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CHEMISTRY OPTIONAL SYLLABUS FOR UPSC CSE MAINS PDF DOWNLOAD

UPSC Chemistry optional syllabus

The UPSC Chemistry optional syllabus consists of 2 papers. Each paper in the Chemistry syllabus for UPSC will comprise 250 marks, totalling 500 marks. The time allotted to complete each UPSC Biology paper will be 3 hours. Each paper will contain objective answer-type questions. There is no negative marking.

Overview of UPSC Chemistry Optional Syllabus 2025

Sl. No.	UPSC IAS Mains Papers	Subject	Mark
1	Paper VI	Optional Subject Paper-I	250
2	Paper VII	Optional Subject Paper-II	250
Total			**500**
Time Duration			**3 hours**

UPSC Chemistry Optional Syllabus: Paper 1

The Chemistry UPSC syllabus for optional paper 1 covers several significant and fundamental topics, including Physical Chemistry, which encompasses major areas such as Thermodynamics, Quantum Chemistry, and Chemical Kinetics. Furthermore, it mainly covers the fundamental axioms and theories that are important to know to comprehend chemical processes and reactions.

Topics	Details
Atomic Structure	Heisenberg's uncertainty principle, Schrödinger wave equation, quantum numbers, hydrogen atom wave functions, and 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.

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Topics	Details
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, and 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, and quantum yields.

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Topics	Details
Surface Phenomena and Catalysis	Adsorption isotherms, surface area determination, and 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 Optional Syllabus: Paper 2

The UPSC Chemistry Optional Syllabus: Paper 2 deals with Organic Chemistry, including the study of Organic Reaction Mechanisms.

Topics	Subtopics
Delocalised Covalent Bonding	Aromaticity, anti-aromaticity; annulenes, azulenes, tropolones, fulvenes, sydnones.
Reaction Mechanisms	General methods (kinetic and non-kinetic): isotopic method, cross-over experiment, intermediate trapping, stereochemistry, energy of activation, thermodynamic and kinetic control of reactions.
Reactive Intermediates	Generation, geometry, stability, and reactions of carbonium ions, carbanions, free radicals, carbenes, benzynes, and nitrenes.

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Topics	Details
Substitution Reactions	SN1, SN2, and SNi mechanisms; neighbouring 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 (Chugaev and Cope eliminations).
Addition Reactions	Electrophilic addition to C=C and C=C; nucleophilic addition to C=O, C=N, conjugated olefins, and carbonyls.
Reactions and Rearrangements	(a) Pinacol-pinacolone, Hoffmann, Beckmann, Baeyer-Villiger, Favorskii, Fries, Claisen, Cope, Stevens, and Wagner-Meerwein rearrangements. (b) Aldol condensation, Claisen condensation, Dieckmann, Perkin, Knoevenagel, Wittig, Clemmensen, Wolff-Kishner, Cannizzaro, von Richter, Stobbe, benzoin, and acyloin condensations; Fischer indole synthesis, Skraup synthesis, Bischler-Napieralski, Sandmeyer, Reimer-Tiemann, and Reformatsky reactions.
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: polyethene, polystyrene, polyvinyl chloride, Teflon, nylon, terylene, synthetic and natural rubber.

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Topics	Details
Biopolymers	Structure of proteins, DNA, and RNA.
Synthetic Uses of Reagents	OsO_4, HIO_4, CrO_3, $Pb(OAc)_4$, SeO_2, NBS, B_2H_6, Na-Liquid NH_3, $LiAlH_4$, $NaBH_4$, n-BuLi, and MCPBA.
Photochemistry	Photochemical reactions of simple organic compounds; excited and ground states; singlet and triplet states; Norrish-Type I and Type II reactions.
Spectroscopy	(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; $N \rightarrow \pi^*$ and $\pi \rightarrow \pi^*$ transitions; application to conjugated double bonds and conjugated carbonyls (Woodward-Fieser rules); charge transfer spectra. (iv) Nuclear Magnetic Resonance (1H NMR): Basic principle; chemical shift, spin-spin interaction, and coupling constants. v) Mass Spectrometry: Parent peak, base peak, metastable peak, McLafferty rearrangement.