PHYSICS

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ROTATIONAL MOTION

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ROTATIONAL MOTION

DPP-1 (JPP/047)

[Kenematics of rotational motion, Concept of Rigid body]

1. For particle of a purely rotating body, $v = r\omega$, so correct relation will be -

(A) $\omega \propto \frac{1}{r}$

(B) $\omega \propto v$

(C) $v \propto \frac{1}{r}$

(D) ω is independent of r

2. A rigid body is rotating with angular acceleration 10 rad/sec². If it is started from rest then find the angular displacement of the rod in 5 seconds?

(A) 225 rad (B) 125 rad
(C) 100 rad (D) 50 rad

3. A wheel starts rotating from rest and attains an angular velocity of 60 rad/sec in 5 seconds. The total angular displacement in radians will be-

(A) 60 (B) 80
(C) 100 (D) 150

4. Let $\vec{A}$ be a unit vector along the axis of rotation of a purely rotating body and $\vec{B}$ be a unit vector along the velocity of a particle P of the body away from the axis. The value of $\vec{A}.\vec{B}$ is-

(A) 1
(B) –1
(C) 0
(D) none of these

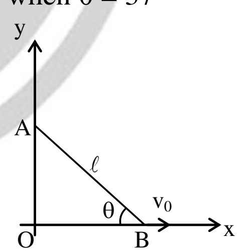
5. A fan is running at 3000 rpm. It is switched off. It comes to rest by uniformly decreasing its angular speed in 10 seconds. The total number of revolution in this period.

(A) 150 (B) 250
(C) 350 (D) 300

6. If angular displacement of a particle moving on a curved path be given as, $\theta = 1.5\, t + 2t^2$, where t is in sec, the angular velocity at t = 2 sec, will be

(A) 1.5
(B) 2.5
(C) 9.5
(D) 8.5

7. In the figure given below, the end B of the rod AB which makes angle θ with the floor is pulled with a constant velocity v_0 as shown. The length of rod is ℓ. At an instant when $\theta = 37°$



(A) Velocity of end A is $\frac{4v_0}{3}$

(B) angular velocity of rod is $\frac{5v_0}{6\ell}$

(C) angular velocity of rod is constant

(D) velocity of end A is constant

8. A disc is rotating with an angular velocity ω_0. A constant retarding angular acceleration is applied on it to stop the disc. The angular velocity becomes $\frac{\omega_0}{2}$ after n rotations. How many more rotations will it make before coming to rest?

(A) n
(B) 2n
(C) $\frac{n}{2}$
(D) $\frac{n}{3}$

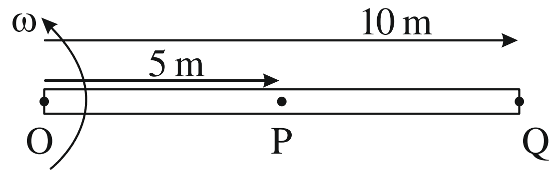
9. The linear velocity of a particle moving with angular velocity $\vec{\omega} = 2\hat{k}$ at position vector $\vec{r} = 2\hat{i} + 2\hat{j}$ is -

(A) $4(\hat{i} - \hat{j})$
(B) $4(\hat{j} - \hat{i})$
(C) $4\hat{i}$
(D) $-4\hat{i}$

10. A chain couples and rotates two wheels in a bicycle. The radii of bigger and smaller wheels are 0.[illegible] m and 0.1 m respectively. The bigger wheel rotates at the rate of 200 rotations per minute, then the rate of rotation of smaller wheel will be-

(A) 1000 rpm
(B) 50/3 rpm
(C) 200 rpm
(D) 40 rpm

11. A rigid body is rotating about an axis passing through O with angular speed 10 rad/sec. Find the linear speed of particle '*P*' & '*Q*' as shown in figure (in m/s).



(A) 50, 100
(B) 100, 50
(C) 25, 50
(D) 100, 200

DPP-2

(JPP/048)

[Moment of Inertia of discrete and continuous body, Theorem of perpendicular axes and parallel axes]

1. Two rings of same radius and mass 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 (mass of the ring = m, radius = r)

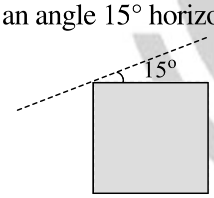
(A) $\frac{1}{2}mr^2$

(B) mr^2

(C) $\frac{3}{2}mr^2$

(D) $2mr^2$

2. A square plate of mass M and edge L is shown in the figure. The moment of inertia of the plate about the axis in the plane of plate and passing through one of its vertex making an angle 15° horizontal is



(A) $\frac{ML^2}{12}$ (B) $\frac{11ML^2}{24}$

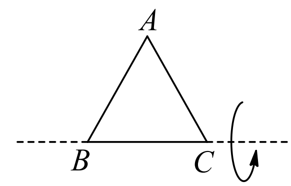
(C) $\frac{7ML^2}{12}$ (D) None of these

3. Four identical rods are joined end to end to form a square. The mass of each rod is M. The moment of inertia of the square about the median line is

(A) $\frac{Ml^2}{3}$ (B) $\frac{Ml^2}{4}$

(C) $\frac{Ml^2}{6}$ (D) None of these

4. Three identical rods, each of mass m and length l, form an equaliteral triangle. Moment of inertia about one of the sides is



(A) $\frac{ml^2}{4}$ (B) ml^2

(C) $\frac{3ml^2}{4}$ (D) $\frac{ml^2}{2}$

5. From a given sample of uniform wire, two circular loops P and Q are made, P of radius r and Q of radius nr. If the M.I of Q about its axis if four times that of P about its axis (assuming the wire to be diameter much smaller than either radius), the value of n is

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

(C) $\frac{1}{2}$ (D) $\frac{1}{4}$

6. The moment of inertia of a door of mass m, length 2l and width l about its longer side is

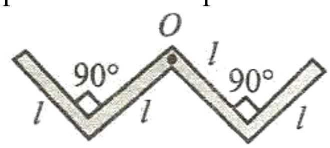
(A) $\frac{11ml^2}{24}$

(B) $\frac{5ml^2}{24}$

(C) $\frac{ml^2}{3}$

(D) None of these

7. A thin rod of length 4l and mass 4m is bent at the points as shown in Figure. What is the moment of inertia of the rod about the axis passing through point O and perpendicular to the plane of the paper



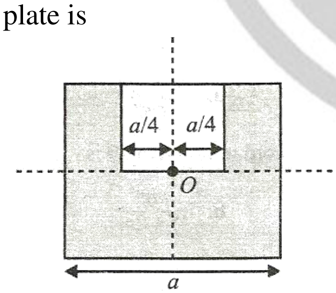
(A) $\frac{Ml^2}{3}$

(B) $\frac{10Ml^2}{3}$

(C) $\frac{Ml^2}{12}$

(D) $\frac{Ml^2}{24}$

8. A square plate of edge a/2 is cut out from a uniform square plate of edge 'a' as shown in Figure. The mass of the remaining portion is M. The moment of inertia of the shaded portion about an axis passing through 'O'(centre of the square of side a) and perpendicular to the plane of plate is



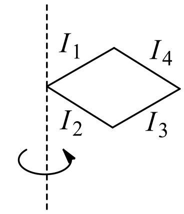
(A) $\frac{9}{64}Ma^2$

(B) $\frac{3}{16}Ma^2$

(C) $\frac{5}{12}Ma^2$

(D) $\frac{Ma^2}{6}$

9. The moment of inertia of a system of four rods, each of length l and mass m, about the axis shown is



(A) $\frac{2}{3}ml^2$ (B) $2ml^2$

(C) $3ml^2$ (D) $\frac{8}{3}ml^2$

10. Three point masses m_1, m_2 and m_3 are located at the vertices of an equilateral triangle of side 'a'. What is the moment of inertia of the system about an axis along the altitude of the triangle passing through m_1?

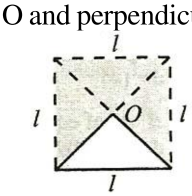
(A) $(m_1 + m_2)\frac{a^2}{4}$

(B) $(m_2 + m_3)\frac{a^2}{4}$

(C) $(m_1 + m_3)\frac{a^2}{4}$

(D) $(m_1 + m_2 + m_3)\frac{a^2}{4}$

11. An isosceles triangular piece is cut from a square plate of side l.The piece is one-fourth of the square and mass of the remaining plate is M. The moment of inertia of the plate about an axis passing through O and perpendicular to its plane is



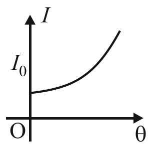
(A) $\frac{Ml^2}{6}$ (B) $\frac{Ml^2}{12}$

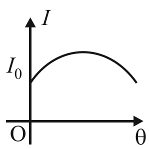
(C) $\frac{Ml^2}{24}$ (D) $\frac{Ml^2}{3}$

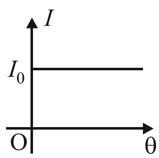
DPP-3 (JPP/049)

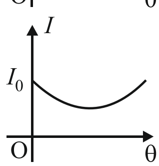
[Moment of inertia of continuous body, Theorem of parallel and perpendicular axes, Radius of gyration]

1. A square plate has a moment of inertia I_0 about an axis lying in its plane, passing through its centre and making an angle θ with one of the sides. Which graph represents the variation of I_0 with θ ?

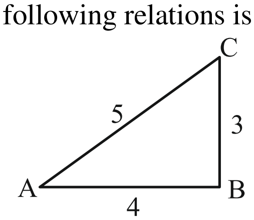
(A) 

(B) 

(C) 

(D) 

2. The ABC is a triangular plate of uniform thickness. The sides are in the ratio shown in the figure. I_{AB}, I_{BC} and I_{CA} are the moments of inertia of the plate about AB, BC and CA respectively. Which one of the following relations is correct?



(A) $I_{AB} + I_{BC} = I_{CA}$
(B) I_{CA} is maximum
(C) $I_{AB} > I_{BC}$
(D) $I_{BC} > I_{AB}$

3. Four spheres of diameter $2a$ and mass M are placed with their centres on the four corners of a square of side b. Then moment of inertia of the system about an axis about one of the sides of the square is

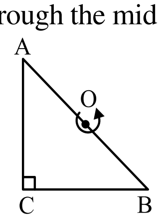
(A) $Ma^2 + 2\,Mb^2$
(B) Ma^2
(C) $Ma^2 + 4\,Mb^2$
(D) $8/5\,Ma^2 + 2\,Mb^2$

4. Two rods of equal mass m and length l lie along the x-axis and y-axis with their center lying at origin. What is the moment of inertia of both about the line $x = y$:

(A) $\frac{ml^2}{3}$ (B) $\frac{ml^2}{4}$

(C) $\frac{ml^2}{12}$ (D) $\frac{ml^2}{6}$

5. Find the moment of inertia of a plate cut in shape of a right angled triangle of mass M, side AC = BC = a about an axis perpendicular to the plane of the plate and passing through the mid point of side AB



(A) $\frac{Ma^2}{12}$ (B) $\frac{Ma^2}{6}$

(C) $\frac{Ma^2}{3}$ (D) $\frac{2Ma^2}{3}$

6. 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-

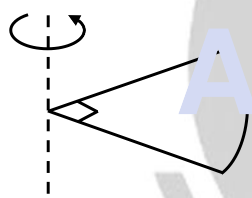
(A) $I_A > I_B$

(B) $I_A = I_B$

(C) $I_A < I_B$

(D) Depends on the actual values of t and r.

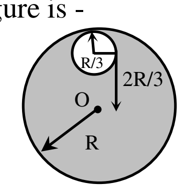
7. One quarter sector is cut from a uniform disc of radius R. This sector has mass M. It is made to rotate about a line perpendicular to its plane and passing through the center of the original disc. Its moment of inertia about the axis of rotation is -



(A) $\frac{1}{2}MR^2$ (B) $\frac{1}{4}MR^2$

(C) $\frac{1}{8}MR^2$ (D) $\sqrt{2}\,MR^2$

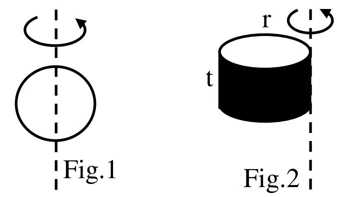
8. Mass and radius of a circular disc is M & R respectively. Moment of inertia of the disc about an axis passing through point O and perpendicular to plane of disc after removal of a disc of radius R/3 as shown in the figure is -



(A) (37/90) MR^2 (B) (9/4) MR^2

(C) (40/91) MR^2 (D) (4/9) MR^2

9. Moment of inertia of solid sphere of mass m and radius R about axis passing through center of mass is I as shown in figure 1. The sphere is moulded in the form of disc of radius 'r' and thickness 't'. The moment of inertia of disc about the axis shown in figure 2 will remain same.

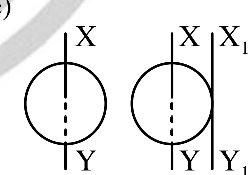


Then The radius of disc is -

(A) $\frac{2R}{\sqrt{15}}$ (B) $\frac{2R}{\sqrt{5}}$

(C) $\frac{R}{\sqrt{15}}$ (D) $\frac{R}{\sqrt{5}}$

10. The moment of inertia of a circular disc of radius 2 m and mass 1 kg about an axis passing through the centre of mass but perpendicular to the plane of the disc is 2 kg m^2. Its moment of inertia about an axis parallel to this axis but passing through the edge of the disc is (see the given figure)



(A) 8 kgm^2 (B) 4 kgm^2

(C) 10 kgm^2 (D) 6 kgm^2

11. 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) $\frac{ML^2}{12}$

12. 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-

13. The moment of inertia of a solid sphere about an axis passing through the centre of gravity is 2/5 MR^2; then its radius of gyration about a parallel axis at a distance 2R from first axis is

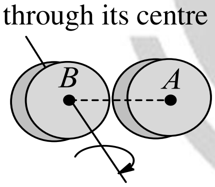
(A) 5R

(B) $R\sqrt{\frac{22}{5}} \Rightarrow R\sqrt{\frac{22}{5}}$

(C) $\frac{5}{2}R$

(D) $\sqrt{\frac{12}{5}R} \Rightarrow R\sqrt{\frac{12}{5}}$

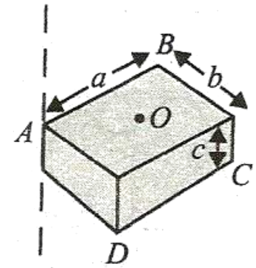
14. Two thin discs, each of mass M and radius r, are attached as shown in Figure, to form a rigid body. The rotational inertia of this body about an axis perpendicular to the plane of disc B passing through its centre is



(A) $2Mr^2$ (B) $3Mr^2$

(C) $4Mr^2$ (D) $5Mr^2$

15. Figure shows a uniform solid block of mass M and edge lengths a,b and c. Its M.I. about an axis through one edge and perpendicular (as shown) to the large face of the block is



(A) $\frac{M}{3}\left(a^2+b^2\right)$ (B) $\frac{M}{4}\left(a^2+b^2\right)$

(C) $\frac{7M}{12}\left(a^2+b^2\right)$ (D) $\frac{M}{12}\left(a^2+b^2\right)$

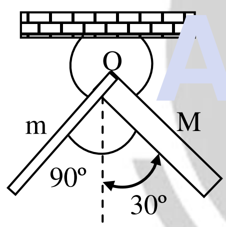
DPP-4

(JPP/050)

[Torque of forces about a point or axis and Rotational Equilibrium]

1. A force of $(2\hat{i}-4\hat{j}+2\hat{k})$ Newton acts at a point having position vector $(3\hat{i}+2\hat{j}-4\hat{k})$ 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

2. Two uniform rods of equal length but different masses are rigidly joined to form an L-shaped body, which is then pivoted as shown. If in equilibrium the body is in the shown configuration, ratio M/m will be -

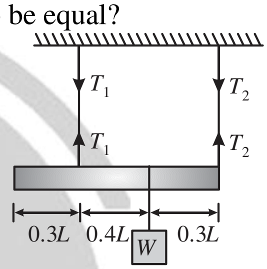


(A) 2 (B) 3
(C) $\sqrt{2}$ (D) $\sqrt{3}$

3. If a rigid body is subjected to two forces $\vec{F}_1=2\hat{i}+3\hat{j}+4\hat{k}$ acting at (3, 3, 4) and $\vec{F}_2=-2\hat{i}-3\hat{j}-4\hat{k}$ acting at (1, 0, 0) then which of the following is (are) true?
(A) The body is in equilibrium.
(B) The body is under the influence of a torque only.
(C) The body is under the influence of a single force.
(D) The body is under the influence of a force together with a torque.

4. A force $\vec{F}=2\hat{i}+3\hat{j}-\hat{k}$ acts at a point $(2,-3,1)$. Then magnitude of torque of this force about point $(0,0,2)$ will be:
(A) 6 (B) $3\sqrt{5}$
(C) $6\sqrt{5}$ (D) None of these

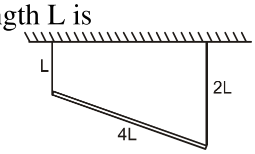
5. In figure, the bar is uniform and weighing 500 N. How large must W be if T_1 and T_2 are to be equal?



(A) 500 N (B) 300 N
(C) 750 N (D) 1500 N

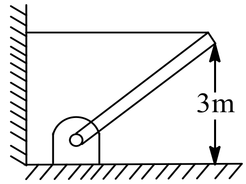
6. Let $\vec{F}$ be a force acting on a particle having position vector $\vec{r}$. Let $\vec{\tau}$ be the torque of this force about the origin, then-
(A) $\vec{r}.\vec{\tau}=0$ and $\vec{F}.\vec{\tau}=0$
(B) $\vec{r}.\vec{\tau}=0$ and $\vec{F}.\vec{\tau}\neq 0$
(C) $\vec{r}.\vec{\tau}\neq 0$ and $\vec{F}.\vec{\tau}\neq 0$
(D) $\vec{r}.\vec{\tau}\neq 0$ and $\vec{F}.\vec{\tau}\neq 0$

7. A uniform rod of length 4L and mass M is suspended from a horizontal roof by two light strings of length L and 2L as shown. Then the tension in the left string of length L is



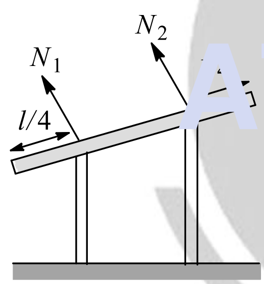
(A) $\frac{Mg}{2}$ (B) $\frac{Mg}{3}$
(C) $\frac{3}{5}Mg$ (D) $\frac{Mg}{4}$

8. A uniform rod of mass 15 kg and length 5 m is held stationary with the help of a light string as shown in Figure. The tension in the string is



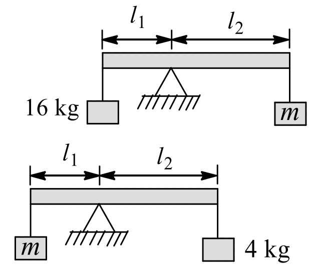
(A) 150 N
(B) 225 N
(C) 100 N
(D) None of the above

9. A uniform rod of length l is placed symmetrically on two walls as shown in Figure. The rod is in equilibrium. If N_1 and N_2 are the normal forces exerted by the walls on the rod, then



(A) $N_2 > N_2$
(B) $N_1 < N_2$
(C) $N_1 = N_2$
(D) N_1 and N_2 would be in the vertical directions

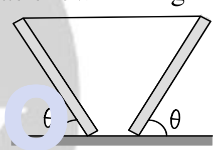
10. In an experiment with a beam balance, an unknown mass m is balanced by two known masses of 16 kg and 4 kg as shown in Figure



The value of the unknown mass m is

(A) 10 kg (B) 6 kg
(C) 8 kg (D) 12 kg

11. Two uniform boards, tied together with the help of a string, are balanced on a surface as shown in Fig



The coefficient of static friction between boards and surface is 0.5. The minimum value of θ, for which this type of arrangement is possible is

(A) 30°
(B) 45°
(C) 37°
(D) It is not possible to have this type of balanced arrangement

DPP-5 (JPP/051)

[Rotation about Fixed axis, Relation between Torque and Moment of inertia, Work done by Torque]

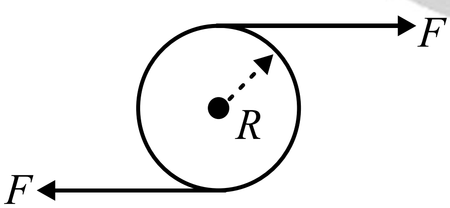
1. A wheel of moment of inertia 5×10^{-3} kg-m^2 is making 20rev/s. The torque required to stop it in 10 sec is -

(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

2. An automobile engine develops 100 H.P. when rotating at a speed of 1800 rad/min. The torque it delivers is nearly

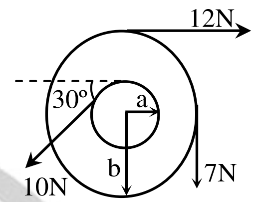
(A) 3.33 W-s
(B) 200W-s
(C) 248.7 W-s
(D) 2487 W-s

3. Two equal and opposite forces are applied tangentially to a uniform disc of mass M and radius R as shown in the figure. If the disc is pivoted at its centre and free to rotate in its plane, the angular acceleration of the disc is



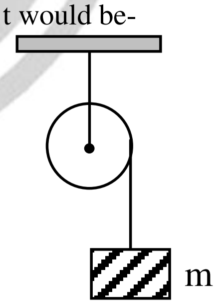
(A) $\frac{F}{MR}$
(B) $\frac{2F}{3MR}$
(C) $\frac{4F}{MR}$
(D) Zero

4. In the figure a = 6 cm and b = 20 cm. If the moment of inertia of the system is 3200 kg-m^2, its angular acceleration would be – (Assume all forces to be tangential)



(A) 10^{-1}rad/s^2
(B) 10^{-2}rad/s^2
(C) 10^{-3}rad/s^2
(D) 10^{-4}rad/s^2

5. In the following figure, a body of mass m is tied at one end of a light string and this string is wrapped around the solid cylinder of mass M and radius R. At the moment t = 0 the system starts moving. If the friction is negligible, angular velocity at time t would be-



(A) $\frac{mgRt}{(M+m)}$
(B) $\frac{2Mgt}{(M+2m)}$
(C) $\frac{2mgt}{R(M-2m)}$
(D) $\frac{2mgt}{R(M+2m)}$

6. One end of a uniform rod having mass m and length ℓ is hinged. The rod is placed on a smooth horizontal surface and rotates on it about the hinged end at a uniform angular velocity ω. The force exerted by the hinge on the rod has a horizontal component

(A) $m\omega^2\ell$ (B) zero

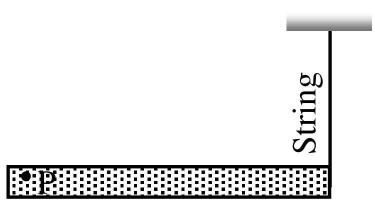
(C) mg (D) $\frac{1}{2}m\omega^2\ell$

7. A cubical block of mass m and edge **a** slides down a rough inclined plane of inclination θ with a uniform speed. Find the torque of the normal force acting on the block about its centre -

(A) mga sinθ (B) $\frac{1}{3}$ mga sinθ

(C) $\frac{1}{4}$ mga sinθ (D) $\frac{1}{2}$ mga sinθ

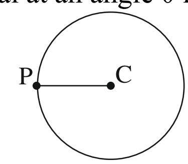
8. A uniform meter stick of mass M is hinged at one end P and supported in a horizontal position by a string attached to the other end as shown in figure. If the string is cut, then the initial angular acceleration of the stick is-



Meter Stick

(A) g rad/s^2
(B) 3g rad/s^2
(C) 3g/2 rad/s^2
(D) 6g rad/s^2

9. A uniform disc of mass *m* and radius *R* is pivoted at point *P* and is free to rotate in vertical plane. The centre *C* of disc is initially in horizontal position with P as shown in figure. If it is released from this position, then its angular acceleration when the line *PC* is inclined to the horizontal at an angle θ is

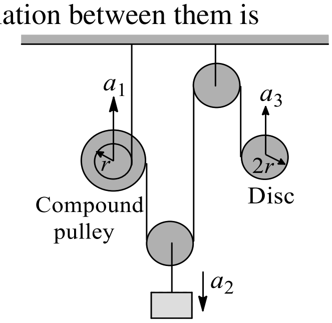


(A) $\frac{2g\cos\theta}{3R}$ (B) $\frac{g\sin\theta}{2R}$

(C) $\frac{2g\sin\theta}{R}$ (D) $\frac{2g\sin\theta}{3R}$

10. The angular velocity of a body is $\vec{\omega}=2\hat{i}+3\hat{j}+4\hat{k}$ and a torque $\vec{\tau}=\hat{i}+2\hat{j}+3\hat{k}$ acts on it. The rotational power will be-

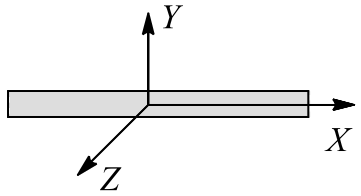
11. In the figure shown, suppose the compound pulley and the disc have the same angular acceleration in clockwise direction. If a_1 is the upward acceleration of the compound pulley's centre (inner radius r, outer radius 3r); a_2 is the downward acceleration of the block while a_3 is the upward acceleration of the centre of the disc (radius 2r). From kinematic constraints of the thread, the relation between them is



(A) $\frac{a_2-a_3}{2}=2a_1$ (B) $a_2+a_3=\frac{a_1}{3}$

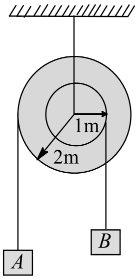
(C) $2a_2-a_3=4a_1$ (D) $a_2+2a_3=a_1$

12. A uniform rod of mass M and length L is free to rotate in X-Z plane, i.e., $\vec{F} = \left(3\hat{i} + 2\hat{j} + 6\hat{k}\right)N$ is acting on the rod at (L/2,0,0) in the situation shown in Figure. The angular acceleration of the rod is (Take M = 6 kg and L= 4 m)



(A) $-\frac{3}{2}\hat{j}+1/2\hat{k}$
(B) $-\frac{3}{2}\hat{j}$
(C) $\frac{1}{2}k$
(D) $4\hat{j}$

13. In the pulley system shown, if radii of the bigger and smaller pulley are 2 m and 1 m, respectively, and the acceleration of block A is 5 m/s^2 in the downward direction, the acceleration of block B will be



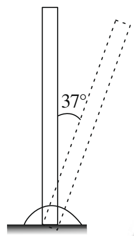
(A) 0 m/s^2
(B) 5 m/s^2
(C) 10 m/s^2
(D) $\frac{5}{2}$ m/s^2

DPP-6

(JPP/052)

[Angular Momentum, Conservation of Angular Momentum and Rotational Kinetic energy]

1. A uniform rod of mass M and length L is hinged about its one end as shown. Initially it is held vertical and then allowed to rotate, the angular velocity of rod when it makes an angle of 37° with the vertical is



(A) $\sqrt{\frac{12g}{5L}}$
(B) $\sqrt{\frac{3g}{5L}}$
(C) $\sqrt{\frac{g}{5L}}$
(D) $\sqrt{\frac{g}{L}}$

2. A thin rod of length L is suspended from one end and rotated with n rotations per second. The rotational kinetic energy of the rod will be:
(A) $2mL^2\pi^2n^2$
(B) $\frac{1}{2}mL^2\pi^2n^2$
(C) $\frac{2}{3}mL^2\pi^2n^2$
(D) $\frac{1}{6}mL^2\pi^2n^2$

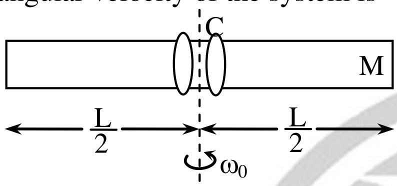
3. The rotational kinetic energy of a body is E. In the absence of external torque, if mass of the body remains same and radius of gyration doubled, then its rotational kinetic energy will be :-
(A) 0.5E
(B) 0.25E
(C) E
(D) 2E

4. A particle of mass m is describing a circular path of radius r with uniform speed. If L is the angular momentum of the particle (about the axis of the circle), then the kinetic energy of the particle is
(A) $\frac{L^2}{mr^2}$
(B) mr^2L
(C) $\frac{L^2}{2mr^2}$
(D) $\frac{L^2r^2}{m}$

5. A flywheel is making $\frac{3000}{\pi}$ revolutions per minute about its axis. If the moment of inertia of the flywheel about that axis is 400 kgm^2, its rotational kinetic energy is
(A) 2×10^6 J
(B) 3×10^3 J
(C) $500\pi^2$ J
(D) 12×10^3 J

6. **Statement-1:** Kinetic energy of a body rotating about a fixed axis is $\sum\frac{1}{2}m_i(r_i\omega)^2$, where m_i and r_i are elementary mass of rigid body and position of m_i from fixed axis respectively. (ω is the angular velocity about fixed axis).
Statement-2: All particles of rigid body are moving in circular orbit about fixed axis.
(A) Both Statement-1 and Statement-2 are true and the Statement-2 is the correct explanation of the Statement-1.
(B) Both Statement-1 and Statement-2 are true but the Statement-2 is not the correct explanation of the Statement-1.
(C) Statement-1 is true but the Statement-2 is false.
(D) Both Statement-1 and Statement-2 are false.

7. A smooth uniform rod of length L and mass M has two identical beads of negligible size, each of mass m, which can slide freely along the rod. Initially, the two beads are at the centre of the rod and the system is rotating with angular velocity ω_0 about an axis perpendicular to rod and passing through the mid-point of rod. There are no external forces. When the beads reach the ends of the rod the angular velocity of the system is -



(A) $\frac{M}{M+3m}\omega_0$ (B) $\frac{M}{M+6m}\omega_0$

(C) $\frac{M+6m}{M}\omega_0$ (D) ω_0

8. A thin circular ring of mass M and radius 'r' is rotating about its axis with a constant angular velocity ω. Four objects each of mass m, are kept gently to the opposite ends of two perpendicular diameters of the ring. The angular velocity of the ring will be:-

(A) $\frac{M\omega}{4m}$ (B) $\frac{M\omega}{M+4m}$

(C) $\frac{(M+4m)\omega}{M}$ (D) $\frac{(M+4m)\omega}{M+4m}$

9. If due to internal force radius of the earth reduces to one third of its original value then rotational kinetic energy of earth becomes n times its original value. Then n is

(A) $\frac{1}{9}$ (B) 9

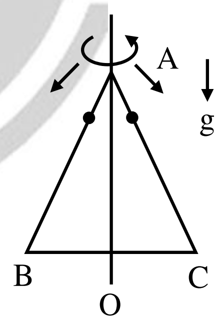
(C) 3 (D) $\frac{1}{3}$

10. A rotating table completes one rotation in 10 sec. and its moment of inertia is 100 kg-m^2. A person of 50 kg. mass stands at the centre of the rotating table. If the person moves 2m radially outward from the centre, the angular velocity of the rotating table (in rad/sec). will be:

(A) $\frac{2\pi}{30}$ (C) $\frac{20\pi}{30}$

(C) $\frac{2\pi}{3}$ (D) 2π

11. An equilateral triangle ABC formed from a uniform wire has two small identical beads initially 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 the beads slide down are :



(A) angular velocity and total energy (kinetic and potential)

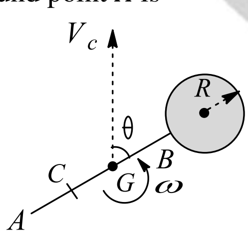
(B) total angular momentum and total energy

(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.

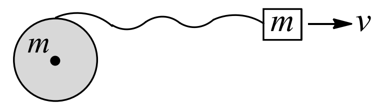
12. **Statement-1:** For a system of particles under a central force field, the total angular momentum is conserved.
Statement-2: The torque acting on such a system is zero.
(A) Both Statement-1 and Statement-2 are true and the Statement-2 is the correct explanation of the Statement-1.
(B) Both Statement-1 and Statement-2 are true but the Statement-2 is not the correct explanation of the Statement-1.
(C) Statement-1 is true but the Statement-2 is false.
(D) Both Statement-1 and Statement-2 are false.

13. In Figure, the rod AB of mass 2m and length $4R$ is rigidly attached to a disc of mass m, and radius R in the same plane. The system has prescribed motion in its own plane defined by the velocity v of its centre of mass G and its angular velocity ω. If the end A of the rod is suddenly fixed by a pin, the new angular velocity ω′ around point A is



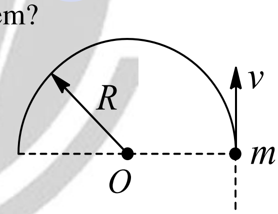
(A) $\dfrac{18v_c\cos\theta + 55R\omega}{73R}$
(B) $\dfrac{18v_c\sin\theta + 55R\omega}{73R}$
(C) $\dfrac{54v_c\sin\theta + 55R\omega}{217R}$
(D) None of these

14. A block of mass m is attached to a pulley disc of equal mass m and radius r by means of a slack string as shown. The pulley is hinged about its centre on a horizontal table and the block is projected with an initial velocity of 5 m/s. Its velocity when the string become taut will be



(A) 3 m/s
(B) 2.5 m/s
(C) 5/3 m/s
(D) 10/3 m/s

15. A small bead of mass m moving with velocity v gets threaded on a stationary semicircular ring of mass m and radius R kept on a horizontal table. The ring can freely rotate about its centre. The bead comes to rest relative to the ring. What will be the final angular velocity of the system?

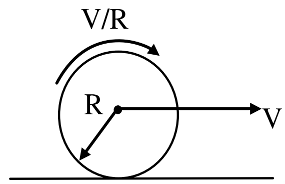


(A) $\dfrac{v}{R}$
(B) $\dfrac{2v}{R}$
(C) $\dfrac{v}{2R}$
(D) $\dfrac{3v}{R}$

DPP-7 (JPP/053)

[Velocity, Acceleration and Instantaneous axis in Rolling Motion]

1. A disc is performing pure rolling on a smooth stationary surface with constant angular velocity as shown in figure. At any instant, for the lower most point of the disc.



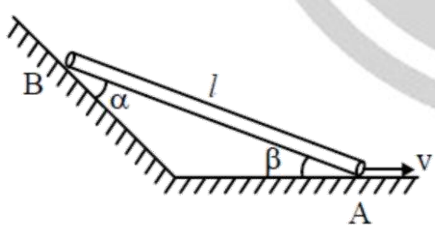
(A) Velocity is v, acceleration is zero

(B) Velocity is zero, acceleration is zero

(C) Velocity is v, acceleration is $\frac{v^2}{R}$

(D) Velocity is zero, acceleration is nonzero

2. A rod of length l slides down along the inclined wall as shown in figure. At the instant shown in figure, the speed of end A is v, then the speed of B will be



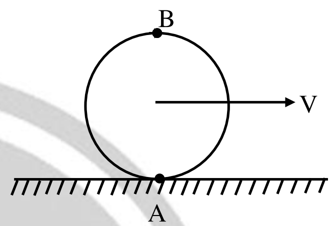
(A) $\frac{v\sin\beta}{\sin\alpha}$

(B) $\frac{v\sin\alpha}{\sin\beta}$

(C) $\frac{v\cos\beta}{\cos\alpha}$

(D) $\frac{v\cos\alpha}{\cos\beta}$

3. A wheel is rolling without slipping along a level road (see figure). The speed of transitional motion of the wheel axis is V. What are the speeds of the points A and B on the wheel rim relative to the road at the instant shown in the figure?



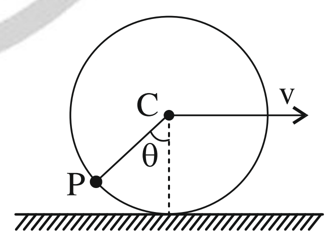
(A) $V_A = V$; $V_B = 0$

(B) $V_A = 0$; $V_B = V$

(C) $V_A = 0$; $V_B = 0$

(D) $V_A = 0$; $V_B = 2V$

4. A hoop rolls on a horizontal ground without slipping with linear speed v. Speed of a particle P on the circumference of the hoop at angle θ is:



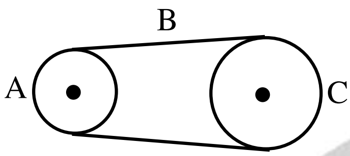
(A) $2v\sin\left(\frac{\theta}{2}\right)$

(B) $v \sin \theta$

(C) $2v\cos\left(\frac{\theta}{2}\right)$

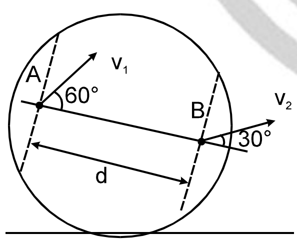
(D) $v \cos \theta$

5. As shown in figure, wheel A of radius r_A = 10 cm is coupled by belt B to wheel C of radius r_C = 25 cm. The angular speed of wheel A is increased from rest at a constant rate of 1.6 rad/s^2. Time after which wheel C reaches a rotational speed of 100 rpm, assuming the belt does not slip, is nearly -



(A) 4 sec
(B) 8 sec
(C) 12 sec
(D) 16 sec

6. Two points A & B on a disc have velocities v_1 & v_2 at some moment. Their directions make angles 60° and 30° respectively with the line of separation as shown in figure. The angular velocity of disc is



(A) $\frac{\sqrt{3}v_1}{d}$

(B) $\frac{v_2}{\sqrt{3}d}$

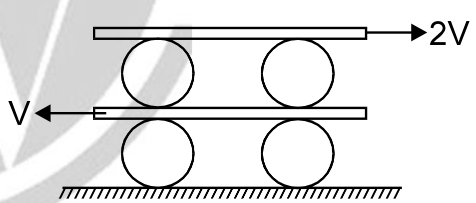
(C) $\frac{v_2 - v_1}{d}$

(D) $\frac{v_2}{d}$

7. A sphere of radius 'R' is rolling over a horizontal surface. All measurement are made with respect to surface over which sphere is rolling. Which of the following strictly confirms pure rolling motion of sphere over horizontal surface ?

(A) $x_{cm} = R\theta$: x_{cm} & R in meter & 'θ' is in radian
(B) $v_{cm} = R\omega$: R in meter, v_{cm} in m/s, 'ω' in rad/sec
(C) $a_{cm} = R\alpha$: a_{cm} in cm/s^2, R in cm, α in rad/s^2
(D) All of the above

8. A system of uniform cylinders and plates is shown in figure. All the cylinders are identical and there is no slipping at any contact. Velocity of lower & upper plate is V and 2V respectively as shown in figure. Then the ratio of angular speed of the upper cylinders to lower cylinders is

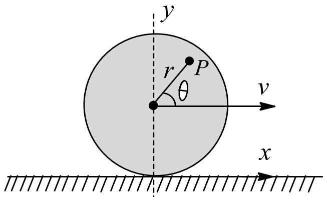


(A) 3
(B) 1/3
(C) 1
(D) None of these

9. When a person throws a meter stick it is found that when meter stick is horizontal, the centre of the stick is moving with a speed of 10 m/s vertically upwards & left end of stick with a speed of 20 m/s vertically upwards. Then the angular speed of the stick is:

(A) 20 rad/ sec (B) 10 rad/sec
(C) 30 rad/sec (D) none of these

10. A disc radius R rolls without slipping at speed v along positive x-axis. Velocity of point P at the instant shown in Figure is



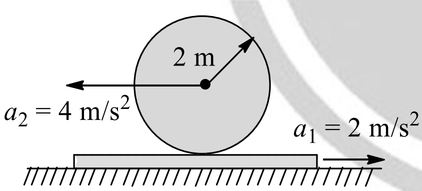
(A) $\vec{V}_p = \left(v + \frac{vr\sin\theta}{R}\right)\hat{i} + \frac{vr\cos\theta}{R}\hat{j}$

(B) $\vec{V}_p = \left(v + \frac{vr\sin\theta}{R}\right)\hat{i} - \frac{vr\cos\theta}{R}\hat{j}$

(C) $\vec{V}_p = \frac{vr\sin\theta}{R}\hat{i} + \frac{vr\cos\theta}{R}\hat{j}$

(D) $\vec{V}_p = \frac{vr\sin\theta}{R}\hat{i} - \frac{vr\cos\theta}{R}\hat{j}$

11. In Figure, a sphere of radius 2 m rolls on a plank. The acceleration of the sphere and the plank are indicated. The value of α is



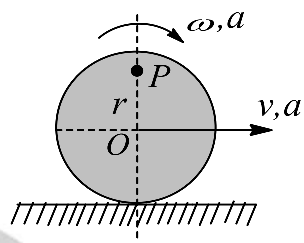
(A) 2rad/s^2

(B) 4rad/s^2

(C) 3rad/s^2

(D) 1rad/s^2

12. A disc of radius R rolls on a horizontal ground with linear acceleration a and angular acceleration α as shown in Figure. The magnitude of acceleration of point P as shown in the figure at an instant when its linear velocity is v and angular velocity is ω will be



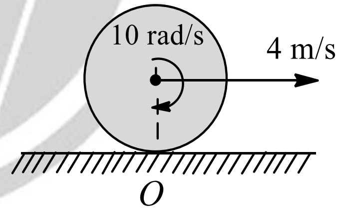
(A) $\sqrt{(a + r\alpha^2) + (r\omega^2)^2}$

(B) $\frac{ar}{R}$

(C) $\sqrt{r^2\alpha^2 + r^2\omega^4}$

(D) $r\alpha$

13. A disc of radius 0.2 m is rolling with slipping on a flat horizontal surface, as shown in Figure. The instantaneous centre of rotation is (the lowest contact point is O and centre of disc is C)



(A) Zero

(B) 0.1 m above O on line OC

(C) 0.2 m below O on line OC

(D) 02 m above O on line OC

DPP-8

(JPP/054)

[Rolling Motion on horizontal and Inclined Surface, Kinetic Energy in Rolling Motion]

1. A disc rolls down a plane of length L and inclined at angle θ, without slipping from rest. Its velocity on reaching the bottom will be :-

(A) $\sqrt{\dfrac{4gL\sin\theta}{3}}$ (B) $\sqrt{\dfrac{2gL\sin\theta}{3}}$

(C) $\sqrt{\dfrac{10gL\sin\theta}{7}}$ (D) $\sqrt{4gL\sin\theta}$

2. A spherical shell and a solid cylinder of same radius rolls down an inclined plane. The ratio of their accelerations will be :-

(A) 15 : 14
(B) 9 : 10
(C) 2 : 3
(D) 3 : 5

3. A ring takes time t_1 sliding down from rest on a smooth inclined plane and time t_2 rolling down a rough inclined plane of length L for reaching the bottom. The ratio of t_1 and t_2 is :-

(A) $\sqrt{2}$: 1 (B) 1 : $\sqrt{2}$
(C) 1 : 2 (D) 2 : 1

4. Calculate the ratio of the times taken by a uniform solid sphere and a disc of the same mass and the same diameter to roll down through the same distance from rest on a inclined plane.

(A) 15 : 14
(B) $\sqrt{15} : \sqrt{14}$
(C) $15^2 : 14^2$
(D) $\sqrt{14} : \sqrt{15}$

5. A solid cylinder of mass M and radius R rolls without slipping down an inclined plane of length L and height h. What is the speed of its centre of mass when the cylinder reaches its bottom?

(A) $\sqrt{2gh}$
(B) $\sqrt{\dfrac{3}{4}gh}$
(C) $\sqrt{\dfrac{4}{3}gh}$
(D) $\sqrt{4gh}$

6. A force F is applied at the centre of a disc of mass M. The minimum value of coefficient of friction of the surface for pure rolling is

(A) $\dfrac{F}{2Mg}$
(B) $\dfrac{F}{3Mg}$
(C) $\dfrac{2F}{5Mg}$
(D) $\dfrac{2F}{7Mg}$

7. The condition that a rigid body is rolling without slipping on an inclined plane is-

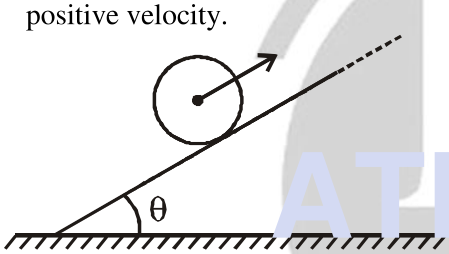
(A) it has acceleration less than g.
(B) it has rotational and translational K.E. to be equal
(C) it has linear velocity equal to radius times angular velocity
(D) the plane is frictionless.

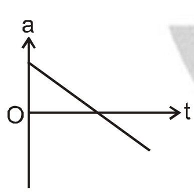
8. A heavy solid sphere is thrown on a horizontal rough surface with initial velocity u and zero angular velocity. What will be its speed, when it starts pure rolling motion?

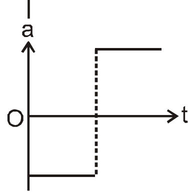
(A) $\frac{3u}{5}$ (B) $\frac{2u}{5}$

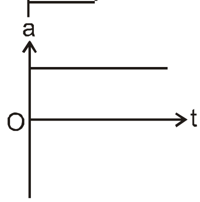
(C) $\frac{5u}{7}$ (D) $\frac{2u}{7}$

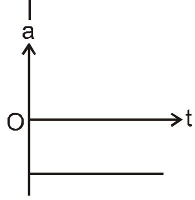
9. A uniform solid sphere rolls up (without slipping) the rough fixed inclined plane, and then back down. Which is the correct graph of acceleration 'a' of centre of mass of solid sphere as function of time t (for the duration sphere is on the incline) ? Assume that the sphere rolling up has a positive velocity.



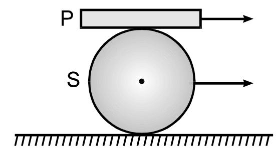
(A)


(B)


(C)


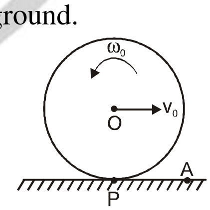
(D)


10. A plank P is placed on a solid cylinder S, which rolls on a horizontal surface. The two are of equal mass. There is no slipping at any of the surfaces in contact. The ratio of the kinetic energy of P to the kinetic energy of S is



(A) 1: 1
(B) 2: 1
(C) 8: 3
(D) 1: 4

11. A uniform wheel is released on a rough horizontal floor after imparting it an initial horizontal velocity v_0 and angular velocity ω_0 as shown in the figure below. Point O is the centre of mass of the wheel and point P is its instantaneous point of contact with the ground. The radius of wheel is r and its radius of gyration about O is k. Coefficient of friction between wheel and ground is μ. A is a fixed point on the ground.



If the wheel comes to permanent rest after sometime, then :

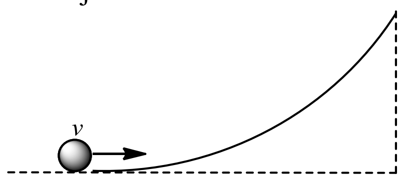
(A) $v_0 = \omega_0 r$

(B) $v_0 = \frac{\omega_0 k^2}{r}$

(C) $v_0 = \frac{\omega_0 r^2}{k}$

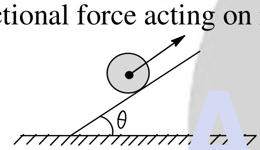
(D) $v_0 = \omega_0\left(r + \frac{k^2}{r}\right)$

12. A small object of uniform density roll up a curved surface with an initial velocity v. It reaches up to a maximum height of $\frac{3v^2}{4g}$ with respect to the initial position. The object is



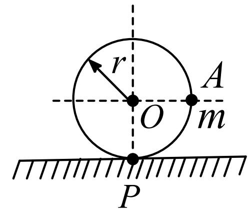
(A) Ring
(B) Solid sphere
(C) Hollow sphere
(D) Disc

13. A sphere has to purely roll upwards. At an instant when the velocity of sphere is v, frictional force acting on it is



(A) Downwards and μmg cosθ
(B) Downwards and $\frac{2mg\sin\theta}{7}$
(C) Upwards and μmg cosθ
(D) Upwards and $\frac{2mg\sin\theta}{7}$

14. A particle of mass 'm' is rigidly attached at ‘A’ to a ring of mass '3m' and radius ‘r’. The system is released from rest and rolls without sliding. The angular acceleration of ring just after release is

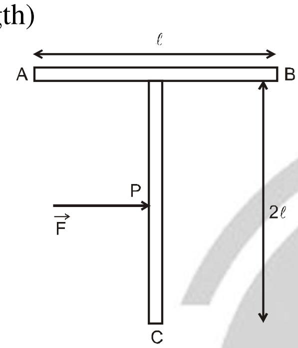


(A) $\frac{g}{4r}$
(B) $\frac{g}{6r}$
(C) $\frac{g}{8r}$
(D) $\frac{g}{2r}$

DPP-9 (JPP/055)

[Rolling Motion and Impulsive Torque]

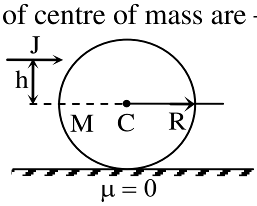
1. A 'T' shaped object with dimensions shown in the figure, is lying on a smooth floor. A force $\vec{F}$ is applied at the point P parallel to AB, such that the object has only the translational motion without rotation. Find the location of P with respect to C : (take λ as mass per unit length)



(A) $\frac{2}{3}\ell$ (B) $\frac{3}{2}\ell$

(C) $\frac{4}{3}\ell$ (D) ℓ

2. A solid sphere of mass M and radius R is placed on a smooth horizontal surface. It is given a horizontal impulse J at a height h above the centre of mass and sphere starts pure rolling then, the value of h and speed of centre of mass are –



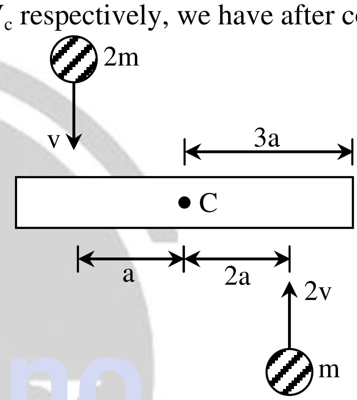
(A) $h = \frac{2}{5}R$ and $v = \frac{J}{M}$

(B) $h = \frac{2}{5}R$ and $v = \frac{2}{5}\frac{J}{M}$

(C) $h = \frac{7}{5}R$ and $v = \frac{7}{5}\frac{J}{M}$

(D) $h = \frac{7}{5}R$ and $v = \frac{J}{M}$

3. 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 speed 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 centre of mass velocity by ω; E and V_c respectively, we have after collision -



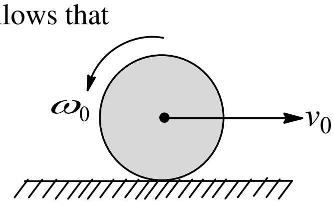
(A) $V_c = 0$

(B) $\frac{3mv^2}{5}$

(C) $\omega = \frac{v}{5a}$

(D) All of these

4. A uniform circular disc of radius r is placed on a rough horizontal surface and given a linear velocity v_0 and angular velocity ω_0 as shown. The disc comes to rest moving some distance to the right. It follows that



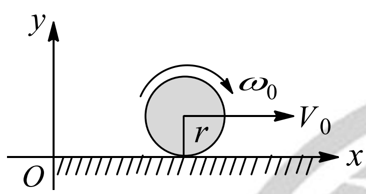
(A) $3v_0 = 2\omega_0 r$

(B) $2v_0 = \omega_0 r$

(C) $v_0 = \omega_0 r$

(D) $2v_0 = 3\omega_0 r$

5. A uniform sphere of mass m radius r and moment of inertia I about its centre moves along the x-axis as shown in Figure. Its centre of mass moves with velocity = v_0, and it rotates about its centre of mass with angular velocity = ω_0. Let $\vec{L} = (I\omega_0 + mv_0 r)(-k)$. The angular momentum of the body about the origin O is



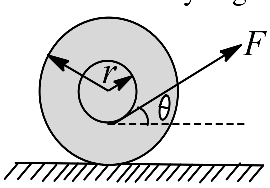
(A) $\vec{L}$, only if $v_0 = \omega_0 r$

(B) Greater than $\vec{L}$, if $v_0 > \omega_0 r$

(C) Less than $\vec{L}$, if $v_0 > \omega_0 r$

(D) $\vec{L}$, for all values of ω_0 and v_0

6. The spool shown in the figure is placed on a rough horizontal surface and has inner radius r and outer radius R. The angle θ between the applied force and the horizontal can be varied. The critical angle (θ) for which the spool does not roll and remains stationary is given by



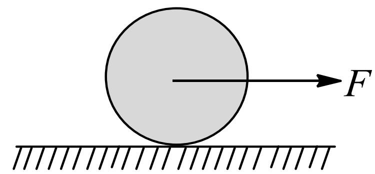
(A) $\theta = \cos^{-1}\left(\frac{r}{R}\right)$

(B) $\theta = \cos^{-1}\left(\frac{2r}{R}\right)$

(C) $\theta = \cos^{-1}\sqrt{\frac{r}{R}}$

(D) $\theta = \sin^{-1}\left(\frac{r}{R}\right)$

7. A solid sphere of mass m is lying at rest on a rough horizontal surface. The coefficient of friction between the ground and sphere is μ. The maximum value of F, so that the sphere will not slip, is equal to



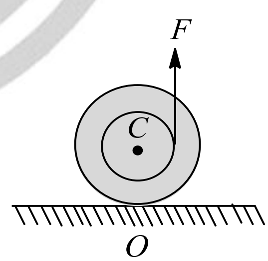
(A) $\frac{7}{5}\mu mg$

(B) $\frac{4}{7}\mu mg$

(C) $\frac{5}{7}\mu mg$

(D) $\frac{7}{2}\mu mg$

8. A yo-yo is placed on a rough horizontal surface and a constant force F, which is less than its weight, pulls it vertically. Due to this



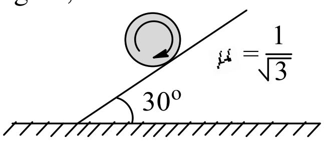
(A) Friction force acts towards left, so it will move towards left

(B) Friction force acts towards right, so it will move towards right

(C) It will move towards left, so friction acts towards left

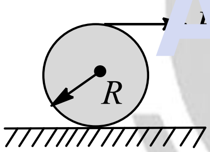
(D) It will move towards right so friction force acts towards right

9. A disc is rotated about its axis with a certain angular velocity and lowered gently on a rough inclined plane as shown in Figure, then



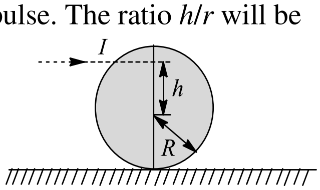
(A) It will rotate at the position where it was placed and then will move downwards
(B) It will go downwards just after it is lowered
(C) It will go downwards first and then climb up
(D) It will climb upwards and then move downwards

10. An object of mass M and radius R is performing pure rolling motion on a smooth horizontal surface under the action of a constant force F as shown in Figure. The object may be



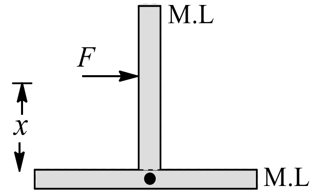
(A) Disk
(B) Ring
(C) Solid cylinder
(D) Hollow sphere

11. A solid sphere rests on a horizontal surface. A horizontal impulse is applied at height h from centre. The sphere starts starts rolling just after the application of impulse. The ratio h/r will be



(A) $\frac{1}{2}$ (B) $\frac{2}{5}$
(C) $\frac{1}{5}$ (D) $\frac{2}{3}$

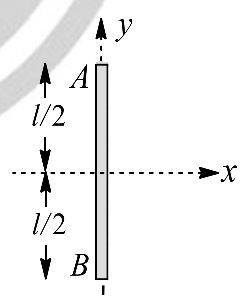
12. An inverted T-shaped object is placed on a smooth horizontal floor as shown in fig.



A force F is applied on the system as shown in fig. The value of x so that the system performs pure translational motion is

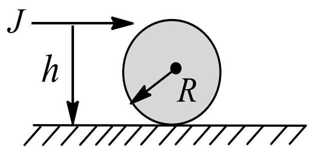
(A) $\frac{L}{4}$ (B) $\frac{3L}{4}$
(C) $\frac{L}{2}$ (D) $\frac{3L}{2}$

13. A uniform rod of mass m and length l is placed over a smooth horizontal surface along the y-axis and is at rest as shown in Figure. An impulsive force F is applied for small time t along x-direction at point A. The x-coordinate of end A of the rod when the rod become parallel to x-axis for the first time is [initially, the coordinate of centre of mass of the rod is (0,0)]



(A) $\frac{\pi l}{12}$
(B) $\frac{l}{2}\left(1+\frac{\pi}{12}\right)$
(C) $\frac{l}{2}\left(1-\frac{\pi}{6}\right)$
(D) $\frac{l}{2}\left(1+\frac{\pi}{6}\right)$s

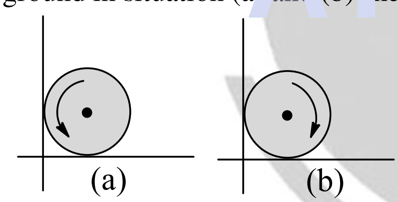
14. A solid sphere of mass M and radius R is placed on a rough horizontal surface. It is struck by a horizontal cuestick at a height h above the surface. The value of h so that the sphere performs pure rolling motion immediately after it has been struck is



(A) $\frac{2R}{5}$ (B) $\frac{5R}{2}$

(C) $\frac{7R}{5}$ (D) $\frac{9R}{5}$

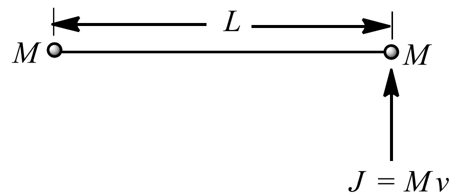
15. A sphere is placed rotating with its centre initially at rest in a corner as shown in figures (a) and (b). Coefficient of friction between all surfaces and the sphere is 1/3. Find the ratio of the friction forces f_a to f_b by ground in situation (a) and (b). The



(A) 1 (B) $\frac{9}{10}$

(C) $\frac{10}{9}$ (D) None of these

16. Consider a body, shown in figure, consisting of two identical balls, each of mass M connected by a light rigid rod. If an impulse J=Mv is impared to the body at one of its ends, what would be its angular velocity?



(A) v/L

(B) $2v/L$

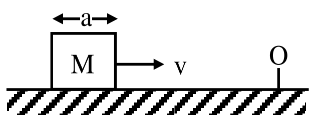
(C) $v/3L$

(D) $v/4L$

DPP-10 (JPP/056)

[Toppling, Impulsive Torque and Miscellaneous]

1. A cubical block of side a is moving with velocity v on a horizontal smooth plane as shown. It hits a small obstacle at point O. The angular speed of the block just after it hits O is –



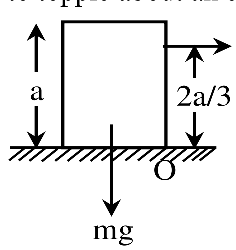
(A) $\frac{3v}{4a}$

(B) $\frac{3v}{2a}$

(C) $\frac{\sqrt{3}v}{\sqrt{2}a}$

(D) Zero

2. A cube of side a and mass m is placed on a smooth surface as shown in figure. The minimum value of F for which the cube begins to topple about an edge is-



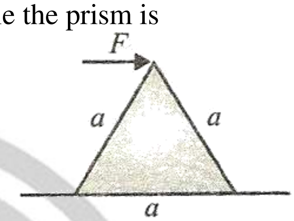
(A) $\frac{2}{3}$ mg

(B) 3mg

(C) $\frac{3}{4}$ mg

(D) mg

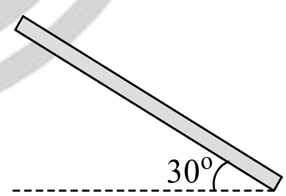
3. An equilateral prism of mass m rests on a rough horizontal surface with coefficient of friction μ. A horizontal force F is applied on the prism as shown in Figure. If the coefficient of friction is sufficiently high so that the prism does not slide before toppling, the minimum force required to topple the prism is



(A) $\frac{mg}{\sqrt{3}}$ (B) $\frac{mg}{4}$

(C) $\frac{\mu mg}{\sqrt{3}}$ (D) $\frac{\mu mg}{4}$

4. A slender rod of mass m and length L is pivoted about horizontal axis through one end and released from rest at an angle of 30° above the horizontal. The force exerted by the pivot on the rod are the instant when the rod passes through a horizontal position is



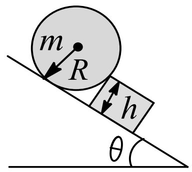
(A) $\sqrt{\frac{10}{4}}mg$ along horizontal

(B) mg along horizontal

(C) $\frac{\sqrt{10}}{4}mg$ along a line making an angle of $\tan^{-1}\left(\frac{1}{3}\right)$ with the horizontal

(D) $\frac{\sqrt{10}}{4}mg$ along a line making an angle of $\tan^{-1}(3)$ with the horizontal

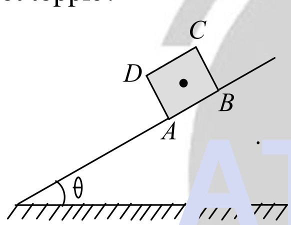
5. Find the minimum height of the obstacle so that the sphere can stay in equilibrium



(A) $\dfrac{R}{1+\cos\theta}$ (B) $\dfrac{R}{1+\sin\theta}$

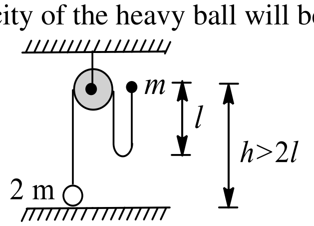
(C) $R(1-\sin\theta)$ (D) $R(1-\cos\theta)$

6. A cube of side a is placed on an inclined plane of inclination θ. What is the maximum value of θ for which the cube will not topple?



(A) 15°
(B) 30°
(C) 45°
(D) 60°

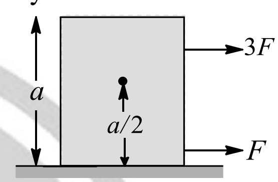
7. In fig., a heavy ball of mass 2 m rests on the horizontal surface and the lighter ball of mass m is dropped from a height h > 2l. At the instant the string gets taut, the upward velocity of the heavy ball will be



(A) $\frac{2}{3}\sqrt{gl}$ (B) $\frac{4}{3}\sqrt{gl}$

(C) $\frac{1}{3}\sqrt{gl}$ (D) $\frac{1}{2}\sqrt{gl}$

8. A rectangular block of mass M and height a is resting on a smooth level surface. A force F is applied to one corner as shown in Figure. At what point should a parallel force 3F be applied in order that the block shall undergo pure translational motion? Assume normal contact force between the block and surface passes through the centre of gravity of the block



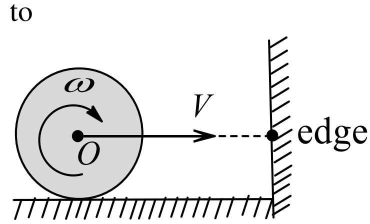
(A) $\frac{a}{3}$ vertically above centre of gravity

(B) $\frac{a}{6}$ vertically above centre of gravity

(C) No such point exists

(D) It is not possible

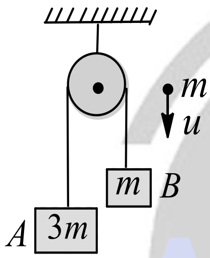
9. A uniform solid sphere of radius r is rolling on a smooth horizontal surface with velocity V and angular velocity ω = (V = ωr). The sphere collides with a sharp edge on the wall as shown in Figure. The coefficient of friction between the sphere and the edge μ = 1/5. Just after the collision the angular velocity of the sphere becomes equal to zero. The linear velocity of the sphere just after the collision is equal to



(A) V (B) $\frac{V}{5}$

(C) $\frac{3V}{5}$ (D) $\frac{V}{6}$

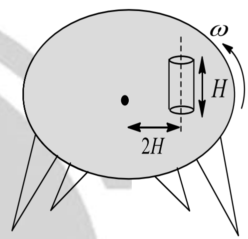
10. A system of two blocks A and B are connected by an inextensible massless string as shown in fig. The pulley is massless and frictionless. Initially, the system is at rest. A bullet of mass `m' moving with a velocity `u' as shown hits block `B' and gets embedded into it. The impulse imparted by tension force to the block of mass 3m is



(A) $\frac{5mu}{4}$ (B) $\frac{4mu}{5}$

(C) $\frac{2mu}{5}$ (D) $\frac{3mu}{5}$

11. A cylinder of height H and diameter H/4 is kept on a frictional turntable as shown in Figure. The axis of the cylinder is perpendicular to the surface of the table and the distance of axis of the cylinder is 2H from the centre of the table. The angular speed of the turntable at which the cylinder will start toppling (assume that friction is sufficient to prevent slipping) is



(A) $\sqrt{\frac{g}{4}\left(\frac{1}{2}-H\right)}$ (B) $\sqrt{g\left(\frac{1}{2}-H\right)}$

(C) $\sqrt{\frac{g}{4H}}$ (D) $\sqrt{\frac{g}{8H}}$