PHYSICS

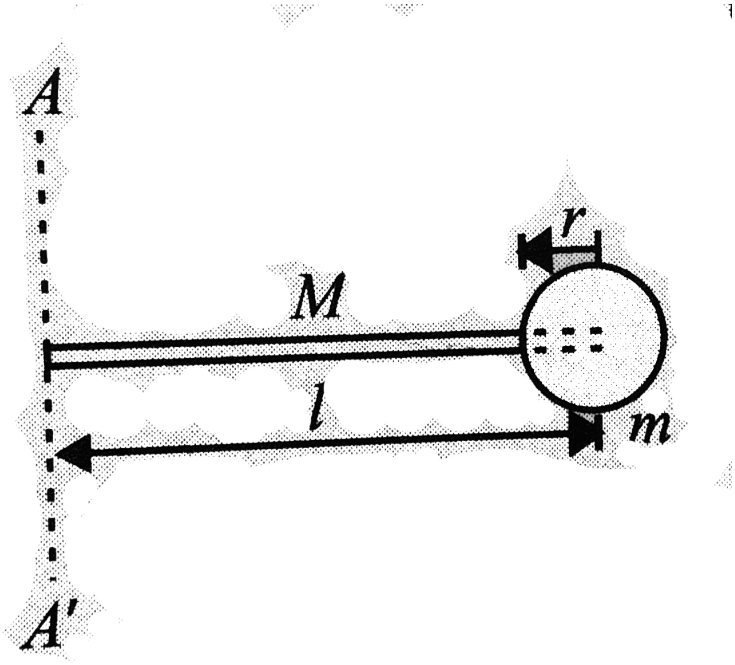
BOOKS - GK PUBLICATIONS PHYSICS (HINGLISH)

RIGID BODIES AND ROTATIONAL MOTION

Illustration

1. Find the moment of inertia about AA' of a spherical ball of mass m and radius r attached at the end of a straight rod of mass M and length l, if this system is free to rotate about an axis passing through

the end of the rod (end of the rod opposite to sphere).



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2. A rod of length l is pivoted about an end . Find the moment of inertia of the rod about this axis if the linear mass density of rod varies as $\rho = ax^2 + b$ kg/m

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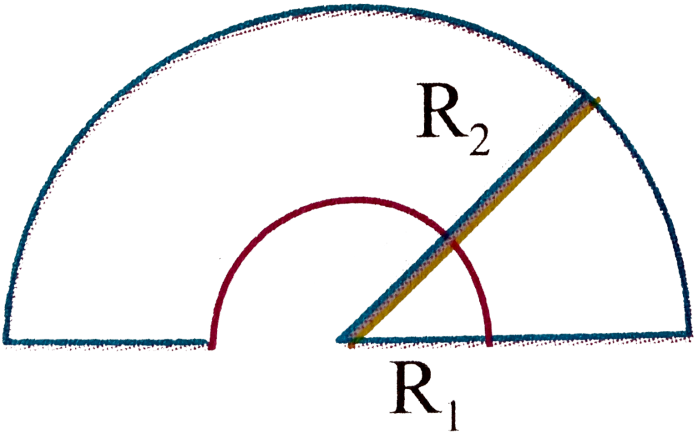
3. Find moment of inertia of half disc of radius R_2 and mass M about its centre. A smaller half disc of radius R_1 is cut from this disc



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4. Find the acceleration of m_1 and m_2 in an Atwood's Machine if there is friction present between surface of pulley and the thread and thread does not slip over the surface ofpulley. Moment of inertia of pulley is I.

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5. A uniform disc of radius R and mass M is mounted on an axis supported in fixed friction less bearing. A light cord is wrapped around the rim of the wheel and suppose we hang a body of mass m from the cord.

(a) Find the angular acceleration of the disc and tangential acceleration ofpoint on the rim.

(b) At a moment t= 0, the system is set in motion, find the time dependence of the angular velocity of the system and the kinetic energy ofthe whole system.

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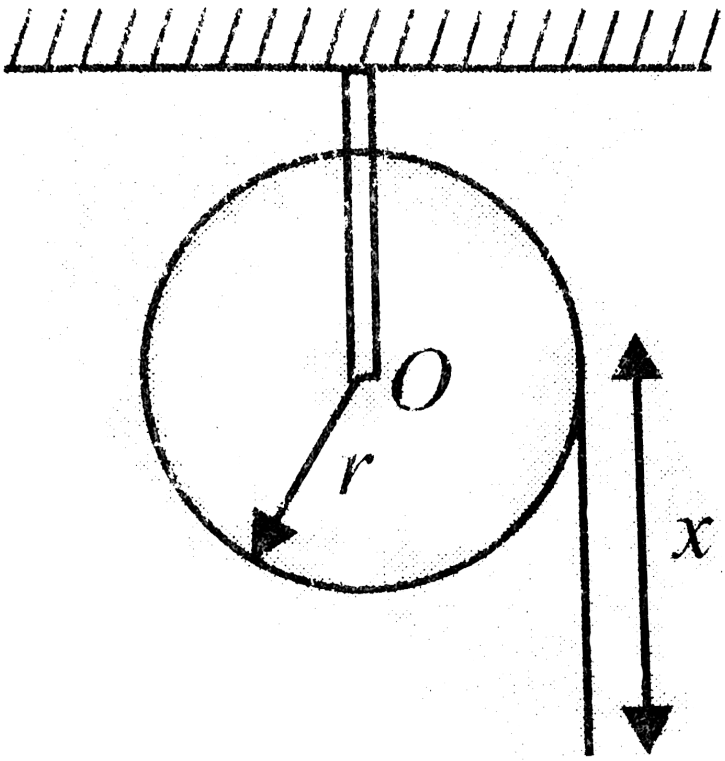
6. A uniform cylinder of radius r and mass m can rotate freely about a fixed horizontal axis. A thin cord of length l and mass m_0 is would on the cylinder in a single layer. Find the angular acceleration of the cylinder as a function of the length x of the hanging part of the end. the wound part of the cord is supposed to have its centre of gravity

on the cylinder axis is shown in figure.



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7. A cylinder of mass m suspended by two strings wrapped around the cylinder one near each end, the free ends of the string being attached to hooks on the ceiling, such that the length of the cylinder is horizontal. From the position of rest , the cylinder is allowed to roll

down as suspension strings unwind , calculate

(a) The downward linear acceleration of the cylinder

(b) The tension in the strings

(c) The time dependence of the instantaneous power developed by gravity

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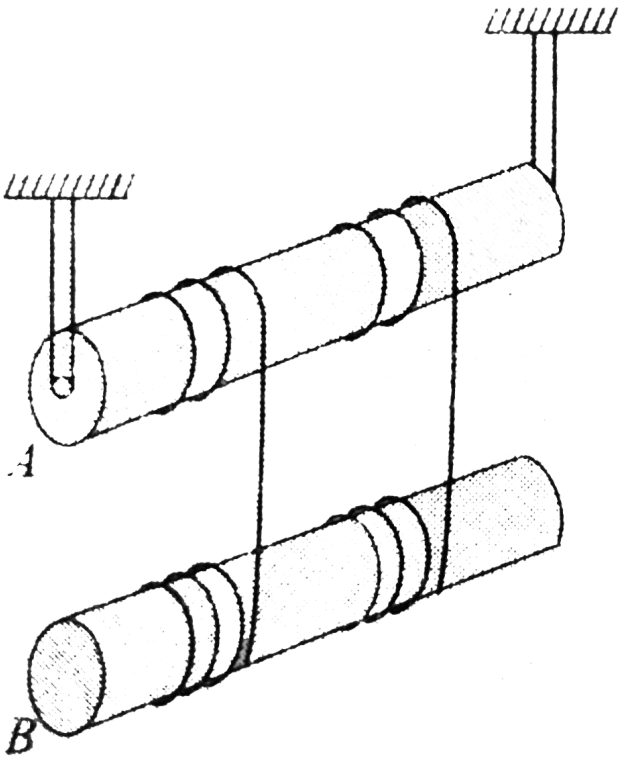
8. The arrangement shown in figure consists of two identical, uniform, solid cylinders, each of mass m, on which two light theads are wound symmetrically.

Find the tensions of each thread in the process of motion. The friction

in the axle of the upper cylinder is assumed to be absent.



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9. In an At wood's machine the pulley mounted in horizontal frictionless bearings has a radius R=0.05m.The cord passing over the pulley carries a block of mass $m_1 = 0.75$ kg at one end and a block of mass$m_2 = 0.50$ kg on the other end . When set free from rest, the

heavier block is observed to fall' a distance 1 metre in 10 seconds. Find the moment ofinertia of the pulley.

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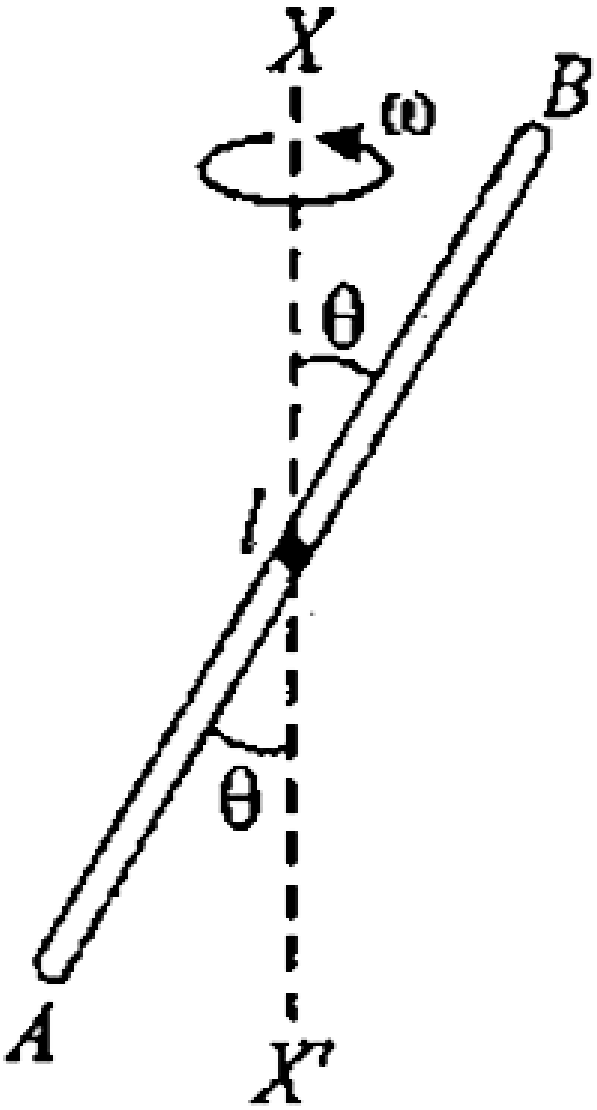
10. Find total energy of the inclined rod of mass m shown in figure-5.39 , rotating with angular velocity ω , about a vertical axis XX', shown

in figure .



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11. Find the angular momentum of the system of at wood's machine used in example-5.4 after t second from start about point O, the axle ofpulley.

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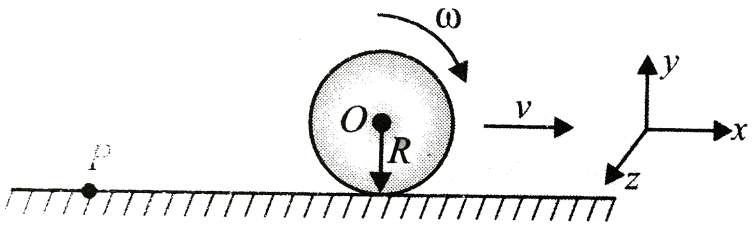
12. Consider a cylinder rolling on a horizontal plane. Its linear velocity is v and rotational angular velocity is ω. Find its angular momentum about point P on the ground as shown in Fig. What happens to this angular momentum if the cylinder is rotating in opposite direction but moving translationally in the same direction.



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13. A disc with moment of inertia I_1, is rotating with an angular velocity ω_1 about a fixed axis. Another coaxial disc with moment of inertia I_2, which is at rest is gently placed on the first disc along the axis. Due to friction discs slips against each other and after some time both disc start rotating with a common angular velocity. Find this common angular velocity.

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14. A child of mass m is standing, on the periphery of a circular platform of radius R, which can rotate about its central axis. The moment of inertia of the platform is I. Child jumps off from the platform with a velocity u tangentially relative to the platform. Find the angular speed of the platform after the child jumps off.

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15. Suppose in the previous poroblem, the child stays at rest on the platform and one of hils firend throws a ball of mas m_1 towards thim with a velocity of v from a direction tangential to the platform and the child on the platform catches the ball. Find the angular velocity of the platform after he catches the ball.

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16. In previous problem, if initially the platform with the child is rotating with an angular speed ω_1. If child start walking along its periphery in opposite direction with speed u relative to platform, what will be the new angular speed ofthe platform.

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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. A turn table of mass M and radius R is rotating with angular velocity ω_0 on frictionless bearing. A spider of mass m falls vertically onto the rim of the turn table and then walks in slowly towards the centre ofthe table. What is the angular velocity of the system when spider is at a distance r from the centre. Compute also the angular velocity of the turn table when the spider is at the rim and at the centre of the table .Is the energy of the system in this problem conserved ?

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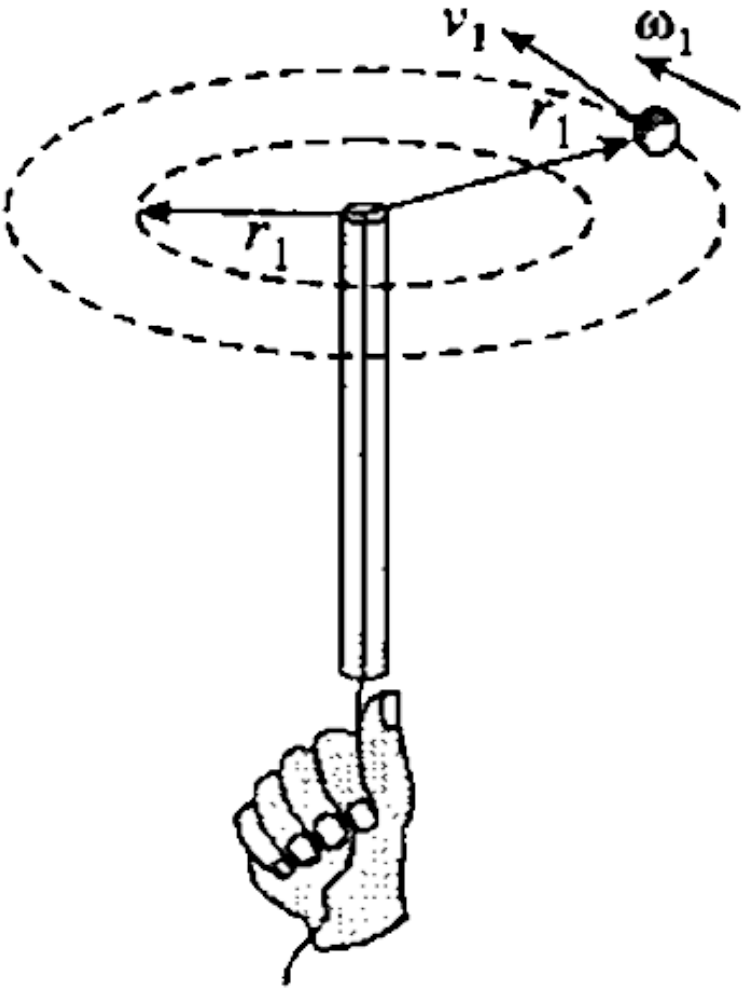
19. A point mass is tied to one end of a cord whose other end passes through a vertical hollow tube , caught in one hand. The point mass is being rotated in a horizontal circle ofradius 2 m with speed of

4m/sec.The cord is then pulled down so that the radius of the circle reduces to 1m . Compute the new linear and angular velocities of the point mass and compute the kinetic energies under the initial and final states.



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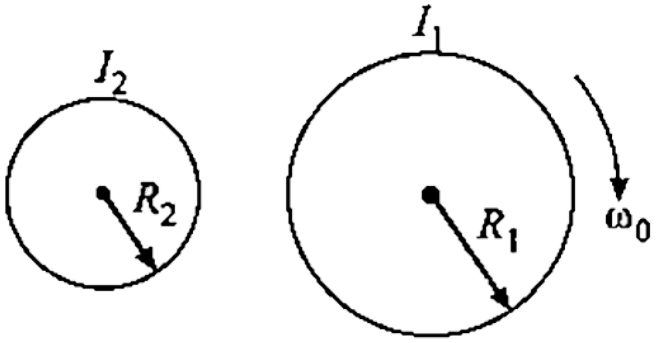
20. Two cylinders having radiii R_1 and R_2 and rotational inertia I_1 and I_2 respectively, are supported by fixed axes perpendicular to the plane of figure-5.52. The large cylinder is initially rotating with angular velocityω_0. The small cylinder is moved to the right until it touches the large cylinder 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, (a) Find the final angular velocity ω_2 of the small cylinder in terms of I_1, I_2, R_1, R_2 and ω_0. (b) Is total angular momentum conserved in this case ?



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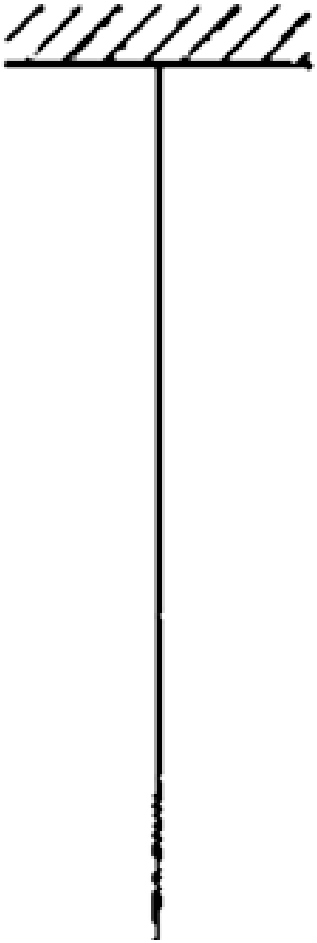
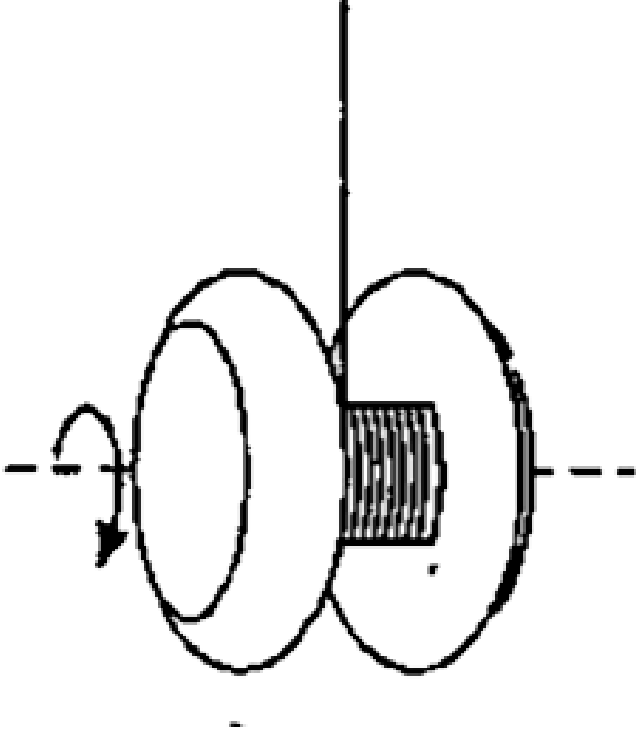
21. A primitive yo-yo is made by wrapping a string several times around a solid cylinder with mass M and radius R shown in figure-5.56. The end of the string stationary while releasing the cylinder with no initial motion. The string unwinds but does not slip or Stretch as the cylinder drops and rotates. Use energy considerations to find the speedv ofthe centre ofmass ofthe solid cylinder after it has dropped a distance h.





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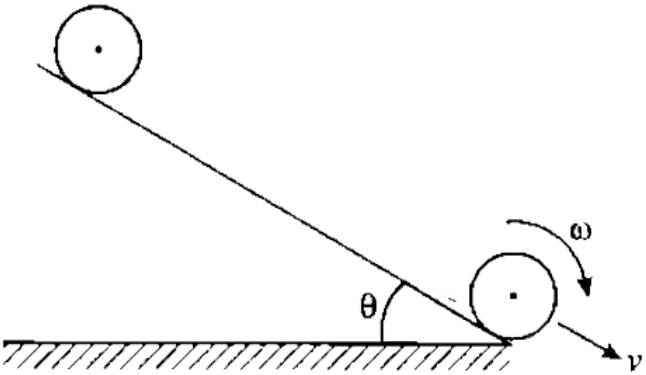
22. A rolling body (it.can be ring, sphere,... etc) rolls down from the top of an inclined plane as shown in figure-5.57. Find how its velocity

depends on its geometry.



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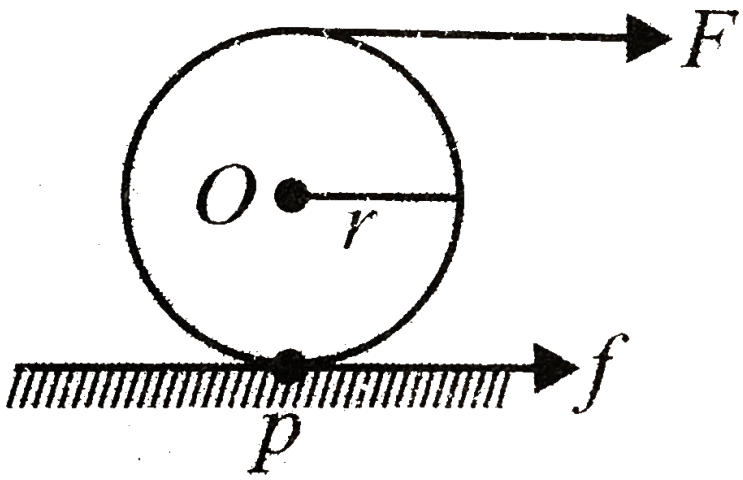
23. A force F acts tangentially at the highest point of a sphere f mass m kept on a rough horizontal plane. If the sphere rolls without

slipping, find the acceleration of the centre of the sphere.



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24. A cylinder of radius R and mass M rolls without slipping down a plane inclined at an angle θ. Coeff. of friction between the cylinder and the plane is μ. For what maximum inclination θ, the cylinder rolls without slipping ?

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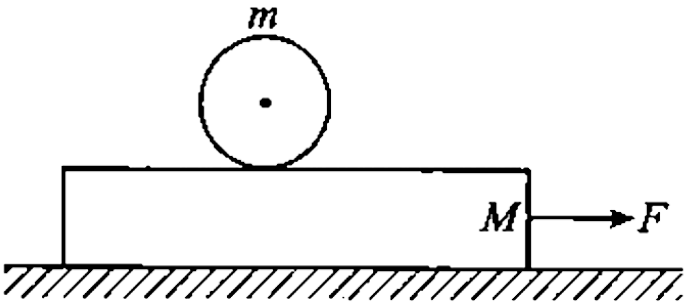
25. A plank of mass M is placed on a smooth surface over which a cylinder of mass m and radius R is placed as shown in figure-5.63. Now the plank is pulled towards right with an external force F. If cylinder does not slip over the surface of plank find the linear acceleration of plank and cylinder and the angular acceleration of the cylinder.



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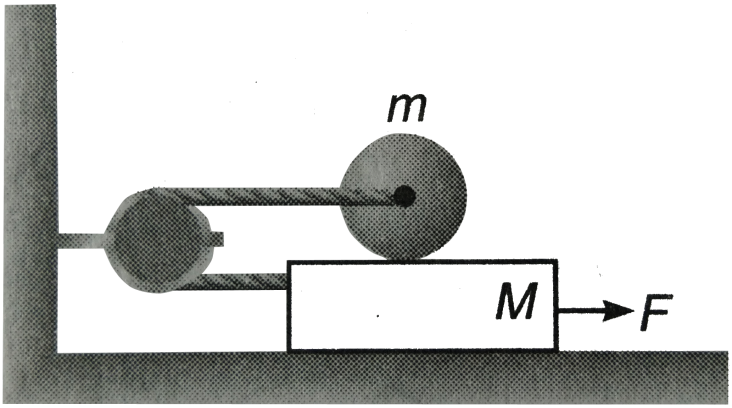

26.

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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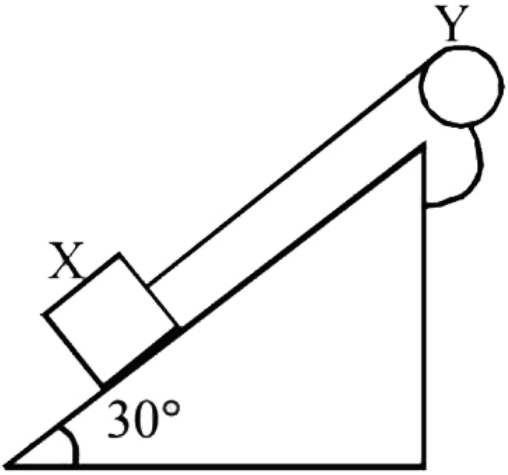
27. A block X of mass 0.5 kg is held by a long massless string on a frictionless inclined plane of inclination 30° to the horizontal. The string is wound on a uniform solid cylindrical drum Y of mass 2kg and of radius 0.2 and of radius 0.2 m as shown in Fingure. The drum is

given an initial angular velocity such that the block X starts moving up the plane.

(i) Find the tension in the string during the motion.

(ii) At a certain instant of time the magnitude of the angular velocity of Y s $10 rads^{-1}$ calculate the distance travelled by X from that instant of time until it comes to rest



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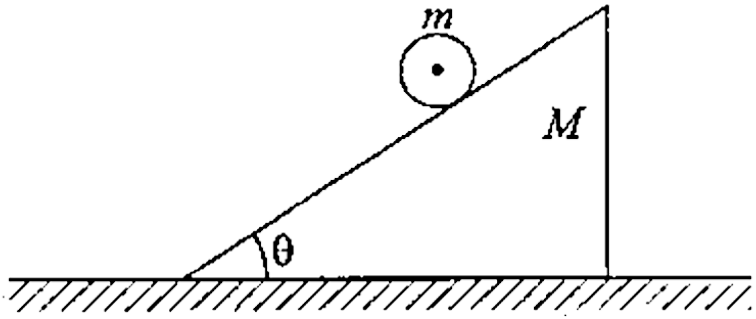
28. A rough wedge of mass M is free to move on a smooth horizontal plane as shown in figure-5.69.The uniform cylinder of mass m is placed on the wedge and it begins to roll down without slipping . Show that

the acceleration of cylinder on the surface of wedge is given as

$$a = \frac{2g\sin\theta(m+M)}{m+3M+2m\sin^2\theta}$$



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29. A thin spherical shell of radius R lying on a rough horizontal surface is hit sharply and horizontally by a cue. Where should it be hit so that the shell does not slip on the surface?

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30. A uniform solid cylinder of mass m and radius R is set in rotation about its axis with an angular velocity ω_0, then lowered with its lateral surface onto a horizontal plane and released. The coefficient of friction between the cylinder and the plane is equal to μ. Find

(a) how long the cylinder will move with sliding,

(b) the total work performed by the sliding friction force acting on the cylinder.

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31. A billiard ball is struck by a cue. The line of action of the applied impulse is horizontal andpasses through thecentre of theball. The initial velocityofthe ball is v_0. If is the radius, M is the mass of the ball and μ is the coefficient of friction between the ball and the floor, find how far the ball moves before it ceases to slip on the floor.

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32. A small disc and a thin uniform rod of length l, whose mass is η times greater than the mass of the disc, lie on a smooth horizontal plane. The disc is set in motion, in horizontal direction and perpendicular to the rod, with velocity v, after which it elastically collides with the end of the rod. Find the velocity of the disc and the angular velocity of the rod after the collision. At what value of η will the velocity of the disc after the collision be equal to zero? reverse its direction?

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Practice Exercise

1. Find the moment of inertia of a cylinder of mass M, radius R and length L about an axis passing through its centre and perpendicular to its symmetry axis. Do this by integrating an elemental disc along the length of the cylinder.

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2. Calculate the moment of inertia of a rod whose linear density changes from ρ to $\eta\rho$ from the thinner end to the thicker end. The mass of the rod is equal to M and length L. Consider the axis of rotation perpendicular to the rod and passing through the thinner end. Express your answer in terms of M,L and η.

$$\left[\frac{1}{6}ML^2\frac{3\eta+1}{\eta+1}\right]$$

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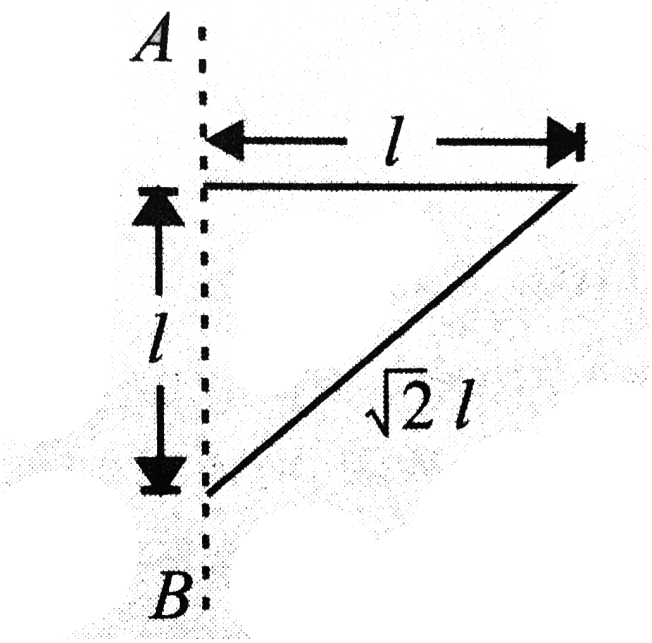
3. Find MI of a triangular lamina of mass M about the axis of rotation AB shown in Fig.



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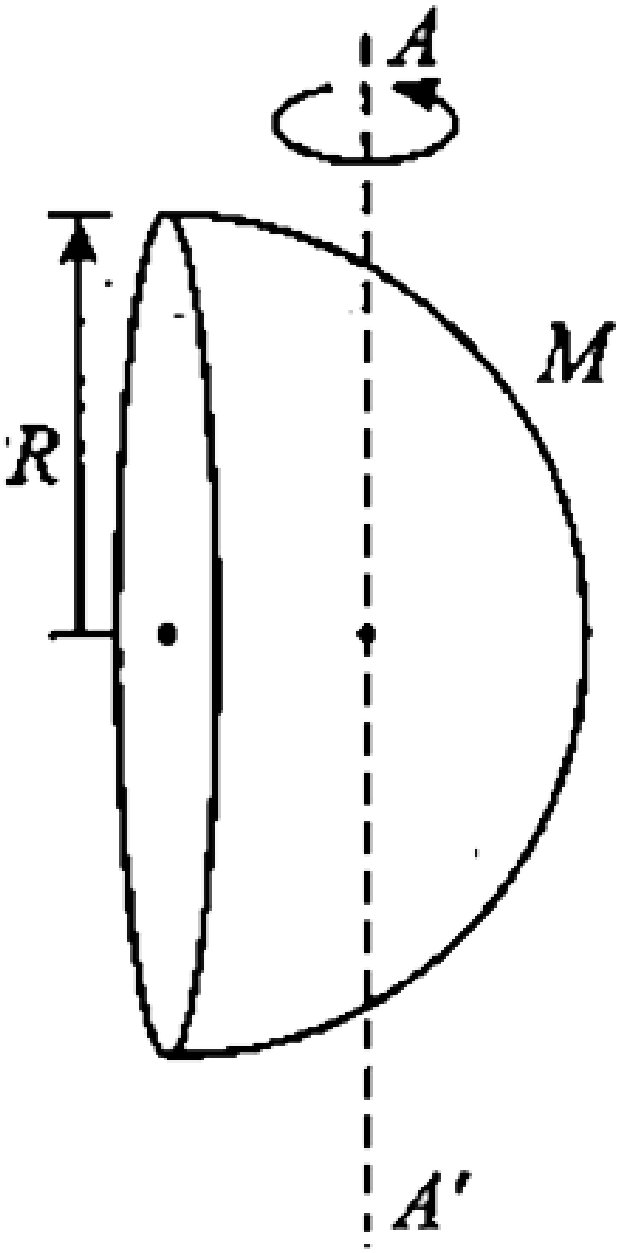
4. Find the moment of inertia of a hemisphere of mass M shown in figure - 5.28 , about an axis AA' passing through its centre of mass .



$\left[\left[\frac{83}{320}MR^2\right]\right]$

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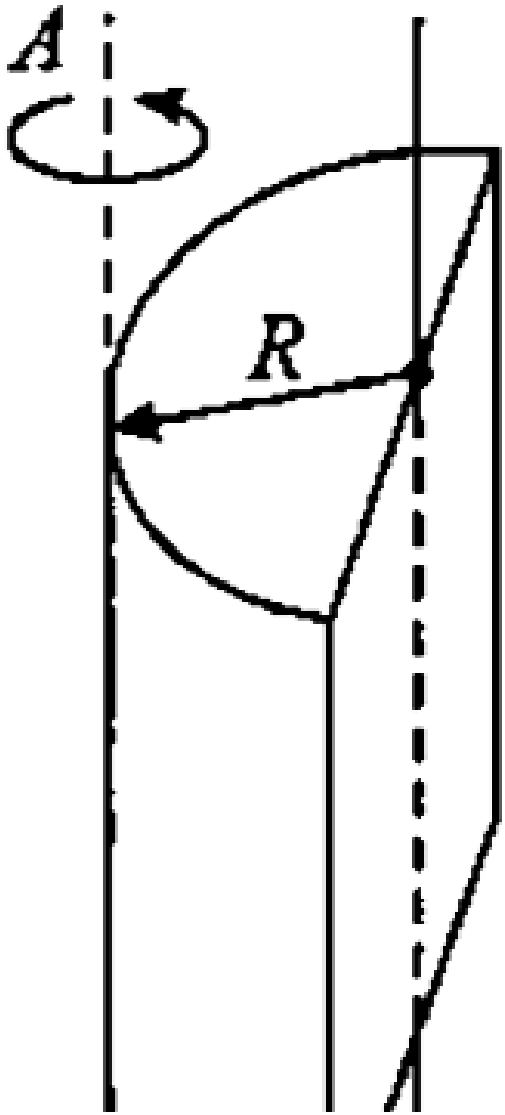
5. Find the of inertia of the half cylinder of mass M shown in figure - 5.29 , about the axis AA'

$$\left[\left[\left(\frac{9\pi - 16}{6\pi}\right)MR^2\right]\right]$$



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6. On the flat surface of a disc of radius aa small circular hole of radius b is made with its centre at a distance c from the centre of the disc. If mass of the whole un cut disc is M, calculate the moment of inertia of the holed disc about the axis of the circular hole.

$$\left[\frac{1}{2}\left[a^2+2c^2-\frac{b^4}{a^2}\right]\right]$$

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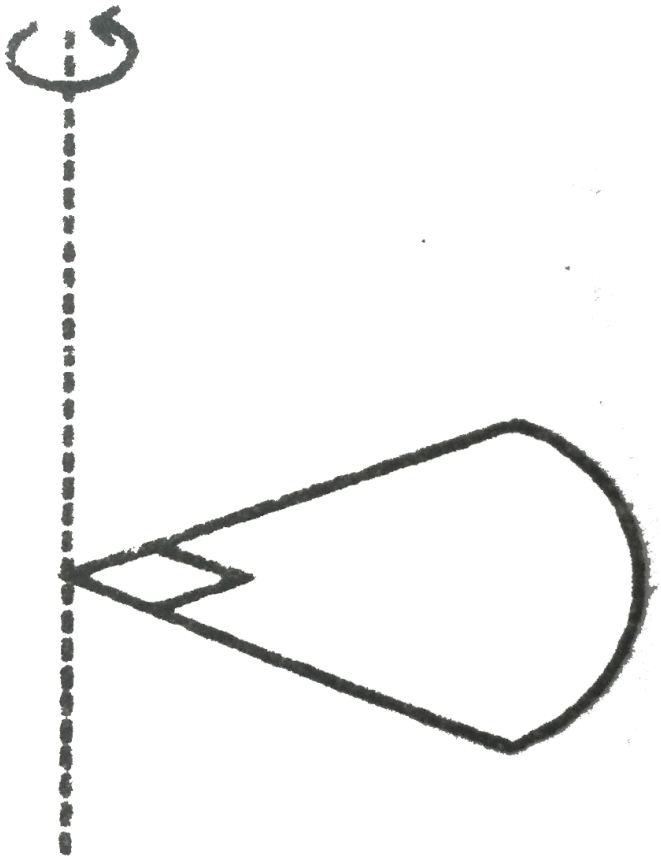
7. One quarter sector is cut from a uniform circular disc of radius R. This sector has mass M. It is made to rotate about a line

perpendicular to its plane and passing through the centre of the original disc. It moment of inertia about the axis of rotation is.



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8. Calculate the moment of inertia of a wheel about its axis which is having rim of mass 24 M and twenty four spoken each of mass M and length l .

$[32Ml^2]$

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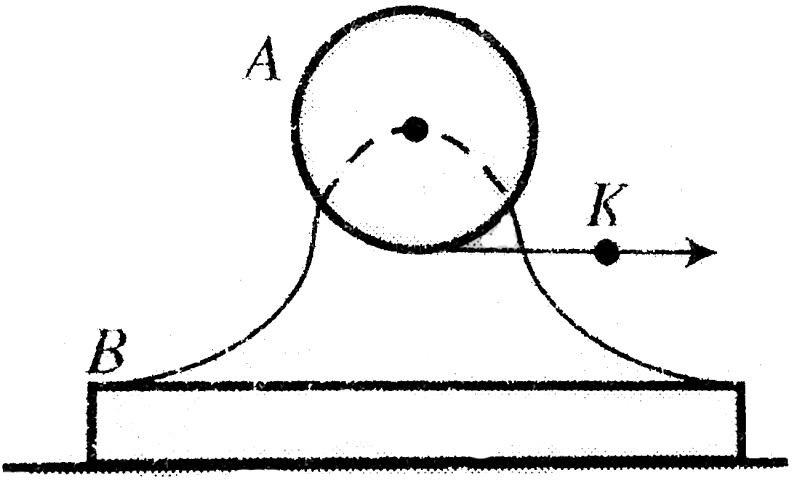
9. A uniform solid. cylinder A of mass m1 can freely rotate about a horizontal axis fixed to a mount of mass m_2. A constant horizontal force F is applied to the end K of a light thread tightly wound on the cylinder. The friction between the mount and the supporting horizontal plane is assumed to be absent. Find the acceleration of the

point K.



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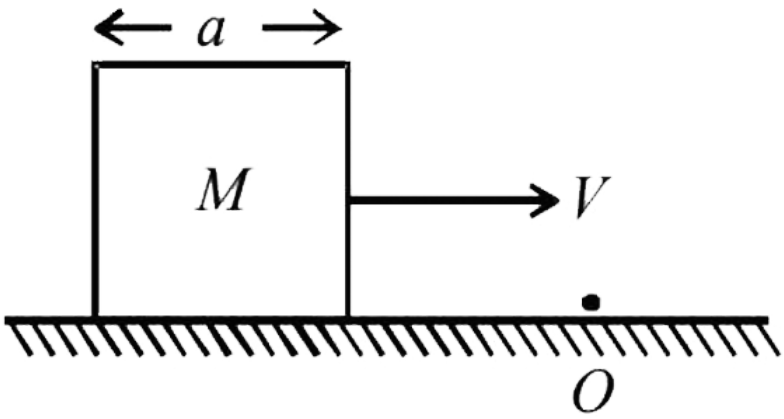
10. A cubical block of side a is moving with velocity V on a horizontal smooth plane as shown in Figure. It hits a ridge at point O. The

angular speed of the block after it hits O is



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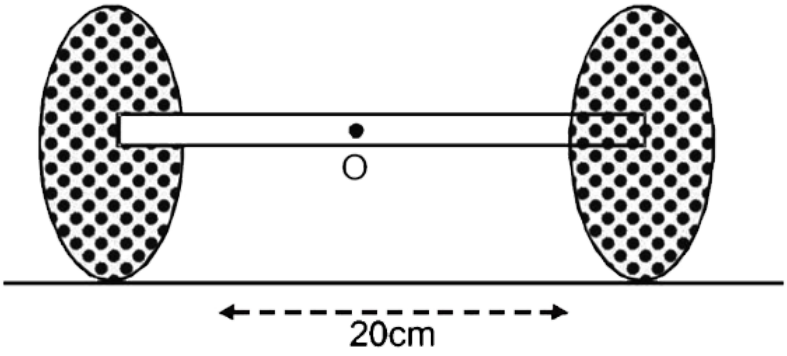
11. Two thin circular disks of mass 2kg and radius 10 cm each are joined by a rigid massless rod of length 20 cm. the axis of the rod is along the perpendicular to the planes of the disk through their centres. This object is kept on a truck in such a way that the axis of the object is horizontal and perpendicular to the direction of the motion of the truck. Its friction with the floor of the truck is large enough so that the object can roll on the truck without slipping. Take x axis as the direction of motion of the truck and z-axis as the vertically upwards

direction. if the truck has an acceleration of $9m/s^2$ Calculate:

(i) The force fo friction on each disk,

(ii) The magnitude and the direction of the frictional torque acting on each disk about the centre of mass O of the object. Express the torque in the vector form in terms of unit vectors $\hat{i}, \hat{j}$ and $\hat{k}$ in the x,y, and z directions.



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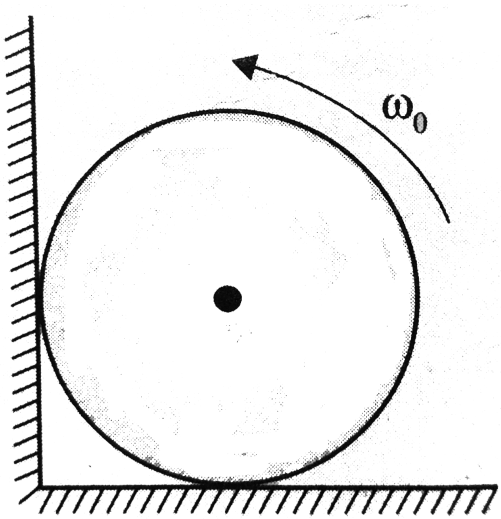
12. A uniform cylinder of radius R is spinned about it axis to the angular velocity ω_0 and then placed into a corner,. The coeficient of friction between the corner walls and the cylinder is μ_k How many

turns will the cylinder accomplish before it stops?



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13. A flywheel with the initial angular velocity ω_0 decelerates due to the forces whose moment relative to the axis is proportional to the square root of its angular velocity. Find the mean angular velocity of the flywheel averaged over the total decleration time.

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14. A uniform disc of radius R is spinned to the angular velocity ω and then carefully placed on a horizontal surface. How long will the disc be rotating on the surface if the friction coeffiecient is equal to k? The pressure exerted by the disc on the surface can be regarded as uniform.

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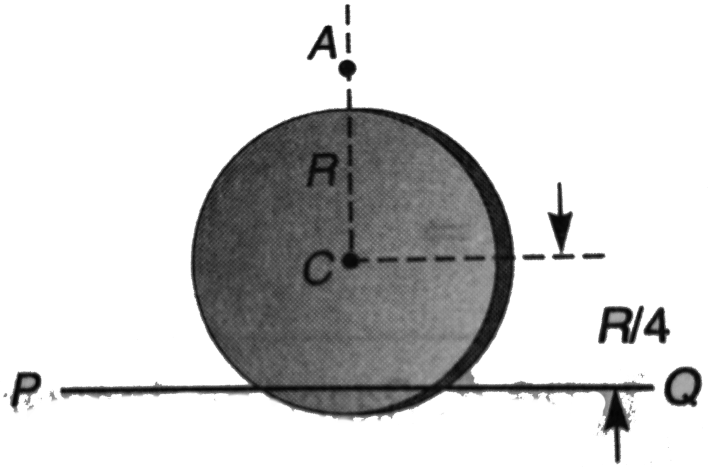

15.

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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16. A wheel of radius $6cm$ is mounted so as to rotate about a horizontal axis through its centre. A string of negligibe mass wrapped round its circumference carries a mass of $0.2kg$ attached to its free end. When let to fall, the mass descends through $1m$ in $5s$. Calculate the angular acceleration of the wheel, its moment of inertia and tension in the cord.

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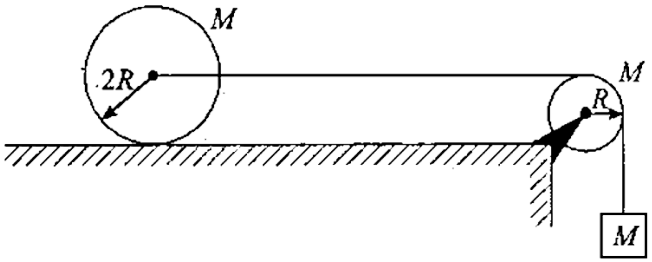
17. A uniform solid cylinder of mass M and radius 2R rests on a horizontal table top. A string attached to it runs over a pulley (disc) of mass M and radius R thatis mounted on a frictionless axle through its centre. A block of mass M is suspended from the free end of the string. The string doesn't slip over the pulley surface, and the cylinder rolls without slipping on the, table top. Find the acceleration of the block.



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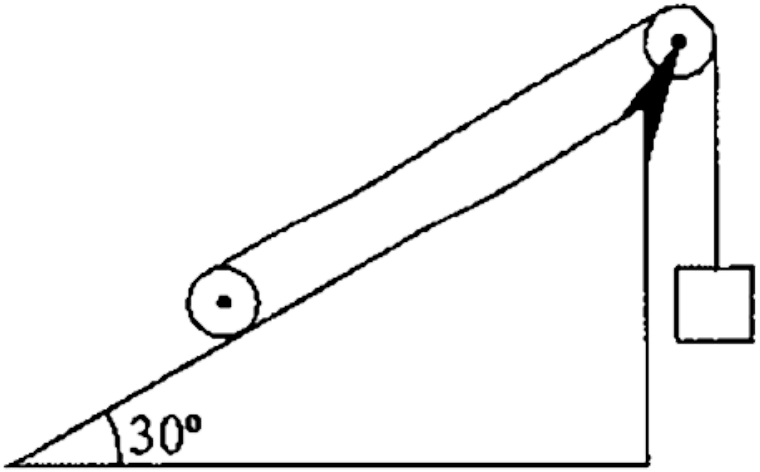
18. As shown in figure-5.72 the solid disc and pulley have the same radii and same mass distribution. The solid disc, pulley and the block

have equal masses. The plane has a slope of 30° .The disc rolls on the incline without slipping or loss of energy. Find the acceleration of the hanging block. Consider there is no shipping of string over pulley surface. Take g= 10 m/s^2.



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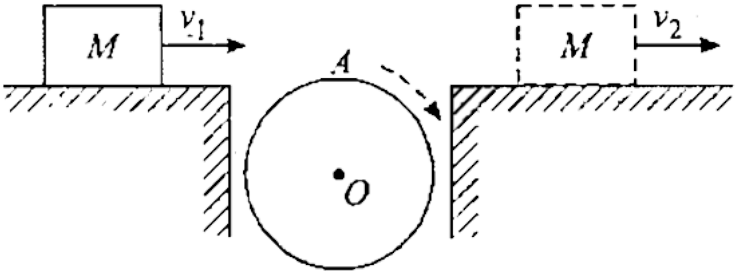
19. The axis of a cylinder of radius R and moment of inertia about its axis I is fixed at centre O as shown in figure - 5.73 . Its highest point A is in level with two plane horizontal surfaces . A block of mass M is initially moving to the right without friction with speed v_1 . It passes

over the cylinder to the dotted position . calculate the speed v_2 in the dotted position and the angular velocity acquired by the cylinder . if at the time of detaching from cylinder block stops slipping on it .

$$\left[\frac{v_1}{1+\frac{I}{MR^2}}, \frac{v_1}{R\left(1+\frac{I}{MR^2}\right)}\right]$$



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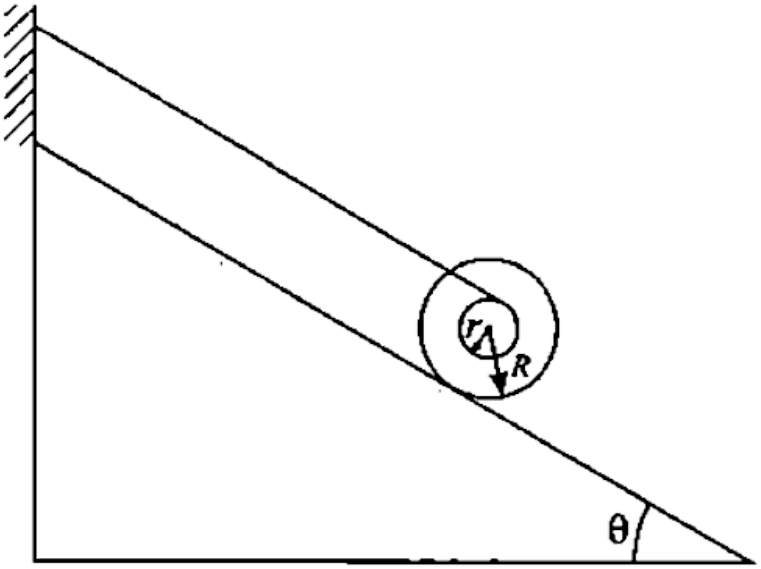
20. A spool of thread of mass m is placed on an inclined smooth plane set at an angleθ to the horizontal. The free end of the thread is attached to the wall as shown in figure-5.74. Calculate the acceleration of the centre of mass of the spool , if its moment of inertia about its axis is Iand the radius of the wound thread layer is r.

$$\left[\frac{g\sin\theta}{1+\frac{I}{mr^2}}\right]$$



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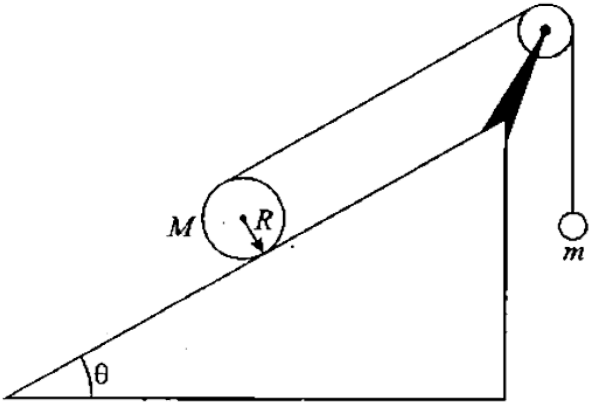
21. A uniform solid cylinder of mass M and radius R rolls a rough inclined plane with its axis perpendicular to the line of greatest slope as shown in figure-5.75. As the cylinder rolls it winds up a light string which passes over a light and smooth pulley and attached to a mass m , the part of the string between pulley and cylinder being parallel to

the line of greatest slope. Prove that the tension in the string is

$$T = \left[\frac{(3 + 4\sin\theta)Mmg}{3M + 8m}\right]$$



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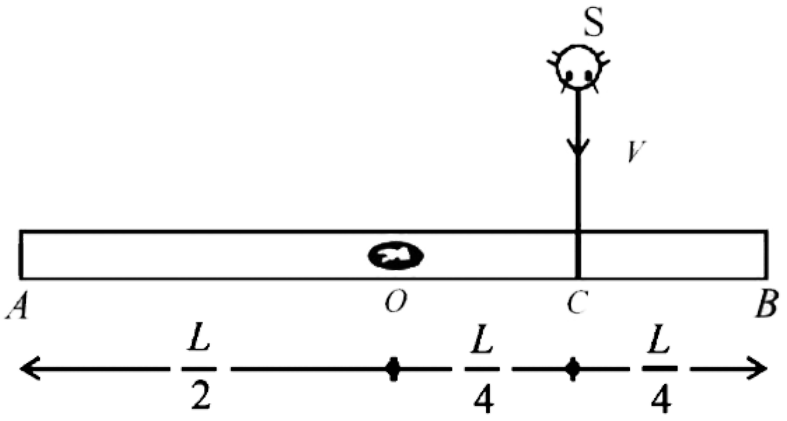
22. A uniform ball of radius r rolls without slipping down from the top of a sphere of radius R Find the angular velocity of the ball at the moment it breaks off the sphere. The initial velocity of the ball is negligible.

Watch Video Solution

23. A homogeneous rod AB of length L = 1.8 m and mass M is pivoted at the center O in such a way that it can rotate it can rotate freely position. An insect S of the same mass M falls vertically with speed V on the point C, midway between the points O and B. Immediately after falling, the insect moves towards the end B such that the rod rotates with a constant angular velocity omega.

(a) Determine the angular velocity ω in terms of V and L.

(b) If the insect reaches the end B when the rod has turned through an angle of 90°, determine V.



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24. A plank of mass m_1 with a uniform sphere of mass m_2 placed on it rests on a smooth horizontal plane. A constant horizontal force F is applied to the plank. With what acceleration will the plank and the centre of the sphere move provided there is no sliding between the plank and the sphere?

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25. A cylinder of mass M and radius R is resting on a horizontal platform (which is parallel to the x-y plane) with its axis fixed along the y-axis and free to rotate about its axis. The platform is given a motion in the x-direction given by $x = A\cos(\omega t)$. There is no slipping between the cylinder and platform. The maximum torque acting on the cylinder during its motion is .....

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26. A uniform solid cylinder of mass m and radius R is set in rotation about its axis with an angular velocity ω_0, then lowered with its lateral surface onto a horizontal plane and released. The coefficient of friction between the cylinder and the plane is equal to μ. Find

(a) how long the cylinder will move with sliding,

(b) the total work performed by the sliding friction force acting on the cylinder.

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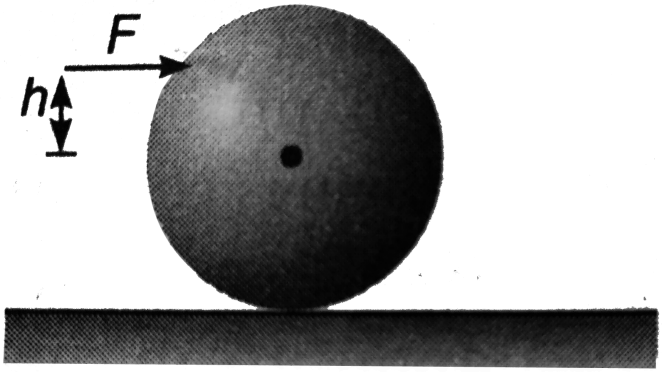

27.

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 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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28. A hollow sphere is released from the top of an inlcined plane of inclination θ. A. What should be the minimum coefficientof friction between the shphere and the plane to prevent sliding? B. Find the kinetic energy of the ball as it moves down a length l on the incline if the friction coefficient is half the value calculated in part a.

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29. A solid wooden door 1 m wide and 2 m high is hinged along one side and has a total mass of 50 kg . Initially open and at rest , the door is struck at its centre by a handful of sticky and mud of mass 0.5 kg travelling at 12 m/s just before impact . Find the final angular velocity of the door .

$[\frac{72}{403}$ rad/s]

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30. A thin uniform square plate with side l and mass M can rotate freely abouta stationary vertical axis coinciding with one of its sides . A small ball of mass m flying with velocity v at right angles to the plate strikes elastically to the centre of it. Find the velocity of the ball v'after the impact and the horizontal component of the force which the axis will exert on the plate after the impact.

$$\left[\frac{3m-4M}{3m+4M}v, \frac{72Mm^2v^2}{l(3m+4m)^2}\right]$$

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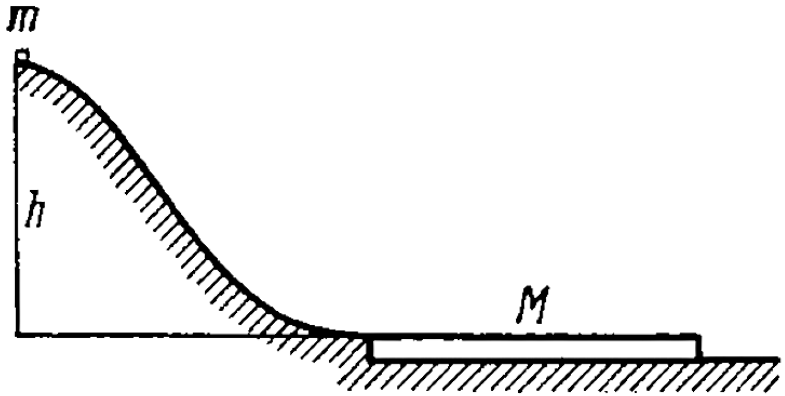
31. A small disc of mass m slides down a smooth hill of height h without initial velocity and gets onto a plank of mass M lying on the horizontal plane at the base of the hill. (figure). Due to friction between the disc and the plank the disc slows down and, beginning with a certain moment, moves in one piece with the plank.

(1) Find the total work performed by the friction forces in this process.

(2) Can it be stated that the result of obtained does not depend on

the choice of the reference frame?



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32. A man of mass m_1 stands on the edge of a horizontal uniform disc of mass m_2 and radius R which is capable of rotating freely about a stationary vertical axis passing through its centre . The man walks along the edge of the disc through angle θ relative to the disc and

then stops . find the angle through which the disc turned the time the man stopped .

$$\left[\frac{2m_1\theta}{2m_1+m_2}\right]$$

Watch Video Solution

33. A uniform rod AB of length 2l and mass 2m is suspended freely at A and hangs vertically at rest when a particle of mass m is fired horizontally with speed v to strike the rod at its mid point. If the particle is brought to rest by the impact , find : (a) the impulsive reaction at A , (b) the initial angular speed of the rod and (c) the maximum angle the rod makes with the vertical in the subsequent motion .

[mv/4 , 3v/8l , $\cos^{-1}\left(1-\frac{3v^2}{32lg}\right)$]

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34. A metre stick is held vertically with one end on the floor and is then allowed to fall . Find the speed of the other end when it hits the floor , assuming that the end of the floor does not slip . Take g = 10 m/ s^2.

$[\sqrt{30}m/s]$

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Discussion Question

1. Can a single force applied to a body change both its translational and rotational motion? Explain.

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2. A meter stick, half of which is wood and the other half steel, is pivoted at the wooden end and same force isapplied to the steel end.

Next, it is pivoted at the steel end and the same force is applied at the wooden end. Does one getthesame angular acceleration in eachcase ? Explain

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3. How a swimmer jumping form a height is able to increase the number of loops made in the air ?

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4. The melting of the polar ice capshs supposed to be a possible cause of the variation of the earth's time period of rotation.'Explain

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5. The angular velocity of the earth's rotation, it is 2π rad/day, in which reference frame we are thinking of?

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6. When electrical motor isturned on,it takes longer to come up to final speed if there is a grinding wheel attached to the, shaft. Why ?

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7. Does a body rotating about a fixed axis have to be perfectly rigid for all points on the body to have the same angular velocity and the same angular acceleration ?Explain.

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8. If you roll two eggs on an incline plane , it si possible to tell which one is raw and which and which is boiled. How

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9. If you stop a spinning raw egg for the shortest instant you can and then release it, the egg will start spinning again.If you do the same to a hard boiled egg, it will remain stopped. Explainit.

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10. A helicopter has a large main rotor that rotates in a horizontal plane and provides lift. There is also a small rotor on the tail that rotates in a vertical plane.What is the purpose of the tail rotor ?

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11. A body is in pure rolling on a surface. Is it necessarily being acted upon by an external torque ?

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12. Why it is more difficult to revolve a stone by tying it to a longer string than by tying it to a shorter string ?

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13. A thin wheel can stay upright on its rim for a considerable length of time when rolled with a considerable velocity, while it falls from its upright position at the slightest disturbance, when stationary. Explain.

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14. 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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15. A cylindrical container filled with cheese and another identical can filled with beer both roll down an incline plane. How different their linear and angular accelerations.

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16. (i) A person sits near the edge of a circular platform revolving with a uniform angualr speed. What will be the change in the motion of the platform ?

(ii) What if the person stars moving from the edge towards the centre of the platform ?

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17. The harder you hit the brakes while driving forward, the more the front end of your car will move down and the rear end move up. Why? What happens when, accelerating

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18. A car's speedometer read the speed of car.Will there be a correction in speedometer if tyres become old (snowed tyres).

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19. When car is moving on a horizontal icy floor, if its brakes are locked,wheels stops rotating and starts liding. What happens to rotational kinetic energy ?

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20. A rear wheel drive car accelerates quickly from rest, and the driver observes. that the car noses up. Why does it do that ? Would a front wheel drive car do that ?

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21. A disc rotates with constant angular velocity. Doesa point on its rim have a tangential acceleration or a radial acceleration ? Are these accelerations constant ? '

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22. A disc is fnst spinned and then placed gentlyon a rough floor with its surface horizontal. Will centre of mass of disc advance in some direction ? Explain.

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23. A cylinder of mass M and radius R can rotate about its axis of symmetry. Can mass inside the cylinder can be distributed such that the moment of inertia of it become more than MR^2.

Watch Video Solution

24. A disc of metal is melted and recast in the form of a soild sphere. What will happen to the moment of inertia anout a vertical axis passing through the centre ?

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25. A wheel is rolling without slipping on a horizontal surface. In an inertial frame of reference in which the surface is at rest, is the reanypoint on the wheel that has a velocity that is purely vertical ? Is

there any point that has a horizontal velocity component opposite to the velocity of the centre of mass ? Explain. What would be the results if wheel is slipping with rolling ?

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26. If the atmosphere suddenly condensed into a solid mass and formed a thin layer on the siuface of the earth,what effect would it have on the time of rotation of the earth about it

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27. A point particle travels in a straight line at constant speed. The closest it comes to the origin of coordinatesisa distance l With respect to this origin, does the particle have nonzero angular momentum ? As the particle moves along its straight line path, does its angular momentum with respect to origin change.

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28. An electric grinding wheel rotates for sometime after the power is turned off, but an electric drilling machine stops after few seconds of turning of fthe power.Why?

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29. An electric grinding wheel rotates for sometime after the power is turned off, but an electric drilling machine stops after few seconds of turning of fthe power.Why?

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30. A student stands on a table rotating with an angular speed ω while holding two equal dumbbells at arm's length. With out moving anything else,the two dumbbells are dropped. What changes will be

there in motion, if any? What would be the changes if he bring the dumbbells to keep in touch with his chest by folding his arms ? Explain

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Conceptual Mcqs Single Option Correct

1. A cylinder rolls up an inclined plane, reaches some height, and then rolls down (without slipping throughout these motions). The directions of the frictional force acting on the cylinder are.

A. Uptheincline whileascending anddown theincline while descending

B. Up the incline while ascending aswell asdescending.

C. Down theincline while ascending and up theinclinewhile descending.

D. Down the incline while ascending as well as descending.

Answer: B

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2. Let I_1 and I_2 be the moments of inertia of two bodies of identical geometrical shapek, the first made of aluminium and the second of iron.

A. $i_1 < I_2$

B. $I_1 = I_2$

C. $I_1 > I_2$

D. Relation between I_1 and I_2 depends on the actual shapes ofthe bodies.

Answer: A

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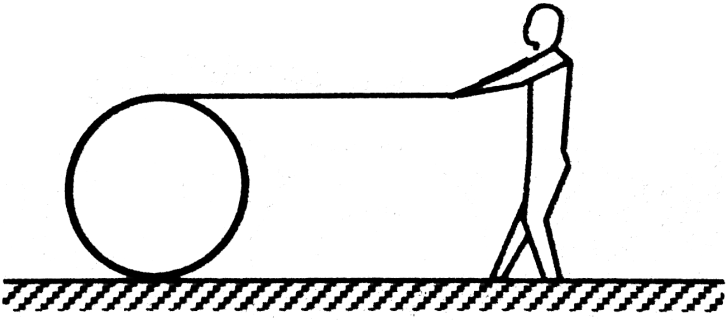
3. A string of negligible thicknes is wrapped several times around a cylinder kept on a rough horizontal surface. A man standing at a distance l from the cylinder holds one end of the sitting an pulls the cylinder towards him figure. There is no slipping anywhere. The length of the string passed through the hand of the man whicle the cylinder reaches his hands is



A. l

B. 2l

C. 3l

D. 4l

Answer: B

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4. If there is no external force acting on a nonrigid body, which of the followhng quantities must remain constant?

A. Angular momentum

B. Linearmomentum

C. Kinetic energy

D. Moment ofinertia

Answer: B

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5. A nollow sphere and a solid sphere having same mass and same radii are rolled down a rough incline plane.

A. The hollow sphere reaches the bottom first

B. The solid sphere reaches thebottom with greater speed

C. Thesolid sphere reaches thebottom with greater kinetic energy

D. The two spheres will reach the bottom with same linear momentum

Answer: B

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6. When a steady torque (net force is zero) is acting on a body, the body.

A. Gets linear acceleration only

B. Getsan angularacceleration

C. Continues torotate asa steady rate

D. None ofthes

Answer: B

Watch Video Solution

7. A wheel of radius 20 cm is pushed ot move it on a rough horizontal surface. It is found to move through a distance of 60 cm on the road during the time it completes one revolutionabout the centre. Assume that the linear and the angular accelerations are uniform. The frictional force acting on the wheel by the surface is

A. Along the velocityofthe wheel

B. Oppositetothe velocityofthe wheel

C. Perpendicularto thevelocityofthe wheel

D. Zero

Answer: A

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8. The density of as rod graduallly decreases from one end to the other. It is pivoted at an end so that ilt can move about a vertical axius through the pivot. A horizontal force F is applied on the free end n a direction perpendicular to the rod. The quantities, that do not depend on which end of the rod is pivoted are

A. Angular acceleration

B. Angular velocity when therodcompletes one rotation

C. Angular momentum when therodcompletes one rotation

D. Torqueofthe applied force

Answer: D

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9. A man stands in the middle of a rotating table which has an angular velocity ω He is holding two equal masses at arms lengtii ineach hand. Without moving his arms he just drops the two masses. How will be the angular speed of table get changed?

A. Itwillbegreater than ω

B. It will be less than ω

C. It willnot change

D. The increase ordecrease will be decided bythe quantityof the masses dropped.

Answer: C

Watch Video Solution

10. 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.

A. Cannot be predicted

B. Discwithlargerdensity

C. Disc with smallerdensity

D. Bothhavesamemomentofinertia

Answer: C

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

A. The solid sphere

B. The hollow sphere

C. The disc

D. All will achieve same kinetic energy

Answer: D

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12. A body is rotating uniformly about a vertical axis fixed in an inertial frame. The resultant force on a particle of the body not on axis is

A. Vertical

B. Horizontal andskewwiththeaxis

C. Horizontal andintersecting theaxis

D. None ofthese.

Answer: C

Watch Video Solution

13. 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. Decreases

C. Increases

D. May increases or decreases depending upon the thickness of ice layer

Answer: B

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14. A uniform rod is kept vertically on a horizontally smooth surface at a point O. IF it is rotated slightly and released, it falls down on the horizontal surface. The lower end will remain

A. At O

B. At a distance less than //2 from O

C. At a distance HI from O

D. At a distance larger than//2from

Answer: C

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15. A person sitting firmly over a rotating stool has his arms stretched. If he folds his arms, his angular momentum about the axis of rotation

A. Increas

B. Decreases

C. Remains unchanged

D. Doubles

Answer: C

Watch Video Solution

16. A solid sphere and a hollow sphere are identical in mass and radius. The ratio of their moment of inertia about diameter is :

A. $5:3$

B. $1:1$

C. $1:2$

D. $3:5$

Answer: D

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17. Consider four bodies-a ring, a cube, a disc and a sphere. All the bodies have the same diameter, equal to the length of the cube on ech edge.All rotate about their axes through their respective centres of mass. Which one has the largest moment of inertia?

A. Ring

B. Cube

C. Disc

D. Sphere

Answer: A

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18. A circular disc A of radius r is made from an iron plate of thickness t and another circular idsc B of radius 4 r is made from another iron plate of thickness t/4. The relation between the moments of inertia I_1 and I_2 B is :

A. $I_A > I_B$

B. $I_A = I_B$

C. $I_A < I_B$

D. Depends on the actual values of t and r

Answer: C

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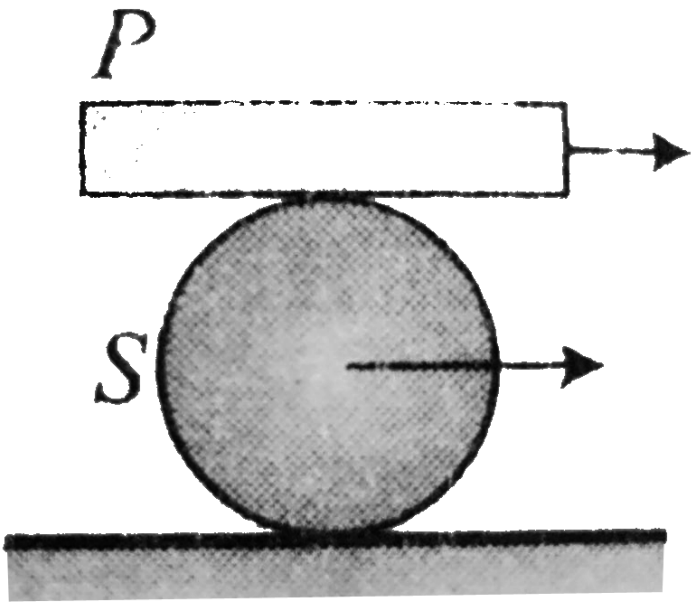
19. A plank P is placed on a solid cylinder S, which rolls on a horizontal surface. The two are of equal mass. There is no slipping at any of the surfaces in contact. The ratio of kinetic energy of P to the

kinetic energy of S is:



A. $1:1$

B. $2:1$

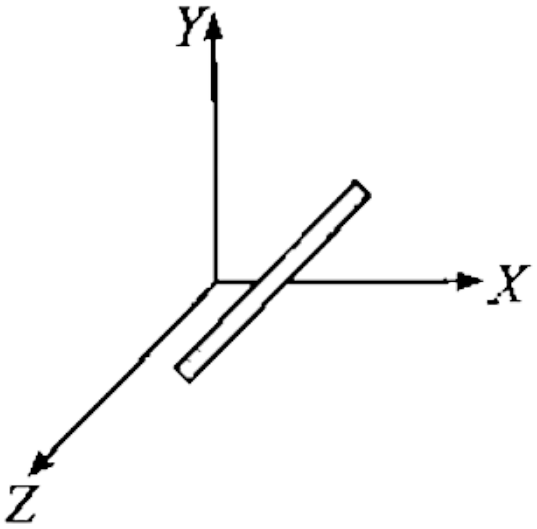
C. $8:3$

D. $11:8$

Answer: C

Watch Video Solution

20. The locus of all the points on theX- Y plane, about which the moment of inertia of the rod along an axis parallel to z axis is same as that about O is [The rod is lying inXZplane]:



A. Straight line

B. Circle

C. Paranola

D. Ellipse

Answer: B

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21. A particle moves with a constant velocity parallel to the X-axis. Its angular momentum with respect to the origin

A. Is constant

B. Is constant

C. Goeson increasing

D. Goes on decreasing

Answer: B

Watch Video Solution

22. A body is rotating uniformly about a vertical axis fixed in an inertial frame. The resultant force on a particle of the body not on axis is

A. Vertical

B. Horizontaland skewwithAe axis

C. Horizontal and intersectingthe axis

D. None of these

Answer: B

Watch Video Solution

23. 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

Watch Video Solution

24. A sphere can roll without slipping on a surface inclined at an angle θ if the fiiction coefficient is more than (2/7)g sin θ Suppose the friction coefficient is (l/7)g sin θ If a sphere is released from rest on this incline then which ofthe following are possible situations:

A. It will stay at rest

B. Itwill make pure translational motion

C. It will translate and rotate about the centre

D. The angular momentum of the spheres about its centre will remain constant

Answer: C

Watch Video Solution

25. A boiled egg and a raw egg of same mass and size are made to rotate about their own axis. If I_1 and I_2 are moments of inertia of boiled egg and raw egg, then

A. Equal to one

B. Greater than one

C. Less than one

D. Less than half

Answer: B

Watch Video Solution

26. The angular velocity of the engine (and hence of the wheel) on a scooter is proportional to the petrol input per second. The scooter is

moving on a frictionless road with uniform velocity. If the petrol input is increased by 10% the linear velocity of the scooter is increased by

A. $50\ \%$

B. $10\ \%$

C. $20\ \%$

D. $0\ \%$

Answer: D

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27. Only under gravity and some initial impulsea sphere cannot roll without sliding on :

A. A smooth horizontal surface

B. A smooth inclined surface

C. A rough horizontal surface

D. A rough inclined surface

Answer: B

Watch Video Solution

28. A closed cylindrica tube containing some water (not filling the entire tube) lies in a horizontal plane. If the tueb is rotated about a perpendicular bisector, the moment of inertia of water about the axis

A. Icreases

B. Decreases

C. Remains constant

D. Increases if the rotation is clockwise and decreases if it is in anticlockwise

Answer: A

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29. 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 mass of the body but B does not. Then

A. $I_A < I_B$

B. If $I_A < I_B$ the axes are parallel

C. If the axes are parallel ,$I_A < I_B$

D. If the axes are not parallel, $I_A < I_B$

Answer: C

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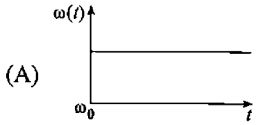
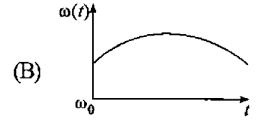
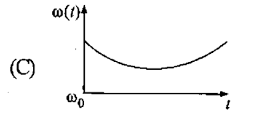
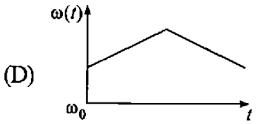
30. A circular plarform is free to rotate in a horizontal plane about a vertical axis passing through its centre. A tortoise is sitting at the edge of the platform. Now, the platform is given an angular velocity ω_0

. When the tortoise move along a chord of the platform with a constant velocity (with respect to the platform), the angular velocity of the platform $\omega(t)$ will vary with time t as

A. 

B. 

C. 

D. 

Answer: B

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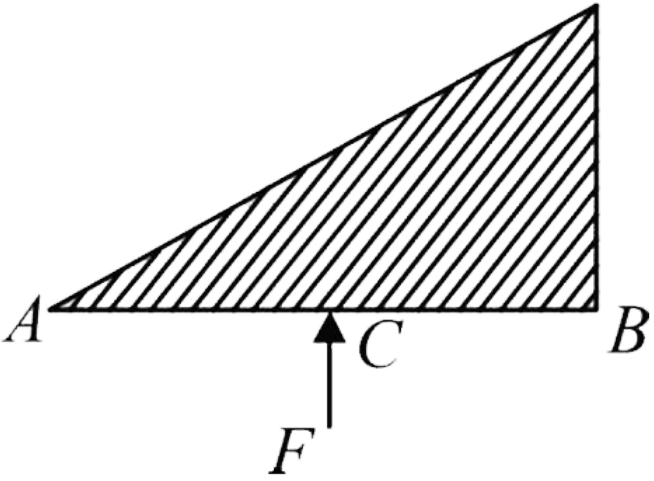
31. A triangular plate of uniform thickness and density is made to rotate about an axis perpendicular to the plane of the paper and (a) passing through A,(b) passing through B, by the application of the same force, F, at C (midpoint of AB) as shown in the figure. The angular acceleration in both the cases will be the same.



A. $\alpha_A = \alpha_B$

B. $\alpha_A < \alpha_B$

C. $\alpha_A > \alpha_B$

D. $\alpha_A = \alpha_B = 0$

Answer: B

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32. A satellite is revolving round the earth. If the universal gravitational constant(G)was decreasing imiformly with time for the satellite, the quantity that still remains constant is

A. Weight

B. Radius

C. Tangential speed

D. Angular momentum

Answer: D

Watch Video Solution

33. A body si rolling without slipping on a horizontal plane. If the rotational energy of the body is $40\,\%$ of the total kinetic energy then the body might be:

A. Cylinder

B. Hollow sphere

C. Solid cylinder

D. Ring

Answer: B

Watch Video Solution

34. A person is sitting near the edge fo a rotating platfrom when he walks towards the centere, then:

A. Moment ofinertia ofsystem increases

B. Angular velocity ofplatform decreases

C. Angular velocity ofplatform increases

D. Angular velocity of platform remains unchanged

Answer: C

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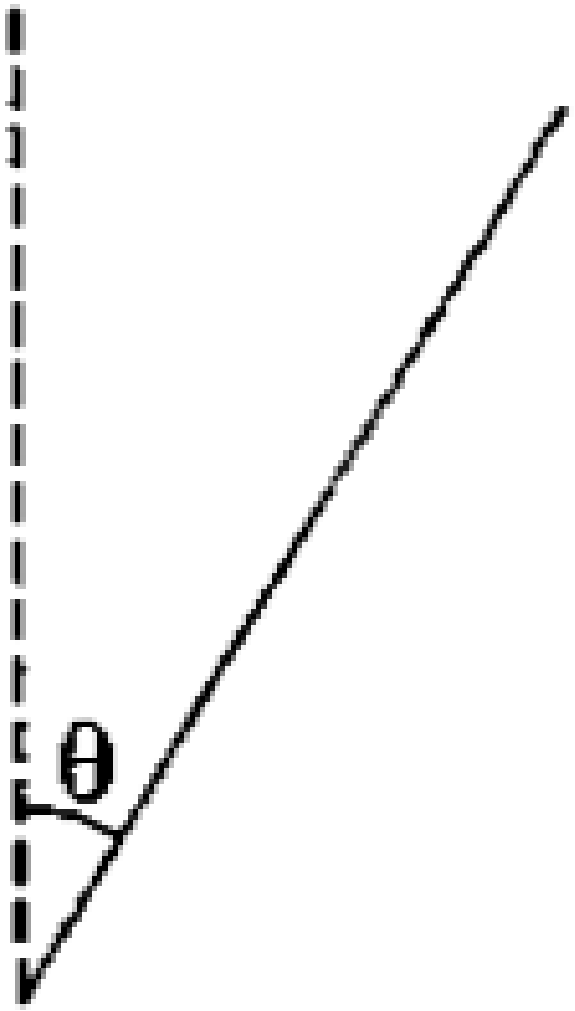
35. A pencil is placed vertically on a table top with its point end up and its sticky eraser end down As it falls over from this unstable. Position.

Its point of contact with the tangential acceleration of its tip.



A. decreasing continuously

B. .exceeds g at some instant

C. becomes g just before hitting the table

D. IS constant

Answer: B

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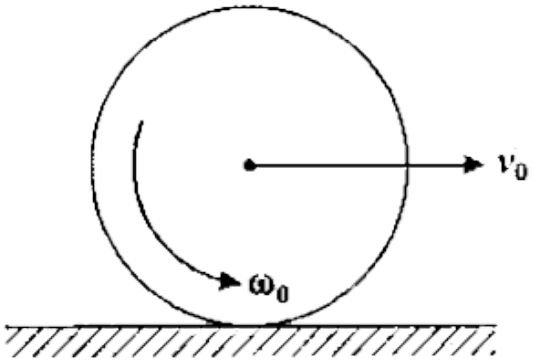
36. A disc of radius R is spum to an angular speed ω about its axis and then imported a horiznotal velociy of magnitude $\frac{\omega_0 R}{4}$ (at=t=0) with its plane remaining vertical. The coefficent of friction between the disc and the plane is μ The sence of rotation and direction of its lincer speed are shown. in the figure -5.97 choose the correct statement The

disc will returen to its intial position :



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

B. irrespective of the value of $\mu(\mu > 0)$

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

D. if $\mu > 1$

Answer: B

Watch Video Solution

37. A rod of mass M and length l is placed on a smooth horizontal table and is hit by a ball moving horizontally and prependicular to length of rod and sticks to it Then conservation of angular momentum can be applied:

A. About any point on the rod

B. About a point at the centre of the rod

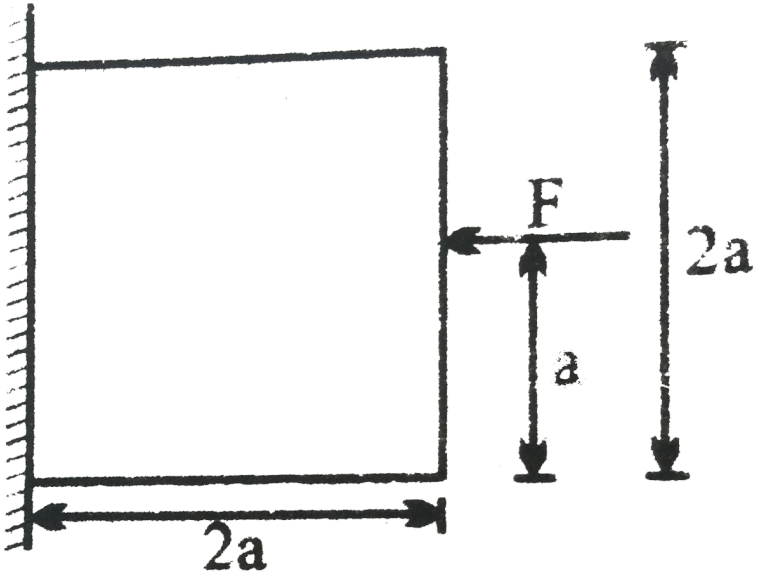
C. About end point of the rod

D. None

Answer: D

Watch Video Solution

38. A block of mass m is held fixed against a wall by a applying a horizontal force F. Which of the following option is incorrect :



A. frictional force f=mg

B. normal reaction N=F

C. F will not produce a torque

D. N will not produce any torque

Answer: D

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39. If net external torque, about a point, acting on the system is zero, then we can surely say:

A. Kinetic energy of the system remains constant

B. Mechanical energy of the system remains constant

C. Toruqe of Internal forces is zero

D. Momentum of system will remain constant

Answer: C

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Numerical Mcqs Single Option Corrrect

1. The moment of inertia of cylinder of radius a, mass M and height h about an axis parallel to the axis of the cylinder and distance b from its centre is :

A. $\frac{1}{2}M\left(a^2+2b^2\right)$

B. $\frac{1}{2}M\left(2a^2+b^2\right)$

C. $\frac{1}{2}M\left(a^2+b^2\right)$

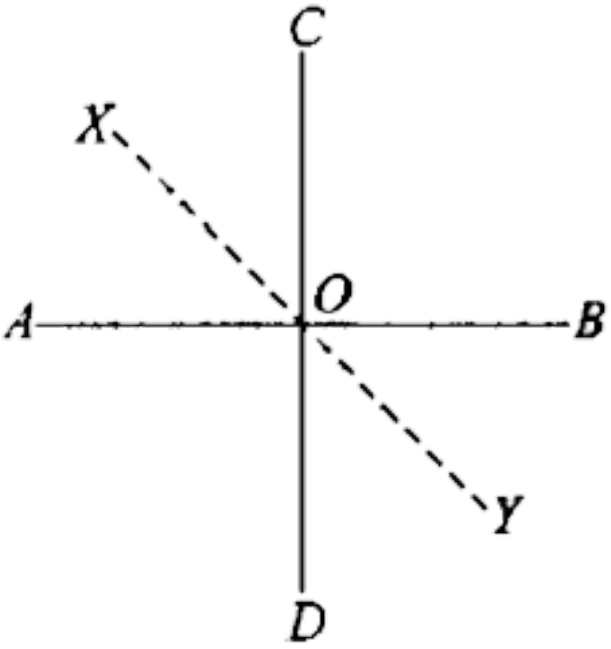
D. $\frac{1}{2}M\left(\frac{a^2}{3}+\frac{b^2}{12}\right)$

Answer: A

Watch Video Solution

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

B. $\frac{ML^2}{6}$

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

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

Answer: A

Watch Video Solution

3. 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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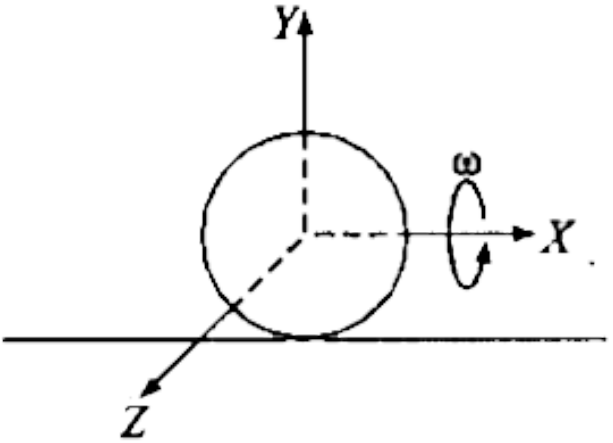
4. A solid sphere of mass m and radius R is moving with velocity of centre of mass$v\hat{i}$ and angular velocity about centre ofmass $\omega\hat{i}$ If the coefficient of friction between the sphere and ground μ the frictional

force vectoris (consider $v = \omega R$):



A. $\mu mg\left(\hat{i} + \hat{k}\right)$

B. $\frac{\mu mg}{\sqrt{2}}\left(\hat{i} + \hat{k}\right)$

C. $\frac{\mu mg}{\sqrt{2}}\left(\hat{k} + \hat{i}\right)$

D. $\mu mg\hat{k}$

Answer: C

Watch Video Solution

5. A disc of mass M and radius R is rolling with angular speed ω on a horizontal plane. The magnitude of angular momentum of the disc about a point on ground along the line of motion of disc is :

A. $(1/2)MR^2\omega$

B. $MR^2\omega$

C. $(3/2)MR^2\omega$

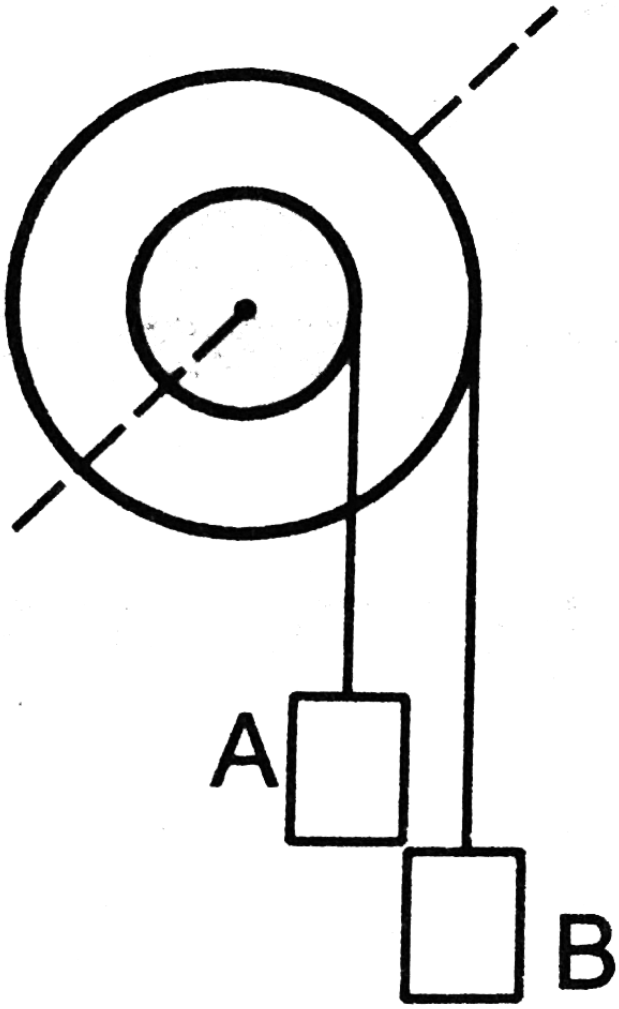
D. $2MR^2\omega$

Answer: C

Watch Video Solution

6. Figure shows a small wheel fixed coaxially on a bigger one of double the radius. The system rotates about the comon axis. The strings supporting A and B do not slip on the wheels. If x and y be

thedistances travelled by A and B in the same time interval, then



A. $x = 2y$

B. $x = y$

C. $y = 2x$

D.

Answer: C

Watch Video Solution

7. The centre of a wheel rolling on a plaen surface moves with a speed v_0. A particle on the rim of the wheel at the same level as the centre will be moving at speed

A. Zero

B. v_0

C. $\sqrt{2}V_0$

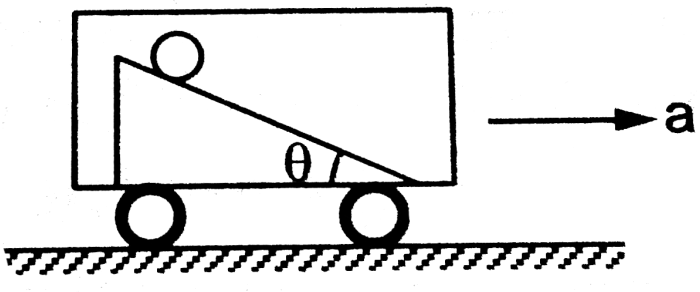
D. $2v_0$

Answer: C

Watch Video Solution

Watch Video Solution

8. Figure shows smooth inclined plane fixed in a car acceleratiing on a horizontal road. The angle of incline θ is related to the acceleration a of the car as $a = > an\theta$. If the sphere is set in pure rolling on the incline



A. It will continue purerolling

B. It will slip down the plane

C. Its linearvelocity will increase

D. Its linear velocity will decrease

Answer: A

Watch Video Solution

9. A points is A located on the rim of a wheel of radius R which rolls without slipping along a horizontal surface with velocity v. The total distance travelled by the point A between successive moments at which it touches the surface is :

A. 4R

B. 2R

C. 8R

D. $\sqrt{8}R$

Answer: C

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10. A hollow straight tube of length l and mass m can turn freely about its centre (fixed) on a smooth horizontal table. Another smooth uniform rod of same length and mass is fitted into the tube so that their centres coincide. They system is set in motion with an initial angular velocity ω_0. the angular velocity of the rod at an instant when the rod slips out of the tube is :

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

B. $\frac{\omega_0}{5}$

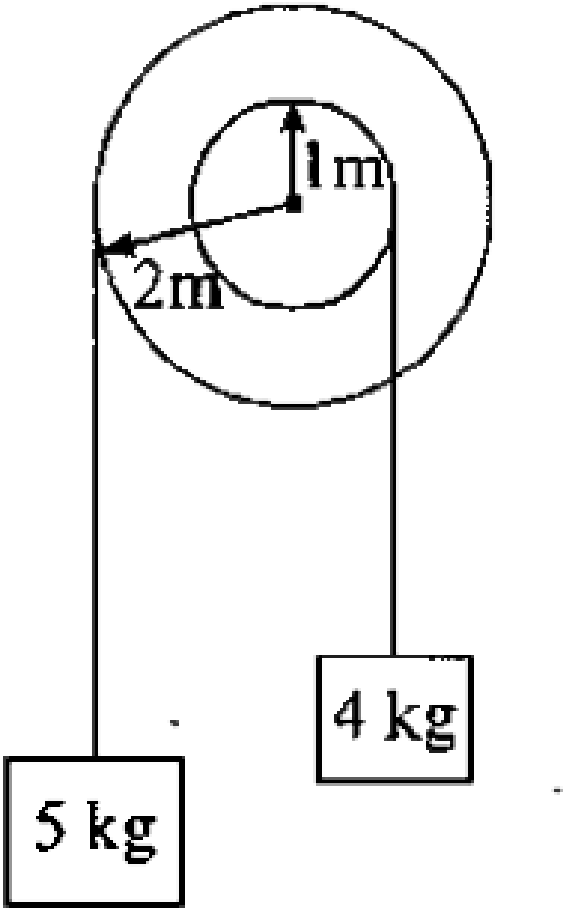
C. $\frac{\omega_0}{7}$

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

Answer: C

Watch Video Solution

11. The moment of inertia of the pulleys system as shown in the figure-5.103 is 4 kgm^2 The radii of bigger and smaller pulleys 2 mand 1m respectively.The angular acceleration of the pulley system is: (take $= 10m/s^2$)



A. $2.1rad/s^2$

B. $4.2 rad / s^2$

C. $1.2 rad / s^2$

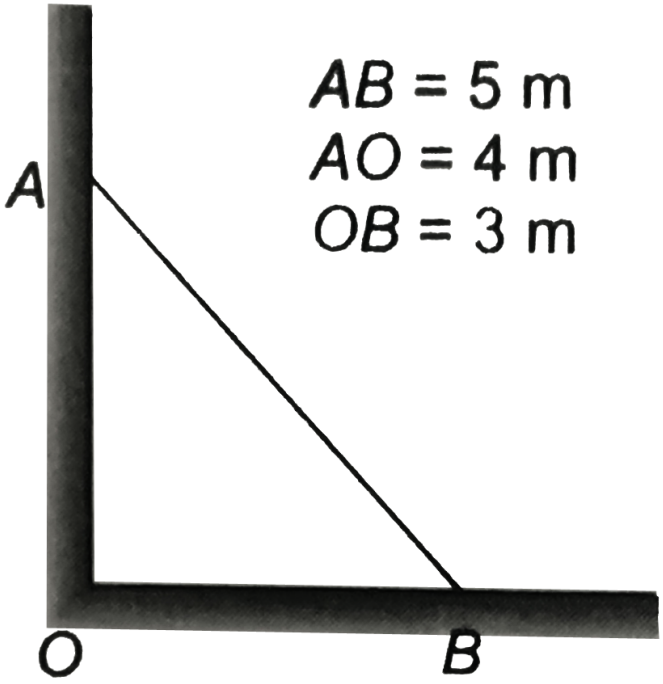
D. $0.6 rad / s^2$

Answer: A

Watch Video Solution

12. A ladder of length $5m$ is placed against a smooth wall as shown in figure. The coefficient or friction is μ between ladder and ground.

What is the minimum value of μ , If the ladder is not to slip?



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

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

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

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

Answer: C

Watch Video Solution

13. 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. $\frac{3}{2}mr^2$

D. $2mr^2$

Answer: C

Watch Video Solution

14. A body is uniformly rotating bout an axis fixed in an inertial frame of reference. Let $\vec{A}$ be a unit vector along the axis of rotation and $\vec{B}$ be the unit vector along the resultant force on a particle P of te ody away from the axis. The value of $\vec{A} . \vec{B}$ is

A. 1

B. -1

C. 0

D. None of these

Answer: C

Watch Video Solution

15. The moment of inertia of a uniform semicirculararwire of mass M and radius r about a line perpendicular to the plane of the wire through the centre is :

A. Mr^2

B. $(1/2)(Mr^2)$

C. $1/4(Mr^2)$

D. $2/5(Mr^2)$

Answer: A

Watch Video Solution

16. A uniform rod of mass m and length l makes a constant angle θ with an axis of rotation which passes through one end of the rod. Its moment of inertia about this axis is

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

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

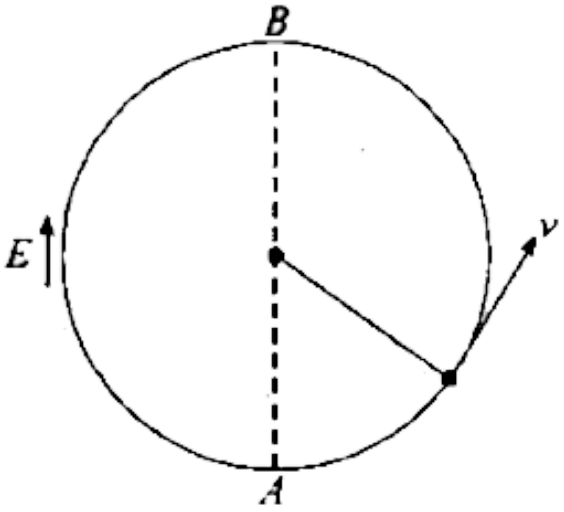
C. $\frac{ml^2}{3}\sin^2\theta$

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

Answer: C

Watch Video Solution

17. A particle of mass m and charge Q is attached to a string of length l. It is whirled in a vertical circle in the region of an electric field E as shown in the figure-5.105.What is the speed given to the particle at the point B,so that tension in the string when the particle is at A is ten times the weight of the particle?



A. $\sqrt{5gl}$

B. $\sqrt{5\left(g-\frac{QE}{m}\right)l}$

C. $\sqrt{\frac{QEl}{m}}$

D. $\sqrt{5\left(g+\frac{QE}{m}\right)l}$

Answer: D

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18. A particle is attached by a light string of length 3 a to a fixed point and describes a horizontal circle of radius a with uniform angular velocity ω If, when the particle is moving in this manner, is suddenly stopped and then let go,find its velocity when the string is vertical in its subsequent motion :

A. $\left[2ga\left(3-2\sqrt{2}\right)\right]^{1/2}$

B. $2ga\left(3-2\sqrt{2}\right)$

C. $ga\left(3-2\sqrt{2}\right)$

D. $\frac{2ga}{3-2\sqrt{2}}$

Answer: A

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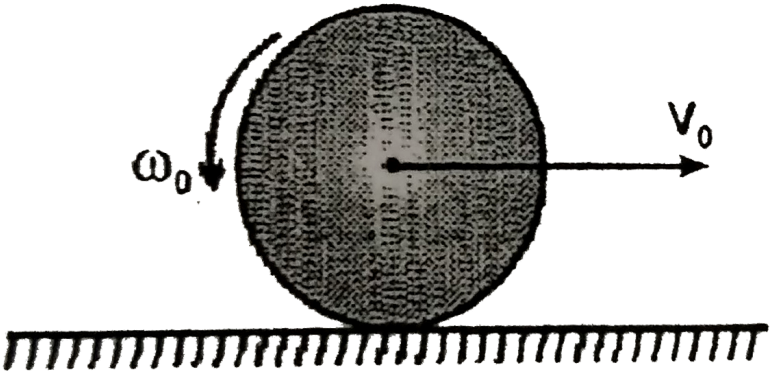
19. A uniform circular disc placed on a horizontal rough surface has initially a velocity v_0 and an angular velocity ω_0 as shown in the figure. The disc comes to rest after moving some distance in the direction of motion. Then v_0 / ω_0 is :



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

B. 1

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

D. 2

Answer: A

Watch Video Solution

20. A cubical block of mass M and edge a slides down a rougg inclined plane of inclination θ with a uniform velocity. The torque of the normal force on the block about its centre has magnitude.

A. Zero

B. Mga

C. Mga $\sin\theta$

D. $1/2(Mga\sin\theta)$

Answer: D

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21. A hoop ofradius r weights m kg. It rolls-without sliding along a horizontal floor so that its centre of mass has a speed v m/s How much work has to be done to stop it?

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

B. mv^2

C. $2mv^2$

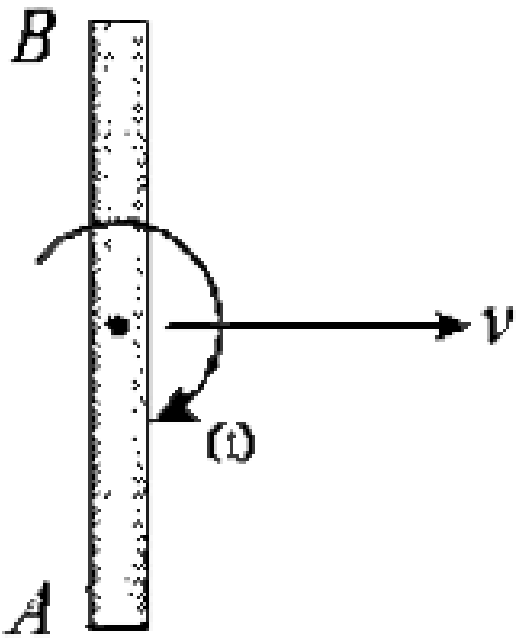
D. $\frac{1}{3}mv^2$

Answer: B

Watch Video Solution

22. A uniform rod AB of length l rotating with an angular velocity ω while its centre moves with a linear velocity $v = \frac{\omega l}{6}$ If the end A of

the rod is suddenly fixed, the angular velocity of



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

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

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

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

Answer: C

Watch Video Solution

23. 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. $\frac{2F}{3Mr}$

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

C. $\frac{F}{3Mr}$

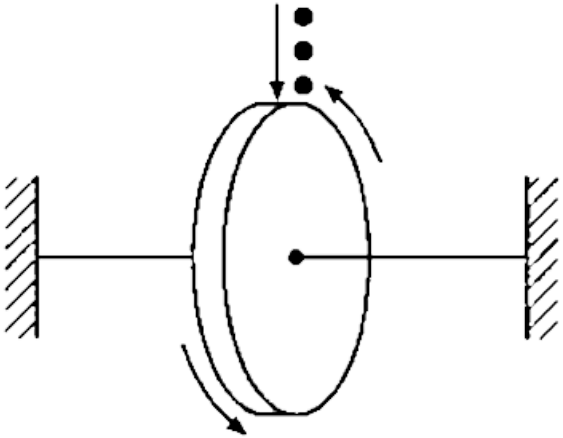
D. $\frac{F}{2Mr}$

Answer: A

Watch Video Solution

24. A disc of mass m_0 rotates freely about a fixed horizontal axis through its centre. A thin cotton pad is fixed to its rim, which can

absorb water. The mass of water dripping onto the pad is n per second: After what time will the angular velocity of the disc get reduced to half of its initial value ?



A. $\frac{2m_0}{\mu}$

B. $\frac{3m_0}{\mu}$

C. $\frac{m_0}{\mu}$

D. $\frac{m_0}{2\mu}$

Answer: D

Watch Video Solution

25. 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 :

A. $\frac{mu^3 \sin^2\theta\cos\theta}{3g}$

B. $\frac{3mu^3 \sin^2\theta\cos\theta}{3g}$

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

D. $\frac{2mu^3 \sin\theta\cos^2\theta}{3g}$

Answer: C

Watch Video Solution

26. 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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27. One end of a uniform rod of mas m and length l is clamped. The rod lies on a smooth horizontal surface and rotates on it about the clamped end at a unifrom angular velocity ω. Theforce exerted by the clamp on the rod has a horizontal component

A. $m\omega^2 l$

B. Zero

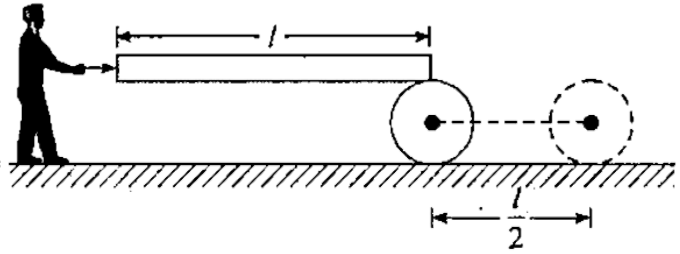
C. mg

D. $(1/2)m\omega^2 l$

Answer: D

Watch Video Solution

28. A man pushes a cylindrical drum through a board of length l as shownin figure-5.109. The drum rolls forward on the ground a distance of $\frac{1}{2}$ There is no slipping at any instant.During the process of pushing the board the distance moved by the man on the ground is :



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

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

C. l

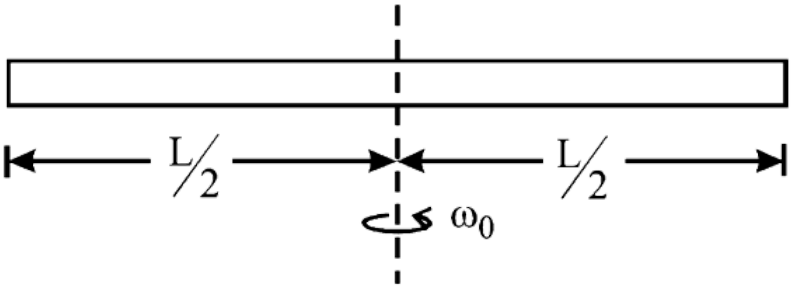
D. $\frac{3l}{8}$

Answer: C

Watch Video Solution

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

the rod, the angular velocity of the system is .....



A. $\omega_0\sqrt{\frac{M}{M+6}}$

B. $\frac{M\omega_0}{M+6m}$

C. ω_0

D. Zero

Answer: B

Watch Video Solution

30. A sphere and circular disc of same mass and radius are allowed to roll down an inclined plane from the same height without slipping. Find the ratio of times taken by these two to come to the bottom of incline :

A. $\sqrt{14}:\sqrt{15}$

B. $15:14$

C. $\sqrt{2}:1$

D. $7:9$

Answer: A

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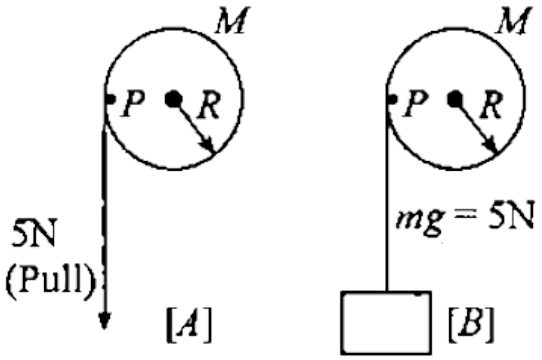
31. A uniform disc of mass M =2.50 kg and radius $R = 0.20$ m is mounted on an axle supported on fixed frictionless bearings. A light cord wrapped around the rim is pulled with a force 5 N. On the same

system of pulley and string, instead of pulling it down, a body of weight 5 N is suspended. If the first processis termed A and the second B, the tangential acceleration of point P will be:



A. Equal in the processes A and B.

B. Greaterin process A than in B.

C. Greater in process Bthan in 4.

D. Independent of the two processes.

Answer: B

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32. Two identical discs are moving with the same kinetic energy. One rolls and the other slides. The ratio of their speeds is:

A. $1:1$

B. $\sqrt{2}:\sqrt{3}$

C. $2:3$

D. $1:2$

Answer: B

Watch Video Solution

33. A bit of mud stuck to a bicycle's front wheel of radius r detaches and is flung horizontally forward when it is at the top of the wheel. The bicycle is moving forward at a speed v and it is rolling without slipping. The horizontal distance travelled by the mud after detaching from the wheel is:

A. $\sqrt{2rv^2/g}$

B. $\sqrt{8rv^2/g}$

C. $\sqrt{4rv^2/g}$

D. $\sqrt{16rv^2/g}$

Answer: D

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34. A particle of mass 10 kg is moving with a uniform speed of 6m/sec, in x-y plane along the line $3y = 4x + 10$ the magnitude of its angular momentum about the origin in kg^2/s

A. zero

B. 80

C. $30\sqrt{2}$

D. 120

Answer: D

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35. A flywheel rotates about an axis. Due to friction at the axis, it experiences an angular retardation proportional to its angular velocity. If its angular velocity falls to half while it makes n rotations, how many more rotations will it make before coming to rest?

A. 2n

B. n

C. n/2

D. n/3

Answer: B

Watch Video Solution

36. If the distance of the moon from earth is and the period of revolution is T_m,then the mass of the earth is

A. $\frac{4\pi^2 r_m^2}{GT_m}$

B. $\frac{4\pi^2 r_m^3}{GT_m^2}$

C. $\frac{4\pi^2 r_m}{GT_m}$

D. $\frac{4\pi^2 r_m}{GT_m^2}$

Answer: B

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37. A body of mass m slides down an smooth incline and reaches the bottom with a velocity, Now smooth incline surface is made rough and the same mass was in the form of a ring which rolls down this incline, the velocity of the ring at the bottom would have been:

A. v

B. $\sqrt{2}v$

C. $v/\sqrt{2}$

D. $\sqrt{2/5}.\ v$

Answer: C

Watch Video Solution

38. A fly wheel rotating about a fixed axis has a kinetic energy of $360J$. When its angular speed is $30rads^{-1}$. The moment of inertia of the wheel about the axis of rotation is

A. $0.6kg \times \text{metre}^2$

B. $0.15kg \times \text{metre}^2$

C. $0.8kg \times \text{metre}^2$

D. $0.75kg \times \text{metre}^2$

Answer: C

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39. A wheel initially at rest, is rotated with a uniform angular acceleration. The wheel rotates through an angle θ_1 in first one second and through an additional angle θ_2 in the next one second. The ratio θ_2 / θ_1 is :

A. 4

B. 2

C. 3

D. 1

Answer: C

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Paragraph

1. 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 the plane with angular velocity ω. Another disc of same mass but half the radius is gently placed over it coaxially. The angular speed ofthe composite disc will be:

A. $5\omega/4$

B. $4\omega/5$

C. $2\omega/5$

D. $5\omega/2$

Answer: B

Watch Video Solution

2. A rod of mass M and length l is suspended freely from its endandit canoscillate in the vertical plane about the point of suspension. It is pulled to one side and then released. It passes through the equilibrium position withangular speed ω . What is the kinetic energy while passing through the mean position ?

A. $Ml^2\omega^2$

B. $Ml^2\omega^2/4$

C. $Ml^2\omega^2/6$

D. $Ml^2\omega^2/12$

Answer: C

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3. A tube of length L is filled completely with an incomeressible liquid of mass M and closed at both the ends. The tube is then rotated in a

horizontal plane about one of its ends with a uniform angular velocity ω. The force exerted by the liquid at the other end is

A. $\frac{M\omega^2 L}{2}$

B. $M\omega^2 L$

C. $\frac{M\omega^2 L}{4}$

D. $\frac{M\omega^2 L}{2}$

Answer: A

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4. We have two spheres, one of which is hollow and the other solid. They have identical masses and moment of intertia about their respective diameters. The ratio of their radius is given by.

A. $5:7$

B. $3:5$

C. $\sqrt{3}:\sqrt{5}$

D. $\sqrt{3}:\sqrt{7}$

Answer: C

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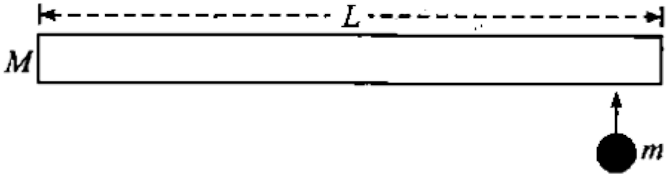
5. A Stick of length L and mass M lies on a fnctionless horizontal surface on which it is free to move in any way. A ball of mass m moving with speed v collides elastically with the stick as shownin figure-5.115. If after the collision ball comes to rest, then what should be the mass of the ball ?



A. $m = 2M$

B. $m = M$

C. $m = M/2$

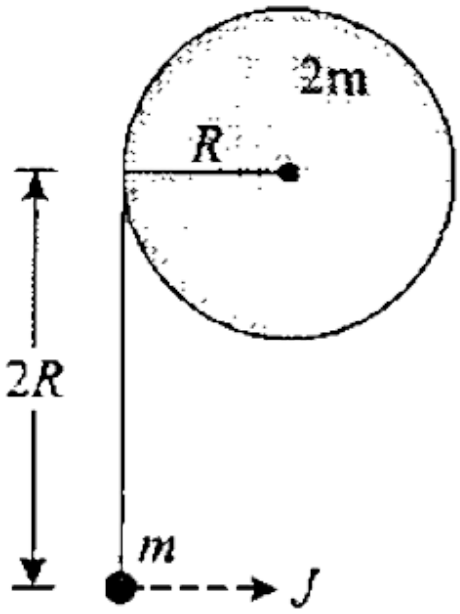
D. $m = M/4$

Answer: D

Watch Video Solution

6. A uniform circular disc of mass 2 m and radius R placed freely on a horizontal smooth surface as shown in the figure- 5.116.A particle of mass m is connected to the circumference of the disc with a massless string. Now an impulse J is applied on the particle in the directions shown by dotted line. The acceleration of centre of mass of the disc just after application of implues is

$\left(\text{If J} \quad = 10N - \text{sec.}, m = \sqrt{10}kg \text{ and } R = 25cm\right)$



A. $1m/s^2$

B. $2m/s^2$

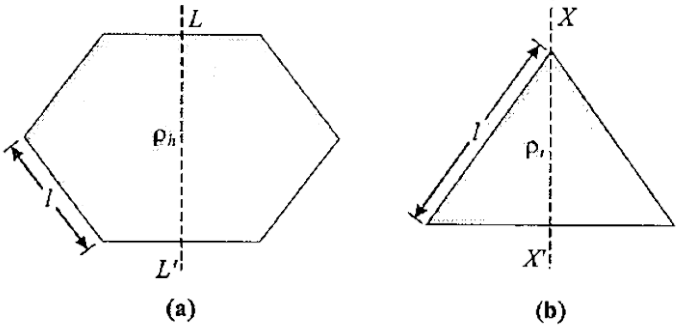
C. $3m/s^2$

D. $4m/s^2$

Answer: D

Watch Video Solution

7. Moment of inertia of a uniform hexagonal plate about an axis 'LL' is'I' as shown in the figure-5.117. The moment of inertia (about axisXX') of an equilateral uniform triangular plate of thickness double that of the hexagonal plateis (Ratio of specific gravity $\frac{\rho t}{\rho h} = 3$):



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

B. $\frac{I}{10}$

C. I

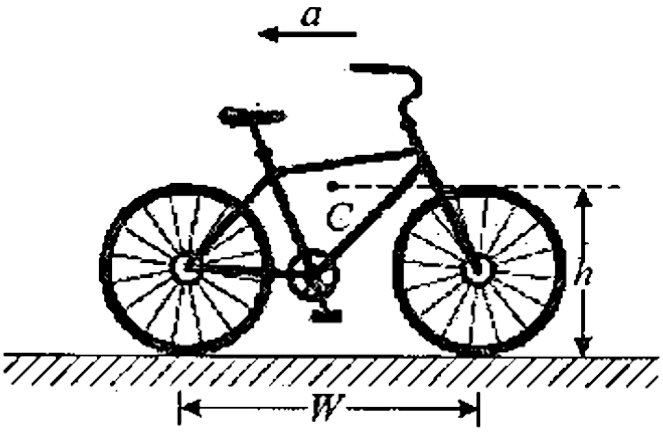
D. Zero

Answer: A

Watch Video Solution

8. A simplified model of a bicycle of mass M has two tires that each comes into contact with the ground at a point. The wheel base of this bicycle is JV, and the centre of mass C of the bicycle is located mid way between the tires and a height h above the ground.The bicycleis moving to the right,but slowing down at a constant acceleration a. Air resistance may be ignored. Assuming that the coefficient of sliding friction between each tyre and the ground is μ and that both tyres are skidding (sliding without rotating). Express your answer in terms of w,h,M and g .

What is the maximum value of μ so that both tires remain in contact with the ground :



A. $W / 2h$

B. $h / 2W$

C. $2h / W$

D. W / h

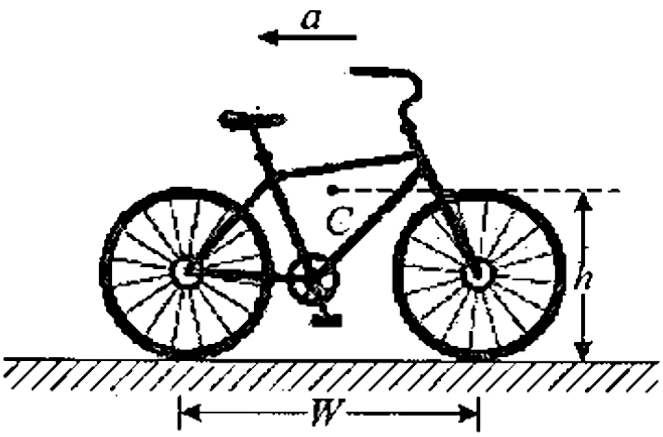
Answer: A

Watch Video Solution

9. A simplified model of a bicycle of mass M has two tires that each comes into contact with the ground at a point. The wheel base of this bicycle is JV, and the centre of mass C of the bicycle is located mid way between the tires and a height h above the ground.The bicycleis moving to the right,but slowing down at a constant acceleration a. Air resistance may be ignored. Assuming that the coefficient of sliding friction between each tyre and the ground is μ and that both tyres are skidding (sliding without rotating). Express your answer in terms of

w,h,M and g .

What is the maximum value of a so that both tyres remain in contact with the ground ?



A. $\frac{Wg}{h}$

B. $\frac{Wg}{2h}$

C. $\frac{hg}{2W}$

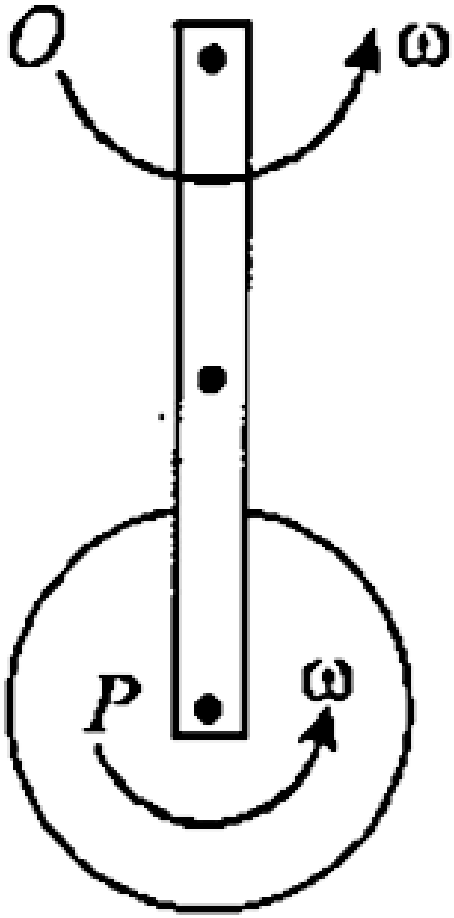
D. $\frac{h}{2Wg}$

Answer: B

Watch Video Solution

10. A rod of mass m and length 2R can rotate about an axis passing through O invertical plane.A disc of mass m and radius $R/2$ is hinged to the other end P ofthe rod and can freely rotate about P. When disc is at lowest point both rod and disc has angular velocity ω. If rod rotates by maximum angle$\theta = 60^\circ$ with downward vertical, then ω

interms of R and g will be(all hinges are smooth)



A. $\sqrt{\frac{9g}{16R}}$

B. $\sqrt{\frac{3g}{23R}}$

C. $\frac{1}{3}\sqrt{\frac{g}{R}}$

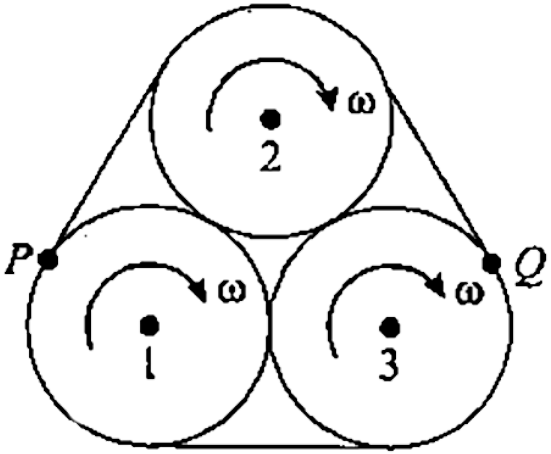
D. None of these

Answer: A

Watch Video Solution

11. Three identical cylinders of radius R are in contact.Each cylinder is rotating with angular velocity ω.A thin belt is moving without sliding on the cylinders. Calculate the magnitude of velocity of point P with respect to Q.P and Q are two points of belt which are in contact with

the cylinder.



A. $2R\omega$

B. $R\omega$

C. $R\omega/2$

D. $R\omega/\sqrt{3}$

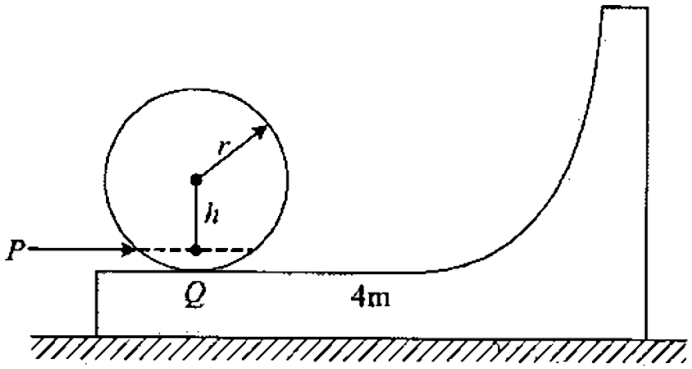
Answer: D

Watch Video Solution

12. If no external force is acting on the system,net linear momentum of the system is conserved.If system is acted upon by some external force,the component of momentum of the system,along which no external force is present or their vector sum is zero,is conserved. If a sharp blow is given to a body its linear momentum changes immediately.Changein angular momentum not only depends on the magnitude of the blow but also on point ofapplication.In the case of symmetrical body we take the axis of rotation through center of the body. A wedge of mass 4m is placed at rest on a smooth horizontal surface. A uniform solids phere of mass m and radiusr is placed at reston the flat portion of the wedge at the point Q as shown in the figure. A sharp horizontal impulse P is given to the sphere at a point below $h = 0.4r$from the center of the sphere.The radius of curvature of the curvedportion of the wedge is R.Coefficient off riction to the left side of point Q is μ and to the right side of point Q is zero. For a body to rollon a surface without slipping, there should be no relative velocity between the points of contact.

The maximum height to which the center of mass of the sphere will

climb on the curved portion of the wedge is



A. $2\frac{P^2}{5m^2g}$

B. $\frac{P^2}{5m^2g}$

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

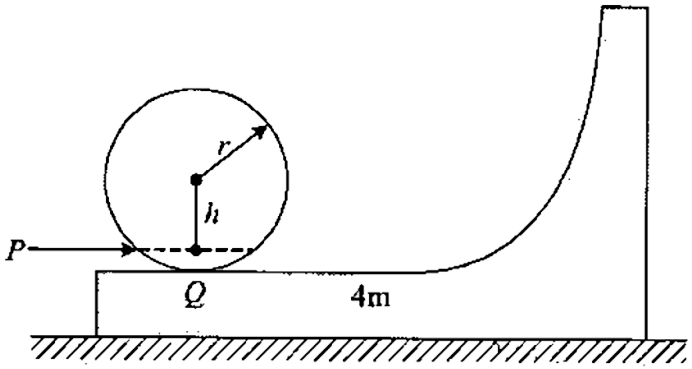
D. None of these

Answer: A

Watch Video Solution

13. If no external force is acting on the system,net linear momentum of the system is conserved.If system is acted upon by some external force,the component of momentum of the system,along which no external force is present or their vector sum is zero,is conserved. If a sharp blow is given to a body its linear momentum changes immediately.Changein angular momentum not only depends on the magnitude of the blow but also on point ofapplication.In the case of symmetrical body we take the axis of rotation through center of the body. A wedge of mass 4m is placed at rest on a smooth horizontal surface. A uniform solids phere of mass m and radiusr is placed at reston the flat portion of the wedge at the point Q as shown in the figure. A sharp horizontal impulse P is given to the sphere at a point below $h = 0.4r$from the center of the sphere.The radius of curvature of the curvedportion of the wedge is R.Coefficient off riction to the left side of point Q is μ and to the right side of point Q is zero. For a body to rollon a surface without slipping, there should be no relative velocity between the points of contact.

Kinetic energy ofthesystem when sphere isatthehighest point is :



A. $\left(P^2\right)/(10\mathrm{m})$`

B. $\left(P^2\right)/(5\mathrm{m})$`

C. $\left(3P^2\right)/(10\mathrm{m})$`

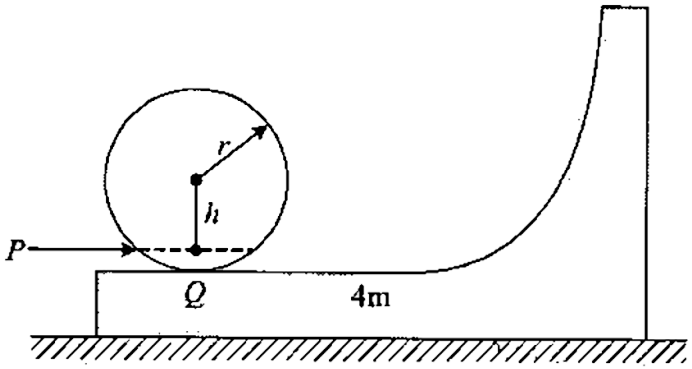
D. $\left(3P^2\right)/(5\mathrm{m})$`

Answer: C

Watch Video Solution

14. If no external force is acting on the system,net linear momentum of the system is conserved.If system is acted upon by some external force,the component of momentum of the system,along which no external force is present or their vector sum is zero,is conserved. If a sharp blow is given to a body its linear momentum changes immediately.Changein angular momentum not only depends on the magnitude of the blow but also on point ofapplication.In the case of symmetrical body we take the axis of rotation through center of the body. A wedge of mass 4m is placed at rest on a smooth horizontal surface. A uniform solids phere of mass m and radiusr is placed at reston the flat portion of the wedge at the point Q as shown in the figure. A sharp horizontal impulse P is given to the sphere at a point below $h = 0.4r$from the center of the sphere.The radius of curvature of the curvedportion of the wedge is R.Coefficient off riction to the left side of point Q is μ and to the right side of point Q is zero. For a body to rollon a surface without slipping, there should be no relative velocity between the points of contact.

Speed ofthe wedge when sphereреaches the flat portion again:



A. $\frac{2P}{5m}$

B. $\frac{3p}{5m}$

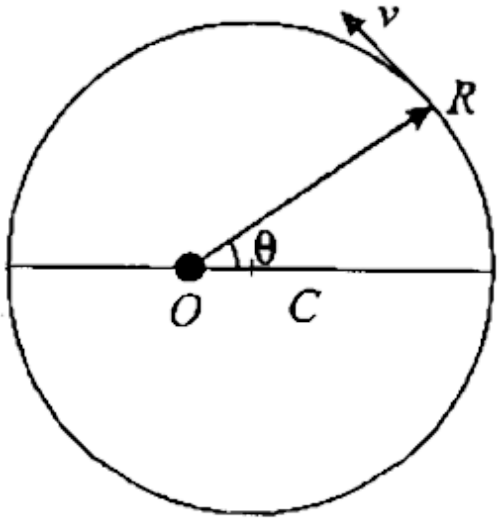
C. $\frac{8P}{5m}$

D. $\frac{P}{5m}$

Answer: A

Watch Video Solution

15. A particle is revolving in a circular path as shownin figure in the horizontal plane such that the angular velocity of the particle about the point O is constant and is equal to $1rad/s$. Distance of the particle from O is given by$R = R_0 - \beta t$ where $R_0$and $B\eta$ are constant. The speed ofthe particle,as afunction of time is: ltbrlt



A. $\sqrt{\beta^2 + 1}$

B. $(R_0 - \beta t)$

C. $\sqrt{\beta^2 + (R_0 - \beta t)^2}$

D. β

Answer: C

Watch Video Solution

16. A particle is projected horizontally with velocity$V_0 = \sqrt{2ga}$ along the smooth inside surface of a fixed hollow hemisphere of inner radius 'a' at the level of the centre 'O'. The subsequent motion of the particle is confined between the horizontal planes one through the centre and the other at a depth h. Find the value of h:

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

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

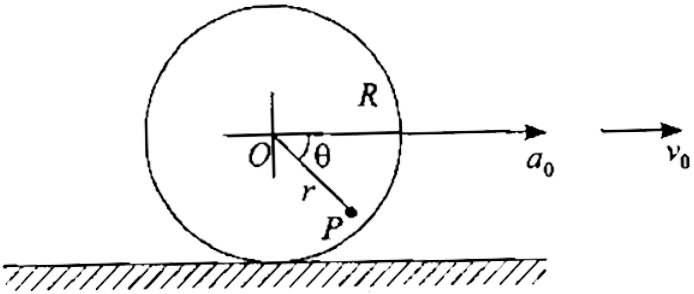
C. $\frac{\sqrt{5-1}}{2}a$

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

Answer: C

Watch Video Solution

17. The wheel of radius R rolls with out slipping on horizontal rough surface, and its centre O has an horizontal acceleration in a_0 forward direction. A point P on the wheel is a distancer r from O and angular position θ from horizontal. For the given values of a_0 R and r, determine the angle θ for which point P has no acceleration in this position.



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

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

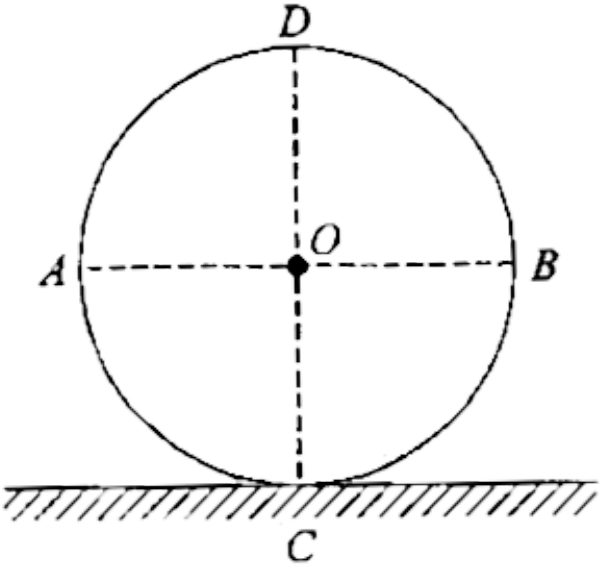
C. $\sin^1 . \frac{r}{R}$

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

Answer: C

Watch Video Solution

18. A uniform ring of mass m and radius R is in uniform pure rolling motion on a horizontal surface. The velocity of the centre of ring is V_0. The kinetic energy of the segment ABC is:



A. $\frac{mV_0^2}{2} - \frac{mV_0^2}{\pi}$

B. $\frac{mv_0^2}{2} + \frac{mv_0^2}{\pi}$

C. $\frac{mv_0^2}{2}$

D. mv_0^2

Answer: A

Watch Video Solution

19. 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

B. $I\cos^2\theta$

C. $I \sin^2 \theta$

D. $I \cos^2(\theta/2)$

Answer: A

Watch Video Solution

20. A rectangular block has a square base measuring $a \times a$ and its height is h. It moves on a horizontal surface in a direction perpendicular to one of the edges. The coefficient of friction is μ. It will topple if

A. $\mu > a/2h$

B. $\mu > 2a/h$

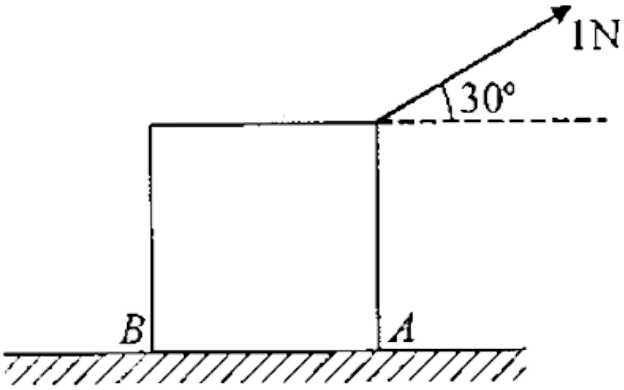
C. $\mu > a/h$

D. $\mu > h/a$

Answer: A

Watch Video Solution

21. A cubical block ofmass $\frac{\sqrt{3}}{10}$ kg and edge 20cm is placed on a rough horizontal surface as shown in the figure-5.126. A force of 1N is applied at one end of the block and the block remains stationary. The normal force exerted by the surface on the block acts $(g = 10m/s^2)$



A. throught the centre of mass of the block

B. through point B

C. through point A

D. through the point at the distance 5 m from A

Answer: B

Watch Video Solution

22. A rope of mass'm' is looped in a circle of radius R and rotated with a constant angular velocity about its axis in gravity free space . Find the tension in the rope ?

A. $T = mR\omega_0^2$

B. $2mR\pi\omega^2$

C. $T = \frac{mR\pi\omega_0^2}{2\pi}$

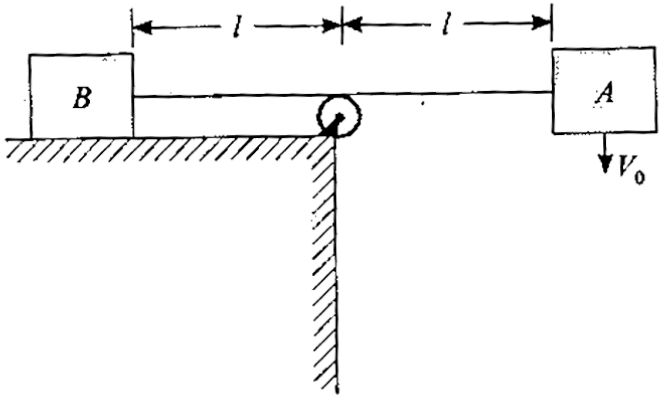
D. $4mR\pi\omega_0^2$

Answer: C

Watch Video Solution

23. Two identical blocks are placed on as mooth horizontal surface, connected by a light string of length 2l. String touches a fixed smooth pulley at its mid-point initially. Which is attached to two smooth vertical walls as shown in figure-5.127. Blocks is given a speed V_0 perpendicular to string as shown indiagram. B strikes the pulley and stops.

Speed of block B gwhen it hits the pulley is :



A. $\frac{V_0}{2}$

B. $V_0\sqrt{\frac{3}{2}}$

C. V_0

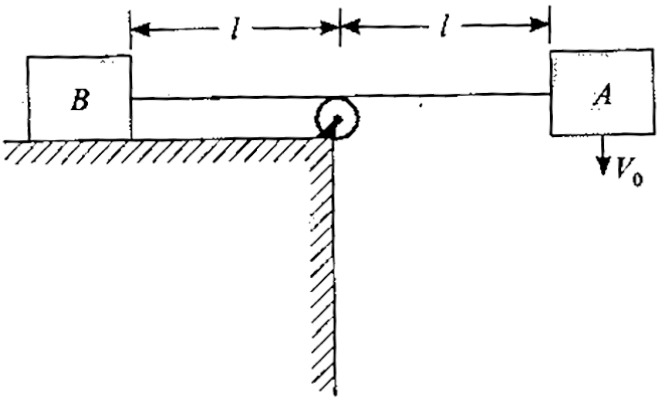
D. $V_0\sqrt{\frac{3}{8}}$

Answer: D

Watch Video Solution

24. Two identical blocks are placed on as mooth horizontal surface, connected by a light string of length 2I. String touches a fixed smooth pulley at its mid-point initially. Which is attached to two smooth vertical walls as shown in figure-5.127. Blocks is given a speed V_0 perpendicular to string as shown indiagram. B strikes the pulley and stops. .

Speed of A when it hits the wall is :



A. $\frac{V_0}{2}$

B. $V_0\sqrt{\frac{3}{2}}$

C. V_0

D. $V_0\sqrt{\frac{3}{8}}$

Answer: A

Watch Video Solution

Mcq

1. Asphere, a disc and a ring of the same mass but of different density and radii are allowed to roll down on an inclined plane without slipping simultaneously, through the same height, then:

A. The body of greater.density will reach the bottom earliest

B. The body of least density will reach will reach the bottom earliest

C. The sphere will reach the bottom earlier

D. The ring will reach the bottom with the least linear momentum.

Answer: C::D

Watch Video Solution

2. The axis of rotation of a purely rotating body

A. Must pass throughthe centre of mass

B. May pass through the centre of mass

C. Must pass through a particle of the body

D. May pass through a particle of the body

Answer: B::D

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3. In rear wheel drive cars the engine rotastes the rear whel and the front wheels rotates only becomes the car moves. Ilf such a car accelerates on horizontal road the friction

A. On the rear wheels is in the forward direction

B. On the front wheels is in the backward direction

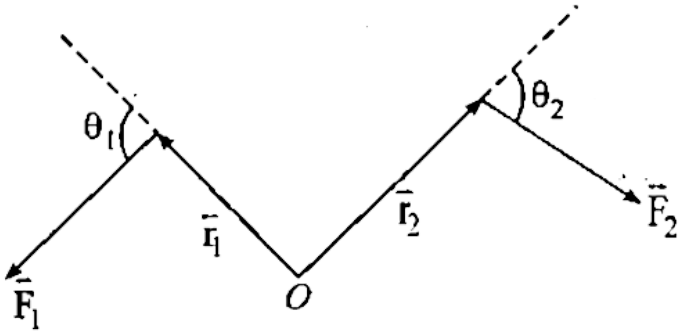
C. On the rear wheels has larger magnitude than the friction

D. On the car is in the backard direction

Answer: A::B::C

Watch Video Solution

4. In the figure-5.128 are shown the lines of action and moment arms of two forces about the origin O.Imagining theseforces to beacting on arigid body pivoted at, all vectors shown being in the planeof the figure, the magnitude and direction of the resultant torque will be :



A. $(F_2 r_2 \sin\theta_1 - F_2 r_2 - \sin\theta_1)$ outofthe plane ofthe page.

B. $(F_1 r_1 \sin\theta_1 - F_2 r_2 - \sin\theta_2)$ out ofthe plane ofthe page

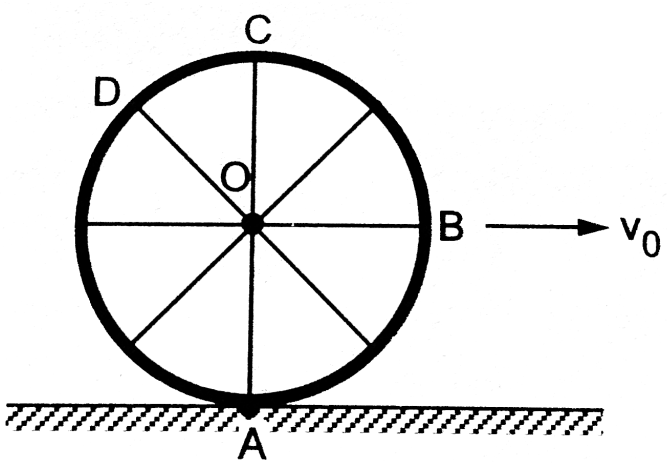
C. $(F_2 r_2 \sin\theta - F_1 r_1 - \sin\theta_1)$ into the plane ofthe page.

D. zero

Answer: B::C

Watch Video Solution

5. Consider a wheel of a bicycle rolling on a level road at a liner speed v_0 figure.



A. The speed of the particle Aiszero

B. The speed B, C and D are equal to v_0

C. The speed of C is $2v_0$

D. The speed of B is greater than the speed of O.

Answer: A::C::D

Watch Video Solution

6. A sphere is rolled on a rough horizontal surface. It gradually slows down and stops. The force of friction tries to

A. Decrease thelinear velocity

B. Increase the linear velocity

C. Increase the linear momentum

D. Decrease the angular momentum

Answer: A

Watch Video Solution

7. Asphere is rotating about adiameter atuniform angular speedthenwhich ofthefollowing options is/arecorrect:

A. The particles on the surface ofthe sphere do not have any linear accleration:

B. The particles on the diameter mentioned above do not have any linear acceleration

C. Different particles on the surface have different angular speeds

D. All the speeds on the surface have the same linear speed.

Answer: B

Watch Video Solution

8. A smooth sphere A is moving on a frictionless horizontal plane with angular speed ω and centre of mass velocity v. It collides elastically and head on with an identical sphere B at rest. Neglect friction

everywhere. After the collision, their angular speeds are ω_A and ω_B respectively. Then

A. $w_A < w_B$

B. $w_A = w_B$

C. $w_A = w$

D. $w_B = 0$

Answer: C::D

Watch Video Solution

9. A particle moves on a straight line with a uniform velocity. The angular momentum of the particle is

A. Is alwayss zero

B. Is zero about a point on the straight line

C. Is not zero about apoint away from the straight line

D. About any given point remains constant

Answer: B::C::D

Watch Video Solution

10. A thin uniform 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 at its lowest point, normal to its length immediately after impact,

A. The angular momentum of the road is Jl

B. Angular velocity of the rod Is 3J/ml

C. The K.E. of the rod is $3J^2/2m$

D. The linear velocity of the midpoint of the rod is 3J/2m.

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

Watch Video Solution

11. Two identical semicircular discs of mass 'm' each and radius 'R' are placed in the XY (horizontal) plane and the YZ (vertical) plane, respectively. They are so placed that they have their common diameter along the y-axis. Then, the moment of inertia I_n of the system about the appropriate axis is given by (I_n refers to moment of inertia about axis n-where n is X, Y, Z)

A. $l_x = \frac{1}{2}mR^2$

B. $l_Y = \frac{1}{2}mR^2$

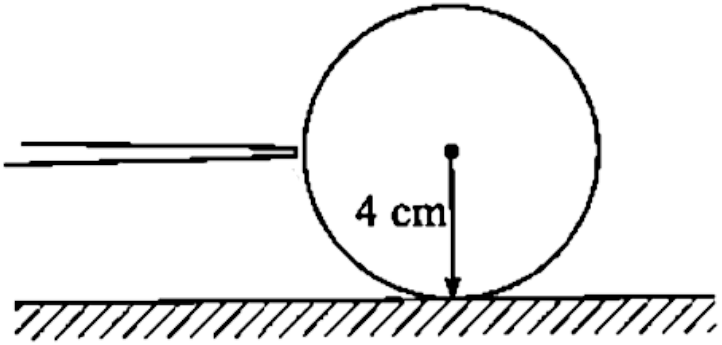
C. $l_Z = \frac{3}{4}mR^2$

D. $l_X = l_Y = l_Z$

Answer: B::C

Watch Video Solution

12. A uniform ring placed on a rough horizontal surface is given a sharp impulse as shown in the figure-5.130. As a consequence, it acquires a linear velocity of 2m/s. If coefficient of friction between the ring and the horizontal surface is 0.4 :



A. Ring wil lstart pure rolling afler O.25s

B. When ring will start pure rolling its .velocity is 1m//s

C. After 0.5s from impulse its velocity is 1m//s.

D. After0.125 s from impulse its velocity is 1m//s.

Answer: A::B::C

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13. The density of as rod graduallly decreases from one end to the other. It is pivoted at an end so that ilt can move about a vertical axius through the pivot. A horizontal force F is applied on the free end n a direction perpendicular to the rod. The quantities, that do not depend on which end of the rod is pivoted are

A. Angular acceleration

B. Total kinetic energy of the rod, when the rod completes one revolution

C. Angular momentum when the rod completes one revolution

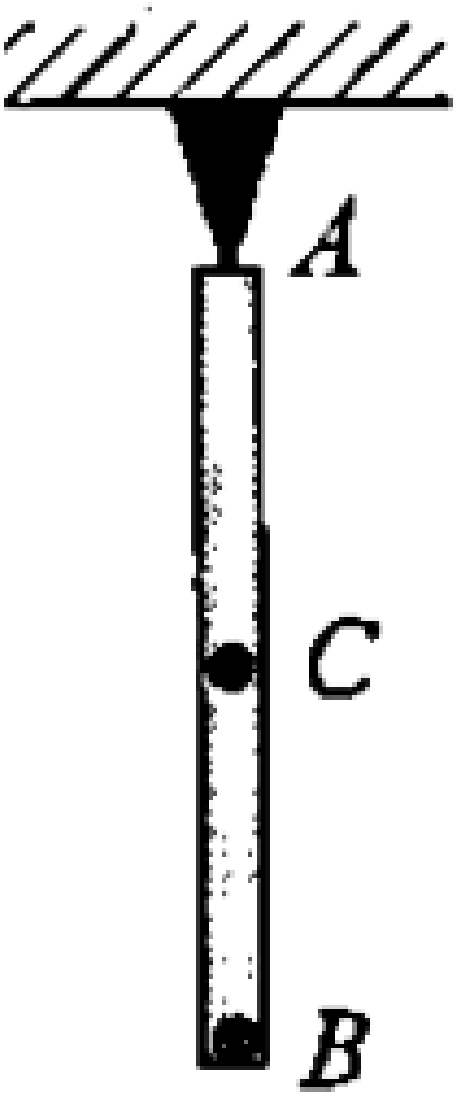
D. Angular velocity of rod

Answer: A::C::D

Watch Video Solution

14. A weightless rigid rod AB of length / connects two equal masses m one particle is fixed at the end B and the other at the middle ofthe rod as shown in the figure-5.131. The rod can rotate in the vertical plane

freely around the hinge point/4. Choose the correct option(s)



A. The minimum horizontal velocity required to be given to the particle B so as to make the rod go around in the complete vertical circleis

B. The minimum horizontal velocity required to begivento the particle B so as to make the rod go around in the complete vertical circle is

C. The ratio of compressive force in the rods AC and BC is 2 : 1 when the masses are at highest point.

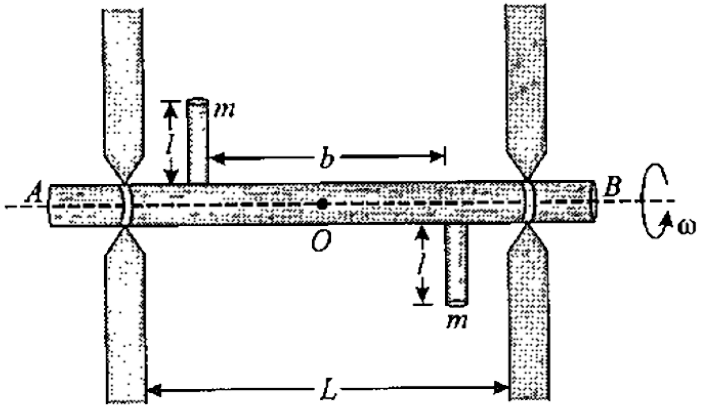
D. The ratio of compressive force in the rodsA

Answer: A::C

Watch Video Solution

15. Figure shows a horizontal rod AB which is free to rotate about two smooth bearing system. Two identical uniform rods each of mass m

are attached to lod AB symmetrically about the centre ofmassO oftherodAB. All the dimensions are given in the figure-5.132. The system is rotating with constant angular velocity co insuch away that the upper rod is coming outward from the plane of the paper in the position shown. Gravity can be assumed to be absent in the experiment, then choose the correct option(s).



A. The hinge reaction at A on the rod AB is downward

B. The hinge reaction at B on the rod AB is upward

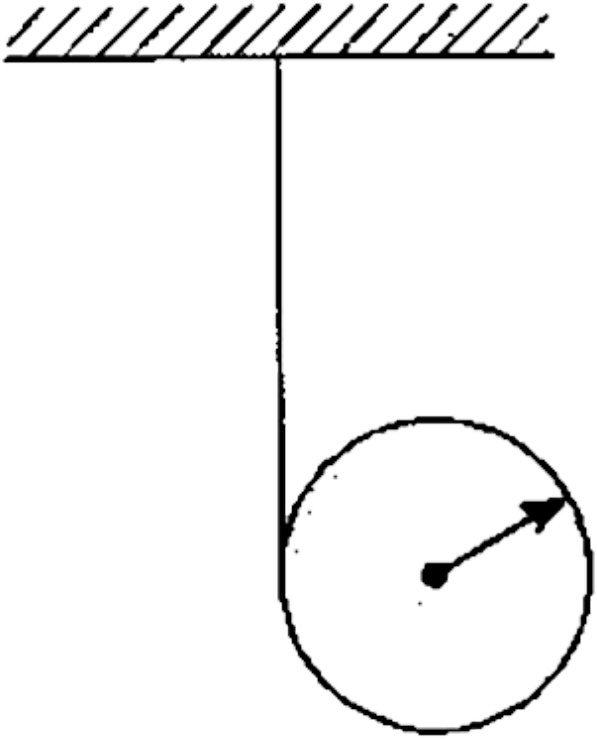
C. The hinge reaction at B on the rod AB is downard

D. The angular momentum of the system about point O is NOT along the rod AB.

Answer: A::B::D

Watch Video Solution

16. A string is wrapped over a uniform cylinder, as shown in diagram (sideview). When cylinder is released, string unwraps without any slipping and cylinder comes down. Which ofthe following is true ?



A. Work done by Tension force on the cylinder is zero

B. Work done by the Tension is negative

C. Ratio of rotational kinetic energy and 1 translational kinetic energy is -

D. Ratio ofrotational kinetic energy to translational kinetic energy is 2

Answer: A::C

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Unsolved Numerical

1. Two masses M and m are connect by a light string gong over a pulley of radis r. The pulley is free to rotate about its axis which is kept horizontal. The moment of inertia of the pulley about the axis is I. The system is releaed from rest. Find the angular momentum fo teh

system when teh mass Mhas descended through a height h. The string does not slip over the pulley.

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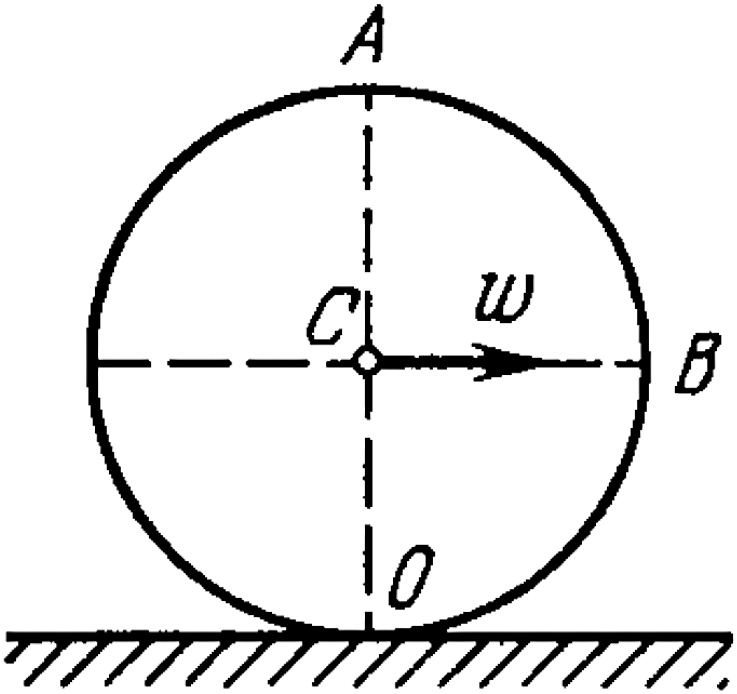
2. A ball of radius $R = 10.0cm$ rolls without slipping down an inclined plane so that its centre moves with constant acceleration $w = 2.50cm / s^2, t = 2.00s$ after the beginning of motion its position corresponds to that shown in figure. Find:

(a) the velocities of the points A, B, and O,

(b) the accelerations of these points.



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3. 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 ?

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4. A conical pendulum, a thin uniform rod of length l and mass m, rotates uniformly about a vertical axis with angular velocity ω(the upper end of the rod is hinged). Find the angle θ between the rod and the vertical.

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5. A point A is located on the rim of a wheel of radius R which rolls witout slipping along a horizontal surface witih velocity V. Find the total distance traversed by the point A between successive moments at which it touches the surface.

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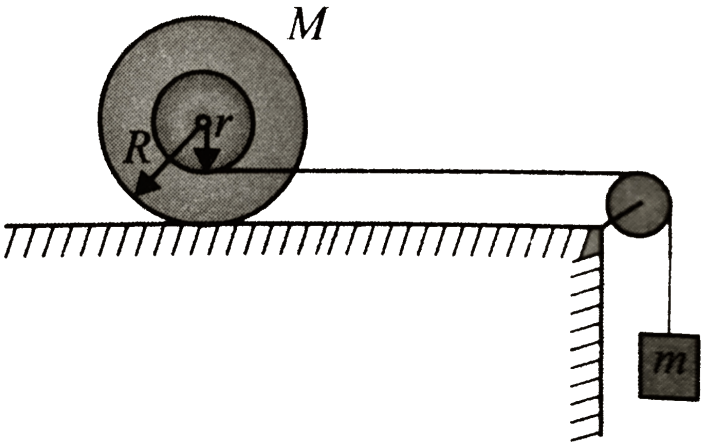
6. A spool (consider it as a double disc system joined by a short tube at their centre) is placed on a horizontal surface as shown Fig. A light

string wound several times over the short connecting tube leaves it tangentially and passes over a light pulley. A weight of mass m is attached to the end of the string. The radius of the connecting tube is r and mass of the spool is M and radius is R. Find the acceleration of the falling mass m. Neglect the mass of the connecting tube and slipping of the spool.



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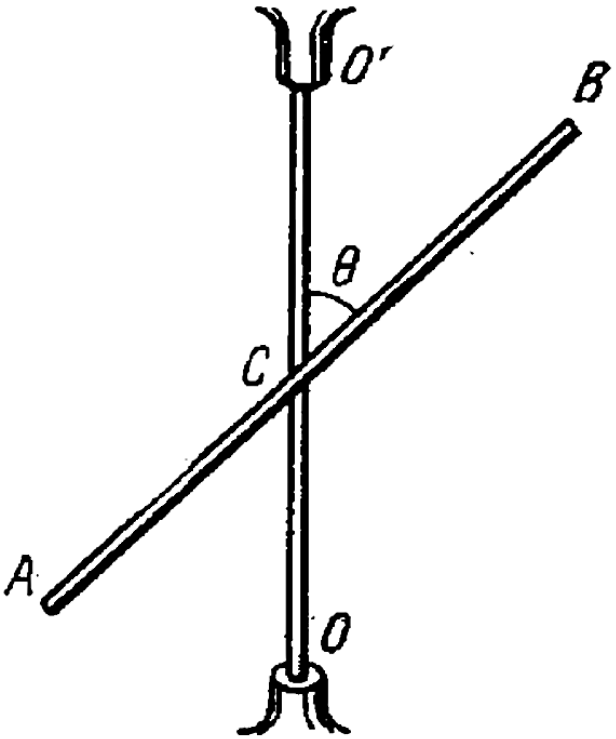
7. A midpoint of a thin uniform rod AB of mass m and length l is rigidly fixed to a rotation axle OO' as shown in figure. The rod is set into rotation with a constant angular velocity ω. Find the resultant

moment of the centrifugal forces of inertia relative to the point C in the reference frame fixed to the axle OO' and to the end.



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8. A particle is projected at time t=0 from a point P on the ground with a speed v_0, at an angle of 45° to the horizontal. Find the magnitude

and direction of the angular momentum of the particle about P at tiem $t = v_0 / g$

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9. What is the angular momentum of the seconds hand on a clock about an axis through the centre ofthe clock face if the clock hand has a length of 25 cm and amass of 15gm ?

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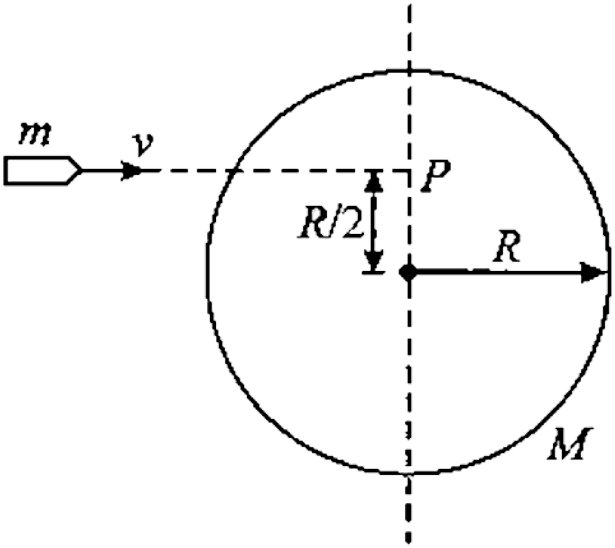
10. A solid uniform sphere, with radius R = 0.2 m and mass M=50kg,is at rest in an inertial reference frame in deep space. A bullet with mass w = 20 gm and a velocity v= 400 m/s strikes the sphere along the line shownin figufe-5.137, and rapidly comes to rest within the sphere at point P. Determine the subsequent motion of the sphere and the

embedded bullet.



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11. In a spring gun, a spring of force constant 200N/mis compressed 0.15 m. When fired, 80% of the elastic potential energy stored in the spring is eventually converted into kinetic energy of a 0.1 kg uniform ball that is rolling without slipping at the base of a ramp. The ball continues to roll without slipping up the ramp with 90% of the kinetic energy at the bottom converted into an increase in gravitational

potential energy at the instant it stops.

(a) What is the speed of the ball's centre ofmass at the base of the ramp

(b) At this position, what is the speed of a point at the top of the ball?

(c) What maximum vertical height up the ramp does the ball move?

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12. A diver makes 2.5 revolutions on the way from a $10 - m - high$ platform to the water. Assuming zero initial vertical velocity, the average angular velocity during the dive is.

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13. (a) Compute the torque developed by an automotive engine whose output is 180 kW at an angular velocity of 4000rev/min. (b)A drum of negligible mass, 0.min diameter, is attached to the motorshaft,and the powerout put of the motor is used to raise a weight hanging from a

rope wrapped around the drum. How large a weight can be liftd? Assume contant speed(c) With with what speed will the weigh rise?

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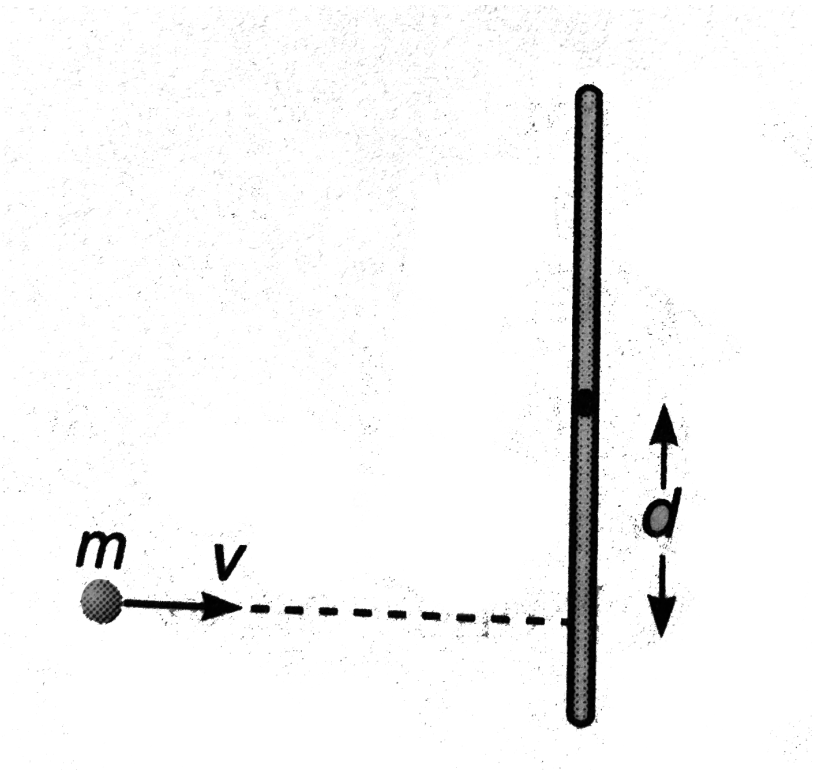

14.

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 ball 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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15. A small steel sphere of mass m and radius r rolls without slipping on the fiictionless surface of a large hemisphere of radius R{R gt gt r) whose axis of symmetry is vertical. It starts at the top from the rest, (a) What is the kinetic energy at the bottom ? (b) What fraction is the rotational kinetic energy of the total kinetic energy at the bottom? (b) What fraction is the rotational kinetic energy of the total kinetic energy? (c) What fraction is the translational kinetic energy of the total kinetic energy? (d) Calculate the normal force that the small sphere will exerton.the hemisphere at its bottom. Howthe results will be affected if r is not very sjnall as compared to R.

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16. The carbide tips of the cutting teeth of a circulars aware 9.2 cm from the axis ofrotation, (a) The no-load speed of the saw,whenit is not cutting anything, is 5000 rev/min.Why is its no-load power output negligible ? (b) While cutting lumber, the angular speed of the saw slows to 2500 rev/min, and the power output is 2.1 hp. What is the tangential force that the wood exerts on the carbide tips.

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17. A uniform rod ofmassm and length / rests on a smooth horizontal surface. One of the ends ofthe rod is struck in'a horizontal direction at right angles to the rod. As a result the rod obtains velocity Vq. Findtheforcewithwhich onehalfof the rod will act on the other in the process ofmotion.

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18. A smooth uniform rod AB of mass M and length l rotates freely with an angular velocity ω_0 in a horizontal plane about a stationary vertical axis passing through its end A. A small sleeve of mass m starts sliding along the rod from the point A. Find the velocity v' of the sleeve relative to the rod at the moment it reaches its other and B.

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19. The fly wheel of a large motorin a factory has mass 30kg and moment of inertia $67.5kg - m^2$ about its rotation axis. The motor develops a constanttorque of 600N-m, and the fly wheel starts from rest, (a) What is the angular acceleration of the fly wheel ? (b) What is its angular velocity after making 4 revolutions ? (c) How much work is done by the motor during the first 4 revolutions ? (d) What is the average power output ofthe motor during the first 4 revolutions ?

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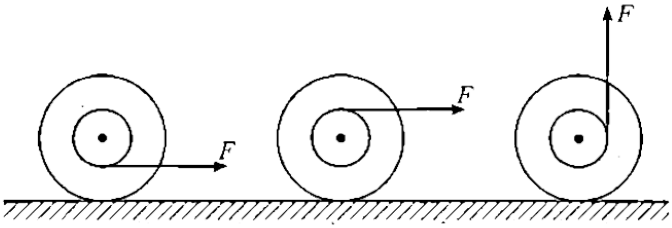
20. Figure-5.139 shows three identical kiting spools at rest on a rough horizontal groundinitially.In each case the string is pulled in the direction shown in figure. In each case it is given that spool rolls without slipping. In what direction will each spoolwill move and with what acceleration. Moment ofinertia ofeach spool is 7and radius of innertube is r and that ofouter disc is R.



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21. A closed system consists of two particles of masses m_1 and m_2 which move at right angles to each other with velocities v_1 and v_2. Find:

(a) the momentum of each particle and

(b) the total kinetic energy of the two particles in the reference frame fixed to their centre of inertia.

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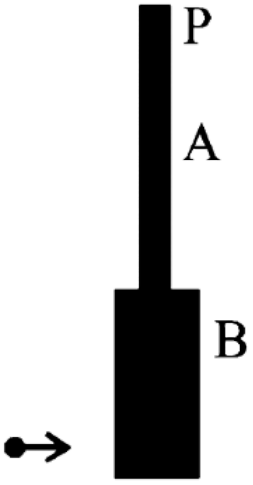
22. Two uniform thin rods A and B of length 0.6 m each and of masses 0.01 kg and 0.02kg respectively are rigidly joined end to end. The combination is pivoted at the lighter end, P as shown in fig. Such that it can freely rotate about point P in a vertical plane. A small object of mass 0.05kg, moving 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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23. A insect of mass m stands on a horizontal disc platform of moment of inertia 1 which is at rest. What is the angular velocity of the disc platform when the insect goes along a circle of radius r, concentric with the disc, with velocity v relative to the disc.

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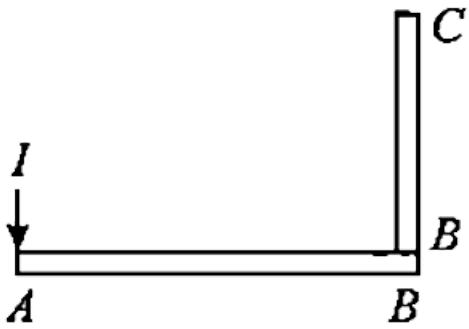
24. A uniform rod AB of mass M is placed in contact. with a second rod BC of mass m = M/2 on a horizontal smooth table at right angles to each other as shown in figure-5.141. Find the initial velocity of BC and

kinetic energy generated in it ifan impulse 7 is imparted to



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25. A uniform thin rod of mass m and length L is standing vertically along the y-axis on a smooth horizontal surface, with its lower end at the origin (0,0). A slight disturbane at t = 0 causes the lower end t slip on the smooth surface along the positive x-axis, and the rod starts falling.

(i) What is the path followed by the centr of mass of the rod during its fall?

(ii) Find the equaiton to the trajectory of a point on the rod shape of the path of this point?

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26. A carpet of mass M is rolled along its length so as to from a cylinder of radius R and is kept on a rough floor. When a negligibly small push is given to the cylindrical carpet, it stars unrolling itself without sliding on the floor. Calculate horizontal velocity of cylindrical part of the carpet when its radius reduces to $R/2$.

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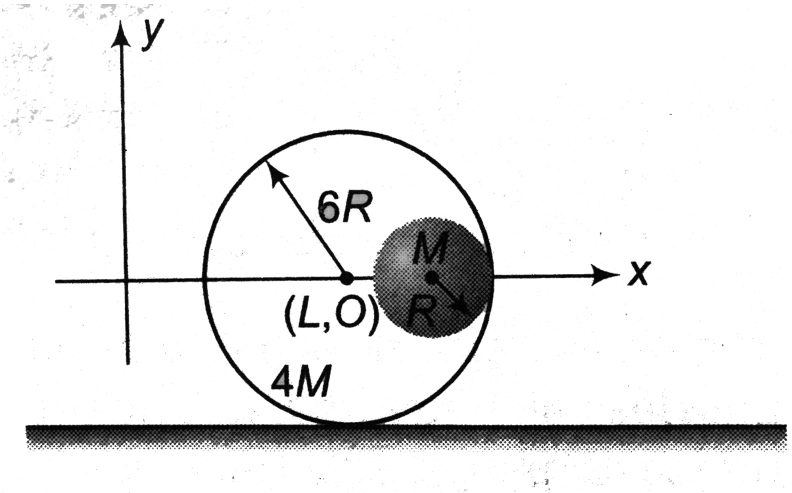
27. A small sphere of radius R is held against the inner surface of larger sphere of radius $6R$ (as shown in figure). The masses of large and small spheres are $4M$ and M respectivley. This arrangement is placed on a horizontal table. There is no friction between any surfaces of contact. The small sphere is now released. Find the coordinates of the centre of the large spheres, when the smaller sphere reaches the

other extreme position.



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28. A vertically oriented uniform rod of mass M and length l can rotate about its upper end. A horizontally flying bullet of mass m strikes the lower end of the rod and gets stuck in it, as a result, the rod swings through an angle α. Assuming that $m < < M$, find:

(a) the velocity of the flying bullet,

(b) the momentum increment in the system "bullet-rod" during the impact, what causes the change of that momentum,

(c) at what distance x from the upper end of the rod the bullet must

strike for the momentum of the system "bullet-rod" to remain constant during the impact.

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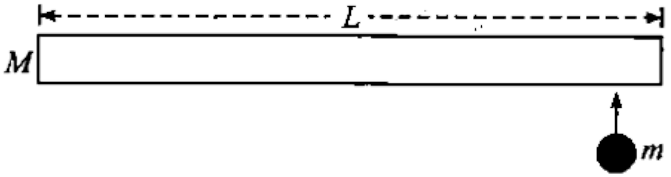
29. A Stick of length L and mass M lies on a fnctionless horizontal surface on which it is free to move in any way. A ball of mass m moving with speed v collides elastically with the stick as shownin figure-5.115. If after the collision ball comes to rest, then what should be the mass of the ball ?



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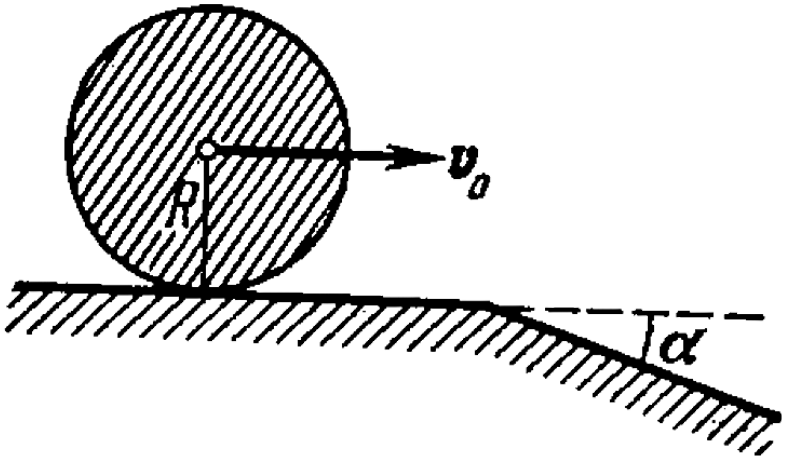
30. A uniform solid cylinder of radius $R = 15cm$ rolls over a horizontal plane passing into an inclined plane forming an angle

$\alpha = 30^\circ$ with the horizontal(figure). Find the maximum value of the velocity v_0 which still permits the cylinder to roll onto the inclined plane section without a jump. The sliding is assumed to be absent.



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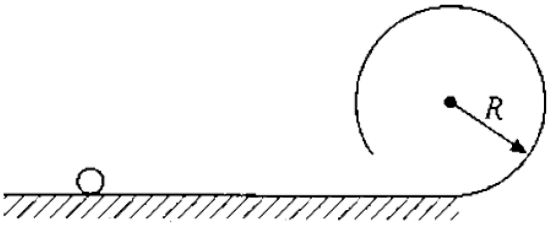
31. A small spherical marble of mass m and radius r is rolling without slipping on a rough track with speed v.The track further is in the shape

of a vertical circle of radius R as shown in figure-5.144. With what minimum linear speed the marble is rolling so that it completely goes round the circle on the circular part of track.



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32. A horizontal rotating disc placed on arough surface has an angular speed of 8 rad/s when it is lowered on the surface. After 3 seconds, it is observed to have an angular speed of 2.6 rad/s. How many revolutions it made from the time of lowering on the surface until it stops ? Assume the pressure on the surface due to disc is uniform on its area.

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33. A thin horizontal uniform rod AB of mass m and length l can rotate freely about a vertical axis passing through its end A. At a certain moment, the end B starts experiencing constant force F which is always perpendicular to the original position of the stationary rod and directed in a horizontal plane. Find the angular velocity of the rod as a function of its rotation angle ϕ counted relative to the initial position.

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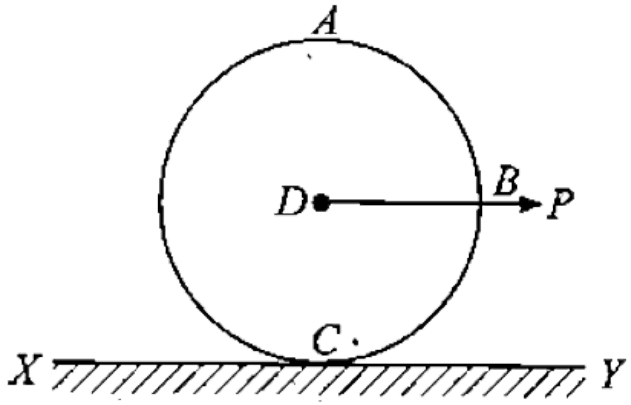
34. A disc of circumference S stands vertically on a horizontal surface as shown in figure-5.145, A horizontal force P acts on the centre of the disc. Half of the circumference {ABC) is rough and the friction is sufficient to prevent slipping when the disc rolls along X¥.The other half of the circumference (ADC) is smooth. The disc starts from rest when P begins to act and the point C is at the bottom. Find the

distance moved by the disc along xy when it completes one rotation.



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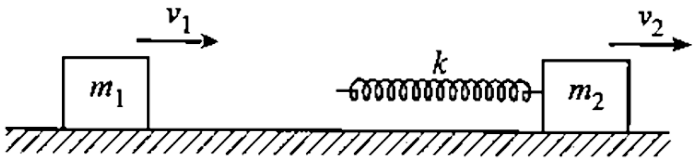
35. A block of mass m_1 =2 kg slides along a frictionless table with a speed of 10m/s. Directly infront of it,and moving in the same direction is a block of mass m_2 5 kg moving at 3 m/s. A mass less spring with a spring constant 11.2 N/cm is attached to as shown in figure-5.146. When the block collide,what is the maximum compression

of the spring ? Assume that the spring does not bend.



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36. A uniform rod of length 2a is held with one end resting on a smooth horizontal table making an angle a with the vertical. Show that when the rod is released, its angular velocity when it makes an angle θ with the vertical is given by

$$\omega = \left[\frac{6g(\cos\alpha - \cos\theta)}{(1 + 3\sin^2\alpha)}\right]$$

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37. A hollow sphere of radius r is rotating about a horizontal axis at some angular speed ω_0. It is gently lowered to ground and the

coefficient of friction between sphere and the ground is μ.How far does the sphere move before it starts pure rolling?

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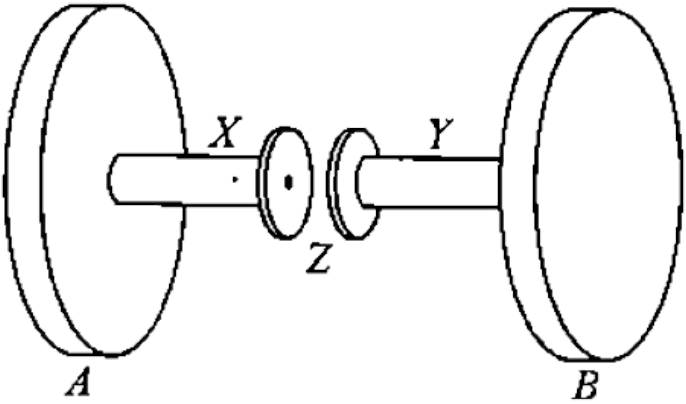
38. Discs A and B are mounted on a shaft XY and may be connected or disconnected by a coupling Z as shown in figure-5.147. The moment of inertia of disc A about the shaft is half that of disc B. The moments of inertia of the shaft and the coupling are negligible. Initially A is disconnected and rotated at an angular velocity ω. It is now coupled to disc B using couplings.It is found that 5000 J of thermal energy is developed in the coupling when the connection is made. What was

the original kinetic energy of the disc A.



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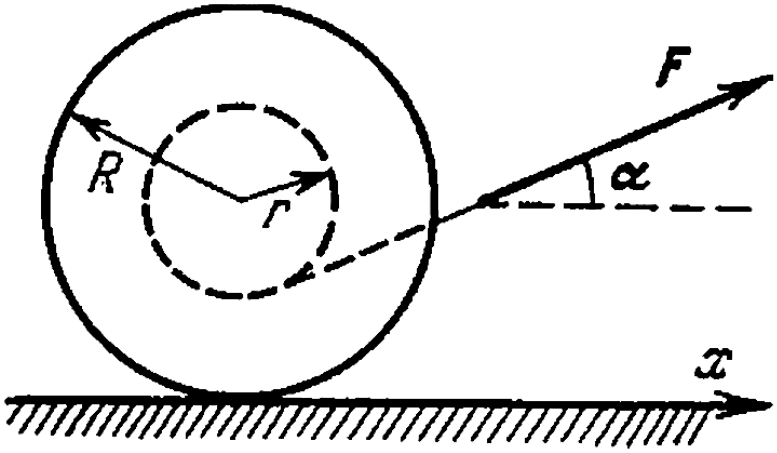
39. A spool with thread wound on it, of mass m, rests on a rough horizontal surface. Its moment of inertia relative to its own axis is equal to $I = \gamma m R^2$, where γ is a numerical factor, and R is the outside radius of the spool. The radius of the wound thread layer is equal to r. The spool is pulled without sliding by the thread with a constant force F directed at an angle α to the horizontal (figure). Find: (a) the projection of the acceleration vector of the spool axis on the x-axis,

(b) the work performed by the force F during the first t seconds after the beginning of motion.



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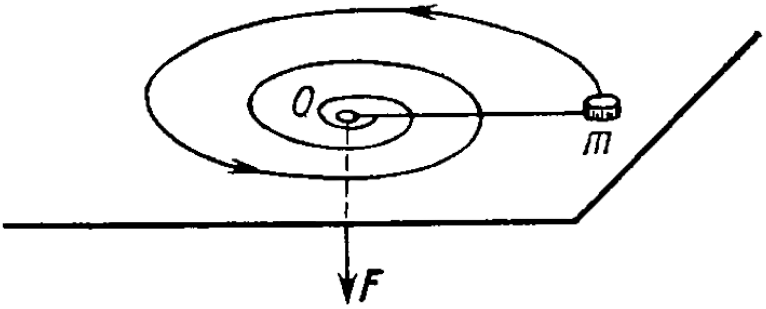
40. A small body of mass m tied to a non-stretchable thread moves over a smooth horizontal plane. The other end of the thread is being drawn into a hole O(figure) with a constant velocity. Find the thread

tension as a function of the distance r between the body and the hole if at $r = r_0$ the angular velocity of the thread is equal to ω_0.



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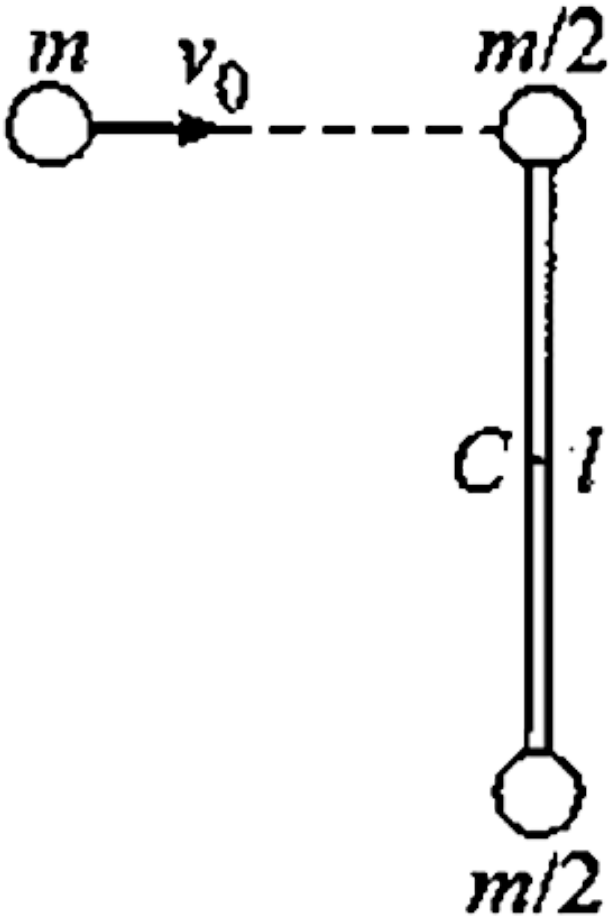
41. A ball ofmass m moving with velocity experiences a head on elastic collision with one of the spheres of as tationary rigid dumbbell as shown in figure-5.149. The mass of each sphere equals m/2, and the

distance between them is l.Disregarding the size of the spheres, find the angular momentum of the dumbbell in the reference frame moving translationally and fixed to the centre of mass of the dumbbell.



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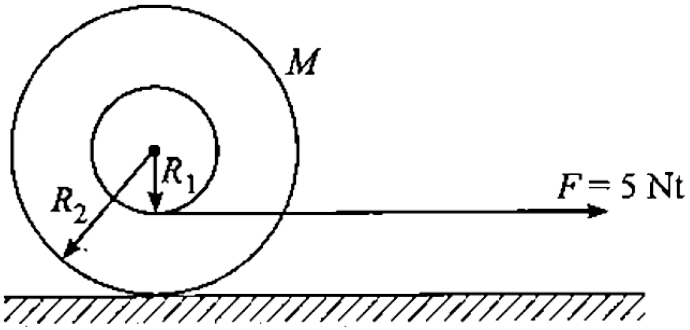
42. A spool has a mass of 2 kg,an inner radius R_1 =3cm,and an outer radius

$R_2 = 5\text{cm}$, the radius of gyration about the axis of the spool is if $= 4cm$ .A constant horizontal force of 5N is applied to the free end of a massless thread that is wrapped around the inner cylinder of the spool as shownin figure-5.150. If the spool rolls without slipping, calculate the linear acceleration along the horizontal surface. What is the minimum coefficient of static friction required to prevent slipping ?



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43. A homogeneous disc of weight W and radius R rotates about the vertical axis OZ, the initial angular velocity being ω_0. During the motion, the brake block A is pressed to the disc,with a radial force N for t_0 seconds and the disc comes to rest because of friction. Find the coefficient of friction.

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44. A uniform disc of mass m and radius R is projected horizontally with velocity v_0 on a rough horizontal floor so that it starts with a purely sliding motion at t= 0. After t_0 seconds it acquires a purely rolling motion.

(a) Calculate the velocity of the centre of mass of the disc at t_0

(b) Assuming the coefficient of friction to be μ, calculate to. Also calculate the work done by the frictional force as a function of time and the total work done by it over a time t muchlonger than t_0.

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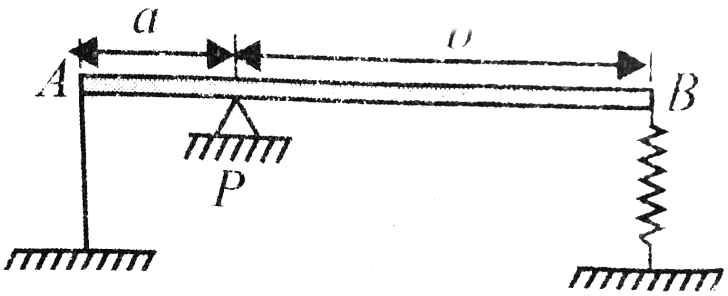
45. A uniform rod AB of mass $m = 2kg$ and length $l = 1.0m$ is placed on a sharp support P such that $a = 0.4m$ and $b = 0.6m$. A. spring of force constant $k = 600N/m$ is attached to end B as shown in Fig. To keep the rod horizontal, its end A is tied with a thread such that the spring is B elongated by $1CM$. Calculate reaction of support P when the thread is burnt.



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46. A small ball is suspended from a point O by a light thread of length l. Then the ball is drawn aside so that thread deviates through an angle θ from the vertical and set in motion in a horizontal direction

at right angles to the vertical plane in which the thread is located. What is the initial velocity that has to be imparted to the ball so that it could deviate through the maximum angle $\pi/2$ in the process of motion?

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47. An object rotates about a fixed axis, such that a reference line on the object makes an angle $\theta = ae^{bt}$ with its starting position at time t. Find for a particle on object at a distance r from the axis of rotation, the tangential, the radial and the total acceleration of the point.

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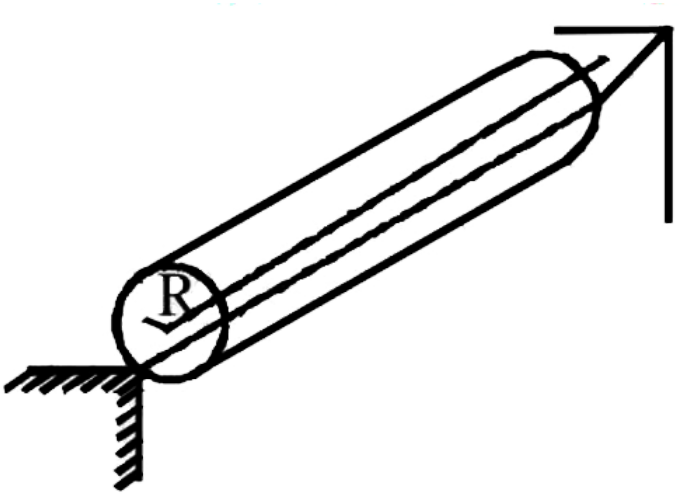
48. A rectangular rigid fixed block has a long horizontal edge. A solid homogeneous cylinder of radus R is placed horizontally at rest its length parallel to the edge such that the exis of the cylinder and the endg of the block are in the same vertical plane as shown in the figure

below. Ther is sufficinet friction present at the edge s that a very small displacement causes the cylinder to roll off the edge without slipping. Determine:



(a) the angle θ_c through which the cylinder rotates before it leaves contact with the edge,

(b) the speed of the centre of mass of the cylinder before leaving contact with the edge, and

(c) the ratio of the translational to rotational kinetic energy of the cylinder when its centre of mass is in horizontal line with the edge.

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49. A 392 N wheel comes off a moving truck and rolls without slipping along a highway. At the bottom of a hill it is rotating at 50 rad/s. The radius ofthewheel is 0.6m, and its moment of inertia about its rotation axis is $0.8MR^2$. Friction does 3000 J of work on the wheel as it rolls up the hill to a stop a height h above the bottom of the hill. Calculate h.

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50. A grindstone in the form of a solid cylinder has a radius of 0.2m and a mass of 30 kg. (a)What constant torque will bring it from rest to an angular velocity of 250 rev/min in 10 s ?

(b) Through what angle has it turned during that time ?

(c) Calculate the work done by the torque.

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51. A constant net torque equal to 20 N-m is exerted on a pivoted wheel for 8 sec, during which time the angular velocity of the wheel increases from zero to 100 re/min. The external torque is then removed and the wheel is brought to rest by friction in its bearings in 70 sec. Compute (a) the moment of inertia of the wheel about the rotation axis, (b) the friction torque(c)thetotal no. of revolutions made by the wheel in the70 sec time interval

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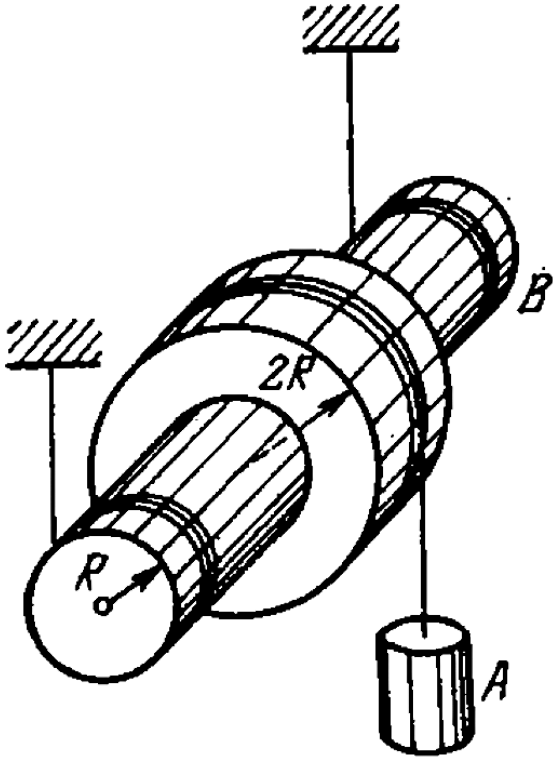
52. In the arrangement shown in figure a weight A possesses mass m, a pulley B possesses mass M. Also known are the moment of inertia I of the pulley relative to its axis and the radii of the pulley R and $2R$. The mass of the threads is negligible. Find the acceleration of the

weight A after the system is set free.



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53. A solid spherical ball of radius 30 cm and mass M is connected to a point A on wall with a thread and freely rotate about its central axis with angular velocity 60 rad/sec. If the ball is resting onthe vertical face of a wall, what time will elapse before it comes to rest ? The

coefficient of friction between wall and ball is 0.25 and inclination of thread to vertical is 15°.

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54. A thin uniform rod of mass m and length l rotates with the constant angular velocity ω about the vertical axis passing through the rod's suspension point O. In doing so, the rod describes a conical surface with a half separated angle θ.Find the angle θ as well as the magnitude and direction of the reaction force at the point O.

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55. A rod of mass m and length l is held vertically on a smooth horizontal floor. Now it is released from this position, find the speed of its centre of mass when it makes an angle θ with the vertical.

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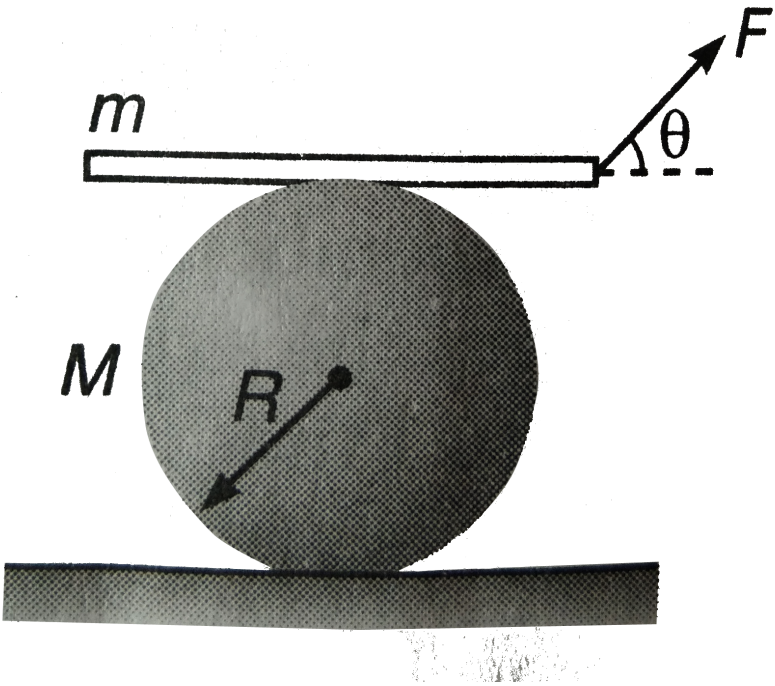

56.

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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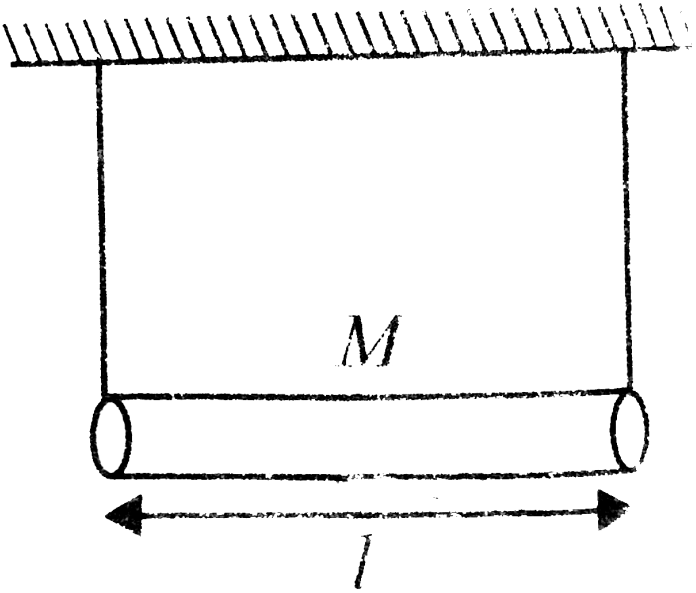
57. A uniform rod of length $1m$ and mass $2kg$ is suspended. Calculate tension T (in N) in the string at the instant when the right string snaps $\left(g = 10m/s^2\right)$.



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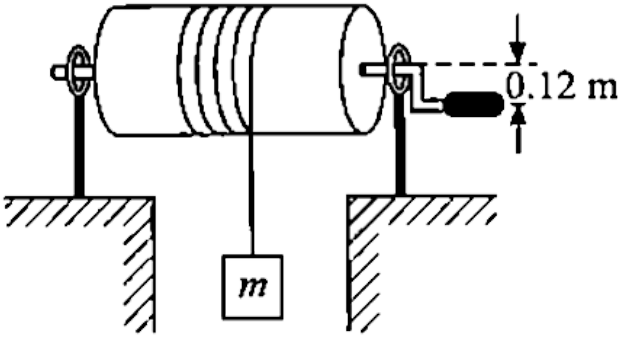
58. The mechanism shown in figure-5.156 is used to raise a wooden box of mass 50kg .A string is wrapped around a cylinder that turns on an axle.The cylinder has radius 0.25 m and moment of inertia 0.92 $kg - m^2$ about the axle. What magnitude of the force F applied

tangentially to the rotating crank handle is required to raise the box with an acceleration of 0.80m/s.Here we can neglect the moment of inertia of the axle and the crank



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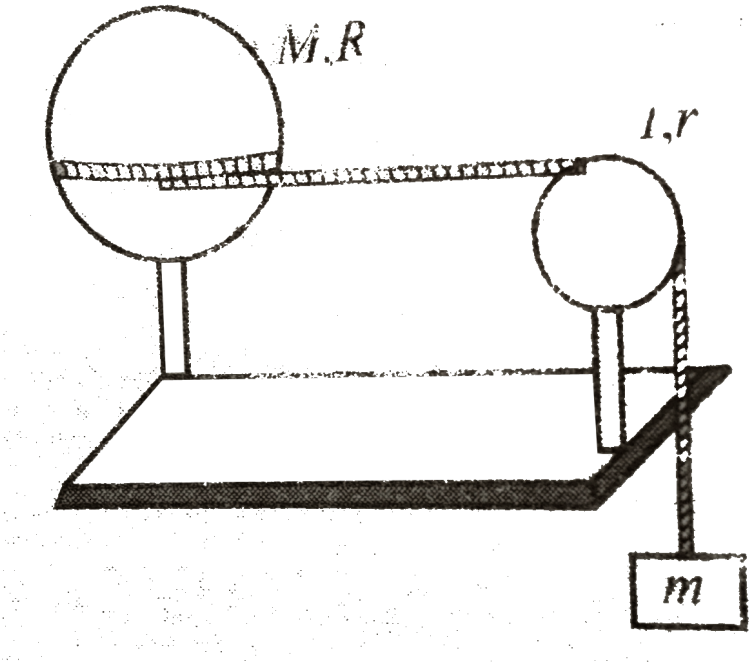
59. A uniform spherical shell of mass M and radius R rotates, about a vertical axis on frictionless bearing. A massless cord passes around the equator of the shell., over a pulley of rotational inertia I and radius r and is attached to small object of mass m that is otherwise free to fall under the influence of gravity. There is no friction of pulley's axle, the cord does not slip on the pulley. What is the speed of the object after it has fallen a distance h. from rest? Use work-energy

considerations.



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60. 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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61. Two wooden disc , one with radius 2 cm and mass 1 kg and the other with radius 4 cm and mass 2 kg , are welded together coaxially and mounted on a frictionless axis through their common centre. Alight string is wrapped around the edge of the smaller disc, and a 3 kg block is suspended from the free end of the string.What is the acceleration of the block after it is released? Repeat the above process if the stringi swrapped around the edge of the larger disc.

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62. A horizontal wooden disc of mass 8 kg and diameter 1m is pivoted on frictionless bearing about a vertical axis through its centre.We put a toy train track model in the disc.The track has a negligible mass and average diameter 0.95 ra.The mass ofmodel train is 1.2 kg which can run with a battery.When we switch on the engine the train moves anticlockwise, soon attaining a constant speed of 0.6 m/s with respect to the track. Find the magnitude and direction of the angular velocity of the disc relative to the earth.

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63. A 50 kg runner runs around the edge of a turn table mounted on frictionless bearings. With respect to earth the velocity of runner is 2m/s.The turntable is rotating in opposite direction with an angular velocity of magnitude 0.2 rad/s with respect to earth.The radius of turntable is 4m, and its moment of inertia is 1000 $kg - m^2$. Find the final angular velocity of the system if runner comes to rest relative to turntable.

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Others

1. A solid cylinder is relased from rest from the top of an inclined plane of inclination 60° where friction coefficient varies with distance x as

$mi = \frac{2 - 3x}{\sqrt{3}}$. Find the distance travelled by the cylinder on incline before it starts slipping.

A. 1/3 m

B. $1/\sqrt{3}$ m

C. 3 m

D. $\sqrt{3}m$

Answer: A

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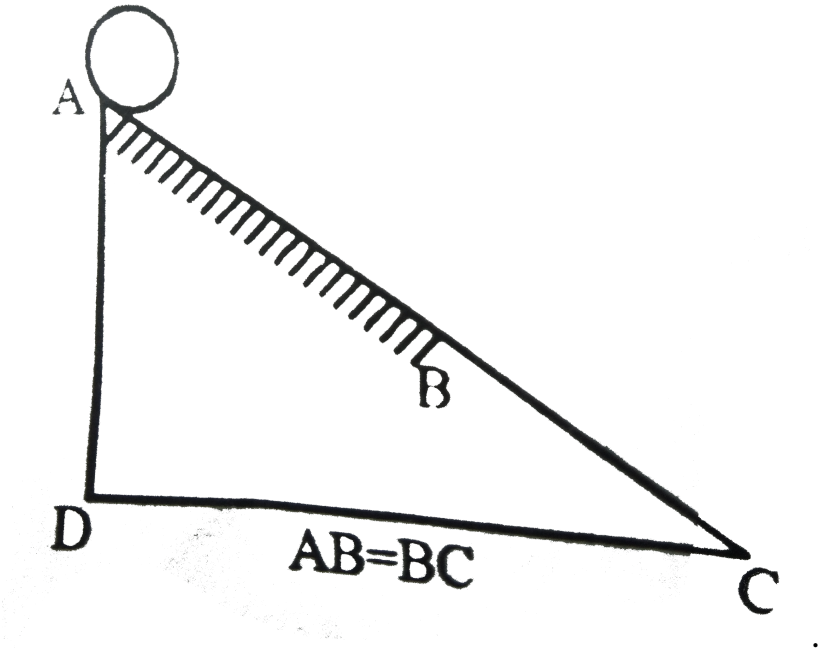
2. Portion AB of the wedge shown in figure is rough and BC is smooth. A solid cylinder rolld without slipping from A to B. Find the ratio of translational kinetic energy to rotationa linetic energy, when

the cylinder reaches point C.



A. $3/4$

B. 5

C. $7/5$

D. $8/3$

Answer: B

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3. A ball is thrown down a lawn in such a way that it initially slides with a speed v_0 without rolling. It gradually picks up rotational motion. Find the speed of the ball at which there will be rolling without slipping :

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

B. $\frac{2}{5}v_0$

C. $\frac{5}{7}v_0$

D. $\frac{3}{5}v_0$

Answer: C

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4. A uniform sphere of mass m and radius r rolls without slipping down a inclined plane, inclined at an angle 45° to the horizontal . Find the magnitude of frictional coefficient at which slipping is absent :

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

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

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

D. $\frac{1}{7}$

Answer: B

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5. The mass of earth is increasing at the rate of 1 part in 5×10^{19} per day due to the acceleration of meteors falling normally on the surface of earth evenly everywhere. Find the corresponding change of period of rotation of earth , taking the earth to be a sphere of uniform density :

A. 8×10^{-19} hr/day

B. 5×10^{-19} hr/day

C. 3×10^{-19} hr/day

D. 4×10^{-19} hr/day

Answer: A

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6. A pendulum consists of a wooden bob of mass m and length l. A bullet of mass m_1 is fired towards the pendulum with a speed v_1. The bullet emerges out of the bob with a speed of $(v_1)/3$ and the bob just completes motion along a vertical circle, then v_1 is

A. $\frac{3}{2}\left(\frac{m}{m_1}\right)\sqrt{5gl}$

B. $\left(\frac{m}{m_1}\right)\sqrt{5gl}$

C. $\frac{3}{2}\left(\frac{m}{m_1}\right)\sqrt{gl}$

D. $\frac{3}{2}\left(\frac{m_1}{m}\right)\sqrt{5gl}$

Answer: A

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7. A sphere of outer radius R having some cavity inside is allowed to roll down on an incline. The incline is then made smooth by waxing and the sphere is allowed to slide without rolling and now the speed attained is $(5/4)v_0$. What is the radius of gyration of the sphere about an axis passing through its centre ?

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

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

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

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

Answer: B

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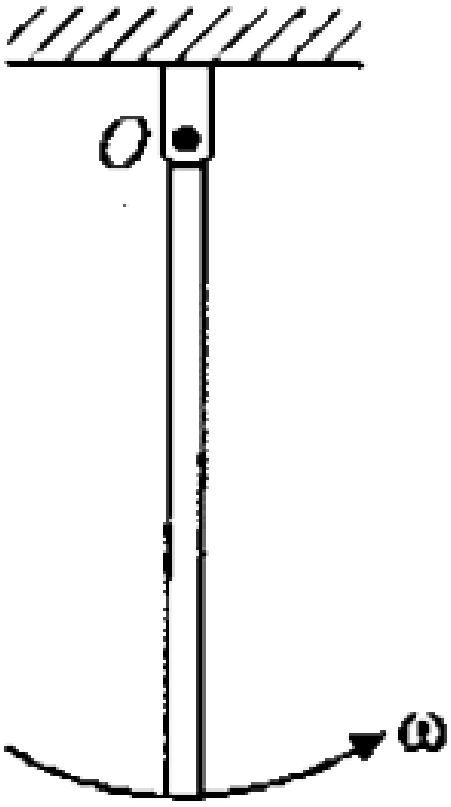
8. A thin uniform heavy rod of length l hangs from a horizontal axis passing through one end. The initial angular velocity ω that must be imparted to it to rotate it through 90° is :



A. $\sqrt{g/l}$

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

C. $\sqrt{(2g/l)}$

D. $\sqrt{6g/l}$

Answer: B

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9. A hollow sphere of radius R and mass m fully filled with water of mass m. It is rolled down a horizontal plane such that its centre of mass moves with a velocity v. If it purely rolls.

A. Kinetic energy of the sphere is 5/6 mv^2

B. kinetic energy of the sphere is 4/5 mv^2

C. Angular momentum of the sphere about a fixed point on ground is 8/3 mvR

D. Angular momentum of the sphere about a fixed point on ground is 14/5 mvR

Answer: C

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10. Let $\vec{F}$ be a force acting on a particle having positon vector $\vec{r}$. $Let\,\vec{r}$ be the torque of this force about the origin then

A. $\because \bar{\tau} = 0$ and $\overline{F}.\,Bar\tau = 0$

B. $\because \bar{\tau} = 0$ and $\overline{F}.\,Bar\tau \neq 0$

C. $\because \bar{\tau} \neq 0$ and $\overline{F}.\,Bar\tau = 0$

D. $\because \bar{\tau} \neq 0$ and $\overline{F}.\,Bar\tau \neq 0$

Answer: A

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11. A body having its centre of mass at the origin has three of its particles at $(a, 0, 0), (0, a, 0), (0, 0, a)$. The moments of inertia of the body about the X and Y axes are 0.20 kg $-m^2$ each. The moment of inertia about the Z-axis

A. Is $0.20kg - m^2$

B. Is $0.40kg - m^2$

C. Is $0.20\sqrt{2}kg - m^2$

D. cannot be deduced with this infrormation

Answer: D

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12. Where must the cue hit a billiard ball so that it rolls without sliding form the start if R is the radius of the ball?

A. At a height $\frac{2}{5}$ R above centre.

B. At a height equal to the radius from table

C. At a height equal to 2R from the table

D. At a height equal to $\frac{R}{2}$ from table.

Answer: A

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13. A thin circular ring of mass M and radius r is rotating about its ais with an angular speed ω. Two particles having mas m each are now attached at diametrically opposite points. The angular speed of the ring will become

A. $\frac{\omega M}{M+m}$

B. $\frac{\omega M}{M+2m}$

C. $\frac{\omega(M-2m)}{M+2m}$

D. $\frac{\omega(M+2m)}{M}$

Answer: D

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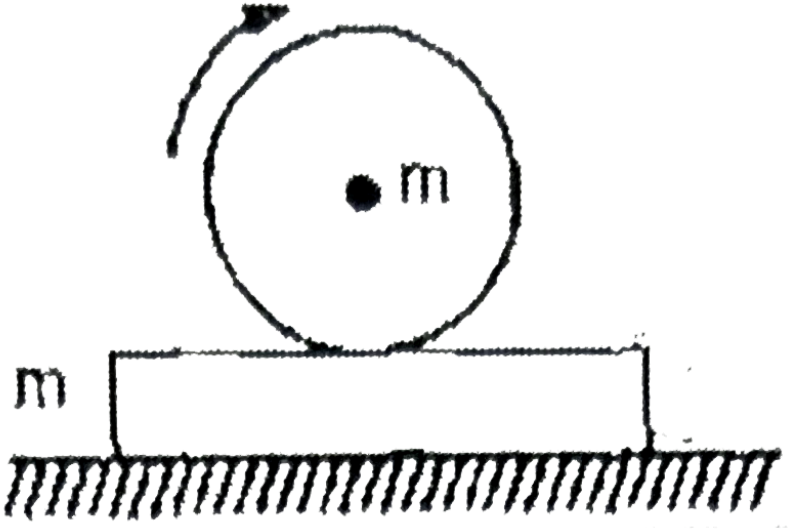
14. A sphere of mass m is given some angular velocity about a horizontal axis through the center, and gently placed on a plank of mass m. The coefficient of friction between the two is μ. The plank rests on a smooth horizontal surface. The intial acceleration of the sphere relative to the plank will be:



A. zero

B. μg

C. $7/5\mu g$

D. $2\mu g$

Answer: D

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