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1 SEM TDC PHY M 1

2021

(March)

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 from the following : $1\times8=8$

(a) Newton's second law, i.e., $\overline{F} = m\overline{a}$ holds good only where mass m remains constant.

(i) True

(ii) False

(b) Reduced mass of two particles having masses m_1 and m_2 is expressed as

(i) $\dfrac{m_1 + m_2}{m_1 m_2}$

(ii) $\dfrac{m_1 m_2}{m_1 + m_2}$

(iii) $\dfrac{m_1 + m_2}{m_1 - m_2}$

(iv) None of the above

(c) The moment of momentum of a body rotating about an axis is given by

(i) $mr\omega^2$

(ii) $mr^2\omega$

(iii) $mr^2\omega^2$

(iv) $mr\omega$

(d) Moment of inertia of a solid circular lamina or disc about an axis passing through its centre and perpendicular to its plane is

(i) $\frac{1}{4} MR^2$

(ii) $\frac{5}{4} MR^2$

(iii) $\frac{1}{2} MR^2$

(iv) $\frac{3}{2} MR^2$

(e) In inelastic collision

(i) momentum is changed

(ii) kinetic energy is changed

(iii) total energy is changed

(iv) All of the above

(f) The correct relation connecting Y, K and η is

(i) $\frac{9}{Y} = \frac{3}{K} + \frac{1}{\eta}$

(ii) $\frac{9}{Y} = \frac{1}{K} + \frac{3}{\eta}$

(iii) $\frac{3}{Y} = \frac{1}{K} + \frac{9}{\eta}$

(iv) $\frac{1}{Y} = \frac{9}{K} + \frac{3}{\eta}$

(g) Coriolis force is expressed as

(i) $-2m(\overline{\omega} \times \overline{v})$

(ii) $-m\overline{\omega} \times (\overline{\omega} \times \overline{r})$

(iii) $-m(\overline{\omega} \times \overline{v})$

(iv) $-2m(\overline{\omega} \times \overline{r})$

(h) Generalized velocity need not have the dimension of velocity.

(i) True

(ii) False

2. *(a)* What do you understand by Galilean invariance? Show that law of conservation of momentum is invariant under Galilean transformation. 1+3=4

(b) What is the difference between inertial and non-inertial frame of reference? Give one example of each. 1+1=2

(c) Define the principle of conservation of angular momentum for a system of particles and prove it. 1+3=4

(d) A particle of mass 5 kg is revolving in a circular orbit of radius 4 m with a constant velocity of 10 m/sec. Calculate the angular momentum about the centre of the circle and about a point on the axis of the circle distant 3 m from its centre. 3

(e) Show that the centre of mass of two particles must lie on the line joining them. 3

(f) Show that in absence of any external torque on a rotating particle, its angular momentum remains constant with time. 4

3. (a) What do you understand by conservative force and central force? When a particle moves under a central force, prove that the aerial velocity of the radius vector remains constant. 2+3=5

(b) Derive the gravitational potential at a point outside a spherical shell. 3

(c) What is the difference between elastic and inelastic collisions? Show that in elastic collision, the relative velocity of approach before collision is equal to the relative velocity of separation after collision. 1+2=3

4. (a) Explain the physical significance of moment of inertia. Calculate the moment of inertia of a solid cylinder about an axis perpendicular to the geometrical axis and passing through its centre. 2+4=6

(b) What do you mean by lateral strain? Deduce the relation $K = \dfrac{Y}{3(1-2\sigma)}$, where Y, K and σ represent Young's modulus, Bulk modulus and modulus of rigidity. 1+4=5

(c) Derive an expression for depression at the free end of a cantilever. 4

(d) Define surface tension. Calculate the work done in blowing a soap bubble of 5 cm radius. Surface tension of soap solution is 50 dynes/cm. 1+2=3

5. (a) What do you understand by fictitious force? Show that centrifugal force is a fictitious force. 1+3=4

(b) Calculate the fictitious 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. 2

(c) State the principle of virtual work. Derive the Lagrange's equation from d'Alembert's principle. 1+5=6

(d) What are the similarities and differences between Newtonian and Lagrangian equation? Why is Lagrangian formulation more advantageous over Newtonian formulation? 2+2=4

6. Write short notes on any *two* of the following : $3\frac{1}{2} \times 2 = 7$

(*a*) Foucault pendulum

(*b*) Coriolis force due to rotation of the earth

(*c*) d'Alembert's principle

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