LEVEL # 1

Questions based on **Moment of inertia**

Q.1 The moment of inertia of a body depends upon -
(A) mass only
(B) angular velocity only
(C) distribution of particles only
(D) mass and distribution of mass about the axis

Q.2 On account of melting of ice at the north pole the moment of inertia of spinning earth -
(A) increases
(B) decreases
(C) remains unchanged
(D) depends on the time

Q.3 Two spheres of same mass and radius are in contact with each other. If the moment of inertia of a sphere about its diameter is I, then the moment of inertia of both the spheres about the tangent at their common point would be -
(A) 3I   (B) 7I   (C) 4I   (D) 5I

Q.4 Moment of inertia of a cylindrical shell of mass M, radius R and length L about its geometrical axis would be -

(A) MR^2

(B) $\frac{1}{2}MR^2$

(C) $M\left(\frac{R^2}{4} + \frac{L^2}{12}\right)$

(D) $\frac{ML^2}{12}$

Q.5 The moment of inertia of a sphere of radius R about an axis passing through its centre is proportional to -
(A) R^2 (B) R^3 (C) R^4 (D) R^5

Q.6 The moment of inertia of a body does not depend on
(A) its mass
(B) angular velocity
(C) distribution of its particles
(D) its axis of rotation

Q.7 The moment of inertia of NaCl molecule with bond length r about an axis perpendicular to the bond and passing through the centre of mass is

(A) $(m_{Na} + m_{Cl})r^2$

(B) $\frac{m_{Na} + m_{Cl}}{m_{Na} \times m_{Cl}} r^2$

(C) $\frac{m_{Na} \times m_{Cl}}{m_{Na} + m_{Cl}} r^2$

(D) $\frac{m_{Na} + m_{Cl}}{m_{Na} - m_{Cl}} r^2$

Q.8 A disc of metal is melted to recast in the form of a solid sphere. The moment of inertia about a vertical axis passing through the centre would
(A) decrease
(B) increase
(C) remains same
(D) nothing can be said

Q.9 Which of the following quantity is direction less
(A) moment of momentum
(B) Moment of force
(C) Moment of charge
(D) Moment of inertia

Q.10 The M.I. of a disc about its diameter is 2 units. Its M.I. about axis through a point on its rim and in the plane of the disc is
(A) 4 units.   (B) 6 units
(C) 8 units   (D) 10 units

Q.11 A solid sphere and a hollow sphere of the same mass have the same moments of inertia about their respective diameters, the ratio of their radii is
(A) $(5)^{1/2} : (3)^{1/2}$ (B) $(3)^{1/2} : (5)^{1/2}$
(C) 3 : 2   (D) 2 : 3

Q.12 The physical significance of mass in translational motion is same as that of the following in rotational motion -
(A) moment of inertia
(B) angular momentum
(C) torque
(D) angular acceleration

Q.13 A stone of mass 4kg is whirled in a horizontal circle of radius 1m and makes 2 rev/sec. The moment of inertia of the stone about the axis of rotation is
(A) $64 \text{ kg} \times m^2$ (B) $4 \text{ kg} \times m^2$
(C) $16 \text{ kg} \times m^2$ (D) $1 \text{ kg} \times m^2$

Q.14 In an arrangement four particles, each of mass 2 gram are situated at the coordinate points (3, 2, 0), (1, –1, 0), (0, 0, 0) and (–1, 1, 0). The moment of inertia of this arrangement about the Z-axis will be

(A) 8 units   (B) 16 units

(C) 43 units   (D) 34 units

Q.15 Two discs have same mass and thickness. Their materials are of densities ρ_1 and ρ_2. The ratio of their moment of inertia about central axis will be -

(A) $\rho_1 : \rho_2$ (B) $\rho_1\rho_2 : 1$

(C) $1 : \rho_1\rho_2$ (D) $\rho_2 : \rho_1$

Q.16 Three rings, each of mass P and radius Q are arranged as shown in the figure. The moment of inertia of the arrangement about YY' axis will be
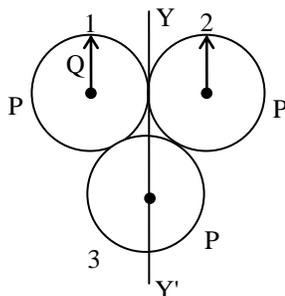
(A) $\dfrac{7}{2} PQ^2$ (B) $\dfrac{2}{7} PQ^2$

(C) $\dfrac{2}{5} PQ^2$ (D) $\dfrac{5}{2} PQ^2$

Q.17 Three thin uniform rods each of mass M and length L and placed along the three axis of a Cartesian coordinate system with one end of each rod at the origin. The M.I. of the system about z-axis is

(A) $\dfrac{ML^2}{3}$ (B) $\dfrac{2ML^2}{3}$

(C) $\dfrac{ML^2}{6}$ (D) ML^2

Q.18 A circular disc A of radius r is made from an iron plate of thickness t and another circular disc B of radius 4r is made from an iron plate of thickness t/4. The relation between the moments of inertia I_A and I_B is

(A) $I_A > I_B$

(B) $I_A = I_B$

(C) $I_A < I_B$

(D) depends on the actual values of t and r.30.5 m

Questions based on Torque

Q.19 A disc of radius 2m and mass 200kg is acted upon by a torque 100N-m. Its angular acceleration would be

(A) 1 rad/sec^2 (B) 0.25 rad/sec^2

(C) 0.5 rad/sec^2.   (D) 2 rad/sec^2.

Q.20 The product of moment of inertia and angular acceleration is -
(A) force
(B) torque
(C) angular momentum
(D) rotational kinetic energy

Q.21 The torque needed to produce an angular acceleration of 18rad/sec^2 in a body of moment of inertia 2.5kg-m^2 would be -
(A) 4.5 newton - metre
(B) 45 newton-metre
(C) 4.5×10^2 newton-metre
(D) 45×10^{-2} newton- metre

Q.22 Dimensions of torque are -
(A) $M^2L^2T^{-2}$ (B) $M^1L^2T^{-2}$
(C) ML^2T^{-1} (D) $ML^{-1}T^2$

Q.23 On applying a constant torque on a body -
(A) linear velocity increases
(B) angular velocity may increase or decrease
(C) it will rotate with constant angular velocity
(D) it will move with constant velocity

Q.24 A wheel starting with angular velocity of 10 radian/sec acquires angular velocity of 100 radian/sec in 15 seconds. If moment of inertia is 10kg-m^2, then applied torque (in newton-metre) is
(A) 900   (B) 100   (C) 90   (D) 60

Q.25 When a steady torque is acting on a body, the body
(A) continues in its state or uniform motion along a straight line
(B) gets linear acceleration
(C) gets angular acceleration
(D) rotates at a constant speed.

Q.26 A wheel of moment of inertia 5×10^{-3} kg-m^2 is making 20rev/s. The torque required to stop it in 10 sec is -
(A) $2\pi \times 10^{-2}$ N-m   (B) $2\pi \times 10^{2}$ N-m
(C) $\pi \times 10^{-2}$ N-m   (D) $4\pi \times 10^{-2}$ N-m

Q.27 An automobile engine develops 100H.P. when rotating at a speed of 1800 rad/min. The torque it delivers is
(A) 3.33 W-s   (B) 200W-s
(C) 248.7 W-s   (D) 2487 W-s

Q.28 A disc of radius 1m and mass 1 kg is rotating with 40 radians/sec. the torque required to stop it in 10sec will be
(A) 1N-m   (B) 2N-m
(C) 0.5N-m   (D) 4N-m

Q.29 The moment of inertia and rotational kinetic energy of a fly wheel are 20kg-m^2 and 1000 joule respectively. Its angular frequency per minute would be -
(A) $\dfrac{600}{\pi}$ (B) $\dfrac{25}{\pi^2}$
(C) $\dfrac{5}{\pi}$ (D) $\dfrac{300}{\pi}$

Q.30 A force of $(2\hat{i} - 4\hat{j} + 2\hat{k})$ Newton acts at a point $(3\hat{i} + 2\hat{j} - 4\hat{k})$ metre from the origin. The magnitude of torque is
(A) zero   (B) 24.4 N-m
(C) 0.244 N-m   (D) 2.444 N-m

Q.31 The angular velocity of a body is $\hat{\omega} = 2\hat{i} + 3\hat{j} + 4\hat{k}$ and a torque $\hat{r} = \hat{i} + 2\hat{j} + 3\hat{k}$ acts on it. The rotational power will be
(A) 20 watt   (B) 15 watt

(C) $\sqrt{17}$ watt   (D) $\sqrt{14}$ watt

Q.32 A torque of 2 newton-m produces an angular acceleration of 2 rad/sec^2 a body. If its radius of gyration is 2m, its mass will be :
(A) 2kg   (B) 4 kg
(C) 1/2 kg   (D) 1/4 kg

Q.33 The three similar torque (τ) are acting at an angle of 120º with each other. The resultant torque will be:
(A) zero   (B) $\sqrt{2}\ \tau$
(C) 3τ (D) $\tau/3$

Q.34 A ring of diameter 1m is rotating with an angular momentum of 10 Joules-sec. The necessary tangential force required to increase its angular momentum by 50% in 1sec will be (in newtons) :
(A) 10   (B) 5   (C) 15   (D) 20

Q.35 A particle is at a distance r from the axis of rotation. A given torque τ produces some angular acceleration in it. If the mass of the particle is doubled and its distance from the axis is halved, the value of torque to produce the same angular acceleration is
(A) $\tau/2$ (B) τ (C) 2τ (D) 4τ

Q.36 A body is rotating nonuniformly about a vertical axis fixed in an inertial frame. The resultant force on a particle of the body not on the axis is
(A) vertical
(B) horizontal and skew with the axis
(C) horizontal and intersecting the axis
(D) none of these

Q.37 Torque/moment of inertia equals to
(A) angular velocity
(B) angular acceleration.
(C) angular momentum.
(D) force

Q.38 Equivalent to force in rotational motion is
(A) moment of force   (B) impulse

(C) moment of inertia   (D) none of these

Q.39 The radius of gyration of a rotating body depends upon -
(A) mass   (B) volume of the body
(C) shape of the body   (D) applied torque.

Angular Momentum

Q.40 The rate of change of angular momentum is called
(A) angular velocity
(B) angular acceleration
(C) force
(D) torque

Q.41 A man sitting on a rotating stool with his arms stretched out, suddenly lowers his hands
(A) his angular velocity decreases
(B) his moment of inertia decreases.
(C) his angular velocity remains constant
(D) his angular momentum increases.

Q.42 The rotational kinetic energy of a rigid body of moment of inertia 5 kg-m^2 is 10 joules. The angular momentum about the axis of rotation would be -
(A) 100 joule-sec   (B) 50 joule-sec
(C) 10 joule-sec   (D) 2 joule –sec

Q.43 A circular ring of mass 1kg and radius 0.2m executes 10 revolutions per sec. Its angular momentum would be - (kg-m^2/sec)
(A) 0.025   (B) 0.25   (C) 2.5   (D) 25

Q.44 Which quantity is not directly related with rotational motion
(A) mass
(B) angular momentum
(C) torque
(D) moment of inertia

Q.45 A particle of mass m is rotating in a circular path of radius r. Its angular momentum is J. The centripetal force acting on the particle would be
(A) $\dfrac{J^2}{mr^2}$ (B) $\dfrac{J^2}{mr^3}$ (C) $\dfrac{J^2r^2}{m}$ (D) J^{2}rm

Q.46 When a mass is rotating in a plane about a fixed point, its angular momentum is directed along-
(A) radius
(B) the tangent to the orbit
(C) a line perpendicular to the plane of rotation
(D) none of the above

Q.47 The torque applied to a ring revolving about its own axis so as to change its angular momentum by 2 J-s. in 5 s, is
(A) 10N-m   (B) 2.5 N-m
(C) 0.1N-m   (D) 0.4N-m

Q.48 The angular velocity of a body changes from one revolution per 9second to 1 revolution per second without applying any torque. The ratio of its radius of gyration in the two cases is
(A) 1 : 9   (B) 3 : 1   (C) 9 : 1   (D) 1 : 3

Rotational Kinetic Energy

Q.49 The rotational kinetic energy is -
(A) mω^2 (B) $\dfrac{1}{2}$ Iα^2
(C) $\dfrac{1}{2}$ Iω^2 (D) $\dfrac{1}{2}$ mv^2

Q.50 A circular ring of wire of mass M and radius R is making n revolutions/sec about an axis passing through a point on its rim and perpendicular to its plane. The kinetic energy of rotation of the ring is given by-
(A) 4π^{2}MR^{2}n^2 (B) 2π^{2}MR^{2}n^2
(C) $\dfrac{1}{2}$ π^{2}MR^{2}n^2 (D) 8π^{2}MR^{2}n^2

Q.51 Rotational kinetic energy of a disc of constant moment of inertia is -
(A) directly proportional to angular velocity
(B) inversely proportional to angular velocity
(C) inversely proportional to square of angular velocity
(D) directly proportional to square of angular velocity

Q.52 The kinetic energy of a body rotating with constant angular velocity only depends upon its -
(A) mass   (B) radius of gyration

(C) moment of inertia   (D) angular momentum

Q.53 Rotational kinetic energy of a given body about an axis is proportional to -

(A) time period   (B) (time period)^2

(C) (time period)$^{-1}$ (D) (time period)$^{-2}$

Q.54 A circular disc has a mass of 1kg and radius 40 cm. It is rotating about an axis passing through its centre and perpendicular to its plane with a speed of 10rev/s. The work done in joules in stopping it would be-

(A) 4   (B) 47.5   (C) 79   (D) 158

Q.55 A fly wheel of moment of inertia I is rotating at n revolutions per sec. The work needed to double the frequency would be -

(A) $2\pi^2 I n^2$ (B) $4\pi^2 I n^2$

(C) $6\pi^2 I n^2$ (D) $8\pi^2 I n^2$

Q.56 A thin bar of length L is suspended from one end and rotated at a speed of n revolutions per second. The rotational kinetic energy of the bar is -

(A) $2ML^2\pi^2 n^2$ (B) $1/2\ ML^2\pi^2 n^2$.

(C) $2/3\ ML^2\pi^2 n^2$ (D) $1/6\ ML^2\pi^2 n^2$.

Questions based on **Rolling Motion**

Q.57 A ring of mass 1kg and diameter 1m is rolling on a plane road with a speed 2m/s. Its kinetic energy would be -

(A) 1 joule   (B) 4 joule

(C) 2 joule   (D) 0.5 joule

Q.58 A disc is rolling without slipping. The ratio of its rotational kinetic energy and translational kinetic energy would be -

(A) 1 : 1   (B) 2 : 1   (C) 1 : 2   (D) 1 : 4

Q.59 A disc rolls on a table. The ratio of its K.E. of rotation to the total K.E. is -

(A) 2/5   (B) 1/3   (C) 5/6   (D) 2/3

Q.60 A hoop having a mass of 1kg and a diameter of 1 meter rolls along a level road at 2m/sec. Its total K.E. would be -

(A) 1 Joule   (B) 4 joules

(C) 2 joules   (D) 0.5 joule

Q.61 A cylinder of mass M and radius R rolls on an inclined plane. The gain in kinetic energy is

(A) $\dfrac{1}{2}Mv^2$ (B) $\dfrac{1}{2}I\omega^2$

(C) $\dfrac{3}{4}Mv^2$ (D) $\dfrac{3}{4}I\omega^2$

Q.62 The condition that a rigid body is rolling without slipping on an inclined plane is
(A) it has acceleration less than g.
(B) it has rotational and translational K.E. to be equal
(C) it has linear velocity equal to radius times angular velocity
(D) the plane is fricitionless.

Q.63 A disk and a ring of the same mass are rolling to have the same kinetic energy. What is ratio of their velocities of centre of mass

(A) (4:3)$^{1/2}$ (B) (3 : 4)$^{1/2}$

(C) (2)$^{1/2}$: (3)$^{1/2}$ (D) (3)$^{1/2}$: (2)$^{1/2}$

Q.64 The acceleration down the plane of spherical body of mass m radius R and moment of inertia I having inclination θ to the horizontal is

(A) $\dfrac{g\sin\theta}{1+I^2/R^2}$ (B) $\dfrac{g\sin\theta}{1+I/R^2}$

(C) $\dfrac{g\sin\theta}{1+I/MR^2}$ (D) $\dfrac{g\sin\theta}{MR^2+I}$

Q.65 A solid cylinder starts rolling from a height h on an inclined plane. At some instant t, the ratio of its rotational K.E. and the total K.E. would be
(A) 1 : 2   (B) 1 : 3   (C) 2 : 3   (D) 1 : 1

Q.66 When different regular bodies roll down along an inclined plane from rest, then acceleration will be maximum for a body whose -
(A) radius of gyration is least
(B) mass is least
(C) surface area is maximum
(D) moment of inertia is maximum

Q.67 A sphere rolls down an inclined plane through a height h. Its velocity at the bottom would be

(A) $\sqrt{2gh}$ (B) $\sqrt{\dfrac{7}{10}gh}$

(C) $\sqrt{\dfrac{10}{7}gh}$ (D) $\left(\sqrt{\dfrac{10}{7}}\right)gh$

Q.68 If the applied torque is directly proportional to the angular displacement θ, then the work done

33.[8] Conservation of angular momentum

$I_1\omega_1 = I_2\omega_2$