CSM—54/24

PART—II/PAPER—VI

PHYSICS

PAPER—I

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Time : 3 Hours

Full Marks : 250

The question paper contains **18 (Eighteen)** *questions in* **GROUP—A, (12)** *and* **GROUP—B, (06)** *together.*

GROUP—A

Condidates to attempt **10** ***(ten)*** *questions.*

Each question carries **15** *marks.*

Marks of the bit question (a) and (b) are indicated against each.

1. *(a)* A meter stick is held at 45° with the direction of motion in a system moving with a velocity 0.8 c. What are the length and orientation of the stick observed from a rest frame? 8

1. *(b)* Two lumps of clay, each of rest mass m, collide head on at the speed $\frac{4}{5}c$ and stick together. Find the mass of the composite lump. 7

2. *(a)* Two glasses have dispersive powers in the ratio of 2 : 3. These glasses are to be used in the manufacture of an achromatic object of focal length 20 cm. Find the focal lengths of the glasses. 8

2. *(b)* Deduce the missing orders for a double-slit Fraunhofer diffraction pattern if the slit widths are 0·16 mm and they are 0·8 mm apart. 7

3. *(a)* Write down the solution of a damped harmonic oscillator. Graphically represent various cases depending on the damping parameter. 8

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3. *(b)* A particle is subjected to two simple harmonic motions along x- and y-directions with equal frequency but different amplitudes. Find the trajectory of the particle when the phase differences between two simple harmonic motions are *(i)* $\delta = 0$ and *(ii)* $\delta = \frac{5}{2}$. 7

4. *(a)* Discuss the state of polarization when x- and y-components of electric field are given by the following equations :

(i) $E_x = E_0 \cos(\omega t + kz)$, $E_y = E_0 \cos(\omega t + kz + \pi)$

(ii) $E_x = E_0 \sin(\omega t + kz)$, $E_y = E_0 \cos(\omega t + kz)$ 8

4. *(b)* The rotation in the plane of polarization in a certain substance is 10^6/cm. Find the difference between the refractive indices for right-circularly and left circularly polarized light in the substance. (Given λ = 5893 Å) 7

5. *(a)* Determine the positions of the focal points, principal point and nodal point in the case of sphere of radius 10 cm and made of a material of μ = 1·5. Indicate the positions in a schematic diagram. 8

5. *(b)* A thin lens of focal length +16 cm is immersed in water (μ = 1·3). What is its new focal length? 7

6. *(a)* What are the major differences between interference and diffraction? 8

6. *(b)* Define coherence length. Calculate it for CO_2 laser whosc line width is 10^{-5} nm at emission wave length of 10·6 micro-meter. 7

7. *(a)* Define the moment of inertia tensor. The moment of inertia tensor for a system is given by

$$M_{ij} = I_0 \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$$

Find the principal moment of inertia for that system. 8

7. *(b)* Write down the Euler equations for a force-free symmetric top. Find the solution for this top. 7

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4. *(b)* The rotation in the plane of polarization in a certain substance is 10^3/cm. Find the difference between the refractive indices for right circularly and left circularly polarized light in the substance. (Given λ = 5893 Å) 7

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GROUP – B

Candidates to attempt **05** *(five) questions.*

Each question carries **20** *marks.*

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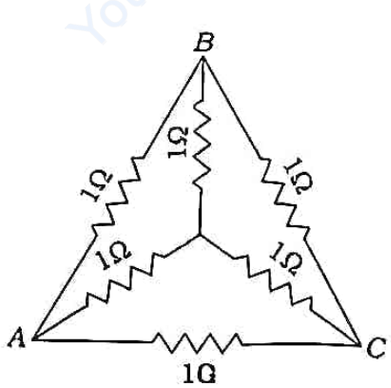
13. *(a)* N moles of an ideal gas undergo an adiabatic change from (P_1, V_1, T_1) to (P_f, V_f, T_f). Show that work done for the process is $C_v(T_1 - T_f)$. 10

13. *(b)* Find the change in entropy when one mole of van der Waals gas changes from (P_1, V_1, T_1) to (P_2, V_2, T_2). 10

14. *(a)* Find the pastition function for a particle at temperature T, whose dynamics is governed by the Hamiltonion $H = \begin{pmatrix} \alpha & -\beta \\ -\beta & -\alpha \end{pmatrix}$, where α and β are real numbers. 10

14. *(b)* Two Carnot engines A and B are operated in series. A receives beat at 900 K and rejects at T K. B receives heat rejected by A and in turn rejects at 400 K. Find the value of T when *(i)* work outputs of A and B are same and *(ii)* efficiencies of A and B are same. 10

15. *(a)* Find the equivalent resistance between points A and C in the following diagram : 10



15. *(b)* Draw the circuit diagrams of the series and parallel LCR circuit and construct the differential equations for the current in those circuits. 10

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16.-(a) What is the meaning of gauge fixing? Express Maxwell's equations in terms of potentials in Lorentz gauge.

16. (b) Find three different vector potentials which will produce the uniform magnetic field $\vec{B} = 2\hat{i} + 3\hat{j}$. 10

17. (a) What is black body? Write down Planck's law of black-body radiation and demonstrate it graphically for two different temperatures. Discuss limiting cases for high and low values of the wave length. 10

17. (b) A Carnot engine whose low temperature reservoir is at 7 °C has an efficiency of 40%. By how many degree should the temperature of the source be increased to have an efficiency of 60%? 10

18. (a) Write Laplace's equation in spherical polar coordinates for an arbitrary potential $V(r,\theta,\varphi)$. Show that the equation can be separated into coordinates r, θ, φ if $V(r,\theta,\varphi)$ is of the form $P(r)\,Q(\theta)\,P(\varphi)$, where $P(r)$, $Q(\theta)$, and $R(\phi)$ are arbitrary functions of the respective variables. 10

18. (b) In spherical coordinates, $V = 0$ for $r = 10$ cm and $V = 100$V for $r = 200$ cm. Assuming free space between these concentric spherical shells, find Electric field, E. 10

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