PHYSICS

BOOKS - DC PANDEY ENGLISH

ROTATIONAL MECHANICS

Examples

1. Three particles of masses 1 g, 2g and 3 g are kept at points (2cm,0), (0.6 cm), (4cm, 3cm) find moment of inertia of all three particles (in gm

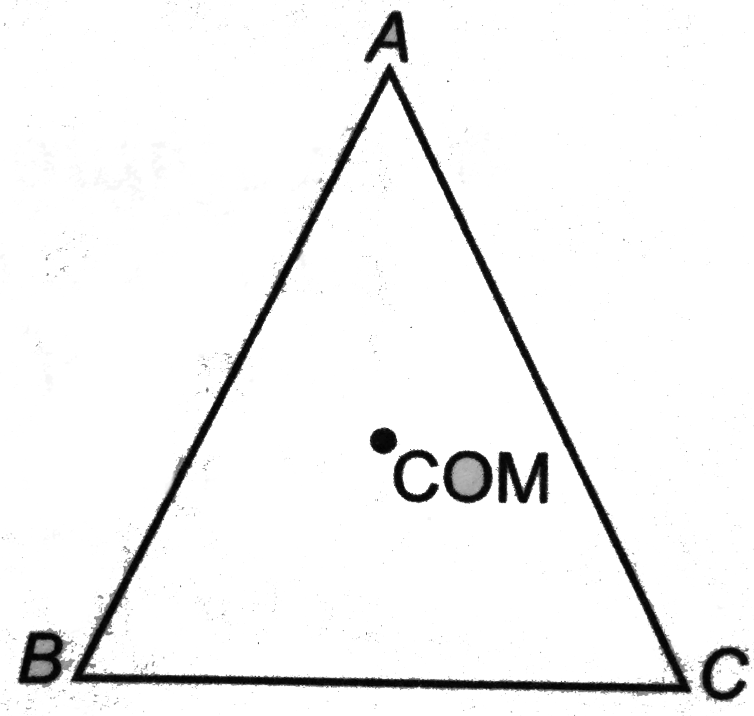
$-cm(2))$ about (a) x-axis

(b). Y-axis

(c). Z-axis.

Watch Video Solution

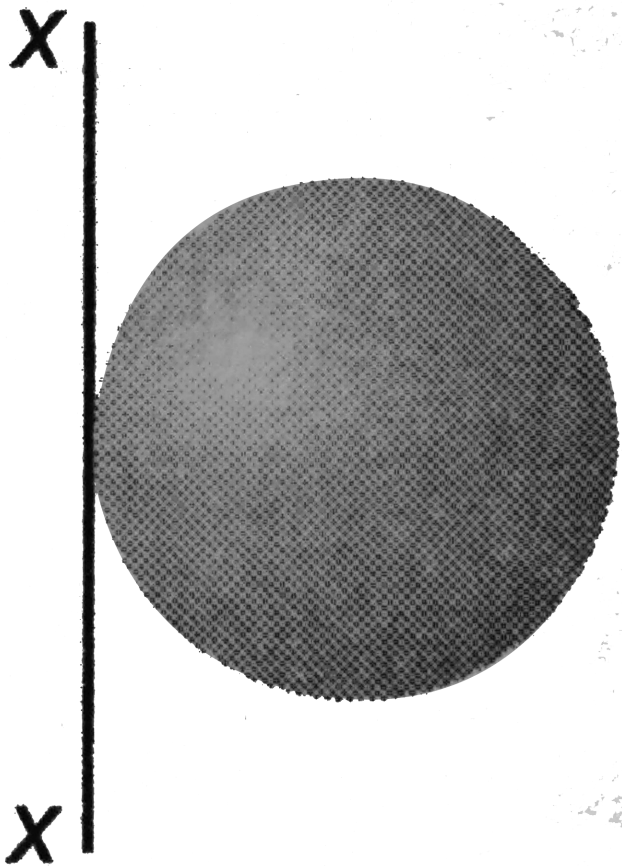
2.



Three rods each of mass m and length l are joined together to form an equilateral triangle as shown in figure. Find the moment of inertial of the system about an axis passing through its centre of mass and perpendicular to the plane of the particle.

Watch Video Solution

3.

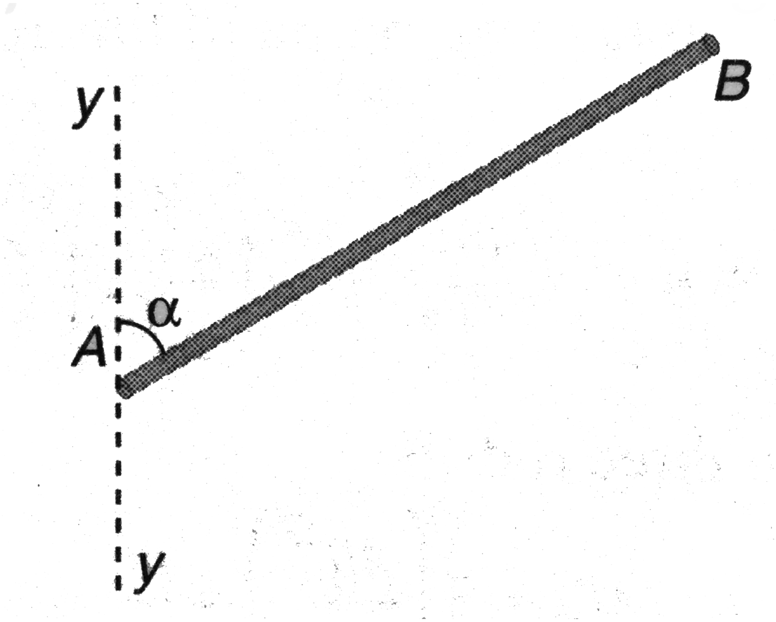


Find the moment of inertia of a solid sphere of mass M and radius R about an axis XX shown in figure. Also find radius of gyration about the given axis.

Watch Video Solution

4. Consider a uniform rod of mass m and length 2l with two particles of mass m each at its ends. Let AB be a line perpendicular to the length of rod and passig through its centre. Find the moment of inertial of the system about AB.

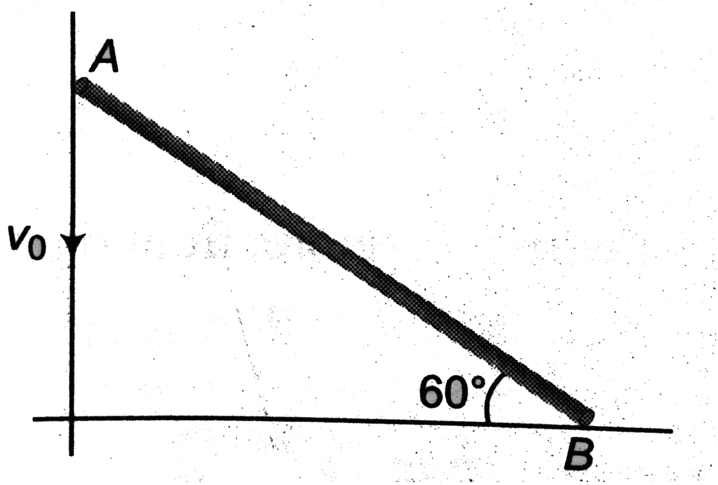
Watch Video Solution

5. 

Find the moment of inertia of the rod AB about an axis yy as shown in figure. Mass of the rod is m and length is l.

Watch Video Solution

6.



Rod AB has length L. velocity of end A of the rod has velocity v_0 at the given instant.

(a). Which type of motion the rod has?

(b). Find velocity of end B at the given instant.

(C). Find the angular velocity of the rod.

Watch Video Solution

7. Find the torque of a force $F = a\left(\hat{i} + 2\hat{j} + 3\hat{k}\right)\ N$ about a point O. The position vector of point of application of force about O is $r = \left(2\hat{i} + 3\hat{j} - \hat{k}\right)\ m$.

Watch Video Solution

8. A small ball of mass 1.0 kg is attached to one end of a 1.0 m long massless string and te other end of the string is hung from a point O. When the resulting pendulum is making $30^{\circ}C$ from the vertical, what is the magnitude

of net torque about the point of suspension?

[Take $g = 10m/s^2$]

Watch Video Solution

9. A force $F = \left(2\hat{i} + 3\hat{j} + 4\hat{k}\right)N$ is acting at point $P(2m, -3m, 6m)$ find torque of this force about a point O whose position vector is $\left(2\hat{i} - 5\hat{j} + 3\hat{k}\right)$ m.

Watch Video Solution

10. A solid sphere of mass 2 kg and radius 1 m is free to rotate about an axis passing through its centre. Find a constant tangential force F required to the sphere with ω = 10 rad/s in 2 s.

A. $4N$

B. $8N$

C. $2N$

D. $6N$

Watch Video Solution

11. A angular positio of a point on the rim of a rotating wheel is given by $\theta = 4t - 3t^2 + t^3$ where θ is in radiuans and t is in seconds. What are the angualr velocities at

(a).$t = 2.0$ and

(b). $t = 4.0s$

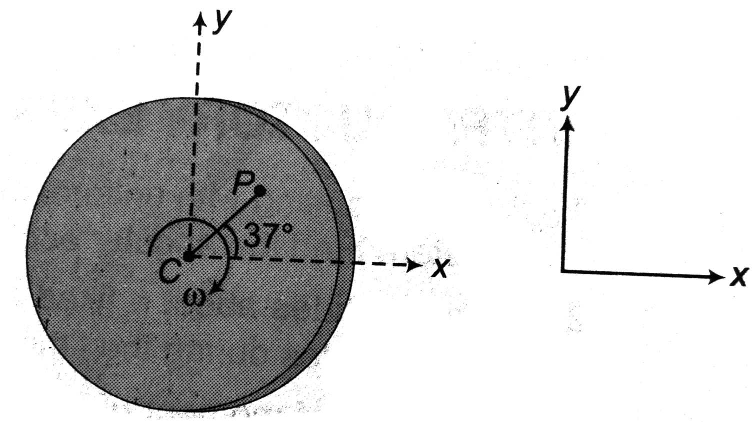
(c). What is the average angular acceleration for the time interval that begins at $t = 2.0s$ and ends at $t = 4.0s$?

(d). What are the instantaneous angular

acceleration at the biginning and the end of this time interval?

Watch Video Solution

12.



A circular disc is rotating with an angular speed (in radian per sec)

$\omega = 2t^2$

given, $CP = 2m$

In terms of $\hat{i}$, $\hat{j}$ and $\hat{k}$ at $t = 1s$

find,

(a). ω

(b). α

(c). linear velocity of the particle lying at P (d).

linear acceleration of the particle lying P

Watch Video Solution

13. A particle of mass m is moving along the

line $y = b, z = 0$ with constant speed v. State whether the angular momentum of particle about origin is increasing. Decreasing or constant.

Watch Video Solution

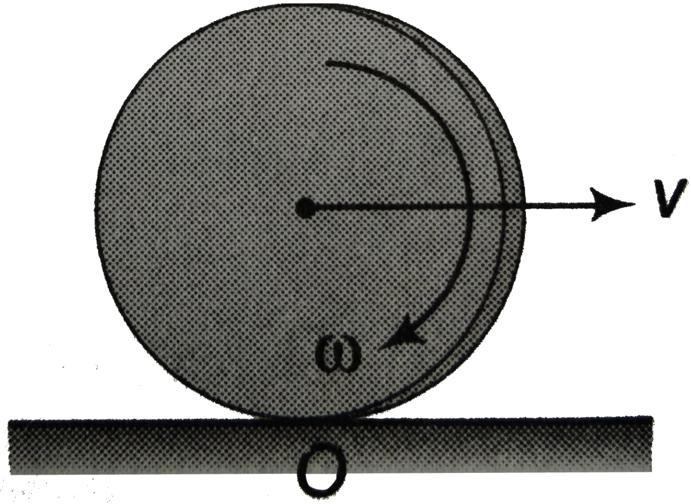
14. A particle of mass m is projected from origin O with speed u at an angle θ with positive x-axis. Positive y-axis is in vertically upward. Direction. Find the angular momentum of particle at any time t about O before the particle strikes the ground again.

Watch Video Solution

15. 

A rod of mass 2 kg ad length 2 m is rotating about its one end O with an angular velocity $\omega = 4rad/s$. Find angular momentum of the rod about the axis rotation.

Watch Video Solution

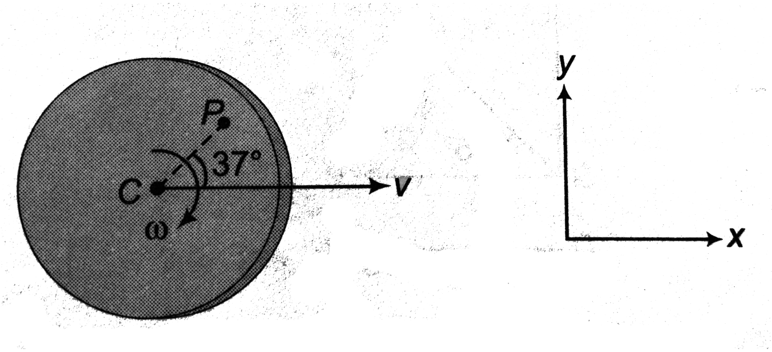
16. 

A cicular disc of mass m and radius R is set into motion on a horizontal floor with a linear speed v in the forward direction and an angular speed $\omega = \dfrac{v}{R}$ in clockwise direction as shown in figure. Find the magnitude of the total angular momentum of the disc about bottom most point O of the disc.

Watch Video Solution

17. A wheel of moment of inertial I and radius R is rotating about its axis at an angular speed ω. It picks up a stationary particle of mass m at its edge. Find the new angular speed of the wheel.

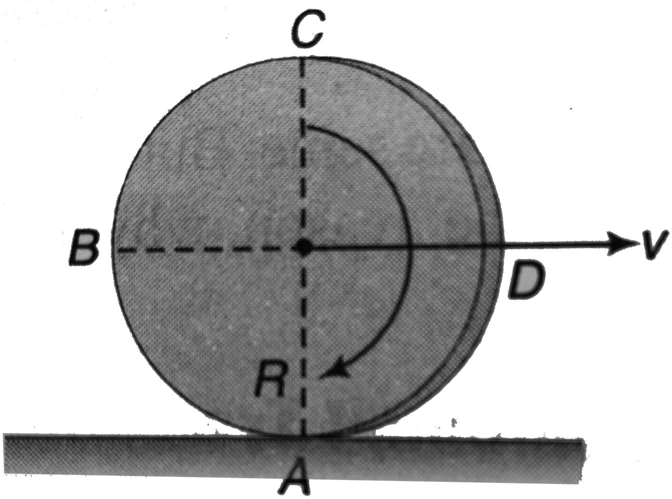
Watch Video Solution

18. 

In the figure shown $v = 2m/s$ $\omega = 5rad/s$ and $CP = 1m$

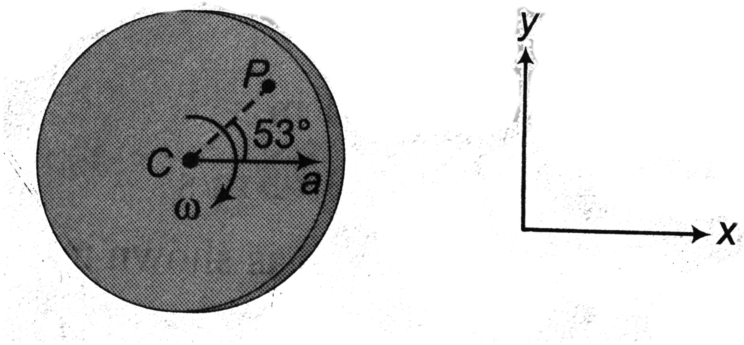
In terms of $\hat{i}$ and $\hat{j}$ find linear velocity of particle P.

Watch Video Solution

19. 

A disc of radius R has linear velocity v and angular velocity ω as shown in the figure. Given $v = r\omega$ find velocity of point A, B, C and D on the disc.

Watch Video Solution

20. 

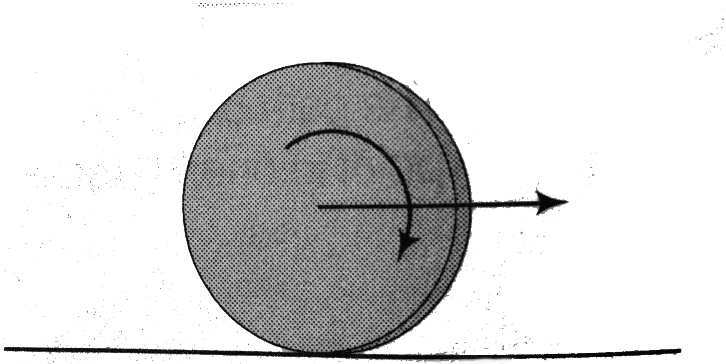
In the shown figure,

$a = 2m/s^2, \omega = (2t) rods^{-1}$ and $CP = 1m$

In terms of $\hat{i}$ and $\hat{j}$, find linear acceleration of the particle at P at P at $t = 1$ s

Watch Video Solution

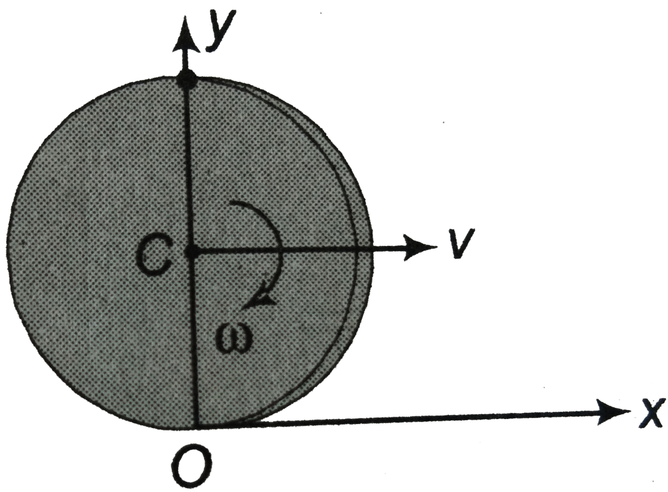
21.



A solid disc is rolling without slipping on a horizontal ground as shown in figure. Its total kinetic energy is 100 J. what is its translational and rotational kinetic energy?

Watch Video Solution

22. A disc of radius R starts at time $t = 0$ moving along the positive x-axis with linear speed v and angular speed ω. Find the x and y coordinates of the bottom most poitn at any time t.



A. $(x, y) \equiv (vt - R\sin\omega t, R - R\cos\omega t)$

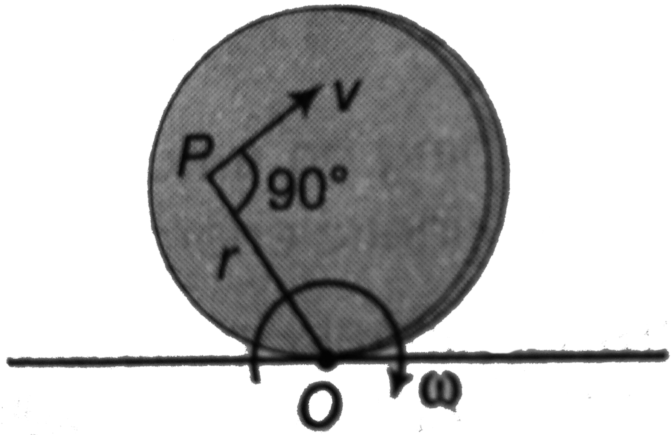
B. $(x, y) \equiv (2vt - R\sin\omega t, R - R\cos\omega t)$

C. $(x, y) \equiv (vt - R\sin 2\omega t, R - R\cos\omega t)$

D. $(x, y) \equiv (R\sin\omega t, R - R\cos\omega t)$

Watch Video Solution

23.



Using the concept of instantaneous axis of rotation. Find speed of particle P as shown in figure, under pure rolling condition.

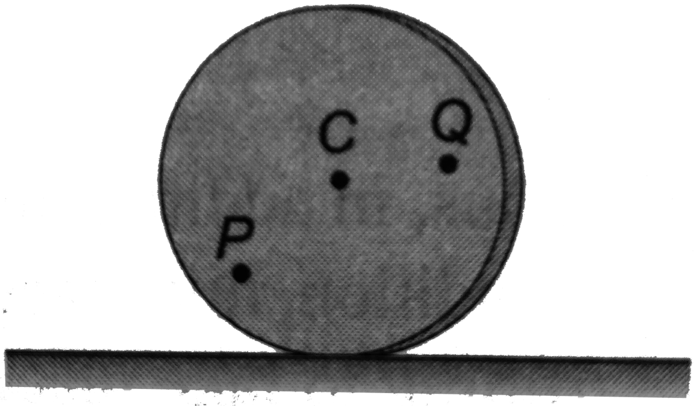
A. ωr

B. $\omega \frac{r}{2}$

C. $2\omega r$

D. $\omega^2 r$

Watch Video Solution

24. 

A disc is rolling (without slipping) on a horizontal surface. C is its centre and Q and P are two point equidistance from C. let v_p, v_Q

and v_C be the magnitude of velocities of points P, Q, and C repsectively,

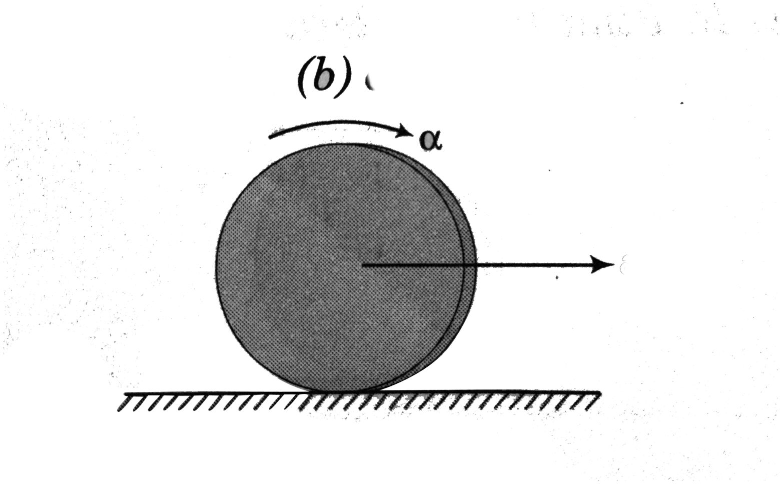
(a). $v_Q > v_C > v_P$

(b). $v_Q < v_C < v_P$

(c). $v_Q = v_P, v_C = \frac{1}{2}v_P$

(d). $v_Q < v_C > v_P$

Watch Video Solution



25.

In the shown figure, accelerated pure rolling with takes place, if $a = R\alpha$, find the case if.

(a). $a > R\alpha$

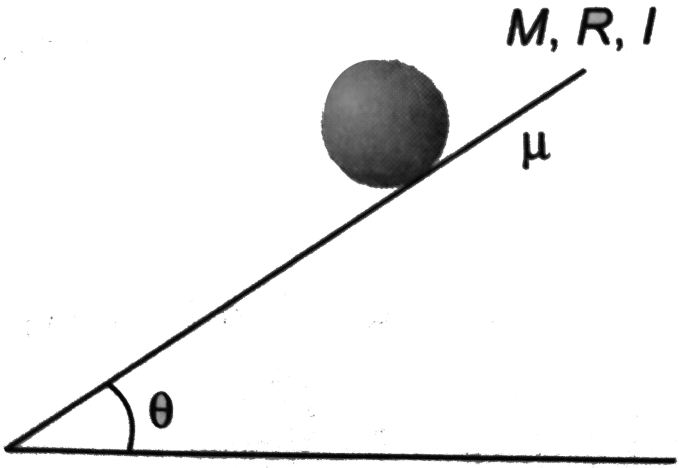
(b). $\alpha < R\alpha$

Watch Video Solution

26. If accelerated pure rolling is taking place on a stationary ground, then work done by friction is always zero, comment on this.

Watch Video Solution

27.



In the shown figure, M is mass of the body, R

its radius an I the moment of inertial about an axis passing through centre. Find force of friction f acting on the body (upwards), its linear acceleration a (down the plane) and type of motion if:

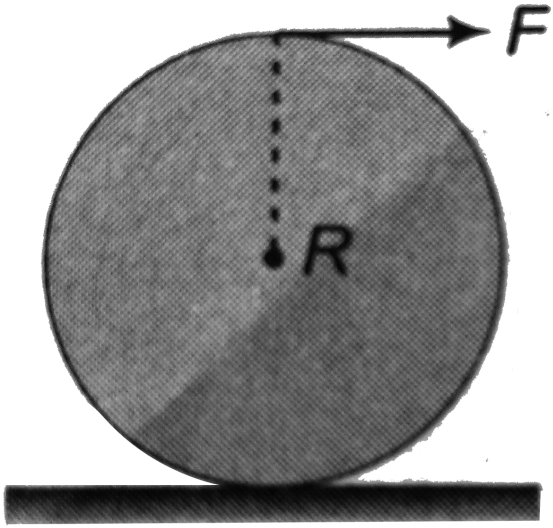
(a) $\mu = 0$

(b). $\mu < \mu_{\min}$

(c). $\mu > \mu_{\min}$

Where $\mu_{\min}$ is the minimum value of coefficient of friction required for pure rolling

Watch Video Solution

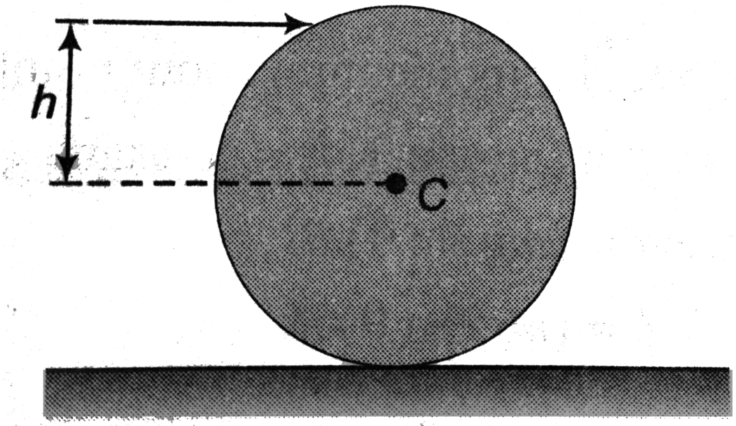
28. 

A tangential force F acts at the top of a thin spherical shell of mass m and radius R. Find the acceleration of the shell if it rolls without slipping.

Watch Video Solution

29. A horizontal force F acts on the sphere at its centre as shown. Coefficient of friction between ground and sphere is μ. What is maximum value of F for which there is no slipping?

Watch Video Solution

30. 

A solid sphere of mass M and radius R is hit by a cue at a height h above the centre C. for what value of h the sphere will rool without slipping ?

Watch Video Solution

31. A uniform sphere of mass m and radius R start rolling without slipping down an inclined plane. Find the time dependence of the angular. How will the result be affected in the case of a perfectly smooth inclined plane? The angle of inclination of the plane is θ.

Watch Video Solution

32. A uniform cube of side a and mass m rests on a rough horizontal table. A horizontal force

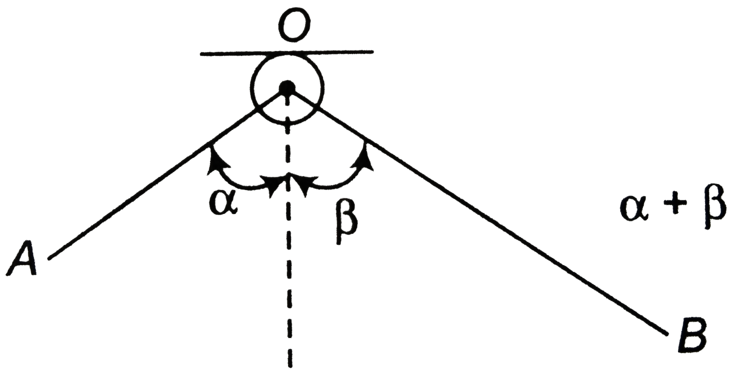
F is applied normal to one of the faces at a point directly above the centre of the face, at a height $\frac{3a}{4}$ above the base. What is the minimum value of F for which the cube begins to tip about an edge?

Watch Video Solution

33. A uniform cylinder of height h and radius r is placed with its circular face on a rough inclined plane and the inclination of the plane to the horizontal is gradually increased. If μ is the coefficient of friction, then under what condition the cylinder will (a) slide before toppling (b) topple before sliding.

Watch Video Solution

Solved Examples



1.

A uniform L shaped rod of mass 3 m is hinged at point O. length OB is two times the length OA. It is in equilibrium.

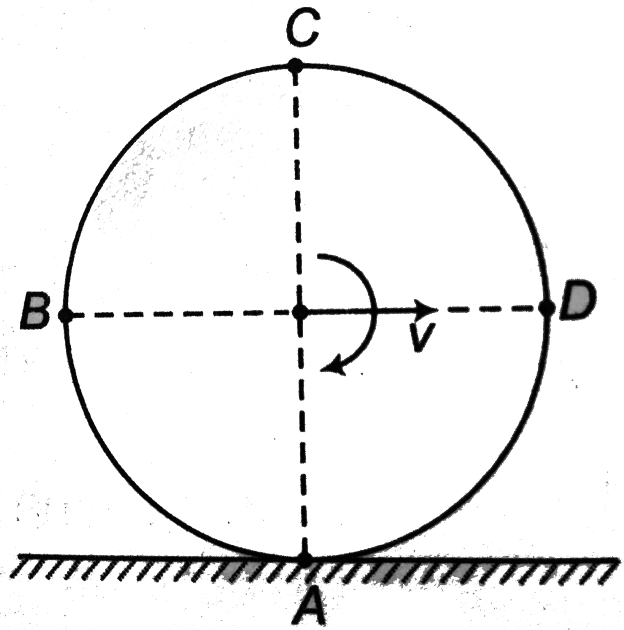
Find

(a). Relation between α and β

(b). Net hinge force.

Watch Video Solution

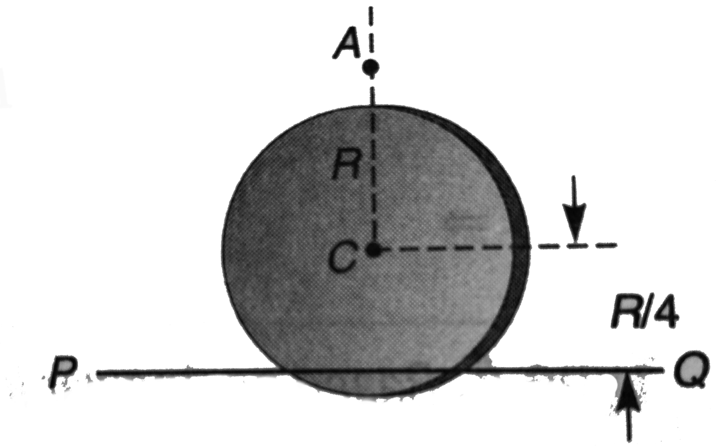
2.



A ring of mass m is rolling without slipping with linear speed v as shown in figure. Four particles each of mass m are also attached at points A, B , C and D find total kinetic energy of the system.

Watch Video Solution

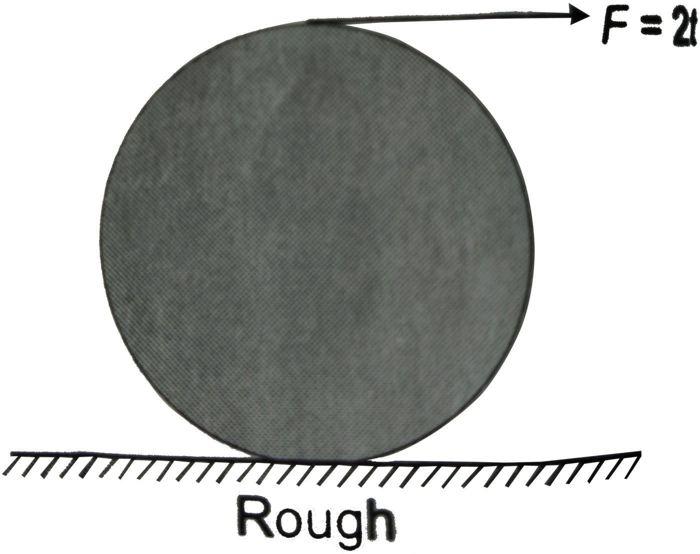
3.



A uniform circular disc has radius R and mass m. A particle, also of mass m, if fixed at a point A on the edge of the disc as shown in the figure. The disc can rotate freely about a horizontal chord PQ that is at a distance $R/4$ from the centre C of the disc. The line AC is perpendicular to PQ. Initially the disc is held vertical with the point A at its highest position. it is then allowed to fall, so that it starts rotation about PQ. Find the linear speed of the particle as it reaches its lowest position.

Watch Video Solution

4.



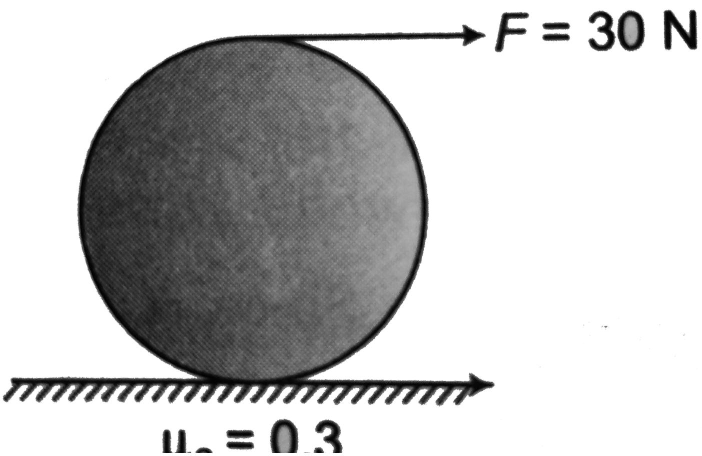
A solid shere of mass m and radius R is kept over a rough ground. A time varying force $F = 2t$ is acting at the topmost point as shown in figure.

(a). Find angular momentum of the sphere about the bottommost point as a function of time t

(b). Does this result depend on the fact whether the ground is rough or smooth?

Watch Video Solution

5.



A solid sphere of mass 5 kg and radius $1m$ is kept over a rough surface as shown in figure. A force $F = 30N$ is acting at the topmost point.

(a). Check whether the pure rolling will take place or not

(b). Find direction and magnitude of friction actually acting on the sphere.

(c). Find linear acceleration a and angular acceleration α take $g = 10m / s^2$

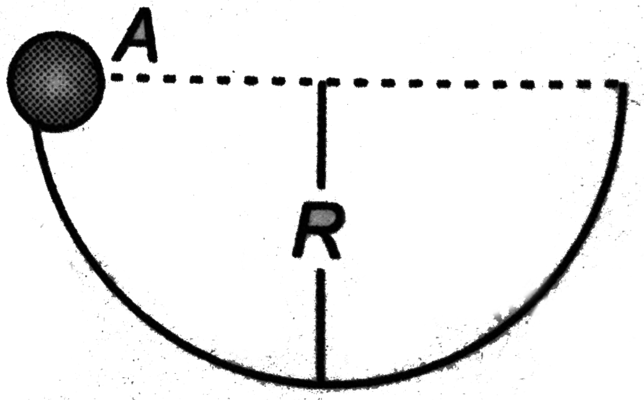
Watch Video Solution

6. Repeat all parts of above problem for $F = 40N$

View Text Solution

7. A solid cylinder of mass m and radius r starts rolling down an inclined plane of inclination θ. Friction is enough to prevent slipping. Find the speed of its centre of mass when its centre of mass has fallen a height h.

Watch Video Solution



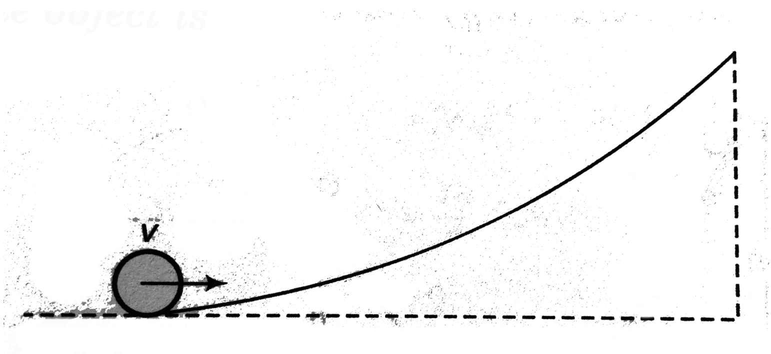
8.

A small solid cylinder of radius r is released coaxially from point A inside the fixed large cylindrical bawl of radius R as shown in figure. If the friction between the small and the large cylinder is sufficient enough to prevent any slipping then find.

(a). What fractions of the total energy are translational and rotational when the small cylinder reaches the bottom of the larger one?

(b). The normal force exerted by the small cylinder on the larger one when it is at the bottom.

Watch Video Solution

9. 

A small object of uniform density rolls 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

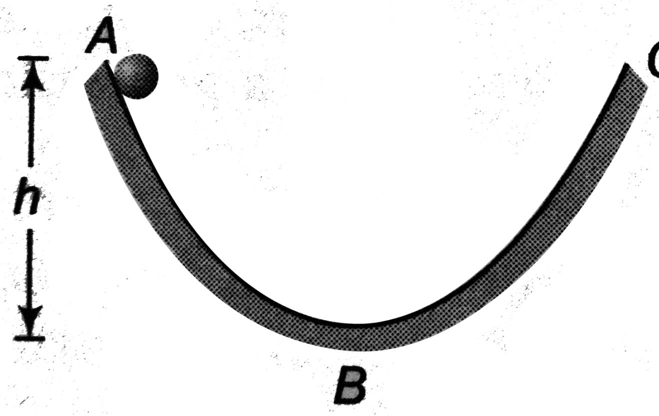
(a). Ring

(b). solid sphere

(c). hollow sphere

(d). disc

Watch Video Solution

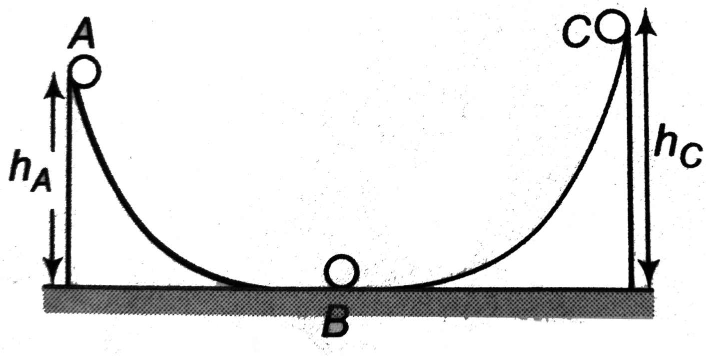


10.

A solid ball rolls down a parabolic path ABC from a height h as shown in figure. Portion AB of the path is rough while BC is smooth. How high will the ball climb in BC?

Watch Video Solution

11.



A ball moves over a fixed track as shown in the figure. From A to B the ball rolls without slipping. If surface BC is frictionless and K_A, K_B and K_C are kinetic energies of the ball at A, B and C respectively then

(a). $h_A > h_C, K_B > K_C$

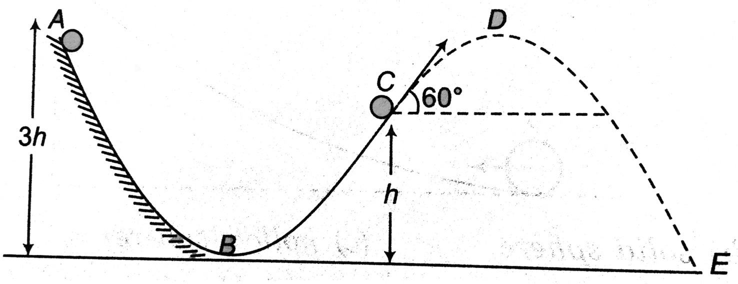
(b). $h_A > h_C, K_C > K_A$

(c). $h_A = h_C, K_B = K_C$

(d). $h_A < h_C, K_B > K_C$

Watch Video Solution

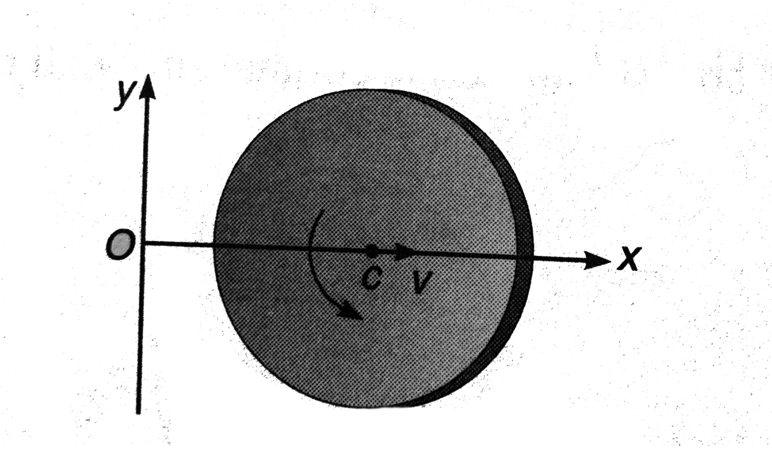
E.



12.

A small solid sphere of mass m is released from point A. portion AB is sufficiently rough (to provide accelerated pure rolling) BC is smooth and after C the ball moves freely under gravity find gravitational potential energy (U), rotational kinetic energy (K_R) ad translational kinetic energy (K_T) at points A, B, C , D and E.

Watch Video Solution

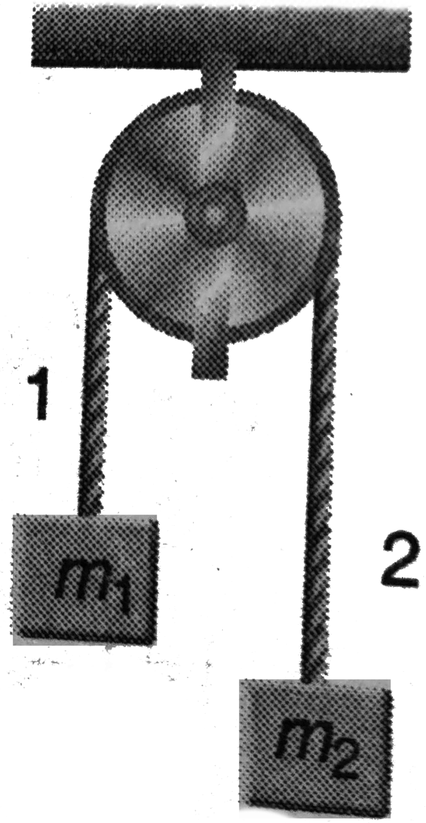
13. 

A rotating disc moves in the positive direction of the x-axis. Find the equation $y(x)$ describing the position of the instantaneous axis of rotation if at the initial moment of the centre c of the disc was located at the point O after which it moved with constant velocity v while the disc started rotating counterclockwise with a constant angular acceleration α. the initial angular velocity is equal to zero.

Watch Video Solution

14. A uniform thin rod of mass m and length l is standing on a smooth horizontal suface. A slight disturbance causes the lower end to slip on the smooth surface and the rod starts falling. Find the velocity of centre of mass of the rod at the instant when it makes an angle θ with horizontal.

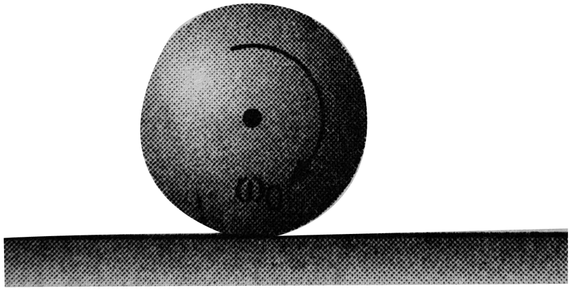
Watch Video Solution



15.

In the arrangement shown in figure the mass of the uniform solid cylindrical pulley of radius R is equal to m and the masses of two bodies are equal to m_1 and m_2. The thread slipping and the friction in the axle of the pulley are supposed to be absent. Find the angular acceleration of the cylinder and the ratio of tensions $\frac{T_1}{T_2}$ of the vertical sections of the thread in the process of motion.

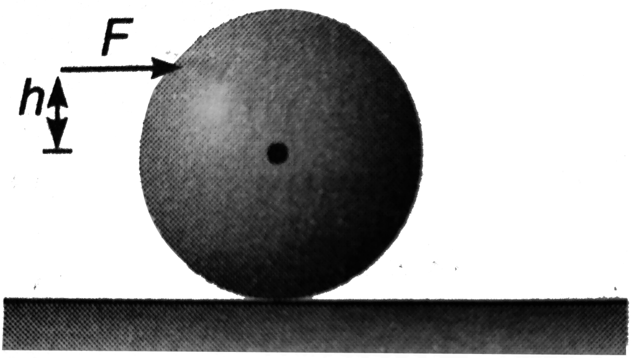
Watch Video Solution



16.

solid sphere of radius r is gently placed on a rough horizontal ground with an initial angular speed ω_0 and no linear velocity. If the coefficient of friction is μ, find the time t when the slipping stops. in addition state the linear velocity v and angular velocity ω at the end of slipping

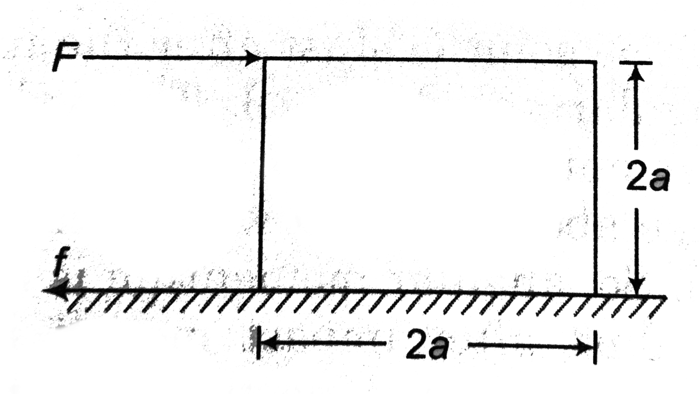
Watch Video Solution

17. 

A billiard ball, initially at rest, is given a sharp impulse by a cue. The cue is held horizontally a distance h above the centre line as shown in figure. The ball leaves the cue with a speed v_0 and because of its forward english (backward slipping) eventually acquires a final speed $\frac{9}{7}v_0$ show that $h = \frac{4}{5}R$

Where R is the radius of the ball.

Watch Video Solution

18. 

For the given dimensions shown in figure, find critical value of coefficient of friction μ

A. $\frac{1}{2}$

B. $\frac{1}{4}$

C. $\frac{1}{3}$

D. $\frac{1}{5}$

Watch Video Solution

19. In the figure shown in the text, if the block is a cube of side a

find

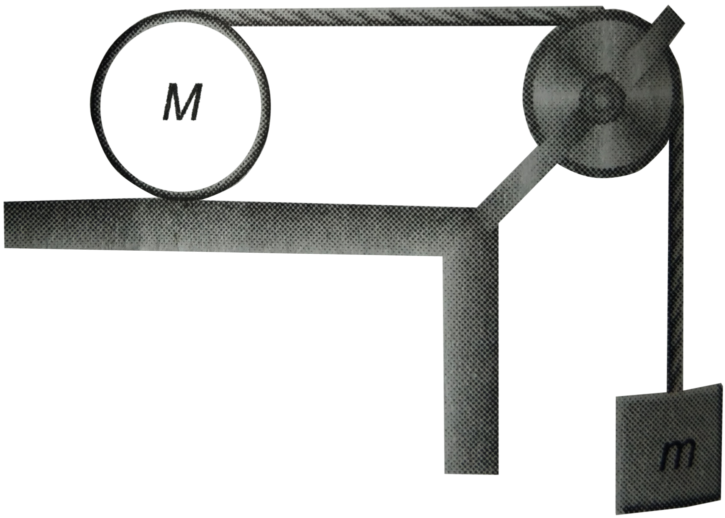
(a). ω just after impact

(b). Loss of mechanical energy during impact

(c) minimum value of v so as the block overcomes the obstacle and does not turn back.

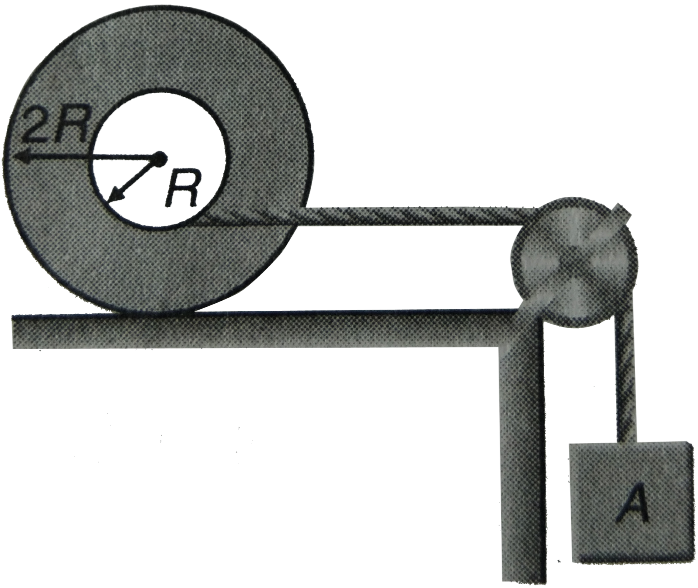
Watch Video Solution

20.



Consider the arrangement shown in figure. The string is wrapped around a uniform cylinder which rolls without slipping. The other end of the string is passed over a masslessm frictionless pulley to a falling weight, determine the acceleration of the falling mass m in terms of only the mass of the cylinder M, the mass m and g

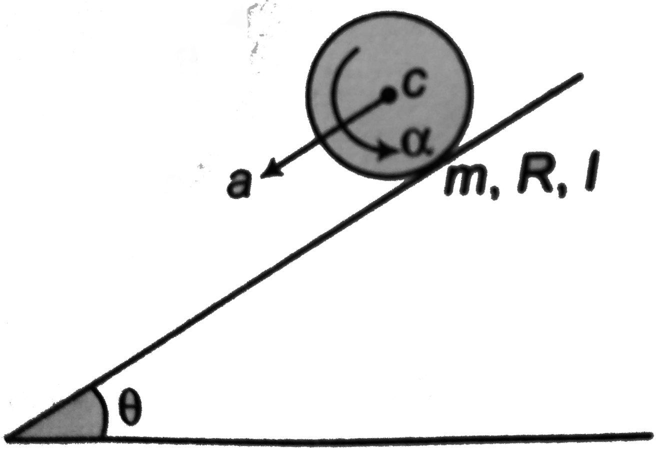
Watch Video Solution

21. 

A thin massless thread is wound on a reel of mass 3 kg and moment of inertial 0.6 $kg - m^3$

the hub radius is $R = 10\text{cm}$ and peripheral radius is $2R = 20$ cm the reel is placed on a rough table and the friction is enough to prevent slipping. find the acceleration of the centre of reel and of hanging mass of 1 kg.

Watch Video Solution

22. 

A body of mass m, radius R and moment of inertia I (about an axis passing through the centre of mass and perpendicular to plane of motion) is released from rest over a sufficiently rough ground (to provide accelerated pure rolling) find linear acceleration of the body.

Watch Video Solution

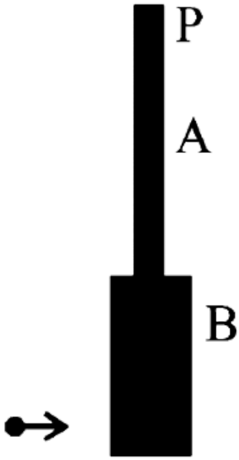
23. In the figure given in the text if mass of the rod is m then find hinge force.

(a). Just after the rod is released from the horizontal position.

(b). When rod becomes vertical

Watch Video Solution

24. Two uniform thin rods A and B of length 0.6 m each and of masses 0.01 kg and 0.02kg respectively are rigidly joined end to end. The combination is pivoted at the lighter end, P as shown in fig. Such that it can freely rotate about point P in a vertical plane. A small object of mass 0.05kg, moving horizontally, hits the lower end of the combination and sticks to it what should be the velocity of the object so that the system could just be reised to the horizontal position.



Watch Video Solution

25. A rod AB of mass M and length L is lying on a horizontal frictionless surface. A particle of mass m travelling along the surface hits the end A of the rod with a velocity v_0 in a direction perpendicular to AB. The collision in elastic. After the collision the particle comes to rest

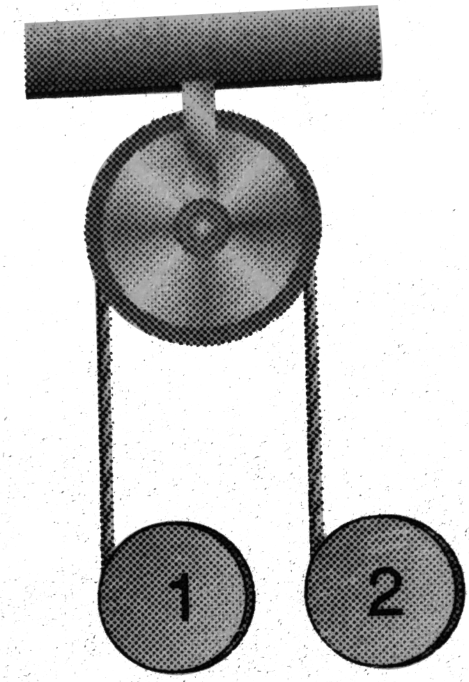
(a). Find the ratio m / M

(b). A point P on the rod is at rest immediately after collision find the distance AP.

(c). Fid the linear speed of the point P a time $\pi L / 3v_0$ after the collision.

Watch Video Solution

Miscellaneous Examples



1.

A thread is wound around two discs on either sides. The pulley and the two discs have the same mass and radius. There is no slipping at the pulley and no friction at the hinge. Find out the acceleration of the two discs and the angular acceleration of the pulley.

Watch Video Solution

2. A uniform disc of radius r_0 lies on a smooth horizontal plane. A similar disc spinning with the angular velocity ω_0 is carefully lowered onto the first disc. How soon do both discs spin with the same angular-velocity if the friction coefficient between them is equal to μ ?

Watch Video Solution

Solved Example

1\.

Determine the maximum horizontal force F that may be applied to the plank of mass m for which the solid sphere does not slip as it begins to roll on the plank. The sphere has a mass M and radius R. The coefficient of static and kinetic friction between the sphere and the plank are μ_S and μ_k respectively.

Watch Video Solution

Exercise 12.1

1. find the radius of gyration of a rod of mass m and length $2l$ about an axis passing through one of its ends and perpendicular to its length.

Watch Video Solution

2. A mass of 1 kg is placed at (1m, 2m, 0). Another mass of 2 kg is placed at (3m, 3m, 0). Find the moment of inertial of both the masses about z-axis

Watch Video Solution

3. Four thin rods each of mass m and length l are joined to make a square. Find moment of inertia of all the four rods about any side of the square.

Watch Video Solution

4. About what axis would a uniform cube have its minimum moment of inertia?

Watch Video Solution

5. There are four solid balls with their centres at the four corners of a square of side a. the mass of each sphere is m and radius is r. Find the moment of inertia of the system about one of the sides of the square

A. $\frac{8}{5}mr^2 + 2ma^2$

B. $\frac{5}{8}mr^2 + 2ma^2$

C. $\frac{8}{5}mr^2 + ma^2$

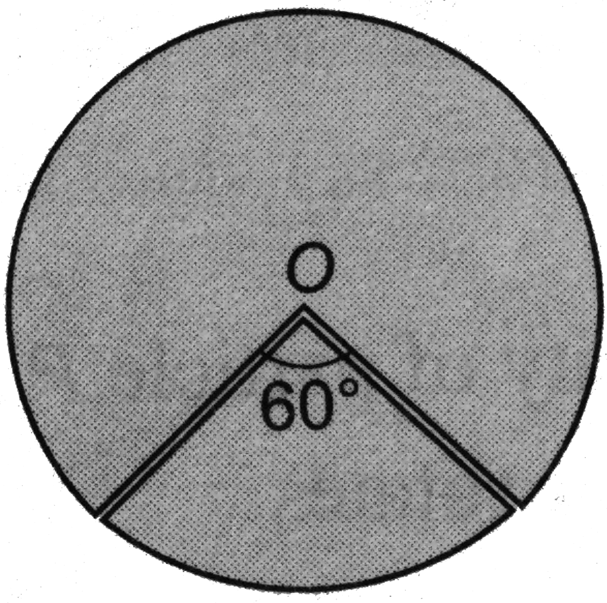
D. $\frac{8}{5}mr^2 + 4ma^2$

Watch Video Solution

6. A non-uniform rod AB has a mass M ad length 2l. The mass per unit length of the rod is mx at a point of the rod distant x from A.

find the moment of inertia of this rod about an axis perpendicular to the rod (a) through A (b) through the mid-point of AB.

Watch Video Solution



7.

The uniform disc shown in the figure has a moment of inertia of $0.6kg - m^2$ around the axis that passes through O and is perpendicular to the plane of the page. If a segment is cut out from the disc as shown, what is the moment of inertia of the remaining disc?

Watch Video Solution

8. If two circular disks of having the same weight and thickness are made from metals having different densities. Which disk, if either will have the larger moment of inertia about its central axis.

Watch Video Solution

9. Particles of masses 1g, 2g, 3g ....100g are kept at the marks 1cm, 2cm, 3cm ...., 100 cm respectively on a metre scale. Find the moment of inertia of the system of particles about a perpendicular bisector of the metre scale.

A. $0.43kgm^2$

B. $0.53kgm^2$

C. $1.43kgm^2$

D. $0.33kgm^2$

Watch Video Solution

10. if l_1 is the moment of inertia of a thin rod about an axis perpendicular to its length and passing through its centre of mass and l_2 te moment of inertia of the ring formed by the same rod about an axis passing through the centre of mass of the ring and perpendicular tot he plane of the ring. then find the ratio $\frac{l_1}{l_2}$.

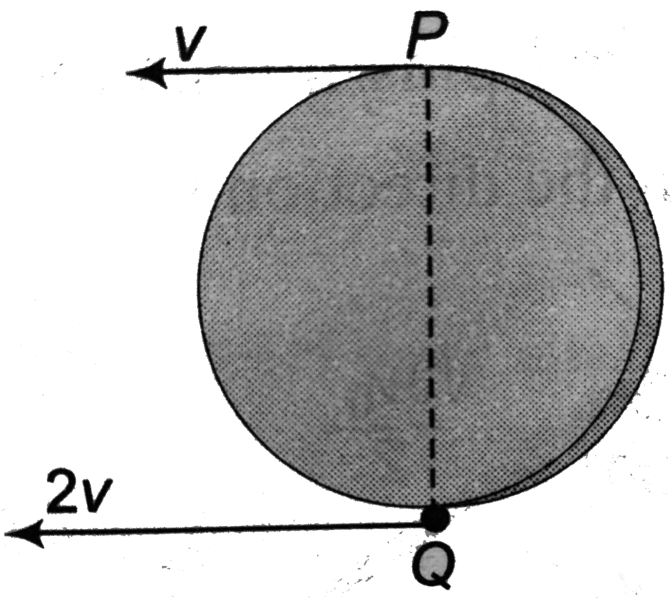
Watch Video Solution

Exercise 12.2

1. Find angular speed of second's clock.

Watch Video Solution

2. Two point P and Q. diametrically opposite on a disc of radius R have linear velocities v and 2v as shown in figure. Find the angular speed of the disc.



A. $\frac{v}{R}$

B. $2\frac{v}{R}$

C. $\frac{v}{2R}$

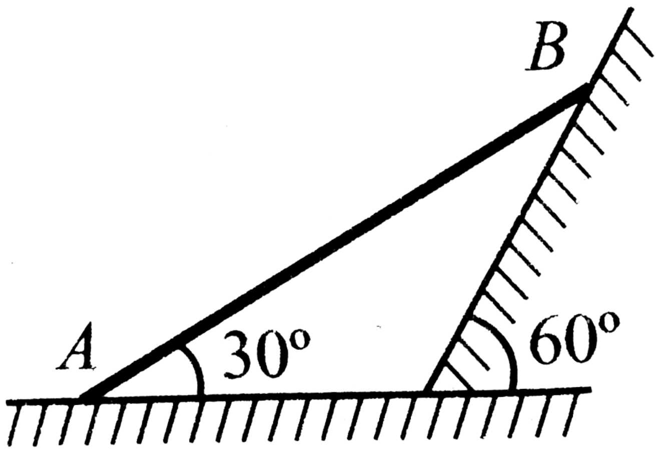
D. $\frac{v}{4}R$

Watch Video Solution

3. A particle is located at (3m , 4m) and moving with $v = \left(4\hat{i} - 3\hat{j}\right)m/s$. Find its angular velocity about origin at this instant.

Watch Video Solution

4. In the figure shown, the instantaneous speed of end A of the rod is v to the left. The angular velocity of the rod of length L must be



A. $\frac{v}{2}L$

B. $\frac{v}{L}$

C. $2\frac{v}{L}$

D. None of these

Watch Video Solution

Exercise 12.3

1. A force $F = \left(2\hat{i} + 3\hat{j} - 2\hat{k}\right)N$ is acting on a body at point (2m, $4m, \ -2m$). Find torque of this force about origin.

Watch Video Solution

2. A particle of mass $m = 1kg$ is projected with speed $u = 20\sqrt{2}m/s$ at angle $\theta = 45^\circ$ with horizontal find the torque of the weight of the particle about the point of projection when the particle is at the highest point.

Watch Video Solution

3. Point C is the centre of mass of the rigid body shown in figure. Find the total torque acting on the body about point C.

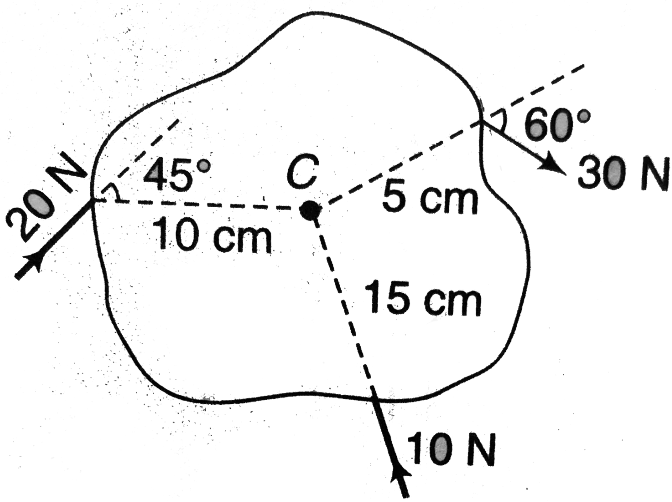


Fig. 12.39

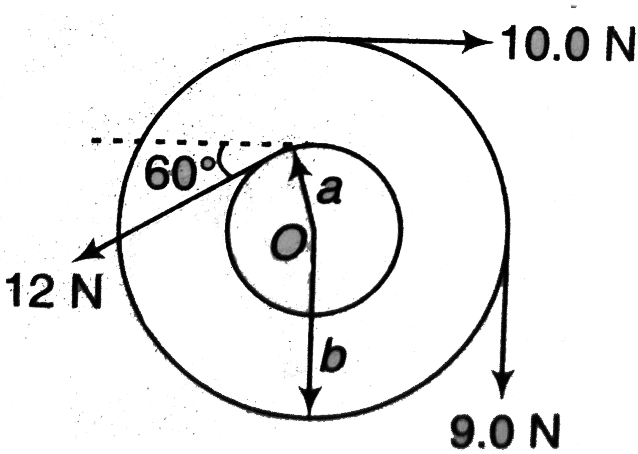
A. $\tau = 3.71 N - m$

B. $\tau = 2.71 N - m$

C. $\tau = 8.91 N - m$

D. $\tau = 1.71 N - m$

Watch Video Solution



4.

Find the net torque on the wheel in figure about the point O if $a = 10 cm$ and $b = 25 cm$

Watch Video Solution

Exercise 12.4

1. A wheel rotating with uniform acceleration covers 50 rev in the first five second after the start. Find the angular acceleration and the angular velocity at the end of five second.

Watch Video Solution

2. A body rotates about a fixed axis with an angular acceleration $1 rad/s^2$ through what angle does it rotates during the time in which its angular velocity increases from $5 rad / s$ to $15 rad / s$?

Watch Video Solution

3. A flywheel of moment of inertia $5.0 kg - m^2$ is rotated at a speed of $10 rad / s$ because of the friction at the axis it comes to rest in 10s. Find the average torque of the friction.

Watch Video Solution

4. A wheel starting from rest is uniformly accelerated at $4rad/s^2$ for $10s$. It is allowed to rotated uniformly for the next 10 s and is finally brought to rest in the next 10 s. Find the total angle rotated by the wheel.

Watch Video Solution

5. A wheel of mass 10 kg and radius 0.2 m is rotating at an angular speed of 100 rpm, when the motion is turned off. Neglecting the friction at the axis. Calculate the force that must be applied tangentially to the wheel to bring it to rest in 10 rev. Assumed wheel to be a disc.

Watch Video Solution

6. A solid body rotates about a stationary axis accordig to the law $\theta = 6t - 2t^3$. Here θ, is in radian and t in seconds. Find

(a). The mean values of thhe angular velocity and angular acceleration averaged over the time interval between $t = 0$ and the complete stop.

(b). The angular acceleration at the moment when the body stops.

Hint: if $y = y(t)$. then mean/average value of y between t_1 and t_2 is

$$< y \geq \left(\int_{t_1}^{t_2} y(t)dt\right)\frac{)}{t_2 - t_1}$$

Watch Video Solution

7. A body rotating at $20 rad/s$ is acted upon by a constant torque providing it a deceleration of $2rad/s^2$. At what time will the body have kinetic energy same as the initial value if thhe torque continues to act?

Watch Video Solution

8. A wheel whose moment of inertial is $0.03kgm^2$, is accelerated from rest to $20rad/s$ in 5 s. When the external torque is removed, the wheel stops in 1 min. Find

(a). The frictional torque.

(b). The external torque.

Watch Video Solution

9. A flywheel whose moment of inertia about its axis of rotation is $16kg-m^2$ is rotating freely in its own plane about a smooth axis through its centre. Its angular velocity is $9rads^{-1}$ when a torque is applied to bring it to rest in t_0 seconds find t_0 if

(a). The torque is constant and of magnitude 4 $N-m$

(b). The magnitude of the torque after t second is given by kt.

Watch Video Solution

10. A shaft is turning at $65 rad/s$ at time zero. Thereafter, angular acceleration is given by

$\alpha = -10 rad/s^2 - 5t rad/s^2$

Where t is the elapsed time

(a). Find its angular speed at $t = 3.0$ s

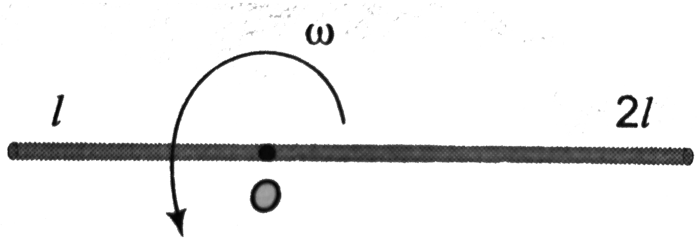
(b). How much angle does it turn in these $3s$?

Watch Video Solution

11. The angular velocity of a gar is controlled according to $\omega = 12 - 3t^2$ where ω in radian per second, is positive in the clockwise sense and t is the time in seconds. Find the net angular displacement $\triangle \theta$ from the time $t = 0$ to $t = 3$s. Also, find the number of revolutions N through which the gear turns during the 3s.

Watch Video Solution

Exercise 12.5

1. 

A uniform rod of mass m is rotated about an axis passing through point O as shown. Find angular momentum of the rod about rotational law.

Watch Video Solution

2. A particle mass 1 kg is moving along a straight line $y = x + 4$. Both x and y are in metres. Velocity of the particle is $2m/s$. Find the magnitude of angular momentum of the particle about origin.

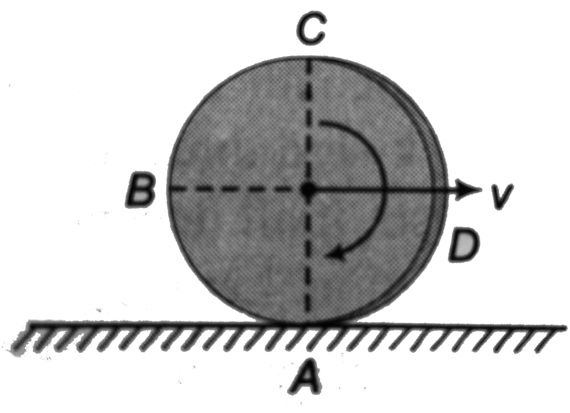
Watch Video Solution

3. A particle of mass m is projected from the ground with an initial speed u at an angle α. Find the magnitude of its angular momentum at the highest point of its trajector about the point of projection.

Watch Video Solution

4. If the angular momentum of a body is zero about some point. Is it necessary that it will be zero. About a differet point?

Watch Video Solution

5. 

A solid sphere of mass m and radius R is rolling without slipping as shown in figure. Find angular momentum of the sphere about z-axis.

Watch Video Solution

6. In example number 12.16 suppose the disc starts rotating anticlockwise with the same angular velocity $\omega = \frac{v}{R}$, then what will be the angular momentum of the disc about bottommost in this new situation?

Watch Video Solution

7. Two particles each of mass m and speed v, travel in opposite direction along parallel lines separated by a distance d. Show that the vector angular momentum of this system of particles is the same about any point taken as origin.

Watch Video Solution

Exercise 12.6

1. A thin circular ring of mass M and radius R is rotating about its axis with an angular speed ω_0 two particles each of mass m are now attached at diametrically opposite points. Find new angular speed of the ring.

Watch Video Solution

2. If the ice at the poles melts and flows towards the equator, how will it affect the duration of day-night?

Watch Video Solution

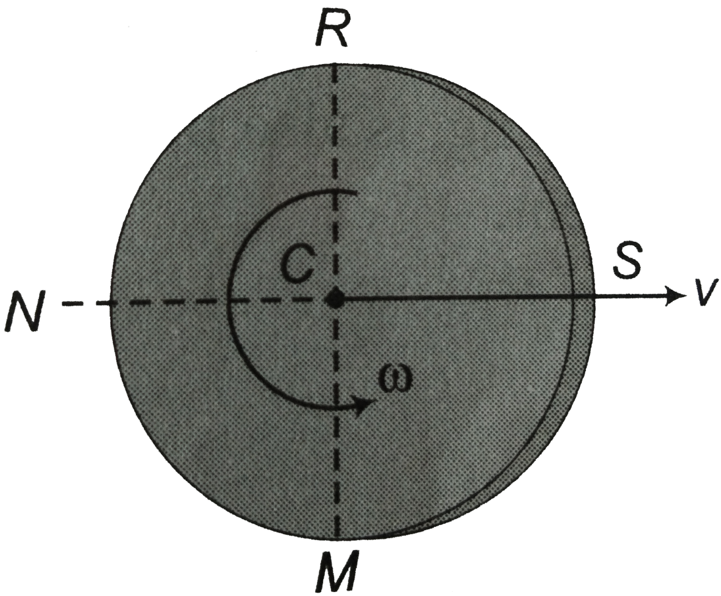
3. When tall buildings are constructed on earth, the duration of day night slightly increases. Is this statement true or false?

Watch Video Solution

4. If radius of earth is increased, without chage in its mass, will the length of day increase, decrease or remain same?

Watch Video Solution

Exercise 12.7



1\.

In the figure shown `omega = v/2R in terms of i and j find the linear velocities of particles M,N,R and S .

Watch Video Solution

2. In the same figure. If v and ω both are constant, then find linear acceleration of point M,N,R and S in terms of $R, \omega, \hat{i}$ and $\hat{j}$ where R is the radius disc.

Watch Video Solution

Exercise 12.8

1. A solid sphere is rolling is rolling without slipping on a horizontal ground. Its rotational kinetic energy is 10 J. Find its translational ad total kinetic energy.

Watch Video Solution

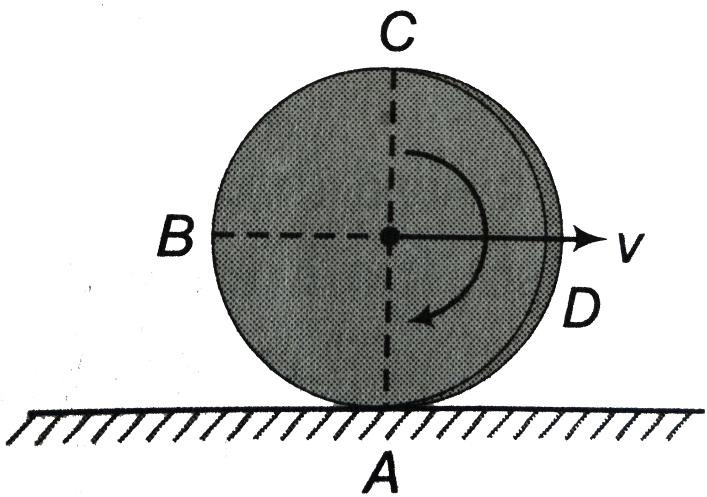
2. Under forward slip condition, translational kinetic energy of a ring is greater than its rotational kinetic energy is this statement true of false?

Watch Video Solution

3. In backward slip condition translational kinetic energy of a disc may be equal to its rotational kinetic energy is this statement true of false?

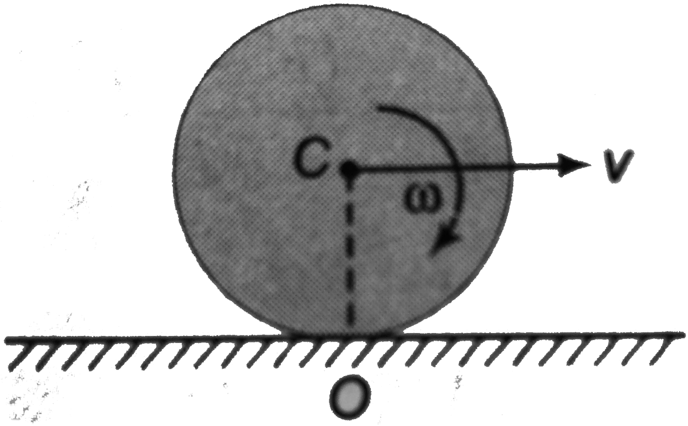
Watch Video Solution

Exercise 12.9

1. 

A disc is rolling without slipping with linear velocity v as shown in figure. With the concept of instantaneous axis of rotation, find velocities of point A, B, C and D.

Watch Video Solution

2. 

A solid sphere is rolling without slipping as shown in figure. Prove that

$$\frac{1}{2}mv^2 + \frac{1}{2}l_C\omega^2 = \frac{1}{2}l_0\omega^2$$

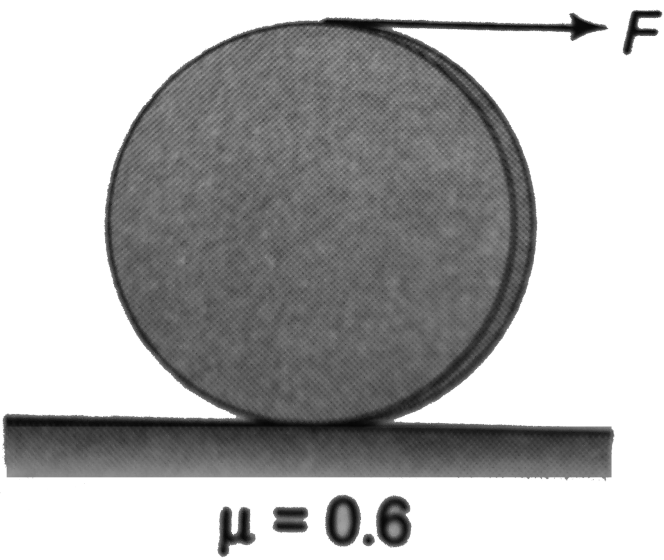
Watch Video Solution

Exercise 12.10

1. Work done by friction in pure rolling is always zero. Is this statement true or false?

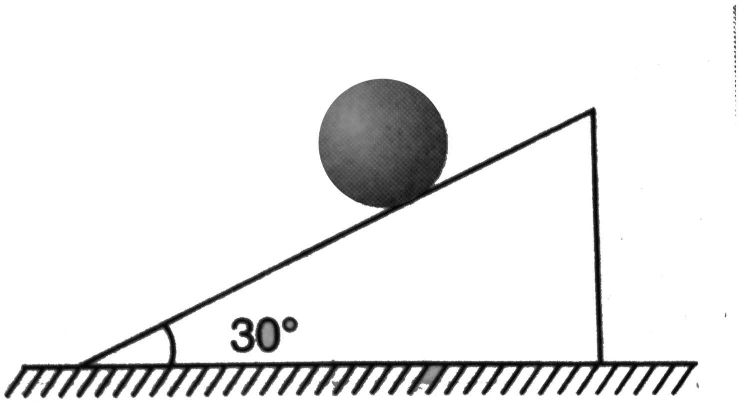
Watch Video Solution

2.



In the figure shown, a force F is applied at the top of a disc of mass 4 kg and radius 0.25 m. find maximum velue of F for no slipping.

Watch Video Solution

3. 

In the figure shown a solid sphere of mass 4kg and radius 0.25 m is placed on a rough surface. $(g = 10ms^2)$

(a). Minimum coefficient of friction for pure rolling to take place,

(b). If $\mu > \mu_{\min}$ find linear acceleration of sphere.

(c). if $\mu = \frac{\mu_{\min}}{2}$, find the linear acceleration of cylinder.

Here $\mu_{\min}$ is the value obtained part (a).

Watch Video Solution

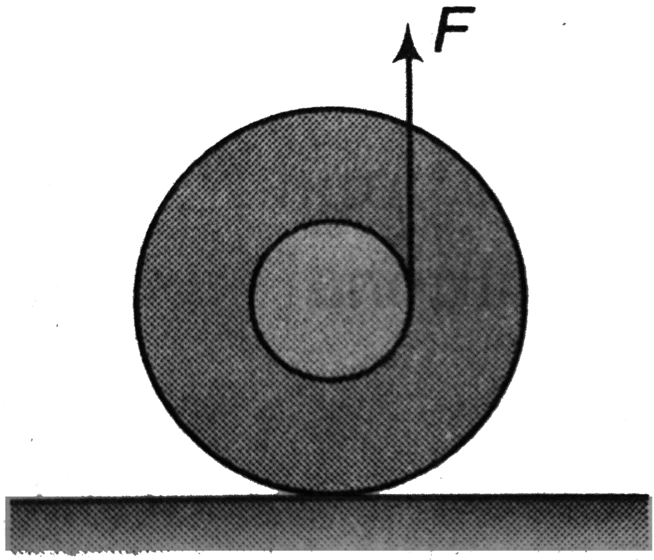
4. A ball of mass M and radius R is released on a rough inclined plane of inclination θ. Friction is not sufficient to prevent slipping. The coefficient friction between the ball and the plane is μ. Find

(a). The linear acceleration of the ball down the plane.

(b). the angular acceleration of the ball about its centre of mass.

Watch Video Solution

5.



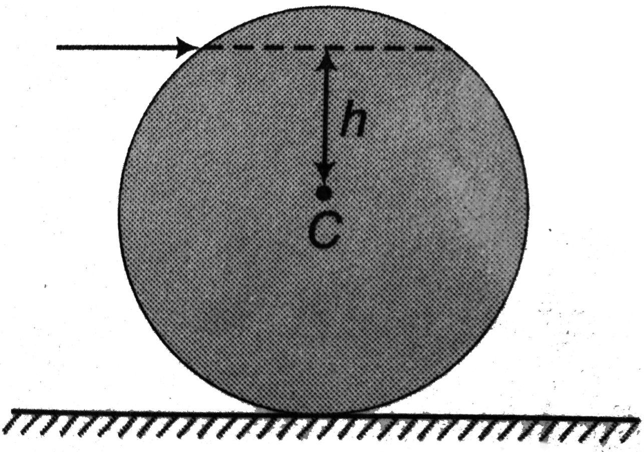
A spool is pulled by a force in vertical direction as shown in figure . What is the direction of friction in this case? The spool does not loose contact with the ground.

Watch Video Solution

Exercise 12.11

1. A cylinder is rolling down a rough inclined plane. Its angular momentum about the point of contact remains constant. Is this statement true or false?

Watch Video Solution



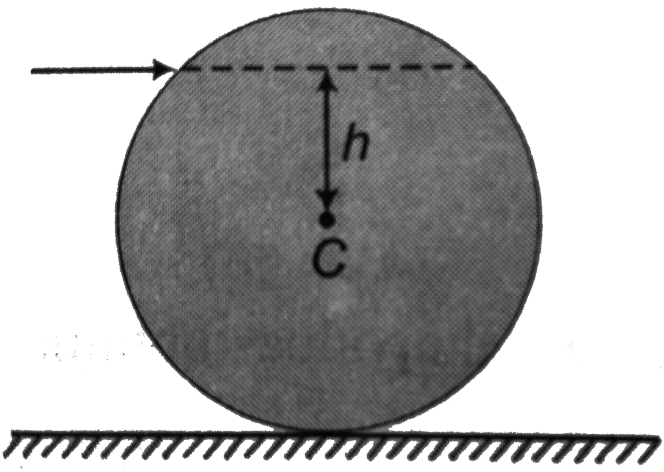
2.

A solid sphere and a hollow sphere both of same mass and same radius are hit by a cue at a height h above the centre C. In which case,

(a). Linear velocity will be more?

(b). Angular velocity will be more?

(c). rotational kinetic energy will be more?



Watch Video Solution

Assertion And Reason

1. Assertion: Moment of inertia of a rigid body about any axis passing through its centre of mass is minimum

Reason: From theorem of parallel axis

$$I = I_{cm} + Mr^2$$

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If assertion is true, but the reaction is false.

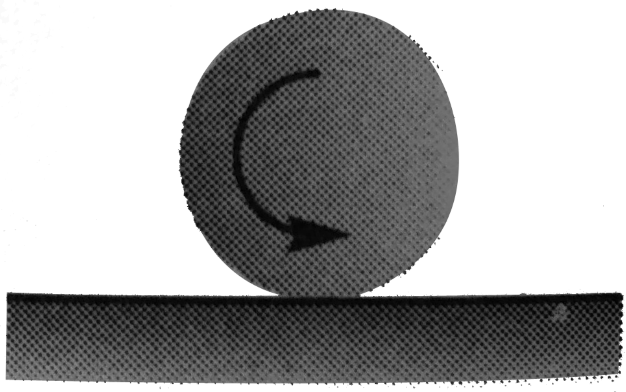
D. If assertion is false but the reason is true.

Watch Video Solution

2. Assertion: A ball is released on a rough ground in the condition shown in figure. it will

start pure rolling after some time towards left side.

Reason: Friction will convert the pure rotational motion of the ball into pure rolling



A. Both Assertion and Reason are true and the Reason is correct explanation of the

Assertion.

B. Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. Assertion is true, but the reaction is false.

D. Assertion is false but the reason is true.

Watch Video Solution

3. Assertion: A solid sphere and a hollow sphere are rolling on ground with same total kinetic energies. if translational kinetic energy of solid sphere is K, then translational kinetic energy of follow sphere should be greater than K.

Reason: In case of hollow sphere rotational kinetic energy is less than its translational kinetic energy.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

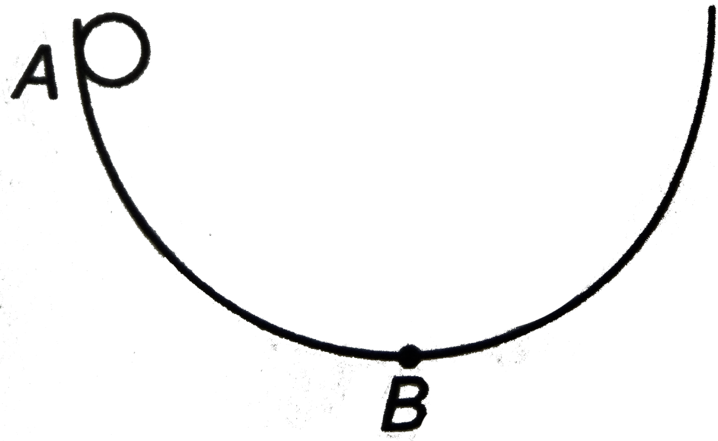
B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If assertion is true, but the reaction is false.

D. If assertion is false but the reason is true.

Watch Video Solution

4.



A small ball is released from rest from point A as shown. if bowl is smooth, than ball will exert more pressure at point B, compared to the situation if bowl is rough.

Reason: Linear velocity and hence, centripetal force in smooth situation is more.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

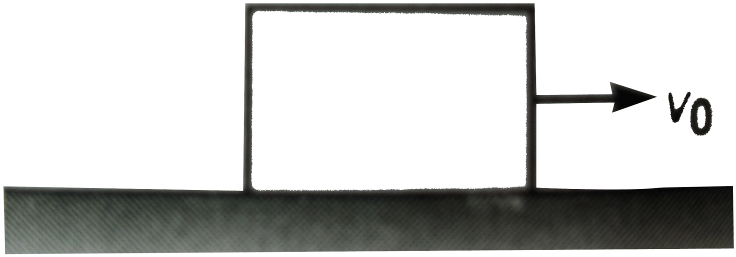
C. If assertion is true, but the reaction is false.

D. If assertion is false but the reason is true.

Watch Video Solution

5. Assertion: A cubical block is moving on a rough ground with velocity v. During motion net normal reaction on the block from ground will not pass through centre of cube. it will shift towards right.

Reason: It is to keep the block is rotational equilibrium



A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If assertion is true, but the reaction is false.

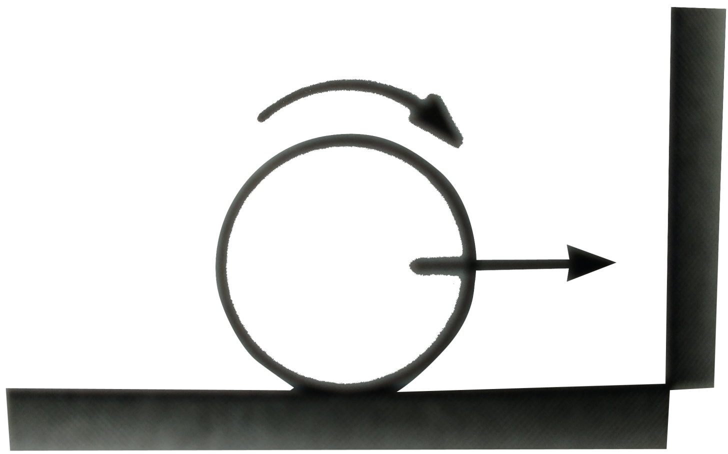
D. If assertion is false but the reason is true.

Watch Video Solution

6. Assertion: A ring is rolling without slipping on a rough ground. It strikes elastically with a smooth wall as shown in figure. Ring will stop

after some time while travelling in opposite direction.

Reason: After impact net angular momentum about an axis passing through bottommost point and perpendicular to plane of paper is zero.



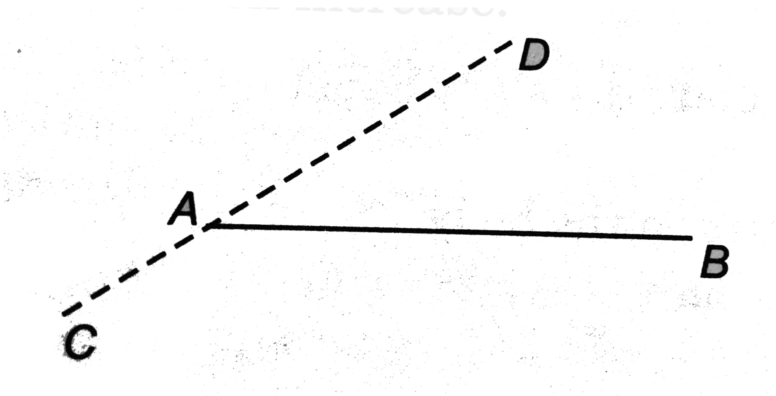
A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If assertion is true, but the reaction is false.

D. If assertion is false but the reason is true.

Watch Video Solution

7. 

Assertion: There is a thin rod AB and a dotted line CD. All the axes we are talking about are perpendicular to plane . As we take different axes moving from A to D, moment of inertia of the rod may first decrease then increase.

Reason: Theorem of perpendicular axis cannot be applied here.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If assertion is true, but the reaction is false.

D. If assertion is false but the reason is true.

Watch Video Solution

8. Assertion: If linear momentum of a particle is constant, then its angular momentum about any point will also remain constant.

Reason: Linear momentum remains constant if $F_{net} = 0$ and angular momentum remains constant if $\tau_{net} = 0$

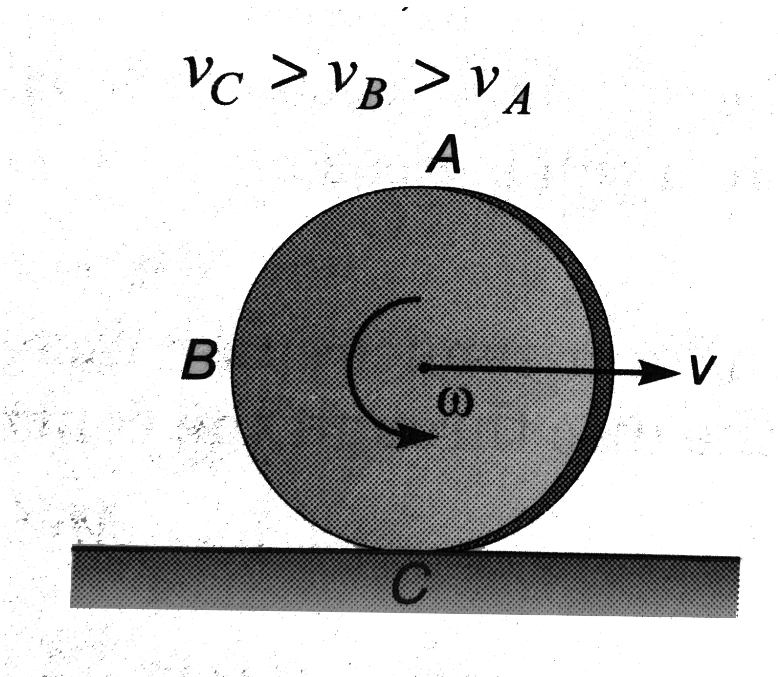
A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If assertion is true, but the reaction is false.

D. If assertion is false but the reason is true.

Watch Video Solution

9. 

In the figure shown A, B and C are three points on the circumference of a disc. Let v_A, v_B and v_c are speeds of these three points then

$v_c > v_B > v_A$

Reason: In case of rotaional plus translational motion of a rigid body, net speed of any point (other than centre of mass) is greater than, less than or equal to the speed of centre of mass.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

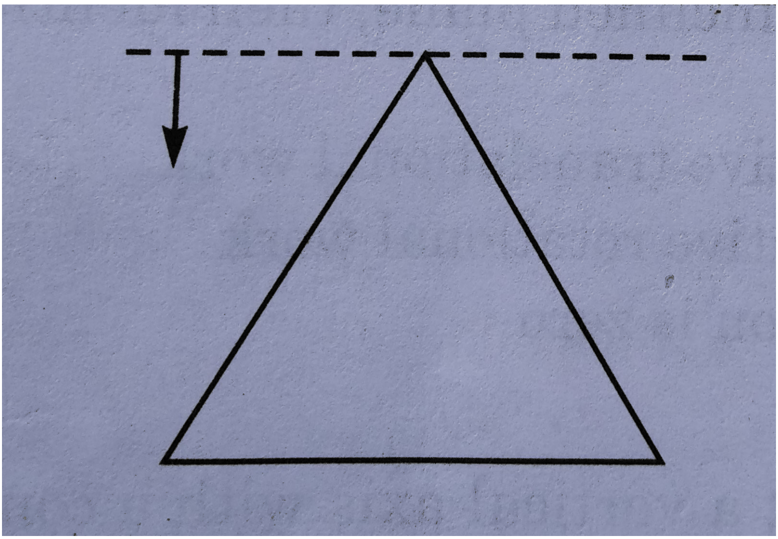
C. If assertion is true, but the reaction is false.

D. If assertion is false but the reason is true.

Watch Video Solution

10. Assertion: There is a triangular plate as shown. A dotted axis is lying in the plane of slab. As the axis is moved downwards, moment of inertia of slab will first decrease then increase.

Reason: Axis is first moving towards its centre of mass and then it is receding from it.



A. Both Assertion and Reason are true and the Reason is correct explanation of the

Assertion.

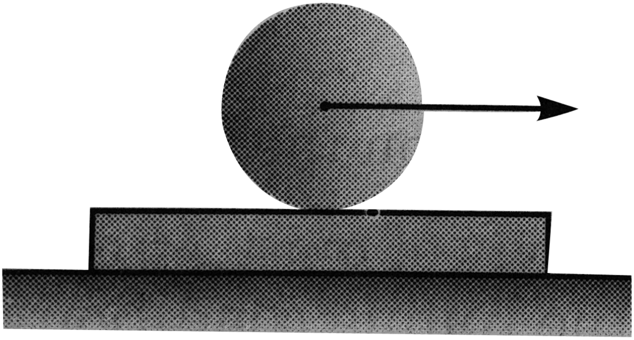
B. Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. Assertion is true, but the reaction is false.

D. Assertion is false but the reason is true.

Watch Video Solution

11.



Assertion: A horizontal force F is applied at the centre of solid sphere placed over a plank. The minimum coefficient of friction between plank and sphere required for pure rolling is μ_1 when plank is kept at rest ad μ_2 when plank can move, then $\mu_2 < \mu_1$

Reason: Work done by frictional force on the sphere in both cases is zero.

A. (a)If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. (b)If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c)If assertion is true, but the reaction is false.

D. (d)If assertion is false but the reason is true.

Watch Video Solution

Level 1 Objective

1. The moment of inertia of a body does not depend on

A. mass of the body

B. the distribution of the mass in the body

C. the axis of rotation of the body

D. none of the above

Answer: D

Watch Video Solution

2. The radius of gyration of a disc of radius 25 cm about a centroidal axis perpendicular to disc is a) 18 cm b) 12.5 cm c) 36 cm d) 50 cm

A. 18 cm

B. 12.5 cm

C. 36 cm

D. 50 cm

Answer: A

Watch Video Solution

3. A shaft initially rotating at 1725 rpm is brought to rest uniformly in 20s. The number of revolutions that the shaft will make during this time is

A. 1680

B. 575

C. 287

D. 627

Answer: C

Watch Video Solution

4. A man standing on a platform holds weights in his outstretched arms. The system is rotated about a central vertical axis. If the man now pulls the weights inwards close to his body then

A. the angular velocity of the system will increase

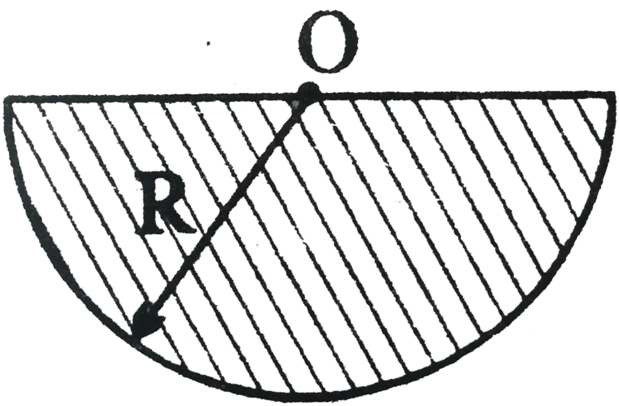
B. the angular momentum of the system will remain constant

C. the kinetic energy of the system will increase

D. all of the above

Watch Video Solution

5. Moment of inertia of a thin semicircular disc $(mass - M\&radius = R)$ about an axis through point O and perpendicular to plane of disc, is given by :



A. Mr^2

B. $\frac{1}{2}Mr^2$

C. $\frac{1}{4}Mr^2$

D. $\frac{2}{5}Mr^2$

Watch Video Solution

6. Two bodies A and B made of same material have the moment of inertial in the ratio $I_A : I_B = 16 : 18$ The ratio of the masses

$m_A : m_B$ is given by a) cannot be obtained b)

2:3 c) 1:1 d) 4:9

A. cannot be obtained

B. $2 : 3$

C. $1 : 1$

D. $4 : 9$

Answer: A

Watch Video Solution

7. When a sphere rolls down an inclined plane, then identity the correct statement related to the work done by friction force.

A. the friction force does positive translational work

B. the friction force does negative rotational work

C. The net work done by friction is zero

D. all of the above

Answer: C

Watch Video Solution

8. A circular table rotates about a vertical axis with a constant angular speed ω. A circular pan rests on the turn table (with the centre coinciding with centre of table) and rotates with the table. The bottom of the pan is covered with a uniform small thick layer of ice placed at centre of pan. The ice starts melting. The angular speed of the turn table.

A. remains the same

B. decrease

C. increase

D. may increase or decrease dependingon the thickness of ice layer

Watch Video Solution

9. If R is the radius of gyration of a body of mass M and radius r, then the ratio of its rotational to translational kinetic energy in the rolling condition is

A. $\frac{R^2}{R_2 + r^2}$

B. $\frac{R^2}{r^2}$

C. $\frac{r^2}{R^2}$

D. 1

Watch Video Solution

10. A solid sphere rolls down two different inclined planes of the same height but of different inclinations

A. in ot cases the speeds and time of descend will be same

B. the speeds will be same but time of descend will be different

C. the speeds will be different but time of descend will be same

D. speeds and time of descend both will be different.

Answer: B

Watch Video Solution

11. For the same total mass, which of the following will have the largest moment of inertia about an axis passing through the centre of mass and perpendicular to the plane of the body

A. (a)a disc of radius R

B. (b)a ring of radius R

C. (c)a square lamina of side 2 R

D. (d)four rods forming a square of side 2R

Answer: D

Watch Video Solution

12. A disc and a solid sphere of same mass and radius roll down an inclined plane. The ratio of thhe friction force acting on the disc and sphere is

A. $\frac{7}{6}$

B. $\frac{5}{4}$

C. $\frac{3}{2}$

D. depends on angle of inclination

Answer: A

Watch Video Solution

13. A horizontal disc rotates freely with angular velocity ω about a vertical axes through its centre. A ring having the same mass and radius as the disc, is now gently placed coaxially on the disc. After some time, the two rotate with a common angular velocity. then.

A. no friction exists between te disc and the ring

B. the angular momentum of the system is conserved

C. the final common angular velocity is $\frac{1}{2}\omega$

D. all of the above

Watch Video Solution

14. A solid homogeneous sphere is moving on a rough horizontal surface, partily rolling and partially sliding. During this kind of motion of the sphere.

A. total kinetic energy of the sphere is conserved.

B. angular momentum of the sphere about any point on the horizontal surface is conserved

C. only the rotational kinetic energy about the centre of mass is conserved

D. none of the above

Watch Video Solution

15. A particle of mass $m = 3kg$ moves along a straight line $4y - 3x = 2$ where x and y are in metre, with constant velocity $v = 5ms^{-1}$ the magnitude of angular momentum about the origin is

A. $12kgm^2s^{-1}$

B. $6.0kgm^2s^{-1}$

C. $4.5mgm^2s^{-1}$

D. $8.0kgm^2s^{-1}$

Watch Video Solution

16. A solid sphere rolls without slipping on a rough horizontal floor, moving with a speed v. It makes an elastic collision with a smooth vertical wall. After impact

A. (a)it will move with a speed v initial

B. (b)its motion will be rolling with slipping initially and its rotational motion will stop momentarily at some instant.

C. (c)its motion will be rolling without slipping only after some time

D. (d)all of the above.

Watch Video Solution

17. 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

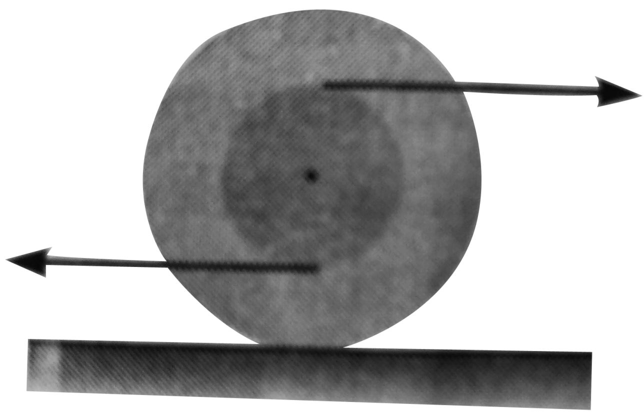
A. $(a) I_0$

B. $(b) I_0 \cos\theta$

C. $(c) I_0 \cos^2\theta$

D. (d)None of these

Watch Video Solution



18.

A spool is pulled horizontally on rough surface by two equal and opposite forces as shown in the figure. Which of the following statements are correct?

A. The centre of mass moves towards left

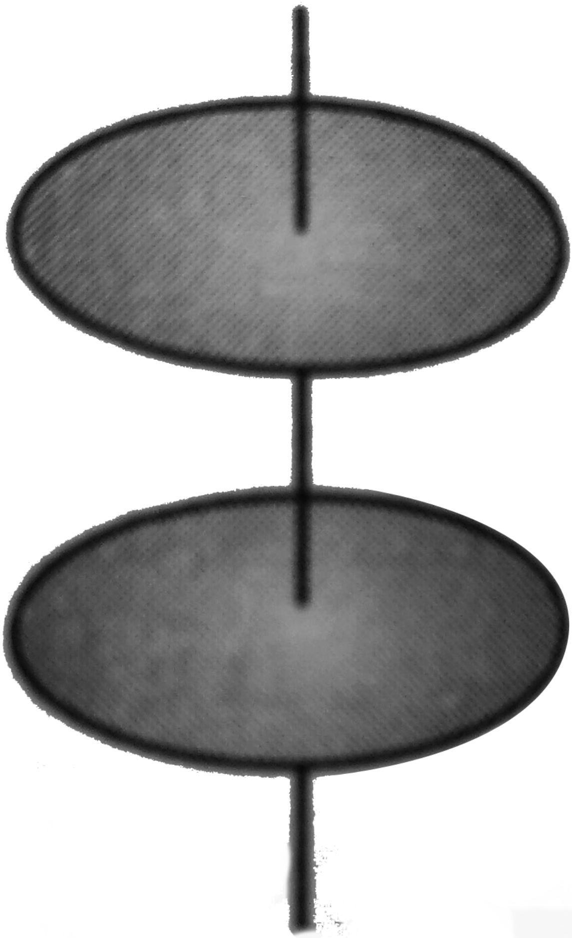
B. the centre of mass moves towrads right

C. the centre of mass remains stationary

D. The net torque about the centre of mass of the spool is zero.

Watch Video Solution

19. Two identical discs are positioned on a vertical axis as shown in the figure. The bottom disc is rotating at angular velocity ω_0 and has rotational kinetic energy K_0.The top disc is initially at rest. It then falls and sticks to the bottom disc. The change in the rotational kinetic energy of the system is



A. $K_0 / 2$

B. $-K_0 / 2$

C. $-K_0/4$

D. $K_0/4$

Watch Video Solution

20. The moment of inertia of hollow sphere (mass M) of inner radius R and outer radius 2R, having material of uniform density, about a diametric axis is

A. $31MR^2/70$

B. $43MR^2/90$

C. $19MR^2/80$

D. None of these

Watch Video Solution

21. A rod of uniform cross-section of mass M and length L is hinged about an end to swing freely in a vertical plane. Howerver, its density is non uniform and varies linearly from hinged end to the free end doubling its value. The moment of inertia of the rod, about the rotation axis passing through the hinge point

A. $2\frac{ML^2}{9}$

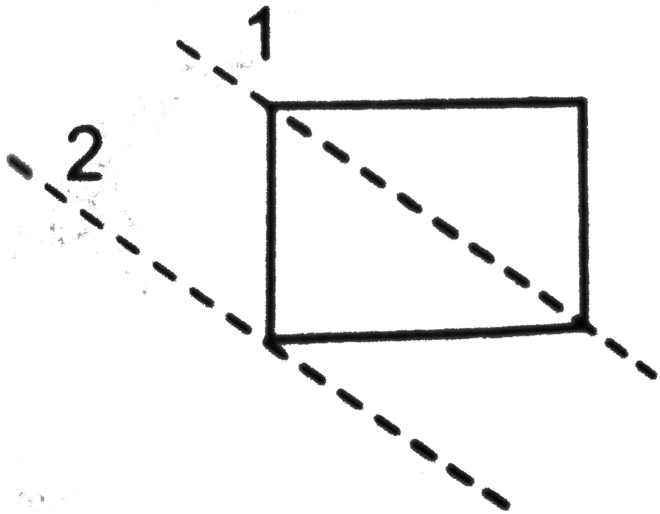
B. $\frac{3ML^2}{16}$

C. $\frac{7ML^2}{18}$

D. none of these

Watch Video Solution

22.



Let I_1 and I_2 be the moment of inertia of a uniform square plate about axes shown in the figure. Then the ratio $I_1 : I_2$ is

A. $1 : \frac{1}{7}$

B. $1 : \frac{12}{7}$

C. $1 : \frac{7}{12}$

D. $1 : 7$

Watch Video Solution

23. Moment of inertia of a uniform rod of length L and mass M, about an axis passing through $L/4$ from one end and perpendicular to its length is

A. $\frac{7}{36} ML^2$

B. $\frac{7}{48}ML^2$

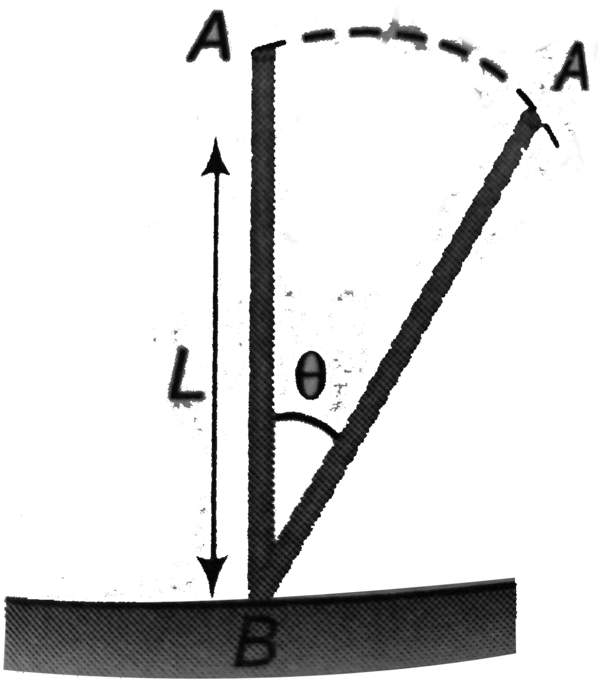
C. $\frac{11}{48}ML^2$

D. $\frac{ML^2}{12}$

Answer: B

Watch Video Solution

24.



A uniform rod of legth L is free to rotate in a vertica plane about a fixed horizontal axis through B. The rod begins rotating from rest. The angular velocity ω at angle θ is given as

A. $\sqrt{\left(\frac{6g}{L}\right)}\sin\left(\frac{\theta}{2}\right)$

B. $\sqrt{\left(\frac{6g}{L}\right)}\cos\left(\frac{\theta}{2}\right)$

C. $\sqrt{\left(\frac{6g}{L}\right)}\sin\theta$

D. $\sqrt{\left(\frac{6g}{L}\right)}\cos\theta$

Watch Video Solution

25. Two partcles of masses 1 kg and 2 kg are placed at a distance of 3 m. Moment of inertia of the particles about an axis passing through their centre of mass and perpendicular to the line joining them is (in $kg-m^2$) a) 6 b) 9 c) 8 d) 12

A. 6

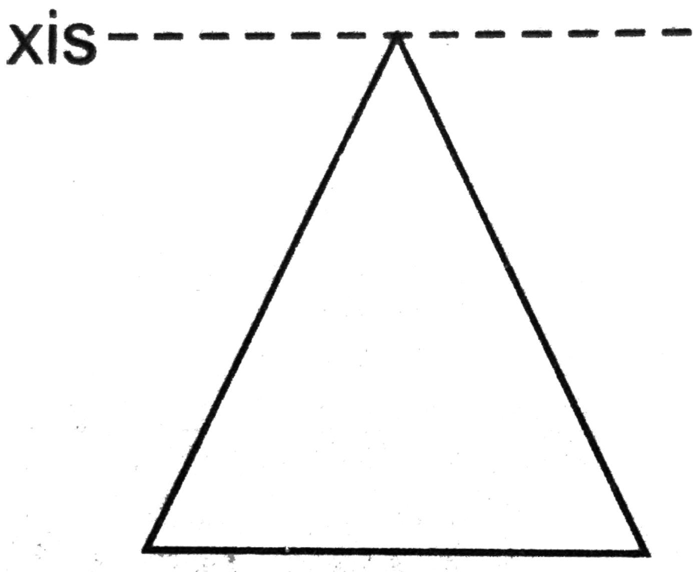
B. 9

C. 8

D. 12

Answer: A

Watch Video Solution



26.

Find moment of inertia of a thin sheet of mass M in the shape of an equilateral triangle about an axis as shown in figure. The length of each side is L

A. $ML^2 / 8$

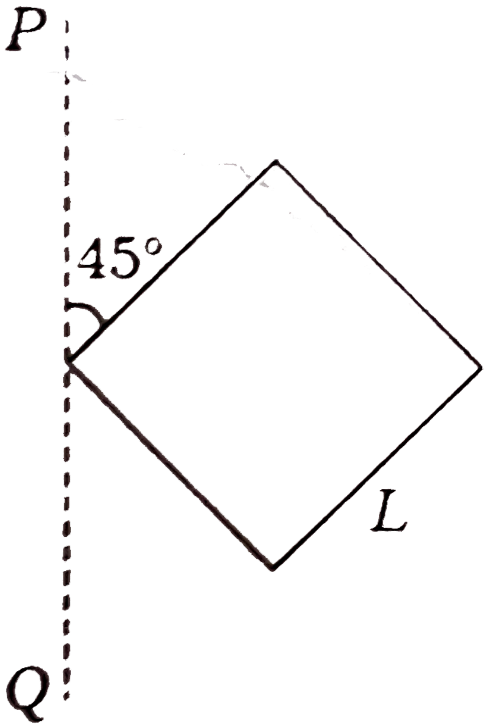
B. $(3)ML^2/8$

C. $7ML^2/8$

D. none of these

Watch Video Solution

27. A square is made by joining four rods each of mass M and length L. Its moment of inertia about an axis PQ, in its plane and passing through one of its corner is



A. $6ML^2$

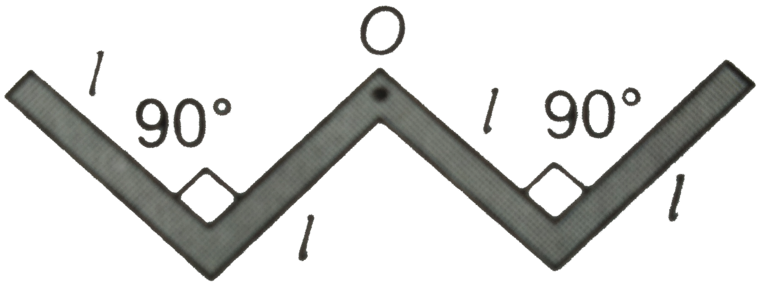
B. $\frac{4}{3}ML^2$

C. $\frac{8}{3}ML^2$

D. $\frac{10}{3}ML^2$

Watch Video Solution

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



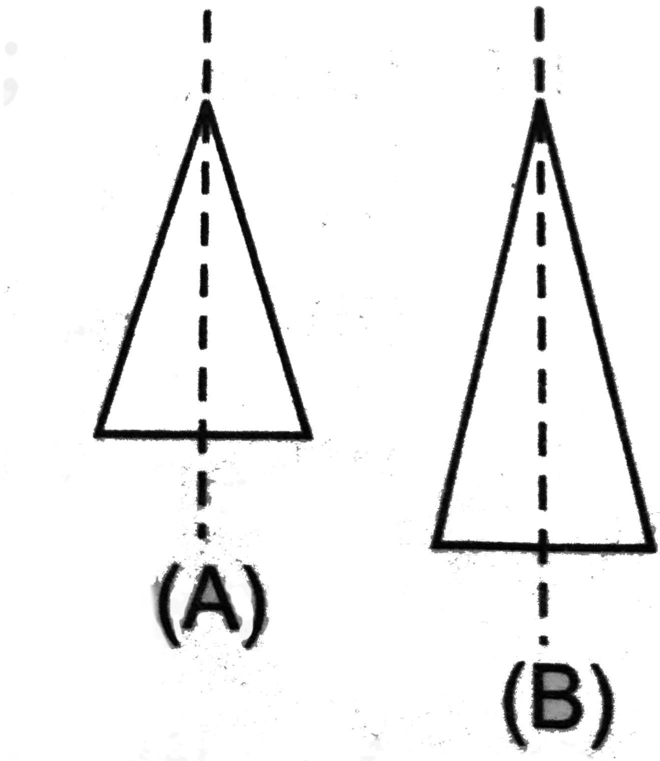
A. $\frac{ml^2}{3}$

B. $\frac{10ml^2}{3}$

C. $\frac{ml^2}{12}$

D. $\frac{ml^2}{24}$

Watch Video Solution



29.

The figure shows two cones A and B with the conditions $h_A < h_B, \rho_A > \rho_B$ $R_A = R_B, m_A = m_B$. Identify the correct statement abut their axis of symmetry.

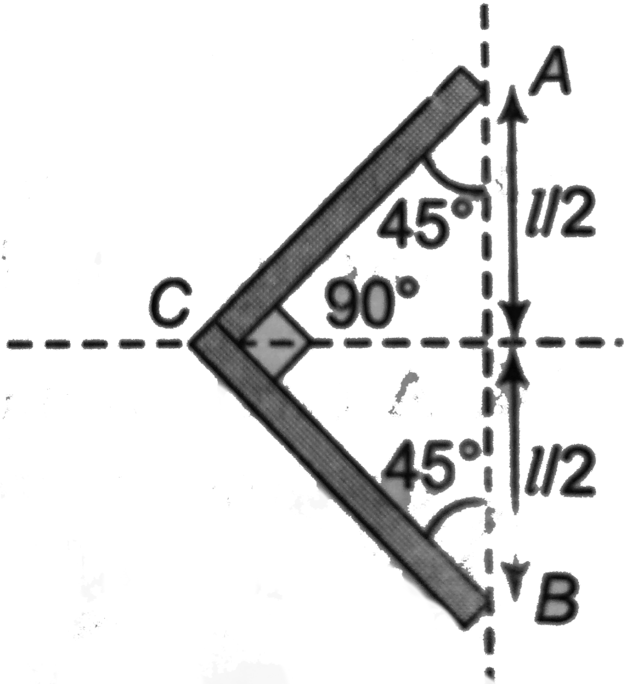
A. both have same moment of inertia

B. a has greater moment of inertia

C. B has greater moment of inertia

D. Nothing can be said

Watch Video Solution

30. 

Linear mass density of the two rods system, AC and CD is x. moment of inertia of two rods about an axis passing through AB is

A. $\dfrac{xl^3}{4\sqrt{3}}$

B. $\frac{xl^3}{\sqrt{2}}$

C. $\frac{xl^3}{4}$

D. $\frac{xl^3}{6\sqrt{2}}$

Watch Video Solution

Level 1 Subjective

1. If radius of the earth contracts to half of its present value without change in its mass, what will be the new duration of the day?

Watch Video Solution

2. The radius of gyration of a uniform disc about a line perpendicular to the disc equals ilts radius. Find the distance of the line from the centre.

Watch Video Solution

3. Find the moment of inertia of a uniform square plate of mass M and edge a about one of its diagonals.

Watch Video Solution

4. Moment of inertia of a uniform rod of mass m and length l is $\frac{7}{12}ml^2$ about a line perpendicular to the rod. Find the distance of this line from the middle point of the rod.

A. $\frac{l^2}{2}$

B. $6l$

C. $2l$

D. $\frac{l}{\sqrt{2}}$

Watch Video Solution

5. Two point masses m_1 and m_2 are joined by a weightless rod of length r. Calculate the moment of inerrtia of the system about an axis passing through its centre of mass and perpendicular to the rod.

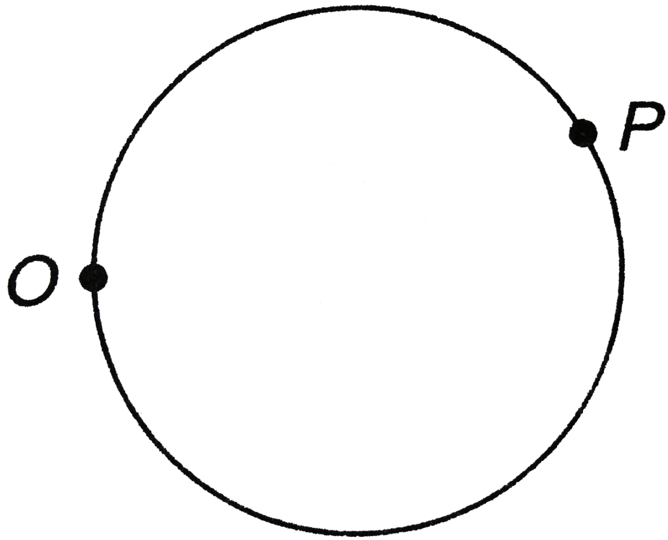
Watch Video Solution

6. Radius of gyration of a body about an axis at a distance 6 cm from its centre of mass is 10 cm. Find its radius of gyration about a parallel axis through its centre of mass.

Watch Video Solution

7. A wheel rotates around a stationary axis so that the rotation angle θ varies with time as $\theta = at^2$ where $a = 0.2rad/s^2$. Find the magnitude of net acceleration of the point A at the rim at the moment $t = 2.5s$ if the linear velocity of the point A at this moment is $v = 0.65m/s$.

Watch Video Solution



8.

Particle P shown in figure is moving in a circle of radius $R = 10$ cm with linear speed $v = 2m/s$ Find the angular speed of particle about point O.

Watch Video Solution

9. A particle of mass m is projected from the ground with an initial speed u at an angle α. Find the magnitude of its angular momentum at the highest point of its trajector about the point of projection.

A. $\frac{(m)u^3 \cos\alpha \sin^2\alpha}{2g}$

B. $\frac{(m)u^3 \cos\alpha \sin^2\alpha}{g}$

C. $\frac{(m)u^3 \cos\alpha \sin^2\alpha}{2}$

D. $\frac{u^3 \cos\alpha \sin^2\alpha}{2g}$

Watch Video Solution

10. Linear mss density (mass/length) of a rod depends on the distanec from one end (say A) as $\lambda_x = (\alpha x + \beta)$ here α and β are constants, find the moment of inertia of this rod about an axis passing through A and perpendicular to the rod. Length of the rod is l

.

Watch Video Solution

11. When a body rolls, on a stationary ground, the acceleration of the point of contact is always zero. Is this statement true or false?

Watch Video Solution

12. A solid sphere of mass m rolls down an inclined plane a height h. Find rotational kinetic energy of the sphere.

Watch Video Solution

13. The topmost and bottommost velocities of a disc are v_1 and $v_2(< v_1$ in the same direction. The radius is R. Find te value of angular velocity ω.

Watch Video Solution

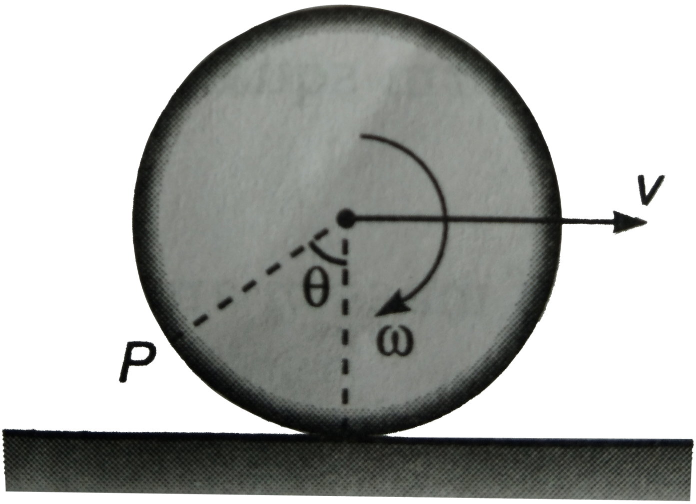
14. A circular lamina of radius a and centre O has a mass per unit area of kx^2, where x is the distance from O and k is a constant. If the mass of the lamina is M, find in terms of M and a, the moment of inertia of the lamina about an axis through O and perpendicular to the lamina.

Watch Video Solution

15. A solid body starts rotating about a stationary axis with an angular acceleration $\alpha = (2.0 \times 10^{-2})t \quad rad/s^2$ here t is in seconds. How soon after the beginning of rotation will the total acceleration vector of an arbitrary point of the body form an angle $\theta = 60^\circ$ with its velocity vector?

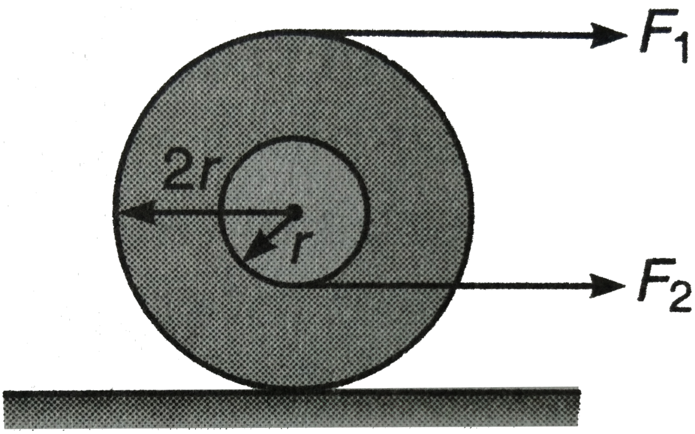
Watch Video Solution

16.



A ring of radius R rolls on a horizontal ground with linear speed v and angular speed ω. For what value of θ the velocity of point P is in vertical direction $(v < R\omega)$.

Watch Video Solution

17. 

Two forces F_1 and F_2 are applied on a spool of mass M and moment of inertia I about an axis passing through its centre of mass. Find the ratio $\frac{F_1}{F_2}$. So that the force of friction is zero. Given that $I < 2Mr^2$.

Watch Video Solution

18. A disc is placed on the ground. Friction coefficient is μ. What is the minimum force required to move the disc if it is applied at the topmost point?

Watch Video Solution

19. A cube is resting on an inclinded plane. If the angle of inclination is gradually increased. What must be the coefficient of friction between the cube and plane so that, (a). Cube slides before toppling?

(b). Cube topples before sliding?

Watch Video Solution

20. A uniform disc of mass 20 kg and radius 0.5 m can turn about a smooth axis through its centre and perpendicular to the disc. A constant torque is applied to the disc for 3s from rest and the angular velocity at the ned of that time is $\frac{240}{\pi} rev / \min$ find the magnitude of the torque. if the torque is then removed and the disc is brought to rest in t seconds by a constant force of 10 N applied tangentially at a point on the rim of the disc, find t

Watch Video Solution

21. A uniform disc of mass m and radius R is rotated about an axis passing through its center and perpendicular to its plane with an angular velocity ω. It is placed on a rough horizontal plane with the axis of the disc keeping vertical. Coefficient of friction between the disc and the surface is μ, find

(a). The time when disc stops rotating

(b). The angle rotated by the disc before stopping.

Watch Video Solution

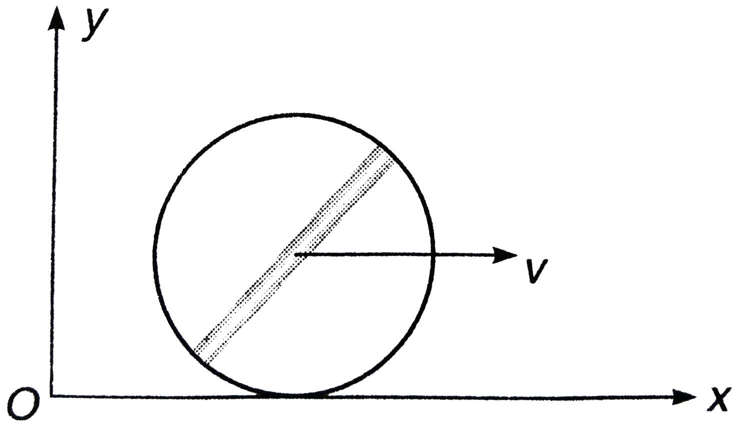
22. A solid body rotates about a stationary axis so that the rotation angle θ varies with time as $\theta = 6t - 2t^3$ radian. Find

(a) the angular acceleration at the moment when the body stops and

(b) the average value of angular velocity and angular acceleration averaged over the time interval between $t = 0$ and the complete stop.

Watch Video Solution

23. A rod of mass m and length 2 R is fixed along te diameter of a ring of same mass m and radius R as shown in figure. The combined body is rolling without slipping along x-axis find the angular momentum about z-axis.



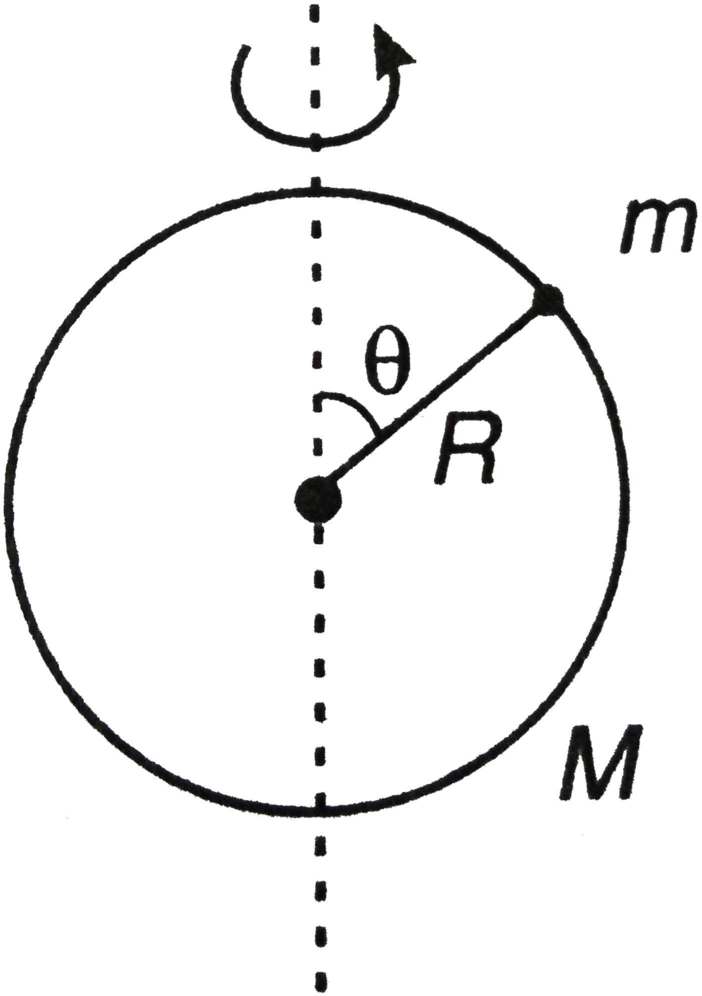
A. $L = \left(-\frac{5}{3}mvR\right)\hat{k}$

B. $L = \left(-\frac{10}{3}mvR\right)\hat{k}$

C. $L = \left(-\frac{10}{5}mvR\right)\hat{k}$

D. $L = \left(-\frac{10}{7}mvR\right)\hat{k}$

Watch Video Solution



24.

The figure shows a thin ring of mass $M = 1kg$ and radius $R = 0.4m$ spinning about a vertical diameter (take $I = \frac{1}{2}MR^2$) A small beam of mass $m = 0.2kg$ can slide without friction along the ring When the bead is at the top of the ring the angular velocity is $5rad/s$ What is the angular velocity when the bead slips halfwat to $\theta = 45^\circ$?

Watch Video Solution

25. A horizontal disc rotating freely about a vertical axis makes 100 rpm. A small piece of wax of mass 10 g falls vertically on the disc and adheres to it at a distance of 9 cm from the axis if the number of revolution per minute is thereby reduced to 90. Calculate the moment of inertia of disc.

Watch Video Solution

26. A man stands at the centre of a circular platform holding his arms extended horizontally with 4 kg block in each hand. He is set rotating about a vertical axis at $0.5 rev/s$. The moment of inertia of the man plus platform is $1.6kg - m^2$, assumed constant, the block are 90 cm from the axis of rotation. He now pulls the blocks in towards his body until they are 15 cm from the axis of rotation. Find (a) his new angular velocity and (b) the initial and final kinetic energy of the man and platform (c) how much work most the man do to pull int he blocks?

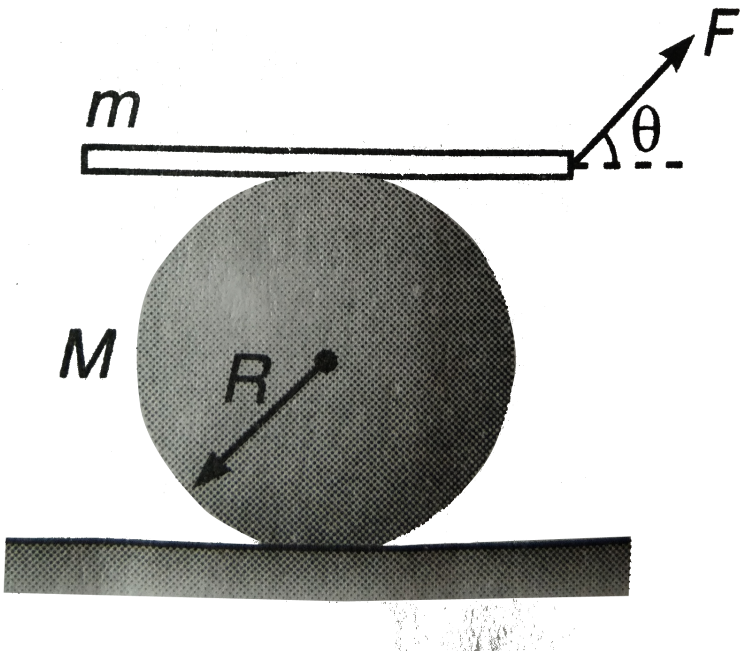
Watch Video Solution

27. A horizontally oriented uniform disc of mass M and radius R rotates freely about a stationary vertical axis passing through its centre. The disc has a radial guide along which can slide without friction a small body of mass m. A light thread running down through the hollow axle of the disc is tied to the body initially the body was located at the edge of the disc and the whole system rotated with ann angular velocity ω_0. Then by means of a force F applied to the lower and of the thread the body was slowly pulled to the rotation axis. find:

(a). The angular velocity of the system in its final state.

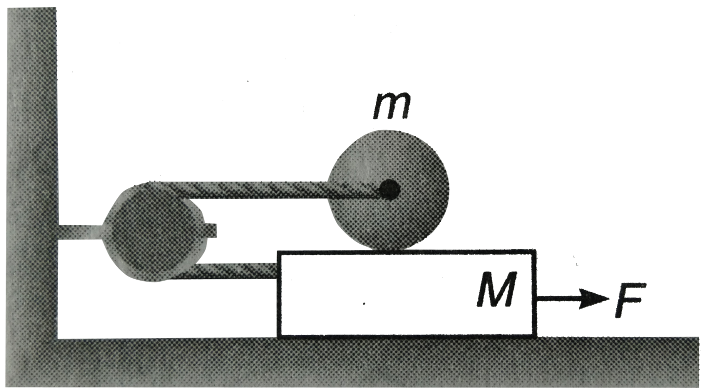
(b). The work performed by the force F.

Watch Video Solution

28. 

Consider a cylinder of mass M and radius R lying on a rough horizontal plane. It has a plank lying on its top as shown in figure. A force F is applied on the plank such that the plank moves and causes the cylinder to roll the plank always remains horizontal. there is no slipping at any point of contact. Calculate the acceleration of the cylinder and the frictional forces at the two contact.

Watch Video Solution

29. 

Find the acceleration of the cylinder of mass m and radius R and that of plank of mass M

placed on smooth surface if pulled with a force F as shown in figure. Given that sufficient friction is present between cylinder and the plank surface to prevent sliding of cylinder.

Watch Video Solution

30. A uniform rod AB of length 2l and mass m is rotating in a horizontal plane about a vertical axis through A, with angular velocity ω, when the mid-point of the rod strikes a fixed nail and is brought immediately to rest. Find the impulse exerted by the nail.

Watch Video Solution

31. A uniform rod of length L rests on a frictionless horizontal surface. The rod is pivoted about a fixed frictionless axis at one end. The rod is initially at rest. A bulled travelling parallel to the horizontal surface and perpendicular to the rod with speed v strikes the rod at its centre and becomes embedded in it. the mass of the bullet is one-sixth the mass of the rod.

(a). What is the final angular velocity of the rod?

(b). What is the ratio of the kinetic energy of the system after the collision to the kinetic energy of te bullet the o collision?

Watch Video Solution

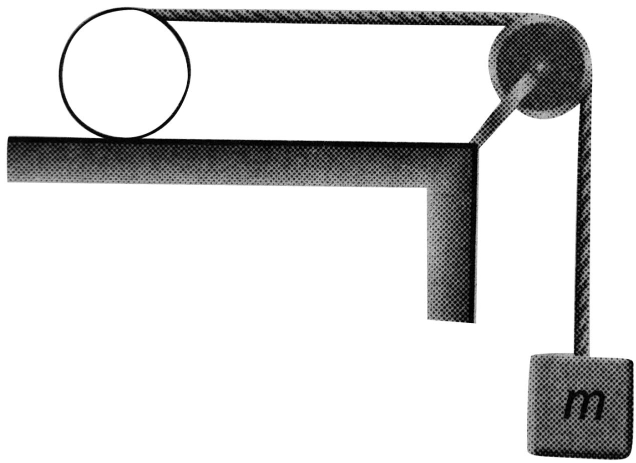
32. A uniform rod AB of mass 3m and length 2l is lying at rest on a smooth horizontal table with a smooth vertical axis through the end A. A particle of mass 2m moves with speed 2u across the table and strikes the rod at its mid-point C if the impact is perfectly elastic. Find the speed of the particle after impact if

(a). It strikes rod normally,

(b). Its path before impact was inclinded at 60° to AC.

Watch Video Solution

Level 2 Single Correct



1.

in the given figure a ring of mass m is kept on a horizontal surface while a body of equal mass m si attached through string, which is wounded on the ring. When the system is released the ring rolls without slipping. consider the following statement and choose the correct options.

(i). Acceleration of centre of mass of ring is $\frac{2g}{3}$

(ii). acceleration of hanging particle is $\frac{4g}{3}$

(iii). Frictional force (on the ring) acts in backward direction.

(iv) . Frictional force (on the ring) acts in backward direction.

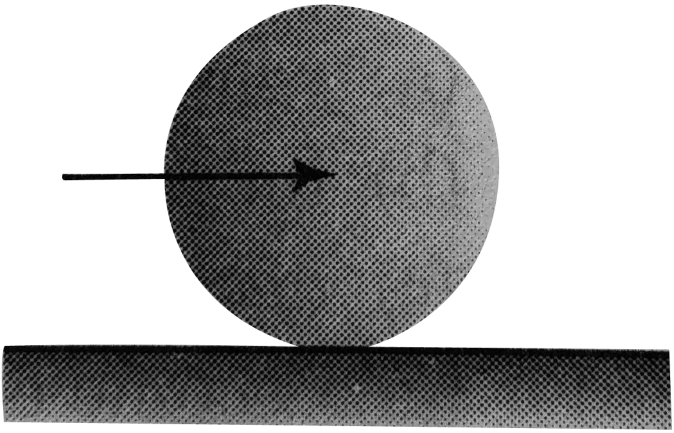
A. only statement (i) and (ii) are correct

B. only statement (ii) and (iii) are correct

C. only statements (iii) and (iv) are correct

D. none of these

Watch Video Solution



2.

A solid sphere of mass 10 kg is placed on a rough surface having coefficient of frictio $\mu = 0.1A$ constant force $F = 7N$ is applied along a line passing through the centre of the sphere as shown in the figure. The value of frictional force on the sphere is

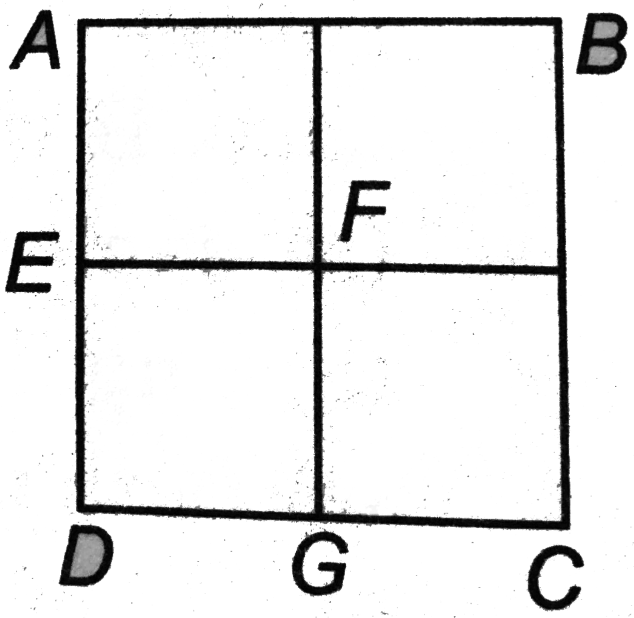
A. 1 N

B. 2 N

C. 3 N

D. 7 N

Watch Video Solution



3.

From a uniform square plate of side a and mass m, a square portion DEFG of side $\frac{a}{2}$ is removed. Then, the moment of inertia of remaining portion about the axis AB is

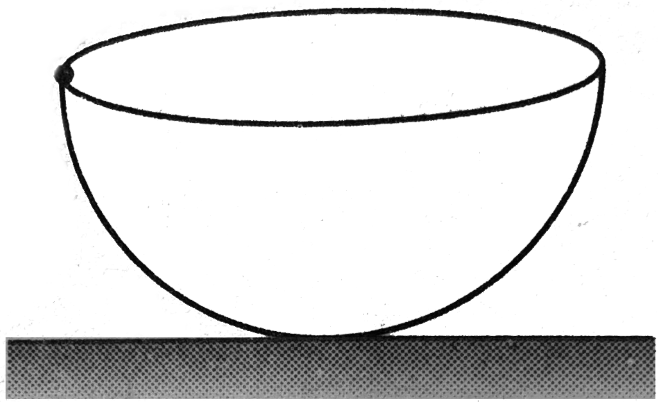
A. $\frac{7ma^2}{16}$

B. $\frac{3ma^2}{16}$

C. $\frac{3ma^2}{4}$

D. $\frac{9ma^2}{16}$

4. A small solid sphere of mass m and radius r starting from rest from the rim of a fixed hemispherical bowl of radius $R(> \; > r)$ rolls inside it without sliding. The normal reaction exerted by the sphere on the hemisphere when it reaches the bottom of hemisphere is



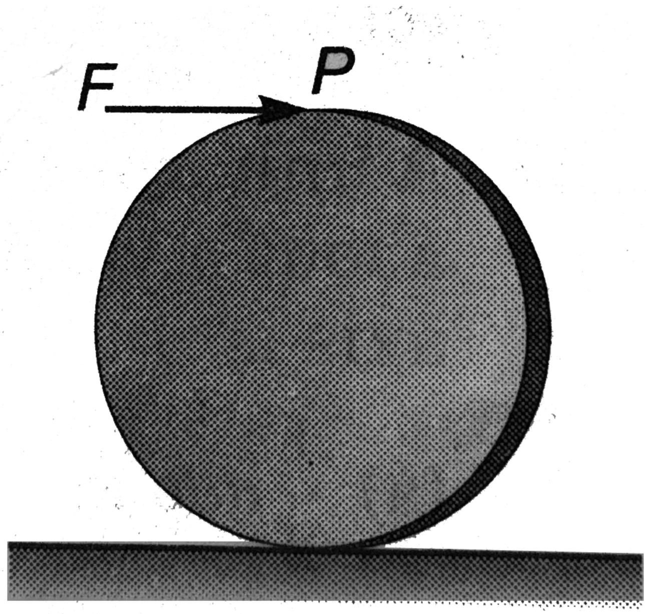
A. $(3/7)mg$

B. $(9/7)mg$

C. $(13/7)mg$

D. $(17/7)mg$

Watch Video Solution



5.

A uniform solid cylinder of mass m and radius

R is placed on a rough horizontal surface. A horizontal constant force F is applied at the top point P of the cylinder so that it start pure rolling. The acceleration of the cylinder is

A. $F/3m$

B. $2F/3m$

C. $4F/3m$

D. $5F/3m$

Watch Video Solution

6. Uniform solid cylinder of mass m and radius R is placed on a rough horizontal surface. A horizontal constant force is applied at the top point P of the cylinder so that it start pure rolling .In the above question, the frictional force on the cylinder is

A. $F/3$ towards right

B. $F/3$ towards left

C. $2F/3$ towards right

D. $2F/3$ towards left

Watch Video Solution

7.

A small pulley of radius 20 cm and moment of inertia $0.32 kg - m^2$ is used to hang a 2 kg mass with the help of massless string. If the block is released, for no slipping condition acceleration of the block will be

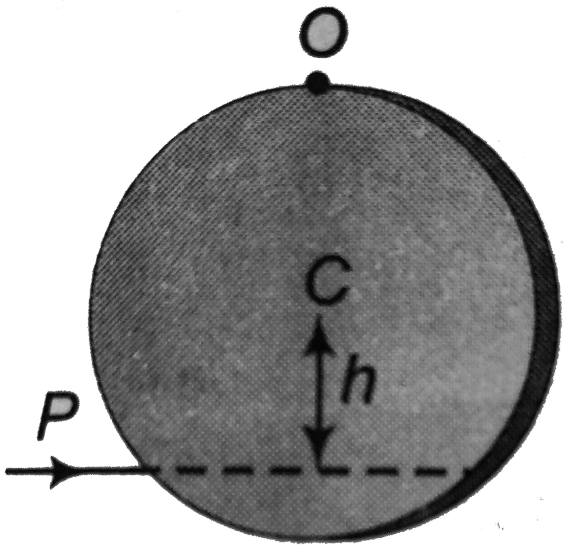
A. $2m / s^2$

B. $4m / s^2$

C. $1m / s^2$

D. $3m / s^2$

Watch Video Solution



8.

A uniform circular disc of radius R is placed on a smooth horizontal surface with its plane horizontal and hinged at circumference through point O as shown . An impulse P is applied at a perpendicular distance h from its centre C. The value of h so that the impulse due to hinge is zero, is

A. $(a) R$

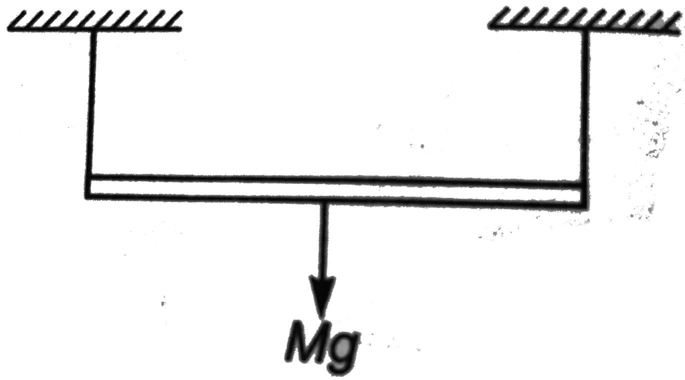
B. $(b) R/2$

C. $(c) R/3$

D. $(d) R/4$

Watch Video Solution

9.



A rod is supported horizontally by means of two strings of equal length as shown in figure. If one of the string is cut. Then tension in other string at the same instant will.

A. remains unaffected

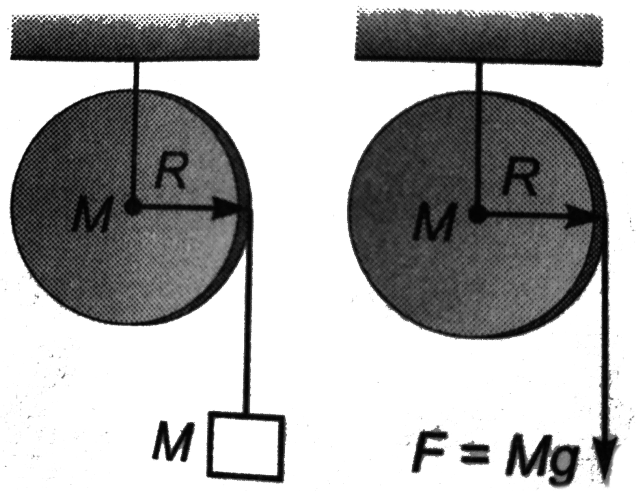
B. increase

C. decrease

D. become equal to weight of the rod.

Answer: C

Watch Video Solution



10.

The figure represent two cases. In first case a block of mass M is attached to a string which is tightly wound on a disc of mass M and radius R. In second case $F = Mg$ initially the disc is stationary in each case. if the same length of string is unwound from the disc, then

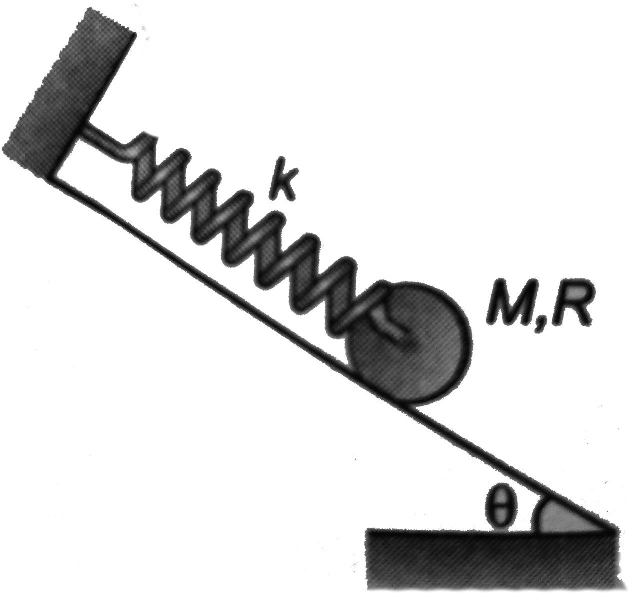
A. (a)same amount of work is done on both discs

B. (b)angular velocities of both the discs are equal

C. (c)both the discs have unequal angular accelerations

D. (d)All of the above

Watch Video Solution



11.

A uniform cylinder of mass M and radius R is released from rest on a rough inclined surface of inclination θ with the horizontal as shown in figure. As the cylinder rolls down the inclined surface, the maximum elongation it

the spring stiffness k is

A. $\frac{3}{4}\frac{Mg\sin\theta}{k}$

B. $\frac{2Mg\sin\theta}{k}$

C. $\frac{Mg\sin\theta}{k}$

D. none of these

12. A uniform rod of mass m and length l rotates in a horizontal plane with an angular velocity ω about a vertical axis passing through one end. The tension in the rod at a distance x from the axis is

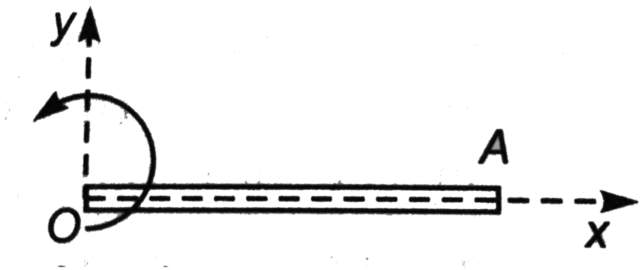
A. $\frac{1}{2}m\omega^2 x$

B. $\frac{1}{2}m\omega^2\left(1-\frac{x^2}{l}\right)$

C. $\frac{1}{2}m\omega^2 l\left(1-\frac{x^2}{l^2}\right)$

D. $\frac{1}{2}m\omega^2 l\left[1-\frac{x}{l}\right]$

Watch Video Solution

13. 

A rod of length 1 m rotates in the xy plane about the fixed point O in the anticlockwise sense, as shown in figure with velocity $\omega = a + bt$ where $a = 10rads^{-1}$ and $b = 5rads^{-2}$. The velocity and acceleration of the point A at $t = 0$ is

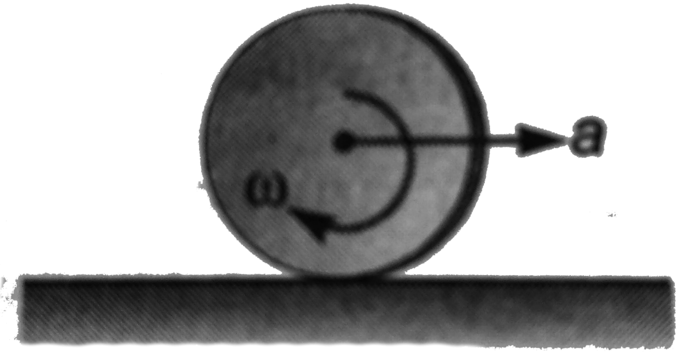
A. $+10\hat{i}ms^{-1}$ and $+5\hat{i}ms^{-2}$

B. $+10\hat{j}ms^{-1}$ and $\left(-100\hat{i}+5\hat{j}\right)ms^{-2}$

C. $-10\hat{j}ms^{-1}$ and $\left(100\hat{i}+5\hat{j}\right)ms^{-2}$

D. $-10\hat{j}ms^{-1}$ and $-5\hat{j}ms^{-1}$

Watch Video Solution

14. 

A ring of radius R rolls on a horizontal surface with constant acceleration a of the centre of mass as shown in figure. If ω is the instantaneous angular velocity of the ring. Then the net acceleration of the point of contact of the ring with gound is

A. zero

B. $\omega^2 R$

C. a

D. $\sqrt{a^2 + (\omega^2 R)^2}$

Answer: B

Watch Video Solution

15. The density of a rod AB increases linearly from A to B its midpoint is O and its centre of mass is at C. four axes pass through A, B, O and C, all perpendicular to the length of the rod. The moment of inertial of the rod about these axes are I_A, I_B, I_O and I_C respectively.

A. $I_A > I_B$

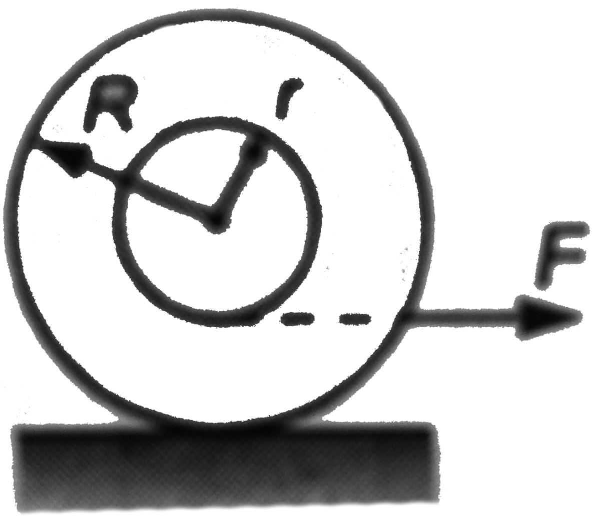
B. $I_C < I_B$

C. $I_O > I_C$

D. All of these

Watch Video Solution

16. The figure shows a spool placed at rest on a horizontal rough surface. A tightly wound string on the inner cylinder is pulled horizontally with a force F. identify the correct alternative related to the friction f acting on the spool



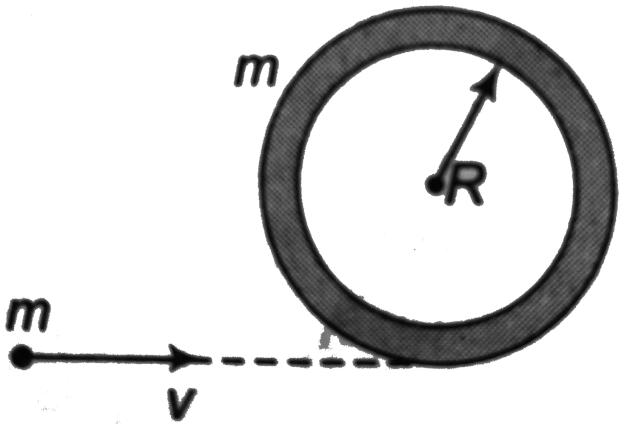
A. f acts left ward with $f < F$

B. f acts leftwards but nothing can be said about its magnitude

C. $f < F$ but nothing can be said about its magnitude.

D. none of the above

17.



A circular ring of mass m and radius R rests flat on a horizontal smooth surface as shown in figure. A particle of mass m, and moving with a velocity v. Collides inelastically $(e = 0)$ with the ring the angular velocity with which the system rotates after the particle strikes the ring is

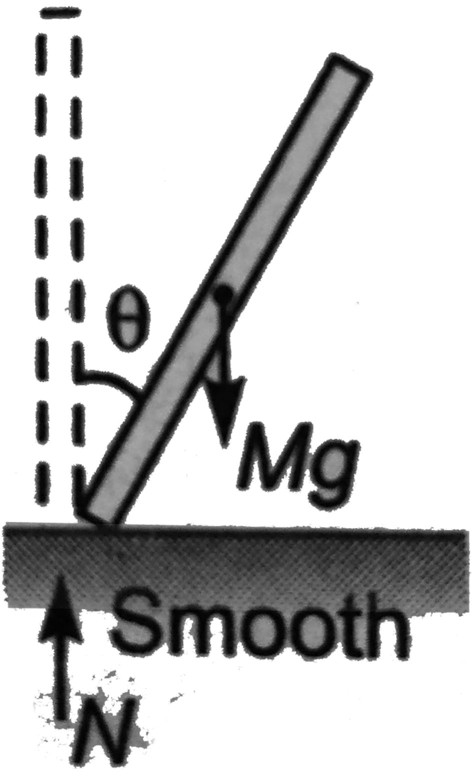
A. $\frac{v}{2R}$

B. $\frac{v}{3R}$

C. $\frac{2v}{3R}$

D. $\frac{3v}{4R}$

Watch Video Solution



18.

A stationary uniform rod in the upright position is allowed to fall on a smooth horizontal surface. The figure shows the instantaneous position of the rod. Identify the correct statement. 1) Normal reaction N is equal to Mg 2) N does positive rotational work about the centre of mass 3) A couple of equal and opposite forces acts on the rod 4) All of the above

A. normal reaction N is equal to Mg

B. N does positive rotational work about the centre of mass

C. a couple of equal and opposite forces acts on the rod

D. all of the above.

Watch Video Solution

19. A thin unifrom rod of mass m and length l is free to rotate about its upper end When it is at rest. It receives an impulse J as its lowest point, normal to its length immediately after impact.

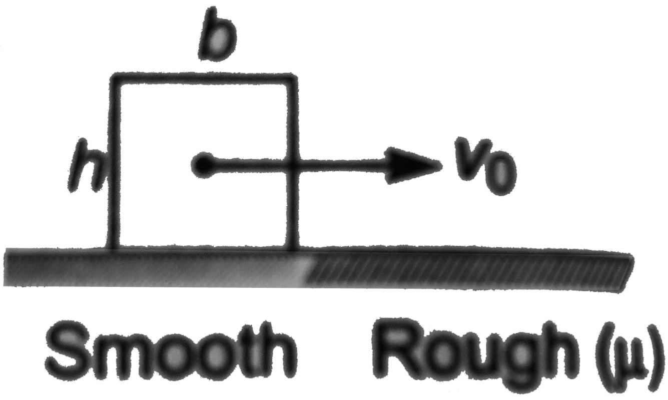
A. the angular mumentum of the rod is Jl

B. The angular velocity of the rod is $3J/ml$

C. The kinetic energy of the rod is $3J^2/2m$

D. Linear velocity of the rod at the mid point is 3J//2m

Watch Video Solution



20.

A rectangular block of size ($\times h$) moving with velocity v_0 enters on a rough surface where the coefficient of friction is μ as shown in figure. Identify the correct statement.

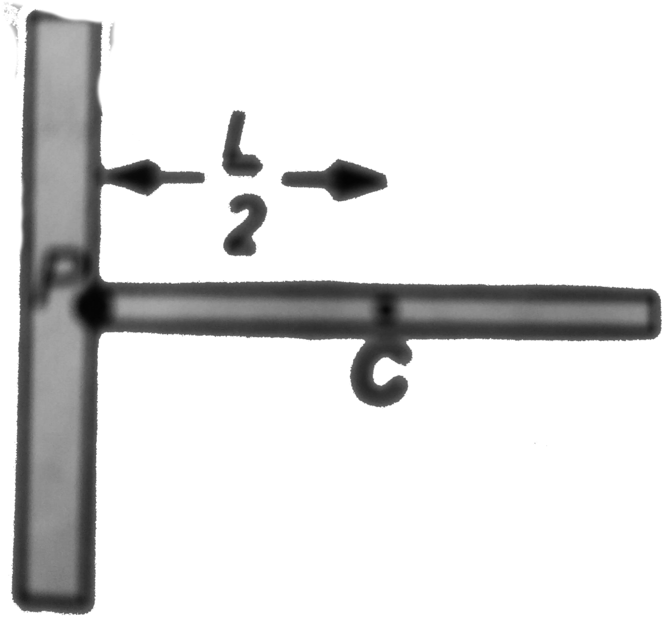
A. Thenet torque acting on the block about its COM is $\mu m \frac{g(h)}{2}$ (clockwise)

B. the net torque acting on the block about its COM is zero

C. The net torque acting on the block about its COM is in the anticlockwise sense

D. None of the above.

Watch Video Solution

21. 

A uniform rod of length L and mass m is free to rotate about a frictionless pivot at one end as shown in figure. The rod is held at rest in the horizontal position and a coin of mass m is placed at the free end. Now the rod is released The reaction on the coin immediately after the rod starts falling is

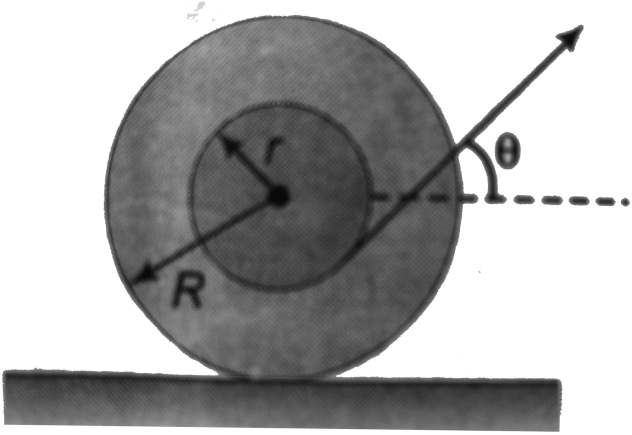
A. $\frac{3mg}{2}$

B. $2mg$

C. zero

D. $\frac{mg}{2}$

Watch Video Solution



22.

A spool is pulled at an angle θ with the horizontal on a rough horizontal surface as shown in the figure. If the spool remains at rest, the angle θ is equal to

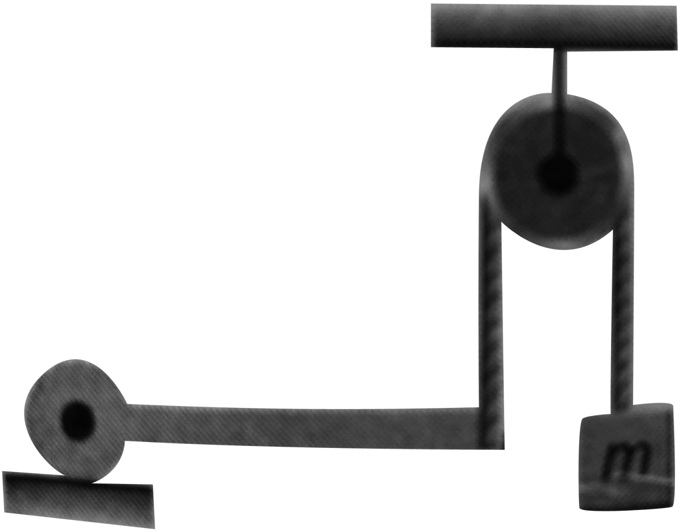
A. $\cos^{-1}\left(\frac{R}{r}\right)$

B. $\sin^{-1}\left(\sqrt{1-\frac{r^2}{R^2}}\right)$

C. $\pi - \cos^{-1}\left(\frac{r}{R}\right)$

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

Watch Video Solution

23. 

Uniform rod AB is hinged at end A in horizontal position as shown in the figure. The other end is connected to a block through a massless string as shown. The pulley is smooth and massless. Mass of block and rod is same and is equal to m Then acceleration of block just after release from this position is

A. $(a)6g/13$

B. $(b)g/4$

C. $(c)3g/8$

D. (d)None of these

Watch Video Solution

24. A cylinder having radius 0.4 m initially rotating (at $r=0$) with $\omega_0 = 54 rad/s$ is placed on a rough inclinded plane with

$\theta = 37^\circ$ having friction coefficient $\mu = 0.5$ the time taken by the cylinder to start pure rolling is $(g = 10m/s^2)$

A. 5.4 s

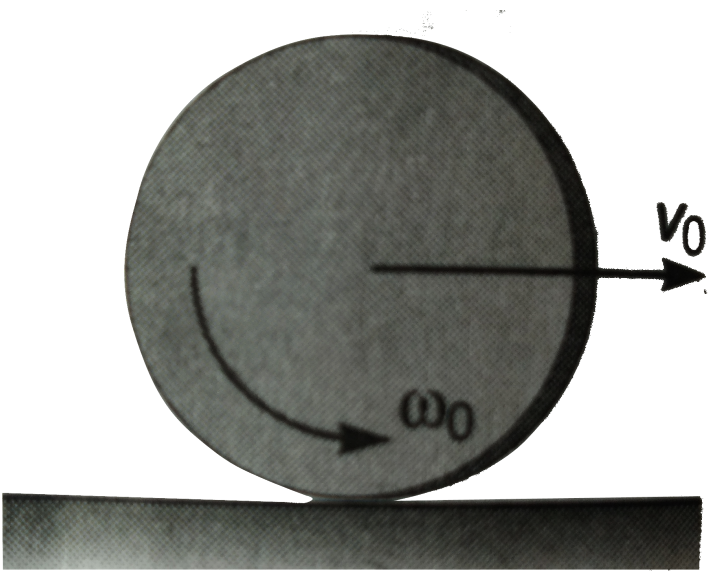
B. 2.4 s

C. 1.4 s

D. none of these

Watch Video Solution

25.



A disc of mass M and radius R is rolling purely with centre's velcity v_0 on a flat horizontal floor when it hits a step in the floor of height $R/4$ The corner of the step is sufficiently rough to prevent any slippoing of the disc against itself. What is the velocity of the centre of the disc just after impact?

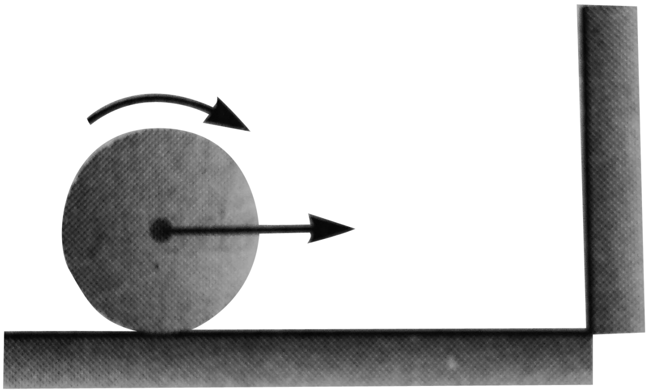
A. $4v_0/5$

B. $4v_0/7$

C. $5v_0/6$

D. none of these

Watch Video Solution

26. 

A solid sphere is rolling purely on a rough horizontal surface (coefficient of kinetic friction $= \mu$) with speed of centre $= u$. It collides inelastically with a smooth vertical wall at a certain moment, the coefficient of restituting being $\frac{1}{2}$. The sphere will begin pure rolling after a time.

A. $(a) \frac{3u}{7\mu g}$

B. $(b) \frac{2u}{7\mu g}$

C. $(c) \frac{3u}{5\mu g}$

D. $(d) \frac{2u}{5\mu g}$

Watch Video Solution

Level 2 Multiple Correct

1. A thin hollow sphere of mass m is completely filled with non viscous liquid of mass m. When the sphere roll-on horizontal ground such that centre moves with velocity v, kinetic enerrgy of the system is equal to

A. mv^2

B. $\frac{4}{3}mv^2$

C. $\frac{4}{5}mv^2$

D. none of these

Watch Video Solution

2. A solid uniform disc of mass m rols without slipping down a fixed inclined plank with an acceleration a. The frictional force on the disc due to surface of the plane is

A. $\frac{1}{4}ma$

B. $\frac{3}{2}ma$

C. ma

D. $\frac{1}{2}ma$

Watch Video Solution

3. A uniform slender rod of mass m and length L is released from rest, with its lower end touching a frictionaless horizontal floor. At the initial moment, the rod is inclined at an angle $\theta = 30^\circ$ with the vertical. Thent he value of normal reaction from the from the floor just after release will be

A. $4mg/7$

B. $5mg/9$

C. $2mg/5$

D. None of these

Watch Video Solution

4. A uniform slender rod of mass m and length L is released from rest, with its lower end touching a frictionaless horizontal floor. At the initial moment, the rod is inclined at an angle θ=30∘ with the vertical. Thent he value of normal reaction from the from the floor just after release will be 4mg /7 In the above problem, the initial acceleration of the lower end of the rod will be

A. $g\sqrt{3}/4$

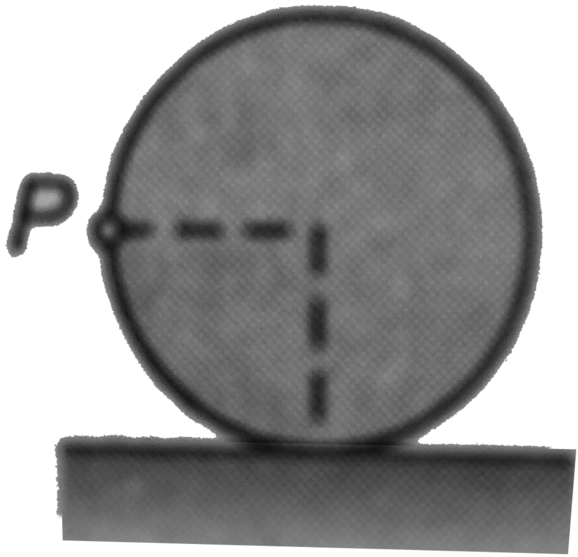
B. $g\sqrt{3}/5$

C. $3g\sqrt{3}/7$

D. None of these

Watch Video Solution

5. A disc of radius R is rolling purely on a flat horizontal surface, with a constant angular velocity. The angle between the velocity ad acceleration vectors of point P is



A. $zero$

B. 45°

C. $\tan^{-1}(2)$

D. $\tan^{-1}(1/2)$

Watch Video Solution

6. A straight rod AB of mass M and length L is placed on a frictionless horizontal surface. A force having constant magnitude F and a fixed direction start acting at the end A. The rod is initially perpendicular to the force. The initial acceleration of end B is

A. zero

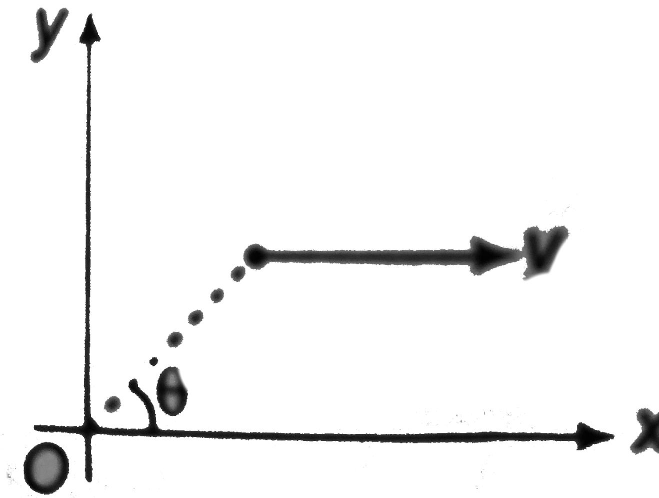
B. $2F/M$

C. $4F/M$

D. None of these

Watch Video Solution

7. A particle mass parallel to x-axis with constant velocity v as shown in the figure. The angular velocity of the particle about the



origin O

A. remains constant

B. continuously increases

C. continuously decreases

D. oscillates.

Watch Video Solution

8. A thin uniform rod mass M and length L is hinged at its upper end. And released from rest from a horizontal position. The tenstion at a point located at a distance $L/3$ from the hinge point, when the rod become vertical will

A. $22Mg/27$

B. $11Mg/13$

C. $6Mg/11$

D. $2Mg$

Watch Video Solution

9.

A uniform rod AB of length L and mass m is suspended freely at A and hangs vertically at rest when a particle of same mass m is fired horizontally with speed v to strike the rod at its mid point. If the particle is brought to rest after the impact. Then the impulsive reaction at A is horizontal direction is

A. $(a) mv/4$

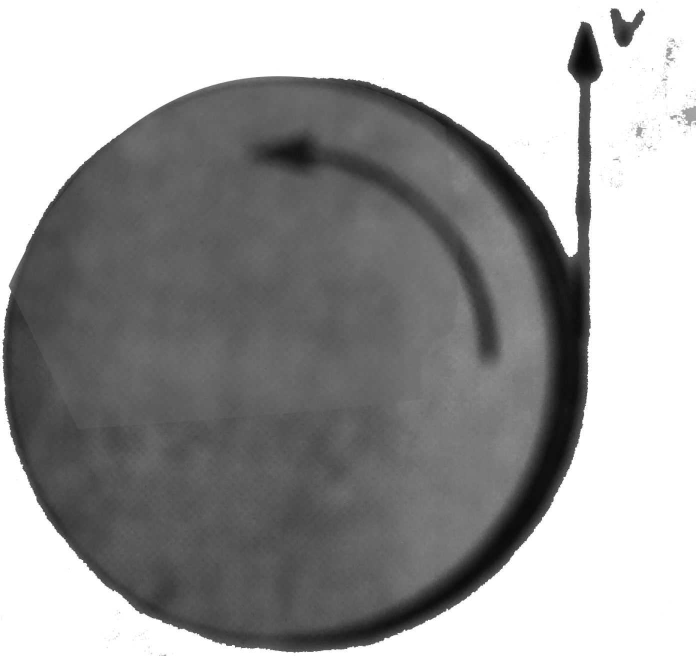
B. $(b) mv/2$

C. $(c) mv$

D. $(d) 2mv$

Watch Video Solution

10.



A child with mass m is standing at the edge of a merry go round having moment of inertia I, radius R and initial angular velocity ω as shown in the figure. The child jumps off the edge of the merry go round with tangential velocity v with respect to the ground. The new angular velocity of the merry go round is

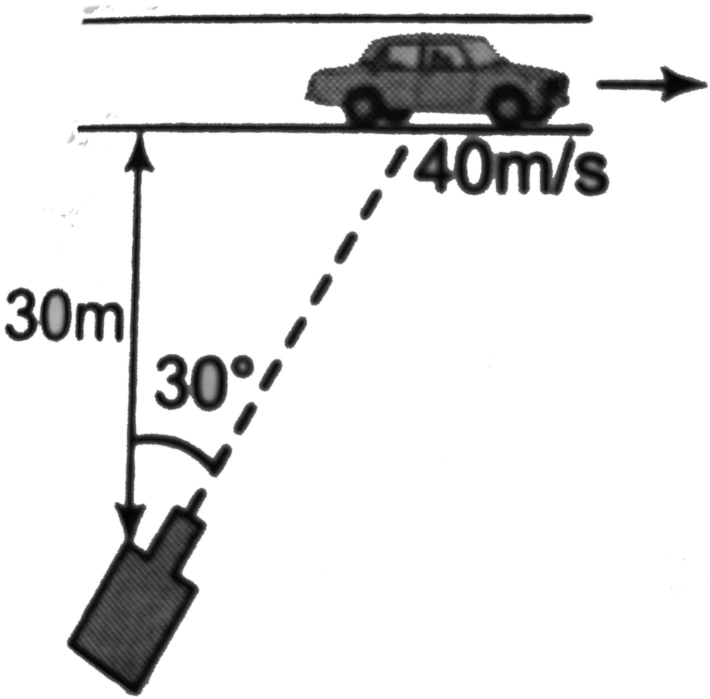
A. $(a)\sqrt{\frac{I\omega^2 - mv^2}{I}}$

B. $(b)\sqrt{\frac{(I + mR^2)\omega^2 - mv^2}{I}}$

C. $(c)\frac{I\omega - mvR}{I}$

D. $(d)\frac{(I + mR^2)\omega - mvR}{I}$

Watch Video Solution



11.

A racing car is travelling along a straight track at a constant velocity of $40m/s$. A fixed TV camera is recording the even as shown in figure. In order to keep the car in view in the position shown the angular velocity of camera should be

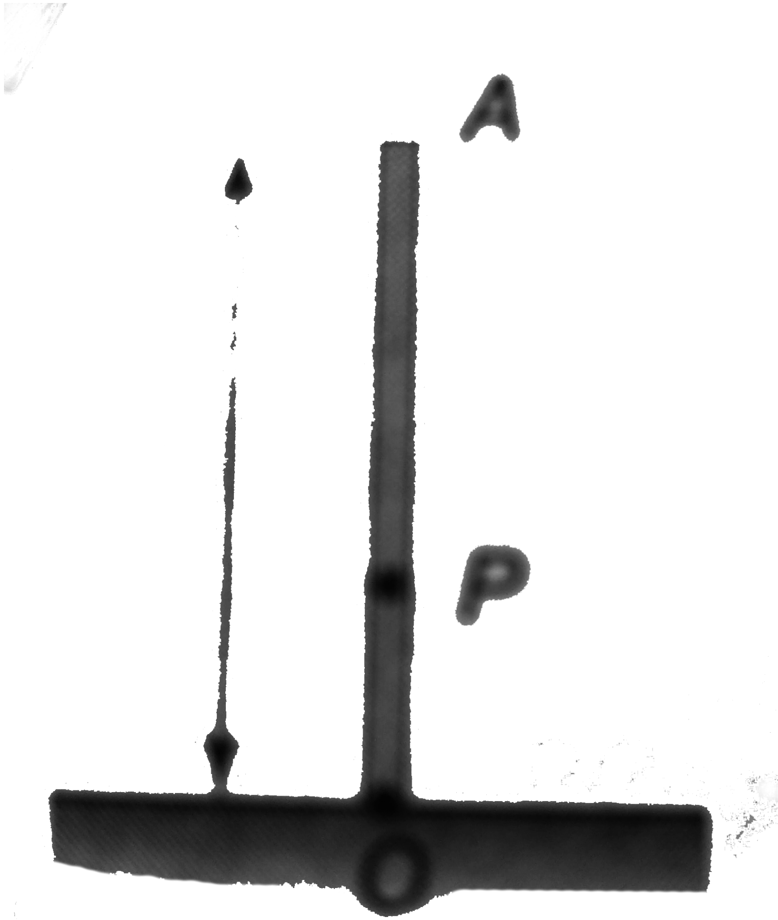
A. $(a) 3 rad / s$

B. $(b) 2 rad / s$

C. $(c) 4 rad / s$

D. $(d) 1 rad / s$

Watch Video Solution



12.

A uniform rod OA of length l, resting on smooth surface is slightly distributed from its vertical position P is a point on the rod whose locus is a circle during the subsequent motion of the rod, then the distance OP is equal to

A. $l/2$

B. $l/3$

C. $l/4$

D. there is no such point.

Watch Video Solution

13. A uniform rod OA of length l, resting on smooth surface is slightly distributed from its vertical position P is a point on the rod whose locus is a circle during the subsequent motion of the rod, then the distance OP is equal to 'l/4'. In the above question, the velocity of end O when end A hits the gournd is

A. zero

B. along the horizontal

C. along the vertical

D. at some inclination of the ground $(\neq 90^{\circ})$

Watch Video Solution

14. A uniform rod OA of length l resting on smooth surface slightly disturbed from its vertical position . P is a ipoint on the rod whose locus is a circle during the subsequent motion of the rod. the OP distance is l/4 . In the above question, the velocity of end A at the instant it hits the ground is

A. $\sqrt{3gl}$

B. $\sqrt{12gl}$

C. $\sqrt{6gl}$

D. none of these

Watch Video Solution

15.

A solid sphere of mass m and radius R is gently placed on a conveyer belt moving with constant velocity v_0. If coefficient of friction between belt and sphere is $2/7$ the distance traveled by the centre of the sphere before it starts pure rolling is

A. $\frac{v_0^2}{7g}$

B. $\frac{2v_0^2}{49g}$

C. $\frac{2v_0^2}{5g}$

D. $\frac{2v_0^2}{7g}$

Watch Video Solution

16. A mass m of radius r is rolling horizontally without any slip with a linear speed v. It then rolls up to a height given by $\frac{3}{4}\frac{v^2}{g}$

A. the body is identified to be a disc or a solid cylinder

B. the body is a solid sphere

C. moment of inertia of the body about instantaneous axis of rotation is $\frac{3}{2}mr^2$

D. moment of inertial of the body about instantaneous axis of rotation is $\frac{7}{5}mr^2$

Watch Video Solution

17. Four identical rods each of mass m and length l are joined to form a rigid square frame. The frame lies in the xy plane, with its centre at the origin and the sides parallel to the x and y axes. Its moment of inertia about

A. the x-axis is $\frac{2}{3}ml^2$

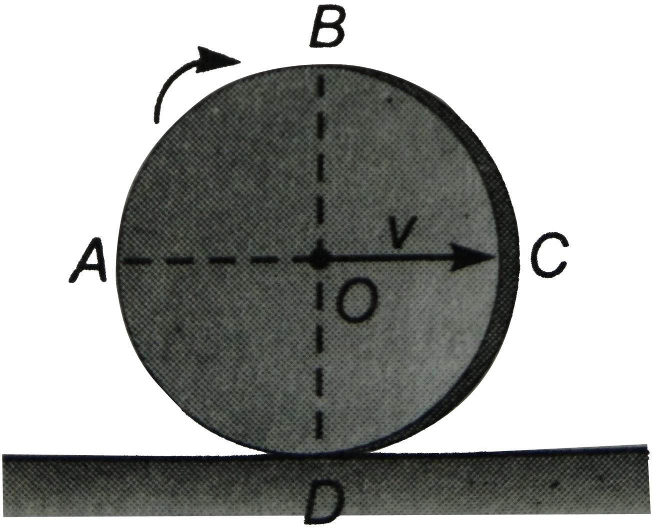
B. the z-axis is $\frac{4}{3}ml^2$

C. an axis parallel to the z-axis and passing through a corner is $\frac{10}{3}ml^2$

D. one side is $\frac{5}{3}ml^2$

Watch Video Solution

18.



A uniform circular ring rolls without slipping on a horizontal surface. At any instant, its position is as shown in the figure. Then

A. (a) section ABC has greater kinetic energy than section ADC

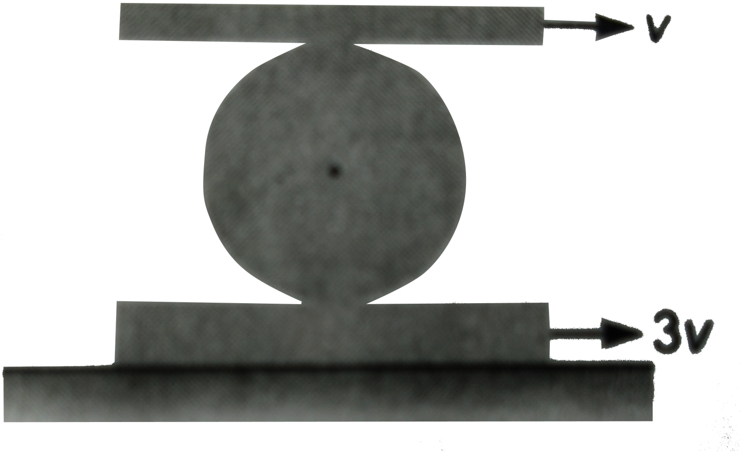
B. (b) section BC has greater kinetic energy than section CD.

C. (c) section BC has the same kinetic energy as section DA

D. (d) the section CD and DA have the same kinetic energy.

Watch Video Solution

19.



A cylinder of radius R is to roll without slipping between two planks as shown in the figure. Then

A. (a)angular velocity of the cylinder is $\frac{v}{R}$ counter clockwise

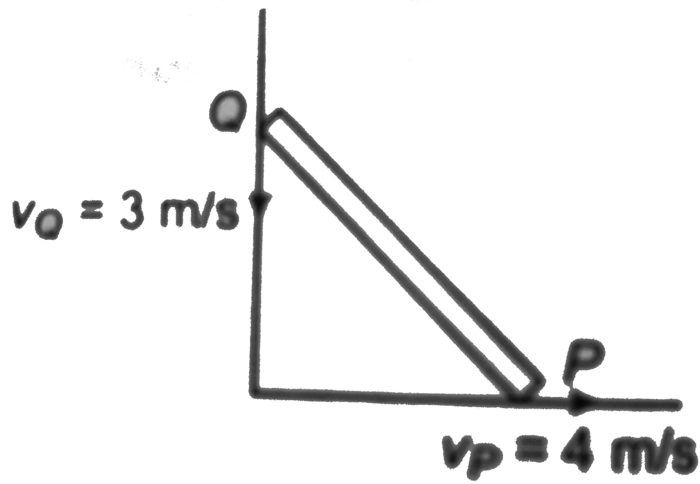
B. (b)angular velocity of the cylinder is $\frac{2v}{R}$ clockwise

C. (c)velocity of centre of mass of the cylinder is v towards left

D. (d)velocity of centre of mass of the cylinder is $2v$ towards right.

Watch Video Solution

20.



A uniform rod of mass $m = 2kg$ and length $l = 0.5m$ is sliding along two mutually perpendicular smooth walls with the two ends P and Q having velocities $U_P = 4m/s$ and $v_Q = 3m/s$ as shown then

A. The angular velocity of rod,

$\omega = 10 rad / s$ counter clockwise

B. The angular veloicty of rod

$\omega = 5.0 rad / s$ counter clockwie

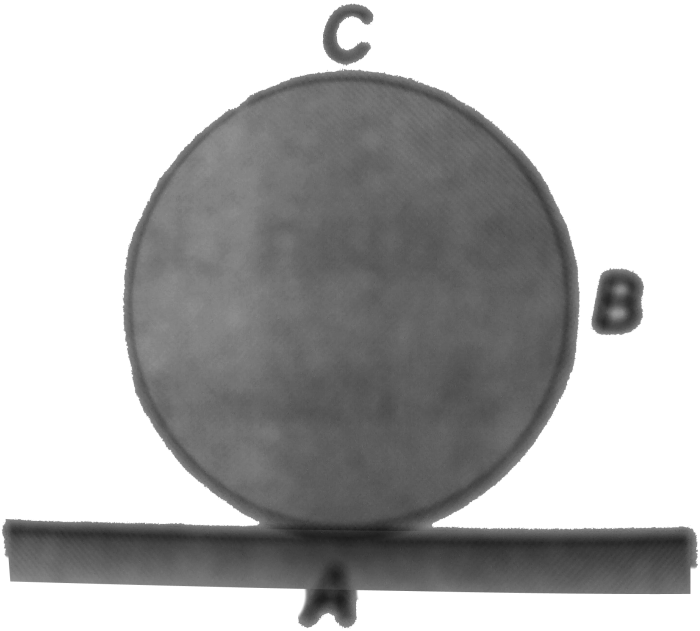
C. The velocity of centre of mass of rod

$v_{cm} = 2.5 m / s$

D. The total kinetic energy of rod,

$K = \frac{25}{3}$joule

Watch Video Solution

21. 

A wheel is rolling without slipping on a horizontal plane with velocity v and acceleration a of centre of mass as shown in figure. Acceleration at

A. A is vertically upwards

B. B may be vertically downwards

C. C cannot be horizontal

D. A point on the rim may be horizontal leftwards.

Watch Video Solution

22. A uniform rod of length l and mass 2 m rests on a smooth horizontal table. A point mass m moving horizontally at right angles to the rod with velocity v collides with one end of the rod and sticks it. Then

A. angular velocity of the system after collision is $\frac{2}{5}\frac{v}{l}$

B. angular velocity of the system after collision is $\frac{v}{2l}$

C. The loss in kinetic energy of the system as a whole as a result of the collision $\frac{3}{10}mv^2$

D. The loss in kinetic energy of the system as a whole as a result of the collision $\frac{7mv^2}{24}$

Watch Video Solution

23. A non-uniform ball of radius R and radius of gyration about geometric centre $= R/2$ is kept on a frictionless surface. The geometric centre coincides with the centre of mass. The ball is struck horizontally with a sharp impulse $= J$ the point of application of the impulse is at a height h above the surface. then.

A. (a)The ball will slip on surface for all cases

B. (b)the ball will roll purely if $h = 5R/4$

C. (c)the ball will roll purely if $h = 3R/2$

D. (d)there will be no rotation if $h = R$

Watch Video Solution

24. A hollow spherical ball is given an initial push, up an incline of inclination angle α. The ball rolls purely coefficient of static friction between ball and incline $= \mu$. During its upwards journey.

A. friction acts up along the incline

B. $\mu_{\min} = (2 \tan \alpha) / 5$

C. friction will be no rotation if $h = R$

D. $\mu_{\min} = (2 \tan \alpha) / 7$

Watch Video Solution

25. A uniform disc of mass m and radius R rotates about a fixed vertical axis passing through its centre with angular velocity ω. A particle of same mass m and having velocity of $2\omega R$ towards centre of the disc collides with the disc moving horizontally and sticks to its rim. Then

A. the angular velocity of the disc will become $\omega/3$

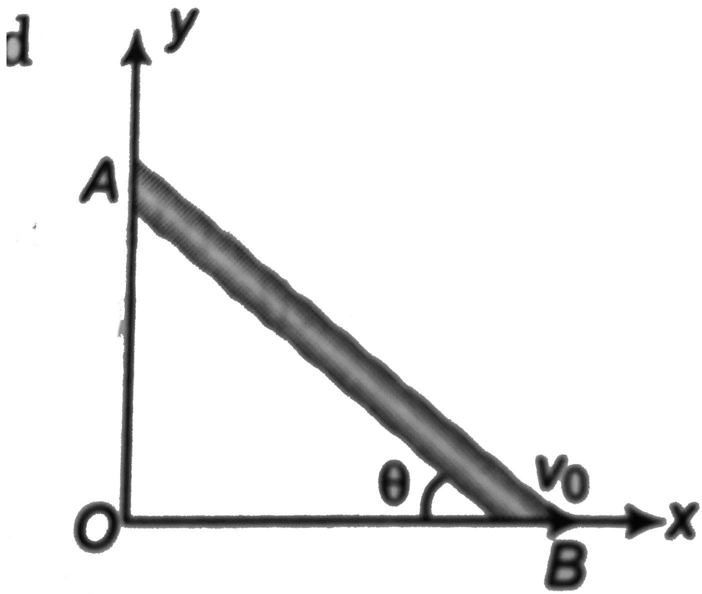
B. the angular veloicity of the disc will become $5\omega/3$

C. the impulse on the particle due to disc is $2m\omega R$

D.

Watch Video Solution

26.



The end B of the rod AB which makes angle θ with the floor is being pulled with a constant velocity v_v as shown. The length of the rod is l.

A. (a)At $\theta = 37^\circ$ velocity of end A is $\frac{4}{3}v_0$ downwards

B. (b)At $\theta = 37^{\circ}$ angular velocity of rod is

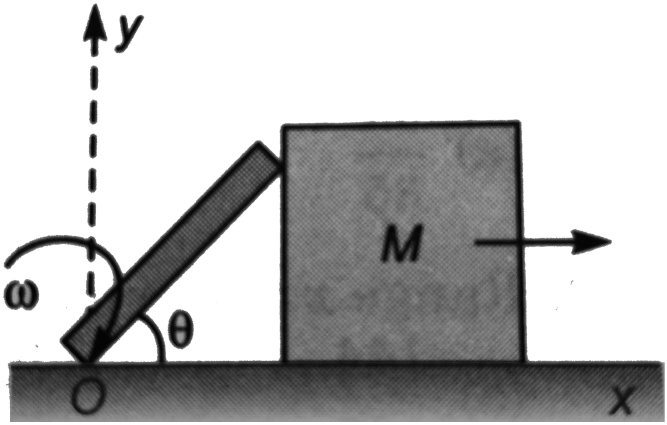
$$\frac{5v_0}{3l}$$

C. (c)Angular velocity of rod is constant

D. (d)velocity of end A is constant.

Watch Video Solution

27.



A uniform rod of mass m and length l is applied pivoted at point O. The rod is initially in vertical position and touching a block of mass M which is at rest on a horizontal surface. The rod is given a slight jerk and it starts rotating about point O this causes the block to move forward as shown The rod loses contact with the block at $\theta = 30^\circ$ all surfaces are smooth now answer the following questions.

Q. The value of ratio M/m is a) 2:3 b) 3:2 c) 4:3 d) 3:4

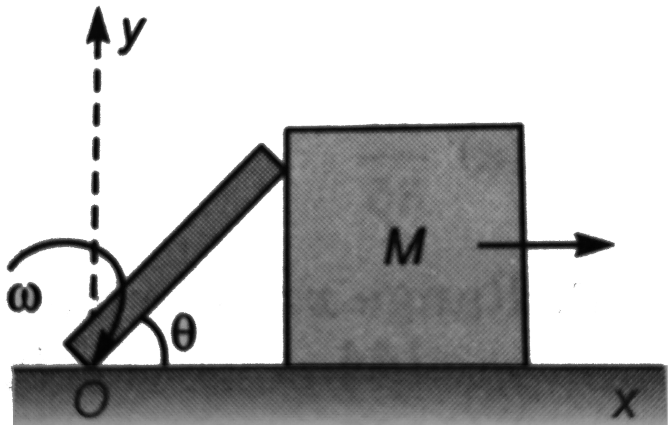
A. $(a)2:3$

B. $(b)3:2$

C. $(c)4:3$

D. $(d)3:4$

Watch Video Solution

28. 

A uniform rod of mass m and length l is applied pivoted at point O. The rod is initially in vertical position and touching a block of mass M which is at rest on a horizontal surface. The rod is given a slight jerk and it starts rotating about point O this causes the block to move forward as shown The rod loses contact with the block at $\theta = 30^\circ$ all surfaces are smooth now answer the following questions.

Q. The velocity of block when the rod loses contact with the block is

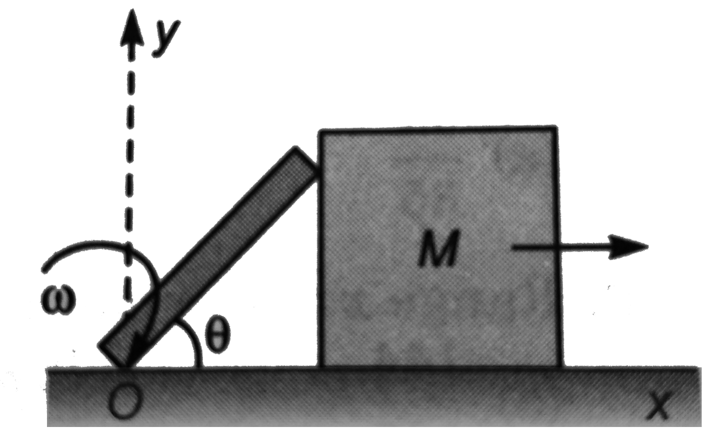
A. $\frac{\sqrt{3gl}}{4}$

B. $\frac{\sqrt{5gl}}{4}$

C. $\frac{\sqrt{6gl}}{4}$

D. $\frac{\sqrt{7gl}}{4}$

Watch Video Solution

29. 

A uniform rod of mass m and length l is applied pivoted at point O. The rod is initially in vertical position and touching a block of mass M which is at rest on a horizontal surface. The rod is given a slight jerk and it starts rotating about point O this causes the block to move forward as shown The rod loses contact with the block at $\theta = 30^\circ$ all surfaces are smooth now answer the following questions.

Q. The acceleration of centre of mass of rod, when it loses contact with the block is

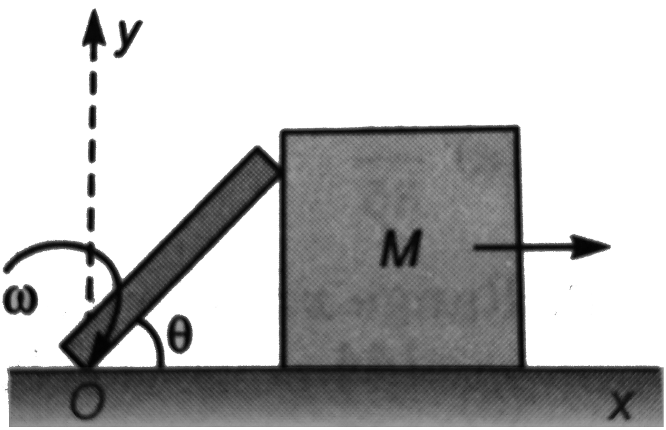
A. $5g/4$

B. $5g/2$

C. $3g/2$

D. $3g/4$

Watch Video Solution

30. 

A uniform rod of mass m and length l is applied pivoted at point O. The rod is initially in vertical position and touching a block of mass M which is at rest on a horizontal surface. The rod is given a slight jerk and it starts rotating about point O this causes the block to move forward as shown The rod loses contact with the block at $\theta = 30^\circ$ all surfaces are smooth now answer the following questions.

Q. The hinge reaction at O on the rod when it loses contact with the block is

A. $\frac{3mg}{4}\left(\hat{i}+\hat{j}\right)$

B. $\left(\frac{mg}{4}\right)\hat{j}$

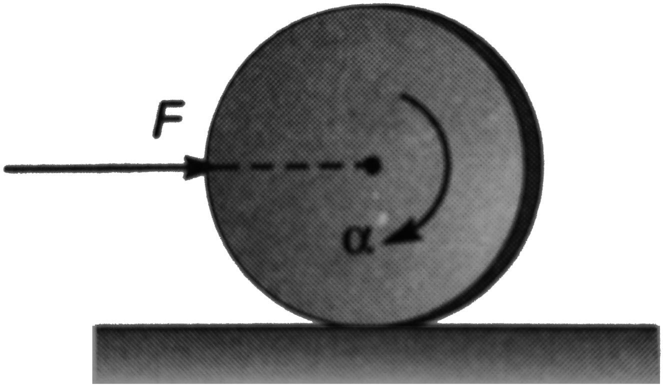
C. $\left(\frac{mg}{4}\right)\hat{i}$

D. $\frac{mg}{4}\left(\hat{i}+\hat{j}\right)$

Watch Video Solution

31. Consider a uniform disc of mass m, radius r rolling without slipping on a rough surface with linear acceleration a and angular acceleration α due to an external force F as shown in the figure coefficient of friction is μ.

Q. The work done by the frictional force at the instant of pure rolling is



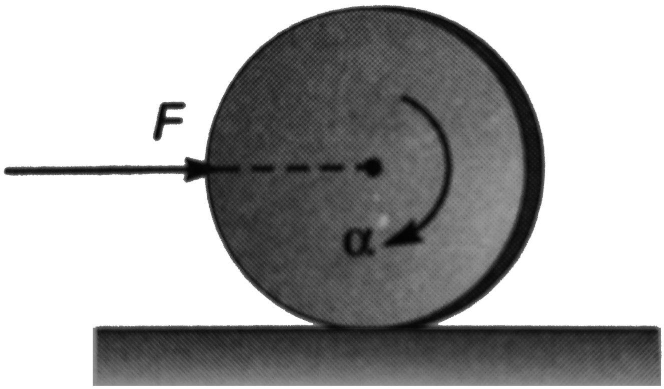
A. $\frac{\mu mgat^2}{2}$

B. $\mu mgat^2)$

C. $\mu m\frac{g(at^2)}{\alpha}$

D. zero

Watch Video Solution

32. 

Consider a uniform disc of mass m, radius r rolling without slipping on a rough surface with linear acceleration a and angular acceleration α due to an external force F as shown in the figure coefficient of friction is μ.

Q. The magnitude of frictional force acting on the disc is

A. ma

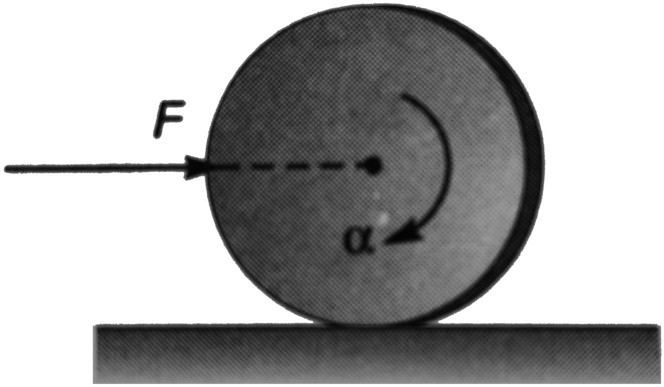
B. μmg

C. $\frac{ma}{2}$

D. zero

Watch Video Solution

33.



Consider a uniform disc of mass m, radius r rolling without slipping on a rough surface with linear acceleration a and angular acceleration α due to an external force F as shown in the figure coefficient of friction is μ.

Q. Angular momentum of the disc will be conserved about

A. centre of mass

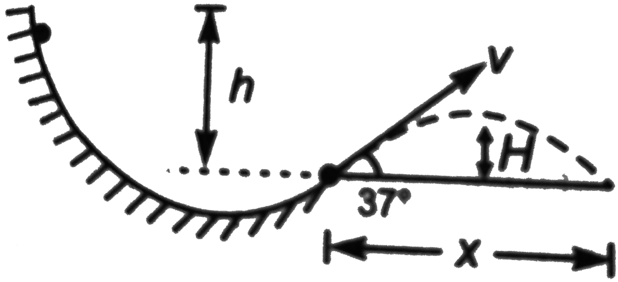
B. point of contact

C. a point at a distance $3R/2$ vertically above the point of contact

D. a point at a distance $4R/3$ vertically above the point of contact.

Watch Video Solution

34.



A tennis ball, starting from rest, rolls down the hill in the drawing. At the end of the hill the ball becomes airborne, leaving at an angle of 37° with respect to the ground treat the ball as a thin-walled spherical shell.

Q. The velocity of projection v is

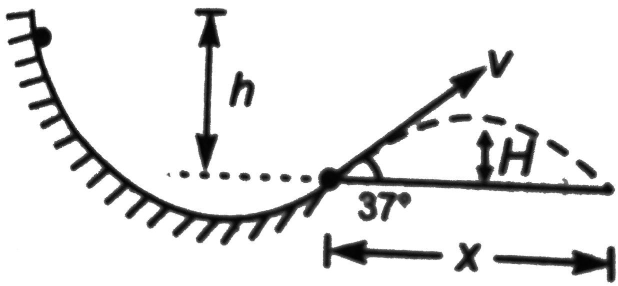
A. $\sqrt{2gh}$

B. $\sqrt{\frac{10}{7}gh}$

C. $\sqrt{\frac{5}{7}gh}$

D. $\sqrt{\frac{6}{5}gh}$

Watch Video Solution



35.

A tennis ball, starting from rest, rolls down the hill in the drawing. At the end of the hill the ball becomes airborne, leaving at an angle of 37° with respect to the ground treat the ball as a thin-walled spherical shell.

Q. Maximum height reached by ball H above ground is

A. $\frac{9h}{35}$

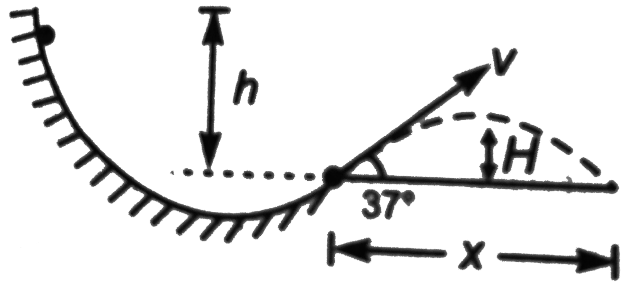
B. $\frac{18h}{35}$

C. $\frac{18h}{25}$

D. $\frac{27h}{125}$

Watch Video Solution

36.



A tennis ball, starting from rest, rolls down the hill in the drawing. At the end of the hill the ball becomes airborne, leaving at an angle of 37° with respect to the ground treat the ball as a thin-walled spherical shell.

Q. Range x of the ball is

A. $\frac{144}{125}h$

B. $\frac{48}{25}h$

C. $\frac{48}{35}h$

D. $\frac{24}{7}h$

Watch Video Solution

Level 2

1.

A disc of radius R is spun to an angualr speed ω_0 about its axis and then imparted a horizontal velocity of magnitude $\frac{\omega_0 R}{4}$. The coefficient of friction is μ. The sense of rotation and direction of linear velocity are shown in the figure. The disc will return to its initial position.

A. if the value of $\mu < 0.5$

B. irrespective of the value of μ

C. if the value of $0.5 < \mu < 1$

D. if $\mu > 1$

Watch Video Solution

Level 2 Subjective

1\.

Figure shows three identical yo-yos initially at rest on a horizontal surface. For each yo-yo the string is pulled In the direction shown. In each case there is sufficient friction for the yo-

yo to roll without slipping. Draw the free-body diagram for each yo-yo in what direction will each yo-yo rotate?

Watch Video Solution

2.

A uniform rod of mass m and length l is held horizontally by two vertical strings of negligible mass, as shown in the figure.

(a). Immediately after the right string is cut, what is the linear acceleration of the end of the rod?

(b). Of the middle of the rod?

(c). Determine the tension in the left string immediately after the right string is cut.

Watch Video Solution

3. A solid disk is rolling without slipping on a level surface at a constant speed of $2.00m/s$. How far can it roll up a 30° ramp before it stops? (take $g = 9.8m/s^2$)

Watch Video Solution

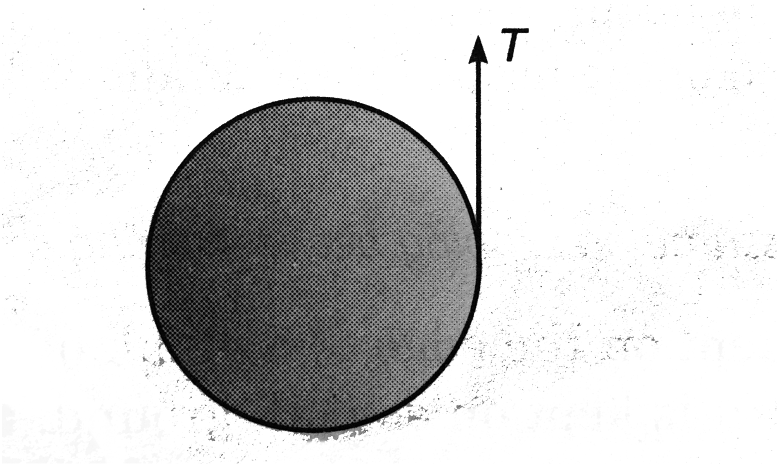
4. A lawn roller in the form of a thin-walled hollow cylinder of mass M is pulled horizotally with a constant horizontally force F applied by a handle attached to the axle. If it rolls without slipping. Find the acceleration and the friction forces.

Watch Video Solution

5.

Due to slipping points A and B on the rim of the disk have the velocities shown. Determine the velocities of the centre point C and point F at this instant.

Watch Video Solution

6. 

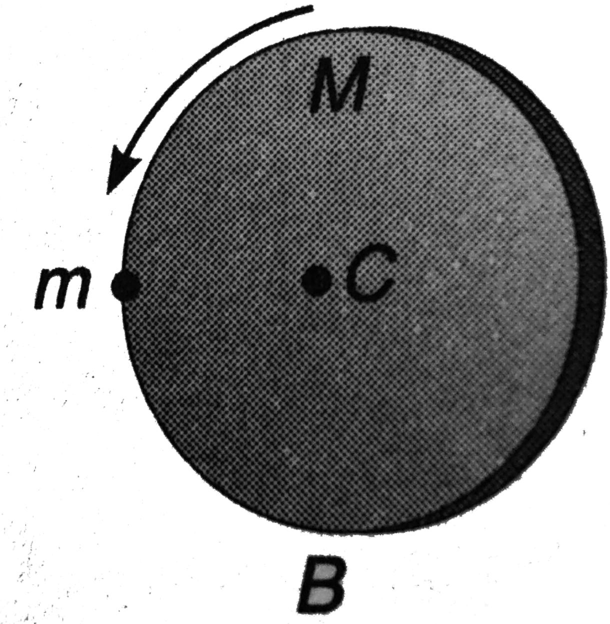
A uniform cylider of mass M and radius R has a string wrapped around it. The string is held fixed and the cylinder falls vertically, as in figure.

(a). Show that the acceleration of the cylinder is downward with magnitude $a = \frac{2g}{3}$

(b). Find the tension in the string.

Watch Video Solution

disc when m reache



7.

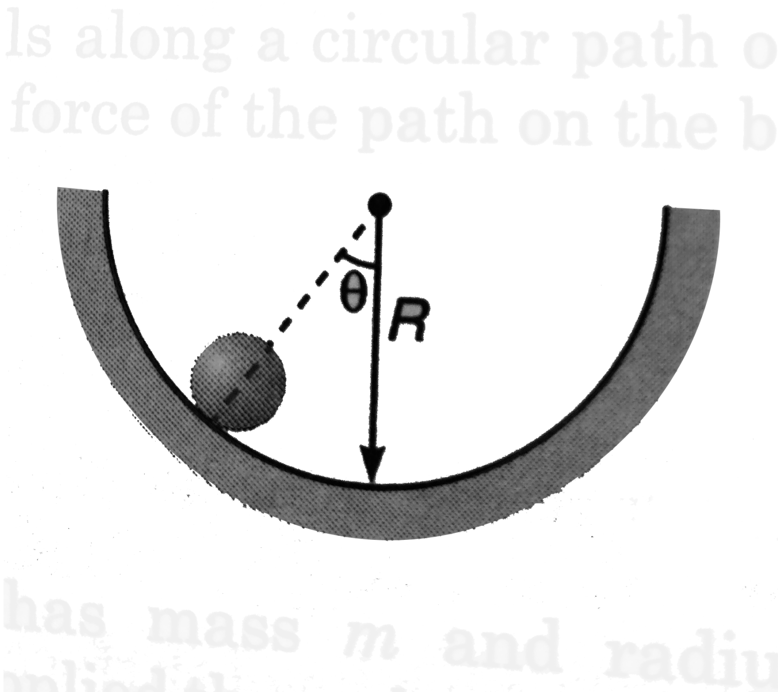
A uniform disc of mass M and radius R is pivoted about the horizontal axis through its centre C A point mass m is glued to the disc at its rim, as shown in figure. If the system is released from rest, find the angular velocity of the disc when m reaches the bottom point B.

Watch Video Solution

8. A disc of radius R and mass m is projected on to a horizontal floor with a backward spin such that its centre of mass speed is v_0 and angular velocity is ω_0. What must be the minimum value of ω_0 so that the disc eventually returns back?

Watch Video Solution

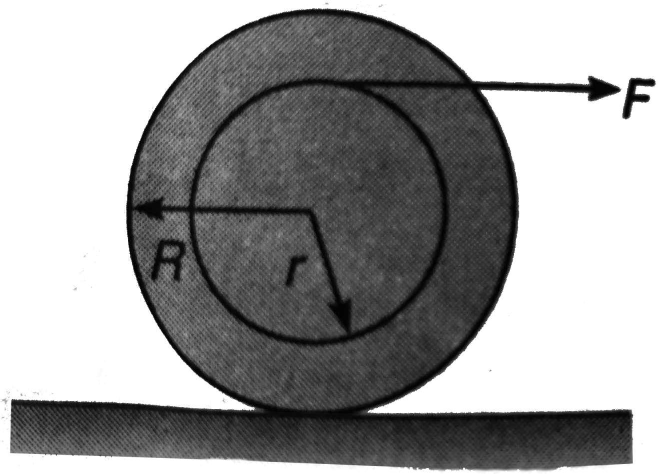
9.



A ball of mass m and radius r rolls along a circular path of radius R its speed at the bottom $(\theta = 0^\circ)$ of the path is v_0 find the force of the path on the ball as a function of θ.

Watch Video Solution

10.



A heavy homogeneous cyliner has mass m and radius R. It is accelerated by a force F which is applied through a rope wound around a light drum of radius r attached to the cylinder (figure) the coefficient of static friction is sufficient for the cylinder to roll without slipping.

A. Find the friction force.

B. Find the acceleration a of the centre of the cylinder

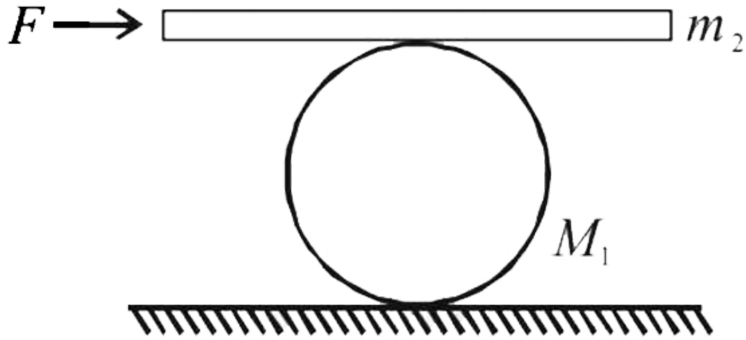
C. it is possible to choose r, so that a is greater than $\frac{F}{m}$? How ?

D. What is the direction of the friction in the circumstances of part(C)?

Watch Video Solution

11. A man pushes a cylinder of mass m_1 with the help of a plank of mass m_2 as shown in figure. There in no slipping at any contact. The horizontal component of the force applied by the man is F.

(a) the acceleration fo the plank and the center of mass of the cylinder, and



(b) the magnitudes and direction of frictional force at contact points.

Watch Video Solution

12. 

For the system shown in figure, $M = 1kg$ $m = 0.2$ kg, $r = 0.2m$ calculate

$(g = 10m / s^2)$

(a). The linear acceleration of hoop,

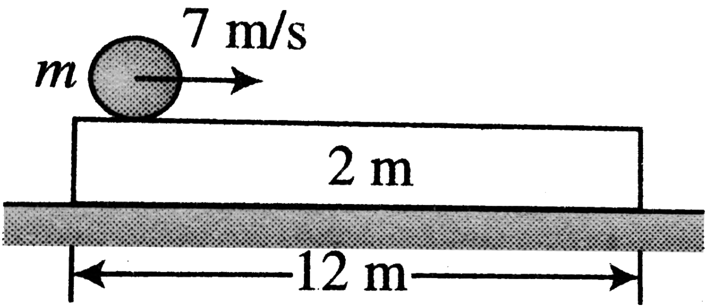
(b). The angular acceleration of the hoop of mass M and

(c). The tension in the rope.

Watch Video Solution

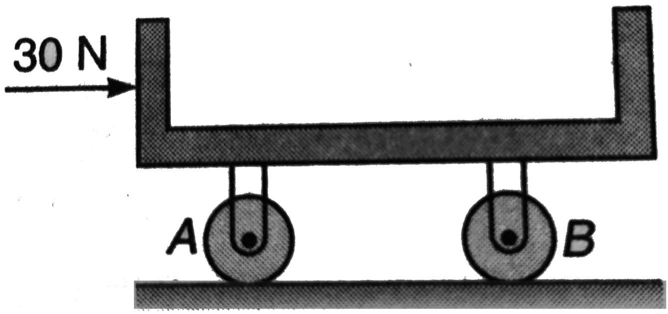
13. A cylinder of mass m is kept on the edge of a plank of mass $2m$ and length $12m$, which in turn is kept on smooth ground. Coefficient of friction between the plank and the cylinder is

0.1. The cylinder is given an impulse, which imparts it a velocity $7ms^{-1}$ but no angular velocity. Find the time after which the cylinder falls off the plank.



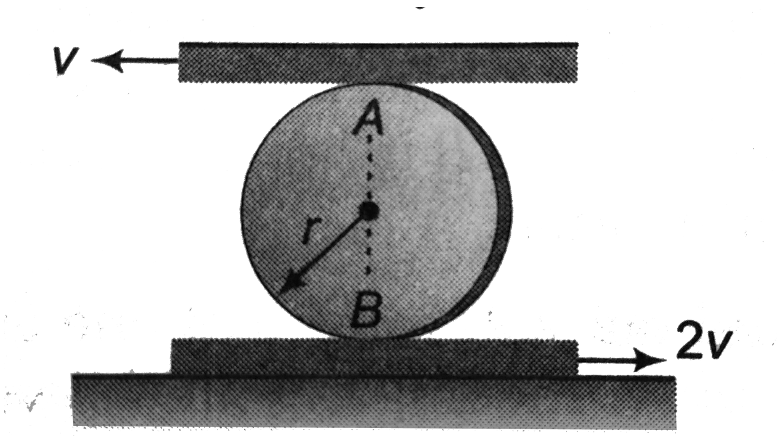
Watch Video Solution

14.



The 9 kg cradle is supported as shown by two uniform disks that roll without sliding at all surfaces of contact. The mass of each disk is $m = 6kg$ and the radius of each disk is $r = 80mm$. Knowing that the system is initially at rest, determine the velocity of the cradle after it has moves 250 mm.

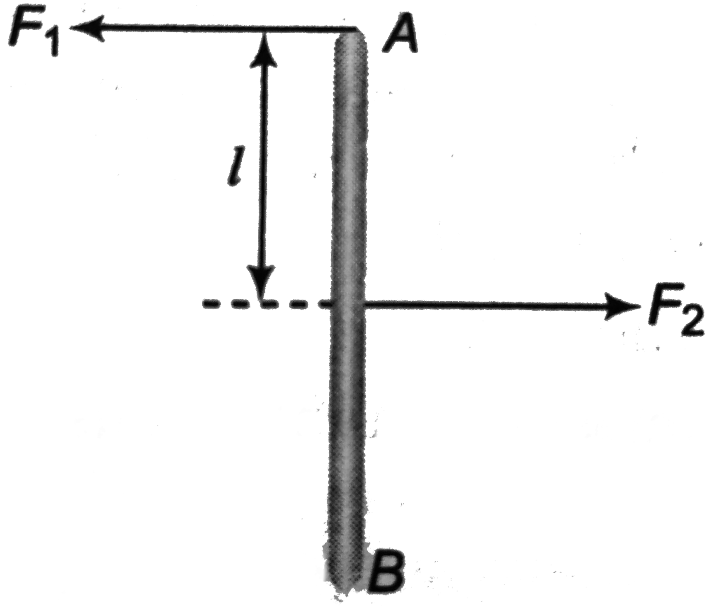
Watch Video Solution

15. 

the disc of the radius r is confined to roll without slipping at A and B if the plates have the velocities shown, determine the angular velocity of the disc.

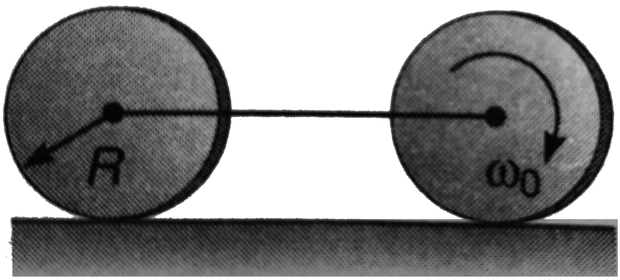
Watch Video Solution

16.



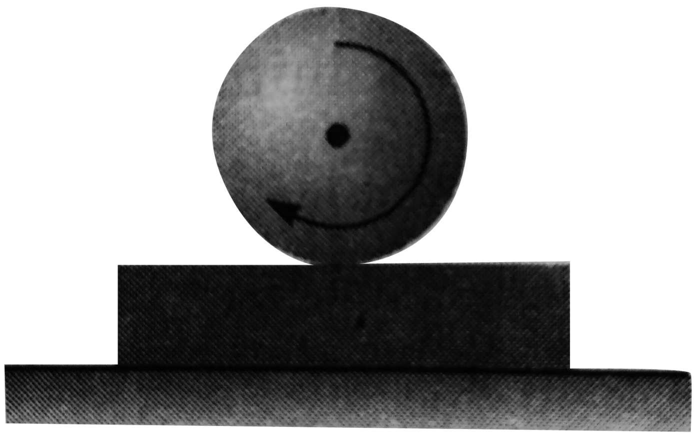
A thin uniform rod AB of mass $m = 1kg$ moves translationally with acceleration $a = 2m/s^2$ and to two anitiparallel forces F_1 and F_2. The distance between the points at which these forces are applied is equal to $l = 20cm$ besides it is known that $F_2 = 5N$ find the length of the rod.

Watch Video Solution

17. 

The assembly of two discs as shown in figure is placed on a rough horizontal surface and the front disc is given an initial angular velocity ω_0. Determine the final linear and angular velocity when both the discs start rolling. it is given that friction is sufficient to sustain rolling the rear wheel from the starting of motion.

Watch Video Solution



18.

A horizontal plank having mass m lies on a smooth horizontal surface. A sphere of same mass and radius r is spined to angular frequency ω_0 and gently placed on the plank as shown in the figure. If coefficient of friction between the plank and the sphere is μ. Find the distance moved by the plank till sphere starts pure rolling on the plank. the plank is long enough.

Watch Video Solution

19. A ball rolls without sliding over a rough horizontal floor with velocity $v_0 = 7m/s$

towards a smooth vertical wall. If coefficient of restitution between the wall and the ball is $e = 0.7$. Calculate velocity v of the ball after the collision.

Watch Video Solution

20. A sphere a disk and a hoop made of homogeneous materials have the same radius (10 cm) and mass (3kg) They are released from rest at the top of a 30° incline and roll down without slipping through a vertical distance of

2m. $\left(g = 9.8m / s^2\right)$

(a). What are their speeds at the bottom?

(b). findt the friction force f each case

(c). if they start together at $t = 0$, at what time does each reach the bottom?

Watch Video Solution

21. ABC is a triangular framwork of three uniform rods each of mass m and length $2l$. It is free to rotate in its own plane about a smooth horizontal axis through A which is perpendicular to ABC. If it is released from rest when AB is horizontal and C is above AB. Find the maximum velocity of C in the subsequent motion.

Watch Video Solution

22. A uniform stick of length L and mass M hinged at end is released from rest at an angle θ_0 with the vertical show that when the angle with the vertical is θ. The hinge exerts of force F_r along the stick and F_t perpendicular tot he stick given by $F_r = \frac{1}{2}Mg(5\cos\theta - 3\cos\theta_0)$ and $F_t = \frac{1}{4}Mg\sin\theta$

Watch Video Solution

23. A uniform rod AB of mass 3m and length 4l, which is free to turn in a vertical plane about a smooth horizontal axis through A, is released from rest when horizontal. When the rod first becomes vertical, a point C of the rod, where AC=3l strikes a fixed peg. Find the linear impulse exerted by the peg on the rod if (a). The rod is brought to rest by the peg.

(b). The rod rebounds and next comes to instantaneous rest inclined to the downward vertical at an angle $\frac{\pi}{3}$ radian.

Watch Video Solution

24.

A uniform rod of length 4l and mass m is free to rotate about a horizontal axis passing through a point distant l from its one end.

When the rod is horizontal its angular velocity is ω as shown in figure. calculate

(a). reaction of axis at this instant,

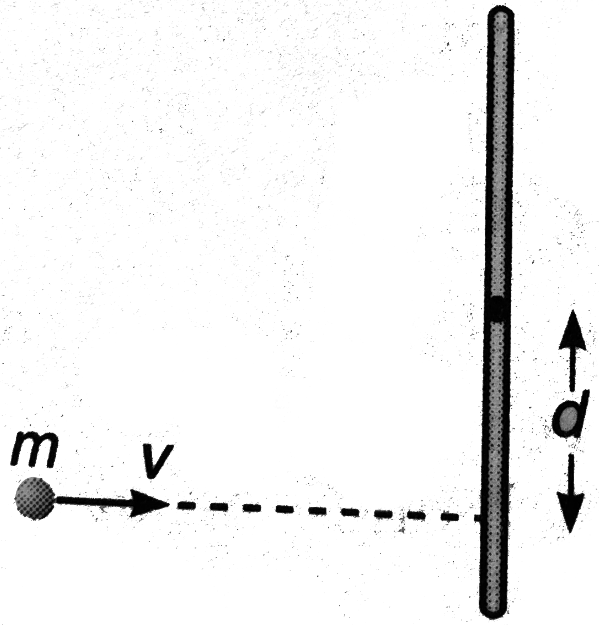
(b). Acceleration of centre of mass of the rod at this instant.

(c). reaction of axis and acceleration of centre mass of the rod when rod becomes vertical for the first time.

(d). minimum value of ω, so that centre of rod can complete circular motion.

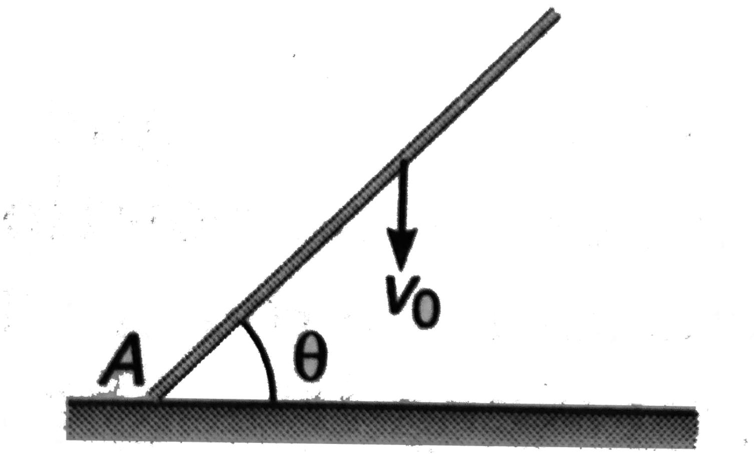
Watch Video Solution

25.



A stick of length l lies on horizontal table. It has a mass M and is free to move in any way on the table. A bal of mass m moving perpendicularly to the stick at a distance d from its centre with speed v collides elastically with it as shown in figure. what quantities are conserved in the collision ? what must be the mass of the ball, so that it remains at rest immediately after collision?

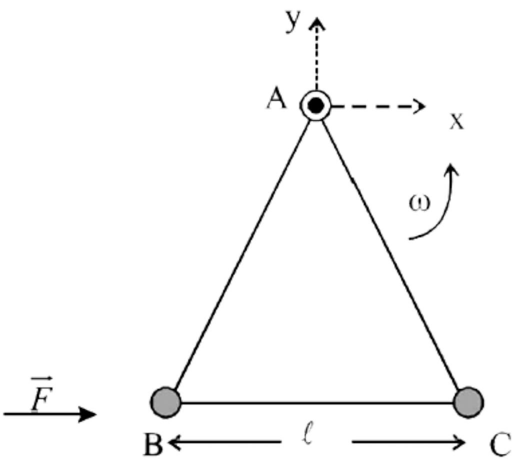
Watch Video Solution

26. 

A rod of length l forming an angle θ with the horizontal strikes a frictionless floor at A with its centre of mass velocity v_0 and no angular velocity. Assuming that the impact at A is perfectly elastic. Find the angular velocity of the rod immediately after the impact.

Watch Video Solution

27. Three particles A, B and C each of mass m, are connected to each other by three massless rigid rods to form a rigid, equilateral triangular body of side l. This body is placed on a horizontal frictionless table (x-y plane) and is hinged to it at the point A so that it can move without friction about the vertical axis through A . the body is set into rotational motion on the table about A with a constant angular velocity ω.

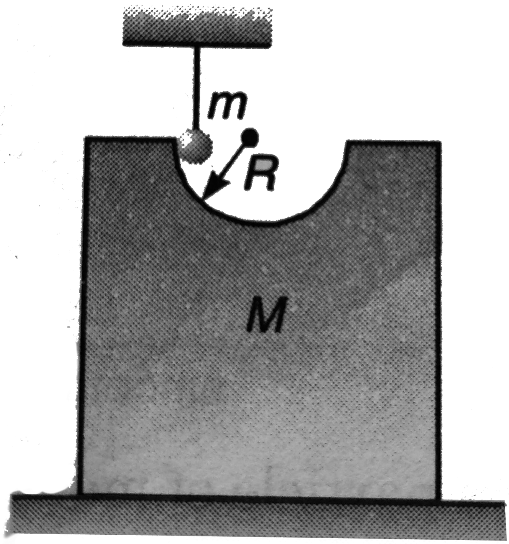


(a) Find the magnitude of the horizontal force exerted by the hinge on the body.

(b) At time T, when the side BC is parallel to the x-axis, a force F is applied on B along BC (as shown). Obtain the x-component and the y-component of the force exerted by the hinge on the body, immediately after time T.

Watch Video Solution

28.



A semicircular track of radius $R = 62.5 cm$ is cut in a block. Mass of block having track, is $M = 1 kg$ and rests over a smooth horizontal floor. A cylinder of radius $r = 10$cm and mass $m = 0.5 kg$ is hanging by thread such that axes of cylinder and track are in same level and surface of cylinder is in contact with the track as shown in figure When the thread is burnt, cylinder starts to move down the track. Sufficient friction exists between surface of cylinder and track, so that cylinder does not slip.

Calculate velocity of the block when it reaches bottom of the track. Also find force applied by block on the floor at that moment. $(g = 10m / s^2)$

Watch Video Solution

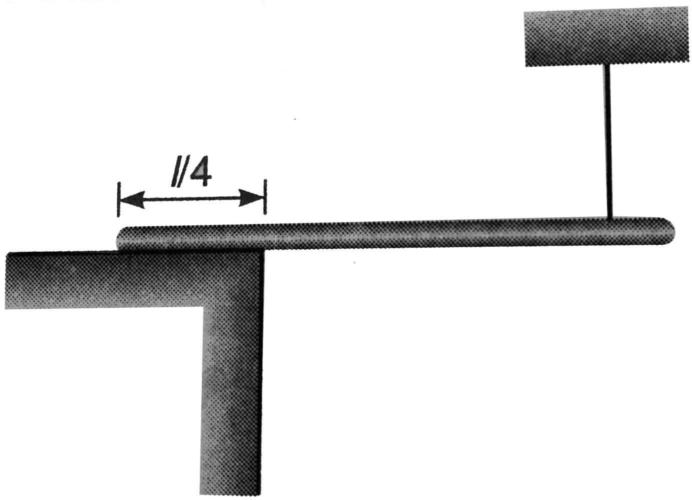
29. A uniform circular cylinder of mass m and radius r is given an initial angular velocity ω and no initial translational velocity it is placed in contact with a plane inclined at an angle α to the horizontal. If there is a coefficient of friction μ for sliding between the cylinder and plane. Find the distance the cylinder moves up before sliding stops also calculate the maximum distance it travels up the plane assume $\mu > \tan\alpha$.

Watch Video Solution

30. Show that if a rod held at angle θ to the horizontal and released, its lower end will not slip if the friction coefficient between rod and ground is greater than $\dfrac{3 \sin \theta \cos \theta}{1 + 3 \sin^2 \theta}$

Watch Video Solution

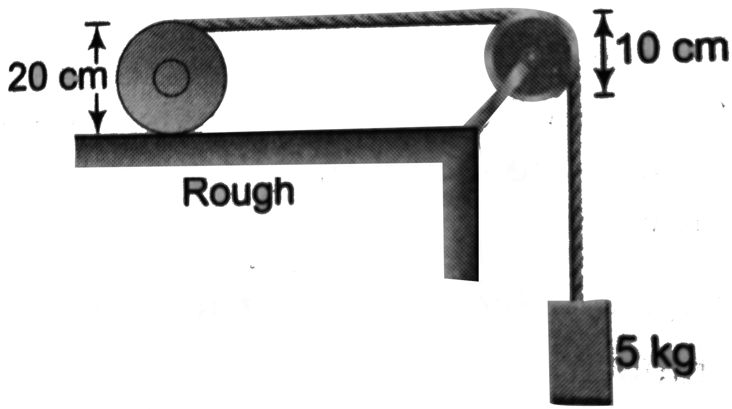
the surface is μ.



31.

One-fourth length of a uniform rod of mass m and length l is placed on a rough horizontal surface and it is held stationary in horizontal position by means of a light thread as shown in the figure. The thread is then burnt and the rod start rotating about the edge. Find the angle between the rod and the horizontal when it is about to slide on the edge. The coefficient of friction between the rod and surface is μ.

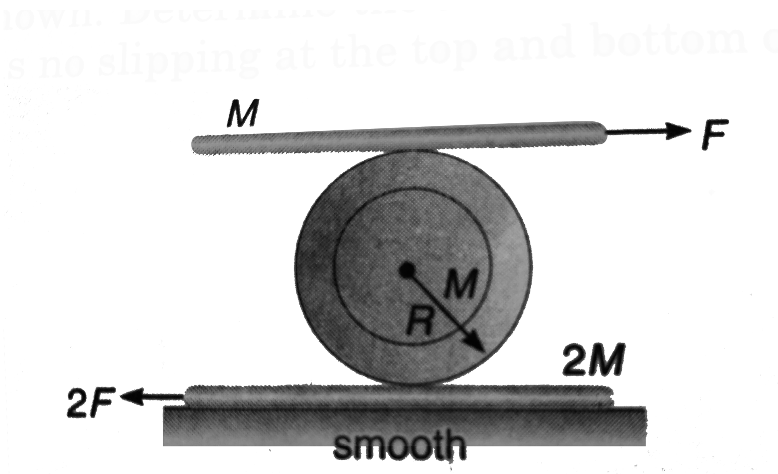
Watch Video Solution

32. 

in figure the cylinder of mass $10kg$ and radius 10 cm has a tape wrapped round it. The pully weighs 100 N and has a radius 5 cm. When the system is released the 5 kg mass comes down and the cylinder rolls without slipping. Calculate the acceleration and velocity of the mass as a function of time.

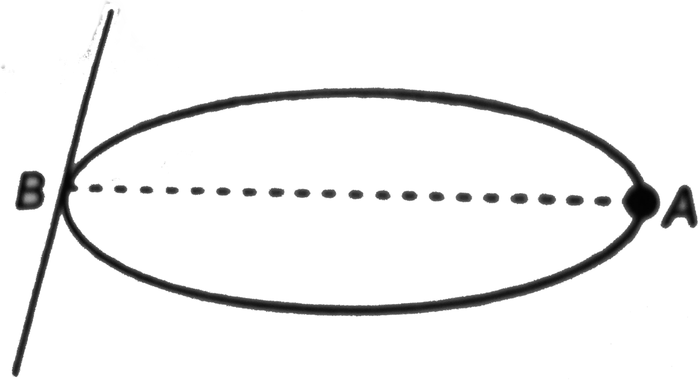
Watch Video Solution

33.



A cylinder is sandwiched between two planks. Two constant horizontal forces F and $2F$ are applied on the planks as shown. Determine the acceleration of the centre of mass of cylinder and the top plank. If there is no slipping at the top and bottom of cylinder.

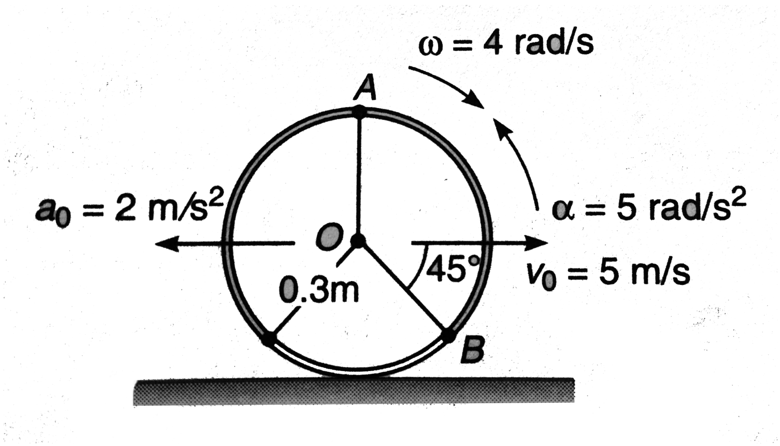
Watch Video Solution



34.

A ring of mass m and radius r has a particle of mass m attached to it at a point A. the ring can rotate about a smooth horizontal axis which is tangential to the ring at a point B diametrically opposite to A. The ring is released from rest when AB is horizontal. find the angular velocity and the angular acceleration of the body when AB has turned through an angle $\frac{\pi}{3}$.

Watch Video Solution

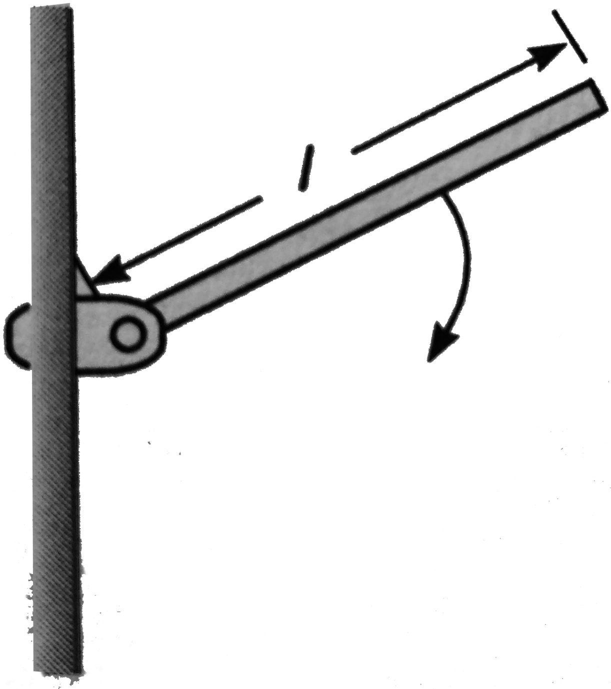
35. 

a hoop is placed on the rough surface such that it has an angular velocity $\omega = 4rad/s$ and an angular deceleration $\alpha = 5rad/s^2$

also its centre has a velocity of $v_0 = 5m/s$ and a deceleration $a_0 = 2m/s^2$ determine the magnitude of acceleration of point B at this instant.

Watch Video Solution

36.



A thin plank of mass M and length l is pivoted at one end. The plank is releaed at 60° from the vertical. What is the magnitude and direction of the force on the pivot when the plank is horizontal?

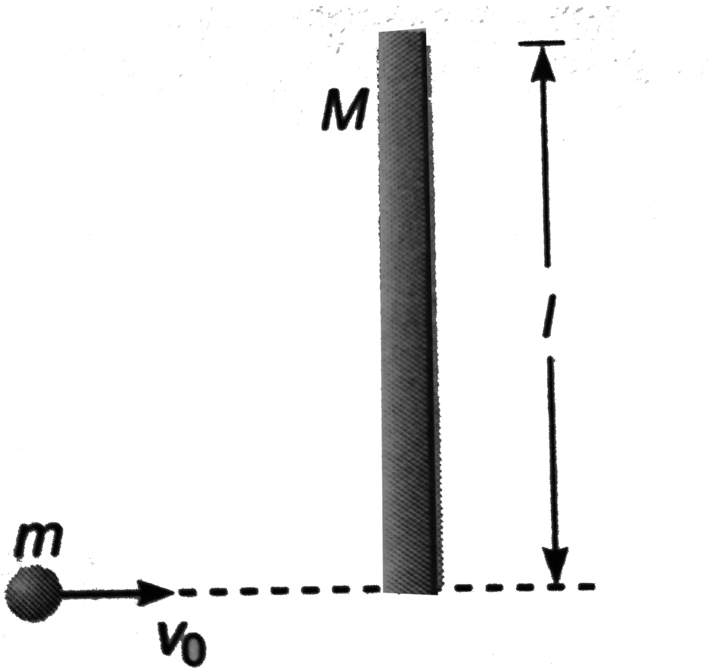
Watch Video Solution

Subjective Questions

1. A uniform rod of mass m and length l rests on a smooth horizontal surface. One of the ends of the rod is struck in a horizontal direction at right angles to the rod. As a result the rod obtains velocity v_0. Find the force with which one-half of the rod will act ont he other in the process of motion.

Watch Video Solution

2.



A boy mass m runs on ice with velocity v and steps on the end of a plank of length l and mass M which is perpendicular to his path.

(a). Describe quantitatively the motion of the system after the boy is on the plank. Neglect friction with the ice.

(b). One point on the plank is at rest immediately after the collision. Where is it?