RAJASTHAN PUBLIC SERVICE COMMISION, AJMER

SYLLABUS FOR THE POST OF SENIOR SCIENTIFIC OFFICER - PHYSICS DIVISION
STATE FORENSIC SCIENCE LABORATORY, RAJASTHAN, JAIPUR.

PHYSICS
PART- I

Topic 1 . Conservation Laws. Collisions, impact parameter, centre of mass and lab systems with transformation of physical quantities. Rotating frame of reference, coriolis force, motion of rigid bodies, moment of inertia, angular momentum, torque and precession of top. Central forces, motion under inverse square law, Special Theory of Relativity, Michelson-Morely experiment, Lorentz Transformations-addition of velocities, Time dilation and length contraction, variation of mass with velocity, mass-energy equivalence.

Oscillations, simple harmonic motion, damped harmonic motion, force oscillation and resonance. Wave equation, harmonic solutions, plane and spherical waves, superposition of waves, beats, stationary waves, phase and group velocities. Conditions of interference, Newton's rings and Michelson's interferometer. Diffraction-Fresnel and Fraunhofer, diffraction by plain transmission grating, Rayleigh criterion, resolving power of grating and telescope Polarisation : Plane, circular and elliptically polarized light, its production and detection .

Topic 2. Kinetic theory of gases, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac Distribution. Maxwell's distribution of velocities, equipartition of energy, specific heats of gases, mean free path Brownian motion. Black-Body radiation. Wien's law, Planck' law, Solar constant, specific heat of solids - Einstein and Debye theories.

Electric field and potential, Gauss's law. Poisson's and Laplace equations, dielectrics and polarization, dielectric sphere placed in a uniform electric field. Electromagnetic induction, transformer. Transient behaviour of R-C, and R-L

circuits, time constant. Response of an L-C-R circuit for alternating voltages; series and parallel resonance, band-width and Q-factor. Magnetic properties of materials: para, dia ferro, anti-ferro and ferri magnetism. Curie and Curie - Weiss Laws ,maxwell's equations and their application to plane electromagnetic wave. Poynting vector. Vector and scalar potentials; Electromagnetic field tensor, covariance of Maxwell's equations; Wave equations in isotropic dielectrics, reflection and refraction at the boundary of two dielectrics; Fresnel's relations; Total internal reflection; Normal and anomalous dispersion; Lasers, He-Ne and Ruby lasers, spatial and temporal coherence, elementary ideas about holography and laser applications.

Topic 3. De Borglie waves. Photo-electric effect, Compton effect, wave-particle duality, Uncertainty principle; size of H-atom, zero point energy, wave packet, finite width of energy levels. Schrodinger wave equation with application ,Hydrogen spectrum, electron spin, Stern-Gerlach experiment, space-quantisation, vector model of atom, J-J and L-S coupling, Zeeman effect, characteristic and continuous x-rays.

scanning and transmission electron microscopies; Band theory of solids - conductors, insulators and semiconductors; Thermal properties of solids, specific heat, Debye theory, Elements of superconductivity, Meissner effect, Josephson junctions and applications; Elementary ideas about high temperature superconductivity.

Kirchhoff's law, Thevenin, Norton and maximum power-transfer theorems. Input and output impedances. p-n junction diode, use of diode for rectification, zener diode and its use in voltage regulation. Transistor, its biasing, common emitter amplifier. Feedback, Barkhausen criterion, oscillators, Basic principles of radio and T.V. transmission and reception, Digital electronics-Boolean identities, De Morgan's laws, logic gates and truth tables; Simple logic circuits.

PART -II

Topic 4. Spectroscopic methods in structure determination of organic compounds: Different units of measurement of wavelength frequency, different regions of electromagnetic radiations. Interaction of radiation with matter, excitation of molecules with different energy levels, such as rotational, vibrational and electronic level, types of spectroscopy and advantages of spectroscopic methods of X-ray analytical method, Electron Microscopy, I R microscopy, Raman spectrographic methods , U V spectroscopy. DTA Methods.

Instrumental Analysis of Glass, Refractive index measurement, methods of analysis of Metals, Alloys, Cement, Sand and elementary knowledge of ore composition and separation .

Forensic methods of soil analysis, Density gradient methods and preparations, Short circuit Analysis, Micro etching processes on metals , restoration of metallic surfaces for vehicle identification numbers, Basic principles of vehicle accident analysis , Tool marks examination, Basic methods of fiber identification and examination. Metal composition and alloys, elementary knowledge of paper making and analysis.

Topic 5 . Elementary knowledge of computer hardware and software, processors, Microsoft office, Operating systems. Software applications, Mobile hardware and applications. Basic knowledge of electronic storage media.

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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 Physics or Physical Chemistry.

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PHYSICAL CHEMISTRY

PART –I

Topic 1. Chemical kinetics: order, molecularity, methods to determine order of reaction using integrated rate equation, zero, first, second and half integral order reactions, determining the order- graphical method, half-life method, differential method, effect of temperature on reaction rate, Arrhenius equation.

Basics of atomic structure: electronic configuration, shapes of orbitals, hydrogen atom spectra.

Electrolytic conductance, specific and equivalent conductance, variation of equivalent conductance with concentration, Kohlrausch's law and its applications. Electrochemical cells: Reversible and irreversible cells, EMF and its measurements, standard cells, cell reaction and EMF, single electrode potential and its calculation, calculation of cell EMF, thermodynamics of cell EMF, types of electrodes, classification of electrochemical cells with and without transference, applications of EMF measurement i) Solubility product of sparingly soluble salt, ii) Determination of pH, iii) Potentiometric titration.

Topic 2. Zero, first, second and third law of thermodynamics- enthalpy, entropy, free energy and their dependence on pressure and temperature.

Surface Chemistry: adsorption, physisorption and chemisorption, Freundlich and Langmuir adsorption isotherms, surface area determination. Phase rule: Definitions, Gibb's phase rule, one component system (moderate pressure only) for sulphur and water system, two component system for silver-lead and zinc-cadmium.

The atom, nucleus and outer sphere, classification of nuclides, nuclear stability and binding energy, discovery of radioactivity, types of radioactivity, general characteristics of radioactive decay and decay kinetics, measurements radioactivity, gaseous ion collection method, proportional and G.M. counter, applications of radioactivity, radiochemical principles in the use of tracers, typical applications of radioisotopes as a tracer.

Crystal structure: Crystallization and fusion process, crystallography, crystal systems, properties of crystals, crystal lattice and unit cell, crystal structure analysis by X ray, The Laue's method and Bragg's method, X-ray analysis of NaCl crystal system, calculation of d and λ for a crystal system.

Photochemistry: Introduction, thermal reactions and photochemical reactions, laws of photochemistry, quantum yield, measurement of quantum yield, types of photochemical reactions, photosynthesis, photolysis, photocatalysis, photosensitization, photophysical process, fluorescence, phosphorescence, quenching, chemiluminescence.

Topic 3. Molecular Orbital Theory: Limitations of Valence Bond theory (VBT), need of Molecular Orbital Theory (MOT), features of MOT, formation of molecular orbitals (MO's) by LCAO principle, rules of LCAO combination, different types of combination of Atomic orbital (AO's): σ, π and δ MOs, Non-bonding combination of orbitals (formation of NBMO), M.O. energy level diagram for homonuclear diatomic molecules, bond order and existence of molecule from bond order.

Metallic bonding, band theory in metals with respect to Na along with n (E) and N(E) diagrams, Electrical conductivity of metals (Na, Mg, Al), valence electrons and conductivity.

Ionic Solids: Crystalline and amorphous solids, crystal structures, simple cubic, body centered cubic and face centered cubic, properties of ionic solids, packing arrangements of anions in an ionic solids, voids in crystal structure, tetrahedral and octahedral, ionic radius, Pauling's univalent and crystal radii, conversion of univalent radii to crystal radii, problems based on conversion of radii, radius ratio effect, Lattice energy, Schottky and Frenkel defect.

Heterogenous and homogenous catalysis. Separation techniques, spectroscopic electro- and thermoanalytical methods. Photosystems, porphyrines, metalloenzymes, oxygen transport, electron-transfer reactions, nitrogen fixation.

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