1 SEM TDC PHY M 1

2018

(November)

PHYSICS

(Major)

Course : 101

(Mechanics and Properties of Matter)

Full Marks : 80

Pass Marks : 32/24

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct option form the following : 1×8=8

(a) Coriolis force is maximum at a lattitude (ϕ) of

(i) $\phi = 20°$

(ii) $\phi = 0°$

(iii) $\phi = 180°$

(iv) $\phi = 90°$

(Turn Over)

(b) The slope of potential energy versus position graph represents

(i) force
(ii) work
(iii) power
(iv) momentum

(c) In Galilean transformations, time interval is

(i) different for different frames
(ii) vector
(iii) relative
(iv) same for all frames

(d) Angular momentum is

(i) a scalar
(ii) a polar vector
(iii) a pseudo-scalar
(iv) an axial vector

(e) In a gravitational field, if a body is bound, the total energy has

(i) positive value
(ii) zero value
(iii) negative value
(iv) kinetic energy<potential energy

(f) In the northern hemisphere, the directions of wind around a centre of high pressure and around a low pressure point due to presence of Coriolis force are

(i) anticlockwise, clockwise
(ii) anticlockwise, anticlockwise
(iii) clockwise, anticlockwise
(iv) clockwise, clockwise

(g) A particle of mass m moves in a plane. Its motion defined by (r,θ) under the influence of a force $f = -kr$ is directed towards the origin. The Lagrangian of the system is given by

(i) $\frac{1}{2}m\dot{r}^2 + \frac{1}{2}mr^2\dot{\theta}^2 - \frac{1}{2}kr^2$

(ii) $\frac{1}{2}m\dot{r}^2 + \frac{1}{2}kr^2$

(iii) $\frac{1}{2}m\dot{r}^2 + \frac{1}{2}mr\dot{\theta} - \frac{1}{2}kr^2$

(iv) $\frac{1}{2}m\dot{r}^2 + \frac{1}{2}mr^2\dot{\theta}^2 + \frac{1}{2}kr^2$

(h) A cylinder rolling without slipping down a rough inclined plane of angle θ is an example of

(i) scleronomic, conservative system only

(ii) scleronomic, holonomic, conservative system

(iii) only conservative system

(iv) only scleronomic system

2. A particle of mass $m = 5$ units is moving with a uniform speed $3\sqrt{2}$ units in XY-plane along a straight line $y = x + 4$. Find the magnitude of the angular momentum about the origin.

Or

Show that for a system of particles governed by Newtonian mechanics the total angular momentum is the sum of the angular momentum of the centre of mass about a reference point and the angular momentum of the system about the position of the centre of mass.

3. Show that the distance between two points in space and the force acting on a moving particle are Galilean invariant. 2+2=4

(Continued)

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4. Define conservative force and show that a conservative force can be expressed as a negative gradient of a potential. 4

5. Define gravitational field and its intensity at a point. Calculate the potential and intensity at a point due to a spherical shell when the point lies outside the shell. 6

6. Establish a relation between the scattering angles in the laboratory and centre of mass reference frames in a two-body elastic collisions. 5

7. State the three Kepler's laws of planetary motion. Obtain the differential equation of the orbit of an object which is moving under central force. 2+3=5

8. A copper wire 3 meters long, for which Young's modulus is $12{\cdot}5 \times 10^{11}$ dynes per square cm, has a diameter of 1 mm. If a weight of 10 kg is attached to one end, what extension is produced? If Poission's ratio is 0·26, what lateral compression is produced? 4

Or

Derive an expression for the bending moment of a horizontal beam clamped at one end and loaded at the other.

(Turn Over)

9. Show that the excess pressure acting on the curved surface of a curved membrane is given by

$$P = 2T\left(\frac{1}{r_1}+\frac{1}{r_2}\right)$$

where r_1 and r_2 are the radii of curvatures and T is the surface tension of the membrane.

10. A sphere of mass 0·1 kg, diameter 0·02 m, rolls without slipping with a velocity of 0·05 m/sec. Calculate its total energy.

11. Four solid spheres each of same mass and radius are placed with their centres on the four corners of a square. Calculate the moment of inertia of the system about a side of the square.

12. Calculate the fictitious force and total force acting on a freely falling body of mass 10 kg with reference to a frame moving with a downward acceleration of 5 m/sec^2.

13. What is Coriolis force? Deduce an expression for horizontal displacement of a freely falling body under the action of gravity from its vertical path due to the effect of Coriolis force. 1+5=6

14. What are generalised coordinates? Deduce an expression for generalised velocity associated with a particular coordinate. 5

15. What is virtual displacement? Explain the principle of virtual work. State and explain d'Alembert principle. 1+2+3=6

16. Set up the Lagrangian for a simple pendulum and obtain an equation describing its motion. 5

17. An electrical circuit contains an inductance L and capacitance C. Find the Lagrange's equation of motion, when the charge of the condenser is q. 6

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