IIT JAM & M.Sc. Entrance Classroom & Test Series

MOCK TESTS & CLASSROOM PROGRAM in Chemical Science for JAM-2019 & Other Competitive Exams

Our Aims & Objectives

The primary objective of this Mock Test Series & Classroom Lectures is to look after the conceptual difficulties of the students and to prepare them for the IITJAM | M.Sc. Entrance 2019 as well as other competitive exams like BHU, JNU, School of Science Hyderabad, University of Calcutta, Jadavpur University and so on.

Our endeavour will be to provide a comfortable & supportive setting where you and your fellow students can pool your talents.

The major advantage of this curriculum is that the entire syllabus of Entrance Exams will divided into several small portions and there will be Mock Tests (MCQ, MSQ and NAT) as well as Classroom Lectures on each part. This will not only assist the students to recapitulate the portion of the topics that are covered in the Part-I , Part-II & Part-III of the UG course, but also to practice solving the MCQ (Multiple Choice Questions), MSQ (Multiple Select Questions) and NAT (Numerical Answer Type) Questions that are usually given in IITJAM.

Classroom session

There will be Interactive classes by knowledgeable and experienced faculty members in an effort to expand the student's ability to understand and develop analytical skills and question solving aptitude.

Practice Problem Sheets

Students will be provided with 25 to 30 questions (MCQ, MSQ & NAT) in the class to monitor their progress. The questions will be selected in such a

way that they will bear a certain concept and this will be of immense help to the students.

Doubt Clearing Classes

We will also conduct the doubt clearing classes regularly after completion of each course. Student's doubts from practice problem sheets will be clarified from the grass root level to ensure complete preparation in all respect.

Printed Study Material

Study Material prepared by our subject faculties will be provided and it will cover relevant theory notes, illustrations with stage by stage system to and it will indeed be beneficial for the students.

Online Periodic Assessment Tests

These tests will be conducted according to the schedule that will be provided at the time of admission. The intention of periodic assessment tests (via offline and online) is continuous assessment of the extent of preparedness of students (own / comparative) and compel him/her to study, practice and execute as per the requirement.

Visit our website for more details: https://www.aspirationacademy.in/

Academic Performance Analysis

Students' academic performance in each test may be analyzed on the basis of various parameters at macro level through STUDENTS' TEST ANALYSIS REPORT. Analysis will be subject wise, topic wise, and question wise, etc. and special academic initiatives may be taken to improve the performance.

IIT JAM | M.Sc. Entrance Classroom Course Syllabus

PHYSICAL CHEMISTRY

UNIT – 1: GASEOUS STATE, CHEMICAL KINETICS & ADSORPTION:

- **GASEOUS STATE:** Kinetic theory of gases, Maxwell-Boltzmann distribution law – detailed treatment. Equipartition principle. Fundamental concepts for real gases- van der Waal's equation. Deviation from ideal behavior; Compressibility factor; Amagat's curves and Boyle temperature, Andrew's experimental curves. Van der Waals interpretation of these curves. Critical constants in terms of van der Waals equation; Reduced equation of state-law of corresponding states. Virial equation of state.

- **CHEMICAL KINETICS:** Degree of advancement of a reaction. Rate law – reaction rate, rate constant, order and molecularity. Reactions of zero order, first order and fractional order; Pseudo first order. Concept of rate determining step and steady state approximation and their applications. Complex reactions - Parallel, opposing and consecutive. Temperature dependence of rate constant- Arrhenius' equation, activation energy. Theory of reactions – collision theory and transition state theory-basic treatment, concept of enthalpy and free energy of activation. Primary kinetic salt effect and its applications. Lindemann theory of unimolecular reactions.
  Basic knowledge of catalyst and catalysis. Homogeneous and Heterogeneous catalysis. Acid base catalysis, auto catalysis and enzyme catalysis. Michaelis - Menten equation, influence of temperature and pH. Chain reactions - normal and branched. photochemical processes.

- **ADSORPTION:** Gibbs adsorption equation; adsorption isotherm; types of adsorption; surface area of adsorbents; surface films on liquids

UNIT – 2: THERMODYNAMICS & THERMOCHEMISTRY:

- **THERMODYNAMICS:** System and surroundings –basic concepts and examples, Extensive and intensive properties- basic concepts and examples, State functions and path functions-fundamental knowledge and basics properties. Zeroth law of thermodynamics and concept of thermal equilibrium. Heat and work (IUPAC convention)- calculation of work done for reversible and irreversible processes and relevant graphical representation.

First & Second law of Thermodynamics –Concept of 'U'& 'H' as a state function. Concept of C_p and C_v. Isochoric, Isobaric, Isothermal and Adiabatic processes (detailed mathematical treatment).
Heat reservoirs, heat engines and refrigerators. Kelvin –Planck statement and Clausius statement and their equivalence. Carnot's theorem and its consequences. Carnot's cycle- detailed mathematical treatment and various graphical representations. Concept of entropy as a state function. Clausius inequality and its significance and second law in terms of entropy. Equations of state (1^{st} and 2^{nd} equation of state). Calculation of entropy for various reversible and irreversible processes. Auxiliary state functions (G&A) – their variations with fundamental state functions T, P & V, criteria for spontaneity and equilibrium there from. Thermodynamics relations: Maxwell's relation, Gibb's-Helmholtz equations. Joule's experiment and its consequences. Joule-Thomson experiment – concept of Joule –Thomson co-efficient, concept of inversion temperature, comparison with isoentropic process.

- THERMOCHEMISTRY: Heat changes during various physicochemical processes, Kirchoff's relations, concept of standard state, Bond dissociation energy.

UNIT – 3: CHEMICAL, IONIC & PHASE EQUILIBRIUM:

- CHEMICAL EQUILIBRIUM:- Thermodynamics conditions for equilibrium, Van't Hoff's reaction isotherm – k_p , k_c and k_x. Van't Hoff's reaction isobar and isochors- effect of temperature on K. Le-chatelier's principle- effect of temperature, pressure and introduction of inert gas. Clausius – Clapyeron equation, concept of triple point, phase diagrams of one component system.

- IONIC EQUILIBRIUM- pH and buffer solutions, hydrolysis, solubility product.

- PHASE EQUILIBRIUM- phase rule and its applications, binary system- ideal solutions, Duhem-Margules equations, Henry's law, Konowaloff's rule, fractional distillation, phase diagrams, azeotrope , eutectic, partial miscibility and critical solution temperature. *Colligative properties*: Thermodynamic derivation and their interrelationships, abnormal colligative properties.

UNIT – 4: ELECTROCHEMISTRY

- CONDUCTANCE: Electrical conductance – specific and equivalent conductance for strong and weak electrolytes and effect of dilution, concept of infinite dilution, mobility of ions, conductometric titrations. Kohlrausch's law –

independent migration and applications. Transport numbers- dependence and determination.

- ELCTROCHEMICAL CELL: Types of cells with examples and cell reactions , application of Nernst equation, ΔG, ΔH and ΔS of a cell reaction and its application in various types of potentiometric titrations-determination of solubility product and other examples, glass electrode and pH determination. Concentration cells with and without transport, liquid junction potential and its elimination, polarography.

UNIT – 5: QUANTUM CHEMISTRY & SPECTROSCOPY:

- QUANTUM CHEMISTRY: Fundamental particles; Bohr's theory of hydrogen-like atom; wave-particle duality; uncertainty principle; Schrodinger's wave equation; quantum numbers; shapes of orbitals; Hund's rule and Pauli's exclusion principle; electronic configuration of simple homonuclear diatomic molecules. Postulates of quantum mechanics –interpretation of wave function and their acceptability, elementary concept of operators –various types with examples, calculation of average values of various physical observables. Concept of particle in a box problem: - Detailed quantum mechanical treatment of particle in one dimensional box. Hence its extension to two and three dimensions and the concept of degenerate energy levels.

- SPECTROSCOPY: Rotational spectroscopy of diatomic molecules-Rigid rotator model, selection rules, spectral lines, bond length and isotopic substation. Vibrational spectroscopy of diatomic molecules- SHO model, selection rules, spectrum, anharmonicity- energy levels, selection rules and spectrum. Roto-vibronic spectrum of diatomic molecules: branching of the spectral lines, Raman Effect and its simple applications- mutual exclusion principle.

UNIT – 6: SOLID STATE & PHOTOCHEMISTRY:

- SOLID STATE: Crystal planes, designation by rational indices, Bragg's law and its applications, percentage occupancy and crystal structures, heat capacities of solids- Einstein and Debye concepts. X-rays; NaCl and KCl structures; close packing; atomic and ionic radii; radius ratio rules; lattice energy; Born-Haber cycle; isomorphism; heat capacity of solids.

- PHOTOCHEMISTRY: Laws of photochemistry and quantum yield. Lambert – Beer's law and applications. Frank-Condon principle- Potential energy curves, Jablonski diagrams, Fluorescence and phosphorescence and non-radiative decay, photochemical dissociations and pre-dissociation. Photo stationary state, photosensitized reaction and actinometry.

INORGANIC CHEMISTRY

UNIT – 1: PERIDIC TABLE & CHEMICAL BONDING:

- **PERIDIC TABLE:** Classification of elements in the modern form of periodic table; periodicity in the atomic radius, ionization enthalpy, electro-negativity and electron affinity of the representative elements, transition elements and the inner transition elements; general methods of isolation and purification of elements.

- **CHEMICAL BONDING:** VSEPR– application and shortcomings; concept of hybridization, Resonance, Dipole Moment, pseudo-rotation, Bent's Rule and applications, odd electron molecules; Lattice Energy and its application, concept of radius ratio, Born Haber cycle, lattice defect; polarization; MO approach for bonding in simple molecules.

UNIT – 2: CHEMISTRY OF MAIN GROUP ELEMENTS:

- **CHEMISTRY OF MAIN GROUP ELEMENTS:** General trends in the oxidation states, elemental state, catenation property, hydrolytic behavior, redox properties, acidity trends. Structure and Bonding as well as reactivity in diborane, boron halides, aluminium and galium halides, boron nitride, borazine, boric acid, graphite, diamond, fullerenes, silicates, silicones, oxides of N and P, oxoacids of P, phosphonitriles, oxoacids of S, Se and Te, O_2F_2, SF_4, SF_6, S-N compounds, oxoacids of halogens, fluorides and oxides of Xe.

UNIT – 3: RADIOACTIVITY & COORDINATION CHEMISTRY (I):

- **RADIOACTIVITY:** Problems related to disintegration, radioactive equilibrium and nuclear stability (n/p ratio, NBE, odd-even rule); nuclear reactions including transmutations, application of isotopes.

- **COORDINATION CHEMISTRY (I):** Werner's Theory and applications, IUPAC Nomenclature and Isomerism.

UNIT – 4: BONDING IN COMPLEXES & ANALYTICAL CHEMISTRY (I):

- **BONDING IN COMPLEXES:** 18-e-rule, VBT, CFT and applications, tetragonal distortion and JT Theorem, Spectrochemical and Nephalauxetic series & MOT.

- **ANALYTICAL CHEMISTRY (I):** Principles of Qualitative and Quantitative Analysis; concepts of acids and bases-different theories; redox principles in analysis; complexometry and precipitation reactions; choice of indicators in acid-base, redox as well as in complexometric titrations.

UNIT – 5: ORGANOMETALLICS & ANALYTICAL CHEMISTRY (II):

- ORGANOMETALLIC CHEMISTRY: Aspects of Bonding, spectra and reactivity in metal carbonyls and nitrosyls, metallocenes, complexes of π-donor, π-acceptor ligands e.g. Zeise's salt, metal phosphine complexes. Organometallic Catalysts (Wilkinson, $Co_2(CO)_8$ and Zeiglar Natta)

- ANALYTICAL CHEMISTRY (II): Instrumental Methods of Analysis: Basic Principles and Applications of conductometry, UV-vis spectro-photometry and potentiometry; analysis of water, air and soil samples.

UNIT – 6: ELECTRONICSPECTRA, MAGNETOCHEMISTRY & BIO-INORGANIC CHEMISTRY:

- ELECTRONIC, CT SPECTRA AND MAGNETOCHEMISTRY: Electronic Spectra in transition metal complexes– d-d spectra and Orgel Diagrams for d^n H.S systems, CT spectra (LMCT, MLCT and MMCT), Magnetochemistry for transition metal complexes– orbital contribution to the magnetic moment and spin orbit coupling.

- BIO-INORGANIC CHEMISTRY: Role of metal ions in biology; structure of the active site and bio-function of Hemoglobin, Myoglobin, Ferredoxins, Cytochromes, Cytochrome C oxidase, Carboxypeptidase, Carbonic Anhydrase, Nitrogenase; metal ions as drugs and chelation therapy.

ORGANIC CHEMISTRY

UNIT – 1: FUNDAMENTAL ORGANIC CHEMISTRY & ACYCLIC STEREOCHEMISTRY:

- **FUNDAMENTAL ORGANIC CHEMISTRY:** Electronic effect (inductive, resonance, hyperconjugation, tautomerization) and steric effects and its applications (acid/base property).

- **ACYCLIC STEREOCHEMISTRY:** Stereogenicity, Chirotopicity. Pseudoasymmetric centres. Enantiotopic and diastereotopic atoms, groups and faces. Stereoselective and stereospecific synthesis. Chirality of organic molecules with or without chiral centers (allenes, biphenyls). Specification of configuration in compounds having one or more stereogenic centres. Conformational analysis of acyclic. Geometrical isomerism. Configurational and conformational effects on reactivity and selectivity/specificity.

UNIT – 2: REACTIVE INTERMEDIATES, AROMATICITY, SUBSTITUTION, ELIMINATION & NGP:

- **REACTIVE INTERMEDIATES:** Discussion involving reactive intermediates- carbocations, carbanions, carbenes, nitrenes, arynes, free radicals.

- **AROMATICITY, SUBSTITUTION, ELIMINATION AND NGP:** Concept on Aromaticity (aromatic/antiaromatic/nonaromatic/homoaromatic), Functional group interconversion, structural problems using chemical reactions (based on substitution, elimination and NGP), identification of functional groups by chemical tests.

UNIT – 3: ORGANIC NAME REACTIONS:

- **NAME REACTIONS:** Synthesis, reactions, mechanisms and selectivity involving the following name reactions- Cis and Trans hydroxylation, Oxymercuration-demercuration, Hydroboration-oxidation, Birch reduction, Mitsunobu Reaction, Simmons-Smith reaction, Reimer-Tiemann reaction, Michael reaction, Darzens reaction, Wittig reaction, McMurry reaction, Wacker Reaction, Oxidation and reduction reactions in organic chemistry.

UNIT – 4: MOLECULAR REARRANGEMENTS, FRAGMENTATION & ORGANOMETALLIC CHEMISTRY:

- **REARRANGEMENTS:** Molecular rearrangements involving electron deficient atoms (elementary ideas). Hofmann-Lossen-Curtius-Schmidt rearrangement, Wolff rearrangement, Pinacol-pinacolone, Favorskii, Benzil-benzilic acid

rearrangement, dienone-phenol rearrangement, Bayer-Villeger reaction. Beckmann Rearrangement and Fragmentation.

- ORGANOMETALLIC CHEMISTRY: Organometallic reagents in organic synthesis (Grignard, Organolithium, Organocopper, Organozinc).

UNIT – 5: CYCLIC STEREOCHEMISTRY, CONFORMATIONAL ANALYSIS & BIO-ORGANIC CHEMISTRY:

- CYCLIC STEREOCHEMISTRY: Baeyer strain theory.

- CONFORMATIONAL ANALYSIS: Cyclohexane, mono and disubstituted cyclohexane, symmetry properties and optical activity. Conformation & reactivity in cyclohexane system: elimination (E2), rearrangement, nucleophilic substitution (S_N1, S_N2, NGP), oxidation of cyclohexanol, esterification, saponification, lactonisation.

- BIO-ORGANIC CHEMISTRY: Carbohydrates and amino acids, peptides, nucleic acids and introductory chemistry of alkaloids, terpenes.

UNIT – 6: PERICYCLIC REACTIONS, SPECTROSCOPY & HETEROCYCLIC CHEMISTRY:

- PERICYCLIC REACTIONS: Diels-Alder reaction, Sigmatropic reactions(mainly [1,3], [1,5], [3,3], [2,3] Sigmatropic Shift)

- SPECTROSCOPY: Elementary ^1H NMR and IR spectroscopy as a tool for structural elucidation.

- HETEROCYCLIC CHEMISTRY: Structure, preparation, properties and reactions of pyrrole, furan, thiophene, pyridine, indole and their derivatives.

For ONLINE EXAM

Visit our website for more details:

https://www.aspirationacademy.in/

Venue and Batch Timing

South Kolkata: 30A, Southern Avenue Kolkata - 26. (Near Kalighat Metro)
Batch Timing: Every Sunday 3pm to 5pm

North Kolkata: 47, Tarak Pramanick Rd Kolkata - 06. (Near Girish Park Metro)
Batch Timing: Every Sunday 6pm to 8pm