit cell, Bragg’s law, X-ray diffraction, close packing, radius ratio rules, structures of NaCl, ZnS, CsCl, CaF2, stoichiometric and nonstoichiometric defects, impurity defects, semiconductors.
Gaseous State and Transport Phenomenon	Equation of state for real gases, intermolecular interactions, critical phenomena, liquefaction of gases, Maxwell’s distribution of speeds, intermolecular collisions, collisions on the wall, effusion, thermal conductivity, viscosity of ideal gases.
Liquid State	Kelvin equation, surface tension, surface energy, wetting, contact angle, interfacial tension, capillary action.
Thermodynamics	Work, heat, internal energy, first law of thermodynamics, second law, entropy as a state function, entropy changes, entropy-reversibility, irreversibility, free energy functions, thermodynamic equation of state, Maxwell relations, temperature, volume, pressure dependence, J-T effect, equilibrium, Nernst heat theorem, third law of thermodynamics.
Phase Equilibria and Solutions	Clausius-Clapeyron equation, phase diagram for a pure substance, phase equilibria in binary systems, partially miscible liquids, upper and lower critical solution temperatures, partial molar quantities, excess thermodynamic functions.
Electrochemistry	Debye-Hückel theory, galvanic cells, concentration cells, electrochemical series, measurement of e.m.f. of cells, fuel cells, batteries, processes at electrodes, double layer, rate of charge transfer, current density, overpotential, electroanalytical techniques (amperometry, ion-selective electrodes).

Chemical Kinetics	Differential and integral rate equations for zeroth, first, second, fractional order reactions, reverse, parallel, consecutive, and chain reactions, branching chain reactions, explosions, temperature and pressure effects on rate constant, fast reaction methods (stop-flow, relaxation), collisions, transition state theories.
Photochemistry	Absorption of light, decay of excited states, photochemical reactions between hydrogen and halogens, quantum yields.
Surface Phenomena and Catalysis	Adsorption from gases and solutions on solid adsorbents, Langmuir and B.E.T. adsorption isotherms, surface area determination, reaction mechanisms on heterogeneous catalysts.
Bioinorganic Chemistry	Metal ions in biological systems, ion-transport mechanisms, oxygen-uptake proteins, cytochromes, ferredoxins.
Coordination Chemistry	Bonding in transition metal complexes, valence bond theory, crystal field theory, isomerism, nomenclature, stereochemistry, chelate effect, polynuclear complexes, trans effect, substitution reactions in square-planar complexes, thermodynamic and kinetic stability, EAN rule, synthesis, structure, reactivity of metal carbonyls, carboxylate anions, carbonyl hydrides, metal nitrosyl compounds, complexes with aromatic systems, coordinative unsaturation, oxidative addition reactions, insertion reactions, fluxional molecules, metal-metal bonds, metal atom clusters.
Main Group Chemistry	Boranes, borazines, phosphazenes, cyclic phosphazene, silicates, silicones, interhalogen compounds, sulfur-nitrogen compounds, noble gas compounds.
General Chemistry of ‘f’ Block Elements	Lanthanides and actinides: separation, oxidation states, magnetic and spectral properties, lanthanide contraction.

UPSC Chemistry Optional Syllabus- Preparation Strategy

Candidates preparing for the UPSC Chemistry Optional should begin their studies as early as possible to effectively cover the entire syllabus and allow time for thorough revision. A well-structured study plan is essential for success. Here are some key tips to help you navigate the UPSC Chemistry Optional Syllabus:

- **Understand the Syllabus**: Start by thoroughly reviewing the UPSC Chemistry Syllabus. Focus on major topics such as physical chemistry and inorganic chemistry, which should be prioritized in your preparation.
- **Build a Strong Foundation**: Before diving into complex topics, ensure you have a solid grasp of the basics. Reviewing Class 11 and Class 12 NCERT textbooks can provide a strong foundation.
- **Utilize Mnemonics and Diagrams**: Use data charts, diagrams, and mnemonics to enhance memory retention of key concepts, such as the periodic table. These tools can make complex information more manageable.
- **Practice Numericals**: In the inorganic chemistry section, practice solving numericals to apply theoretical concepts effectively. Regular problem-solving will improve your accuracy and understanding. Additionally, consider attempting UPSC Revision Test Series to reinforce your knowledge and test your progress.

Books to Study for UPSC Chemistry Syllabus

Selecting the right books is crucial for mastering the UPSC Chemistry syllabus, as they provide comprehensive coverage and detailed explanations of key concepts. Essential texts include standard reference books and NCERT textbooks, which form the foundation for both Paper 1 and Paper 2:

Chemistry Optional Books: Paper I

S.No.	Book	Author
1	Physical Chemistry	P.W. Atkins
2	Concise Inorganic Chemistry	J.D. Lee
3	Organic Chemistry	Morrison & Boyd
4	Quantum Chemistry	Ira N. Levine
5	Chemical Kinetics and Catalysis	Richard I. Masel
6	Solid State Chemistry and its Applications	Anthony R. West
7	Spectroscopy of Organic Compounds	P.S. Kalsi

Chemistry Optional Books: Paper II

S.No.	Book	Author
1	Advanced Organic Chemistry	Francis A. Carey & Sundberg
2	Inorganic Chemistry	C. Housecroft & A.G. Sharpe
3	The Elements of Physical Chemistry	P.W. Atkins
4	Modern Electrochemistry	John O'M. Bockris & Amulya K.N. Reddy
5	Molecular Quantum Mechanics	Atkins & Friedman
6	Organic Synthesis: The Disconnection Approach	Stuart Warren & Paul Wyatt
7	Industrial Chemicals	W.L. Faith, D.B. Keyes & R.L. Clark

Other Related UPSC Optional Syllabus		
UPSC Commerce Optional Syllabus	UPSC Geography Optional Syllabus	UPSC Geology Optional Syllabus
UPSC History Optional Syllabus	UPSC Law Optional Syllabus	UPSC Maths Optional Syllabus

Other Related UPSC Optional Syllabus		
UPSC Medical Science Optional Syllabus	UPSC Philosophy Optional Syllabus	UPSC Physics Optional Syllabus
UPSC PSIR Optional Syllabus	UPSC Psychology Optional Syllabus	UPSC Sociology Optional Syllabus
UPSC Zoology Optional Syllabus	UPSC Economics Optional Syllabus	UPSC Agriculture Optional Syllabus
UPSC Anthropology Optional Syllabus	UPSC Botany Optional Syllabus	UPSC Chemistry Optional Syllabus
UPSC Civil Engineering Optional Syllabus	UPSC Management Optional Syllabus	UPSC Mechanical Engineering Optional Syllabus
UPSC Public Administration Optional Syllabus	UPSC Statistics Optional Syllabus	UPSC Electrical Engineering Optional Syllabus
UPSC Animal Husbandry & Veterinary Science Optional Syllabus		