Total number of printed pages–5

63 (FY) SEM–1/MAJ1/PHYMAJ1014

2024

PHYSICS

Paper : PHYMAJ1014

(Mechanics)

Full Marks : 50

Pas Marks : 20

Time : Two hours

The figures in the margin indicate full marks for the questions.

1. Answer the following questions : (***all*** compulsory) 1×5=5

   (a) Gravitational mass is defined as

   (i) the resistance of a body to change in its state of motion

   (ii) the mass that determines the strength of the gravitational attraction

   (iii) the mass that interacts with electromagnetic fields

Contd.

(iv) the mass of an object measured in vacuum

(b) Kepler's laws of planetary motion are a direct consequence of

(i) Newton's law of universal graviation

(ii) Electromagnetic forces

(iii) Special relativity

(iv) Quantum mechanics

(c) In an inertial reference frame, which of the following laws holds true ?

(i) Newton's first law only

(ii) Newton's second law only

(iii) Newton's third law only

(iv) All three of Newton's laws

(d) Choose the correct answer for a conservative force.

(i) The work done depends on the path taken between two points

(ii) The work done by the force over a closed path is always zero

(iii) The force cannot be expressed as the gradient of a potential energy

(iv) The work done by the force cannot be recovered as mechanical energy

(e) Smaller the damping, the quality factor of the oscillator will be

(i) smaller

(ii) greater

(iii) remaining same

(iv) nearly equal to zero

2. Answer the following questions : ***(any five)*** 2×5=10

(a) Define, what is meant by sharpness of resonance.

(b) In a streamline flow of Newtonian fluid two streamlines never intersect. Explain.

(c) The modules of rigidity and Poisson's ratio of a wire are $2{\cdot}87 \times 10^{10}\ N/m^2$ and 0·379 respectively. Find the value of Young's modulus of the wire.

(d) Prove that the work done by a force on a body is equal to the change in the kinetic energy.

(e) A ball is projected vertically upward with an initial velocity of 50 m/s. Determine the speed of the ball when it reaches half of its maximum height.

(f) What is a fictitious force ? Why is it so called ?

(g) State the postulates on which special theory of relativity is based.

3. Answer the following : ***(any five)*** 5×5=25

(a) Define Poisson's ratio(σ) ? Show that $Y = 3K(1-2\sigma)$. 1+4=5

(b) Derive the expression for the gravitational potential and gravitational field for a uniform solid sphere at a point inside and outside the sphere.

(c) Discuss the two-body problem and describe how it can be simplified to a one-body problem.

(d) Derive differential equation of simple harmonic motion and obtain solution for it.

(e) Given a solid hemisphere of radius R and density ρ. Show that the coordinates of its center of mass are $\left(\frac{3}{8}R, 0, 0\right)$ assuming the origin of the system is at the center of the hemisphere.

(f) Derive an expression for the moment of inertia of a spherical shell about an axis passing through its diameter.

(g) What are damped vibrations ? Obtain an expression for displacement of a particle vibrating in a high resistive medium. 1+4=5

(h) Obtain Einstein's mass-energy relation and discuss its significance. 4+1=5

4. Answer the following : ***(any one)*** 10×1=10

(a) Explain the principle of rocket propulsion and derive the equation

$$v = v_0 + u\log_e \frac{M_0}{M}$$

where the symbols have their usual meanings. 2+8=10

(b) Establish Lorentz transformation equations and discuss their significance. A rod has length 1 metre. When the rod is in a satellite moving with velocity 0·8c relative to laboratory, what is the length of the rod as determined by an observer *(i)* in the satellite, *(ii)* in the laboratory ? 7+1+2=10
