CBSE

SYSTEM OF PARTICLES AND ROTATIONAL MOTION WS 9

Class 11 - Physics

Section A

1. A car is moving at a speed of 72 km/h. The diameter of its wheels is 0.5 m. If the wheels are stopped in 20 rotations by applying brakes, then angular retardation produced by the brakes is **[1]**

   a) 33.5 rad/s^2 b) - 45.5 rad/s^2

   c) - 29.5 rad/s^2 d) -25.5 rad/s^2

2. A Merry-go-round, made of a ring-like platform of radius R and mass M, is revolving with angular speed ω. A person of mass M is standing on it. At one instant, the person jumps off the round, radially away from the centre of the round (as seen from the round). The speed of the round afterwards is **[1]**

   a) 2ω b) 0

   c) $\frac{\omega}{2}$ d) ω

3. An elevator starts going up with an acceleration 2 m/ s^2. If radius of the wheel attached to the elevator is 0.1 m, then find out the number of revolutions in 10 s. **[1]**

   a) 180 b) 160

   c) 170 d) 190

4. In pure rolling, the velocity of the contact point is **[1]**

   a) zero b) ωr

   c) $< \omega r$ d) $> \omega r$

5. A body of mass 2.0 kg and radius of gyration 0.5 m is rotating about an axis. If its angular speed is 2.0 rad/s, the angular momentum of the body (in kg - m^2/s) is: **[1]**

   a) 2.0 b) 0.5

   c) 1.5 d) 1.0

6. The motor of an engine is rotating about its axis with an angular velocity of 100 rev/m. It comes to rest in 15 s, after being switched off. Assuming constant angular deceleration, what are the number of revolutions made by it before coming to rest? **[1]**

   a) 40 b) 15.6

   c) 12.5 d) 32.6

7. The centre of a wheel rolling on a plane surface moves with a speed v_0. A particle on the rim of the wheel at the same level as the centre will be moving at speed. **[1]**

   a) $2v_0$ b) zero

   c) $\sqrt{2}v_0$ d) v_0

8. A wheel starts rotating from rest at time t = 0 with an angular acceleration of 50 radian/s^2. The angular acceleration α decreases to zero value after 5 seconds. During this interval, α varies according to the equation: $\alpha = \alpha_0 \left(1 - \frac{t}{5}\right)$ .The angular velocity at t = 5s will be **[1]**

a) 100 rad/s
b) 250 rad/s
c) 125 rad/s
d) 10 rad/s

9. Two racing cars of masses m_1 and m_2 are moving in circles of radii r_1 and r_2 respectively. Their speeds are such that each makes a complete circle in the same time t. The ratio of the angular speeds of the first to the second car will be **[1]**

a) $r_1 : r_2$
b) $m_1 : m_2$
c) $m_1 m_2 : r_1 r_2$
d) 1 : 1

10. The front wheel on an ancient bicycle has radius 0.5 m. It moves with angular velocity given by the function $\omega(t) = 2 + 4t^2$, where t is in seconds. About how far does the bicycle move between t = 2 and t = 3 seconds? **[1]**

a) 27 m
b) 14 m
c) 36 m
d) 21 m

11. A cylinder is rolling down an inclined plane of inclination 60°. **[1]**
What is its acceleration?

a) $\sqrt{\frac{2}{3}}g$
b) $\frac{g}{\sqrt{3}}$
c) $g\sqrt{3}$
d) $g + \sqrt{3}$

12. A circular platform is mounted on a frictionless vertical axle. Its radius R = 2 m and its moment of inertia about the axle is 200kgm^2. It is initially at rest. A 50 kg man stands on the edge of the platform and begins to walk along the edge at the speed of 1ms-1 relative to the ground. Time taken by the man to complete one revolution is **[1]**

a) π s
b) $\frac{3\pi}{2}s$
c) $\frac{\pi}{2}s$
d) 2 πs

13. A small object of uniform density rolls up a curved surface with an initial velocity v'. If reaches up to a maximum height of $\frac{3v^2}{4g}$ with respect to the initial position. The object is **[1]**

a) solid sphere
b) ring
c) disc
d) hollow sphere

14. The acceleration of a solid cylinder rolling down an inclined plane of inclination 30° is **[1]**

a) $\frac{g}{3}$
b) $\frac{g}{4}$
c) $\frac{g}{2}$
d) $\frac{2g}{2}$

15. **Assertion:** In a rigid body the magnitude of linear velocity of any point is given by the product of angular velocity co with the distance of that point from the instantaneous axis of rotation. **[1]**
Reason: Instantaneous axis is an imaginary axis about the motion of a rigid body in combined translation and rotation motion can be taken as pure rotation.

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

for assertion.

explanation for assertion.

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

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

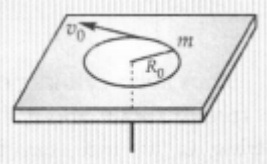
16. **State True or False:** **[1]**

(a) When a solid sphere and a hollow sphere of same mass and size roll down an inclined plane without slipping, the solid sphere reaches the bottom of the incline earlier than the hollow sphere. **[1]**

17. **Fill in the blanks:** **[1]**

(a) In pure rotational motion, the plane of the circle in which any particle moves is always _____ to the fixed axis of rotation and has its centre on the axis. **[1]**

18. A mass m moves in a circle on a smooth horizontal plane with velocity v_0 at a radius R_0. The mass is attached to a string which passes through a smooth hole in the plane as shown. The tension in the string is increased gradually and finally m moves in a circle of radius $\frac{R_0}{2}$. The final value of the kinetic energy is **[1]**



a) $2mv_0^2$

b) $\frac{1}{2}mv_0^2$

c) mw_0^2

d) $\frac{1}{4}mv_0^2$

19. A particle revolves uniformly along a circular path, on a smooth horizontal table, by means of a string connected to it. Does its angular momentum change, if the string is suddenly cut? **[1]**

20. A circular turn-table rotates at a constant angular velocity about a vertical axis. There is no friction and no driving torque. An ice pan containing ice also rotates with it. The ice melts but none of the water escapes from the pan. Is the velocity now greater, the same or less than the original velocity? Give reason. **[1]**

21. If earth were to shrink suddenly, what would happen to the length of the day? **[1]**

22. Two bodies move in two concentric circular paths of radii r_1 and r_2 in the same time. What is the ratio of their angular velocities? **[1]**

23. A body is moving in a circle of radius r centimetre at a constant speed of v cm s^{-1}. What is the angular velocity? **[1]**

Section B

24. A grindstone has a moment of inertia of 6 kg m^2. A constant torque is applied and the grindstone is found to have a speed of 150 rpm, 10 seconds after starting from rest. Calculate the torque. **[2]**

25. Establish the relation $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$, where the letters have their usual meanings. **[2]**

26. A comet revolves around the Sun in a highly elliptical orbit having a minimum distance of 7×10^{10} m and a maximum distance of 1.4×10^{13}m. If its speed while nearest to the sun is 60 kms^{-1}, find its linear speed when situated farthest from the sun. **[2]**

27. The angle θ covered by a body in rotational motion is give by the equation $\theta = 6t + 5t^2 + 2t^3$. Determine the value of instantaneous angular velocity and angular acceleration at time t = 2s. **[2]**

28. An automobile moves on a road with a speed of 54 km h^{-1}. The radius of its wheels is 0.35 m. What is the average negative torque transmitted by its brakes to a wheel if the vehicle is brought to rest in 15s? The moment of inertia of the wheel about the axis of rotation is 3 kg m^2. **[2]**

29. A flywheel rotating at 420 rpm slows down at a constant rate of 2 rad s^{-2}. What time is required to stop the **[2]**

flywheel?

30. What are the characteristics of rotational motion? **[2]**

31. A ball tied to a string takes 4s to complete revolution along a horizontal circle. If by pulling the cord, the radius of the circle is reduced to half of the previous value, then how much time the ball will take in one revolution? **[2]**

32. A body of mass 5 kg is attached to a weightless string wound round a cylinder of mass 8 kg and radius 0.3 m The body is allowed to fall. Calculate **[2]**

    i. tension in the string

    ii. acceleration with which the body falls and

    iii. the angular acceleration of the cylinder.

Section C

33. The oxygen molecule has a mass of 5.30×10^{-26} kg and a moment of inertia of $1.94 \times 10^{-46} \mathrm{kgm}^2$ about an axis through its centre perpendicular to the lines joining the two atoms. Suppose the mean speed of such a molecule in a gas is 500 m/s and that its kinetic energy of rotation is two thirds of its kinetic energy of translation. Find the average angular velocity of the molecule. **[3]**

34. Derive an expression for the rotational kinetic energy of a body and hence define moment of inertia. **[3]**

35. A solid cylinder of mass 20 kg rotates about its axis with angular speed 100 rad s^{-1}. The radius of the cylinder is 0.25 m. What is the kinetic energy associated with the rotation of the cylinder? What is the magnitude of angular momentum of the cylinder about its axis? **[3]**

Section D

36. Three bodies, a ring, a solid cylinder and a solid sphere roll down the same inclined plane without slipping. They start from rest. The radii of the bodies are identical. Which of the bodies reaches the ground with maximum velocity? **[5]**

37. Two discs of moments of inertia I_1 and I_2 about their respective axes (normal to the disc and passing through the centre), and rotating with angular speeds ω_1 and ω_2 are brought into contact face to face with their axes of rotation coincident. **[5]**

    a. What is the angular speed of the two-disc system?

    b. Show that the kinetic energy of the combined system is less than the sum of the initial kinetic energies of the two discs. How do you account for this loss in energy? Take $\omega_{1 \neq} \omega_2$.