CSM : 22

PHYSICS

PAPER - I

Time Allowed : 3 hours Full Marks : 100

Marks for each question is indicated against it.
Attempt <u>any 5 (five)</u> questions taking not more than 3 (three) questions from each Part.

PART - A

1. (a) What is a central force? Give two examples of central force. **(4)**

(b) Show that the angular momentum $(\vec{L})$ of a particle in central force field is a constant of motion. **(8)**

(c) Discuss the motion of a particle when the central force obeys inverse square law, in case of repulsive as well as attractive forces. **(8)**

2. (a) Define the terms moment of inertia and radius of gyration. What is the physical significance of moment of inertia? **(1+1+2=4)**

(b) Derive the equations for the motion of a body rotating with a constant angular acceleration. **(8)**

(c) What is gravitational self-energy of a body? Obtain an expression for it for a uniform solid sphere. **(3+5=8)**

3. (a) A reference frame S' moves with respect to rest frame S with a uniform velocity 'v' parallel to x-direction. Show from Lorentz transformation that the two events simultaneous ($t_1 = t_2$) at different positions $(x_1 \neq x_2)$ in frame S are not in general simultaneous in S' frame. **(8)**

(b) The mean life of π^- meson is 2×10^{-8} seconds. Calculate the mean life of a meson moving with a velocity of 0.8c, where c is the velocity of light. **(8)**

(c) A particle travelling with velocity 0.8c emits a photon in the direction of motion. What will be the velocity of a photon for an observer on the ground? **(4)**

4. (a) State the drawbacks of Einstein model of specific heat. Derive an expression for lattice heat capacity following Debye model. Discuss the high and low temperature limits of Debye's T^3 law. **(2+6+4=12)**

(b) What is adiabatic demagnetisation? Using Maxwell's thermodynamical relations obtain an expression for cooling produced in adiabatic demagnetisation of a paramagnetic salt. **(1+7=8)**

PART - B

5. (a) Define simple harmonic motion. Derive a general differential equation of motion and obtain its solutions. Show that for a body executing simple harmonic motion the acceleration leads the velocity by p/2 and displacement by a phase angle of p. **(2+6+4=12)**

(b) What do you mean by group and phase velocity? Establish the relation between them. **(1+1+2=4)**

(c) Explain the phenomena of refraction from Huygen's principle. **(4)**

6. (a) Discuss two characteristics of Laser light; i.e., spatial and temporal coherence. Describe with a neat sketch the construction and working of He-Ne laser. **(6+4=10)**

(b) Explain the terms 'stimulated emission' and 'spontaneous emission' giving their transition probabilities. What are Einstein A and B coefficients? **(2+2+2=6)**

(c) Why two-level laser system cannot work? What is the minimum number of energy levels required for Laser operation? **(3+1=4)**

7. (a) Using Biot-Savart's law, find the force between two long straight conductors carrying current. **(8)**

(b) A solenoid of length 20 cms and radius 2 cms is closely wound to 200 turns. Calculate the field at the centre of one end of the solenoid if a current of 5 amps flow through the windings. **(6)**

(c) What are series and parallel resonance circuits? What are they used for? **(6)**

8. (a) Using Planck's radiation law, deduce Wein's displacement law. How does this law enable one to estimate the surface temperature of the sun? **(10)**

(b) Using Ampere's law and continuity equation, show that the divergence of the total current density is zero. **(10)**

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