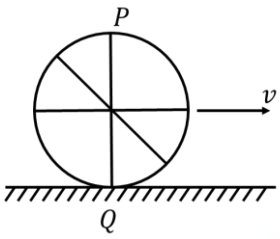
1. A wheel of a bullock cart is rolling on a level road as shown in the figure below. If its linear speed is v in the direction shown, which one of the following options is correct (P and Q are any highest and lowest points on the wheel, respectively). **(2024)**



(a) Point P moves faster than point Q.
(b) Both the points P and Q move with equal speed.
(c) Point P has zero speed.
(d) Point P moves slower than point Q.

2. The moment of inertia of a thin rod about an axis passing through its mid-point and perpendicular to the rod is 2400 $g\,cm^2$. The length of the 400 g rod is nearly. **(2024)**

(a) 17.5 cm (b) 20.7 cm
(c) 72.0 cm (d) 8.5 cm

3. The angular acceleration of a body, moving along the circumference of a circle, is: **(2023)**

(a) along the axis of rotation
(b) along the radius, away from centre
(c) along the radius towards the centre
(d) along the tangent to its position

4. The ratio of radius of gyration of a solid sphere of mass M and radius R about its own axis to the radius of gyration of the thin hollow sphere of same mass and radius about its axis is: **(2023)**

(a) 5 : 2
(b) 3 : 5
(c) 5 : 3
(d) 2 : 5

5. Two objects of mass 10 kg and 20 kg respectively are connected to the two ends of a rigid rod of length 10 m with negligible mass. The distance of the center of mass of the system from the 10 kg mass is: **(2022)**

(a) $\frac{20}{3}m$ (b) 10 m
(c) 5 m (d) $\frac{10}{3}m$

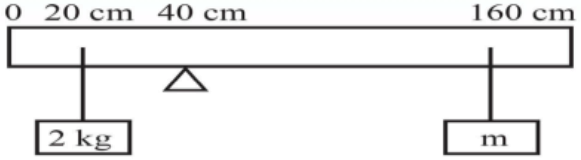
6. The angular speed on a fly wheel moving with uniform angular acceleration changes from 1200 rpm to 3120 rpm in 16 seconds. The angular acceleration in rad/s^2 is: **(2022)**

(a) 4π (b) 2π
(c) 6π (d) 8π

7. The ratio of the radius of gyration of a thin uniform disc about an axis passing through its centre and normal to its plane to the radius of gyration of the disc about its diameter is: **(2022)**

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

8. A uniform rod of length 200 cm and mass 500 g is balanced on a wedge placed at 40 cm mark. A mass of 2 kg is suspended from the rod at 20 cm and another unknown mass 'm' is suspended from the rod at 160 cm mark as shown in the figure. Find the value of 'm' such that the rod is in equilibrium. (g = 10 m/s^2) **(2021)**



(a) $\frac{1}{3}$ kg
(b) $\frac{1}{6}$ kg
(c) $\frac{1}{12}$ kg
(d) $\frac{1}{2}$ kg

9. Find the torque about the origin when a force of $3\hat{j}$ N acts on a particle whose position vector is $2\hat{k}$ m **(2020)**

(a) $6\hat{j}$ N m (b) $-6\hat{i}$ N m

(c) $6\hat{k}$ N m (d) $6\hat{i}$ N m

10. Two particles of mass 5 kg and 10 kg respectively are attached to the two ends of a rigid rod of length 1 m with negligible mass. The centre of mass of the system from the 5 kg particle is nearly at a distance of : **(2020)**

(a) 50 cm (b) 67 cm

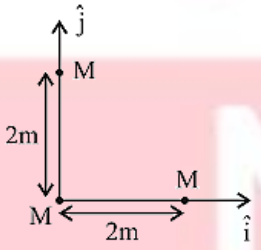
(c) 80 cm (d) 33 cm

11. The angular speed of the wheel of a vehicle is increased from 360 rpm to 1200 rpm in 14 second. Its angular acceleration is **(2020 Covid Re-NEET)**

(a) 12π rad/s^2 (b) $120\,\pi$ rad/s^2

(c) $1\,\pi$ rad/s^2 (d) 2π rad/s^2

12. Three identical spheres, each of mass M, are placed at the corners of a right angle triangle with mutually perpendicular sides equal to 2 m (see figure). Taking the point of intersection of the two mutually perpendicular sides as the origin, find the position vector of centre of mass. **(2020 Covid Re-NEET)**



(a) $(\hat{i}+\hat{j})$ (b) $\frac{2}{3}(\hat{i}+\hat{j})$

(c) $\frac{4}{3}(\hat{i}+\hat{j})$ (d) $2(\hat{i}+\hat{j})$

13. A disc of radius 2 m and mass 100 kg rolls on a horizontal floor. Its centre of mass has speed of 20 cm/s. How much work is needed to stop it? **(2019)**

(a) 3 J (b) 30 kJ

(c) 2 J (d) 1 J

14. A solid cylinder of mass 2 kg and radius 4 cm is rotating about its axis at the rate of 3 rpm. The torque required to stop after 2π revolutions is **(2019)**

(a) 2×10^{-6} N m (b) 2×10^{-3} N m

(c) 12×10^{-4} N m (d) 2×10^{6} N m

15. A solid sphere is in rolling motion. In rolling motion a body possesses translational kinetic energy (K_t) as well as rotational kinetic energy (K_r) simultaneously. The ratio $K_t: (K_t + K_r)$ for the sphere is: **(2018)**

(a) 10 : 7 (b) 5 : 7

(c) 7 : 10 (d) 2 : 5

16. A solid sphere is rotating freely about its symmetry axis in free space. The radius of the sphere is increased keeping its mass same. Which of the following physical quantities would remain constant for the sphere? **(2018)**

(a) Rotational kinetic energy

(b) Moment of inertia

(c) Angular velocity

(d) Angular momentum

17. Three objects, A : (a solid sphere), B : (a thin circular disk) and C : (a circular ring), each have the same mass M and radius R. They all spin with the same angular speed ω about their own symmetry axes. The amounts of work (W) required to bring them to rest, would satisfy the relation **(2018)**

(a) $W_B > W_A > W_C$ (b) $W_A > W_B > W_C$

(c) $W_C > W_B > W_A$ (d) $W_A > W_C > W_B$

18. The moment of the force, $\vec{F} = 4\hat{i} + 5\hat{j} - 6\hat{k}$ at $(2, 0, -3)$, about the point (2, –2, –2) is given by **(2018)**

(a) $-7\hat{i} - 8\hat{j} - 4\hat{k}$ (b) $-4\hat{i} - \hat{j} - 8\hat{k}$

(c) $-8\hat{i} - 4\hat{j} - 7\hat{k}$ (d) $-7\hat{i} - 4\hat{j} - 8\hat{k}$

19. Which of the following statements are correct?

(1) Centre of mass of a body always coincides with the centre of gravity of the body

(2) Centre of gravity of a body is the point at which the total gravitational torque on the body is zero

(3) A couple on a body produce both translational and rotational motion in a body.

(4) Mechanical advantage greater than one means that small effort can be used to lift a large load

(2017-Delhi)

(a) (1) and (2) (b) (2) and (3)

(c) (3) and (4) (d) (2) and (4)

20. A rope is wound around a hollow cylinder of mass 3 kg and radius 40 cm. What is the angular acceleration of the cylinder if the rope is pulled with a force of 30 N? **(2017-Delhi)**

(a) $0.25\ rad/s^2$ (b) $25\ rad/s^2$
(c) $5\ m/s^2$ (d) $25\ m/s^2$

21. Two discs of same moment of inertia rotating about their regular axis passing through centre and perpendicular to the plane of disc with angular velocities ω_1 and ω_2. They are brought into contact face to face coinciding the axis of rotation. The expression for loss of energy during this process is: **(2017-Delhi)**

(a) $\frac{1}{4}I(\omega_1-\omega_2)^2$ (b) $I(\omega_1-\omega_2)^2$
(c) $\frac{1}{8}I(\omega_1-\omega_2)^2$ (d) $\frac{1}{2}I(\omega_1-\omega_2)^2$

22. A thin uniform rod of mass 'M' and length 'L' is rotating about a perpendicular axis passing through its centre with a constant angular velocity 'ω'. Two objects each of mass $\frac{M}{3}$ are attached gently to the two ends of the rod. The rod will now rotate with an angular velocity of: **(2017-Gujrat)**

(a) $\frac{1}{3}\omega$ (b) $\frac{1}{7}\omega$
(c) $\frac{1}{6}\omega$ (d) $\frac{1}{2}\omega$

23. The rotational kinetic energy of a solid sphere of mass 3 kg and radius 0.2 m rolling down an inclined plane of height 7 m is: **(2017-Gujrat)**

(a) 42 J (b) 60 J
(c) 36 J (d) 70 J

24. A light rod of length l has two masses m_1 and m_2 attached to its two ends. The moment of inertia of the system about an axis perpendicular to the rod and passing through the centre of mass is: **(2016 - II)**

(a) $(m_1+m_2)\ell^2$ (b) $\sqrt{m_1m_2}\ell^2$
(c) $\frac{m_1m_2}{m_1+m_2}\ell^2$ (d) $\frac{m_1+m_2}{m_1m_2}\ell^2$

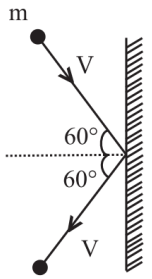
25. A solid sphere of mass m and radius R is rotating about its diameter. A solid cylinder of the same mass and same radius is also rotating about its geometrical axis with an angular speed twice that of the sphere. The ratio of their kinetic energies of rotation $E_{sphere}/E_{cylinder}$ will be: **(2016 - II)**

(a) 1 : 4 (b) 3 : 1
(c) 2 : 3 (d) 1 : 5

26. Two rotating bodies A and B of masses m and 2m with moments of inertia I_A and I_B ($I_B > I_A$) have equal kinetic energy of rotation. If L_A and L_B be their angular momenta respectively, then: **(2016 - II)**

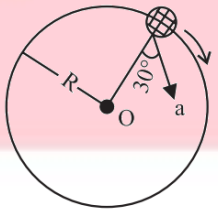
(a) $L_B > L_A$ (b) $L_A > L_B$
(c) $L_A = \frac{L_B}{2}$ (d) $L_A = 2L_B$

27. A rigid ball of mass m strikes a rigid wall at 60° and gets reflected without loss of speed as shown in the figure below. The value of impulse imparted by the wall on the ball will be: **(2016 - II)**



(a) $\frac{mV}{2}$ (b) $\frac{mV}{23}$
(c) mV (d) 2mV

28. In the given figure, a = 15 m/s^2 represents the total acceleration of a particle moving in the clockwise direction in a circle of radius R = 2.5 m at a given instant of time. The speed of the particle is: **(2016 - II)**



(a) 5.7 m/s (b) 6.2 m/s
(c) 4.5 m/s (d) 5.0 m/s

29. From a disc of radius R and mass M, a circular hole of diameter R, whose rim passes through the centre is cut. What is the moment of inertia of the remaining part of the disc about a perpendicular axis, passing through the centre? **(2016 - I)**

(a) $15MR^2/32$ (b) $13MR^2/32$
(c) $11MR^2/32$ (d) $9MR^2/32$

30. Three identical spherical shells, each of mass m and radius r are placed as shown in figure. Consider an axis XX′ which is touching the two shells and passing through diameter of the third shell. Moment of inertia of the system consisting of these three spherical shells about XX′ axis is: **(2015)**

(a) $3mr^2$ (b) $\frac{16}{5}mr^2$

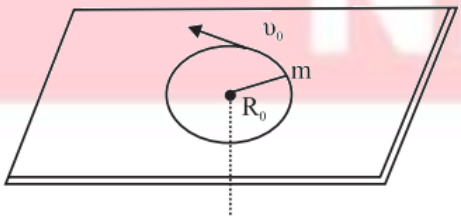
(c) $4mr^2$ (d) $\frac{11}{5}mr^2$

31. A rod of weight W is supported by two parallel knife edges A and B and is in equilibrium in a horizontal position. The knives are at a distance d from each other. The center of mass of the rod is at distance x from A. The normal reaction on A is: **(2015)**

(a) $\frac{Wd}{x}$ (b) $\frac{W(d-x)}{x}$

(c) $\frac{W(d-x)}{d}$ (d) $\frac{Wx}{d}$

32. 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: **(2015)**

(a) $\frac{1}{4}mv_0^2$ (b) $2mv_0^2$

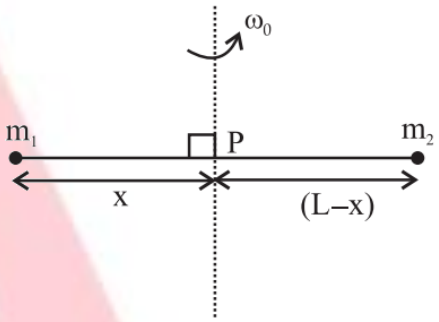
(c) $\frac{1}{2}mv_0^2$ (d) mv_0^2

33. A force $\vec{F} = \alpha\hat{i} + 3\hat{j} + 6\hat{k}$ is acting at a point $\vec{r} = 2\hat{i} - 6\hat{j} - 12\hat{k}$. The value of α for which angular momentum about origin is conserved is: **(2015 Re)**

(a) 1 (b) -1

(c) 2 (d) Zero

34. Point masses m_1 and m_2 are placed at the opposite ends of a rigid rod of length L, and negligible mass. The rod is to be set rotating about an axis perpendicular to it. The position of point P on this rod through which the axis should pass so that the work required to set the rod rotating with angular velocity ω_0 is minimum, is given by



(2015 Re)

(a) $x = \frac{m_2 L}{m_1+m_2}$ (b) $x = \frac{m_1 L}{m_1+m_2}$

(c) $x = \frac{m_1}{m_2}L$ (d) $x = \frac{m_2}{m_1}L$

35. An automobile moves on a road with a speed of 54 km/h. The radius of its wheels is 0.45 m and the moment of inertia of the wheel about its axis of rotation is 3 kg m^2. If the vehicle is brought to rest in 15 s, the magnitude of average torque transmitted by its brakes to wheel is: **(2015 Re)**

(a) 2.86 kg m^2/s^2

(b) 6.66 kg m^2/s^2

(c) 8.58 kg m^2/s^2

(d) 10.86 kg m^2/s^2

36. The ratio of the accelerations for a solid sphere (mass m and radius R) rolling down an incline of angle 'θ' without slipping and slipping down the incline without rolling is: **(2014)**

(a) 5 : 7 (b) 2 : 3

(c) 2 : 5 (d) 7 : 5

37. A solid cylinder of mass 50 kg and radius 0.5 m is free to rotate about the horizontal axis. A massless string is wound round the cylinder with one end attached to it and other hanging freely. Tension in the string required to produce an angular acceleration of 2 revolutions s^{-2} is: **(2014)**

(a) 25 N (b) 50 N

(c) 78.5 N (d) 157 N

38. A body of mass (4m) is lying in x-y plane at rest. It suddenly explodes into three pieces. Two pieces each of mass (m) move perpendicular to each other with equal speeds (v). The total kinetic energy generated due to explosion is: **(2014)**

(a) mv^2 (b) $\frac{3}{2}mv^2$

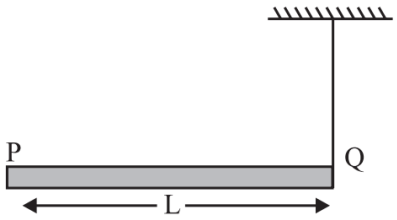
(c) $2\ mv^2$ (d) $4\ mv^2$

39. An explosion breaks a rock into three parts in a horizontal plane. Two of them go off at right angles to each other. The first part of mass 1 kg moves with a speed of 12 ms^{-1} and the second part of mass 2 kg moves with 8 ms^{-1} speed. If the third part flies off with 4 ms^{-1} speed, then its mass is: **(2013)**

(a) 17 kg (b) 3 kg

(c) 5 kg (d) 7 kg

40. A rod PQ of mass M and length L is hinged at end P. The rod is kept horizontal by a massless string tied to point Q as shown in figure. When string is cut, the initial angular acceleration of the rod is: **(2013)**



(a) $\frac{2g}{3L}$ (b) $\frac{3g}{2L}$

(c) $\frac{g}{L}$ (d) $\frac{2g}{L}$