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(November)

PHYSICS

(Major)

Course : 101

(Mechanics and Properties of Matter)

Full Marks : 80

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct option from the following :

$1 \times 8 = 8$

(a) In Galilean transformations, time interval is

(i) different for different frames

(ii) vector

(iii) relative

(iv) same for all the frames

(b) If a torque acting on a particle is zero, what is conserved?

   (i) Linear momentum

   (ii) Energy

   (iii) Angular momentum

   (iv) All of the above

(c) A central force is an example of

   (i) fictitious force

   (ii) frictional force

   (iii) conservative force

   (iv) non-conservative force

(d) In an elastic collision, kinetic energy

   (i) remains constant

   (ii) decreases

   (iii) increases

   (iv) may decrease or increase

(e) A metallic beam is fixed at ends and a load is suspended in the middle. The depression of the beam is proportional to

   (i) Y

   (ii) Y^2

   (iii) $\frac{1}{Y}$

   (iv) $\frac{1}{Y^2}$

(f) When the temperature increases, the angle of contact of a liquid

    (i) increases

    (ii) decreases

    (iii) remains unchanged

    (iv) first increases and then decreases

(g) If generalized coordinate has the dimension of momentum, the generalized velocity will have the dimension of

    (i) velocity

    (ii) acceleration

    (iii) force

    (iv) torque

(h) Lagrange's equations of motion are second-order equations. The degrees of freedom of these are

    (i) $2n-1$

    (ii) $2n+1$

    (iii) $2n$

    (iv) $2n+2$

2. (a) Show how a two-body problem can be reduced to a single-body problem. Hence, explain the concept of reduced mass.   4+1=5

(b) What is a conservative force? Show that the work done by a conservative force around a closed path is zero.   1+2=3

(c) Differentiate between angle of twist and angle of shear.   3

(d) What do you mean by virtual displacement? Deduce the principle of virtual work.   2+3=5

3. *(a)* What are inertial and non-inertial frames? Show that the basic laws of Physics are invariant under Galilean transformation.   4+5=9

Or

Show that the law of conservation of linear momentum can be obtained from the law of conservation of energy and the principle of Galilean invariance.   9

(b) Explain the terms 'accelerated frame of reference' and 'fictitious force' with examples. Show that fictitious force does no work.   5+4=9

4. What do you mean by gravitational potential and gravitational field? Calculate the gravitational potential due to a solid sphere at a point outside the sphere. Show that the gravitational field inside a hollow sphere is zero.   2+2+1=5

5. *(a)* State and prove the theorem of parallel axes. Calculate the moment of inertia of an uniform solid cylinder about an axis passing through its centre of mass and perpendicular to its own length. 1+2+3=6

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Or

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What do you understand by surface tension? Derive an expression for excess pressure inside a curved surface in terms of radius of curvature and surface tension. 2+4=6

(b) What is a cantilever? Obtain an expression for depression of its free end if the cantilever is cylindrical. [Neglect the weight of the cantilever.] A brass bar 1 cm square in cross-section supported horizontally on two knife edges 100 cm apart is loaded with 1 kg at the centre of the bar. Find how much the middle of the bar is stressed.

$[Y = 9 \cdot 77 \times 10^{11}$ dynes cm$^{-2}]$ 1+3+5=9

6. *(a)* What are constraints? Distinguish between holonomic and non-holonomic constraints. Write down the equations of constraints for a simple pendulum executing simple harmonic motion.

2+5+2=9

Or

Discuss the d'Alembert's principle. A particle is constrained to move along a circle lying in the vertical xy-plane. With the help of d'Alembert's principle, show that the equation of motion is $\ddot{x}y - \ddot{y}x - gx = 0$, where g is the acceleration due to gravity.   4+5=9

(b) What is Coriolis force? What is the effect of Coriolis force on a particle falling under earth's gravity? Derive a mathematical expression for Foucault's pendulum.   2+3+4=9

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