

Tamil Nadu Public Service Commission
Syllabus
Chemistry and Chemical Engineering
(Degree Standard)

Code: 529

Unit I: Solid State Chemistry (20 Questions)

Crystal systems – Designation of crystal faces. Lattice structure and unit cell, law of rational indices – Bragg's Law and X-ray diffraction by crystals – Determination of crystal structure by Bragg's Method – Structure of NaCl, Wurzite, TiO_2 and Spinel -Crystal defects: Stoichiometric and non-Stoichiometric defect – line and plain defects - Schottky and Frenkel defects – Electrical Properties – Insulators and semiconductors – Band theory of solids – Superconductors – Nanomaterials preparations and properties

Unit II: Co-ordination Compounds, Rare Earth Elements and Nuclear Chemistry (20 Questions)

Chemistry of Co-ordination Compounds: structural aspects, isomerism-octahedral and tetrahedral, crystal-splitting of orbitals - CFSE - magnetism and color of transition metal ions - charge transfer spectra - crystal field theory and ligand field theory – MO theory complexes of pi-acceptor ligands - stereochemistry of inorganic co-ordination compounds.

Chemistry of lanthanides and actinides: Electronic configuration - occurrence and separation techniques -oxidation states, colour. Magnetic and spectroscopic properties – lanthanide contraction, use of lanthanide compounds as shift reagents.

Nuclear Chemistry: Radio activity - detection and measurement – Half-life period - nuclear stability - n/p ratio - isotopes, isobars and isotones -nuclear reactions - spallation - nuclear fission and fusion - stellar energy - Uses of nuclear energy - Applications of radioactive isotopes in industries, medicine and agriculture.

Unit III: Chemical Kinetics and Electrochemistry (20 Questions)

Rate laws - order and molecularity of reactions - I, II, III, and zero order reactions – concept of Arrhenius theory - Collision theory and Transition state theory.

Conductance in electrolytic solution, specific and molar conductance - Ostwald's dilution law - Kohlraush's law - Debye Huckel theory- Types of reversible electrodes - Nernst equation - reference electrode and standard hydrogen electrode - computation of cell e.m.f. -calculations of thermodynamic quantities of cell reactions (ΔG , ΔH , ΔS and K) Determination of pH and pKa of acids by potentiometric methods. Primary and secondary fuel cells – Corrosion and prevention - dry cells and storages batteries

Unit IV: Organic Reaction Mechanism (20 Questions)

Nature of bonding - Hybridization (sp , sp^2 and sp^3) and Geometry of molecules - cleavage of bonds - homolytic and heterolytic fission of carbon-carbon bonds - General methods (Kinetics and non-Kinetic) of study of reaction mechanism - Method of determining reaction mechanism – isotopic labelling, SN_1 , SN_2 Mechanism – addition substitution reactions, Elimination Reactions E_1 , E_2 and E_{1CB} , thermal elimination, rearrangements, free radicals mechanism, aromatic substitution – and stability of reactive intermediates (Carbocations, Carbanion's free radicals, nitrate and benzyne) – Polar effects – Hammett's equation and its modification.

Unit V: Stereochemistry, Carbohydrates and Amino acids (20 Questions)

Optical isomerism and Geometrical isomerism - chirality - optical isomerism of lactic and tartaric acid - Racemization – Resolution-asymmetric synthesis - Walden inversion - *cis* and *trans* isomerism of maleic and fumaric acids-R and S-Notations, E and Z nomenclature - conformational analysis of cyclohexane.

Classification, sources, preparation and reactions - Glucose, Fructose, Sucrose and lactose - structure of glucose and fructose.

Classification - Zwitter ion - peptide linkage - structure of proteins - structure and functions of DNA and RNA

Unit VI: Chemical Technology, Chemical Process Calculations, Mechanical Operations (20 Questions)

Fertilizers, Cement, Glass, Ceramic and Refractories, Fermentation Products, Oils, Soaps and Detergents, Pulp and paper, Dyes, sugar, leather and rubber, polymer, pharmaceutical and food industries, Marine chemicals.

Properties of gases, liquids and solids, Humidity and saturation, Gas laws, steady and unsteady state material balance - involving recycle, by-pass and purge systems, Material with reactions, use of tie components, Gibbs Phase rule and degree of freedom analysis.

Laws of size Reduction, Mixing and agitation, Filtration, Sedimentation and Conveying of solids. Materials of construction for chemical Industries - Metallic, Non-metallic, Polymeric and composite materials, Nano and biomaterials. Corrosion - prevention and control.

Unit VII: Thermodynamics, Fluid Mechanics and Heat transfer (20 Questions)

Thermodynamics functions - Chemical and Phase Equilibrium - Ideal and non-ideal gases and solutions – Equation of state and residual properties, compression of fluids, Second law of Thermodynamics and entropy, Chemical potential, properties of mixtures - fugacity, partial molar properties, excess properties and activity coefficient. Predicting Vapour Liquid Equilibrium (VLE) of systems, Free Energy Change and Chemical Reaction Equilibrium.

Fluid Statics, Newtonian and Non-Newtonian fluids, Types of Manometers, Equation of continuity, Equation of motion, Bernoulli equation, Friction Factor, Dimensional analysis and similitude, Flow through pipes, velocity profiles, flow through fixed and fluidized beds, flow meters.

Thermal boundary layer and heat transfer coefficient. Design of heat exchangers- Double pipe, Shell and tube, single and multiple effect evaporators.

Unit VIII: Mass Transfer, Separation Processes and Process Control (20 Questions)

Fick's Law, Diffusion, Mass Transfer Coefficient and theories of Mass Transfer, Momentum, Heat and Mass transfer analogies, Inter phase Mass transfer operations, Transfer Unit concepts, Design of equipment - Distillation, Extraction, Absorption, Drying. Crystallization and Membrane separation processes, Ion Exchange chromatography and electrodialysis, Separations involving pervaporation and permeation techniques for solids, liquids and gases, supercritical fluid extraction.

Sensitivity analysis, Constrained and unconstrained NLP, Newton's method, Quasi-Newton's method, Cost estimation, Plant utilities, pinch technology, Laplace transformation, application to solve Ordinary Differential Equation (ODEs). Open-loop systems, first order systems, first order

systems in series, second order systems and their dynamics; transportation lag. Closed loop control systems, feed-back control systems, BODE diagram, stability criterion, frequency response.

Unit IX: Chemical reaction Engineering and Computational methods (20 Questions)

Reaction rates - homogeneous and heterogeneous reactions, single and multiple reactions in ideal reactors. Residence time distribution. Design of reactors - Isothermal and non-isothermal fixed bed reactors and fluidized bed reactors. Kinetics of heterogeneous catalytic reactions. Diffusion effects in catalysis- rate and performance equations, Catalyst deactivation.

Numerical solutions of linear and non-linear algebraic equations, solution of initial and boundary values, Integration of Simpson rule. Solution of partial differential equations. Eigen value problems - Theorem for Eigen values and Eigen functions.

Unit X: Environmental Engineering, Occupational Safety and Health in Chemical Industry (20 Questions)

Air, Water, Soil pollution and Noise control. Wastewater treatment by various methods: Chemical, biochemical and advanced oxidation process. Industrial hygiene, occupational safety & health in chemical industries, Industrial safety principles, plant layout, chemical hazards identification and classification, Safety in operations and processes, fire safety, hazard identification techniques, disposal of hazardous and toxic wastes, onsite and offsite emergency preparedness plan, safety audit, work permit system, roles and responsibilities of safety officers and welfare officers, occupational diseases.

Kohlberg's theory – Gilligan's theory - Safety and Risk – Assessment, Risk Benefit Analysis and Reducing Risk, Respect for Authority, Collective Bargaining, Confidentiality, Conflicts of Interest, Occupational Crime, Professional Rights, Employee Rights. Intellectual Property Rights (IPR), Employee Discrimination. Multinational Corporations, Environmental Ethics & legislation – Engineers as Managers, Expert Witnesses and Advisors. Moral Leadership, Code of Conduct, Corporate Social Responsibility

Dated: 25.03.2025