FS – 23 / 15-16
Physics
Paper – I

Time : 3 hours

Full Marks : 200

The figures in the right-hand margin indicate marks.

Candidates should attempt Q. No. 1 from

Section – A and Q. No. 5 from Section – B

*which are compulsory and any **three** of*

the remaining questions, selecting

*at least **one** from each Section.*

SECTION – A

1. Answer any **two** of the following questions :

    $20 \times 2 = 40$

    (a) Discuss the dynamics of a moving object as observed in a stationary frame S and in a rotating frame S.

    (b) A particle of rest mass m_0 is travelling so that

its total energy is just twice its rest mass energy. It collides with a stationary particle of rest mass m_0 to form a new particle. What is the rest mass of the new particle ?

(c) What does LASER stand for ? What is Lasing principle ? Describe three-level scheme of a Laser operation.

2. (a) What is a simple pendulum ? What is a compound pendulum ? How does one determine the value of acceleration due to gravity 'g' using these pendulums in laboratory ? Explain what we learn from Foucault's pendulum.   6+7+7 = 20

(b) (i) A coin of mass 'm' and radius 'r' rolls along a horizontal table with a velocity 'v'. What is its kinetic energy ?   7

(ii) Explain the working of Gyroscope.   13

3. (a) A particle of mass 'm' moves in a central force field such that its potential energy is given by $V = kr^n$, where 'r' is its distance from center of force and 'k' and 'n' are constants. Find the conditions for a stable circular orbit.   14

(b) State the two postulates of Special Theory of Relativity. What are four vectors ? Show that four-velocity vector is perpendicular to four-acceleration vector. $3+3+7 = 13$

(c) What are longitudinal waves ? What are transverse waves ? Give an example in each case. Explain the terms (i) Beats, (ii) Resonance. 13

4. (a) Explain the working of Michelson Inter-ferometer. Discuss its original application to Michelson-Morley experiment and conse-quences of its negative result. 14

(b) What is Interference ? What is Diffraction ? What is the difference between Fraunhofer and Fresnel diffraction ? 13

(c) State few principles of fiber optics. Discuss electromagnetic wave propagation in single mode fiber. 13

SECTION – B

5. Answer any **two** of the following : $20 \times 2 = 40$

(a) (i) Find the field outside a uniformly charged solid sphere of radius 'R' and total charge 'q'.

(ii) An infinite plane carries a uniform surface charge σ. Find its electric field.

(b) Poynting vector $\vec{S}\left(\vec{x}, t\right) = \dfrac{1}{\mu_0} \left(\vec{E}\left(\vec{x}, t\right) \times \vec{B}\left(\vec{x}, t\right)\right)$. Given $E_y\left(\vec{x}, t\right) = -2E_0 \sin kx.\sin \omega t$ and $B_z\left(\vec{x}, t\right) = -2B_0 \cos kx.\cos \omega t$. Show that the time average of Poynting vector (intensity) at any point is zero.

(c) Explain briefly, Einstein's and Debye's theories of specific heat of solids.

6. (a) From the Hysteresis loop diagram, how can one classify materials in terms of their magnetic properties ? Explain.   14

(b) Explain how charge 'q' varies with time 't' in a LCR circuit, by setting up the equation and graphically discuss the behaviour in three (under damped, critically damped and over damped) cases.   13

(c) A point charge 'q' is held at a distance 'd' above an infinite grounded conducting plane. Using method of images, find the potential in the region above the plane.   13

7. (a) State four Maxwell equations and explain their physical significance. Obtain the wave equation for electric field in vacuum.   20

   (b) What is the order of magnitude of Planck length, Planck mass and Planck time ? What is the relevance of these scales in the present understanding of Universe ? What is black body radiation ?   20

8. (a) Explain the four thermodynamics processes : (i) adiabatic (ii) isothermal, (iii) isobaric and (iv) isochoric, for a constant amount of an ideal gas, through PV (pressure, volume) diagram.   20

   (b) Compare and contrast respective PV diagram of a Otto Engine and an diesel engine.   20

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