

RAJASTHAN PUBLIC SERVICE COMMISSION, AJMER
SYLLABUS FOR SCREENING TEST FOR THE POST OF

SENIOR CHEMIST

(MINES & GEOLOGY DEPARTMENT)

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy, use of tie components, recycle, bypass and purge calculations; degree of freedom analysis. First law of thermodynamics and its application to close and open systems, Second law of thermodynamics, Entropy, thermodynamic properties of pure substances: equation of state and departure function, properties of mixtures, partial molar properties, fugacity, excess properties and activity coefficients, phase equilibria: predicting VLE of systems, chemical reaction equilibria.

Fluid Flow Operation: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation and its applications, Orifice and Venturi meter, impulse momentum equation and its application, friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation, types of heat exchangers, evaporators and their design.

Mass Transfer: Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories, momentum, heat and mass transfer analogies, stagewise and continuous contacting and stage efficiencies; HTU and NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, Constant volume and Varying volume Batch Reactor, Batch Reactor Design Equations, Design Equations for Flow Reactors, Applications of the Design Equations for Continuous-Flow Reactors, Reactors in Series.

Plant Design and Economics: Process design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in design.

Mechanical Operation: Particle size and shape, Measurement and analysis, Screening and screen analysis- Screen effectiveness, working principle of industrial screening equipments, Shape factor, Selectivity index. Size reduction, principal of comminution, Crushing, Grinding, Pulverization, Ultra fine grinding, Grindability, Crushing laws.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

Petroleum: Origin occurrence of petroleum, Formation and Evaluation of Crude Oil, Testing of Petroleum Products, Petroleum refining processes, Cracking and reforming, Fluid catalytic cracking, general processing, vacuum distillations. Thermal cracking in vapor, liquid and mixed phase, Overview of Refinery Products, Proximate and ultimate analysis of solid, liquid and gaseous fuels: Calorific value, Antiknock rating and octane number, Cetane number, flash point; Char value, Smoke point, viscosity and Aniline point.

Environmental Technology: Classification of air pollutants, Primary and Secondary pollutants, Source of air pollution, Atmospheric Dispersion: Meteorology, Adiabatic lapse rate, Atmospheric stability, Inversion – types of inversion, maximum mixing height, Atmospheric classes, Plumes and types of plumes under different atmospheric condition, plume rise, Particulate Pollutant: Particulate pollution and control equipment, centrifugal collector, Electronic precipitators, Bag filter and Scrubber, Characteristic of water and waste water, Oxygen Demand, BOD, NBOD, CBOD, Primary Treatment by Sedimentation, Flocculation, Coagulation, Filtration, Disinfections, Waste water treatment, Biological (secondary) waste water treatment, Advance treatment methods.

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Pattern of Question Papers:

1. Objective Type Paper
2. Maximum Marks : 100
3. Number of Questions : 100
4. Duration of Paper : Two Hours
5. All Questions carry equal marks
6. There will be Negative Marking
7. The candidate has to choose either Chemical Engineering or Chemistry.

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CHEMISTRY

1. Atomic orbitals, quantum numbers, electronic configuration of the elements. Periodicity in different properties of elements. Ionic, covalent and coordinate bonds. Hybridization, VBT, MOT.
2. Explanation of magnetism, bonding, geometry, spectral behavior, color and coordination of transition metal complexes on the basis of VBT and CFT. General characteristics, oxidation state, magnetic & spectral properties and uses of lanthanoids and actinoids.
3. Solid State – Metals, Insulators and Semi conductors, electronic structure of solids, Band theory – Band structure of solids, Intrinsic and extrinsic semiconductors, doping semiconductors, p-n junction.
Crystal Defects- Types of Defects, thermodynamics of Schottky and Frenkel defect.
4. Classification, general study and applications of non-aqueous solvents with special reference to liquid NH_3 , liquid SO_2 , liquid HF and anhydrous H_2SO_4 . Arrhenius, Bronsted and Lewis concept of acids and bases. HSAB.
5. Minerals, ores, general principles of extraction of metals and their purification with special reference to Cu, Pb, Zn, Al & Fe. Ellingham Diagram. Principle and applications of solvent extraction with special reference to U, Mo, Fe, Cu and Ni.
6. Corrosion- Surface mechanism of the corrosion of the metals, thermodynamics and stability of metals, factors influencing corrosion. Measurement of corrosion rate: (i) Weight loss method (ii) Electrochemical method.
Inhibiting corrosion- prevention and control methods.
7. Electrochemistry- Electrochemistry of solutions, Nernst equation, redox systems, electrochemical cells, Debye Huckel theory, electrolytic conductance, Kohlrausch law and its applications, ionic equilibria, conductometric and potentiometric titrations.
8. Soil and soil pollution- definition, types, components and fertility management of soils. Physical and chemical analysis of soil with various parameters. Types, sources and different parameters of soil pollution, its control. Behaviours of heavy metal ions and pesticides in the soil and their effects.
Water and water pollution- sources, quality parameters and analysis of water. Hardness, softening techniques, sources of water pollution. Treatment of sewage and industrial waste water.

9. Solutions- Normal, Molar and Molal solutions, Equivalent weight, indicator, buffer solution, solubility product, common ion effect, pH, hydrolysis of salt, surface tension and viscosity.
Dilute solution- Colligative properties, Osmotic pressure & Molecular weight determination.
10. Chromatography- Paper, column, thin-layer chromatography, high performance thin-layer chromatography (HPTLC), high performance liquid & gas-liquid chromatography (HPLC, GLC). Basic principles & applications.
11. (a) Classification and structure of silicates, uses of silicates and zeolites in industry and technology.
(b) Cationic, anionic, chelating and liquid ion exchangers, their mechanism of action and applications. Demineralisation of sea water.
12. Introduction, principle and application of Mosbauer, Raman, ESR, IR, UV, AAS, NMR spectroscopy with special reference to structural inorganic chemistry. Principle, instrumentation and applications of inductively coupled plasma emission spectroscopy.
13. Introduction, principle, methodology and applications of voltammetry polarography. Ilkovic equation.
Fundamental concepts, principles, methodology of DTA and TGA. Thermometric titrations.
14. General awareness of computer, basic knowledge of hardware and software, input-output devices, memory & secondary storage. Introduction to computer language and operating system, principles of Programming, Algorithm & Flow charts. Precision, Accuracy, Standard Deviation, Correlation coefficient and significant figure. Laboratory, maintenance and preparation of Reagents.

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