PHYSICS

BOOKS - DC PANDEY PHYSICS (HINGLISH)

ROTATION

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.

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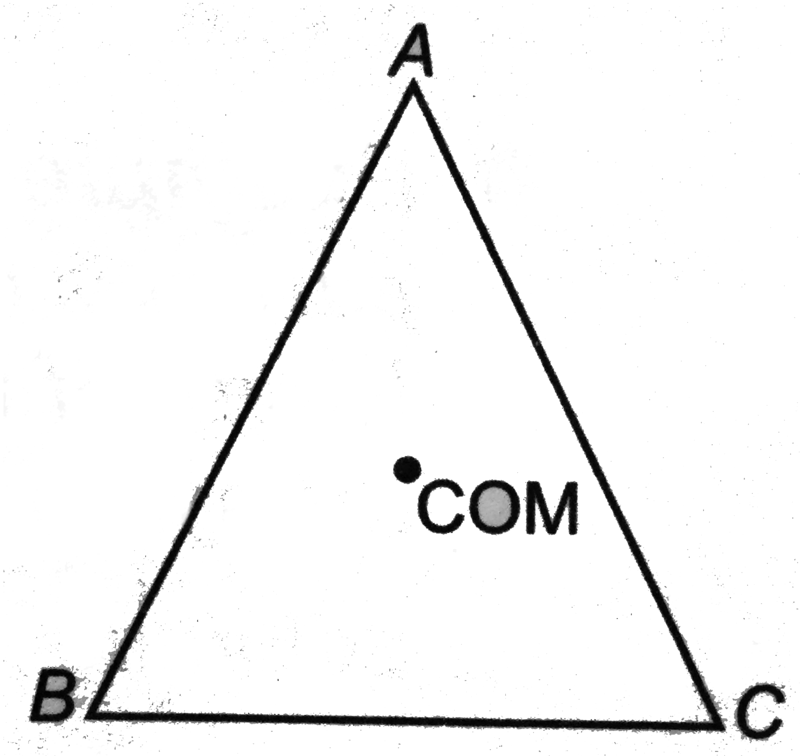
2. 

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 passig through its centre of mass and perpendicular to the plane of the particle.

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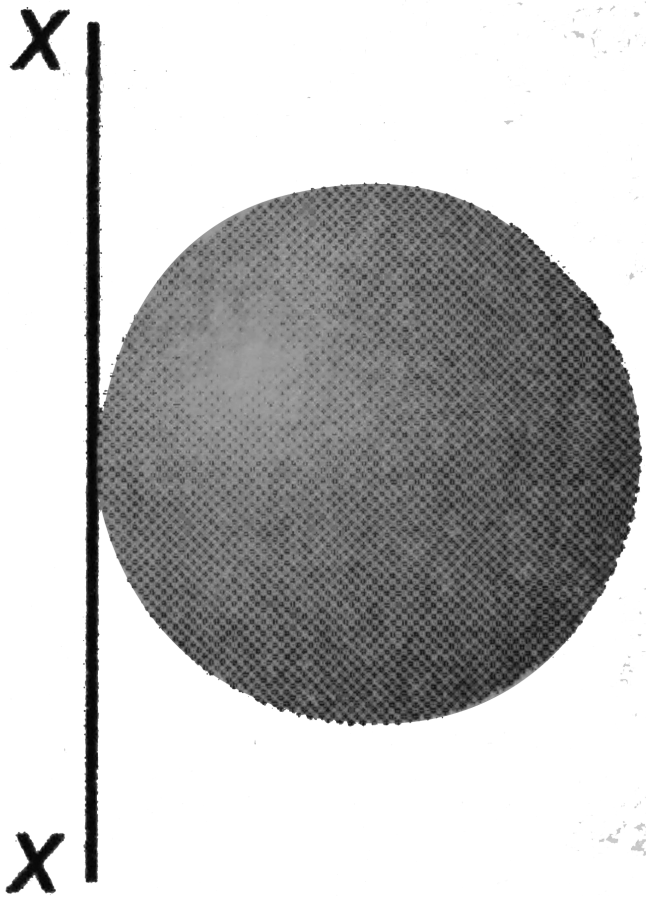
3.



Find the moment of inertia of a solid sphere of mass M and radias R about an axis XX shown in figure.

A. $\frac{7}{5}MR^2$

B. $\frac{4}{5}MR^2$

C. $\frac{3}{5}MR^2$

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

Answer: A

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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.

A. $\frac{5}{3}ml^2$

B. $\frac{7}{3}ml^2$

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

D. $\frac{11}{3}ml^2$

Answer: B

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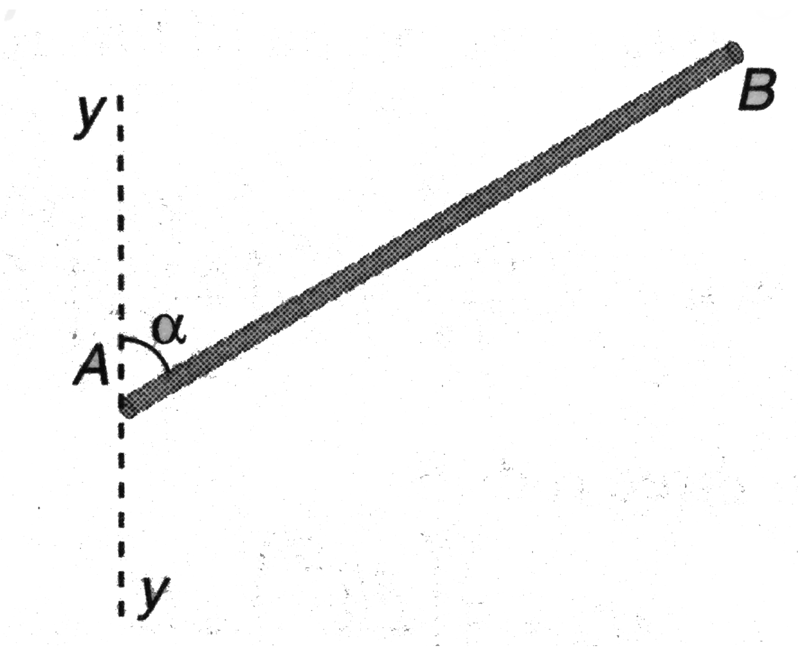
5. 

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.

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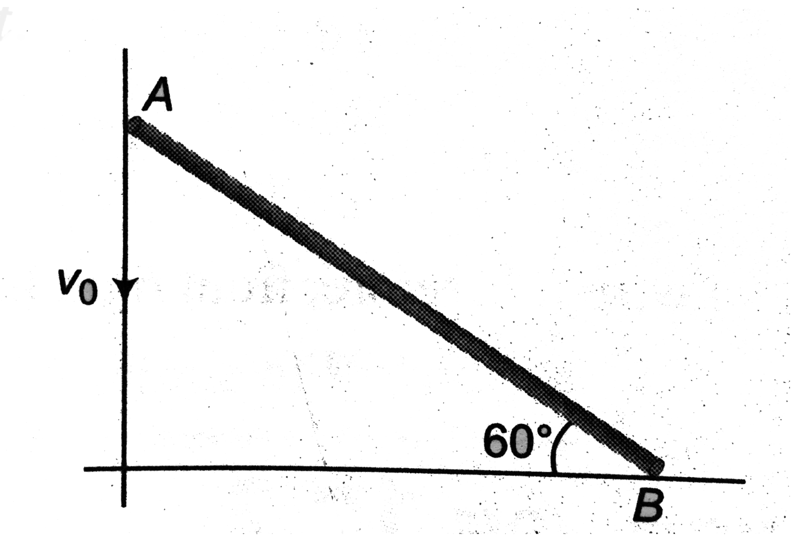
6. 

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.

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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.

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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 $g = 10m/s^2$]

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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.

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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 requird to rotate the sphere I that tim interval.

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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?

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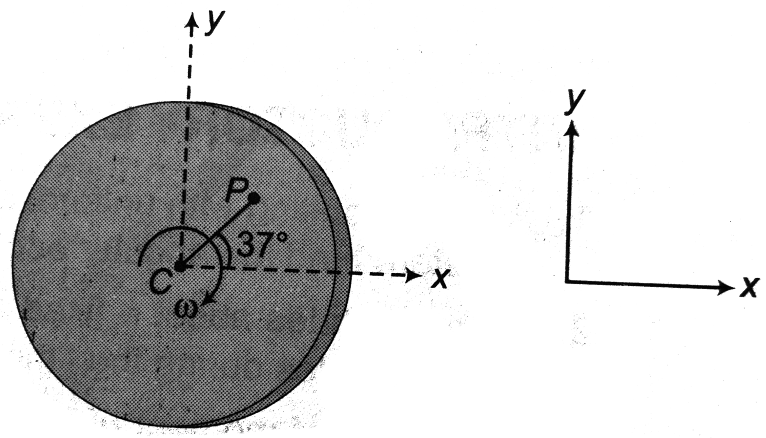

12.

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

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13. A particle of mass m is moving along the line $y = b, z = 0$ with constnat speed v. State whether the angular momentum of particle about origin is increasing. Decreasing or constant.

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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 strkes the ground again.

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15.

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

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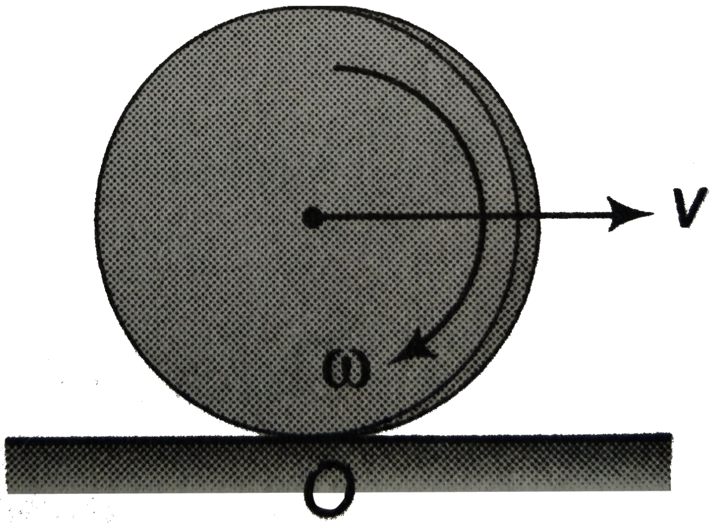
16. 

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 $\omega = \frac{v}{R}$ 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.

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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.

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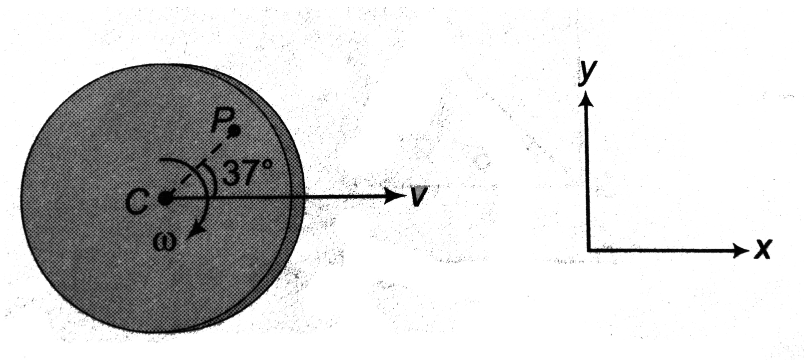
18. 

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

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

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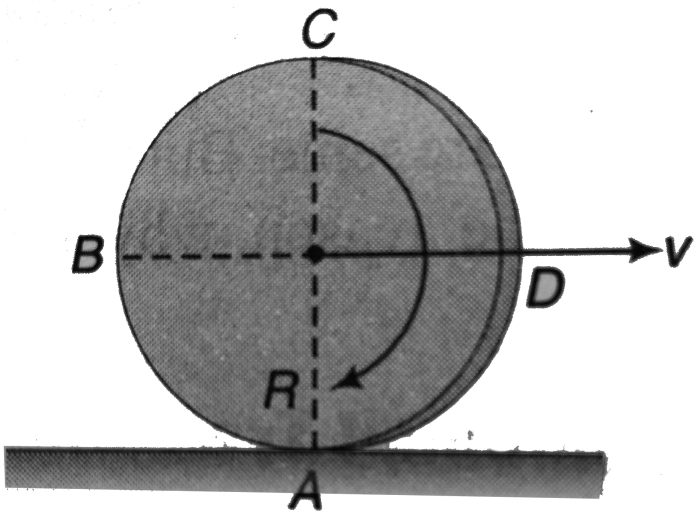
19. 

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

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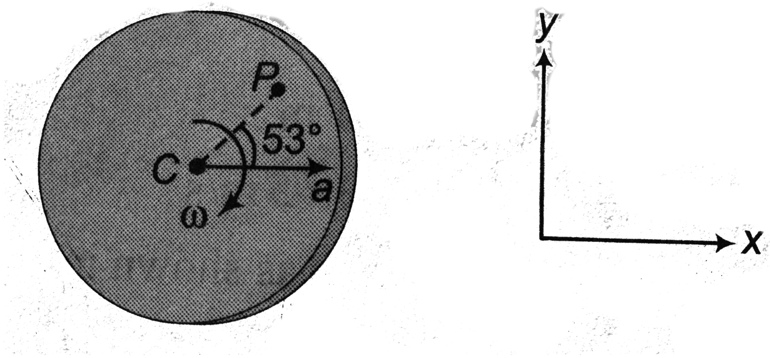
20. 

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

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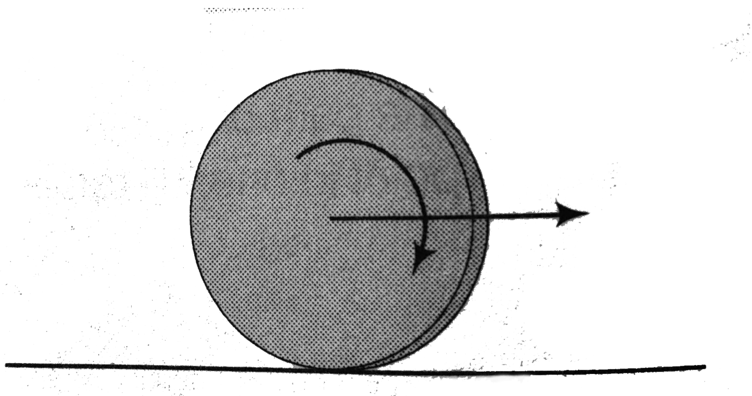
21.



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?

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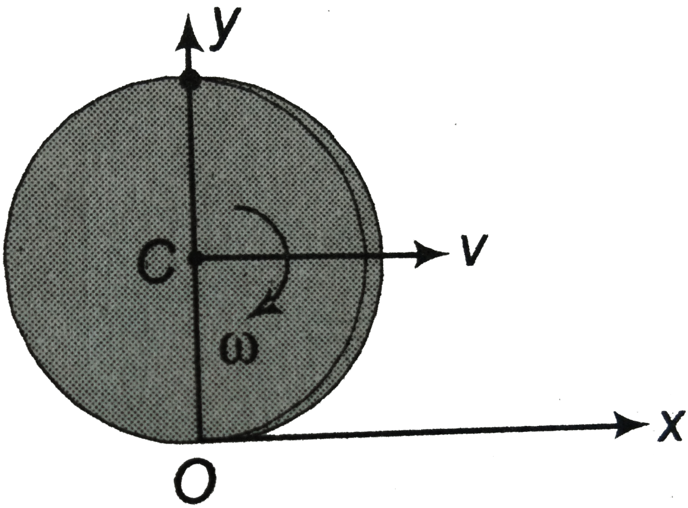
22.



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.

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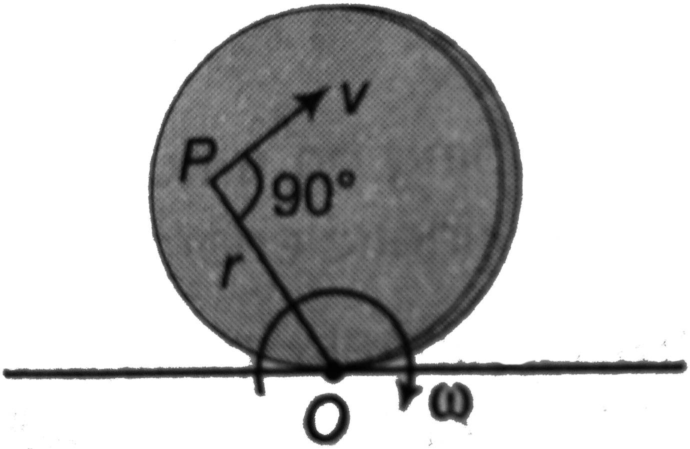
23. 

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

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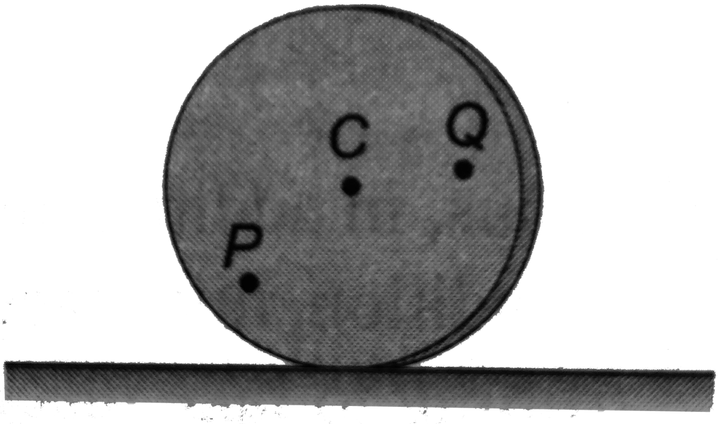
24. 

A disc is rolling (without slipping) on a horizontal surface. C is its centre and Q and P are two point equidistanec from C. let υ_p, υ_Q and υ_C be the magnitude of velocities of points P, Q, and C repsectively,

(a). $\upsilon_Q > \upsilon_C > \upsilon_P$

(b). $\upsilon_Q < \upsilon_C < \upsilon_P$

(c). $\upsilon_Q = \upsilon_P, \upsilon_C = \frac{1}{2}\upsilon_P$

(d). $\upsilon_Q < \upsilon_C > \upsilon_P$

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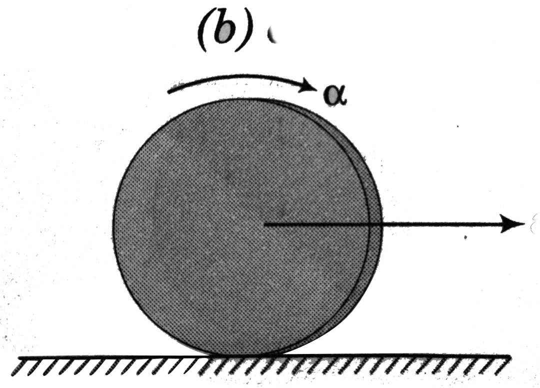

25.

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

(a). $a > R\alpha$

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

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

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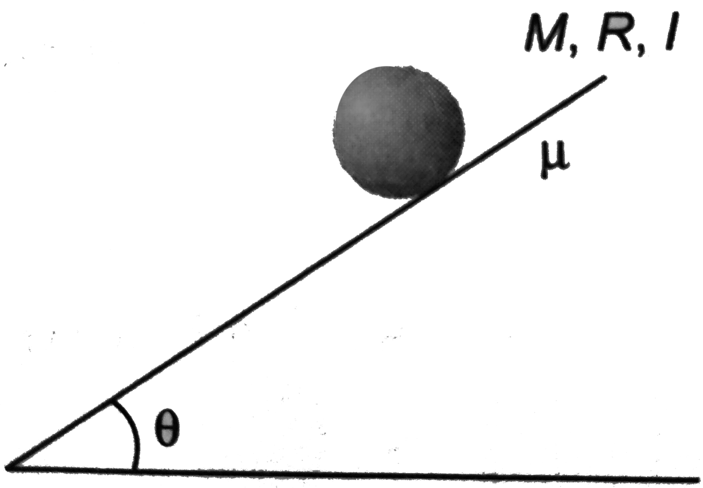
27.



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

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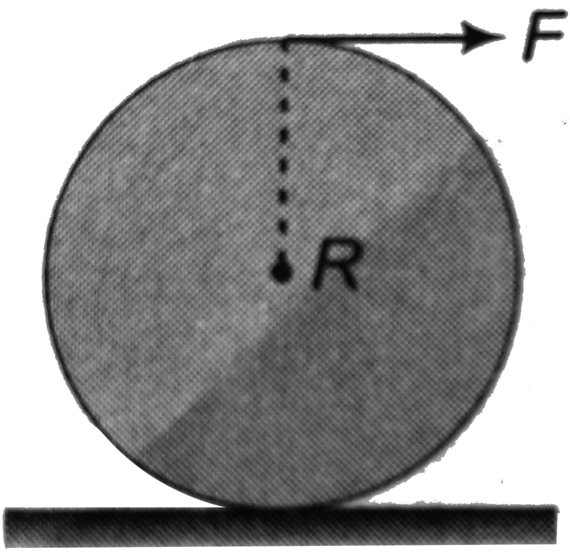

28.

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.

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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?

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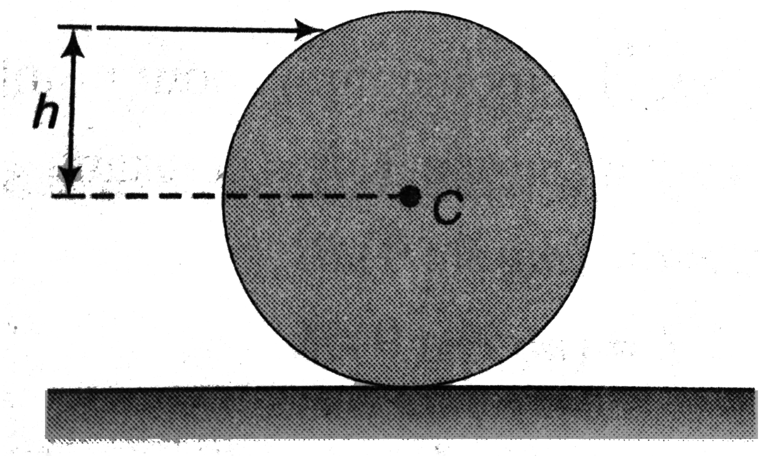
30. 

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 ?

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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.

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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?

A. mg

B. $\frac{mg}{3}$

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

D. $\frac{5mg}{3}$

Answer: C

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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.

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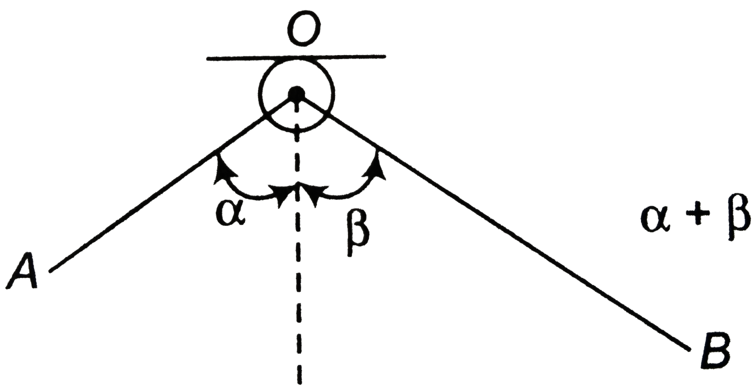
Solved Examples



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 equilibriu.

Find

(a). Relation between α and β

(b). Net hinge force.

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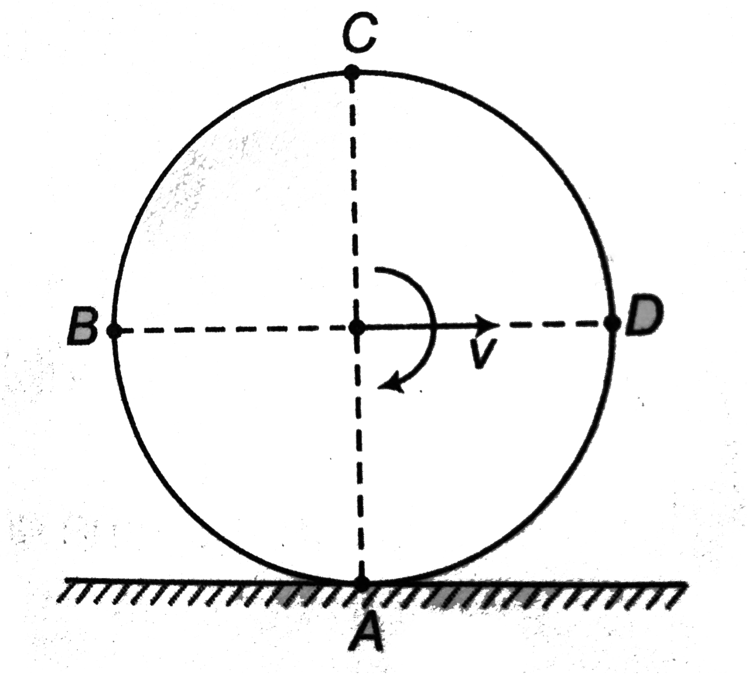
2. 

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.

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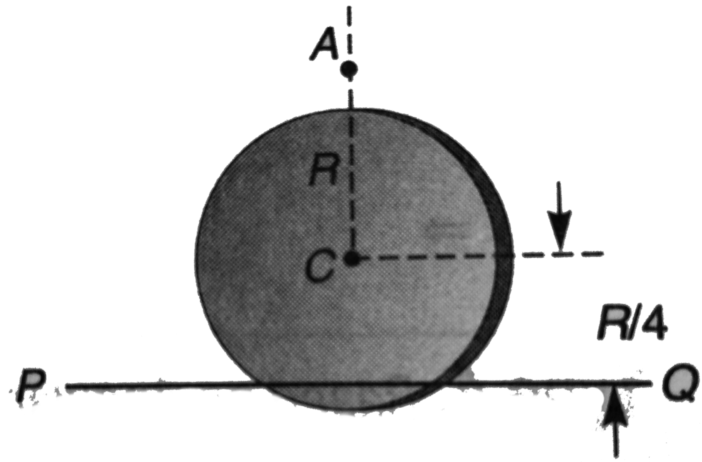
3. 

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.

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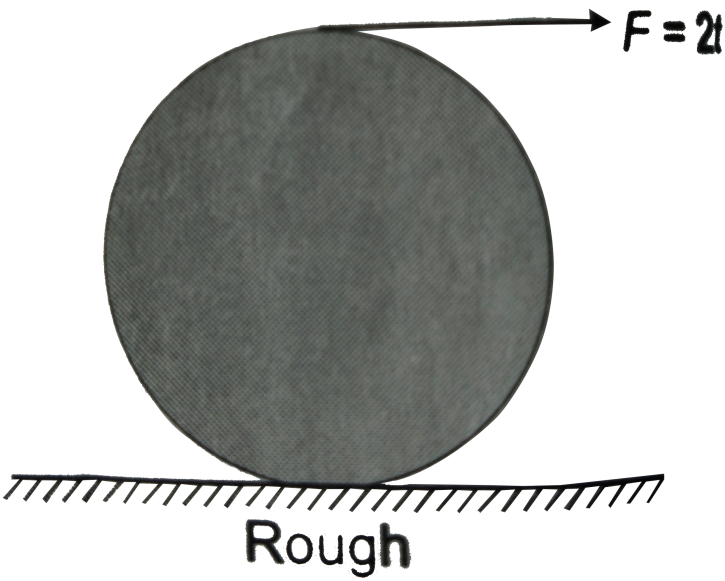
4.



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?

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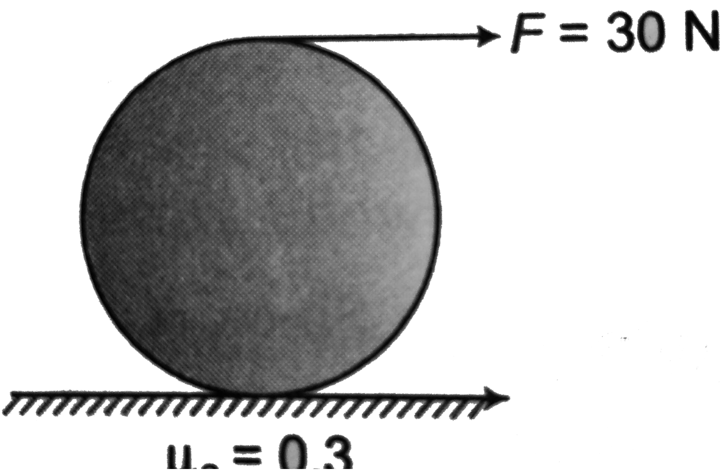
5. 

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 $g = 10m/s^2$

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

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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.

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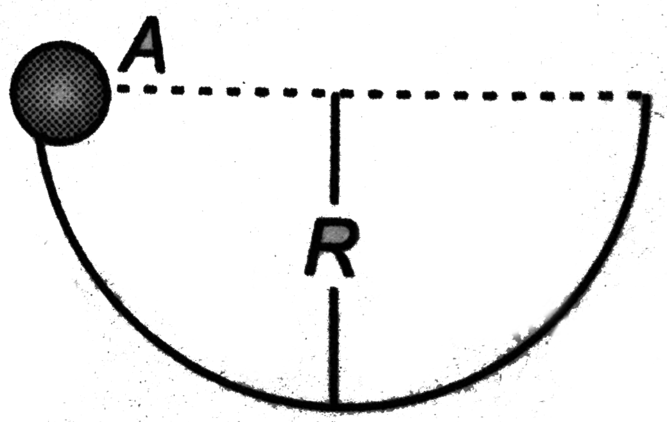

8.

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.

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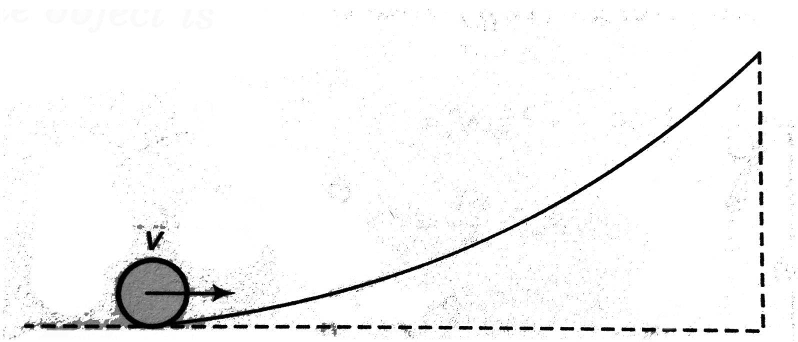
9. 

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

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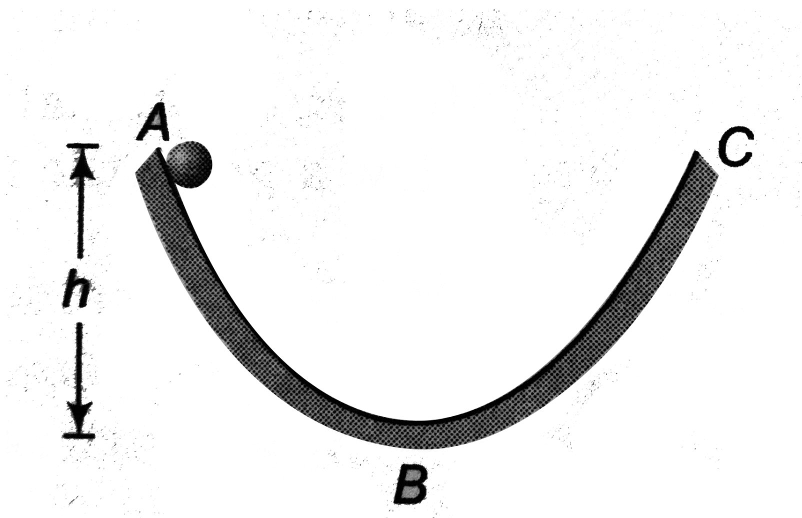

10.

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?

A. $\frac{3h}{5}$

B. $\frac{4h}{9}$

C. $\frac{5h}{7}$

D. None of these

Answer: C

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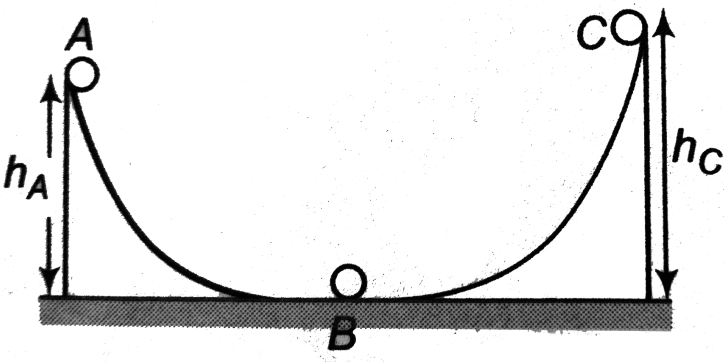
11. 

A ball moves over a fixed track as shown in thre 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). $h_A < h_C, K_B > K_C$

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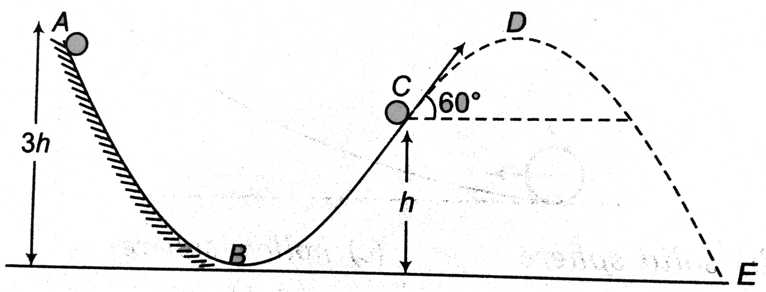
E.



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 $\left(K_R\right)$ ad translational kinetic energy $\left(K_T\right)$ at points A, B, C , D and E.

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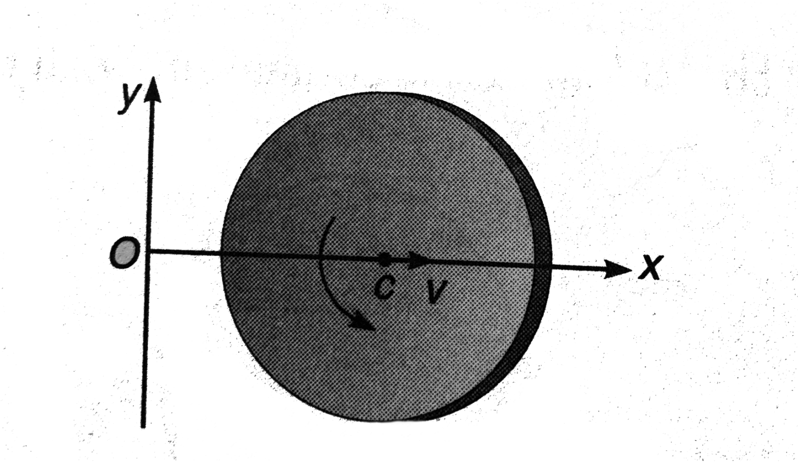
13. 

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 $alhpa$. the initial angular velocity is equal to zero.

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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.

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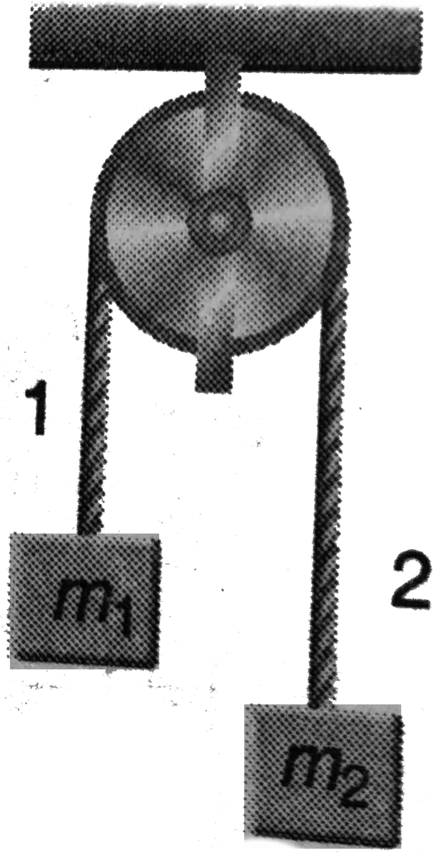

15.

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.

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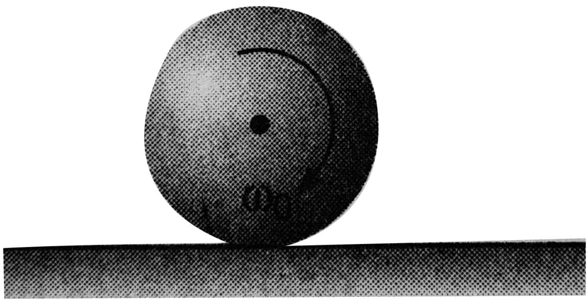

16.

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

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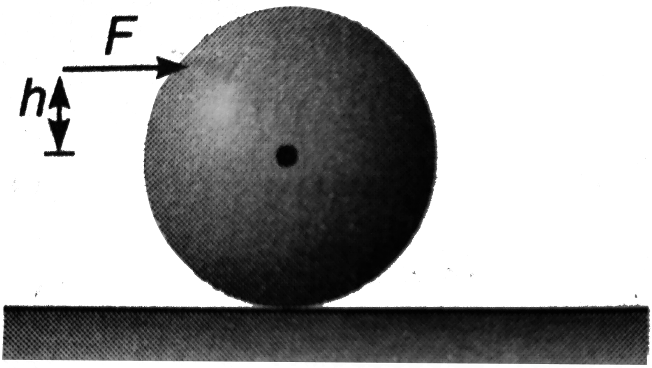

17.

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.

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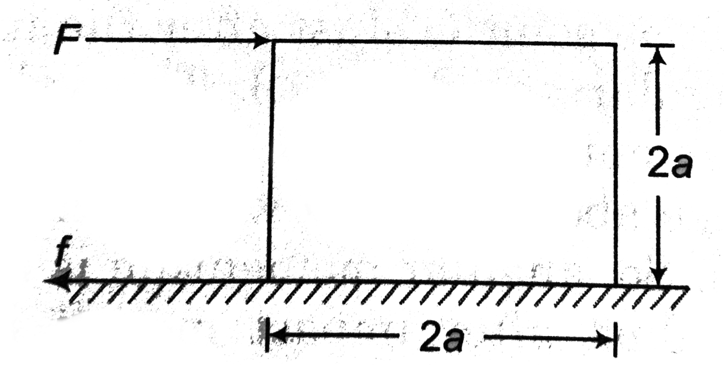
18. 

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

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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 enegy during impact

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

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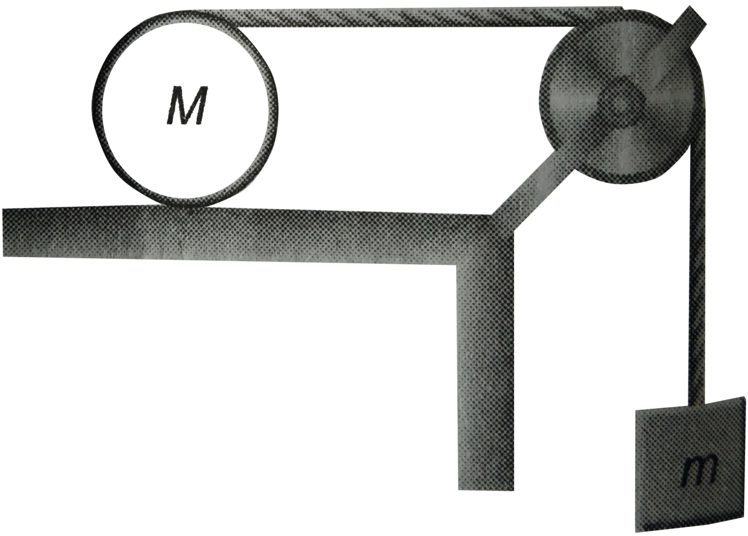

20.

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

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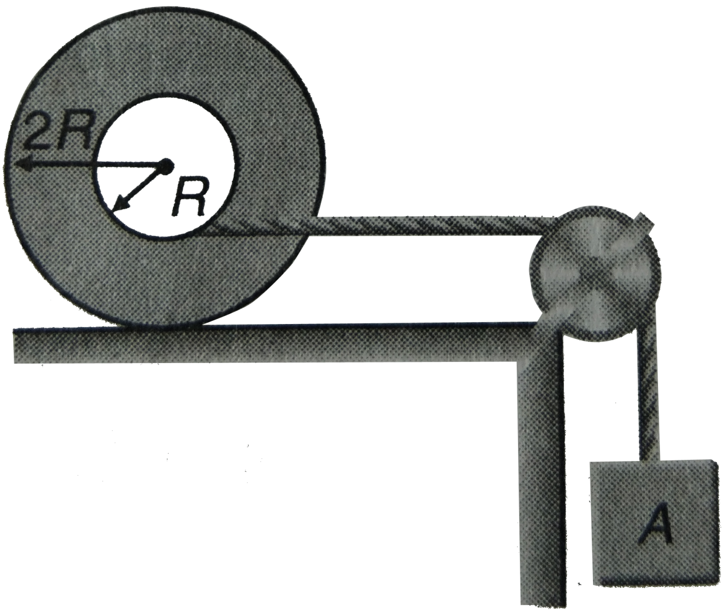
21. 

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.

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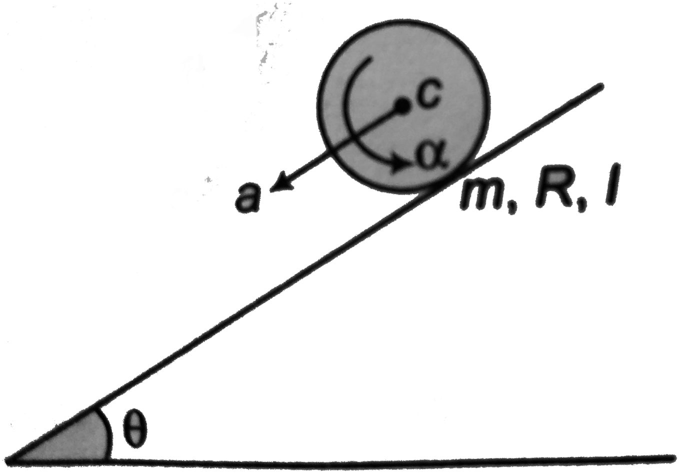
22. 

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.

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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

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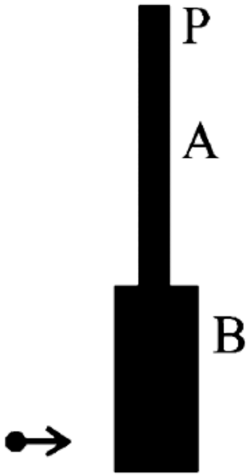
24. Two uniform thin rods A and B of length 0.6 m each and of masses 0.01 kg and 0.02kg respectively are rigidly joined end to end. The combination is pivoted at the lighter end, P as shown in fig. Such that it can freely rotate about point P in a vertical plane. A small object of mass 0.05kg, moving 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.



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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.

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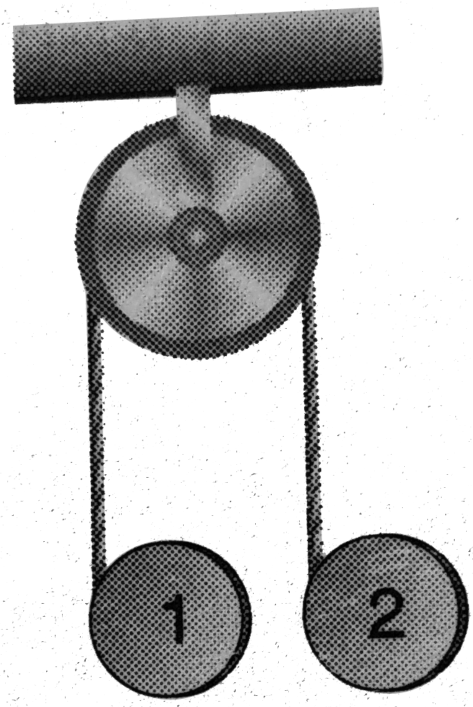
Miscellaneous Examples

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.

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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?

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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.

View Text 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 eneds and perpendicular to its length.

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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

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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.

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

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5. There are four solid balls with their centres at the four comers 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 (i) one of the sides of the square (ii) one of the diagonals of the square.

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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.

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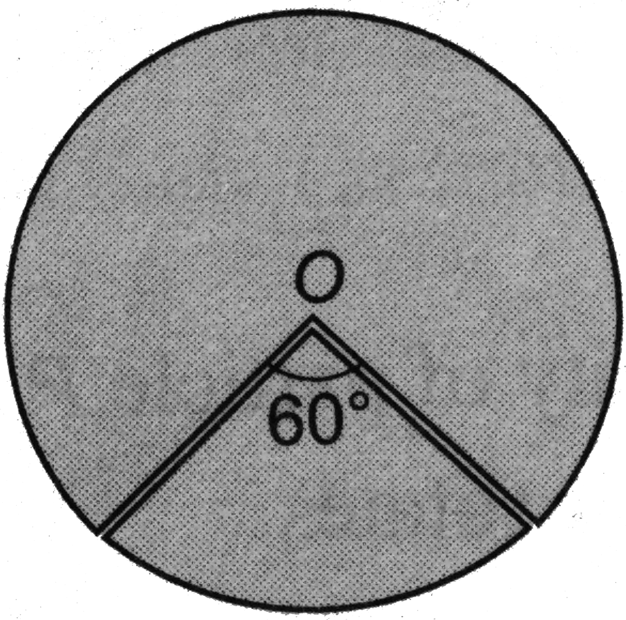
7.



The uniform disc shown in the figure has a moment of inertia of $0.6 kg - m^2$ arouond the axis that passes thorugh 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 remaning disc?

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8. If two circular disks of the 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.

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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 besector of the metre scale.

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10. if I_1 is te moment of inertia of a thin rod about an axis perpendicular to its length and passing thorugh its centre of mass and I_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 $\frac{I_1}{I_2}$.

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Exercise 12.2

1. Find angular speed of second's clock.

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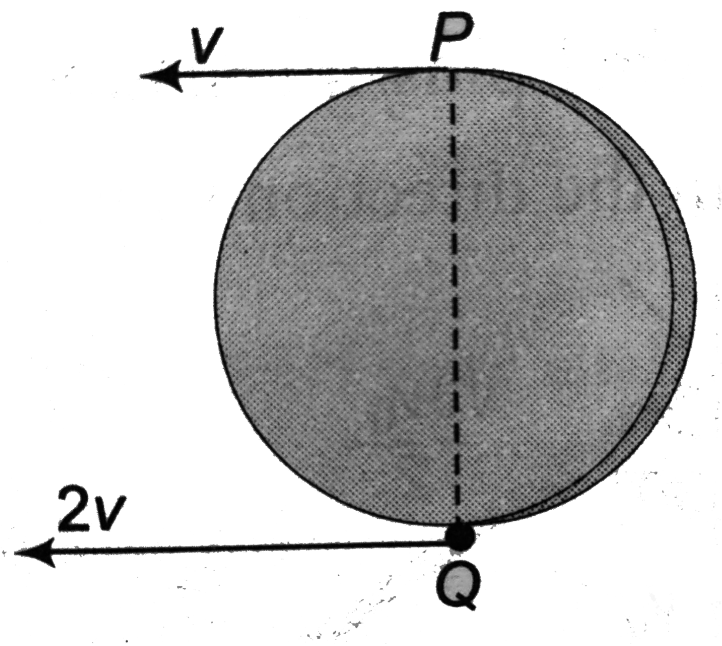

2.

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.

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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.

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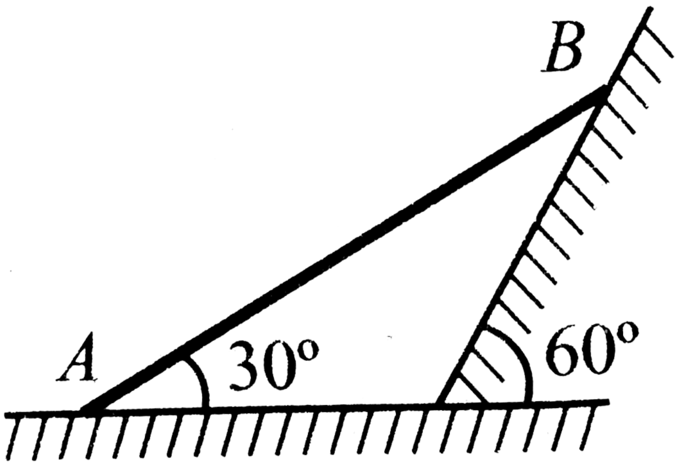
4. In the figure shown, the instantaneous speed of end A of the rod is v to the left. The angular velocity of the rod of length L must be



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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.

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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.

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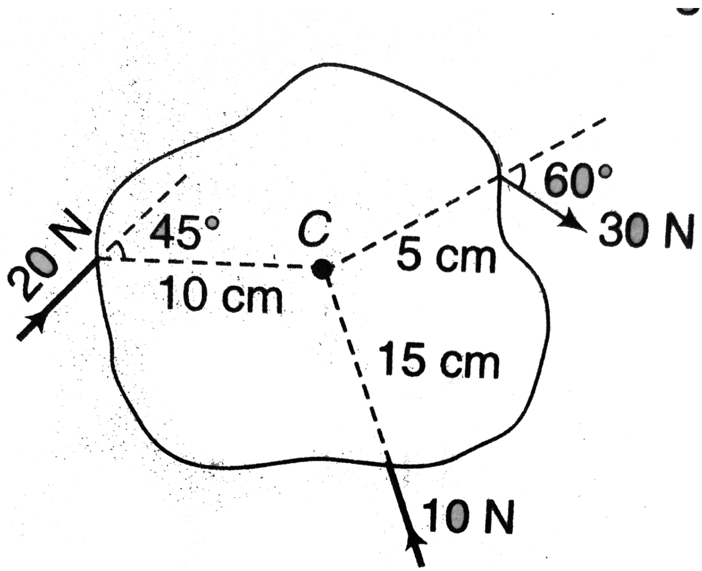

Fig. 12.39

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.

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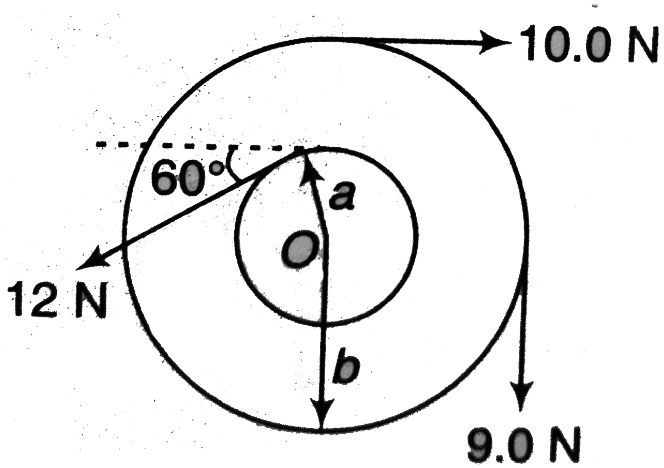

4.

Find the net torque on the wheel in figure about the point O if

$a = 10cm$ and $b = 25cm$

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Exercise 12.4

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

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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 $15 rad/s$?

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

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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.

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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.

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

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

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

(a). The frictional torque.

(b). The external torque.

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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 $4N - m$

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

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10. A shaft is turning at $65rad/s$ at time zero. Thereafter, angular acceleration is given by $\alpha = -10rad/s^2 - 5trad/s^2$

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 $3s$?

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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.

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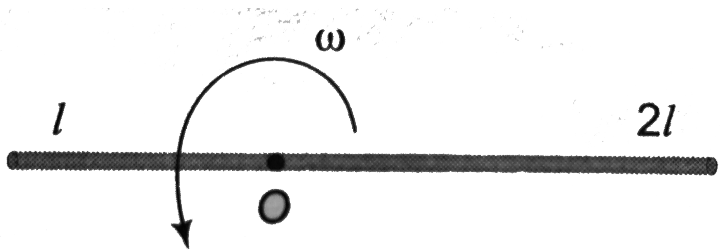
Exercise 12.5

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.

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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.

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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.

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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?

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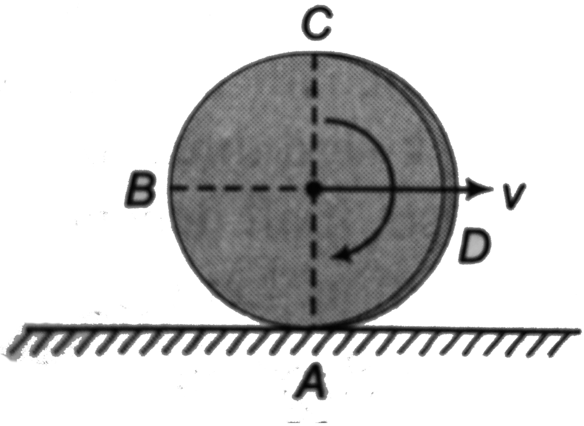
5. 

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.

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

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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.

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Exercise 12.6

1. A thin circular right 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.

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

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

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

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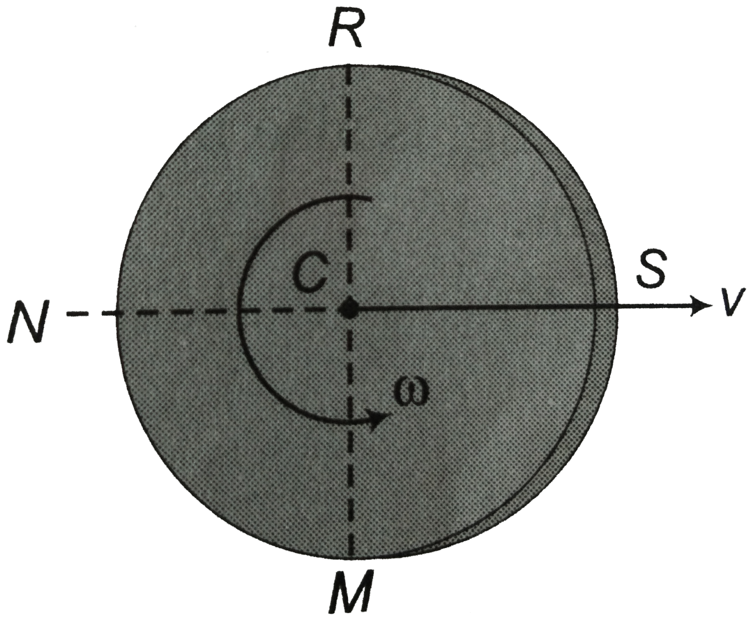
Exercise 12.7

1. 

In the figure shown $\omega = \frac{v}{2R}$ in terms of $\hat{i}$ and $\hat{j}$ find linear velocities of particles M, N, R and S.

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

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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.

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

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

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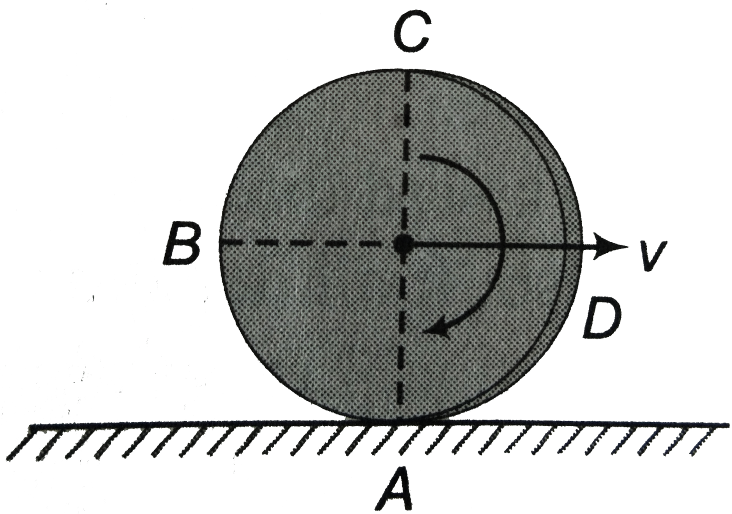
Exercise 12.9

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.

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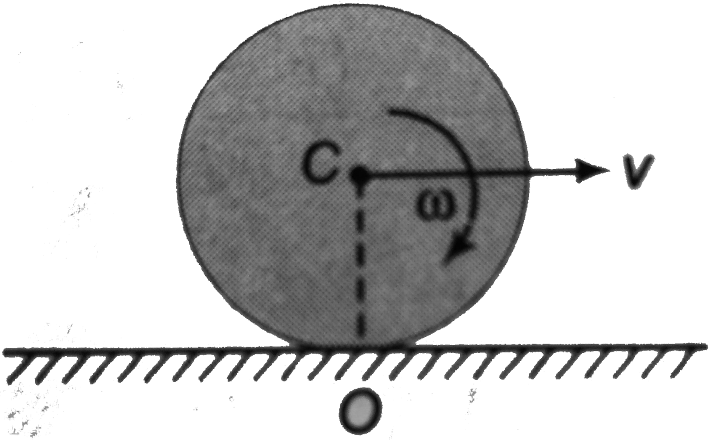
2.



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

Prove that

$$\frac{1}{2}mv^2 + \frac{1}{2}I_C\omega^2 = \frac{1}{2}I_0\omega^2$$

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Exercise 12.10

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

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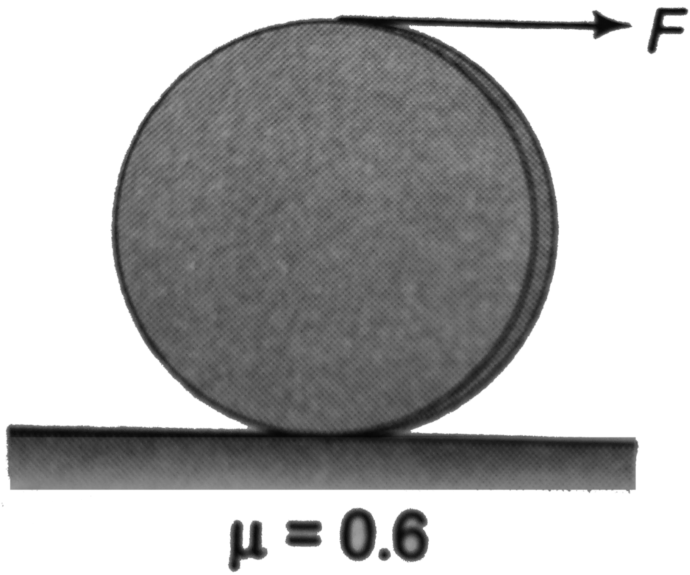
2. 

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.

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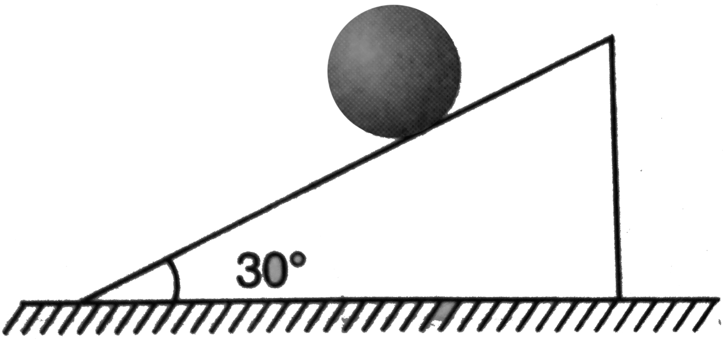
3. 

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

(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).

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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.

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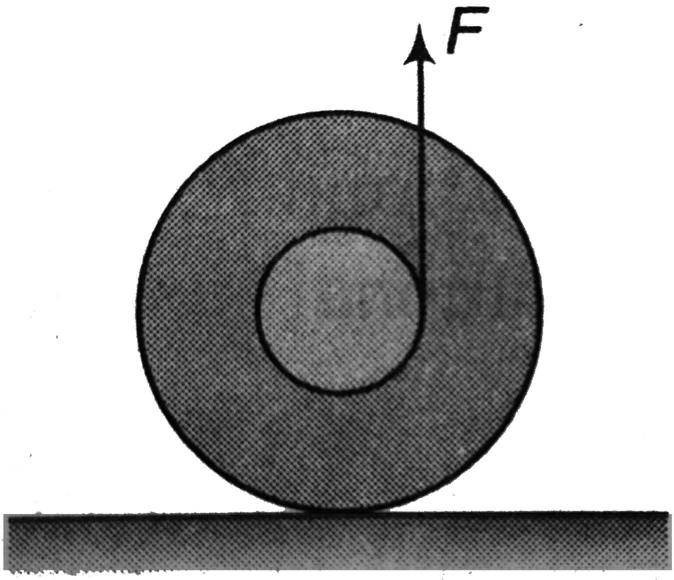

5.

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.

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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?

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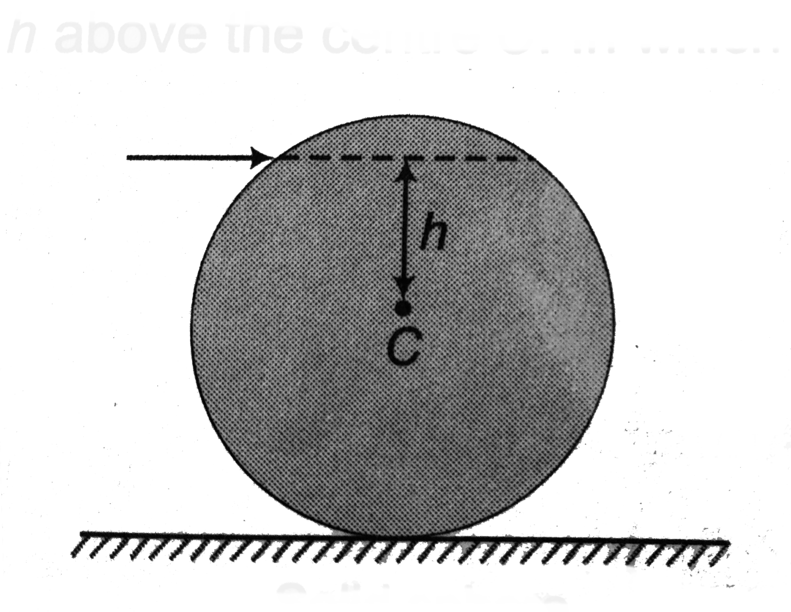


2.

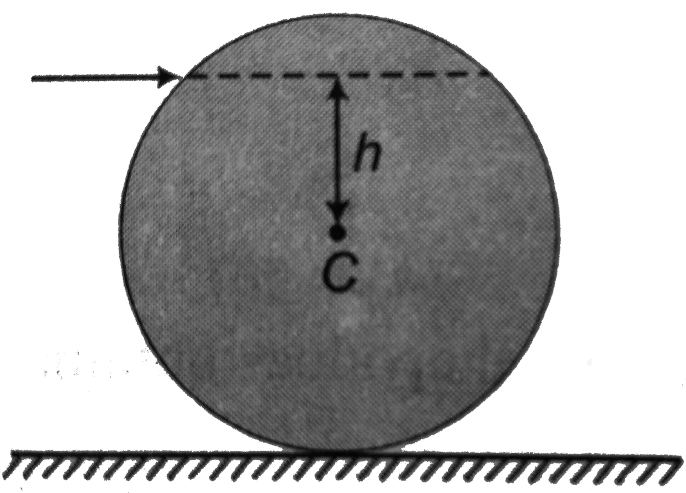
A solid sphere and a hollow sphere both of same mass and same radius are hit by a cue at a height h above the centre C.

In which case,

(a). Linear velocity will be more?

(b). Angular velocity will be more?

(c). rotational kinetic energy will be more?



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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.

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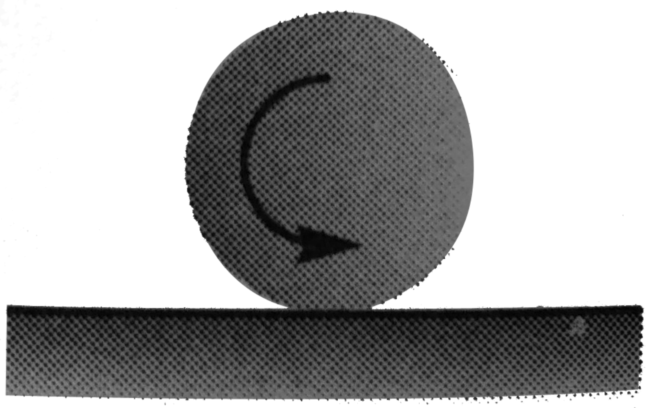
2. Assertion: A ball is released on a rough ground in the condition shown in figure. it will start pure rolling after some time towards left side.

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



A. 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.

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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.

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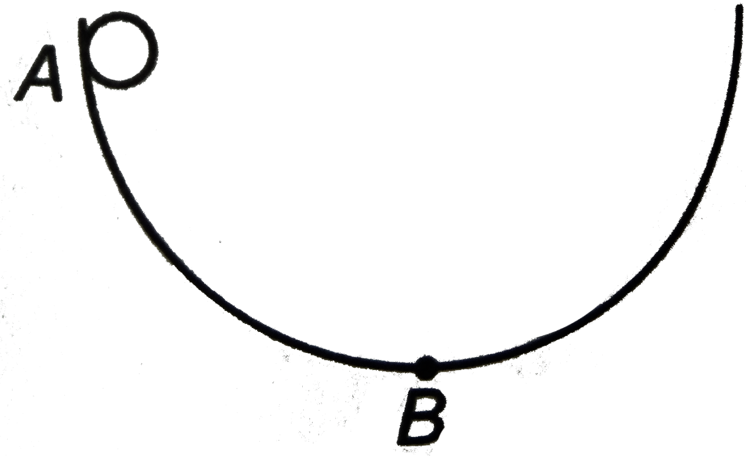
4.



A small ball is released from rest from point A as shown. if bowl is smotth, 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.

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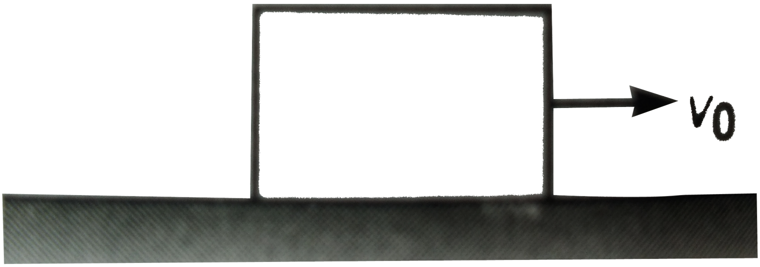
5. Assertion: A cubical block is moving on a rough ground with velocity v. During motion net normal reaction on the block from ground will not pass through centre of cube. it will shift towards right.

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.

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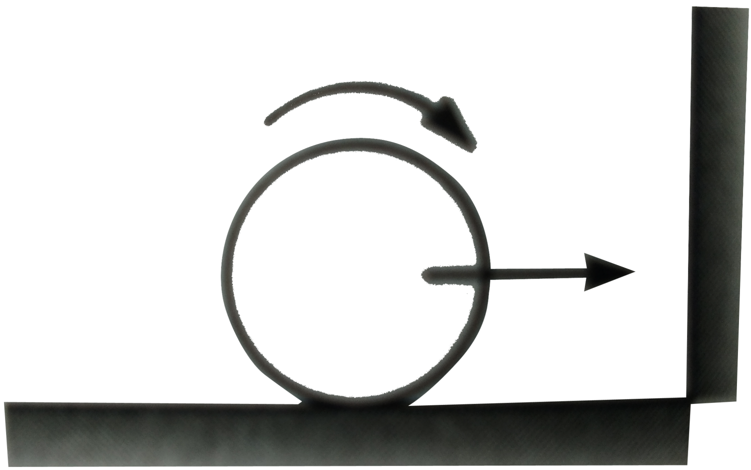
6. Assertion: A ring is rolling without slipping on a rough ground. It strikes elastically with a smooth wall as shown in figure. Ring will stop after some time while travelling in opposite direction.

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.

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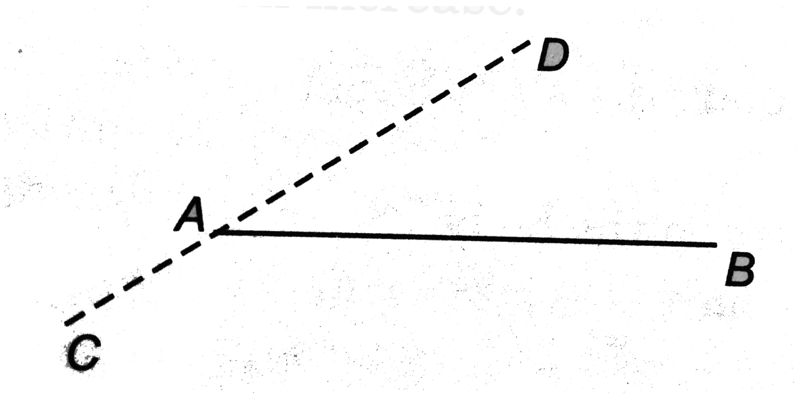
7. 

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.

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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.

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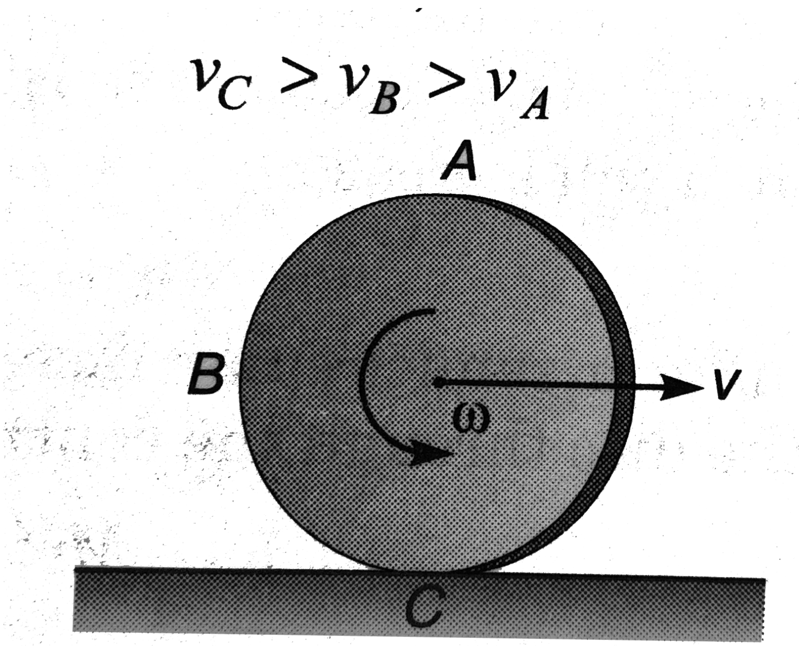

9.

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.

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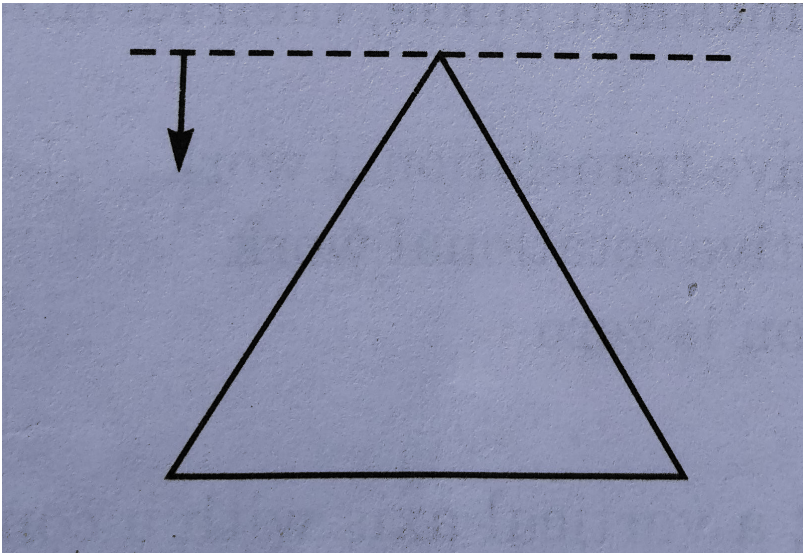
10. 

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. 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.

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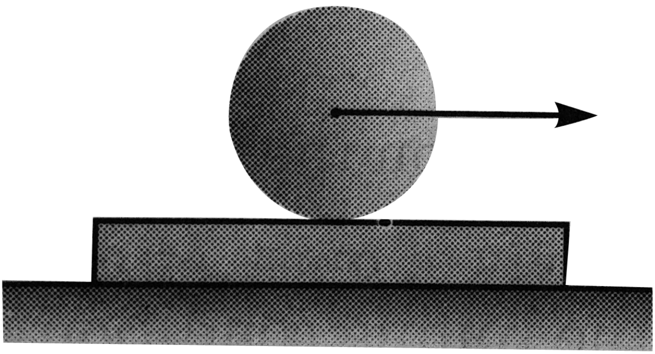

11.

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. 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.

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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

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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

Answer: A

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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

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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

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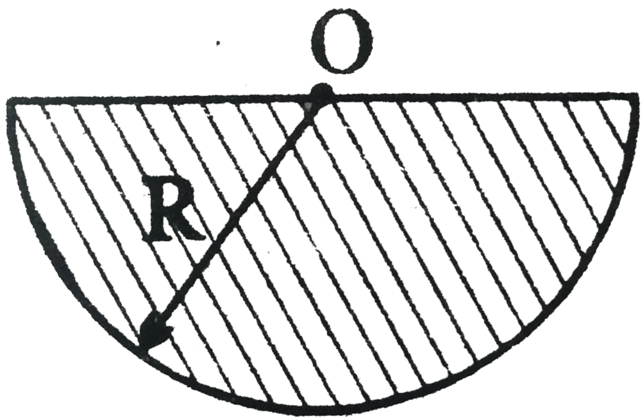
5. Moment of inertia of a thin semicircular disc $(mass - M\&radius = R)$ about an axis through point O and perpendicular to plane of disc, is given by :



A. Mr^2

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

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

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

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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. $4 : 9$

Answer: A

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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

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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

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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. $\dfrac{R^2}{R_2 + r^2}$

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

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

D. 1

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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

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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 disc of radius R

B. a ring of radius R

C. a square lamina of side 2 R

D. four rods forming a square of side 2R

Answer: D

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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

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13. A horizontal disc rotates freely with angular velocity ω about a vertical axes through its centre. A rig 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

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14. A solid homogeneous sphere is moving on a rough horizontal surface, partily rolling and partly 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

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

Answer: B

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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. it will move with a speed v initiall

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

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

D. all of the above.

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

A. I_0

B. $I_0 \cos\theta$

C. $I_0 \cos^2\theta$

D. None of these

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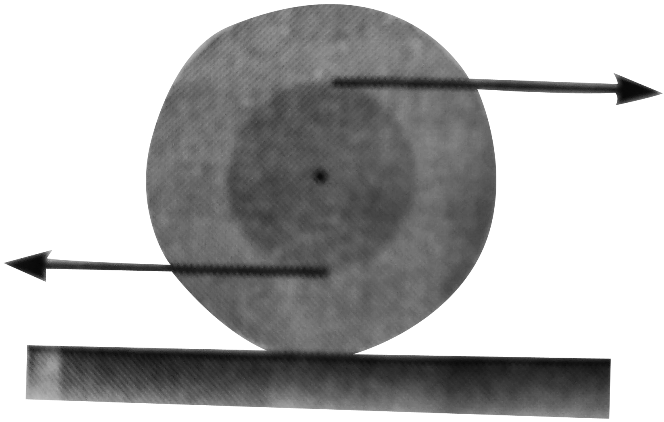

18.

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.

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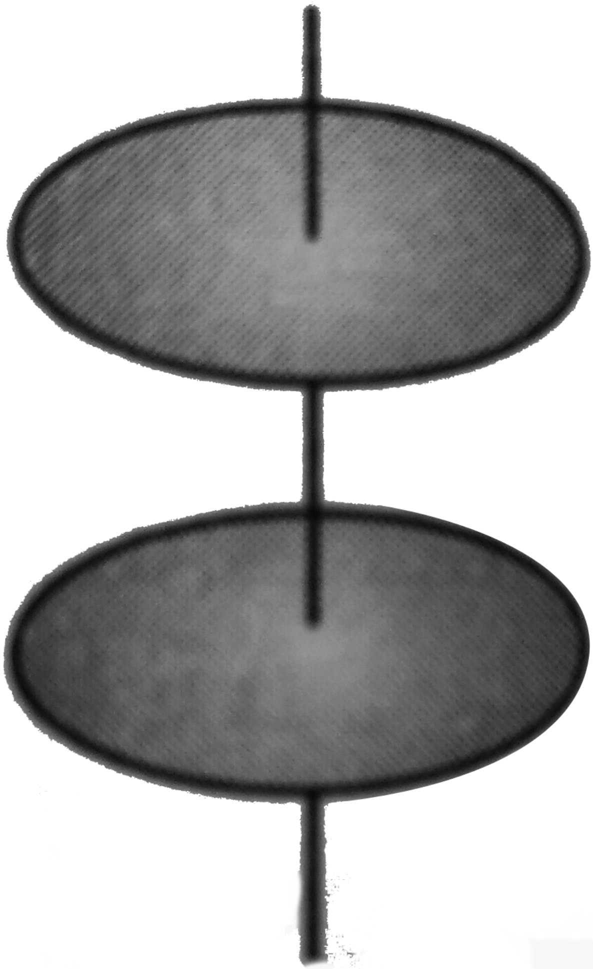

19.

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. Change in the rotational kinetic energy of the system is

A. $K_0/2$

B. $-K_0/2$

C. $-K_0/4$

D. $K_0/4$

Answer: A

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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

Answer: D

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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. However, 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

Answer: C

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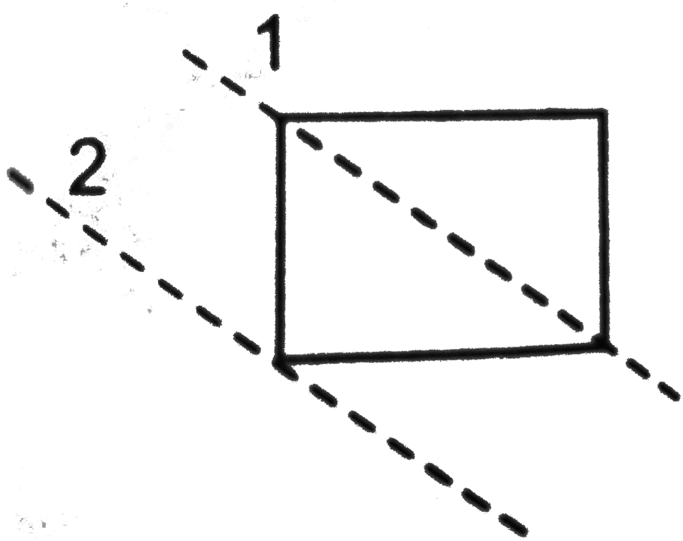
22. 

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. $1 : 7$

Answer: D

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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

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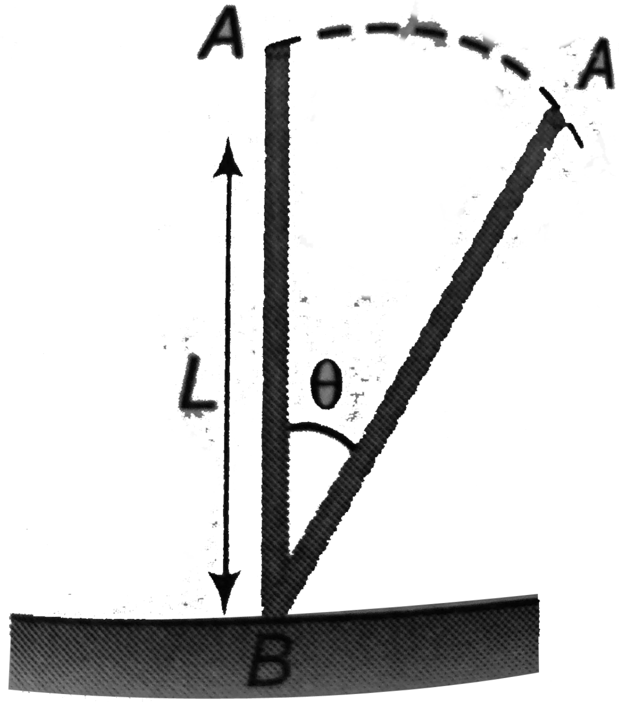
24. 

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

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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 perpedicular to the line joining them is (in $kg - m^2$)

A. 6

B. 9

C. 8

D. 12

Answer: A

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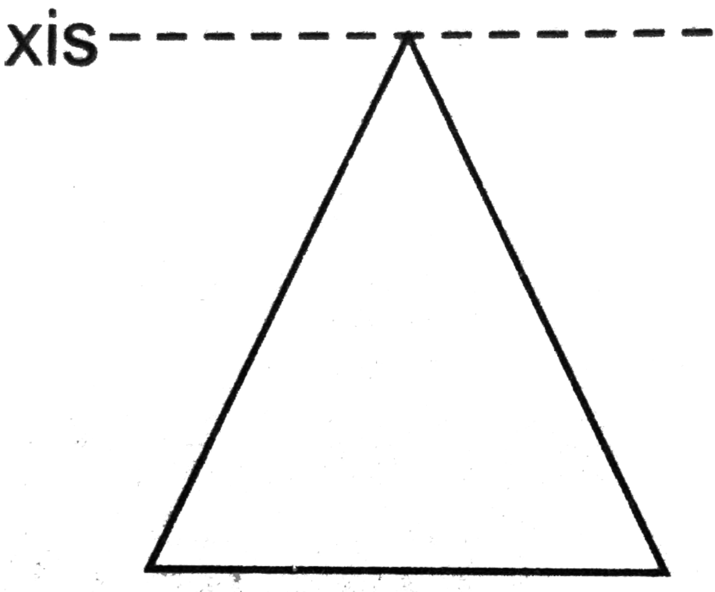

26.

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. $3ML^2/8$

B. $3\sqrt{3}ML^2/8$

C. $7ML^2/8$

D. none of these

Answer: A

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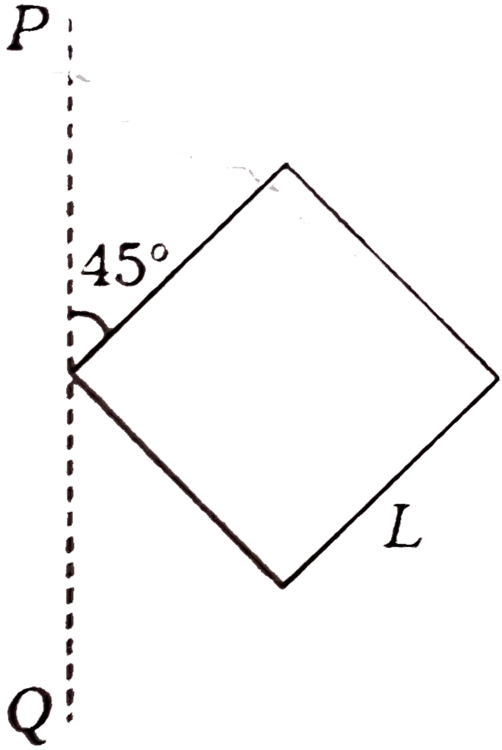
27. A square is made by joining four rods each of mass M and length L. Its moment of inertia about an axis PQ, in its plane and passing through one of its corner is



A. $6ML^2$

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

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

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

Answer: C

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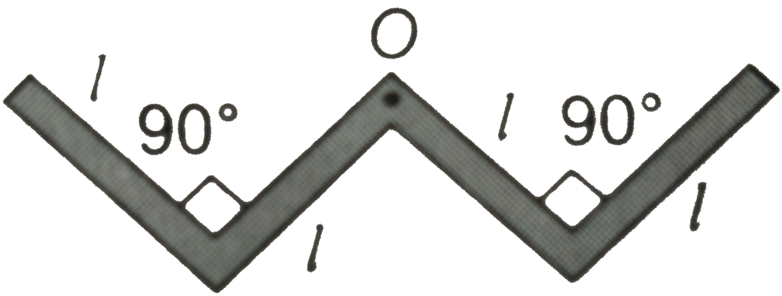
28. 

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

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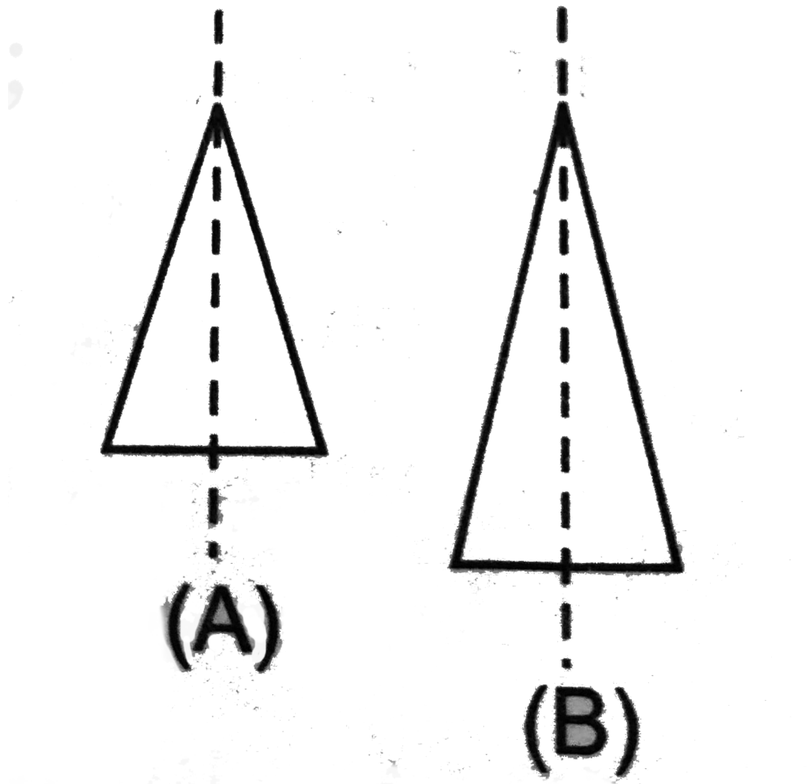

29.

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

Answer: A

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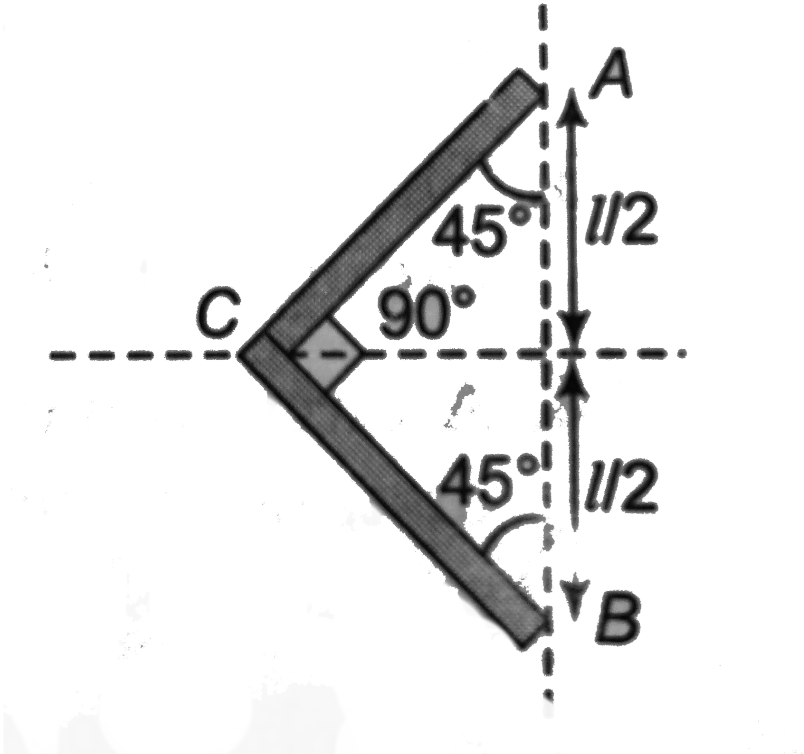
30.



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

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

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

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

Answer: D

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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?

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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.

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

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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.

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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.

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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.

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7. A wheel rotates around a stationary axis so that the rotation angle θ varies with time as $\theta = at^2$ where $a = 0.2 rad/s^2$. 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 $v = 0.65 m/s$.

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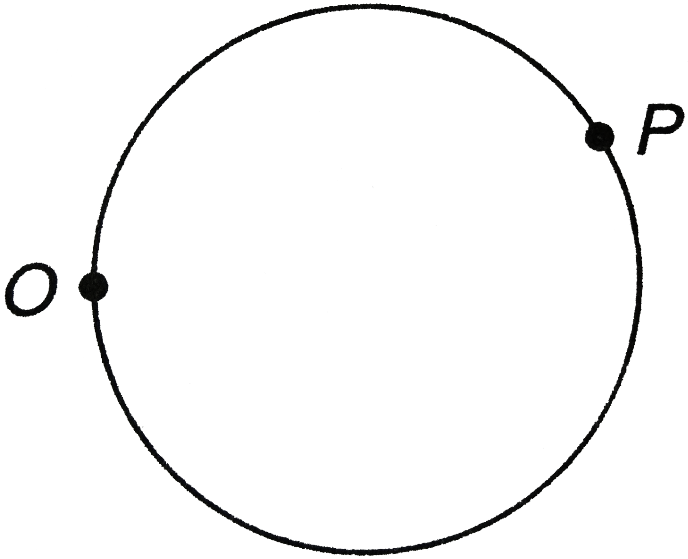

8.

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.

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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.

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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.

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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?

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

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13. The topmost and bottommost velocities of a disc are v_1 and $v_2\left(< v_1\right.$ 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.

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15. A solid body starts rotating about a stationary axis with an angular acceleration $\alpha = \left(2.0 \times 10^{-2}\right) t rad/s^2$ 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?

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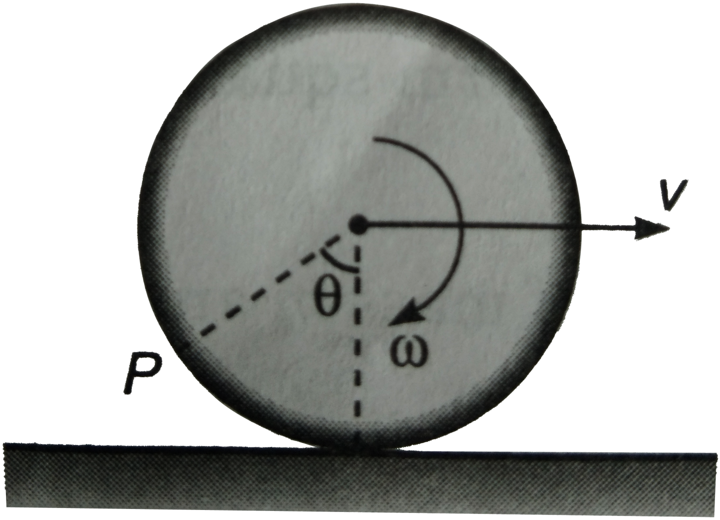
16. 

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 $(v < R\omega)$.

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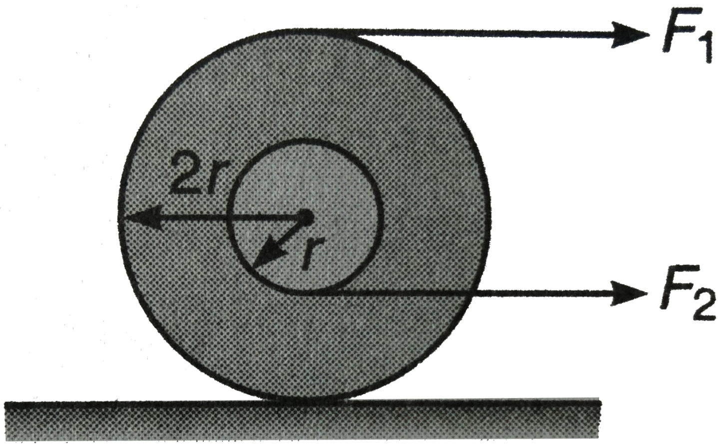

17.

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 $I < 2Mr^2$.

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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?

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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 topplies before sliding?

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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

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21. A uniform disc of mass m and radius R I rotated about an axis passing through its centre 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. Coefficnet of friction between te disc and the surface is μ, find

(a). The time when disc stops rotating

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

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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.

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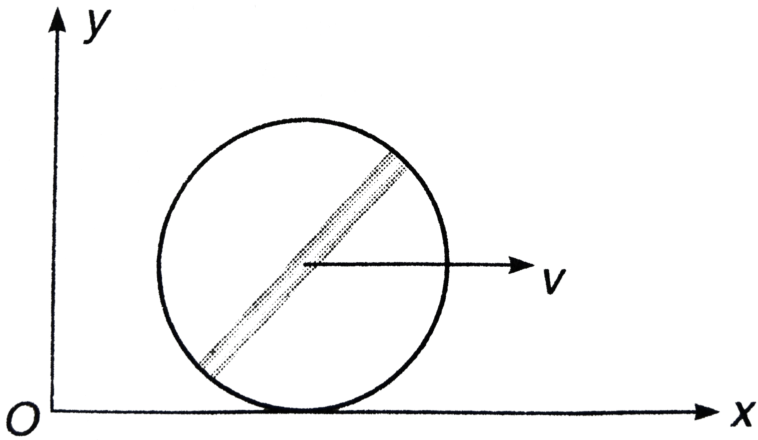
23. 

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.

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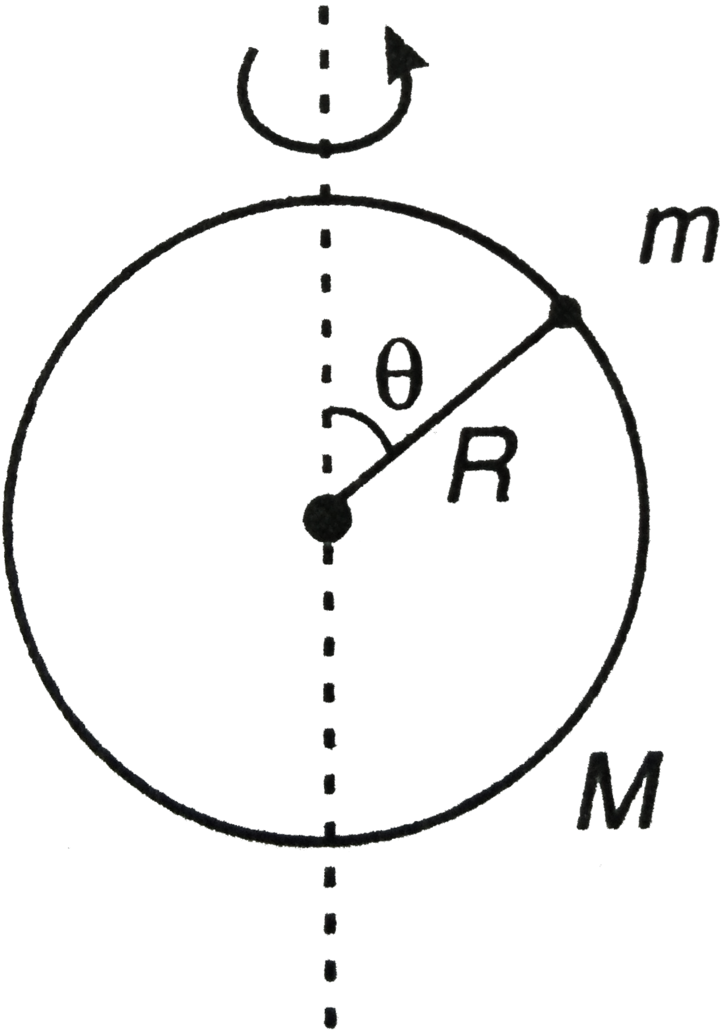

24.

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 $5 rad/s$ What is the angular velocity when the bead slips halfwat to $\theta = 45^{\circ}$?

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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.

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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 $1.6 kg - m^2$, 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?

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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.

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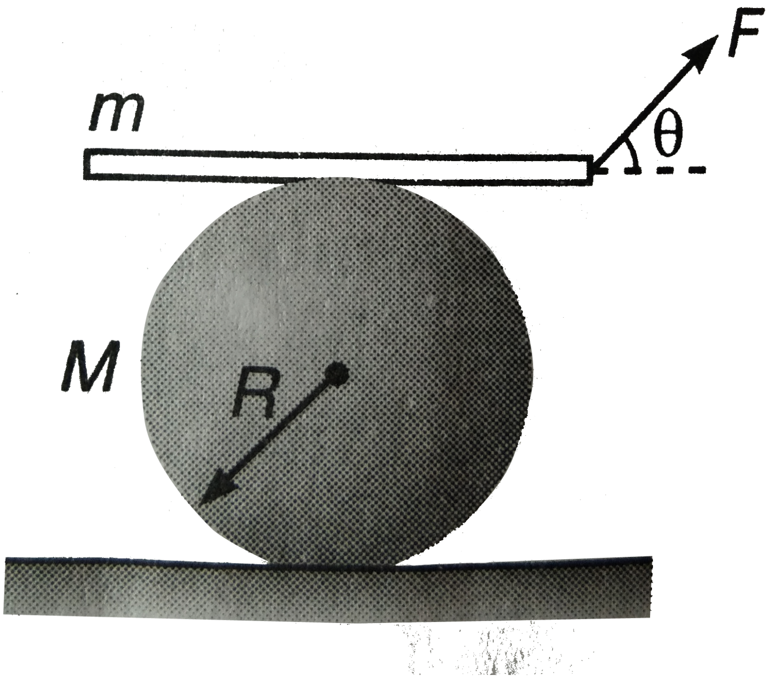

28.

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.

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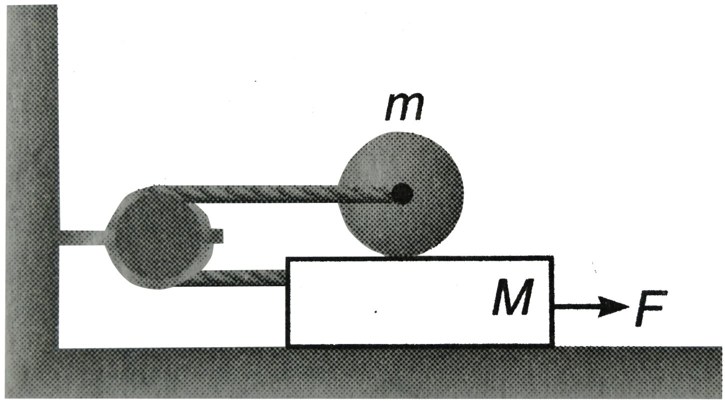
29. 

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.

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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.

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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?

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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.

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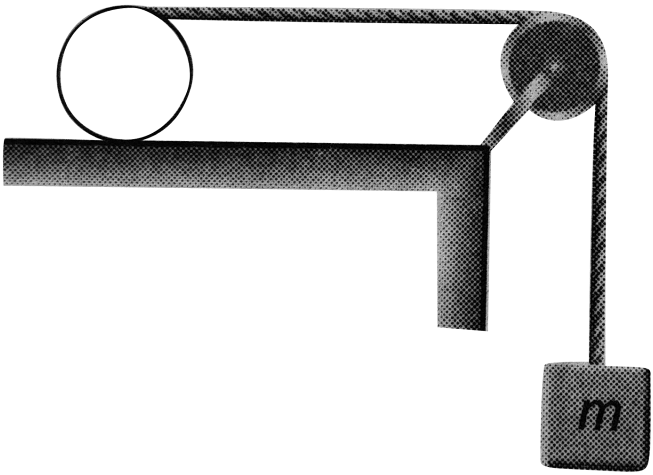
Level 2 Single Correct



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.

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

(iv) . Fraction 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

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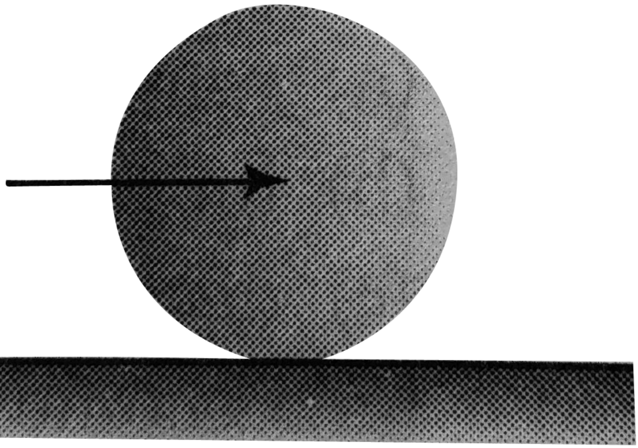

2.

A solid sphere of mass 10 kg is placed on a rough surface having coefficient of friction $\mu = 0.1A$ 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

Answer: B

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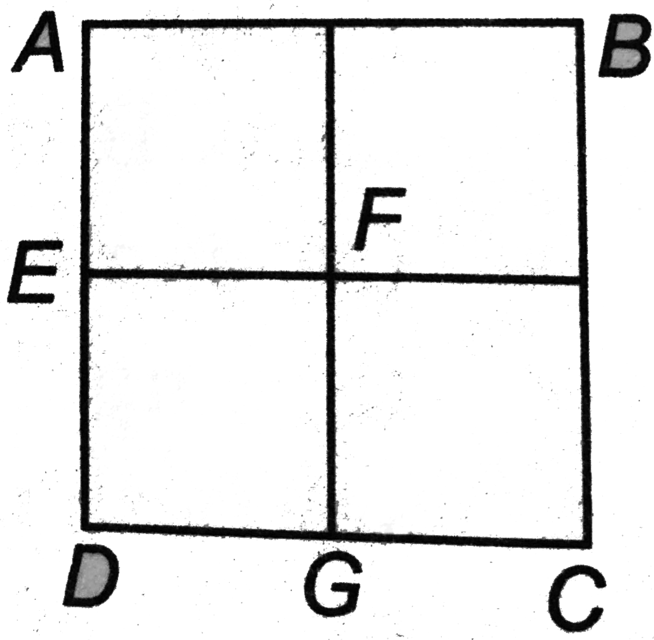

3.

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

Answer: B

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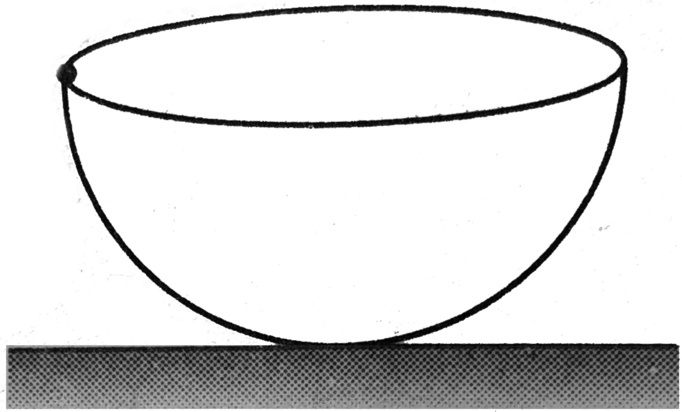

4.

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. $(17/7)mg$

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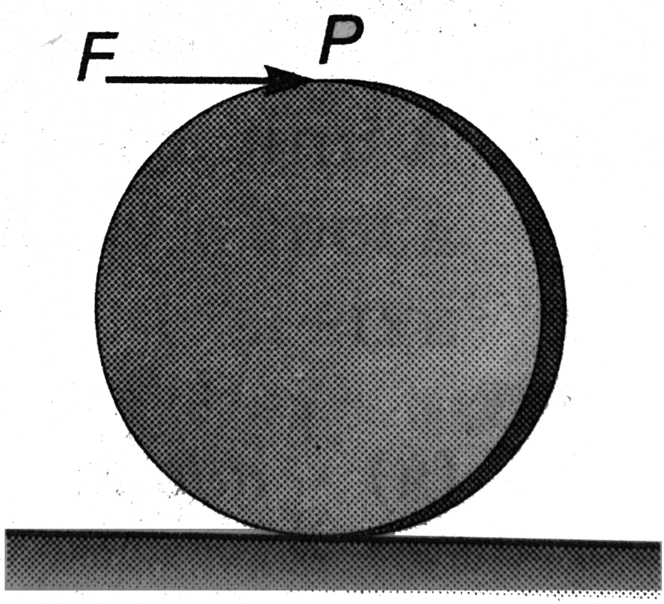

5.

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. $5F/3m$

Answer: C

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6. 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


2kg

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. $3m/s^2$

Answer: A

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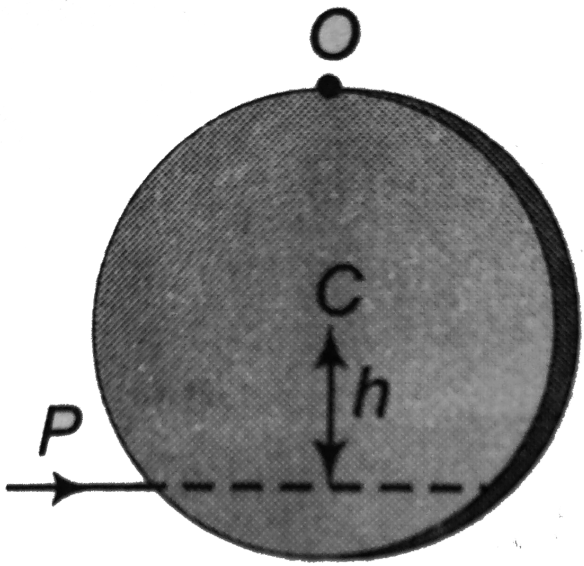

8.

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. R

B. $R/2$

C. $R/3$

D. $R/4$

Answer: B

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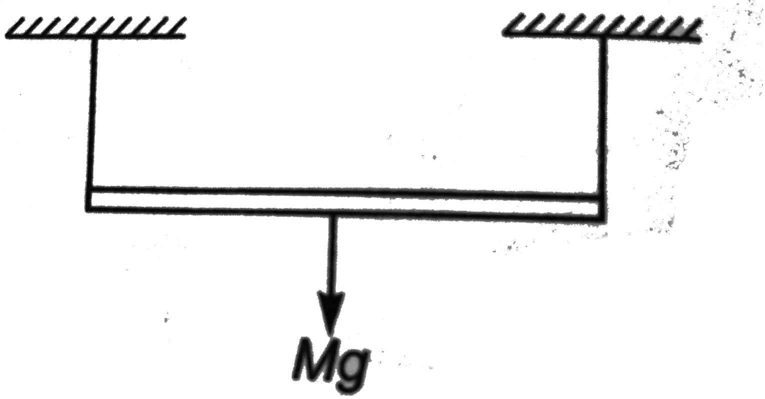

9.

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

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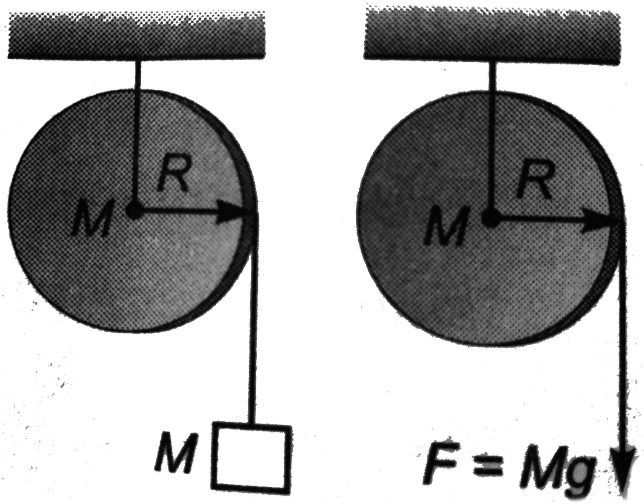

10.

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. same amount of work is done on both discs

B. angular velocities of both the discs are equal

C. both the discs have unequal angular accelerations

D. All of the above

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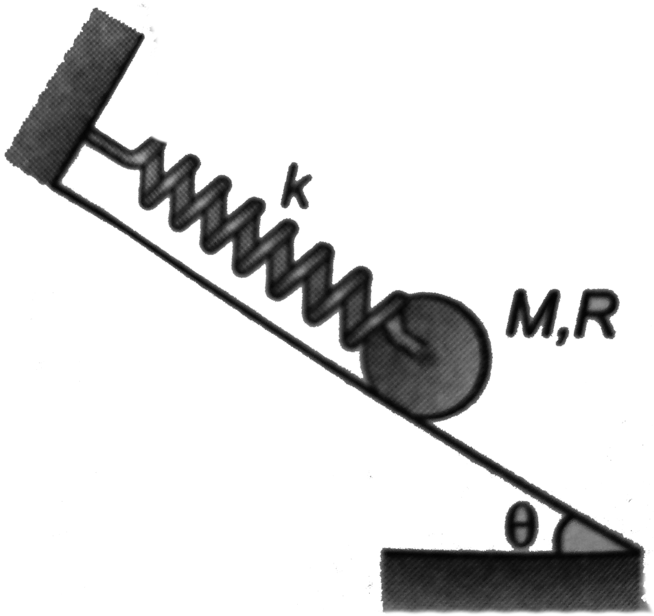

11.

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

Answer: B

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

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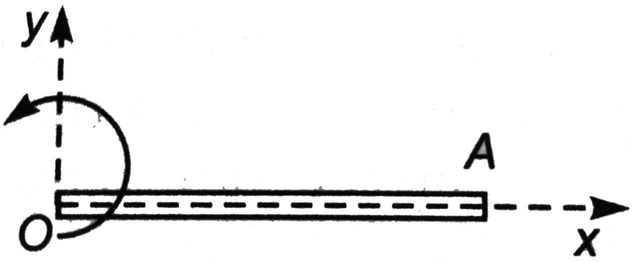
13. 

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 $a = 10 rads^{-1}$ and $b = 5 rads^{-2}$. 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 $-5\hat{j}ms^{-1}$

Answer: B

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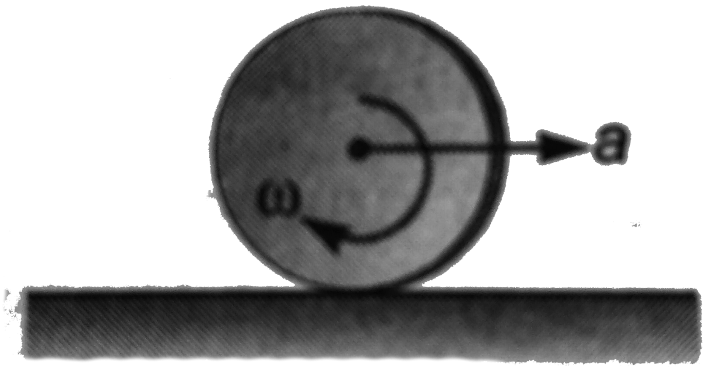
14. 

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

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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

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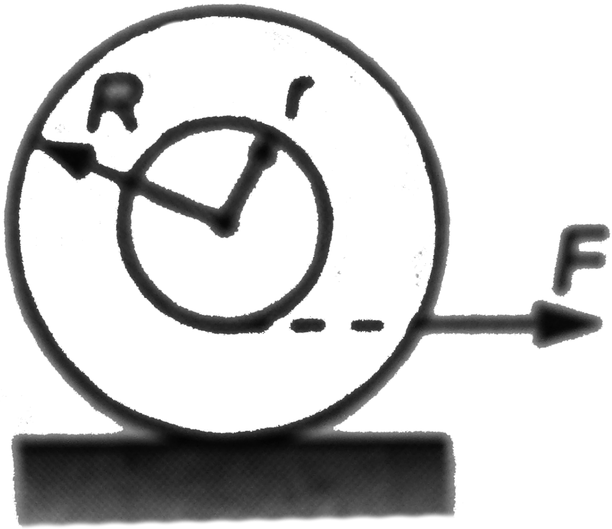

16.

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

Answer: A

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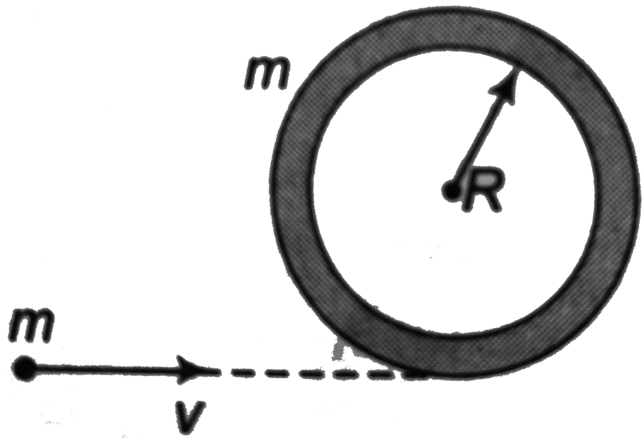
17.



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

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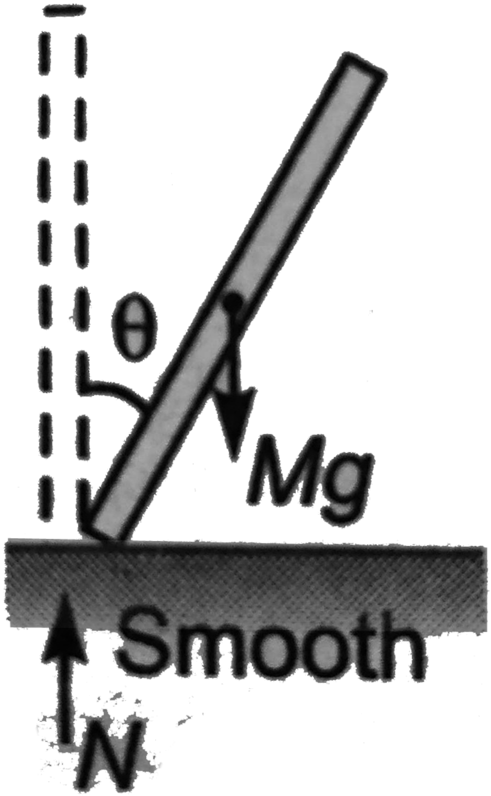
18.



A stationary uniform rod in the upright position is allowed to fall on a smooth horizotal surface. The figure shows the instantaneous position of the rod. Identify the correct statement.

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.

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. All of these

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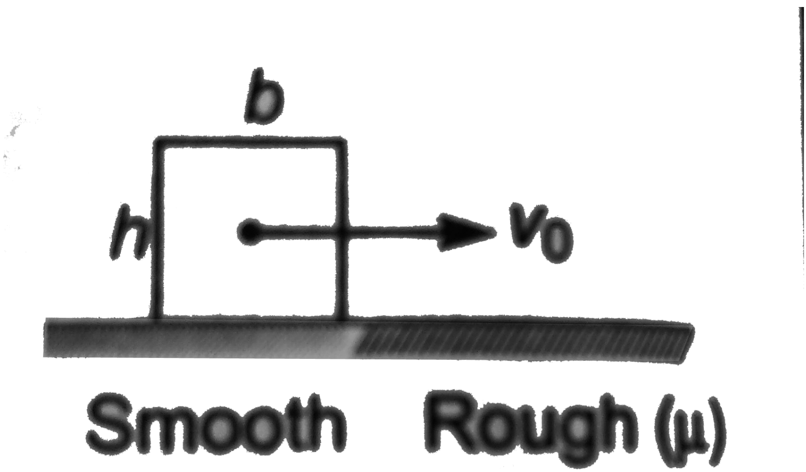

20.

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.

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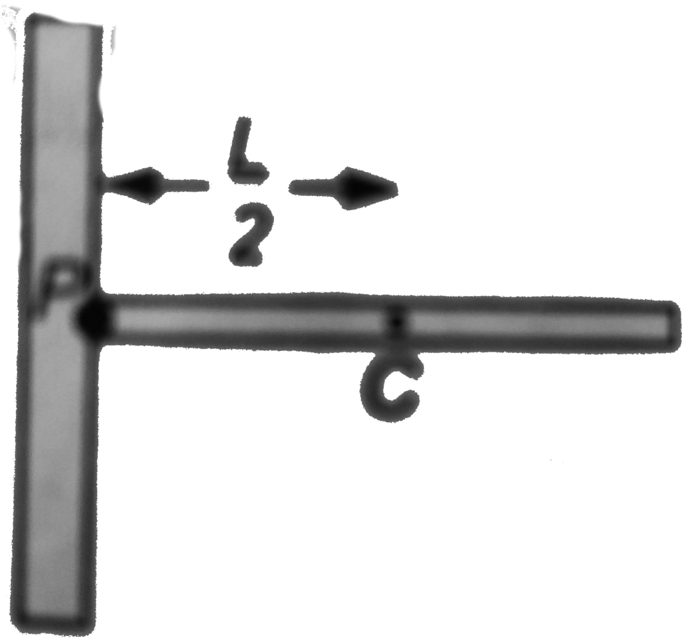
21. 

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. $\dfrac{3mg}{2}$

B. $2mg$

C. zero

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

Answer: C

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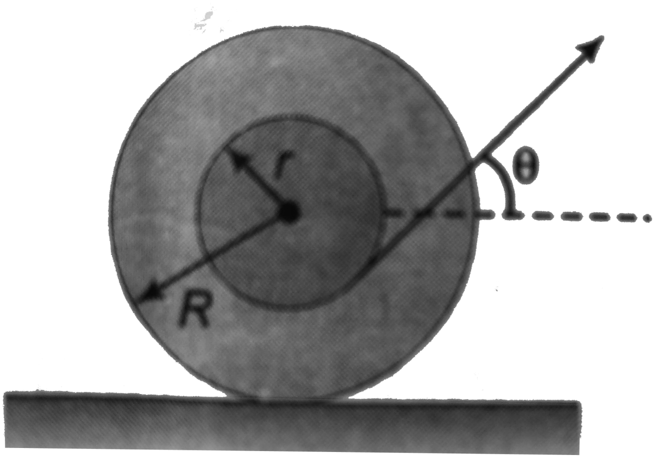

22.

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

Answer: B

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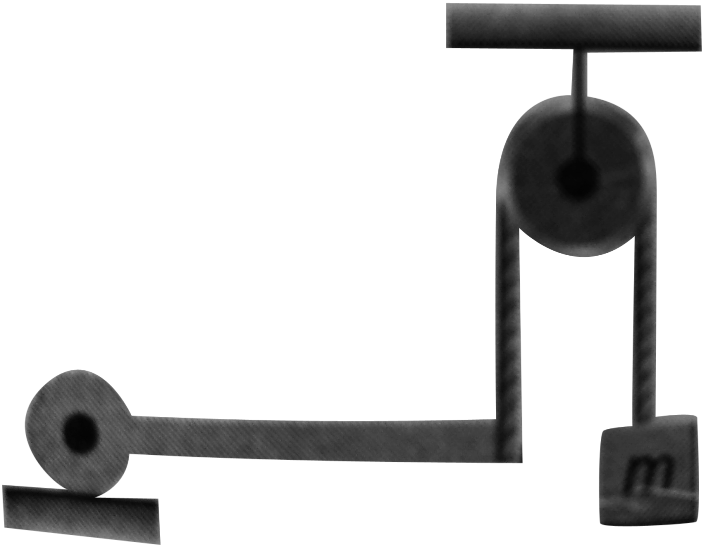
23. 

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. $6g/13$

B. $g/4$

C. $3g/8$

D. None of these

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24.

A cylinder having radius 0.4 m initially rotating (at $r = 0$) with $\omega_0 = 54 rad/s$ is placed on a rough inclined plane with $\theta = 37^\circ$ having friction coefficient $\mu = 0.5$ the time taken by the cylinder to start pure rolling is $\left(g = 10 m/s^2\right)$

A. 5.4 s

B. 2.4 s

C. 1.4 s

D. none of these

Answer: D

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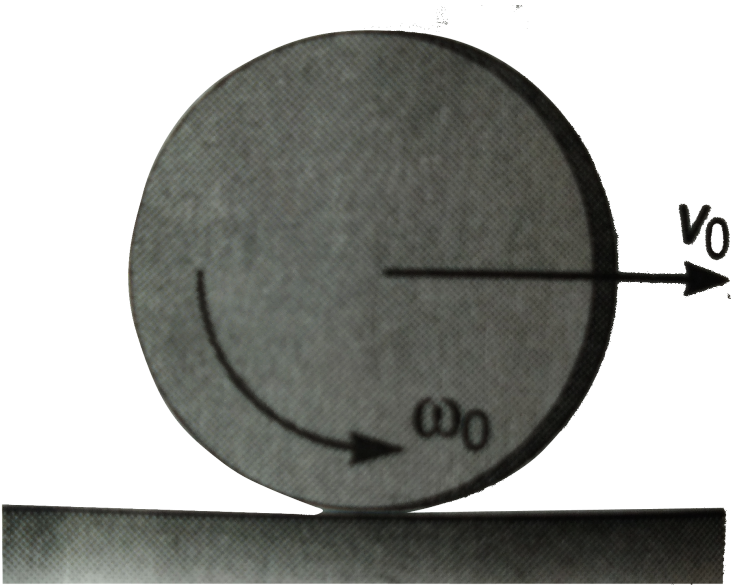

25.

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

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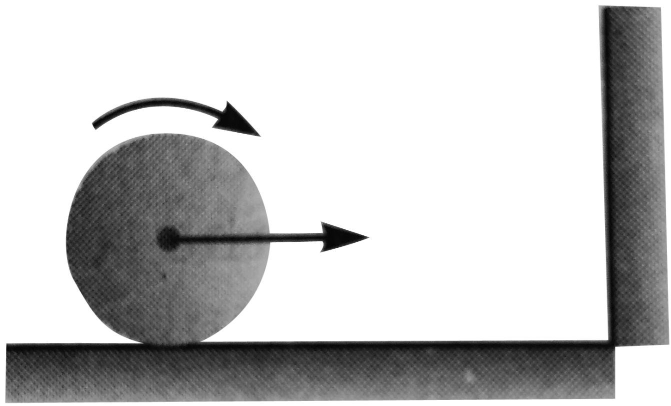
26. 

A solid sphere is rolling purely on a rough horizontal surface (coefficient of kinetic friction $= \mu$) with speed of centre $= u$. It collides in-elastically 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. $\frac{3u}{7\mu g}$

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

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

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

Answer: A

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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 energy 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

Answer: B

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

Answer: D

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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

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4. 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

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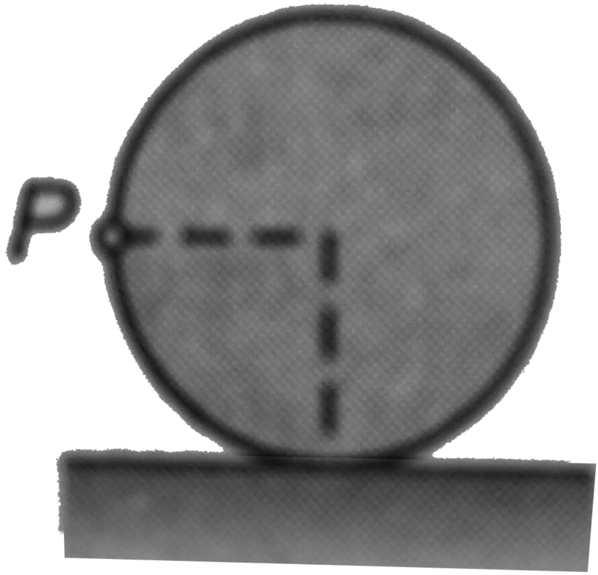

5.

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

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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 prependicular to the force. The initial acceleration of end B is

A. zero

B. $2F/M$

C. $4F/M$

D. None of these

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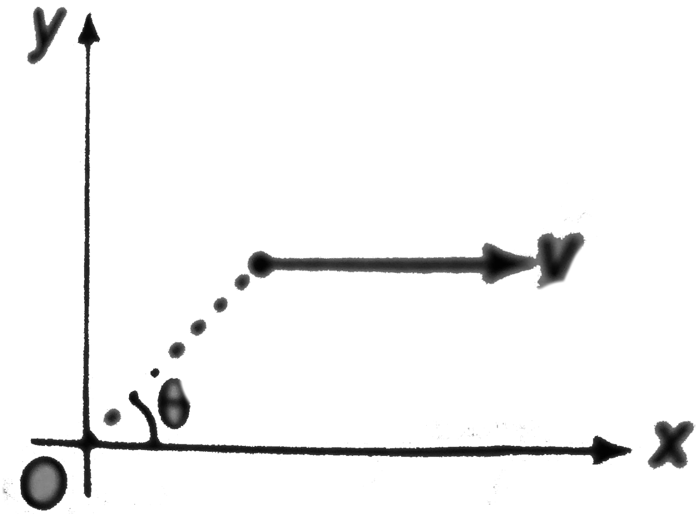

7.

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.

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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. $2Mg$

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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. $mv/4$

B. $mv/2$

C. mv

D. $2mv$

Answer: A

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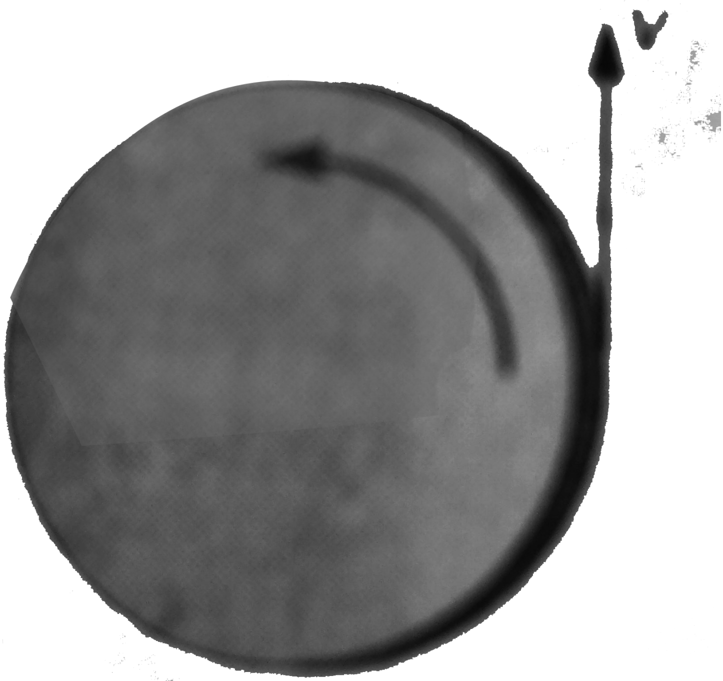

10.

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. $\sqrt{\frac{I\omega^2 - mv^2}{I}}$

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

C. $\frac{I\omega - mvR}{I}$

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

Answer: D

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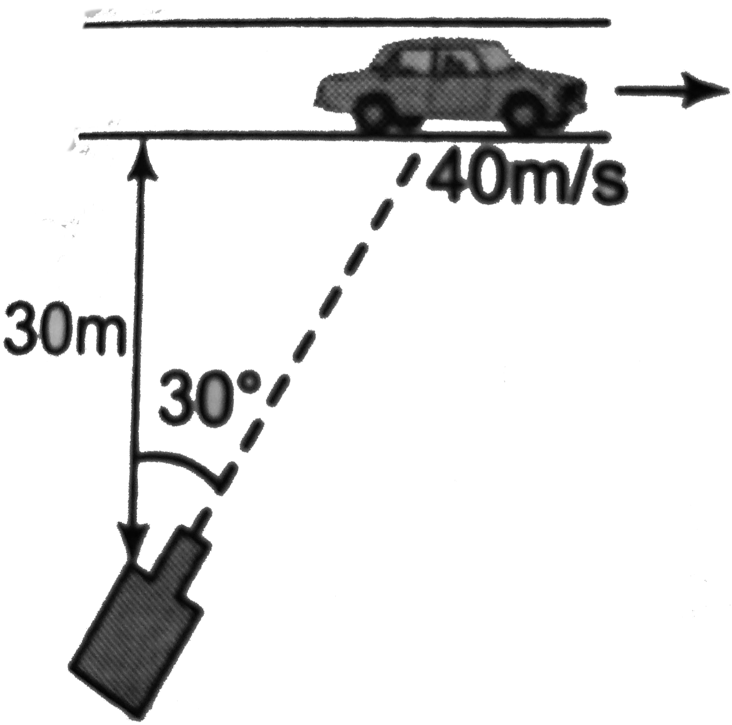

11.

A racing car is travelling along a straight trach at a constant velocity of $40 m/s$. 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. $3 rad/s$

B. $2 rad/s$

C. $4 rad/s$

D. $1 rad/s$

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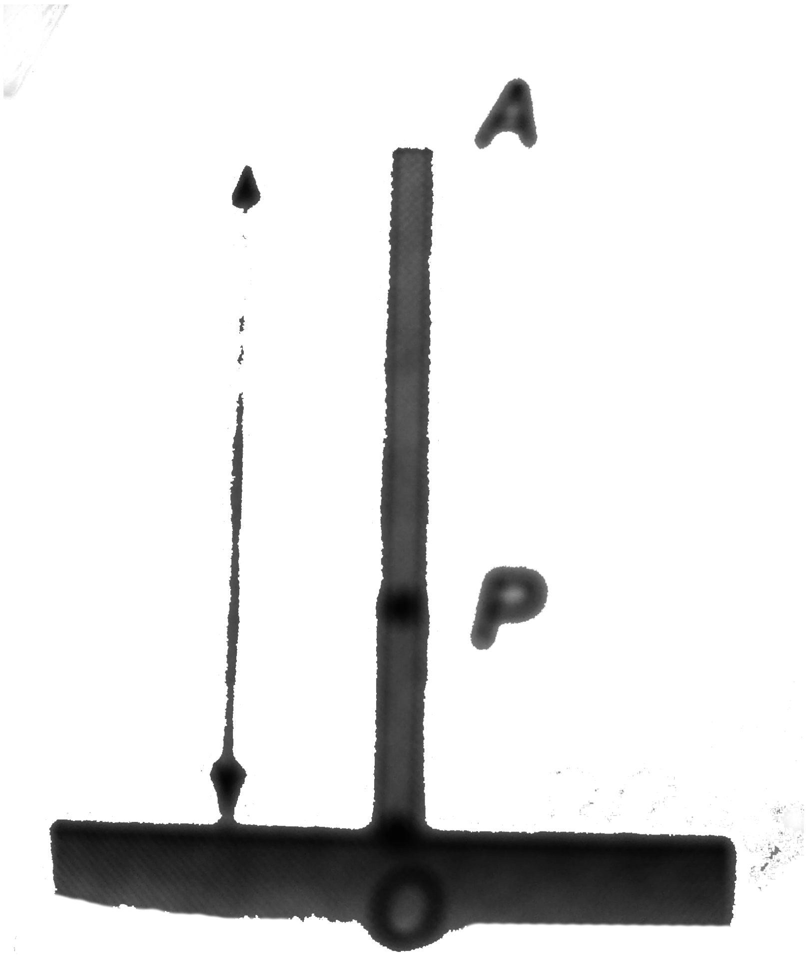

12.

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.

Answer: C

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13. 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 $\left(\neq 90^{\circ}\right)$

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14. 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

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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. $\dfrac{v_0^2}{7g}$

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

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

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

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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 $\frac{7}{5}mr^2$

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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 inertial 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 $\frac{5}{3}ml^2$

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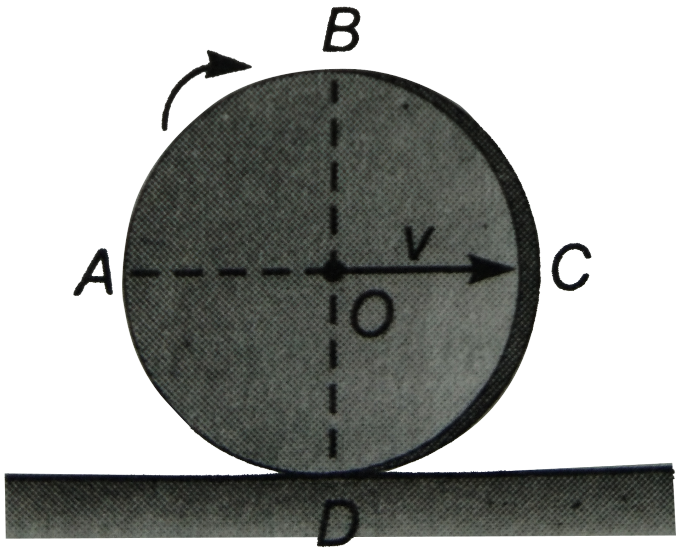
18. 

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

A. section ABC has greater kinetic energy than section ADC

B. section BC has greater kinetic energy than section CD.

C. section BC has the same kinetic energy as section DA

D. the section CD and DA have the same kinetic energy.

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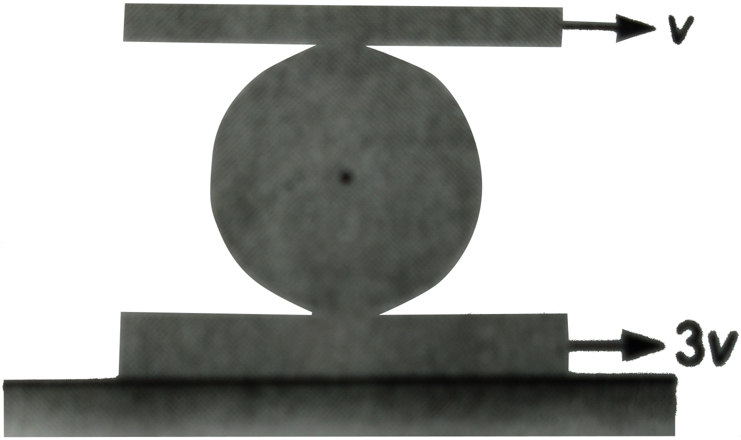
19. 

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

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

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

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

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

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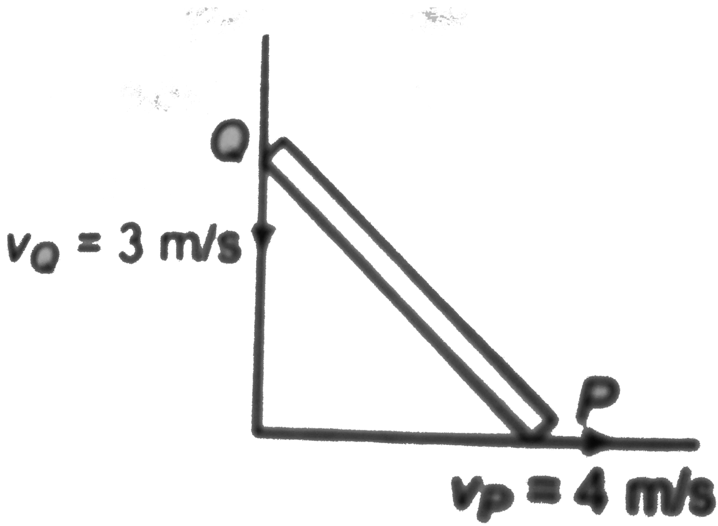

20.

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

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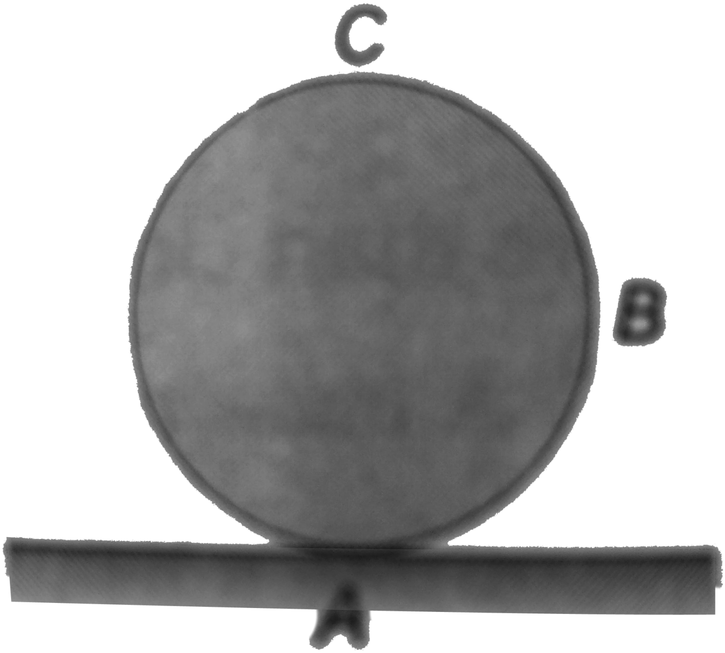
21. 

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.

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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 $\frac{7mv^2}{24}$

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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. The with slip on surface for al cases

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

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

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

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

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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.

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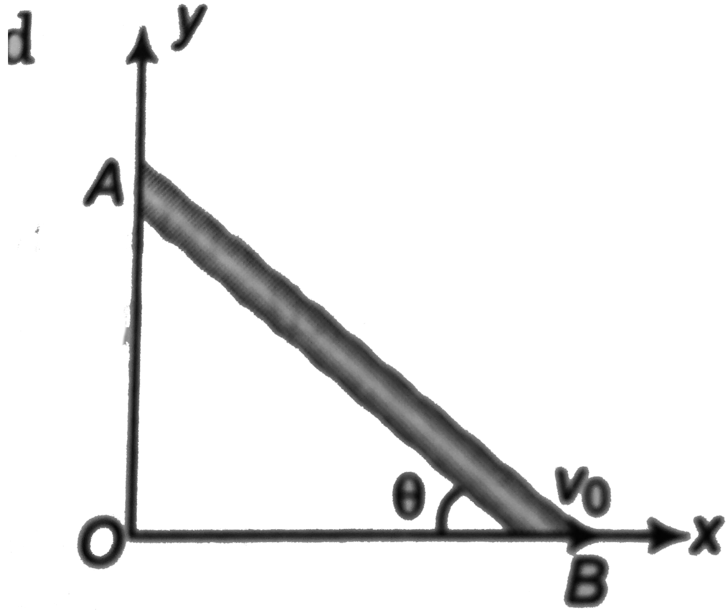

26.

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

B. At $\theta = 37^\circ$ angular velocity of rod is $\frac{5v_0}{3l}$

C. Angular velocity of rod is constant

D. velocity of end A is constant.

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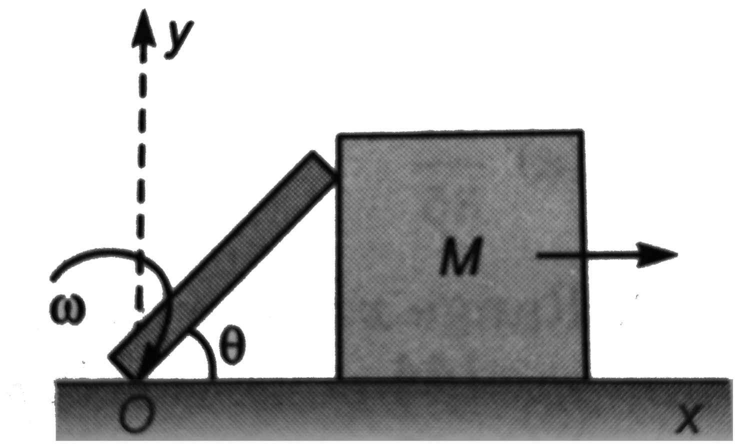
27. 

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. $3:4$

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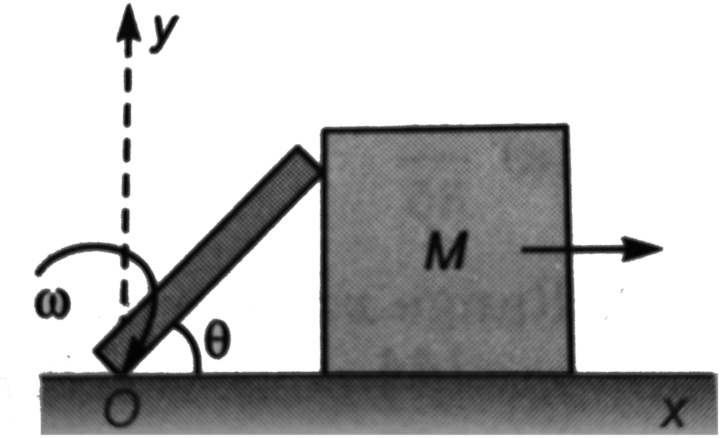
28.



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

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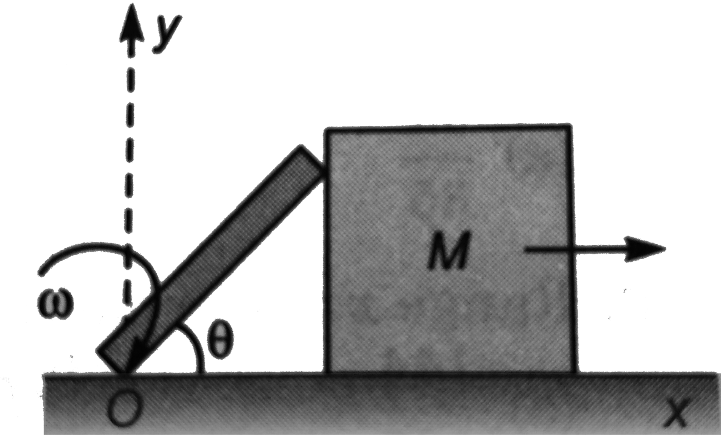
29.



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. $3g/4$

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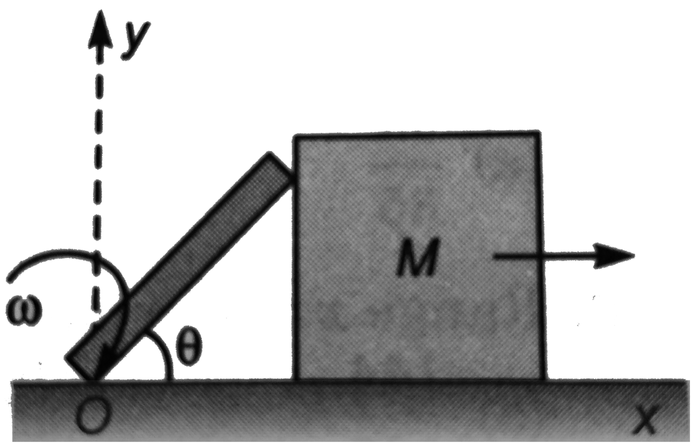

30.

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

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

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

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

Answer: B

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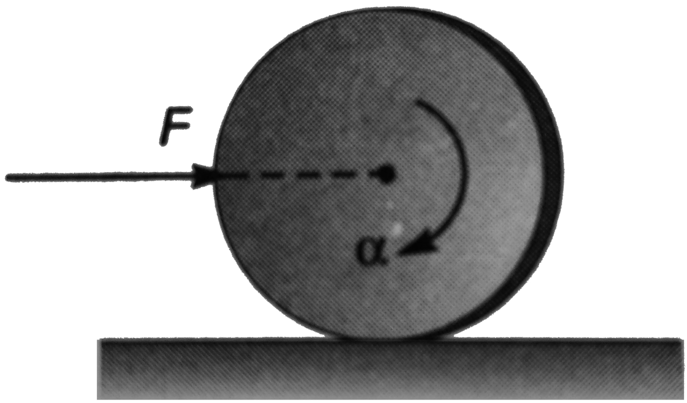
31.



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

D. zero

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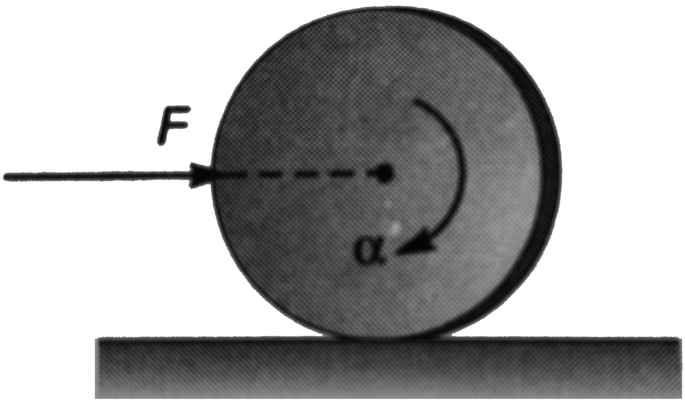

32.

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

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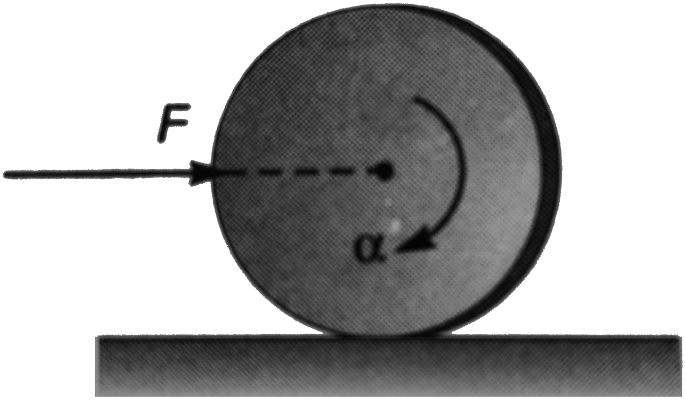

33.

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.

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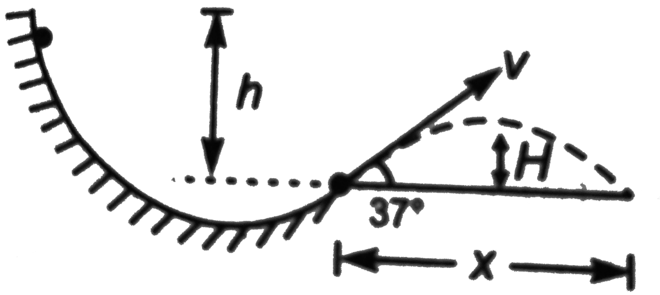

34.

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

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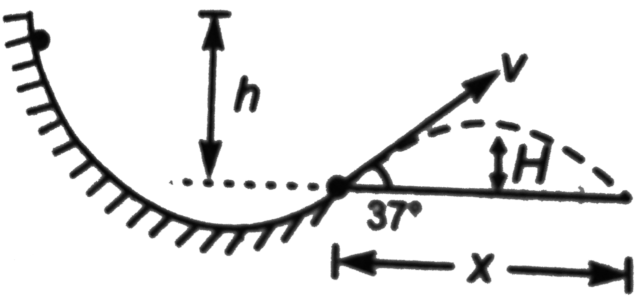

35.

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

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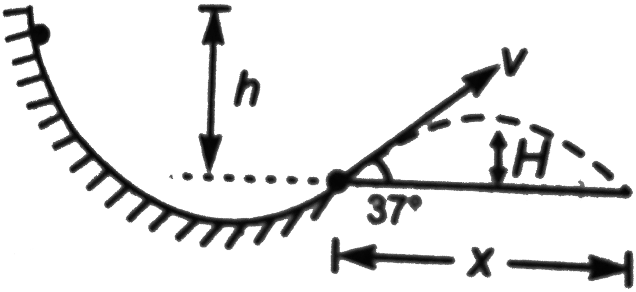
36.



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

Answer: A

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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 $\mu > 1$

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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?

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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.

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

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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.

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5.

Due to slippoing 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.

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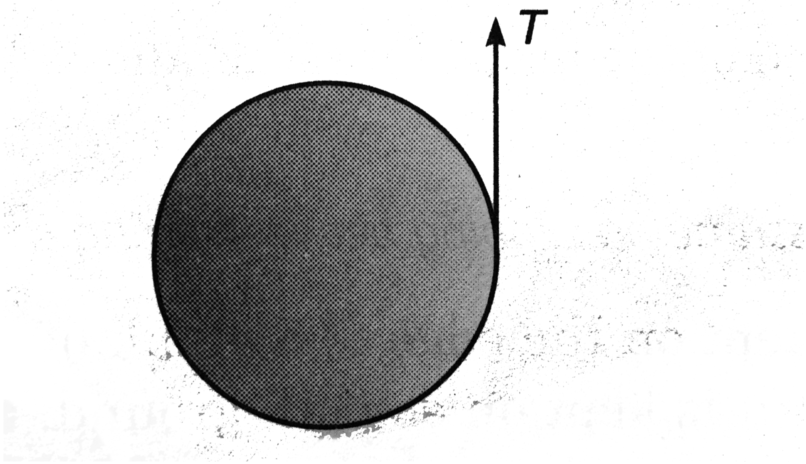
6. 

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.

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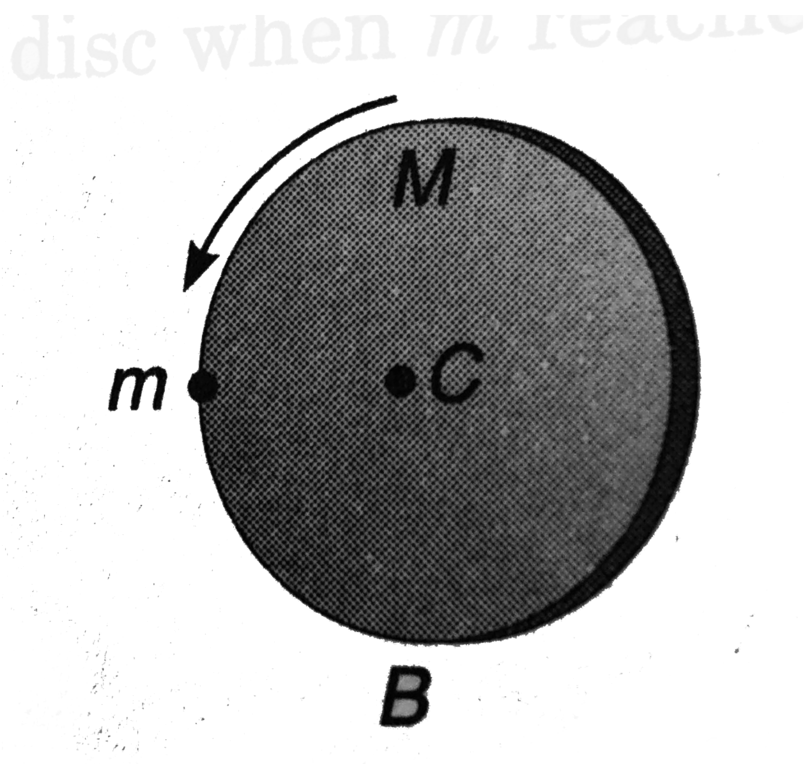

7.

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.

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?

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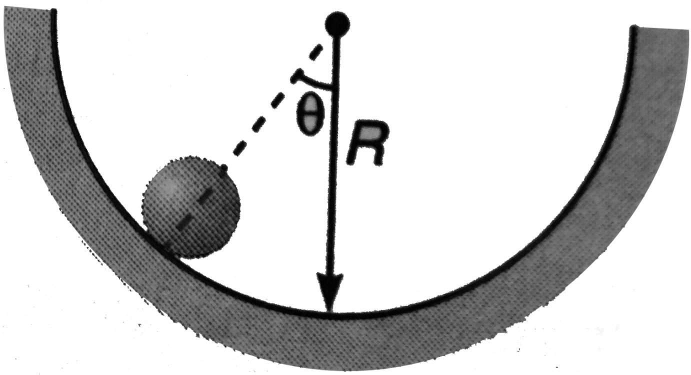
9.



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

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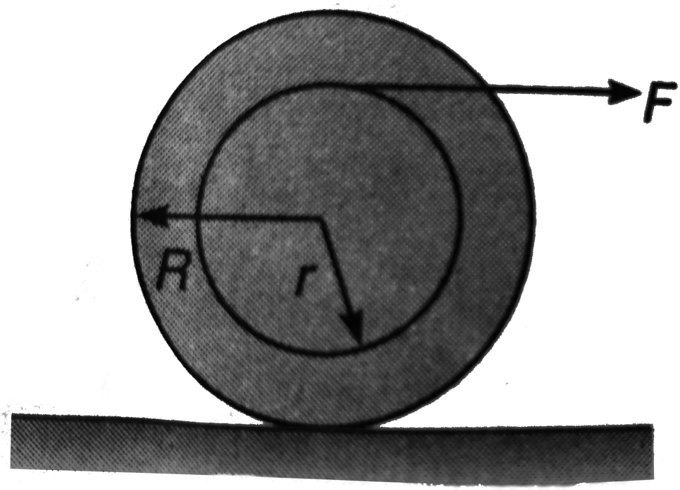

10.

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)?

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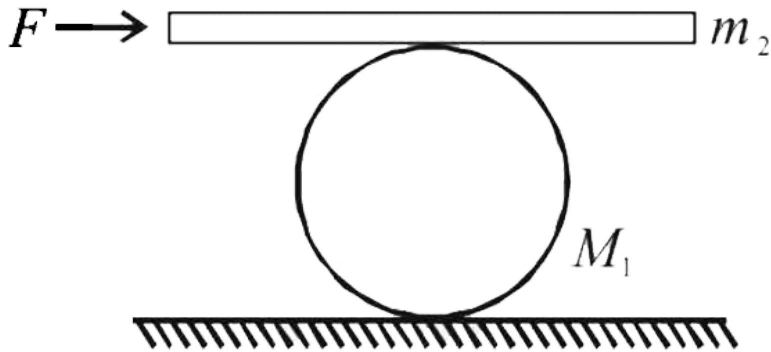
11. A man pushes a cylinder of mass m_1 with the help of a plank of mass m_2 as shown in figure. There in no slipping at any contact. The horizontal component of the force applied by the man is F.

(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.

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12.

For the system shown in figure, $M = 1kg$ $m = 0.2$ kg, $r = 0.2m$ calculate $\left(g = 10m/s^2\right)$

(a). The linear acceleration of hoop,

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

(c). The tension in the rope.

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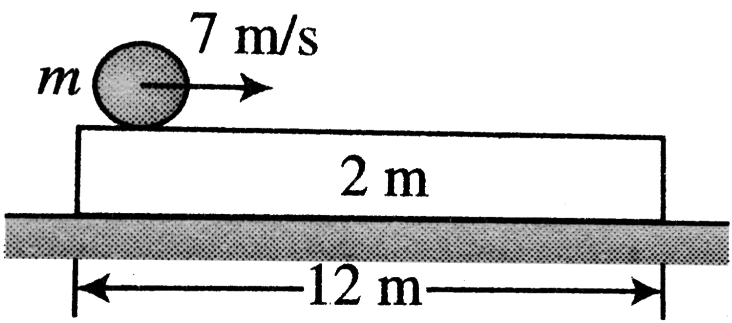
13. A cylinder of mass m is kept on the edge of a plank of mass $2m$ and length $12m$, which in turn is kept on smooth ground. Coefficient of friction between the plank and the cylinder is 0.1. The cylinder is given an impulse, which imparts it a velocity $7ms^{-1}$ but no angular velocity. Find the time after which the cylinder falls off the plank.



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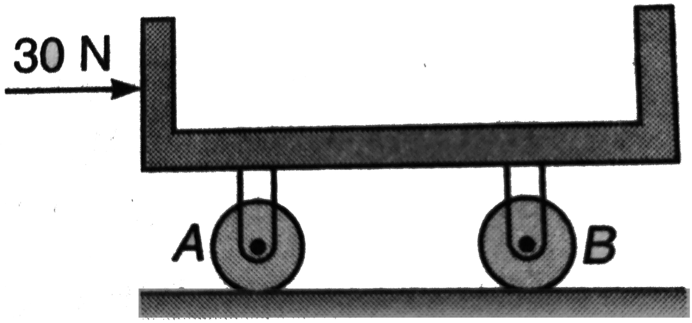
14. 

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.

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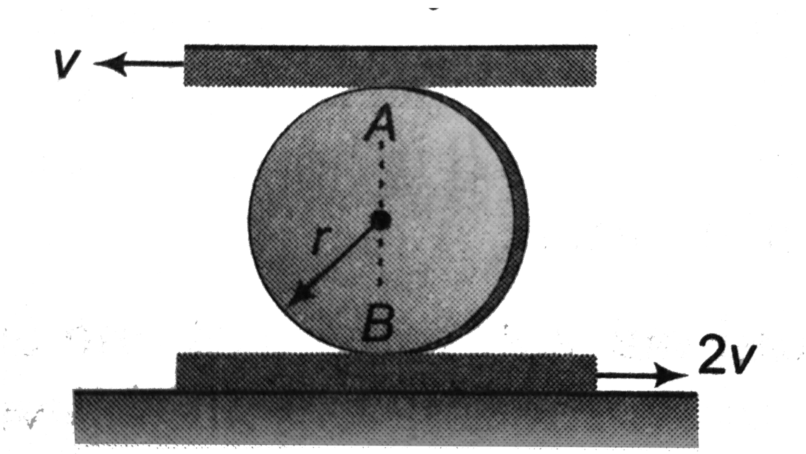

15.

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.

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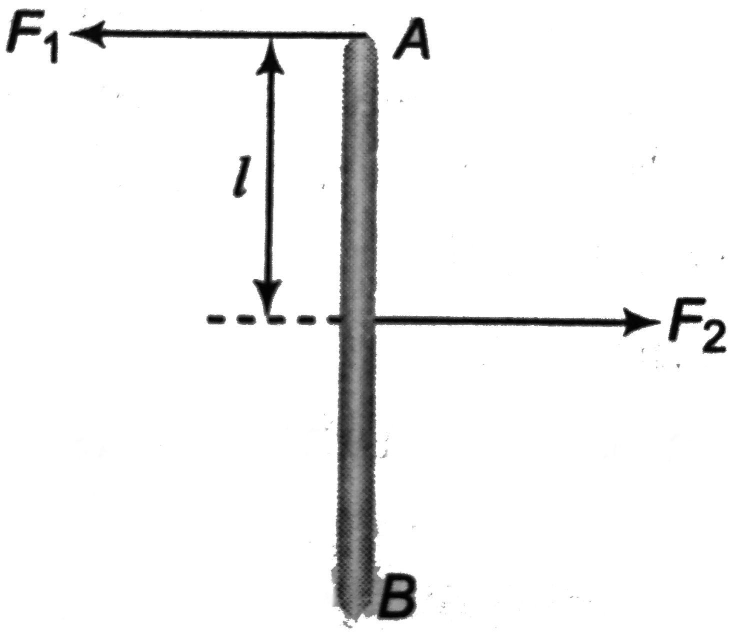
16. 

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.

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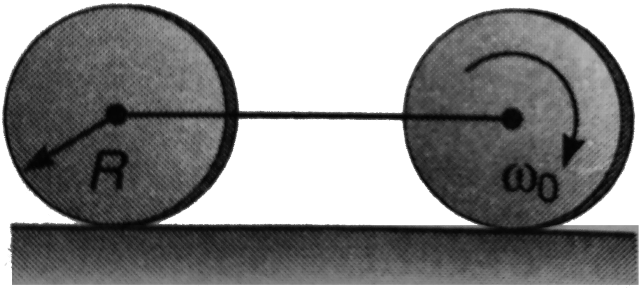
17. 

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.

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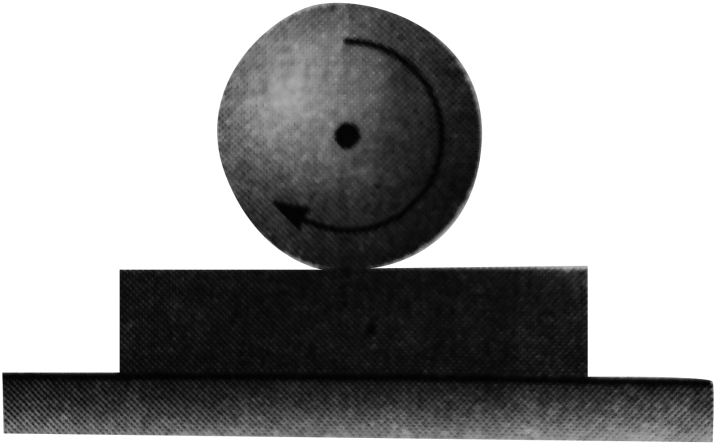

18.

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.

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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 long after the collision.

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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?

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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.

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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 $F_r = \frac{1}{2}Mg\left(5\cos\theta - 3\cos\theta_0\right)$ and $F_t = \frac{1}{4}Mg\sin\theta$

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23. A uniform rod AB of mass 3m and length 4l, which is free to turn in a vartical plane about a smooth horizontal axis through A, is released from rest when horizontal When the rod first impulse exerted by the peg on the rod it.

(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.

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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.

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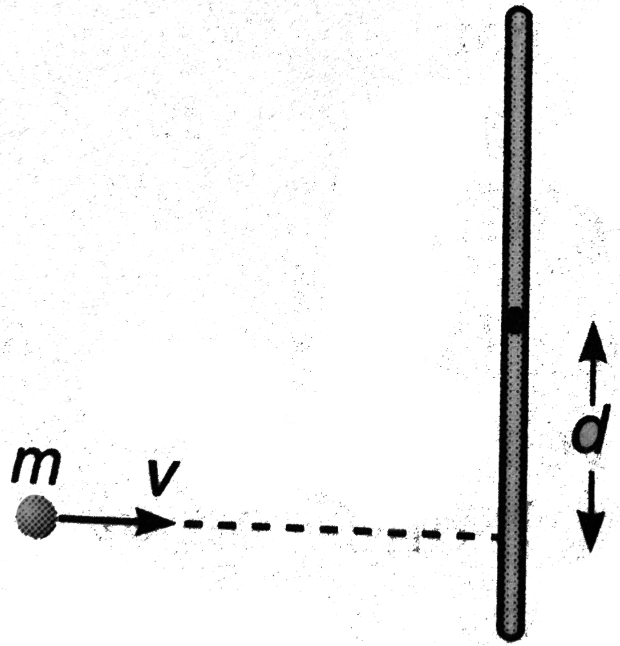

25.

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?

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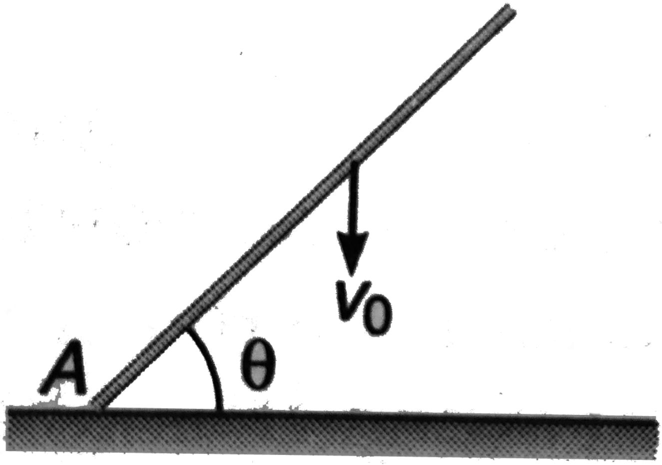
26. 

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.

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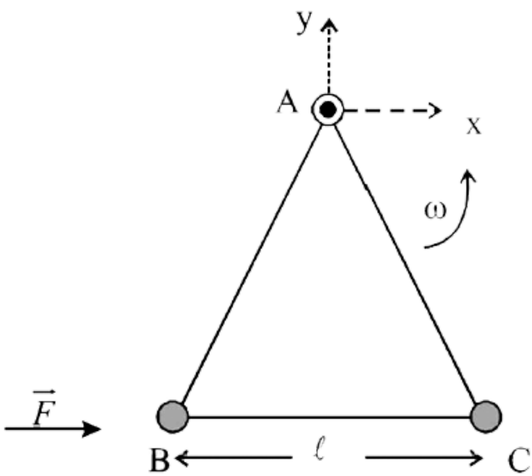
27. Three particles A, B and C each of mass m, are connected to each other by three massless rigid rods to form a rigid, equilateral triangular body of side l. This body is placed on a horizonta frictionsess table (x-y plane) and is hinged to it at the point A so that it can move without friction about 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.

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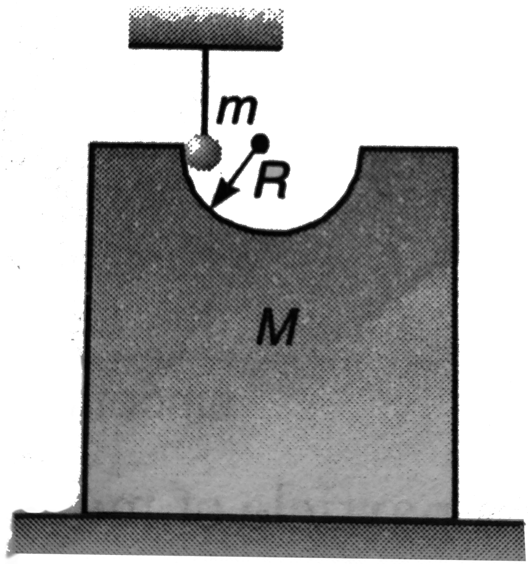
28. 

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

$m = 0.5kg$ 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. $\left(g = 10m/s^2\right)$

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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 $\mu > \tan\alpha$.

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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 $\frac{3\sin\theta\cos\theta}{1 + 3\sin^2\theta}$

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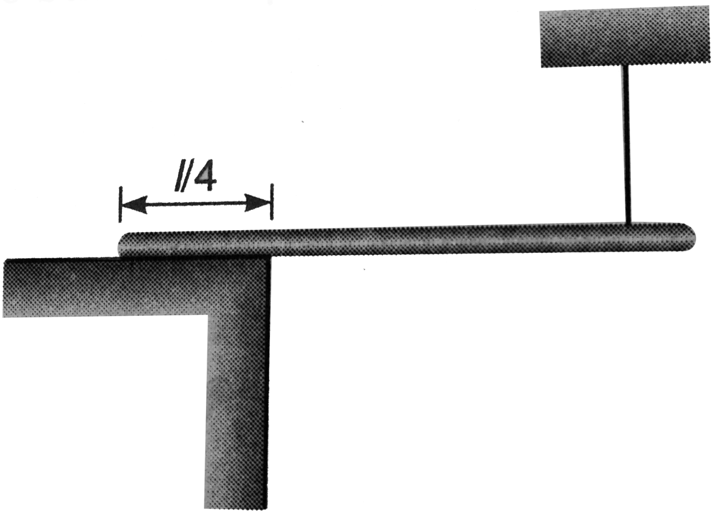
the surface is μ.



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.

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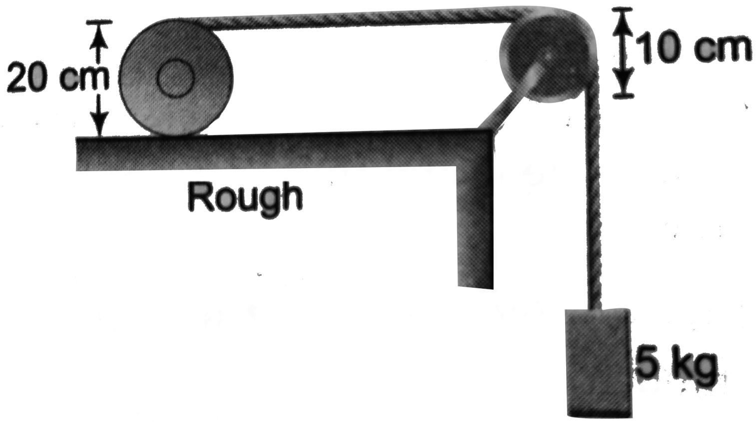
32. 

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.

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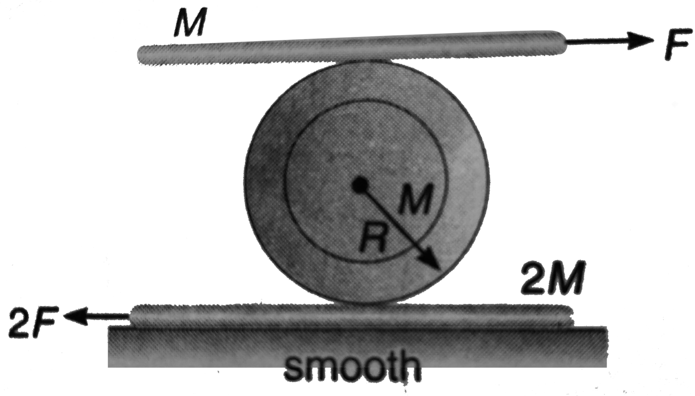
33. 

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.

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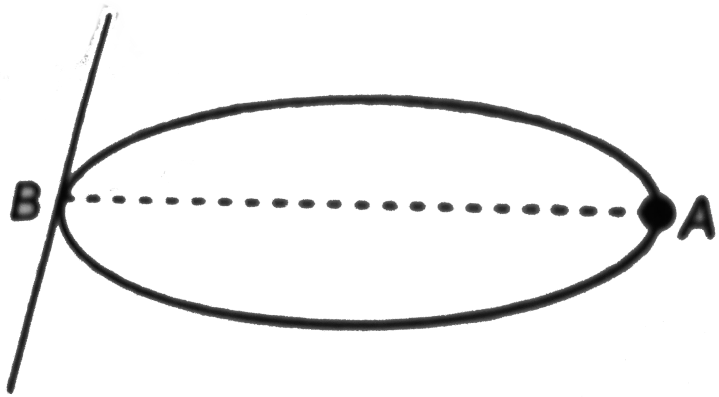

34.

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 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 veloicity and the angular acceleration of the body when AB has turned through an angle $\frac{\pi}{3}$.

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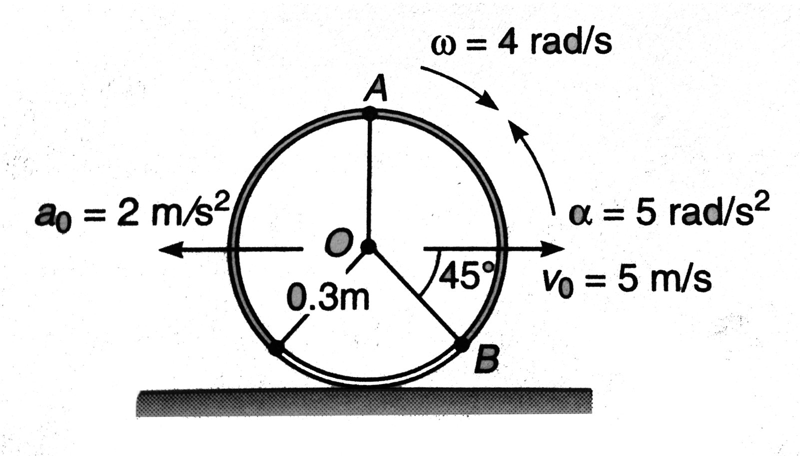
35. 

a hoop is placed on the rough surface such that it has an angular velocity $\omega = 4 rad/s$ and an angular deceleration $\alpha = 5 rad/s^2$ also its centre has a velocity of $v_0 = 5 m/s$ and a decoleration $a_0 = 2 m/s^2$ determine the magnitude of acceleration of point B at this instant.

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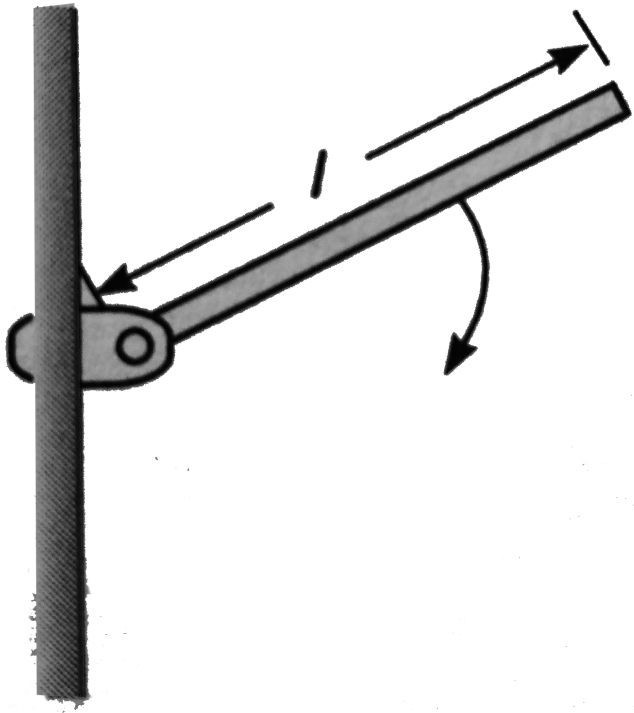
36.



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?

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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.

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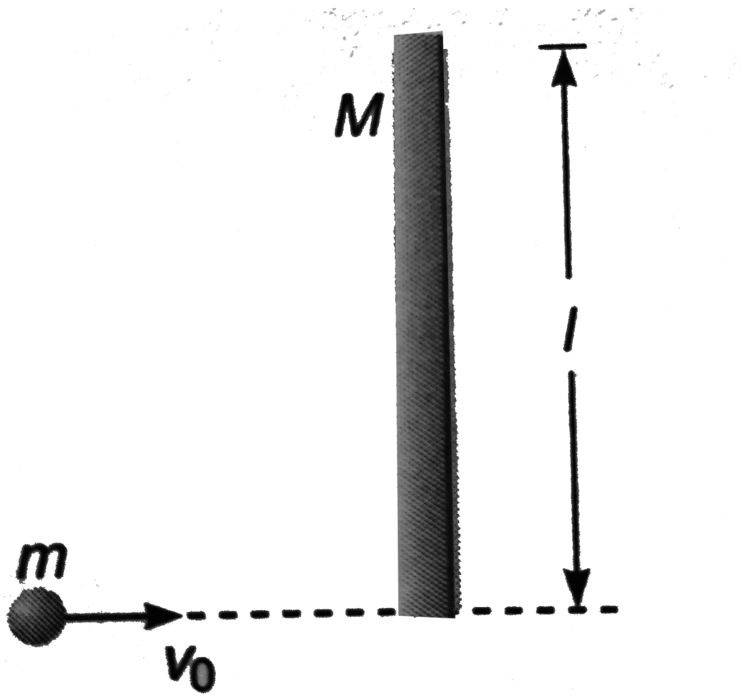
2.



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 quatitatively 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?

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JEE Main

1. A circular disc A of radius r is made from an iron plate of thickness t and another circular disc B of radius 4r is made from an iron plate of thickness $t/4$. The relation between the moments of inertia I_A and I_B is (about an axis passing through centre and perpendicular to the disc)

A. $l_A > l_B$

B. $l_A = l_B$

C. $l_A < l_B$

D. depends on the actul values of t and r

Answer: C

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2. A force F=$2\hat{i} + 3\hat{j} - \hat{k}$ acts at a point (2,-3,1). Then magnitude of torque about point (0,0,2) will be

A. 6 units

B. $3\sqrt{5}$ units

C. $6\sqrt{5}$ units

D. None of these

Answer: C

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3. A rod of weight w is supported by two parallel knife edges A and B and is in equilibrium in a horizontal position. The knives are at a distance d from each other. The centre of mass of the rod is at distance x from A. The normal reaction on A is.. And on B is......

A. $N_A = 2w(1 - x/d), N_B = wx/d$

B. $N_A = w(1 - x/d), N_B = wx/d$

C. $N_A = 2w(1 - x/d), N_B = 2wx/d$

D. $N_A = wx/d, N_B = w\left(1 - \frac{x}{d}\right)$

Answer: B

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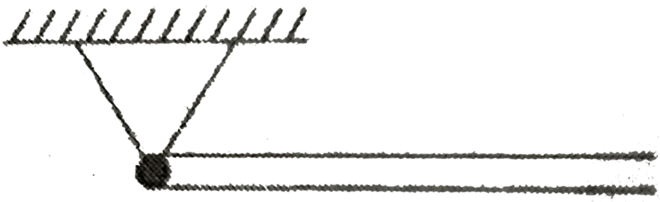
4. A uniform rod of mass 20 Kg and length 1.6 m is piovted at its end and swings freely in the vertical plane. Angular acceleration of the rod just after the rod is relased from rest in the horizontal position is



A. $\frac{15g}{16}$

B. $\frac{17g}{16}$

C. $\frac{16g}{15}$

D. $\frac{g}{15}$

Answer: A

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5. In the above problem, if the rod is released from horizontal position, the angular velocity of the rod as it passes the vertical position is (l=length fo rod)

A. $\sqrt{\frac{12g}{5l}}$

B. $\sqrt{\frac{2g}{3l}}$

C. $\sqrt{\frac{3g}{l}}$

D. $\sqrt{\frac{3g}{7l}}$

Answer: C

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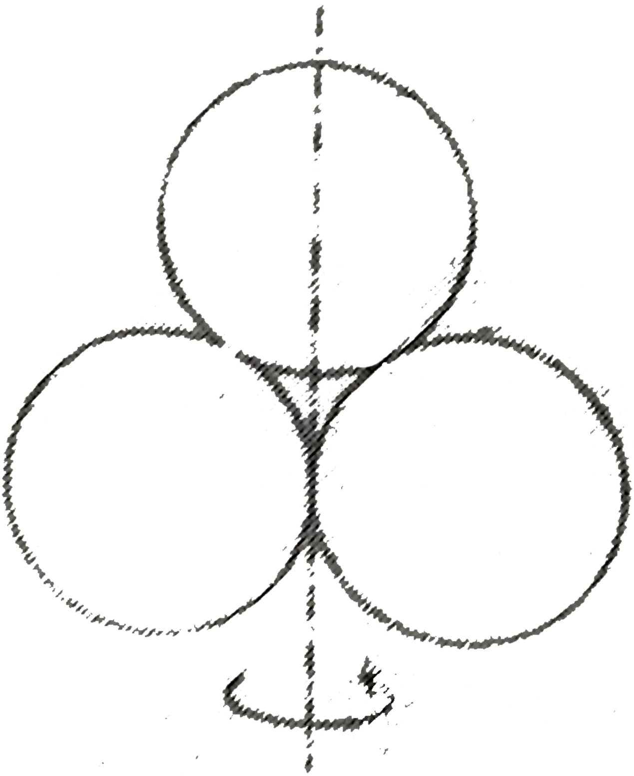
6. Three rings each of mass m and radius r are so placed that they touch each other. The radius of gyration of the system about the axis as shown in the figure is



A. $\sqrt{\frac{6}{5}}r$

B. $\sqrt{\frac{5}{6}}r$

C. $\sqrt{\frac{6}{7}}r$

D. $\sqrt{\frac{7}{6}}r$

Answer: D

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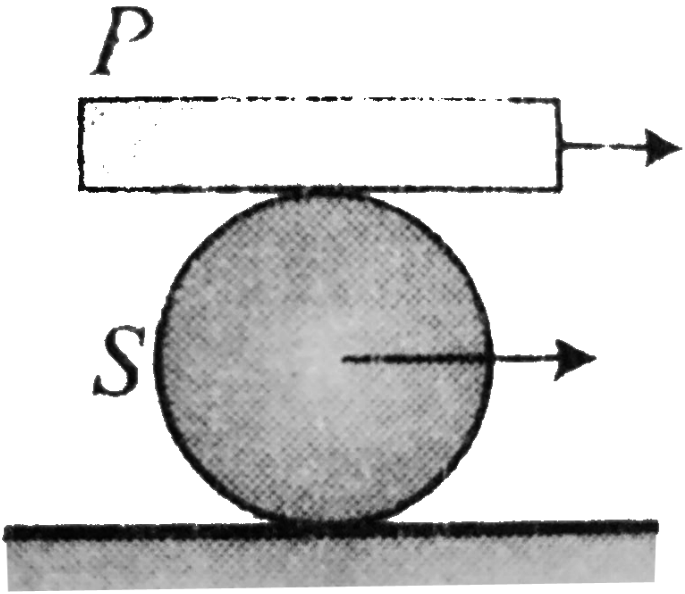
7. A plank P is placed on a solid cylinder S, which rolls on a horizontal surface. The two are of equal mass. There is no slipping at any of the surfaces in contact. The ratio of kinetic energy of P to the kinetic energy of S is:



A. $1:1$

B. $2:1$

C. $8:3$

D. $5:3$

Answer: C

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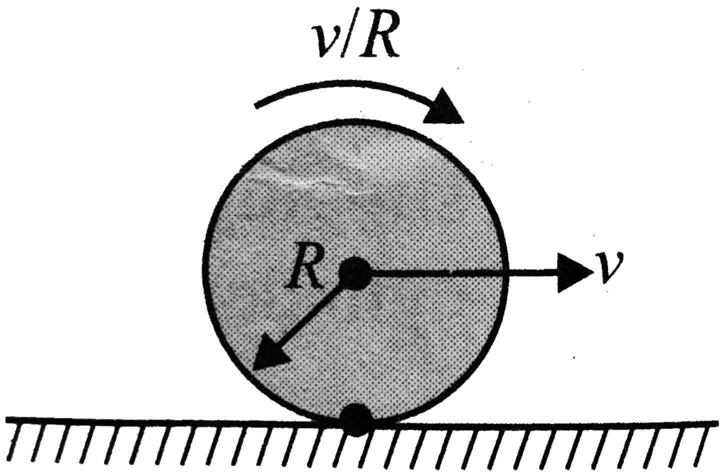
8. A disc is performing pure rolling on a smooth stationary surface with constant angular velocity as shown in Fig,. At any instant, for the lower most point of the disc,



A. velocity is v, acceleration is zero

B. velocity is zero, acceleration is zero

C. velocity is v, acceleration is $\frac{V^2}{R}$

D. velocity is zero, acceleration is $\frac{V^2}{R}$

Answer: D

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9. A ball rolls without slipping. The radius of gyration of the ball about an axis passing through its centre of mass is k. If radius of the ball be R, then the fraction of total energy associated with its rotation will be.

A. $\frac{R^2}{R^2 + k^2}$

B. $\frac{k^2}{R^2 + k^2}$

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

D. $\frac{k^2}{R^2}$

Answer: B

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10. A particle of mass $2kg$ located at the position $(\hat{i}+\hat{j})m$ has velocity $2(\hat{i}-\hat{j}+\hat{k})m/s$. Its angular momentum about Z-axis in kgm^2/s is

A. zero

B. $+8$

C. 12

D. -8

Answer: D

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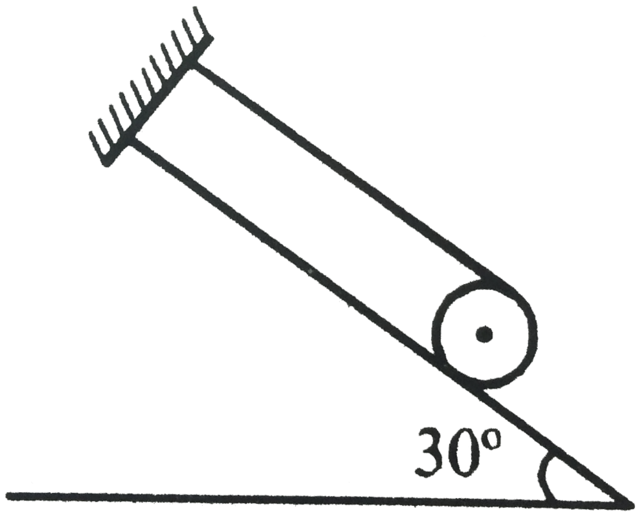
11. A thin hoop of weight $500N$ and radius $1m$ rest on a rought inclined plane as shown in the figure. The minimum coefficient of friction needed for this configuration is.



A. $\frac{1}{3\sqrt{3}}$

B. $\frac{1}{\sqrt{3}}$

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

D. $\frac{1}{2\sqrt{3}}$

Answer: D

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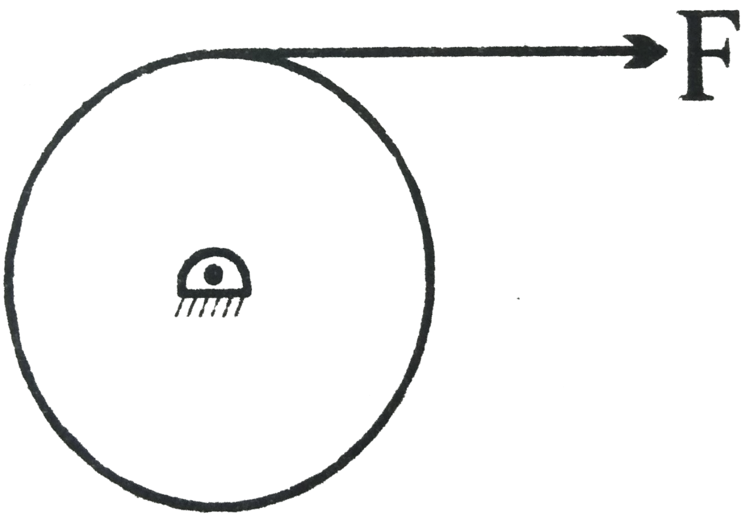
12. A pulley is hinged at the centre and a massless thread is wrapped around it. The thread is pulled with a contant froce F starting from rest. As the time increases -



A. its angular velocity increases, but force on hinge remains constant

B. its angular velocity remains same, but force on hinge increases

C. its angular velocity increases and force on hinge increases

D. its angular velocity remains same and force on hinge is also constant

Answer: A

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13. A solid uniform disc of mass m rolls 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. 2 ma

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

C. ma

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

Answer: D

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14. A weightless rod is acted upon by two upward parallel forces of $2N$ and $4N$ at ends A and B respectively. The total length of the rod $AB = 3m$. To keep the rod in equilibrium a force of $6N$ should act in the following manner.

A. downwards at any point between A and B

B. downwards at mid point of AB

C. downwards at a point C such that AC=1 m

D. downwards at a point D such that BD=1 m

Answer: D

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15. A rigid body can be hinged about any point on the x-axis. When it is hinged such that the hinge is at x, the moment of interia is given by

$I = 2x^2 - 12x + 27$

The x-coordinate of centre of mass is.

A. $x = 2$

B. $x = 0$

C. $x = 1$

D. $x = 3$

Answer: D

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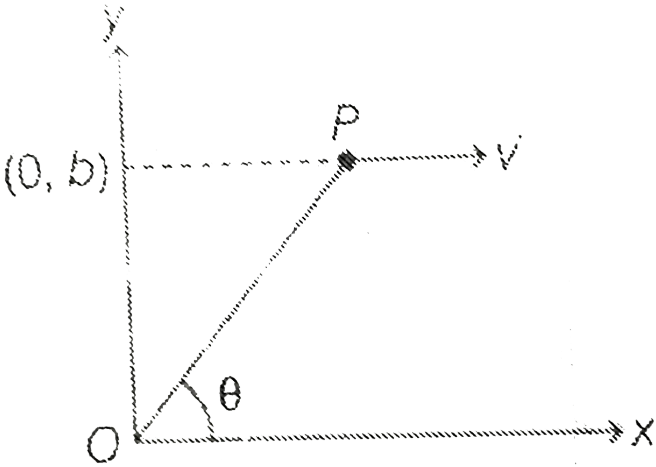
16. A particle is moving parallel to x-axis as shown in the figure. The angular velocity of the particle about the origin is



A. $(v/b)\sin^2\theta$

B. (v/b)

C. $(v/b)\sin\theta$

D. $\dfrac{v}{b\sin\theta}$

Answer: A

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17. Two men each of mass m stand on the rim of a horizontal circular disc, diametrically opposite to each other. The disc has a mass M and is free to rotate about a vertical axis passing through its centre of mass. Each mass start simultaneously along the rim clockwise and reaches their original starting positions on the disc. The angle turned through by disc with respect to the ground (in radian) is

A. $\dfrac{8m\pi}{4m + M}$

B. $\dfrac{2m\pi}{4m + M}$

C. $\dfrac{m\pi}{M + m}$

D. $\dfrac{4m\pi}{2M + m}$

Answer: A

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18. When a solid sphere rolls without slipping down an inclined plane making an angle θ with the horizontal, the acceleration of its centre of mass is a. If the same sphere slides without friction, its.

A. $(7/2)$ a

B. $(5/7)$ a

C. $(7/5)$ a

D. $(5/2)$ a

Answer: C

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19. Two rings of same radius and mass are placed such that their centres are at a common point and their planes are perpendicular to each other. The moment of inertia of the system about an axis passing through the centre and perpendicular to the plane of one of the rings is (mass the ring $= m$, radius $= r$)

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

B. mr^2

C. (3)/(2)mr^(2)`

D. 2mr^(2)`

Answer: C

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20. A uniform thin bar of mass $6m$ and length $12L$ is bend to make a regular hexagon. Its moment of inertia about an axis passing through the centre of mass and perpendicular to the plane of the hexagon is :

A. $20mL^2$

B. $6mL^2$

C. $\frac{12}{5}mL^2$

D. $30mL^2$

Answer: A

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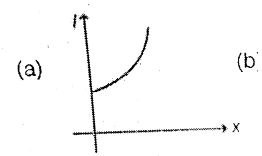
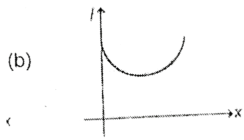
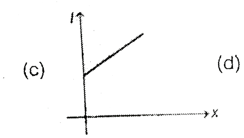
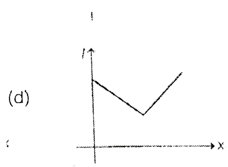
21. Moment of inertia I of a solid sphere about an axis parallel to a diameter and at a distance x from it varies as:

A. 

B. 

C. 

D. 

Answer: A

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22. Locus of all the points in a plane on which the moment of inertia about all mutually parallel axes of a rigid body is same throughout is

A. a straight line

B. a circle

C. a parabola

D. an ellipse

Answer: B

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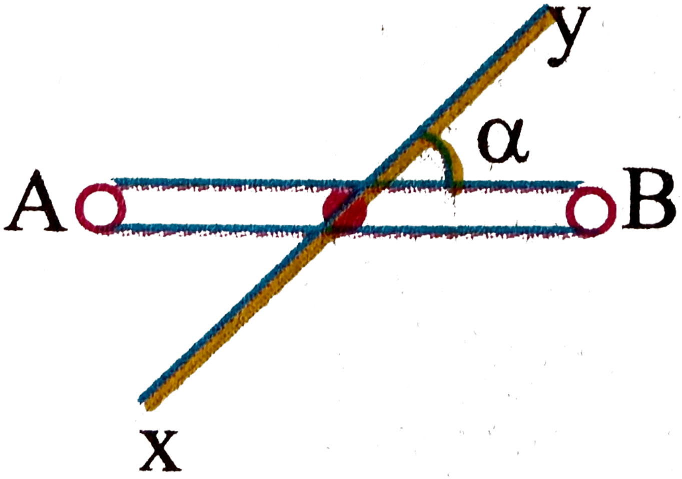
23. The moment of inertia of a uniform rod of length $2l$ and mass m about an axis xy passing through its centre and inclined at an enable α is



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

B. $\frac{ml^2}{12}\sin^2\alpha$

C. $\frac{ml^2}{6}\cos^2\alpha$

D. $\frac{ml^2}{2}\cos^2\alpha$

Answer: A

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24. A wire of length l and mass m is bent in the form of a rectangle $ABCD$ with $\frac{AB}{BC} = 2$. The moment of inertia of this wife frame about the side BC is

A. $\frac{11}{252}ml^2$

B. $\frac{8}{203}ml^2$

C. $\frac{5}{136}ml^2$

D. $\frac{7}{162}ml^2$

Answer: D

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25. A particle moves in a circle with constant angular velocity ω about a point P on its circumference. The angular velocity of the particle about the centre C of the circle is

A. 2ω

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

C. ω

D. Not constant

Answer: A

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26. Two equal and opposite forces act on a rigid body at a certain distance. Then

A. the body is in equilibrium

B. the body will rotate about its centre of mass

C. the body may rotate about any point other than its centre of mass

D. the body cannot rotate about its centre of mass

Answer: B

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27. A uniform stick of length l and mass m lies on a smooth table. It rotates with angular velocity ω about an axis perpendicular to the table and through one end of the stick. The angular momentum of the stick about the end is

A. $ml^2\omega$

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

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

D. $\frac{ml^2\omega}{6}$

Answer: B

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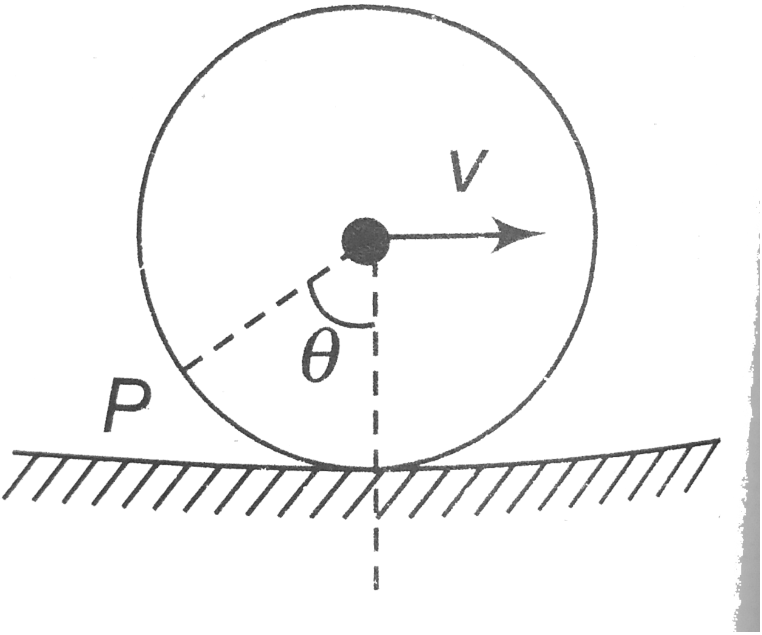
28. A hoop rolls on a horizontal ground without slipping with linear speed v. Speed of a particle P on the circumference of the hoop at angle θ is :



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

B. $v\sin\theta$

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

D. $v\cos\theta$

Answer: A

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

A. n

B. 2n

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

D. $\frac{n}{3}$

Answer: D

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30. A uniform cube of side and mass m rests on a rough horizontal surface. A horizontal force F is applied normal to one face at point that is directly above the centre of the face at a height $\frac{a}{4}$ above the centre. The minimum value of F for which the cube begins to topple above an edge without sliding is

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

B. 2mg

C. $\frac{1}{2}mg$

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

Answer: D

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31. 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.

A. $4kg - m^2/s$

B. $2\sqrt{2}kg - m^2/s$

C. $4\sqrt{2}kg - m^2/s$

D. $2kg - m^2/s$

Answer: B

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32. A rigid spherical body is spinning around an axis without any external torque. Due to temperature its volume increases by 3%. Then percentage change in its angular speed is:

A. -2%

B. -1%

C. -3%

D. 1%

Answer: A

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33. A circular platform is mounted on a vertical frictionless axle. Its radius is $r = 2m$ and its moment of inertia$I = 200 kgm^2$. It is initially at rest. A $70kg$ man stands on the edge of the platform and begins to walk along the edge at speed

$v_0 = 1ms^{-1}$ relative to the ground. The angular velocity of the platform is.

A. $1.2 rad/s$

B. $0.4 rad/s$

C. $2.0 rad/s$

D. $0.7 rad/s$

Answer: D

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34. In the above problem, when the man has walked once around the platform, so that he is at his original position on it, what is his angular displacement relative to ground?

A. $\frac{6}{5}\pi$

B. $\frac{5}{6}\pi$

C. $\frac{4}{5}\pi$

D. $\frac{5}{4}\pi$

Answer: B

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

A. the speed and time of descend will be same

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

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

D. the speed and time of descend will be different

Answer: B

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36. An inclined plane makes an angle of 60° with horizontal. A disc rolling down this inclined plane without slipping has a linear acceleration equal to

A. $\frac{g}{3}$

B. $\frac{3}{4}g$

C. $\frac{g}{\sqrt{3}}$

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

Answer: C

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37. A homogeneous cylinder of mass Mand radius r is pulled on a horizontal plane by a horizontal force F acting through its centre of mass. Assuming rolling without slipping, find the angular acceleration of the cylinder,

A. $\frac{3F}{2MR}$

B. $\frac{2F}{3MR}$

C. $\frac{F}{2MR}$

D. $\frac{3F}{4MR}$

Answer: B

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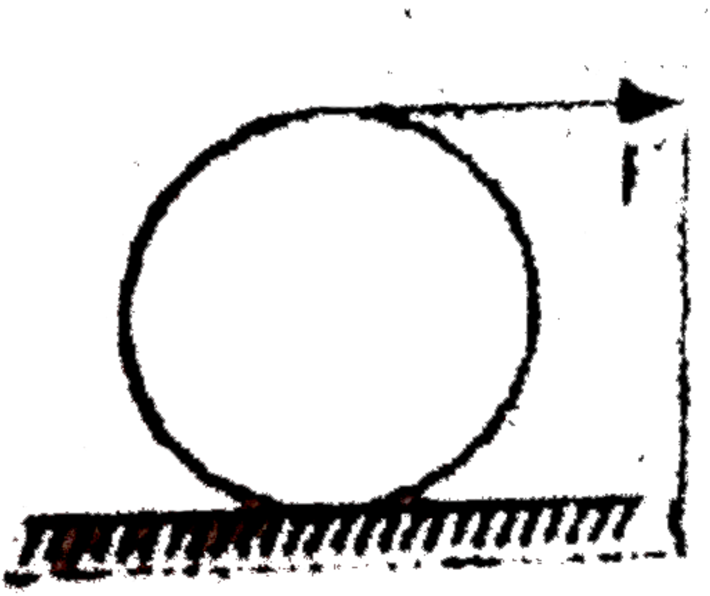
38. A force F is applied at the top of a ring of mass M and radius R placed on a rough horizontal surface as shown in figure. Friction is sufficient to prevent slipping. The friction force acting on the ring is:



A. $\frac{F}{2}$ towards right

B. $\frac{F}{3}$ towards left

C. $\frac{2F}{3}$ towards right

D. zero

Answer: D

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39. A body of radius R and mass m is rolling smoothly with speed v on a horizontal surface. It then rolls up a hill to a maximum height h. If $h = 3v^2/4g$. What might the body be ?

A. solid sphere

B. hollow sphere

C. disc

D. ring

Answer: C

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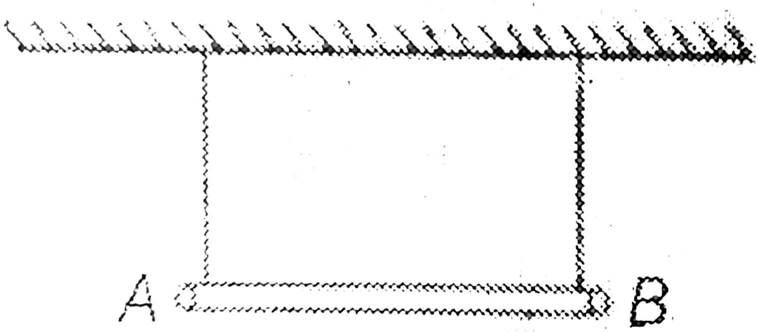
40. A uniform rod of mass m and length l is suspended by means of two light inextensible strings as shown in figure. Tension in one string immediately after the other string is cut



is

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

B. 2mg

C. $\frac{mg}{4}$

D. mg

Answer: C

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41. A billiard ball of mass m and radius r, when hit in a horizontal direction by a cue at a height h above its centre, acquired a linear velocity v_0. The angular velocity ω_0 acquired by the ball is

A. $\frac{2v_0h}{5r^2}$

B. $\frac{5v_0h}{2r^2}$

C. $\frac{5v_0r^2}{5h}$

D. $\frac{5v_0r^2}{2h}$

Answer: B

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42. The linear velocity perpendicular to radius vector of a particle moving with angular velocity $\omega = 2\hat{K}$ at position vector $r = 2\hat{i} + 2\hat{j}$ is

A. $4\left(\hat{i} - \hat{j}\right)$

B. $4\left(\hat{j} - \hat{i}\right)$

C. $4\hat{i}$

D. $-4\hat{i}$

Answer: B

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43. ABC is a right angled triangular plate of uniform thickness. The sides are such that $AB > BC$ as shown in figure. I_1, I_2, I_3 are moments of inertia about AB, BC and AC respectively. Then which of the following relations is correct?

A. $l_1 = l_2 = l_3$

B. $l_2 > l_1 > l_3$

C. $l_3 < l_2 < l_1$

D. $l_3 > l_1 > l_2$

Answer: C

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44. A solid sphere, a ring and a disc all having same mass and radius are placed at the top of an incline and released. The friction coefficient between the objects and the incline are same but not sufficient to allow pure rolling. Least time will be taken in reaching the bottom by

A. the solid sphere

B. the ring

C. the disc

D. all will take the same time

Answer: D

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45. In the previous question the smallest kinetic energy at the bottom of the incline will be achieved by

A. the solid sphere

B. the ring

C. the disc

D. all will achieve the same kinetic energy

Answer: B

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46. A wheel of radius R rolls on the ground with a uniform velocity v. The relative acceleration of topmost point of the wheel with respect to the bottommost point is:

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

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

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

D. $\frac{4v^2}{R}$

Answer: B

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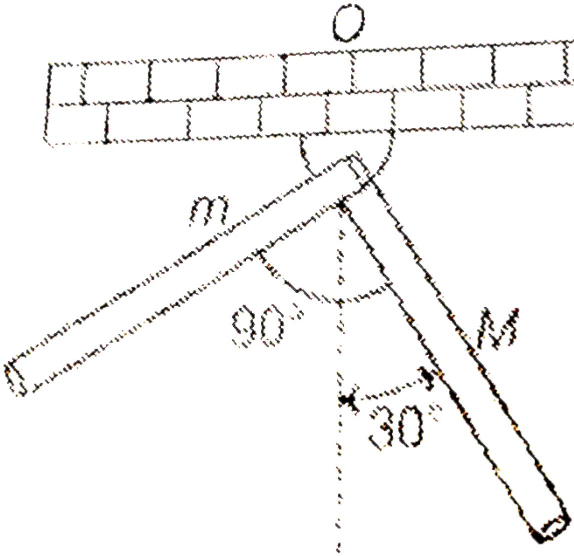
47. Two uniform rods of equal length but different masses are rigidly joined to form an L-shaped body, which is then pivoted as shwon. If in equilibrium, the body is in the shown configuration, ratio `M//m will be



A. 2

B. 3

C. $\sqrt{2}$

D. $\sqrt{3}$

Answer: D

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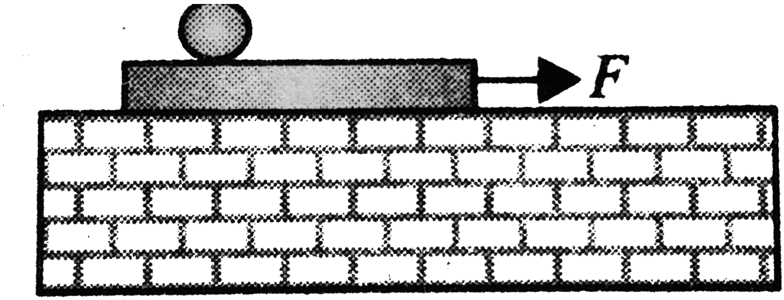
48. A plank with a uniform sphere placed on it resting on a smooth horizontal plane. Plank is pulled to right by a constant force F. If sphere does not slip over the plank. Which of the following is incorrect?



A. Acceleration of the centre of sphere is less than that of the plank

B. Work done by friction acting on the sphere is equal to its total kinetic energy

C. Total kinetic energy of the system is equal to work done by the force F

D. None of the above

Answer: D

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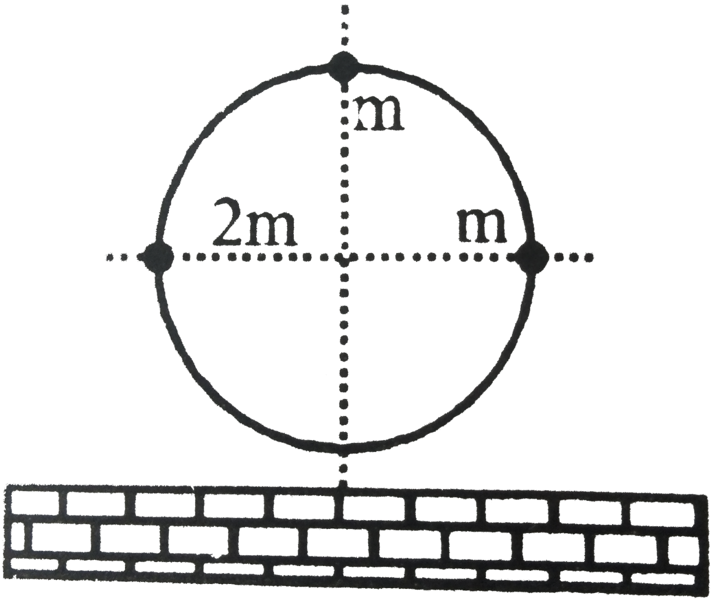
49. A ring mass m and radius R has three particle attached to the ring as shown in the figure. The centre of the centre v_0.

Find the kinetic energy of the system. (Slipping is absent).



A. $6mv_0^2$

B. $12mv_0^2$

C. $4mv_0^2$

D. $8mv_0^2$

Answer: A

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50. A solid uniform sphere rotating about its axis with kinetic energy E_1 is gently placed on a rough horizontal plane at time t=0, Assume that, at time $t = t_1$, it starts pure rolling and at that instant total KE of the sphere is E_2. After sometime, at time $t = t_2$. KE of the sphere is E_3. Then

A. $E_1 = E_2 = E_3$

B. $E_1 > E_2 = E_3$

C. $E_1 > E_2 > E_3$

D. $E_1 < E_2 = E_3$

Answer: B

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51. A solid sphere and a solid cylinder of same mass are rolled down on two inclined planes of heights h_1 and h_2 respectively. If at the bottom of the plane the two objects have same linear velocities, then the ratio of $h_1 : h_2$ is

A. $2:3$

B. $7:5$

C. $14:15$

D. $15:14$

Answer: C

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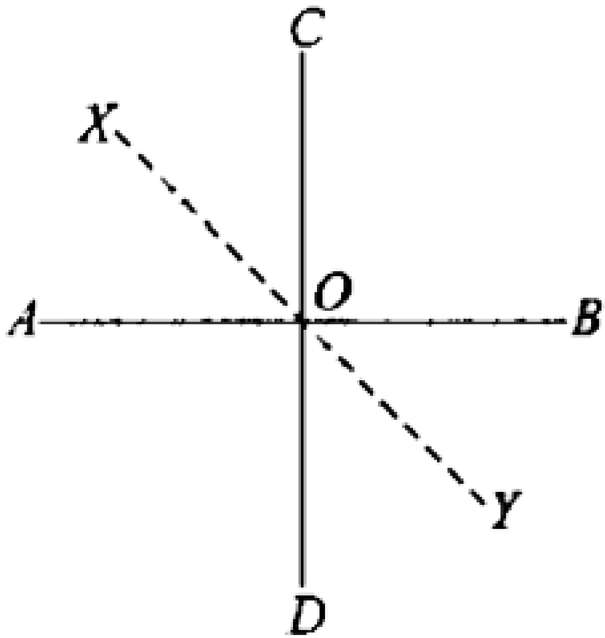
52. AB and CD are two indential rods each of length L and mass M joined to from a cross. Find the M.L of the system about a bisector of the angel between the rods (XY):



A. $\frac{ml^2}{6}$

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

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

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

Answer: C

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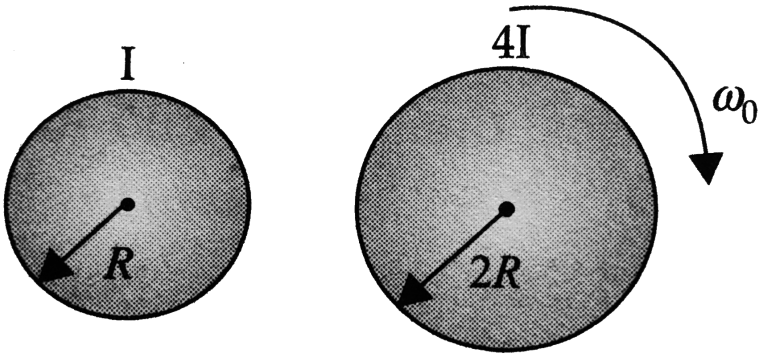
53. Two cylinders having radii $2R$ and R and moment of inertia $4I$ and I about their central axes are supported by axles perpendicular to their planes. The large cylinder is initially rotating clockwise with angular velocity ω_0. The small cylinder is moved to the right until it touches the large cylinder and is caused to rotate by the frictional force between the two. Eventually slipping ceases and the two cylinders rotate at constant rates in opposite directions. During this



A. angular momentum of system is conserved

B. kinetic energy is conserved

C. neither the angular momentum nor the kinetic energy is conserved

D. both the angular momentum and kinetic energy are conserved

Answer: C

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54. In the above problem the final angular velocity of the small cylinder is

A. $\frac{\omega_0}{4}$

B. ω_0

C. $\frac{\omega_0}{2}$

D. $\frac{\omega_0}{8}$

Answer: B

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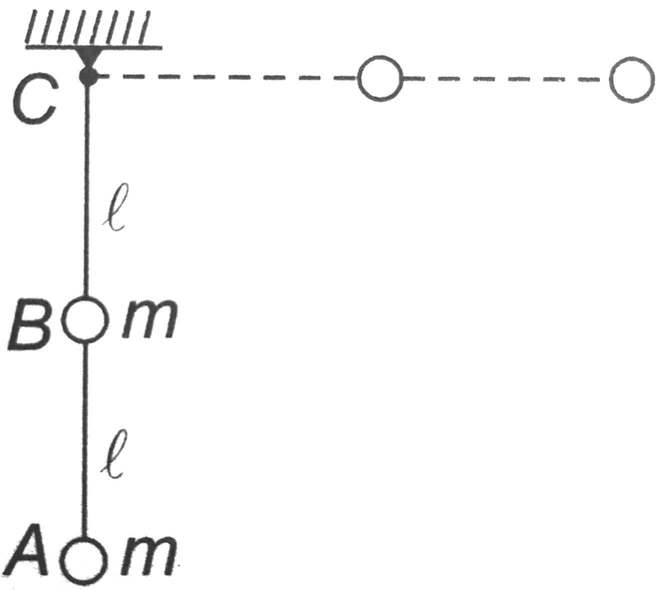
55. A weightless rod of length $2l$ carries two equal masses 'm', one tied at lower end A and the other at the middle of the rod at B. The rod can rotate in vertical plane about a fixed horizontal axis passing thriugh C. The rod of is released from rest in horizontal possion. The speed of the mass B at the instant rod become vertical is:



A. $\sqrt{\frac{3gl}{5}}$

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

C. $\sqrt{\frac{6gl}{5}}$

D. $\sqrt{\frac{7gl}{5}}$

Answer: C

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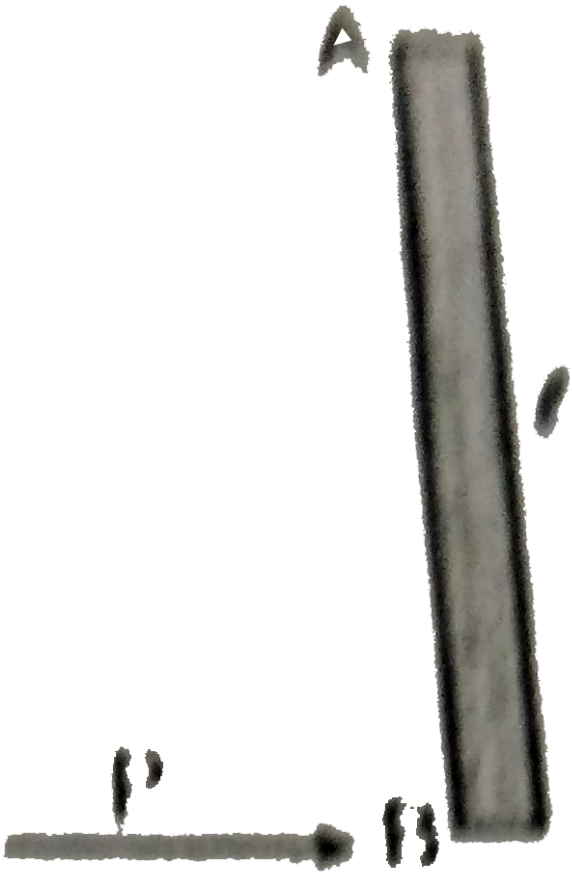
56. A uniform rod AB of mass m and length l at rest on a smooth horizontal surface . An impulse P is applied to the end

B. The time taken by the rod to turn through a right angle is :



A. $\frac{2\pi ml}{P}$

B. $\frac{\pi ml}{3P}$

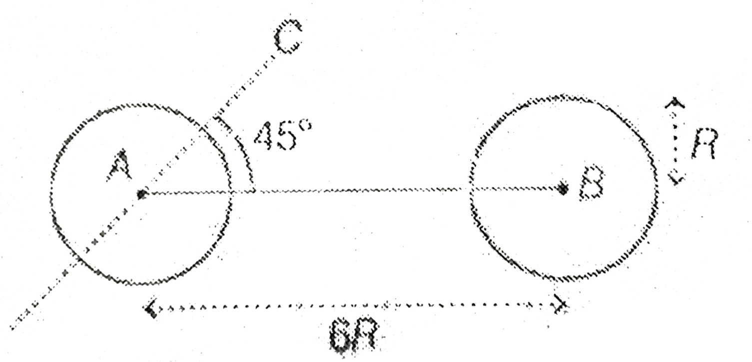
C. $\frac{\pi ml}{12P}$

D. $\frac{2\pi ml}{3P}$

Answer: C

Watch Video Solution

57. The moment of inertia of a dumb bell consisting of two identical uniform solid spheres of mass m and radius R each, joined by a thin metallic rod of equal mass m (separation between the centres of the spheres is 6R) is I about the axis AB. Its moment of inertia, about an axis making an angle of 45° with AB, is



A. $\frac{37}{2}l$

B. $\frac{94}{5}l$

C. 31l

D. $\frac{77}{2}l$

Answer: C

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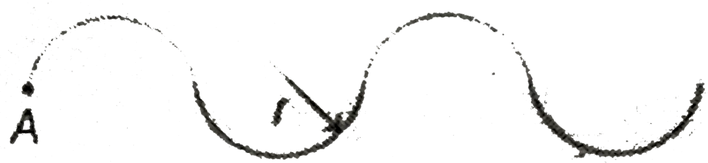
58. A uniform rod of mass 2M is bent into four adjacent semicircles each of radius r, all lying in the same plane. The moment of inertia of the bent rod about an axis through one end A and perpendicular to plane of rod is



A. $22Mr^2$

B. $88Mr^2$

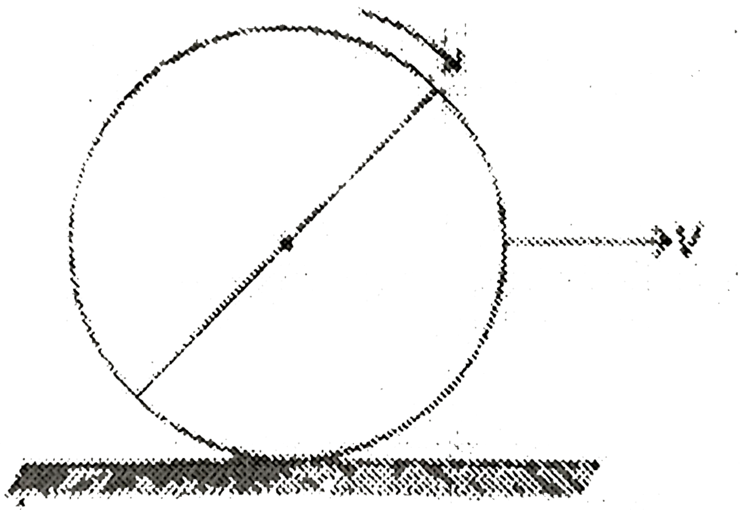
C. $44Mr^2$

D. $66Mr^2$

Answer: C

View Text Solution

59. A ring of mass m is rolling without slipping with linear velocity v as shown is figure. A rod of identical mass is fixed alone one of its diameter. The total kinetic energy of the system is



A. $\frac{7}{5}mv^2$

B. $\frac{2}{5}mv^2$

C. $\frac{5}{3}mv^2$

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

Answer: C

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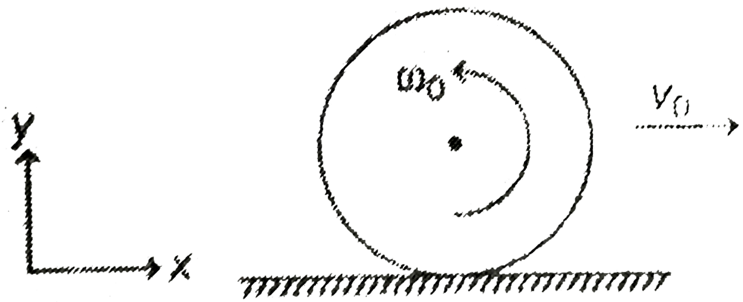
60. A disc is given an angular velocity ω_0 and a linear velocity v_0 as shown in the figure. It is released on a rough horizontal surface of friction coefficient μ. Mark the correct statement $\left(\omega_0 = 3v_0/R\right)$



A. The frictional force will be μmg during the entire motion.

B. After some time the disc will start rolling without sliding along positive x-axis.

C. After some time the disc will start rolling without sliding along negative x-axis.

D. The mechnical energy of the disc will remain conserved.

Answer: C

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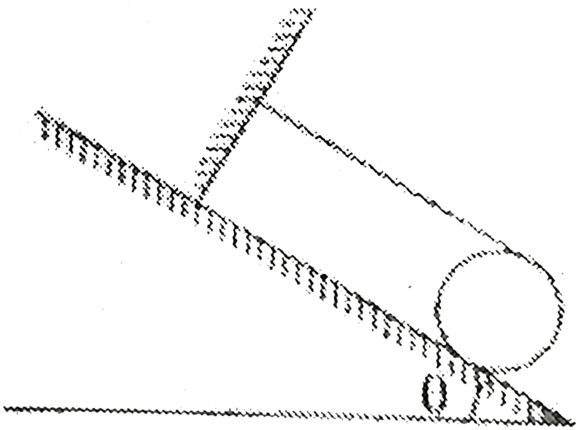
61. A string is wrapped on a uniform disc and the other end of the string connected to a wall. The system is placed on a smooth plane, inclined at an angle θ, with the string parallel to the plane, as shown in the figure. The acceleration of the



disc is

A. $\frac{1}{3}g\sin\theta$

B. $\frac{1}{2}g\sin\theta$

C. $\frac{2}{3}g\sin\theta$

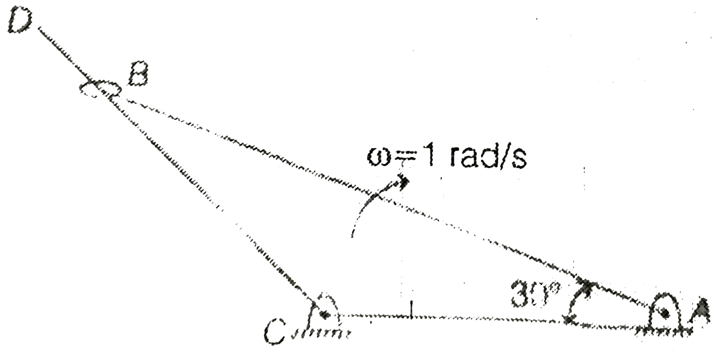
D. $\frac{1}{3}g\sin\theta$

Answer: C

View Text Solution

62. In the figure shown a smooth ring is connected to rod AB, while rod CD passes through ring. At the given instant angular velocity of rod AB about hinge A is 1 rod/s and AC=CB.

Instantaneous angular velocity of rod CD about hinge C is



A. $1rad/s$

B. $1/2rad/s$

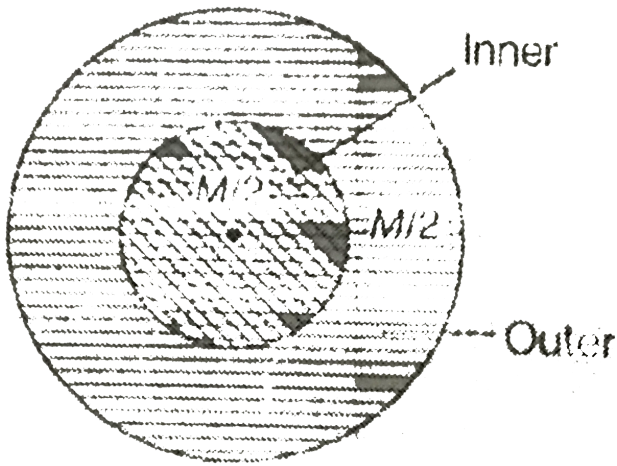
C. $\sqrt{3/2}rad/s$

D. $3/2rad/s$

Answer: D

View Text Solution

63. Consider the moment of inertia I of the rigid homogerneous disc of mass M as shown in the figure about an axis through its centre (different shadings only differentiate the two parts of the disc each with equal mass $M/2$). Which one of the following statements concerning I is



correct?

A. The inner and outer parts of the disc, each with mass $M/2$, contribute equal amounts to /.

B. The inner part of the disc contributes less to// than outer part.

C. The inner part of the disc contributes less to//than the outer part.

D. The inner part of the disc may contribute more or less to//depending on the actul numerical value to the mass M of the disc.

Answer: C

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A Only One Option is Correct

1. A solid sphere and a hollow sphere of equal mass and radius are placed over a rough horizontal surface after rotating it about its mass centre with same angular velocity ω_0. Once the pure rolling starts let v_1 and v_2 be the linear speeds of their centres of mass. Then

A. $v_1 = v_2$

B. $v_1 > v_2$

C. $v_1 < v_2$

D. data is insufficient

Answer: C

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2. In the above problem, if coefficient of friction for both the spheres is same and let t_1 and t_2 be the times when pure rolling of solid sphere and of hollow sphere is started. Then

A. $t_1 = t_2$

B. $t_1 < t_2$

C. $t_1 > t_2$

D. None of these

Answer: B

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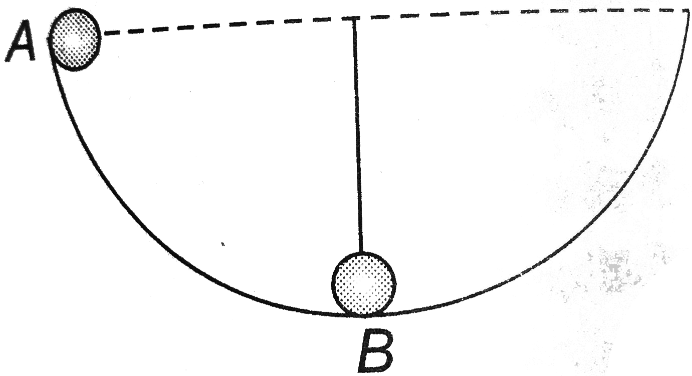
3. A ball of mass m and radius r rolls inside a hemispherical shell of radius R. It is released from rest from point A as shown in figure. The angular velocity of centre of the ball in position B about the centre of the shell is.



A. $\sqrt{\frac{g}{5(R - r)}}$

B. $\sqrt{\frac{10g}{7(R - r)}}$

C. $\sqrt{\frac{2g}{5(R - r)}}$

D. $\sqrt{\frac{5g}{2(R - r)}}$

Answer: B

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4. In the above probllem, the normal force between the ball and the shell in position B is (m=mass of ball)

A. $\frac{12}{7}mg$

B. $\frac{7}{9}mg$

C. $\frac{17}{7}mg$

D. $\frac{10}{7}mg$

Answer: C

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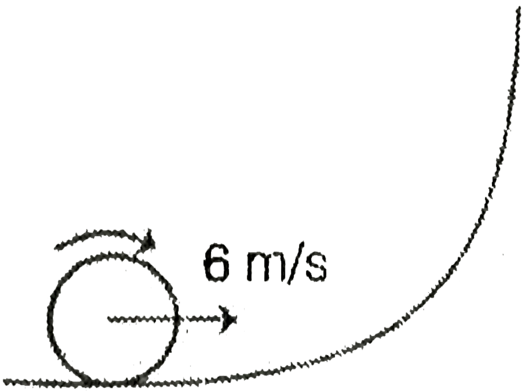
5. A disc of radius 0.1 mrolls without sliding on a horizontal suirface with a velocity of 6 m/s. It then ascends a smooth continous track as shown in figure. The height upto which it will ascend is (g=$10 m/s^2$)



A. 2.4 m

B. 0.9 m

C. 2.7 m

D. 1.8 m

Answer: D

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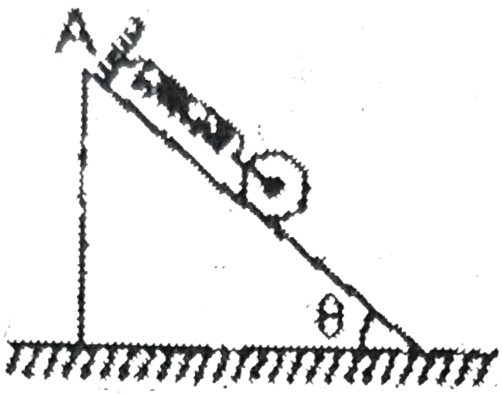
6. A uniform cylinder of mass M and radius R rolls without slipping down a slope of angle 8 with horizontal. The cylinder is connected to a spring of force constant k at the centre, the other side of which is connected to a fixed support at A. The cylinder is released when the spring is unstretched. The· force of friction (f):



A. always upwards

B. always downwards

C. initially upwards and then becomes downwards

D. initially upwards and then becomes zero

Answer: C

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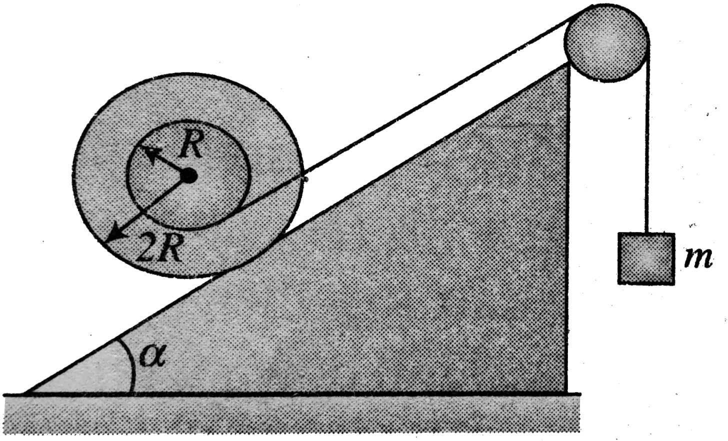
7. A spool of mass M and radius $2R$ lies on an inclined plane as shown in the figure. A light thread is wound around the connecting tube of the spool and its free end carries a weight of mass m. The value of m so that system is in equilibrium is



A. $2M\sin\alpha$

B. $M\sin\alpha$

C. $2M\tan\alpha$

D. $M\cos\alpha$

Answer: A

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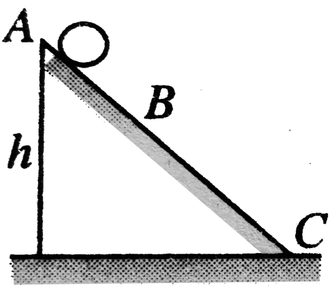
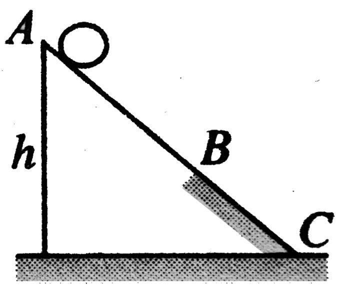
8. In both the figures all other factors are same, except that in figure (i) AB is rough and BC is smooth while in figure (ii) AB is smooth and BC is rough. In figure (i), if a sphere is released from rest it starts rolling. Now consider the figure (ii), if same sphere is A released from top of the inclined plane, what will be the kinetic energy of the sphere on reaching the bottom:



(i)



(ii)

A. is same in both the cases

B. is greater in case (i)

C. is greater in case (ii)

D. information is unsufficent

Answer: B

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9. A ring of radius R is first rotated with an angular velocity ω and then carefully placed on a rough horizontal surface. The coefficient of friction between the surface and the ring is μ. Time after which its angular speed is reduced to half is

A. $\frac{\omega_0 \mu R}{2g}$

B. $\frac{\omega_0 g}{2\mu R}$

C. $\frac{2\omega_0 R}{\mu g}$

D. $\frac{\omega_0 R}{2\mu g}$

Answer: D

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10. A rod of length l is given two velocities v_1 and v_2 in opposite directions at its two ends at right angles to the length. The distance of the instantaneous axis of rotation from v_1 is

A. zero

B. $\frac{v_1}{v_1 + v_2} l$

C. $\frac{v_2 l}{v_1 + v_2}$

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

Answer: B

View Text Solution

11. Two particles connected by a rigid light rod AB, lying on a smooth horizontal table. An impulse J is applied at A in the plane of thetable and perpendicular at AB. Then the velocity of particle at A is

A. $\frac{J}{2m}$

B. $\frac{J}{m}$

C. $\frac{2J}{m}$

D. zero

Answer: B

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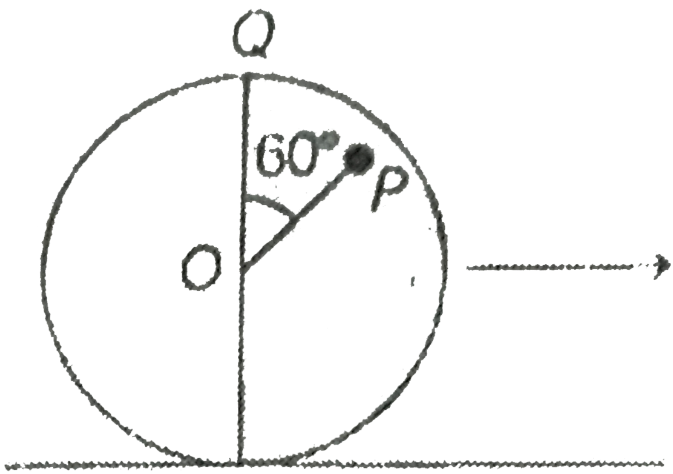
12. A disc of radius r rolls without slipping on a rough horizontal floor. If veloocity of its centre of mass is v_0, then velocity of point P, as shown in the figure

(OP=r/2 and $\angle QOP = 60°$)is



A. v_0

B. $\frac{v_0}{2}$

C. $\frac{v_0}{2}\sqrt{7}$

D. $\frac{v_0}{2}\sqrt{3}$

Answer: C

View Text Solution

13. A flat rail road car is accelariting along the positive x-axis with an acceleration a_p. A sphere is placed over the car. The friction between the car and the sphere is not sufficent to support pure rolloing of sphere. The correct statement is

A. The sphere will slip and force of friction on sphere is along -x direction

B. The sphere will slip and force of friction on sphere is along +x direction

C. Acceleration of sphere is along -x direction

D. None of the above

Answer: B

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14. A uniform ring of mass m and radius R is released from top of an inclined plane. The plane makes an angle θ with horizontal. The cofficent of friction between the ring and plane is μ. Initially, the point of contact of ring and plane is P. Angular momentum of ring about an axis passing from point P and perpendicular to plane of motion as a function of time t is

A. $mgR(\sin\theta)t - \mu mgR(\cos\theta)t$

B. $mgR(\sin\theta)t$

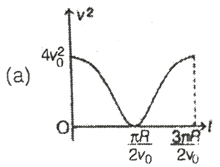
C. $mgR(\sin\theta)t + \mu mgR(\cos\theta)t$

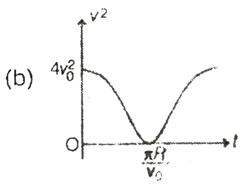
D. $mgR\left(1 - \mu^2\right)(\sin\theta)t$

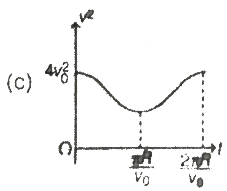
Answer: B

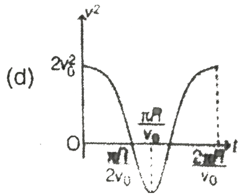
View Text Solution

15. A wheel ios rolling without sliding on a horizontal surface. The centre of the wheelk moves with a constant speed v_0. Consider a point P on the rim which is at the top at time t=0. The square of speed of point P is plooted against time t. The correct plot is (R is radius of the wheel)

A. 

B. 

C. 

D. 

Answer: B

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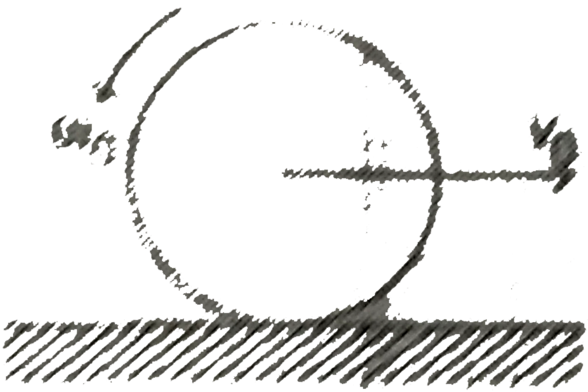
16. a uniform circular disc of radiu8s r placed on a roughn horizontal plane has initial velocity v_0 and an angul,ar velocity ω_0 has shown The disc comes to rest after moving some distance in the direction of motion. Then



A. the friction force acting in the towards direction

B. the point of contact of disc with ground has initially zero velocity

C. v_0 must be equal to $r\omega_0/2$ in magnitude

D. v_0 must be equal to $2r\omega_0$ in magnitude

Answer: C

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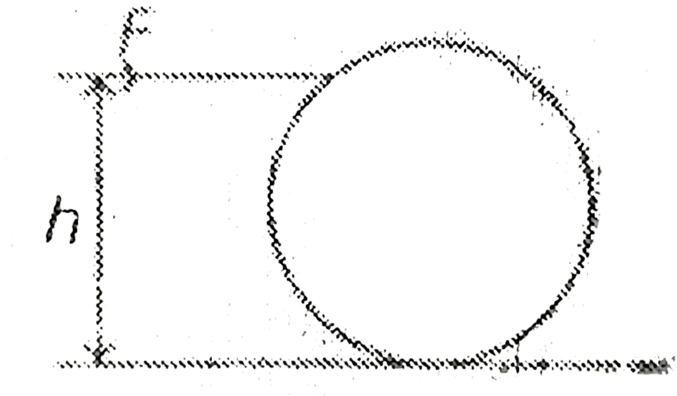
17. A solid sphere of radius R is resting on a smooth horizontal surface. A constant force F is applied at a height h from the bottom. Vhoose the correct alternative.



A. Sphere will always slide whatever be the value of h

B. Sphere will roll without sliding when $h \geq 104R$

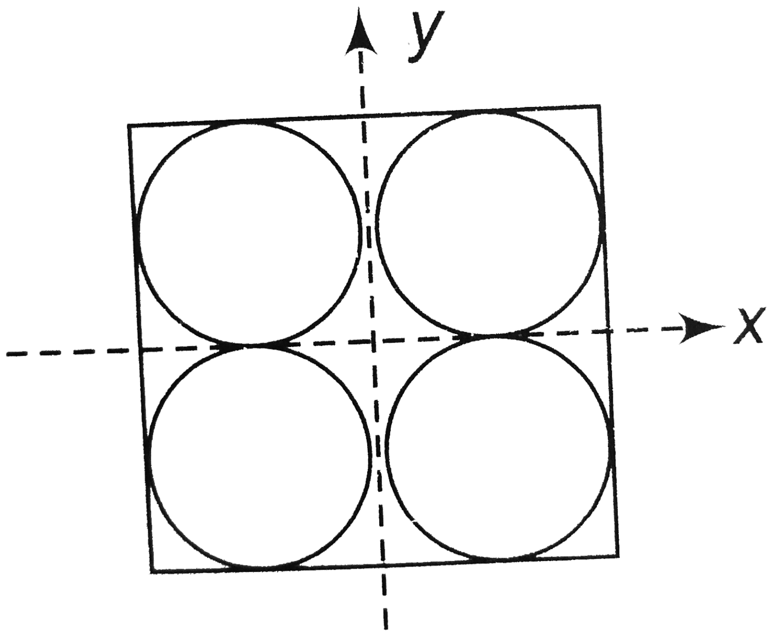
C. Sphere will roll without sliding if h=1.4R

D. None of the above

Answer: C

View Text Solution

18. Four holes of radius R are cut from a thin square plate of side $4R$ and mass M. The moment of inertia of the remaining portion about z-axis is :



A. $\frac{\pi}{12} MR^2$

B. $\left(\frac{4}{3} - \frac{\pi}{4}\right) MR^2$

C. $\left(\frac{8}{3} - \frac{10\pi}{16}\right) MR^2$

D. $\left(\frac{4}{3} - \frac{\pi}{6}\right)MR^2$

Answer: C

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19. A wire of mass m and length l is bent in the form of a quarter circle. The moment of the inertia of the wire about an axis is passing through the centre of the quarter circle is approximately

A. $0.6ml^2$

B. ml^2

C. $0.2ml^2$

D. $0.4ml^2$

Answer: D

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20. A uniform disc of radius R lies in x-y plane with its centre at origin. Its moment of inertia about the axis x=2R and y=0 is equal to the moment of inertia about the axis y=d and z=0, where d is equal to

A. $\frac{4}{3}R$

B. $\frac{\sqrt{17}}{2}R$

C. $\sqrt{13}R$

D. $\frac{\sqrt{15}}{2}R$

Answer: B

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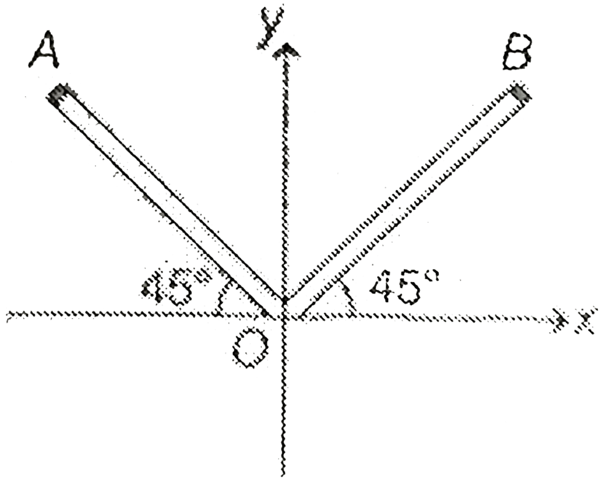
21. Two rods OA and OB of equal length and mass are lying on xy plane as shown in figure. Let I_x, I_y and I_z be the moment of inertia of both the rods bout x,y and z axis respectively. Then,



A. $I_x = I_y > I_z$

B. $I_x = I_y < I_z$

C. $I_x > I_y > I_z$

D. $l_z > l_y > l_x$

Answer: B

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22. A wire of length l and mass m is first bent in a circle, then in a square and then in an equilateral triangle. The moment of inertia in these three cases about an axis perpendicular to their planes and passing through their centrer of mass are I_1, I_2 and I_3 respectively. Then maximum of them is

A. l_1

B. l_2

C. l_3

D. Data insuffcent

Answer: A

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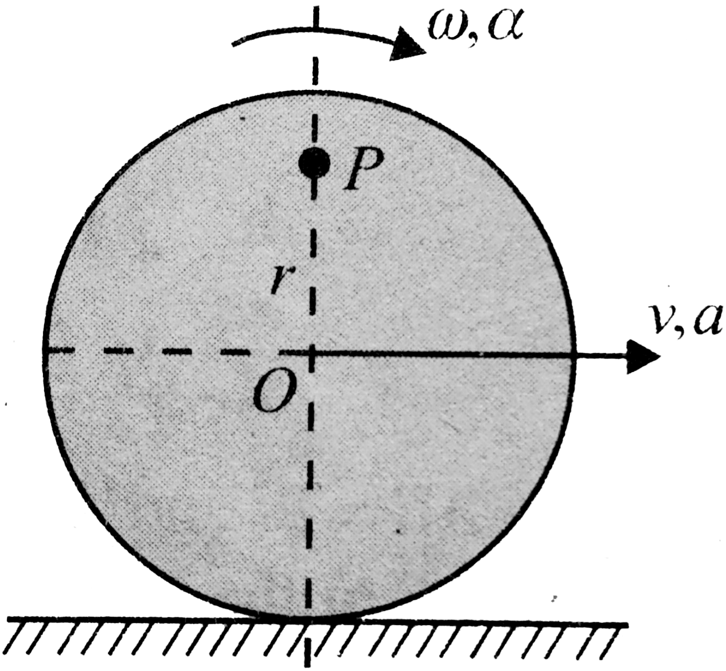
23. A disc of radius R rolls on a horizontal ground with linear acceleration a and angular acceleration α as shown in Fig. The magnitude of acceleration of point P as shown in the figure at an instant when its linear velocity is v and angular velocity is ω

will be a



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

B. $\frac{ar}{R}$

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

D. $r\alpha$

Answer: A

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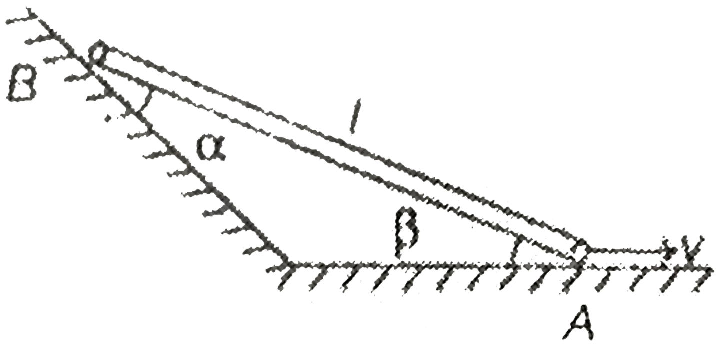
24. A rod of length l slided down along the inclined wall as shown in figure. At the instant shown in figure, the speed of end A is v, then the speed of B will be



A. $\frac{v\sin\beta}{\sin\alpha}$

B. $\frac{v\sin\alpha}{\sin\beta}$

C. $\frac{v\cos\beta}{\cos\alpha}$

D. $\frac{v\cos\alpha}{\cos\beta}$

Answer: C

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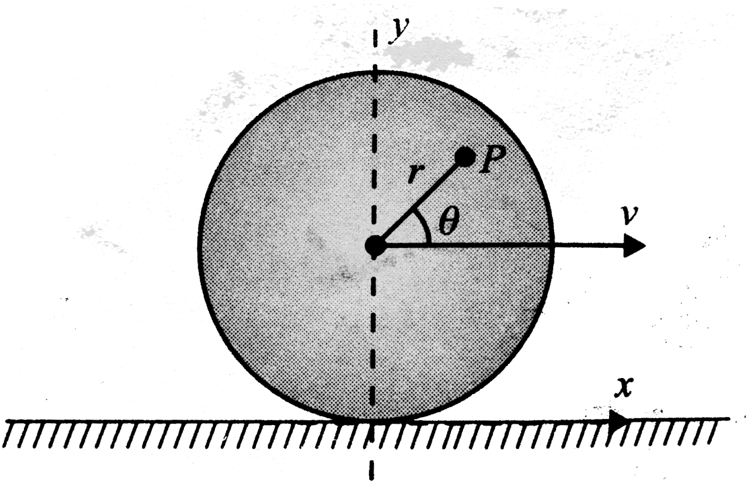
25. A disc of radius R rolls without slipping at speed v along positive x-axis. Velocity of point P at the instant shown in Fig. is



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

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

C. $v_p = v + \frac{vr\sin\theta}{R}\hat{i} + \frac{vr\cos\theta}{R}\hat{j}$

D. $v_p = v + \frac{vr\sin\theta}{R}\hat{i} - \frac{vr\cos\theta}{R}\hat{j}$

Answer: B

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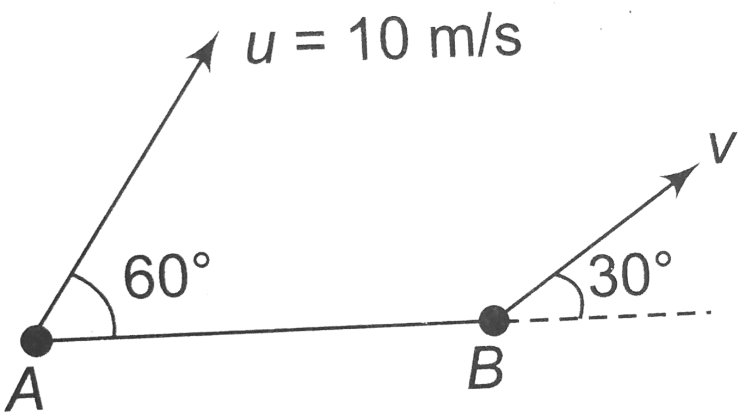
26. Two particles A and B are situated at a distance $d = 2m$ apart. Particle A has a velocity of $10m/s$ at an angle of 60° and particle B has a velocity v at an angle 30° as shown in figure. The distance d between A and B is constant. the angular velocity of B with respect to A is :



A. $5\sqrt{3}rad/s$

B. $\frac{5}{\sqrt{3}}rad/s$

C. $10\sqrt{3}rad/s$

D. $\frac{10}{\sqrt{3}}rad/s$

Answer: B

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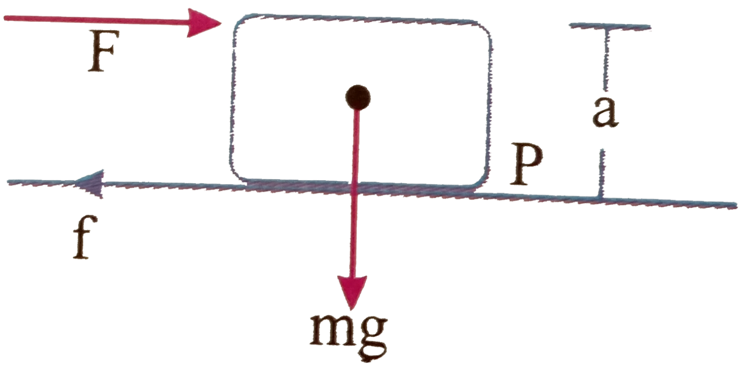
27. A force F is applied on the top of a cube as shown in the figure. The coefficient of friction between the cube and the ground is μ. If F is gradually increased, find the value of μ for which the cube will topple before sliding.



A. $\mu > \frac{1}{4}$

B. $\mu < \frac{1}{2}$

C. $\mu > \frac{1}{2}$

D. $\mu < 1$

Answer: C

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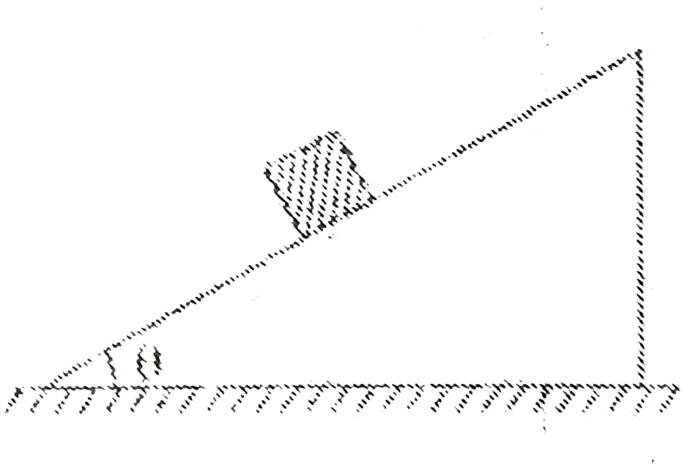
28. A cube is pplaced on an inclined plane of inclinbation θ as shown in figure. Cofficent of friction br=etween the cube and the plane is μ. As the angle θ is gradually increased, the cube slides before toppling if



A. $\mu > 1$

B. $\mu > \frac{1}{2}$

C. $\mu < 1$

D. None of the above

Answer: C

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29. A uniform rod AB of mass m and length l is at rest on a smooth horizontal surface. An impulse J is applied to the end B, perpendicular to the rod in the horizontal direction. Speed of particlem P at a distance $\frac{l}{6}$ from the centre towards A of the rod after time $t = \frac{\pi ml}{12J}$ is.

A. $2\frac{J}{M}$

B. $\frac{J}{\sqrt{2}M}$

C. $\frac{J}{M}$

D. $\sqrt{2}\frac{J}{M}$

Answer: D

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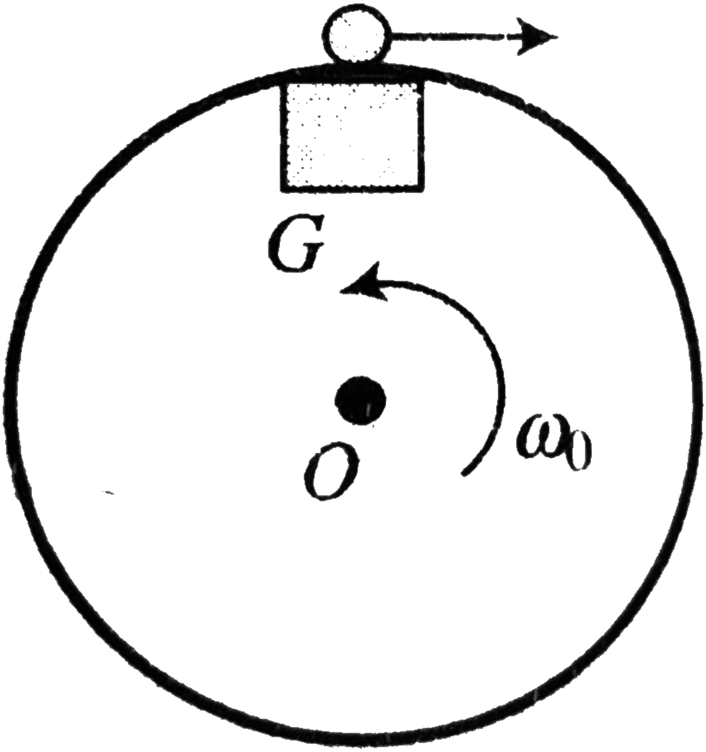
30. A horizontal turn table in the form of a disc of radius r carries a gun at G and rotates with angular velocity ω_0 about a vertical axis passing through the centre O. The increase in angular velocity of the system if the gun fires a bullet of mass m with a tangential velocity v with respect to the gun is (moment of inertia of gun + table about O is I_0



A. $\frac{mvr}{I_0 + mr^2}$

B. $\frac{2mvr}{I_0}$

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

D. $\frac{mvr}{2I_0}$

Answer: A

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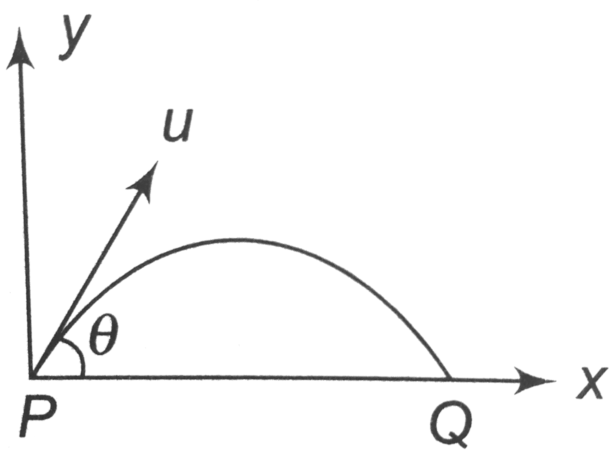
31. Average torque on a projectile of mass m (initial speed u and angle of projection θ) between initial and final positions P and Q as shown in figure, about the point of projection is :



A. $\frac{\text{mu}^2\sin 2\theta}{2}$

B. $\text{mu}^2\cos\theta$

C. $\text{mu}^2\sin\theta$

D. $\frac{mu^2\cos\theta}{2}$

Answer: A

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32. A uniform rod AB of mass m and length 2a is falling freely without rotationb under gravity with AB horizontal. Suddenly the end A is fixed when the speed of the rod is v. The angular speed which the rod begains to rotate is

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

B. $\frac{4v}{3a}$

C. $\frac{v}{3a}$

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

Answer: D

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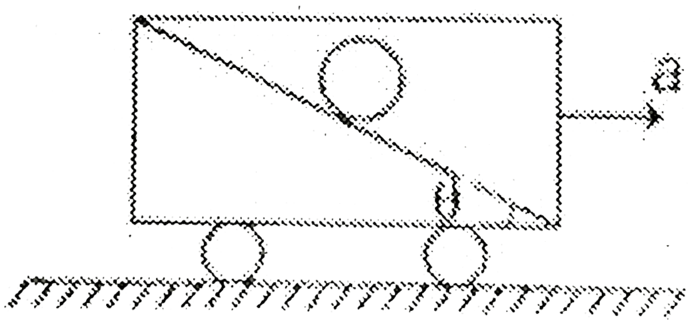
33. Figures shows a smooth inclined plane of inclination θ fixed ina car. A sphere is set in pure rolling on the incline. For what value of a (the acceleration of car in horizontal direction) the sphere will continue pure rolling ?



A. $g\cos\theta$

B. $g\sin\theta$

C. $g\cot\theta$

D. $g\tan\theta$

Answer: D

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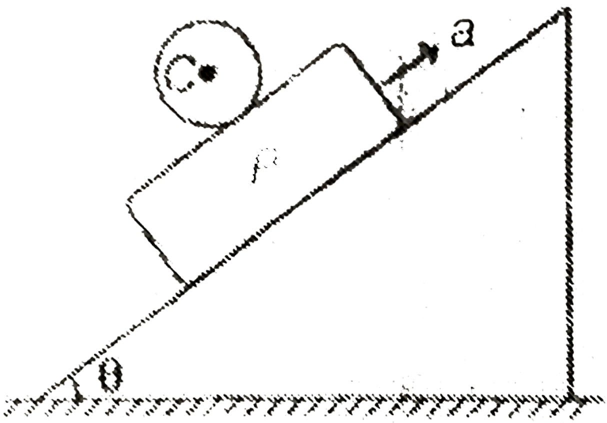
34. The acceleration a of the plank P required to keep the centre C of a cylinder in a fixed position during the motion is (no slipping take place between cylinder and plank)



A. $\frac{g}{2}\sin\theta$

B. $2g\sin\theta$

C. $g\sin\theta$

D. $g\tan\theta$

Answer: B

View Text Solution

35. A spherical body of radius R is allowed to roll down on an incline with out slipping and it recheas with a speed v_0 at the bottom. The incline is then made smooth by waxing and the body is allowed top slide without rolling and now the speed attained is $\frac{5}{4}v_0$ The radius of gyration of the body about an axis passing through the centre is

A. $\frac{4}{3}R$

B. $\frac{3}{4}R$

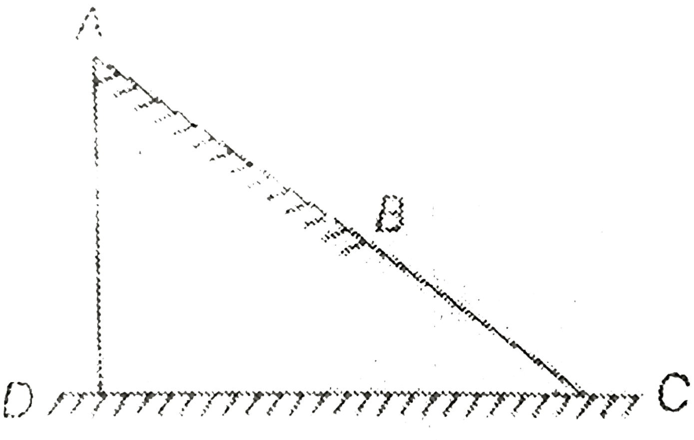
C. $\frac{5}{2}R$

D. $\frac{2}{5}R$

Answer: B

View Text Solution

36. Portion AB of the wedge shown in figure is rough and Bc is smooth. A solid cylinder rolls without spinning from A to B. If AB=BC, then ratio of transitional kinetic energy to rotational kinetic energy, when the cylinder reaches point C is



A. $\frac{3}{5}$

B. 5

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

D. $\frac{8}{3}$

Answer: B

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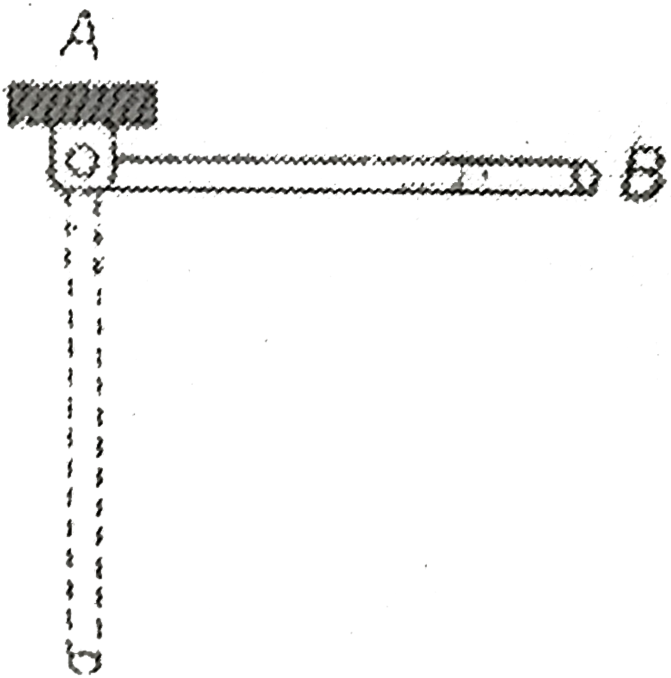
37. One end of a uniform rod of length l and mass m is hinged at A. It is released from the rest from horizontal position AB as shown in figure. The force exerted by the rod on the hinge when it becomes verticle is



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

B. $\frac{5}{2}mg$

C. $3mg$

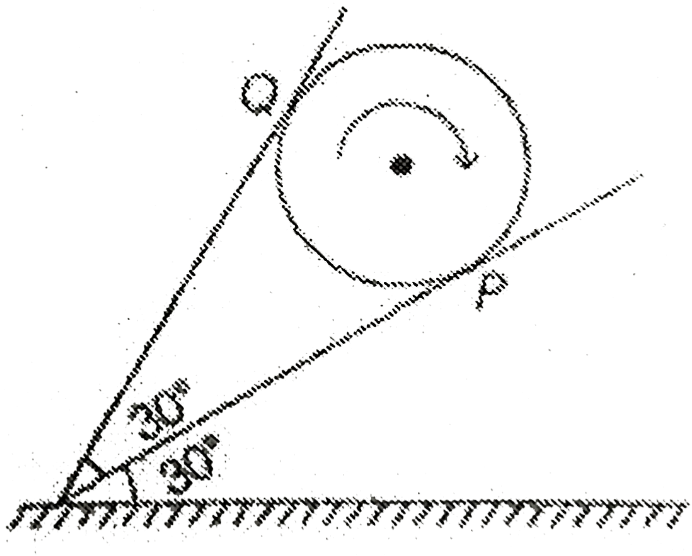
D. 5mg

Answer: B

View Text Solution

38. A sphere is rotating between two rough inclined walls as shoen in fiogure. Cofficent of friction between each wall and the sphere is $\frac{1}{3}$. If f_1 and f_2 be the ffriction forces at PO and Q.

Then $\frac{f_1}{f_2}$ is



A. $\frac{4}{\sqrt{3}} + 1$

B. $\frac{1}{\sqrt{3}} + 2$

C. $\frac{1}{2} + \sqrt{3}$

D. $1 + 2\sqrt{3}$

Answer: A

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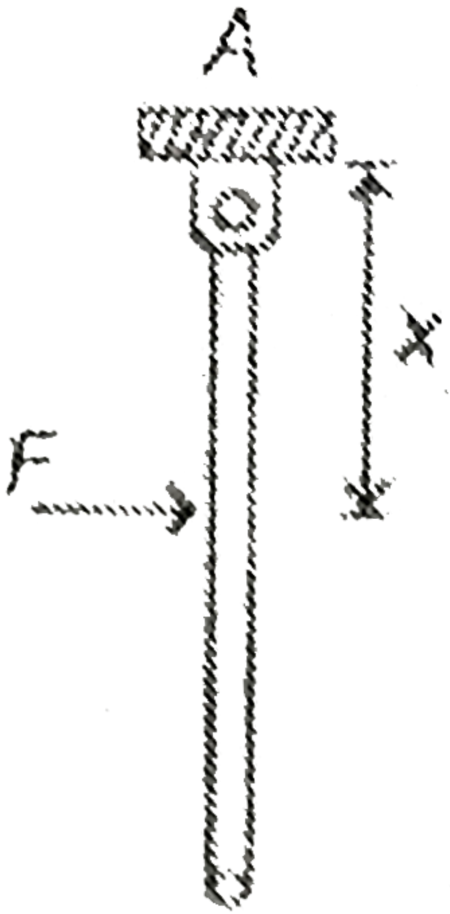
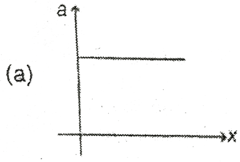
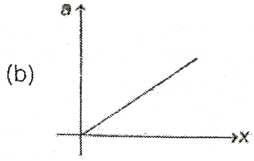
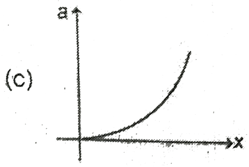
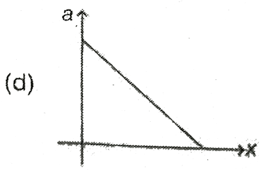
39. A rod of mass m and length l is hinged at one of its end A as shown in figure. A force F is applied at a distance x from A. The acceleration of centre of mass a varies with x as



A. 

B. 

C. 

D. 

Answer: B

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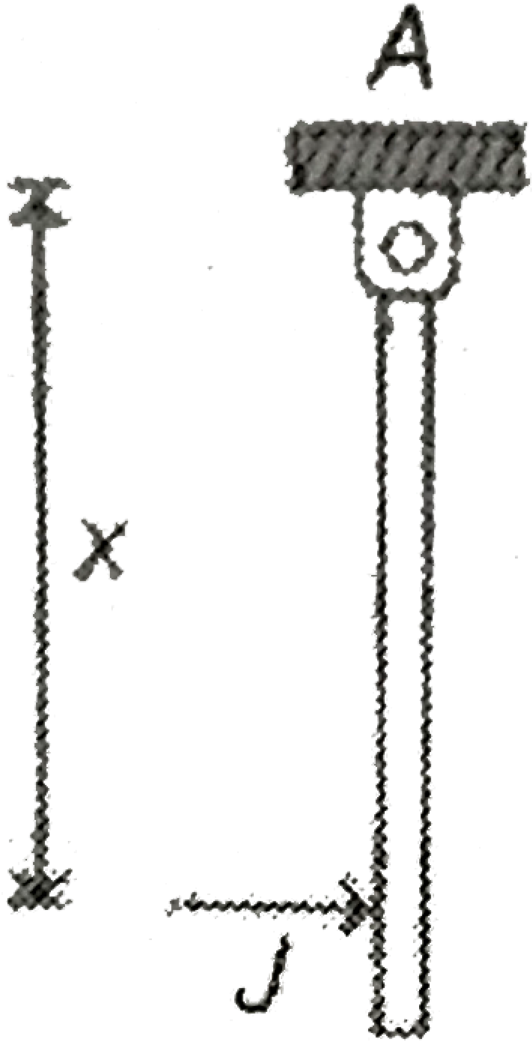
40. A uniform rod of length l is pivoted at point A. It struk n=by an horizontal force which delivers an ikmpulse J at a distance c from point A as shown in figure. Impulse delivered by pivot is zero, if x is equal to



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

B. $\frac{l}{3}$

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

D. $\frac{3l}{4}$

Answer: C

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41. A thin uniform rod of mass m moves translationally with acceleration a due to two antiparallel forces of lever arm l. One force is of magnitude F and acts at one extreme end. The length of the rod is

A. $\frac{2(F + ma)l}{ma}$

B. $l\left(1 + \frac{F}{ma}\right)$

C. $\frac{(F + ma)l}{2ma}$

D. $\frac{mal}{ma + F}$

Answer: A

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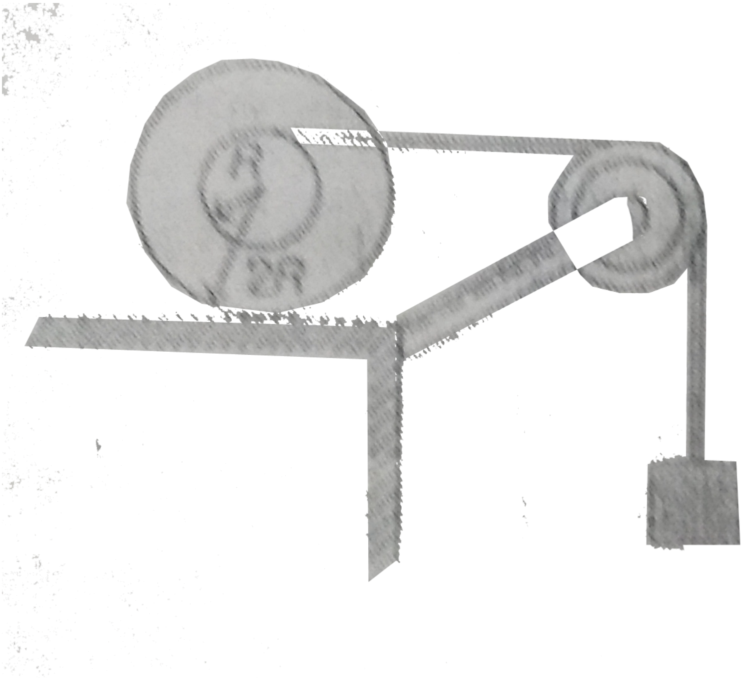
42. In the figure shon mass of both, the spherical body and blocks is m. Moment of inertia of the spherical body about centre of mass is $2mR^2$. The spherical body rolls on the horizontal surface. There is no sliiping between any two surfaces in contact. The ratio of kinetic energy of the spherical body to that of block is



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

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

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

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

Answer: C

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43. A particle is projected with velocity v at an angle θ aith horizontal. The average angle velocity of the particle from the point of projection to impact equals

A. $\frac{g\cos\theta}{\theta v}$

B. $\frac{g}{v\sin\theta}$

C. $\frac{g}{v\theta}$

D. $\frac{g\theta}{v\sin\theta}$

Answer: D

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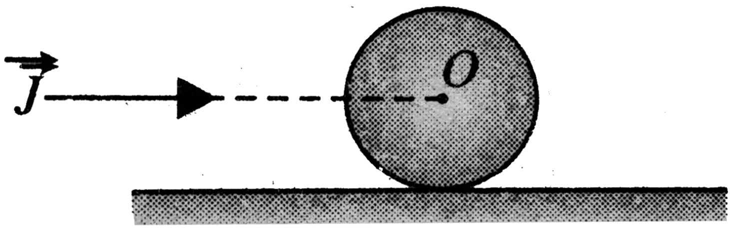
44. An impulse J is applied on a ring of mass m along a line passing through its centre O. The ring is placed on a rough horizontal surface. The linear velocity of centre of ring once it starts rolling without slipping is



A. J/m

B. $\frac{J}{2m}$

C. $\frac{J}{4m}$

D. $\frac{J}{3m}$

Answer: B

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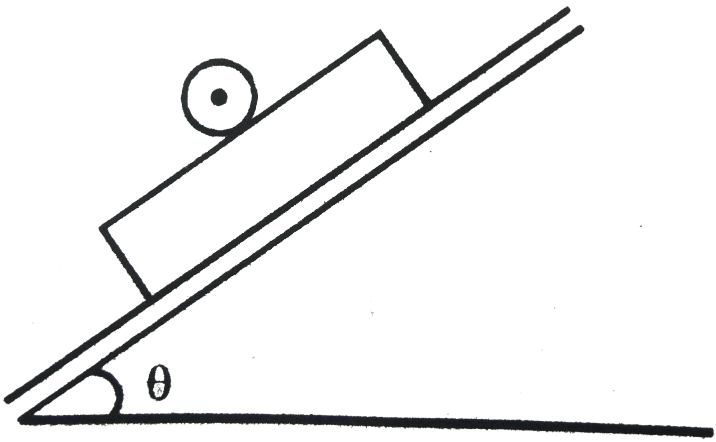
45. A plank of mass M is placed over smooth inclined plane and sphere is also placed over the plank. Friction is sufficient between sphere and plank. If plank and sphere are released from rest, the frictional force on sphere is -



A. up the plane

B. down the plane

C. zero

D. maybe up or down the plane

Answer: C

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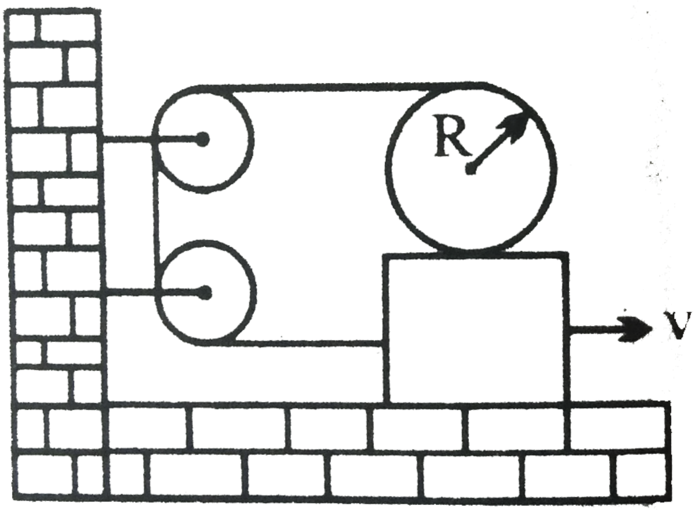
46. In the figure shown, the plank is being pulled to the right with a constant speed v. If the cylinder does not slip then:



A. the speed of the centre of the mass of the cylinder is 2 V

B. the speed of the centre of the mass of the cylinder is v

C. The angular velocity of the cylinder is v/R

D. The angular velocity of the cylinder is zero

Answer: C

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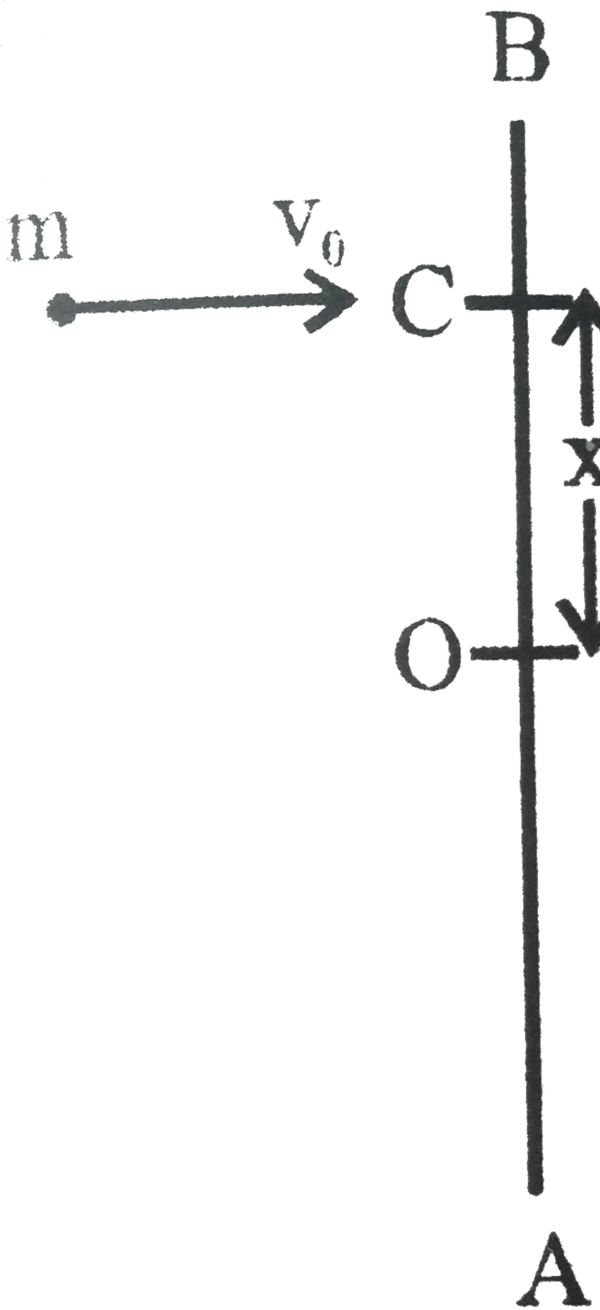
47. A uniform rod AB of length L and mass M is lying on a smooth table. A small particle if mass m strike the rod with velocity v_0 at point C at a distance comes to rest after collision. Then find the value of x, so that point A of the rod remains stationary just after collision.



A. L/3

B. L/6

C. L/4

D. L/12

Answer: B

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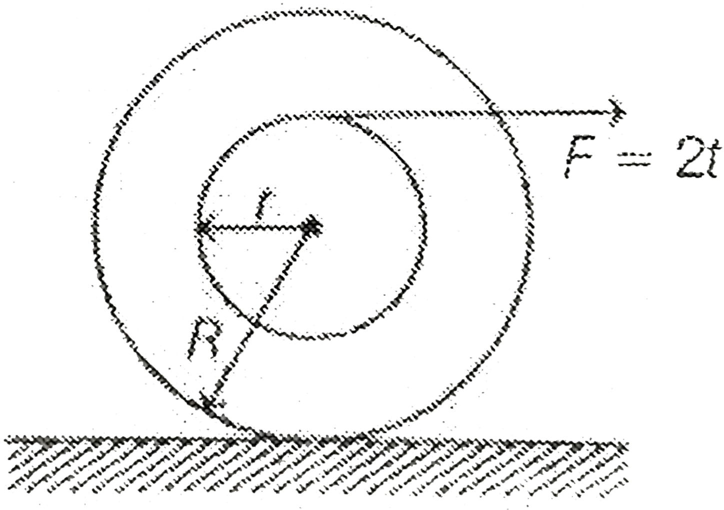
48. A time varying force F=2t is applied on a spool as shown in figure. The angular momentum of the spool at time t about bottommost point is



A. $\dfrac{r^2t^2}{R}$

B. $\dfrac{(R+r)^2}{r}t^2$

C. $(R+r)t^2$

D. Data insufficent

Answer: C

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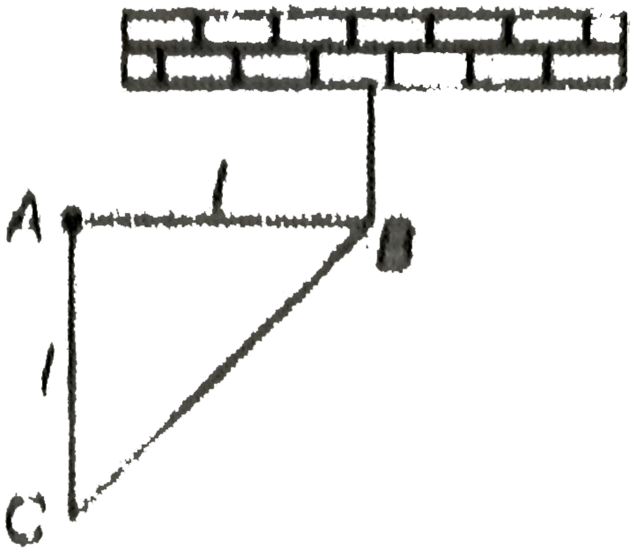
49. A right triangular plate ABC of mass m is free to rotate in the verticle plane about a fixed horizontal axis through A. It is supported by a string such that the side AB is horizontal. The reaction at the support A is



A. $m\frac{g}{3}$

B. $2m\frac{g}{3}$

C. $m\frac{g}{2}$

D. mg

Answer: B

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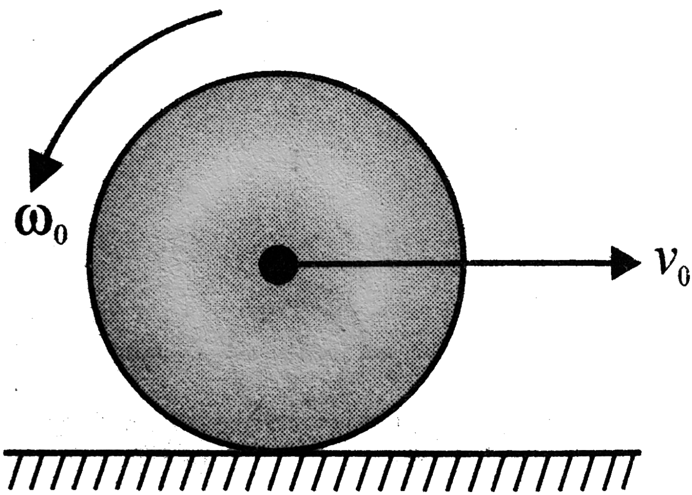
50. A uniform circular disc of radius r is placed on a rough horizontal surface and given a linear velocity v_0 and angular velocity ω_0 as shown. The disc comes to rest after moving some distance to the right. It follows that



A. $v_0 = \omega_0 R$

B. $2v_0 = 5\omega_0 R$

C. $5v_0 = 2\omega_0 R$

D. $2v_0 = \omega_0 R$

Answer: C

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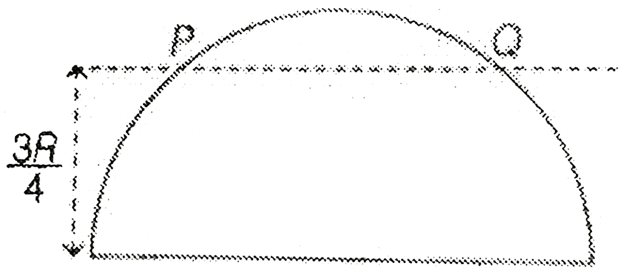
51. The radius of gyration of a solid hemisphere of mass M and radius Rn about an axis parallel to the diameter at a distance $\frac{3}{4}$R is given by (centre of mass of the hemisphere lies at a height $3R/8$ from the base.)



A. $\frac{3R}{\sqrt{10}}$

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

C. $\frac{5R}{8}$

D. $\sqrt{\frac{2}{5}}R$

Answer: D

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52. Two particles A and B are moving with constant velocities $V_1 = \hat{j}$ and $v_2 = 2\hat{i}$ respectively in XY plane. At time t=0, the particle A is at co-ordinates (0,0) and B is at (-4,0). The angular velocities of B with respect to A at t=2s is (all physical quantities are in SI units)

A. $\frac{1}{2} rad/s$

B. $2 rad/s$

C. $4 rad/s$

D. $1 rad/s$

Answer: D

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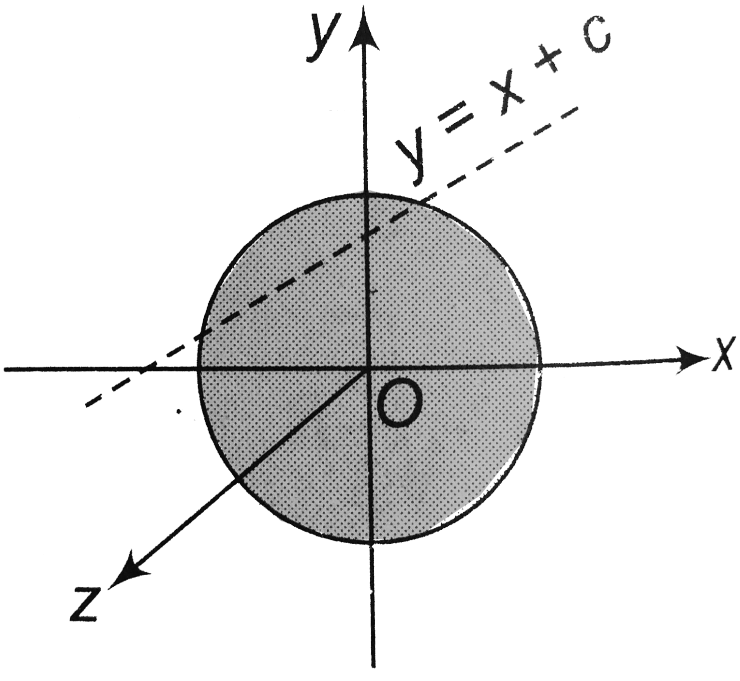
53. A uniform disc of radius R lies in the x - y plane, with its centre at origin. Its moment of inertia about z-axis is equal to its moment of inertia about line $y = x + c$. The value of c will be.



A. $R/\sqrt{2}$

B. $-R/2$

C. $+R/4$

D. -R

Answer: A

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54. A uniform rod of mass m and lkength 2a lies at rest on rotating with angular speed $\omega_0 = 40 rad/s$ is placed between two smooth walls on a rough ground. Distance between the walls is slightly greater than the diameter of the sphere . Cofficent of friction between the sphere and the ground is μ =0.1. Sphere will stop rotating after time t=.......s.

A. $\frac{4}{13}mv^2$

B. $\frac{1}{4}mv^2$

C. $\frac{8}{25}mv^2$

D. None of these

Answer: C

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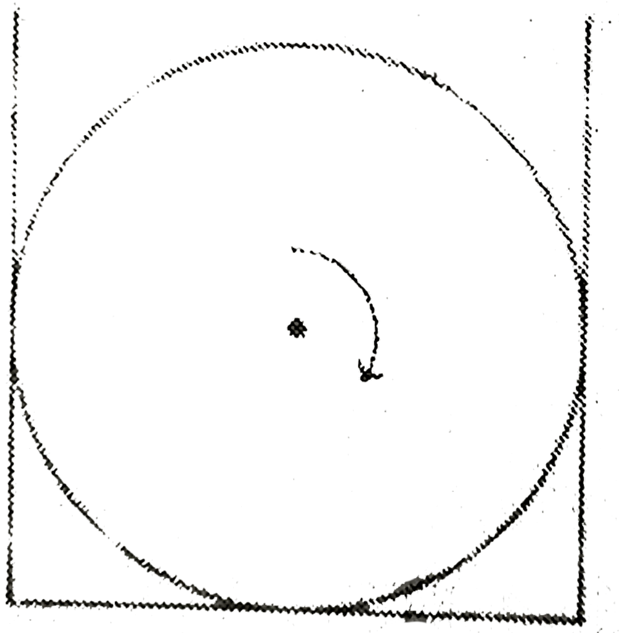
55. A solid sphere of mass 5 kg and and radius 1 m after rotating with angular speed $\omega_0 = 40 rad/s$ is placed between two smooth walls on a rough ground. Distance between the walls is slightly greater than the diameter of the sphere. Coffiecient of friction between the sphere and the ground is

$\mu = 0.1$. sphere will stop rtotating after time t = ...s .



A. 8

B. 12

C. 20

D. 16

Answer: D

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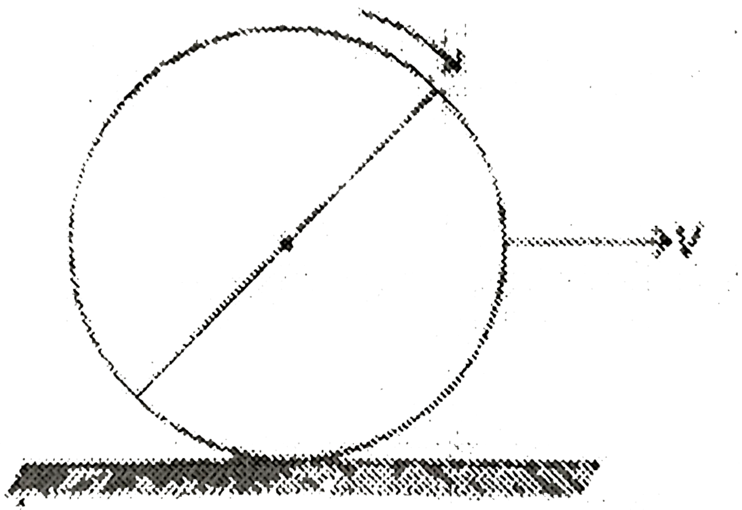
56. A ring of mass m is rolling without slipping with linear velocity v as shown is figure. A rod of identical mass is fixed alone one of its diameter. The total kinetic energy of the system is



A. $\frac{7}{5}mv^2$

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

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

D. $\frac{5}{3}mv^2$

Answer: D

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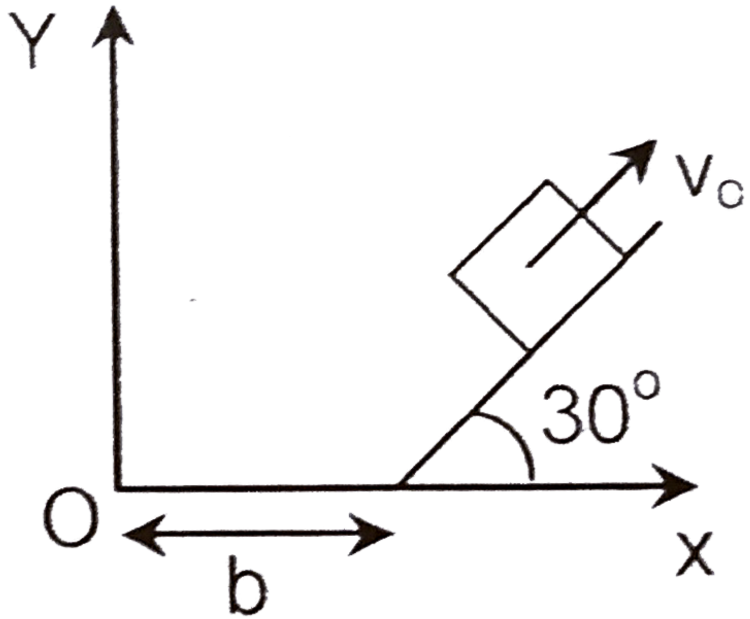
57. A cube of mass m and side a is moving along a plane with constant speed v_o as shown in figure. The magnitude of angular momentum of the cube about z -axis would be.



A. $\frac{mv_0b}{2}$

B. $\frac{\sqrt{3}mv_0b}{2}$

C. $mv_0\left(b - \frac{a}{2}\right)$

D. none of these

Answer: D

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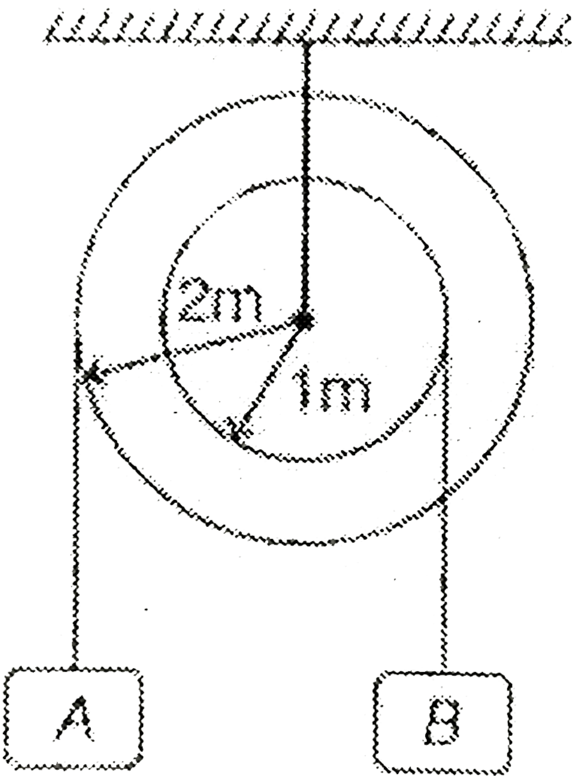
58. In the pully system shown, if radii of the bigger and smaller pulley are 2m and 1m respectively and the acceleration of block A is $5m/s^2$ in the downward direction, then the acceleration of block B will be



A. $0m/s^2$

B. $5m/s^2$

C. $10m/s^2$

D. $\frac{5}{2}m/s^2$

Answer: D

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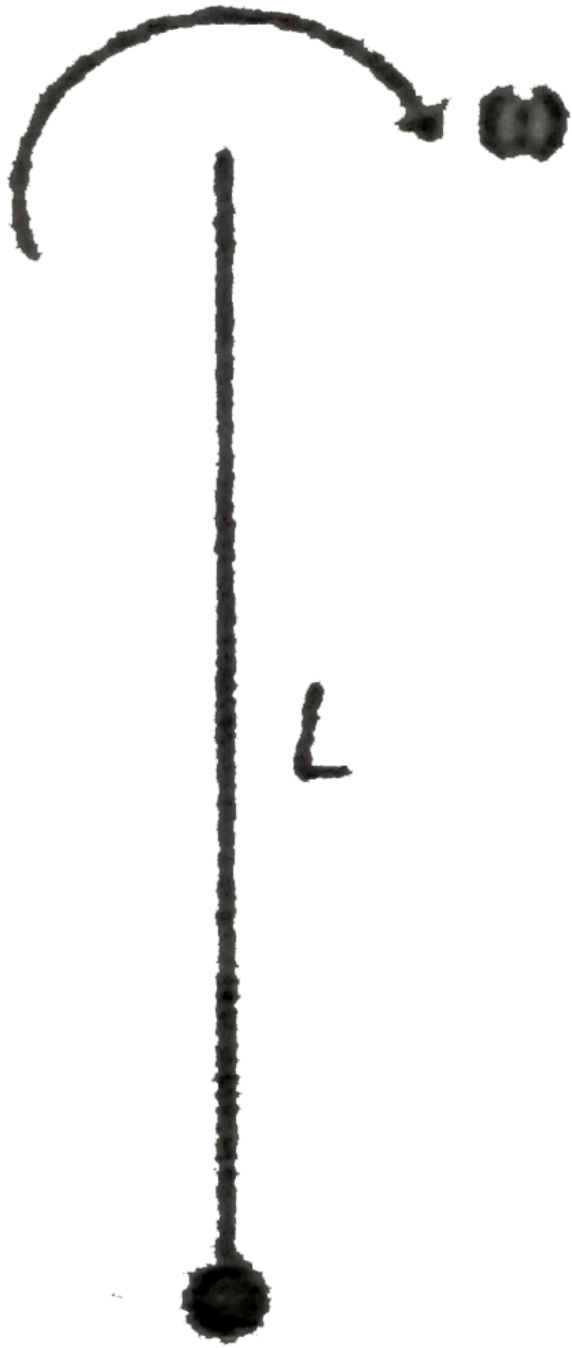
59. A uniform rod is hinged at its one end and is allowed to rotate in verticle plANE. Rod is given angular velocity ω in its verticle position as shown in figure. The value of ω for the force exerted by the hinge on rod is zero in this position is


L

A. $\sqrt{\frac{g}{L}}$

B. $\sqrt{\frac{2g}{L}}$

C. $\sqrt{\frac{g}{2L}}$

D. $\sqrt{\frac{3g}{L}}$

Answer: B

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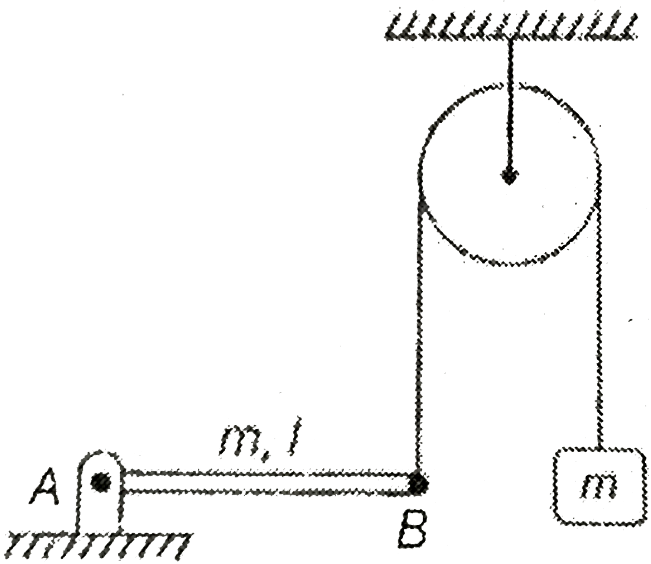
60. Uniform rod Ab is hinged at the end A in the figure. The other end of the rod is connected toa block through a massless string as shown. The pulley is smooth and massless. Masses of the block and the rod are same and are equal to 'm'. Acceleration due to gravity is g. The tension in the thread and angular acceleration of the rod just after releases of block from this position are



A. $\dfrac{3mg}{8}, \dfrac{g}{8l}$

B. $\dfrac{5mg}{8}, \dfrac{3g}{8l}$

C. $\dfrac{mg}{8}, \dfrac{5g}{8l}$

D. $\dfrac{7mg}{8}, \dfrac{7g}{8l}$

Answer: B

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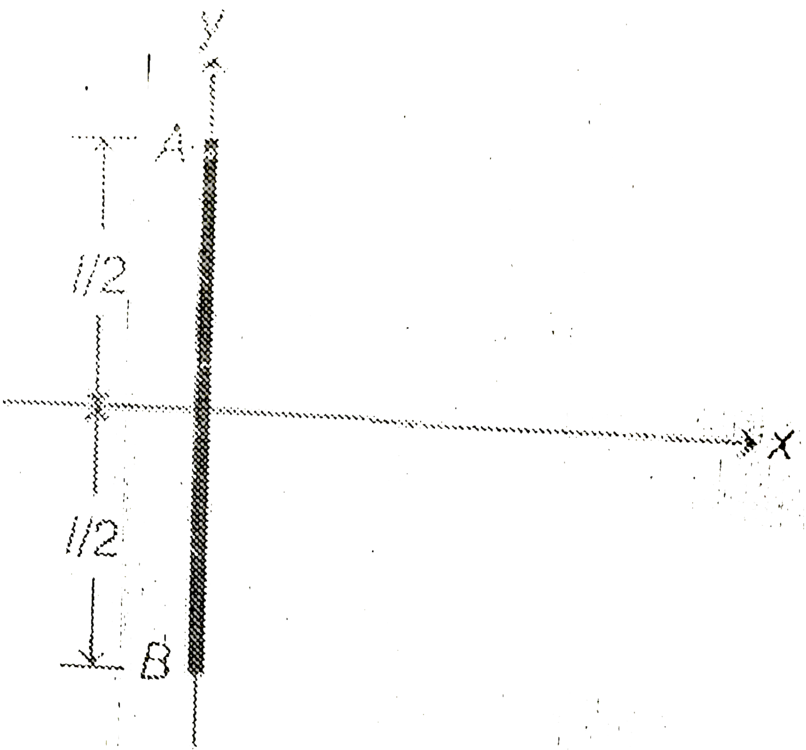
61. A uniform rod of mass m, length l is placed over a smooth horizontal surface along y -axis and is at rest as shown in figure. An impulsive force F is applied for a small time Δt along x-direction at point A. The x-coordinte of end A of the rod when the rod becomes parallel to x-axis for the first is (in itially the coordinates opf centre of mass of the rod is (0,0).



A. $\frac{\pi l}{12}$

B. $\frac{l}{2}\left(1 + \frac{\pi}{12}\right)$

C. $\frac{l}{2}\left(1 - \frac{\pi}{6}\right)$

D. $\frac{l}{2}\left(1 + \frac{\pi}{6}\right)$

Answer: D

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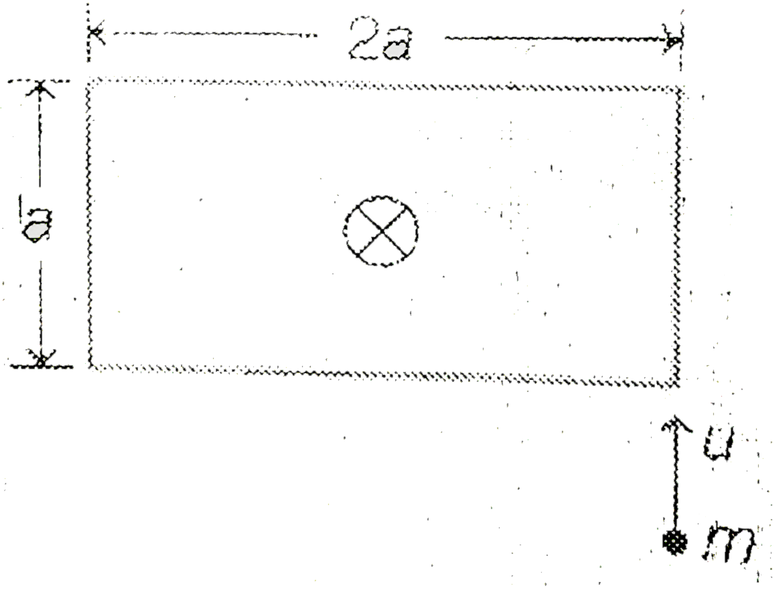
62. A uniform rectangular plate of mass m which is free to rotate about the smooth vwerticle hinge passing through the centre and perpendicular to the plate, is lying on a smooth horizontal surface. A particle of mass m is moving with speed 'u' collides with the plate and sticks to it as shown in figure.

The angular velocity of the platye after colli9sion will be



A. $\frac{12u}{5a}$

B. $\frac{12u}{19a}$

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

D. $\frac{3u}{5a}$

Answer: D

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63. The angular momentum of a particle about origin is varying as L =4t+8(SI units) whern its moves along a straight line y=x-4(x,y in metres). The magnitude of force acting on the particle will be

A. 1 N

B. 2 N

C. $\sqrt{2}N$

D. $\sqrt{3}N$

Answer: C

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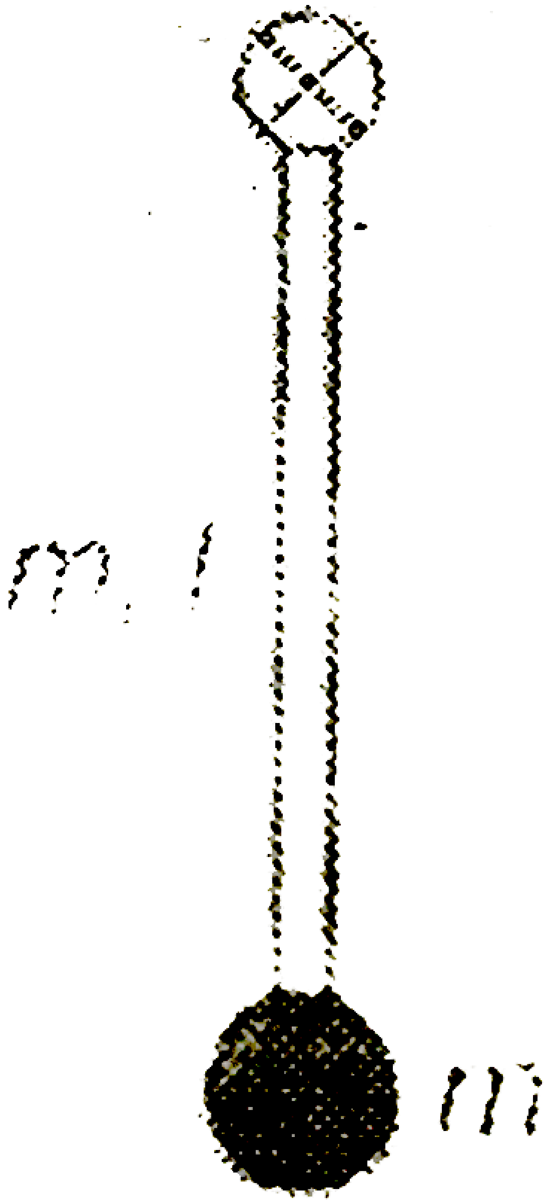
64. A Particle is attached to the lower end of a uniform rod which is hinged at its other end as shown in the figure. The minimum speed given to the particle so that the rod performs circular motion in a verticle plane will be [length of the rod is l, consider masses of bopth rod and particle to be same]



A. $\sqrt{5gl}$

B. $\sqrt{4gl}$

C. $\sqrt{4.5gl}$

D. $\sqrt{2.25gl}$

Answer: C

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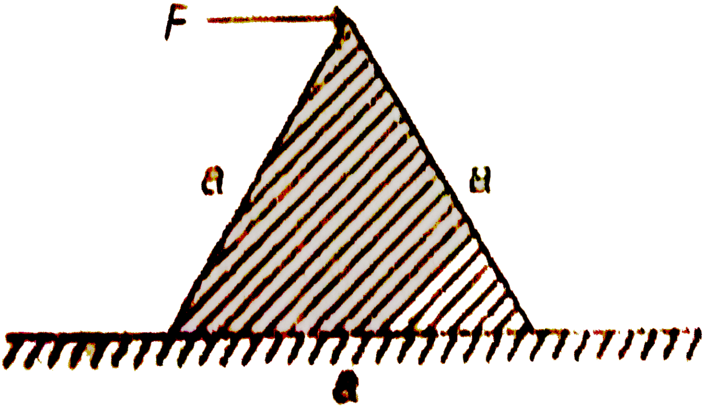
65. An equilateral prism of mass m rests on a rough horizontal surface with cofficent of friction μ. A horizontal force F is applied on the prism as shown in the figure. If the cofficent of the friction is sufficently high so that the prism does not slide before toppling, then the minimum force required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



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

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

C. $\frac{\mu mg}{\sqrt{3}}$

D. $\frac{\mu mg}{4}$

Answer: A

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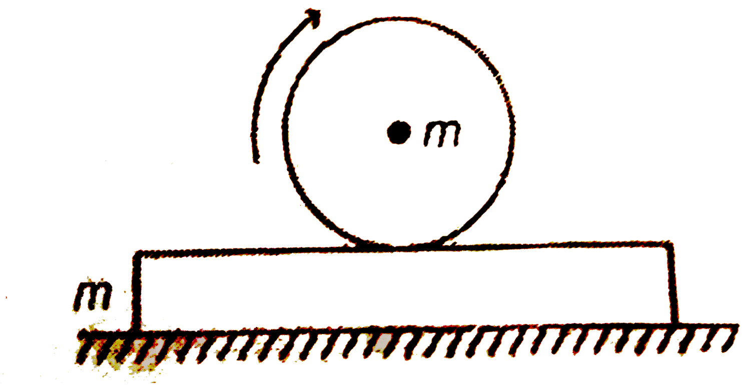
66. A sphere of mass m is given some angular velocity about a horizontal axis through its centre and gently placed on a plank of mass 'm'. The co-efficent of friction between the two is μ. The plank rests on a smooth horizontal surface. The initial acceleration of the centre of sphere relative to the plank will be



A. zero

B. μg

C. $(7/5)\mu g$

D. $2\mu g$

Answer: D

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67. When a perosn throws a meter stivk it is found that the centre of the stick is moving with speed $10m/s$ and left end stick with speed $20m/s$. Both points move vertically upwards at that moment. Then angular speed the stick is :

A. $20rad/s$

B. $10rad/s$

C. $30rad/s$

D. None of these

Answer: A

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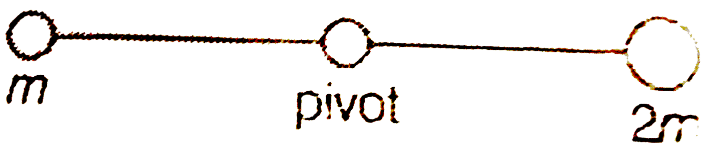
68. A rod of negligble mass and length l is pioveted at its centre. A particle of mass m is fixed to its left end and another particle of mass 2 m is fixed to the right end. If the system is released from rest and after sometime becomes vericle, The speed v of the two mases and angular velocity at that instant are



A. $\sqrt{gl/3}, \sqrt{4g/3l}$

B. $\sqrt{4gl/3}, \sqrt{4g/3l}$

C. $\sqrt{4gl/3}, \sqrt{4gl/3}$

D. $\sqrt{gl/3}, \sqrt{gl/3}$

Answer: A

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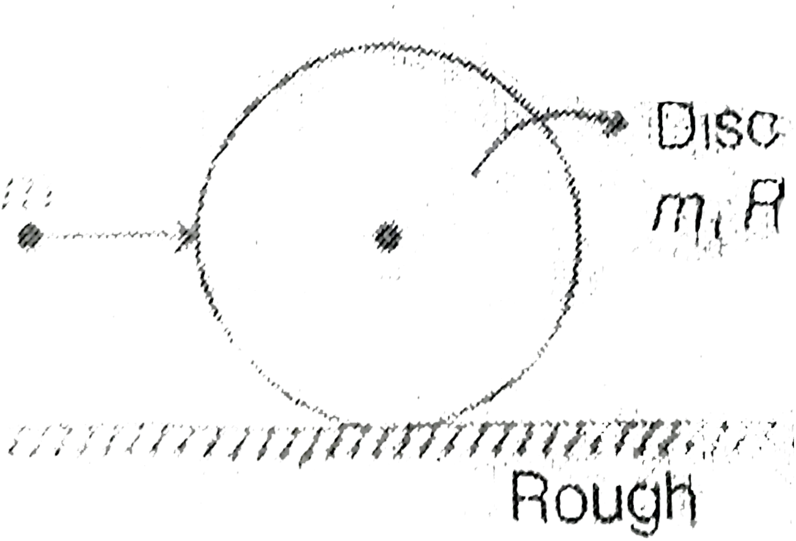
69. A point mass m collides with a disc of mass m and radius R resting on a rough horizontal surface as shown . Its collision is perfectly elastic. Find angular velocity of the disc after pure rolling starts



A. $\left(\frac{2u}{3R}\right)$

B. $\left(\frac{3u}{3R}\right)$

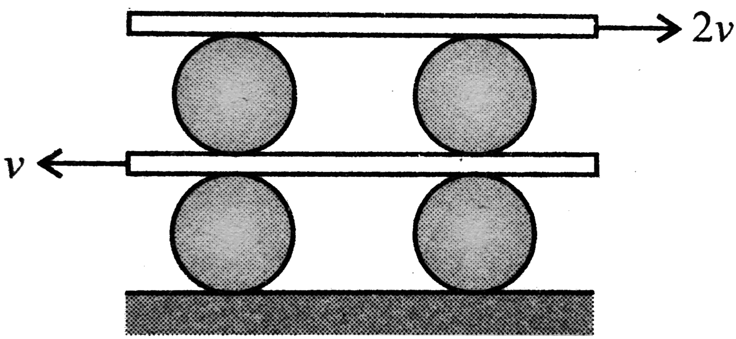
C. $\left(\frac{5u}{3R}\right)$

D. $\left(\frac{2u}{5R}\right)$

Answer: A

View Text Solution

70. A system of identical cylinders and plates is shown in Fig. All the cylinders are identical and there is no slipping at any contact. The velocity of lower and upper plates are V and $2V$, respectively, as shown in Fig. Then the ratio of angular speeds of the upper cylinders to lower cylinders is



A. 3

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

C. 1

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

Answer: A

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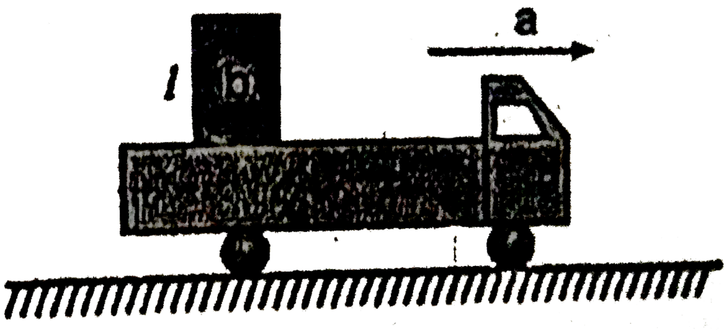
71. A box of dimensions l and b is kept on a truck moving with an acceleration a. if box does not slide, maximum acceleration for it to remain in equilibrium (w.r.t. truck) is



A. $\frac{gl}{b}$

B. $\frac{gb}{l}$

C. g

D. None of these

Answer: B

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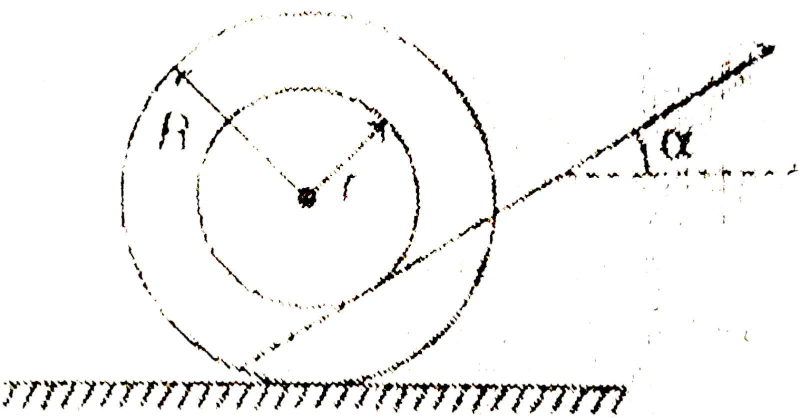
72. Inner and outer radii of a spool are r And R respectively. A thread is wound over ita ineer surface and placed over a rough horizontal surface. Thread is pulled by a force F as shown in the figure. Then in case of pure rolling.



A. thread unwinds, spool rotates anticlockwise and friction leftwards

B. thread winds, spool rotates clockwise and friction leftwards

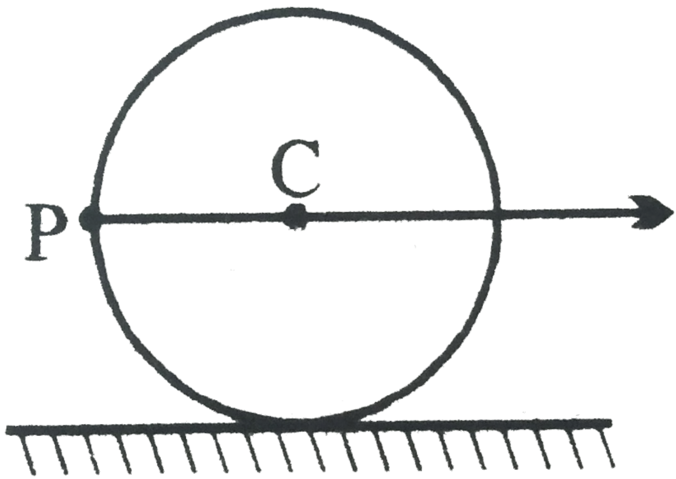
C. thread winds, spool moves to the right and friction acts rightwards

D. thread winds, spool moves to the right and friction does not come into existence

Answer: B

View Text Solution

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



A. Zero

B. 45°

C. 135°

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

Answer: B

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74. A uniform solid cylinder of mass 5kg and radius 0.1m is resting on a horizontal platform (parallel to the x-y plane) and is free to rotate about its axis along the y-axis the platform is given a motion in the x direction given by x=0.2 cos (10t) m if there is no slipping then maximum torque acting on the cylinder during its motion is

A. $0.2N - m$

B. $2.0N - m$

C. $5.0N - m$

D. $10.0N - m$

Answer: C

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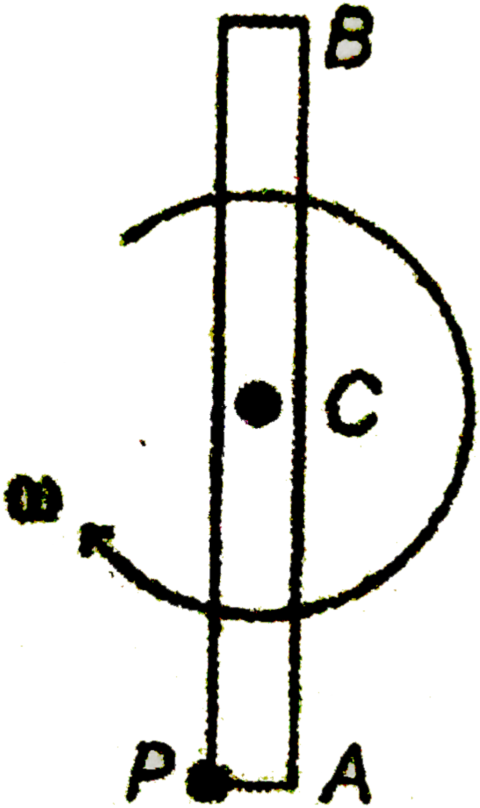
75. A rod lying on a frictionless horizontal surface is initially given an anglular velocity ω about vertical axis which passes through center of mass. The centre of mass is at rest but not fixed. The length of the rod is L. Subsequently, end A of the rod collides with nail P, which is near to A such that end A becomes stationery immediately after impact. Velocity of end

B just after collision will be



A. ωL

B. $\omega L/2$

C. $\omega L/4$

D. $\omega L/6$

Answer: C

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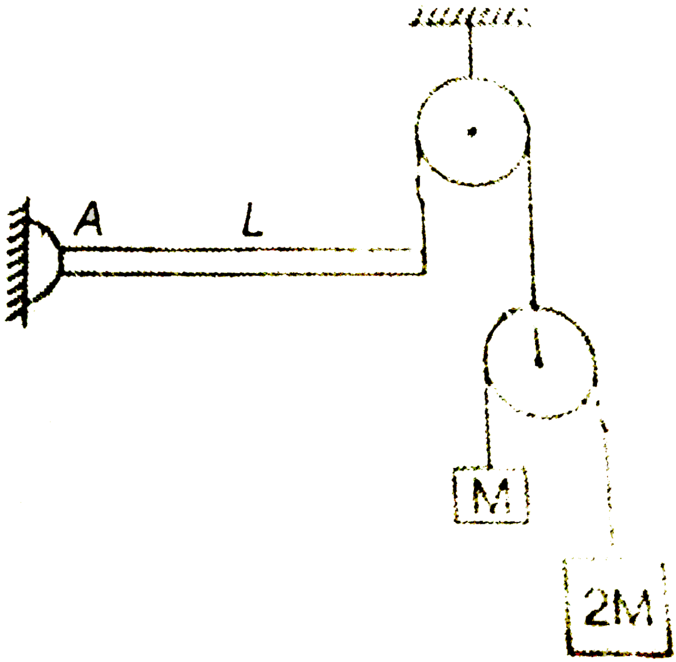
76. Consider the situation shown in the figure. Uniform rod of length L can rotat freely about the hinge A in vertical plane. Pulleys and stringa are light and frictionless. If the rod remains horizontal at rest when the system is released then the mass of the rod is



A. $\frac{4}{3}M$

B. $\frac{8}{3}M$

C. $\frac{16}{3}M$

D. $\frac{32}{3}M$

Answer: C

77. A homogeneous rod of mass 3 kg is pushed along the smooth horizontal surface by a horizontal suface by a horizontal force F equal to 40 N. The angle θ for which rod hasd pure translation motion is $\left(g = 10 m / s^2\right)$

A. 45°

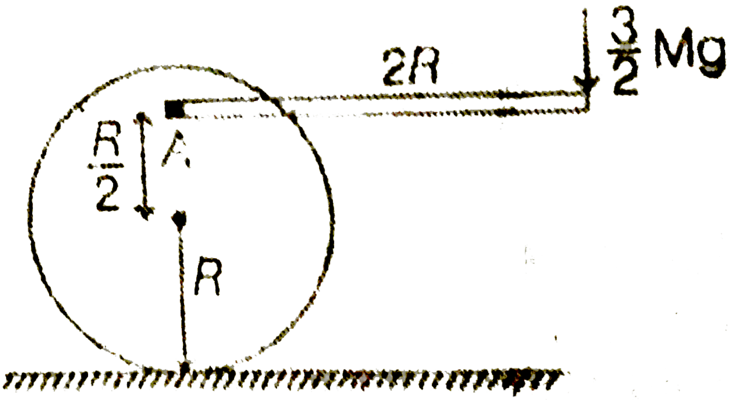
B. 37°

C. 53°

D. 60°

Answer: B

78. A disc of mass M and radius R is placed on a rough horizontald surface. A light rod of length 2R is fixed to the disc at pointt A as shown in figure and force $\frac{3}{2}$ Mg is applied at the other end of the rod. Find the minimum value of coefficient of friction (upto on decimal place) between disc and horizontal surface, so that disc starts to roll without slipping .



A. 0.2

B. 0.4

C. 0.6

D. 0.8

Answer: D

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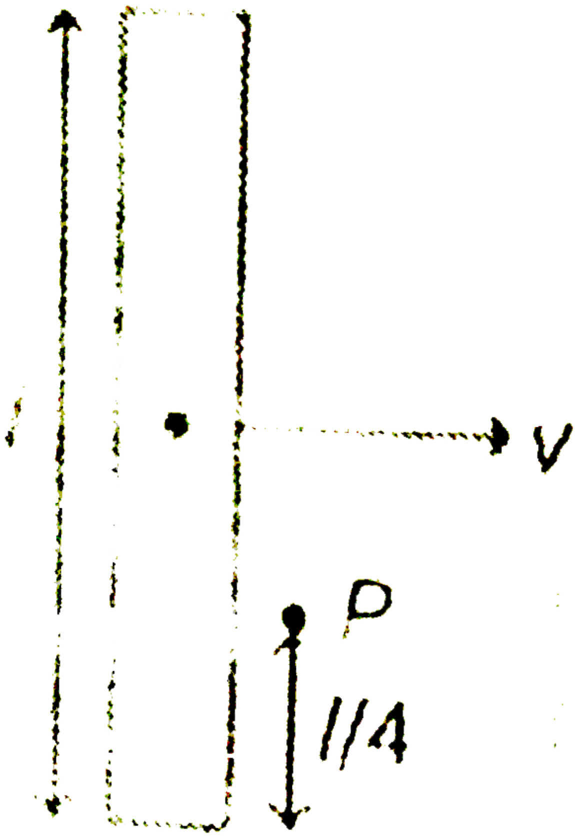
79. A uniform rod of mass m , length l moving with a velocity v (perpendicular to its length) on a smooth horizontal plane, encounters a fixed peg P at a distance l/4 from its nearer end. The rod collides with the peg. The duration of impact Δt is very small. The average force exerted by the peg on the rod during the impact is of magnitude.



A. $\frac{4mv}{7\Delta t}$

B. $\frac{4mv}{5\Delta t}$

C. $\frac{12mv}{7\Delta t}$

D. $\frac{12mv}{5\Delta t}$

Answer: A

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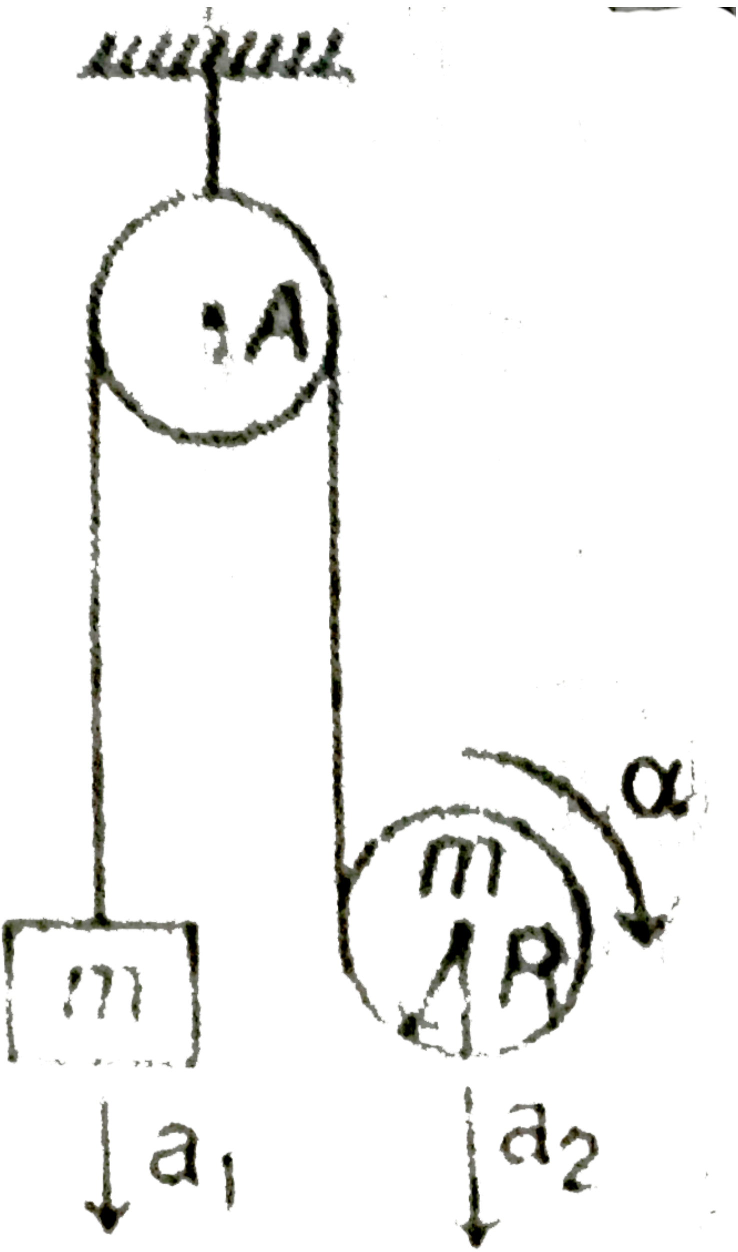
80. An ideal inextensible string is wrapped over the disc of mass m and radius R. The other end of the string is connected to mass m. the string is passing over an ideal pulley A as shown in the figure. At any time t, mass m and disc are moving downward with acceleration of magnitude a_1 and a_2 respectively. The disc is rotating clockwise with angular acceleration of magnitude α . There is no slipping betweeb string and disc. choose the incorrect option



A. $a_1 = a_2$

B. $\alpha R > a_1$

C. $\alpha R = a_1$

D. $\alpha R < a_2$

Answer: D

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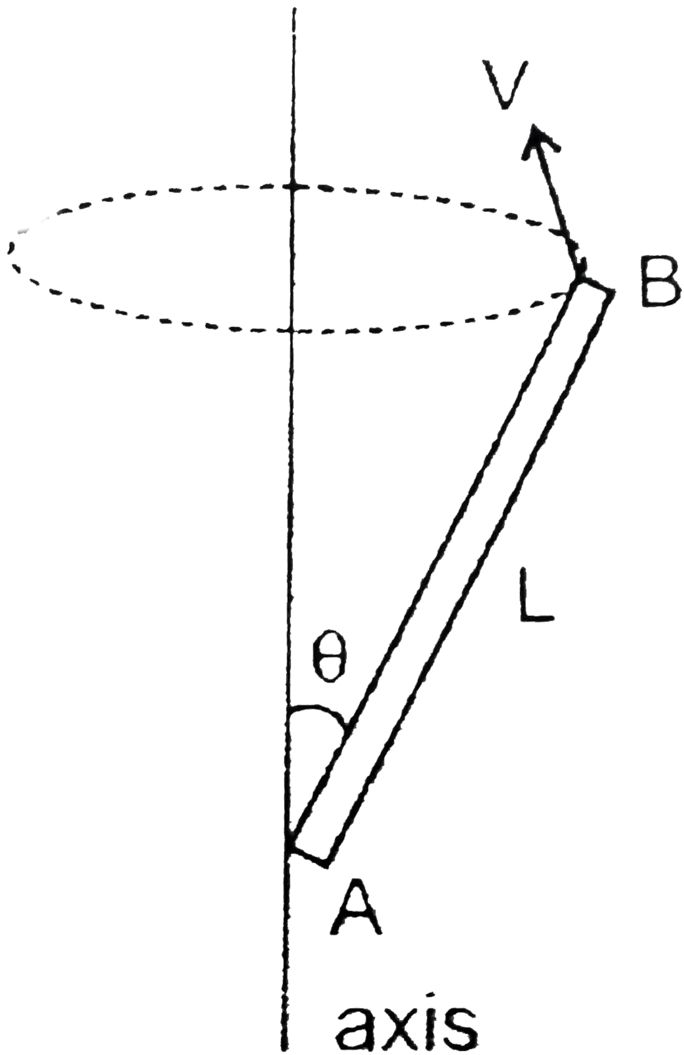

81.

A uniform rod AB of mass m and length L rotates about a fixed vertical axis making a constant angle θ with it as shown in figure. The rod is rotated about this axis, so that point B the free end of the rod moves with a uniform speed V in the horizontal plane then the angular momentum of the rod about the axis is:

A. $\frac{1}{3}mvL\sin\theta$

B. $\frac{1}{4}mvL\sin\theta$

C. $mvL\cos\theta$

D. none of these

Answer: A

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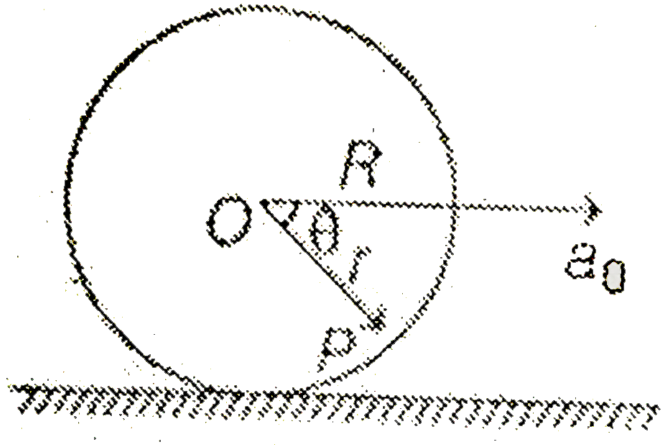
82. The wheel of radius R rolls wihtout slipping on horizontal rough surface and its centre O has an acceleration a_0 in forward direction. A point P on the wheel is a distance r from

O and angular position θ from horizontal. Find the angle θ for which point P can have zero acceleration in this position .



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

B. $\frac{\tan^{-1}(r)}{R}$

C. $\frac{\sin^{-1}(r)}{R}$

D. $\frac{\cos^{-1}(r)}{2R}$

Answer: C

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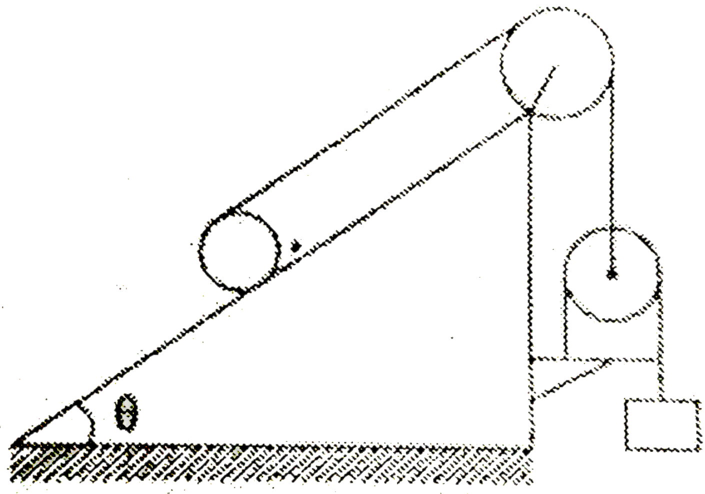
83. A string is warapped around a cylinder of mass m and radius r. The string is also connected to a block of same mass m with the help of another pulley as shown in figure. The angular acceleration of the cylinder is (friction is sufficient for rolling) (all pulleys are ideal)



A. $\dfrac{g(2 - \sin\theta)}{16R}$

B. $\dfrac{2g(4 - \sin\theta)}{35R}$

C. $\dfrac{7g(3 - \sin\theta)}{25R}$

D. $\dfrac{g(2 - \sin\theta)}{12R}$

Answer: B

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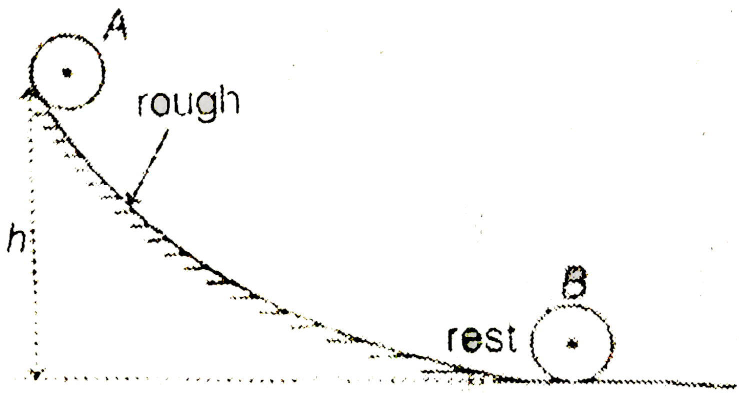
84. A small uniform solid sphere A rolls down a fixed surface starting at a height h and collides elastically with a sphere B which is identical in size to A but has twice its mass. The speed of the sphere B, just after the collision is



A. $\frac{\sqrt{2gh}}{3}$

B. $\frac{2\sqrt{2gh}}{3}$

C. $\frac{\sqrt{10gh}}{63}$

D. $\frac{\sqrt{40gh}}{63}$

Answer: D

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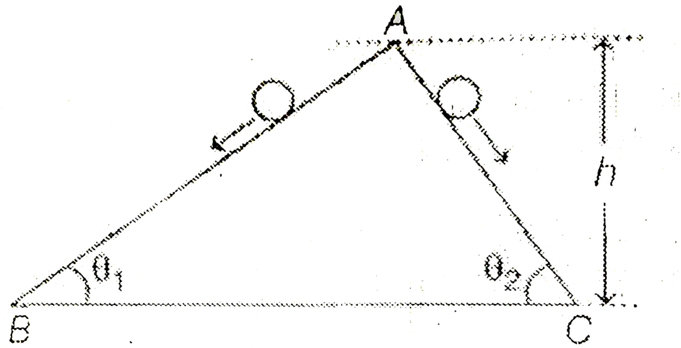
85. A small disc is released from rest at A on an inclined plane AB so that it rolls down wihtout slipping. It reaches the bottom with linear velocity v_1 in time t_1. Next a small ring released form rest on the inclined plane AC so that it rolls down without slipping. It reaches the bottom with linear vlocity v_2 in time t_2. Given $\theta_1 = 30^\circ, \theta_2 = 60^\circ$, and h=10m.

Then,



A. $v_1 > v_2, t_1 < t_2$

B. $v_1 < v_2, t_1 > t_2$

C. $v_1 > v_2, t_1 > t_2$

D. $v_1 < v_2, t_1 < t_2$

Answer: C

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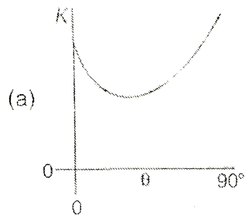
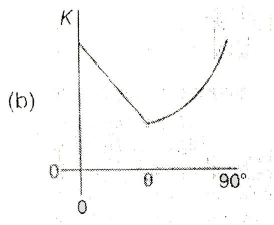
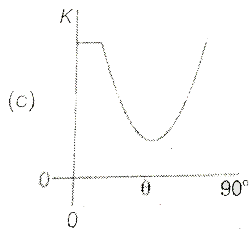
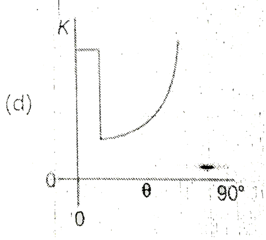
86. A solid ball is realeased from rest down inclines of various inclination angle θ but through a fixed vertical height h. The coefficient of static and kinetic friction are both equal to μ. Which of the following graph best represents the total kinetic energy K of the ball at the bottom of the incline as a function of the angle θ of the incline?

A. 

B. 

C. 

D. 

Answer: C

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More than one option is correct

1. Which of the following statement (s) is / are correct for a spherical body rolling without slipping on a rough horizontal ground at rest?

A. The acceleration of a point in contact with ground is zero

B. The speed of some of the point (s) is (are) zero.

C. Friction force may or may be zero

D. Work done by friction may or may not be zero

Answer: B::C

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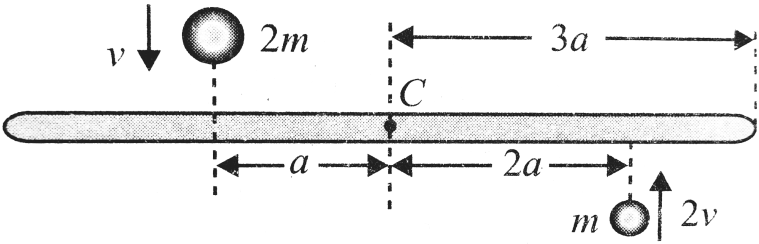
2. A uniform bar of length $6a$ and mass $8m$ lies on a smooth horizontal table. Two point masses m and $2m$ moving in the same horizontal plane with speeds $2v$ and v, respectively, strike the bar (as shown in the figure) and stick to the bar after collision. Denoting angular velocity (about the centre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



A. $v_c = 0$

B. $\omega = \frac{3v}{5a}$

C. $\omega = \frac{v}{5a}$

D. $E = \frac{mv^2}{5}$

Answer: A::C::D

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3. A particle moves in a circle of radius r with angular velocity ω. At some instant its velocity is v radius vector with respect to centre of the circel is r.At this particular instant centripetal acceleration a_c of the particle would be

A. $\omega \times v$

B. $v \times \omega$

C. $\omega \times (\omega \times r)$

D. $v \times (r \times \omega)$

Answer: A::C

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4. A particle of mass m is travelling with a constant velocity $v = v_0\hat{i}$ along the line $y = b, z = 0$. Let dA be the area swept out by the position vector from origin to the particle in time dt and L the magnitude of angular momentum of particle about origin at any time t. Then

A. L=constant

B. $L \neq$ constant

C. $\frac{dA}{dt} = \frac{2L}{m}$

D. $\frac{dA}{dt} = \frac{L}{2m}$

Answer: A::D

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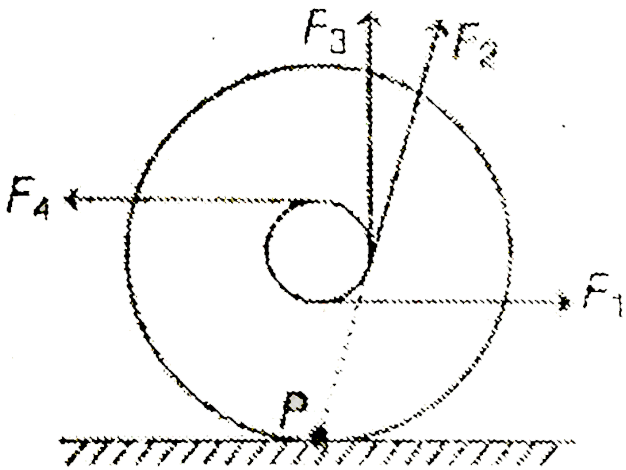
5. A spool of wire rests on a horizontal surface as shown in figure. As the wire is pulled, the spool does not slip at contact point P. On separate trials, each one of the force F_1, F_2, F_3 and F_4 is applied to the spool. For each one of these forces the spool.



A. will rotate anticlockwise if F_1 is applied

B. will not rotate if F_2 is applied

C. will rotate anticlockwise if F_3 is applied

D. will rotate clockwise if F_4 is applied

Answer: B::C

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6. In the above problem, direction of friction force is

A. towards left if F_1 is applied

B. towards left if F_2 is applied

C. towards right if F_3 is applied

D. may be right or left or friction may be zero if F_4 is applied

Answer: A::B::D

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7. A constant force F is applied at the top of a ring as shown in figure. Mass of the ring is M and radius is R. Angular momentum of particle about point of contact at time t

A. is constant

B. increases linearly with time

C. is 2F R t

D. decrease linearly with time

Answer: B::C

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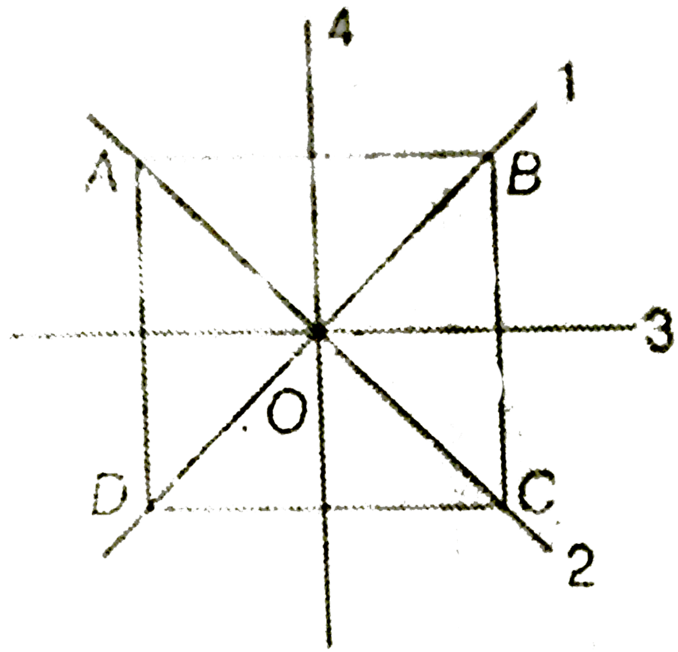
8. The moment of inertia of a thin square plate ABCD of uniform thickness about an axis passing through the centre O and perpendicular to plate is



A. $I_1 + I_2$

B. $I_2 + I_3$

C. $I_1 + I_3$

D. $I_3 + I_4$

Answer: A::B::C::D

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9. In pur rolling, fraction of its total energy associatedd with rotation is α for a ring and β for a solid sphere. Then

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

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

C. $\beta = \frac{2}{5}$

D. $\beta = \frac{2}{7}$

Answer: A::D

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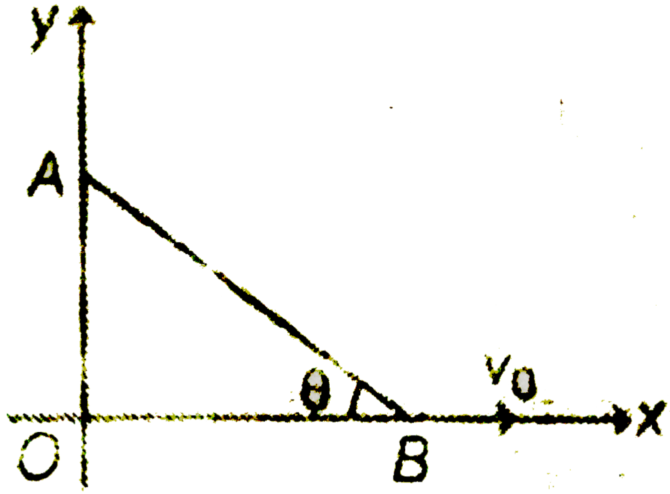
10. The end B of the rod AB which makes angle θ with the floor is being pulled with a constant velocity v_0 as shown. The length of the rod is l. At the instant when $\theta = 37°$



A. velocity of end A is $\frac{4}{3}v_0$ downwards

B. angular velocity of rod is $\frac{5}{3}\frac{v_0}{l}$

C. angular velocity of rod is constant

D. velocity of end A is constant

Answer: A::B::D

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11. A disc can roll wihtout slippingg, without applying any external force on a

A. rough inclined plane

B. smooth inclined plane

C. rough horizontal surface

D. smooth horizontal surface

Answer: A::C::D

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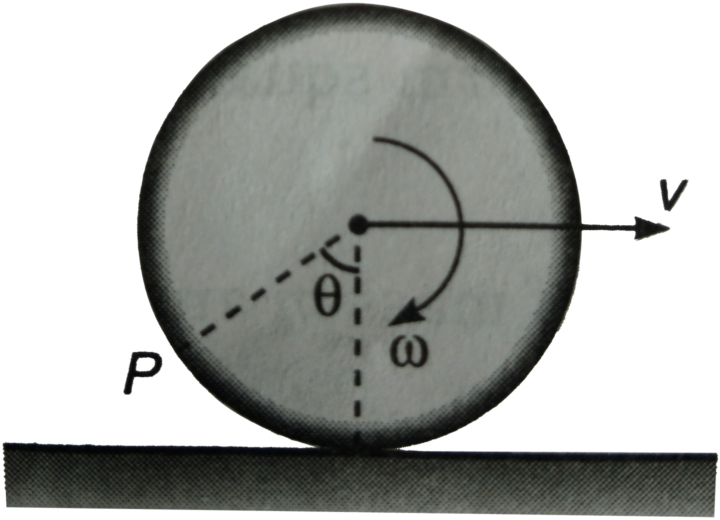
12.



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 ($v < R\omega$).

A. $\pi + \dfrac{\sin^{-1}(v)}{R\omega}$

B. $\dfrac{\pi}{2} - \dfrac{\sin^{-1}(v)}{R\omega}$

C. $\pi - \dfrac{\cos^{-1}(v)}{R\omega}$

D. $\pi + \dfrac{\cos^{-1}(v)}{R\omega}$

Answer: C::D

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13. If a circular concentric hole is made on a disc then about an axis passing through the centre of the disc and perpendicular to its plane

A. moment of inertia decreases

B. moment of inertia increases

C. radius of gyration increases

D. radius of gyration decreases

Answer: A::C

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14. A uniform disc is rotating at a constantt speed in a vertical plane about a fixed horizontal axis passing through the centre of the disc. A piece of the disc from its rim detaches itself from the disc at the instant when it is at horizontal level with the centre of the disc and moving upward. Then about the fixed axis, the angular speed of the

A. remaining disc remains unchanged

B. remaining disc decreases

C. remaining disc increases

D. broken away piece decrease initially and later

Answer: A::D

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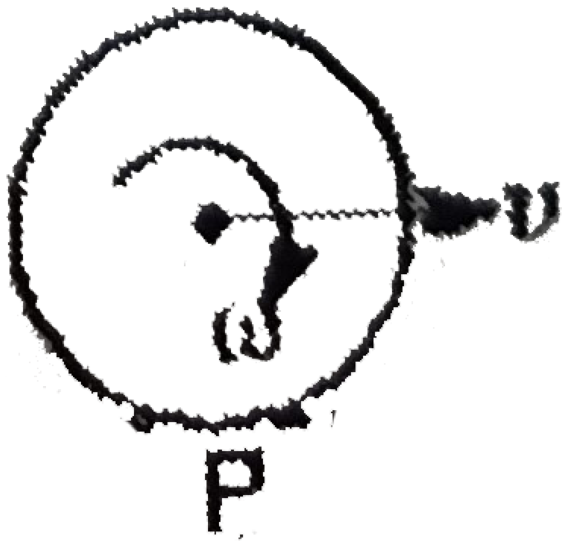
15. A spherical body of radius R rolls on a horizontal surface with linear velociltly v. Let L_1 and L_2 be the magnitudes of angular momenta of the body about centre of mass and point of contact P. Then:



A. $L_2 = 2L_1$, if radius of gyration about centroidal axis K=R

B. $L_2 = 2L_1$, for all cases

C. $L_2 < 2L_1$, if radius of gyration about centroidal axis $K < R$

D. $L_2 < 2L_1$, if radius of gyration about centroidal axis $K > R$

Answer: A::C

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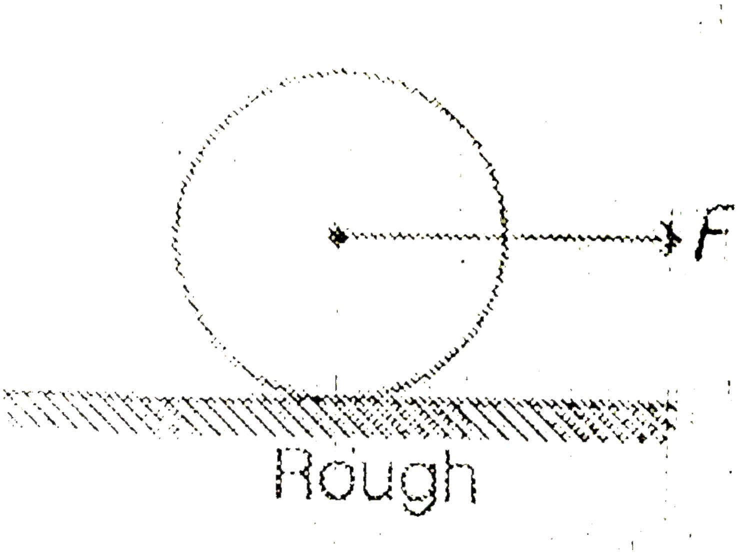
16. A solid cylinder of mass M and radius R pure rolls on a rough surface as shown in the figure. Choose the correct alternative (s).



A. The acceleration of the centre of mass is $\frac{F}{M}$

B. The acceleration of the centre of mass is $\frac{2}{3}\frac{F}{M}$

C. The friction force on the cylinder acts backward

D. The magnitude of the friction force is $\frac{F}{3}$

Answer: B::C::D

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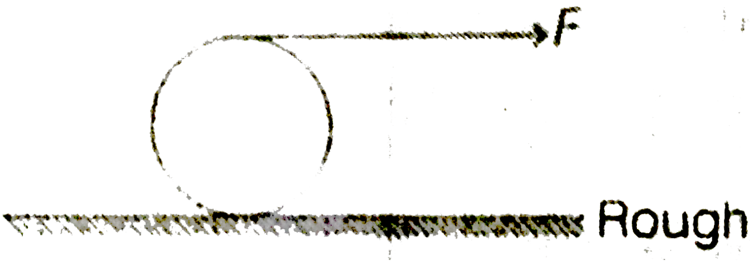
17. A solid sphere of radius R is rolled by a force F acting at the topo of the sphere as shown in the figure. There is no slipping and initially sphere is in the rest position, then (CM= centre of mass)



A. Work done by force F when the centre of mass move a distance S is 2 FS

B. speed of the CM when CM moves a distance S is $\sqrt{\frac{20}{7}\frac{FS}{M}}$

C. work done by the Force F when CM move a distance S is FS

D. speed of the CM when CM moves a distance S is $\sqrt{\frac{6}{5}\frac{FS}{M}}$

Answer: A::B

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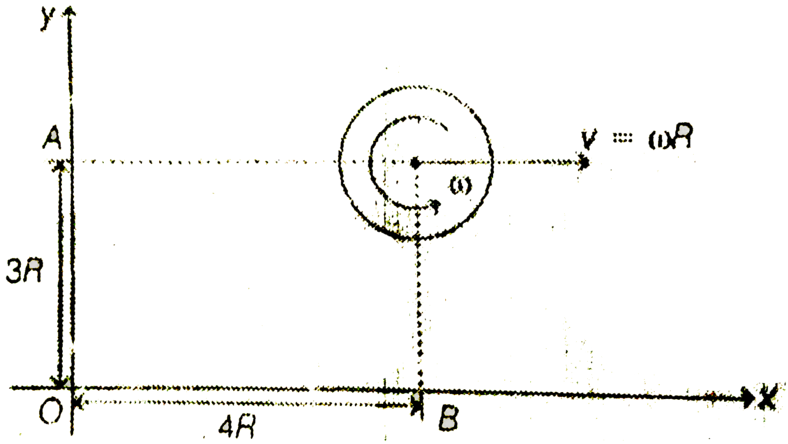
18. A disc of mass M and radius R moves in the x-y plane as shown in the figure. The angular momentum of the disc at tihe instant shows is



A. $\frac{5}{2}mR^2\omega$ about O

B. $\frac{7}{2}mR^2\omega$ about O

C. $\frac{1}{2}mR^2\omega$ about A

D. $4mR^2\omega$ about A

Answer: A::C

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19. Four particle of mass m each are placed at four corners of a square ABCD of side a. Point O is the centre of the square. Moment of inertia of all four particles about an axis passing through

A. A and B is $2ma^2$

B. A and C is ma^2

C. O and perpendicular to plane of square is $2ma^2$

D. O and parallel to CD is ma^2

Answer: A::B::C::D

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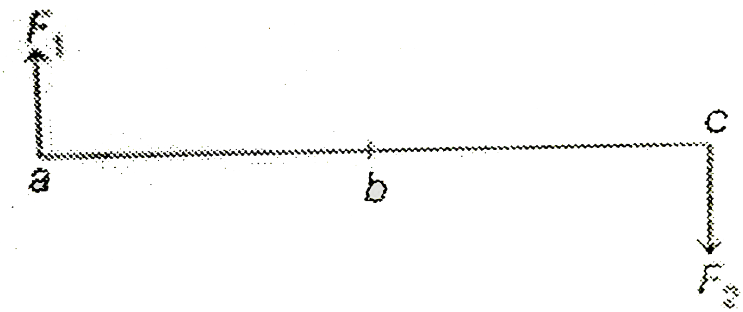
20. Two forces F_1 and F_2 are acting on a rod abc as shown in figure.



A. if $F_1 = F_2$ then $\tau_a = \tau_b = \tau_c$ (for both forces)

B. if $F_1 = F_2$ then $\tau_a = \tau_c \neq \tau_b$ (for both forces)

C. if $F_1 \neq F_2$ then $\tau_a \neq \tau_b \neq \tau_c$ (for both forces)

D. if $F_1 \neq F_2$ then $\tau_a = \tau_c \neq \tau_b$ (for both forces)

Answer: A::C

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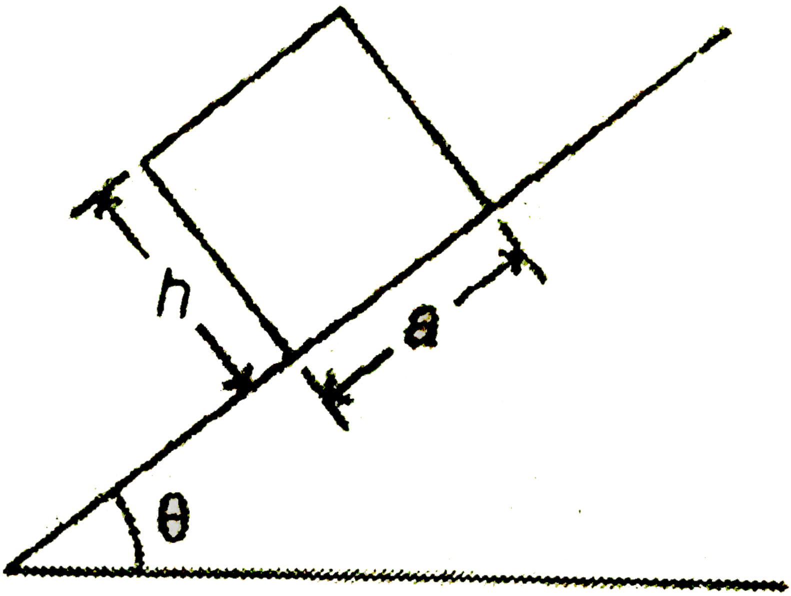
21. A block with a square base measuring $a \times a$ and height h, is placed on an inclined plane. The coefficient of friction is μ. The angle of inclination (θ) of the plane is gradually increased. The block will



A. topple before sliding if $\mu > \frac{a}{h}$

B. topple before sliding if $\mu < \frac{a}{h}$

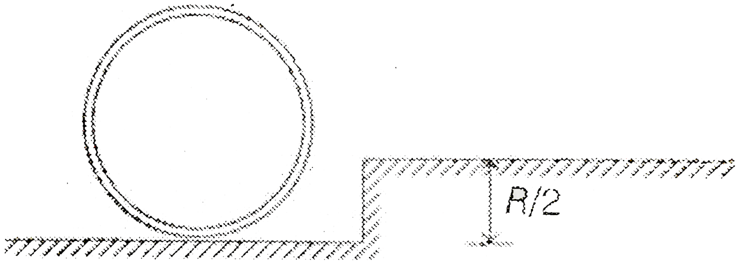
C. slide before toppling if $\mu > \frac{a}{h}$

D. slide before toppling if $\mu > \frac{a}{h}$

Answer: A::D

Watch Video Solution

22. A wheel (to be considered as a ring) of mass m and radius R rolls without sliding on a horizontal surface with constant velocity v. It encounters a step of height R/2 at which it ascends without sliding



A. the angular velocity of the ring just after it comes in contact with step is 3v/4R

B. the normal reaction due to the step on the wheel just after the impact is $\frac{mg}{2} - \frac{9mv^2}{16R}$

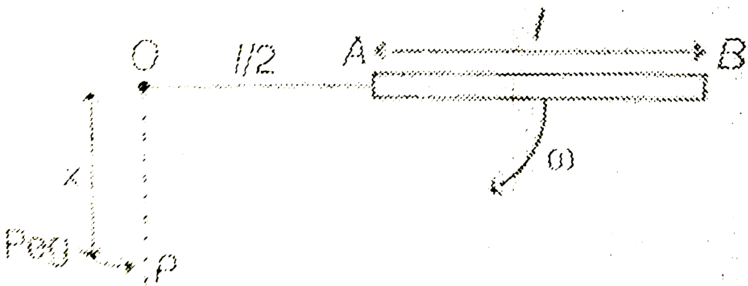
C. the normal reaction due to the step on the wheel increases as the wheel ascends.

D. the friction will be absent during the ascent.

Answer: A::B::C

View Text Solution

23. A uniform thin rod AB of mass M and length l attached to a string OA of length $= \frac{1}{2}$ is supported by a smooth horizontal plane and rotates with angular velocity ω around a vertical axis through O. A peg P is inserted in the plane in order that on striking it the rod will come to rest.



A. magnitude of angular momentum of rod about O is $\frac{4}{3}l^2\omega$

B. Magnitude of tension in string is M/ω^2

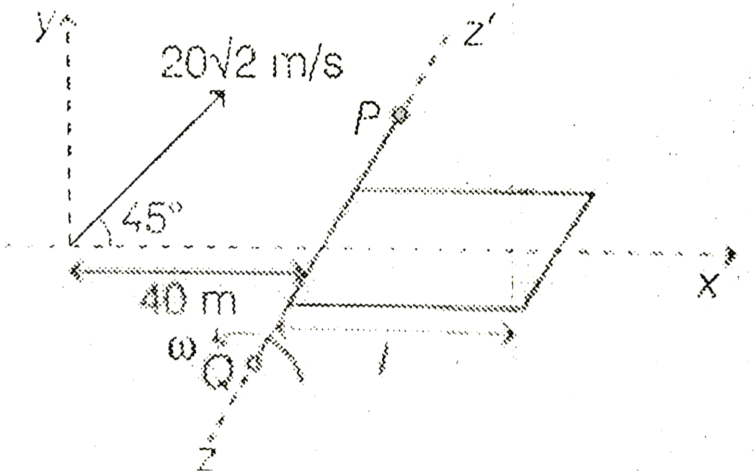
C. Location of peg for rod coming to rest is x $= \frac{13}{12}l$

D. magnitude of angular impulse by peg on the rod is $\frac{4}{3}l^2\omega$

Answer: B::C

View Text Solution

24. A ball is projected with velocityd of $20\sqrt{2}$ m/s at an angle of 45° with horizontal and at the same instant another plate is rotating with constant angular velocity $\omega = \frac{\pi}{4}$ rad/sec in vertical plane as shown in the figure (assume the length of plate is sufficient for collision to take place). If the mass of the plate is much larger than the mass of the ball, the plate is initially in horizontal position and collision is perfectly elastic, then choose the correct statement (s)



A. Time when the ball collides with the plate is 2 (SI unit)

B. velocity of the ball just after collision with the plate is

$10(2+\pi)$(SI unit)

C. Distance of ball when it again collides on the ground

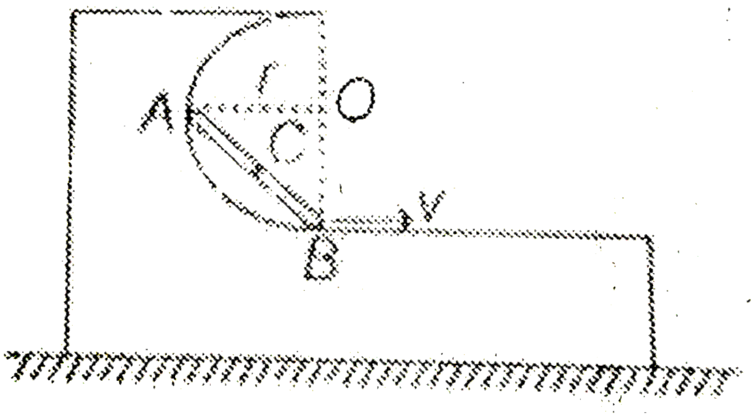
surface from the projection point is 20π(SI unit)

D. Maximum height achieved by the ball is 20 (SI unit)

Answer: A::B::C::D

View Text Solution

25. A rigid rod of mass m slides along a fixed circular track followed by a flat track. At the given instant, velocity of end B is v along horizontal plane. Then at the given instant:



A. angular speed of rod is $\frac{v}{r}$

B. velocity of centre of mass is $\frac{v}{\sqrt{2}}$

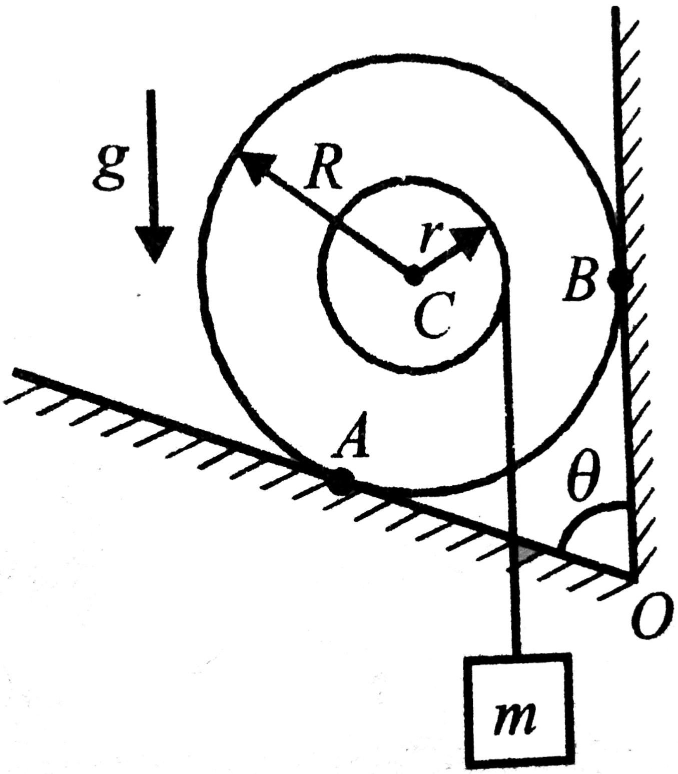
C. angular momentum of rod about O is $\frac{2}{3}$mvr

D. kinetic energy of rod is $\frac{mv^2}{6}$

Answer: A::B::C

View Text Solution

26. A massless spool of inner radius r outer radius R is placed against a vertical wall and a titled split floor as shown. A light inextensible thread is tightly wound around the spool through which a mass m is hainging. There exists no friction at point A, while the coefficient of friction between the spool and point B is μ. The angle between the two surface is θ



A. The magnitude of force on the spool at B in order ot maintain equilibrium is $mg\sqrt{\left(\frac{r}{R}\right)^2 + \left(1 - \frac{r}{R}\right)^2 \frac{1}{\tan^2\theta}}$

B. The magnitude of force on the spool at B in order to maintain equilibrium is $mg\left(1 - \frac{r}{R}\right)\frac{1}{\tan^2\theta}$

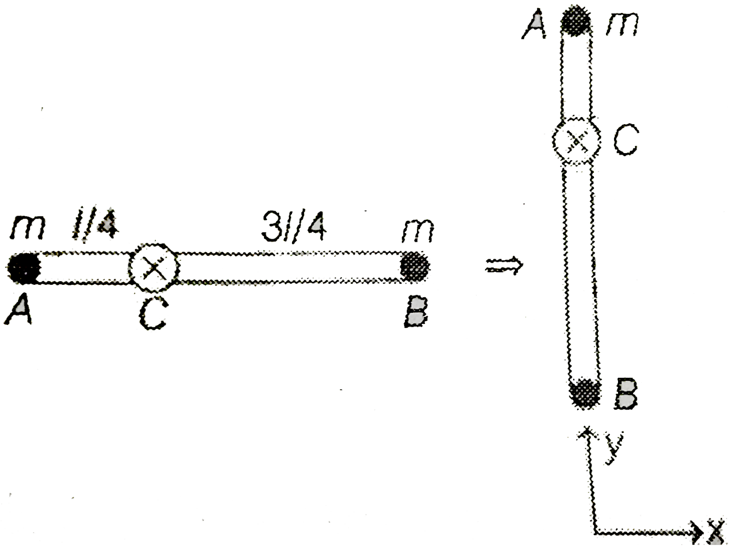
C. The minimum value of μ for the system to ramain in equilibrium is $\dfrac{\cot\theta}{(R/r)-1}$

D. The minimum value of μ for the system to ramain in equilibrium is $\dfrac{\tan\theta}{(R/r)-1}$

Answer: A::D

Watch Video Solution

27. Two particles each of mass m are attached at end points of a massless rod AB of length l. Rod is hinged at point C as shown. Rod is released from rest from horizontal position. At the instant when rod reaches its vertical position as shown, which of the following is / are correct:



A. Speed of the particle at B is thrice the speed of particle at A

B. Net force on particle B is $\frac{6mg}{5}$

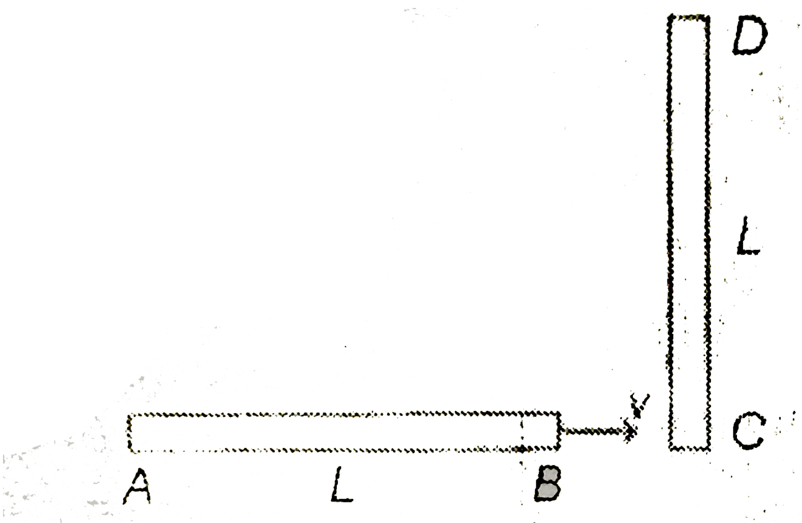
C. Angular acceleration of the system is zero.

D. Both x and y components of hinge force are non-zero

Answer: A::B::C

View Text Solution

28. A rod CD of length L and mass m is placed horizontally on a frictionless horizontal surface as shown. A second identical rod AB which is also placed horizontally (perpendicular to CD) on the same horizontal surface is moving along the surface with a velocity v in a direction perpendicular to rod CD and its and B strikes the rod CD at end C and sticks to it rigidity. Then,



A. Velocity of centre of mass of the system just after collision is $\frac{v}{4}$

B. angular speed of system just after collision is $\frac{2v}{5L}$

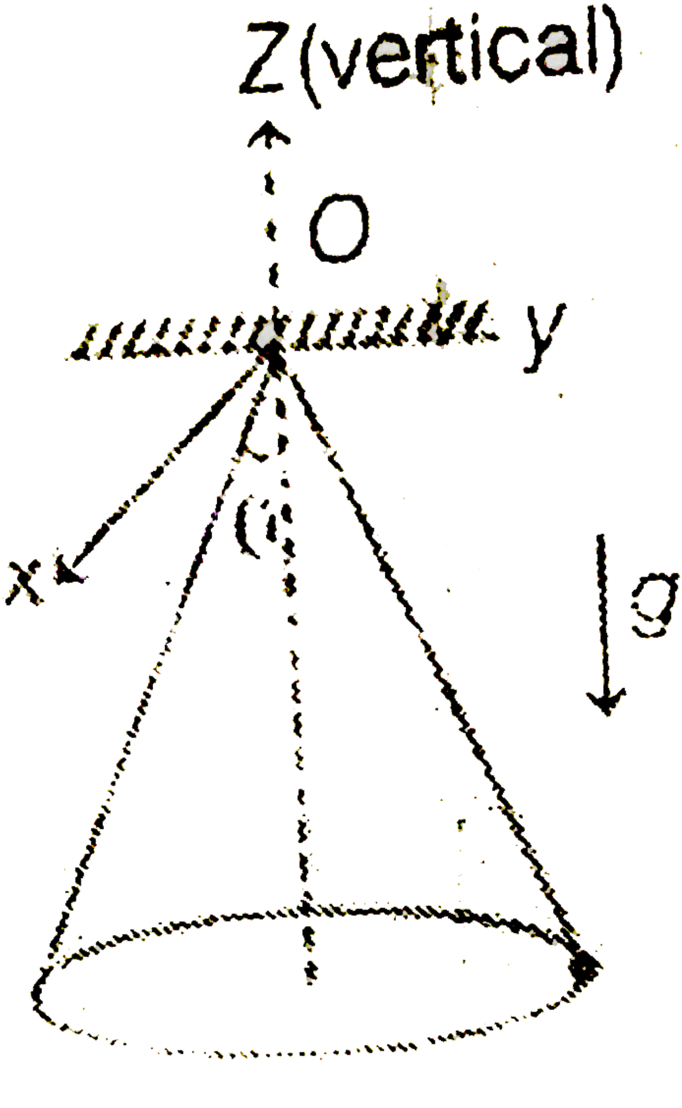
C. Velocity of centre of mass of the system just after collision is $\frac{v}{2}$

D. angular speed of system just after collision is $\frac{5L}{3L}$

Answer: B::C

View Text Solution

29. A particle of mass m is doing horizontal circular motion with the help of a string (conical pendulu) as shown in the figure. If speed of the particle is constant then,



A. the angular momentum of the particle about O is changing

B. magnitude of angular momentum about O remains constant

C. z component of the angular momentum remains conserved

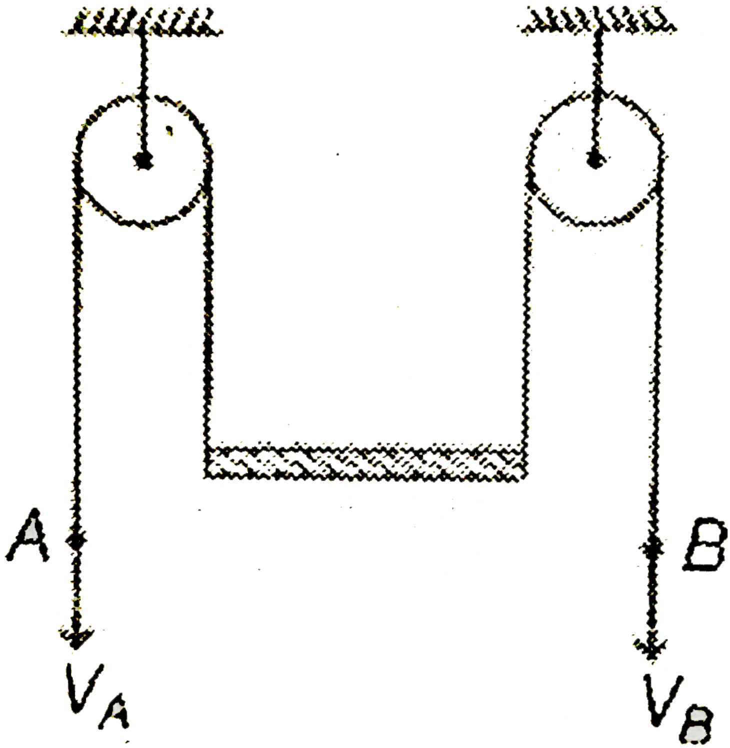
D. z component of torque is always zero.

Answer: A::B::C::D

View Text Solution

30. A thin uniform rod of mass 5 kg and length 1 m is held in horizontal position with the help of strings attachedd to ends of rod. Other ends of strings are held by some external agent. Now end A is pulled down with speed $v_A = 3t$ and end B is pulled down with speed $v_B = t$, where t is time in second.

Choose the correct choice(s)



A. Angular acceleration of rod is 2 rad/s^2

B. Tension in left string is $\frac{185}{6}$N

C. Acceleration of rod is 1m/s^2

D. Tension is right string is $\frac{170}{3}$N

Answer: A::B

View Text Solution

31. In the figure shown a uniform rod of length l and mass m is kept at rest in horizontal position on an elevated edge. The value of x is such that the rod will have maximum angular acceleration α, as soon as it is set free.

A. x is equal to $\frac{l}{2\sqrt{3}}$

B. α is equal to $\frac{g\sqrt{3}}{2l}$

C. α is equal to $\frac{g\sqrt{3}}{l}$

D. x is equal to $\frac{l}{\sqrt{3}}$

Answer: A::C

View Text Solution

32. A particle of mass 'm' is attached to the rim of a uniform disc of mass 'm' and radius R. The disc is rolling wihtout slipping on a stationery horizontal surface as shown in the figure. At a particular instant, the particle is at the topmost position and centre of the disc has speed v_0 amd its angular speed is ω. Choose the correct option (s).

A. $v_0 = \omega R$

B. kinetic energy of the system is $\frac{11}{4}mv_0^2$.

C. speed of point mass m is less than $2v_0$

D. $\left|v_C - v_B\right| = \left|v_B - v_D\right|$

Answer: A::B::D

View Text Solution

33. A uniform square plate of mass m and edge a initially at rest startas rotating about one of the edge under the action of a constant torque τ. Then at the end of the 5^{th} sec after start

A. angular momentum is equal to 5τ

B. kinetic energy is equal to $\frac{75\tau^2}{ma^2}$

C. angular momentum is equal to 2.5τ

D. kinetic energy is equal to $\frac{75\tau^2}{2ma}$

Answer: A::D

View Text Solution

34. A particle of mass m and velocity v_0 is fired at a solid cylinder of mass M and radius R. The cylinder is initially at rest and is mounted on a fixed horizontal axle that runs through the centre of mass. The line of motion of the particle is perpendicular to the axle and at a distance d, less than R, from the centre and the particle sticks to the surface of hte cylinder, then

A. Angular speed of the system just after the particle stick is $\dfrac{2mv_0 d}{R^2(M+2m)}$

B. Mechanical energy is conserved

C. angular speed of the system just after the particle sticks is $\dfrac{mv_0 d}{R^2(M+2m)}$

D. Mechanical energy is not conserved

Answer: A::D

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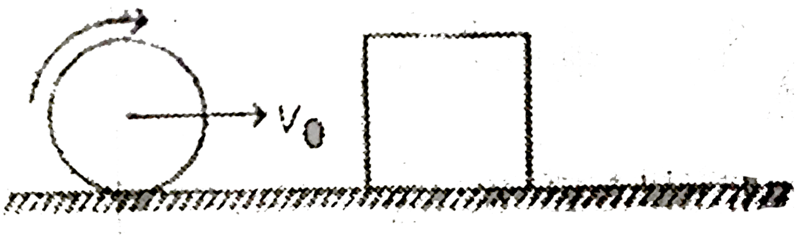
35. A cylinder is rolling towards a cube of same mass on rough horizontal surface (coefficient of friction = μ) with velocity v_0 as shown in figure. Assume elastic collision and friction is negligible between cube and cylinder. Then after collision



A. Cylinder will stop permanently

B. Cylinder will stop and then move towards right.

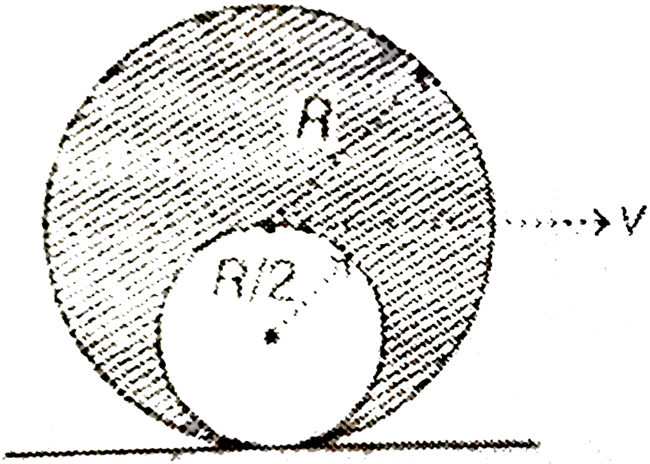
C. The maximum seperation between cylinder and block is $\frac{4v_0^2}{9\mu g}$

D. The time after the collision , the cylinder will again start pure rolling is $\frac{v_0}{3\mu g}$

Answer: B::D

View Text Solution

36. A uniform solid cylinder of radius 'R' has a circular cut of radius $\frac{R}{2}$ from the edge, Its mass is M. It is rolling wihtout slipping on a rough horizontal floor. When the cut part is at lowest position, centre of the disc is moving with horizontal velocity v. Choose the alternative:



A. Total kinetic energy at this moment is $\frac{15}{16}Mv^2$

B. Total kinetic energy at this moment is $\frac{15}{9}Mv^2$

C. Velocity of centre of mass of the cylinder at this moment is $\frac{4}{3}v$

D. Velocity of centre of mass of the cylinder at this moment is $\frac{7}{6}v$

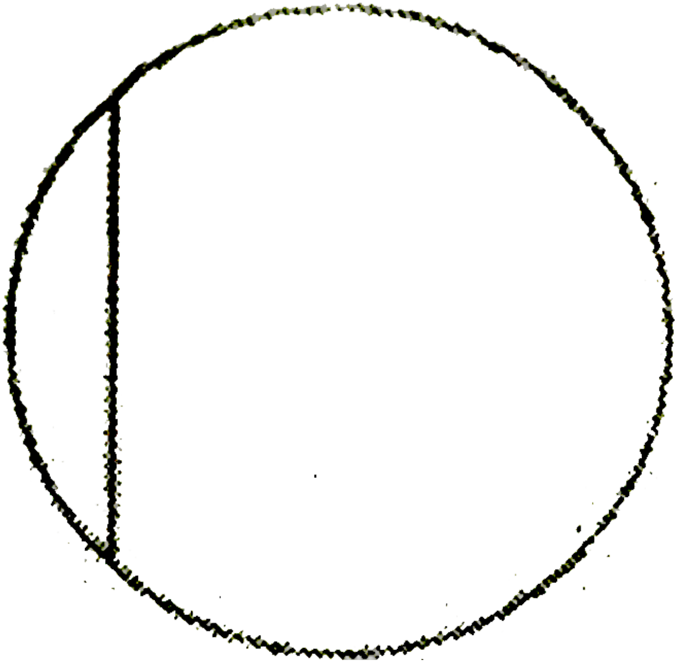
Answer: A::D

View Text Solution

Comprehension Type Questions

1. A rod of length 2 m is kept vertical inside a smooth spherical shell of radius 2m. The rod starts slipping inside the shell . Mass of the rod is 4 kg.

Angular speed of the rod(in rad/s) in the position when it becomes horizontal is



A. 4.6

B. 6.8

C. 3.2

D. 7.2

Answer: C

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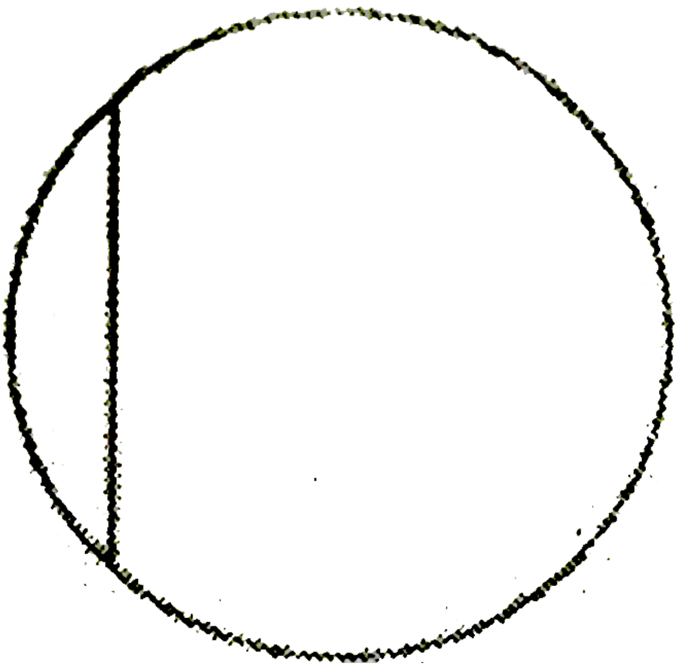
2. A rod of length 2 m is kept vertical inside a smooth spherical shell of radius 2m. The rod starts slipping inside the shell . Mass of the rod is 4 kg.

Velocity of centre of the rod (in m/s) at the instant is approximately



A. 5.5

B. 6.2

C. 3.2

D. 10.2

Answer: A

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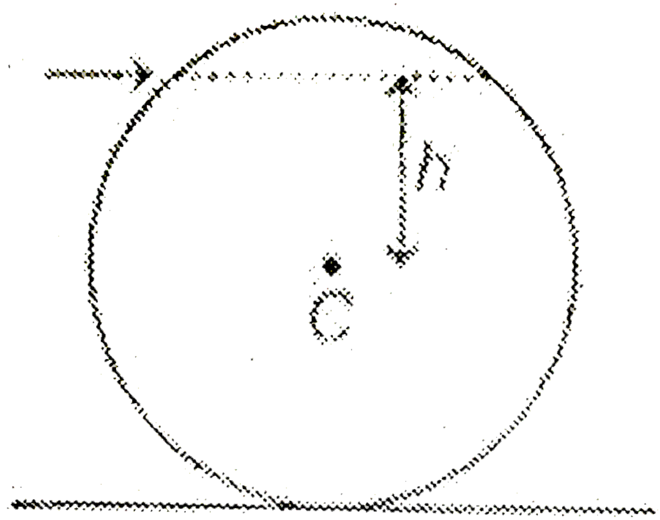
3. A solid sphere is kept over a smooth surface as shown in figure. It is hit by a cute at height h above the centre C.



In case 1, $h = \frac{R}{2}$ and in case 1 the sphere acquires a total kinetic energy k_1 and in case 2 total kinetic energy is k_2 . Then,

A. $k_1 = k_2$

B. $k_1 > k_2$

C. $k_1 < k_2$

D. Data is sufficient

Answer: C

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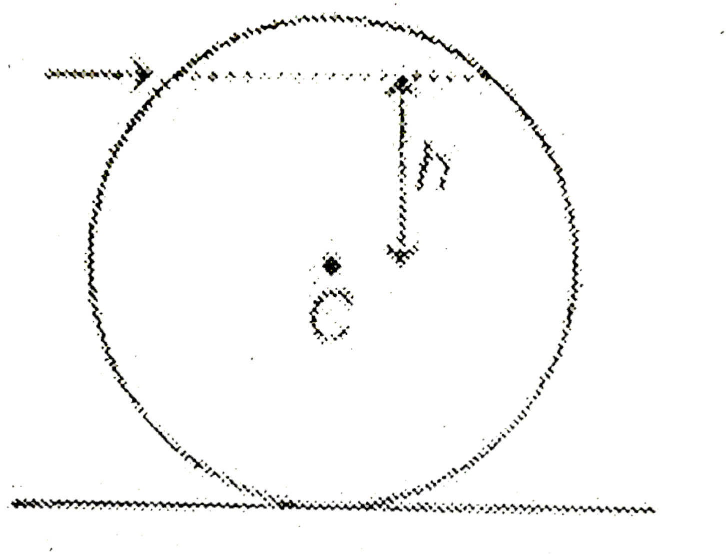
4. A solid sphere is kept over a smooth surface as shown in figure. It is hit by a cute at height h above the centre C.



If the surface is rough, then after hitting the sphere, in which case the force of friction is in forward direction.

A. In case 1

B. In case 2

C. In both the cases

D. In none of the cases

Answer: B

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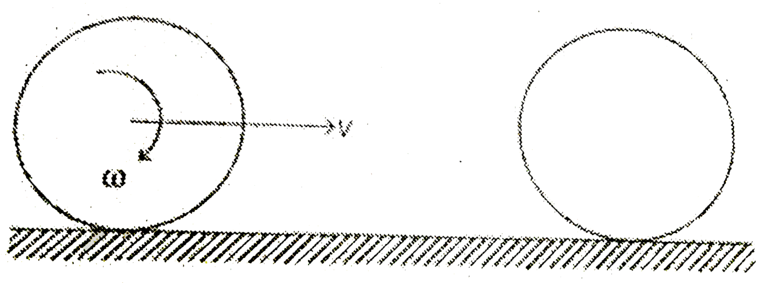
5. A solid sphere is rolling without slipping on rough ground as shown in figure. If collides elastically with an identical another sphere at rest. There is no friction between the two spheres . Radius of each sphere is R and mass is m.



Linear velocity of first sphere after it again starts rolling without slipping is

A. $\frac{2}{5}\omega R$

B. $\frac{2}{7}\omega R$

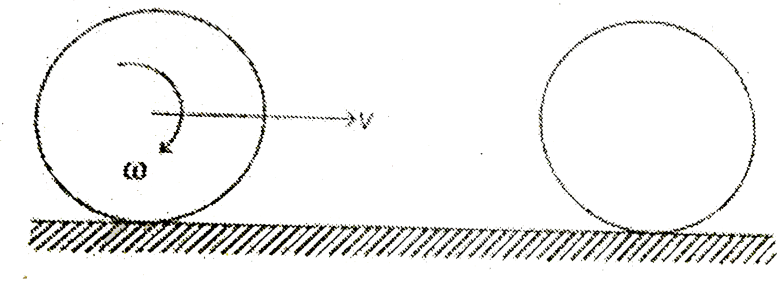
C. $\frac{7}{10}\omega R$

D. $\frac{7}{5}\omega R$

Answer: B

View Text Solution

6. A solid sphere is rolling without slipping on rough ground as shown in figure. If collides elastically with an identical another sphere at rest. There is no friction between the two spheres . Radius of each sphere is R and mass is m.



What is the net angular impulse imparted to second sphere by the external forces?

A. $\frac{2}{7}mRv$

B. $\frac{5}{7}mRv$

C. $\frac{2}{5}mRv$

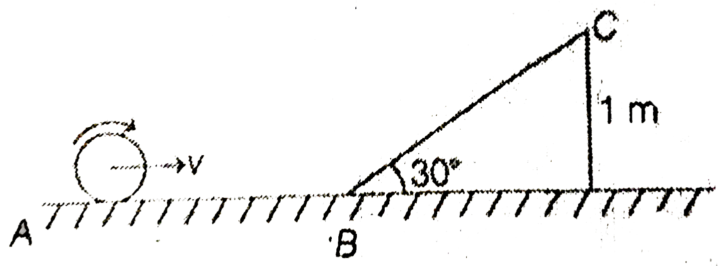
D. $\frac{7}{10}mRv$

Answer: A

View Text Solution

7. A small sphere of mass 1 kg is rolling without slipping with linear speed

$$v = \sqrt{\frac{200}{7}} m/s$$



It leaves the inclined plane at point C.

Find the linear speed at point C.

A. $\sqrt{\frac{100}{7}}$ m/s

B. $\sqrt{\frac{50}{7}}$ m/s

C. $\sqrt{\frac{100}{35}}$ m/s

D. $\sqrt{\frac{200}{35}}$ m/s

Answer: A

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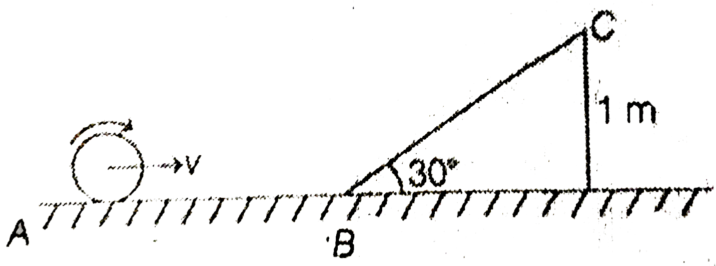
8. A small sphere of mass 1 kg is rolling without slipping with linear speed

$$v = \sqrt{\frac{200}{7}} m/s$$



It leaves the inclined plane at point C.

Find ratio of rotational and translational kinetic energy of the sphere when it strikes the ground after leaving from point C.

A. $\frac{2}{5}$

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

C. $\frac{1}{6}$

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

Answer: C

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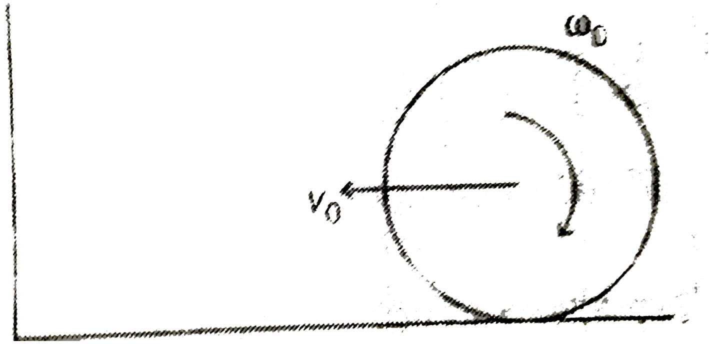
9. A solid sphere has linear velocity $v_0 = 4$ m/s and angular velocity $\omega_0 = 9$ rad/s as shown. Ground on which it is moving , is smooth . It collides elastically with a rough wall of coefficient of friction μ . Radius of the sphere is 1m and mass is 2 kg .



If the sphere after colliding with the wall rolls without slipping on opposite direction, then coefdicient of friction μ is

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

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

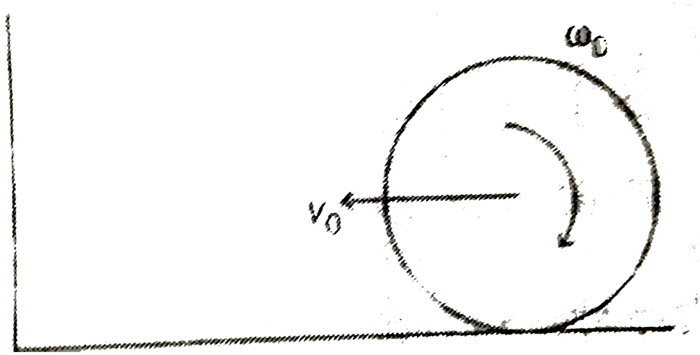
C. $\frac{1}{3}$

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

Answer: D

View Text Solution

10. A solid sphere has linear velocity $v_0 = 4$ m/s and angular velocity $\omega_0 = 9$ rad/s as shown. Ground on which it is moving , is smooth . It collides elastically with a rough wall of coefficient of friction μ . Radius of the sphere is 1m and mass is 2 kg .



What is net linear impulse imparted by the wall on the sphere during impact ?

A. $\sqrt{32}N$ - s

B. $4\sqrt{17}N$ - s

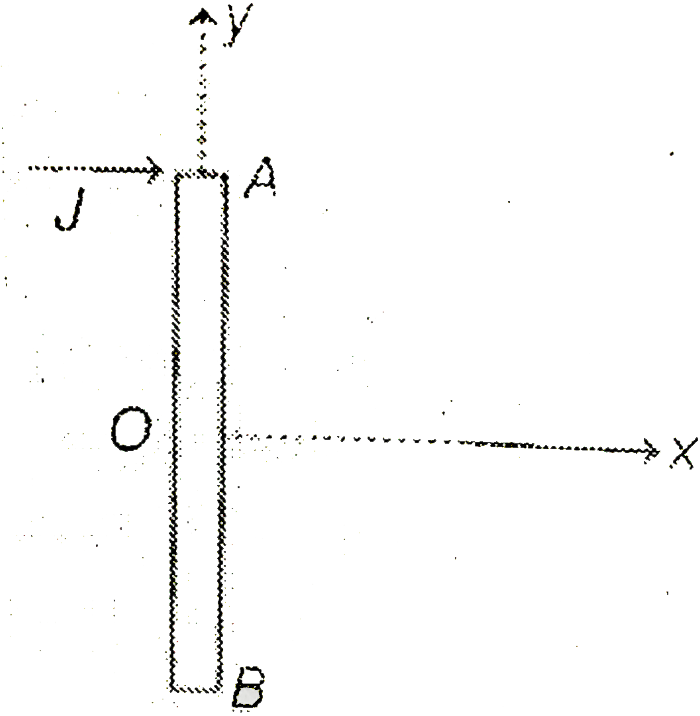
C. $4\sqrt{5}N$ - s

D. $15\sqrt{2}N$ - s

Answer: B

View Text Solution

11. A rod AB of length 2 m and mass 2 kg is lying on a smooth horizontal x-y plane with its centre at origin O as shown in figure. An impulse J of magnitude 10 N-s is applied perpendicular to AB at A.



The distance of point P from centre of the rod which is at rest just after impact is

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

B. $\frac{1}{3}$ m

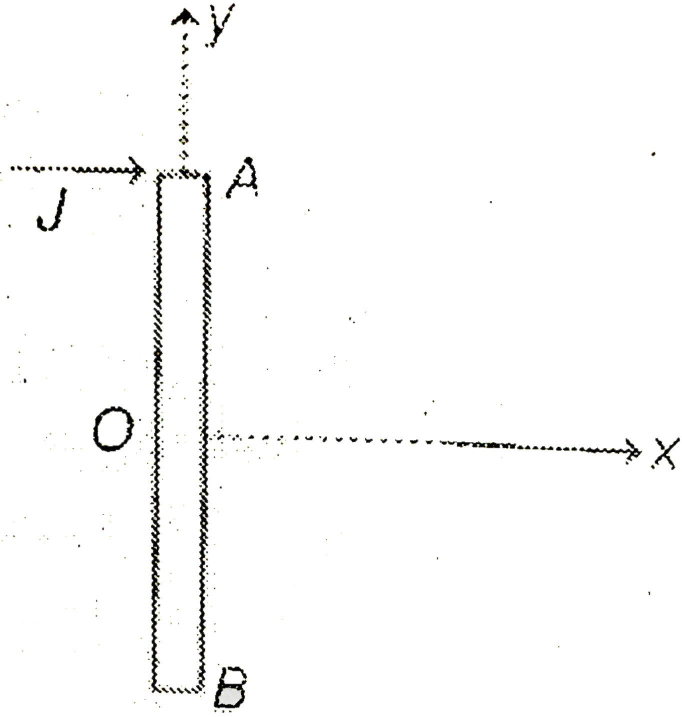
C. $\frac{1}{2}$ m

D. $\frac{1}{4}$m

Answer: B

View Text Solution

12. A rod AB of length 2 m and mass 2 kg is lying on a smooth horizontal x-y plane with its centre at origin O as shown in figure. An impulse J of magnitude 10 N-s is applied perpendicular to AB at A.



Co-ordinates of point A of the rod after time t $= \dfrac{\pi}{45}$ s will be

A. $\left[\left(\dfrac{\pi}{9}+\dfrac{\sqrt{3}}{2}\right)m, \dfrac{1}{2}m\right]$

B. $\left[\dfrac{3}{4}m\ \ \dfrac{3}{2}m\right]$

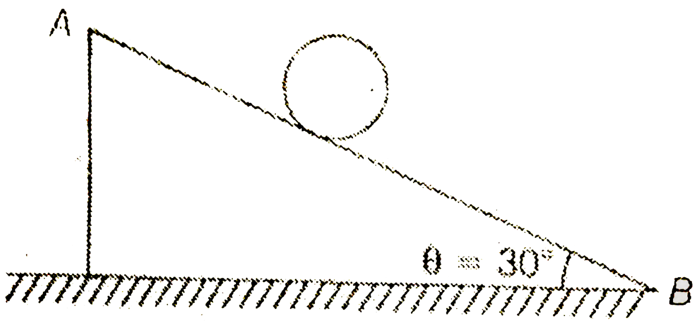
C. $\left[\left(\dfrac{\pi}{6}+\dfrac{1}{2}\right)m, \dfrac{1}{2}m\right]$

D. $\left[\dfrac{1}{2}m, \dfrac{1}{2}m\right]$

Answer: A

View Text Solution

13. Length AB in the figure shown in 5 m. The body is released from A. Friction is sufficient for pure rolling to take place.



The maximum time which anybody (which can roll) can take to reach the bottom is

A. 8 s

B. 6s

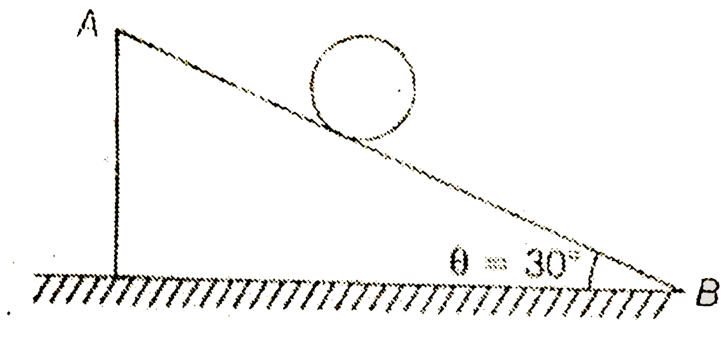
C. 2 s

D. 4 s

Answer: C

View Text Solution

14. Length AB in the figure shown in 5 m. The body is released from A. Friction is sufficient for pure rolling to take place.



In the above case suppose we have four bodies ring, disc, solid sphere and hollow sphere. The angle θ is now gradually increased. Which body will start slipping very fast. All the bodies have same mass and radius. Coefficient of friction is also same ?

A. Ring

B. Disc

C. Solid sphere

D. Hollow sphere

Answer: A

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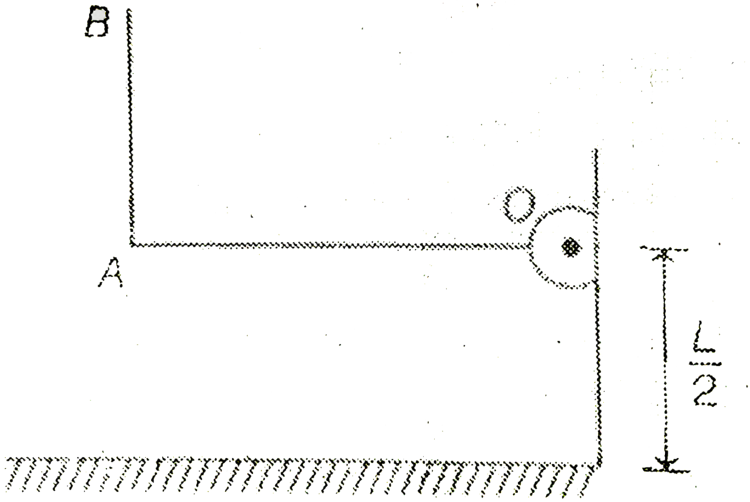
15. An L shaped frame is free to rotate in a vertical plane about a horizontal axis passing through a smooth hinge O. Each side of the frame has a length L and mass m. Frame is let to fall with one side horizontal and the other vertical.



Angular acceleration of the frame just after it is allowed to fall is

A. $\frac{4g}{3L}$

B. $\frac{9g}{10L}$

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

D. $\frac{3g}{2L}$

Answer: B

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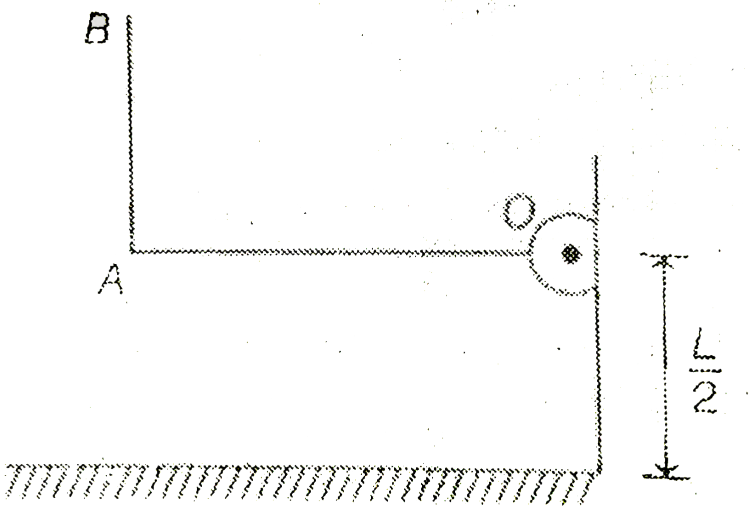
16. An L shaped frame is free to rotate in a vertical plane about a horizontal axis passing through a smooth hinge O. Each side of the frame has a length L and mass m. Frame is let to fall with one side horizontal and the other vertical.



With what speed the end A will strike the ground ?

A. $\sqrt{gL}$

B. $2\sqrt{gL}$

C. $3.2\sqrt{gL}$

D. $1.6\sqrt{gL}$

Answer: A

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17. Moment of inertia of a straight wire about an axis perpendicular to the wire passing through one of its end is I. This wire is now framed into a circle (a ring) of single turn. The moment of inertia of this ring about an axis passing through centre and perpendicular to its plane would be

A. $\left(\frac{3}{\pi^2}\right)l$

B. $\left(\frac{3}{4\pi^2}\right)l$

C. $\left(\frac{\pi^2}{3}\right)l$

D. $\left(\frac{4\pi^2}{3}\right)l$

Answer: B

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18. Moment of inertia of a straight wire about an axis perpendicular to the wire passing through one of its end is I. Now the same wire is bent into a ring of two turns , then the moment of inertia would be

A. $\left(\frac{\pi^2}{3}\right)l$

B. $\left(\frac{\pi^2}{12}\right)l$

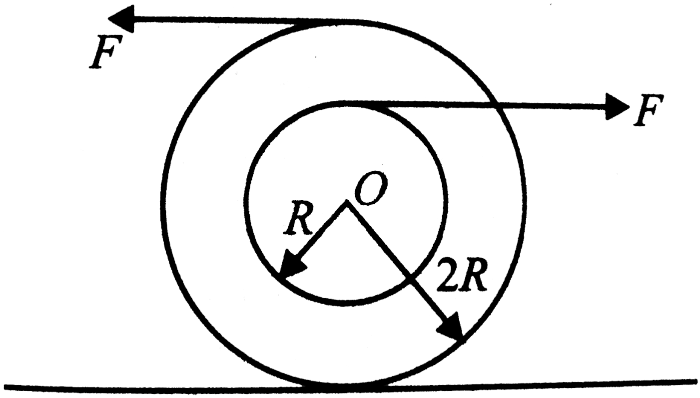
C. $\left(\frac{3}{16\pi^2}\right)l$

D. $\left(\frac{3}{4\pi^2}\right)l$

Answer: C

View Text Solution

19. In the given figure $F = 10N$, $R = 1m$, mass of the body is $2kg$ and moment of inertia of the body about an axis passing through O and perpendicular to the plane of the body is $4kgm^2$. O is the centre of mass of the body.



If the ground is smooth, what is the total kinetic energy of the body after $2s$?

A. 25 J

B. 50 J

C. 75 J

D. 100 J

Answer: B

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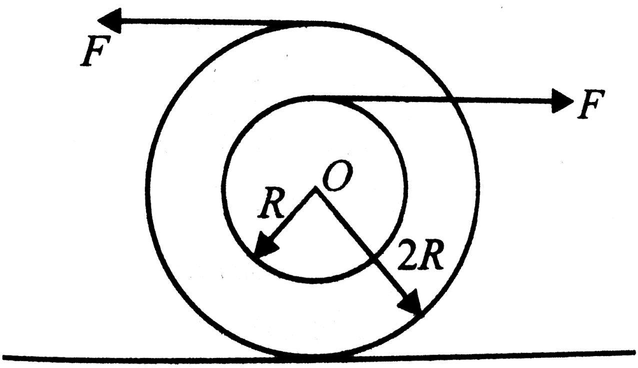
20. In the given figure $F = 10N, R = 1m$, mass of the body is $2kg$ and moment of inertia of the body about an axis passing through O and perpendicular to the plane of the body is $4kgm^2$. O is the centre of mass of the body.



If the ground is sufficiently rough to ensure rolling, what is the kinetic energy of the body now in the given time interval of $2s$?

A. 10.33 J

B. 25.67 J

C. 16.67 J

D. None of these

Answer: C

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21. A rod of mass m and length l in placed on a smooth table. An another particle of same mass m strikes the rod with velocity v_0 in a direction perpendicular to the rod at distance $x(< l/2)$ from its centre . Particle sticks to the end. Let ω be the angular speed of system after collision , then

As x is increased from 0 to l/2 , the angular speed ω.

A. will continuously increase

B. will continuously decrease

C. will first increase and then decrease

D. will first increase and then decrease

Answer: C

Watch Video Solution

22. A rod of mass m and length l in placed on a smooth table. An another particle of same mass m strikes the rod with velocity v_0 in a direction perpendicular to the rod at distance $x(< l/2)$ from its centre . Particle sticks to the end. Let ω be the angular speed of system after collision , then

Find the maximum possible value of impulse (by varying x) that can be imparted to the particle during collision. Particle still sticks to the rod.

A. $\frac{mv_0}{2}$

B. $\frac{2mv_0}{3}$

C. $\frac{3mv_0}{4}$

D. $\frac{4mv_0}{5}$

Answer: A

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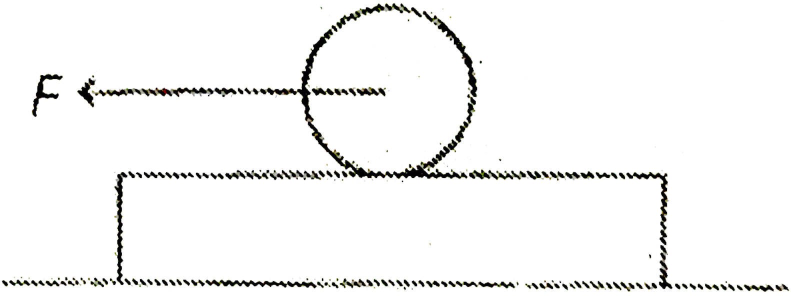
23. A disc of mass m and radius R is placed over a plank of same mass m. There is sufficient friction between disc and plank to prevent slipping. A force F is applied at the centre of the disc.



Acceleration of the plank is

A. $\frac{F}{2m}$

B. $\frac{3F}{4m}$

C. $\frac{F}{4m}$

D. $\frac{3F}{2m}$

Answer: C

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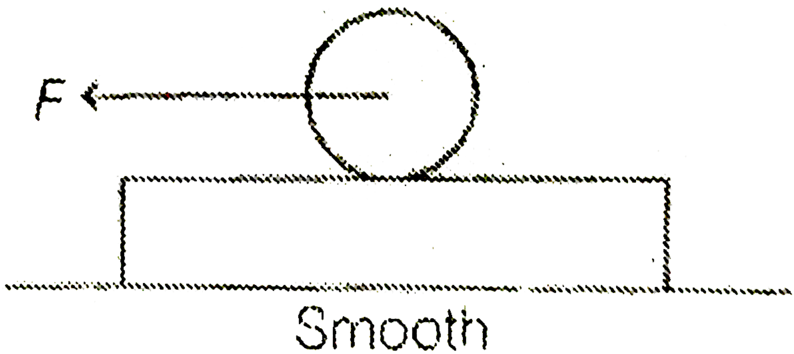
24. A disc of mass m and radius R is placed over a plank of same mass m. There is sufficient friction between disc and plank to prevent slipping. A force F is applied at the centre of the disc.



Force of friction between the disc and the plank is

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

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

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

D. $\frac{2F}{3}$

Answer: B

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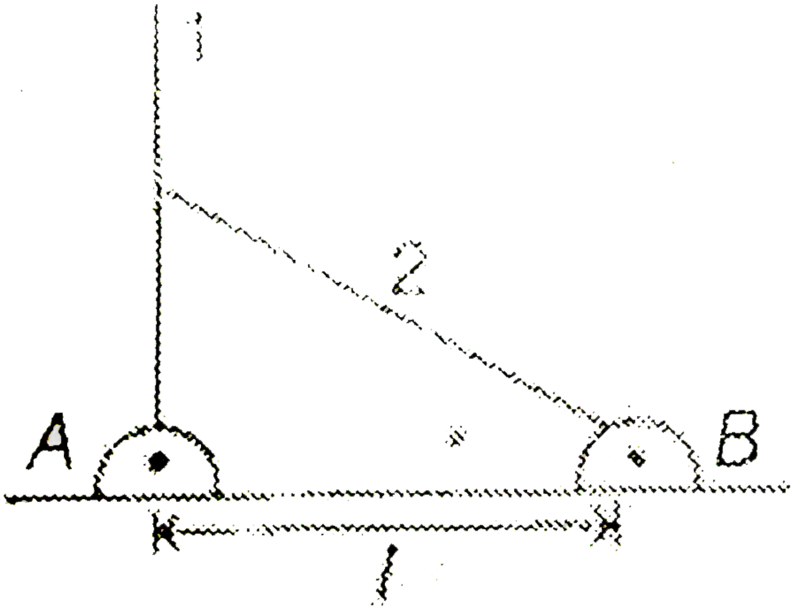
25. Two rod 1 and 2 are released from rest as shown in figure . Given, $l_1 = 4l, m_1 = 2m, l_2 = 2l$ and $m_2 = m.$ There is no friction between the two rods . If α be the angular acceleration of rod 1 just after the rods are released . Then,

What is the normal reaction between the two rods at this instant ?



A. $16\sqrt{3}m/\alpha$

B. $\dfrac{4m/\alpha}{\sqrt{3}}$

C. $\dfrac{32m/\alpha}{3\sqrt{3}}$

D. $12\sqrt{3}\big)m/\alpha$

Answer: C

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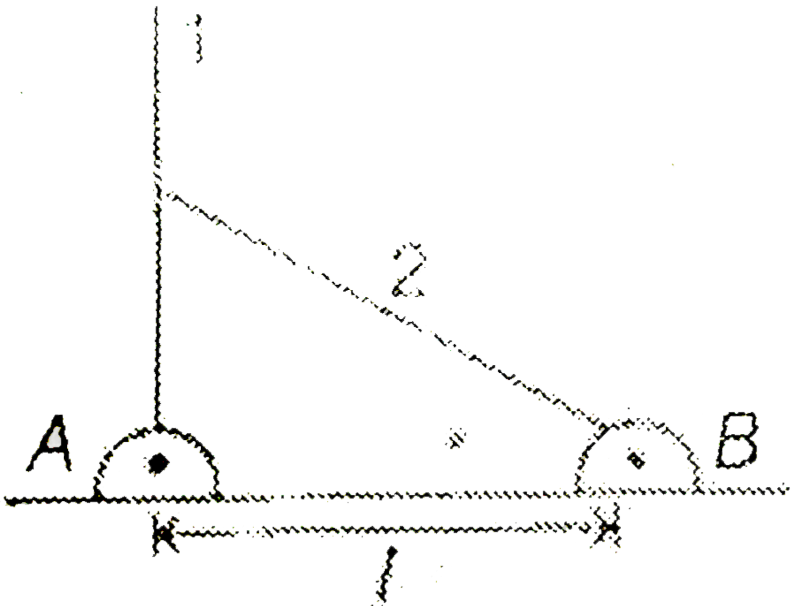
26. Two rod 1 and 2 are released from rest as shown in figure .

Given, $l_1 = 4l, m_1 = 2m, l_2 = 2l$and $m_2 = m$. There is no friction between the two rods . If α be the angular acceleration of rod 1 just after the rods are released . Then,

What is the horizontal force on rod 1 by hinge. A at this instant ?



A. $\left(\dfrac{32 - 12\sqrt{3}}{3\sqrt{3}}\right)m/\alpha$

B. $\left(\dfrac{16 - 2\sqrt{3}}{\sqrt{3}}\right)m/\alpha$

C. $\left(14 + 2\sqrt{3}\right)m/\alpha$

D. $\sqrt{3}m/\alpha$

Answer: A

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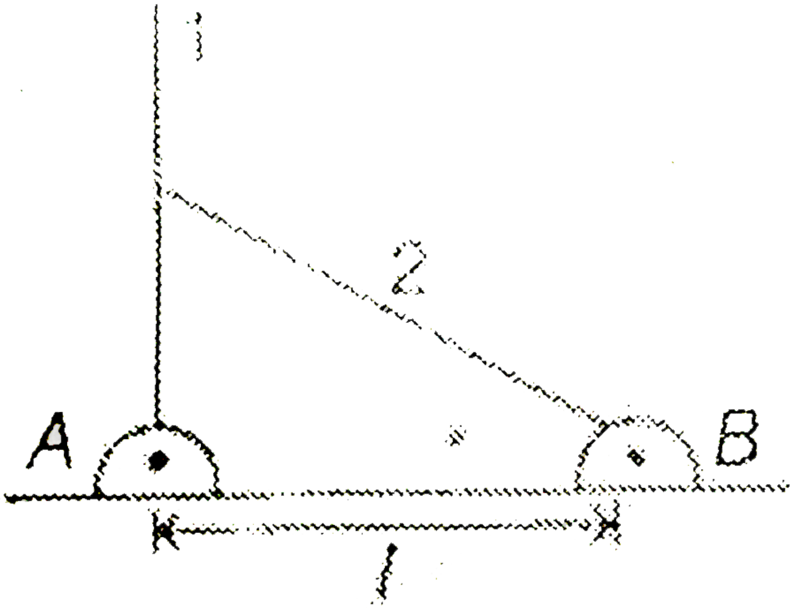
27. Two rod 1 and 2 are released from rest as shown in figure . Given, $l_1 = 4l, m_1 = 2m, l_2 = 2l$and $m_2 = m.$ There is no friction between the two rods . If α be the angular acceleration of rod 1 just after the rods are released . Then,

What is the initial angular acceleration of rod 2 in terms of the given parameters in the question ?



A. $\left[\frac{2\sqrt{3}g}{2l} + 2\sqrt{3}\alpha\right]$

B. $\left[\frac{3\sqrt{3}g}{l} - \sqrt{3}\alpha\right]$

C. $\left[\frac{6\sqrt{3}g}{8l} + 5\sqrt{3}\alpha\right]$

D. $\left[\frac{3\sqrt{3}g}{8l} - \frac{8}{\sqrt{3}}\alpha\right]$

Answer: D

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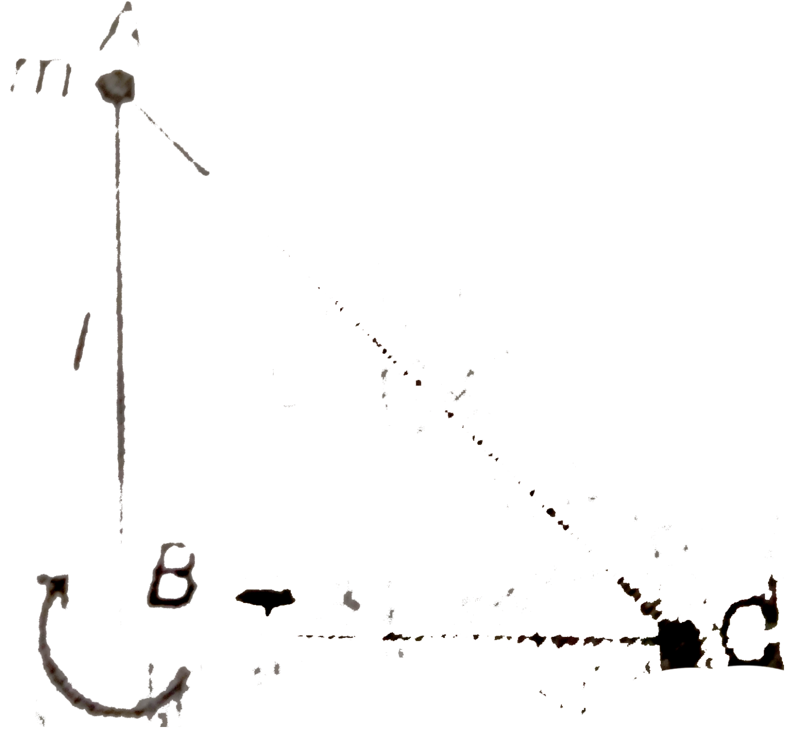
28. Three massless rods are fixed to form a right angled triangular frame such that AB=BC=1 . Two identical small objects of mass m are fixed at A and C . The frame is hinged about B such that the frame can rotate in vertical plane about an horizontal axis without friction. Initially AB is vertical and BC is horizontal and the system is released from rest.



The maximum shift of centre of mass of two mass system from its initial position is

A. $\sqrt{2}l$

B. 1.5 l

C. $l/\sqrt{2}$

D. 2 l

Answer: A

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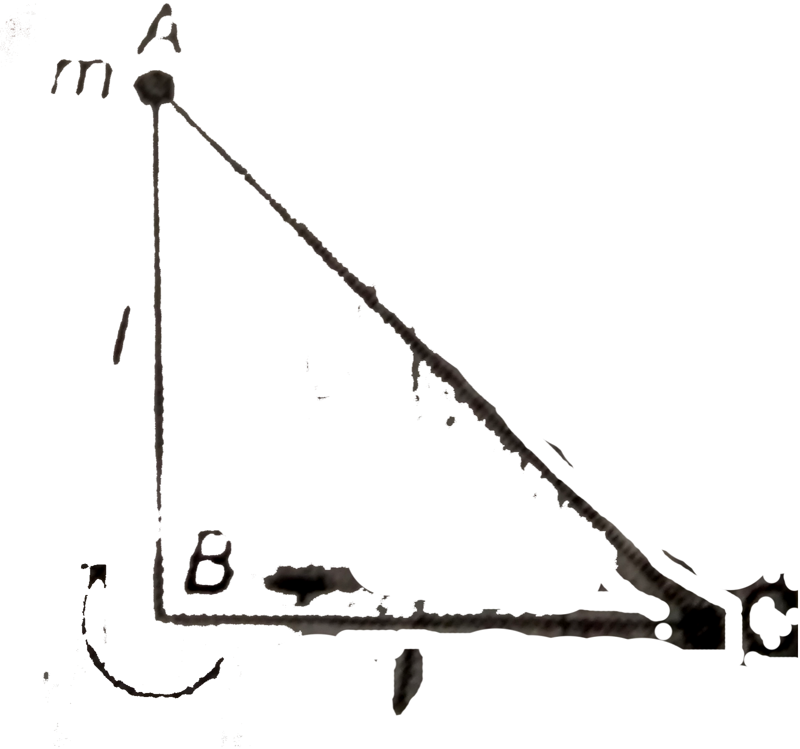
29. Three massless rods are fixed to form a right angled triangular frame such that AB=BC=1 . Two identical small objects of mass m are fixed at A and C . The frame is hinged about B such that the frame can rotate in vertical plane about an horizontal axis without friction. Initially AB is vertical and BC is horizontal and the system is released from rest.



The magnitude of acceleration of mass A when the rod AC becomes horizontal is

A. $g\left(1+\sqrt{2}\right)$

B. $g\left(2+\sqrt{2}\right)$

C. $2g\left(1+\sqrt{2}\right)$

D. $g\left(\sqrt{2}-1\right)$

Answer: A

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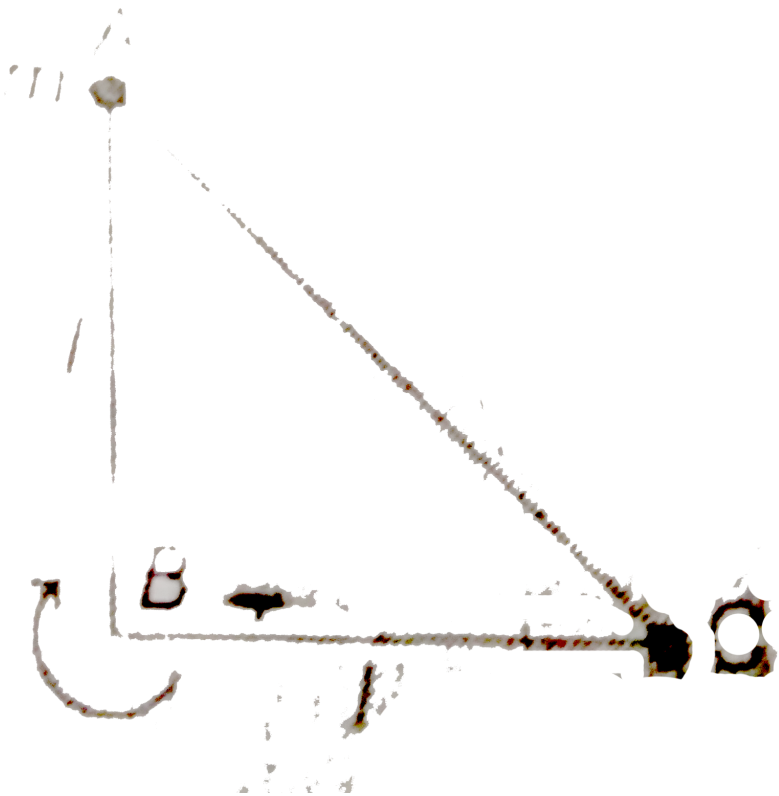
30. Three massless rods are fixed to form a right angled triangular frame such that AB=BC=1 . Two identical small objects of mass m are fixed at A and C . The frame is hinged about B such that the frame can rotate in vertical plane about an horizontal axis without friction. Initially AB is vertical and BC is horizontal and the system is released from rest.



Tension in the rod AC when it (rod AC) becomes horizontal is

A. mg

B. $\sqrt{2}$mg

C. $\dfrac{mg}{\sqrt{2}}$

D. $\left(s\sqrt{2} - 1\right)$ mg

Answer: A

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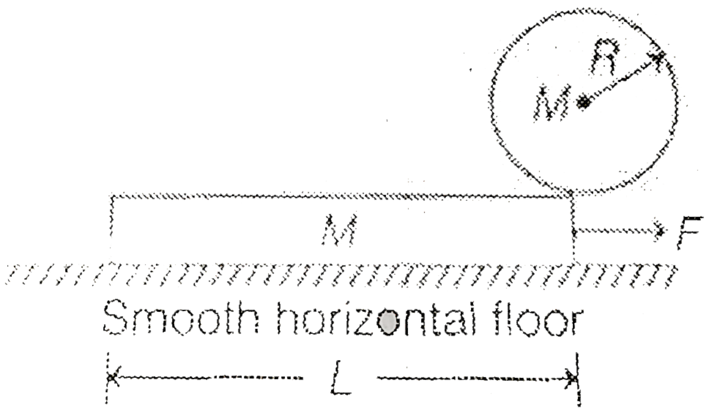
31. A uniform disc of mass M and radius R initially stands vertically on the right end of a horizontal plank of mass M and length L, as shown,



The plank rests on a smooth horizontal floor and friction between disc and plank is sufficiently high such that disc rolls on plank without slipping . The plank is pulled to right with a constant horizontal force of magnitude F.

The magnitude of acceleration of plank is

A. $\frac{F}{6M}$

B. $\frac{F}{4M}$

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

D. $\frac{3F}{4M}$

Answer: C

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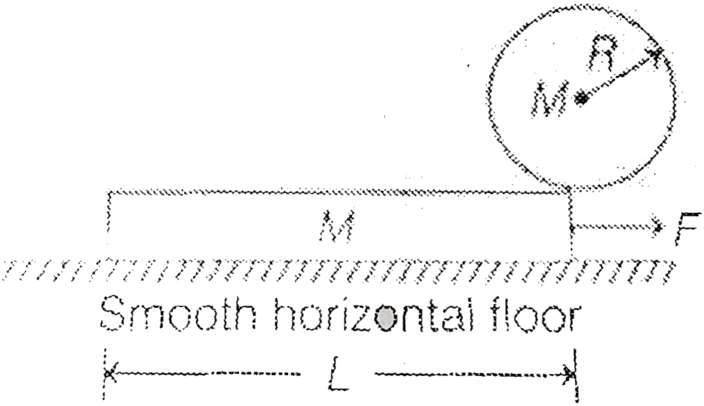
32. A uniform disc of mass M and radius R initially stands vertically on the right end of a horizontal plank of mass M and length L, as shown,



The plank rests on a smooth horizontal floor and friction between disc and plank is sufficiently high such that disc rolls on plank without slipping . The plank is pulled to right with a constant horizontal force of magnitude F.

The magnitude of angular acceleration of the disc is

A. $\frac{F}{4MR}$

B. $\frac{F}{8MR}$

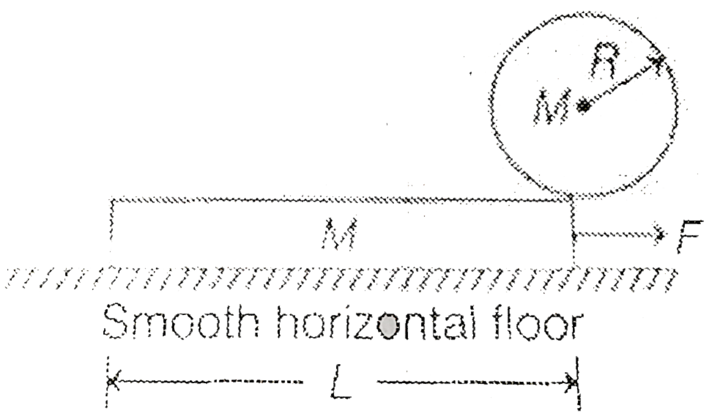
C. $\frac{F}{2MR}$

D. $\frac{3F}{2MR}$

Answer: C

View Text Solution

33. A uniform disc of mass M and radius R initially stands vertically on the right end of a horizontal plank of mass M and length L, as shown,



The plank rests on a smooth horizontal floor and friction between disc and plank is sufficiently high such that disc rolls on plank without slipping . The plank is pulled to right with a constant horizontal force of magnitude F.

The distance travelled by centre of disc from its initial position till the left end of plank comes vertically below the centre of disc is

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

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

C. $\frac{L}{8}$

D. L

Answer: A

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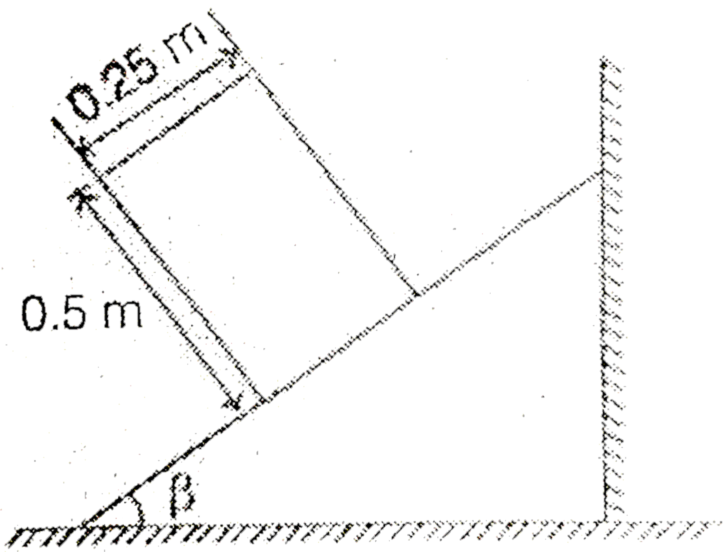
34. An engineer is designing a conveyor system for loading lay bales into a wagon. Each bale is 0.25 m high, and 0.80 m long (the dimension perpendicular to the plane of the figure), with mass 30.0 kg. The centre of gravity of each bale is at its geometrical centre. The coefficient of static friction between a bal and the conveyor belt is 0.60, and the belt moves with constant speed. The angle β of the conveyor is slowly increased. At some critical angle a bale will tip (if it doesn't slip first), and at some different critical it will slip (if it doesn't tip first).



Find the first critical angle (In the same conditions) at which it tips.

A. $\beta = \tan^{-1}(0.50)$

B. $\beta = \tan^{-1}(0.60)$

C. $\beta = \tan^{-1}(0.40)$

D. $\beta = \tan^{-1}(0.20)$

Answer: A

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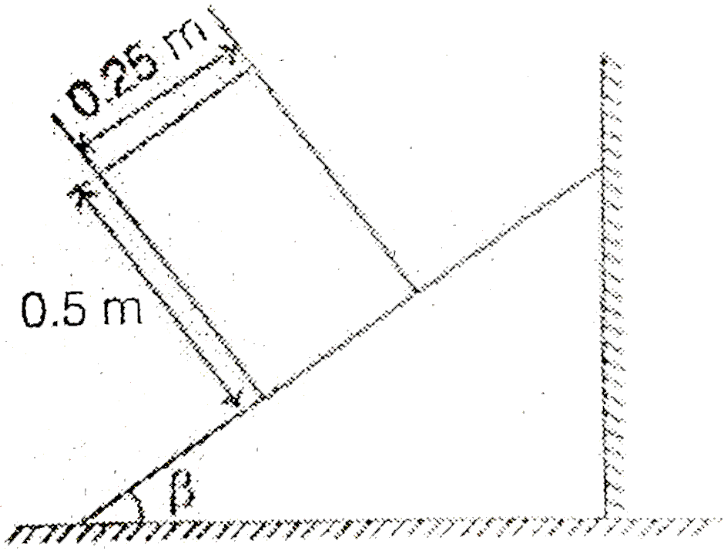
35. An engineer is designing a conveyor system for loading lay bales into a wagon. Each bale is 0.25 m high, and 0.80 m long (the dimension perpendicular to the plane of the figure), with mass 30.0 kg. The centre of gravity of each bale is at its geometrical centre. The coefficient of static friction between a bal and the conveyor belt is 0.60, and the belt moves with constant speed. The angle β of the conveyor is slowly increased. At some critical angle a bale will tip (if it doesn't slip first), and at some different critical it will slip (if it doesn't tip first).



Find the second critical angle (in the same conditions) at which it slips.

A. $\beta = \tan^{-1}(0.50)$

B. $\beta = \tan^{-1}(0.60)$

C. $\beta = \tan^{-1}(0.12)$

D. $\beta = \tan^{-1}(0.70)$

Answer: B

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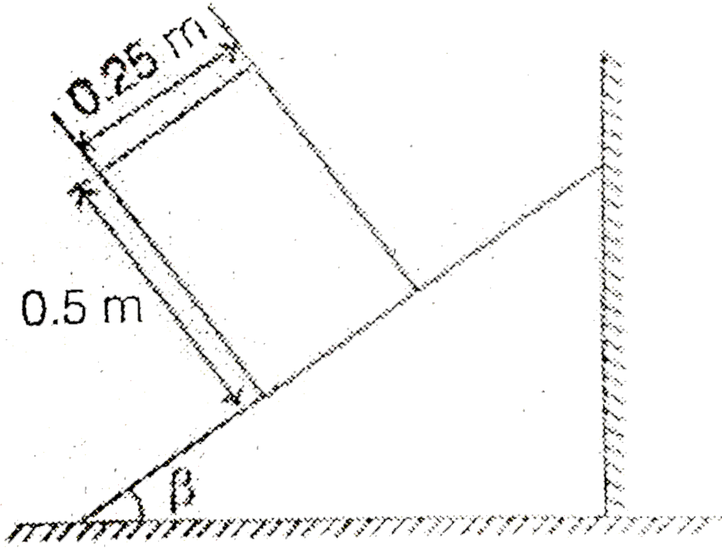
36. An engineer is designing a conveyor system for loading lay bales into a wagon. Each bale is 0.25 m high, and 0.80 m long (the dimension perpendicular to the plane of the figure), with mass 30.0 kg. The centre of gravity of each bale is at its geometrical centre. The coefficient of static friction between a bal and the conveyor belt is 0.60, and the belt moves with constant speed. The angle β of the conveyor is slowly increased. At some critical angle a bale will tip (if it doesn't slip first), and at some different critical it will slip (if it doesn't tip first).



Which statement is correct ?

A. It will tip first if $\mu_s = 0.6$

B. It will slide first if $\mu_s = 0.40$

C. Both are correct

D. Both are wrong

Answer: C

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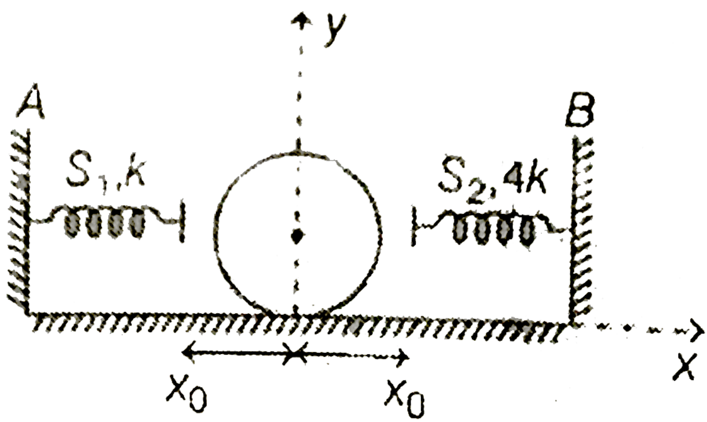
37. In the figure S_1 and S_2 are two light springs of stiffness k and 4k respectively. When springs are in relaxed state, seperation between their free ends is $2x_0$. A uniform solid cylinder of mass m and radius R$\left(< x_0\right)$ is placed exactly midway between the free ends of the springs with its axis horizontal and perpendicular to the springs . Now consider the two cases separately.



Case I : The cylinder is imparted speed v_0 towards left. When the cylinder comes to rest momentarily the co-ordinates of its centre are either (-x_1, $R\Big)$ or $\left(x_2, R\right)$.

Case II: The Cylinder is imparted speed v_0 toward left and angular speed ω^0 in clockwise sense simultaneously . At the time of maximum compression in the springs the co-ordinates of centre of the cylinder are either $\left(-x_3, R\right)$ or $\left(x_4, R\right)$ Now answer the following questions assuming that friction is absent every where.

Choose the correct option

A. $x_1 = x_2$

B. $x_1 = x_3$

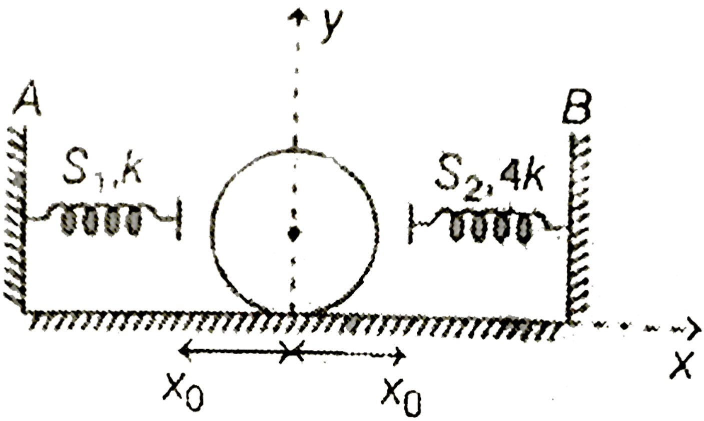
C. $x_1 = x_4$

D. $x_3 = x_4$

Answer: B

View Text Solution

38. In the figure S_1 and S_2 are two light springs of stiffness k and 4k respectively. When springs are in relaxed state, seperation between their free ends is $2x_0$. A uniform solid cylinder of mass m and radius R$\left(< x_0 \right)$ is placed exactly midway between the free ends of the springs with its axis horizontal and perpendicular to the springs . Now consider the two cases separately.



Case I : The cylinder is imparted speed v_0 towards left. When the cylinder comes to rest momentarily the co-ordinates of its centre are either $(-x_1, R)$ or $\left(x_2, R\right)$.

Case II: The Cylinder is imparted speed v_0 toward left and angular speed ω^0 in clockwise sense simultaneously . At the time of maximum compression in the springs the co-ordinates of centre of the cylinder are either $\left(-x_3, R\right)$ or $\left(x_4, R\right)$ Now answer the following questions assuming that friction is absent every where.

The value of x_3 is

A. $x_0 + v_0\sqrt{\frac{m}{k}}$

B. $x_0 + 2v_0\sqrt{\frac{m}{k}}$

C. $x_0 + \frac{v_0}{2}\sqrt{\frac{m}{k}}$

D. $x_0 + v_0\sqrt{\frac{m}{2k}}$

Answer: A

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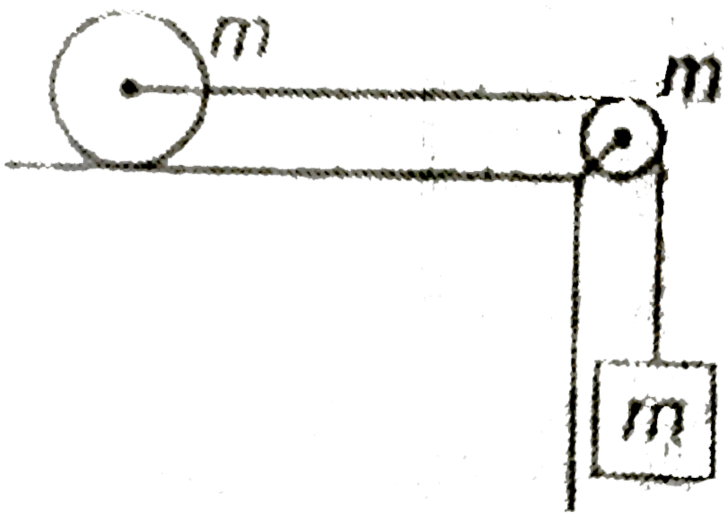
39. A uniform solid cylinder of mass m and radius 2R rests on a horizontal table. A string attached to it passes over a pulley (disc) of mass m and radius R that is mounted on a fricitonaless axle through its centre . A block of mass m is suspended from the free end of the spring . The string does not slip over the pulley surface and the cylinder rolls without slipping on the table.



Acceleration of the block is

A. $\frac{g}{3}$

B. $\frac{3g}{4}$

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

D. $\frac{5g}{7}$

Answer: A

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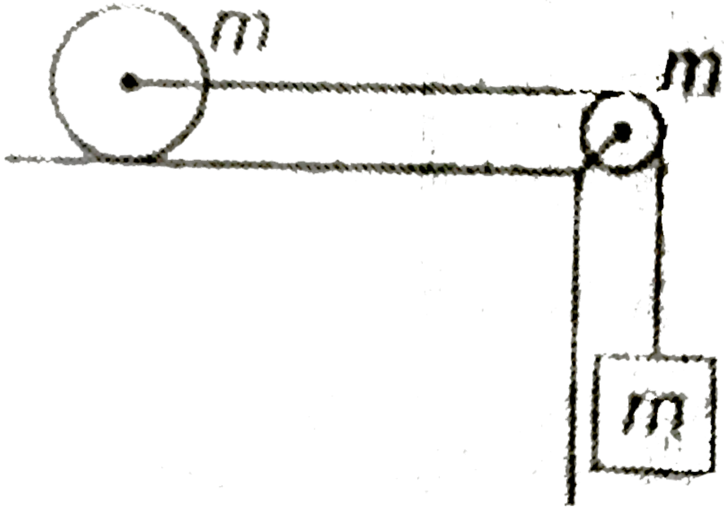
40. A uniform solid cylinder of mass m and radius 2R rests on a horizontal table. A string attached to it passes over a pulley (disc) of mass m and radius R that is mounted on a fricitonaless axle through its centre . A block of mass m is suspended from the free end of the spring . The string does not slip over the pulley surface and the cylinder rolls without slipping on the table.



Force of friction acting on the cylinder is

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

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

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

D. $\frac{mg}{6}$

Answer: D

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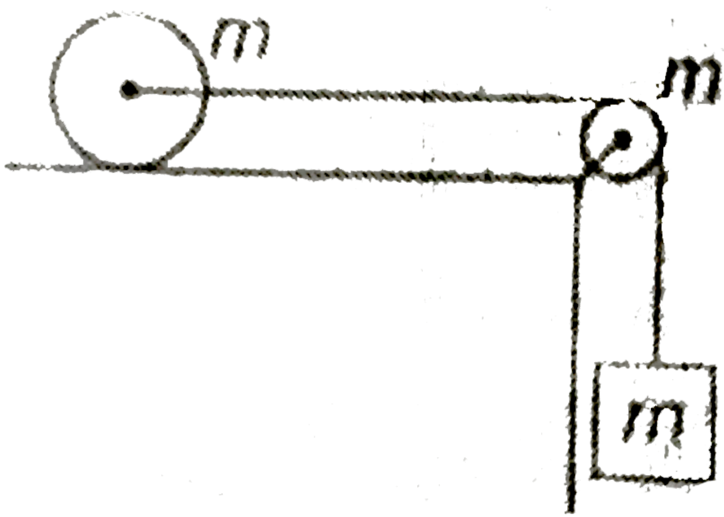
41. A uniform solid cylinder of mass m and radius 2R rests on a horizontal table. A string attached to it passes over a pulley (disc) of mass m and radius R that is mounted on a fricitonaless axle through its centre . A block of mass m is suspended from the free end of the spring . The string does not slip over the pulley surface and the cylinder rolls without slipping on the table.



Angular acceleration of the cylinder is

A. $\dfrac{g}{3R}$

B. $\frac{3g}{2R}$

C. $\frac{g}{6R}$

D. $\frac{g}{9R}$

Answer: C

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Matrix Matching Type Questions

1. Four rods of equal length l and mass m each form a square as shown in figure. Moment of inertia about three axes 1,2 and 3 are say I_1, I_2 and I_3. Then, match the following

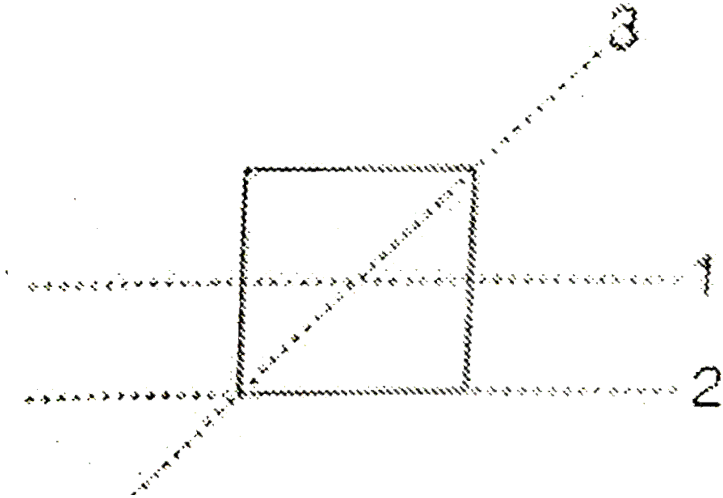
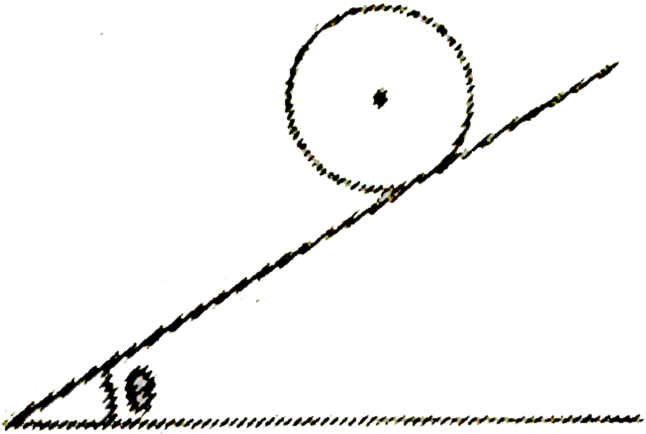


Table-1	Table-2
(A) I_1	(P) $\frac{4}{3}ml^2$
(B) I_2	(Q) $\frac{2}{3}ml^2$
(C) I_3	(R) $\frac{1}{2}ml^2$
	(S) None

View Text Solution

2. A ring of mass m and radius R is placed on a rough inclined plane so that it rolls without slipping . Match the following table.



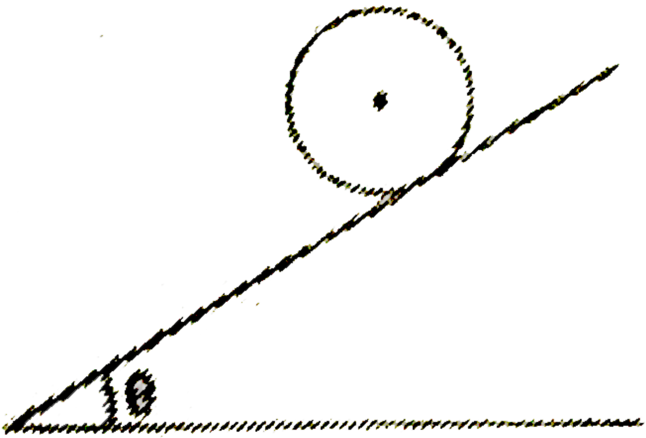


Table-1	Table-2
(A) Linear acceleration of centre of mass	(P) is directly proportional to [illegible]
(B) Angular acceleration	(Q) is inversely proportional to [illegible]
(C) Rotational kinetic energy at any instant	(R) is directly proportional to R^2
(D) Translational kinetic energy at any instant	(S) is inversely proportional to R
	(T) None

View Text Solution

3. The particle of mass 1 kg is projected with velocity $20\sqrt{2}$m/s at 45° with ground . When , the particle is at highest point $\left(g = 10m/s^2\right)$,

Table-1	Table-2
(A) Net torque on the particle about point of projection	(P) 200 SI unit
(B) Angular momentum of the particle about point of projection	(Q) 400 SI unit
(C) Angular velocity of the particle about point of projection	(R) 1.0 SI unit
	(S) None

View Text Solution

4. A disc rolls on ground without slipping . Velocity of centre of mass is v. There is a point P on circumference of disc at angle θ . Suppose v_p is the speed of this point. Then, match the following the following table.

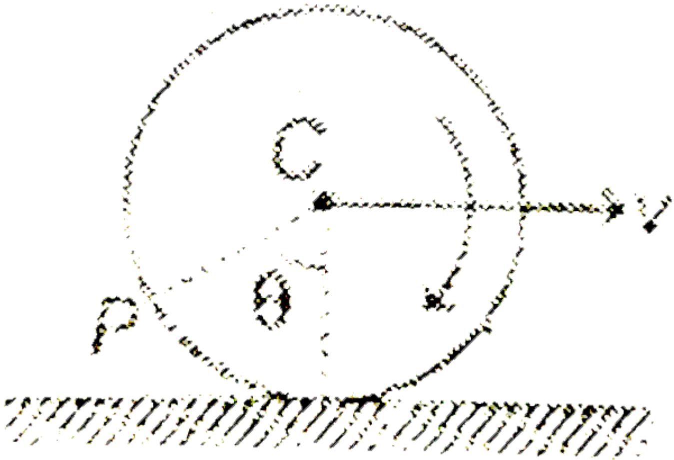


Table-1	Table-2
$\theta = 60^\circ$	(P) $v_P = \sqrt{2}v$
$\theta = 90^\circ$	(Q) $v_P = v$
$\theta = 120^\circ$	(R) $v_P = 2v$
$\theta = 180^\circ$	(S) $v_P = \sqrt{3}v$

View Text Solution

5. Match the following .

Table-1	Table-2
(A) In pure rolling work done by friction	(P) is always zero
(B) In forward slipping work done by friction	(Q) may be zero
(C) In backward slipping work done by friction	(R) is always negative
	(S) is always positive
	(T) may be negative
	(U) may be [illegible]

View Text Solution

6. A disc with linear velocity v and angular velocity ω is placed on rough ground. Suppose a and α be the magnitudes of linear and angular acceleration due to friction.

Table-1	Table-2
(A) When $v = R\omega$	(P) $a = R\alpha$ $(a \neq 0)$
(B) When $v = \frac{R\omega}{2}$	(Q) $a > R\alpha$
(C) When $v = 2R\omega$	(R) $a < R\alpha$
	(S) None

View Text Solution

7. In net force on a rigid body is zero. Then, match the following table.

Table-1	Table-2
(A) Linear velocity of COM	(P) is zero
(B) Angular velocity of rigid body	(Q) is constant
(C) Angular momentum about an axis passing through COM	(R) may be varying
(D) Angular momentum about an axis not passing through COM	

View Text Solution

8. If radius of earth is reduced to half without changing its mass,

Table-1	Table-2
(A) Angular momentum of earth	(P) will become two times
(B) Time period of rotation of earth	(Q) will become four times
(C) Rotational kinetic energy of earth	(R) will remain constant
	(S) None

View Text Solution

9. A semi-circular ring has mass m and radius R as shown in figure. Let I_1, I_2, I_3 and I_4 be the moments of inertia about the four axes as shown . Axis 1 passes through centre and is perpendicular to plane of ring. Then , match the following.

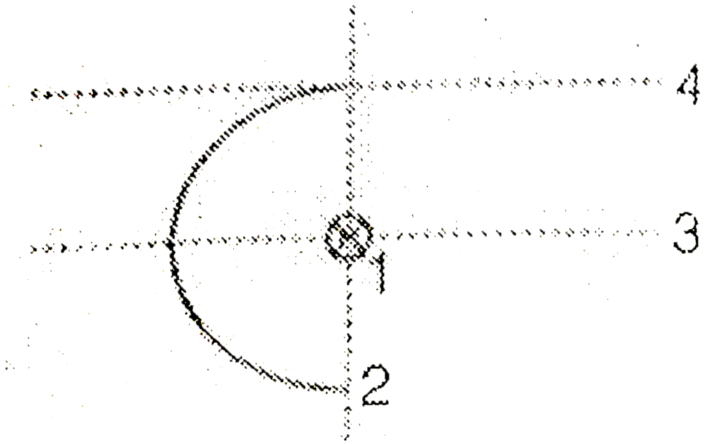


Table-1	Table-2
(A) I_1	(P) $\frac{mR^2}{2}$
(B) I_2	(Q) $\frac{3}{2}mR^2$
(C) I_3	(R) mR^2
(D) I_4	(S) Data is insufficient

View Text Solution

10. A solid sphere is rotating about an axis as shown in figure. An insect follows the dotted path on the cricumference of sphere as shown .

Match the following

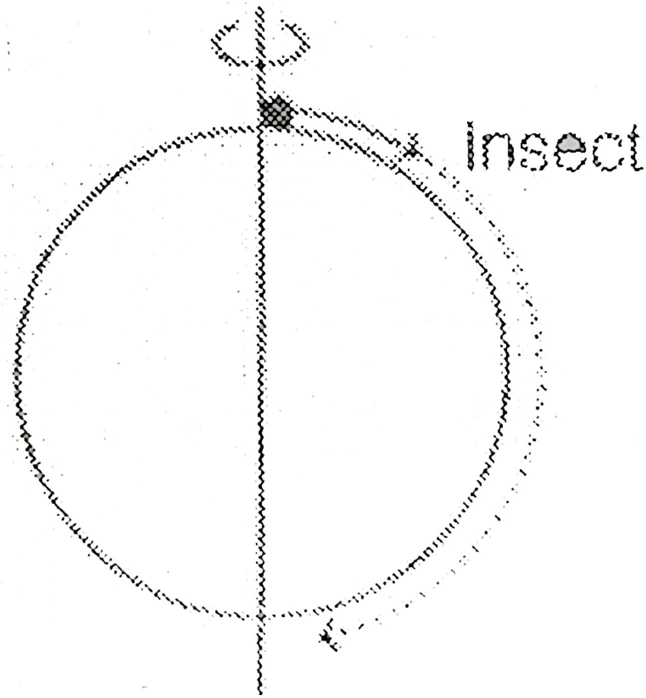
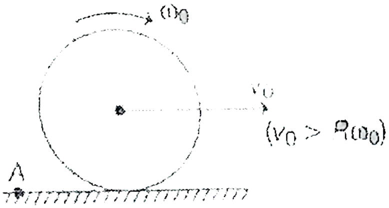
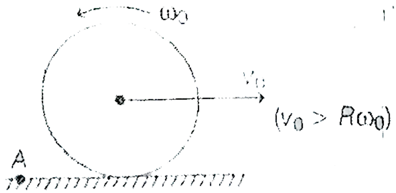
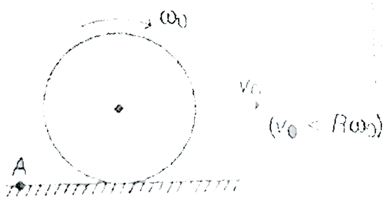
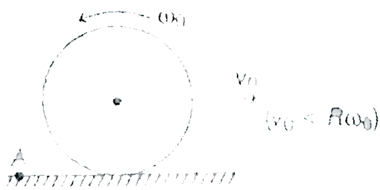


Table-1	Table-2
(A) Moment of inertia	(P) will remain constant
(B) Angular velocity	(Q) will first increase then decrease
(C) Angular momentum	(R) will first decrease then increase
(D) Rotational kinetic energy	(S) will continuously decrease
	(T) will continuously increase
	(U) Data is insufficient

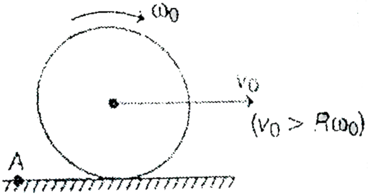
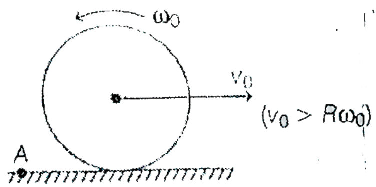
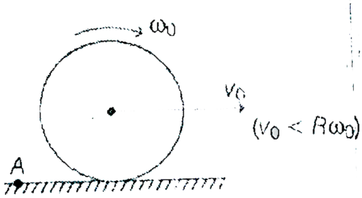
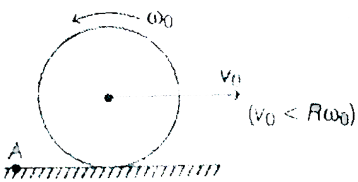
View Text Solution

11. In each situation of Table-1, a uniform disc of mass m and radius R rolls on a rough fixed horizontal surface as shown. At, t=0 (initially) the angular velocity of disc is ω_0 and velocity of centre of mass of disc is v_0 (in horizontal direction). The relation between v_0 and ω_0 for each situation and also initial sense of rotation is given in Table-1 . Then match the statements in Table-1 with the corresponding results in Table-

2.

Table-1	Table-2
(A) 	(P) The angular momentum of disc about point A remains conserved.
(B) 	(Q) The kinetic energy of disc after it starts rolling without slipping is less than its initial kinetic energy.
(C) 	(R) In the duration, disc rolls with, slipping, the friction acts on disc towards left.
(D) 	(S) In the duration disc rolls with slipping, the friction acts on disc for some time to right and for some time to left

12. A solid sphere, a hollow sphere, a solid disc and a hollow cylinder are allowed to roll down a sufficiently rough inclined plane starting from rest. All have same mass and radius.

Table-1	Table-2
(A) 	(P) The angular momentum of disc about point A remains conserved.
(B) 	(Q) The kinetic energy of disc after it starts rolling without slipping is less than its initial kinetic energy.
(C) 	(R) In the duration, disc rolls with slipping, the friction acts on disc towards left.
(D) 	(S) In the duration disc rolls with slipping, the friction acts on disc for some time to right and for some time to left

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13. A uniform rod of mass m and length l is lying on a smooth table. An impulse J acts on the rod momentarily as shown in figure at point R. Just after that:

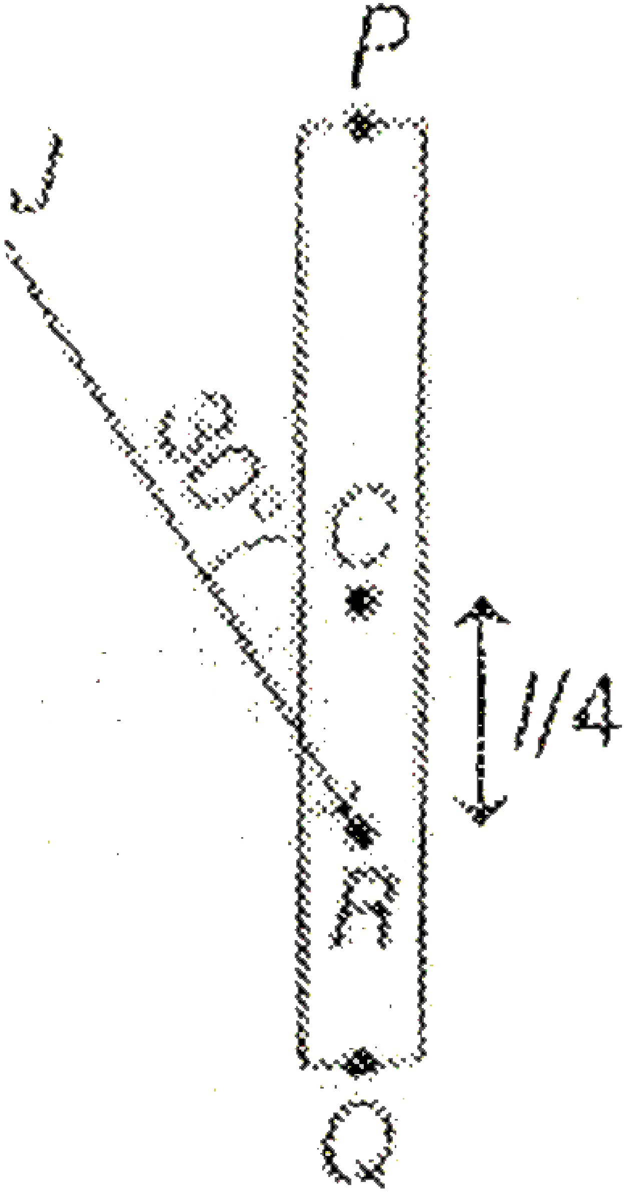
P
ω
θ
C
l/4
R
Q

Table-1	Table-2
(A) Speed of upper end P of rod	(P) $\frac{\sqrt{97}}{8}\left(\frac{J}{m}\right)$
(B) Speed of lower end Q of rod	(Q) $\frac{5}{4}\left(\frac{J}{m}\right)$
(C) Speed of point R of rod	(R) $\frac{\sqrt{13}}{4}\left(\frac{J}{m}\right)$
(D) Speed of upper end P after rod turns through 30°	(S) $\frac{\sqrt{37}}{4}\left(\frac{J}{m}\right)$

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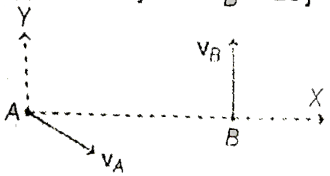
14. There are two point masses A and B, situated at origin and point (5m,0m) respectively . At a certain time v_A and v_B are respectively the velocities of point masses A and B . Match the situations under Table-1 with their correct option under Table-

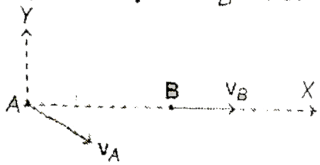
2

Table-1

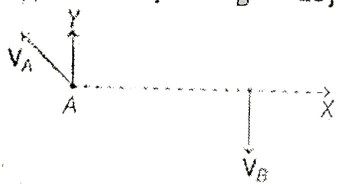
(A) $\mathbf{v}_A = 5\hat{i} - 5\hat{j}$ and $\mathbf{v}_B = 20\hat{j}$



(B) $\mathbf{v}_A = 5\hat{i} - 5\hat{j}$ and $\mathbf{v}_B = 20\hat{i}$



(C) $\mathbf{v}_A = -5\hat{i} + 5\hat{j}$ and $\mathbf{v}_B = -20\hat{j}$



(D) $\mathbf{v}_A = 5\hat{i} - 5\hat{j}$ and $\mathbf{v}_B = -10\hat{i} + 10\hat{j}$

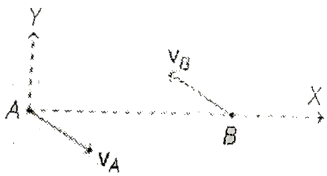


Table-2

(P) The speed of approach between point masses A and B at the given time is 5 m/sec

(Q) The speed of separation between point masses A and B at the given time is 5 m/sec

(R) At the given time, the magnitude of angular velocity of point mass A with respect to B is 3 rad/sec

(S) At the given time, the magnitude of angular velocity of point mass A with respect to B is 1 rad/sec

15. A uniform rod AB of mass 1 kg is supported on a horizontal smooth surface by a small roller of negligible mass and dimension. If the cofficient of friction between end B and vertical wall is 1/3 . The rod is released from rest in the shown position. (Given length of rod =2m, $g = 10 m/s^2$).Match Table-1 with Table-2 and select the correct answer using the codes given below the lists:

Table 1 Physical quantity related to rod just after release of the rod	Table 2 Magnitude of p[illegible] quantity (SI[illegible]
(A) The magnitude of initial acceleration of end A of rod AB	(P) 1
(B) The magnitude of frictional force	(Q) 3
(C) The magnitude of normal force given by wall on rod	(R) 6
(D) The magnitude of initial acceleration of rod AB	(S) $3\sqrt{2}$

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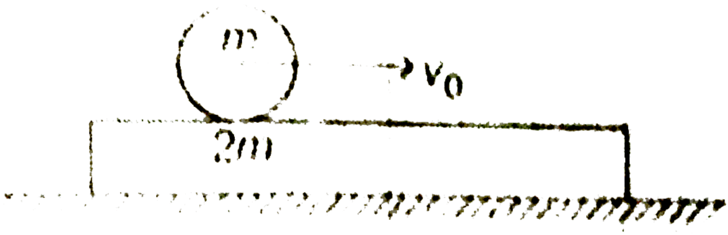
16. A thin but very large plank of mass 2 m is placed on a horziontal smooth surface. A solid cylinder of mass m and radius r is given only translational velocity v_0 and gently placed on the plank as shown in the figure. The coefficient of kinetic friciton between the plank and the cylinder is μ.



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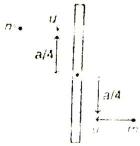
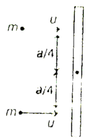
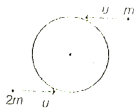
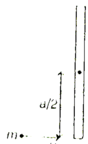
17. Match the following two Tables .

Table-1		Table-2
(A) Two point masses each of mass 'm' collide with a uniform rod of same mass 'm' and length 'a'. Initially the rod is at rest and lying on a smooth horizontal surface. Assuming collision to be perfectly inelastic the angular velocity of rod just after the collision is		(P) 0
(B) Two point masses each of mass 'm' collide with a uniform rod of same mass 'm' and length 'a'. Initially the rod is at rest and lying on a smooth horizontal surface. Assuming collision to be perfectly inelastic, the angular velocity of rod just after the collision is		(Q) $\frac{12u}{5a}$
(C) Two point masses of mass m and 2m collide with a uniform ring of mass 'm' and radius 'a'. The ring is hinged at its centre and free to rotate about its centre. Assuming collision to be perfectly inelastic, the angular velocity of ring just after the collision is		(R) $\frac{6u}{5a}$
(D) A point mass 'm' collides with a uniform rod of same mass 'm' and length 'a'. Initially the rod is at rest and lying on a smooth horizontal surface. Assuming collision to be perfectly inelastic, the angular velocity of rod just after the collison is		(S) $\frac{3u}{4a}$

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Integer Type Questions

1. A ring and a disc having the same mass, roll without slipping with the same linear velocity. If the kinetic energy of the ring is

8 j , Find the kinetic energy of disc (in J)

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2. A wheel starting from rest is uniformly acceleration with angular acceleration of $4\text{rad}/s^2$ for 10 seconds . It is then allowed to rotate uniformly for next 10 seconds and finally brought to rest in next 10 seconds by uniform angular retardation. Total angle rotated is (100 n) radian. Find value of n.

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3. Radius of gyration of a body about an axis at a distance 6 cm from it COM is 10 cm . Its radius of gyration about a parallel axis passing through its COM is (n) cm . find value of n.

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4. A uniform rod of mass 2 kg and length 1 m lies on a smooth horizontal plane. A particle of mass 1 kg moving at a speed of 2m/s perependicular to the length of the rod strikes it at a distance $\frac{1}{4}$ m from the centre and stops . Find the angular velocity of the rod about its centre just after the collision (in rad/s)

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5. A uniform rod of mass m, hinged at its upper end, is released from rest from a horizontal position. When it passes through the vertical position, the force on the hinge is

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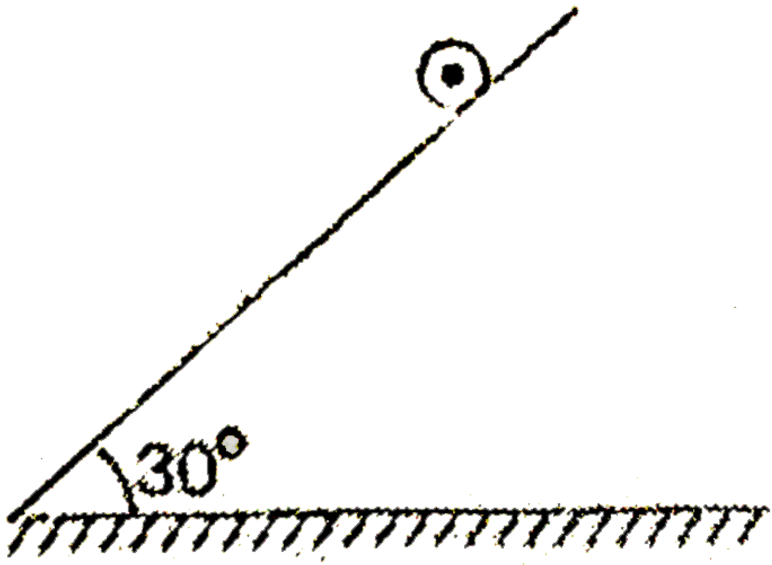
6. An uniform spherical shell of mass m and radius R starts from rest with pure rolling on long inclined plane as shown in figure. The angular momentum of shell about point of contact after 1 s of its starting is KmR. Determine the value of $k\left(g = 10m/s^2\right)$.



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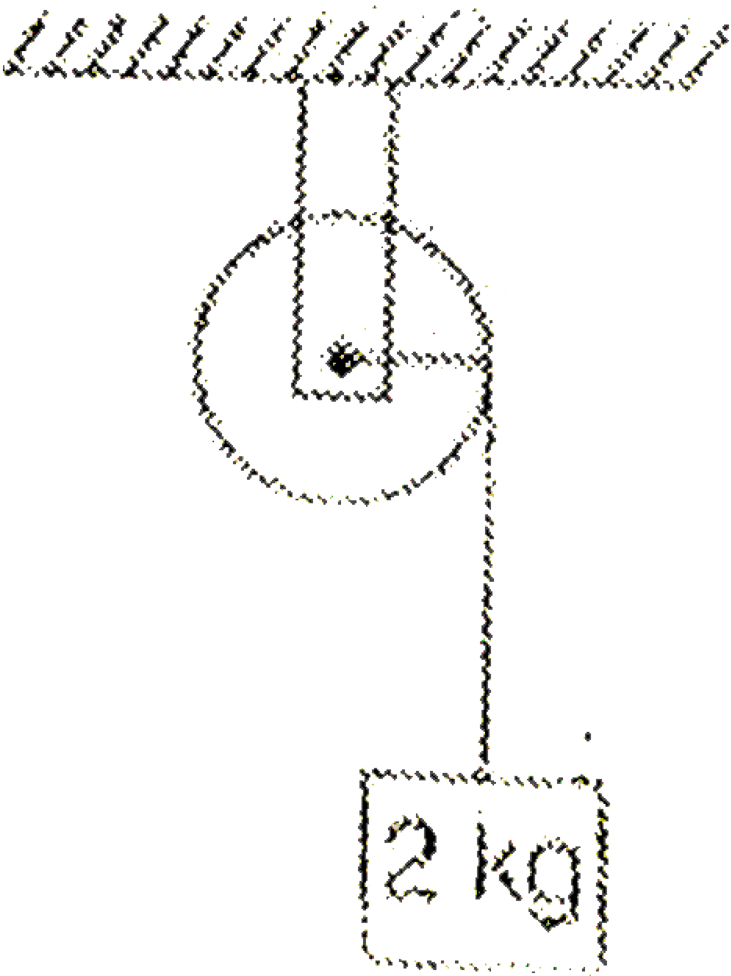
7. A small pulley of radius 20 cm and moment of inertia $0.32 kg - m^2$ is used to hang a 2 kg mass with the help of massless string. If the block is released, for no slipping condition find the acceleration of the block (in m/s^2).



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8. If a disc of mass m and radius r is reshaped into a ring a radius 2r,the mass remaining the same, the radius of gyration about centroidal axis perpendicular to plane goes up by a factor of $\sqrt{x}$. Find the value of x.

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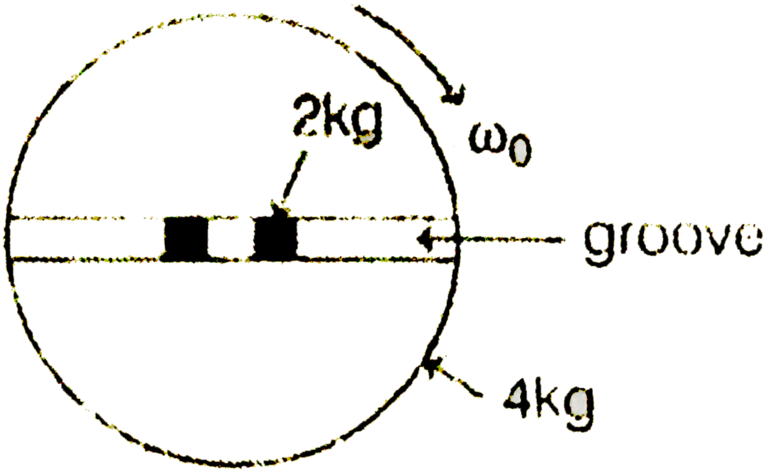
9. A disc of mass 4 kg and radius 6 metre is free to rotate in horizontal plane about a vertical fixed axis passing through its centre. There is a smooth groove along the diameter of the disc and two small blocks of masses 2 kg each are placed in it on either side of the centre of the disc as shown in figure. The disc is given initial angular velocity ω_0 =12 rad/sec and released. Find the angular speed of disc (in radian/sec) when the blocks reach the ends of the disc.



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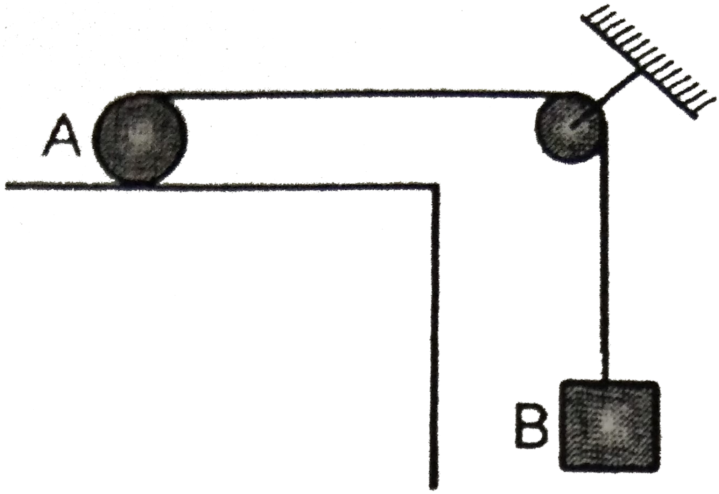
10. Find the acceleration of slid right circular roller A, weighing $12kg$ when it is being pulley by another weight $B(6kg)$ along the horizontal plane as in figure (pulley in massless). The weight B is attached to the end of a string wound around the circularference of roller. Assume there is no slipping of the roller and the string is inextensible.



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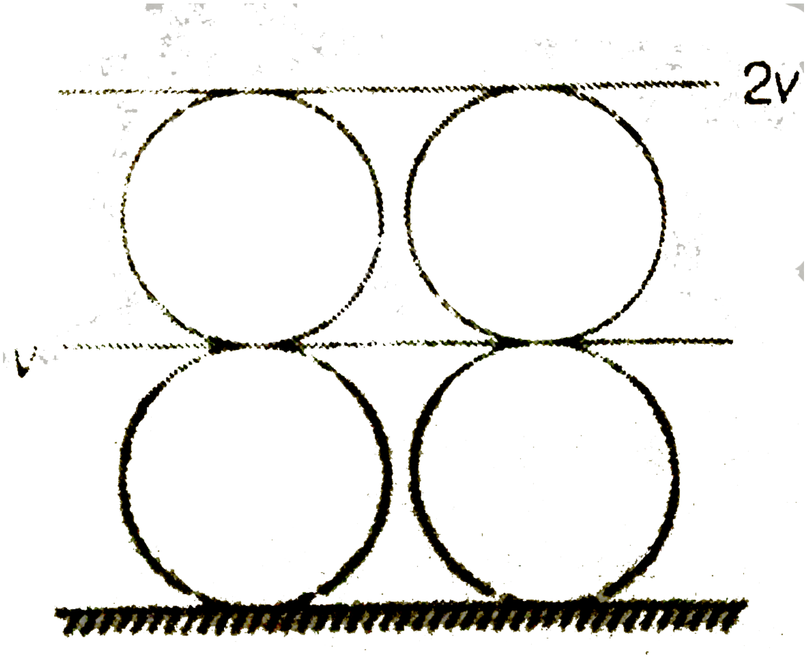
11. Two thin planks are moving on a four identical cylinders as shown. There is no slipping at any contact points. Calculate the ratio of angular speed of upper cylinder to lower cylinder



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12. A wheel of radius R=1 m rolls on ground with uniform velocity v=2 m/s . Calculate the relative acceleration of topmost point of wheel with respect to bottom most point (in m/s^2).

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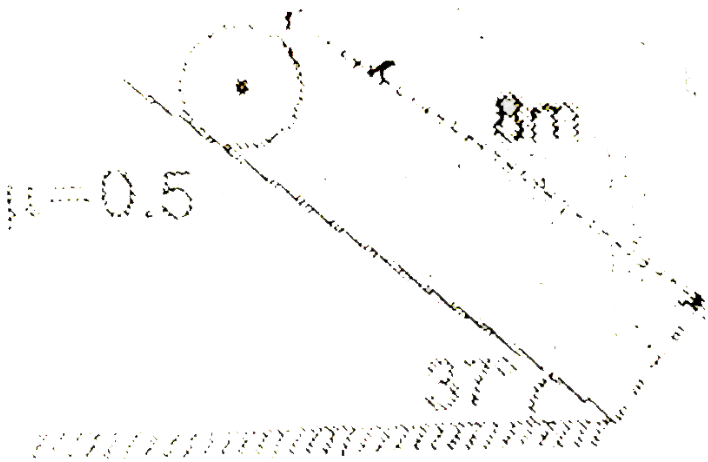
13. A cylinder rolls down on an inclined plane of inclination 37° from rest. Coefficient of friction between plane and cylinder is 0.5. Calculate the time (in s) of travelling down the incline 8 m as shown in figure . $\left(g = 10m/s^2\right)$



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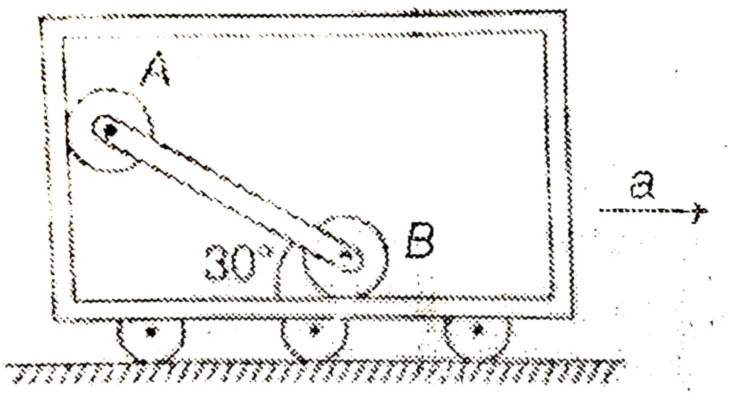
14. A car is moving rightward with acceleration $a = g\sqrt{k} m/s^2$. Find the value of k so that , rod maintains its orientation as shown in the figure. Neglect the friction and mass of the small rollers at A and B.



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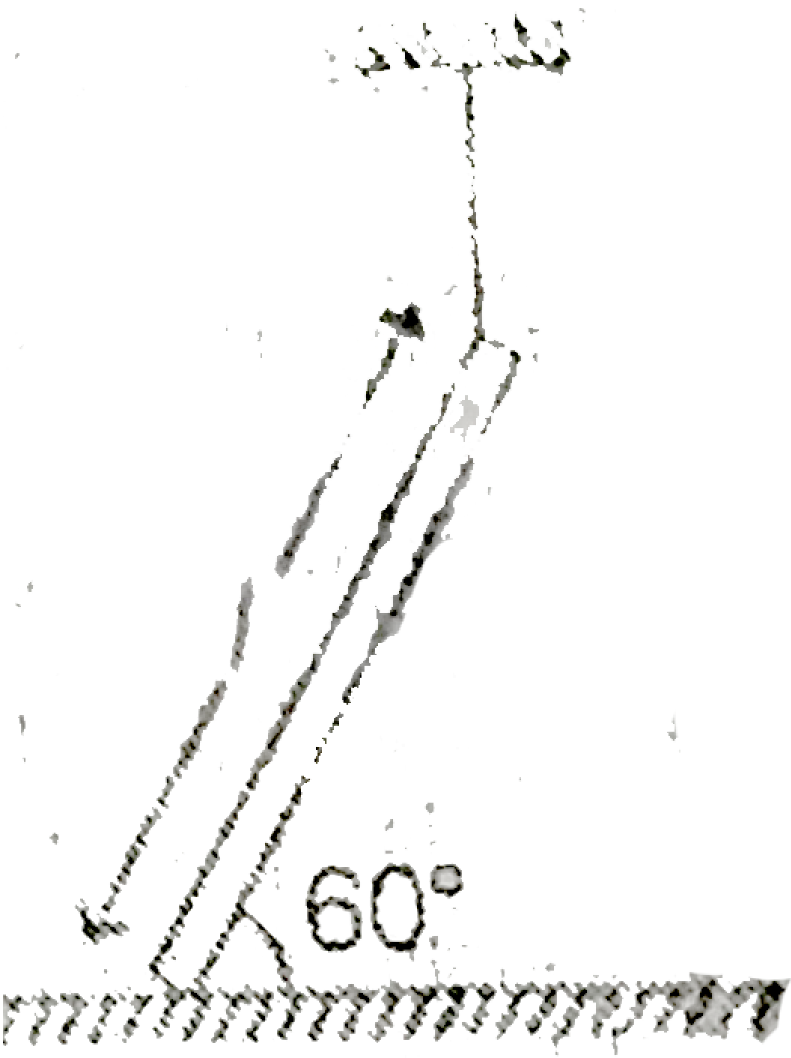
15. A uniform thin rod has mass m and length l. One end of the rod lies over rough horizontal surface and the other end is connected to a light vertical string as shown in the figure.

When string is cut, there is no slipping between rod and surface.Calculate the friction force (in N) on the rod immediately after the string is cut .(Given $mg = \frac{16}{\sqrt{3}} N$)



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16. A wheel of radius R=2m performs pure rolling on a rough horizontal surface with speed v=10 m/s . In the figure shown, angle θ is angular position of point P on wheel reaches the maximum height from ground. Find the value of $\sec\theta$ (take $g = 10m/s^2$).

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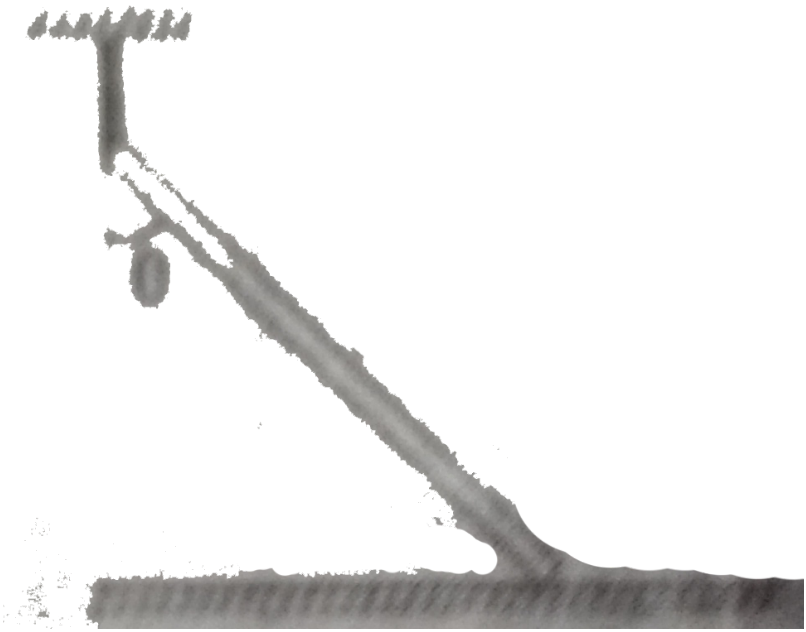
17. A uniform rod of length l and mass m is suspended from one end by inextensible string and other end less lies on smooth ground. The angle made by the rod with vertical is $\theta = \sin^{-1}\left(1/\sqrt{3}\right)$. If N_1 and N_2 represent the contact force from ground on rod just before and just after cutting the string then the ratio of N_1/N_2 is 0.25 x. Find the value of x.



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Example

1. A ring of diameter 0.4 m and of mass 10 kg is rotating about its geometrical axis at the rate of 35 ratation/second. Find the moment of intertia.

A. 0.1

B. 0.2

C. 0.3

D. 0.4

Answer: D

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

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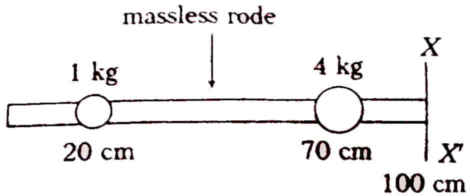
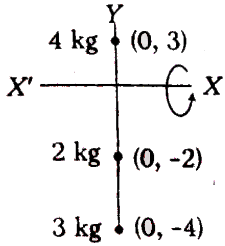
3. Calculate moment of inertia w.r.t. rotational axis XX' in following figures.





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4. Find the moment of inertia of a uniform cylinder about an axis through its centre of mass and perpendicular to its base. Mass of the cylinder is M and radius is R.

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5. A wheel of mass 8 kg has moment of inertia equals to 0.5kg-m^2. Determine its radius of gyration.

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6. The moment of inertia of a solid cylindrer about its axis of ratation is $\frac{MR^2}{2}$. What is the value if the radius of gyration of the cylinder about this axis ?

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7. Find the moment of inertia of a sphere about a tangent to the sphere, while the mass of the sphere is M and the radius of the sphere is R.

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8. The mass of the cylinder is 25 kg and radius of cylinder is 5 m. Find the moment of inertia of a solid cylinder about a tangent to the cylinder.

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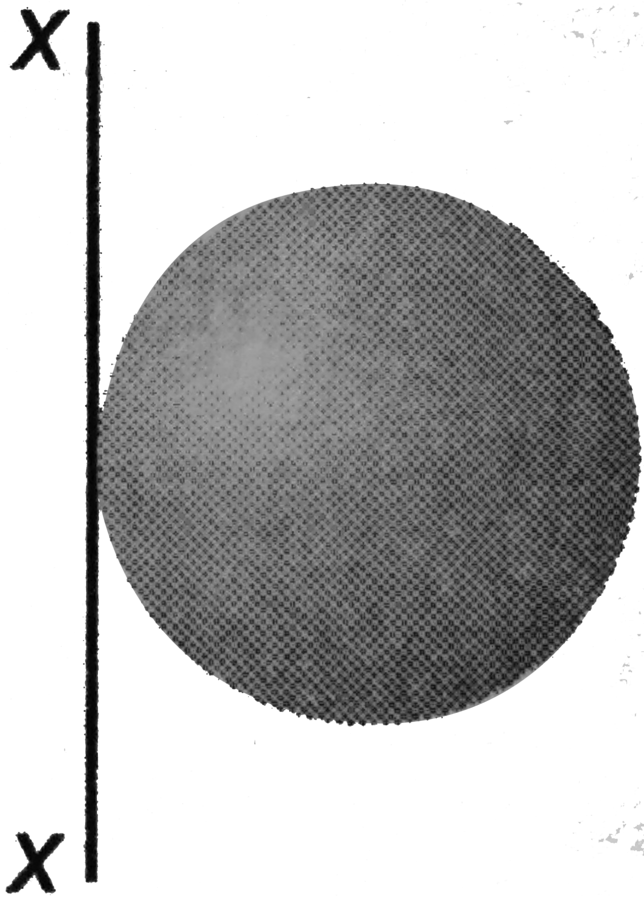

9.

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

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10. What is the moment of inertia of a

(i) uniform circular ring of mass 2 kg about its 4 m diameter ?

(ii) a thin disc about an axis coinciding with a diameter ?

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11. Calculate the moment of inertia of a rod of mass 2 kg and length 5 m about an axis perpendicular to it and passing through one of its ends.

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12. Two masses m_1 and m_2 are placed at a distance r from each other. Find out the moment of inertia of system about an axis passing through their centre of mass.

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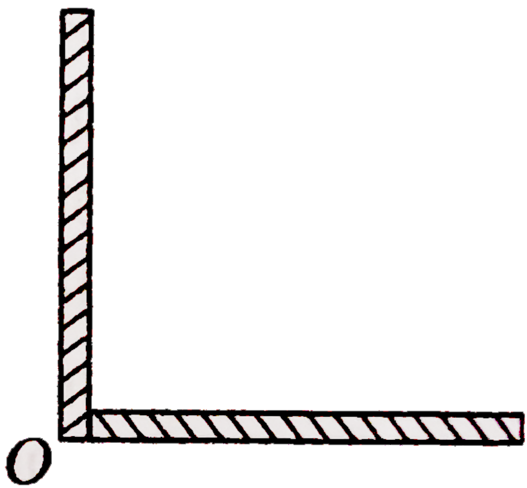
13. Two identical rods each of mass M and length L are kept according to figure. Find the moment of inertia of rods about an axis passing through O and perpendicular to the plane of rods.



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14. 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.

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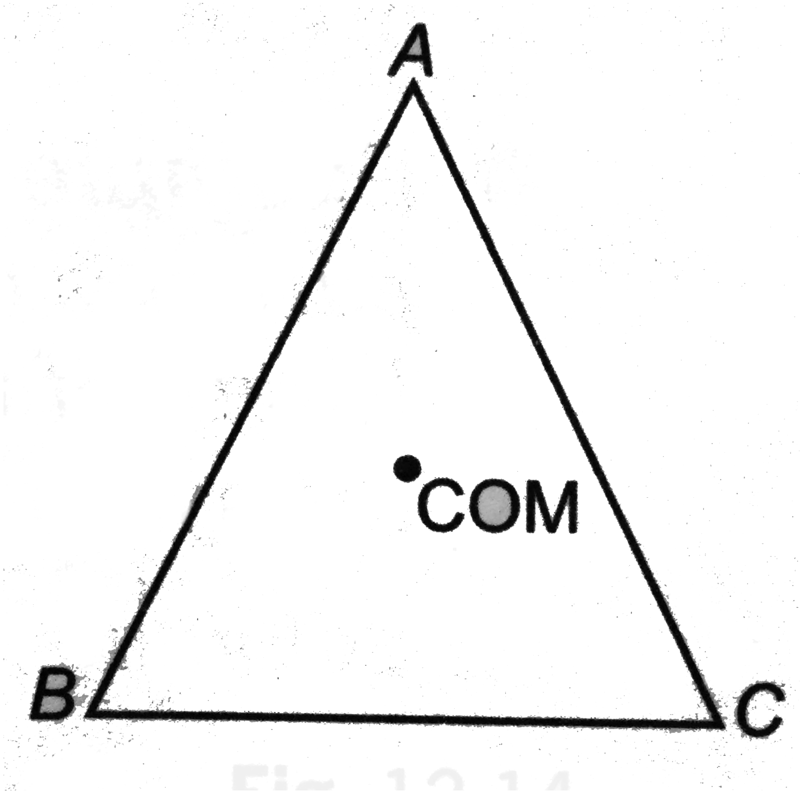
15. 

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 passig through its centre of mass and perpendicular to the plane of the particle.

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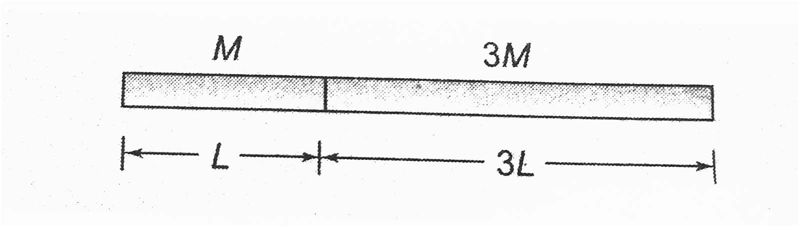
16. Two thin uniform rods $A\,(M.\,L)$ and $B\,(3M,\,3L)$ are joined as shown. Find the $M.\,I.$ about an axis passing through the center of mass of system of rods and perpendicular to the length.



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17. Two thin uniform rings made of same material and of radii R and $4R$ are joined as shown. The mass of smaller ring is m. Find the $M.\,I.$ about an axis passing through the center of mass of system of rings and perpendicular to the plane.

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

A. $\tau = \left(-7\hat{i} + 5\hat{j} + \hat{k}\right)\text{Nm}$

B. $\tau = \left(-7\hat{i} + 6\hat{j} + \hat{k}\right)\text{Nm}$

C. $\tau = \left(-7\hat{i} + 8\hat{j} + \hat{k}\right)\text{Nm}$

D. $\tau = \left(7\hat{i} + 5\hat{j} + \hat{k}\right)\text{Nm}$

Answer: A

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19. A force of $-4F\hat{K}$ acts O, the origin of the coordinate system. The torque about the point $(1, -1)$ is

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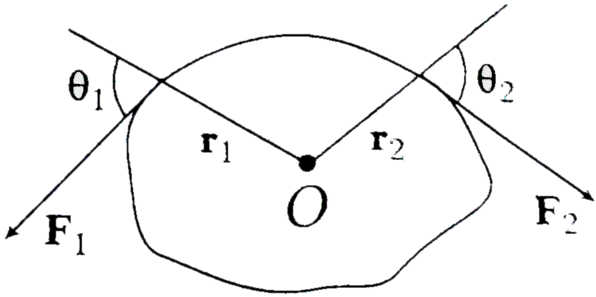
20. The body in figure shown is pivoted at O and two forces acts on it as shown



(i) Find an expression of the net torque on the body about the pivot

(ii) If $r_1 = 1.30m, r_2 = 2.15m, F_1 = 4.20N, F_2 = 4.90N, \theta_1 = 75^\circ$ and $\theta_2 = 60^\circ$, what is the net torque about the pivot ?

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21. 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 $g = 10m/s^2$]

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22. A solid flywheel of 20 kg mass and 120 mm radius revolves at 600revmin^{-1}. With what force must a brake lining be pressed against it for the flywheel to stop in 3s, if the coefficient of friction is 0.1 ?

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23. To maintain a rotor at a uniform angular speed of 100 $rads^{-1}$ an engine needs to transmit a torque of 200 Nm. What is the power required by engine ? Assume 100 % efficiency of engine.

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24. The power output of an antomobile engine is advertised to be 200 at 6000 rpm. What is the corresponding torque ?

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25. A flywheel of moment of inertia $10kgm^2$ is rotating at $50rad/s$. It must be brought to stop in $10s$.

(a) How much work must be done to stop it?

(b) What is the required average power?

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26. A car of mass 300 kg is travelling on a circular track of radius 100 m with a constant speed of 60 m/s

Calculate the angular momentum ?

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27. A particle of mass m is moving along the line $y = b, z = 0$ with constnat speed v. State whether the angular momentum of particle about origin is increasing. Decreasing or constant.

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28. A particle of mass m is projected with a velocity μ at an angle of θ with horizontal.The angular momentum of the particle about the highest point of its trajectory is equal to :

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29. Find the components along the x, y, z axes of the angular momentum $\vec{L}$ of a particle, whose position vector is $\vec{r}$ with components x, y, z and momentum is $\vec{p}$ with components p_x, p_y and p_z. Show that if the particle moves only in the x - y plane, the angular momentum has only a z-component.

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30. A $40kg$ flywheel in the from of a uniform circular disc of $1m$ radius is making 120 rpm. Calculate the angular momentum.

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31. A torque of 10 Nm is applied on a wheel having angular momentum of $2kgm^2s^{-1}$, calculate the angular momentum of the wheel after 4 seconds.

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32. The diameter of a solid disc is 0.5 m and its mass is 16 kg. What torque will increase its angular velocity from zero to 120 ratations/minute in 8 seconds.

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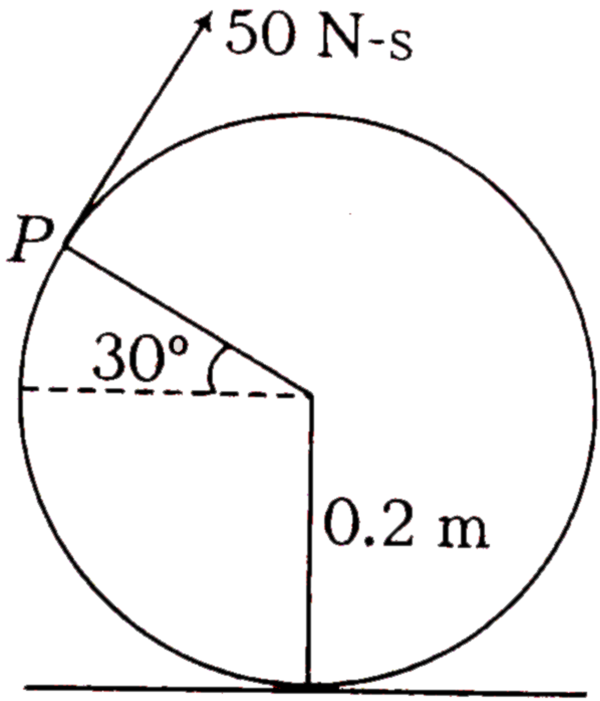
33. A solid ball of radius 0.2 m and mass 1 kg is given an instantaneous impulse of 50 N-s at point P as shown. Find the number of rotations made by the ball about its diameter before hitting the ground. The ball is kept on smooth surface intially



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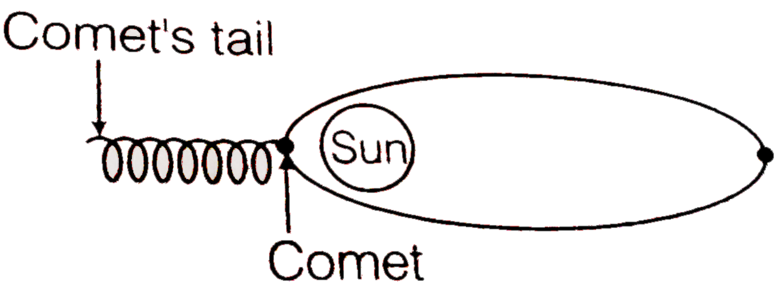
34. The maximum and minimum distances of a cornet form Sun are $1.4 \times 10^{12} m$ and $7 \times 10^{10} m$. If velocity nearest to Sun is $6 \times 10^4 ms^{-1}$, what is velocity if cornet when it is farthest from the Sun ?



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35. 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.

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36. If the 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?

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37. A wheel is rotating at a speed of 1000 rpm and its KE is $10^6 J$. What is moment of inertia of the wheel about its axis of rotation ?

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38. A flywheel of mass 0.2 kg and radius 10 cm is rotating with $5/\pi \text{rev/s}$ about an axis perpendicular to its plane passing through its centre. Calculate angular momentum and kinetic energy of flywheel.

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39. An energy of $484J$ is spent in increasing the speed of a flywheel from 60 rpm to 360 rpm. Calculate moment of inertia of flywheel.

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40. If the rotational kinetic energy of a body is increased by 300 %, then determine percentage increase in its angular momentum.

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41. A thin meter scale is kept vertical by placing its one end on floor, keeping the end in contact stationary, it is allowed to fall. Calculate the velocity of its upper end when it hit the floor.

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42. A disc of mass 5 kg and radius 50 cm rolls on the ground at the rate of $10ms^{-1}$. Calculate the K.E. of the disc.

Watch Video Solution

43. A hollow sphere of mass M and radius R lies on a rough horizontal plane when a particle of mass m traveling with speed v collides and sticks with it. If line of motion of the particle is at height h above the center of sphere, find h if the body rolls without slipping after collision ($m < < M$).

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44. 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.

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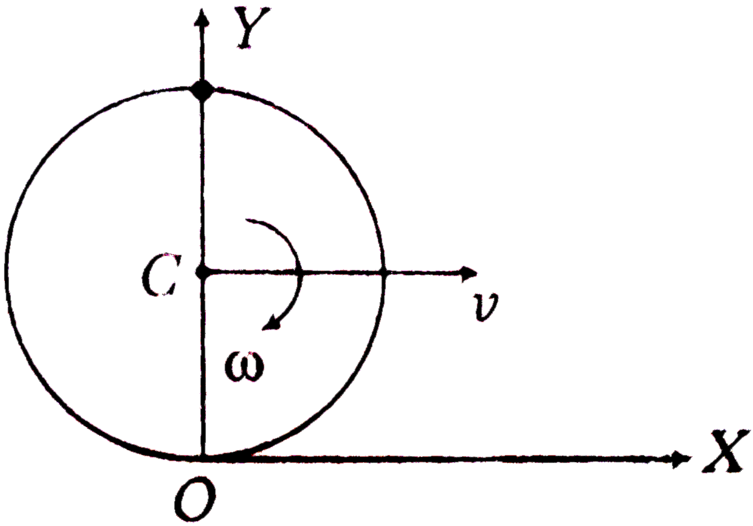
45. A disc of radius R start at time $t = 0$ moving along the positive X-axis with linear speed b and angular speed ω. Find the x and y-coordinates of the bottommost point at any time t.



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46. 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?

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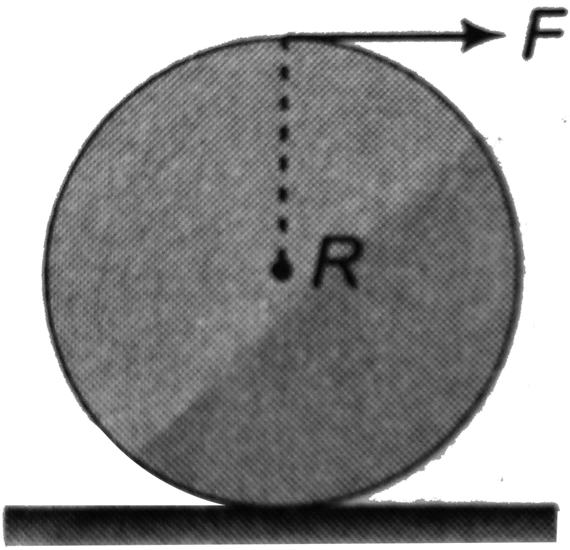

47.

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.

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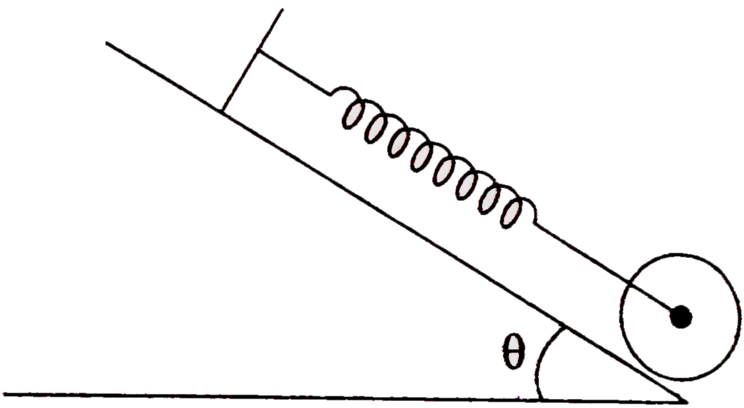
48. A sphere of mass m attached to a spring on incline plane as shown in figure is held in unstretched position of spring. Suddenly sphere is left free what is the maximum extension of spring if friction allows only rolling of sphere about horizontal diametre ?



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49. Calculate the kinetic energy of rolling ring of mass 0.2 kg about an axis passing through its centre of mass and perpendicular to it, if centre of mass is moving with a velocity of 3 m/s.

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50. A solid sphere is rolling down an inclined plane without slipping of height 20 m. Calculate the maximum velocity with which it will reach the bottom of the plane $\left(g = 10m/s^2\right)$

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51. 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 $g = 9.8m/s^2$)

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52. When a body is under pure rolling, the fraction of its total kinetic energy which is the purely rotational is 2/5. Identify the body.

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53. A uniform sphere of mass m and radius R rolls without slipping down an inclined plane set at an angle θ to the horizontal. Find

(a) the friction coefficient at which slipping is absent,

(b) the kinetic energy of the sphere t seconds after the beginning of motion.

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Check point 9.1

1. A car moves on a circular road. It describes equal angles about the centre in equal intervals of time. Which of the following statement about the velocity of the car is true

A. Magnitude of velocity is not constant

B. Both magnitude and direction of velocity change

C. Velocity is directed towards the centre of the circle

D. Magnitude of velocity is constant but direction changes.

Answer: D

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2. A wheel rotates with a constant angular velocity of 300 rpm.

The angle through which the wheel rotates in 1 s is.

A. π rad

B. 5π rad

C. 10π rad

D. 20π rad

Answer: C

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3. A motor is rotating at a constant angular velocity of 500 rpm. Thw angular displacement per second is

A. $\frac{3}{50\pi}$ rad

B. $\frac{3\pi}{50}$ rad

C. $\frac{25\pi}{3}$ rad

D. $\frac{50\pi}{3}$ rad

Answer: D

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4. The angle turned by a body undergoing circular motion depends on time as $\theta = \theta_0 + \theta_1 t + \theta_2 t^2$. Then the angular acceleration of the body is

A. θ_1

B. θ_2

C. $2\theta_1$

D. $2\theta_2$

Answer: D

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5. A rotating wheel changes angular speed from 1800 rpm to 3000 rpm in 20 s. What is the angular acceleration assuming to be uniform?

A. $60\pi rads^{-2}$

B. $90\pi rads^{-2}$

C. $2\pi rads^{-2}$

D. $40\pi rads^{-2}$

Answer: C

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6. A body rotating with uniform angular acceleration covers 100π (radian) in the first 5 s after the start. Its angular speed at the end of 5 s (in rad/s) is

A. 40π

B. 30π

C. 20π

D. 10π

Answer: C

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7. The angular velocity of a wheel increases from 100 to 300 in 10 s. The number of revolutions made during that time is

A. 600

B. 1500

C. 1000

D. 2000

Answer: D

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8. A wheel has angular acceleration of $3.0 rad/s^2$ and an initial angular speed of $2.00 rad/s$. In a tine of $2s$ it has rotated through an angle (in radian) of

A. 6

B. 10

C. 12

D. 4

Answer: B

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9. A body rotates about a fixed axis with an angular acceleration of $3 rad/s^2$ The angle rotated by it during the time when its angular velocity increases frm 10 rad/s to 20 rad/s (in radian) is

A. 50

B. 100

C. 150

D. 200

Answer: A

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10. A wheel which is initially at rest is subjected to a constant angular acceleration about its axis. It rotates through an angle of 15° in time t sec. Then how much it rotates in the next $2t$ sec

A. 90°

B. 120°

C. 30°

D. 45°

Answer: B

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11. Analogue of mass in rotational motion is.

A. moment of inertia

B. angular momentum

C. gyration

D. None of these

Answer: A

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12. Moment of inertia of a body depends upon

A. axis of rotation

B. torque

C. angular momentum `

D. angular velocity

Answer: A

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13. A particle of mass 1 kg is kept at (1m,1m,1m). The moment of inertia of this particle about Z-axis would be

A. 1kg-m^2

B. 2kg-m^2

C. 3kg-m^2

D. None of these

Answer: B

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14. The radius of gyration of a solid sphere of radius R about its tangential is

A. $\sqrt{\frac{7}{5}}R$

B. $\sqrt{\frac{2}{5}}R$

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

D. R

Answer: A

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15. What is the moment of inertia of a solid sphere of density ρ and radius R about its diameter ?

A. $\frac{105}{176}R^5\rho$

B. $\frac{176}{105}R^5\rho$

C. $\frac{105}{176}R^2\rho$

D. $\frac{176}{105}R^2\rho$

Answer: B

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16. One circular ring and one circular disc, both are having the same mass and radius. The ratio of their moments of inertia about the axes passing through their centres and perpendicular to their planes, will be

A. $1:1$

B. $2:1$

C. $1:2$

D. $4:1$

Answer: B

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17. The moment of inertia of a solid cylinder of mass M, length 2R and radius R about an axis passing through the centre of mass and perpendicular to the axis of the cylinder is I_1 and about an axis passing through one end of the cylinder and perpendicular to the axis of cylinder is I_2

A. $l_2 - l_1 = MR^2$

B. $l_2 = l_1$

C. $\frac{l_2}{l_1} = \frac{19}{12}$

D. $l_1 - l_2 = MR^2$

Answer: A

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18. If I_1 is the moment of inertia of a thin rod about an axis perpendicular to its length and passing through its centre of mas and I_2 is the moment of inertia of the ring about an axis perpendicular to plane of ring and passing through its centre formed by bending the rod, then

A. $\frac{I_1}{I_2} = \frac{3}{\pi^2}$

B. $\frac{I_1}{I_2} = \frac{2}{\pi^2}$

C. $\frac{I_1}{I_2} = \frac{\pi^2}{2}$

D. $\frac{I_1}{I_2} = \frac{\pi^2}{3}$

Answer: D

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19. Moment of inertia of a rod of mass m and length l about its one end is l. If one-fourth of its length is cur away, then moment of inertia of the remaining rod about its one end will be

A. $\frac{3}{4}l$

B. $\frac{9}{16}l$

C. $\frac{27}{64}l$

D. $\frac{l}{16}$

Answer: C

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20. Three thin rods each of length Land mass M are placed along x, y and z-axes such that one of each rod is at origin. The moment of inertia of this system about z-axis is

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

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

C. $\frac{5ML^2}{3}$

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

Answer: A

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Check point 9.2

1. The torque of a force $F = -6\hat{i}$ acting at a point $r = 4\hat{j}$ about origin will be

A. $-24\hat{k}$

B. $24\hat{k}$

C. $24\hat{j}$

D. $24\hat{i}$

Answer: B

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2. Moment of a force of magnitude 20 N acting along positive x-direction at point $(3m, 0, 0)$ about the point $(0, 2, 0)$ (in N-m) is

A. 20

B. 60

C. 40

D. 30

Answer: C

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3. The torque of force $F = -3\hat{i} + \hat{j} + 5\hat{k}$ acting on a point $r = 7\hat{i} + 3\hat{j} + \hat{k}$ about origin will be

A. $14\hat{i} - 38\hat{j} + 16\hat{k}$

B. $4\hat{i} + 4\hat{j} + 6\hat{k}$

C. $-14\hat{i} + 38\hat{j} - 16\hat{k}$

D. $-21\hat{i} + 3\hat{j} + 5\hat{k}$

Answer: A

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4. The torque of a force $F = -2\hat{i} + 2\hat{j} + 3\hat{k}$ acting on a point $r = \hat{i} - 2\hat{k} + \hat{k}$ about origin will be

A. $8\hat{i} + 5\hat{j} + 2\hat{k}$

B. $-8\hat{i} - 5\hat{j} - 2\hat{k}$

C. $8\hat{i} - 5\hat{j} + 2\hat{k}$

D. $-8\hat{i} + 5\hat{j} - 2\hat{k}$

Answer: B

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5. A door 1.6 m wide requires a force of 1 N to be applied at the free and to open or close it. The force that is required at a point 0.4 m distant from the hinges for opening or closing the door is

A. 1.2 N

B. 3.6 N

C. 2.5 N

D. 4 N

Answer: D

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6. A flywheel of moment of inertia 2kg-m^2 is rotated at a speed of 30rad/s. A tangential force at the rim stops the wheel in 15 second. Average torque of the force is

A. 4 N-m

B. 2 N-m

C. 8 N-m

D. 1 N-m

Answer: A

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7. A mass of 10 kg connected at the end of a rod of negligible mass is rotating in a circle of radius 30 cm with an angular velocity of 10 rad/s. If this mass is brought to rest in 10 s by a brake, what is the magnitude of the torque applied ?

A. 0.9 N-m

B. 1.2 N-m

C. 2.3 N-m

D. 0.5 N-m

Answer: A

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8. A disc is rotating with angular velocity ω. A force F acts at a point whose position vector with respect to the axis of rotation is r. The power associated with torque due to the force is given by

A. $(r \times F).\,\omega$

B. $(r \times F) \times \omega$

C. $r \times (F.\,\omega)$

D. $r.\,(F \times \omega)$

Answer: A

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9. Angular momentum is

A. moment of momentum

B. product of mass and angular velocity

C. product of moment of inertia and velocity

D. moment in angular motion

Answer: A

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10. The unit mass having $r = 8\hat{i} - 4\hat{j}$ and $v = 8\hat{i} + 4\hat{j}$ in its angular momentum is

A. 64 units in $-\hat{k}$ direction

B. 64 units in $+\hat{k}$ direction

C. 64 units in $+\hat{j}$ direction

D. 64 units in $+\hat{i}$ direction

Answer: B

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11. If the earth is a point mass of $6 \times 10^{24} kg$ revolving around the sun at a distance of 1.5×10^{8}km and in time, $T = 3.14 \times 10^{7} s$, then the angular momentum of the earth around the sun is

A. 1.2×10^{18}kg m$^2/s$

B. 1.8×10^{29}kg m$^2/s$

C. 1.5×10^{37}kg m$^2/s$

D. 2.7×10^{40}kg m$^2/s$

Answer: D

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12. A particle with the position vector r has linear momentum p. Which of the following statements is true is respect of its angular momentum L about the origin ?

A. L acts along p

B. L acts along r

C. L is maximum when p and r are parallel

D. L is maximum when p is perpendicular to r

Answer: D

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13. By keeping moment of inertia of a body constant, if we double the time period, then angular momentum of body

A. remains constant

B. becomes half

C. doubles

D. quadruples

Answer: B

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14. It torque is zero, then

A. angular momentum is conserved

B. linear momentum is conserved

C. energy is conserved

D. angular momentum is not conserved

Answer: A

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15. Total angular momentum of a rotating body remains constant, if the net torque acting on the body is

A. zero

B. maximum

C. minimum

D. unit

Answer: A

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16. The angular momentum of a rotating body changes from A_0 to $4A_0$ in 4 min. The torque acting on the body is

A. $\frac{3}{4}A_0$

B. $4A_0$

C. $3A_0$

D. $\frac{3}{2}A_0$

Answer: A

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17. If the radius of earth contracts 1/n of its present day value, the length of the day will be approximately

A. $\frac{24}{n}h$

B. $\frac{24}{n^2}h$

C. $24nh$

D. $24n^2h$

Answer: B

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18. A thin circular ring of mass M and radius R is rotating about its axis with constant angular velocity ω. The objects each of mass m are attached gently to the ring. The wheel now rotates with an angular velocity.

A. $\dfrac{\omega M}{(m + M)}$

B. $\dfrac{\omega(M - 2M)}{(M + 2m)}$

C. $\dfrac{\omega M}{(M + 2m)}$

D. $\dfrac{\omega(M + 2m)}{M}$

Answer: C

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19. A disc of mass 2 kg and radius 0.2 m is rotating with angular velocity 30rad s^{-1}. What is angular velocity, if a mass of 0.25 kg is put on periphery of the disc ?

A. 24 rad s^{-1}

B. 36 rad s^{-1}

C. 15 rad s^{-1}

D. 26 rad s^{-1}

Answer: A

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20. Circular disc of mass 2 kg and radius 1 m is rotating about an axis perpendicular to its plane and passing through its centre of mass with a rotational kinetic energy of 8 J. The angular momentum is (Js) is

A. 8

B. 4

C. 2

D. 1

Answer: B

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Check point 9.3

1. At any instant, a rolling body may be considered to be in pure rotation about an axis through the point of contact. This axis is translating forward with speed

A. equal to centre of mass

B. zero

C. twice of centre of mass

D. None of these

Answer: A

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2. A wheel of radius R rolls on the ground with a uniform velocity v. The velocity of topmost point relative to the bottommost point is

A. v

B. 2v

C. v/2

D. zero

Answer: B

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3. the center of a wheel rolling on a plane surface moves with a speed v_0. A particle on the rim of the wheel at the same level as the center will be moving at speed

A. zero

B. v_0

C. $\sqrt{2}v_0$

D. $2v_0$

Answer: C

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4. A uniform solid spherical ball is rolling down a smooth inclined plane from a height h. The velocity attained by the ball when it reaches the bottom of the inclined plane is v. If ball when it reaches the bottom of the inclined plane is v. If the ball is now thrown vertically upwards with the same velocity v, the maximum height to which the ball will rise is

A. $\frac{5h}{8}$

B. $\frac{3h}{5}$

C. $\frac{5h}{7}$

D. $\frac{7h}{9}$

Answer: C

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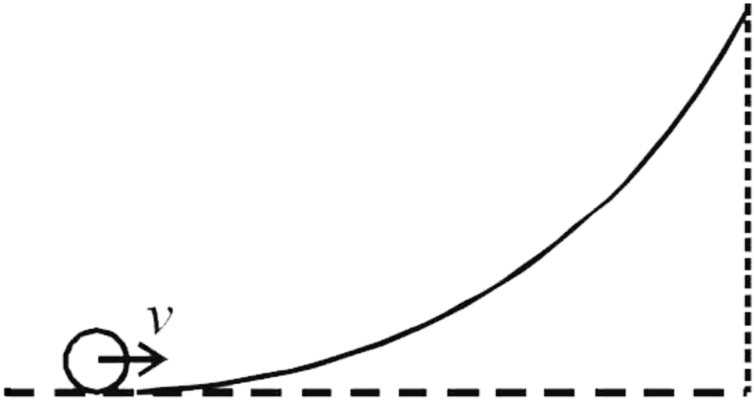
5. A small object of uniform density rolls up a curved surface with an initial velocity v. it reaches up to a maximum height of `(3v^2)/(4g)



with respect to the initial position. The object is

A. ring

B. solid sphere

C. hollow sphere

D. disc

Answer: D

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6. A sphere is rolling down a plane of inclination θ to the horizontal. The acceleration of its centre down the plane is

A. $g\sin\theta$

B. less than $g\sin\theta$

C. greater than $g\sin\theta$

D. zero

Answer: B

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7. Two uniform solid spheres having unequal rdii are released from rest from the same height on a rough incline. Ilf the spheres roll without slipping

A. the heavier sphere reaches the bottom first

B. the bigger sphere reaches the bottom first

C. the two spheres reach the bottom together

D. the information given is not sufficient to tell which sphere will reach the bottom first

Answer: C

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8. A solid sphere of mass m rolls without slipping on an inclined plane of inclination θ. The linear acceleration of the sphere is

A. $\frac{7}{5} g \sin\theta$

B. $\frac{2}{7} g \sin\theta$

C. $\frac{3}{7} g \sin\theta$

D. $\frac{5}{7} g \sin\theta$

Answer: D

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9. An inclined plane makes an angle 30° with the horizontal. A solid sphere rolling down this inclined plane from rest without slipping has a linear acceleration equal to

A. $\frac{g}{3}$

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

C. $\frac{5g}{7}$

D. $\frac{5g}{14}$

Answer: D

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10. A thin uniform circular ring is rolling down an inclined plane of inclination 30° without slipping. Its linear acceleration along the inclined plane will be

A. g

B. $\frac{g}{2}$

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

D. $\frac{g}{4}$

Answer: D

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11. The ratio of the time taken by a solid sphere and that taken by a disc of the same mass and radius to roll down a rough inclined plane from rest, from the same height is

A. $15:14$

B. $\sqrt{15}:\sqrt{14}$

C. $14:15$

D. $\sqrt{14}:\sqrt{15}$

Answer: D

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12. A soldi sphere a hollow sphere and a disc, all haing same mass and radius are placed at the top of an incline and released. The friction coefficients between the objects and the incline are same and not sufficient to allow pure rolling. Least time will be taken in reaching the bottom by

A. the solid sphere

B. the hollow sphere

C. the disc

D. All will take same time

Answer: D

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13. A solid sphere a hollow sphere and a disc all having same mass and radius, are placed at the top of a moth incline and released. Least time will be taken in reaching the bottom by

A. the solid sphere

B. the hollow sphere

C. the disc

D. All will take same time

Answer: A

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14. The speed of a homogeneous solid sphere after rolling down an inclined plane of vertical height h from rest without slipping will be.

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

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

C. $\sqrt{\frac{4gh}{5}}$

D. $\sqrt{2gh}$

Answer: B

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15. A solid cylinder rolls down an inclined plane of height $3m$ and reaches the bottom of plane with angular velocity of $2\sqrt{2}rad/s$. The radius of cylinder must be [take $g = 10m/s^2$]

A. 5 cm

B. 0.5 cm

C. $\sqrt{10}$ cm

D. $\sqrt{5}$ m

Answer: D

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(A) Chapter Exercises

1. The angular momentum of a system of particles is conserved

A. when no external force acts upon the system

B. when no external torque acts upon the system

C. when no external impulse acts upon the system

D. when axis of rotation remains same

Answer: B

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2. If a person standing on a rotating disc stretches out his hands, the angular speed will

A. increase

B. decrease

C. remain same

D. None of these

Answer: B

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3. When a disc rotates with uniform angular velocity, which of the following is not true ?

A. The sense of rotation remains same

B. The orientation of the axis of rotation remain same

C. The speed of rotation is non-zero and remains same

D. The angular acceleration is non-zero and remains same

Answer: D

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4. A ring of diameter 0.4 m and of mass 10 kg is rotating about its axis at the rate of 1200 rpm. The angular momentum of the ring is

A. $60.28 \text{kgm}^2 s^2$

B. $55.26 \text{kgm}^2 s^2$

C. $40.28 \text{kgm}^2 s^2$

D. $50.28 \text{kgm}^2 s^2$

Answer: D

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5. A uniform disc of radius a and mass m, is rotating freely with angular speed ω in a horizontal plane. About a smooth fixed vertical axis through its centre. A particle, also of mass m, is suddently attached to the rim of the disc of the disc and rotates with it. The new angular speed is

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

B. $\frac{\omega}{3}$

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

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

Answer: B

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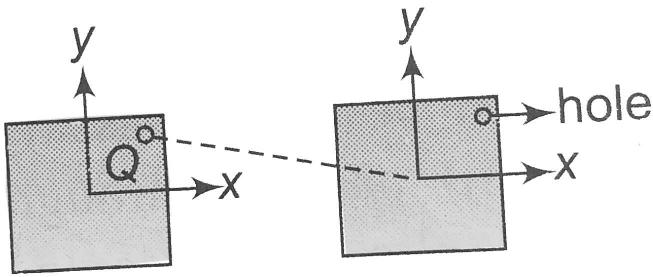
6. A uniform square plate has a small piece Q of an irregular shape removed and guled to the centre of the plate leaving a hole behind in figure. The moment of inertia about the z-axis is then,



A. increased

B. decreased

C. the same

D. changed in unpredicted manner

Answer: B

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7. A diver in a swimming pool bends his head before diving, because it

A. decreases his moment of inertia

B. decreases his angular velocity

C. increases his moment of inertia

D. decreases his linear velocity

Answer: A

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8. A ody is in pure rotation. The linear speed v of a particle, the distance r of the particle from the axis and the angular velocity ω of the body are related as $\omega = \frac{v}{r}$. Thus

A. $\omega \propto \frac{1}{r}$

B. $\omega \propto r$

C. $\omega = 0$

D. ω is independent of r.

Answer: D

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9. The rotational kinetic energy of a body is E and its moment of inertia is I. The angular momentum is

A. EI

B. $2\sqrt{(EI)}$

C. $\sqrt{(2EI)}$

D. $\frac{E}{I}$

Answer: C

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10. A body is under the action of two equal and oppositely directed forces and the body is rotating with constant non-zero angular acceleration. Which of the following cannot be the separation between the lines of action of the forces ?

A. 1 m

B. 0.4 m

C. 0.25 m

D. zero

Answer: D

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11. A particle performing uniform circular motion gas angular momentum L. If its angular frequency is double and its kinetic energy halved, then the new angular momentum is :

A. 2L

B. 4L

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

D. $\frac{L}{4}$

Answer: A

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12. Moment of a force of magnitude 10 N acting along positive y-direction at point $(2m, 0, 0)$ about the point $(0, 1m, 0)$ in N-m is

A. 10

B. 20

C. $10\sqrt{2}$

D. 30

Answer: B

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13. The radius of gyration of a uniform rod of length L about an axis passing through its centre of mass is

A. $\frac{L}{2\sqrt{3}}$

B. $\frac{L^2}{12}$

C. $\frac{L}{\sqrt{3}}$

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

Answer: A

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14. Five particles of mass 2 kg are attached to the rim of a circular disc of radius 0.1 m & negligible mass. Moment of inertia of the system about an axis passing through the centre of the disc & perpendicular to its plane is

A. 1kg-m^2

B. $0.1 kg\text{-}m^2$

C. $2 kg\text{-}m^2$

D. $0.2 kg\text{-}m^2$

Answer: B

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15. A particle is moving in a circular orbit with constant speed.

Select wrong alternate.

A. Its linear momentum is conserved

B. Its angular momentum is conserved

C. It is moving with variable velocity

D. It is moving with variable acceleration

Answer: A

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16. If the equation for the displacement of a particle moving on a circle path is given by, $\theta = 2t^2 + 0.5$ where, θ is in radian and t is in second, then the angular velocity of the particle after 2 s is

A. $8 rads^{-1}$

B. $12 rads^{-1}$

C. $24 rads^{-1}$

D. $36 rads^{-1}$

Answer: C

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17. A wheel is a rest. Its angular velocity increases uniformly and becomes $80 rads^{-1}$ after 5 s. The total angular displacement is

A. 800 rad

B. 400 rad

C. 200 rad

D. 100 rad

Answer: C

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18. A rigid body rotates about a fixed axis with variable angular velocity equal to $\alpha - \beta$, at the time t, where α, β are constant. The angle through which it rotates before its stops

A. $\frac{\alpha^2}{2\beta}$

B. $\frac{\alpha^2 - \beta^2}{2\alpha}$

C. $\frac{\alpha^2 - \beta^2}{2\beta}$

D. $\frac{(\alpha - \beta)\alpha}{2}$

Answer: A

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19. A wheel is rotating at the rate of 33rev min^{-1}. If it comes to stop in 20 s. Then, the angular retardation will be

A. $\pi rads^{-2}$

B. $11\pi rads^{-2}$

C. $\frac{\pi}{200} rads^{-2}$

D. $\frac{11\pi}{200} rads^{-2}$

Answer: D

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20. A wheel is rotating at 900 rpm about its axis. When power is cut off it comes to rest in 1 min. The angular retardation in $rads^{-2}$ is

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

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

C. $\frac{\pi}{6}$

D. $\frac{\pi}{8}$

Answer: A

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21. A wheel is subjected to uniform angular acceleration about its axis. Initially, its angular velocity is zero. In the first $2\sec$, it rotates through an angle θ_1, in the next $2\sec$, it rotates through an angle θ_2. The ratio of θ_2/θ_1 is

A. 1

B. 2

C. 3

D. 5

Answer: C

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22. The motor of an engine is rotating about its axis with an angular velocity of 100 rpm. It comes to rest in 15 s after being switched off. Assuming constant angular deceleration, calculate the number of revolution made by it before coming to rest.

A. 12.5

B. 40

C. 32.6

D. 15.6

Answer: A

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23. If $\vec{F}$ is the force acting in a particle having position vector $\vec{r}$ and $\vec{\tau}$ be the torque of this force about the origin, then

A. $r.\tau = 0$ and $F.\tau = 0$

B. $r \times \tau = 0$ and $F \times \tau \neq 0$

C. $r.\tau \neq 0$ and $F.\tau \neq 0$

D. $r \times \tau \neq 0$ and $F \times \tau = 0$

Answer: A

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24. A particle of mass 5 kg is moving with a uniform speed of $3\sqrt{2}\text{cm s}^{-1}$ in the XY-plane along the line $y = 2\sqrt{5}$ cm. The magnitude of its angular momentum about the origin in $\text{g-cm}^2\text{s}^{-1}$ is

A. zero

B. 30

C. $30\sqrt{2}$

D. $30\sqrt{10}$

Answer: D

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25. A particle of mass m is moving in yz-plane with a unifrom velocity v with its trajectory running parallel to +ve y-axis and intersecting z-axis at $z = a$ Fig. The change in its angular momentum about the origin as it bounces elastically from a wall at y = constant is :

A. $mva\hat{e}_x$

B. $2mva\hat{e}_x$

C. $ymv\hat{e}_x$

D. $2ymv\hat{e}_x$

Answer: B

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26. A particle of mass $m = 5$ units is moving with a uniform speed $v = 3\sqrt{2}$ units in the XY-plane along the $y = x + 4$. The magnitude of the angular momentum about origin is

A. zero

B. 60 unit

C. 7.5 unit

D. $40\sqrt{2}$ unit

Answer: B

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27. A particle of mass $2mg$ located at the position $\left(\hat{i} + \hat{k}\right)m$ has a velocity $2\left(+\hat{i} - \hat{j} + \hat{k}\right)m/s$. Its angular momentum about z - axis in $kg - m^2/s$ is :

A. $+4$

B. $+8$

C. -4

D. -8

Answer: D

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28. A particle of mass m is projected with velocity v moving at an angle of 45° with horizontal. The magnitude of angular momentum of projectile about point of projection when particle is at maximum height, is

A. zero

B. $\frac{mvh}{\sqrt{2}}$

C. mvh

D. $\sqrt{2}mvh$

Answer: B

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29. A sphere of mass M rolls without slipping on rough surface with centre of mass has constant speed v_0. If mass of the sphere is m and its radius be R`, then the angular momentum of the sphere about the point of contact is.

A. $\frac{5}{7}Mv_0R$

B. $\frac{7}{5}Mv_0R$

C. $\frac{3}{5}Mv_0R$

D. $\frac{1}{2}Mv_0R$

Answer: B

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30. A constant torque of $1000N - m$ turns a wheel of moment of inertia $200kg - m^2$ about an axis through its centre. Its angular velocity after 3 seconds is.

A. $1rads^{-1}$

B. $5rads^{-1}$

C. $10rads^{-1}$

D. $15rads^{-1}$

Answer: D

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31. A Merry -go-round, made of a ring-like platform of radius R and $mass M$, is revolving with angular speed ω. A person of mass M is standing on it. At one instant, the person jumps off the round, radially away from the centre of the round (as see from the round). The speed of the round after wards is

A. 2ω

B. ω

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

D. 0

Answer: A

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32. A flywheel having a radius of gyration of 2m and mass 10 kg rotates at an angular speed of $5 rad s^{-1}$ about an axis perpendicular to it through its centre. The kinetic energy of rotation is

A. 500 J

B. 2000 J

C. 1000 J

D. 250 J

Answer: A

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33. A flywheel is in the form of a uniform circular disc of radius $1m$ and mass $2kg$. The work which must be done on it to increase its frequency of rotation from 5 to $10 rev/s$ is approximately

A. $1.5 \times 10^2 J$

B. $3.0 \times 10^2 J$

C. $1.5 \times 10^3 J$

D. $3.0 \times 10^3 J$

Answer: C

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34. A rod is placed along the line, $y = 2x$ with its centre at origin. The moment of inertia of the rod is maximum about.

A. X-axis

B. Y-axis

C. Z-axis

D. Data insufficient

Answer: C

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35. The ratio of the radii of gyration of a circular disc and a circular ring of the same radii about a tangential axis perpendicular to plane of disc or ring is

A. $1:2$

B. $\sqrt{5}:\sqrt{6}$

C. $2:3$

D. $\frac{\sqrt{3}}{2}$

Answer: D

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36. Let I_A and I_B be moments of inertia of a body about two axes A and B respectively. The axis A passes through the centre of massof the body but B does not. Choose the correct option.

A. $I_A < I_B$

B. $I_A < I_B$, whether the axes are parallel or not parallel

C. if the axes are parallel $I_A < I_B$

D. If the axes are not parallel $I_A \geq I_B$

Answer: C

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37. The ratio of the radii of gyration of a hollow sphere and a solid sphere of the same radii about a

A. $\sqrt{\frac{7}{3}}$

B. $\frac{5}{\sqrt{21}}$

C. $\sqrt{\frac{21}{5}}$

D. $\frac{25}{9}$

Answer: B

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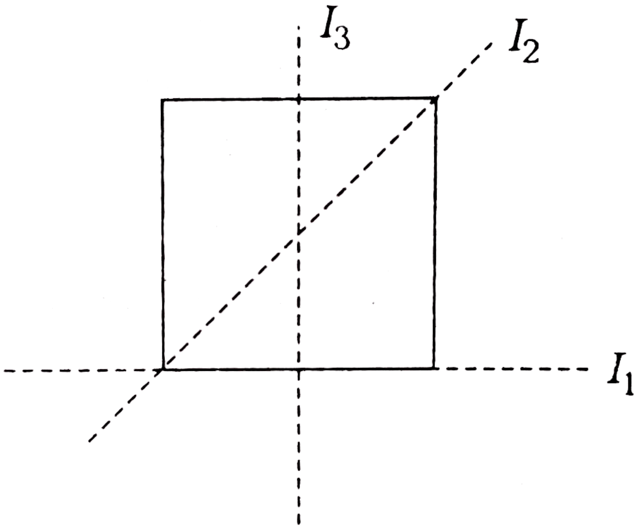
38. A square lamina is as shown in figure. The moment of inertia of the frame about the three axes as shown in figure I_1, I_2 and I_3 respectively. Select the correct alternative.



A. $I_2 = I_2 > I_1$

B. $I_1 > I_2 > I_3$

C. $I_2 = I_3 < I_1$

D. $I_1 < I_2 < I_3$

Answer: C

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39. The ratio of the radii of gyration of a circular disc about a tangential axis in the plane of the disc and a circular ring of the same radius about a tengential axis in the plane of the ring is

A. $\sqrt{3}:\sqrt{4}$

B. $\sqrt{5}:\sqrt{6}$

C. $\sqrt{6}:\sqrt{5}$

D. $\sqrt{4}:\sqrt{3}$

Answer: B

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40. A thin uniform circular disc of mass M and radius R is rotating in a horizontal plane about an axis passing through its centre and perpendicular to its plane with an angular velocity ω . Another disc of same dimensions but of mass $\frac{1}{4}$ M is placed gently on the first disc co-axially. The angular velocity of the system is

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

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

C. $\frac{3}{4}\omega$

D. $\frac{1}{3}\omega$

Answer: B

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41. A ring is kept on a rough inclined surface. But the coefficient of friction is less than the minimum value required for pure rolling. At any instant of time let K_T and K_R be the translational and rotational kinetic energies of the ring, then

A. $K_R = K_T$

B. $K_R > K_T$

C. $K_T > K_R$

D. $K_R = 0$

Answer: C

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42. A wheel of bicycle is rolling without slipping on a level road. The velocity of the centre of mass is v_{CM}, then true statement is

A. the velocity of point A is $2v_{CM}$ and velocity of point B is zero

B. the velocity of point A is zero and velocity of point BN is $2v_{CM}$

C. the velocity of point A is $2v_{CM}$ and velocity of point B is $-v_{CM}$

D. the velocities of both A and B are v_{CM}

Answer: A

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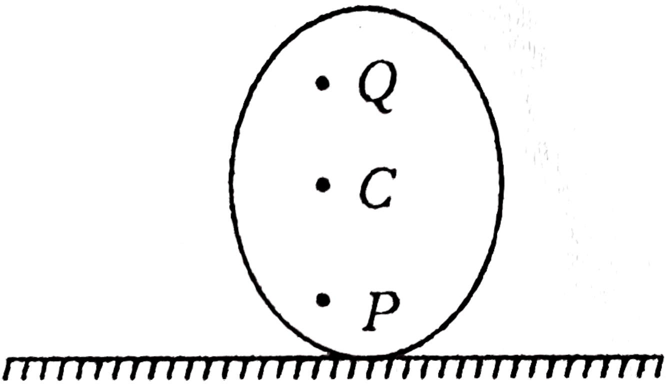
43. A disc is rolling without slipping on a horizontal surface with C, as its centre and Q and P the two points equidistant from C. Let v_P, v_Q and v_C be the magnitudes of velocities of point P,Q and C respectively, then



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. $v_Q < v_C > v_P$

Answer: A

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44. A rigid body rotates with an angular momentum L. If its rotational kinetic energy is made 4 times, its angular momentum will become

A. 4L

B. 16L

C. $\sqrt{2}L$

D. 2L

Answer: D

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45. A rigid and a disc of different masses are rotating with the same kinetic energy. If we apply a retarding torque τ on the ring, it stops after making n revolution. After how many revolutions will the disc stop, if the retarding torque on it is also τ ?

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

B. n

C. $2n$

D. Data insufficient

Answer: B

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46. Work done by friction in case of pure rolling

A. is always zero

B. is always positive

C. is always negative

D. may be positive,negative or zero

Answer: A

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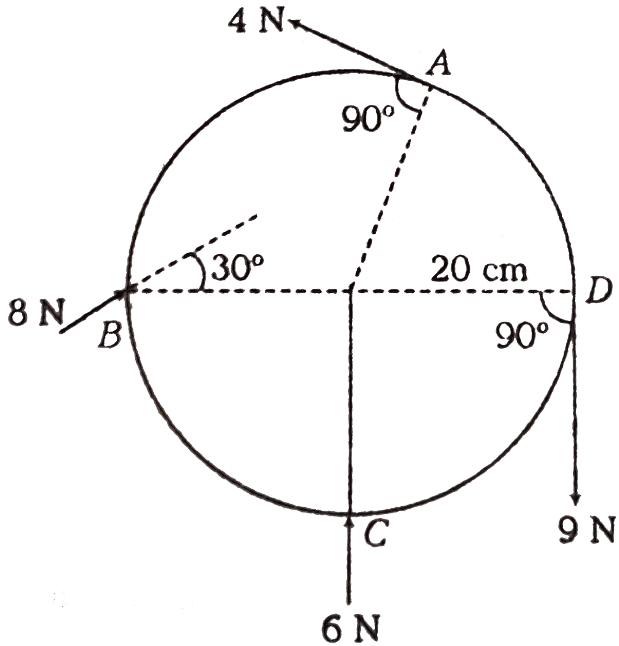
47. Forces are applied on a wheel of radius 20 cm as shown in the figure. The torque produced by the forces 4 N at A, 8N at

B, 6 N at C and 9N at D at angles indicated is



A. 5.4 N-m anti-clockwise

B. 1.80 N-m clockwise

C. 2.0 N-m clockwise

D. 3.6 N-m clockwise

Answer: B

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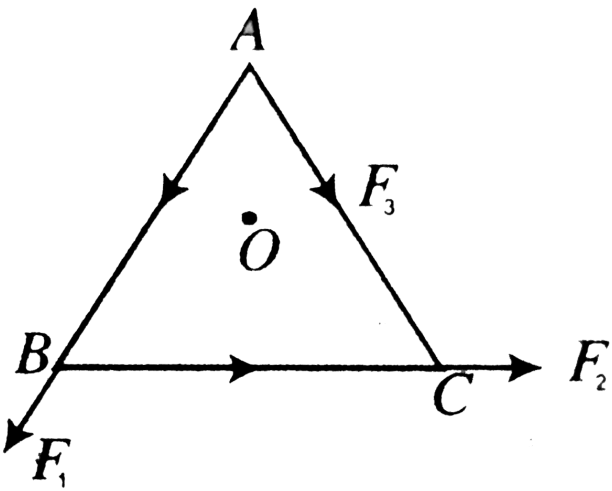
48. O is the centre of an equilateral triangle ABC. F_1, F_2 and F_3 are the three forces acting along the sides AB, BC and AC respectively. What should be the value of F_3 so that the total torque about O is zero?



A. $\frac{(F_1 + F_2)}{2}$

B. $(F_1 - F_2)$

C. $\left(F_1 + F_2\right)$

D. $2\left(F_1 + F_2\right)$

Answer: C

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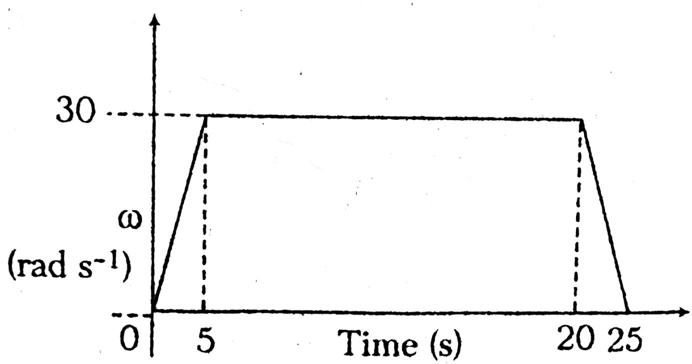
49. The figure shows the angular velocity versus time graph of a flywheel. The angle, in radians through which the flywheel turns during 25 s is



A. 120

B. 480

C. 600

D. 750

Answer: C

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50. A table fan, rotating at a speed of 2400 rpm, is switched off and the resulting variation of the rpm with time is shown in the figure. The total number of revolutions of the fan before it comes to rest is

A. 420

B. 190

C. 280

D. 380

Answer: C

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51. A sphere can roll on a surface inclined at an angle θ, if the friction coefficient $\mu > (2/7)g\sin\theta$. Now suppose the friction coefficient is $(1/7)g\sin\theta$ and the sphere is released from rest on the incline, then

A. it will stay at rest

B. it will make pure translational motion

C. it will translate and rotate about the centre

D. the angular momentum of he sphere about its centre will remains constant

Answer: C

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52. If a disc of mass m and radius r is reshaped into a ring of radius$2r$, the mass remining the same, the radius of gyration about centrodal axis perpendicular to plane goes up by a factor of

A. $\sqrt{2}$

B. 2

C. $2\sqrt{2}$

D. 4

Answer: C

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53. A disc of mass m and radius R is rolling on horizontal ground with linear velocity v. What is the angular momentum of the disc about an axis passing through bottommost point and perpendicular to the plane of motion ?

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

B. mvR

C. $\frac{1}{2}mvR$

D. $\frac{4}{3}mvR$

Answer: A

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54. Two discs have same mass and thickness. Their materials are of densities d_1 and d_2. The ratio of their moments of inertia about an axis passing through the centre and perpendicular to the plane is

A. $d_1 : d_2$

B. $d_2 : d_1$

C. $\left(\frac{d_1}{d_2}\right)^2$

D. $\left(\frac{d_2}{d_1}\right)^2$

Answer: B

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55. A ball rolls without slipping. The radius of gyration of the ball about an axis passing through its centre of mass is K, If radius of the ball be R, then the fraction of total energy associated with its rotational energy will be

A. $\dfrac{K^2}{K^2 + R^2}$

B. $\dfrac{R^2}{K^2 + R^2}$

C. $\dfrac{K^2 + R^2}{R^2}$

D. $\dfrac{K^2}{R^2}$

Answer: A

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56. The speed of a homogenous solid sphere after rolling down an inclined plane of vertical height h, from rest without sliding is

A. $\sqrt{gh}$

B. $\sqrt{\left(\frac{g}{5}\right)gh}$

C. $\sqrt{\left(\frac{4}{3}\right)gh}$

D. $\sqrt{\left(\frac{10}{7}\right)gh}$

Answer: D

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57. Consider three solid spheres, sphere (i) has radius r and mass m, sphere (ii) has radius r and mass 3 m, sphere (iii) has radius 3r and mass m, All can be placed at the same point on the same inclined plane, where they will roll without slipping to the bottom, If allowed to roll down the incline, then at the bottom of the incline

A. sphere (i) will have the largest speed

B. sphere (ii) will havethe largest speed

C. sphere (iii) will have the largest kinetic energy

D. all the sphere will have equal speeds.

Answer: D

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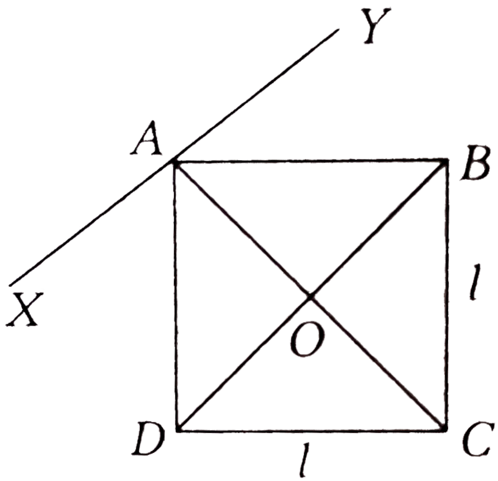
58. Four point masses each of value m, are placed at the corners of a square ABCD of side l, The moment of inertia of the system about an axis passing throught A and parallel to BD is



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

B. $3ml^2$

C. ml^2

D. $2ml^2$

Answer: B

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59. The density of a non-uniform rod of length 1m is given by $\rho(x) = a\left(1 + bx^2\right)$ where, a and b are constant and $0 \leq x \leq 1$. The centre of mass of the rod will be at

A. $\dfrac{3(2+b)}{4(3b+b)}$

B. $\dfrac{4(2+b)}{3(3+b)}$

C. $\dfrac{3(3+b)}{4(2+b)}$

D. $\dfrac{4(3+b)}{3(2b+b)}$

Answer: A

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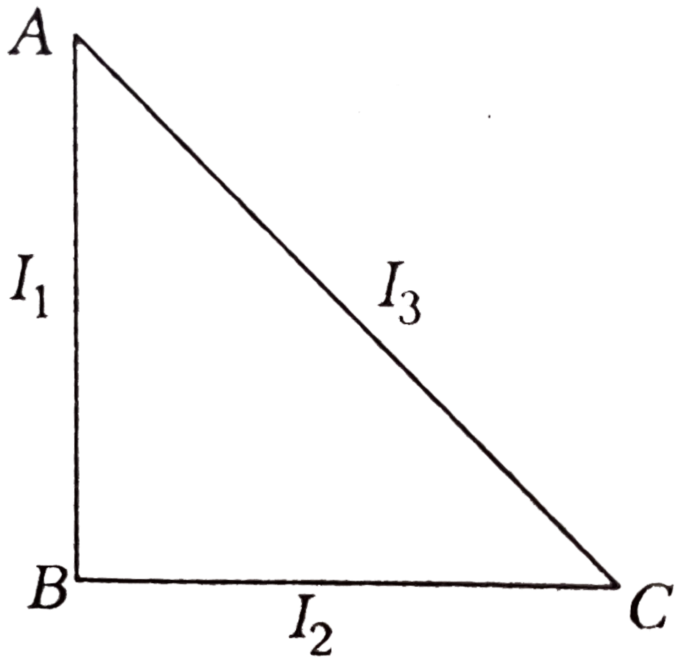
60. ABC is a right angled triangular plate of uniform thickness. The sides are such that $AB > BC$ as shown in figure. I_1, I_2 and I_3 are moments of inertia about AB,BC and AC respectively. Then, which of the following relation is correct ?



A. $I_1 = I_2 = I_3$

B. $I_2 > I_1 > I_3$

C. $I_3 < I_2 < I_1$

D. $I_2 > I_1 > I_2$

Answer: B

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61. The moment of inertia of a cube of mass m and side a about one of its edges is equal to

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

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

C. $3ma^2$

D. $\frac{8}{3}ma^2$

Answer: B

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62. Two uniform, thin identical rods each of mass M and length l are joined together to form a cross. What will be the moment of inertia of the cross about an axis passing through the point at which the two rods are joined and perpendicular to the plane of the cross ?

A. $\frac{Ml^2}{12}$

B. $\frac{Ml^2}{6}$

C. $\frac{Ml^2}{4}$

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

Answer: B

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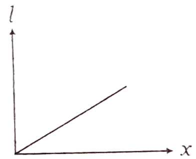
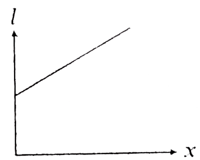
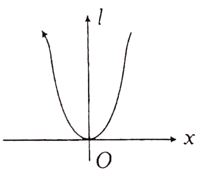
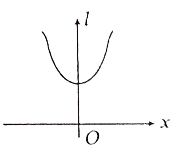
63. Figure represents the moment of inertia of the solid sphere about an axis parallel to the diameter of the solid sphere and at a distance x from t. Which one of the following represents the variations of I with x ?

A. (a) 

B. (b) 

C. (c) 

D. (d) 

Answer: D

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64. When a body is projected at an angle with the horizontal in the uniform gravitational field of the earth, the angular momentum of the body about the point of projection, as it proceeds along its path

A. remains constant

B. increases

C. decreases

D. initially decreases and after its highest point increases

Answer: B

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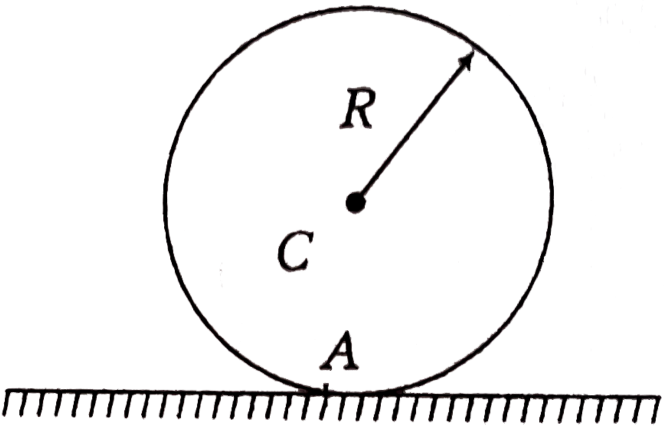
65. A disc of radius R rolls on a rough horizontal surface. The distance covered by the point A in one revolution is



A. $2\pi R$

B. 2R

C. 8R

D. πR

Answer: C

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66. A uniform rod of mass 2 kg and length 1 m lies on a smooth horizontal plane. A particle of mass 1 kg moving at a speed of $2ms^{-1}$ perpendicular to the length of the rod strikes it at a distance $\frac{1}{4}$m from the centre and stops. What is the angular velocity of the rod about its centre just after the collision ?

A. $3rads^{-1}$

B. $4rads^{-1}$

C. $1rads^{-1}$

D. $2rads^{-1}$

Answer: A

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67. A particle P is moving in a circle of radius a with a uniform speed u, C is the centre of the circle and AB is a diameter. The angular velocities of P about A and C are in the ratio

A. $1:1$

B. $1:2$

C. $2:1$

D. $4:1$

Answer: B

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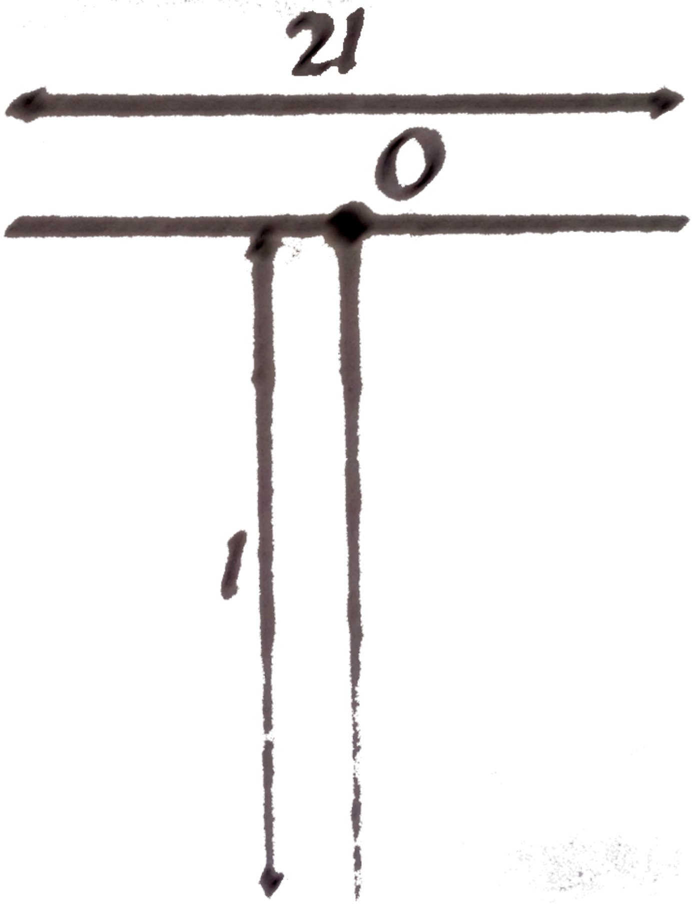
68. For the uniform T shaped structure, with mass 3M, moment of inertia about an axis normal to the plane and passing through O would be



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

B. Ml^2

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

D. None of these

Answer: B

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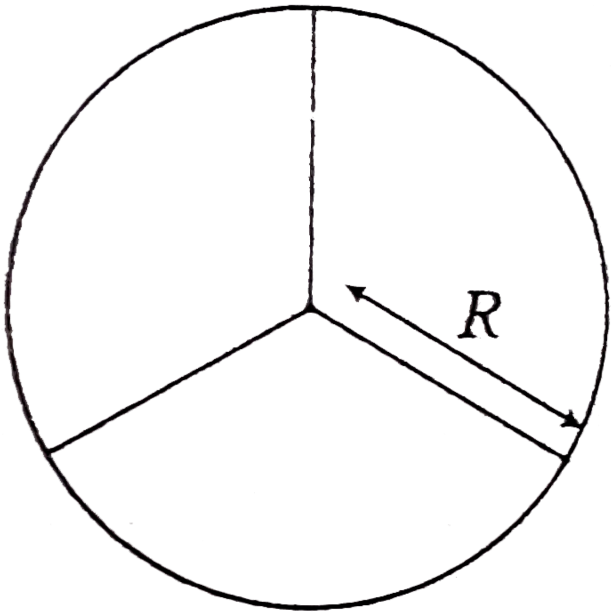
69. A wheel comprises a ring of radius R and mass M and three spokes of mass m each. The moment of inertia of the wheel about its axis is



A. $\left(M+\frac{m}{4}\right)R^2$

B. $(M+m)R^2$

C. $(M+3m)R^2$

D. $\left(\frac{M+m}{2}\right)R^2$

Answer: B

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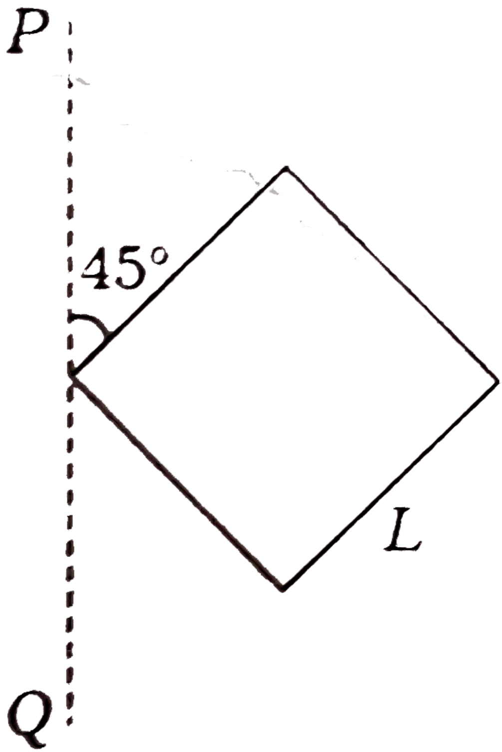
70. A square is made by joining four rods each of mass M and length L. Its moment of inertia about an axis PQ, in its plane and passing through one of its corner is



A. $6ML^2$

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

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

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

Answer: C

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71. A solid homogeneous sphere is moving on a rough horizontal surface, partly rolling and partly sliding. During the king of motion of the sphere.

A. total kinetic energy is conserved

B. angular momentum of the sphere about the point of contact with the plane is conserved

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

D. angular momentum about centre of mass is conserved

Answer: B

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72. A sphere cannot roll on

A. a smooth inclined surface

B. a smooth horizontal surface

C. a rough inclined surface

D. a rough horizontal surface

Answer: B

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73. A thin bar of mass m and length l is free to rotate about a fixed horizontal axis through a point at its end. The bar is brought to a horizontal position. $\left(\theta = 90\,^{\circ}\right)$ and then released. The angular velocity when it reaches the lowest point is

A. directly proportional to its length and inversely proportional to its mass

B. independent of mass and inversely proportional to the square root of its length

C. dependent only upon the acceleration due to gravity and the mass of the bar

D. directly proportional to its length and inversely proportional to its length and inversely proportional to the acceleration due to gravity.

Answer: B

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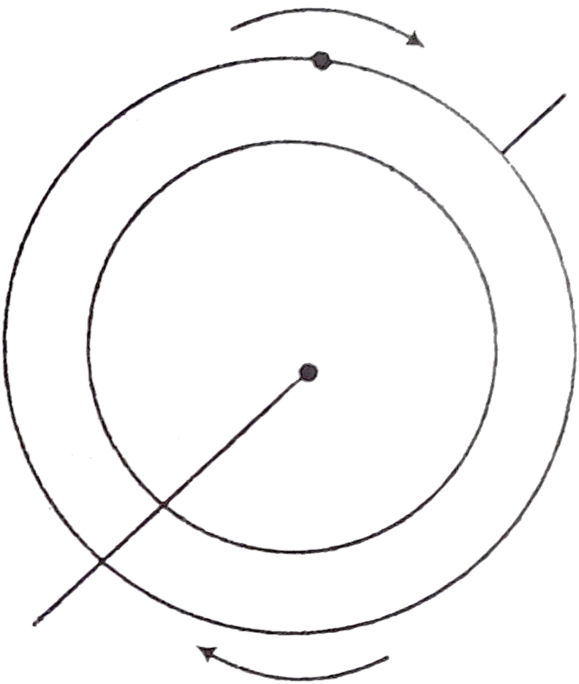
74. A disc is free to rotate about a smooth horizontal axis passing through its centre of mass. A particle is fixed at the top of the disc. A slight push is given to the disc and it starts rotating. During the process.



A. only mechanical energy is conserved

B. only angular momentum (about the axis of rotation) is conserved

C. both mechanical energy and angular momentum are conserved

D. Neither the mechanical energy nor the angular momentum are conserved.

Answer: A

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75. A rod of length L whose lower end is fixed along the horizontal plane starts to topple from the vertical position. The velocity of the upper end of the rod when it hits the ground is

A. $\sqrt{3gL}$

B. $\sqrt{2gL}$

C. $\sqrt{gL}$

D. $\sqrt{5gL}$

Answer: A

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76. A solid sphere and a solid cylinder of same mass are rolled down on two inclined planes of heights h_1 and h_2 respectively. If at the bottom of the plane the two objects have same velocities, then the ratio of $h_1 : h_2$ is

A. $2:3$

B. $7:5$

C. $14:15$

D. $15:14$

Answer: C

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77. A solid sphere of mass 2 kg rolls up a 30° incline with an initial speed of $10ms^{-1}$. The maximum height reached by the sphere is $\left(g = 10ms^{-2}\right)$

A. 3.5 m

B. 7 m

C. 10.5 m

D. 14 m

Answer: B

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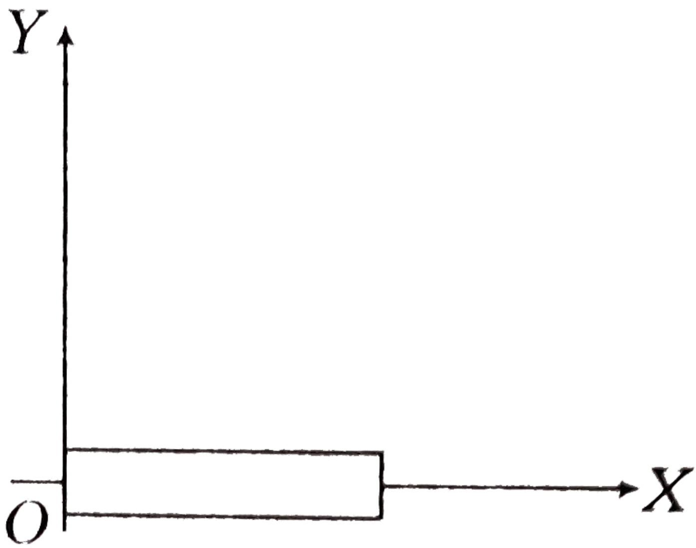
78. The figure shows a uniform rod lying along the X-axis. The locus of all the points lying on the XY-plane, about which the moment of inertia of the rod is same as that about O is



A. an ellipse

B. a circle

C. a parabola

D. a straight line

Answer: B

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79. A cord is wound around the circumference of wheel of radius r. The axis of the wheel is horizontal and MI is I. A weight mg is attached to the end of the cord and falls from rest. After falling through a distance h, the angular velocity of the wheel will be

A. $\sqrt{\frac{2gh}{I+mr^2}}$

B. $\left(\frac{2mgh}{I+mr^2}\right)^{1/2}$

C. $\left(\frac{2mgh}{I+2mr^2}\right)^{1/2}$

D. $\sqrt{2gh}$

Answer: B

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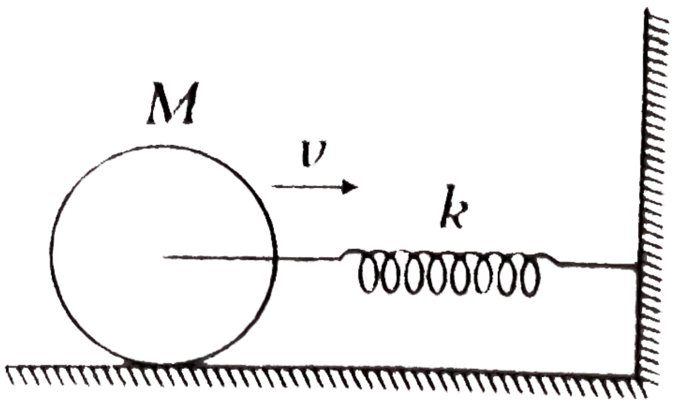
80. A solid sphere rolls without slipping and presses a spring of spring constant k as shown in figure. Then, the compression in the spring will be



A. $v\sqrt{\frac{2M}{3k}}$

B. $v\sqrt{\frac{2M}{5k}}$

C. $v\sqrt{\frac{5k}{7M}}$

D. $v\sqrt{\frac{7M}{5k}}$

Answer: D

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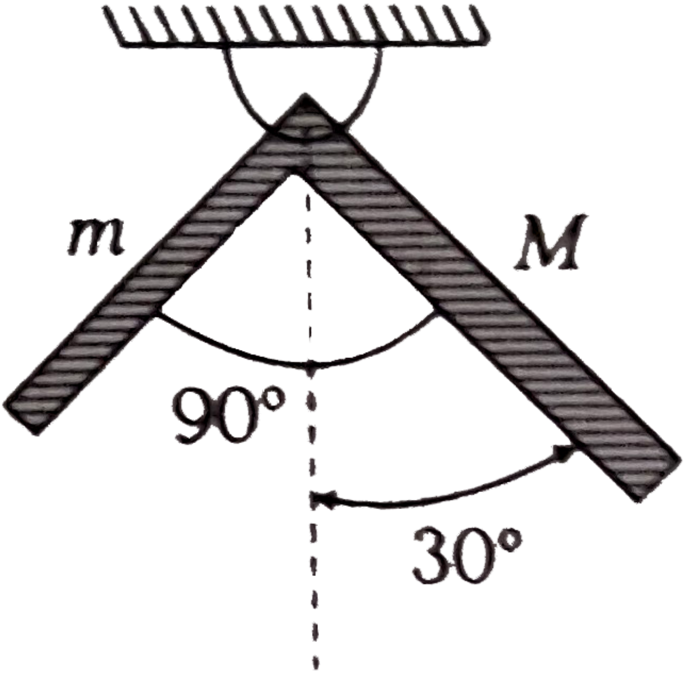
81. Two uniform rods of equal length but different masses are rigidly joined to form an L-shaped body, which is then pivoted as shown in figure. If in equilibrium the body is in the shown configuration, ratio M/m will be



A. 2

B. 3

C. $\sqrt{2}$

D. $\sqrt{3}$

Answer: D

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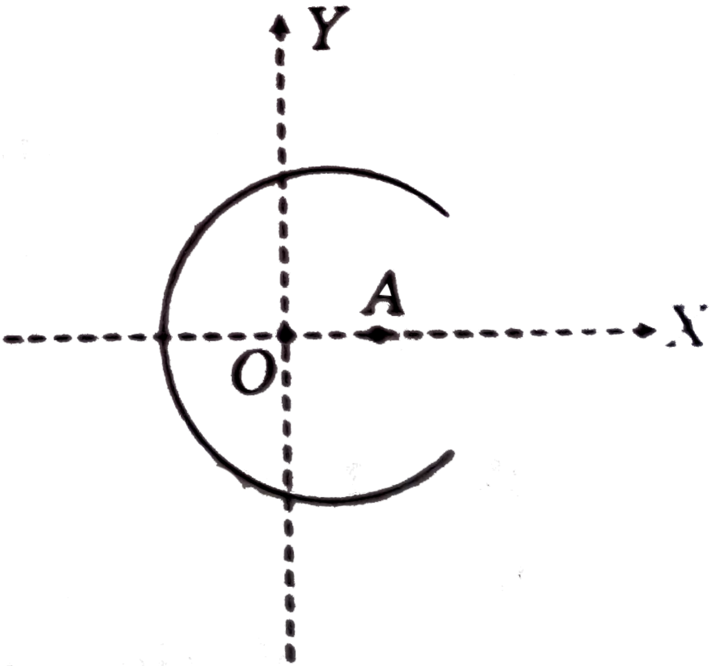
82. A portion of a ring of radius R has been removed as shown in figure. Mass of the remaining portion is m. Centre of the ring is at origin O. Let I_A and I_O be the moment of inertia passing through points A and O are perpendicular to the plane of the ring. Then,



A. $I_O = mR^2$

B. $I_O = I_A$

C. $I_O > I_A$

D. $I_A > I_O$

Answer: D

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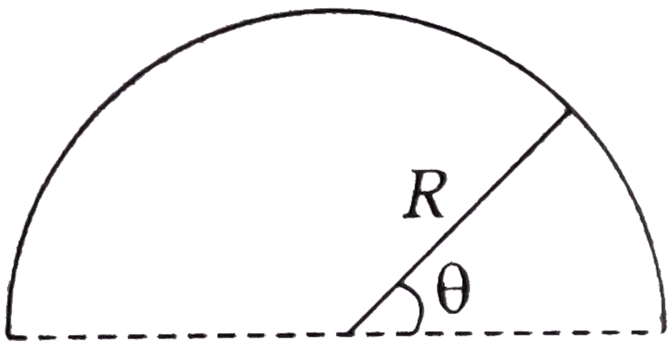
83. The moment of inertia of a semicircular ring of mass M and radius R about an axis which is passing through its centre and at an angle θ with the line joining its ends as shown in figure is



A. $\frac{MR^2}{4}$ if $\theta = 0^\circ$

B. $\frac{MR^2}{2}$ if $\theta = 0^\circ$

C. $\frac{MR^2}{2}$ if $\theta =$ any angle

D. $\frac{MR^2}{2}$ if $\theta = 90^\circ$

Answer: C

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(B) Chapter Exercises

1. Assertion : Moment of inertia about an axis passing throught centre of mass is always minimum

Reason : Theorem of parallel axis can be applied for 2-D as well as 3-D bodies.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: B

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2. Assertion : A body is moving along a circle with a constant speed. Its angular momentum about the centre of the circle remains constant

Reason : In this situation, a constant non-zero torque acts on the body.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: C

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3. Assertion : The angular velocity of a rigid body in motion is defined for the whole body

Reason : All points on a rigid body performing pure rotational motion are having same angular velocity.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: B

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4. Assertion : If a particle is rotating in a circle, then angular momentum about centre is mvR

Reason : In circular motion, angular momentum about centre is always constant.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: A

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5. Assertion : If we draw a circle around the centre of mass of a rigid body, then moment of inertia about all parallel axes passing through any point on this circle has a constant value.

Reason : Dimensions of radius gyration are $\left[M^0LT^0\right]$

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: B

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6. Assertion : The condition of equilibrium for a rigid body is

Translational equilibrium $\Sigma F = 0$ and

Rotational equilibrium $\Sigma \tau = 0$

Reason : A rigid body musy be in equilibrium under the action of two equal and opposite forces.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: C

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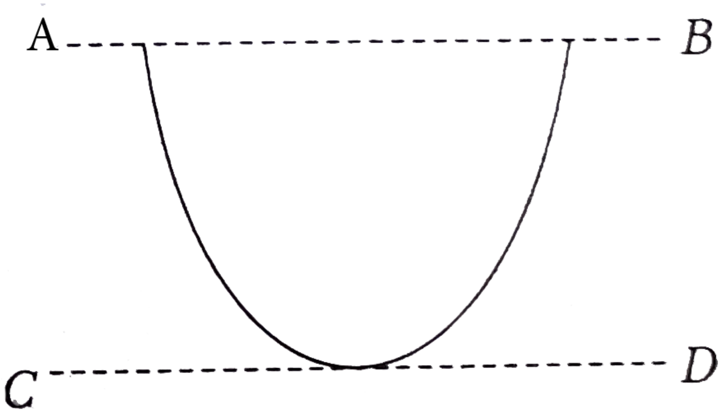
7. Assertion : Two axes AB and CD are as shown in figure. Given figure is of a semi-circular ring. As the axis moves from AB towards CD, moment of inertia first decreases, then increases.



Reason : Centre of mass lies somewhere between AB and CD.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: A

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8. Assertion : If a particle moves with a constant velocity, then angular momentum of this particle about any point remains constant.

Reason : Angular momentum has the units of Plank's constant.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: B

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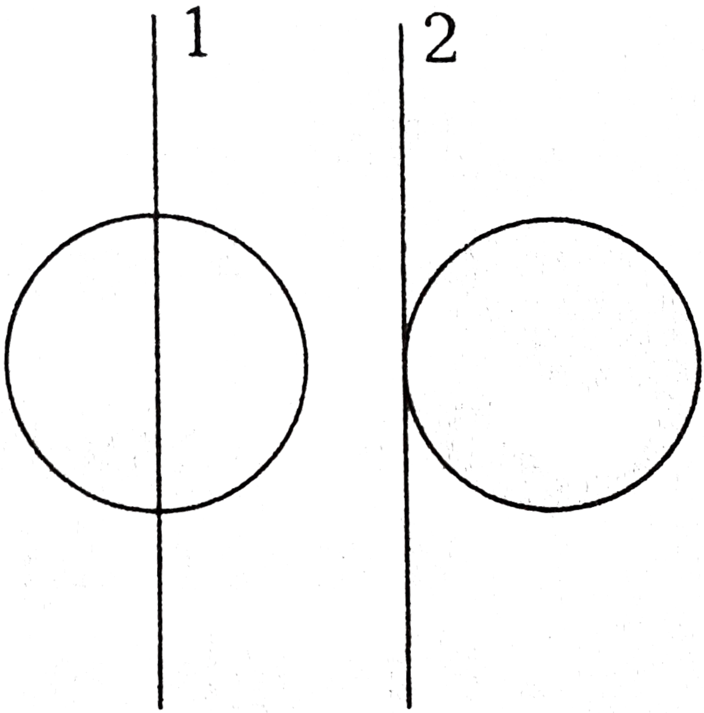
9. Assertion : Two identical solid spheres are rotated frm rest to same angular velocity ω about two different axes as shown in figure. More work will have to be done to rotate the sphere in case-2

Reason : Moment of inertia is case-2 is more.



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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: A

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10. Assertion : A ring and a disc of same mass and radius begin to roll without slipping from the top of an inclined surface at $t = 0$. The ring reaches the bottom of incline in time t_1 while the disc reaches the bottom in time t_2, then $t_1 < t_2$

Reason : Disc will roll down the plane with more acceleration because of its lesser value of moment of inertia.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: D

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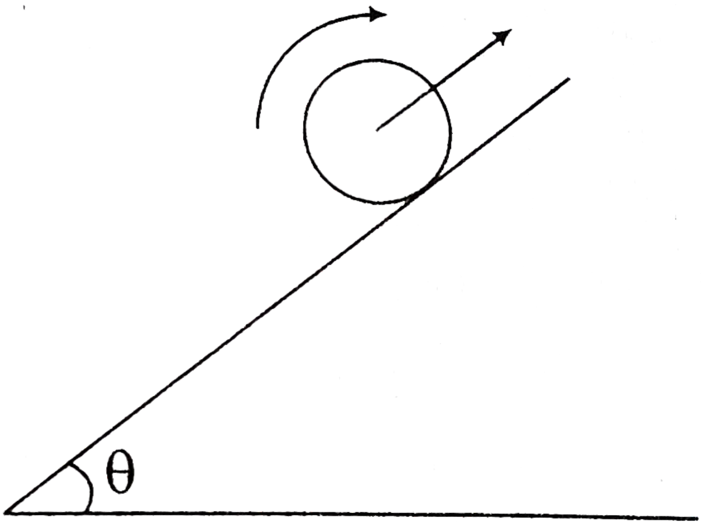
11. Assertion : A sphere is placed in pure rolling condition over a rough inclined surface.Then, force of friction will act in downward direction



Reason : Angular acceleration (actually retardation) due to friction is anti-clockwise.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: D

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12. Assertion : In rotational plus translational motion of a rigid body, different particles of the rigid body may have different velocities but they will have same accelerations

Reason : Translational motion of a particle is equivalent to the translation motion of a rigid body.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: D

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13. Assertion : Angular momentum of sun and planet system about any point remains constant

Reason : Two equal and opposite forces will acts on them. Net torque of these two set of forces about any point is zero.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: A

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14. Assertion : Moment of inertia about an axis passing throught centre of mass is always minimum

Reason : Theorem of parallel axis can be applied for 2-D as well as 3-D bodies.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: C

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15. Assertion : A solid sphere cannot roll without slipping on smooth horizontal surface

Reason : If the sphere is left free on smooth inclined surface. It cannot roll without slipping.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: D

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16. Assertion : Speed of any point on rigid body executing rolling motion can be calculated by expression $v = r\omega$, where r is distance of point from intantaneous centre of rotation

Reason : Rolling motion of rigid body can be considered as a pure rotation about instantaneous centre of rotation.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: C

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17. Assertion : A solid sphere and a ring of same mass and radius are released simultaneously from the top of an inclined surface. The two objects roll down the plane without slipping. They reach the bottom of the incline with equal linear speeds

Reason : Decrease in potential enery for both is the same.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: D

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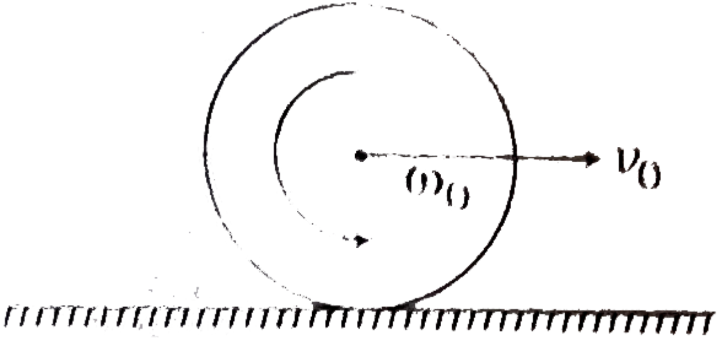
18. Assertion : A uniform disc of radius R is performing impure rolling motion on a rough horizontal plane as shown in figur. After some time the disc comes to rest. It is possible only when $v_0 = \frac{\omega_0 R}{2}$



Reason : For a body performing pure rolling motion, the angular momentum uis conserved about any point in space.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: C

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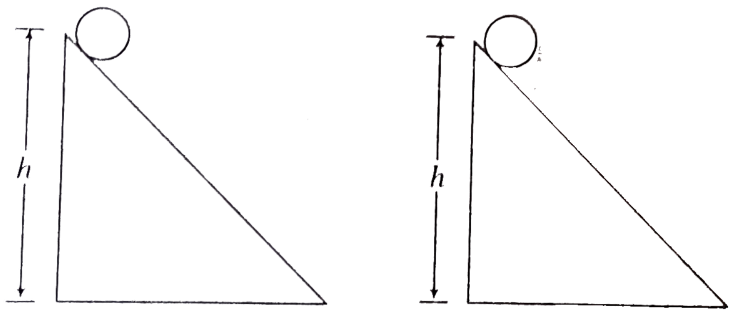
19. Assertion : Two identical spherical balls are released from two inclined plane. First is sufficiently rough and second is smooth. Both the balls will have same kinetic energy on reaching the bottom



Reason : Linear velocity of second ball will be more.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: B

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20. Assertion : A solid and a hollow sphere both of equal masses and radii are put on a rough surface after rotating with some angular velocity say ω_0. Coefficient of friction for both the spheres and ground is same. Solid sphere will start pure rolling first

Reason : Radius of gyration of hollow sphere about an axis passing through its centre of mass is more.

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

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

C. If Assertion is true but Reason is fasle

D. If Assertion is false but Reason is true

Answer: A

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21. If radius if earth is reduced to half without changing its mass, then match the following columns

	Column-I		Column-II
(A)	Angular momentum of earth	(p)	Will become two times
(B)	Time period of rotation of earth	(q)	Will become four times
(C)	Rotational kinetic energy of earth	(r)	Will remain constant
(D)		(s)	None

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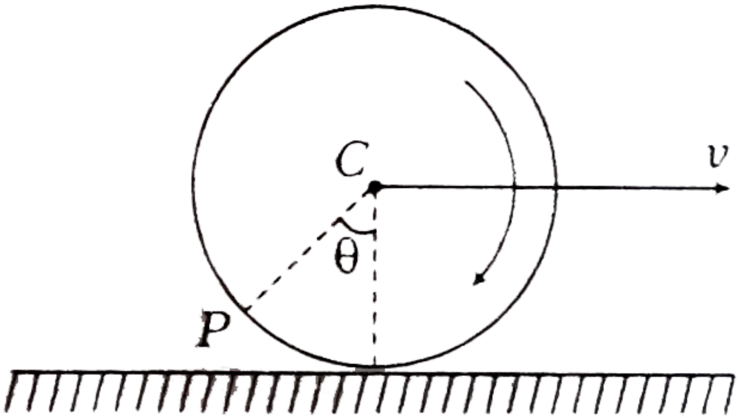
22. A disc rolls on ground without slipping. Velocity of centre of mass is v. There is a point P on circumference of disc at angle θ. Suppose, v_P is the speed of this point. Then, match the following columns



	Column-I		Column-II
(A)	If $\theta = 60^\circ$	(p)	$v_P = \sqrt{2}v$
(B)	If $\theta = 90^\circ$	(q)	$v_P = v$
(C)	If $\theta = 120^\circ$	(r)	$v_P = 2v$
D)	If $\theta = 180^\circ$	(s)	$v_P = \sqrt{3}v$

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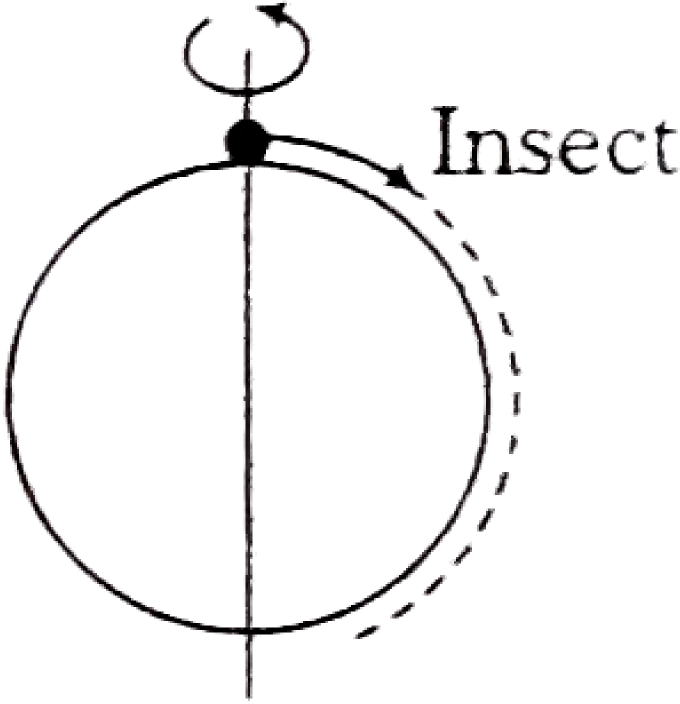
23. A solid sphere is rotating about an axis shown in figure. An insect follows the dotted path on the circumference of sphere as shown in the figure.



	Column-I		Column-II
(A)	Moment of inertia	(p)	Will remain constant
(B)	Angular velocity	(q)	Will first increase, then decrease
(C)	Angular momentum	(r)	Will first decrease then increase
(D)	Rotational kinetic energy	(s)	Will continuously decrease
		(t)	Will continuously increase

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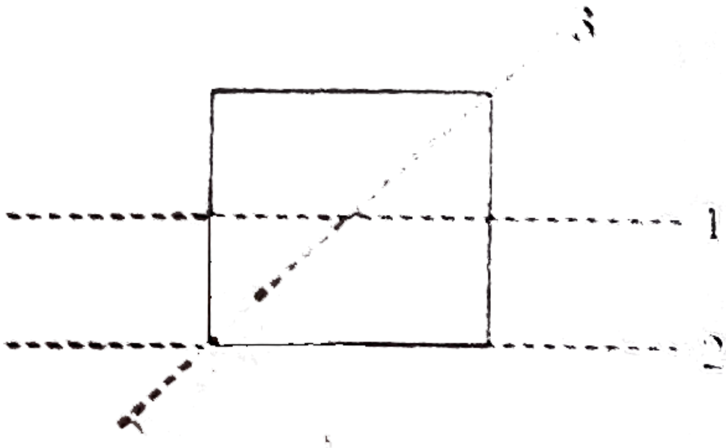
24. Four rods of equal length l and mass m each forms a square as shown in figure

Moment of inertia about three axes 1,2 and 3 are say I_1, I_2 and I_3. Then, match the following columns



Column-I		Column-II
(A) I_1	(p)	$\frac{4}{3}ml^2$
(B) I_2	(q)	$\frac{2}{3}ml^2$
(C) I_3	(r)	$\frac{1}{2}ml^2$
	(s)	None

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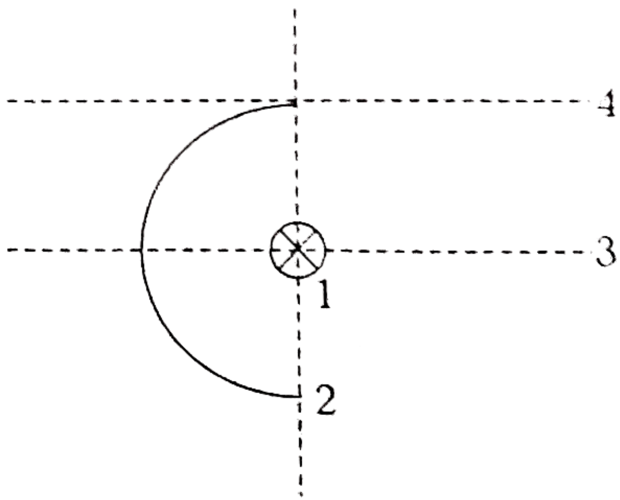
25. A semicircular ring has mass m and radius R as shown in figure. Let I_1, I_2, I_3 and I_4 be the moments of inertia of the four axes as shown. Axis 1 passes through centre and is perpendicular to plane of ring. Then, match the following columns.



	Column-I		Column-II
(A)	I_1	(p)	$\frac{mR^2}{2}$
(B)	I_2	(q)	$(3/2)mR^2$
(C)	I_3	(r)	mR^2
(D)	I_4	(s)	Data is insufficient

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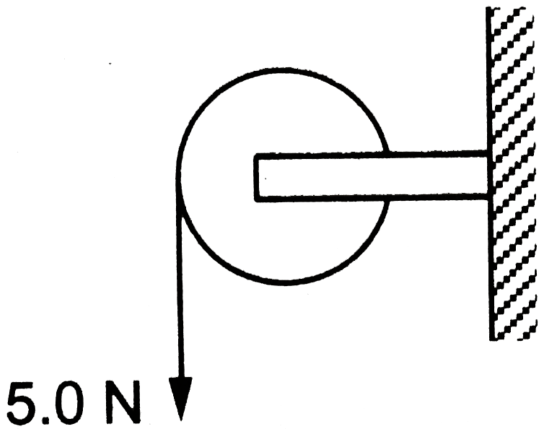
(C) Chapter Exercises

1. A wheel of radius 10 cm can rotate freely about its centre as shown in figure. A string is wrapped over its rim and is pulled by a force of 5.0 N. It is found that the torque produces an angular acceleration 2.0 $ra\frac{d}{s^2}$ in the wheel. Calculate the moment of inertia of the wheel.



A. 0.25kg-m^2

B. 0.45kg-m^2

C. 0.15kg-m^2

D. 0.16kg-m^2

Answer: A

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2. From a disc of radius R and $mass M$, a circular hole of diameter R, whose rim passes through the centre is cut. What is the moment of inertia of remaining part of the disc about a perependicular axis, passing through the centre ?

A. $13MR^2/32$

B. $11MR^2/32$

C. $9MR^2/32$

D. $15MR^2/32$

Answer: A

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3. A disc and a solid sphere of same radius but different masses roll off on two inclined planes of the same altitude and length. Which one of the two objects gets to the bottom of the plane first ?

A. Sphere

B. Both reach at the same time

C. Depends on their masses

D. Disc

Answer: A

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4. A uniform circular disc of radius $50cm$ at rest is free to turn about an axis, which is perpendicular to the plane and passes through its centre. It is subjected to a torque which produces a constant angular acceleration of $2.0rad/s^2$. Its net acceleration in m/s^2 at the end of $2.0s$ is approximately

A. 7

B. 6

C. 3

D. 8

Answer: D

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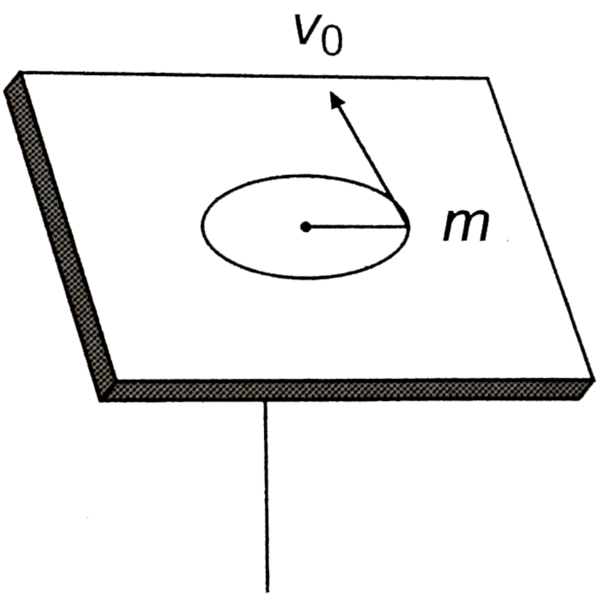
5. A mass m moves in a circles on a smooth horizontal plane with velocity v_0 at a radius R_0. The mass is attached to string which passes through a smooth hole in the plane as shown. The tension in string is increased gradually and finally m moves in a circle of radius $\frac{R_0}{2}$. the final value of the kinetic energy is



A. mv_0^2

B. $\frac{1}{4}mv._0^2$

C. $2mv._0^2$

D. $\frac{1}{2}mv._0^2$

Answer: C

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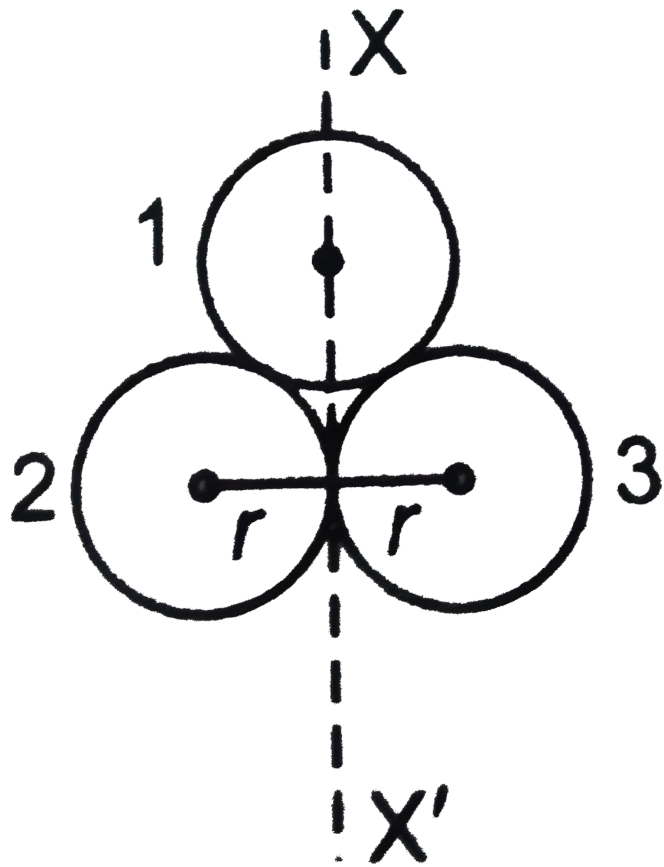
6. Three identical spherical shells each of mass m and radius r are placed as shown in Fig. Consider an axis XX' which is touching the two shells and passing through diameter of third shell. Moment of Inertia of the system consisting of these three spherical shells about XX' as axis is :



A. $\frac{11}{5}mr^2$

B. $3mr^2$

C. $\frac{16}{5}mr^2$

D. $4mr^2$

Answer: D

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7. A uniform metallic rod rotates about its perpendicular bisector with constant angular speed. If it is heated uniformly to raise its temperature slightly, then

A. Its speed of rotation increases

B. Its speed of rotation decreases

C. Its speed of rotation remains same

D. its speed increases because its moment of inertia increases

Answer: B

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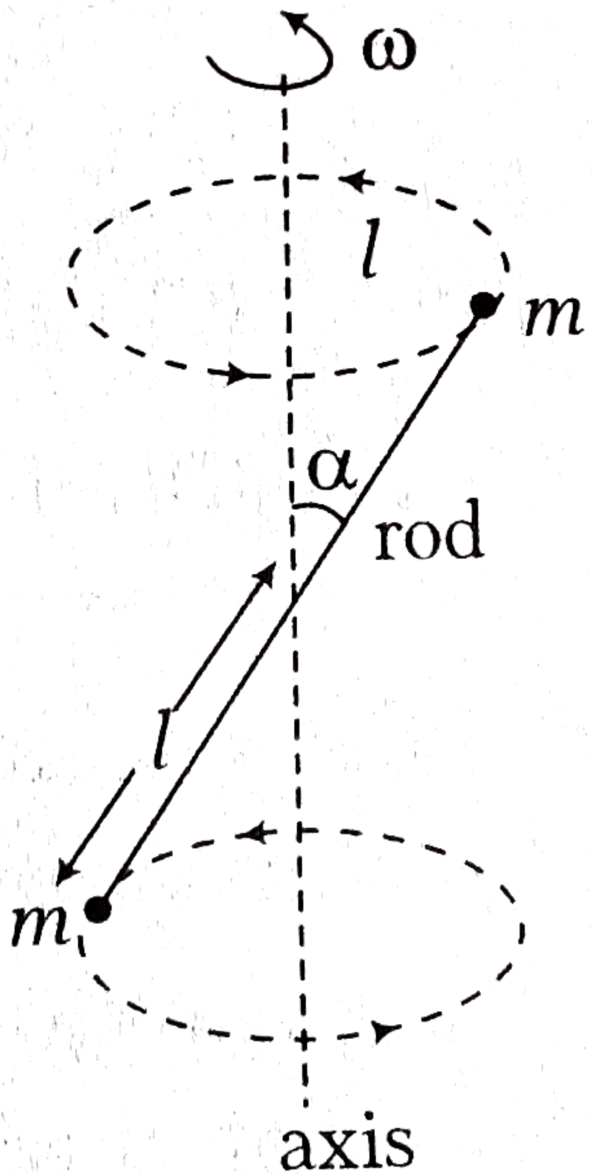
8. A massless rod S having length $2l$ has equal point masses attached to its two ends as shown in figure. The rod is rotating about an axis passing through its centre and making angle α with the axis. The magnitude of change of momentum of rod i.e., $\left|\frac{dL}{dt}\right|$ equals



A. $2ml^3\omega^2\sin\theta.\cos\theta$

B. $ml^2\omega^2\sin 2\theta$

C. $ml^2\sin 2\theta$

D. $m^{1/2}l^{1/2}\omega\sin\theta.\cos\theta$

Answer: B

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9. A particle travels in a circle of radius 20 cm at a uniformly increasing speed. If the speed changes from $8ms^{-1}$ to $9ms^{-1}$ in 2s, what would be the angular acceleration in rad s^{-2} ?

A. 1.5rad s^{-2}

B. 2.5rad s^{-2}

C. 3.5rad s^{-2}

D. 4.5rad s^{-2}

Answer: B

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10. A solid sphere of radius r r is rolling on a horizontal surface. The ratio between the rotational kinetic energy and total energy.

A. $\frac{5}{7}$

B. $\frac{2}{7}$

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

D. $\frac{1}{7}$

Answer: B

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11. If two circular discs A and B are of same mass but of radii r and 2r respectively, then the moment of inertia of A is

A. the same as that of B

B. twice that of B

C. four times that of B

D. one-fourth that of B

Answer: D

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12. Choose the wrong statement.

A. The centre of mass of a uniform circular ring is at its geometric centre

B. Moment of inertia is scalar quantity

C. Radius of gyration is a vector quantity

D. Force in translational motion is analogous to torque in rotational motion

Answer: B

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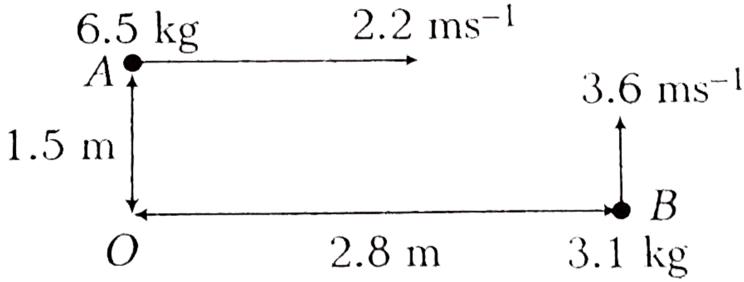
13. Two particle A and B are moving as shown in the figure



Their total angular momentum about the point O is

A. $9.8 kgm^2 s^{-1}$

B. zero

C. $52.7 kgm^2 s^{-1}$

D. $37.9 kgm^2 s^{-1}$

Answer: A

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14. A rod of mass 5 kg is connected to the string at point B. The span of rod is along horizontal. The other end of the rod is hinged at point A. If the string is massless, then the reaction of hinge at the instant when string is cut, is (Take, $g = 10ms^{-2}$)

A. 10.1 N

B. 12.5 N

C. 5 N

D. 15 N

Answer: B

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15. A particle moves with a constant velocity parallel to the X-axis. Its angular momentum with respect to the origin

A. is zero

B. remains constant

C. goes on increasing

D. goes on decreasing

Answer: B

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16. A ring of radius 0.5 m and mass 10 kg is rotating about its diameter with angular velocity of $20 rads^{-1}$. Its kinetic energy is

A. 10 J

B. 100 J

C. 500 J

D. 250 J

Answer: D

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17. A uniform sphere of mass $500g$ rolls without slipping on a plane surface so that its centre moves at a speed of $0.02m/s$. The total kinetic energy of rolling sphere would be (in J)

A. $1.4 \times 10^{-4}J$

B. $0.75 \times 10^{-3}J$

C. $5.75 \times 10^{-3}J$

D. $4.9 \times 10^{-5} J$

Answer: A

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18. A rotating wheel changes angular speed from 1800 rpm to 3000 rpm in 20 s. What is the angular acceleration assuming to be uniform?

A. $60\pi rads^{-2}$

B. $90\pi rads^{-2}$

C. $2\pi rads^{-2}$

D. $40\pi rads^{-2}$

Answer: C

19. The moment of inertia of ring about an axis passing through its diameter is I. Then moment of inertia of that ring about an axis passing through its centre and perpendicular to its plane is

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

B. $2I$

C. $\frac{I}{4}$

D. $4I$

Answer: B

20. Two bodies have their moments of inertia I and $2I$, respectively about their axis of rotation. If their kinetic energies of rotation are equal, their angular velocity will be in the ratio

A. $2:1$

B. $1:2$

C. $\sqrt{2}:1$

D. $1:\sqrt{2}$

Answer: C

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21. A body having a moment of inertia about its axis of rotation equal to 3kg-m^3 is rotating with angular velocity of

$3 rad s^{-1}$. Kinetic energy of this rotating body is same as that of a body of mass 27 kg moving with a velocity v. The value of v is

A. $1 ms^{-1}$

B. $0.5 ms^{-1}$

C. $2 ms^{-1}$

D. $1.5 ms^{-1}$

Answer: A

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22. A uniform solid spherical ball is rolling down a smooth inclined plane from a height h. The velocity attained by the ball when it reaches the bottom of the inclined plane is v. If

ball when it reaches the bottom of the inclined plane is v. If

the ball is now thrown vertically upwards with the same velocity v, the maximum height to which the ball will rise is

A. $\frac{5h}{8}$

B. $\frac{3h}{5}$

C. $\frac{5h}{7}$

D. $\frac{7h}{9}$

Answer: C

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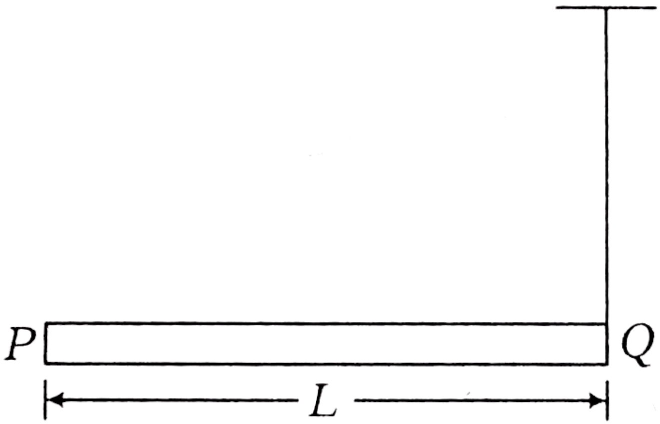
23. A rod PQ of mass M and length L is hinged at end P. The rod is kept horizontal by a massless string tied to point Q as shown in figure. When string is cut, the intial angular acceleration of the rod is



A. $\frac{3g}{2L}$

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

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

D. $\frac{2g}{3L}$

Answer: A

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24. A small object of uniform density rolls up a curved surface with an initial velocity v'. It reaches upto to 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

Answer: D

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25. The conservation of angular momentum demands that

A. the external force on the system must be zero

B. the external torque on the system must be zero

C. Both the external force as well as the external torque must be zero

D. Neither of them must be zero

Answer: B

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26. The moment of inertia (I) and the angular momentum (L) are related by the expression

A. $I = L\omega$

B. $L = I\omega$

C. $L = I^2\omega$

D. $\omega = LI$

Answer: B

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27. The moment of ineria (I) of a sphere of radius R and mass M is given by

A. $I = MR^2$

B. $I = (1/2)MR^2$

C. $I = (4/3)MR^2$

D. $I = (2/5)MR^2$

Answer: D

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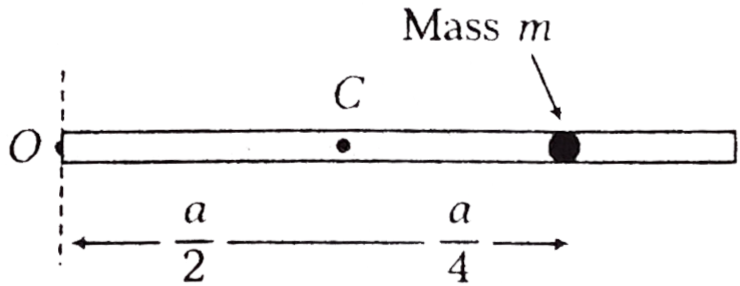
28. A particle mass m is attached to a thin uniform rod of length a at a distance of $\frac{a}{4}$ from the mid-point C as shown in the figure. The mass of the rod is $4m$

The moment of inertia of the combined system about an axis passing through O and perpendicular to the rod is



A. $\frac{91}{48}ma^1$

B. $\frac{27}{48}ma^2$

C. $\frac{51}{48}ma^2$

D. $\frac{64}{48}ma^2$

Answer: A

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29. A particle moving in a circular path has an angular momentum of L. If the frequency of rotation is halved, then its angular momentum becomes

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

B. L

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

D. $\frac{L}{4}$

Answer: A

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30. The torque of a force $F = 2\hat{i} - 3\hat{j} + 5\hat{k}$ acting at a point whose position vector $r = 3\hat{i} - 3\hat{j} + 5\hat{k}$ about the origin is

A. $-3\hat{i} + 5\hat{k}$

B. $-5\hat{i} + 3\hat{k}$

C. $-5\hat{j} - 3\hat{k}$

D. $3\hat{i} - 5\hat{j} + 3\hat{k}$

Answer: C

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31. Moment of inertia of a disc of radius R about a diametric axis is 35kg m^{-2}. The MI of the disc about a parallel axis at a distance $R/2$ from the centre is

A. 31.25kg-m^2

B. 37.5kg-m^2

C. 50kg-m^2

D. 62.5kg-m^2

Answer: B

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32. A wheel having moment of inertia 2kg-m^2 about its vertical axis, rotates at the rate of 60 rpm about this axis. The torque which can stop the wheel's rotation in one minute would be

A. $\frac{\pi}{15}$ N-m

B. $\frac{2\pi}{15}$ N-m

C. $\frac{\pi}{18}$ N-m

D. $\frac{\pi}{12}$ N-m

Answer: A

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33. What is the moment of inertia of solid sphere of density ρ and radius R about its diameter ?

A. $\frac{105}{176}R^2\rho$

B. $\frac{105}{176}R^2\rho$

C. $\frac{176}{105}R^2\rho$

D. $\frac{186}{105}R^2\rho$

Answer: C

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34. The radius of gyration of a body depends upon

A. shape and size of body

B. nature of mass distribution of body

C. choice of axis of rotation

D. All of the above

Answer: D

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35. Two discs have same mass and thickness. Their materials are of densities π_1 and π_2. The ratio of their moment of inertia about central axis will be

A. $1:\rho_1\rho_2$

B. $\rho_1\rho_2:1$

C. $\rho_1:\rho_2$

D. $\rho_2:\rho_1$

Answer: D

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36. If a disc starting from rest acquires an angular velocity of 240rev min^{-1} in 10 s, then its angularw acceleration will be

A. $1.52 rads^{-1}$

B. $3.11 rads^{-1}$

C. $2.51 rads^{-1}$

D. $1.13 rads^{-1}$

Answer: C

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37. A thin hollow sphere of mass m is completely filled with a liquid of mass m. When the sphere rolls with a velocity v kinetic energy of the system is (neglect friction)

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

B. mv^2

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

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

Answer: C

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38. The moment of inertia of a circular loop of radius R, at a distance of $R/2$ around a rotating axis parallel to horizontal diameter of loop is

A. MR^2

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

C. $2MR^2$

D. $\frac{3}{4}MR^2$

Answer: D

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39. A rod of length L is composed of a uniform length 1/2 L of wood mass is m_w and a uniform length 1/2 L of brass whose mass is m_b. The moment of inertia I of the rod about an axis perpendicular to the rod and through its centre is equal to

A. $\left(m_w + m_b\right)L^2/12$

B. $\left(m_w + m_b\right)L^2/6$

C. $\left(m_w + m_b\right)L^2/3$

D. $\left(m_w + m_b\right)L^2/2$

Answer: A

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