CBSE

SYSTEM OF PARTICLES AND ROTATIONAL MOTION WS 11

Class 11 - Physics

Section A

1. If a person standing on a rotating disc stretches out his hands, the angular speed will **[1]**

   a) remain same
   b) Rise
   c) decrease
   d) increase

2. A particle performs uniform circular motion with an angular momentum L. If the frequency of particle's motion is doubled and its K.E. is halved, the angular momentum becomes: **[1]**

   a) $\frac{L}{4}$
   b) 2L
   c) 4L
   d) $\frac{L}{2}$

3. In precession such as that of a top: **[1]**

   a) the axis of rotation oscillates horizontally
   b) the axis of rotation oscillates vertically
   c) the axis of rotation is fixed
   d) the axis of rotation moves

4. A diver in a swimming pool bench his head before diving. It: **[1]**

   a) increases his moment of inertia
   b) increases his linear velocity
   c) decreases his moment of inertia
   d) decreases his angular velocity

5. If there is change of angular momentum from j to 4 j in 4s, then the torque is **[1]**

   a) $\frac{5}{4}j$
   b) $\frac{4}{3}j$
   c) 1 j
   d) $\frac{3}{4}j$

6. A tube of length L is filled completely with an incompressible liquid of mass M and closed at both the ends. The tube is then rotated in a horizontal plane about one of its ends with a uniform angular velocity ω. The force exerted by the liquid at the other end is **[1]**

   a) $\frac{ML^2\omega}{2}$
   b) $ML\omega^2$
   c) $\frac{ML^2\omega^2}{2}$
   d) $\frac{ML\omega^2}{2}$

7. If a gymnast sitting on a rotating stool with his arms outstretched, suddenly lowers his hands: **[1]**

   a) The angular velocity decreases
   b) His moment of inertia decreases
   c) The angular momentum increases
   d) The angular velocity stays constant

8. A circular disc of mass M and radius R is rotating with an angular velocity a about an axis passing through its centre and perpendicular to the plane of the disc. A small point-like part of mass m datches from the rim of the disc and continues to move with same angular speed. The angular velocity of remaining disc just after detaching will become **[1]**

   a) $\left(\frac{M-2m}{M-m}\right)\omega$
   b) $\left(\frac{M+2m}{M-m}\right)$

c) $\left(\frac{M+2m}{M+m}\right)$ d) $\left(\frac{M-2m}{M+m}\right)\omega$

9. The angular momentum of a system of particles is conserved **[1]**

a) when no external force acts upon the system b) when no external impulse acts upon the system

c) when axis of rotation remains same d) when no external torque acts upon the system

10. A thin circular ring of mass M and radius R is rotating about its central axis with angular velocity. Four-point objects each of mass m are attached gently to the opposite ends of two perpendicular diameters, the angular velocity of the ring is given by: **[1]**

a) $\frac{M-4m}{M+4m}\cdot\omega$ b) $\frac{M+4m}{M}\cdot\omega$

c) $\frac{M}{M+m}\cdot\omega$ d) $\frac{M}{M+4m}\cdot\omega$

11. A body is projected from the ground with some angle to the horizontal. What happens to the angular momentum about the initial position in this motion? **[1]**

a) remains same b) first increases and then decreases

c) increases d) decreases

12. A flywheel is attached to an engine to **[1]**

a) decrease its speed b) decrease its energy

c) increase its speed d) help in overcoming the dead point

13. The motion of planets in the solar system is an example of the conservation of **[1]**

a) energy b) mass

c) angular momentum d) linear momentum

14. A boy comes running and sits on a merry-go-round. What is conserved? **[1]**

a) Angular momentum b) Linear momentum

c) The kinetic energy of rotation d) The kinetic energy of function

15. **Assertion:** The hard boiled egg and raw egg can be distinguished on the basis of spinning of both. **[1]**
Reason: The moment of inertia of hard boiled egg is more as compared to raw egg.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion. b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement. d) Assertion is wrong statement but reason is correct statement.

16. **Assertion:** Angular momentum of a rigid body will remain conserved even when the moment of inertia of the body changes. **[1]**
Reason: Angular momentum of a rigid body does not depend upon the moment of inertia of the rigid body.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion. b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

17. **Assertion (A):** A right body will be at mechanical equilibrium if total force and total torque acting on it are zero. **[1]**
Reason (R): A rigid body is said to be in mechanical equilibrium if both its linear momentum and angular momentum are not changing with time, or equivalently, the body has neither line acceleration nor angular acceleration.

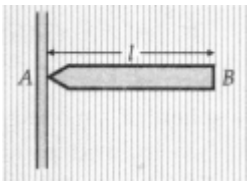
a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

18. A uniform rod AB of length l and mass m is free to rotate in a vertical plane about point A. The rod is released from rest in the horizontal position. Given that the moment of inertia of the rod about A is $\frac{m^2}{3}$, the initial angular acceleration of the rod will be **[1]**



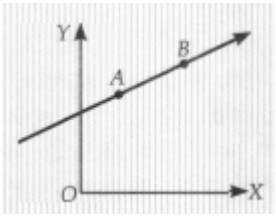
a) $\frac{2g}{3l}$

b) $\frac{mgl}{2}$

c) $\frac{3}{2}gl$

d) $\frac{3g}{2l}$

19. A particle of mass m moves in the XY plane with a velocity v along the straight line AB. If the angular momentum of the particle with respect to origin O is LA when it is at A and Lg when it is at B, then **[1]**



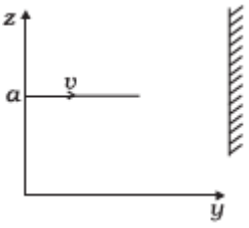
a) $L_A < L_B$

b) $L_A = L_B$

c) $L_A > L_B$

d) the relationship between L_A and L_B depends upon the slope of the line AB

20. A particle of mass m is moving in yz-plane with a uniform velocity v with its trajectory running parallel to +ve y-axis and intersecting z-axis at z = a (Figure). The change in its angular momentum about the origin as it bounces elastically from a wall at y = constant is: **[1]**



a) $Mva\hat{e}_x$

b) $2ymv\hat{e}_x$

c) $ymv\hat{e}_x$

d) $2mva\hat{e}_x$

21. A heavenly body (such as a comet) revolves around a massive star in a highly elliptical orbit. Is its angular momentum constant over the entire orbit? (Ignore any mass loss of the comet when it comes too close to the **[1]**

star).

22. Why does a girl lean towards right while carrying a bag in her left hand? **[1]**

23. What is the angular momentum of a body of mass m moving in a circular path of radius r with constant speed v? **[1]**

24. A flywheel is revolving with a constant angular velocity. A chip of its rim breaks and flies away. What will be the effect on its angular velocity? **[1]**

Section B

25. **State True or False:** **[2]**
    (a) The angular momentum of a system is always conserved. **[1]**
    (b) Two satellites of equal masses, which can be considered as particles, are orbiting the earth at different heights. Their moments of inertia will be equal. **[1]**

26. **Fill in the blanks:** **[2]**
    (a) The angular momentum of a particle is equal to twice the product of its _____ and _____. **[1]**
    (b) A ballet dancer stretches her hands out for slowing down. This is based on the conservation of the principle of conservation of _____. **[1]**

27. A horizontal disc rotating about a vertical axis passing through its centre makes 180 rpm. A small piece of wax of mass 10 g falls vertically on the disc and adheres to it at a distance of 8 cm from its axis. If the frequency is thus reduced to 150 rpm, calculate the moment of inertia of the disc. **[2]**

28. If earth contracts to half its radius what would be the length of the day at equator? **[2]**

29. A 40 kg flywheel in the form of a uniform circular disc of 1 m radius is making 120 rpm. Calculate the angular momentum. **[2]**

30. The maximum and minimum distances of a comet from the sun are 1.4×1012 m and 7×10^{10} m. If its velocity nearest to the sun is $6 \times 10^{4} ms^{-1}$, what is the velocity in the farthest position? Assume that path of the comet in both the instantaneous positions is circular. **[2]**

31. Initial angular velocity of a circular disc of mass M is cor. Then two small spheres of mass m are attached gently to two diametrically opposite points on the edge of the disc. What is the final angular velocity of the disc? **[2]**

32. A planet revolves around on massive star in a highly elliptical orbit is its angular momentum constant over the entire orbit. Give reason. **[2]**

33. Show that the angular momentum about any point of a single particle moving with constant velocity remains constant throughout the motion. **[2]**

34. Explain how a cat is able to land on its feet after a fall taking advantage of the principle of conservation of angular momentum? **[2]**

35. A small block is rotating in a horizontal circle at the end of a thread which passes down through a hole at the centre of tabletop. If the system is rotating at 2.5 rps in a circle of 30 cm radius, what will be the speed of rotation when the thread is pulled inwards to decrease the radius to 10 cm? Neglect friction. **[2]**

36. Mass of an electron is 9.0×10^{-31} kg. It revolves around the nucleus of an atom in a circular orbit of radius 4.0 $\mathring{A}$ with a speed of 6.0×10^{6} ms^{-1}. Calculate the angular momentum of the electron. **[2]**

37. Prove that for an earth satellite, the ratio of its velocity at apogee (when farthest from the earth) to its velocity at perigee (when nearest to the earth) is the inverse ratio of its distances from apogee and perigee. **[2]**

38. The speed of a whirlwind in a tornado is alarmingly high. Why? **[2]**

39. How does an ice-skater, a ballet dancer or an acrobat take advantage of the principle of conservation of angular momentum? **[2]**

40. Does the angular momentum of a body in translatory motion is zero? **[2]**

41. Two boys of the same weight sit at the opposite ends of a diameter of a rotating circular table. What happens to the speed of rotation if they move nearer to the axis of rotation? **[2]**

42. A person is standing on a rotating table with metal spheres in his hands. If he withdraws his hands to his chest, what will be the effect on his angular velocity? **[2]**

43. What is the use of flywheel in railway engine? **[2]**

44. The angular momentum of a body is 31.4 Js and its rate of revolution is 10 cycles per second. Calculate the moment of inertia of the body about the axis of rotation. **[2]**

45. Define angular momentum. Prove that angular momentum of a particle is equal to twice the product of its mass and areal velocity. **[2]**

46. A flywheel of mass 25 kg has a radius of 0.2 m. What force should be applied tangentially to the rim of the flywheel so that it acquires an angular acceleration of 2 rad s^{-2}? **[2]**

Section C

47. A circular ring of diameter 40cm and mass 1kg is rotating about an axis normal to its plane and passing through the centre with a frequency of 10 rotations per second. Calculate the angular momentum about its axis of rotation. **[3]**

48. What will be the duration of the day, if earth suddenly shrinks to $\frac{1}{64}$ of its original volume, mass remaining the same? **[3]**

49. The angular speed of a motor wheel is increased from 1200 rpm to 3120 rpm in 16s. **[3]**

    a. What is its angular acceleration, assuming the acceleration to be uniform?

    b. How many revolutions does the engine make during this time?

50. State and prove the principle of conservation of angular momentum. Explain it with a suitable example. **[3]**

51. Determine the angular velocity of **[3]**

    i. hour hand of clock,

    ii. second hand of a clock, and

    iii. Earth

    about its own axis.

52. A body of mass 1.0 kg is rotating on a circular path of diameter 2.0 m at the rate of 10 rotations in 31.4 s. Calculate **[3]**

    i. angular momentum of the body and

    ii. rotational kinetic energy.

Section D

53. Define rotational motion of a body. Derive the following equations of rotational motion under constant angular acceleration. **[5]**

    i. $\omega = \omega_0 + \alpha t$

    ii. $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

    iii. $\omega^2 - \omega_0^2 = 2\alpha\theta$

54. Define radius of gyration. Derive an expression for the radius of gyration of a body consisting of n particles about an axis of rotation. **[5]**

55. **[5]**

    a. A cat is able to land on its feet after a fall. Why?

    b. If angular momentum moment of inertia is decreased, will its rotational K.E. be also conserved? Explain.

56. Two particles each of mass m and speed v travel in opposite direction along parallel lines, separated by a **[5]**

distance d. Show that vector angular momentum of the two particles system is same whatever be the point about which angular momentum is taken.