CSM : 16

PHYSICS

PAPER - I

Time Allowed : 3 hours | Full Marks : 100

Marks for each question is indicated against it.

Attempt any 5 (five) questions taking not more than 3 (three) questions from each Part.

PART - A

1. (a) What are central and non-central forces? Show that in a central force field the angular momentum of a particle is conserved. **(3+4=7)**

(b) Define gravitational potential and intensity at a point. Find gravitational potential at a point inside a thin spherical shell. **(1+1+4=6)**

(c) State Kepler's laws of planetary motion. Show from the second law that the force between the sun and a planet is a central force. **(3+4=7)**

2. (a) Write down Euler's theorem for a moving fluid and obtain from it the Bernoulli's theorem. State Stoke's law. **(1+5+2=8)**

(b) Distinguish between streamline and turbulent motion. Deduce Poiseuille's law for streamline flow of liquid in a capillary tube of radius *'r'* and length *'l'* under pressure difference *P*. **(2+7=9)**

(c) Find the velocity of efflux of a liquid of density 2500 kg m^{-3} from a tank to which the pressure of the liquid at the orifice is 9.8×10^3 N m^{-2} above the pressure of the atmosphere. (g=9.8ms^{-2}) **(3)**

3. (a) What is Lorentz transformation? Derive the Lorentz transformation equation. Using Lorentz transformation equations, derive the formula for relativistic addition of velocities. What do you understand by 'proper time' and 'proper length' in relativity? **(1+5+4+2=12)**

(b) A source emitting light of wavelength 6000Å is receding from an observer with a speed of 0.6 c. Find the wavelength of light as observed by the observer. **(3)**

(c) Derive mass energy relationship in relativistic mechanics. **(5)**

4. (a) State the first law of thermodynamics and hence show that C_p-C_v = R for a perfect gas. **(1+4=5)**

(b) Deduce Van der Waal's equation of state for a real gas. **(5)**

(c) Deduce the relation **(4)**

$$TdS = C_p dT - T(\delta V/\delta T)_p dP$$

(d) Discuss the basic features of Bose-Einstein and Fermi-Dirac distributions. **(3+3=6)**

PART - B

5. (a) Prove that the wave equation for a transverse wave in a string is given by

$$\frac{d^2y}{dx^2} = \frac{d^2y}{v^2 dt^2}$$

Where $v = \sqrt{\frac{T}{\rho}}$, T being the tension and ρ the linear density of the string. **(5)**

(b) Two thin lenses of focal length f_1 and f_2 separated by a distance d have an equivalent focal length 50 cm. The combination satisfies the condition for no chromatic aberration and minimum spherical aberration. Find the values of f_1, f_2 and d. Assume that both lenses are of the same material. **(5)**

(c) Describe Michelson interferometer and show how it can be used for standardisation of a meter length. **(4+3=7)**

(d) In a Newton's ring experiment, the diameter of the 15^{th} ring was found to be 0.59 cm and that of the 5^{th} ring was 0.336 cm. If the radius of the plano-convex lens is 100 cm, calculate the wavelength of light used. **(3)**

6. (a) What is Fraunhoffer diffraction? Discuss Fraunhoffer diffraction in a double slit and hence deduce an expression for the intensity distribution of the diffraction pattern. **(1+4=5)**

(b) What do you understand by plane polarised light and circularly polarised light? Describe how you will produce circularly polarised light and distinguish it from un-polarised light. **(2+4=6)**

(c) What is the principle of a three level laser? Describe the construction and working of a Ruby Laser. **(2+4=6)**

(d) Calculate the least width of a plane transmission grating having 500 lines/cm which will just resolve in the second order, the sodium lines of wavelength 5890Å and 5896Å. **(3)**

7. (a) Determine with the help of the method of electrical image, the potential and the field at any point in space when a point charge is placed in front of a conducting plane of infinite extent maintained at zero potential. **(10)**

(b) Set up the *emf* equation in a series LCR circuit driven by a sinusoidal voltage. Solve the equation to find the instantaneous current. How does the impedance of the circuit behave at resonance? Find the two half-power frequencies and hence the Q value of the circuit. **(10)**

8. (a) Using Maxwell's equations, prove that the velocity of electromagnetic wave in free space is equal to $\frac{1}{\sqrt{\varepsilon_o \mu_o}}$. **(6)**

(b) Discuss the term magnetic vector potential as applied in magnetism and hence derive an expression for the magnetic vector potential. **(6)**

(c) State and deduce Stephan-Boltzmann law of heat radiation. **(8)**

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