

**Syllabus for entrance examination for PhD in Chemical Sciences (Organic,  
Inorganic, Physical and Medicinal Chemistry)**

**Educational qualification:** MSc./M.Pharm. in Chemistry or equivalent with Chemistry as a subject with minimum of 60% (55% for SC/ST/OBC) marks in aggregate from a recognized Indian or foreign university.

**Section A  
Aptitude Test**

**General aptitude:**

- 1. General Science:** General appreciation and understanding of science including matters of everyday observation and experience.
- 2. Environmental awareness:** Pollution and its impacts, climate change, sustainable development.
- 3. Current events:** Knowledge of significant national and international events.
- 4. General mental ability and reasoning:** Reasoning and analytical abilities.
- 5. Elementary Computer Science:** Basic computer awareness and its uses.
- 6. Interactive English:** Grammar, vocabulary, sentence completion, usage, synonyms, antonyms, one word substitute, idioms/phrases, error detection and comprehension.
- 7. Information and Communication Technology (ICT):** Terminology and abbreviations used in ICT, applications of ICT in academics and research.

**Research aptitude:**

1. Meaning, nature, significance and types of research.
2. End to end process of research, research proposal, synopsis, hypothesis, data collection, literature survey, sampling, interviewing, questionnaire, data processing, interpretation, report writing, bibliography.
3. Thesis/ Dissertation writing.
4. Article, research paper, seminar, conference, symposium, workshop etc.
5. Role of governing bodies/research organizations like UGC, CSIR, ICAR, ICSSR, ICPR, ISRO, DRDO etc. in research and development.
6. Role and use of computers in research.

## Section B

- 1. Stereochemistry:** Configuration and chirality, optical isomerism, R,S-convention, enantiotopic and diastereotopic groups, methods of resolution, asymmetric synthesis. Geometrical isomerism E,Z-convention. Conformational analysis; effect of conformation on reactivity.
- 2. Organic Reaction Mechanisms:** Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. Mechanism of nucleophilic substitution (SN1 and SN2) and elimination (E1 and E2).
- 3. Naming reactions:** Sandmeyer reaction, free radical rearrangement, Hunsdieker reaction. Vilsmeier reaction, Gattermann-Koch reaction, The Von Richter, Sommelet-Hauser, Smiles Rearrangement, Beckmann Rearrangement, Pinacol Pinacolone Rearrangement, Wagner-Meerwein Rearrangement, Benzil-Benzilic acid Rearrangement, Favorskii Rearrangement, Arndt-Eistert Synthesis.
- 4. Addition to Carbon-Carbon Multiple Bonds:** Mechanism, direction and stereochemistry, addition to alkenes and alkynes, Transition metal organometallics.
- 5. Addition to Carbon-hetero Multiple Bonds:** Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles, addition of Grignard reagents.
- 6. Oxidation and Reduction:** Swern oxidation, Oppenauer oxidation, Baeyer Villiger Oxidation, Prevost Reaction, Catalytic Hydrogenation, Dissolving Metal Reductions, Meerwin Ponderf Varely Reduction, Wolf Kishner Reduction, Clemmenson's Reduction
- 7. Spectroscopy:** Structure elucidations of organic compounds with the help of UV-Vis, IR,  $^1\text{H}$  &  $^{13}\text{C}$  NMR analysis.
- 8. Photochemistry and Pericyclic reactions:** Main features of photochemistry and pericyclic reactions, Classification of pericyclic reactions; Electrocyclic reactions, Cycloaddition reactions, Sigmatropic reactions.
- 9. Natural Products and drugs of natural origins:**, Natural products, Natural product based drugs.
- 10. Solutions:** Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solution, Colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, Osmosis law of osmotic pressure and its measurement. Elevation of boiling point and depression of freezing point, Thermodynamic derivation of relation between molecular weight and

elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties.

11. **Theory of Gases:** Kinetic theory of gases. Maxwell-Boltzmann distribution law; Equipartition of energy.
12. **Chemical Thermodynamics:** Reversible and irreversible processes; First law of thermodynamics and its application to ideal and non-ideal gases; Criteria for spontaneity. Second and third law of thermodynamics. Gibbs and Helmholtz energy; Free energy change and spontaneity
13. **Chemical and Phase Equilibria:** Law of mass action;  $K_p$ ,  $K_c$ ,  $K_x$  and  $K_n$ ; Effect of temperature on  $K$ ; Ionic equilibria in solutions; pH and buffer solutions; Hydrolysis; Solubility product; Phase equilibria–Phase rule and its application to one-component and two-component systems; Colligative properties.
14. **Electrochemistry:** Conductance and its applications; Transport number; Galvanic cells; EMF and Free energy; Concentration cells with and without transport; Polarography.
15. **Chemical Kinetics:** Reactions of various order, Arrhenius equation, Collision theory; Theory of absolute reaction rate; Chain reactions - Normal and branched chain reactions; Enzyme kinetics; Photophysical and photochemical processes; Catalysis.
16. **Periodic Table:** Periodic classification of elements and periodicity in properties; general methods of isolation and purification of elements.
17. **Chemical bonding and shapes of compounds:** Types of bonding; VSEPR theory and shapes of molecules; hybridization; dipole moment; ionic solids; structure of NaCl, CsCl, diamond and graphite; lattice energy.
18. **Main group elements (s and p blocks):** Chemistry with emphasis on group relationship and gradation in properties; structure of electron deficient compounds of main group elements and application of main group elements.
19. **Transition metals and inner transition metals (d and f block):** Characteristics of 3d elements; oxide, hydroxide and salts of first row metals; coordination complexes; VB and Crystal Field theoretical approaches for structure, colour and magnetic properties of metal complexes.
20. **Analytical Chemistry:** Principles of qualitative and quantitative analysis; acid-base, oxidation reduction and precipitation reactions; use of indicators; use of organic reagents in inorganic analysis; radioactivity; nuclear reactions; applications of isotopes.