

## THIRD SEMESTER B.Sc. DEGREE EXAMINATION, NOVEMBER 2012

Physics—Core Course

PH 3.B.05—MECHANICS

Three Hours

Maximum : 30 Weightage

I. Answer all twelve questions.

- 1 A lift is moving down with acceleration  $a$ . A man in the lift drops a ball inside the lift. Acceleration of the ball as observed by the man in the lift and a man on the ground are :
- (a)  $g, g$ . (b)  $g - a, g - a$ .  
(c)  $g - a, g$ . (d)  $a, g$ .
- 2 When a  $U^{238}$  nucleus originally at rest, decays by emitting an alpha particle having speed  $u$ . The recoil speed of residual nucleus is :
- (a)  $\frac{-4u}{238}$ . (b)  $\frac{4u}{238}$ .  
(c)  $\frac{-4u}{234}$ . (d)  $\frac{4u}{234}$ .
- 3 The time taken by the plumb of oscillation of Foucault's pendulum to turn through  $90^\circ$  at a point where the Co-latitude is  $60^\circ$ , is :
- (a) 12 hrs. (b) 24 hrs.  
(c) 36 hrs. (d) 48 hrs.
- 4 For same K.E, momentum shall be maximum for :
- (a) Proton. (b) Electron.  
(c) Deuteron. (d) Alpha particle.
- 5 Two identical particle move towards each other with velocities  $2V, V$  respectively. Then velocity of centre of mass is :
- (a)  $V$ . (b)  $\frac{V}{3}$ .  
(c)  $\frac{V}{2}$ . (d)  $0$ .
- 6 A solid sphere is rotating in free space. If radius of sphere is increasing keeping mass same, which of the following will not be affected ?
- (a) Moment inertia. (b) Angular momentum.  
(c) Angular velocity. (d) Rotational KE.

Turn over

7 Kinetic energy needed to project a body of mass  $M$  from earth to infinity is :

(a)  $\frac{MgR}{2}$  (b)  $MgR$ .

(c)  $\frac{Mg}{R}$  (d)  $\frac{MgR}{4}$ .

8 The time period of a satellite of earth is 5 hrs. If the separation between earth and satellite increased to 4 times previous value, the new time period is :

(a) 24 hrs. (b) 10 hrs.

(c) 8 hrs. (d) 40 hrs.

9 Identify holonomic constraints :

(a) Motion of a body on an inclined plane under gravity.

(b) A bead on circular wire.

(c) A particle moving on an ellipsoid under gravity.

(d) A pendulum with variable length.

10 Which of the following is not Galilean invariant ?

(a) Length.

(b) Velocity.

(c) Acceleration.

(d) Law of conservation of energy.

11 In Minkowski's space :

(a) The space interval between two points is invariant.

(b) The time interval between two points is invariant.

(c) The space-time interval between two points invariant.

(d) The space-time interval between two points is different.

12 If Lagrangian does not depend on time explicitly, then :

(a) Hamiltonian is constant.

(b) Hamiltonian is not constant.

(c) Kinetic energy constant.

(d) Potential energy constant.

(12 × ¼ = 3 weight)

II. Answer *all nine* questions.

13 Prove that angular momentum remains same for motion under central forces.

14 What is inertial frame ? How will you realise it in practice ?

15 Is Newton's first law a particular case of Newton's second law ?

16 What do you understand by internal and external forces ?

17 State and prove work energy theorem.

18 'Moon has no atmosphere'. Why ?

- 19 What is meant by Hamiltonian function ?
- 20 What are generalized co-ordinates ?
- 21 Derive the relationship between torque and angular momentum.

(9 × 1 = 9 weightage)

Answer any *five* questions from seven.

- 22 A particle of mass 2kg with position vector  $r = 5t^2i + 3t^2j - t^2k$ , find out its angular momentum at the instant  $t = 2s$ .
- 23 Prove that gravitational force between two masses is conservative.
- 24 Find the magnitude of Coriolis force on a train of mass  $10^6$  kg is moving north to south with a speed of 72 km/hr at latitude of  $30^\circ$ . Angular velocity of earth's rotation =  $7.3 \times 10^{-3}$  rad/s.
- 25 Two masses 2 kg and 10 kg are 20 cm apart. Locate the position of a point on the line joining them so that the third mass of 1 kg experience no force.
- 26 Locate the position of centre of mass of three particles of masses in each at the vertices of an equilateral triangle of side 1 m.
- 27 A certain strain of bacteria doubles in number in each 20 days. Two of this bacteria are placed in a space ship and sent away from earth for 1000 earths days. During this time speed of ship was 0.995 C. How many bacteria would be abroad when the ship lands on earth.
- 28 A particle of mass  $m_1$  moving with velocity  $u_1$  collides with another particle of mass  $m_2$  at rest. As a result of collision, two particle stick together. Calculate the kinetic energy of combined particles.

(5 × 2 = 10 weightage)

Answer any *two* questions from three.

- 29 Establish the relation giving the variation of mass with velocity of particle.
- 30 Derive Lagrange's equation from D'Alembert's principle.
- 31 State and prove Kepler's laws in planetary motion.

(4 × 2 = 8 weightage)