2023

(Held in 2024)

PHYSICS

Paper : PHYMAJ1014

(Mechanics)

Full Marks : 50

Pass Marks : 20

Time : 2 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer : 1×5=5

(a) When work is done in moving a particle around a closed loop in a field is zero, forces in the field are called

(i) zero forces

(ii) non-conservative forces

(iii) conservative forces

(iv) viscous forces

(b) The radial component of velocity for a particle moving in a circular path is

(i) constant

(ii) radius itself

(iii) variable

(iv) zero

(c) Dimension of angular momentum is

(i) $[ML^2T^{-2}]$

(ii) $[M^{-1}L^2T^{-1}]$

(iii) $[M^2L^2T^{-2}]$

(iv) $[ML^1T^{-2}]$

(d) Keplar's third law of planetary motion is

(i) $T^2 \propto R^2$

(ii) $T^2 \propto R^{\frac{1}{3}}$

(iii) $T^2 \propto R^3$

(iv) $T^2 \propto R^4$

(e) In SHM acceleration is maximum at

(i) mean position

(ii) extreme position

(iii) Can not predict

(iv) rest

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

(a) Find the impulse and its magnitude developed on a body of mass 1 kg which changes its velocity from $(2\hat{i}-3\hat{j}+4\hat{k})$ m/s to $(-2\hat{i}+\hat{j}+2\hat{k})$ m/s.

(b) Find the expression for elastic potential energy.

(c) Find the moment of inertia of a rectangular body about an axis passing through its centre and parallel to one side.

(d) What is modulus of rigidity? Define Poisson's ratio (σ). 1+1=2

(e) What is a central force? Give any one feature of central force. 1+1=2

(f) Find the time taken by the particle to go from its mean position to half of its amplitude in SHM. '*T*' is the time period.

(g) Find the magnitude of Coriolis force acting on a body of 10 gm moving with velocity $(2\hat{i}+3\hat{j}-4\hat{k})ms^{-1}$ with respect to a rotating frame having angular velocity $(4\hat{i}+2\hat{j})s^{-1}$.

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

(a) Establish the relation giving variation of mass with velocity of a particle in special theory of relativity.

(b) Discuss about kinetic energy and potential energy of a simple harmonic oscillator and show that mechanical energy of the oscillator remain conserved. 2+3=5

(c) Find out the expression for gravitational potential due to a spherical shell at an external point. What will be the gravitational field at that point? 4+1=5

(d) Prove that the reduced mass of two-body problem is always smaller than either of the masses.

(e) Derive Poiseuille's formula for the rate of flow of a liquid flowing through a narrow capillary tube.

(f) State and prove the law of conservation of angular momentum of a system. Give some of its applications. 3½+1½=5

(g) Define centre of mass. Discuss about motion of centre of mass. In absence of external force show that velocity of centre of mass remains constant. 1+2+2=5

(h) Define conservative and non-conservative forces with examples. Prove that $\vec{F} = -\vec{\nabla}U$, where the symbols have their usual meanings. 1+1+3=5

4. Answer the following questions (any *one*) : 10

(a) What do you mean by non-inertial frame of reference and fictitious force? Find the expression for total force in a non-inertial frame of reference. 3+7=10

(b) Derive Einstein's formula for addition of velocities. Show that addition of velocity of light to the velocity of light equals to the velocity of light. 8+2=10

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