Syllabus for M.Sc. Chemistry entrance test

1. Reactions and reagents: Organometallic compounds - Grignard reagent - synthesis of different types of compounds like alcohol, aldehyde, acid, amine and organometallic. Acetoacetic ester - tautomerism - base hydrolysis - acid hydrolysis - malonic ester - cyano acetic ester - synthesis of dicarboylic acids and unsaturated acids.

2. Carbohydrates: R, S, configuration, mutarotation, conversions - glucose to fructose and vice versa, sucrose - structural elucidation, extraction, reactions, starch and cellulose - structural details, applications

3. Alicyclic compounds, aromatic compounds, fats and oils: Alicyclic compounds - nomenclature - synthesis of alicyclic compounds using carbon - acroyloin condensation - Diels Alder reaction, Freunds's synthesis - bayer's strain theory postulates, drawbacks - theory of strainless rings - conformations of cyclohexane. Coal tar distillation, separation of benzene, toluene, phenol and naphthalene - Aromaticity exhibited by these compounds. Fats and oils - Saponification- hydrogenation of oils

4. Amino acids, proteins and dyes: Amino acids and proteins- classification - synthesis of amino acids - reactions of carboxyl group and amino group - peptide linkage - end group analysis - colour reaction of proteins- denaturation. Dyes - colors and constitution - chromophores and auxochromes- Quinine theory and electron theory of dyes- preparation-colour and application of azodyes - acidic. basic, mordant, direct azodyes - Triphenylmethane dyes - malachite green, crystal violet, Rosaniline, prosaniline mordant dyes-application, vat dyes-indigo-synthesis and application

5. Heterocyclic compounds and natural products: Heterocyclic compounds-synthesis and reaction of pyrrole ,furan ,thiophene, pyridine, quinine, isoquinoline. Alkaloids-Isolation from natural products-colour reaction-structural elucidation of nicotine. Terpenoids- Isolation - Isoprene rule-structural elucidation of citral.

6. Polymer: Nomenclature, functionality, classification, methods of polymerization, mechanism of polymerization, molecular weight determination-Viscometry, light scattering methods. Plastics-Moulding constituents of a plastics and moulding of plastics into articles. Important thermoplastics and thermosetting resins- synthesis & applications of PVA, 23 FLUON, PC, Kevlar, ABS polymer, phenolic & amino resins, epoxy resins and polyurethanes. Conductive polymers.

7. Nucleophilic substitution: Reactivity, structural and solvent effects, substitution in SN1, SN2, SNi. Neighbouring group participation -Norbornyl and bridgehead systems, substitution at allylic and vinylic carbons, substitution by ambident nucleophiles, aromatic nucleophilic substitution, SN Ar, benzyne, SN1. Aromatic nucleophilic substitution of activated halides

8. Elimination reactions: E1, E2, E1CB- mechanism, stereochemistry, orientation of double bonds - Hoffmann, Zaitsev, Bredts rule - pyrolytic elimination, Chugaev reaction. Oxidation and reduction: Reduction using hydride reagents, LiAlH4, NABH4 and other organoboranes: chemo- and stereoselectivity, catalytic hydrogenation (homogenous and heterogeneous catalysts), Swern and Dess-Martin oxidations, Corey-Kim oxidation, PCC, KMnO4 oxidations.

9. Theories of aromaticity: Aromaticity, antiaromaticity, Huckel's rule, annulences and heteroannulenes, fullerenes (C60). Other conjugated systems, Chichibabin reaction. Aromatic electrophilic substitution: Orientation, reactivity, and mechanisms. Substitution in thiophene and pyridine. Reactive intermediates - carbenes, nitrenes, radicals, Ylides - Formation, stability and their applications.

10. Addition to carbon-carbon multiple bonds: Electrophilic, nucleophilic and free radical addition. Stereochemistry and orientation of the addition. Hydrogenation, halogenation, hydroxylation, hydroboration. Addition to carbonyl compounds - 1,2 and 1,4-addition, benzoin, Knoevenegal, Stobbe and Darzen glycidic ester reactions.

11. Gaseous state: Kinetic theory of gases, Vander waal's equation. Law of equipartition principle, Translational, Rotational and vibrational energies of molecules, Joule-Thomson effect, liquefaction of gases. Critical constants.

12. Atomic structure: Photoelectric effect, dual nature of electrons, Heisenberg's uncertainty principle, quantum numbers, electronic configuration, wave mechanics.

13. Reaction kinetics: Rate order and molecularity of chemical reactions. Methods of their evaluation. Calculation of rate constants. Consecutive - Parallel and opposing reactions. Chain reactions. Energy of activation - Theories on reaction rates. Heterogeneous reactions - zero order reactions.

14. Phase equilibria: Phase rule: Application - to one components system (water, sulphur and carbon dioxide), Two component systems (Eutetic, Intermediate compound formation and solid solutions) and simple three component systems.

15. Solutions: Ideal and non-ideal solutions solubility of gases in liquids. Henry's law. Completely miscible liquids - Rauolt's law - vapour pressure and boiling point diagrams. Partially miscible liquids - Critical solution temperature -completely immiscible liquids - Nernst: distribution law - Dilute solution and their colligative properties. Molecular weight determination using these properties.

16. Electrochemistry: Conductivity of electrolytes- Specific, molar and equivalent conductivity, Nernst equation for electrode potential, EMF series, hydrogen electrode, calomel electrode, glass electrode, Electrolytic and galvanic cells, cell EMF, its measurement and applications, Weston standard cell, reversible and irreversible cells, concentration cell, electrode (hydrogen gas electrode) and electrolyte concentration cell, concentration cell with and without transference.

17. Electrical conductance: Debye - Huckell Onsager theory; Ostwald's dilution law - solubility of electrolytes and solubility product - Applications, common ion action.

18. Ionic equilibrium: Acids, bases - definitions a) based on proton transference, dissociation constant, amphoteric electrolyte - pH -Buffer solutions. Salts - water of crystallisation, double salts, complex ions and salts, hydrolysis. Decomposition potential, over voltage, e.m.f. and energy relations. Conductometry, Potentiometry, their applications, Fuel cells.

19. Surface chemistry: Derivation of Langmuir adsorption isotherm, B.E.T adsorption isotherm, Determination of surface area of solids by B.E.T. method. Catalysis- Homogeneous catalysis, heterogeneous catalysis, Enzyme catalysis, adsorption chromatography.

20. Thermodynamics: Entropy as a thermodynamic quantity, entropy changes in isothermal expansion of an ideal gas, reversible and irreversible processes, physical transformations, work & free energy functions, Helmholtz and Gibbs free energy functions, Gibbs-Helmholtz equation, Gibbs-Duhem equation, Clapeyron-Clausius equation & its applications, Van't Hoff isotherm and applications.

21. Chemical Bonding: Basic concepts, bonding in metals, electron gas theory, physical properties of metals (electrical & thermal conductivity, opaque & lusture, malleability & ductility), Alloy-substitutional alloys, interstitial alloys. Coordinate bond, EAN rule, 16 & 18 electron rule.

22. Shape & Intermolecular Interactions: Shape-Lewis dot structures, formal charge, VSEPR method, consequences of shape, dipole moment, valence bond theory; Intermolecular interactions-ion ion interactions, ion-dipole interactions, hydrogen bonding, dipole-dipole interactions, London / dispersion forces, relative strength of intermolecular forces; Consequences-surface tension.

23. Solid State: Types of solids - close packing of atoms and ions - bcc , fcc structures of rock salt - cesium chloride- spinel - normal and inverse spinels, Stoichiometric Defect, controlled valency &

Chalcogen semiconductors, Non-elemental semiconducting Materials, Preparation of Semiconductors-steps followed during the preparation of highly pure materials and further treatments. Semiconductor Devices-p-n junction diode.

24. Theories of coordination compounds - VB theory - CFT - splitting of d orbitals in ligand fields and different symmetries - CFSE - factors affecting the magnitude of 10 Dq - evidence for crystal field stabilization - spectrochemical series - site selection in spinels - tetragonal distortion from octahedral symmetry - Jahn-Teller distortion - Nephelauxetic effect - MO theory - octahedral - tetrahedral and square planar complexes - bonding and molecular orbital theory - experimental evidence for bonding, Substitution reactions in square planar complexes - the rate law and mechanism of nucleophilic substitution in a square planar complex - the trans effect - kinetics of octahedral substitution - ligand field effects and reaction rates.

25. Nuclear Chemistry: Mass defect and binding energy, nuclear reactions, fission and fusion, nuclear reactor and breeder reactors, radiodating.

26. Electronic spectra and magnetism: Microstates, terms and energy levels for d1 – d9 ions in cubic and square fields - selection rules - band intensities and band widths - evaluation of 10 Dq and β for octahedral complexes of cobalt and nickel - charge transfer spectra - magnetic properties of coordination compounds - change in magnetic properties of complexes in terms of spin orbit coupling - temperature independent paramagnetism - spin cross over phenomena.

27. Electromagnetic radiation: its interaction with matter - Einstein coefficients - time dependent perturbation theory - transition probability - transition dipole moments - energy levels in atoms and molecules – Born-Oppenheimer approximation - selection rules - intensity and width of spectral lines.

28. Rotational spectra: Diatomic and polyatomic molecules - selection rules, rotational Raman spectra - vibrational spectra of diatomic molecules - rotational character of vibration spectra - morse potential of real molecules - selection rules - overtones and combination - Fermi resonance.

29. Vibrational spectra: Polyatomic molecules - harmonic and anharmonic oscillators - Morse potential - selection rules - normal modes of vibrations of polyatomic molecules - selection rules - Fourier transformation in IR spectroscopy - Raman spectroscopy – fundamentals - rotational Raman - vibrational Raman spectra - IR/ Raman instrumentation.

30. Periodic table of elements: s-block, p-block, d-block and f-block elements, their periodicity and general properties.

31. Errors in chemical analysis: Terms and definitions - systematic errors. Random errors - statistical treatments - standard deviation of calculated results and reporting computed data - statistical data treatment and evaluation: Confidence intervals, statistical aids to hypothesis testing - analysis of variance and detection of gross errors.

32. Separation techniques: Solvent extraction, chromatography - thin layer chromatography, ion exchange chromatography and size exclusion chromatography, HPLC, Gas chromatography.

33. **Electrochemical techniques:** Potentiometry, polarography, voltammetry & amperometric techniques, electrogravimetry and coulometry.

34. Atomic spectrometry: Atomic absorption spectrometry, atomic emission, plasma sources – inductively coupled plasma - mass spectrometry (ICP–MS) - flame emission techniques.

35. Thermal techniques: Thermogravimetry. Differential thermal analysis Differential scanning calorimetry (DSC) - Thermomechanical analysis (TMA).