

Syllabus for Recruitment of Scientific Officer

Section- C

Syllabus of Chemistry

Unit 1

- Basic principles and applications of quantum mechanics: hydrogen atom, angular momentum.
- Variational and perturbational methods.
- Basics of atomic structure, electronic configuration, shapes of orbitals, hydrogen atom spectra.
- Theoretical treatment of atomic structures and chemical bonding.
- Chemical applications of group theory.

Unit 2

- Basic principles and application of Spectroscopy : rotational, vibrational, electronic, Raman, ESR, NMR
- Chemical thermodynamics
- Phase equilibrium.
- Chemical equilibrium.
- Electrochemistry – Nernst equation, electrode kinetics, electrical double layer, Debye-Huckel theory

Unit3

- Chemical kinetics- empirical rate laws, Arrhenius equation, theories of reaction rates, determination of reaction mechanisms, experimental techniques for fast reactions.
- Concepts of catalysis.
- Polymer chemistry: Molecular weights and their determinations. Kinetics of chain polymerization.
- Solids : structural classification of binary and ternary compounds, diffraction techniques, bonding, thermal, electrical and magnetic properties.
- Colloids and surface phenomena.
- Data analysis.

Unit 4

- Chemical periodicity
- Structure and bonding in homo-and heteronuclear molecules including shapes of molecules,
- Concepts of acids and bases
- Main Group Chemistry: Boranes, borazines, phosphazenes and cyclic phosphazene, silicates and silicones, Interhalogen compounds; Sulphur - nitrogen compounds, noble gas compounds.

Unit 5

- General Chemistry of 'f' Block Elements: Lanthanides and actinides; separation, oxidation states, magnetic and spectral properties; lanthanide contraction.
- Coordination Compounds: Bonding theories of metal complexes, Isomerism in coordination compounds; stereochemistry of complexes with 4 and 6 coordination numbers, kinetics of substitution reactions in square-planer complexes; thermodynamic and kinetic stability of complexes.
- Cages and metal clusters.
- Analytical chemistry : Separation techniques. Spectroscopic electro and thermoanalytical methods.

Unit 6

- Organometallic compounds: synthesis, bonding structure and reactivity. Organometallics in homogeneous catalysis.
- Bioinorganic chemistry : photosystems, porphyrines, metalloenzymes, oxygen transport, electron – transfer reactions, nitrogen fixation.
- Nuclear chemistry : Nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.
- Green Chemistry and sustainable chemical processes.

Unit 7

- IUPAC nomenclature of organic compounds.
- Stereochemistry : Isomerism: E-Z, R-S nomenclature; Elements of symmetry, molecular chirality, enantiomers, optical activity, diastereomers, meso compounds, resolution, inversion and retention of configurations, Racemization, Relative and absolute configuration, chemoselectivity, regioselectivity, stereoselectivity; conformational isomerism in cyclohexane, mono and di- substituted cyclohexane.
- Reactive Intermediates: Generation, geometry, stability and reactions of carbocations and carbanions, free radicals, carbenes, benzyne and nitrenes.
- Delocalised Covalent Bonding: Aromaticity, anti-aromaticity; annulenes, azulenes, tropolones, fulvenes.

Unit 8

- Reaction mechanism: SN1, SN2, SNi, E1 and E2 mechanism; Thermodynamic and kinetic control reaction, Friedel Crafts alkylation and acylation, Knoevenagel, Michael, Wittig, Reformatsky, Claisen-Schmidt, Baeyer-Villiger, Hunsdiecker, Dieckmann, Arndt-eistert, Mannich reaction; Favorskii, pinacol-pinacolone, Wagner Meerwein, Beckmann, Hofmann, Benzil-Benzilic acid, Fries and Claisen rearrangements.
- Photochemistry: Photochemical reactions of simple organic compounds, ground and excited states, singlet and triplet states, Norrish-Type I and Type II reactions.

- Pericyclic Reactions: Classification and examples; Woodward Hoffmann rules - electrocyclic reactions, cycloaddition reactions [2+2 and 4+2] and sigma tropic shifts [1, 3; 3, 3 and 1, 5] , FMO approach

Unit 9

- (i) Preparation and Properties of Polymers: Organic polymers-polyethylene, polystyrene, polyvinyl chloride, teflon, nylon, terylene, synthetic and natural rubber.
(ii) Biopolymers: Structure of proteins, DNA and RNA..
- Synthetic Uses of Reagents: O_3 , HIO_4 , CrO_3 , $Pb(OAc)_4$, SeO_2 , NBS, B_2H_6 , Na-Liquid NH_3 , $LiAlH_4$, $NaBH_4$ and n-BuLi.
- Chemistry of natural product: steroids, alkaloids, terpenoids, peptides, carbohydrates, nucleic acids and lipids.
- Chemistry of five and six membered aromatic heterocyclic compounds.
- Physical characterization of organic compounds by UV-VIS, IR, NMR and Mass spectroscopy

Unit 10

- Chemistry in nanoscience and nanotechnology: Introduction, Effects of Nanoparticles on Health, Self-assembled monolayers, nanofabrications.
- Medicinal chemistry: Drug design approaches, drug-receptor interactions on the molecular level, structure-activity relationships, drug absorption, distribution, metabolism, elimination and toxicology
- Supramolecular chemistry: Basic concepts and principles
- Environmental chemistry: Introduction, water treatment and related technologies, The atmosphere and associated processes,
- Chemistry of toxic materials present in plants

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