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ROTATIONAL MOTION

1. Which of the following has the highest moment of inertia if each has the same mass and the same radius ?

- (a) a ring about its axis perpendicular to the plane of the ring
- (b) A solid sphere about one of its diameters
- (c) a spherical shell about one of its diameters
- (d) A disc about its axis perpendicular to the plane of its disc

2. A mass M is moving with a constant velocity parallel to the x -axis. Its angular momentum with respect to the origin

- (a) is zero
- (b) remains constant
- (c) goes on increasing
- (d) goes on decreasing

3. A thin circular ring of mass M is rotating about its axis with a constant angular velocity. Two objects of mass m , are attached gently to the opposite ends of a diameter of the ring. The ring now rotates with an angular velocity

- (a) $\frac{\omega m}{M+m}$
- (b) $\frac{\omega(M-2m)}{M+2m}$
- (c) $\frac{\omega M}{M+2m}$
- (d) $\frac{\omega(M+2m)}{M}$

4. Moment of inertia of a ring of mass m and radius R about an axis passing through the centre and perpendicular to the plane is

- (a) $\frac{1}{4} mR^2$
- (b) $\frac{1}{2} mR^2$
- (c) $\frac{3}{4} mR^2$
- (d) mR^2

5. When a mass is rotated in a plane about a fixed point, its angular momentum is directed along

- (a) the radius
- (b) the tangent to the orbit
- (c) a line at an angle of 45° to the plane of rotation
- (d) the axis of rotation

6. A hollow sphere and a solid sphere, having the same mass, are released from rest simultaneously from the top of an inclined plane. Which of the two will reach the bottom first?

- (a) solid sphere
- (b) Hollow sphere
- (c) The one which has the greater density
- (d) Both will reach the bottom simultaneously

7. Angular momentum of a body is defined as the product of

- (a) mass and angular velocity
- (b) centripetal force and radius
- (c) linear velocity and angular velocity
- (d) moment of inertia and angular velocity

8. A constant torque acting on a uniform circular wheel changes its angular momentum from A to $4A$ in 4 seconds. The magnitude of this torque is

- (a) $\frac{3A}{4}$
- (b) A
- (c) $4A$
- (d) $12A$

9. A mass is rotating in a plane about a fixed point. Its angular momentum is directed along

- (a) the radius
- (b) The tangent to the point
- (c) a line perpendicular to the plane of rotation
- (d) none of these

10. A solid sphere rolls down without slipping from rest on a 30° incline. Its linear acceleration is

- (a) $5g/7$
- (b) $5g/14$
- (c) $2g/3$
- (d) $g/3$

11. The moment of inertia of a hoop of radius R and mass M about any tangent line is

- (a) $\frac{3}{2} MR^2$
- (b) $\frac{MR^2}{2}$
- (c) $\frac{MR^2}{4}$
- (d) MR^2

12. A thin, uniform, circular disc is rolling down an inclined plane of inclination 30° without slipping. Its linear acceleration along the plane is

- (a) $g/4$
- (b) $g/3$
- (c) $g/2$
- (d) $2g/3$

13. A particle performs uniform circular motion with angular momentum l . If the frequency of the motion of the particle is doubled and its kinetic energy halved, the angular momentum becomes

- (a) $2l$
- (b) $4l$
- (c) $l/2$
- (d) $l/4$

14. A solid sphere of mass 1 kg and radius 3 cm is rotating about an axis passing through its centre with an angular velocity of 50 rad/s. The kinetic energy of rotation is

- (a) $9/20$ J
- (b) 90 J
- (c) 910 J
- (d) 4500 J

15. Two loops P and Q are made from a uniform wire. The radii of P and Q are r_1 and r_2

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respectively, and their moments of inertia are I_1 and I_2 respectively. If $\frac{I_2}{I_1} = 4$ then $\frac{r_2}{r_1}$ equals

- (a) $4^{2/3}$ (b) $4^{1/3}$ (c) $4^{-2/3}$ (d) $4^{-1/3}$

16. Four spheres, each of mass M and diameter $2r$, are placed with their centres on the four corners of a square of side a ($a > 2r$). The moment of inertia of the system about one side of the square is

- (a) $\frac{2}{5}M(5r^2 + 4a^2)$ (b) $\frac{2}{5}M(5r^2 + 2a^2)$
(c) $\frac{2}{5}M(2r^2 + 5a^2)$ (d) $\frac{2}{5}M(4r^2 + 5a^2)$

17. The moment of inertia of a uniform circular disc about diameter is I . Its moment of inertia about an axis perpendicular to its plane and passing through a point on its rim is

- (a) $3I$ (b) $4I$ (c) $5I$ (d) $6I$

18. The moment of inertia of a body about an axis is $1.2 \text{ kg} \cdot \text{m}^2$. Initially the body is at rest. In order to produce a rotational kinetic energy of 1500 J , an angular acceleration of 25 rad/s^2 must be applied about the axis for a duration of

- (a) 2 s (b) 4 s (c) 8 s (d) 10 s

19. A solid sphere, a hollow sphere and a solid cylinder, all of the same radius, roll down an inclined plane from the same height, starting from rest. Which of them takes the least time in reaching the bottom of the plane?

- (a) solid sphere (b) hollow sphere
(c) solid cylinder (d) All will take the same time

20. The rotational kinetic energy of a body is E and its moment of inertia is I . The angular momentum of the body is

- (a) EI (b) $2\sqrt{EI}$ (c) $\sqrt{2EI}$ (d) E/I

21. Two circular rings have masses in the ratio $1:2$ and diameters in the ratio $2:1$. The ratio of their moments of inertia is

- (a) $1:4$ (b) $2:1$ (c) $4:1$ (d) $\sqrt{2}:1$

22. You are given two circular discs having equal masses and equal thicknesses. Their densities, radii and moments of inertia about the central axis are d_1, R_1, I_1 and d_2, R_2, I_2 respectively. For I_1 to be greater than I_2 , the conditions (s) is(are)

- (a) $d_1 > d_2$ (b) $R_1 > R_2$
(c) $d_1 > d_2$ and $R_1 > R_2$
(d) $d_1 < d_2$ and $R_1 < R_2$

23. A false balance has equal arms. An object weighs x when placed in one pan and y when placed in the other pan. The true weight of the object is equal to

- (a) \sqrt{xy} (b) $\frac{x+y}{2}$ (c) $\frac{x^2+y^2}{2}$ (d) $\frac{\sqrt{x^2+y^2}}{2}$

24. Two rings of the same radius (r) and mass (m) are placed such that their centres are at a common point and their planes are perpendicular to each other. The moment of inertia of the system about an axis passing through the centre and perpendicular to the plane of one of the rings is

- (a) $\frac{1}{2}mr$ (b) mr^2 (c) $\frac{3}{2}mr$ (d) $2mr^2$

25. A cord is wound round the circumference of a wheel of radius r . The axis of the wheel is horizontal and its moment of inertia about this axis is I . A weight mg is attached to the end of the cord and is allowed to fall from rest. The angular velocity of the wheel, when the weight has fallen through a distance h , is

- (a) $\left[\frac{2gh}{1+mr}\right]^{1/2}$ (b) $\left[\frac{2mgh}{1+mr^2}\right]^{1/2}$
(c) $\left[\frac{2mgh}{1+2mr^2}\right]^{1/2}$ (d) $(2gh)^{1/2}$

26. A wheel rotates with a constant acceleration of 2.0 rad/s^2 . If the wheel starts from rest, the number of revolutions it makes in the first ten seconds will be approximately

- (a) 8 (b) 16 (c) 24 (d) 32

27. A body having moment of inertia about its axis of rotation equal to $2 \text{ kg} \cdot \text{m}^2$ is rotating with angular velocity equal to 3 rad/s . The kinetic energy of this body is the same as that of a body of mass 27 kg moving with a speed of

- (a) 1.0 m/s (b) 0.5 m/s (c) 1.5 m/s (d) 2.0 m/s

28. A disc is of mass M and radius r . The moment of inertia of the disc about an axis tangential to its edge and in the plane of the disc is

- (a) $5Mr^2/4$ (b) $Mr^2/4$ (c) $3Mr^2/4$ (d) $Mr^2/2$

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29. When the external torque on a system is zero, there will be conservation of its

- (a) Linear momentum (b) angular momentum
(c) total energy (d) none of the above

30. The moment of inertia of a thin uniform circular disc about one of its diameters is I . The moment of inertia about an axis perpendicular to the circular surface and passing through its centre is

- (a) $\sqrt{2}I$ (b) $2I$ (c) $I/2$ (d) $I/\sqrt{2}$

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