CSM – 58/19

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 :

   (a) A particle of mass m_1 and moving with velocity u_1 elastically scattered from another particle of mass m_2 at rest. The two particles move in opposite direction with same speed

after collision. Find the mass of m_2 in terms of m_1. 20

(b) Write a note on Lorentz transformations, length contraction, time dilation and proper time. 5×4 = 20

(c) Using Fermat's principles in geometric optics, explain :

(i) Why setting Sun appears flattened ?

(ii) Formation of mirage. 10+10 = 20

(d) Light + Light does not always give more light. Explain. 20

2. (a) A rocket starts from rest with exhaust velocity of gases 'u' km/s. Calculate the velocity attained by the rocket when the mass of the rocket reduces to $1/50^{th}$ of the initial mass due to burning of the fuel. The gravitational attraction may be neglected. (ln 10 = 2.3, ln 5 = 1.609) 20

(b) What are holonomic and non-holonomic constraints ? Give an example for each case. How does a gyroscope works ? 10+10 = 20

(c) Construct a Lagrangian, and hence, equation of motion of a simple pendulum placed in a uniform gravitational field. 20

3. (a) Write down the equation of motion for damped, driven oscillator and discuss the motion ('x(t)') for various cases. 20

(b) Explain the terms group velocity and phase velocity. When these two are the same ? What are transverse waves and longitudinal waves ? Give an example in each case. What is the characteristic of electromagnetic wave ? 10+10 = 20

(c) Explain the matrix method in paraxial optics. 20

4. (a) Explain the working of Michelson interferometer. How does one measure

wavelength of incident light using this instrument? 20

(b) What is lasing principle? Explain the working of Ruby Laser. 20

(c) Explain the following terms: 10+5+5 = 20

(i) Cornu's spiral

(ii) Zone-plates

(iii) Airy patterns in optics

SECTION – B

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

(a) An infinite plane carries a uniform surface charge σ. Argue that electric field is independent of how far away you are from the plane? 20

(b) What are the phases of matter? Explain a typical PT phase diagram. What is latent heat? 20

(c) What is the final temperature when 200 g of ice at $-20^{\circ}C$ is dropped into 350 g of water

at 40° C contained in a calorimeter of 50-g equivalent ? How many grams of ice melt ? Sp. heat of water 1.00 kcal/kg.°C, and that of ice 0.50 kcal/Kg.°C, and heat of fusion of ice 80 kcal/Kg. 20

(d) Starting from four first order Maxwell equations, obtain the wave equation for electric field and magnetic field in vacuum. 20

6. (a) Classify magnetic materials. State the properties for each class. Give an example for each case. 20

(b) How does a transform work ? An Ac Adaptor has a transformer that converts 120 V Ac into 9.0 V Ac. What turns ratio is required ? Which coil has more turns, primary or secondary ? 20

(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. 20

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

(b) Why day time clear sky appears blue ? Express Maxwell equations in covariant form. 10+10 = 20

(c) Explain Planck radiation law. Argue that it contains Wien displacement law and Stefan-Boltzmann law. Does a black body at 2000K emit X-rays ? Does it emit radio waves ? 20

8. (a) Assume that speed of sound in a gas is same as the root mean squared speed of the molecules, and show how the speed of sound for an ideal gas depends on the temperature. 20

(b) State and explain laws of thermodynamics. What is Carnot cycle ? A gas expands

adiabatically and reversibly. What is the change in entropy? 10+5+5 = 20

(c) Explain (i) Micro canonical, (ii) Canonical and (iii) Grand canonical ensembles. 20