

PHYSICS

Paper-II

Time: 3 Hours

Full Marks: 100

Instructions : (1) Answer any *five* questions.

(2) The figures in the right-hand margin indicate full marks for the questions.

1. (a) Write the Kepler's law of planetary motion. Prove that the line joining a planet and the sun crosses equal areas in equal times. 10
- (b) Answer the following questions : 2×5=10
 - (i) Explain the meaning of reduced mass of two-particle system with one example.
 - (ii) Explain the terms gravitational field and gravitational potential.
 - (iii) Find an expression for the centre of mass of a two-particle system with a neat diagram.
 - (iv) Discuss the equation of continuity for steady current.
 - (v) State and explain Kirchhoff's law of electrical network.
2. Write short notes on the following : 5×4=20
 - (a) Geostationary satellite
 - (b) Brownian motion
 - (c) Doppler's effect of sound
 - (d) AND and NAND gates
3. (a) What is the escape velocity of a body? Derive an expression for the escape velocity v_e in terms of gravitational constant and mass of the earth. 10
- (b) Two point masses of 2 kg and 8 kg are kept 12 m apart. At which point the intensity of gravitational field due to the two masses would be zero? 10
4. (a) State postulates of special theory of relativity. Derive Lorentz transformation equations. Show that four-dimensional volume element is invariant under Lorentz transformation. 10

- (b) A rod of length 1m is placed in a satellite moving with respect to the earth at a speed of $0.95c$, where c is the speed of light. What will be the length of the rod as measured by—
- (i) an observer travelling in the satellite;
- (ii) an observer located at the earth? 5+5=10
5. (a) State and prove Carnot's theorem. Derive the expression for its efficiency. 10
- (b) A Carnot engine has the same efficiency between 1000 K and 500 K and between x K and 1000 K (this being the temperature of the sink in this case). Find the value of x . 10
6. (a) Deduce the latent heat equation, $\frac{dP}{dT} = \frac{L}{T(V_2 - V_1)}$ and explain the change in the melting points of solid and boiling points of liquid. Symbols have their usual meanings. 10
- (b) An ideal refrigerator works between 0°C to 27°C . It expels 240 calories of heat in 1 s. What is its wattage? 10
7. (a) What are free, damped and forced oscillations? Obtain the differential equations for the forced oscillator and solve it. 10
- (b) In case of a driven harmonic oscillator the amplitude of vibrations increases from 0.1 mm at very low frequencies to a maximum value of 5 mm at the frequency 200 Hz. Find the Q-factor, damping constant and relaxation time. 10
8. (a) State Biot-Savart law and relate it to Ampere's law. Show that divergence of magnetic induction is always zero. 10
- (b) A metal wire of diameter 0.8 mm carries a current of 10 A. Find the maximum magnitude of the field \vec{B} due to this current. 10
- — —