CSM – 58/17
Physics
Paper – I

Time : 3 hours

Full Marks : 300

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 **three** of the following :   20×3 = 60

    (a) Assume that the Sun, Moon and Planets exert negligibly small torques on planet Earth. If the polar ice caps were to completely melt due to global warming, what would happen to the length of the day ? Argue.

(b) Two identical bodies each with rest mass m_0 approaching each other at equal speeds 'u', collide, and stick together. The conglomerate body rest mass is $M_0 c^2$. Find M_0 in terms of m_0 and u.

(c) Describe the interference pattern due to Young's double-slit experiment. What is the general expression for intensity at any point on the screen as a function of phase difference (ϕ) ?

(d) What is a Transverse Wave ? What is a Longitudinal Wave ? Give an example in each case. What is Polarization ? How does one produce linearly polarized light from unpolarized light ?

2. (a) What are holonomic and non-holonomic constraints ? Give an example in each case. Set up the Lagrange equation for a linear oscillator and obtain the most general solution. $\qquad$ $10+10 = 20$

(b) Distinguish between Center of Mass (CM) Frame and Laboratory Frame. Obtain the relation between θ_c and θ_1 in terms of masses.   10+10 = 20

(c) Describe the construction and working of Gyroscope.   20

3. (a) Explain the terms :   5+5+5+5 = 20

   (i)   Length contraction

   (ii) Time-dilation

   (iii) Minkowski diagram

   Show that four-momentum vector is perpendicular to four-acceleration vector.

(b) Describe the general behaviour of a damped, forced oscillator for at least two different cases.   20

(c) Describe the formation of images by a thin converging lens for various object distances.   20

4. (a) Explain the working of Fabry-Perot Interferometer. State few principles of fiber optics.   10+10 = 20

(b) Describe Holography principle in detail.

20

(c) How does ordinary light different from LASER light ? Explain lasing principle. How does a Ruby laser works ? $5+10+5 = 20$

SECTION – B

5. Answer any **three** of the following :

(a) A sphere of radius 'a' is made of insulating material and has charge distributed uniformly throughout its volume. The charge density is ρ. Find the field due to the charge for $r \leq a$. 20

(b) Which of the Maxwell equations explain how a credit card reader works ? Which one describes how a wire carrying steady current generates a magnetic field ? Explain in detail. $10+10 = 20$

(c) Describe Planck's radiation law. Obtain Wien displacement law and Stefan-Boltzman laws in appropriate limits. $10+10 = 20$

(d) For a constant amount of ideal gas, explain the characteristics of a isobaric, isothermal, adiabatic processes through PV diagram. 20

6. (a) Classify magnetic materials. What is Hysteresis loop diagram ? For a permanent magnetic material what type of hysteresis loop is desirable ? 10+5+5 = 20

(b) Set up the mathematical equation, how charge 'q' varies with time 't' in a LCR circuit. What resistance R is required (in terms of L and C) to give LCR circuit a frequency that is one-half of the un-damped frequency. 20

(c) Describe the principle of transformer. 20

7. (a) State four Maxwell equations and explain their physical significance. 20

(b) Describe the motion of a electromagnetic wave in vacuum. What happens when such a wave travels in isotropic dielectric ? 10+10 = 20

(c) Explain the following : $\qquad$ 10+5+5 = 20

    (i)   Covariance of Maxwell equations

    (ii) Gauge invariance

    (iii) Poynting vector

8.   (a) State first and second law of thermo-dynamics. What are Maxwell relations ?

$$10+10 = 20$$

    (b) Consider two ideal gases with N_1 and N_2 particles respectively, kept in two separate volumes V_1 and V_2 at the same temperature. What is the change in entropy of the combined system after gases are allowed to mix in a volume $V = V_1 + V_2$.   20

    (c) Explain the terms Micro canonical, Canonical and Grand-canonical ensembles.   20

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