

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 gravitation
 - (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 $2.87 \times 10^{10} \text{ N/m}^2$ 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)** $5 \times 5 = 25$

- (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 $(\frac{3}{8}R, 0, 0)$ 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)** $10 \times 1 = 10$

(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 1 m satellite, (ii) in the laboratory?

7+1+2=10

$$L = \sqrt{1 - \frac{v^2}{c^2}} \times L_0 \rightarrow 1\text{ m}$$

$$v = 0.8$$