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(Held in 2024)

PHYSICS

Paper : PHYMAJ1014

(Mechanics)

<u>Full Marks : 50</u>

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. $3\frac{1}{2}+1\frac{1}{2}=5$

(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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