

## 15. SYLLABUS FOR COMPETITIVE EXAMINATION FOR THE POST OF TEACHING ASSOCIATE IN CHEMISTRY

1. **Chemical Periodicity:** Periodic Table, Electronic Configuration of Various Group Elements. Periodicity in properties of s, p, d and f - block elements and their trends.
2. **Chemical Bonding:** Concept of hybridization VBT, LCAO, MOT of homo and heteronuclear diatomic and polyatomic molecules, Coulson diagrams, Valence Shell Electron Pair Repulsion Theory, Hydrogen bonding, Fajans Rule and Polarity in Covalent Compounds.
3. **Transition Metal Chemistry:** Properties with special reference to variable oxidation state, magnetic, colour and complexation behaviour. Metal to Ligand and Ligand to Metal charge transfer spectra, Metal atom clusters, Nomenclature and Isomerism in coordination compounds, Ligand field theory, high spin and low spin complexes, CFT, CFSE and Jahn-Teller effect.
4. **Green Chemistry and Nano Chemistry:** Principles of Green Chemistry and Sustainable Development, Green Reagents and Green Synthesis. Introduction to Nano particles, Nano Science and Nano Technology. Optical and Magnetic properties of Nano material. Characterization of Nano materials by TEM, SEM, SPMT, AFM, X-Ray Diffraction and ASCA.
5. **Environmental Chemistry:**
  1. **Air Pollution-** Pollution due to SO<sub>x</sub>, NO<sub>x</sub>, Ozone Depletion and Green House Effect, photochemical smog, reaction of hydroxyl radical with CH<sub>4</sub>, SO<sub>x</sub> and NO<sub>x</sub>.
  2. **Water Pollution:** International Standards of drinking water, water quality parameters COD, BOD, TDS, pH etc., Treatment of potable and sewage waste water.
  3. **Soil-** Types of soil, soil profile and analysis of physical and chemical parameters.
6. **Nomenclature of Organic Compounds:** Common and IUPAC nomenclature of Aliphatic, Aromatic, Heteroaromatic, Bicyclo Compounds and Spiranes.
7. **Isomerism:** Structural Isomerism, Stereoisomerism both geometrical and optical with E/Z and R/S systems respectively. Conformational analysis of alkanes and cyclo alkanes, Asymmetric Synthesis Stereoselective and Stereospecific reactions.
8. **Basic principles of Organic Chemistry and Reaction Mechanism:** Inductive, Electromeric, Mesomeric, Hyperconjugative and Resonance effects. Reactive Intermediate species i.e. carbocation (classical and non classical), Carbanion, Carbene, free Radicals, Nitrene and Benzynes. Types of reagents- electrophiles and nucleophiles. Basic reaction mechanism - Addition, Substitution, Elimination and Rearrangements.

9. **Name Reactions and Mechanisms:** Aldol, Benzoin, Cannizzaro's, Perkin's, Stobbe, Dieckmann Condensations. Pinacol - Pinacolone, Wagner- Meerwein, Hoffmann, Schmidt, Lossen, Curtius, Beckmann, Fries, Baeyer Villiger, Wittig, Reformatsky Rearrangements.
10. **Aromatics Heteroaromatics, annulenes and heteroannulenes:** Basics of Aromaticity and anti-aromaticity. Synthesis and reactions of anthracene, phenanthrene, biphenyl, furan, thiophene, pyrrole, pyridine, quinoline, isoquinoline and indole. UV, IR, NMR and mass spectroscopy of organic compounds.
11. **(a) Chemical kinetics:** Ionic Reactions, Kinetic salt effect, Steady State Kinetics, Kinetic and Thermodynamic Control of reactions, Dynamic chain, photochemical reaction, acid base and enzyme catalysis, fast reaction: study by stop flow method. **(b) Acid-bases and Non-aqueous Solvents:** Basic theories, HSAB concept. Non aqueous solvents: DMSO, THF and Liquid NH<sub>3</sub> their reactions and solvent action.
12. **Electrochemistry:** Electrochemistry and Ionic Equilibrium, Theory of strong and weak electrolytes pH, Buffer and Buffer action, Electrolysis and electrolytic Cell, Electrochemical cells and reactions, Nernst equation, emf measurement, Calculation of Gibbs free energy and equilibrium constants. Primary and Secondary cells, fuel cell, corrosion and its prevention.
13. **Nuclear and Radio Chemistry:** Nuclear Models, Radioactive decay, mass defect, binding energy, fission and fusion, Isotopes, Isobars, Isodiaphers and application of Isotopes in medicinal Science.
14. **Solution and Colligative Properties:** Types of Solutions Concentration measurement methods. Normality, Molarity, Molality etc. Raoult's law (deviation from ideal behaviour), Nernst law, Henry law, Relative lowering of Vapour Pressure, Elevation in Boiling Point, Depression in Freezing Point, Osmosis and Osmotic Pressure.
15. **Thermodynamics:** First law: relation between  $C_p$  and  $C_v$ , enthalpies of physical and chemical changes, temperature dependence of enthalpies, Joules Law, Joules Thomson coefficient, Second law: entropy, Criteria of Spontaneity Gibbs and Helmholtz functions, evaluation of entropy and Gibbs function, Gibbs-Helmholtz equation, Maxwell relations. Thermodynamics of ideal and non-ideal gases and solutions. Third Law of Thermodynamics.
16. **Chemistry of Non-Transition and Inner Transition Elements:**  
(i) Preparation, properties and bonding in diborane and higher boranes, polyhedral borane anions and carboranes, borazines, borane nitrile. Silicones and silicates, phosphonitrilic compounds, interhalogen Xenon compounds.  
(ii) Lanthanides and actinides Contraction, oxidation states, super heavy elements, analytical and Medicinal applications.

17. **Organometallic Compounds:** Synthesis, structure, bonding, reactions and reactivity, Applications in homogeneous catalysis. Cage and Cluster Compounds.
18. **Bioinorganic and Supra Molecular Chemistry:** Iron storage and transport, oxygen carriers and transport, electron transfer reactions, Metalloenzymes; Zinc Iron and Copper enzymes, Vita B12 Co-enzyme. Metal deficiency and disease. Supra molecular reactions and Catalysis, supra molecular devices.
19. **Group Theory:** Symmetry elements and operations, point groups, Mulliken symbol, GMT and character Table, Great Orthogonality Theorem and application hybridization and vibrational Spectroscopy. Concepts of inorganic ESR, Mass and IR Spectroscopy.
20. **Statistical Data Analysis and Analytical Technique:** Mean, Mode, Median, Standard Deviation, Regression analysis and Correlation principles and applications of AAS, DTA, TGA. Partition and adsorption chromatography.
21. **Pericyclic Reactions:** Molecular orbital symmetry, Frontier orbitals of ethylene, buta-1,3-diene, hexa-1,3,5-triene. Classification of pericyclic reactions. Woodward Hoffmann correlation diagrams. Electrocyclic and cycloaddition reactions and sigmatropic rearrangements, eg. Cope, Claisen, Aaza-Cope, Sommelet-Hauser rearrangements.
22. **Organic Transformation and Reagents:** Functional group interconversions, oxidative and reductive processes. Common catalyst and reagents (organic, inorganic organometallic and enzymatic like  $\text{LiAlH}_4$ ,  $\text{NaBH}_4$ , iodobenzene diacetate, thallium (III) nitrate  $\text{RuO}_4$ ,  $\text{OsO}_4$ ,  $\text{CH}_3\text{Li}$ ,  $(\text{CH}_3)_2\text{Hg}$ ,  $(\text{CH}_3)_2\text{Zn}$  etc.
23. **Synthetic Application of Organometallics and Reactive Methylene Compounds:** Grignard reagent, Organo lithium compounds, Aceto acetic ester and Malonic ester. Their Synthesis, identification, estimation and important applications in the Synthesis of organic compounds.
24. **Organic Photochemistry:** Jablonski diagram, photochemistry of alkenes, carbonyl compounds and aromatic compounds, photodegradation of polymers, singlet molecular oxygen reactions. Paterno-Buchi reaction, Norrish Type I and II reactions and Barton reaction.
25. **Natural Products and Medicinal Chemistry:** Classification and structure of Carbohydrates, proteins, nucleic acids and fatty acids. Classification, Nomenclature and isolation techniques of Terpenoids, Carotenoids, Alkaloids and terpenes. Drug design and introduction to pharmacodynamics, Some Cardio Vascular Psychotic and Antipsychotic drugs.
26. **Quantum Chemistry:** Basic principles and application of quantum mechanics. Schrodinger equation, hydrogen atom, hydrogen molecule ion and angular momentum. Variational and Perturbational method, term symbols and spectroscopic status. Atomic structure and its theoretical treatment.

27. **Solid State:** Types of solids, Bravais lattices, determination of unit cell parameters, defects in solids- Frenkel, Schottky, Point, Line and Plane defects. Structural classification of binary and ternary compounds, diffraction techniques, bonding, thermal, electrical and magnetic properties. Insulators, Semiconductors and Super conductors.
28. **Statistical Thermodynamics and Phase equilibria:** Boltzmann distribution law, kinetic theory of gases, partition function: vibrational, rotational, translational and electronic properties and applications of partition functions and the relation with thermodynamic quantities. Basic principles of phase equilibria.
29. **Physical Chemistry of Polymers:** Molecular weight determination of polymers: Number average and Weight average molecular weights, End-group analysis, Sedimentation, Light scattering and Viscosity methods. Stereochemistry and mechanism of polymerization. Crystallisation and melting in polymers. Relation between  $T_m$  and  $T_g$ .
30. **Colloids and Surface Chemistry:** Absorption and Adsorption, Adsorption isotherms and surface area analysis, Types and properties of colloids, Micelles, Micelle action and Critical Micelle Concentration. Applications of colloids.
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