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 Hardwar 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 radil, 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 simpleionic 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.

(3) Redox Reactions : Oxidation numbers. Redox potential. Electrochemical series. Redox indicators.

(4) Energetics and Dynamics of Chemical Reactions : Law of conservation of energy. Energyh and enthalpy of reactions. Entropy, free-energy, relationship between free energy.change and equilibrium. Rates of chemical reactions (first-and second- order reactions). Arrhenius equation and concept of transition state. Mechanisms, including SNI and SN2 reactions, Electron transfer reactions, catalysis. Colligative properties of solutions.

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 dorbitals. CFSE, magnetism and colour of transition metal ions. Sandwich compounds, metal carbonyls and metal clusters. Rare gas compounds, non-stoichiometric oxides. Radio activity and transmutaion 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 systers; E-Zisomerisma.

Conformational analysis of simple cyclic (chari and boat cyclo hexanes) and acyclic systems. Interconversion of Fischer, Newmen and Sawhorse projections.

(8) Common Organic Reactions and Mechanisms: Reactive intermediates. Formation and stability of carbonium ions, carbanians, carbenes, nitrenes, radicals and arynes. Nucleophilic, electrophilic, radical substitution, addition and elemination reactions Familiar name reactions : Aldol, Perkin, Stobbe, Dieckmann condersations; Hofmann, Schmidt, Lossen, Curtius, Beckmann and Fries rearrangements; Reimer-Tiemann, Reformatsky and Grignard reactions. Diels-Alder reactions; Clasien rearrangements; Friedeal-Crafts reaftions; Wittig reactions;and robinson annulation. Routine functional group transforma tions and interconversions of simple functionalities. Hydroboration, Oppenaur oxidations; Clemmensen, wolff-Kishner, Meerwein-Ponndrof-Verley and birch reductions.

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

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

PAPER-III

1. Quantum Chemistry: Planck's quantum theory, wave-particle duality. Uncertainty Principle, operators and commutation relations: postulates of quantum mechanics and Schrodinger equation free particle, particle in a box, degeneracy, harmonic oscillator, rigid rotator and the hydrogen atom. Angular momentum, including spin, coupling of angular momenta including spin-orbit coupling.

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

3. Born-Oppenheimer apporximation Hydrogen molecule ion. LCAO-MO and VB treatments of the hydrogen molecule; electron density, forces and their role in chemical binding. Hybridisation and valence Mos of H2O, NG3 and CH4 Huckel plelecton theory and its applications to ethylene, butadience and benzene. Idea of self-consistent fields.

4. Group theoretical representations and quantum mechanics: vanishing of integrals; spectroscopic selection rules for vibrational, electronic, vibronic and Raman spectroscopy. MO treatment of large molecules with symmetry.

5. Spectroscopy: Theoretical treatment of rotational, vibrational and electronic spectroscopy. Principles of magnetic resonance, Mossbauer and photoelectron spectroscopy.

6. Thermodynamics: First law of thermodynamics, relation between Cp and Cv; enthalpies of physical and chemical changes; temperature dependence of enthalpies. Second law of thermodynamics, entropy, Gibbs-Helmoholtz equation. Third law of thermodynamics and calculation of entropy.

7. Chemical Equilibrium: Free energy and entropy of mixing, partial molar quantities, Gibbs-Duhem equation. Equilibrium constant, temperature-dependence of equilibrium constant, phase diagram of one-and two-component systems, phase rele.

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.

9. Electrochemistry: Electronchemical cell reactions, Nernst equation, Electrode Kinetics, electical double layer, electode/electrolyte interface, Batteries, primary and secondary Fuel Cells, corrosion and corrosion prevention.

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

11. Statistical Theromodynamics: 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 equilibirium constants. Theories of specific heat for solids.

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

13. Reaction Kinetics: Methods of determining rate laws. Mechanisms of photochemical, chain and oscillatory reactions. Collision theory of reaction rates, steric factor, treatment of unimolecular reactions. Theory of absolute raction rates, comparision of results with Eyring and Arrhenius equations. Ionic reactions: salt effect. Homogeneous catalysis and Michaelis-Menten kinetics; heterogeneous catalysis.

14. Fast Reaction: Luminescence and Energy trasfer processes. Study of kinetics by stoppedflow technique, relazation method, flash photolysis and magnetic resonance method.

15. Macromelecules : Number-average and weight average molecular weights : determination of molecular weights. Kinetics of polymerisation.

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, polymorphyism of carbon, phosphohrus and sulphur. Synthesis, properties and structure of boranes, carboranes, borazines, silicates carbides, sillicones, phosphazenes, sulphur nitrogen compounds: peroxo compounds of boron,cabron and sulphur, oxy acids of nitrogen, phosphours, sulphur and halogens, intermalogens pseudohalides and noble gas compounds.

19. Chemistry of Translition 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 dorbitals in low-symmetry environments. Jahn-Teller effect; interpreation of electronic spectra including charge transfer spectra; spectrochemical series, nephelauxetic series magetism Dia-para-femo-and antifemomagnetism, quenching of orbital angular moment, spinorbit, copling, inorganic reaction mechanisms; Substitution reactions, trans effect and electron transfer reactions, photechemical 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 reations (hydrogenation-hydrodomaylation, isomerisation and polymerisation); pi-acid metal complexes, activation of small molecules by coordination.

22. Topics in Analytical Chemistry: Adsorption partition, exclusion electrochromatography, 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. Electronalytical techniques: voltammetry, cyclic, voltammetry, polarography, amperometry, colometry and comductometry ion-elective electrodes. Annodic stripping voltammetry; TGA,DTA,DSC and online analysers.

23. Bionorganic Chemistry: Metal ions in Biology, Molecular machanism of ion transport across membranes; ionophores. Photosynthesis, PSL,PSH: nitrogen fixation, oxygen uptake proteins, cytochromes and ferrodoxins.

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

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

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

27. Mechanisms of Organic Reactions: Labelling and Kinetic isotope, effects, Hamett equation, (sigma-rho)relationship, non-classical carbonium ions, neighbouring group participation.

28. Pericyclic Reactions: Selection rules and stereochemistry of electrocyclic reactions, cycloaddition and sigmatropic shifts, Sommelet, Hauser, Cope and Claisen rearrangements.

29. Heterocyclic Chemistry: Synthesis and reactivity of furan, thiophene, pyrrole, pyridine, quinoline, isoquinoline and indole, Skraup synthesis, Fischer indole synthesis.

30. Reagents in Organic Synthesis: Use of the following reagents in organic synthesis and functional group transformations; Complex metal hybrides, Gilman's reagent, lithium dimethylcuprate, lithium disopropylamide (LDS\A) dicyclohexylcarbodimide 1,3-Dithiane (reactivity umpolung), trimethylisilyl iodide, tri-n-butyltin hybride, 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: Famillarity with methods of structure elucidation and biosynthesis of alkaliods, terponoids, 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: Applicatins of mass, UV-VIS, ESRIR and NMR spectroscopy for structural elucidation of compound.

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