

**Maharashtra Public Service Commission****Civil Services Exam – Mains Optional****Physics****(Code No : 606)****Paper - I****Standard** : Degree**Total Marks** : 200**Nature of Paper** : Conventional Type**Duration** : 3 Hours

- Note :**
- 1) Answers to this paper must be written in English only
  - 2) This paper will test the candidate's ability to comprehend, to analyse, to interpret, to criticise and to appraise the subject matter related to the topics/sub topics mentioned below.
  - 3) For judging candidates' conceptual understandings, appropriate numbers of numerical problems will be asked.
  - 4) It is expected from candidates to study the latest and recent developments and happenings pertaining to the topics/sub topics mentioned below.

Section - A ( Marks : 50 )

**Classical Mechanics and Properties of Matter**

- 1) Laws of motion, motion in a uniform field, components of velocity and acceleration in different coordinates systems. Uniformly moving co-ordinate system, non-inertial coordinate system, centripetal acceleration. Motion in a central force field, Kepler laws of motion. Gravitational law and field. Potential due to a spherical body, Gauss and Poisson equation for gravitational self-energy.
- 2) System of particles, definition of center of mass, equation of motion, conservation of linear and angular momenta, conservation of energy, single-stage and multistage rockets, elastic and inelastic collisions.
- 3) Elasticity, small deformations, Hooke's law, elastic constants for an isotropic solid, beams supported at both the end, cantilever, torsion of a cylinder, bending moments and shearing forces.
- 4) Kinematics of moving fluids, equation of continuity, Euler's equation. Bernaulli's theorem, viscous fluids, streamline and turbulent flow. Poiseulle's law. Capillary tube flow, Reynolds's number, Stoke's law.
- 5) Surface tension and surface energy, molecular interpretation of surface tension. Pressure on a

curved liquids surface.

Section - B ( Marks : 50 )

**Special Theory of Relativity, Waves and Acoustics.**

**6) Special Theory of Relativity :**

Michelson-Morley experiment and its implications, Galilean and Lorentz transformations-length contraction, time dilation, addition of velocities, mass-energy relation, limit on velocities by linear forces.

**7) Waves :**

Simple harmonic motion, damped oscillation, forced oscillation and resonance. Beats. Stationary waves in a string. Phase and group velocities. Waves in liquid and gases, longitudinal and transverse waves.

**8) Acoustics :**

**.01) Noise and Music:** Limits of human audibility, intensity and loudness, bel and decibel, principle of a sonar system, sound ranging. Applied acoustics: transducers and their characteristics. Recording and reproduction of sound.

**.02)** Measurements of frequency, waveform, intensity and velocity. The acoustics of halls, reverberation period, Sabine's formula Noise pollution, its measurements. Ultrasonics-production, detection and applications of ultrasonic waves.

**Section - C ( Marks : 50 )**

**Optics**

**9) Interference:**

Interference of a light: the principle of superposition, two-slit interference, coherence requirement for the sources, optical path retardations, and lateral shift of fringes. Localized fringes; thin films, Newton's rings.

**10) Interferometers :**

Haidinger fringes, Fringes of equal inclination. Interferometer, its application for precision determination of wavelength difference, Twyman-Green interferometer and its uses. Intensity distribution in multiple beam interference, Fabry-Perot interferometer.

**11) Diffraction :**

Fresnel half-period zones, zone plates, diffraction at straight edge, rectilinear propagation. Fraunhofer diffraction, diffraction at a slit, the intensity distribution, diffraction at a circular aperture and a circular disc, resolution of images, Rayleigh criterion, resolving power of telescope and microscope.

**12) Diffraction gratings :**

Diffraction at N parallel slits, intensity distribution, plane diffraction grating reflection grating and blazed grating, dispersion and resolving power of a grating, concave grating and different mountings, resolving power of prism.

**13) Polarization :**

Production and detection of linearly and circularly polarized light, double refraction, in uniaxial crystal, Quarter and half wave plates, rotation of plane of polarization, origin of optical rotation in liquids and in crystals, Sacharimeter.

**Section - D ( Marks : 50 )****Kinetic theory, Thermodynamics, Statistical Physics and Atmospheric Science****14) Kinetics theory :**

Kinetics theory of gases, assumptions, kinetic energy estimations RMS speed of molecules, Avogadro hypothesis, equi-partition of energy, Brownian motion, specific heat of gases, Real gasses: Van der Waal's model, equation of state, nature of Van der Waal's forces, critical constants, Joule Thomson cooling, liquification of gases.

**15) Thermodynamics :**

Laws of Thermodynamics, Reversible and irreversible change Carnot cycle & it's efficiency, Carnot's theorem, entropy, principle of increase of entropy, Thermodynamic scale of temperature.

**16) Statistical Physics :**

Maxwell's distribution, experimental verification. Distinction between rms and most probable speed values, Quantum statistics, Bose Einstein and Fermi Dirac statistics & their applications to liquids helium, free electrons in metals, thermionic emission, photon and blackbody chamber, Bose Einstien condensation.

**17) Atmospheric Science :**

Neutral atmosphere, temperature variation in different atmospheric layers, ionosphere, magnetosphere, hydrostatic equilibrium, scale height, ozone layer and its depletion, atmospheric pollution, green-house effect.

**Paper - II**

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**Nature of Paper** : Conventional Type

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### Section – A ( Marks : 50 )

#### Electricity, Magnetism and Electromagnetics

**1) Electrostatics and Magnetostatics :**

- .01)** Laplace and Poisson equations in electrostatics and their applications, energy of a system of charges, multipole expansion of scalar potential, method of images and its applications, potential and field due to a dipole, force and torque on a dipole in an external field.
- .02)** Dielectrics, polarization, solutions to boundary-value problems-conducting and dielectric spheres in a uniform electric field. Magnetic shell, uniformly magnetised sphere, ferromagnetic materials, hysteresis, energy loss.

**2) Current Electricity :**

Kirchhoff's laws and their applications, Biot-Savart law, Ampere's law, Faraday's law, Lenz's law, self and mutual inductances, Mean and rms values in AC circuits, LR CR and LCR circuits series and parallel resonance, Quality factor. Principal of transformer.

**3) Electromagnetic theory :**

Displacement current and Maxwell's equations. Wave equations in vacuum, Poynting theorem, Square wave guides, reflection and refraction at the boundary of two dielectrics, Fresnel's relation, normal and anomalous dispersion, Rayleigh scattering.

### Section – B ( Marks : 50 )

#### Quantum Mechanics

**4) Origin of the quantum theory :**

- .01)** Failure of classical physics to explain the phenomena such as blackbody spectrum, Rayleigh Jeans and Wien's law, Planck's radiation law, photoelectric effect. Wave-particle duality.
- .02)** de Broglie's hypothesis for matter waves; Evidence for diffraction and interference of 'particles', experimental demonstration of matter waves, Heisenberg's uncertainty relation, gamma ray microscope, uncertainty in energy and time.

**5) Schrodinger's equation :**

- .01)** Schrodinger's time independent and time dependent equation, operators, expectation values, probable current density, reflection and transmission at step potential and at rectangular potential barrier, particle in a box, one dimensional linear harmonic oscillator.
- .02)** Schrodinger's equation in central force field, Hydrogen atom, quantum

numbers, angular momentum.

### Section – C ( Marks : 50 )

#### Atomic, Molecular Physics, Lasers and Nuclear Physics

##### 6) Atomic Physics :

Bohr's theory of Hydrogen atom, Hydrogen spectrum, Stern and Gerlach experiment, spectral terms, doublet fine structure, spectra of alkali elements, selection rules, Lamb shift in hydrogen spectrum. Singlet and triplet fine structure in alkaline earth spectra L-S and j-j couplings. Pauli principle, Zeeman effect and Paschen Back effect in one valence electron atoms.

##### 7) Molecular Physics :

Discrete set of electronic energies of molecules, Quantisation of vibrational and rotational energies, types of molecules based on moments of inertia, rigid diatomic molecule, non rigid rotator, Intensity distribution in rotational levels, diatomic molecule as a harmonic and anharmonic oscillator, Rotation-vibration spectra. Born-Oppenheimer approximation, Raman effect, Classical and Quantum mechanical treatments.

##### 8) Lasers and fibre optics :

Monochromaticity, directionality, intensity and coherence of laser beam, Einstein's A & B coefficients, Induced emission, Conditions for lasing, Ruby, Helium-Neon laser, CO<sub>2</sub> laser, Applications of laser in medical treatment, isotope separation, LIDAR technique, Optical fibres, attenuation, pulse dispersion in step index and parabolic index fibres.

##### 9) Nuclear Physics :

Basic nuclear properties : size, binding energy, angular momentum, parity, magnetic moment, Semi-empirical mass formula and applications, Mass parabolas, Ground state of a deuteron, Salient features of nuclear forces.

##### 10) Nuclear Models and elementary particles :

Liquid drop model, shell model of the nucleus-success and limitations, Alpha decay, Geiger Nuttal relation, Beta decay, violation of parity, Gamma decay and internal conversion, Nuclear reactions, Q values, compound nucleus model, Nuclear fission and fusion, energy production in stars, Nuclear reactors, Classification of elementary

particles.

### Section – D ( Marks : 50 )

#### Solid State Physics, Solid State devices, Electronics and Space Science

##### 11) Crystal structure and materials :

Crystal structure; periodicity, lattices and bases, fundamental translation vector, unit cell, primitive cell, lattices type, lattice planes, common crystal structures.

Laue's theory of X-ray diffraction, Bragg's law, Laue patterns, Band structure, electrons in periodic potential; energy bands, energy gap, distinction between metal semiconductor and insulator, Magnetic moment, magnetic susceptibility, Dia, Para and Ferromagnetism, ferromagnetic domains, hysteresis.

##### 12) Semiconductors :

Intrinsic semiconductors, electrons and holes, Fermi level, Temperature dependences of electron and hole concentration, Doping; impurity states, n and p type semiconductors, conductivity, mobility, Hall effect, Hall coefficient, Semiconductors devices:

p-n junction, majority and minority carriers, solar cell.

##### 13) Electronics :

Diode as a circuit element, Load line concept, rectification, ripple factor, Zener diode, LED, Schottky diode, voltage stabilization, characteristics of transistor in CB, CE and CC mode, graphical analysis of the CE configuration, low frequency equivalent circuits, h-parameters, bias stability, IC voltage regulation.

Field effect transistor : JFET volt-ampere curve, biasing JFET, ac operation of JFET, source follower, Depletion and enhancement mode, MOSFET, biasing MOSFET, FET as variable voltage register, digital MOSFET circuits, Digital electronics, Boolean identities, De Morgan's laws, logic gates and truth tables.

##### 14) Space Science :

Near earth orbiting satellites, remote sensing and remote sensing satellites, their application for resource surveys and management. Geostationary satellites, communication, GPS system.

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