06 - ROTATIONAL MOTION

(Answers at the end of all questions)

1) A body A of mass M while falling vertically downwards under gravity breaks into two parts, a body B of mass (1 / 3) M and a body C of mass (2 / 3) M. The centre of mass of bodies B and C taken together shifts compared to body A towards

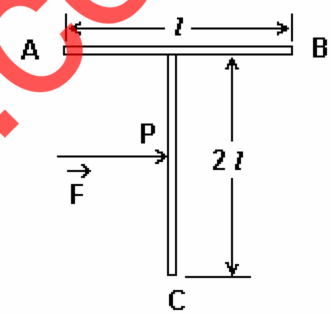
(a) does not shift (b) depends on height of breaking

(c) body B (d) body C [AIEEE 2005]

2) The moment of inertia of a uniform semicircular disc of mass M and radius r about a line perpendicular to the plane of the disc through the centre is

(a) $(2 / 5) Mr^2$ (b) $(1 / 4) Mr^2$ (c) $(1 / 2) Mr^2$ (d) Mr^2 [AIEEE 2005]

3) A 'T' shaped object with dimensions shown in the figure, is lying on a smooth floor. A force '$\vec{F}$' is applied at the point P parallel to AB, such that the object has only translational motion without rotation. Find the location of P with respect to C.



(a) $(3 / 2) l$ (b) $(2 / 3) l$

(c) l (d) $(4 / 3) l$ [AIEEE 2005]

4) A solid sphere is rotating in free space. If the radius of the sphere is increased keeping mass same, which one of the following will not be affected ?

(a) Moment of inertia (b) Angular momentum

(c) Angular velocity (d) Rotational kinetic energy [AIEEE 2004]

5) One solid sphere A and another hollow sphere B are of same mass and same outer radii. Their moment of inertia about their diameters are respectively I_A and I_B such that

(a) $I_A = I_B$ (b) $I_A > I_B$ (c) $I_A < I_B$ (d) $I_A / I_B = d_A / d_B$ [AIEEE 2004]

6) A particle performing uniform circular motion has angular momentum L. If its angular frequency is doubled and its kinetic energy halved, then the new angular momentum is

(a) L / 2 (b) L / 4 (c) 2 L (d) 4 L [AIEEE 2003]

7) Let $\vec{F}$ be the force acting on a particle having position vector $\vec{r}$, and $\vec{\tau}$ be the torque of this force about the origin. Then

(a) $\vec{r} . \vec{\tau} = 0$ and $\vec{F} . \vec{\tau} = 0$ (b) $\vec{r} . \vec{\tau} = 0$ and $\vec{F} . \vec{\tau} \neq 0$

(c) $\vec{r} . \vec{\tau} \neq 0$ and $\vec{F} . \vec{\tau} = 0$ (d) $\vec{r} . \vec{\tau} \neq 0$ and $\vec{F} . \vec{\tau} \neq 0$ [AIEEE 2003]

8) A circular disc X of radius R is made from an iron plate of thickness t, and another disc Y of radius 4R is made from an iron plate of thickness t / 4. The relation between the moments of inertia I_x and I_y is

(a) $I_y = 64 I_x$ (b) $I_y = 32 I_x$ (c) $I_y = 16 I_x$ (d) $I_y = I_x$ [AIEEE 2003]

9) The moment of inertia of a rigid body depends upon

(a) mass of the body (b) angular acceleration of the body

(c) angular velocity of the body (d) distribution of mass from the axis of rotation

[AIEEE 2002]

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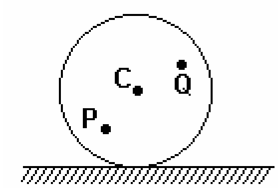
(Answers at the end of all questions)

10) If moment of inertia of a wheel, having radius of gyration 60 cm, is 360 kg-m^2, then mass of the wheel is
(a) 200 kg (b) 500 kg (c) 800 kg (d) 1000 kg [AIEEE 2002]

11) A particle moves on a circular path with decreasing speed. Choose the correct statement.
(a) Angular momentum remains constant. (b) Acceleration is towards the centre.
(c) Particle moves on a spiral path with decreasing radius.
(d) The direction of angular momentum remains constant. [IIT 2005]

12) Mass and radius of a circular disc is 9M and R respectively. Moment of inertia of the disc about an axis passing through point O and perpendicular to its plane after removal of a disc of radius R / 3 touching its circumference is
(a) $\frac{37}{9}$ MR^2 (b) 9 MR^2 (c) $\frac{40}{9}$ MR^2 (d) 4 MR^2 [IIT 2005]

13) A disc is rolling (without slipping) on a horizontal surface. C is the centre and P and Q are two particles of the disc equidistant from C. Let V_P, V_Q and V_C be the magnitudes of velocities of the particles P and Q and the particle at C respectively. Then



(a) $V_Q > V_C > V_P$ (b) $V_Q < V_C < V_P$
(c) $V_Q = V_P$, $V_C = 0.5\, V_P$ (d) $V_Q < V_C > V_P$
[IIT 2004]

14) A child is standing with folded hands at the centre of a platform rotating about its central axis. The kinetic energy of the system is K. The child now stretches his arms so that the moment of inertia of the system doubles. The kinetic energy of the system now is
(a) 2 K (b) K / 2 (c) K / 4 (d) 4 K [IIT 2004]

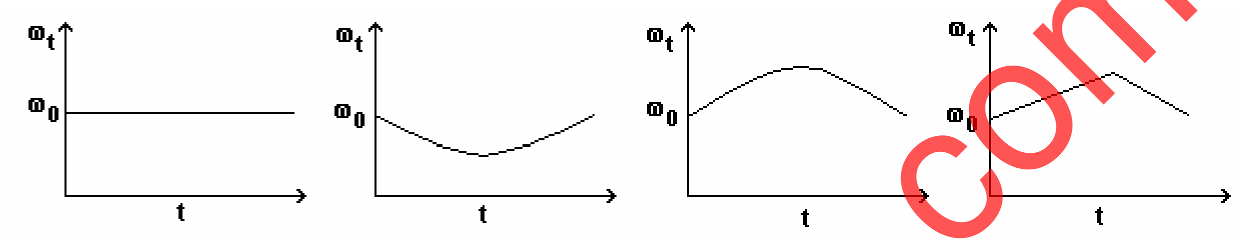
15) Two identical bodies of mass m are connected by a light rod of length l and placed on horizontal smooth surface. An impulse mv is given at one end perpendicular to the length of the rod. The angular velocity of the system is
(a) v / l (b) 2v / l (c) v / 3l (d) v / 4l [IIT 2003]

16) A particle undergoes uniform circular motion. About which point on the plane of the circle will the angular momentum of the particle remain conserved ?
(a) centre of the circle (b) on the circumference of the circle
(c) inside the circle (d) outside the circle [IIT 2003]

17) Two blocks of masses 10 kg and 4 kg are connected by a spring of negligible mass and placed on a frictionalless horizontal surface. An impulse gives a velocity of 14 m/s to the heavier block in the direction of the lighter block. The velocity of the centre of mass is
(a) 30 m/s (b) 20 m/s (c) 10 m/s (d) 5 m/s [IIT 2002]

18) A cylinder rolls up an inclined plane, reaches some height, and then rolls down (without slipping throughout these motions). The directions of the frictional force acting on the cylinder are
(a) up the incline while ascending and down the incline while descending
(b) up the incline while ascending as well as descending
(c) down the incline while ascending and up the incline while descending
(d) down the incline while ascending as well as descending [IIT 2002]

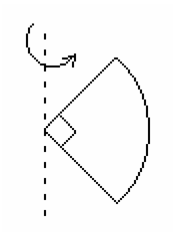
19) A circular platform is free to rotate in a horizontal plane about a vertical axis passing through its centre. A tortoise is sitting at the edge of the platform. Now the platform is given an angular velocity ω_0. When the tortoise moves along a chord of the platform with a constant velocity (with respect to the platform), the angular velocity of the platform ω_t will vary with time as



(a) (b) (c) (d)

[IIT 2002]

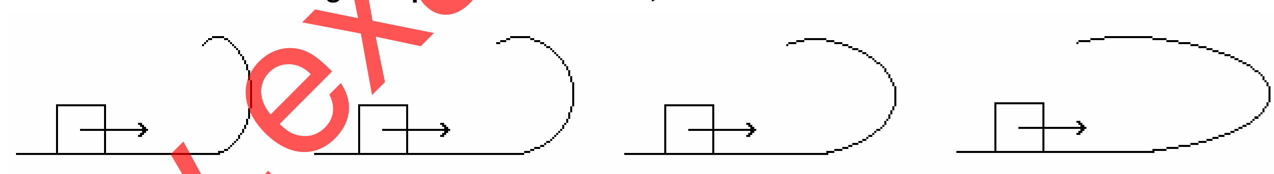
20) One quarter section is cut from a uniform circular disc of radius R. This section has a mass M. It is made to rotate about a line perpendicular to its plane and passing through the centre of the original disc. Its moment of inertia about the axis of rotation is



(a) $\frac{1}{2}MR^2$ (b) $\frac{1}{4}MR^2$ (c) $\frac{1}{8}MR^2$ (d) $\sqrt{2}\,MR^2$

[IIT 2001]

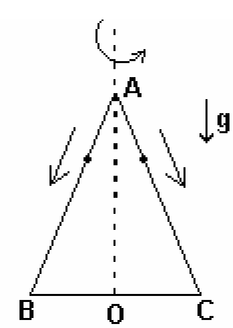
21) A small block is shot into each of the four tracks as shown below. Each of the track rises to the same height. The speed with which the block enters the track is the same in all cases. At the highest point of the track, the normal reaction is maximum in



(a) (b) (c) (d)

[IIT 2001]

22) A equilateral triangle ABC formed from a vertical wire has two small identical beads initially located at A. The triangle is set rotating about the vertical axis AO. Then the beads are released from rest simultaneously and allowed to slide down; one along AB and the other along AC as shown. Neglecting frictional effects, the quantities that are conserved as beads slide down are



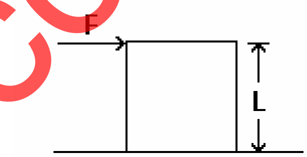
(a) angular velocity and total energy (kinetic and potential)
(b) total angular momentum and total energy
(c) angular velocity and moment of inertia about the axis of rotation
(d) total angular momentum and moment of inertia about the axis of rotation

[IIT 2000]

23) A long horizontal rod has a bead which can slide along its length and is initially placed at a distance L from one end A of the rod. The rod is set in angular motion about A with a constant angular acceleration, α. If the coefficient of friction between the rod and the bead is μ, and gravity is neglected, then the time after which the bead starts slipping is

(a) $\sqrt{\frac{\mu}{\alpha}}$ (b) $\frac{\mu}{\sqrt{\alpha}}$ (c) $\frac{1}{\sqrt{\mu\alpha}}$ (d) infinitesimal [IIT 2000]

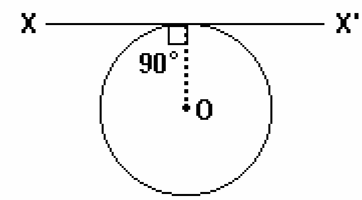
24) A cubical block of side L rests on a rough horizontal surface with coefficient of friction μ. A horizontal force F is applied on the block as shown. If the coefficient of friction is sufficiently high so that the block does not slide before toppling, the minimum force required to topple the block is



(a) infinitesimal (b) $\frac{mg}{4}$ (c) $\frac{mg}{2}$ (d) $mg (1 - \mu)$

[IIT 2000]

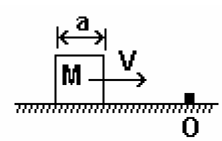
25) A thin wire of length L and uniform linear mass density ρ is bent into a circular loop with centre at O as shown. The moment of inertia of the loop about the axis XX' is



(a) $\frac{\rho L^3}{8\pi^2}$ (b) $\frac{\rho L^3}{16\pi^2}$ (c) $\frac{5\rho L^3}{16\pi^2}$ (d) $\frac{3\rho L^3}{8\pi^2}$

[IIT 2000]

26) A cubical block of side a is moving with velocity V on a horizontal smooth plane as shown. It has a ridge at point O. The angular speed of the block after it hits O is

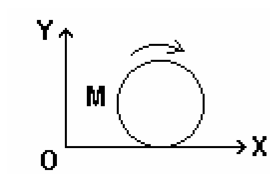


(a) $\frac{3V}{4a}$ (b) $\frac{3V}{2a}$ (c) $\sqrt{\frac{3}{2}}\frac{V}{a}$ (d) zero [IIT 1999]

27) A smooth sphere A is moving on a frictionless horizontal plane with angular velocity ω and centre of mass velocity v. It collides elastically and head on with an identical sphere B at rest. Neglect friction everywhere. After the collision, their angular speeds are ω_A and ω_B respectively. Then

(a) $\omega_A < \omega_B$ (b) $\omega_A = \omega_B$ (c) $\omega_A = \omega$ (d) $\omega_B = \omega$ [IIT 1999]

28) A disc of mass M and radius R is rolling with angular speed ω on a horizontal plane as shown. The magnitude of angular momentum of the disc about the origin O is



(a) $\left(\frac{1}{2}\right)MR^2\omega$ (b) $MR^2\omega$ (c) $\left(\frac{3}{2}\right)MR^2\omega$ (d) $2MR^2\omega$

[IIT 1999]

29) Let I be the moment of inertia of a uniform square plate about an axis AB that passes through its centre and is parallel to two of its sides. CD is a line in the plane of the plate that passes through the centre of the plate and makes an angle θ with AB. The moment of inertia of the plate about the axis CD is then equal to

(a) I (b) $I\sin^2\theta$ (c) $I\cos^2\theta$ (d) $I\cos^2(\theta/2)$ [IIT 1998]

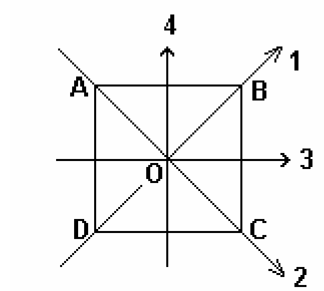
(Answers at the end of all questions)

30) The torque $\vec{\tau}$ on a body about a given point is found to be equal to $\vec{A} \times \vec{L}$ where $\vec{A}$ is a constant vector and $\vec{L}$ is the angular momentum of the body about that point. From this it follows that (a) $\frac{d\vec{L}}{dt}$ is perpendicular to $\vec{L}$ at all instants of time
(b) the component of $\vec{L}$ in the direction of $\vec{A}$ does not change with time
(c) the magnitude of $\vec{L}$ does not change with time (d) $\vec{L}$ does not change with time [IIT 1998]

31) A mass m is moving with a constant velocity along a line parallel to X-axis, away from the origin. Its angular momentum with respect to the origin
(a) is zero (b) remains constant
(c) goes on increasing (d) goes on decreasing [IIT 1997, 1985]

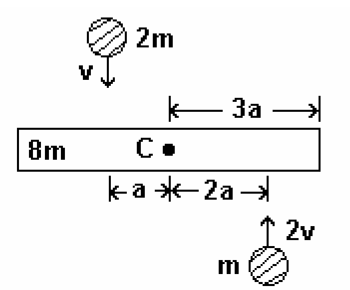
32) A thin circular ring of mass M and radius r is rotating about its axis with a constant angular velocity ω. Two objects, each of mass m, are attached gently to the opposite ends of a diameter of the ring. The wheel now rotates with the angular velocity
(a) $\omega M / (M + m)$ (b) $\omega(M - 2m) / (M + 2m)$
(c) $\omega M / (M + 2m)$ (d) $\omega(M + 2m) / M$ [IIT 1983]

33) The moment of inertia of a thin square plate ABCD, as shown in the figure, of uniform thickness about an axis passing through the centre O and perpendicular to the plane of the plate is
(a) $I_1 + I_2$ (b) $I_3 + I_4$ (c) $I_1 + I_3$ (d) $I_1 + I_2 + I_3 + I_4$
[IIT 1992]



34) 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
(a) $M\omega^2 L / 2$ (b) $M\omega^2 L$ (c) $M\omega^2 L / 4$ (d) $M\omega^2 L^3 / 2$ [IIT 1992]

35) A uniform bar of length 6a and mass 8m lies on a smooth horizontal table. Two point masses m and 2m moving in the same horizontal plane with speeds 2v and v respectively, strike the bar as shown in the figure and stick to the bar after collision. Denoting angular velocity about the centre of mass, total energy and velocity of centre of mass by ω, E and V_c respectively, we have after collision



(a) $V_c = 0$ (b) $\omega = \frac{3v}{5a}$ (c) $\omega = \frac{v}{5a}$ (d) $E = \frac{3mv^2}{5}$

[IIT 1991]

06 - ROTATIONAL MOTION

(Answers at the end of all questions)

36) A particle of mass m is projected with a velocity V making an angle 45° with the horizontal. The magnitude of the angular momentum of the projectile about the point of projection when the particle is at its maximum height h is

(a) zero (b) $\dfrac{m V^3}{4\sqrt{2}\, g}$ (c) $\dfrac{m V^3}{\sqrt{2}\, g}$ (d) $m\sqrt{2 g h^3}$ [IIT 1990]

37) Two particles A and B initially at rest, move towards each other under a mutual force of attraction. At the instant when the speed of A is V and the speed of B is 2V, the speed of the centre of mass of the system is

(a) zero (b) V (c) 1.5 V (d) 3 V [IIT 1982]

38) A rifle of mass M shoots a bullet of mass m at a stationary block of mass M distant D away from it. When the bullet has moved distance d towards the block, the centre of mass of the bullet-block system is at a distance of

(a) $\dfrac{md + MD}{m + M}$ from the rifle (b) $\dfrac{(D - d)m}{M + m}$ from the block

(c) $(D - d)\dfrac{M}{M + m}$ from the block (d) $\dfrac{DM}{M + m}$ from the rifle

39) A hollow cylinder and a solid cylinder having different mass and diameter are released from rest simultaneously from the top of an inclined plane. Which will reach the bottom first ?

(a) solid cylinder (b) can't be determined without knowing their masses
(c) hollow cylinder (d) can't be determined without knowing their diameters

40) A car is moving with a speed of 108 km / hr on a circular path of radius 500 m. Its speed is increasing at the rate of 2 m / s^2. What is the acceleration of the car ?

(a) 9.8 m / s^2 (b) 2.7 m / s^2 (c) 3.6 m / s^2 (d) 1.8 m / s^2

41) A spherical ball rolls on a table about its diameter without slipping. Then the fraction of its total energy associated with its rotation is

(a) $\dfrac{2}{5}$ (b) $\dfrac{2}{7}$ (c) $\dfrac{3}{7}$ (d) $\dfrac{3}{5}$

42) Two discs of same mass and thickness are made from two different materials of densities d_1 and d_2 respectively. The ratio of their moments of inertia about their axis passing through their centres and perpendicular to their planes is

(a) $d_1 : d_2$ (b) $d_2 : d_1$ (c) $(d_1 / d_2) : 1$ (d) $1 : d_1 d_2$

43) Two point masses M_1 and M_2 are at a distance r apart. The moment of inertia of the system about an axis passing through the centre of mass and perpendicular to the line joining the two masses is

(a) $\left[\dfrac{M_1 M_2}{M_1 + M_2}\right] r^2$ (b) $\left[\dfrac{M_1 + M_2}{M_1 M_2}\right] r^2$ (c) $\left[\dfrac{M_1 + M_2}{M_1 - M_2}\right] r^2$ (d) $\left[\dfrac{M_1 - M_2}{M_1 + M_2}\right] r^2$

44) A particle of mass m = 5 is moving with a uniform speed $v = 5\sqrt{2}$ in the XOY plane along the line y = x + 4. The magnitude of the angular momentum about the origin is

(a) 40 units (b) 60 units (c) 80 units (d) 100 units

06 - ROTATIONAL MOTION

(Answers at the end of all questions)

45) A solid cylinder first rolls without sliding and then slides without rolling down the same inclined plane. The ratio of velocities in the two cases, at the bottom of the plane is

(a) 1 : 2 (b) 1 : 3 (c) $\sqrt{6}$: 3 (d) $\sqrt{3}$: 1

Answers

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
a	c	d	b	c	b	a	a	d	d	d	d	a	b	a	a	c	b	c	a	a	b

23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
a	c	d	a	c	c	a	a,b,c	b	c	b		a,c,d	b,d	a	b	a	b	b	b	a

44	45																		
d	c																		