RAJASTHAN PUBLIC SERVICE COMMISSION, AJMER

SYLLABUS OF COMPETITIVE EXAMINATION FOR THE POST OF LECTURER (SCHOOL EDUCATION)
PHYSICS

PAPER – II

Part – I Senior Secondary Level

1. **Physical World and Measurement** - Fundamental and derived units, systems of units, dimensional formula and dimensional equations, accuracy and error in measurement.
2. **Description of Motion** - Motion in one dimension, uniformly accelerated motion, motion with uniform velocity/acceleration in two dimensions and relative velocity.
   Vectors - Scalar and vector quantities, unit vector, addition and multiplication.
   Laws of Motion - First, second and third law of motion, impulse, momentum and conservation of linear momentum.
   Friction - Types of friction, laws of friction.
3. **Work, Energy and Power** - Work done by a constant/variable force, work- energy theorem, K.E., P.E., elastic and inelastic collision in one and two dimensions, conservation of energy, conservative and non-conservative forces, power, motion in vertical plane.
4. **Rotational Motion** - Centre of mass, its motion, rotational motion, torque, angular momentum, laws of conservation of angular momentum, centripetal force, circular motion, moment of inertia, theorems of M.I. and rolling motion.
5. **Oscillatory Motion** - Periodic motion, S.H.M. its equation, K.E. and P.E. of S.H.M., simple pendulum and oscillation of a loaded spring.
   Waves - Type of waves, wave equation, speed of a progressive wave, superposition principle, reflection of waves, beats, stationary waves and normal modes and Doppler's effect.
6. **Gravitation**- Universal law of gravitation, variation of g, gravitational potential energy and potential, orbital and escape velocity, planetary motion, Kepler's Law.
7. **Elasticity** - Hooke's law, Young's modulus, bulk modulus and shear modulus of rigidity. Applications of elastic behaviour of matter.
   Surface Tension - Molecular theory of surface tension, excess of pressure inside a drop and soap bubble, angle of contact, capillarity.
   Liquids in Motion - Fluid pressure, Pascal's law, type of flow of liquid, critical velocity, coefficient of viscosity, terminal velocity, Stoke's law, Reynold’s number, Bernoulli's theorem - its applications.
8. **Kinetic Theory of Gases -** Laws for gases, ideal gas equation, assumptions of kinetic theory of gases, pressure exerted by a gas, r.m.s speed of gas molecules, law of equipartition of energy, degree of freedom, specific heats of gases and solids, mean free path.
   Heat and Thermodynamics - Concept of heat and temperature, temperature scales, thermal expansion of solid, liquid and gases, specific heat, change of state, latent heat, calorimetry, zeroth & first law of thermodynamics, thermodynamic process, second law of thermodynamics, heat engine.
   Radiation - Modes of transmission of heat, thermal conductivity, perfect blackbody, Stefen’s law, Newton's law of cooling, Wein’s displacement law.

9. **Ray Optics and Optical Instruments -** Laws of reflection, reflection by plane and curved mirrors, laws of refraction, total internal refraction - applications, lenses, image formation by lenses, thin lens formula, lens maker formula, power of lens, dispersion by prism, scattering of light, eye, defects of vision, microscopes, telescopes.
   Wave Optics - Interference of light, Young's double slit experiment, diffraction of light, single slit diffraction, resolving power of optical instruments, polarisation of light, law of Malus, polarisation by reflection.
10. **Electrostatics -** Coulomb's law, superposition principle, electric field and potential, dipole, Gauss theorem - its applications, electric lines of force, torque experienced by a dipole in uniform electric field, potential energy of a system of charges, equipotential surfaces.
    Capacitance - Capacity of an isolated spherical conductor, parallel plate capacitor, effect of dielectric on capacitance, series and parallel combinations of capacitors, energy of a capacitor.
    Current Electricity – Drift velocity and mobility, Ohm's law, temperature dependence of resistance, colour code of resistors, series and parallel combination of resistors, resistivity, primary and secondary cells and their combination in series and parallel, Kirchoff's laws, Wheatstone bridge and potentiometer - their applications, electrical energy and power.
11. **Magnetism and Magnetic Effect of Current -** Magnetic lines of force, bar magnet, magnetic moment, torque on a magnetic dipole, magnetic induction, magnetic intensity, permeability, susceptibility & intensity of magnetisation - their relations. Curie law, hysteresis, B-H curve, classification of magnetic materials, magnetic force, motion in the magnetic field, force on current carrying conductor, Biot – Savart's law, magnetic field by a straight conductor & circular current carrying coil, Ampere's circuital law, solenoid, toroid, moving coil galvanometer, ammeter, voltmeter.
    Electromagnetic Induction - Faraday's Law, Lenz's Law, self-induction, mutual induction, electric generators.
    Alternating Current - Mean and rms value of a.c., a.c. circuit containing resistance, inductance and capacitance, series resonant circuit, Q factor, average power in a.c., wattless current, power factor, transformer.
12. **Photoelectric Effect and Matter Waves -** Einstein's photoelectric equation, matter waves, de-Broglie's hypothesis, Davison and Germer's experiment.
    Nuclear Physics and Radioactivity – Nucleus, size, mass defect, binding energy, nuclear fission and fusion, nuclear reactor, radioactivity, laws of disintegration, α, β and γ decays.
    Solids and Semi Conductor Devices - Energy band in solids, semi conductor, p-n junction diodes, special purpose p-n junction diodes, junction transistor, logic gates.
    Electromagnetic Waves and Communication – Displacement current**,** electromagnetic waves, electromagnetic spectrum, elements of a communication system, bandwidth of signals and transmission medium, sky and space wave propagation, need for modulation, production and detection of an AM wave.

Part – II Graduation Level

1. **Mechanics:** Inertial frames, Galilean transformation, non-inertial frames, fictitious forces, rotating coordinate systems, Coriolis force and its applications, postulates of special theory of relativity, Lorentz transformations, relativistic addition of velocities, length contraction, time dilation, variation of mass with velocity, mass-energy relation.

System of particles, concept of reduced mass, single stage and multistage rocket, analysis of collision in centre of mass frame, equation of motion of a rotating body, inertial coefficients, kinetic energy of rotation and idea of principal axes, Euler's equations.

Theory of bending of beams and cantilever, torsion of a cylinder, bending moments and shearing forces.

2. **Waves & Oscillations**: Damped harmonic oscillators, power dissipation, quality factor, driven harmonic oscillator, resonance, transient and steady state, power absorption, motion of two coupled oscillators, normal modes.

   Waves in media, speed of longitudinal waves in a fluid, energy density and energy transmission in waves, group velocity and phase velocity.

   Noise and music: the human ear and its responses: limits of human audibility, intensity and loudness, bel and decibel, the musical scale, temperament and musical instruments, the acoustics of halls, reverberation period.

3. **Electromagnetism**: Concept of multipoles, electrostatic energy of uniformly charged sphere, classical radius of an electron.

   Electric Field in Matter: atomic and molecular dipoles, dielectrics, polarisability, polarisation vector, electric displacement, electrostatic energy of charge distribution in dielectric, Lorentz local field and Clausius-Mossotti equation, electrostatic field – conductors in electric field, boundary conditions for potential and field at dielectric surface, uniqueness theorem, Poisson's and Laplace's equations in cartesian, cylindrical and spherical polar coordinates.

   Maxwell's equations (integral and differential form). E as an accelerating field, E as deflecting field, CRO.

4. **Thermodynamics and Statistical Physics**: Maxwell velocity distribution, transport phenomenon: coefficients of viscosity, thermal conductivity, diffusion and their interrelation. Clausius- Clapeyron equation, vapor pressure curve, thermodynamic potentials, Maxwell relations and their applications, production of low temperatures, Joule-Thomson expansion and J.T. coefficients for ideal as well as Vander Waals gas, temperature inversion, regenerative cooling, cooling by adiabatic demagnetization, liquid helium, He-I and He-II, super fluidity, Nernst heat theorem.

   Phase space, micro and macro states, thermodynamic probability, relation between entropy and thermodynamic probability. Bose-Einstein statistics and its distribution function, Planck distribution function and radiation formula, Fermi-Diarc statistics and its distribution function.

5 **Electronics and Circuit Analysis**: Four terminal networks, Z, Y and hybrid parameters of any four terminal network, Input, output and mutual impedance for an active four terminal network, various circuits theorems: superposition, Thevenin, Norton, reciprocity, maximum power transfer theorems.

Rectifiers- half wave, full wave and bridge rectifier, calculation of ripple factor, efficiency and regulation, filters- series inductor, shunt capacitor, L-section and π-section filters, voltage regulation by Zener diode.

Analysis of transistor amplifiers using hybrid parameters and its gain-frequency response, basic idea of R-C coupled amplifiers.

Transistor biasing - stability factors, various types of bias circuits for thermal bias stability, amplifier with feedback: positive and negative feedback, voltage and current feedback circuits.

Oscillators: criteria for self excited and self sustained oscillators, basic transistor oscillator, circuit and its analysis; Colpitts, Hartley oscillators and R-C oscillators.

Junction field effect transistor (JFET), biasing and volt-ampere relations.

6 **Optics**: Interference of light in thin films, Newton rings, Michelson interferometer, Fabry Perot interferometer. Fresnel diffraction: half periods zones, circular aperture, circular disc, straight edge, Fraunhoffer diffraction: double slit, plane diffraction grating.

Lasers and Holography: Spontaneous and stimulated emission, Einstein's A and B coefficients, condition for amplification, population inversion, methods of optical pumping, energy level schemes of He-Ne and Ruby lasers, working of a laser source, holography.

7 **Quantum Mechanics and Spectroscopy**: Failure of classical physics, uncertainty principle and its consequences, application of uncertainty principle.

Schrodinger equation – time dependent and time independent form, probability current density, operators in quantum mechanics, expectation values of dynamical variables, postulates of quantum mechanics, Dirac notation, eigen function and eigen value, degeneracy, commutation relations, Ehrenfest theorem.

Time independent Schrodinger equation and stationary state solution, particle in one dimensional box, extension of results for three dimensional case and degeneracy of levels, potential step and rectangular potential barrier, reflection and transmission coefficient, square well potential problem. bound state problems - particle in one dimensional infinite potential well and finite depth potential well, simple harmonic oscillator (one dimensional), Schrodinger equation for a spherically symmetric potential, orbital angular momentum and its quantisation, spherical harmonics, energy levels of H-atom.

Elementary Spectroscopy: Quantum features of one electron atoms, Frank-Hertz experiment, Stern and Gerlach experiment, spin and magnetic moment, spin-orbit coupling and fine structure. atoms in a magnetic field, Zeeman effect, molecular spectroscopy, rigid rotator, diatomic molecules, rotational spectra, vibrational spectra, vibrational-rotational spectra, raman effect.

8. **Nuclear Physics**: Quadrupole moment and nuclear ellipticity, nuclear spin, parity and orbital angular momentum, proton-neutron hypothesis, the nuclear potential, nuclear forces, semi empirical mass formula, the liquid drop model.

Accelerators- linear accelerators, cyclotron, synchrocyclotron, betatron, electron synchrotron, proton synchrotron.

Particle and Radiation Detectors: ionisation chamber, region of multiplicative operation, proportional counter, Geiger-Muller counter, scintillation counter, cloud chamber.

9. **Solid State Physics**: Crystal binding and crystal structure: Bravis lattice, Miller indices, crystal structure, X-ray diffraction and Bragg's law, Laue equation of X-ray diffraction.

Thermal Properties of the Solids: Phonons, various theories of lattice specific heat of solids: Einstein model, Debye model, electronic contribution to the specific heat of metals, thermal conductivity of the lattice, band theory of solids: wave function in a periodic lattice and Bloch theorem, Kronig-Penney model, effective mass, momentum, crystal momentum.

Electrical Conductivity: Sommerfield theory of electrical conductivity, Mathiessen's rule, thermal conductivity and Wiedemann-Franz's Law, the Hall effect.

Superconductivity: experimental features of superconductivity, the isotope effect, special features of superconducting materials, flux quantisation, BCS theory of superconductivity: cooper pairs.

Part – III Post Graduation Level

1. **Mathematical Physics and Classical Mechanics**: Vector calculus, tensors, matrices, Fourier series, Fourier and Laplace transforms, special functions, complex analysis, probability theory, basic group theory, constraints, D' Alembert's Principle, Langrangian and Hamiltonian formalism, calculus of variations, canonical transformation, Poisson bracket and Poisson theorem, Hamiltonian Principle and Jacobi equation.
2. **Electricity and Magnetism**: Scalar and vector potentials, gauge invariance, electromagnetic waves in free space, dielectric and conductors, radiation from moving charge and radiation from dipole, concepts of wave guides, retarded potentials, Lienard-Wiechart potential, bremsstrahlung and synchrotron radiation.
3. **Thermodynamics and Statistical Physics**: Canonical and grand canonical ensemble, Bose-Einstein condensation, Gibb's paradox, Liouvilles' theorem, first and second order phase transitions, Landau theory of phase transitions. Langevin theory, Fokker-Plank equation, random walk and brownian motion.
4. **Quantum Physics**: Elementary theory of scattering in a central potential, partial wave and phase-shift analysis, identical particle and spin statistics, approximation methods for stationary states, time dependent perturbation, relativistic quantum mechanics, K-G and Dirac equation, semi classical theory of radiation.
5. **Electronics**: Clipping and clamping circuits, multivibrators, operational amplifiers and its applications, half and full adder circuits, K-maps, flip-flops, counters and registers. A/D and D/A convertors, opto-electronic devices.
6. **Atomic, Molecular and Solid State Physics**: Quantum states of an electron in an atom, hydrogen atom spectra, Pauli's Principle, Paschen-Back effect, Stark effect, LS and JJ coupling, hyperfine structure, Frank-Condon principle.
   Semiconductors statistics of pure and impure semi conductors, electrical conductivity and its temperature dependence, recombination mechanisms, photo conductivity, NMR, ESR and Mossbauer effects.
7. **Nuclear and Particle Physics**: Deuteron problem, nuclear shell model, collective model, Interaction of charged particles and electromagnetic waves with matter, meson theory of nuclear force, nuclear scattering: p-p and n-p, Breit- Wigner scattering formula, nuclear reactions, Fermi theory of beta decay, Gamow theory of alpha decay, elementary particles.

Part – IV (Pedagogy, Teaching Learning Material, Use of Computers and Information Technology in Teaching Learning)

I. Pedagogy and Teaching Learning Material (Instructional Strategies for Adolescent Learner)

- Communication skills and use of various verbal and non verbal classroom communication strategies.
- Teaching models- advance organizer and inquiry training (information processing) Group Investigation (Social Interaction) Non-Directive model (Personal development).
- Preparation and use of teaching-learning material during teaching.
- Cooperative learning.

II. Use of Computers and Information Technology in Teaching Learning

- Concept of ICT and Digital learning
- E-learning and Virtual Classroom.
- Technology integration in teaching-learning and assessment.

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For the competitive examination for the post of **School Lecturer:** -

The question paper will carry maximum **300 marks**.

1. Duration of question paper will be **Three Hours**.
2. The question paper will carry **150 questions** of multiple choices.
3. Negative marking shall be applicable in the evaluation of answers. For every wrong answer one third of the marks prescribed for that particular question shall be deducted.
4. Paper shall include following subjects: -
   (i) Knowledge of Subject Concerned: Senior Secondary Level
   (ii) Knowledge of Subject Concerned: Graduation Level.
   (iii) Knowledge of Subject Concerned: Post Graduation Level.
   (iv) Pedagogy, Teaching Learning Material, Use of Computers and Information Technology in Teaching Learning.

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