Entrance Exam Syllabus for PhD (Chemistry)

Inorganic Chemistry

Chemical periodicity, Structure and bonding in homo- and heteronuclear molecules, VSEPR Theory. Concepts of acids and bases; Main group elements and their compounds - Allotropy, synthesis, structure and bonding, industrial importance of the compounds; Transition, inner transition elements and coordination compounds structure, bonding theories, spectral and magnetic properties, reaction mechanisms; Organometallic compounds, their reactivity and application in homogeneous catalysis; Nuclear chemistry - nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis; Analytical chemistry- separation, IR, Raman, NMR, EPR, Mössbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques, electro- and thermoanalytical methods; Bioinorganic chemistry- photosystems, porphyrins, metalloenzymes, oxygen transport, electron-transfer reactions; nitrogen fixation, metal complexes in medicine;

Physical Chemistry

Basic principles of quantum mechanics: Postulates; operator algebra; exactly- solvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom, orbital and spin angular momenta; tunneling. Approximate methods of quantum mechanics; Atomic structure and spectroscopy- many-electron systems and antisymmetry principle; Chemical bonding in diatomics; MO, VB and Huckel theory; Chemical applications of group theory; Molecular spectroscopy - Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman selection rules; magnetic resonance.; Chemical thermodynamics-Laws, state and path functions; Maxwell's relations; spontaneity and equilibria; Le Chatelier principle; phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions. Statistical thermodynamics- Boltzmann distribution; kinetic theory of gases; partition functions; Electrochemistry- Nernst equation, electrochemical cells; Debye- Huckel theory; Kohlrausch's law and its applications; Chemical kinetics- Rate laws; steady state approximation; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; Colloids and surfaces properties; isotherms; Crystal structures of solids; Bragg's law and applications; Polymer chemistry;

Organic Chemistry

IUPAC nomenclature; Principles of stereochemistry, stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction. Aromaticity, Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes; Organic reaction mechanisms, Determination of reaction pathways, Common named reactions and rearrangements. Organic transformations and reagents, common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Chemo, regio and stereoselective transformations. Retrosynthesis, disconnection, umpolung reactivity and protecting groups; Asymmetric synthesis - Chiral auxiliaries, methods of asymmetric induction, determination of enantiomeric and diastereomeric excess, optical and kinetic Resolution; Pericyclic reactions – electrocyclisation, cycloaddition, sigmatropic rearrangements. photochemical reactions in organic chemistry; Synthesis and reactivity heterocyclic compounds (O, N, S); Chemistry of natural products-Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids; Structure determination of organic compounds by IR, UV-Vis, 1H & 13C NMR and Mass spectroscopic techniques. Green chemistry, Medicinal chemistry, Supramolecular chemistry, Environmental chemistry.