



# TEERTHANKER MAHAVEER UNIVERSITY

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Delhi Road, Moradabad (U.P.)

## SYLLABUS FOR RESEARCH APTITUDE TEST IN CHEMISTRY

The syllabus for Research Aptitude Test (RAT) in Chemistry is divided in two parts viz. Part A & Part B described below:

### PART – A

Part A of the RAT shall be designed to assess the research skills/aptitude of the candidate consisting of questions from the following areas:

- 1. Research Methodology:** meaning, characteristics, and ethical issues in research; types of research; research methods
- 2. Logical Reasoning:** arguments, deductive and inductive research; logical and Venn diagram; inferences; analogies.
- 3. Data Interpretation:** interpretation of data; mapping and analysis of data, tools for data analysis; quantitative and qualitative research.
- 4. General Awareness about Basic Science:** basic science up to the level of SSC.
- 5. Mathematical Reasoning:** number series, letter series, codes; relationships, classification.

### PART – B

Part-B of RAT is designed to assess subject specific knowledge of the candidate covering the syllabus given as below:

#### **INORGANIC CHEMISTRY**

Role of solvents in chemical reactions, physical properties of a solvent, types of solvents and their general characteristics, reactions in non-aqueous solvents with reference to liquid NH<sub>3</sub> and liquid SO<sub>2</sub> Spectroscopic ground states, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d<sup>1</sup>-d<sup>9</sup> states), calculation of Dq, B and β parameters, charge transfer spectra, spectroscopic method for assignment of absolute configuration in optically activemetal chelate and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

VSEPR, Walsh diagram (tri-and penta atomic molecules), d<sup>π</sup>-p<sup>n</sup> bonds, Bent rule and energetics of hybridization, simple reactions of covalently bonded molecules.

#### **MATERIALS CHEMISTRY**

**Corrosion:** Definition, Classification, Units and rate of corrosion, Electrochemical corrosion reaction, Rusting, Polarization, Activation Polarization, Concentration Polarization, Passivity,

Inhibitors, Electrochemical series of metals, Galvanic series of metals and Alloys, Galvanic corrosion, Ceramic corrosion, Pitting corrosion, Inter-granular corrosion, Stress corrosion.

**Magnetic Properties:** Classification of magnetic materials, diamagnetism, paramagnetism, ferromagnetism, magnetic anisotropy, ferromagnetic domains, origin of domain wall anti-ferromagnetism, antiferromagnetic, domains, ferrimagnetism, normal spinel's inverse spinels, ferromagnetic domain.

**Polymer Chemistry:** General characteristics of chain growth polymerization, alkene polymerization by free radical, anionic and cationic initiators, General characteristics of step growth polymerization, synthesis of polymers by step polymerization, polyesters, polycarbonates, polyamides, polyphenylene oxide.

**Glass and Ceramics:** Introduction, Types of ceramics, Chemical bonding in ceramics, Physical properties of ceramics ( Specific Gravity, Porosity, Crystallinity etc.), Electronic configuration of atoms, bonding, Polymorphic forms and transformations, Physical , thermal, electrical, magnetic properties of ceramics.

## ORGANIC CHEMISTRY

**Name Reactions and their Mechanisms:** Formations and stabilities of carbonium ions, carbanions, carbenes, nitrenes, radicals and arynes, Reactive intermediates, Nucleophilic, Electrophilic, Radical substitution, Addition and Elimination reactions. Diels-alder reactions, Friedel crafts reactions, Hoffmann reactions, Hydroboration, Lossen, Mannich, Michael addition, Perkin, Grignard, Reimer-Tiemann, Reformatsky, Wittig, Wolff-Kishner. Oppenaur oxidations, Aldol, Claisen, Schmidt, Condensations, Beckmann and Fries,

**Stereochemistry and Conformational Analysis:** Concept of chirality, Asymmetric synthesis (including enzymatic and catalytic nexus) enantio and diastereo-selective synthesis, racemization, resolution, Walden inversion. Effects of conformation on reactivity in acyclic compounds and cyclohexanes, Conformational analysis of cyclohexane.

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

**Dyes:** Colour and Constitution, Classification of Dyes, Chemistry of Methyl Orange, Malachite Green, Crystal Violet, Phenolphthalein.

## PHYSICAL CHEMISTRY

**Energetic and Dynamics of Chemical Reactions:** Law of conservation of energy, Energy 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 SN1 and SN2 reactions, electron transfer reactions, catalysis. Colligative properties of solutions.

**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-Helmholtz equation. Third law of thermodynamics and calculation of entropy.

**Chemical Equilibrium:** phase diagram of one-and two-component systems, phase rule.

**Ionic Equilibrium:** Ostwald dilution law, Concepts of acid base, Ionic product of water, pH and theory of buffer solutions, Solubility and solubility product, Salt hydrolysis.

**Electrochemistry:** Electrochemical cell reactions, Nernst equation, Electrode Kinetics, electrical double layer, electrode/electrolyte interface, Batteries, primary & secondary Fuel Cells, corrosion and corrosion prevention.

**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 reaction rates, comparison of results with Eyring and Arrhenius

equations. Ionic reactions: salt effect. Homogeneous catalysis and Michaelis-Menten kinetics; heterogeneous catalysis.

**Solids:** Crystalline and Amorphous Solid, Unit cell, Summary of crystal lattices, Reciprocal lattice, Bonding & packing in crystals, Lattice planes, Symmetry elements, Space lattice, X-ray diffraction, Dislocation in solids, Schottky and Frenkel defects, Electrical properties; Insulators and semiconductors; superconductors; band theory of solids, Solid-state reactions.

**States of Matter:** Gaseous laws, Kinetic theory of gases, Molecular velocities, Critical Phenomenon of real gases, Liquefaction of gases, Intermolecular forces and structure of liquids.

**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.