STATE LEVEL ELIGIBILITY TEST
SYLLABUS
CHEMICAL SCIENCES

SUBJECT CODE : 12

PAPER II
SECTION A
1. General information on science and its interface with society to test the candidate's awareness of science, aptitude of scientific and quantitative reasoning.

2. COMMON ELEMENTARY COMPUTER SCIENCE (Applicable to all candidates offering subject areas).
   i) History of development of computers, Mainframe, micro's and Super Computer systems.
   ii) General awareness of computer Hardware i.e. CPU and other peripheral devices (input/output and auxiliary storage devices)
   iii) Basic knowledge of computer systems software and programming language i.e. Machine language. Assembly language and higher level language.
   iv) General awareness of popular commercial software packages like LOTUS, DBASE, WORDSTAR, other Scientific application packages.

PAPER II
SECTION B
(1) Structure and Bonding: Atomic orbitals, Electronic configuration of atoms (L-S coupling) and the periodic properties of elements; ionic radii, ionisation potential, electron affinity, electro-negativity; concept of hybridization. Molecular orbitals and electronic configuration of homonuclear and heteronuclear diatomic molecules. Shapes of polyatomic molecules; VSEPR, theory. Symmetry elements and point groups for simple molecules. Bond lengths, bond angles, bond order and bond energies. Types of Chemical Bond (weak and strong) intermolecular forces, structure of simple ionic and covalent solids, lattice energy.

(2) Acids and Bases : Bronsted and Lewis acids and bases, pH and pka, acid-based concept in non-aqueous media; HSAB concept. Buffer solution.


(5) Aspects of s.p.d.f. Block Elements : General characteristics of each block. Chemical principles involved in extractions and purification of iron, copper, lead zinc and aluminium. Coordination chemistry: structural aspects, isomerism, octahedral and tetrahedral crystal-field splitting of orbitals. CFSE, magnetism and colour of transition metal ions. Sandwich compounds, metal carbonyls and metal clusters. Rare gas compounds, non-stoichiometric oxides. Radioactivity and transmutation of elements. Isotopes and their applications.

(6) IUPAC Nomenclature of Simple Organic and inorganic Compounds:

(7) Concept of Chirality: Recognition of symmetry elements and chiral structures; R-S nomenclature, diastereoisomerism in acyclic and cyclic systems; E-Z isomerism.
Conformational analysis of simple cyclic (chair and boat cyclo hexanes) and acyclic systems. Interconversion of Fischer, Newmen and Sawhorse projections.


Elementary principles and applications of electronic, vibrational, NMR, EPR and Mass Spectral techniques to simple structural problems.

Data Analysis: Types of errors, propagation of errors, accuracy and precision, least-squares analysis, average standard deviation.

PAPER-III


2. The variation method and perturbation theory. Application to the helium atom; antisymmetry and Exclusion Principle, Slater determinantal wave functions. Terms symbols and spectroscopic states.


8. Ideal and Non-ideal solutions. Excess functions, activities, concept of hydration number: activities in electrolytic solutions; mean ionic activity coefficient; Debye-Huckel treatment of dilute electrolyte solutions.

10. **Surface Phenomena**: Surface tension, adsorption on solids, electrical phenomena at interfaces, including electrokinetic, micelles and reverse micelles solubilization, microemulsions. Application of photoelectron spectroscopy. ESCA and Auger spectroscopy to the study of surfaces.

11. **Statistical Thermodynamics**: Thermodynamic probability and entropy; Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Partition function: rotational translational, vibrational and electronic partition functions for diatomic molecules; calculations of thermodynamic functions and equilibrium constants. Theories of specific heat for solids.

12. **Non-equilibrium Thermodynamics**: Postulates and methodologies, linear laws, Gibbs equation, Onsager reciprocal theory.


16. **Solids**: Dislocation in solids, Schottky and Frenkel defects, Electrical properties; Insulators and semiconductors; Superconductors; band theory of solids, Solid-state reactions.

17. **Nuclear Chemistry**: Radioactive decay and equilibrium. Nuclear reactions; Q value, cross sections types of reactions, Chemical effects of nuclear transformations; fission and fusion, fission products and fission yields. Radioactive techniques; tracer technique, neutron activation analysis, counting techniques such as G.M. ionization and proportional counter.

18. **Chemistry of Non-transition Elements**: General discussion on the properties of the nontransition elements: special features of individual elements; synthesis, properties and structure of their halides and oxides, polymorphism of carbon, phosphorus and sulphur. Synthesis, properties and structure of boranes, carboranes, borazines, silicates carbides, sillicones, phosphazenes, sulphur nitrogen compounds: peroxo compounds of boron, carbon and sulphur, oxy acids of nitrogen, phosphorus, sulphur and halogens, intermetallics pseudohalides and noble gas compounds.

19. **Chemistry of Transition Elements**: Coordination chemistry of transition metal ions; Stability constants of complexes and their determination; stabilization of unusual oxidation states. Stereochemistry of coordination compounds. Ligandfield theory, splitting of d orbitals in low-symmetry environments. Jahn-Teller effect; interpretation of electronic spectra including charge transfer spectra; spectrochemical series, nephelauxetic series magnetism Dia-para-femo-and antiferromagnetism, quenching of orbital angular momentum, spinorbit, coupling, inorganic reaction mechanisms; Substitution reactions, trans effect and electron transfer reactions, photochemical reaction of chromium and ruthenium complexes. Fluxional molecules iso-and heteropolyacids; metal dusters. Spin crossover in coordination compounds.

20. **Chemistry of Lanthanides and Actinides**: Spectral and magnetic properties; Use of lanthanide compounds as shift reagents.
21. Organometallic Chemistry of Transition Elements: Synthesis, structure and bonding, organometallic reagents in organic synthesis and in homogeneous catalytic reactions (hydrogenation-hydrodomaylation, isomerisation and polymerisation); pi-acid metal complexes, activation of small molecules by coordination.

22. Topics in Analytical Chemistry: Adsorption partition, exclusion electrophoresis chromatography, Solvent extraction and ion exchange, methods. Application of atomic and molecular absorption and emission spectroscopy in quantitative analysis Light scattering techniques including nephelometry and Raman spectroscopy. Electron analytical techniques: voltammetry, cyclic voltammetry, polarography, amperometry, colometry and conductometry ion-elective electrodes. Anodic stripping voltammetry; TGA,DTA,DSC and online analysers.


24. Aromaticity: Hückel's rule and concept of aromaticity (n) annulenes and heteroannulenes fullerenes (C60).

25. Stereochemistry and conformational Analysis: Nwerek method of asymmetric synthesis (including enzymatic and catalytic nexus), enantio and diastereoselective synthesis Effects of conformation on reactivity in acyclic compounds and cyclohexanes.

26. Selective Organic Name Reactions: Favorskii reaction; Stork enamine reaction; Michael addition, Mannich Reaction, Sharpless asymmetric epoxidation Ene reaction, Barton reaction, Hofmann-Loeffler-Freytag reaction, Shapiro reaction, Baeyer-Villiger reaction, Chichibabin reaction.


30. Reagents in Organic Synthesis: Use of the following reagents in organic synthesis and functional group transformations; Complex metal hydrides, Gilman's reagent, lithium dimethylcuprate, lithium disopropylamide (LDS\A) dicyclohexylcarbodiimide 1,3-Dithiane (reactivity umpolung), trimethylsilyl iodide, tri-n-butylin hydride, Woodward and prevost hydroxylation, osmium tetroxide, DDZ, Selenium dioxide phase transfer catalysts, crown ethers and Merrifield resin, Peterson's synthesis, Wilkinson's catalyst, Baker yeast.

31. Chemistry of Natural Products: Familiarity with methods of structure elucidation and biosynthesis of alkaloids, terpenoids, steroids, carbohydrates and proteins.

32. Bioorganic Chemistry: Elementary structure and function of biopolymers such as proteins and nucleic acids.

33. Photochemistry: Cis-trans isomeriation, Paterno-Buchi reaction, Norrish Type I and II reactions, photoreduction of ketones, dipimethane reurrangement, photochemistry of areanes.

34. Spectroscopy: Applications of mass, UV-VIS, ESRIR and NMR spectroscopy for structural elucidation of compound.