PHYSICS

BOOKS - CENGAGE PHYSICS (ENGLISH)

RIGID BODY DYNAMICS 2

Illustration

1. A uniform sphere of mass m and radius r rolls without sliding over a horizontal plane, rotating ahout a horizontal axle OA. In the process, the centre of the sphere moves with a veocity v along a circle of radius R. Find the kinetic energy of the sphere.

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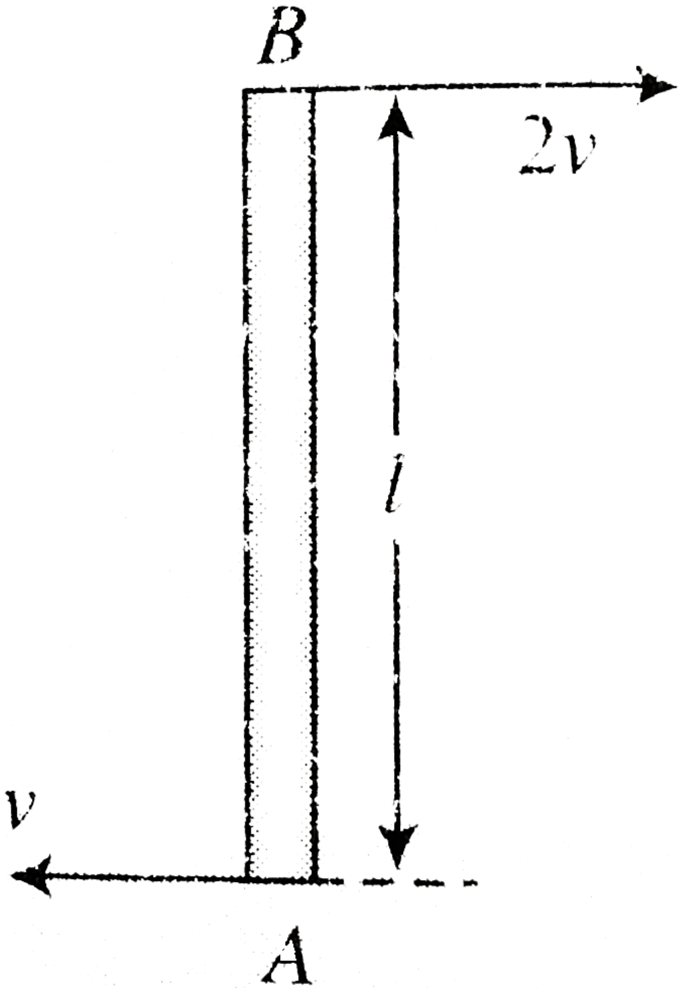
2. A uniform rod of mass $m = 2kg$ and length l is kept on a smooth horizontal plane. If the ends A and B of the rod move with speeds v and $2v$ respectively perpendicular to the rod, find the:

a. angulr velocity of CM of the rod.

b. Kinetic energy of the rod (in Joule).



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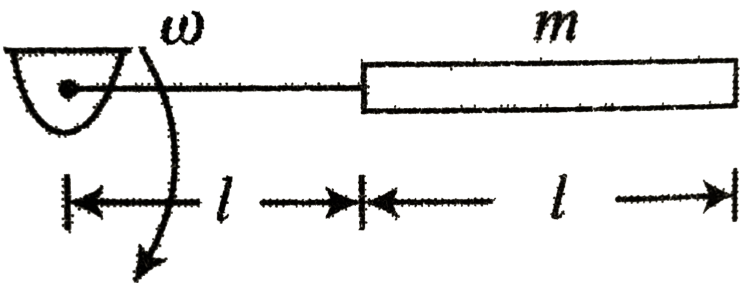
3. A rod of mass m and length l is connected with a light rod of length l. The composite rod is made to rotate with angular velocity ω as shown in the figure. Find the



a. translational kinetic energy.

b. rotational kinetic energy.

c. total kinetic energy of rod.

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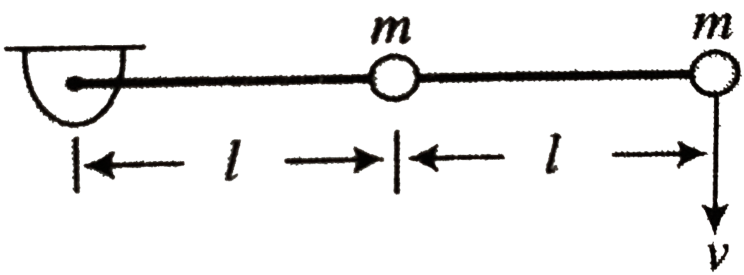
4. Two beads each of mass m are welded at the ends of two light rigid rods each of length l. if the pivots are smooth, find the ratio of translational and rotational kinetic energy of system.



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5. Calculate the torque developed by ann airplane engine whose output is $2000HP$ at an angular velocity of $2400rev/\min$.

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6. 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 a constant force F which is always perpendicular to the original position of the stationary rod and directed in a horizontal plane. The angular velocity of the rod as a function of its rotation angle θ measured relative to the initial position should be.

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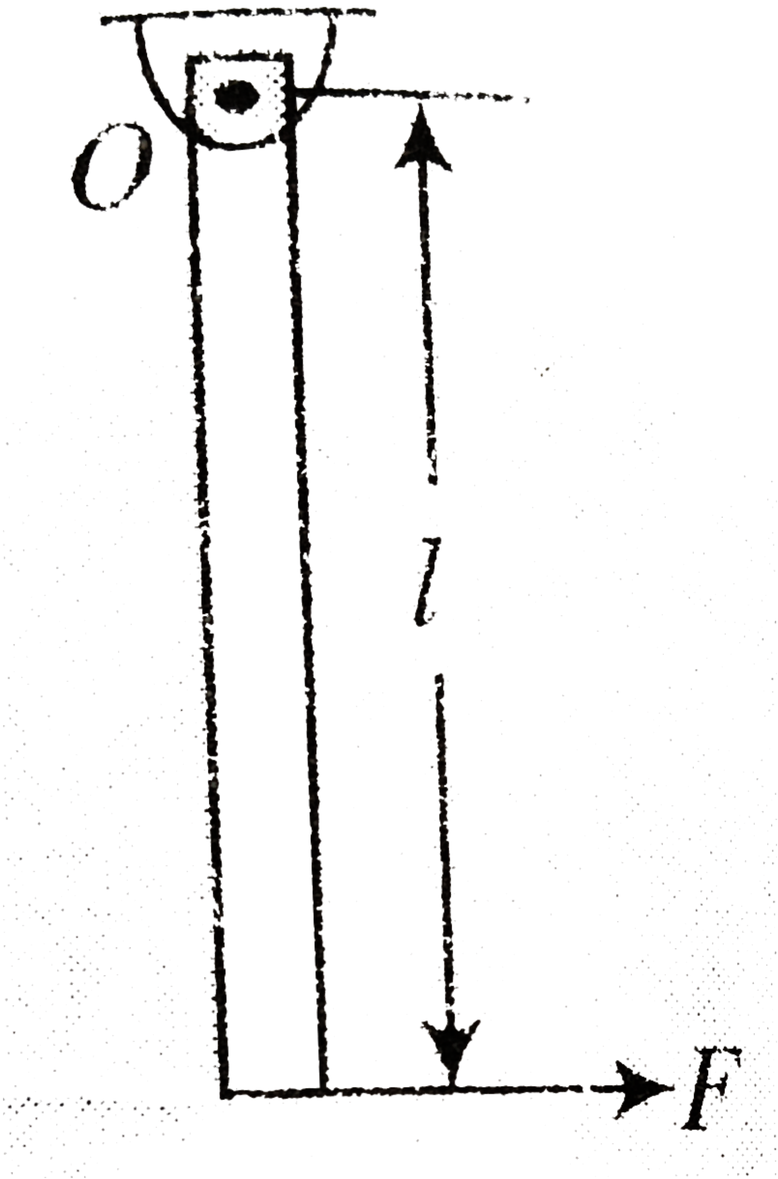
7. A uniform rod of mass m and length l is pivoted smoothly at O. A horizontal force acts at the bottom of the rod.

a. Find the angular velocity of the rod as the function of angle of rotation θ.

b.What is the maximum angular displacement of the rod?



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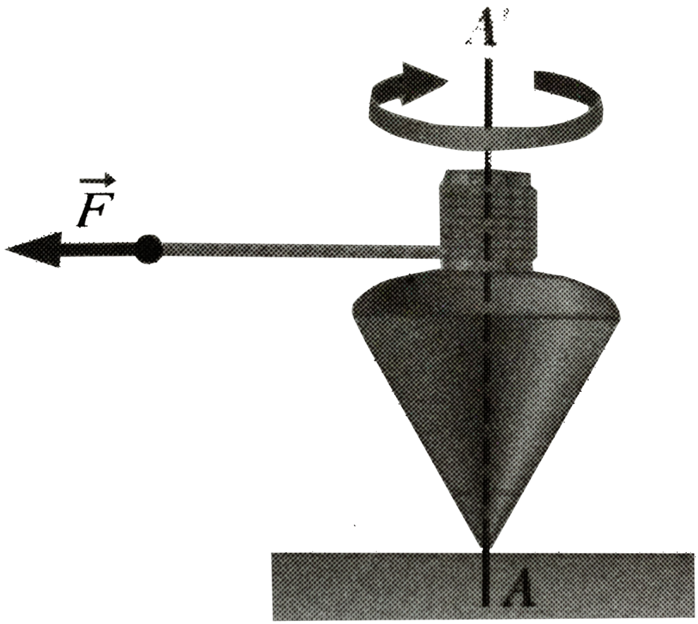
8. The top is figure has moment of inertia equal to $4.00 \times 10^4 kgm^2$ and is initially at rest. It is free to rotate about the stationary axis AA'. A string wrapped around a ped alonng the axis of the top is pulled in such a manners as to maintain a constant tension of $5.57N$.If the string does not slip while it is unwound from the peg, what is the angular speed of the top after $80.0CM$ of string has been pulled of the peg?



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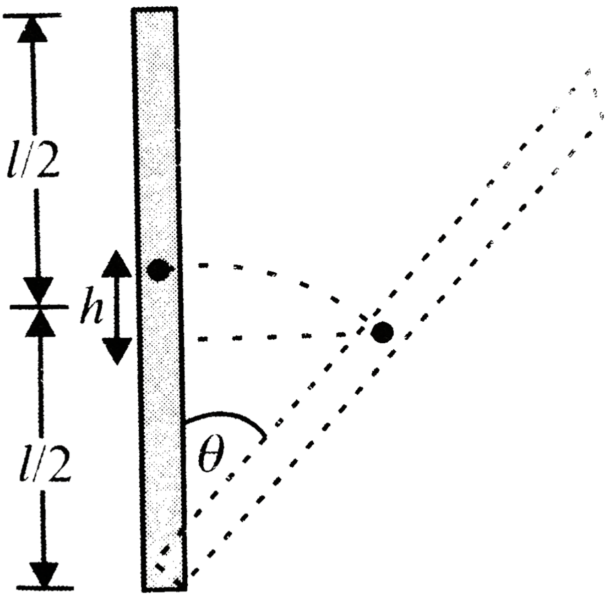
9. A rod of length l is pivoted about a horizontal , frictionless pin through one end.

The rod is released from ret in a vertical position. Find the velocity of the CM of the rod when the rod is inclined at an angle θ from the vertical.



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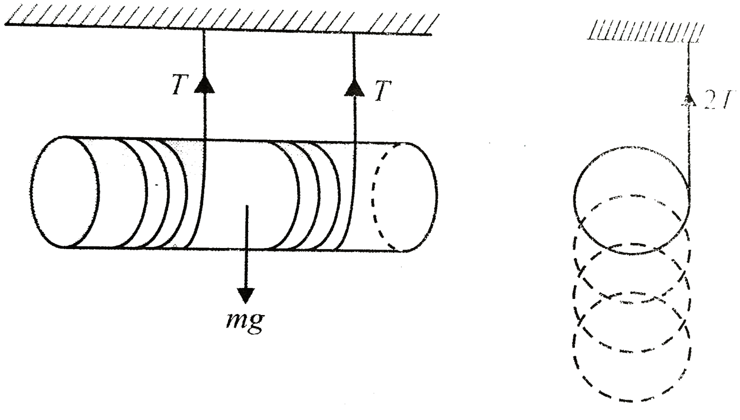
10. A solid cyinder of mass $m = 4kg$ and radius $R = 10cm$ has two ropes wrapped around it. one near each end. The cylinder is held horizontally by fixing the two free ends of the cords to the hooks on the ceiling such that both the cords are exactly vertical. The cylinder is released to fall under gravity. Find the linear acceleration of the cylinder.



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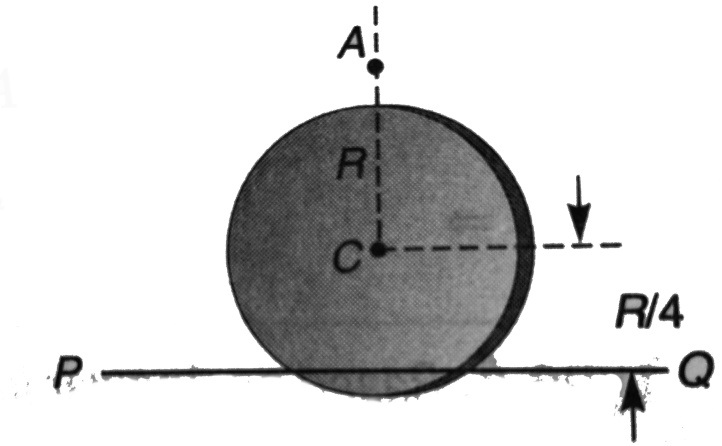

11.

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

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13. A particle is projected at time t=0 from a point P wilth a speed v_0 at an angle of 45° to the horizontal. Find the magnitude and the direction of the angular momentum of the particle about the point P at time $t = \frac{v_0}{g}$

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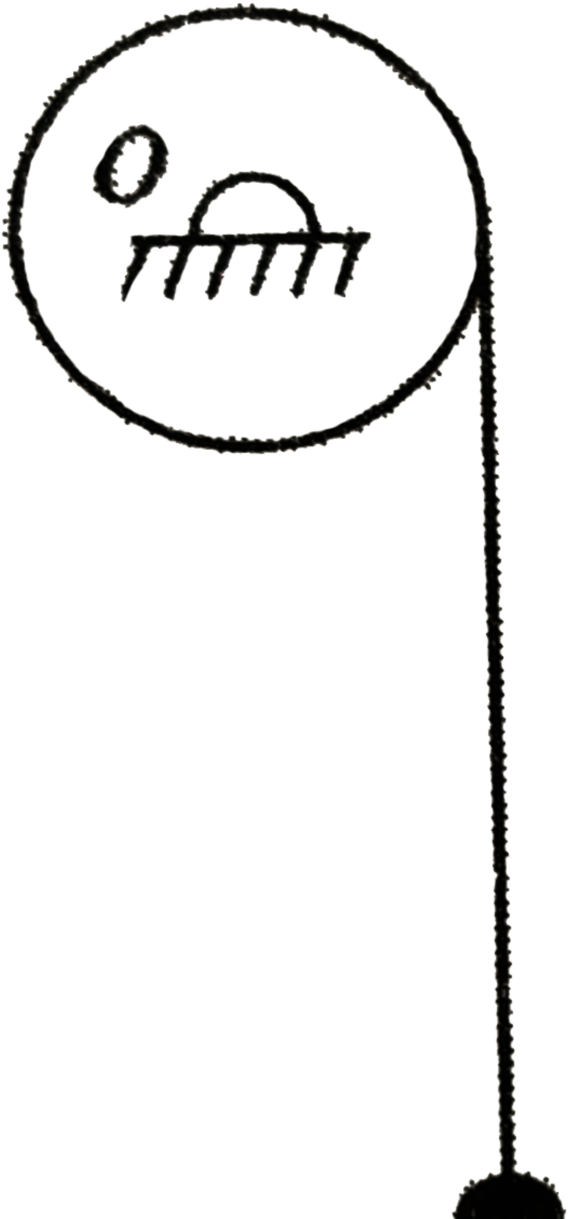
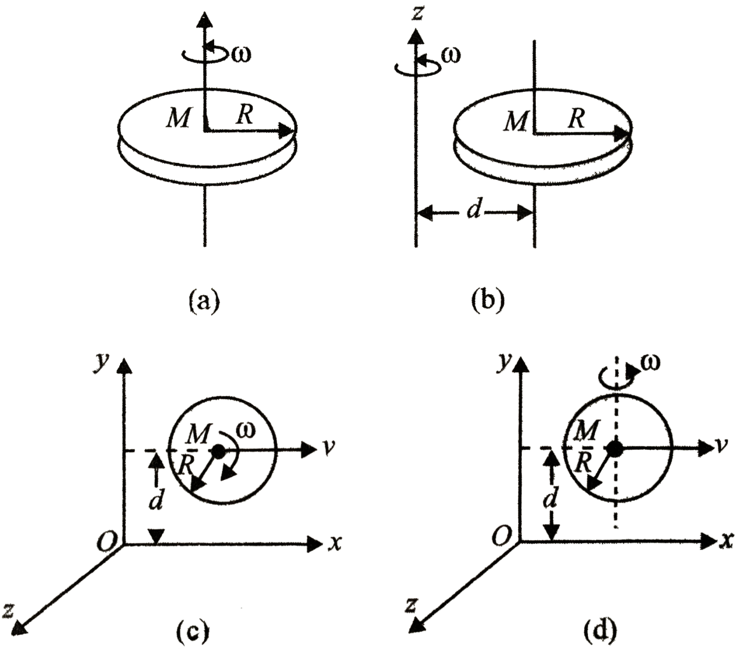
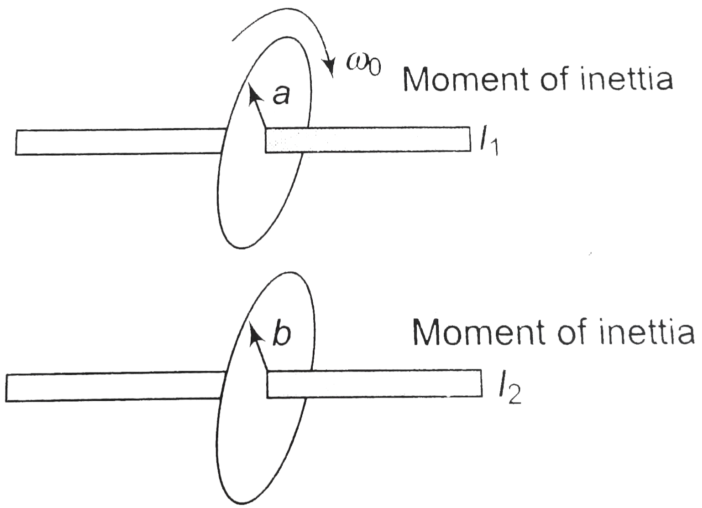
14. A uniform disc of mas M and radius R is smoothly pivoted at O. A light iextensible string wrapped over the disc hangs a particle of mass m. If the system is released from rest, assuming that the string does not slide on the disc, find the angular speed of the disc as the function of time using impulse momentum equation.



15. Find the angular momentum of a disc about the axis shown in figure in the following situations.



16. The two uniform discs rotate separately on parallel axles. The upper disc (radius a and momentum of inertia I_1) is given an angular velocity ω_0 and the lower disc of (radius b and momentum of inertia I_2) is at rest. Now the two discs are moved together so that their rims touch. Final angular velocity of the upper disc is.



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17. A turntable turns about a fixed vertical axis, making one revolution in $10s$. The moment of inertia of the turntable about the axis is

$1200kgm^2$. A man of mass $80kg$, initially standing at centre of the turnable, runs out along the radius. What is the angular velocity of the turtable when the man is $2m$ from the centre?

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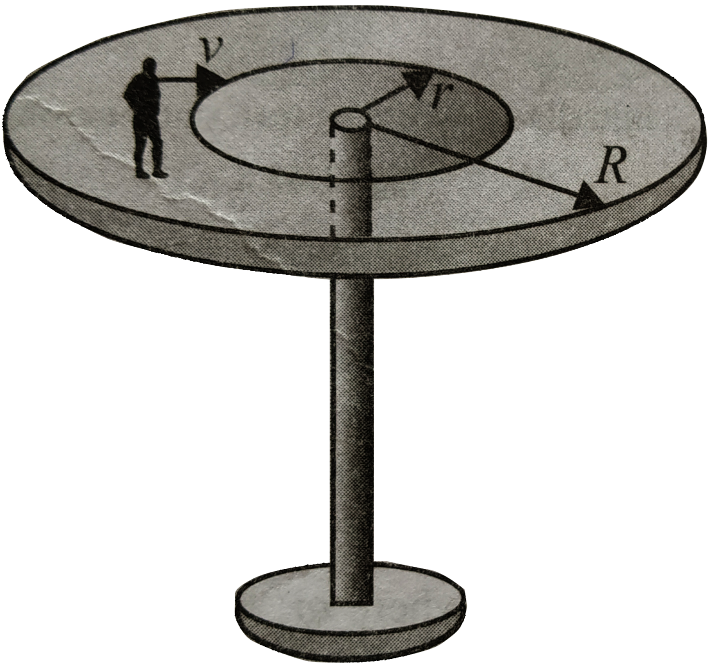
18. A man of mass m stands on a horizontal platform in the shape of a disc of mass m and radius R, pivoted on a vertical axis thorugh its centre about which it can freely rotate. The man starts to move aroung the centre of the disc in a circle of radius r with a velocity v relative to the disc. Calculate the angular velocity of the disc.



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19. A man of mass $100kg$ stands at the rim of a turtable of radius $2m$ and moment of inertia $4000kgm^2$ mounted on a vertical frictionless shaft at its centre. The whole system is initially at rest. The man now walks along the outer edge of the turntable with a velocity of $1m/s$ relative to the earth

a. With what angular velocity and in what direction does the turntable rotate?

b. Through what angle will it have rotated when the man reaches his initial position on the turntable?

c. Through what angle will it have rotated when the man reaches his initial position relative to the earth?

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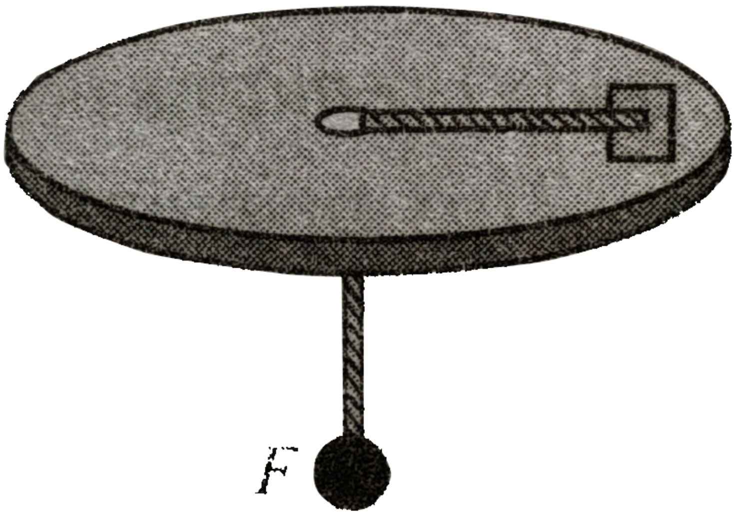
20. A small block of mass $4kg$ is attached to a cord passing through a hole in a horizontal frictionless surface. The block is originally revolving in a circle of radius $0.5m$ about the hole with a tangential velocity of $4m/s$. The cord is then pulled slowly from below, shorteing the radius of the circle in which the block revolves. The breaking strength of the cord is $600N$. What will be radius of the circle when the cord breaks?



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21. Two skaters each of mass $50kg$, approach each other along parallel paths separated by $3m$. They have equal ad opposite velocities of $10m\,/\,s$. The first skater carries a long light pole, $3m$ long, and the second skater grabs the end of it as he passes (assume frictionless ice).

a. Described quantitatively the motion of the skaters after they are connected by the pole.

b. By pulling on the skaters reduce their distance to $1m$. What is their motion then?

c. Compare the KEs of the system in parts a. and b. where does the change come from?

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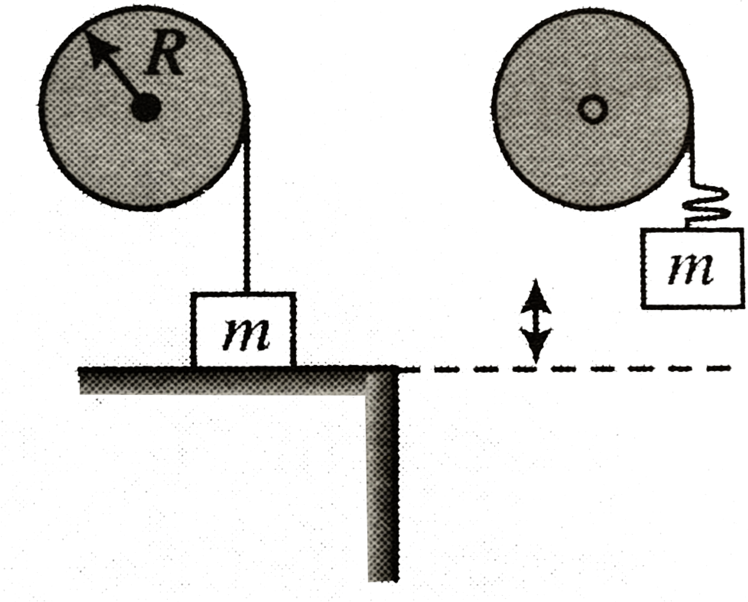
22. A string is wrapped several times on a cylinder of mass M and radius R. the cylinder is pivoted about its adxis of block symmetry. A block of mass m tied to the string rest on a support positioned so that the string has no slack. The block is carefully lifted vertically a distance h, and the support is removed as shown figure.

a. just before the string becomes taut evalute the angular velocity ω_0 of the cylinder ,the speed v_0 of the falling body, m and the kinetic energy K_0 of the system.

b. Evaluate the corresponding quanitities ω_1, v_1 and K_1 for the instant just after the string becomes taut.

c. Why is K_1 less than K_0? Where does the energy go?

d. If $M = m$, what fraction of the kinetic energy is lost when the string becomes taut?



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23. Two motor boats A and B move from same point along a circle of radius 10 m in still water. The boats are so designed that they can

move only with constant speeds. The boats A and B take 16 and 8 sec respectively to complete one circle in stationary water. Now water starts flowing at $t=0$ with a speed $4\frac{m}{s}$ in a fixed direction. Find the distance between the boats after $t=8$ sec.

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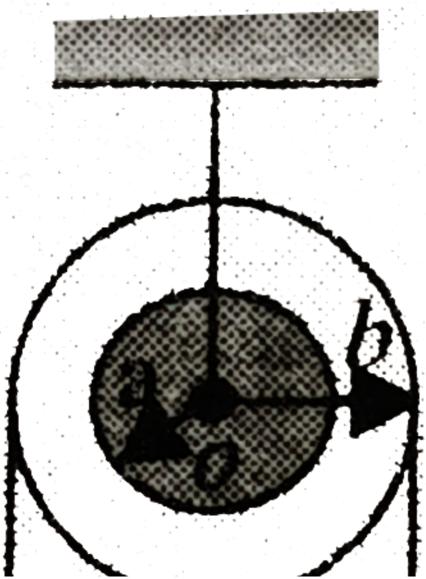
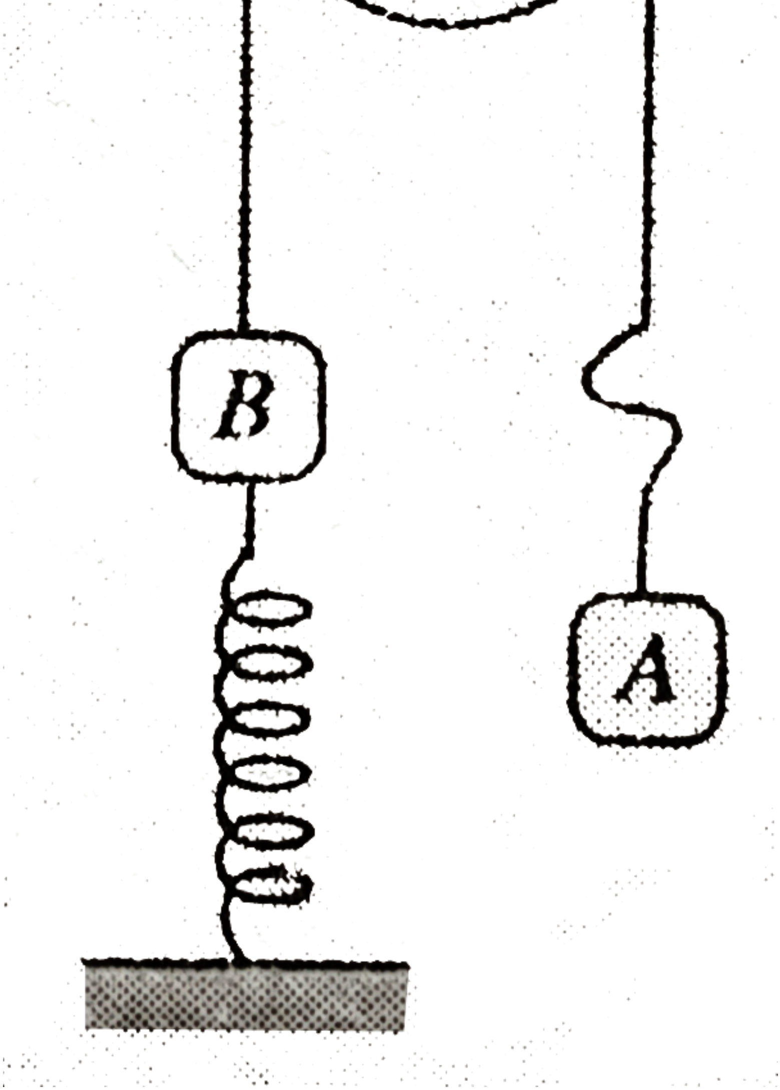
24. A pulley of radius $b=20cm$ is fixed with a shaft of radus $a=10cm$. Moment of inertia of shaft puley system is $I=(33-800)kgm^2$

and the system is free to rotate about axis O of the shaft without friction.

A block B of mass $m_2 = 8kg$ is resting over ann ideal spring of force costant. $K = 2048Nm^{-1}$

Lower end of the spring is fixed to the floor and the spring is vertical. Thread connected betwen shaft and block B is just taut.





Another thead is connected between pulley and block A of mass $m_1 = 4kg$. Initially this thread is loose. When block A is released first it falls freely through a height $h = \frac{405}{1024} m$ then the thread becomes taut and block B is jerked into motion.

calculate:

a. Initial compressiion of the spring

b. Velocity of block B when it is jerked into motion,

c. Loss of energy during that jerk $(g = 10 ms^{-2})$

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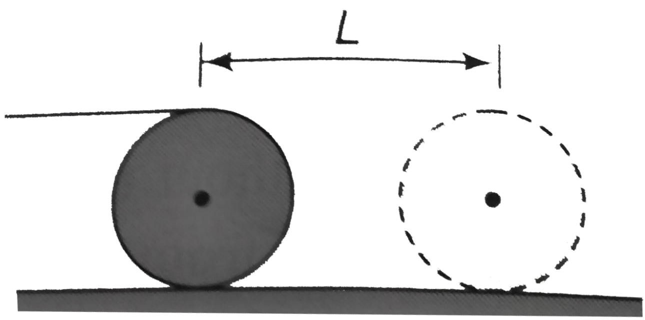
25. A cylindrical drum, pushed along by a board rolls forward on the ground. There is no slipping at any contact. The distance moved by the man who is pushing the board, when axis of the cylinder covers a distance L will be.



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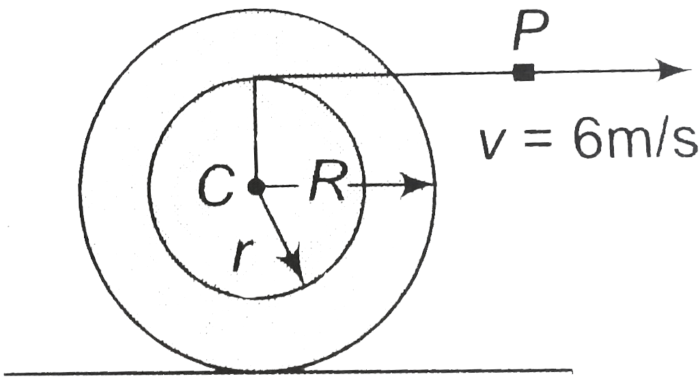
26. A bobbin is pushed along on a rough stationary horizontal surface as shown in the figure. The board is kept horizontal and there is no slipping at any contact points. The distance movedby the board when distance moved by the axis of the bobbin is l is



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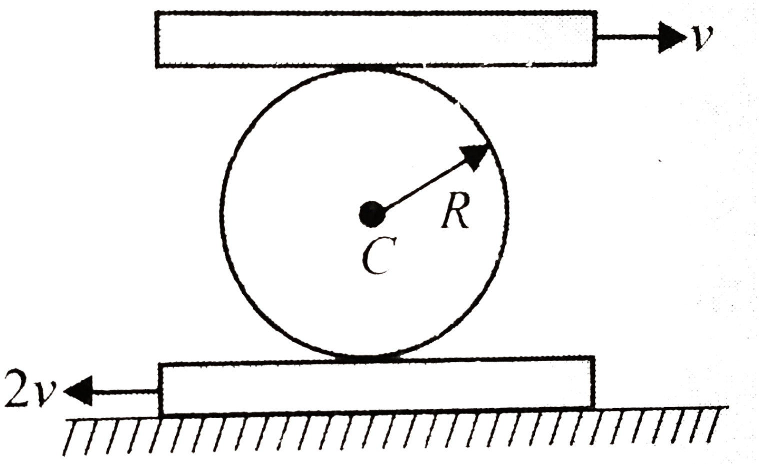
27. A uniform disc of radius R rolls perfectly over two horizontal plank A and B moving with velocities v and $2v$, spectively. Find the



a. velocity of CM of the disc.

b. angular velocity of the disc.

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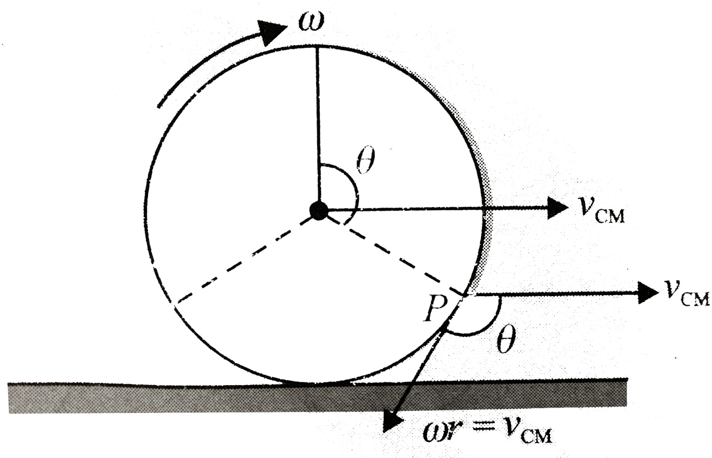
28. A wheel rolls purely on ground. Find a point on the periphery of a body which has a velocity equal in magnitude to the velocity of the centre of mass of the body.



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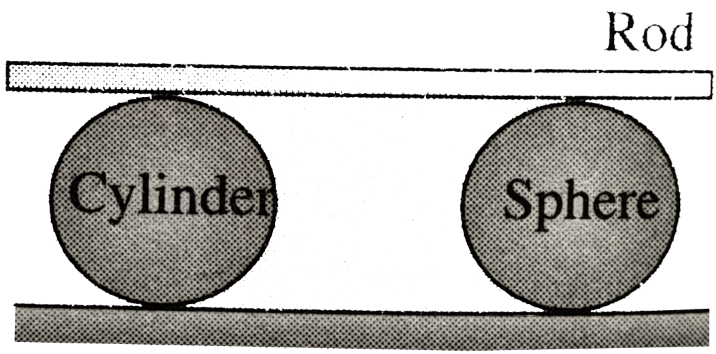
29. A rod of mass m is kept on a cylinder and sphere each of radius R. The masses of the sphere and cylinder are m_1 and m_2 respectively. If the speed of the rod is V, find the KE of the system $(\text{rod} + \text{cylider} + \text{sphere})$. Assume that the surfaces do not slide relative to each other.



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30. A sphere of mass M rolls without slipping on rough surface with centre of mass has constant speed v_0. If mass of the sphere is m and its radius be R`, then the angular momentum of the sphere about the point of contact is.

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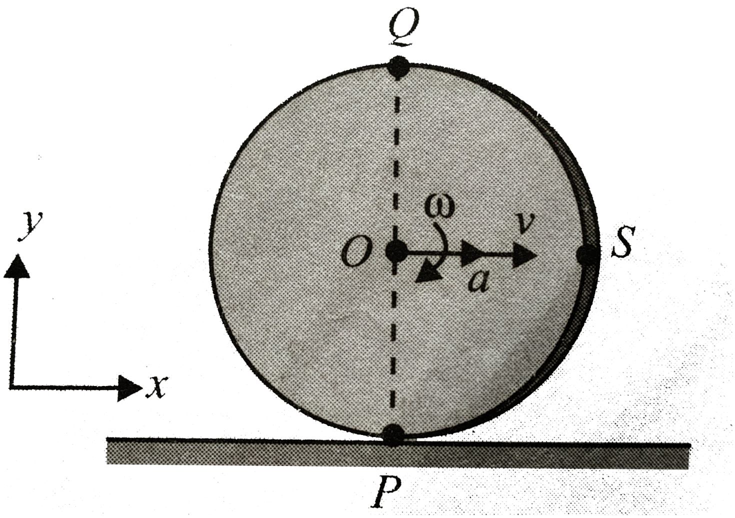
31. Consider a wheel rolls without slipping and its centre moves with constant acceleration a.

Find the acceleration of points O, P, Q and S when linear velocity of the centre of wheel is v.



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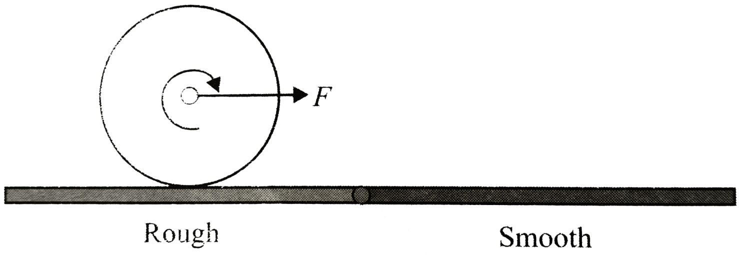
32. A force of magnitude F is acting on rolling body of mass m and radius R as show in figure. What happens when it enters on a smooth surface?



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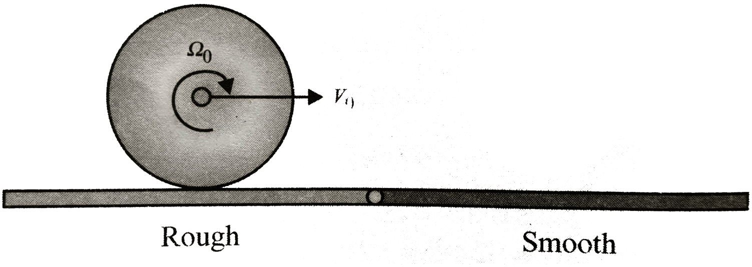
33. A rolling body of mass m and radius R is rolling on a rough surface without any pulling force as shown in figure. What happens when it enters on a smooth surface?



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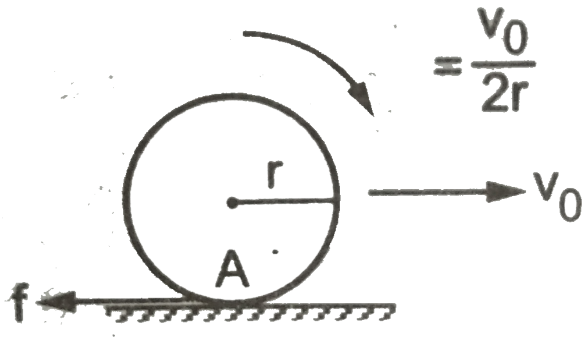
34. A sphere of mass M and radius are shown in figure slips on a rough horizontal plane. At some instant it has translational velocity v_0 and rotational velocity about the centre $\frac{v_0}{2r}$. Find the translational velocity after the sphere starts pure rolling.



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35. A ball (solid sphere) is thrown down the valley in such a way that it slides with a speed v_0 initially without rolling. Prove that it will roll without any sliding when its speed falls to

$\left(\frac{5}{7}\right)v_0$. The transition from pure sliding to pure rolling is gradual, so that both sliding and rolling take place during this interval.

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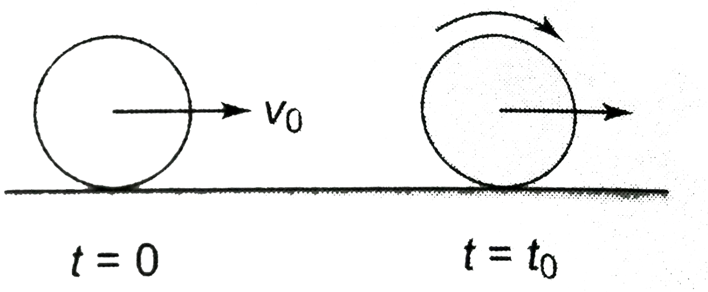
36. A uniform disc of mass m and radius R is projected horizontally with velocity v_0 on a rough horizontal floor so that it starts off with a purely sliding motion at $t = 0$. After t_0 seconds, it acquires pure rolling motion as shown in the figure.

(a) Calculate the velocity of the center of mass of the disc at t_0.

Assuming that the coeffiicent of friction to be μ, calculate t_0.



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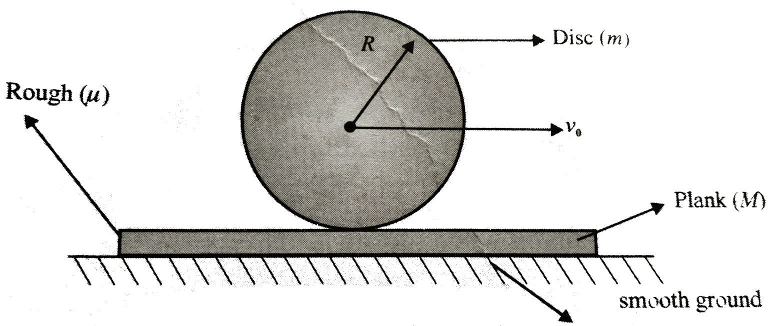
37. A plank of mass M, whose top surface is rough with coefficient of friction μ is placed on a smooth ground. Now a disc of mass $m = M/2$ and radius r is placed on the plank. The disc is now given a velocity v_0 in the horizontal direction at $t = 0$



a. Find the time when the disc starts rolling

b. Find the velocity of the plank and the disc up to that time.

c. Find the distance travelled by the plank up to this instant.

Find the work done by the friction force up to this instant.

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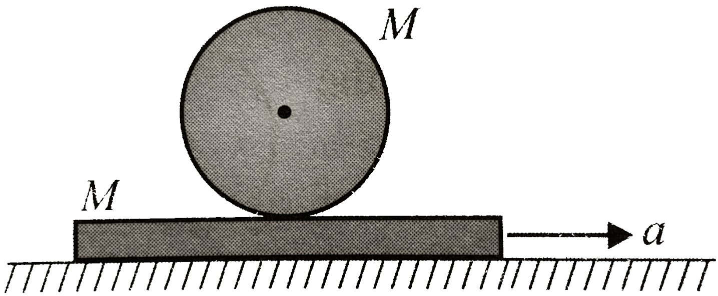
38. A uniform cylinder (mass M) of radius R is kept on an accelerating platform (mass M) as shown in figure. If the cylinder rolls withut slipping on the platform, determine the magnitude of acceleration of the centre of mass of the cylinder. Assuming th coefficient of friction $\mu = 0.40$, determinete maximum acceleration the platform may have without slip between the clyinder and the platform.



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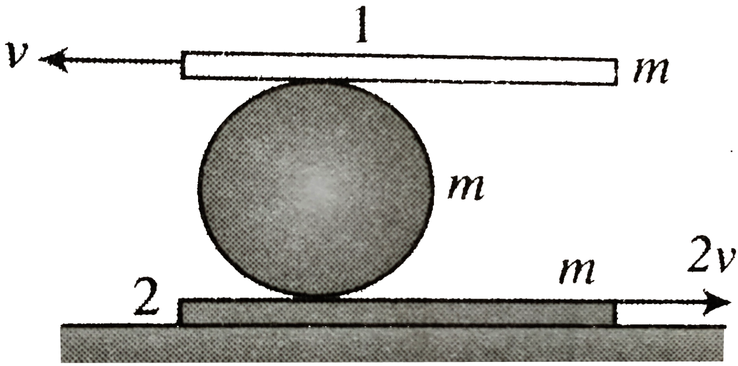
39. Two plates 1 and 2 move with velocities $-v$ and $2v$ respectively. If the sphere does not slide relative to the plates, assuming the masses of each body as m, find the kinetic energy of the system (plates+sphere).



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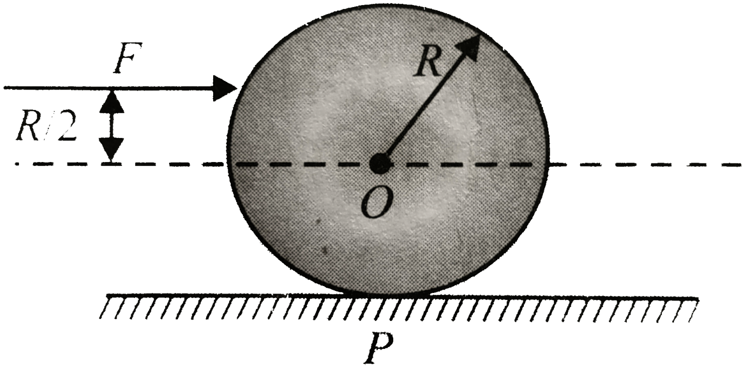
40. Draw the direction of frictionn force in the

followign cases. If rolling object is



A. a ring

B. a disc

C. a solid

D. a hollow sphere

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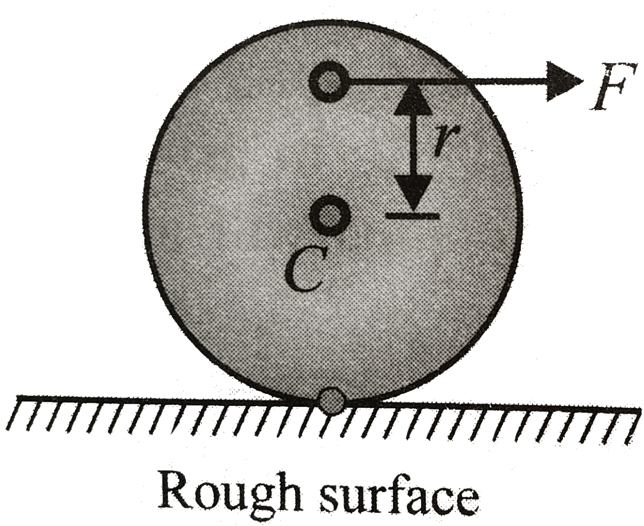
41. A force of magnitude F is acting on a rolling body of mass m and radius R as shown in figure. What happens if the pulling force F is removed ? Discuss the different posibilities when the pulling acts on the body.



a. At centre, b. Above centre, c. Below centre

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42. A force F acts tangentially at the highest point of a sphere of 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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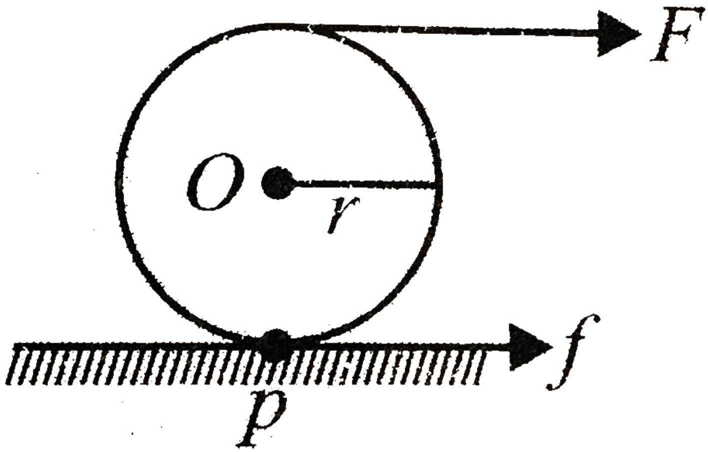
43. A cotton reel has a inner radius r and outer radius R. Mass of the reel is M and moment of inertia about longtudinal rotational axis is I. A force P is applied at the free end of thread wraped of the reel as shown in fig. If the reel moves without sliding.



a. Determine the frictioal force exerted by the table on the reel and the direction in which it acts.

b. I what direction does the reel begin to move?

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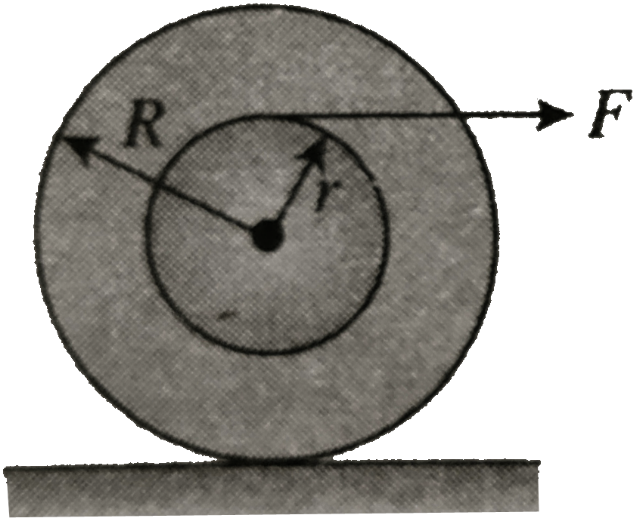
44. A wheel of radius R, mass m and moment of inertia I is pulled along a horizontal surface by application of force F to as rope unwinding from the axel of radius, r as shown in figure. Friction is sufficient for pure rolling of the wheel.



a. What is the linear acceleration of the wheel?

b. Calculate the frictional force that acts on the wheel.

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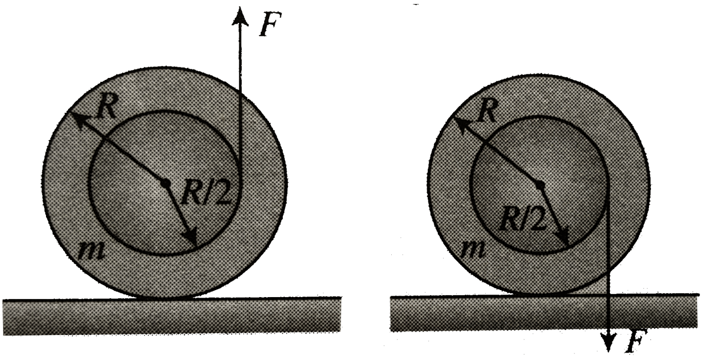
45. A force F is applied onn a spool (mass m and radius R) in vertical direction as shown in case I and case II. The radius of gyration k of spool is $R/(\sqrt{2})$. Assuming pure rolling, find the acceleration of the CM of the body, assuming it as a uniform cylinder of mass m.



Case-I Case-II

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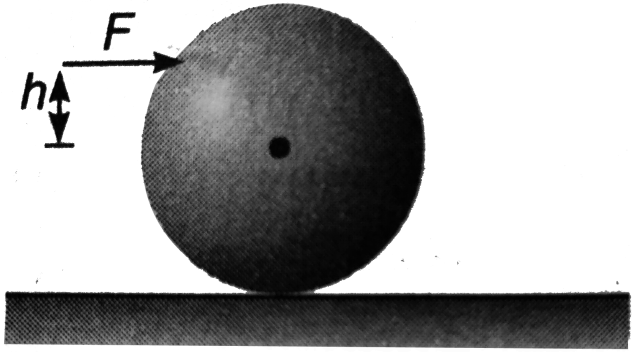
46. 

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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47. A solid cylinder of radius r rolls down an inclined plane of height h and inclination θ. Calculate its speed at the bottom of the plane using energy method. Also calculate the time taken to reach of the bottom.

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48. A solid cylinder of mass M and radius R rolls down an inclined plane without slipping. THE speed of its centre of mass when it reaches the bottom is

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49. A solid sphere is projected up along an inclined plank of inclination $\theta = 30^{\circ}$ with a speed $v = 2ms^{-1}$. If it rolls without slipping find the maximum distance traversed by it ($g = 10ms^{-2}$)

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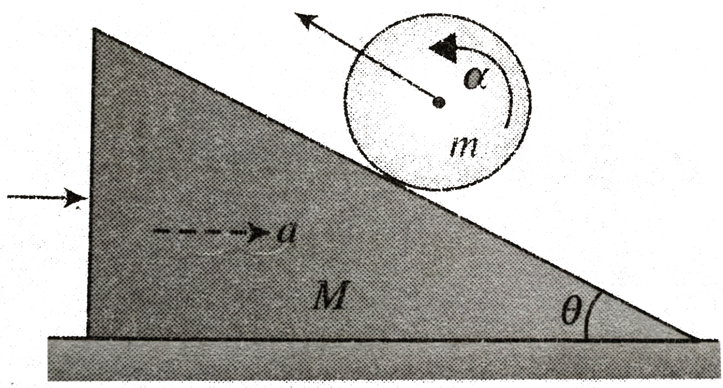
50. A uniform cylnder of radius r and radius of gyration is kept on a fixed wedge of inclination θ. When we push the wedge with a constant acceleration a, the cylinder rolls up the wedge. Find coefficient of friction between the cylinder and wedge.



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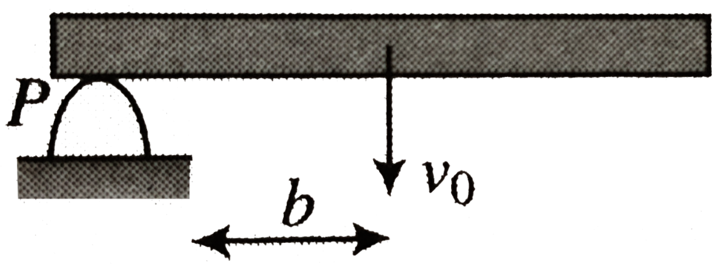
51. A uniform rod of lengh l moving with a downward velocity v_0 strikes a peg P. If the coefficient of restitutioin of impact is e, find the velocity of CM of the rod just after impact.



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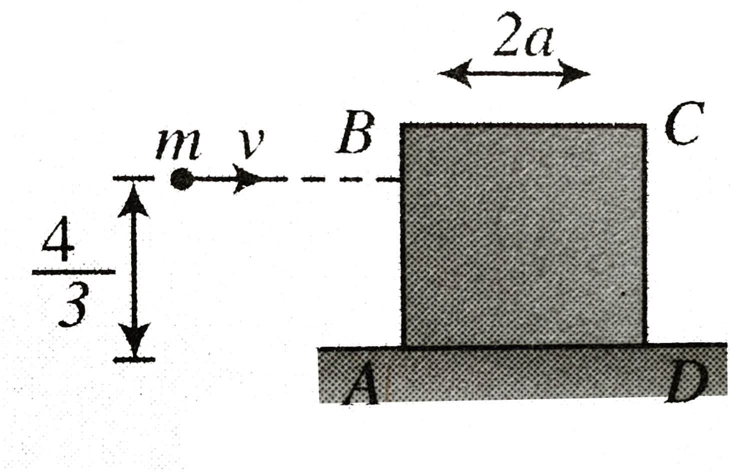
52. A solid cube of wood of side $2a$ and mass M is resting on a horizontal surface. The cube is constrained to rotate about an axis passing through D and perpendicular to face $ABCD$. A bullet of mass m and speed v is shot at a height of $4a/3$ as shown in the figure. The bullet becomes embedded in the cube. Find the minimum value of v required to topple the cube. Assume $m > > M$.



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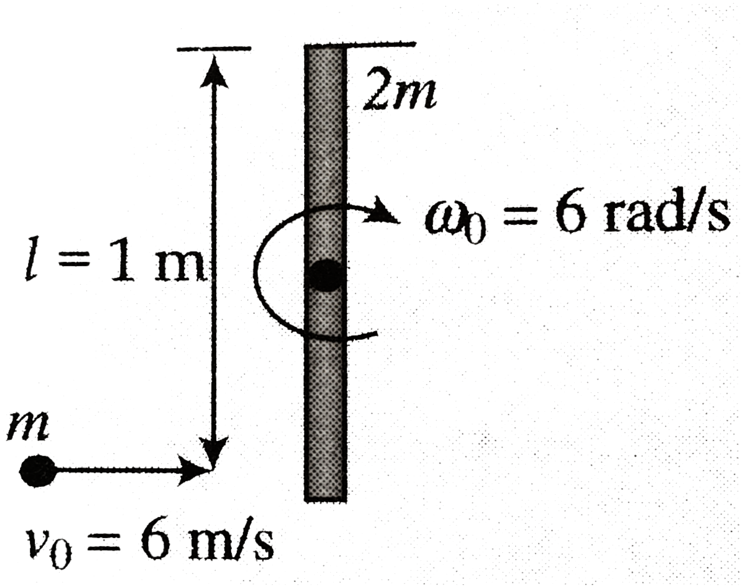
53. A particle of mass $m = 1kg$ collides with the end with velocity $v_0 = 6ms^{-1}$ of a spinning rod of $mass2m$ and length $l = 1m$ at the end of the rod. If the coefficient of restitution of collision $e = (2/3)$, find the

a. velocity of the particle

b. angular velocity of the rod just after the impact.



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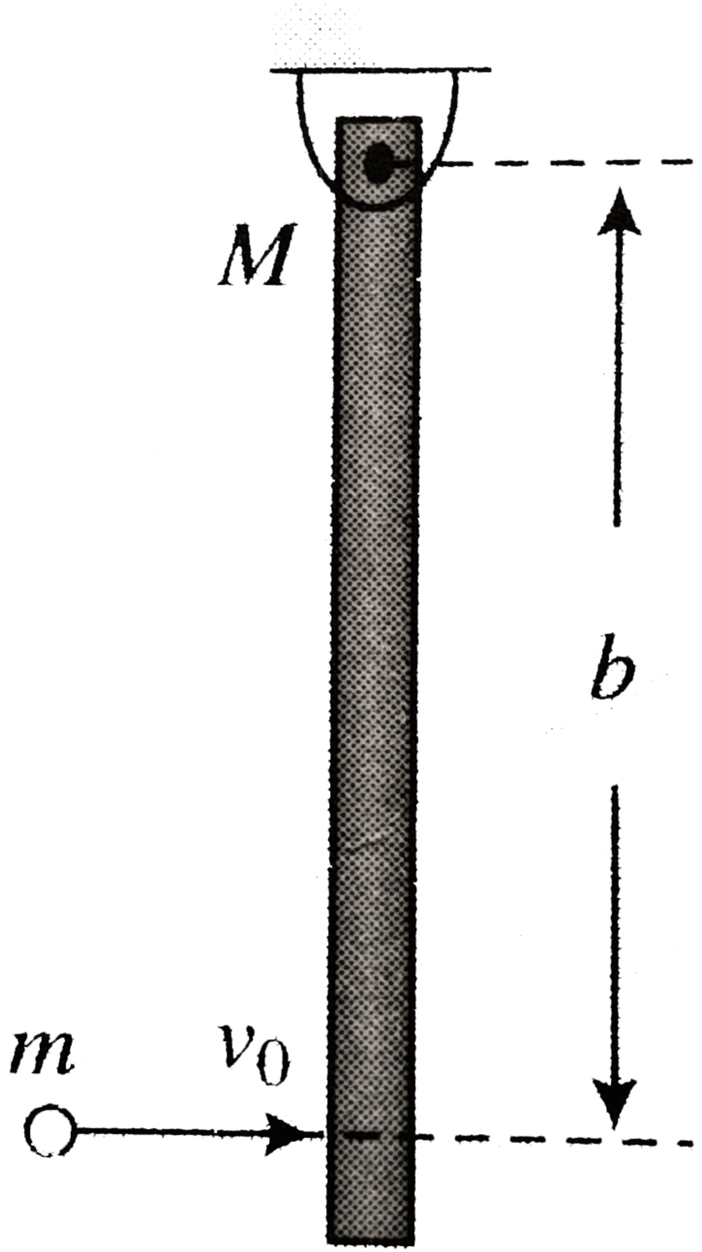
54. A ball of mass m collides elastically with a smooth hanging rod of mass M and length l.

a. If $M = 3m$ find the value of b for which no horizontal reaction occurs at the pivot.

b. For what value of m/M the ball falls dead just after the collision assuminng $e = \left(\frac{1}{2}\right)$?



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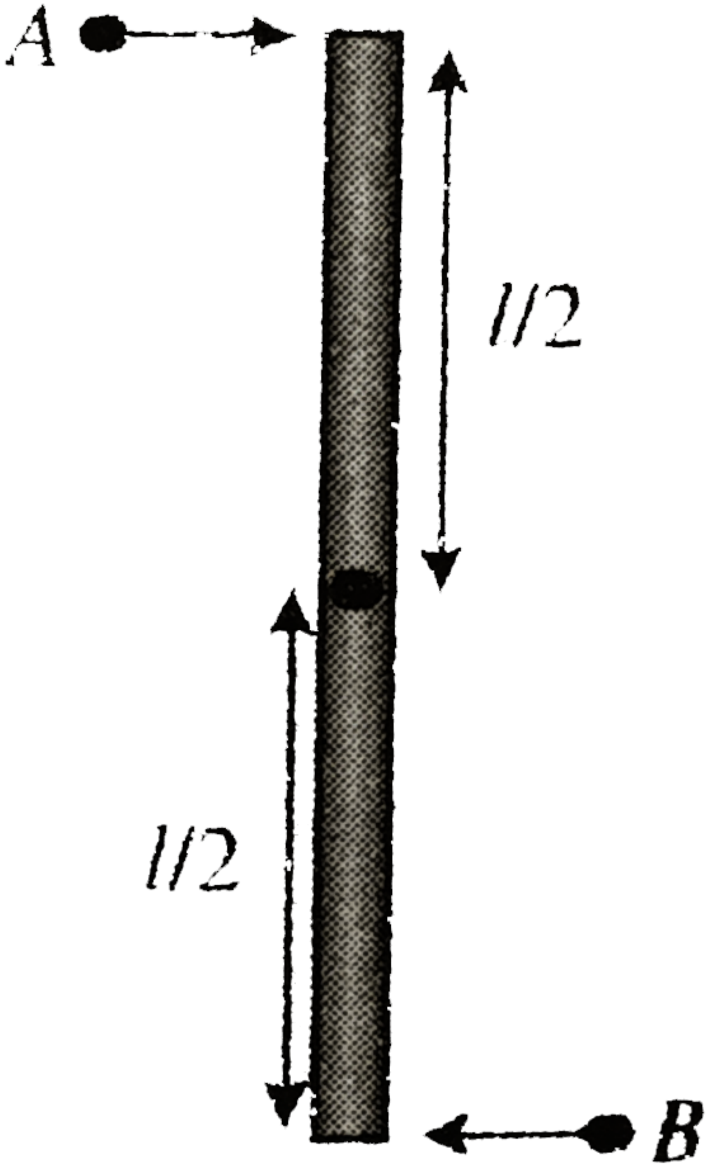
55. Two particles A and B of mass m each hit the ends of a rigid bar of mass M and length l inelastically from opposite sides the speeds v and perpendicular to the rod. The bar is kept on a smooth horizontal plane (as shown). Find the linear and angular speed of the system (bar + particle).



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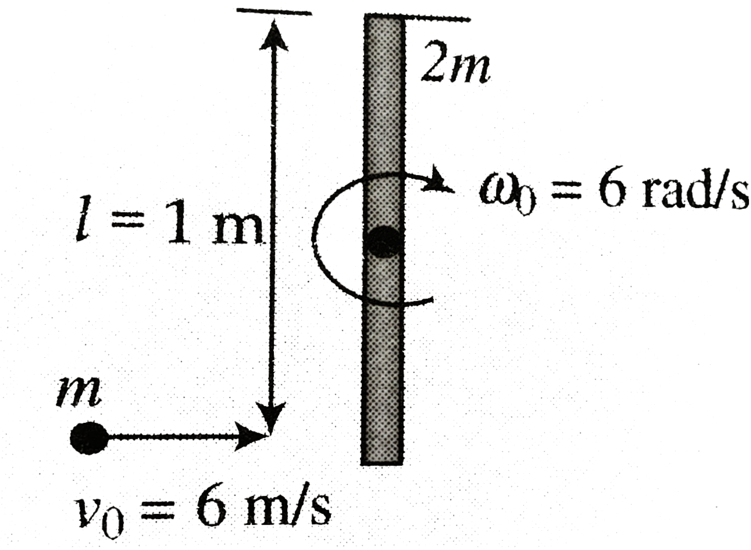
56. A vertically oriented uniform rod of mass M and length l can rotate about its upper end. A horizontally flying bullet of mass m strikes the lower end of the rod and gets stuck in it as a result the rod swings through an angle α. Assuming that $m < < M$. find

a. the velocity of the flying bullet:

b. the moment change in the system bullet rod during the impact: what causes that change of momentum.



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

(a). Find the ratio m/M

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

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

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Solved Examples

1. 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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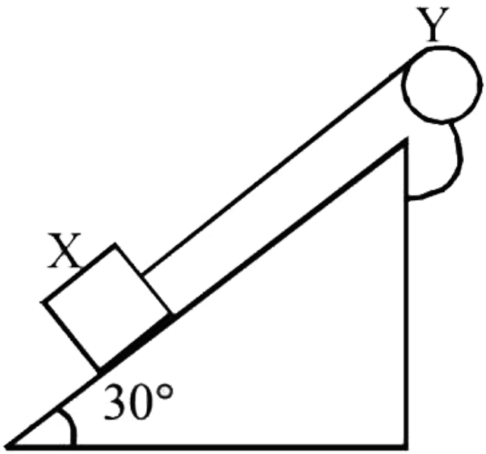
2. A block X of mass 0.5 kg is held by a long massless string on a frictionless inclined plane of inclination 30° to the horizontal. The string is wound on a uniform solid cylindrical drum Y of mass 2kg and of radius 0.2m as shown in Fingure. The drum is given an initial angular velocity such that the 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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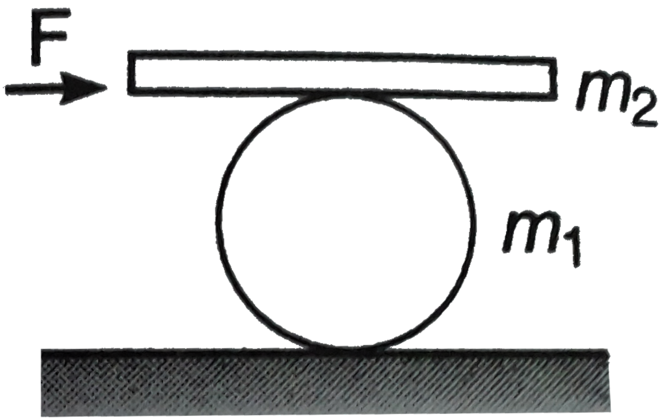
3.



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

(a). the acceleration of the plank and the centre of mass the cylinder and (b). The magnitudes and direction of frictional forces at contact points.

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4. A plank of mass M, is placed on a smooth surface over which a cylinder of mass $m(=M)$ annd radius $R=1m$ is placed as shown in figure. Now the plane is pulled towards the right wilth an external force $F(=2Mg)$. If the cyinder does not slip over the surfcace of the plank, find the linear acceleration of he plank and the cylinder and the angular acceleration of the cylinder. (Take $g = 10ms^2$)

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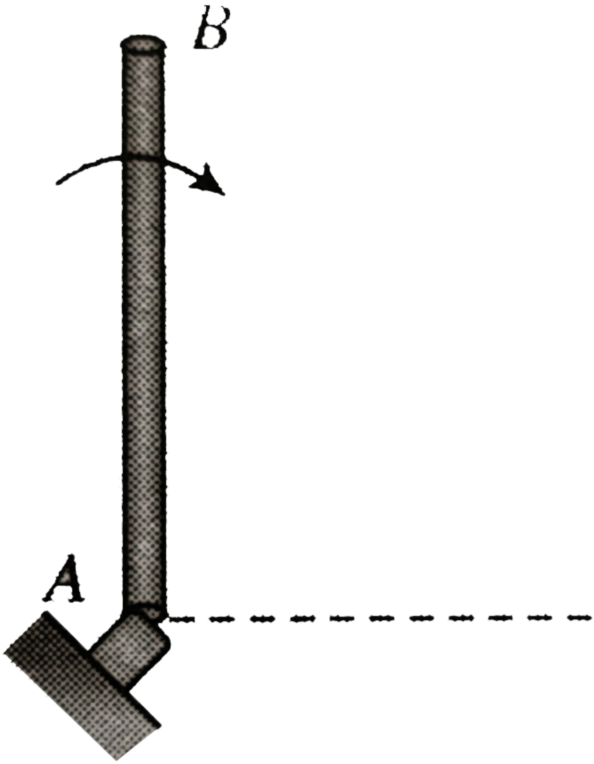
5. A uniform slender bar B of mass m and length L supported by a firctionless pivot at A is released from rest at its vertical position as shown the figure. Calculate the reaction at pivot when the bar just acquires the horizontal position shown dotted.



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6. A hoop of mass m is projected on a floor with linear velocity v_0 and reverse spin ω_0. The coefficient of friction between the hoop and the ground is μ.

a. Under what condition will the hoop return back?

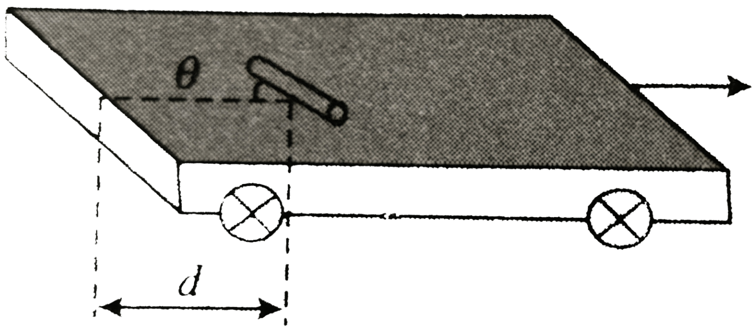
b. How far will it go?

c. How long will it continue to slip when its centre of mass becomes stationary?

d. What is the velocity of return?

7. A trolley intially at rest with a solid cylinder placed on its bed such that cylinder axis makes angle θ with direction of motion of trolley as shown in the figure starts to move forward with constant acceleration a. If initial distance of midpoint of cylinder axis from rear edge of trolley bed is d, calculate the distance s which the trolley goes before the cylinder rolls off the edge of its horizontal bed. Assume dimensions of cylinder to be very small in comparision to other dimensions. Neglect slipping.

Calculate als, frictional force acting on the cylinder.



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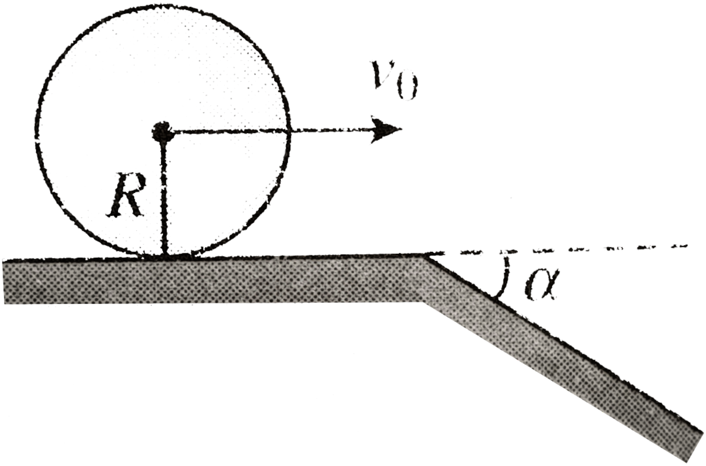
8. A uniform solid cyinder of radius $R = 15cm$ rolls over a horizontal plane passing into an inclined plane forming an ange $\alpha = 30^{\circ}$ with the horizontal. Find the maximum value of the velocity v_0 which still permits the cylinder to roll on the inclined plane section without a jump. (The sliding is asumed to be absent).



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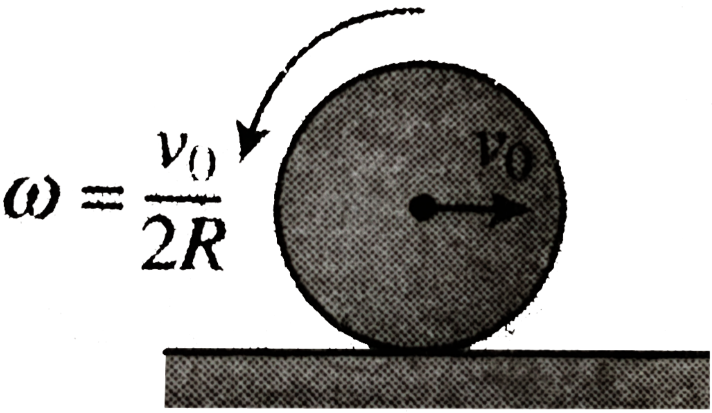
9. A solid sphere of radius R is set into motion on a rough horizontal surface with a inear speed v_0 in forward direction and an angular with a linear speed v_0 in forward directioin and an angular velocity $\omega_0 = v_0/2R$ in counter clockwise direction as shown in figure. If coefficient of friction μ then find

a. the time after which sphere starts pure rolling,

b. the linear speed of sphere when it starts rolling and

c. the work down by friction over a long time.



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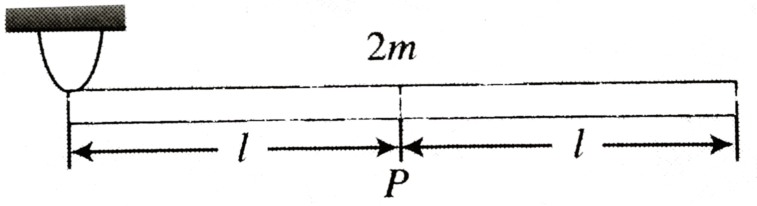
10. A composite rod of mass $2m$ and length $2l$ comprises two indentica rods joined end to end at P. The composite rod hinged at one of its ends is kept horizontal as shown in the figure. If it is realeased from rest.



a. find its angular speed when it becomes vertical.

b. If the lower rod gets detached with the upper rod due to centrifugal effect at their joint P, at the vertical position of the composite rod, find their linear and angular velocities just after their separation.

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11. A ball of radius $R = 20cm$ has mass $m = 0.75kg$ and moment of inertia (about its diameter) $I = 0.0125kgm^2$. The ball rolls without sliding over a rough horizontal floor wilth velocity $v_0 = 10ms^{-1}$ towards a smooth vertical wall if coefficient of resutitution between the wall and the ball is $e = 0.7$, calculate velocity v of the ball long after the collision. $(g = 10ms^{-2})$

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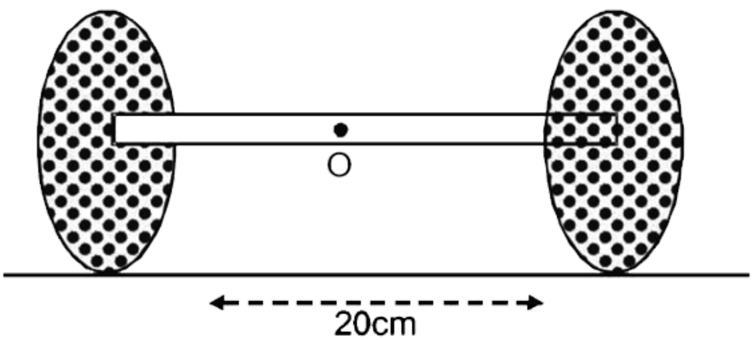
12. Two thin circular disks of mass 2kg and radius 10 cm each are joined by a rigid massless rod of length 20 cm. the axis of the rod is along the perpendicular to the planes of the disk through their centres. This object is kept on a truck in such a way that the axis of the object is horizontal and 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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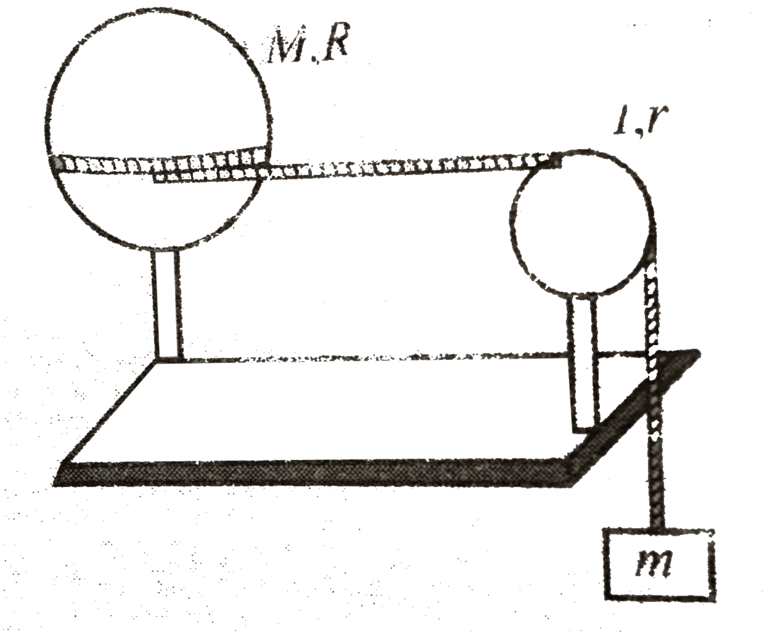
Exercise 3.1

1. 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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2. A uniform rod of mas m and length l is kept vertical with the lower end clamed. It is slightly pushed to let it fall down under gravity. Find its angular speed when the rod is passing through its lowest positon. Neglect any friction at the clamp. What will be the linear speed of the free end at this instant?

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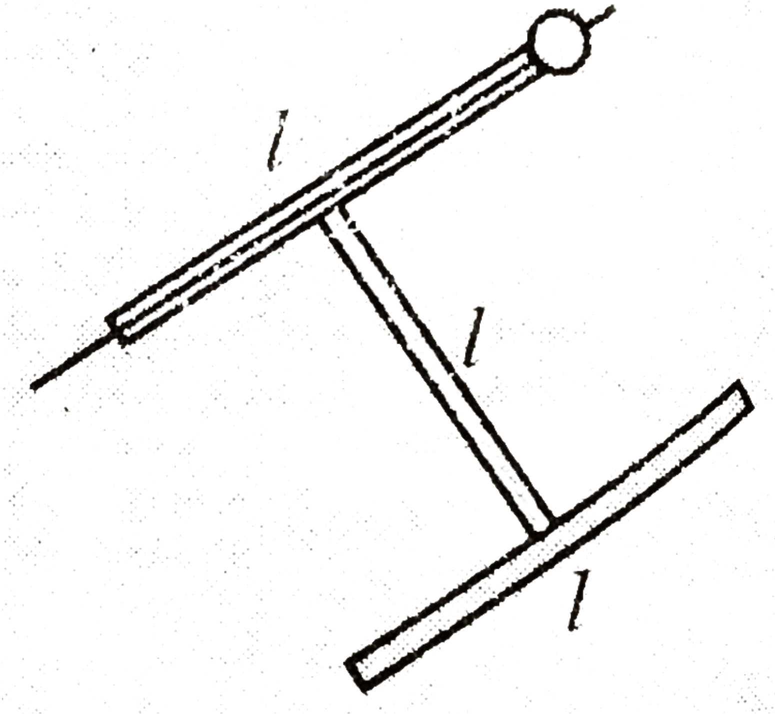
3. A rigid body is made of three identical thin rods, each with length fastened together in the form. of letter H. The body is free to rotate about a horizontal axis that runs along the length of one of the arms of H. The body is allowed to fall from rest from a position in which the plane of the H is horizontal. What is the angular speed of the body when the plane of H is vertical?



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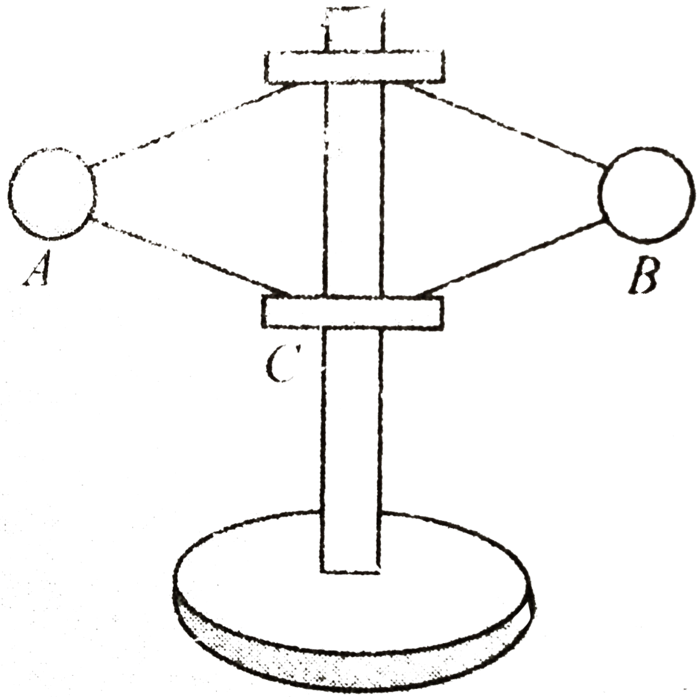
4. The steel balls A and B have a mass of $500g$ each and al rotating about the vertical axis with an angular velocity of $4 rad/s$ at a distance of $15 CM$ from the axis. Collar C is now forced down until the balls are at a distance $5 CM$ from the axis. How Much work must be done move the collar down?



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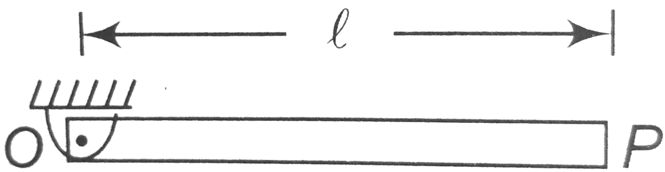
5. A uniform rod smoothly pivoted at one of its ends is released from rest. If it swings in vertical plane, the maximum speed of the end P of the rod is.



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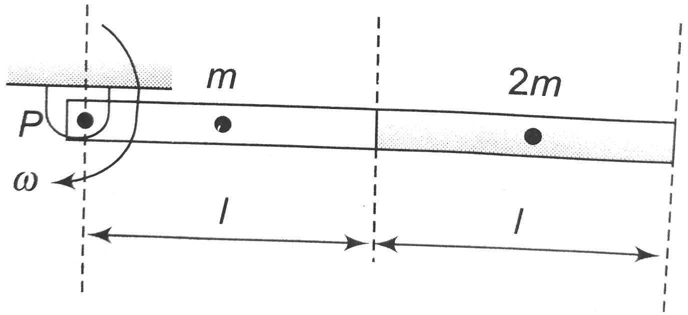
6. A composite rod comprising two rods of mass m and $2m$ and each of length $l = 1m$ as shown in the figure. Assume $\omega = 10 rad/s$ and $m = 1kg$, the KE of the rotating composite rod is.



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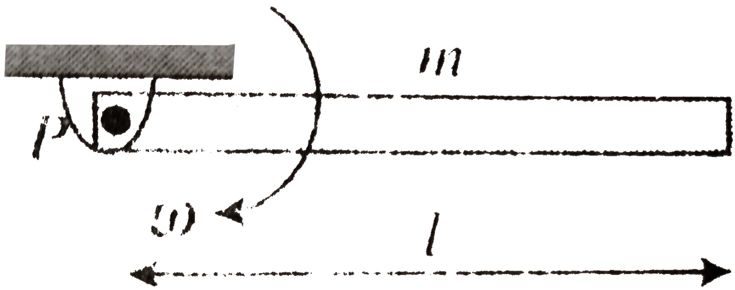
7. A rod of mass m spins with an angular speed $\omega = \sqrt{\frac{g}{l}}$, Find its a. kinetic energy of rotation. b. kinetic energy of translation c. total kinetic energy.



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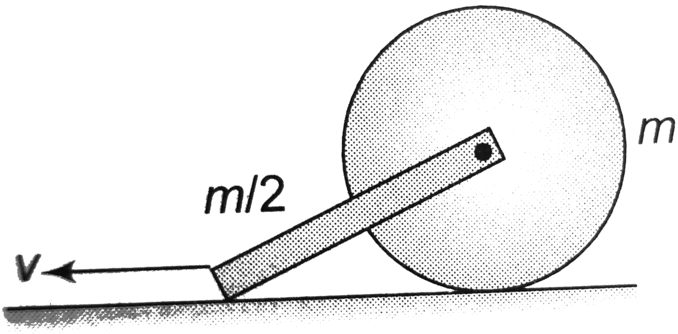
8. A uniform disc of mass m is fitted (pivoted smoothly) with a rod of mass $m/2$. If the bottom of the rod os pulled with a velocity v, it moves without changing its orientation and the disc rolls without sliding. The kinetic energy of the system (rod + disc) is.



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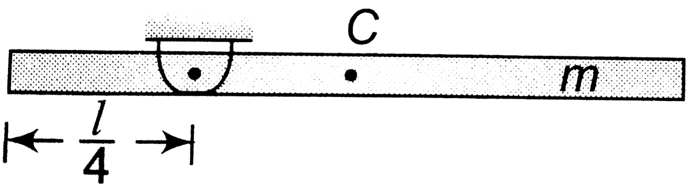
9. A uniform rod of length l is from rest such that it rotates about a smooth pivot. The angular speed of the rod when it becomes vertical is.



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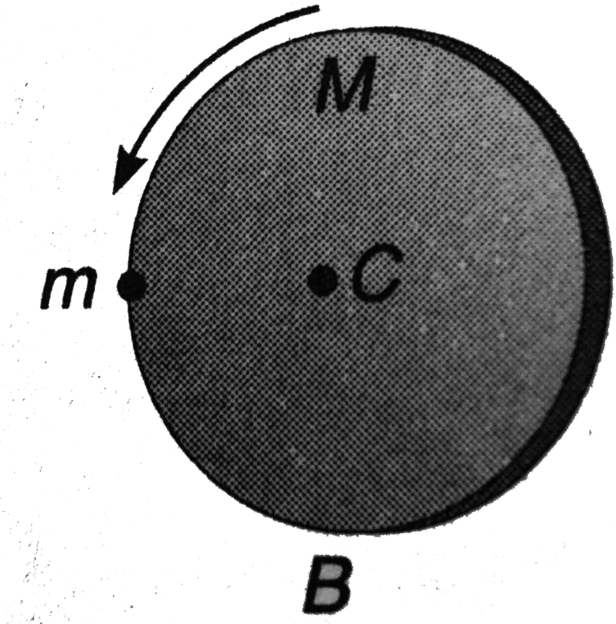
disc when m reache



10.

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

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11. A copper ball of mass $m = 1kg$ with a radius of $r = 10cm$ rotates with angular velocity $\omega = 2rad/s$ about an axis passing through its centre. The work should be performed to increase the angular velocity of rotation of the ball two fold is.

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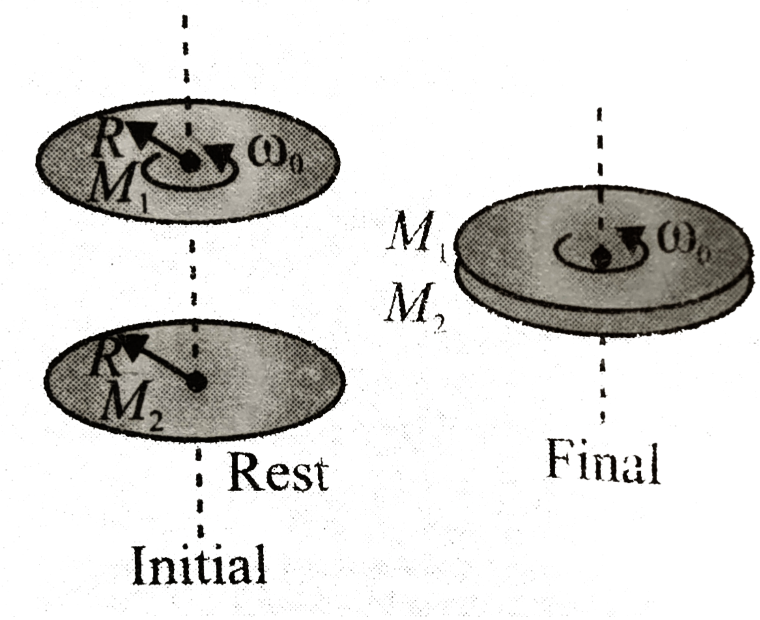
Exercise 3.2

1. A circular disc of mass M_1 and radius R, initially moving, With a constant angular speed ω is gently placed coaxially on a stationary circular disc of mass M_2 and radius R, as shown in Fig. There is a frictional force between the two discs.

If disc M_2 is placed on a smooth surface, then 'determine' the final angular speed of each disc.

b. Determine the work done by friction.

c. Determine the fractional loss in kinetic energy. i.e. $\triangle K / K_i$



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2. 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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3. Suppose in the previous problem, the child stays at rest on the platform and one of his friend throws a ball of mas m_1 towards him 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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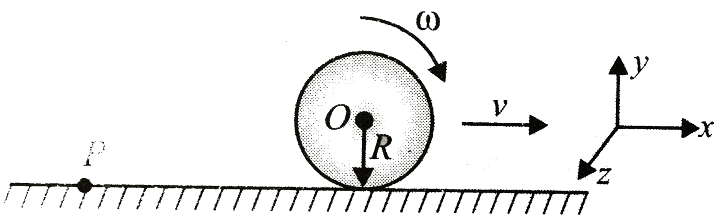
4. Consider a cylinder rolling on a horizontal plane. Its linear velocity is v and rotational angular velocity is ω. Find its angular momentum about point P on the ground as shown in Fig. What happens to this angular momentum if the cylinder is rotating in opposite direction but moving translationally in the same direction.



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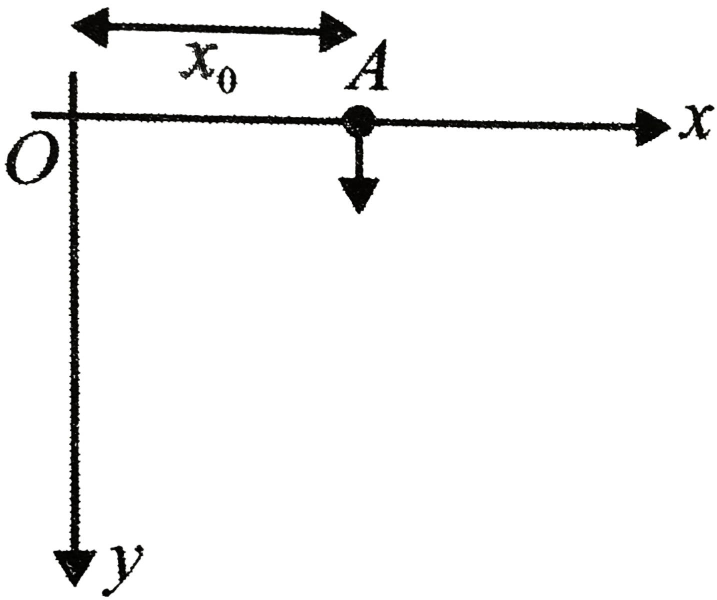
5. A particle of mass m is released from rest at point A in Fig., falling parallel to the (vertical) y-axis. Find the angular momentum of the particle at any time t with respect to the same origin O.



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6. Discs A and B are mounted on a shaft SS and may be connected or disconnected by a clutch C. The moment of inertia of disc A is one half that of disc B. With the clutch disconnected, A is brought up to an angular velocity ω_0 .The accelerating torque is then removed from A and it is coupled to disc B by the clutch (Bearing friction may be neglected). It is found that $2000J$ of heat is developed in the clutch when the connection is made. What is the original kinetic energy of disc A?

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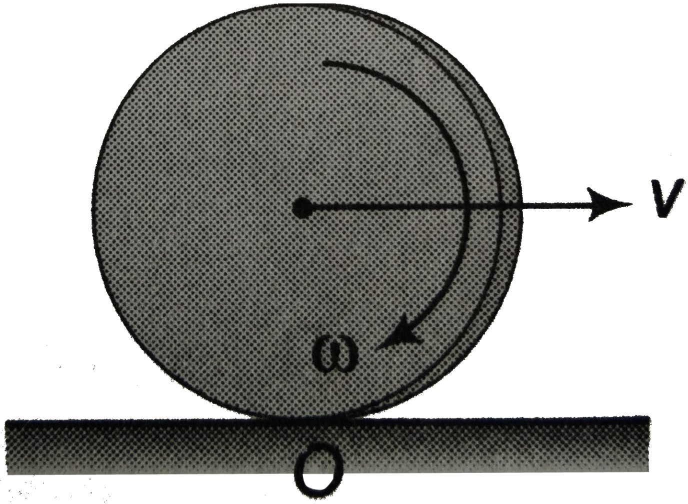
7. 

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

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8. A particle of mass m is projected with a speed u at an angle θ to the horizontal at time $t = 0$. Find its angular momentum about the point of projection O at time t, vectorially. Assume the horizontal and vertical lines through O as X and Y axes, respectively.

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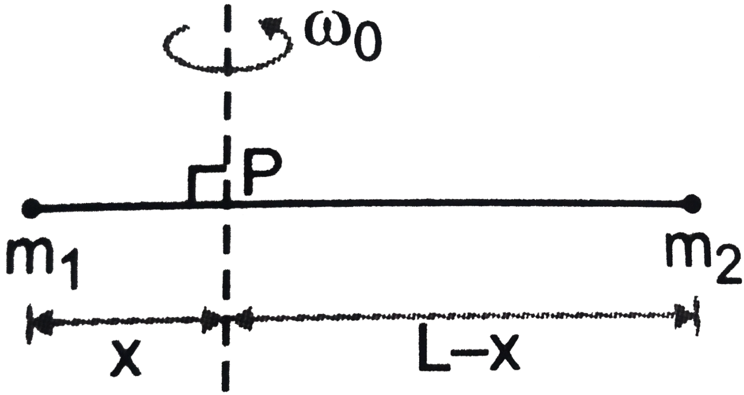
9. Point masses m_1 and m_2 are placed at the opposite ends of a rigid rod of length L, and negligible mass. The rod is to be set rotating about an axis perpendicular to it. The position of point P on this rod through which the axis should pass so that the work required to set the rod rotating with angular velocity ω_0 is minimum, is given by :



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10. A thin uniform circular disc of mass M and radius R is rotating in a horizontal plane about an axis passing through its centre and perpendicular to its plane with an angular velocity ω . Another disc of same dimensions but of mass $\frac{1}{4}$ M is placed gently on the first disc co-axially. The angular velocity of the system is

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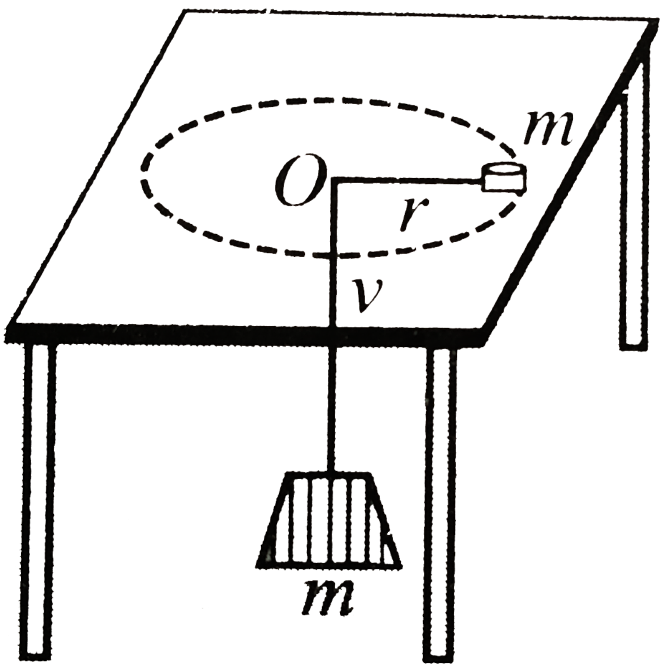
11. A thread is passing through a hole at the centre of frictionless table. At the upper end a block of mass $0.5kg$ is tied and a block of mass $8.0kg$ is tied at the lower end which is freely hanging. The smaller mass is rotate, on the table with a constant angular velocity about the axis passing through the hole so as to balance the heavier mass. If the mass of the hanging block is changed from $8.0kg$ to $1.0kg$, what is the fractional change in the radius and the angular velocity of the smaller mass so that it balances the hanging mass again?



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12. A girl jumps from a height h on the end of a see-saw. The see-saw consists of a uniform plank of length I pivoted at its centre. The plank is horizontal before the girl jumps. The mass of the see-saw is twice the mass of the girl. Find the angular velocity of the plank just after the girl jumps on the plank.

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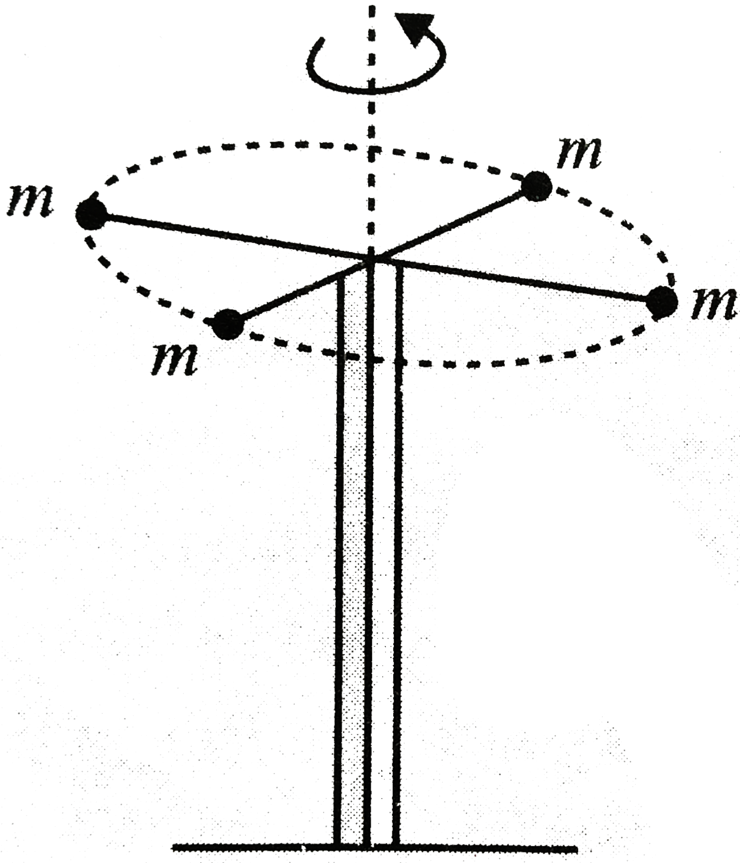
13. The device shown in Fig. rotates on the vertical axle as shown. The frame has negligible mass as compared to the four masses each of mass m. Initial angular velocity of the system is ω_0. Due to an internal mechanism the spokes in the frame lengthen so that the radii of the masses become $2a$. Initially, it was a. What will be the new angular velocity of the system?



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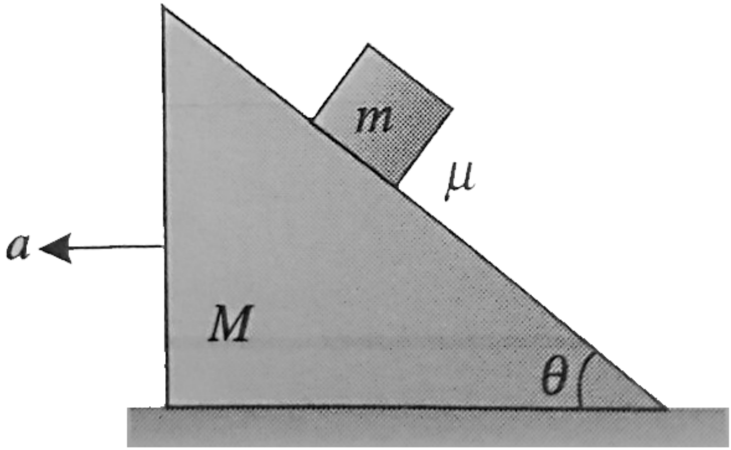
Exercise 3.3

1. 

A block of mass m is at rest relative to the stationary wedge of mass M. The coefficient of friction between block and wedge is μ. The wedge is now pulled horizontally with acceleration a as shown in figure. Then the minimum magnitude of a for the friction between block and wedge to be zero is:

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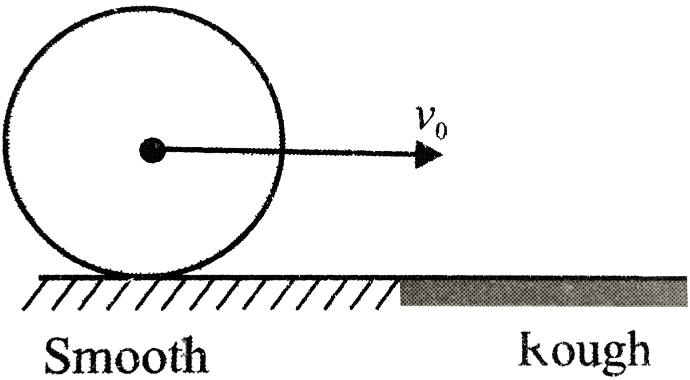
2. A sphere moving with a velocity v_0 on a smooth surface suddenly enters on a rough horizontal surface as shown in Fig. State which of the following statements are true or false



a. The sphere loses translational kinetic energy and gains rotational kinetic energy.

b. The total energy of the sphere is conserved.

c. The angular momentum of the sphere about any point OD the surface is conserved.

d. The final velocity attained by the centre of mass is $2v_0/3$.

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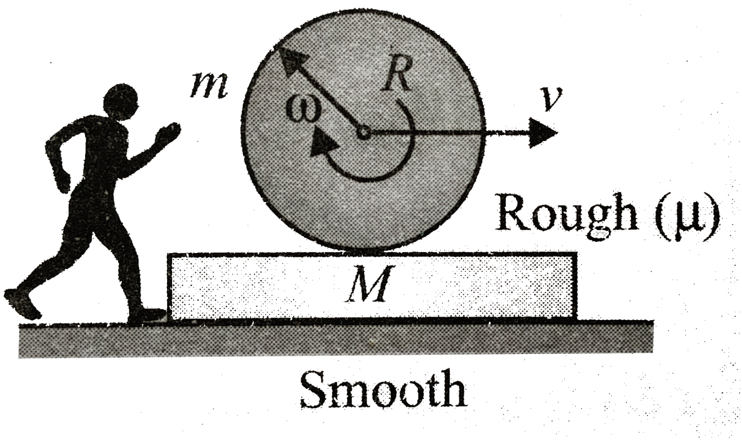
3. A cylinder of mass at and radius R rolls on a stationary plank of mass M. The lower surface of the plank is smooth and the upper surface is sufficiently rough with a coefficient of friction μ. A man is to hold the plank stationary with respect to the ground, as shown Fig.



The force exerted by the man to keep the plank stationary is equal to......

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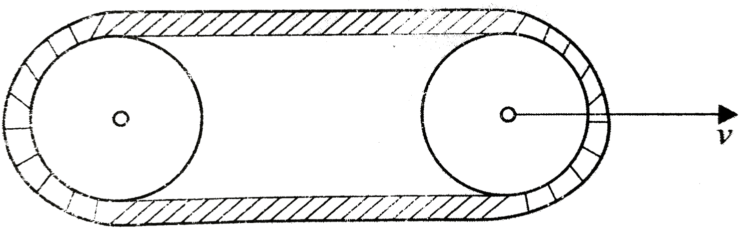
4. Calculate the kinetic energy of a tractor crawler belt of mass m if the tractor moves with a velocity v. There is no slipping. Neglect the size of the wheels.



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5. A constant horizontal force of $10N$ is applied at the centre of a wheel of mass $10kg$ and radius $0.30m$. The wheel rolls without slipping on the horizontal surface, and the acceleration of the centre of mass is $0.60m/s^2$.

a. What are the magnitude and direction of the frictional force on the wheel?

b. What is the rotational inertia of the wheel about an axis through its centre of mass and perpendicular to the plane of the wheel?

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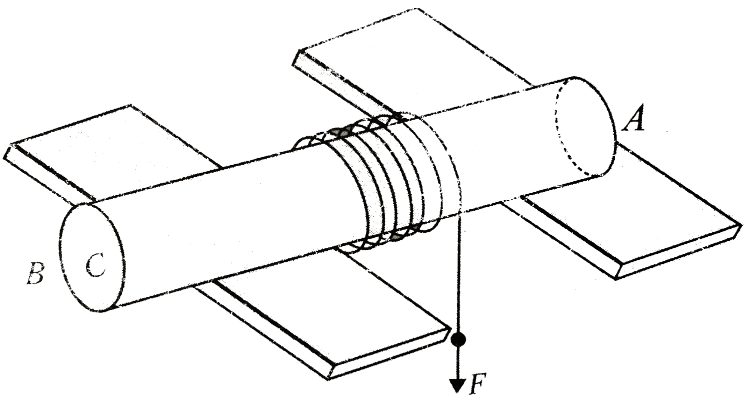
6. A uniform solid cylinder of mass m rests on two horizontal planks. A thread is wound on the cylinder. The hanging end of the thread is pulled vertically down with a constant force F.



Find the maximum magnitude of the force F which may be applied without bringing about any sliding of the cylinder, if the coefficient of friction between the plank and the cylinder is equal to μ. What is the maximum acceleration of the centre of mass over the planks?

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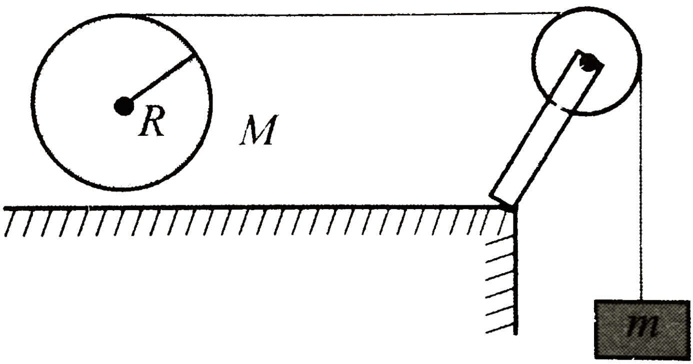
7. A load of mass m is attached to the end of a string wound on a cylinder of mass M and radius R. The string passes round a pulley.



a. Find the acceleration of the cylinder M when it rolls.

b. If the coefficient of friction is μ. Find the accelerative of the cylinder when it slips and rolls.

c. Find the minimum value of coefficient of friction for which the cylinder rolls always

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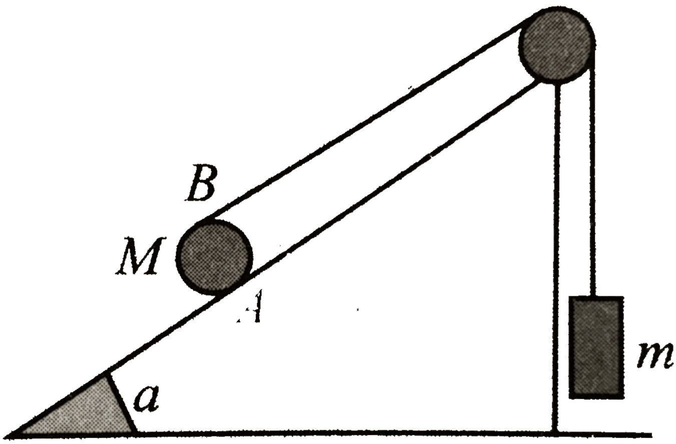
8. Find the tension in the tape and the linear acceleration of the cylinder up the incline, assuming there is no slipping. $(Take M = 4m$ and $g = 10m/s^2)$



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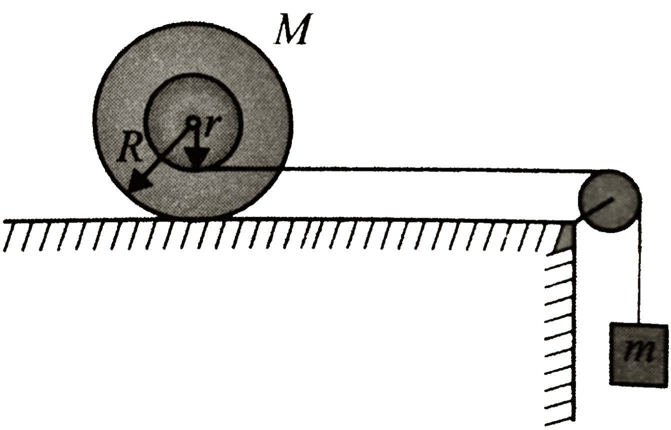
9. A spool (consider it as a double disc system joined by a short tube at their centre) is placed on a horizontal surface as shown Fig. A light string wound several times over the short connecting tube leaves it tangentially and passes over a light pulley. A weight of mass m is attached to the end of 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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10. A solid cylinder wheel of mass M and radius R is pulled by a force F applied to the centre of the wheel at 37° to the horizontal. If the wheel is to roll without slipping, what is the maximum value of $|F|$? The coefficients of static and kinetic friction are $\mu_s = 0.40$ and $m_k = 0.30.$ $\left(\sin 37^\circ = \frac{3}{5}\right)$

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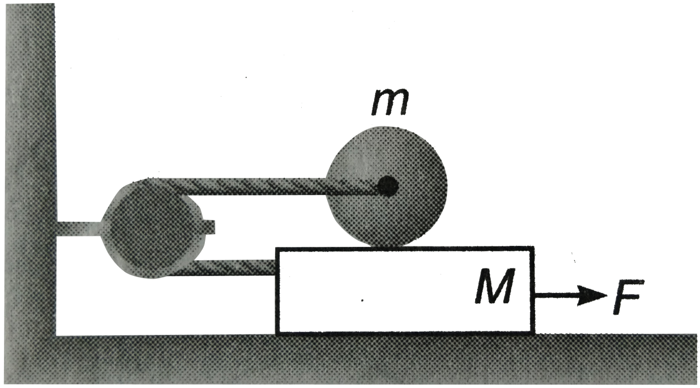
11. 

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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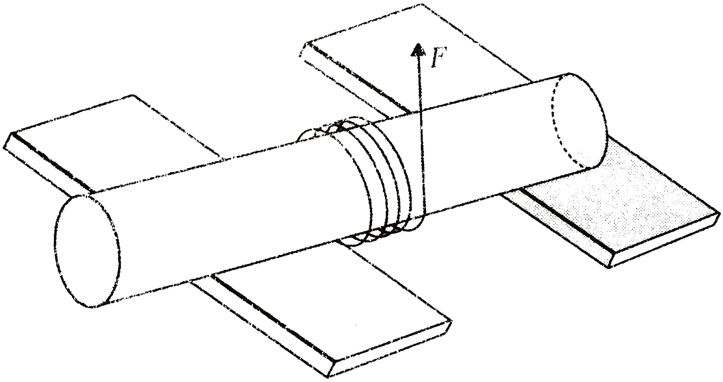
12. A uniform solid cylinder of mass m rests on two horizontal planks as shown in Fig. A thread is wound on the cylinder. The hanging end of the thread is pulled vertically up with a force F. What is the maximum magnitude of the force F which still does not bring about any sliding of the cylinder, if the coefficient of friction between the cylinder and the planks is equal to μ. What is the maximum acceleration of the axis of the cylinder?



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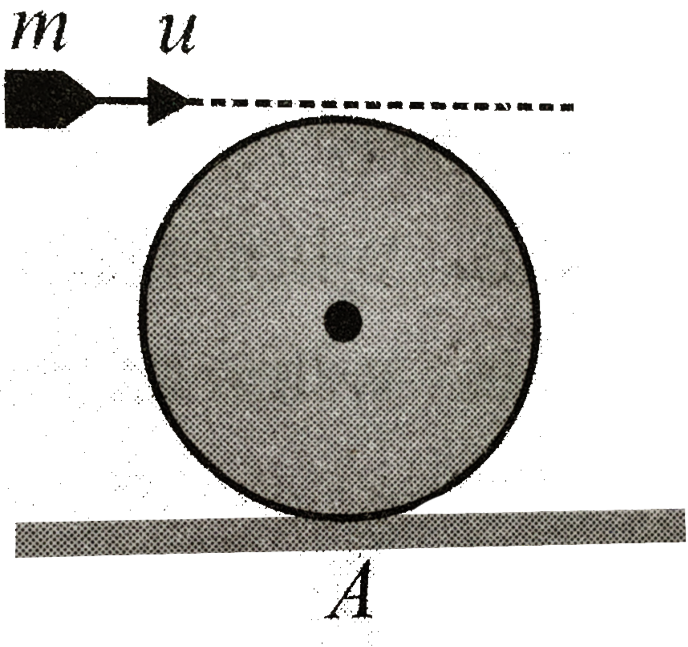
13. A bullet of mass m moving with a velocity of u just grazes the top of a solid cylinder of mass M and radius R resting on a rough horizontal surface as shown and is embedded in the cylinder after impact. Assuming that the cylinder rolls without slipping, find the angular velocity of the cylinder and the final velocity of the bullet.



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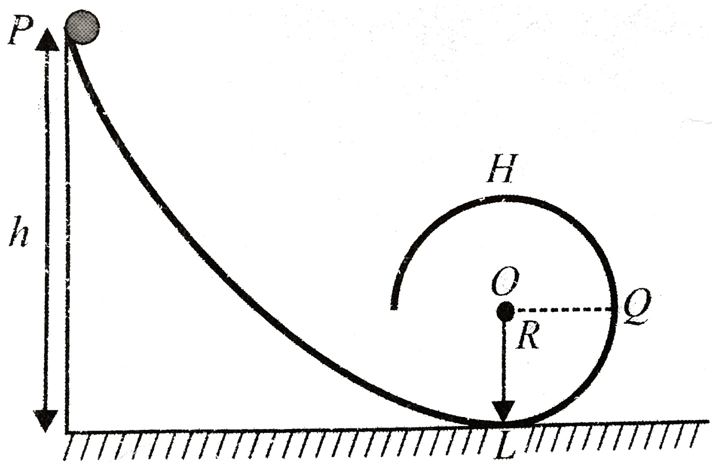
14. A small solid marble of mass M and radius r rolls down along the loop track, without slipping. Find the height h above the base, from where it has to start rolling down the incline such that the sphere just completes the vertical circular loop of radius R.



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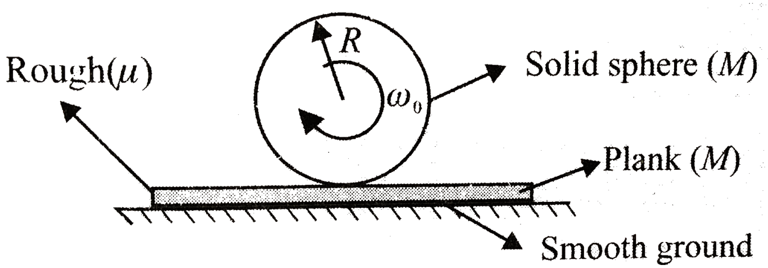
15. A solid sphere of mass M is placed on the top of a plank of the same mass, after giving an angular velocity ω_0 at $t = 0$. Find the velocity of the plank and the sphere when the sphere starts rolling:,



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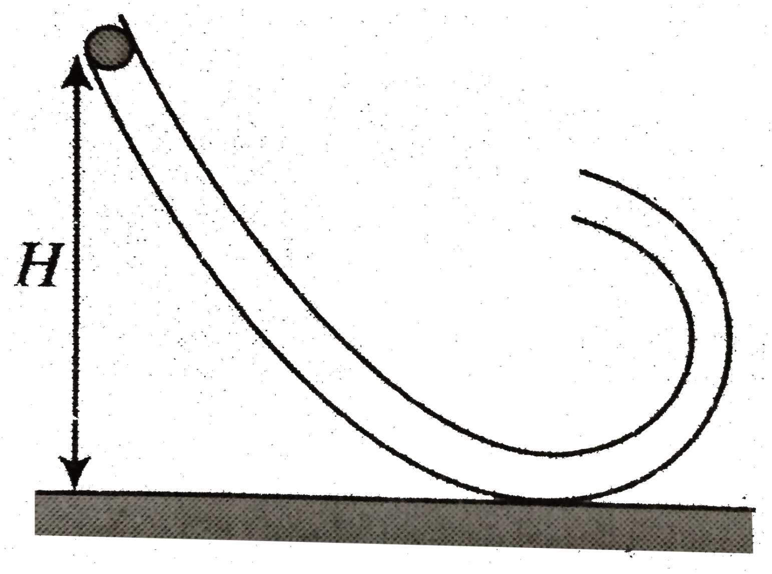
16. A ball of mass m is released from rest from a height H along a smooth, light and fixed tube having a semicircular portion so that the ball just reaches the top of the semicircle.

a. Find the radius of the semi-circle.

b. Find the maximum force imparted by the ball on the ground.



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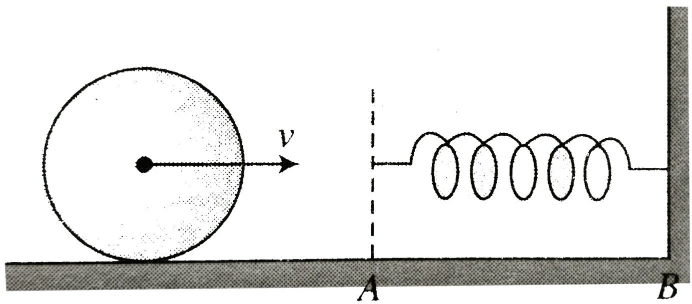
17. A sphere of mass m and radius R rolls without sliding on a horizontal surface. It collides with a light spring of stiffness K with

a kinetic energy E. If the surface (AB) under the spring is smooth, find the maximum compression of the spring.



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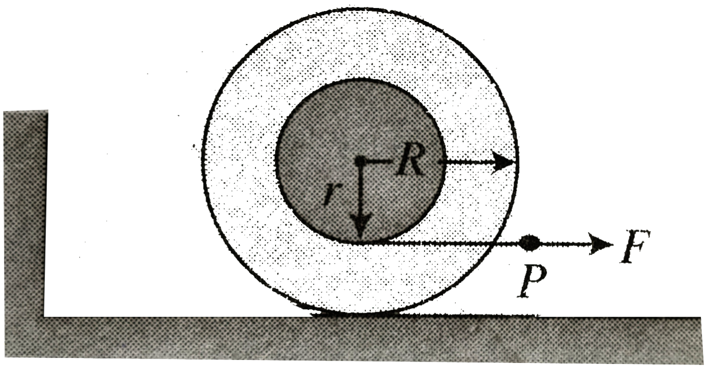
18. Find the acceleration of the body if a force $F = 8N$ pulls the string at P that passes over the body and it is connected by another string to a rigid support at Q.

(Take radius of gyration $k = \frac{2}{\sqrt{3}}m$, $R = 2m$, $r = 1m$, and mass of the body $m = 3kg$)



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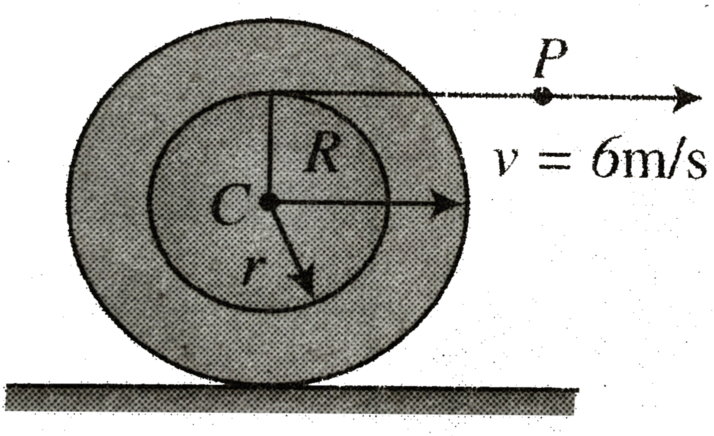
19. A cotton reel rolls without sliding such that the point P of the string has velocity $v = 6ms^{-1}$. If $r = 10cm$ and $R = 20cm$ then find the:



velocity of its center C

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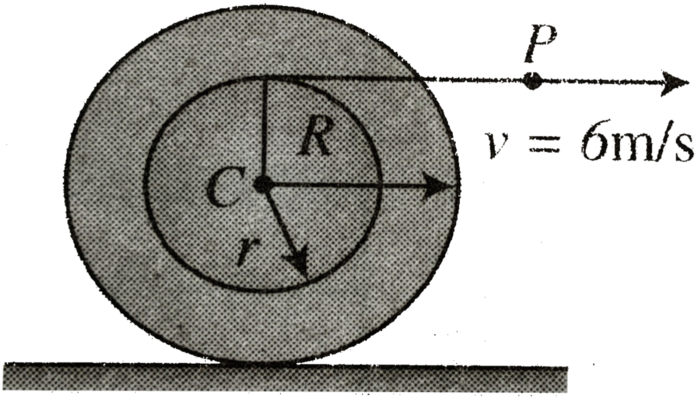
20. A cotton reel rolls without sliding such that the point P of the string has velocity $v = 6ms^{-1}$. If $r = 10cm$ and $R = 20cm$ then find the:



angular velocity of the cotton reel

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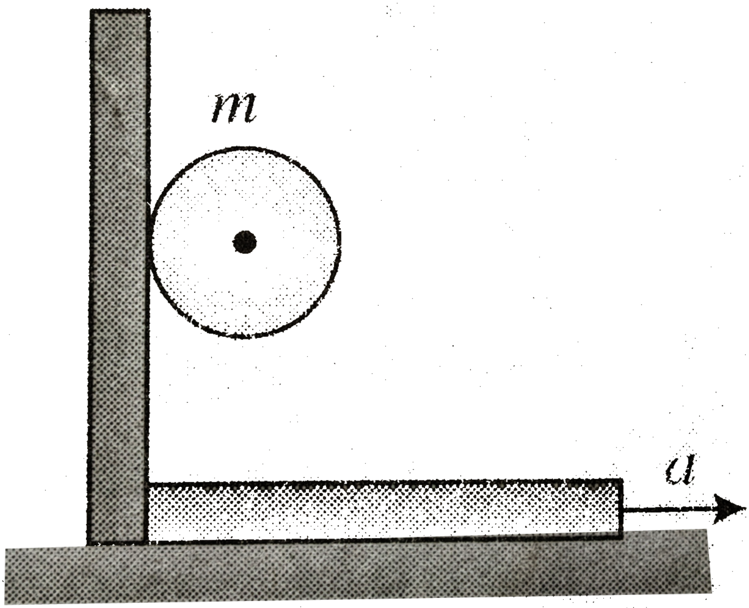
21. A uniform solid sphere rolls down a vertical surface without sliding. If the vertical surface moves with an acceleration $a = g/2$, find the minimum coefficient of friction between the sphere and vertical surfaces so as to prevent relative sliding.



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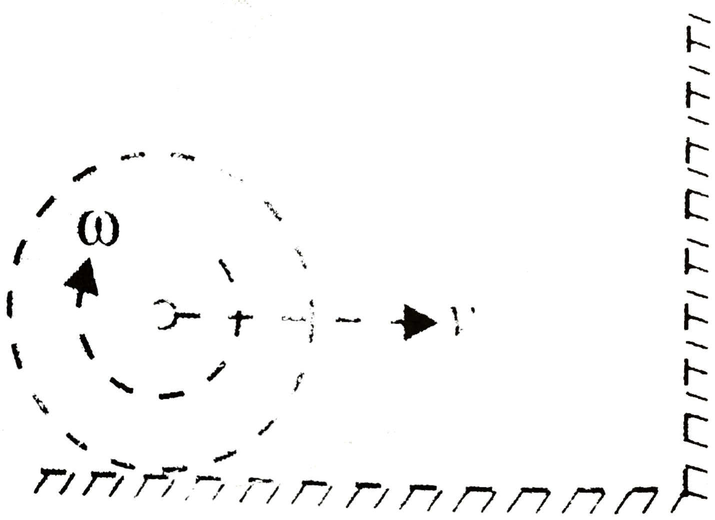
Exercise 3.4

1. A sphere rolling on a horizontal rough surface Collides elastically with a smooth vertical wall, as shown in Fig. State which of the following statements is true or false.



a. After collision, the velocity of the centre of mass gets reversed.

b. Angular momentum of the sphere about the point of contact with the wall is conserved.

c. Angular momentum of the sphere about a stationary point on the horizontal surface is conserved.

d. Just after collision the point of contact with the horizontal surface is moving towards the wall.

e. After collision the friction force acts on the sphere such that it decreases the linear speed and increases the angular speed.

f. Finally, when the sphere starts rolling, it is moving away from the wall.

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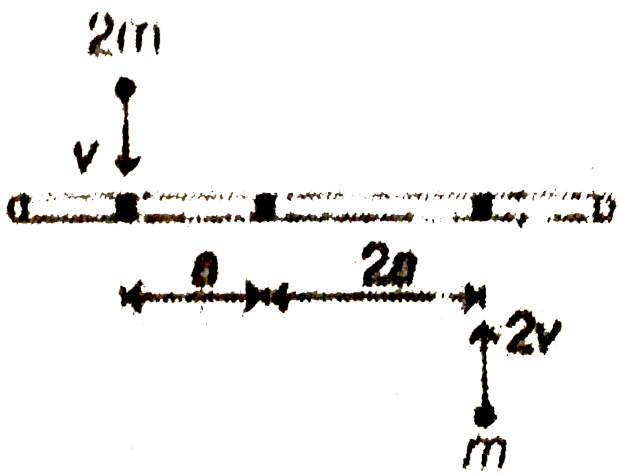
2. A uniform rod of length 6a and mass 8m lies on a smooth horizontal table. Two particle of masses m and 2m , moving in the same horizontal plane but in opposite directions with speeds 2v and v respectively strike and rod normally as shown in figure and stick to the rod. Denoting angular velocity (about the centre of mass), total energy and transnational velocity of centre of mass by ω, E and v_c respectively after the collision.



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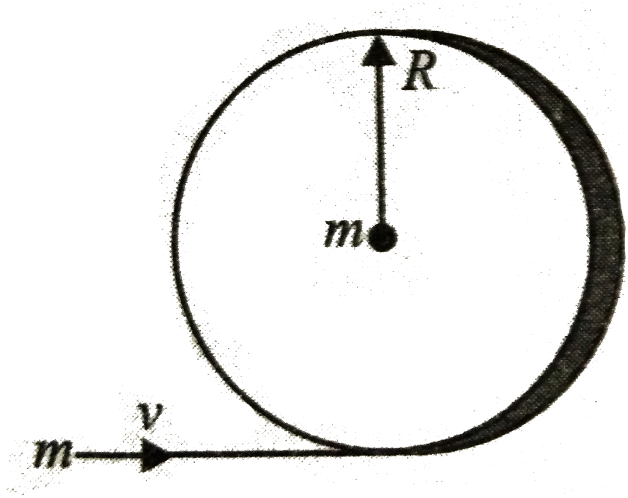
3. A circular wooden hoop of mass m and radius R rests fiat on a frictionless surface. A bullet, also of mass m and moving with a velocity v, strikes the hoop and gets embedded in it. The thickness of the hoop is much smaller than R. Find the angular velocity with which the system rotates in after the bullet strikes the hoop.



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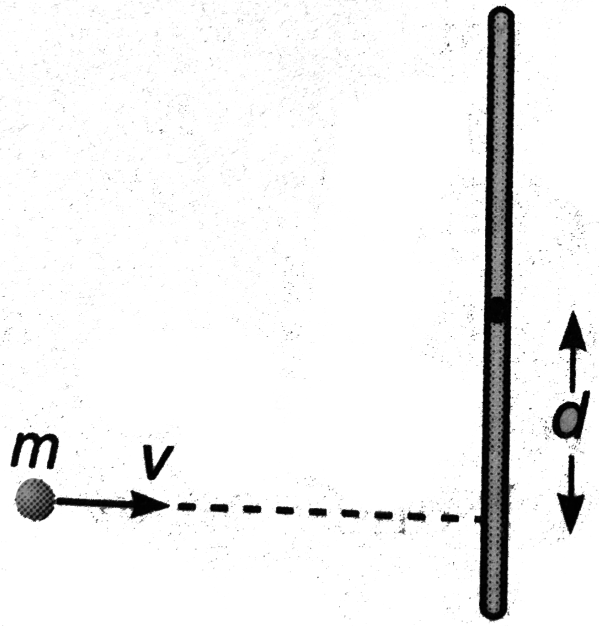

4.

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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5. A thin uniform rod of length l is initially at rest with respect to an inertial frame of reference. The rod is tapped at one end perpendicular to its length. How far the centre of mass translates while the rod completes one revolution about its centre of mass. Neglect gravitational effect.

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6. 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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7. A wheel rolling along a rough horizontal surface with an angular velocity ω strikes a rough vertical wall, normally. Find the initial angular velocity, as it tends to roll up the wall (neglect any slippage) due to impulse.

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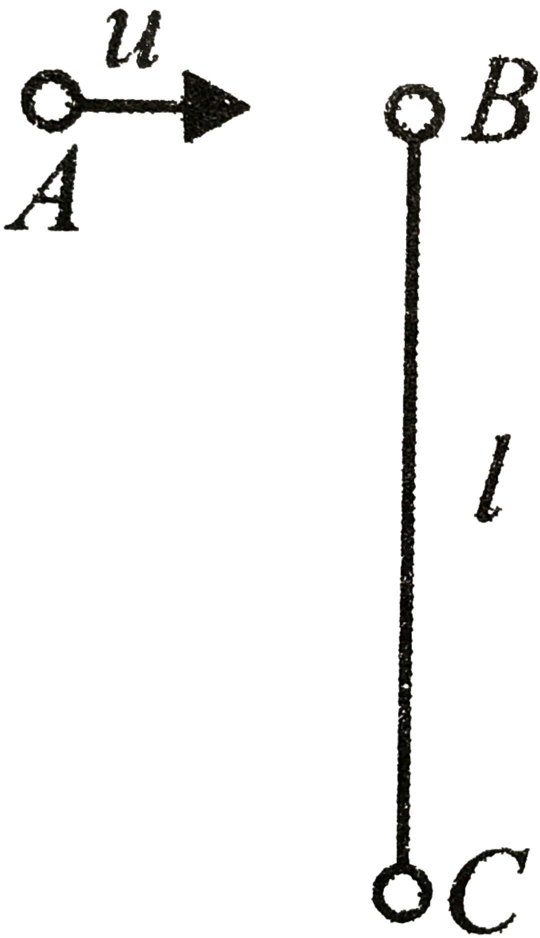
8. Two identical particles B and C each of mass $50g$ are connected by a light rod of length $30CM$. Another particle A of same mass moving With a speed $u = 60CM/s$ strikes B, in a direction perpendicular to AB, and sticks to it. The whole process takes place on a smooth horizontal plane. Find the angular velocity ω of the system about its centre of mass, immediately after the impact.



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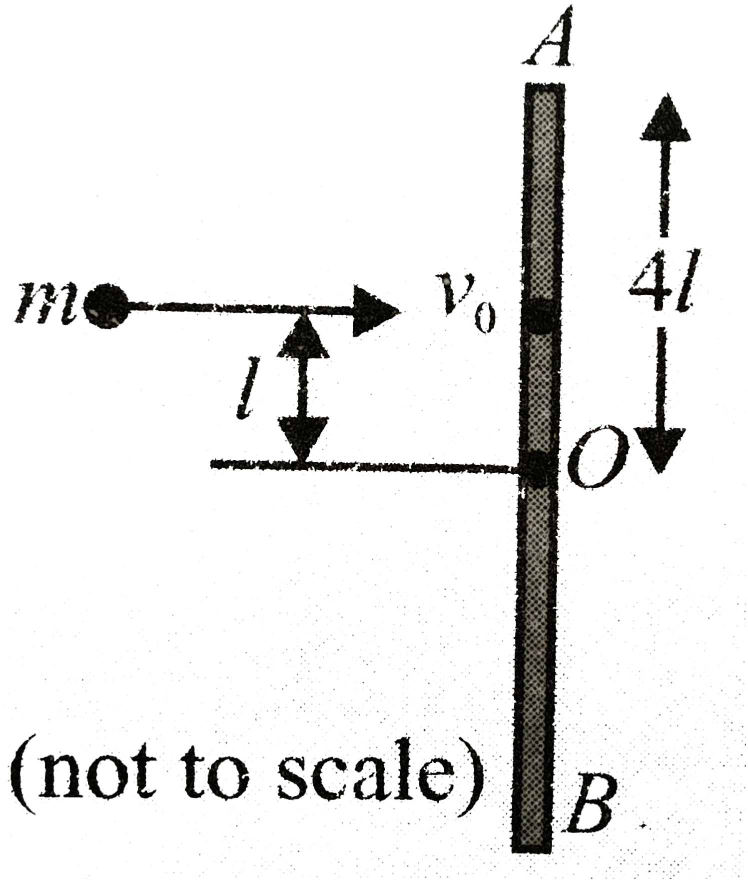
9. A rod AB of mass M and length $8l$ lies on a smooth horizontal surface. A particle, of mass m and velocity v_0 strike's the rod perpendicular to its length, as shown in Fig. As a result of the collision, the centre of mass of the rod attains a speed of $v_0/8$ and the particle rebounds back with a speed of $v_0/4$. Find the following: a. The ratio M/m. b. The angular velocity of the rod about O. c. The coefficient of restitution $'e'$ for the collision. d. The velocities of the ends $'A'$ and $'B'$ of

the rod, namely, v_A and v_B respectively.



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10. A uniform rod of mass M and length a lies on a smooth horizontal plane. A particle of mass m moving at a speed v perpendicular to the length of the rod strikes it at a distance $\frac{a}{4}$ from the centre and stops after the collision. Find (a). the velocity of the centre of the rod and (b). the angular velocity of the rod abut its centre just after the collision.

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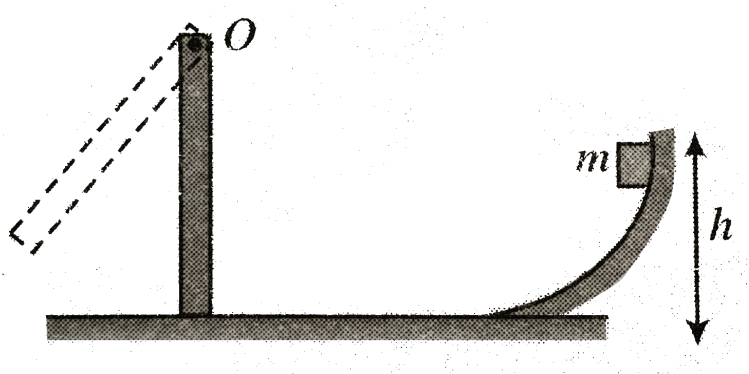
11. In the shown figure a mass m slides down the frictionless surface from height h and collides with the uniform vertical rod of length L and mass M after collision the mass m sticks to the rod. The rod is face to rotate in a vertical plane about fixed axis through O. Find the maximum angular deflection of the rod from its initial position.



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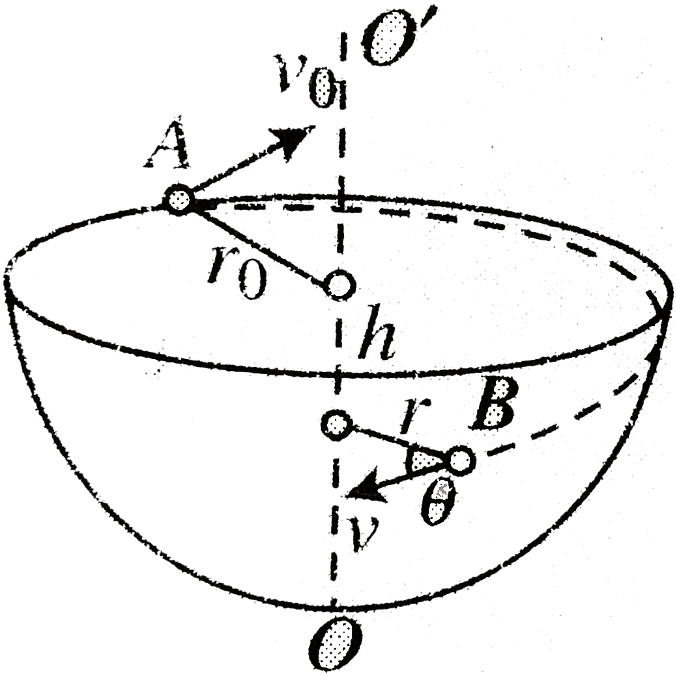
12. A small mass particle is projected with an initial velocity v_0 tangent to the horizontal rim of smooth hemisphereicla bowl at a radius r_0 from the vertical centre line, as shown at point A. As the particle slide past point B, a distance h below A and distance r from the verticle centre line, its velocity v makes an angle θ with the horizontal tangent to the bowl through B.

Determine θ.



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13. A thin uniform rod of length l is initially at rest with respect to an inertial frame of reference. The rod is tapped at one end perpendicular to its length. How far the centre of mass translates while the rod completes one revolution about its centre of mass. Neglect gravitational effect.

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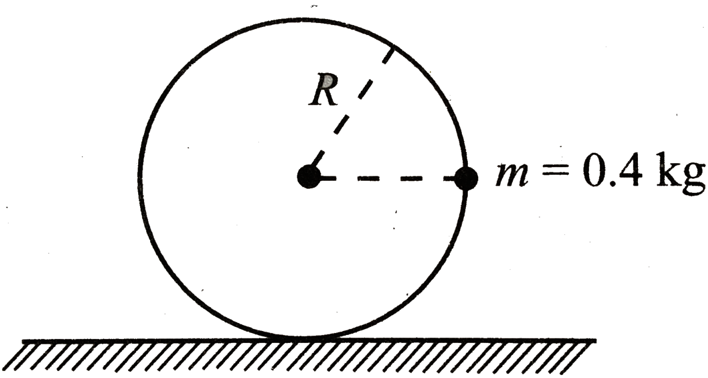
Subjective

1. A uniform thin circular ring of mass $m(m = 0.4kg)$ and radius R has a small particle of the same mass m fixed on it as shown in Fig. The line joining the particle to centre is initially horizontal. The ground is frictionless. Find the contact force (magnitude) exerted by the ground on the ring, when the system is released from rest.



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2. Determine the minimum coefficient of friction $\mu_{\min}$ between as thin homogeneous rod and a floor at which a person can slowly lift the rod the floor without slipage to the vertical position, applying to it a force perpendicular to it.

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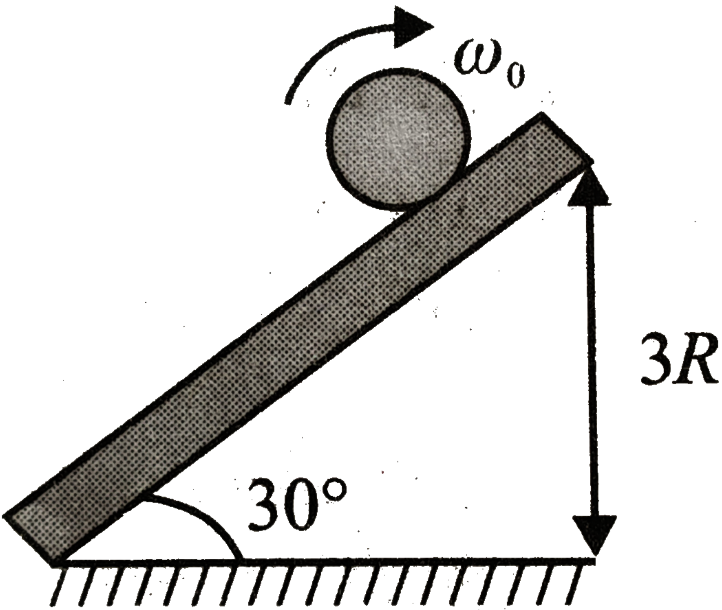
3. A spinning cylinder with angular velocity ω_0 of mass M and radius R is lowered on a rough inclined plane of angle 30° with the horizontal and $\mu = 1/\sqrt{3}$. The cylinder is released at a height of $3R$ from horizontal. Find the total time taken by the cylinder to reach the bottom of the incline.



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4. A hoop of mass m is projected on a floor with linear velocity v_0 and reverse spin ω_0. The coefficient of friction between the hoop and the ground is μ.

Under what condition with the hoop return back?

b. How long will it continue to slip after its centre of mass becomes stationary?

c. What is the velocity of return?

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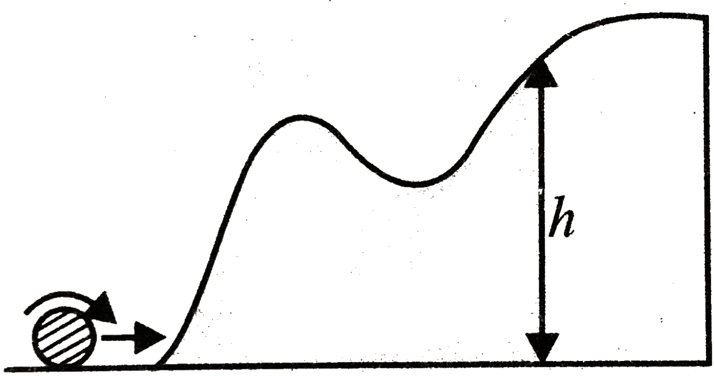
5. A body of mass M and radius r, rolling on a smooth horizontal floor with velocity v, rolls up an irregular inclined plane up to a vertical height $\left(3v^2 / 4g\right)$. Compute the moment of inertia of the body.



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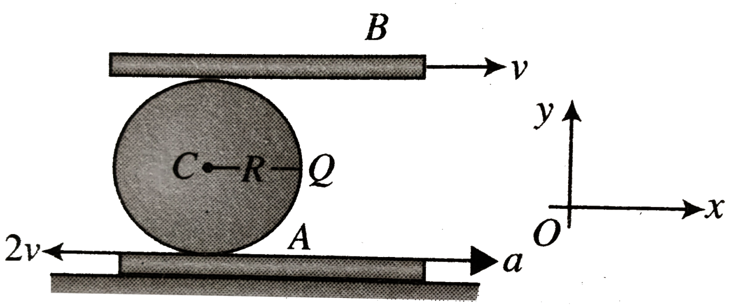
6. A cylinder rolls on the planks A and B without relative sliding. If the planks move with velocities $-2v\hat{i}, v\hat{i}$ respectively and the plank A has acceleration $\vec{a}\left(=a\hat{i}\right)$, find the: (a) v_C and v_Q and (b) a_C and a_Q.



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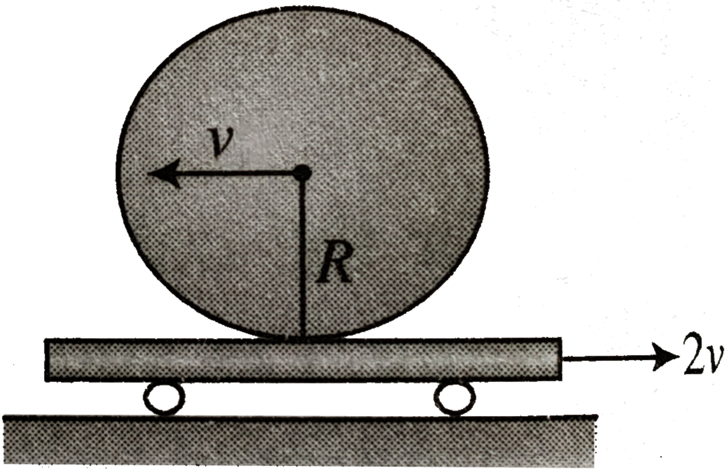
7. A uniform disc is spun with an angular velocity ω and simultaneously projected with a linear velocity v towards left on a plank, while the plank moves towards right with a constant velocity $2v$. If the disc rolls without sliding on the plank just after its spinning, find the magnitude of $\vec{\omega}$. (Take $v = 3ms^{-1}$, $R = 1m$)



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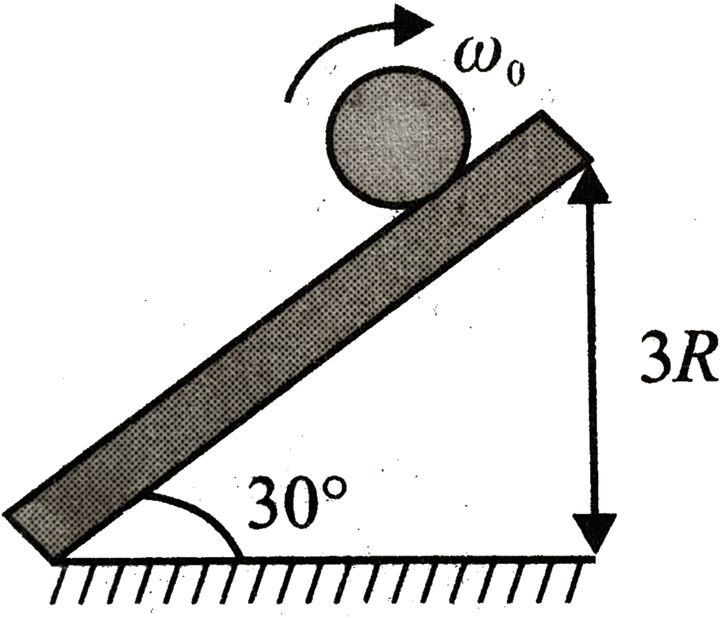
8. A spinning cylinder with angular velocity ω_0 of mass M and radius R is lowered on a rough inclined plane of angle 30° with the horizontal and $\mu = 1/\sqrt{3}$. The cylinder is released at a height of $3R$ from horizontal. Find the total time taken by the cylinder to reach the bottom of the incline.



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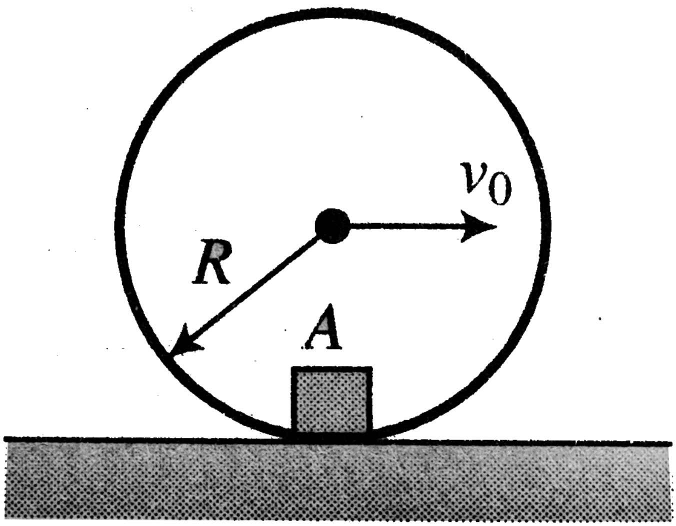
9. A small body A is fixed to the inside of a thin rigid hoop of radius R and mass equal to that of the body A. The hoop rolls without

slipping over a horizontal plane, at the moments when the body A gets into the lower position, the centre of the hoop moves with velocity v_0. At what values of v_0 will the hoop move without bouncing?



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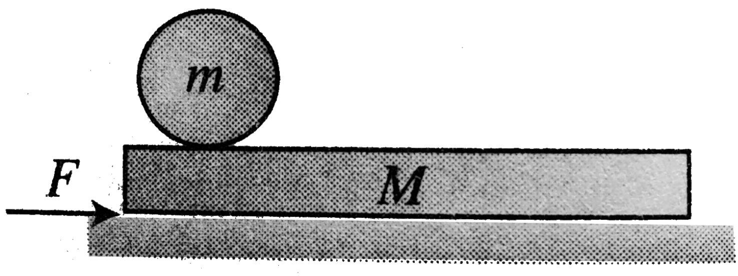
10. A sphere of mass m and radius r is placed on a rough plank of mass M. The system is placed on a smooth horizontal surface. A constant force F is applied on the plank such that the sphere rolls purely on the plank. Find the acceleration of the sphere.



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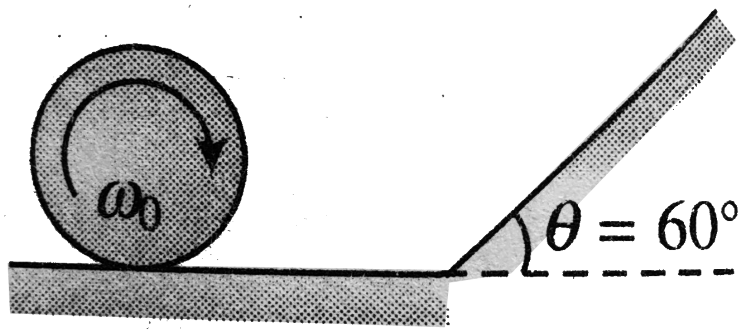
11. A uniform solid sphere of radius R, rolling without sliding on a horizontal surface with an angular velocity ω_0, meets a rough inclined plane of inclination $\theta = 60^\circ$. The sphere starts pure rolling up the plane with an angular velocity ω Find the value of ω.



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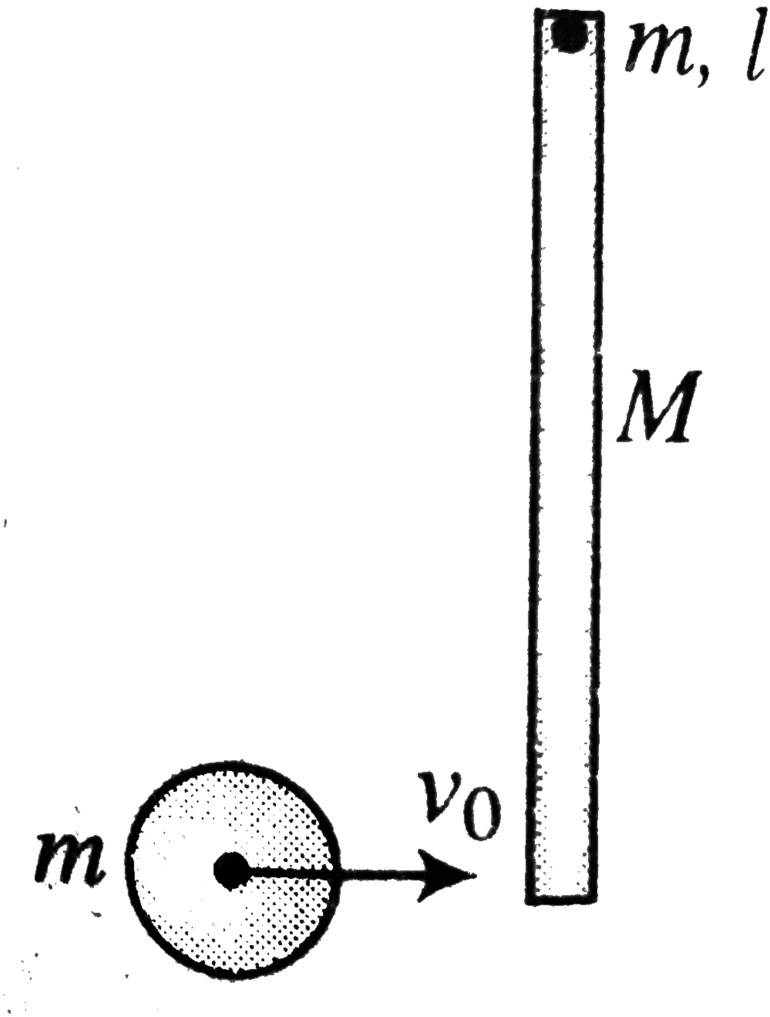
12. A uniform rod of mass M and length l is placed on a smooth- horizontal surface with its one end pivoted to the surface. A small ball of mass m moving along the surface with a velocity v_0, perpendicular to the rod, collides elastically with the free end of the rod. Find:

a. the angular velocity of the rod after collision.

b. the impulse applied by the pivot on the rod during collision. (Take $M/m = 2$)



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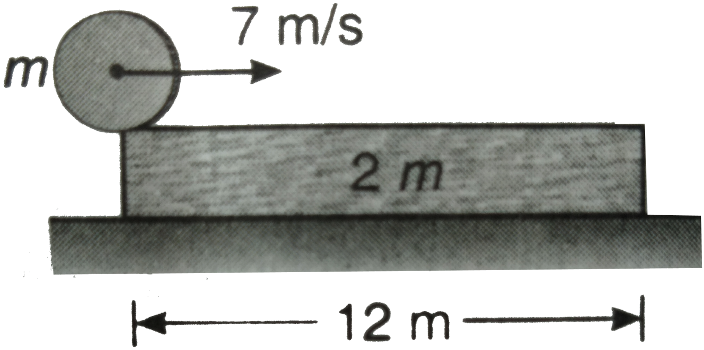
13. 

A cylinder of mass m is kept on the edge of a plank of mass 2m and length 12m, which in turn is kept on smooth ground. Coefficient of friction between the plank and the cylinder is 0.1. The cylinder is given an impulse, which imparts it a velocity $7m/s$ but no angular velocity. find the time after which the cylinder falls off the plank. $(g = 10m/s^2)$

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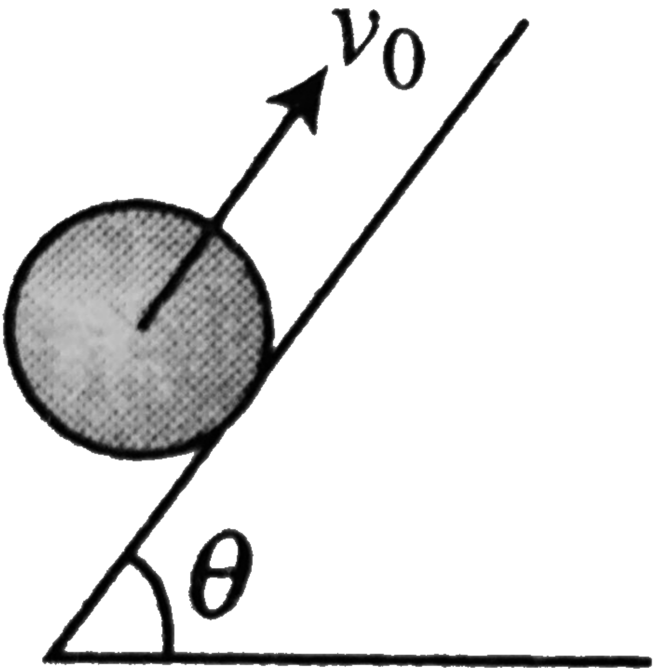
14. A sphere is projected up an inclined plane with a velocity v_0 and zero angular velocity as shown. The coefficient of friction between the sphere and the plane is $\mu = \tan\theta$.. Find the total time of rise of the sphere.



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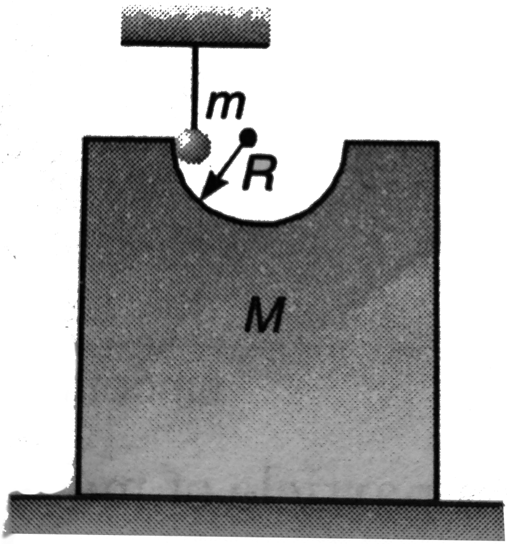
15.



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

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

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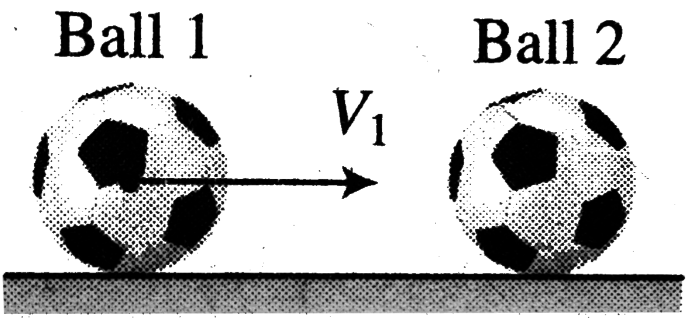
16. A solid spherical ball rolling without slipping collides elastically with an identical ball at rest, as shown in the figure. Assuming that the frictional forces are small enough to have negligible effect during the instant of collision, calculate, the velocity of each ball along enough time after the collision when each ball is again rolling without slipping.



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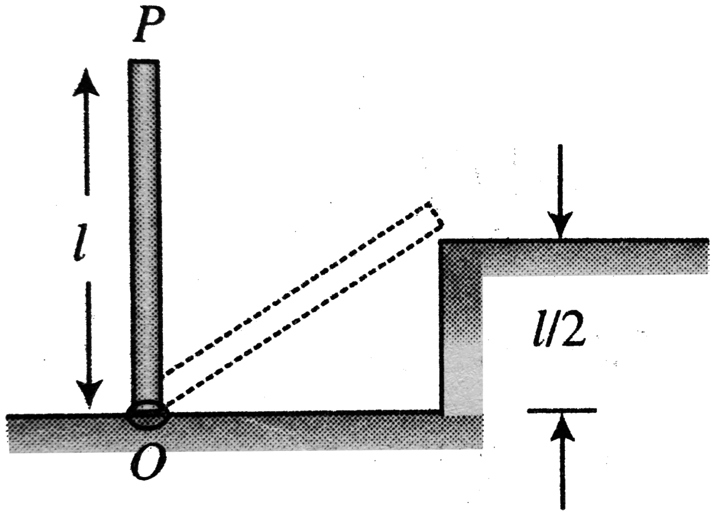
17. A uniform rod of mass m and length l is released from rest from its vertical position by giving a gently push. In consequence, the end of the rod collides at P after rotating about the smooth horizontal axis O. If the coefficient of restitution $e = \left(\frac{1}{2}\right)$. Find the: a. angular speed of the rod just after the impact.



b. energy loss during collision. c. maximum angle rotated by rod after collision.

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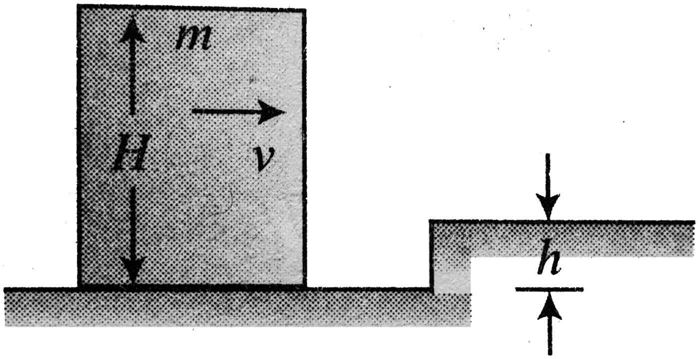
18. A cube of mass m and height H slides with a speed v. It strikes the obstacle of height

$h = \left(\frac{H}{4}\right)$. Find the speed of the CM of the cube just after the collision.



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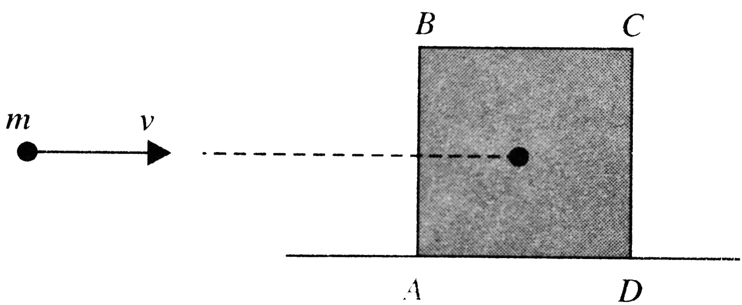
19. Figure shows a cubical wooden block of side length a and mass M which is resting over a horizontal surface and constrained to rotate about its right lower edge D. A bullet of mass m moving horizontally, directly towards its centre with velocity v strikes and gets embedded in it. During subsequent motion the block just topples, calculate v. Assume $m < < M$.



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Single Correct

1. 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.

A. $\sqrt{(5g(R+r))\left(17r^2\right)}$

B. $\left(\frac{10g(R+r)}{17r^2}\right)$

C. $\sqrt{\frac{5g(R-r)}{10r^2}}$

D. $\sqrt{\frac{10g(R+r)}{7r^2}}$

Answer: B

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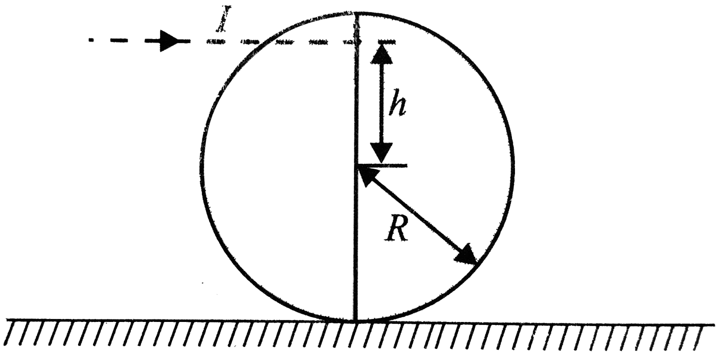
2. A solid sphere rests on a horizontal surface. A horizontal impulse is applied at height h from centre. The sphere starts rolling just after the application of impulse. The ratio

h / R will be



A. $\frac{11}{2}$

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

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

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

Answer: B

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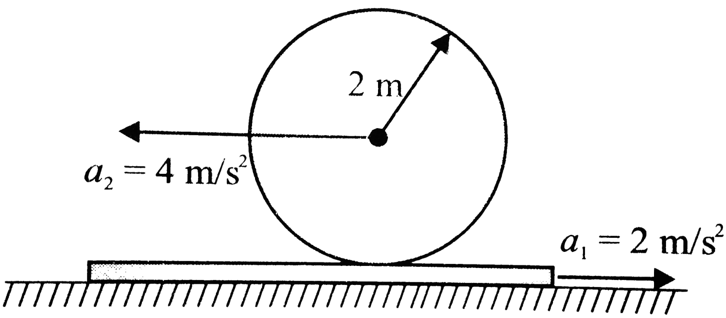
3. In Fig a sphere of radius $2m$ rolls on a plank. The accelerations of the sphere and the plank are indicated. The value of α is



A. $2rad/s^2$

B. $4rad/s^2$

C. $3rad/s^2$

D. $1rad / s^2$

Answer: C

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4. A ring of radius R is first rotated with an angular velocity ω_0 and then carefully placed on a rough horizontal surface. The cofficent of fgriction between the surface and the ring is μ. Time after which its angular speed is reduced to half is

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

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

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

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

Answer: D

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5. Two bodies with moment of inertia I_1 and $I_2 (I_1 > I_2)$ have equal angular momenta. If their kinetic energy of rotation are E_1 and E_2 respectively, then.

A. $E_1 = E_2$

B. $E_1 < E_2$

C. $E_1 > E_2$

D. $E_1 \geq E_2$

Answer: B

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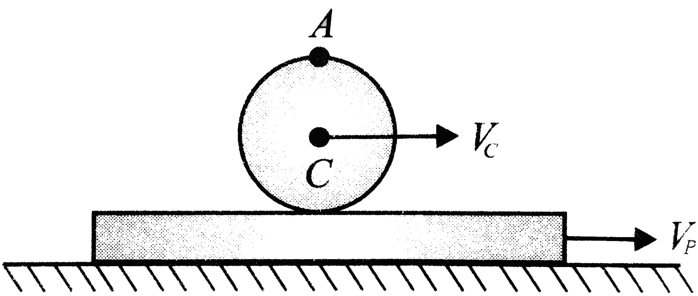
6. In Fig. the velocities are in ground frame and the cylinder is performing pure rolling on the plank, velocity of point $'A'$ would be



A. $2V_C$

B. $2V_C + V_P$

C. $2V_C + V_P$

D. $2(V_C - V_P)$

Answer: C

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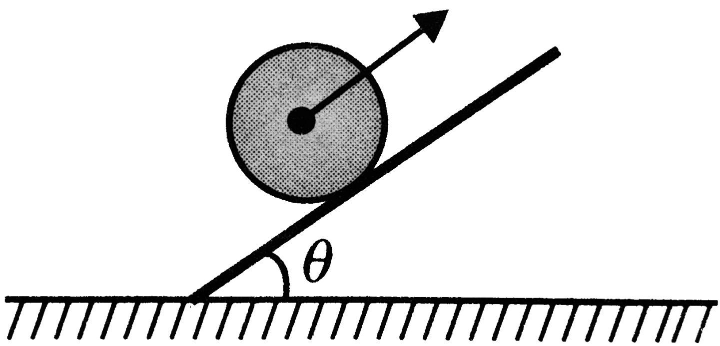
7. A sphere has to purely roll upwards. At an instant when the velocity of sphere is v, frictional force acting on it is



A. a)downwards and $\mu mg\cos\theta$

B. b)downwards and $\frac{2mg\sin\theta}{7}$

C. c)upward and $\mu mg\cos\theta$

D. d)upwards and $\frac{2mg\sin\theta}{7}$

Answer: D

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8. A string is wrapped around a cylinder of mass M and radius R. The string is pulled vertically upwards to prevent the centre of mass from falling as the cylinder unwinds the string. The tension in the string is

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

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

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

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

Answer: B

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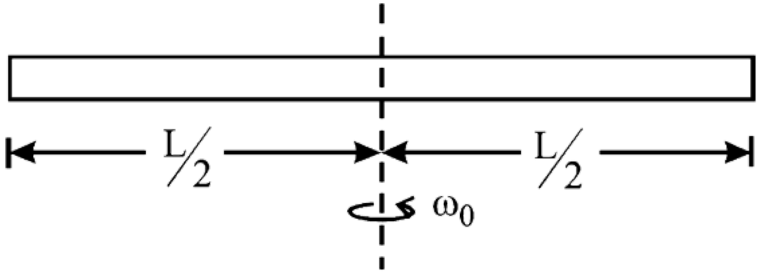
9. A smooth uniform rod of length L and mass M has two identical beads of negligible size each of mass m which can slide freely along the rod. Initially the two beads are at the centre of the rod and the system is rotating with an angular velocity ω_0 about an axis perpendicular to the rod and passing 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. $\dfrac{M\omega_0}{M+6m}$

B. $\dfrac{M\omega_0}{m}$

C. $\dfrac{M\omega_0}{M+12m}$

D. ω_0

Answer: A

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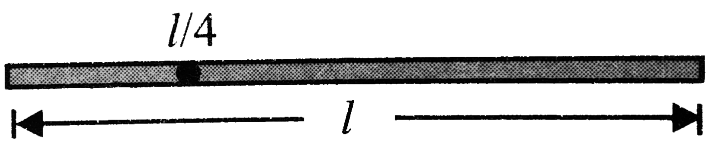
10. A uniform thin rod of length l and mass m is hinged at a distance $l/4$ from one of the end and released from horizontal position as shown in Fig. The angular velocity of the rod as it passes the vertical position is



A. $2\sqrt{\frac{5g}{7l}}$

B. $2\sqrt{\frac{6g}{7l}}$

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

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

Answer: B

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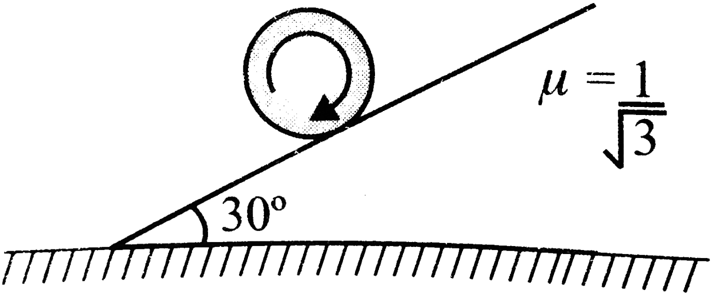
11. A disc is rotated about its axis with a certain angular velocity and lowered gently on a rough inclined plane as shown in Fig., then



A. a)It will rotate at the position where it was placed and then will move downwards

B. b) It will go downwards just after it is lowered

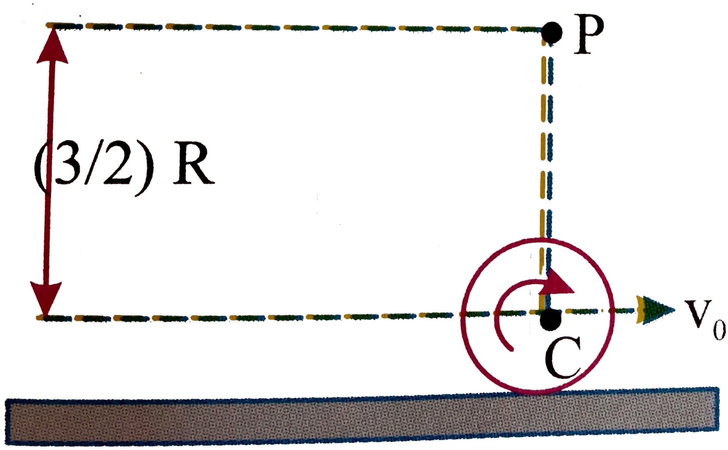
C. c)It will go downwards first and then climb up

D. d) It will climb upwards and then move downwards

Answer: A

Watch Video Solution

12. A uniform circular disc of mass M and radius R rolls without slipping on a horizontal surface. If the velocity of its centre is v_0, then the total angular momentum of the disc about a fixed point P at a height $(3R)/2$ above the centre C.



A. increases continuously as the disc moves away

B. decreases continuously as the disc moves away

C. is equal to $2MRv_0$

D. is equal to MRv_0

Answer: D

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13. A child is standing with folded hands at the center of a platform rotating about its central axis. The kinetic energy of the system is K. The child now stretches his arms so that the moment of inertia of the system doubles. The kinetic energy of the system now is: a) K/4 b) K/2 c) 2K d) 4K

A. $2K$

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

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

D. $4K$

Answer: B

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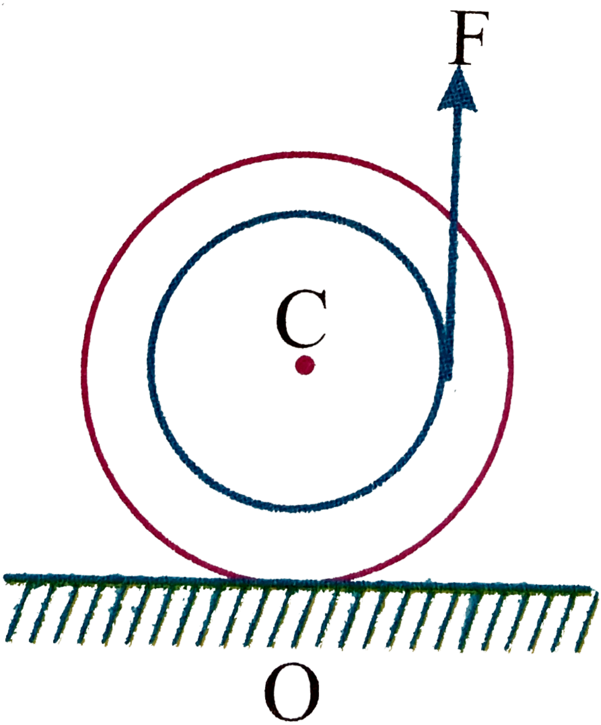
14. A yo-yo is placed on a rough horizontal surface and a constant force F, which is less than its weight, pulls it vertically. Due to this



A. a)friction force acts towards left, so it will move towards left

B. b)friction force acts towards right, so it will move towards right

C. c)it will move towards left, so friction force acts towards left

D. d)it will move towards right so friction force acts towards right

Answer: A

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15. A ring, cylinder and solid sphere are placed on the top of a rough incline on which the sphere can just roll without slipping. When all of them are released at the same instant from the same position, then

A. all of them reach the ground at the same instant

B. the sphere reaches first and the ring at the last

C. the sphere reaches first and the cylinder and ring reach together

D. none of the above

Answer: A

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16. If a spherical ball rolls on a table without slipping, the fraction of its total energy associated with rotation is -

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

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

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

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

D. $\frac{3}{7}$

Answer: B

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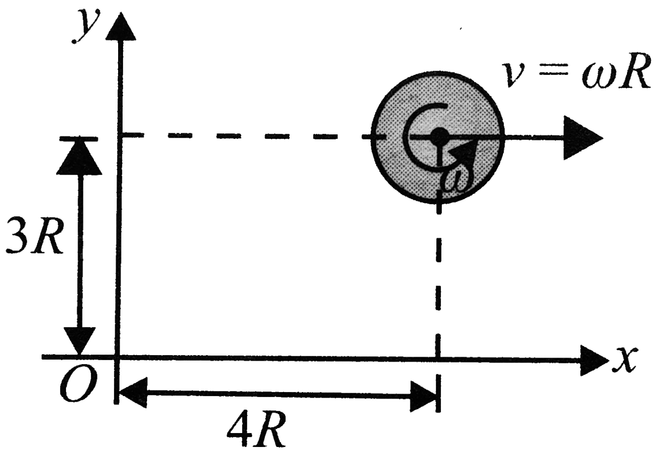
17. A disc of mass m and radius R moves in the $x-y$ plane as shown in Fig. The angular momentum of the disc about the origin O at the instant shown is



A. $-\frac{5}{2}mR^2\omega\hat{k}$

B. $\frac{7}{3}mR^2\omega\hat{k}$

C. $-\frac{9}{2}mR^2\omega\hat{k}$

D. $\frac{5}{2}mR^2\omega\hat{k}$

Answer: A

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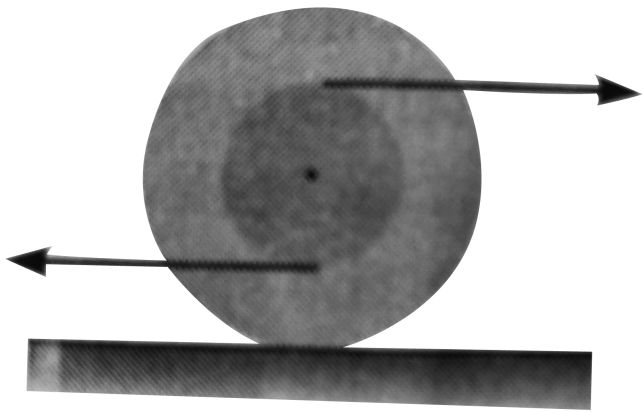


18.

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

A. The centre of mass moves towards left.

B. The centre of mass moves towards right.

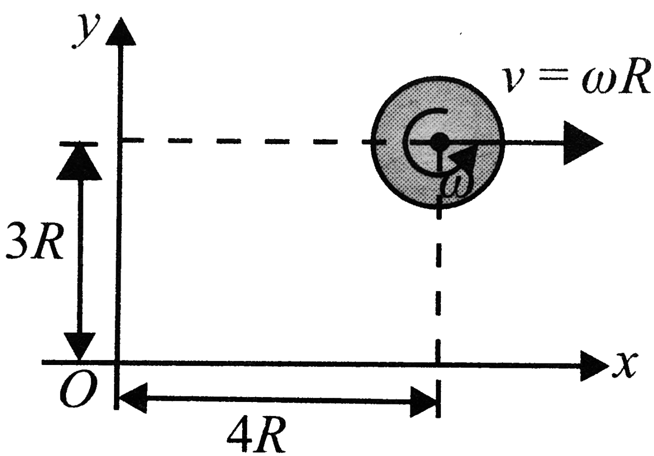
C. The centre of mass remains stationary.

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

Answer: B

Watch Video Solution

19. A disc of mass m and radius R moves in the $x - y$ plane as shown in Fig. The angular momentum of the disc about the origin O at the instant shown is



A. $\vec{L}$ only if $v_0 = \omega r$

B. greater than $\vec{L}$, if $v_0 > \omega_0 r$

C. less than $\vec{L}$, if $v_0 > \omega_0 r$

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

Answer: D

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20. An impulse $J = mv$ at one end of a stationary uniform frictionless rod of mass m and length l which is free to rotate in a gravity-free space. The impact is elastic.

Instantaneous axis of rotation of the rod will pass through

A. its centre of mass

B. the centre of mass of the rod plus ball

C. the point of impact of the ball on the rod

D. the point which is at a distance $2/3$ from the striking end

Answer: D

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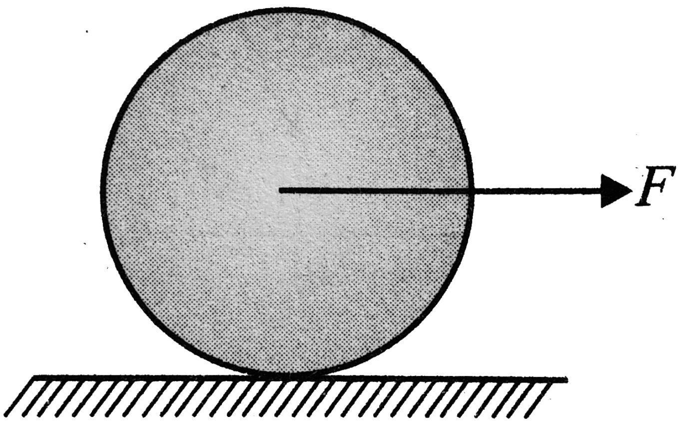
21. A solid sphere of mass m is lying at rest on a rough horizontal surface. The coefficient of friction between the ground and sphere is μ. The maximum value of F, so that the sphere will not slip, is equal to



A. $\frac{7}{5}\mu mg$

B. $\frac{4}{7}\mu mg$

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

D. $\frac{7}{2}\mu mg$

Answer: D

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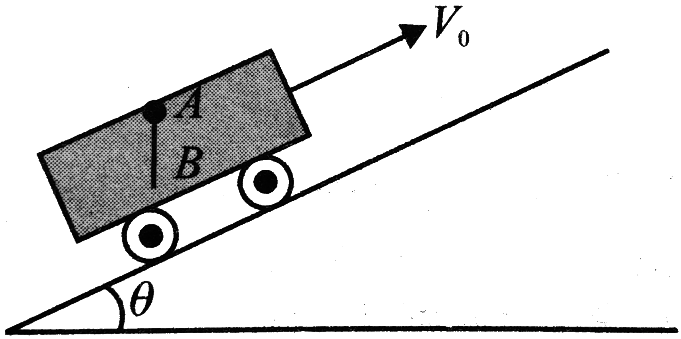
22. A uniform rod AB of length l and mass m hangs from point A in a car moving with velocity v_0 on an inclined plane as shown in Fig. The rod can rotate in vertical plane about the axis at point A. if the car suddenly stops, the angular speed with which the rod starts rotating is



A. $\frac{3}{2}\frac{v_0}{l}\cos\theta$

B. $\frac{v_0}{2}\frac{\cos\theta}{l}$

C. $\frac{3}{2}\frac{v_0}{l}\sin\theta$

D. $\frac{5}{2}\frac{v_0}{l}\sin\theta$

Answer: A

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23. A uniform rod of mass m, length l rests on a smooth horizontal surface. Rod is given a sharp horizontal impulse p perpendicular to the rod at a distance $l/4$ from the centre. The angular velocity of the rod will be

A. a) $\frac{3p}{ml}$

B. b) $\frac{p}{ml}$

C. c) $\frac{p}{2ml}$

D. d) $\frac{2p}{ml}$

Answer: A

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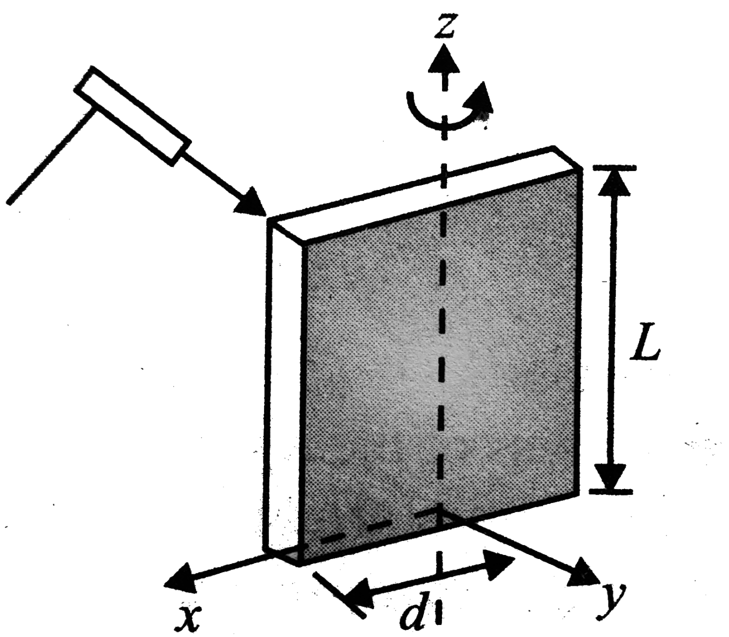
24. A thin plate of mass M,length L and width $2d$ is mounted vertically on a frictionless fixed axle along the z-axis as shown. Initially, the object is at rest. it is then tapped with a hammer to provide a torque τ, which produces an angular impulse H about the z-axis of magnitude $H = \int \tau dt$. What is the angular speed co of the plate about the z-axis after the tap?



A. $\dfrac{H}{Md^2}$

B. $\dfrac{2H}{M}d^2$

C. $\frac{3H}{Md^2}$

D. $\frac{4H}{Md^2}$

Answer: C

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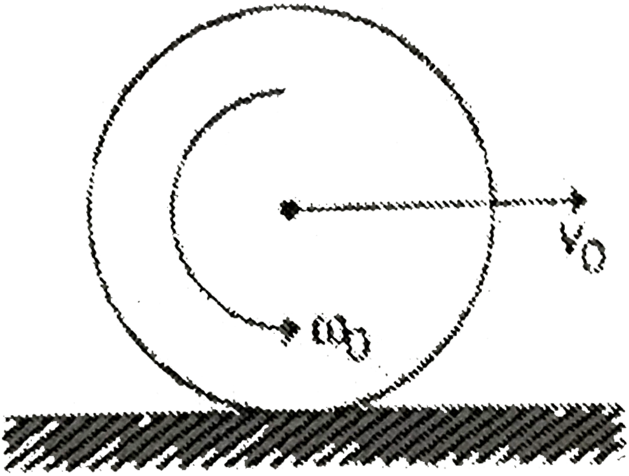
25. A uniform sphere of radius R is placed on a rough horizontal surface and given a linear velocity v_0 and angular velocity ω_0 as shown. The sphere comes to rest after moving some distance to the right. It follows that



A. $3v_0 = 2\omega_0 r$

B. $2v_0 = \omega_0 r$

C. $v_0 = \omega_0 r$

D. $2v_0 = 3\omega_0 r$

Answer: B

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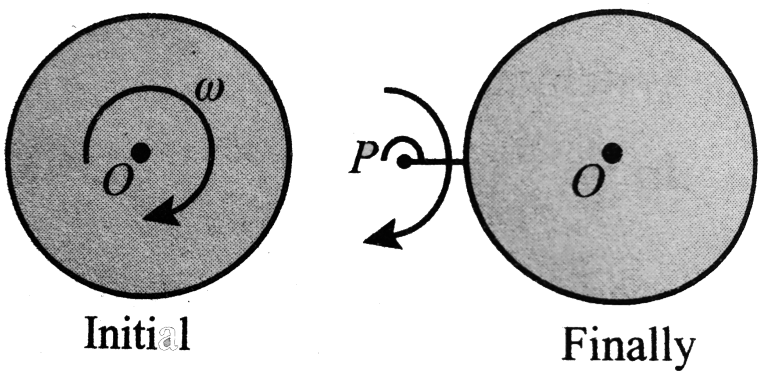
26. A disc is freely rotating with an angular speed ω on a smooth horizontal plane. If it is hooked at a rigid pace P and rotates without bouncing about a point on its circumference. Its angular speed after the impact will be equal to.



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

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

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

D. d. none of the above

Answer: B

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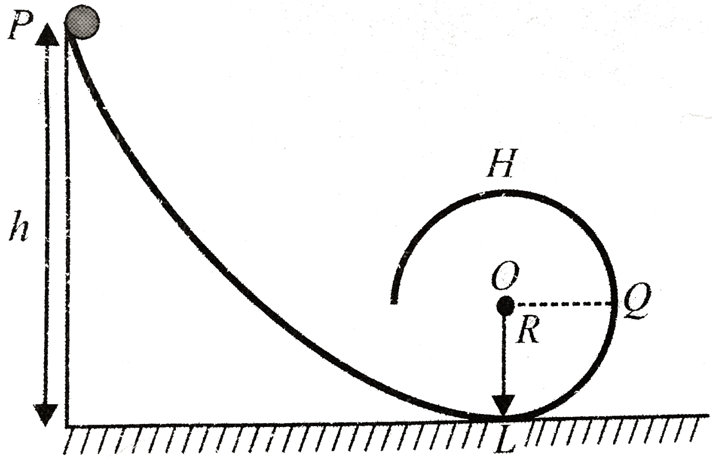
27. A small solid marble of mass M and radius r rolls down along the loop track, without slipping. Find the height h above the base, from where it has to start rolling down the incline such that the sphere just completes the vertical circular loop of radius R.



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

B. $\frac{5}{2}(R-r)$

C. $\frac{25}{10}(R-r)$

D. $\frac{27}{10}R - \frac{17r}{10}$

Answer: D

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28. If a sphere is rolling, the ratio of the translation energy to total kinetic energy is given by

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

B. $\frac{2}{54}$

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

D. none of the above

Answer: C

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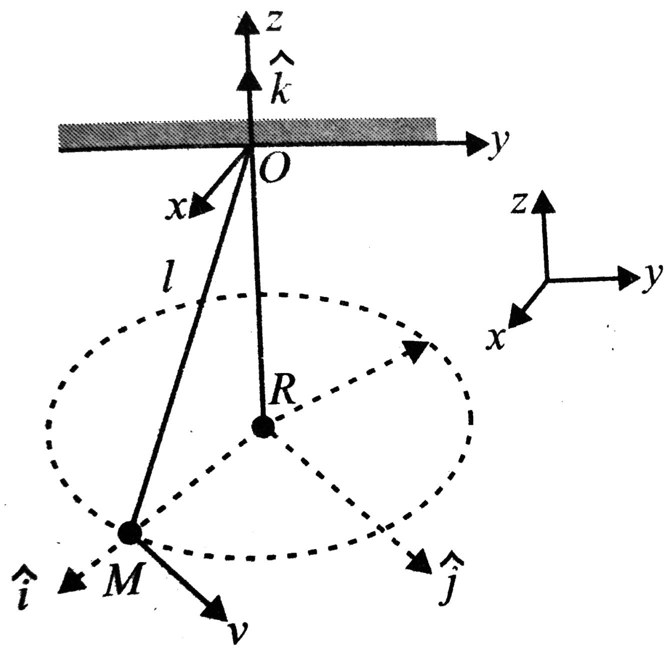
29. A conical pendulum consists of a mass M suspended from a strong sling of length l. The mass executes a circle of radius R in a horizontal plane with speed v. At time t, the mass is at position $R\hat{i}$ and $v\hat{j}$ velocity. At time t the angular momentum vector of mass M about the point from which the string passes on the ceiling is



A. $Mv R\hat{k}$

B. $Mvl\hat{k}$

C. $Mvl\left[\sqrt{\frac{l^2 - R^2}{l}}\hat{i} + \frac{R}{l}\hat{k}\right]$

D. $-Mvl\left[\sqrt{\frac{l^2 - R^2}{l}}\hat{i} + \frac{R}{l}\hat{k}\right]$

Answer: C

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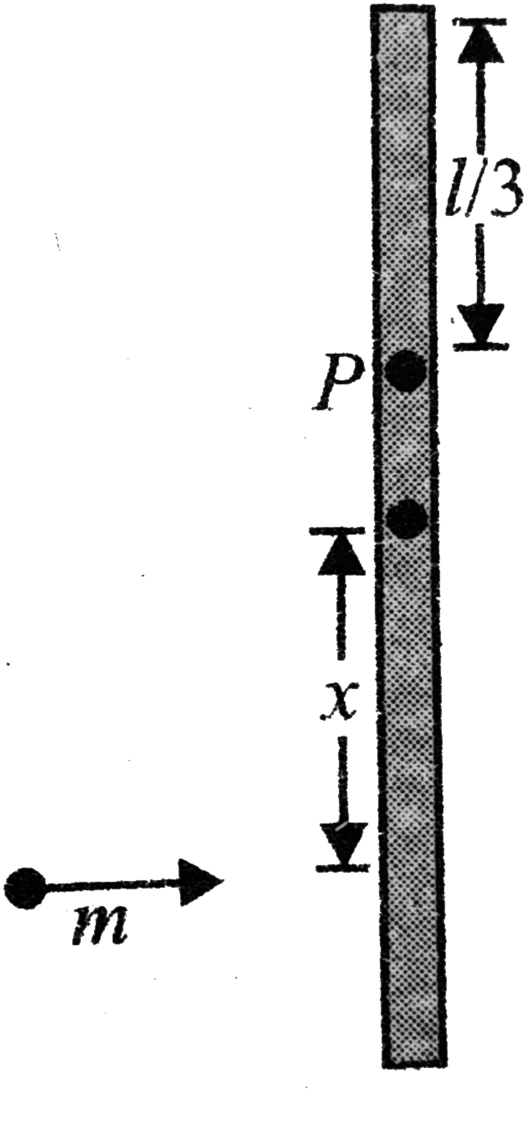
30. A thin uniform rod of mass m and length l is kept on a smooth horizontal surface such that it can move freely. At what distance from centre of rod should a particle of mass m strike on the rod such that the point P at a distance $\frac{l}{3}$ from the end of the rod is instantaneously at rest just after the elastic collision?



A. $1/2$

B. $1/3$

C. $1/6$

D. $1/4$

Answer: A

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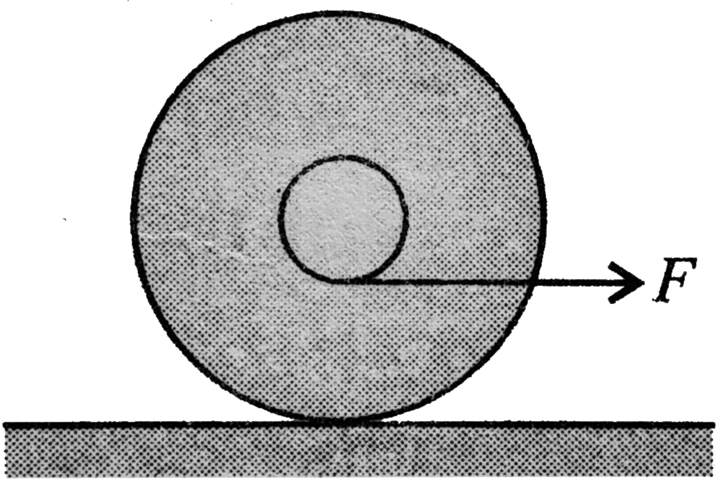
31. A yo-yo, arranged as shown, rests on a frictionless surface. When a force F is applied to the string, the yo-yo



A. moves to the left and rotates counterclockwise

B. moves to the right and rotates counterclockwise

C. moves to the left and rotates clockwise

D. moves to the right and rotates clockwise

Answer: B

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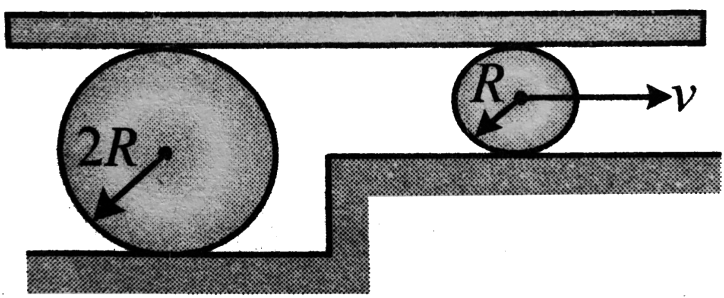
32. Velocity of the centre of a small cylinder is v. There is no slipping anywhere. The velocity of the centre of the larger cylinder is



A. $2v$

B. v

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

D. none of the above

Answer: B

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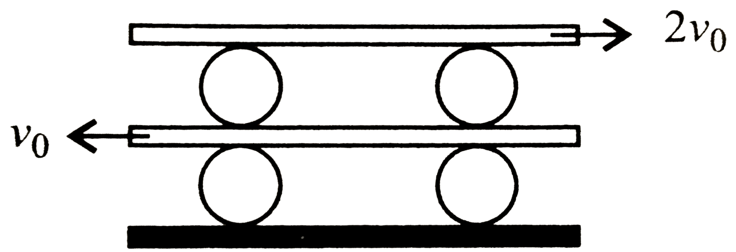
33. A system of uniform cylinders and plates is shown in the figure. All the cylinders are identical and there is no slipping at any contact. Velocity of lower and upper plate is v_0 and $2v_0$ respectively as shown in the figure. Then the ratio of angular speed of upper cylinder to lower cylinder is



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

B. 3

C. 1

D. none of the above

Answer: B

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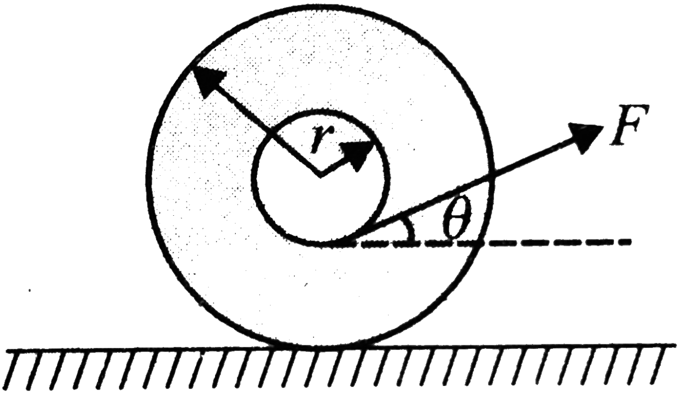
34. The spool shown in the figure is placed on a rough horizontal surface and has inner radius r and outer radius R. The angle θ between the applied force and the horizontal can be varied. The critical angle θ for which the spool does not roll and remains stationary is given by



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

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

C. $\theta \cos^{-1}\sqrt{\frac{r}{R}}$

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

Answer: A

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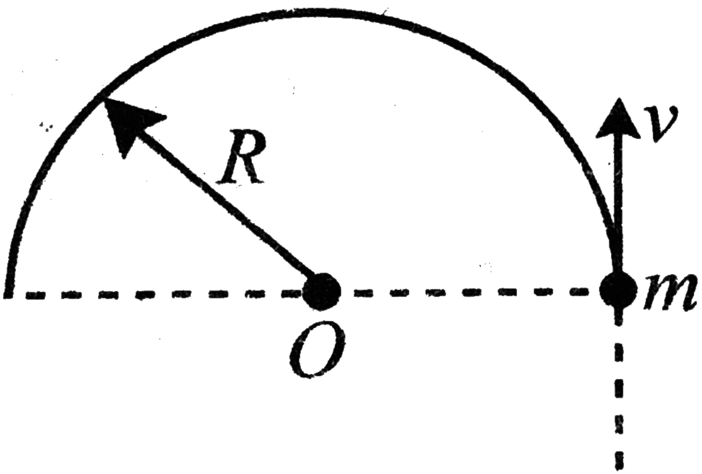
35. A small bead of mass m moving with velocity v gets threaded on a stationary semicircular ring of mass m and radius R kept on a horizontal table. The ring can freely rotate about its centre. The bead comes to rest relative to the ring. What will be the final angular velocity of the system?



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

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

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

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

Answer: C

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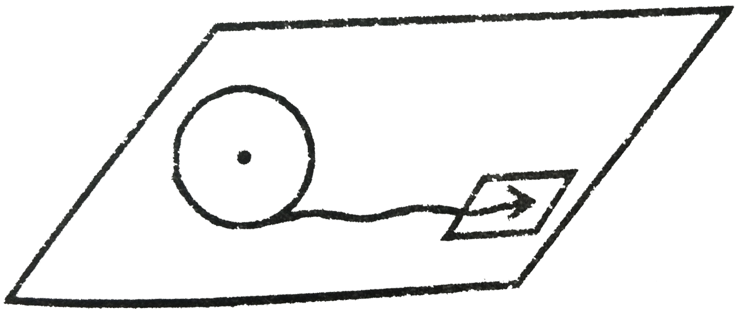
36. A block of mass m is attached to a pulley disc of equal mass, radius r by means of a slack string as shown. The pulley is hinged about its centre on a horizontal table and the block is projected with an initial velocity of $5m/s$. Find the velocity when the string becomes taut.



A. a. $3m / s$

B. b. $2.5m / s$

C. c. $5 / 3m / s$

D. d. $10 / 3m / s$

Answer: D

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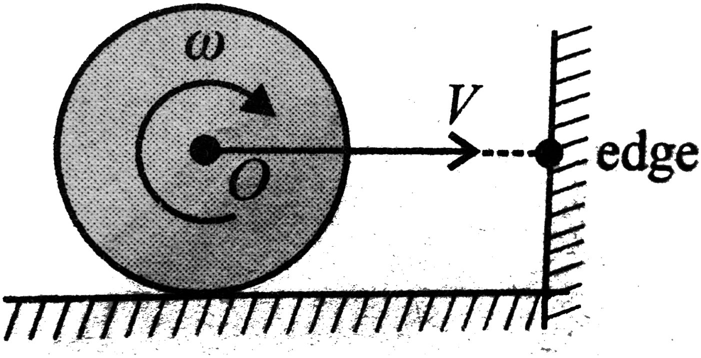
37. A uniform solid sphere of radius r is rolling on a smooth horizontal surface with velocity V and angular velocity $\omega(V = \omega r)$. The sphere collides with a sharp edge on the wall as shown in Fig. The coefficient of friction between the sphere and the edge $\mu = 1/5$. Just after the collision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



A. V

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

C. $\frac{3V}{5}$

D. $\frac{V}{6}$

Answer: A

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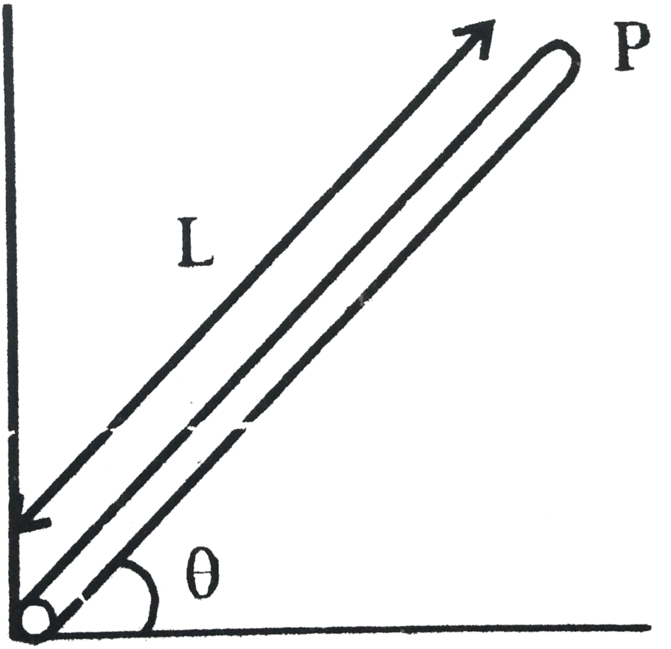
38. A uniform flag pole of length $L$and mass M in pivoted on the ground with a frictionless hinge. The flag pole makes an angle θ with the horizontal. The moment of inertia of the flag pole about one end is $(1/3)ML^2$. If starts falling from the position shown in figure, the linear acceleration of the free end of the flag pole-labeled P - would be.



A. $\left(\frac{2}{3}\right) g \cos \theta$

B. $\left(\frac{2}{3}\right) g$

C. g

D. $\left(\frac{3}{2}\right) g \cos \theta$

Answer: D

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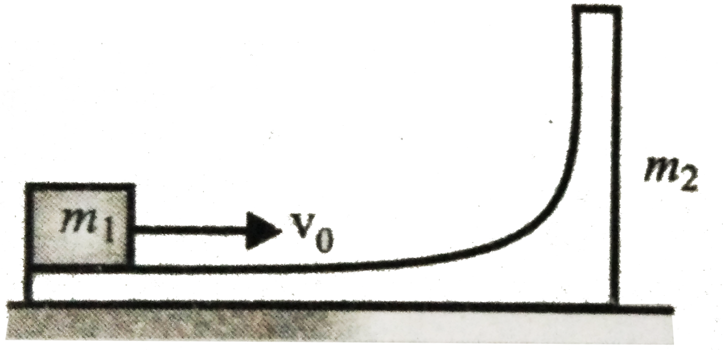
39. A block of mas m_1 is projected with a velocity v_0 so that it climbs onto the smooth wedge of mass m_2. If the block does not level the wedge, find the maximum height attained by the block.



A. $\frac{3v^2}{4g}$

B. $\frac{v^2}{4g}$

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

D. $\frac{v^2}{3g}$

Answer: B

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40. Two points of a rod move with velocity $3v$ and v perpendicular to the rod and in the same direction. Separated by a distance r. Then the angular velocity of the rod is :

A. $\frac{3v}{r}$

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

C. $\frac{5v}{r}$

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

Answer: D

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41. A sphere is released on a smooth inclined plane from the top. When it moves down, its angular momentum is

A. conserved about every point

B. conserved about the point of contact only

C. conserved about the centre of the sphere only

D. conserved about any point on a line parallel to the inclined plane and passing through the centre of the ball

Answer: D

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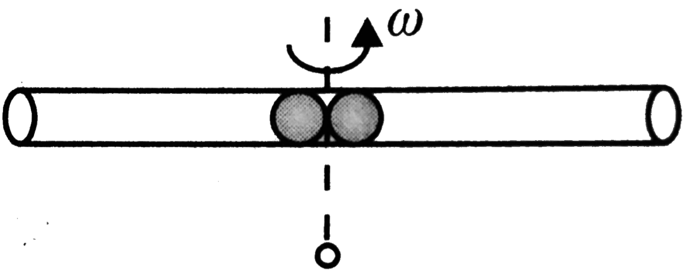
42. A smooth tube of certain mass is rotated in a gravity-free Space and released. The two balls shown in Fig move towards the ends of the tube. For the whole system, which of the following quantities is not conserved.



A. Angular mometum

B. linear momentum

C. kinetic energy

D. angular speed

Answer: D

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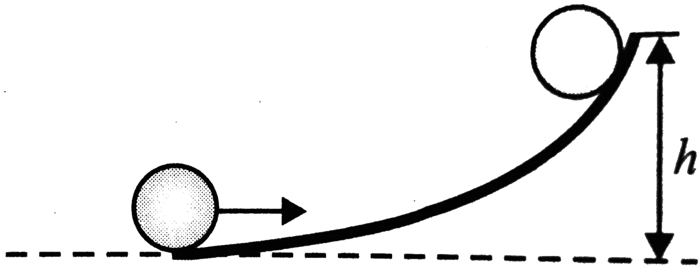
43. In the figure shown, a ball without sliding on a horizontal, surface. It ascends a curved track up to height h returns. The value of h is h_1 for sufficiently rough curved track to avoid sliding and is h_2 for smooth curved track then



A. a)$h_1 = h_2$

B. b)$h_1 < h_2$

C. c)$h_1 > h_2$

D. d)$h_2 = 2h_1$

Answer: C

Watch Video Solution

44. The weight of a body at earth's surface is W. At a depth half way to the centre of earth it will weight

A. R

B. $2R$

C. $4R$

D. none of the above

Answer: C

Watch Video Solution

45. A uniform ring of radius R is given a back spin of angular velocity $V_0 / 2R$ and thrown on a horizontal rough surface with velocity of centre to be V_0. The velocity of the centre of the ring when it starts pure rolling will be

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

B. $\frac{V_0}{4}$

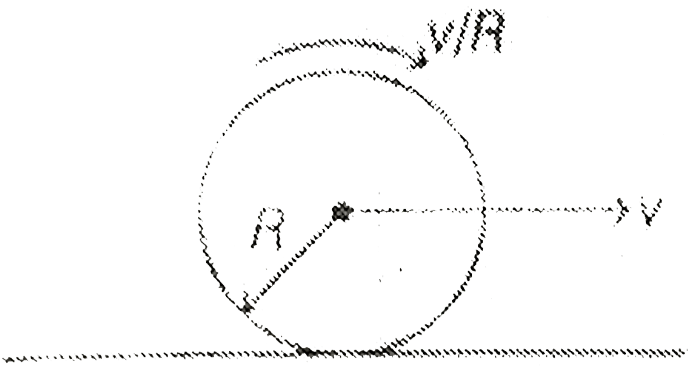
C. $\frac{3V_0}{4}$

D. 0

Answer: B

Watch Video Solution

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



A. velocity is v, acceleration is zero

B. velocity is zero, acceleration is zero

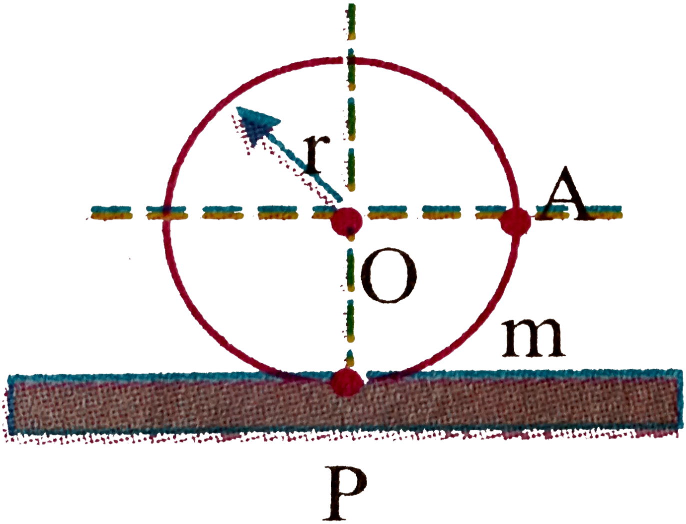
C. velocity is v, acceleration is v^2 / R

D. velocity is 0, acceleration is v^2 / R

Answer: D

Watch Video Solution

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



A. $\dfrac{g}{4r}$

B. $\dfrac{g}{6r}$

C. $\dfrac{v}{8r}$

D. $\dfrac{g}{2r}$

Answer: B

Watch Video Solution

48. A uniform smooth rod (mass m and length l) placed on a smooth horizontal floor is it by a particle (mass m) moving on the floor, at a distance $\frac{l}{4}$ from one end elastically $(e = 1)$. The distance travelled by the centre of the rod after the collision when it has completed three revolutions will be

A. $2\pi l$

B. cannot be determined

C. πl

D. none of the above

Answer: A

Watch Video Solution

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

A. th solid sphere

B. the hollow sphere

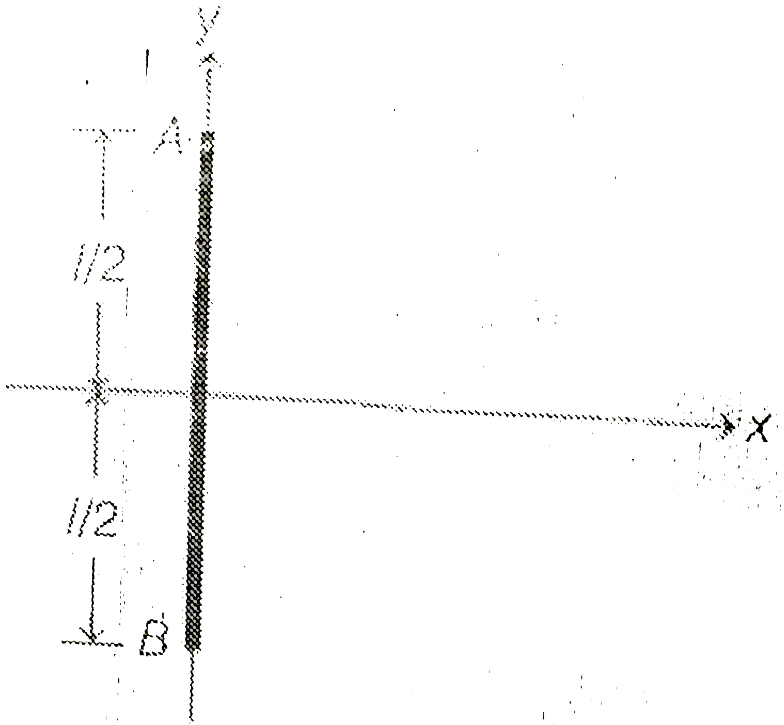
C. the disc

D. all will take the same time

Answer: D

Watch Video Solution

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



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

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

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

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

Answer: D

Watch Video Solution

51. If a man at the equator would weight (3/5)th of his weight, the angular speed of the earth is:

A. $\frac{2v}{3d}$

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

C. $\frac{v}{d}$

D. $\frac{3v}{2d}$

Answer: A

Watch Video Solution

52. A particle falls freely near the surface of the earth. Consider a fixed point O (not vertically below the particle) on the ground.

A. Angular momentum of the particle about O is increasing

B. The moment of inertia of the particle about O is decreasing

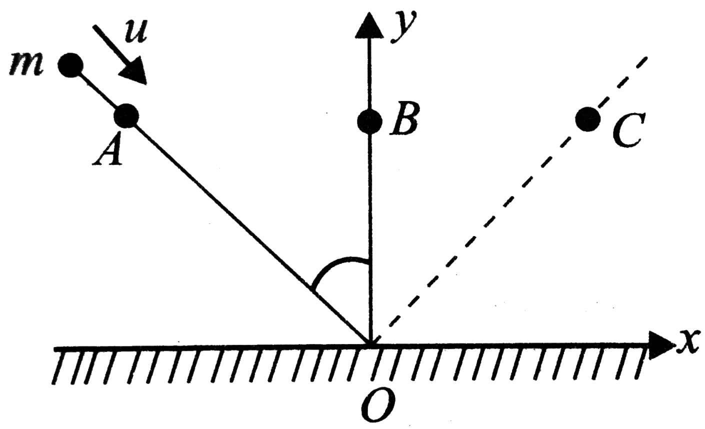
C. The moment of inertia of the particle about O is decreasing

D. The angular velocity of the particle about O is increasing

Answer: B

Watch Video Solution

53. A ball of mass moving with constant velocity u collides with a smooth horizontal surface at O as shown in Fig. Neglect gravity and friction. The y-axis is drawn normal to the horizontal surface at the point of impact O and x-axis is horizontal as shown. About which point will the angular momentum of ball be conserved?



A. a. Point A

B. b. Point B

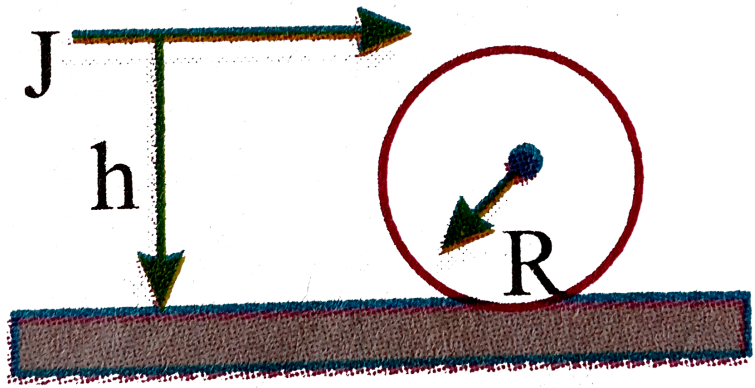
C. c. Point C

D. d. none of the above

Answer: B

Watch Video Solution

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



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

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

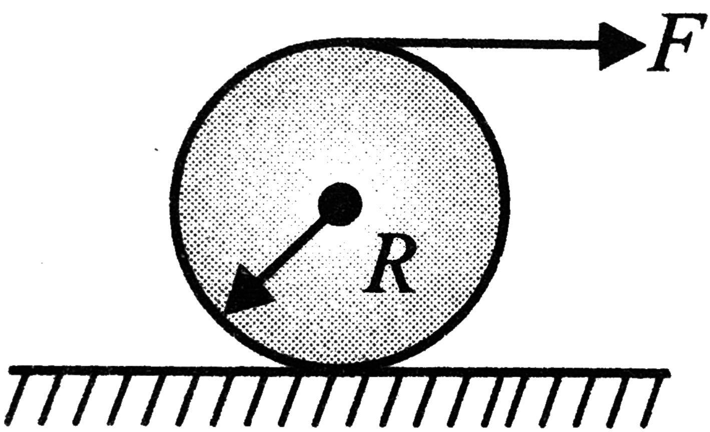
C. $\frac{7R}{5}$

D. $\frac{9R}{5}$

Answer: C

Watch Video Solution

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



A. disk

B. ring

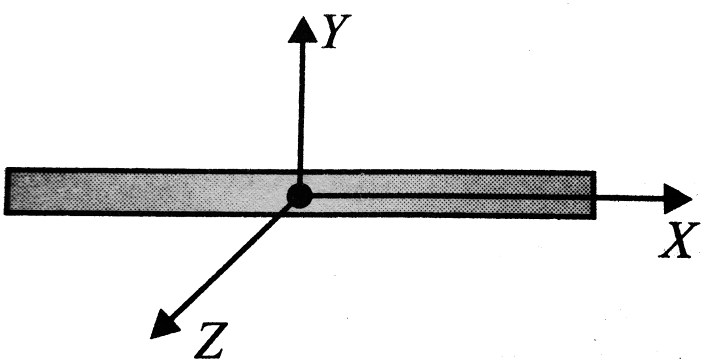
C. solid cylinder

D. hollow sphere

Answer: B

Watch Video Solution

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



A. a. $-\frac{3}{2}\hat{j} + \frac{1}{2}\hat{k}$

B. b. $-\frac{3}{2}\hat{j}$

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

D. d. $4j$

Answer: B

Watch Video Solution

57. A cylinder having moment of inertia, which is free to rotate about its axis, receives an angular impulse of $Jkgm^2 / s$ initially, followed by similar impulse after every $4s$. What is the angular speed of the cylinder $30s$ after the initial impulse?

A. $\frac{7J}{I}$

B. $\frac{8J}{I}$

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

D. zero

Answer: B

Watch Video Solution

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

A. ring

B. solid sphere

C. hollow sphere

D. disc

Answer: D

Watch Video Solution

59. A uniform solid cylinder of mass 5 kg and radius 0.1 m is reting on a horizontal platform (parllel to the x-y plane) and is free to rotate about its axis the x-direction and given by x=0.2 cos (10t)m. If there is no slipping, then maximum torque action on the cylinder during its motion is

A. $\frac{M\omega^2 AR}{3}$

B. $\frac{M\omega^2 AR}{2}$

C. $\frac{2}{3} \times M\omega^2 AR$

D. The situation is not possible

Answer: B

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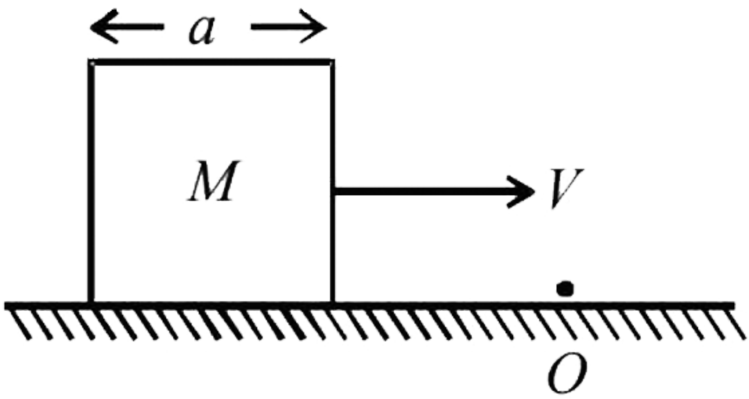
60. A cubical block of side a is moving with velocity V on a horizontal smooth plane as shown in Figure. It hits a ridge at point O. The angular speed of the block after it hits O is



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

B. $\frac{3v}{2a}$

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

D. zero

Answer: A

Watch Video Solution

61. A solid cylinder is placed on the end of an inclined plane. It is found that the plane can be tipped at an angle θ before the cylinder starts to slide. When the cylinder turns on its sides and is allowed to roll, it is found that the steepest angle at which the cylinder performs pure rolling is ϕ. The ratio $\tan\phi / \tan\theta$ is

A. 3

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

C. 1

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

Answer: A

Watch Video Solution

62. A uniform box of height $2m$ and having a square base of side $1m$, weight $150kg$, is kept on one end on the floor of a truck. The maximum speed with which the truck can round a curve of radius $20m$ without causing the block to tip over is (assume that friction is sufficient is no sliding).

A. $15m / s$

B. $10m / s$

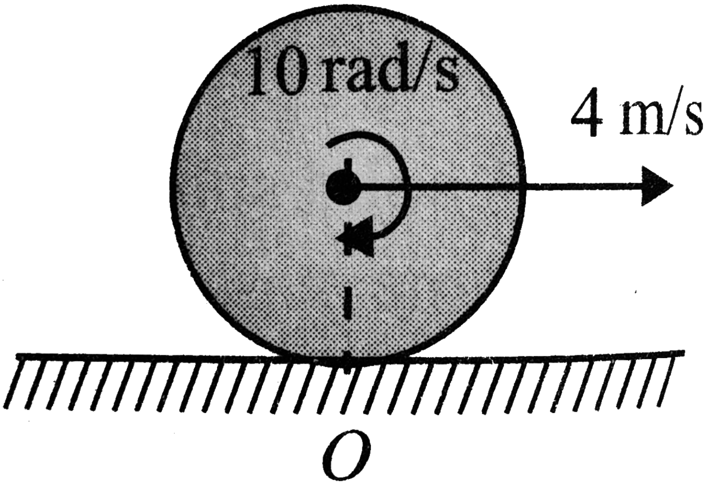
C. $8m / s$

D. depends on the value of coefficient of friction

Answer: B

Watch Video Solution

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



A. zero

B. $0.1m$ above O on line OC

C. $0.2m$ below O on line OC

D. $0.2m$ above O on line OC

Answer: C

Watch Video Solution

64. A slender rod of mass M and length L rests on a horizontal frictionless surface. The rod is pivoted about one of ends. The impulse of the force exerted on the rod by the pivot when the rod is struck by a blow of impulse J perpendicular to the rod at other end is

A. J

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

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

D. Information is insufficient

Answer: B

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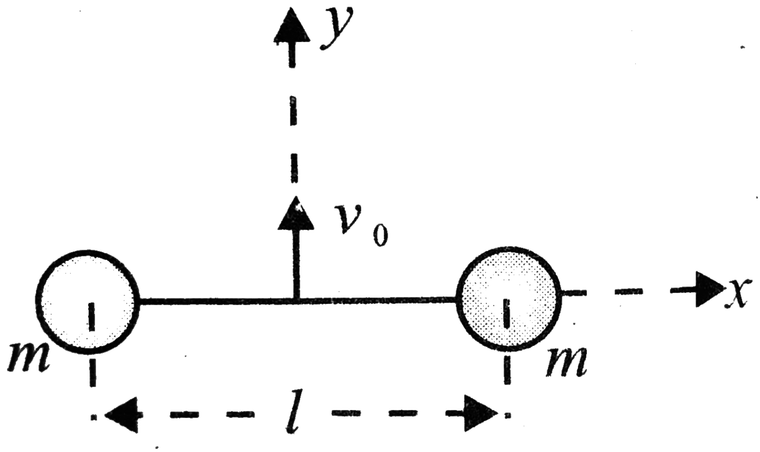
65. Two identical small balls, each of mass m, are connected by a massless and inextensible string of length l and placed on a smooth horizontal xy plane. An external agent pulling the string from its mid-point along y-axis with velocity v_0 as shown in Fig. When the separation between the two balls reduces to $l/2$ then the speed of each ball will be



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66. A ball is given a velocity v and angular velocity such that the ball rolls purely on a plank whose upper surface is rough enough to prevent slipping but lower surface contact with the ground is smooth. No other force is acting on system.

A. The plank will recoil back.

B. The plank will also move forward but with a lesser velocity than that of the ball.

C. The plank will also move forward but with a lesser velocity than that of the ball.

D. The plank will remain at rest.

Answer: D

Watch Video Solution

67. A thick walled hollow sphere has outer radius R. It down an inclined plane without slipping and its -speed the bottom is v. If the inclined plane is frictionless and the sphere slides down without rolling, its speed at the bottom $5v/4$. What is the radius of gyration of the sphere?

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

B. $R/2$

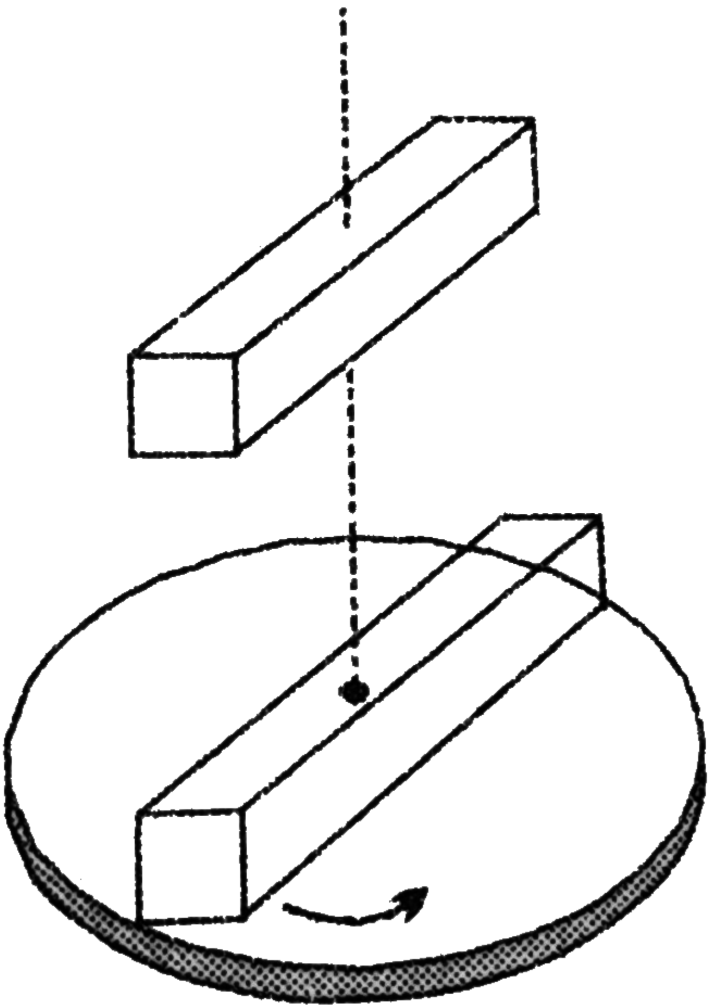
C. $3R/4$

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

Answer: C

Watch Video Solution

68. A uniform disk turns at $2.4 rev / s$ around a frictionless axis. A nonrotating rod, of the same mass as the disk and length equal to the disk's diameter is dropped onto the freely spinning disk (see the figure). They then both turn around the axis with their centres superposed. What will be the angular frequency in rev/s of the combination when they start rotating together.



A. $1.2 rev / s$

B. $2.0 rev / s$

C. $1.44 rev / s$

D. $0.96 rev / s$

Answer: C

Watch Video Solution

69. A rolling object rolls without slipping down an inclined plane (angle of inclination θ), then the minimum acceleration it can have is ?

A. $g \sin \theta$

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

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

D. zero

Answer: C

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70. Suppose you are standing on the edge of a spinning platform and step off at right angles to the edge (radially outward). Now consider it the other way. You are standing on the ground next to a spinning carousel and you step onto the platform at right angles to the edge (radially inward).

A. There is no change in rotational speed of the carousel in either situation.
B. There is a change in rotational speed in the first situation but not the second.
C. There is a change in rotational speed in the second situation but not the first.

D. There is a change in rotational speed in both instances

Answer: C

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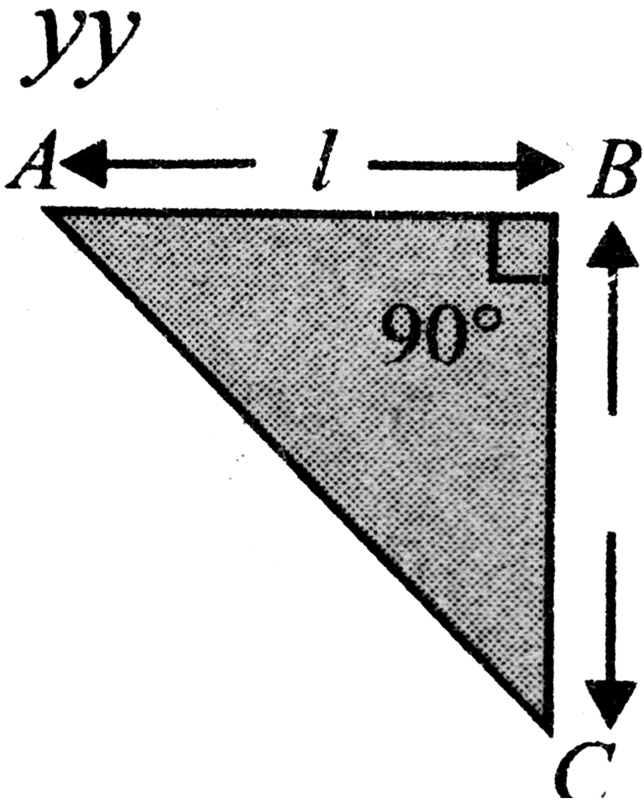
71. Figure shows a thin metallic triangular sheet ABC. The mass of the sheet is M. The moment of inertia of the sheet about side AC

is



A. $\dfrac{Ml^2}{18}$

B. $\dfrac{Ml^2}{12}$

C. $\dfrac{Ml^2}{6}$

D. $\frac{Ml^2}{4}$

Answer: B

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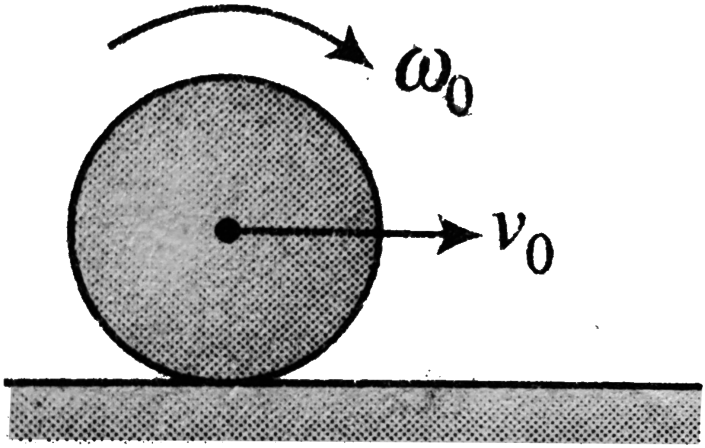
72. A sphere of mass M and radius R is moving on a rough fixed surface, having coefficient of friction μ. as shown in Fig. It will attain a minimum linear velocity after time (

$v_0 > \omega_0 R)$



A. $v_0 / \mu g$

B. $\omega_0 R / \mu g$

C. $2(v_0 - \omega_0 R) / 5\mu g$

D. $2(v_0 - \omega_0 R) / 7\mu g$

Answer: D

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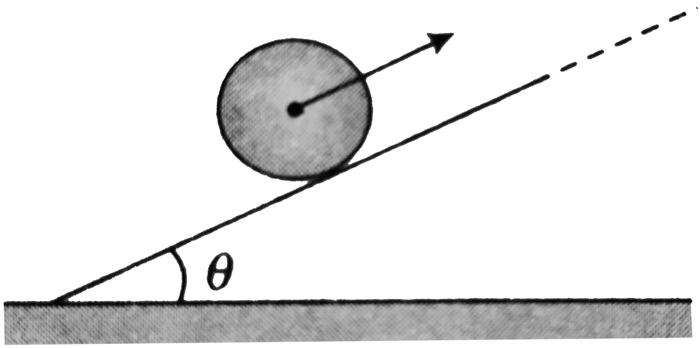
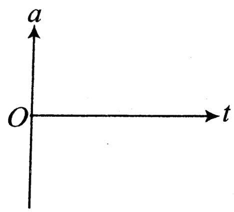
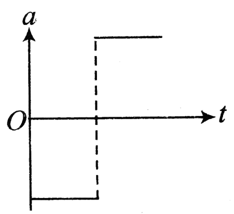
73. A uniform solid sphere rolls up (witout slipping) the fixed inclined plane, and then back down. Which is the correct graph of acceleration a of centre of mass of solid sphere as function of time t (for the duration sphere is on the incline)? Assume that the sphere rolling up has a positive velocity.



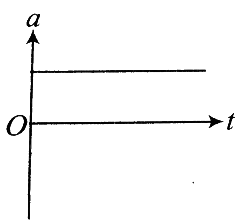
A.

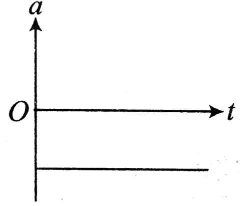


B.



C.



D. 

Answer: D

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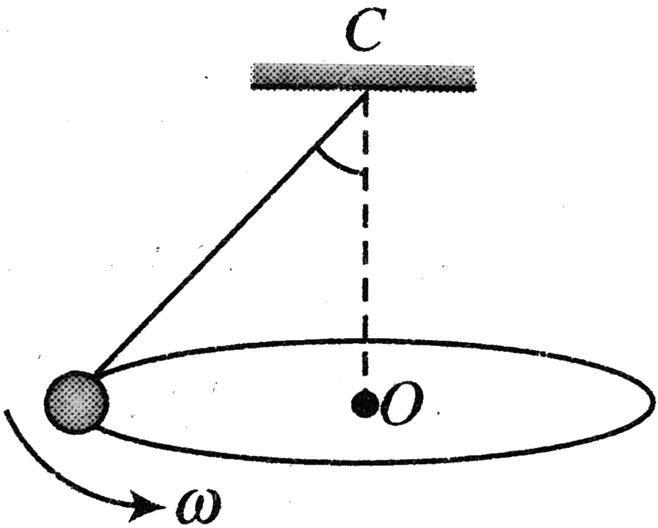
74. A conical pendulum consists of a simple pendulum moving in a horizontal circle as shown in the figure. C is the pivot, O the centre of the circle in which the pendulum bob moves and ω the constant angular velocity of the bob. If $\vec{L}$ is the angular momentum about point C, then



A. $\vec{L}$ is constant

B. only direction of $\vec{L}$ is constant

C. only magnitude of $\vec{L}$ is constant

D. none of the above

Answer: C

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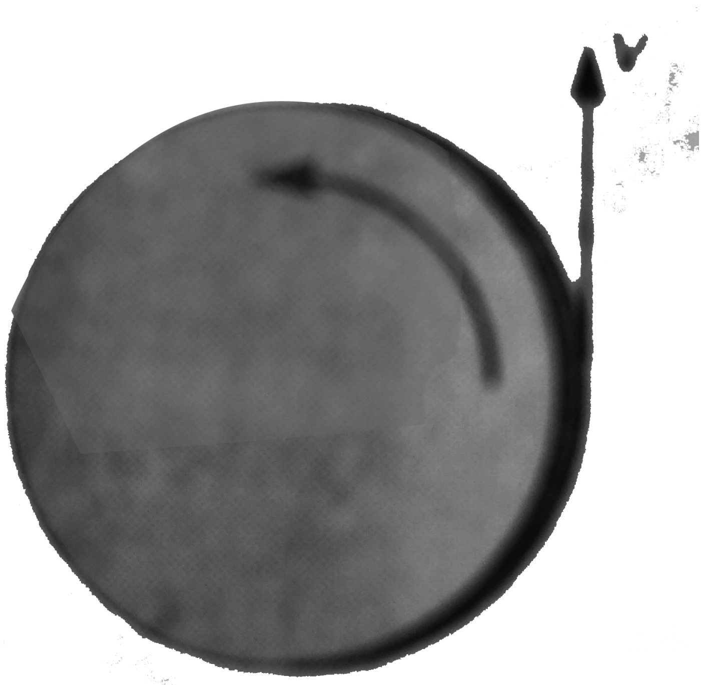

75.

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

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

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

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

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

Answer: D

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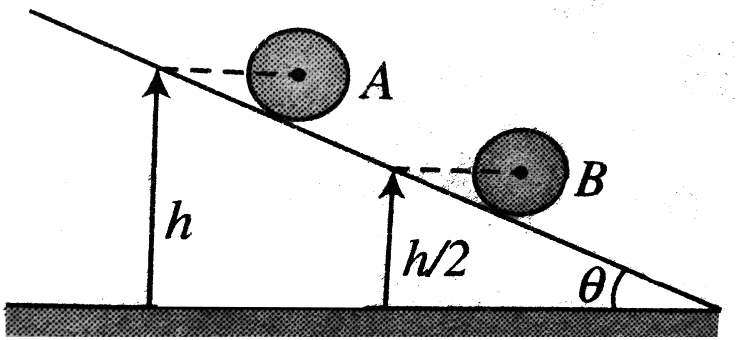
76. Two identical uniform solid spherical balls A and B of mass m each are placed on a the fixed wedge as shown in figure. Ball B is kept at rest and it is released just before two balls collides. Ball A rolls down without slipping on inclined plane and collide elastically with ball B. The kinetic energy of ball A just after the collision with ball B is:



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

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

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

D. $\frac{7mgh}{5}$

Answer: A

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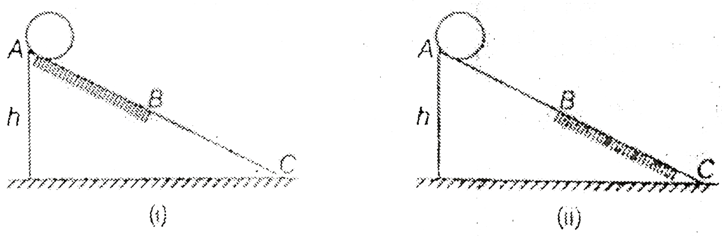
77. In both the figure all other factors are same, except that in figure (i) Ab is sufficiently rough and BC is smooth while in figure (ii) AB is smooth and BC is sufficently rough. Kinetic energy of the ball on reaching the bottom



A. is same in both the cases

B. is greater in case (i)

C. is greater in case (ii)

D. information insufficient

Answer: D

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

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

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

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

D. none of the these

Answer: D

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79. A homogenous rod of length $l = \eta x$ and mass M is lying on a smooth horizontal floor. A bullet of mass m hits the rod at a distance x from the middle of the rod at a velocity v_0 perpendicular to the rod and comes to rest after collision. If the velocity of the farther end of the rod just after the impact is in the opposite direction of v_0, then:

A. $\eta > 3$

B. $\eta < 3$

C. $\eta > 2$

D. $\eta < 6$

Answer: D

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

A. Total kinetic energy is conserved

B. Angular momentum of the sphere about the point of contact is conserved

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

D. Angular momentum about the centre of mass is conserved

Answer: B

Watch Video Solution

81. Two uniform solid spheres having unequal radii are released from rest from the same height on a rough incline. If the spheres roll without slipping

A. The heavier sphere reaches the bottom first

B. The bigger sphere reaches the bottom first

C. The two spheres reach the bottom together

D. The information given is not sufficient to tell which sphere will reach the bottom first

Answer: C

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82. Three identical solid spheres move down three incline A, B and C are all of the same dimensions. A is without friction, the friction between B and a sphere is sufficient to cause rolling without slipping, the friction between C and a sphere causes rolling with slipping. The kinetic energies, of A, B, C at the bottom of the inclines are E_A, E_B, E_C.

A. $E_A = E_B - E_C$

B. $E_A = E_B > E_C$

C. $E_A > E_B > E_C$

D. $E_A > E_B = E_C$

Answer: B

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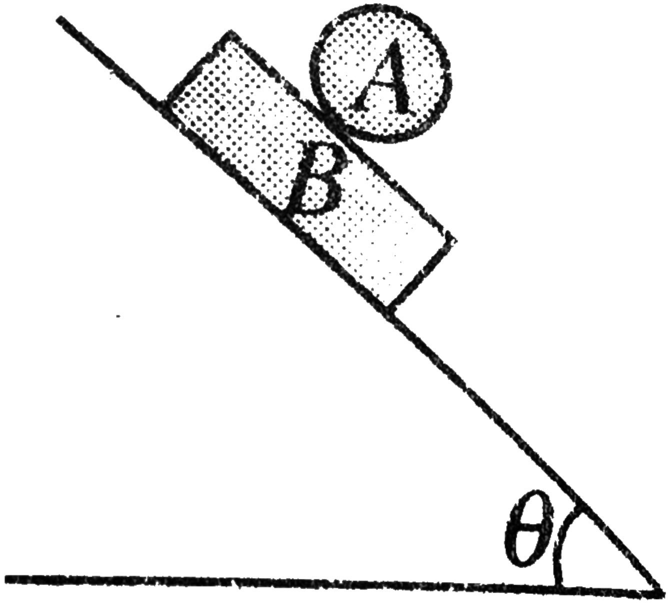
83. A rolling body is kept on a plank B. There is sufficient friction between A and B and no friction between B and the inclined plane.

Then body:



A. A rolls

B. does not experience any friction

C. A and B has equal acceleration and

unequal velocities

D. A rolls depending upon the angle of inclination θ

Answer: B

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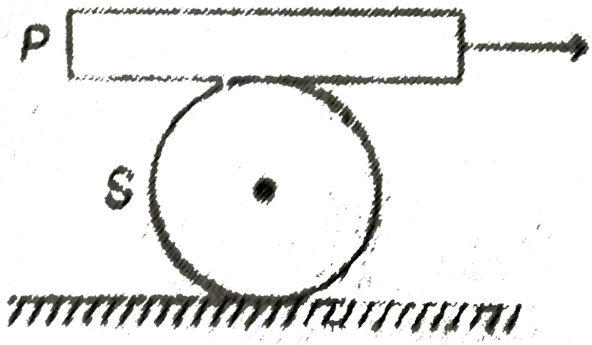
84. A plank P is placed on a solid cylinder S, which rolls on a horizontal surface. The two are of equal masses. There is no slipping at any of the surfaces in contact. The ratio of the kinetic energy of P to the kinetic energy of S is



A. $1:1$

B. $2:1$

C. $8:3$

D. $11:8$

Answer: C

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85. 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. $0.6kgm^{-2}$

B. $0.15kgm^{-2}$

C. $0.8kgm^{-2}$

D. $0.75kgm^{-2}$

Answer: C

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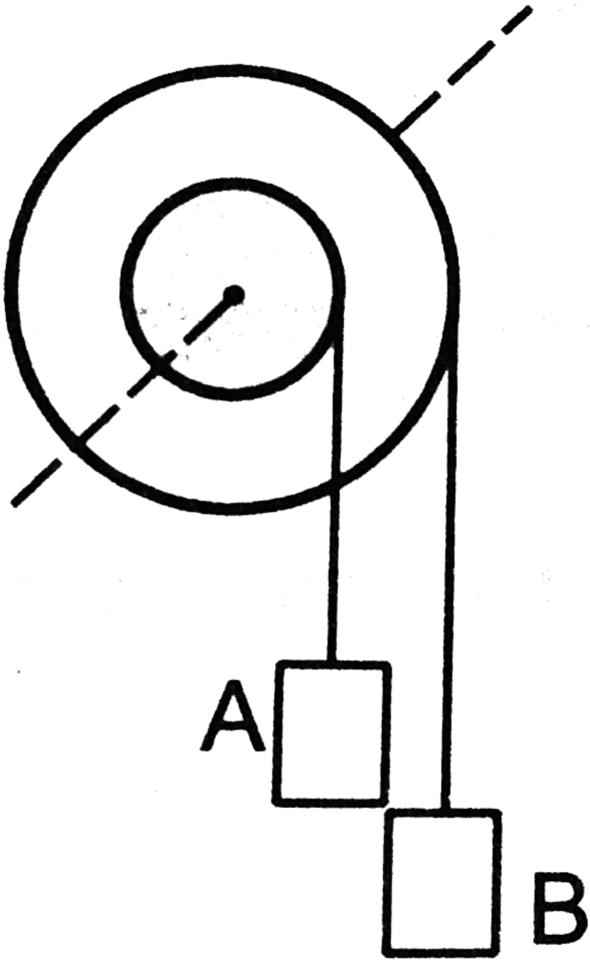
86. Figure shows a small wheel fixed coaxially on a bigger one of double the radius. The system rotates about the common axis. The strings supporting A and B do not slip on the wheels. If x and y be the distances travelled by

A and B in the same time interval, then



A. $x = 2y$

B. $x = y$

C. $y = 2x$

D. none of these

Answer: C

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87. A body is rolling without slipping on a horizontal plane. The rotational energy of the body is 40% of the total kinetic energy. Identify the body.

A. ring

B. Hollow cylinder

C. solid cylinder

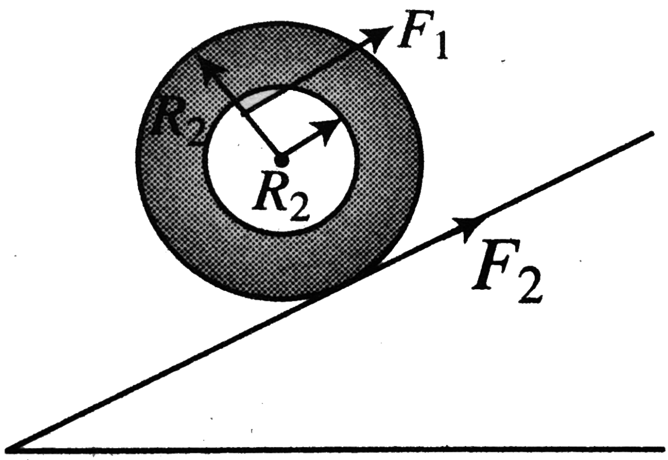
D. hollow sphere

Answer: D

Watch Video Solution

88. A certain bicycle can go up a gentle incline with constant speed when the frictional force of ground pushing the rear wheel is $F_2 = 4N$.

With what force F_1 must the chain pull on the sprocket wheel if $R_1 = 5m$ and $R_2 = 30m$?



A. $4N$

B. $24N$

C. $140N$

D. $35/4N$

Answer: B

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89. A small stone of mass m is attached to a light string which passes through a hollow tube. The tube is held by one hand and the free end of the string by the other hand. The mass is set into revolution in a horizontal circle of radius r_1 with a speed v_1 . The string is pulled down shortening the radius of the circular path to r_2. Which of the following is not correct? (ω_1 and T have usual meanings)

A. $\frac{\omega_2}{\omega_1} = \frac{r_1^2}{r_2^2}$

B. $\frac{E_{k1}}{E_{k2}} = \frac{r_2^2}{r_1^2}$

C. $\frac{E_{k1}}{E_{k2}} = \frac{r_2^2}{r_1^2}$

D. $\frac{T_2}{T_1} = \frac{r_1^3}{r_2^3}$

Answer: D

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90. A ring and a disc having the same mass, roll without slipping with the same linear velocity. If the kinetic energy of the ring is 8 j , Find the kinetic energy of disc (in J)

A. $8J$

B. $6J$

C. $16J$

D. $4J$

Answer: B

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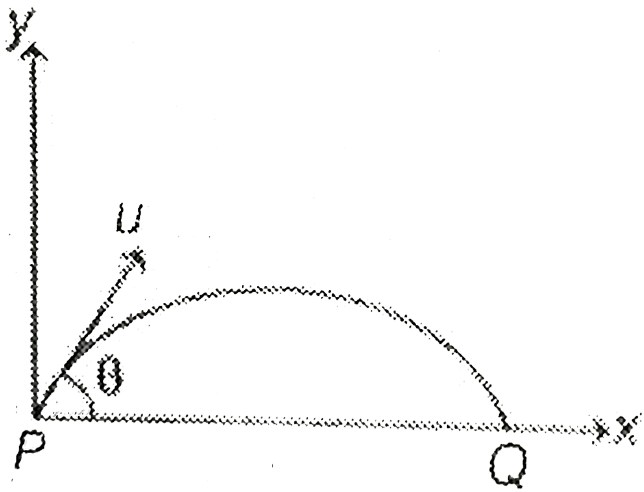
91. Average torque on a projectile of mass m, initial speed u and angl,e of projection θ between initial and final positions P and Q as shown in figure about the point of projectiion is



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

B. $\mu^2 \cos \theta$

C. $\mu^2 \sin \theta$

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

Answer: A

Watch Video Solution

92. A solid sphere and a hollow sphere of equal mass and radius are placed over a rough horizontal surface after rotating it about its mass centre with same angular velocity ω_0.

One the pure rolling starts let v_1 and v_2 be the

linear speeds of their centers of mass. Then

A. $v_1 = v_2$

B. $v_1 < v_2$

C. $v_1 > v_2$

D. data is insufficient

Answer: C

Watch Video Solution

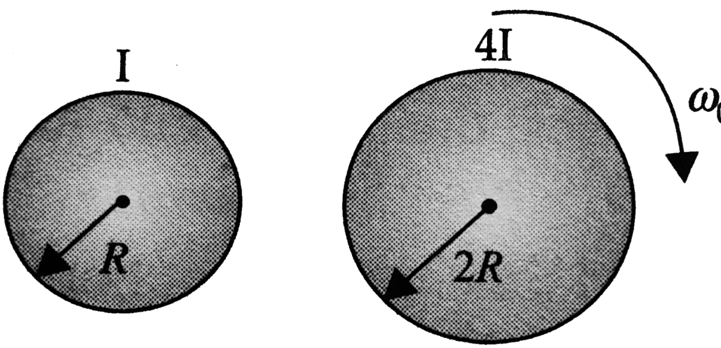
93. Two cylinders having radii $2R$ and R and moment of inertia $4I$ and I about their central axes are supported by axles perpendicular to their planes. The large cylinder is initially rotating clockwise with angular velocity ω_0. The small cylinder is moved to the right until it touches the large cylinder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

(A) angular momentum of system is conserved

(B) kinetic energy is conserved

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

(D) both the angular momentum and kinetic energy are conserved



A. angular momentum of system is conserved

B. kinetic energy is conserved

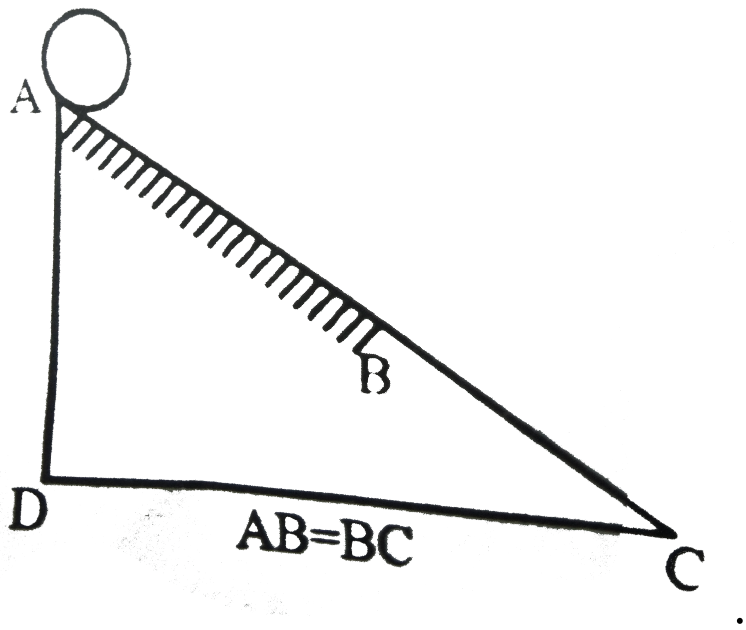
C. neither the angular momentum nor the kinetic energy is conserved

D. both the angular momentum and kinetic energy are conserved

Answer: C

Watch Video Solution

94. 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 rotational kinetic energy, when the cylinder reaches point C.



A. $3/5$

B. 5

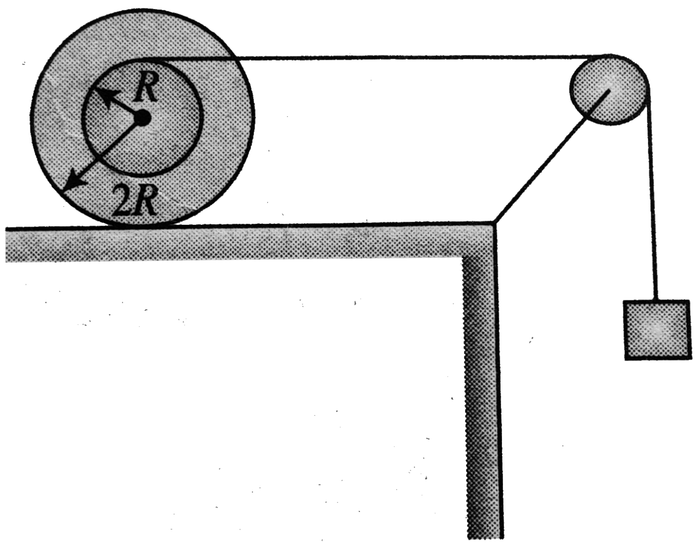
C. $7/5$

D. $8/3$

Answer: B

Watch Video Solution

95. In the figure shown mass of both, the spherical body and block is m. Moment of inertia of the spherical body about centre of mass is $2mR^2$. The spherical body rolls on the horizontal surface. There is no slipping at any surfaces in contact. The ratio of kinetic energy of the spherical body to that of block is



A. $3/4$

B. $1/3$

C. $2/3$

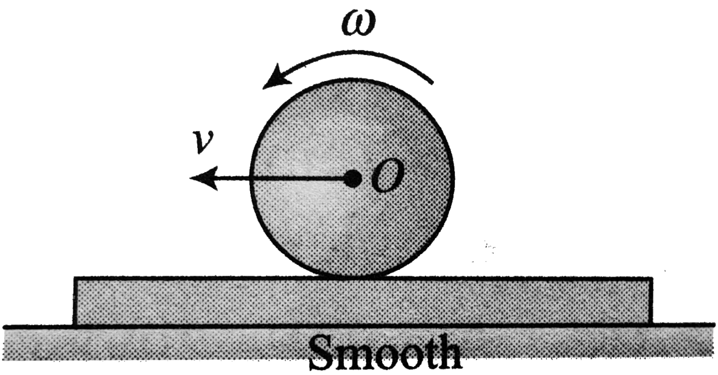
D. $1/2$

Answer: C

Watch Video Solution

96. A cylinder executes pure rolling without slipping with a constant velocity on a plank, whose upper surface is rough enough, but lower surface is smooth. The plank is kept at rest on a smooth horizontal surface by the application of an external force F. The value of

F is ?



A. The direction of F is towards right.

B. The direction of F towards left.

C. The value of F is zero

D. The direction of F depends on the ratio

of the relative masses of disc and plank.

Answer: C

Watch Video Solution

97. A solid sphere rolls down two different inclined planes of the same heights but different angles of inclination. In both cases

A. the speeds will be same but time of descent will be different

B. . in both cases, the speeds and time of descent will be same

C. in both cases, the speeds and time of descent will be same

D. speeds and time of descent both will be different

Answer: A

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98. 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. $\sqrt{2v}$

B. v

C. $\left(\sqrt{\frac{2}{5}}\right)v$

D. $v/\sqrt{2}$

Answer: D

Watch Video Solution

99. Two rigid bodies A and B rotate with angular momenta L_A and L_B respectively. The moments of inertia of A and B about the axes of rotation are I_A and I_B respectively. If $I_A = I_B/4$ and $L_A = 5L_B$, then the ratio of rotational kinetic energy K_A of A to the rotational kinetic energy K_B of B is given by

A. $\frac{K_A}{K_B} = \frac{25}{4}$

B. $\frac{K_A}{K_B} = \frac{5}{4}$

C. $\frac{K_A}{K_B} = \frac{1}{4}$

D. $\frac{K_A}{K_B} = 100$

Answer: D

Watch Video Solution

100. Two discs, each having moment of inertia $5kgm^2$. about its central axis, rotating with speeds $10rads^{-1}$ and $20rads^{-1}$, are brought in contact face to face with their axes of rotation coincided. The loss of kinetic energy in the process is

A. $2J$

B. $5J$

C. $125J$

D. $0J$

Answer: C

Watch Video Solution

101. A boy stands over the centre of a horizontal platform which is rotating freely with a speed of $2\text{revolutions}/s$ about a vertical axis through the centre of the platform and straight up through the boy. He holds $2kg$ masses in each of his hands close to his body. The combined moment of inertia of the system is $1kg \times metre^2$. The boy now stretches his arms so as to hold the masses far from his body. In this situation, the moment of inertia of the system increases to $2kg \times metre^2$, The kinetic energy of the system in the latter case as compared with that in the previous case will

A. Remain unchanged

B. Decrease

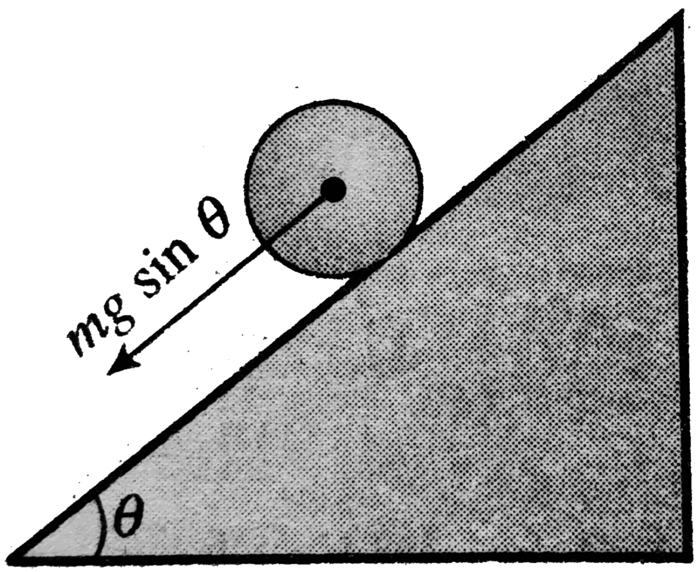
C. Increase

D. Remain uncertain

Answer: B

Watch Video Solution

102. A solid cylinder of mass $3kg$ is placed on a rough inclined plane of inclination 30°. If $g = 10ms^2$, then the minimum frictional force required for it to roll without slipping down the plane is



A. $2N$

B. $5N$

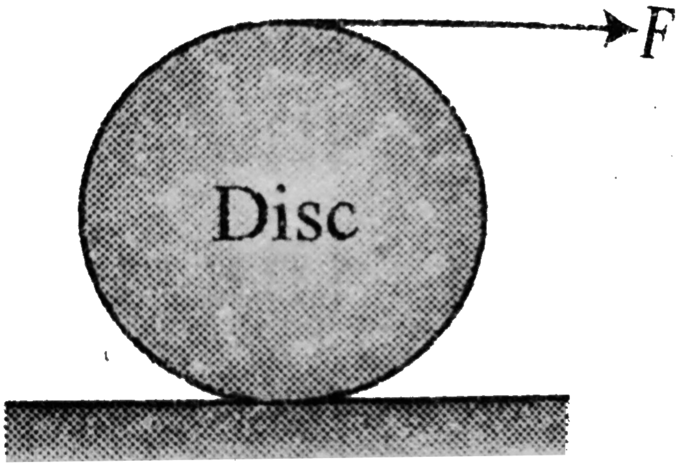
C. $15N$

D. $18N$

Answer: B

Watch Video Solution

103. A force F acts tangentially at the highest point of a disc of mass m kept on a rough horizontal plane. If the disc rolls without slipping, the acceleration of centre of the disc is:



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

B. $\frac{10F}{7m}$

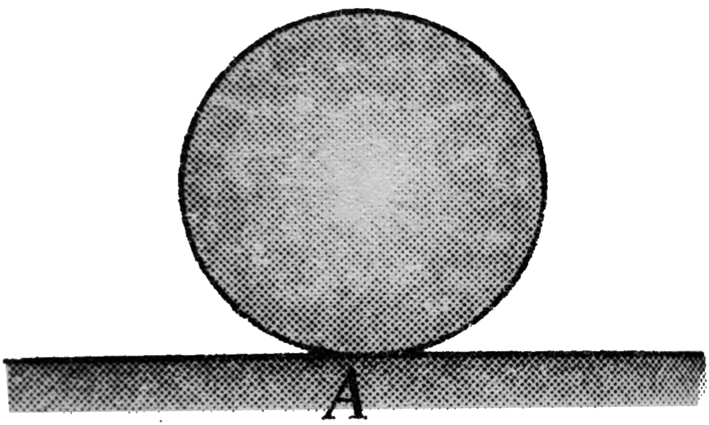
C. zero

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

Answer: D

Watch Video Solution

104. A sphere of mass M and radius r shown in the figure on a rough horizontal plane. At some instant it has translational velocity v_0, and rotational velocity about centre $v_0 / 2r$. The percentage change of translational velocity after the sphere start pure rolling:



A. 14.28%

B. 7.14%

C. 21.42%

D. none

Answer: A

Watch Video Solution

105. A hollow sphere of mass m starting from rest rolls without slipping, on an inclined plane of inclination What is the total energy of the sphere after $10^{-5}s$ if after $10^{-5}isv$?

A. $5/6mv^2$

B. $2/3mv^2$

C. $10^{-5}mv^2$

D. $mv^2/10^{-5}$

Answer: A

Watch Video Solution

106. A solid iron sphere A rolls down an inclined plane. While an identical hollow sphere B of same mass sides down the plane in a frictionless manner. At the bottom of the inclined plane, the total kinetic energy of sphere A is.

A. less than that of B

B. equal to that of B

C. more than that of B

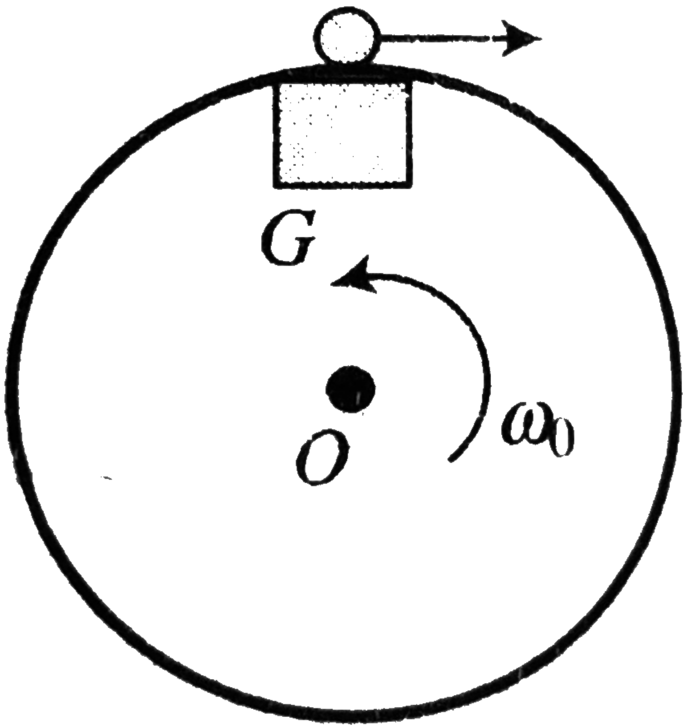
D. Sometimes more and sometimes less

Answer: B

Watch Video Solution

107. Choose the correct option:

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



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

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

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

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

Answer: A

Watch Video Solution

108. A circular platform is mounted on a vertical frictionless axle. Its radius is $r = 2m$ and its moment of inertia$I = 200kgm^2$. It is initially at rest. A $70kg$ man stands on the edge of the platform and begins to walk along the edge at speed $v_0 = 1ms^{-1}$ relative to the ground. The angular velocity of the platform is: a) 1.2 rad/s b) 0.4 rad/s c) 0.7 rad/s d) 2 rad/s

A. $1.2 rads^{-1}$

B. $0.4 rads^{-1}$

C. $2.0 rads^{-1}$

D. $0.7 rads^{-1}$

Answer: D

Watch Video Solution

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

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

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

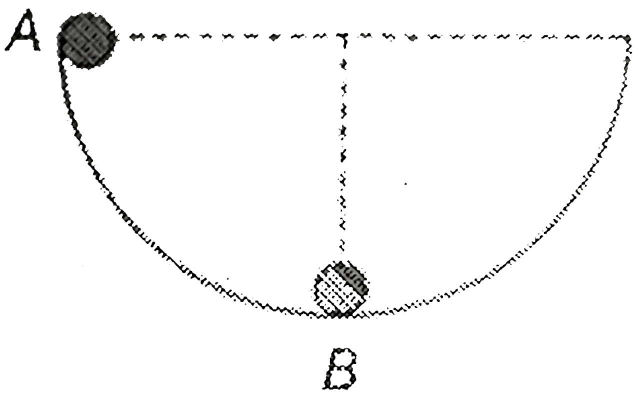
C. $\frac{v}{3a}$

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

Answer: D

Watch Video Solution

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



A. $2\sqrt{\dfrac{g}{5(R-r)}}$

B. $2\sqrt{\dfrac{g}{7(R-r)}}$

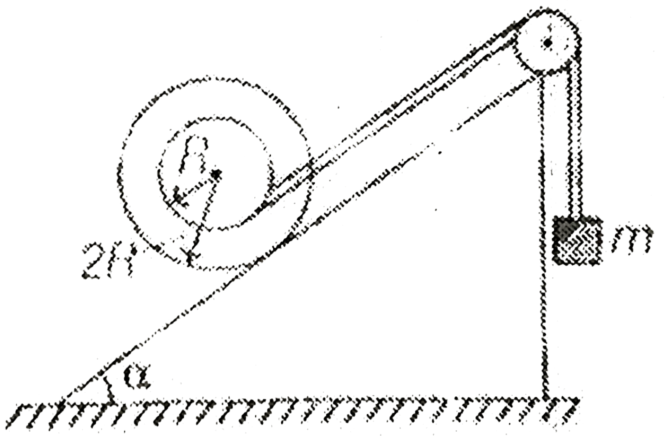
C. $\sqrt{\dfrac{2g}{5(R-r)}}$

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

Answer: B

Watch Video Solution

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



A. $2M \sin \alpha$

B. $M \sin \alpha$

C. $2M \tan \alpha$

D. $M \tan \alpha$

Answer: A

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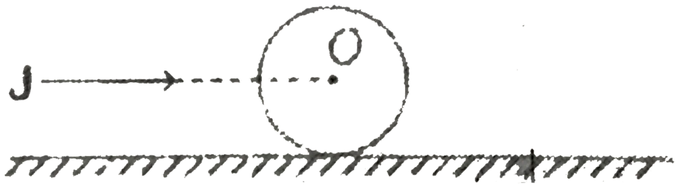
112. An impulse J is applied on a ring of mass m along a line passing through its centre O. the ring is placed on a rough horizontal surface. The linear velocity of centre of ring once it starts rolling without spilling is



A. J/m

B. $J/2m$

C. $J/4m$

D. $J/3m$

Answer: B

Watch Video Solution

113. If a rigid body rolls on a surface without slipping, then:

A. linear speed is maximum at the highest point but minimum at the point of contact

B. linear speed is minimum at highest point but maximum at the point of contact

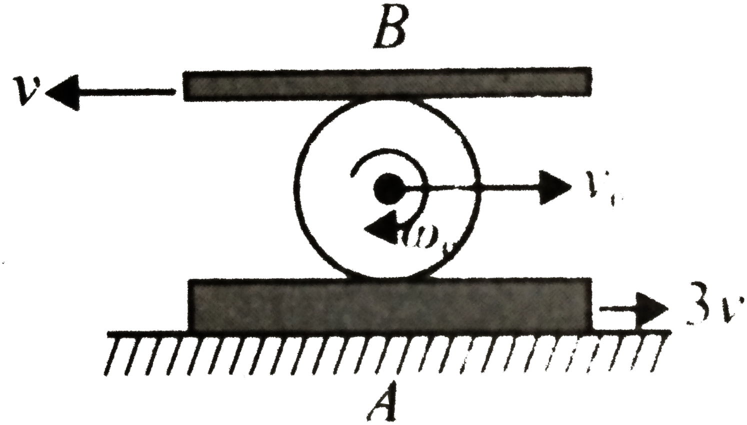
C. linear speed is same at all points of the rigid body

D. angular speed is different at different points of a rigid body

Answer: A

Watch Video Solution

114. The disc of radius r is confined to roll without slipping at A and B. If the plates have the velocities shown, then



A. angular velocity of the disc is $2V / r$

B. linear velocity $V_0 = V$

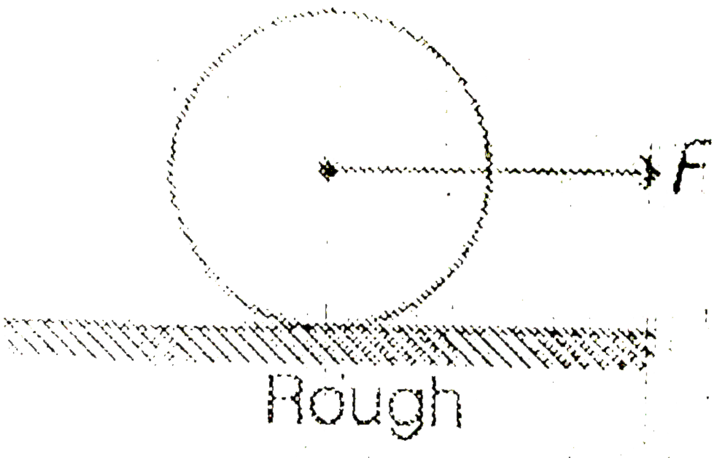
C. angular velocity of the disc is $3V / 2r$

D. none of these

Answer: A::B

Watch Video Solution

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



A. The magnitude of the frictional force is $F/3$.

B. The frictional force on the sphere acts forward.

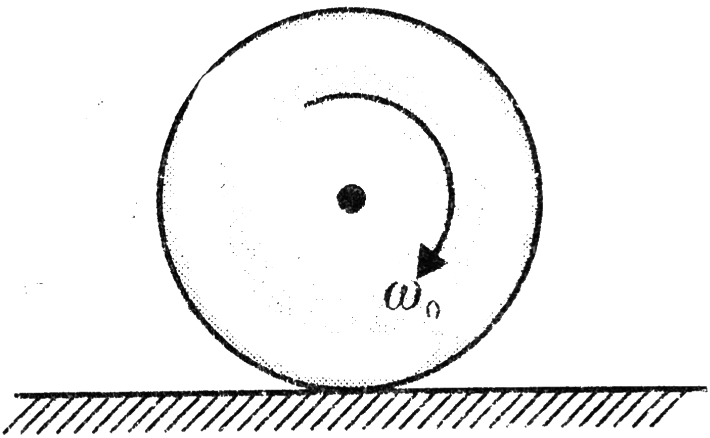
C. The acceleration of the centre of mass is $2F/3M$

D. The acceleration of the centre of mass is F/M.

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

Watch Video Solution

116. A disc is given an initial angular velocity ω_0 and placed on a rough horizontal surface as shown Fig. The quantities which will not depend on the coefficient of friction is/are



A. the time until rolling begins

B. the displacement of the disc until rolling begins

C. the velocity when rolling begins

D. the work done by the force of friction

Answer: C::D

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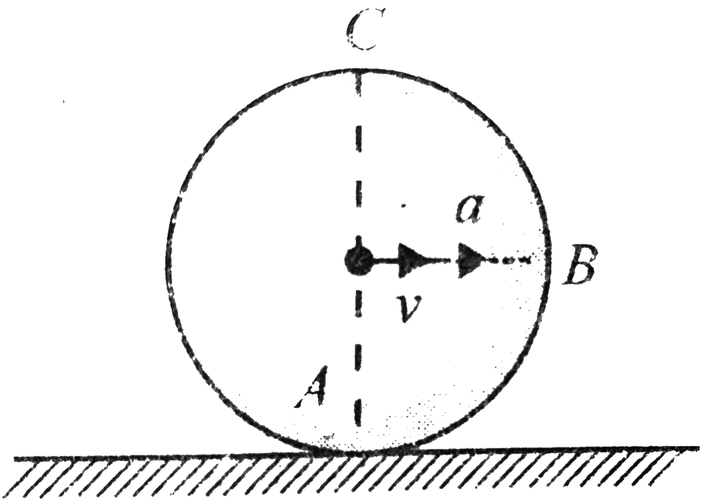
117. A wheel is rolling on a horizontal plane. At a certain instant it has a velocity v and acceleration a of CM as shown in figure .

Acceleration of



A. A is vertically upwards

B. B may be vertically down-wards

C. C cannot be horizontal

D. some point on the rim may he horizontal

leftwards

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

Watch Video Solution

118. Consider three solid spheres, sphere (i) has radius r and mass m, sphere (ii) has radius r and mass 3 m, sphere (iii) has radius 3r and mass m, All can be placed at the same point on the same inclined plane, where they will roll without slipping to the bottom, If allowed to roll down the incline, then at the bottom of the incline

A. sphere (i) will have the largest speed

B. sphere (ii) will have the largest speed

C. sphere (ii) will have the largest kinetic energy

D. all the spheres will have equal speed

Answer: C::D

Watch Video Solution

119. The uniform speed of a body is the same as seen from any point in the body. A light cord is wrapped around the rim of the disc and mass of $1kg$ is tied to the free end. If it is released from rest,

A. the tension in the cord is $5N$

B. in the first $4s$ the angular displacement of the disc is $40rad$

C. the work done by the torque on the disc in the first $4s$ is $200J$

D. the increase in kinetic energy of the disc

in the first $4s$ is $200J$

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

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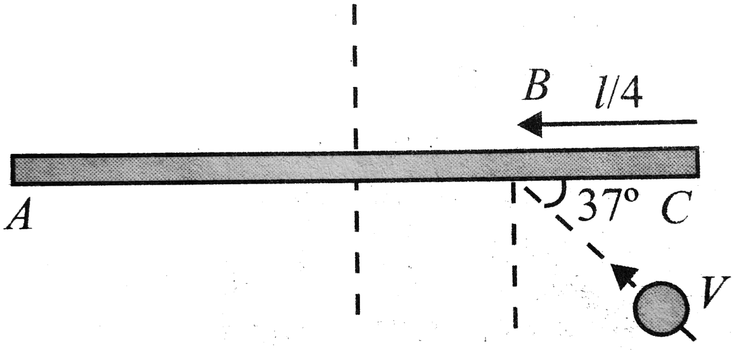
120. A rod AC of length l and mass m is kept on a horizontal smooth plane. It is free to rotate and move. A particle of same mass m moving on the plane with velocity v strikes the rod at point B making angle 37° with the rod.

The collision is elastic. After collision,



A. the angular velocity of the rod will be

$72/55v/l$

B. the centre of the rod will travel a

distance it $\pi l/3$ in the time in which it

makes half rotation

C. impulse of the impact force is $24mV/55$

D. none of these

Answer: A::B::C

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

A. some friction exists between the disc and the ring

B. the angular momentum of the 'disc plus ring' is conserved

C. the final common angular velocity is $\left(\frac{2}{3}\right)$rd of the initial angular velocity of the disc

D. $\left(\frac{2}{3}\right)$rd of the initial kinetic energy changes to heat

Answer: A::B::D

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122. Two horizontal discs of different radii are free to rotate about their central vertical axes: One is given some angular velocity, the other is stationary. Their rims arc now brought in contact. There is friction between the rims. Then

A. the force of friction between the rims will disappear when the discs rotate with equal angular speeds

B. the force of friction between the rims will when they have equal linear velocities

C. the angular momentum of the system will conserved

D. the rotational kinetic energy of the system will not conserved

Answer: B::D

Watch Video Solution

123. A constant external torque τ acts for a very brief period $\triangle t$ on a rotating system having moment of inertia I then

A. the angular velocity of the system will change by $\tau \triangle t / I$

B. the angular velocity of the system will change by $\tau \triangle t / I$

C. if the system was initially at rest, it will acquire rotational kinetic enegy $(\tau \triangle t)^2 / 2I$

D. the kinetic energy of the system will change by $(\tau \triangle t)^2 / (2I)$

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

Watch Video Solution

124. Two identical spheres A and B are free to move and I, rotate about their centres. They are given the same impel J. The lines of action of the impulses pass through tht centre of A and away from the centre of B, then

A. A and B will have the same speed

B. B will have greater kinetic energy than A

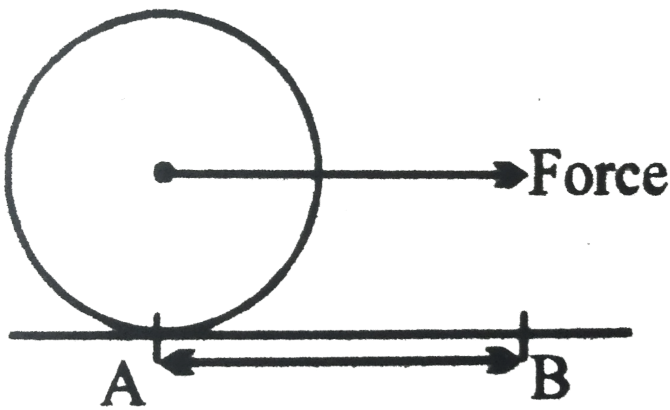
C. they will have the same kinetic energy, but the Linear kinetic energy of B will be less than that of A

D. the kinetic energy of B will depend on the point impact of the impulse on B

Answer: A::B::D

Watch Video Solution

125. A disc of circumference s is at rest at a point A on a horizontal surface when a constant horizontal force begins to act on its centre. Between A and B there is sufficient friction toprevent slipping, and the surface is smooth to the right of B. $AB = s$. The disc moves from A to B in time T. To the right of B,



A. the angular acceleration of the disc will disappear linear acceleration will remain unchanged

B.. linear acceleration of the disc will increase

C. the disc will make one rotation in time $T/2$

D. the disc will cover a distance greater than s in further time T

Answer: B::C::D

Watch Video Solution

126. A ring (R), a disc (D), a solid sphere (S) and a hollow sphere with thin walls (H), all having the same mass but different radii, start together from rest at the top of inclined plane and roll down without slipping. Then

A. all of them will reach the bottom of the incline together

B. the body with the maximum radius will reach bottom first

C. they will reach the bottom in the order S, D, H and R

D. all of them will have the same kinetic energy at bottom of the incline

Answer: C::D

Watch Video Solution

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

A. it will move with a speed v initially

B. its motion will be rolling without slipping

C. its motion will be roilling without slipping initially and its rotational motion will stop momentarily at some instant

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

Answer: A::C::D

Watch Video Solution

128. 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 as its lowest point, normal to its length immediately after impact.

A. the angular momentum of the rod is Jl

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

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

D. the linear velociyt of the midpoint of the rod is $3J/2m$

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

Watch Video Solution

129. Which of the following statements are correct for instantaneous axis of rotation?

A. Acceleration of every point lying on the axis must be equal to zero

B. Velocity of a point distance r from the axis is equal to $r\omega$

C. if moment of inertia of a body about the axis is I and angular velocity is (ω), then kinetic energy of the body is equal to $I\omega^2/2$

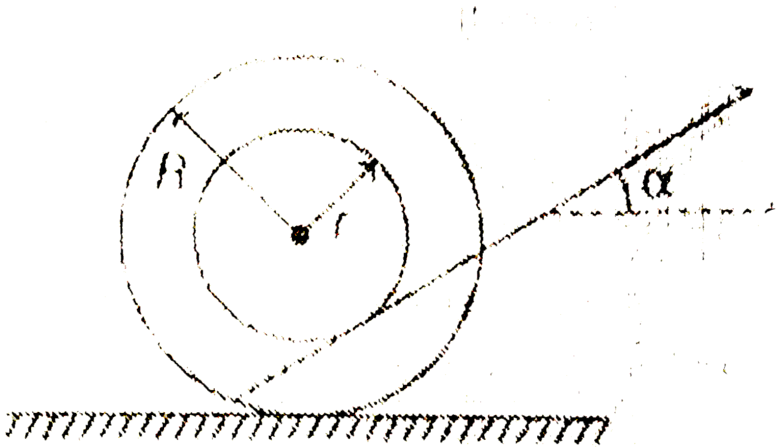
D. Moment of inertia of a body is least about nstantaneous axis of rotation among all the parallel axes.

Answer: B::C::D

Watch Video Solution

130. Choose the correct option:

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



A. Thread unwinds, spool rotates anticlockwise and friction acts leftwards.

B. Thread winds, spool rotates clockwise and friction acts leftwards.

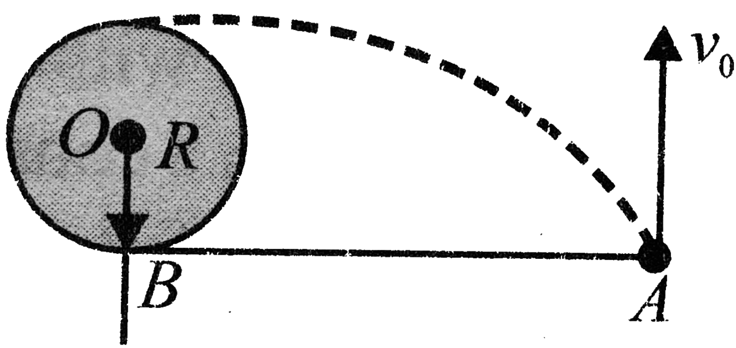
C. Thread winds, spool moves to the right and friction acts rightwards.

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

Answer: A::C::D

Watch Video Solution

131. A horizontal plane supports a fixed vertical cylinder of radius R and a particle is attached to the cylinder by a horizontal thread AB as shown in Fig. The particle initially rest on a horizontal plane. A horizontal velocity v_0 is imparted to the particle, normal to the threading during subsequent motion. Point out the false statements:



A. Angular momentum of particle about O remains constant.

B. Angular momentum about B remains constant

C. Momentum and kinetic energy both remain constant.

D. Kinetic energy remains constant

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

Watch Video Solution

132. A uniform rod is resting freely over a smooth horizontal plane. A particle moving horizontally strikes at one end of the rod normally and gets stuck. Then

A. the momentum of the particle is shared between the particle and the rod and remains conserved.

B. the angular momentum about the mid-point of the rod before and after the collision is equal.

C. the angular momentum about the centre of mass of the combination before and after the collision is equal.

D. . the centre of mass of the rod particle system starts to move translationally with the original momentum of the particle.

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

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133. A ball rolls down an inclined plane and acquires a velocity v_r when it reaches the bottom of the plane. If the same ball slides without friction and acquires rolling from the same height down an equally inclined smooth plane and acquires a velocity v_s (then which of the following statements are not correct?

A. $v_r < v_s$ because a work is done by the rolling ball against the frictional force.

B. $v_r > v_s$, because the angular velocity acquired makes the rolling ball to travel faster

C. $v_r = v_s$ because kinetic energy of the two balls is same at the bottom of the planes.

D. $v_r > v_s$ because the rolling ball acquires rotational as well as translational kinetic energy.

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

Watch Video Solution

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

A. both have the same acceleration

B. acceleration of the centre of sphere is less than that of the plank

C. work done by friction acting on the sphere is equal to its total kinetic energy

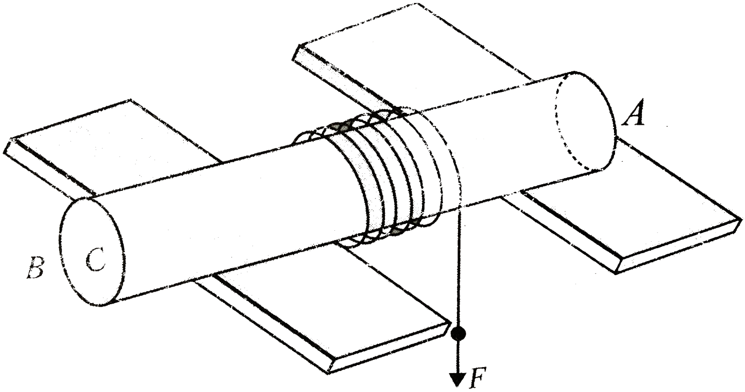
D. total kinetic energy of the system is equal to work done by the force F

Answer: B::C::D

Watch Video Solution

135. A uniform solid cylinder of mass m rests on two horizontal planks. A thread is wound on the cylinder. The hanging end of the thread is pulled vertically down with a constant force

F.



Find the maximum magnitude of the force F which may be applied without bringing about any sliding of the cylinder, if the coefficient of friction between the plank and the cylinder is equal to μ. What is the maximum acceleration of the centre of mass over the planks?

A. Since horizontal acceleration is provided by the friction acting on the cylinder, its translation kinetic energy $\left(\frac{1}{2}mv^2\right)$ is equal to work done by this friction,

B. Since moment about instantaneous axis of rotation is produced by force F. kinetic energy $\left(\frac{1}{2}I\omega^2\right)$ is equal to work done by F where I is moment of inertia about the instantaneous axis of rotation and ω is the-angular velocity.

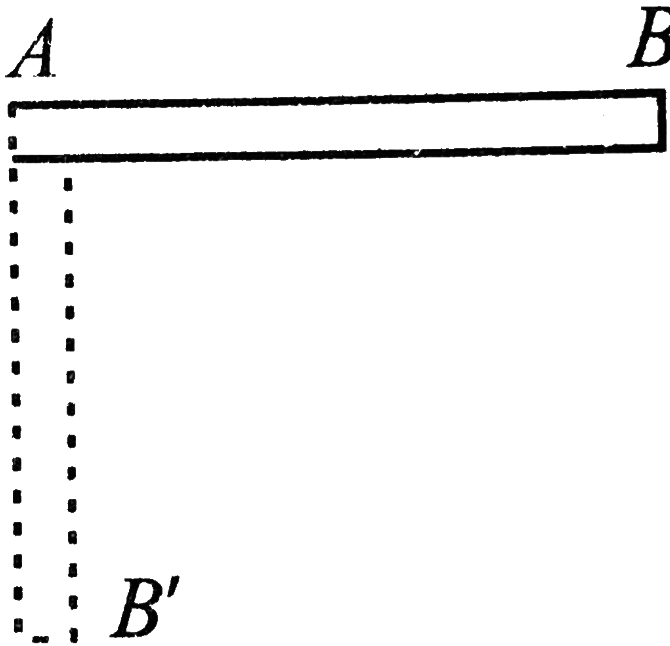
C. Since cylinder is moving, energy is lost against friction.

D. Work done by $F +$ work done by friction on cylinder $= \text{total} KE$ of the cylinder.

Answer: B::D

Watch Video Solution

136. Consider the rotation of a rod of mass m and length I from position AB to AB'. Which of the following statements are correct?



A. Weight of the rod is lowered by $l/2$

B. Loss of gravitational potential energy is

$1/2mgl$

C. Angular velocity is $\sqrt{3g/l}$

D. Rotational kinetic eneryg is $\frac{ml^2\omega^2}{6}$

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

Watch Video Solution

137. A $1kg$ solid sphere rolls without slipping on a rough horizontal surface under the influence of a $7N$ force. The force acts tangentially at the highest point of the sphere. Which of the following statements are correct? ($7N$ force acts towards right).

A. The frictional force on the sphere acts towards right.

B. The value of the frictional force is $3N$

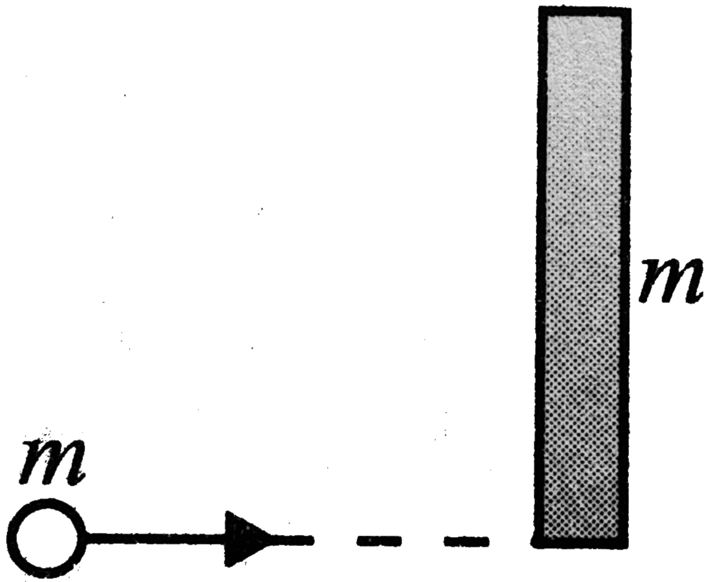
C. The acceleration of the centre of the sphere is $9.8m / s^2$

D. The acceleration of the centre of the sphere is $10m / s^2$

Answer: A::B::D

Watch Video Solution

138. A particle, moving horizontally, collides perpendicularly at one end of a rod having equal mass and placed on a smooth horizontal surface.



A. Particle comes to rest if collision is perfectly elastic and centre of m rod starts to move with the same velocity.

B. Particle continues to move along the same direction, whatever is the value of e.

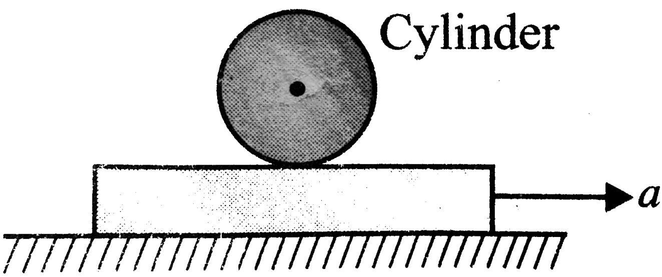
C. Particle may get rebound back.

D. Velocity of mid-point of the rod will be less than $v/2$ if the particle gets stuck.

Answer: B::D

Watch Video Solution

139. A uniform cylinder of mass M and radius R is placed on a rough horizontal board, which in turn is placed on a smooth surface. The coefficient of friction between the board and the cylinder is μ. If the board starts accelerating with constant acceleration a, as shown in the figure, then



Option1

for pure rolling motion of the cylinder, direction of frictional force is forward and its magnitude is M a / 3

Option2

the maximum value of a, so that cyliner performs pure rolling is 3 μ g

Option3

The acceleration of the centre of mass of te cylinder under pure rolling condition for the given a is a / 3

Option4

none of these

A. for pure rolling motion of the cylinder, direction of frictional force is forward and its magnitude is $Ma/3$

B. the maximum value of a, so that cyliner performs pure rolling is $3\mu g$

C. The acceleration of the centre of mass of te cylinder under pure rolling condition for the given a is $a/3$

D. none of these

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

Watch Video Solution

140. A sphere A moving with speed u and rotating With angular velocity ω makes a head-on elastic collision with an identical stationary sphere B. There is no friction between the surfaces of A and B. Choose the conrrect alternative(s). Disregard gravity.

A. A will stop moving but continue to rotate with an angular velocity ω

B. A will come to rest and stop rotating

C. B will move with speed u without rotating

D. B will move with speed u and rotate with an angular velocity ω

Answer: A::C::D

Watch Video Solution

141. A thin bar of mass M and length L is free to rotate about a fixed horizontal axis through a point at its end. The bar is brought to a horizontal position and then released. The axis is perpendicular to the rod. The angular velocity when it reaches the lowest point is

A. directly proportional to its length and inversely proportional to its mass

B. independent of mass and inversely proportional to the square root of its length

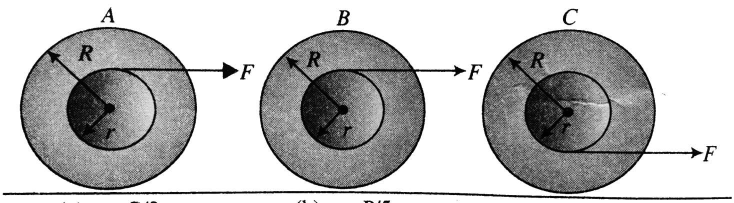
C. dependent only upon the acceleration due to gravity and the length of the bar

D. directly proportional to its length and inversely proportional to the acceleration due to gravity

Answer: B::C::D

Watch Video Solution

142. Three spools A, B and C each having moment of inertia $I = M\frac{R^2}{4}$ are placed on rough ground and equal force F is applied at positions as shown in the figures (a), (b) and (c). Then



(a) $r = R/3$ (b) $r = R/5$ (c) $r = R/5$

A. frictional force on spool A acts in forward direction

B. frictional force on spool A acts in backward direction

C. frictional force on spool B acts in forward direction

D. frictional force on spool B and C acts in backward direction

Answer: A::D

Watch Video Solution

Multiple Correct

1. A ring rolls without slipping on the ground. Its centre C moves with a constant speed u. P

is any point on the ring. The speed of P with respect to the ground is v.

A. $0 \leq v \leq 2u$

B. $v = u,$ if CP is horizontal

C. $v = u$, if CP makes an angle of 30° with the horizontal and P is below the horizontal level of C.

D. $v = \sqrt{2}u,$ if CP is horizontal

Answer: A::C::D

Watch Video Solution

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

A. remaining disc remains unchanged

B. remaining disc decreases

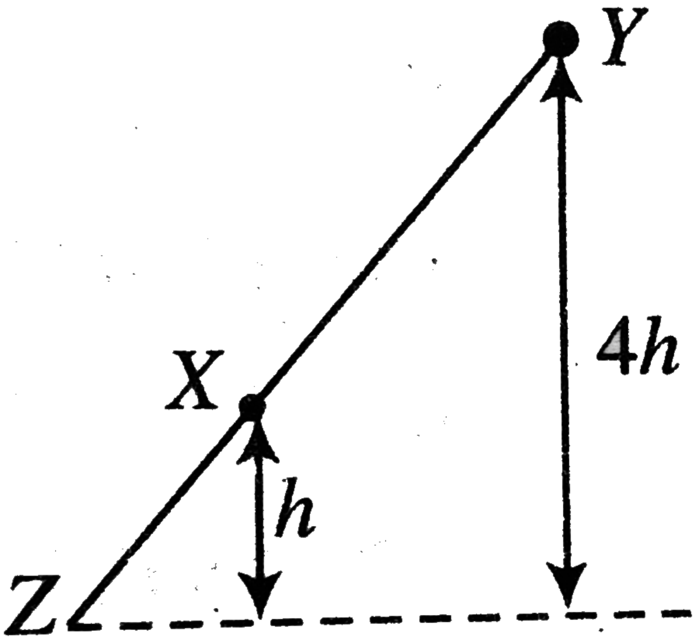
C. remaining disc increases

D. broken away piece decreases initially and later increases

Answer: A::D

Watch Video Solution

3. Two wheels A and B are released from rest from points X and Y respectively on an inclined plane as shown in the figure. Which of the following statement(s) is/are incorrect?



A. Wheel B takes twice as much time to roll from Y to Z than that of wheel A from X to Z.

B. At point Z velocity of wheel A is four times that of wheel B.

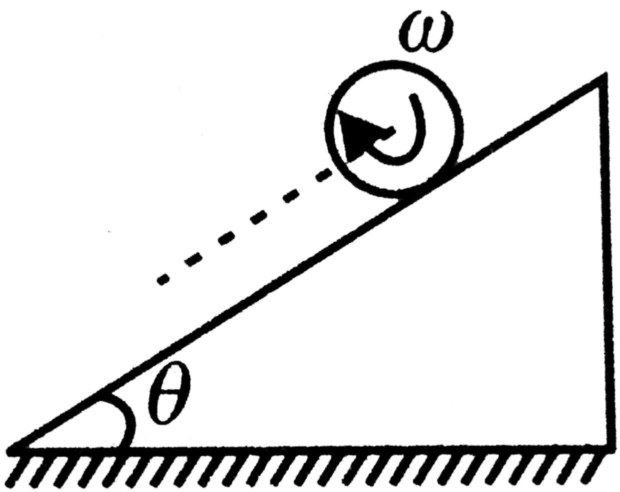
C. Acceleration of the wheel A is twice that of the wheel B.

D. Both wheel take same time to arrive at point Z

Answer: B::C::D

Watch Video Solution

4. A solid sphere is given an angular velocity ω and kept on a rough fixed incline plane. The choose the correct statement.



A. If $\mu = \tan\theta$ then sphere will be in linear equilibrium for some time and after that pure rolling down the plane will start

B. If $\mu = \tan\theta$ then sphere will move up the plane and frictional force acting all the time will be $2mg\sin$

C. If $\mu = \frac{\tan\theta}{2}$ there will never be pure rolling (consider inclined plane to be long enough).

D. If incline plane is not fixed and it is on smooth horizontal surface then linear momentum of the system (wedge and sphere) can be conserved in horizontal direction.

Answer: A::D

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5. A skater rotating about a vertical axis pulls her arms inward. Ignoring all frictional effects, which of the following statements are true? Denote the magnitude of her angular velocity by ω, the magnitude of her angular momentum by L, and her kinetic energy by E_k.

A. L is constant, E_k increases

B. L is constant, ω increases

C. L and E_k are both constant

D. L and ω are both constant

Answer: A::B

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6. The motion of a sphere moving on a rough horizontal surface changes from pure sliding (without rolling) to pure rolling (without slipping). In this process, the force of friction

(i) intially acts opposite to the direction of motion and late in the direction of motion

(ii) cause linear retardation

(iii) causes angular acceleration

(iv) stops acting when pure rolling begins

A. initially acts opposite to the direction of motion and later in the direction of motion

B. causes linear retardation

C. causes angular acceleration

D. stops acting when pure rolling begins

Answer: B::C::D

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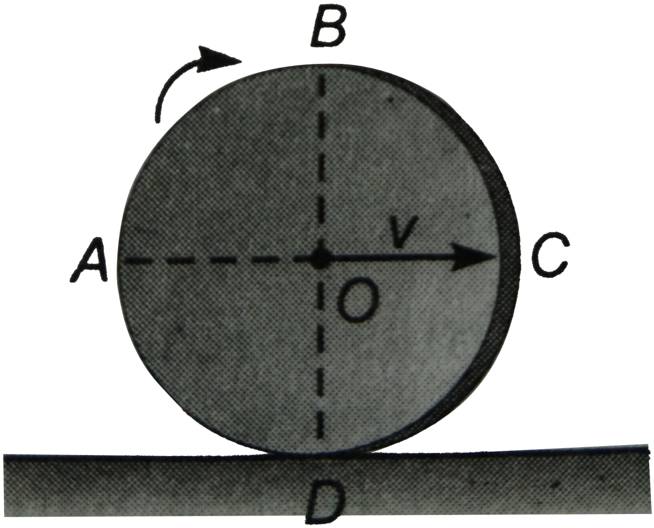
7. 

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

A. section ABC has greater kinetic energy than section ADC

B. section BC has greater kinetic energy than section CD

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

D. The section AB, BC, CD and DA have the same kinetic energy

Answer: A::B

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8. A wheel A starts rolling up a rough inclined plane and another identical wheel B starts rolling up a smooth plane having same inclination with the horizontal. If initial velocity of both the wheels is same then:

A. A stops ascending earlier than B

B. kinetic energy of B never becomes zero

C. maximum height ascended by A is less than that, by B

D. friction acting on A remains constant during the round trip

Answer: B::D

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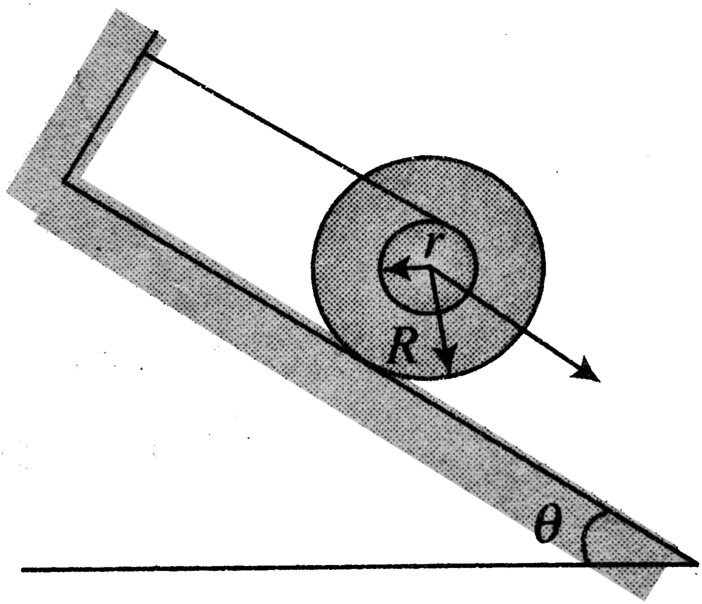
9. Figure shows a spool with thread wound on it placed on a smooth plane inclined at angle from horizontal. The spool has mass m, edge radius R, and is wound up to a radius r. its moment of inertia about its own axis is I. The free end of the thread is attached as shown in the figure. So that the thread is parallel to the inclined plane. T is the tension in the thread. Which of the following is correct?



A. The linear acceleration of the spool axis down the slope mg is $\dfrac{mg\sin\theta - T}{m}$

B. Angular acceleration is $\frac{Tr}{2I}$

C. The linear acceleration of the spool axis down the plane is $\frac{Tr^2}{I}$

D. The acceleration of the spool axis down the slope is $\frac{g \sin \theta}{1 + \frac{I}{mr^2}}$

Answer: A::C::D

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

A. The frictional force is $F/2$

B. Acceleration is $F/2M$

C. Acceleration is F/M

D. The frictional force is $3F/4$

Answer: A::B

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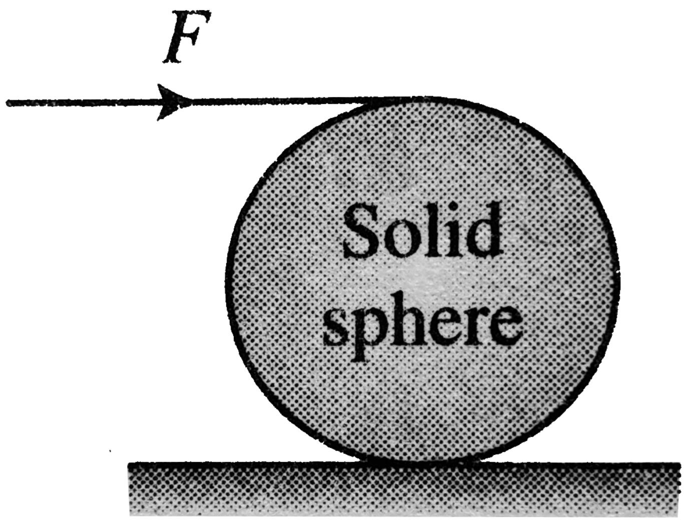
11. In the situation given, a force F is applied at the top of sphere. Study following statements.



A. The sphere will move faster if friction is absent.

B. The sphere will move faster if friction is present

C. The sphere will move with same velocity irrespective the friction.

D. Friction supports the motion

Answer: B::D

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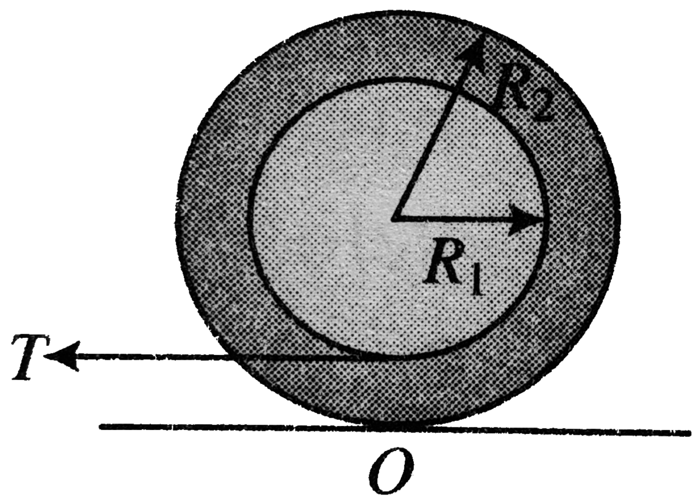
12. A stepped cylinder having mass $50kg$ and a radius of gyration (K) of $0.30m$. The radii R_1 and R_2 are respectively $0.3m$ and $0.6m$. A pull T equal to $200N$ is exerted on the rope attached to inner cylinder. The coefficient of static and dynamic friction between cylinder and ground are 0.1 and 0.08 respectively.



A. the angular acceleration is $2.67 rads^{-2}$

B. The force of kinetic friction is $40N$

C. The acceleration is $3.2 ms^{-2}$ towards let.

D. The acceleratiion is $3.2 ms^{-2}$ towards right

Answer: B::D

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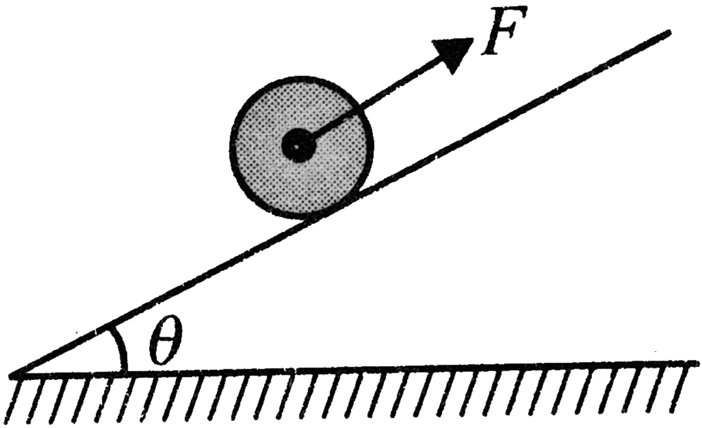
13. Statement I: A disc is allowed to roll purely on an inclined plane as shown in Fig. A force F parallel to the incline and passing through the centre of the disc acts which remains constant during the motion.

It is possible that for certain values of F, the friction on the disc is acting along downward direction and for certain other values of F, the friction on the disc be acting along upward direction and there is no other possibility.



Statement II: The friction (if acting) will be static and not kinetic in nature.

A. a. Statement I is True, Statement II is True, Statement II is a correct explanation for Statement I.

B. b. Statement I is True, Statement II is True, Statement II is NOT a correct explanation for Statement I

C. c. Statement I is True, Statement II is False.

D. d. Statement I is False, Statement II is True.

Answer: D

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14. Many great rivers flow toward the equator. The sediments that they carry, increases the time of rotation of the earth about its own axis.

The angular momentum of the earth about its rotation axis is conserved.

A. Statement I is True, Statement II is True, Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True, Statement II is NOT a correct explanation for Statement I

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: A

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15. The mass of a body cannot be considered to be concentrated at the centre of mass of the body for the purpose of computing its moment of inertia.

For then the moment of inertia of every body about an axis passing through its centre of mass would be zero.

A. Statement I is True, Statement II is True, Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True, Statement II is NOT a correct explanation for Statement I

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: A

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16. A ladders is more likely to slip when a person is near the top than when he is near the bottom.

The friction between the ladder and floor decreases as he climbs up.

A. Statement I is True, Statement II is True, Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True, Statement II is NOT a correct explanation for Statement I

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: C

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17. A solid sphere rolling on a rough horizontal surface. Acceleration of contact point is zero.

A solid sphere can roll on the smooth surface.

A. Statement I is True, Statement II is True, Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True, Statement II is NOT a correct explanation for Statement I

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: D

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18. A disc is rolling on an inclined plane without slipping. The velocity of centre of mass is V. These other point on the disc lie on a circular are having same speed as centre of mass.

When a disc is rolling on an inclined plane. The magnitude of velocities of all the point from the contact point is same, having distance equal to radius r.

A. Statement I is True, Statement II is True, Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True, Statement II is NOT a correct explanation for Statement I

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: A

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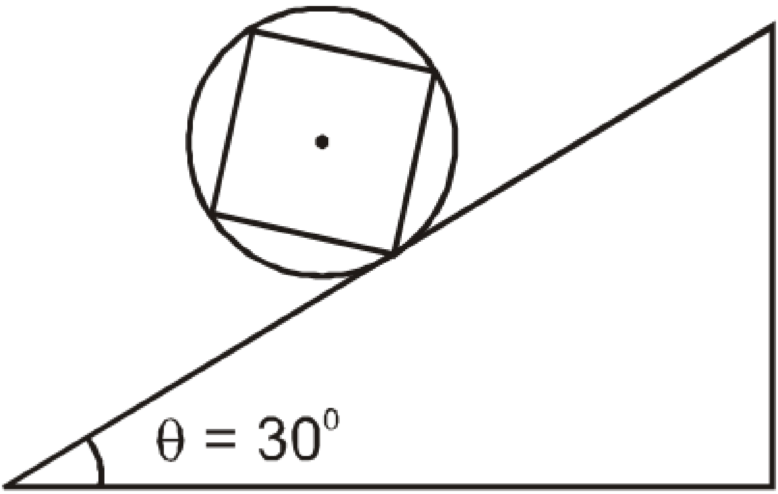
19. 

Four identical uniform rods of mass $M = 6kg$ each are welded at their ends to form a square and then welded to a uniform ring having mass m=4kg & radius R=1m the system is allowed to roll down on the rough and fixed incline of inclination $\theta = 30^\circ$ (assume no sliding anywhere)

Q. The moment of inertia of system about the axis of ring will be-

A. $20kgm^2$

B. $40kgm^2$

C. $10kgm^2$

D. $60kgm^2$

Answer: A

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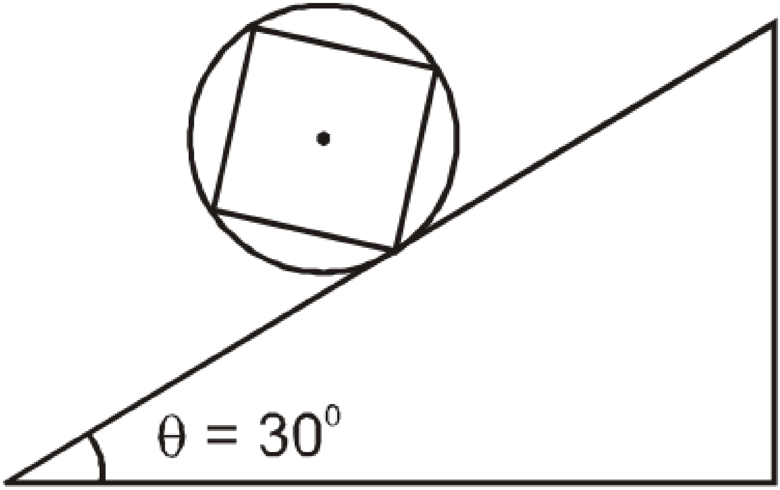
20. 

Four identical uniform rods of mass $M = 6kg$ each are welded at their ends to form a square and then welded to a uniform ring having mass m=4kg & radius R=1m the system is allowed to roll down on the rough and fixed incline of inclination $\theta = 30^\circ$ (assume no sliding anywhere)

Q. The acceleration of centre of mass of system is

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

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

C. $\frac{7g}{24}$

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

Answer: C

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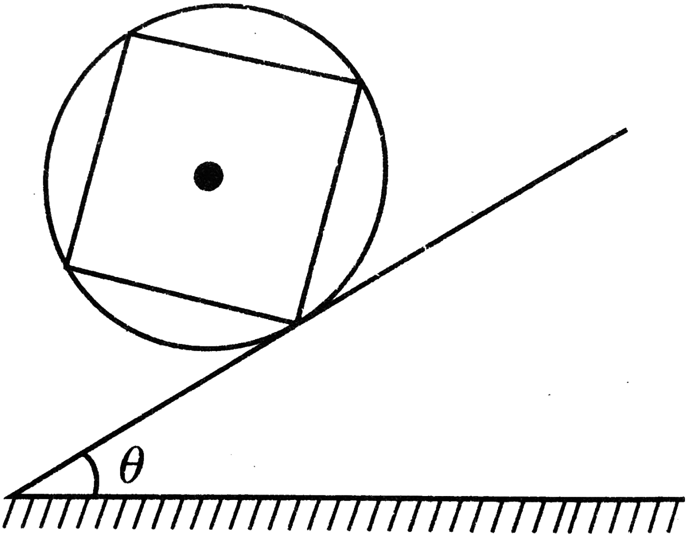
21. Four identical rods of mass $M = 6kg$ each are welded at their ends to form a square and then welded to a massive ring having mass $m = 4kg$ and radius $R = 1m$. If the system is allowed to roll down the incline of inclination $\theta = 30^\circ$, determine the minimum value of the coefficient of static friction that will prevent slipping.



The moment of inertia of the system about the centre of ring will be

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

B. $\frac{5}{12\sqrt{3}}$

C. $\frac{5\sqrt{3}}{7}$

D. $\frac{7}{5\sqrt{3}}$

Answer: B

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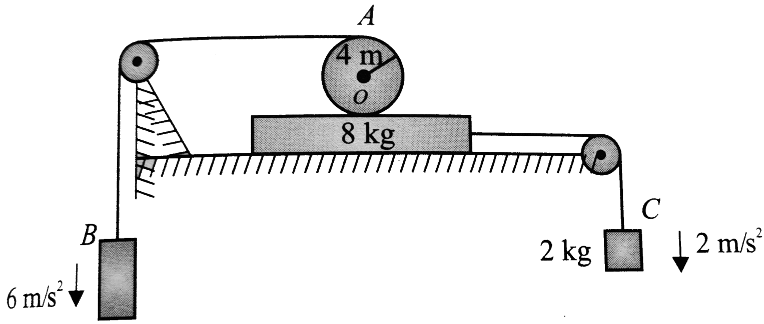
22. Figure shows a uniform smooth solid cylinder A of radius $4m$ rolling without slipping on the $8kg$ plank which, in turn, is supported by a fixed smooth surface. Block B is known to accelerate down with $6m/s^2$ and block C moves down with acceleration $2m/s^2$.



What is the angular acceleration of the cylinder?

A. $\frac{4}{5} rads^{-2}$

B. $\frac{6}{5} rads^{-2}$

C. $2 rads^{-2}$

D. $1 rads^{-2}$

Answer: D

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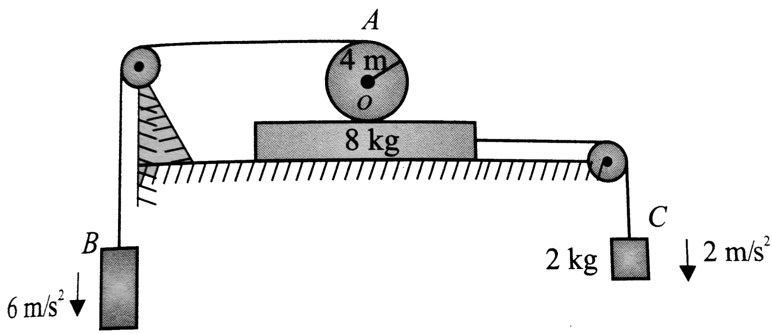
23. Figure shows a uniform smooth solid cylinder A of radius $4m$ rolling without slipping on the $8kg$ plank which, in turn, is supported by a fixed smooth surface. Block B is known to accelerate down with $6m/s^2$ and block C moves down with acceleration $2m/s^2$.



What is the ratio of the mass of the cylinder to the mass of block B?

A. 1

B. 2

C. 3

D. 4

Answer: B

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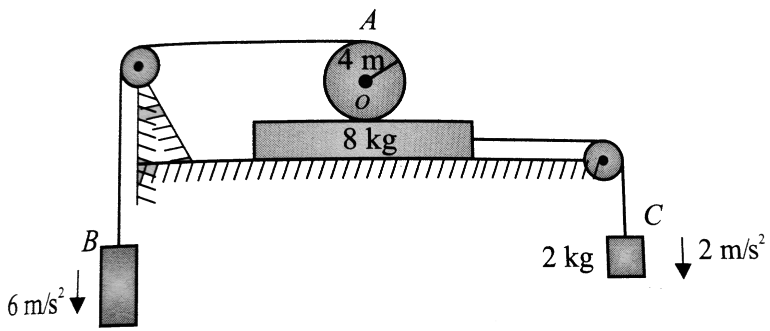
24. Figure shows a uniform smooth solid cylinder A of radius $4m$ rolling without slipping on the $8kg$ plank which, in turn, is supported by a fixed smooth surface. Block B is known to accelerate down with $6m/s^2$ and block C moves down with acceleration $2m/s^2$.



If unwrapped length of the thread between the cylinder and block B is $20m$ at the beginning, when the system was released from rest, what would it be $2s$ later

A. $28m$

B. $30m$

C. $22m$

D. $32.5m$

Answer: A

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25. A man of mass $100kg$ stands at the rim of a turtable of radius $2m$ and moment of inertia $4000kgm^2$ mounted on a vertical frictionless shaft at its centre. The whole system is initially at rest. The man now walks along the outer edge of the turntable with a velocity of $1m/s$ relative to the earth

a. With what angular velocity and in what direction does the turntable rotate?

b. Through what angle will it have rotated when the man reaches his initial position on the turntable?

c. Through what angle will it have rotated when the man reaches his initial position relative to the earth?

A. The table rotates anticlockwise (in the direction of the man motion) with angular velocity $0.05 rad / s$.

B. The table rotates clockwise (opposite to the man) with angular velocity $0.1 rad / s$

.

C. The table rotates clockwise (opposite to the man) with angular velocity $0.05 rad/s$.

D. The table rotates anticlockwise (in the direction of the man motion) with angular velocity $0.1 rad/s$

Answer: C

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26. A man of mass $100kg$ stands at the rim of a turtable of radius $2m$ and moment of inertia $4000kgm^2$ mounted on a vertical frictionless shaft at its centre. The whole system is initially at rest. The man now walks along the outer edge of the turntable with a velocity of $1m/s$ relative to the earth

a. With what angular velocity and in what direction does the turntable rotate?

b. Through what angle will it have rotated when the man reaches his initial position on the turntable?

c. Through what angle will it have rotated when the man reaches his initial position relative to the earth?

A. The table rotates through $2\pi / 11$ radians anticlockwise

B. The table rotates through $4\pi / 11$ radians clockwise

C. The table rotates through $4\pi / 11$ radians anticlock-wise

D. The table rotates through `27pi//11 radians clockwise

Answer: D

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Linked Comprehension

1. A man of mass $100kg$ stands at the rim of a turtable of radius $2m$ and moment of inertia $4000kgm^2$ mounted on a vertical frictionless shaft at its centre. The whole system is initially at rest. The man now walks along the outer edge of the turntable with a velocity of $1 m / s$ relative to the earth

a. With what angular velocity and in what direction does the turntable rotate?

b. Through what angle will it have rotated when the man reaches his initial position on the turntable?

c. Through what angle will it have rotated when the man reaches his initial position relative to the earth?

A. 36° in clockwise direction

B. 36° in anticlockwise direction

C. 72° in clockwise direction

D. 72° in anticlockwise direction

Answer: A

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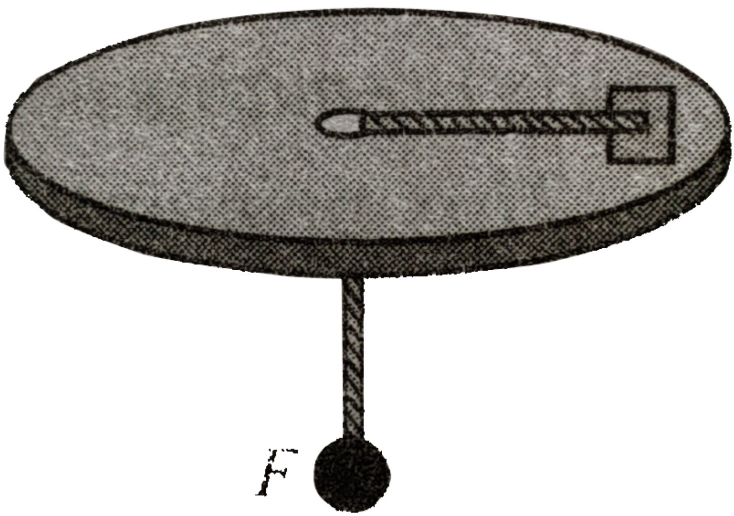
2. A small block of mass $4kg$ is attached to a cord passing through a hole in a horizontal frictionless surface. The block is originally revolving in a circle of radius $0.5m$ about the hole with a tangential velocity of $4m/s$. The cord is then pulled slowly from below, shorteing the radius of the circle in which the block revolves. The breaking strength of the cord is $600N$. What will be radius of the circle when the cord breaks?



A. $4.0m$

B. $1.0m$

C. $3.0m$

D. $2.0m$

Answer: D

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3. A small block of mass $4kg$ is attached to a cord passing through a hole in a horizontal frictionless surface. The block is originally revolving in a circle of radius of $5m$ about the hole, with a tangential velocity of $4m/s$. The cord is then pulled slowly from below, shortening the radius of the circle in which the block revolves. The breaking strength of the cord is $200N$.

Velocity of the block at the time of breaking of the string

A. $10m/s$

B. $20m/s$

C. $7.5m/s$

D. $12.5m/s$

Answer: A

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

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

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

C. $\frac{5v}{3l}$

D. $\frac{3v}{2l}$

Answer: A

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

Determine the position of the point on the rod which remains stationary immediately after collision.

A. The point is a distance $(1/3)l$ from the end where the mass strikes.

B. The point is a distance $(2/3)l$ from the end where the mass strikes.

C. The point is a distance $(2/5)l$ from the end where the mass strikes

D. The point is a distance $(1/5)l$ from the end where the mass strikes

Answer: B

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

A. $\frac{1}{6}mv^2$

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

C. mv^2

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

Answer: A

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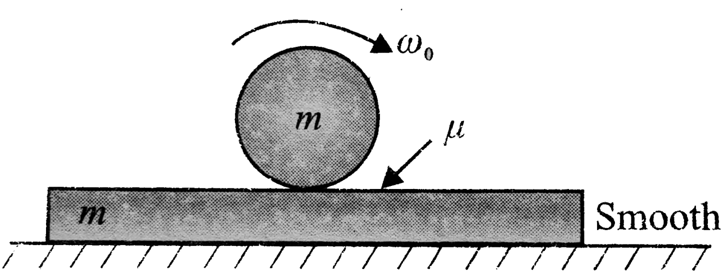
7. A long horizontal plank of mass m is lying on a smooth horizontal surface. A sphere of same mass m and radius r is spinned about its own axis with angular velocity we and gently placed on the plank. The coefficient of friction between the plank and the sphere is μ. After some time the pure rolling of the sphere on the plank will start. Answer the following questions.



Find the time t at which the pure roiling starts

A. $\frac{\omega_0 r}{9\mu g}$

B. $\frac{2\omega_0 r}{9\mu g}$

C. $\frac{\omega_0 r}{3\mu g}$

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

Answer: B

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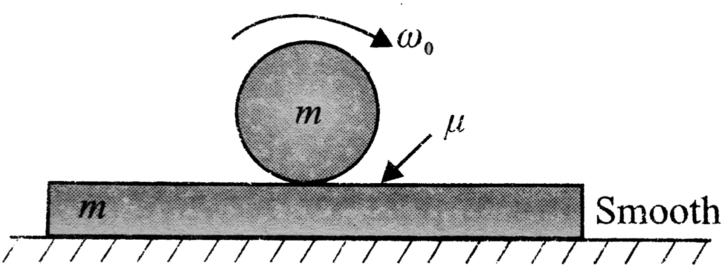
8. A long horizontal plank of mass m is lying on a smooth horizontal surface. A sphere of same mass m and radius r is spinned about its own axis with angular velocity ω_0 and gently placed on the plank. The coefficient of friction between the plank and the sphere is μ.

After some time the pure rolling of the sphere on the plank will start. Answer the following questions.



Find the time t at which the pure roiling starts

A. $\dfrac{2\omega_0 r}{9}$

B. $\dfrac{\omega_0 r}{9}$

C. $\dfrac{\omega_0}{3}$

D. $\frac{2\omega_0 r}{3}$

Answer: A

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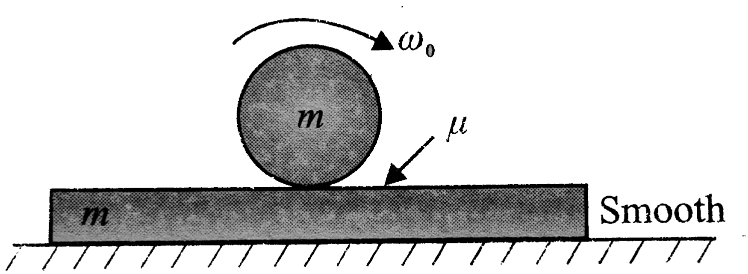
9. A long horizontal plank of mass m is lying on a smooth horizontal surface. A sphere of same mass m and radius r is spinned about its own axis with angular velocity we and gently placed on the plank. The coefficient of friction between the plank and the sphere is μ.

After some time the pure rolling of the sphere on the plank will start. Answer the following questions.



Find the displacement of the plank till the sphere starts pure rolling.

A. $\dfrac{\omega_0^2 r^2}{81\mu g}$

B. $\dfrac{2\omega_0^2 r^2}{27\mu g}$

C. $\dfrac{4\omega_0^2 r^2}{81\mu g}$

D. $\frac{2\omega_0^2 r^2}{81\mu g}$

Answer: D

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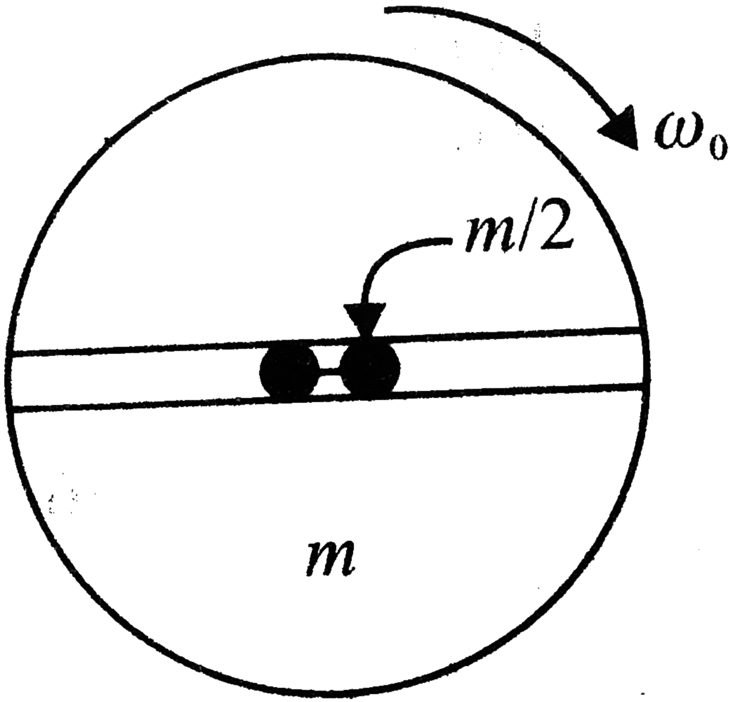
10. A disc of mass m and radius R is free to rotate in a horizontal plane about a vertical smooth fixed axis passing through its centre. There is a smooth groove along the diameter of the disc and two small balls of mass $m/2$ each are placed in it on either side of the centre of the disc as shown in Fig. The disc is given an initial angular velocity ω_0 and released.



The angular speed of the disc when the balls reach the end of the disc is

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

B. $\frac{\omega_0}{3}$

C. $\frac{2\omega_0}{3}$

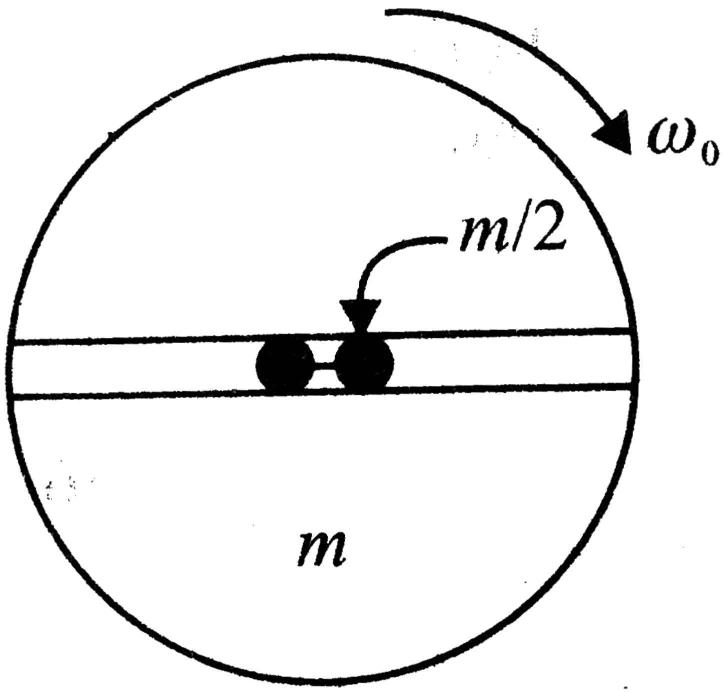
D. $\frac{\omega_0}{4}$

Answer: B

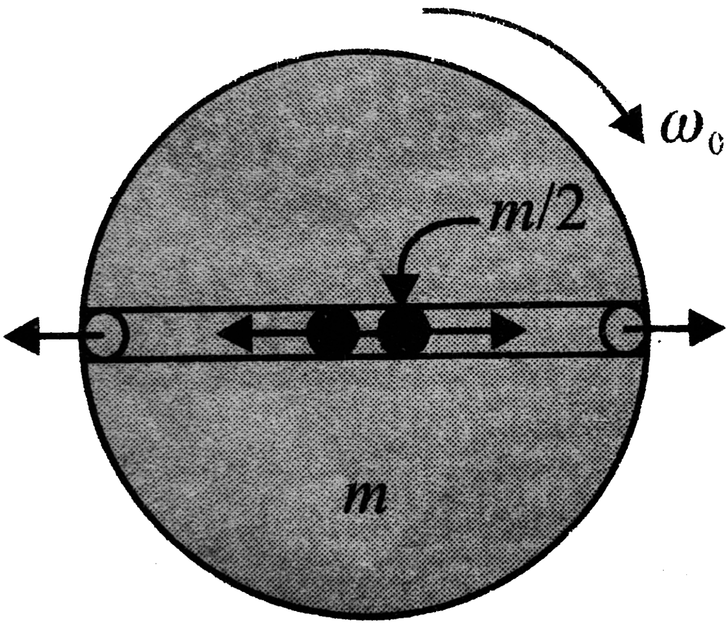
Watch Video Solution

11. A disc of mass m and radius R is free to rotate in a horizontal plane about a vertical smooth fixed axis passing through its centre.

There is a smooth groove along the diameter of the disc and two small balls of mass $m/2$ each are placed in it on either side of the centre of the disc as shown in Fig. The disc is given an initial angular velocity ω_0 and released.



The speed of each ball relative to the ground just after they leave the disc is



A. $\dfrac{R\omega_0}{\sqrt{3}}$

B. $\dfrac{R\omega_0}{\sqrt{2}}$

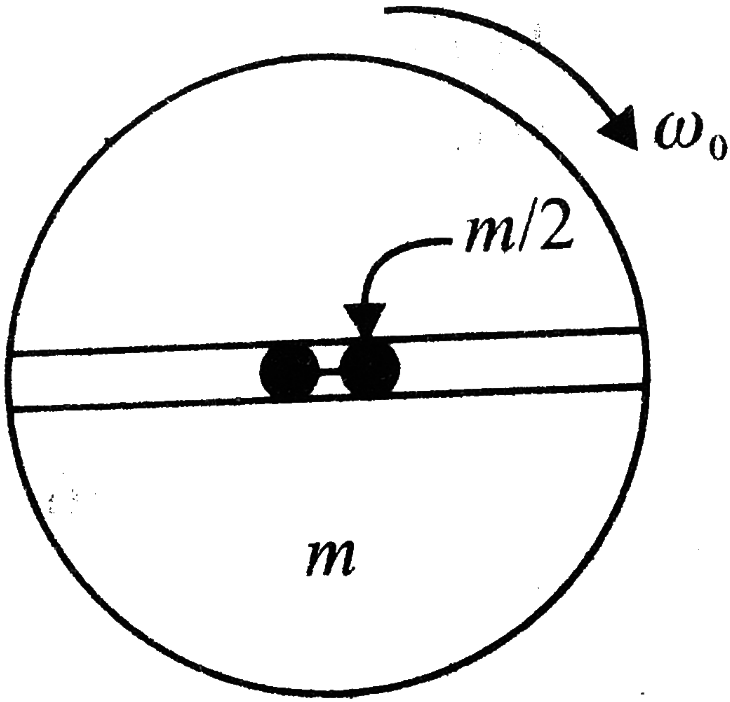
C. $\dfrac{2R\omega_0}{3}$

D. none of these

Answer: C

Watch Video Solution

12. A disc of mass m and radius R is free to rotate in a horizontal plane about a vertical smooth fixed axis passing through its centre. There is a smooth groove along the diameter of the disc and two small balls of mass $m/2$ each are placed in it on either side of the centre of the disc as shown in Fig. The disc is given an initial angular velocity ω_0 and released.



The angular speed of the disc when the balls reach the end of the disc is

A. $\frac{2mR^2\omega_0^2}{9}$

B. $\frac{mR^2\omega_0^2}{18}$

C. $\frac{mR^2\omega_0^2}{6}$

D. $\frac{mR^2\omega_0^2}{9}$

Answer: D

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13. A uniform rod of length L lies on a smooth horizontal table. The rod has a mass M. A particle of mass m moving with speed v strikes the rod perpendicularly at one of the ends of the rod sticks to it after collision.

Find the velocity of the centre of mass C and the angular, velocity of the system about the centre of mass after the collision.

A. $\dfrac{2Mv}{M-m}$

B. $\dfrac{2mv}{M+m}$

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

D. $\dfrac{mv}{M+m}$

Answer: D

Watch Video Solution

14. A uniform rod of length L lies on a smooth horizontal table. The rod has a mass M. A particle of mass m moving with speed v strikes the rod perpendicularly at one of the ends of the rod sticks to it after collision.

Find the velocity of the particle with respect to C before the collision

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

B. $\frac{mv}{M+m}$

C. $\dfrac{2mv}{M+m}$

D. $\dfrac{2Mv}{M+m}$

Answer: A

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15. A uniform rod of length L lies on a smooth horizontal table. The rod has a mass M. A particle of mass m moving with speed v strikes the rod perpendicularly at one of the ends of the rod sticks to it after collision.

Find the velocity of the particle with respect to

C before the collision

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

B. $\frac{mv}{M+m}$

C. $\frac{2mv}{M+m}$

D. $\frac{2Mv}{M+m}$

Answer: B

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16. A uniform rod of mass M and length a lies on a smooth horizontal plane. A particle of mass m moving at a speed v perpendicular to the length of the rod strikes it at a distance $\frac{a}{4}$ from the centre and stops after the collision. Find (a). the velocity of the centre of the rod and (b). the angular velocity of the rod abut its centre just after the collision.

A. $\frac{M^2mvl}{4(M+m)^2}, \frac{m^2Mvl}{4(m+M)}$

B. $\frac{M^2mvl}{2(M+m)^2}, \frac{M^2Mvl}{2(m+M)}$

C. $\frac{M^2mvl}{(M+m)^2}, \frac{m^2Mvl}{(m+M)}$

D. $\frac{2M^2mvl}{(M+m)^2}, 2\frac{m^2Mvl}{(m+M)}$

Answer: B

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17. A uniform rod of mass M and length a lies on a smooth horizontal plane. A particle of mass m moving at a speed v perpendicular to the length of the rod strikes it at a distance $\frac{a}{4}$ from the centre and stops after the collision. Find (a). the velocity of the centre of the rod and (b). the angular velocity of the rod abut its centre just after the collision.

A. $(2mv), (M+m), \frac{3Mv}{(M+2m)L}$

B. $(Mv), (M+m), \frac{6Mv}{(M+4m)L}$

C. $(2mv), (M+m), \frac{3Mv}{(M+4m)L}$

D. $(mv), (M+m), \frac{6Mv}{(M+4m)L}$

Answer: D

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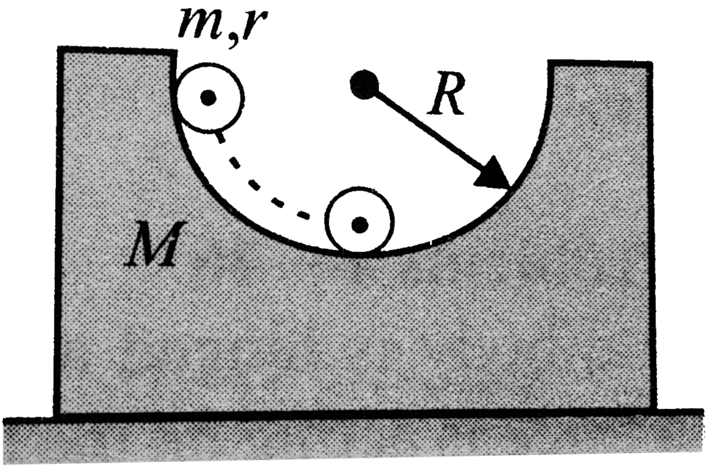
18. A uniform solid cylinder of mass $2kg$ and radius $0.2m$ is released from rest at the top of a semicircular track of radius $0.7m$ cut in a block of mass $M = 3kg$ as shown in Fig. The block is resting on a smooth horizontal surface and the cylinder rolls down without slipping. Based on the above information, answer the following questions:



The distance moved by the block when the cylinder reaches the bottom of the track is

A. $0.3m$

B. $0.5m$

C. $0.7m$

D. $0.2m$

Answer: D

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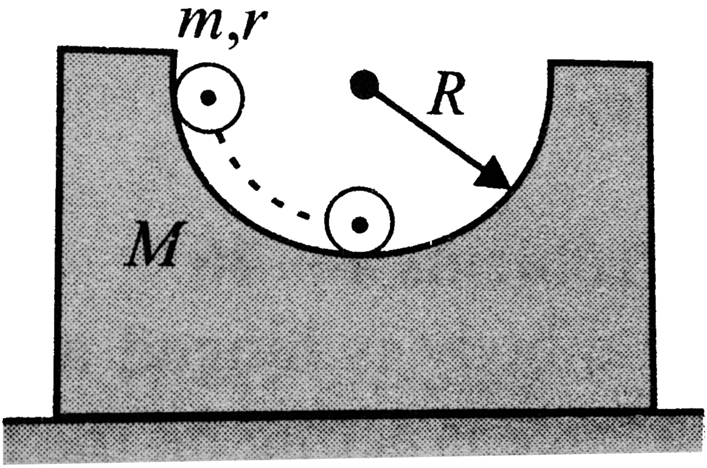
19. A uniform solid cylinder of mass $2kg$ and radius $0.2m$ is released from rest at the top of a semicircular track of radius $0.7m$ cut in a block of mass $M = 3kg$ as shown in Fig. The block is resting on a smooth horizontal surface and the cylinder rolls down without slipping. Based on the above information, answer the following questions:



The distance moved by the block when the cylinder reaches the bottom of the track is

A. $\frac{2}{\sqrt{11}} m/s$

B. $\frac{8}{\sqrt{11}} m/s$

C. $\frac{8}{\sqrt{11}} m/s$

D. $\frac{6}{\sqrt{11}} m/s$

Answer: D

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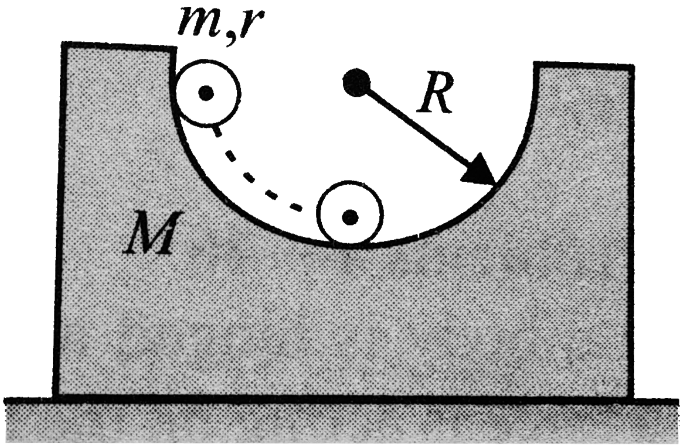
20. A uniform solid cylinder of mass $2kg$ and radius $0.2m$ is released from rest at the top of a semicircular track of radius $0.7m$ cut in a block of mass $M = 3kg$ as shown in Fig. The block is resting on a smooth horizontal surface and the cylinder rolls down without slipping. Based on the above information, answer the following questions:



The speed of the point of contact of the cylinder with the block w.r.t. ground, when the cylinder reaches the bottom of the track is

A. $\frac{2}{\sqrt{11}} m / s$

B. $\frac{8}{\sqrt{11}} m / s$

C. $\frac{4}{\sqrt{11}} m / s$

D. $\frac{6}{\sqrt{11}} m / s$

Answer: D

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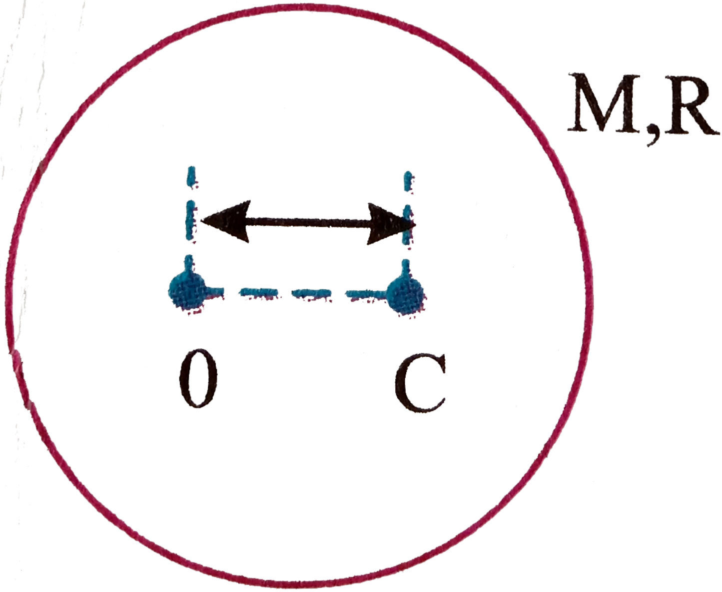
21. A disc of a mass M and radius R can rotate freely in vertical plane about a horizontal axis at O. Distant r from the center of disc as shown in the figure. The disc is released from rest in the shown position.



The angular acceleration of disc when OC rotates by an angles of 37° is

A. $\dfrac{8rg}{5[R^2+2r^2]}$

B. $\dfrac{5rg}{4[R^2+2r^2]}$

C. $\dfrac{10rg}{3[R^2+2r^2]}$

D. $\dfrac{8rg}{5R^2}$

Answer: A

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22. Two uniform spheres A (Hollow) and B (solid) of same radius R (

A. $\sqrt{\dfrac{8gr}{5\{R^2+2r^2]}}$

B. $\sqrt{\dfrac{6gr}{5[R^2+2r^2]}}$

C. $\sqrt{\dfrac{12gr}{5[R^2+2r^2]}}$

D. 0

Answer: C

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23. Two uniform spheres A (Hollow) and B (solid) of same radius R (

A. Mg

B. $\frac{Mg}{5(R^2+2r^2)} \times 3(R^2+6r^2)$

C. $\frac{4Mg}{5(R^2+2r^2)} \times R^2$

D. $\frac{Mg}{5(R^2+2r^2)} \times 4R^2$

Answer: A

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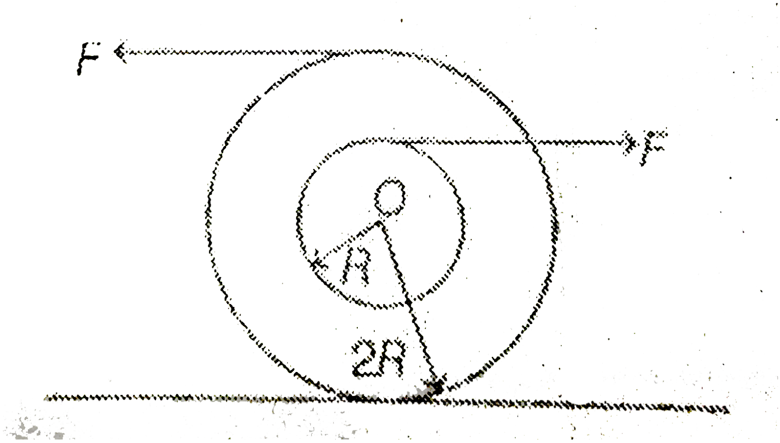
24. In the given figure F=10N , R=1 m , mass of the body is 2 kg and moment of inertia of the body about an axis passing through O and perpendicular to plane of body is $4kg - m^2$ .O is the centre of mass of the body.



If the ground is smooth , what is total kinetic energy of the body after 2 s?

A. $25J$

B. $16.67J$

C. $50J$

D. $37.5J$

Answer: C

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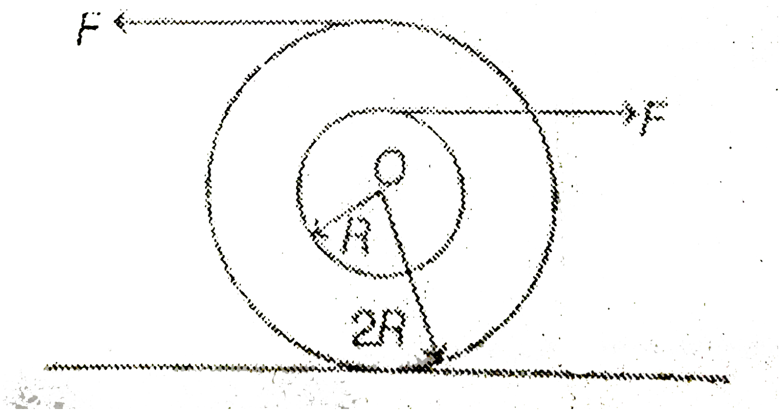
25. In the given figure F=10N , R=1 m , mass of the body is 2 kg and moment of inertia of the body about an axis passing through O and perpendicular to plane of body is $4kg - m^2$ .O is the centre of mass of the body.



If ground is sufficiently rough , what is kinetic energy of the body now in the given time interval ?

A. $18.75J$

B. $25.67J$

C. $16.67J$

D. none of these

Answer: C

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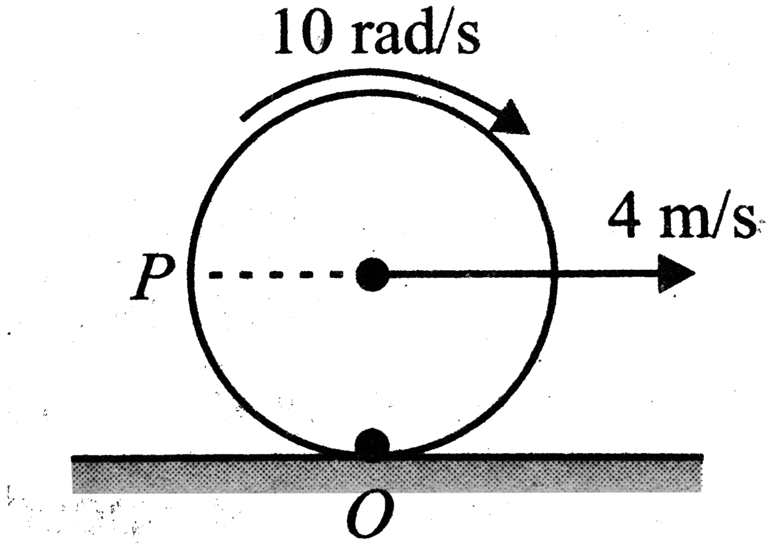
26. A disc of radius $20CM$ is rolling with slipping on a flat horizontal surface. At a certain instant the velocity of its centre is $4m/s$ and its angular velocity is $10rad/s$. The lowest contact point is O.



Velocity of point O is

A. $2m/s$

B. $4m/s$

C. $1m/s$

D. $3m/s$

Answer: A

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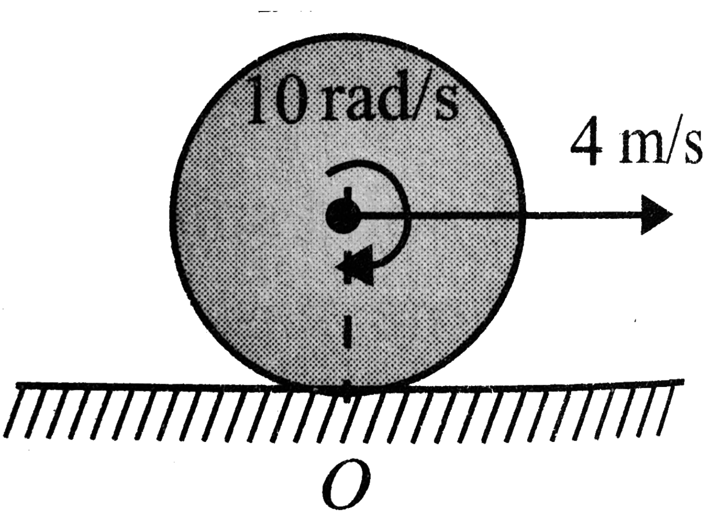
27. A disc of radius $0.2m$ is rolling with slipping on a flat horizontal surface, as shown in Fig. The instantaneous centre of rotation is (the lowest contact point is O and centre of disc is C)



A. $0.2m$ below O

B. $0.2m$ above O

C. $0.6m$ above O

D. $0.4m$ below O

Answer: A

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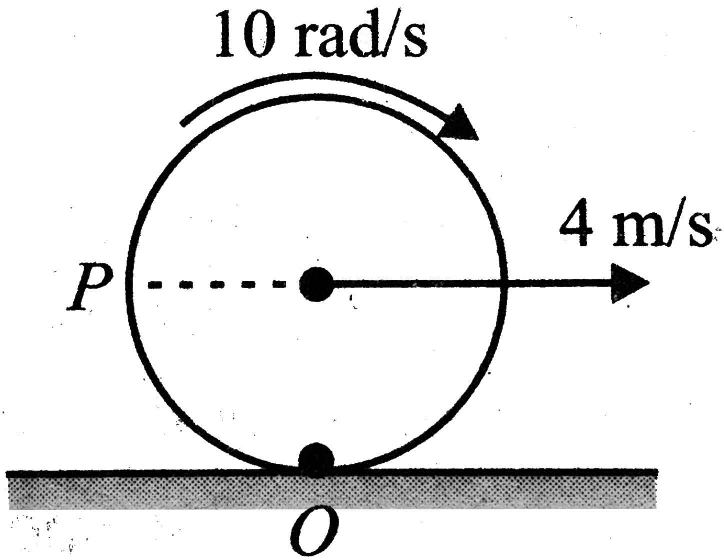
28. A disc of radius $20CM$ is rolling without slipping on a flat horizontal surface. At a certain instant the velocity of its centre is

$4m/s$ and its angular velocity is $10rad/s$. The lowest contact point is O.



Velocity of point P is

A. $\sqrt{10}m/s$

B. $2\sqrt{5}m/s$

C. $\sqrt{5}m/s$

D. $5m / s$

Answer: D

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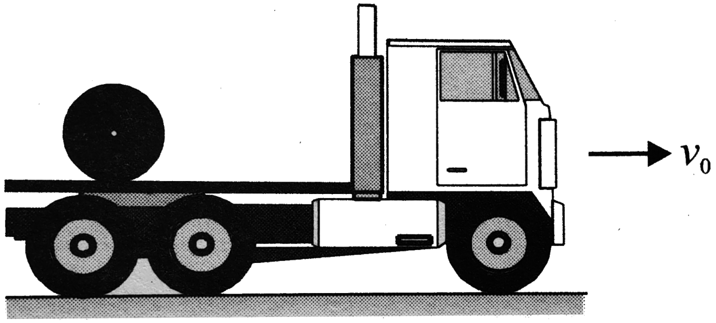
29. A solid sphere of mass M and radius R is initially at rest. Solid sphere is gradually lowered onto a truck moving with constant velocity v_0



What is the final speed of the sphere's centre of mass m ground frame when eventually pure rolling sets in

A. a) $\frac{5}{7}v_0$

B. b) $\frac{2}{7}v_0$

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

D. d) $\frac{7}{2}v_0$

Answer: B

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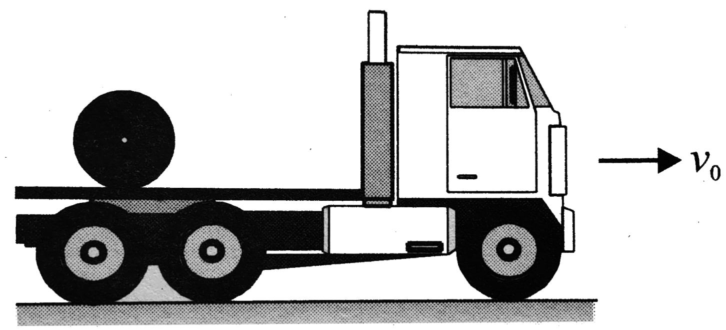
30. A solid sphere of mass M and radius R is initially at rest. Solid sphere is gradually lowered onto a truck moving with constant velocity v_0



What is the final speed of the sphere's centre of mass m ground frame when eventually pure rolling sets in

A. a. $\frac{5}{7}v_0$

B. b. n$\frac{2}{7}v_0$

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

D. d. $\frac{7}{2}v_0$

Answer: B

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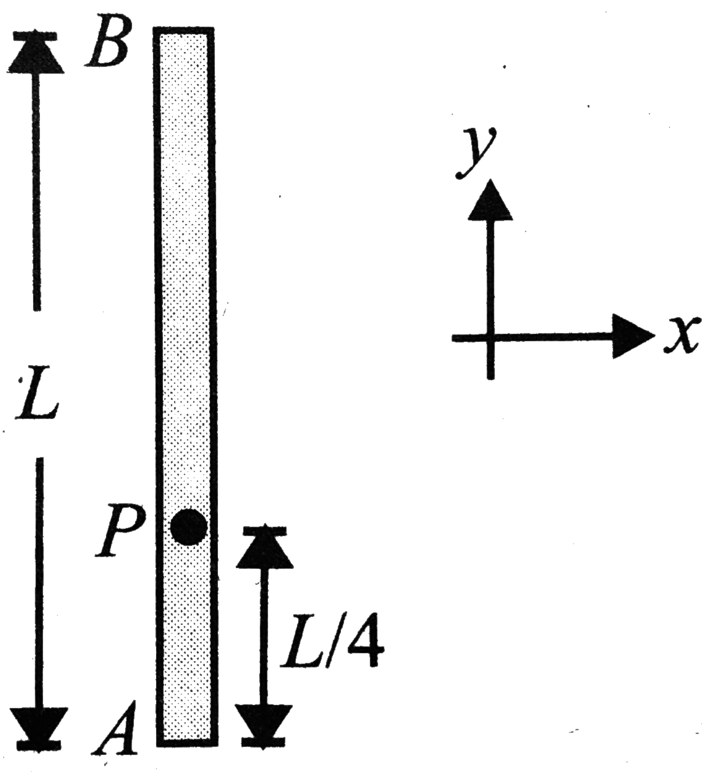
31. A uniform rod AB hinged about a fixed point P is initially vertical. A rod is released from vertical position. When rod is in horizontal position:



The acceleration of the centre of mass of the rod is

A. $-\frac{6g}{7}\hat{i}-\frac{12g}{7}\hat{j}$

B. $-\frac{12g}{7}\hat{i}-\frac{6g}{7}\hat{j}$

C. $-\frac{3g}{7}\hat{i}-\frac{9g}{7}\hat{j}$

D. $-\frac{9g}{7}\hat{i}-\frac{3g}{7}\hat{j}$

Answer: A

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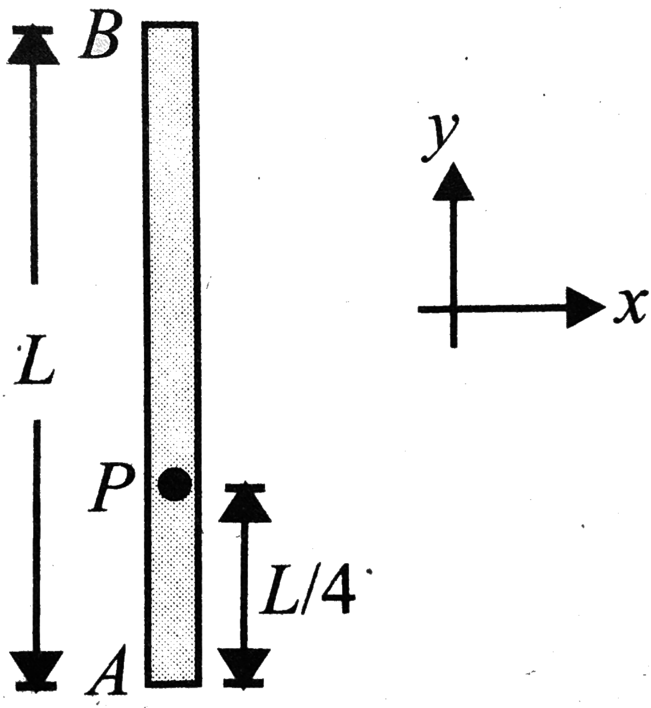
32. A uniform rod AB hinged about a fixed point P is initially vertical. A rod is released from vertical position. When rod is in horizontal position:



The acceleration of end B of the rod is

A. $-\frac{6g}{7}\hat{i}-\frac{12g}{7}\hat{j}$

B. $-\frac{5g}{7}\hat{i}-\frac{6g}{7}\hat{j}$

C. $-\frac{18g}{7}\hat{i}-\frac{5g}{7}\hat{j}$

D. $-\frac{18g}{7}\hat{i}-\frac{9g}{7}\hat{j}$

Answer: D

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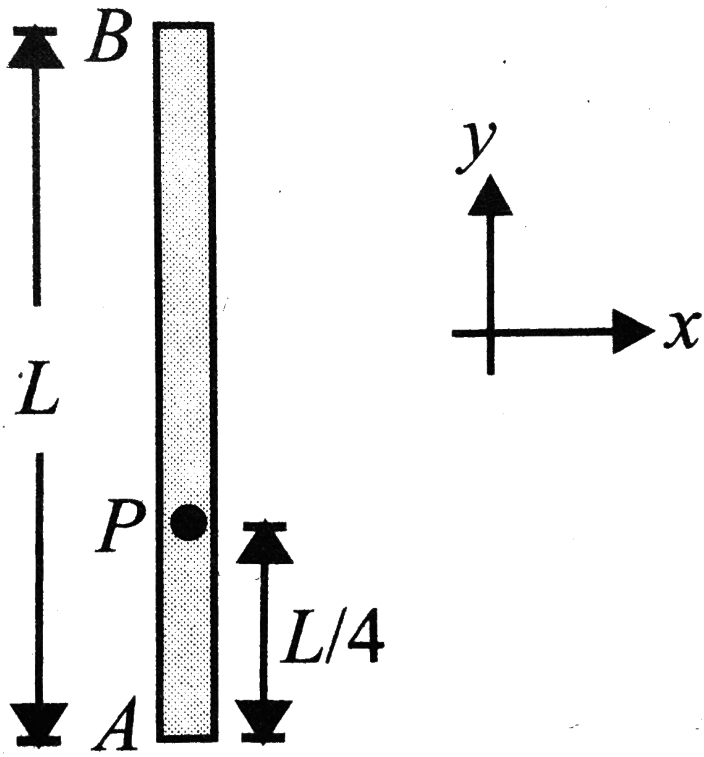
33. A uniform rod AB hinged about a fixed point P is initially vertical. The rod is released from vertical position. When rod is in horizontal position:



The acceleration of the centre of mass of the rod is

A. $-\dfrac{8mg}{7}\hat{i}-\dfrac{12mg}{7}\hat{j}$

B. $-\dfrac{3mg}{7}\hat{i}-\dfrac{9mg}{7}\hat{j}$

C. $-\frac{6mg}{7}\hat{i}-\frac{4mg}{7}\hat{j}$

D. $-\frac{12mg}{7}\hat{i}-\frac{6mg}{7}\hat{j}$

Answer: C

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

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

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

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

D. $\frac{\omega}{4}$

Answer: B

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

A. $\frac{\sqrt{17}}{3} m\omega R$

B. $\frac{\sqrt{35}}{3} m\omega R$

C. $\frac{\sqrt{37}}{3} m\omega R$

D. $\frac{\sqrt{29}}{3} m\omega R$

Answer: C

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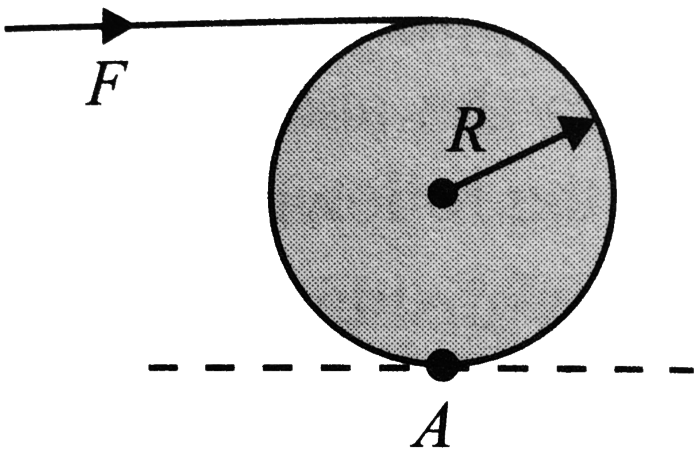
36. When a body is hinged at a point and a force is acting on the body in such a way that the line of action of force is at some distance from the hinged point, the body will start rotating about the hinged point. The angular acceleration of the body can be calculated by finding the torque of that force about the hinged point. A disc of mass m and radius R is hinged at point A at its bottom and is free to rotate in the vertical plane. A force of magnitude F is acting on the ring at top most point.



Tangential acceleration of the centre of mass is

A. $\dfrac{3F}{4m}$

B. $\dfrac{F}{m}$

C. $\dfrac{2F}{3m}$

D. $\dfrac{4F}{3m}$

Answer: D

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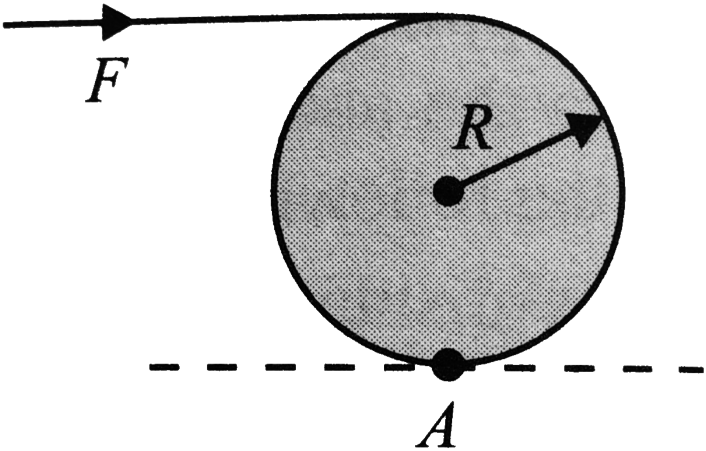
37. When a body is hinged at a point and a force is acting on the body in such a way that the line of action of force is at some distance from the hinged point, the body will start rotating about the hinged point. The angular acceleration of the body can be calculated by finding the torque of that force about the hinged point. A disc of mass m and radius R is hinged at point A at its bottom and is free to rotate in the vertical plane. A force of magnitude F is acting on the ring at top most point.



Component of reaction at the hinge in the vertical direction is

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

B. mg

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

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

Answer: B

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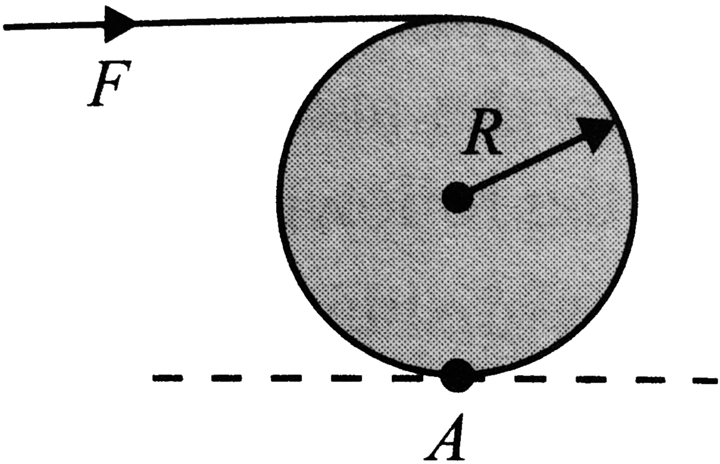
38. When a body is hinged at a point and a force is acting on the body in such a way that the line of action of force is at some distance from the hinged point, the body will start rotating about the hinged point. The angular acceleration of the body can be calculated by finding the torque of that force about the hinged point. A disc of mass m and radius R is hinged at point A at its bottom and is free to rotate in the vertical plane. A force of magnitude F is acting on the ring at top most point.



Component of reaction at the hinge in the horizontal direction is

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

B. F

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

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

Answer: C

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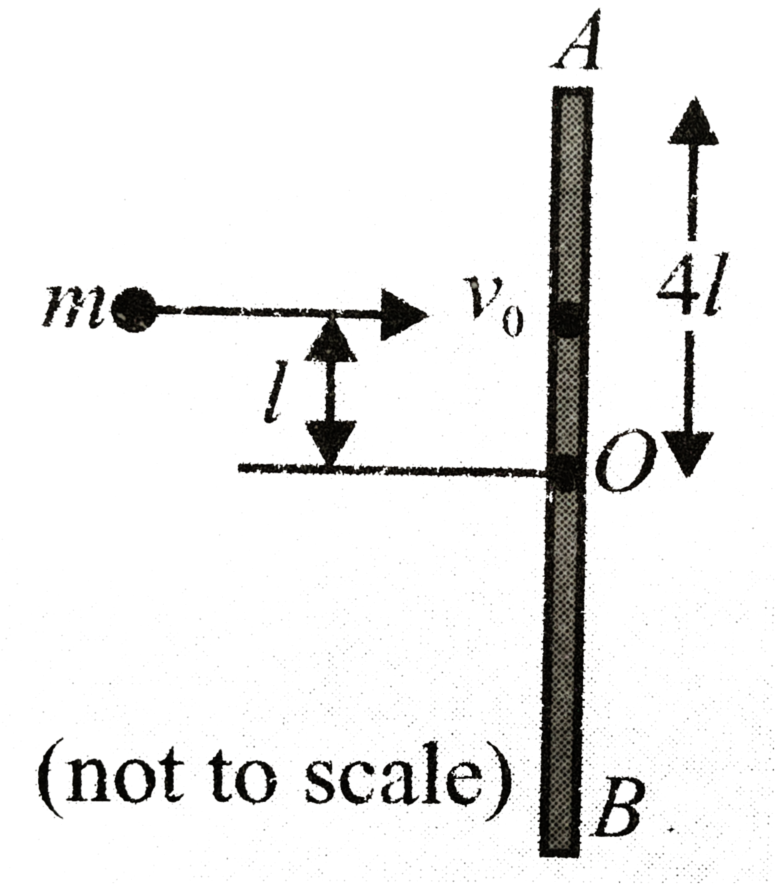
39. A rod AB of mass M and length $8l$ lies on a smooth horizontal surface. A particle, of mass m and velocity v_0 strike's the rod perpendicular to its length, as shown in Fig. As a result of the collision, the centre of mass of the rod attains a speed of $v_0/8$ and the particle rebounds back with a speed of $v_0/4$. Find the following: a. The ratio M/m. b. The angular velocity of the rod about O. c. The coefficient of restitution $'e'$ for the collision. d. The velocities of the ends $'A'$ and $'B'$ of

the rod, namely, v_A and v_B respectively.



A. $\frac{M}{m}=10$

B. $\frac{M}{m}=4$

C. $\frac{M}{m}=8$

D. $\frac{M}{m} = 5$

Answer: A

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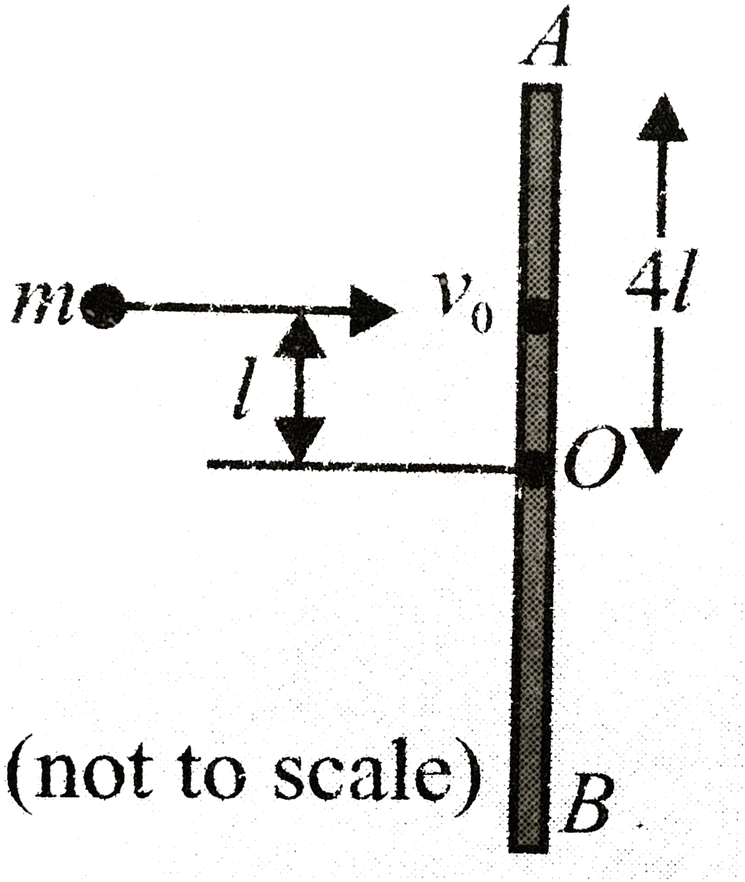
40. A rod AB of mass M and length $8l$ lies on a smooth horizontal surface. A particle, of mass m and velocity v_0 strike's the rod perpendicular to its length, as shown in Fig. As a result of the collision, the centre of mass of the rod attains a speed of $v_0/8$ and the

particle rebounds back with a speed of $v_0\,/\,4$. Find the following: a. The ratio $M\,/\,m$. b. The angular velocity of the rod about O. c. The coefficient of restitution $'e'$ for the collision. d. The velocities of the ends $'A'$ and $'B'$ of

the rod, namely, v_A and v_B respectively.



A. $\frac{5v_0}{128l}$

B. $\frac{3v_0}{128l}$

C. $\frac{v_0}{128l}$

D. $\frac{7v_0}{128l}$

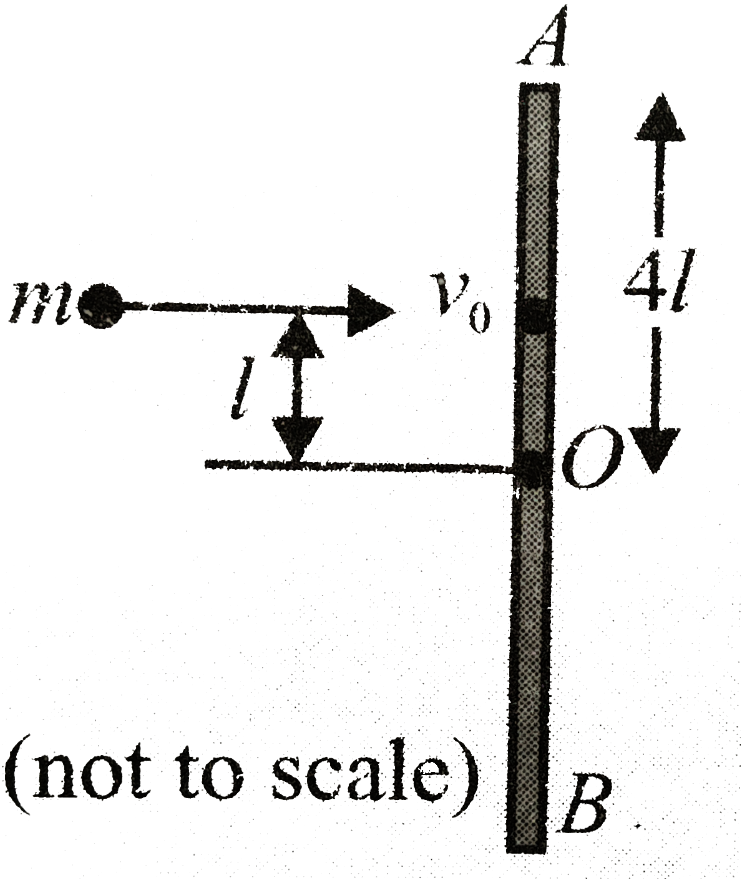
Answer: B

Watch Video Solution

41. A rod AB of mass M and length $8l$ lies on a smooth horizontal surface. A particle, of mass m and velocity v_0 strike's the rod perpendicular to its length, as shown in Fig. As a result of the collision, the centre of mass of the rod attains a speed of $v_0/8$ and the

particle rebounds back with a speed of $v_0\,/\,4$. Find the following: a. The ratio $M\,/\,m$. b. The angular velocity of the rod about O. c. The coefficient of restitution $'e'$ for the collision. d. The velocities of the ends $'A'$ and $'B'$ of

the rod, namely, v_A and v_B respectively.



(not to scale)

A. $\frac{51}{128}$

B. $\frac{61}{128}$

C. $\frac{21}{128}$

D. $\frac{31}{128}$

Answer: A

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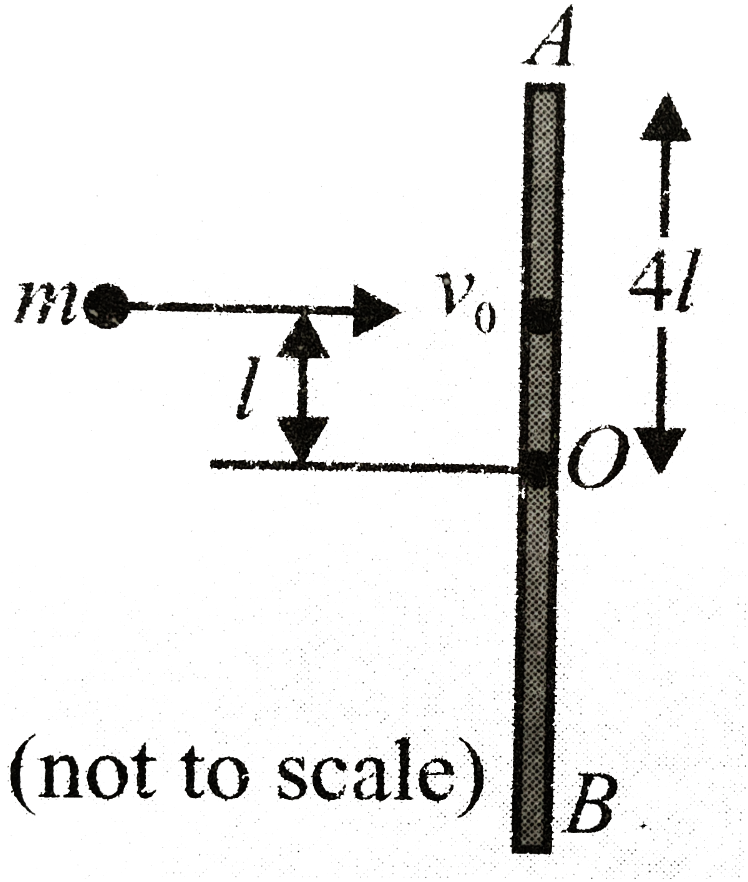
42. A rod AB of mass M and length $8l$ lies on a smooth horizontal surface. A particle, of mass m and velocity v_0 strike's the rod perpendicular to its length, as shown in Fig. As a result of the collision, the centre of mass of the rod attains a speed of $v_0/8$ and the

particle rebounds back with a speed of $v_0/4$. Find the following: a. The ratio M/m. b. The angular velocity of the rod about O. c. The coefficient of restitution $'e'$ for the collision. d. The velocities of the ends $'A'$ and $'B'$ of

the rod, namely, v_A and v_B respectively.



A. $v_A = \frac{5}{32} v_0, v_B = \frac{1}{32} v_0$

B. $v_A = \frac{7}{32} v_0, v_B = \frac{3}{32} v_0$

C. $v_A \frac{=}{32} v_0, v_B = \frac{1}{32} v_0$

D. $v_A = \frac{5}{32}v_0, v_B = \frac{3}{32}v_0$

Answer: C

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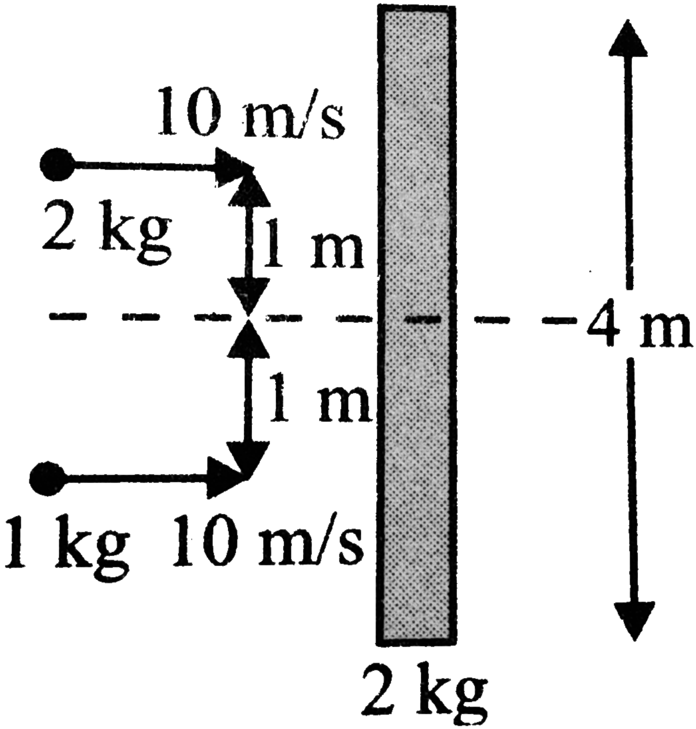
43. A long slender rod of mass $2kg$ and length m is placed on a smooth horizontal table. Two particles of masses $2kg$ and $1kg$ strike the rod simultaneously and stick to the rod after collision as shown in fig.



Velocity of the centre of mass of the rod after collision is

A. $12m / s$

B. $9m / s$

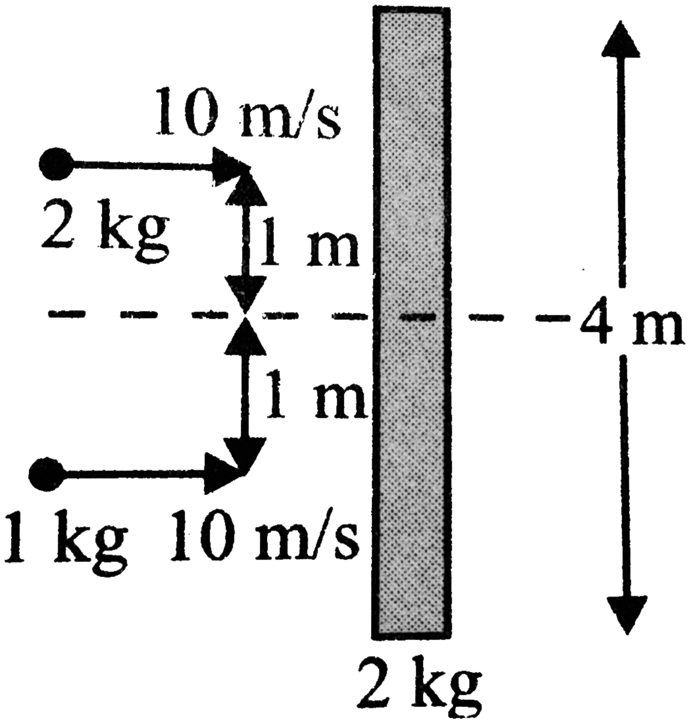
C. $6m / s$

D. $3m/s$

Answer: C

Watch Video Solution

44. A long slender rod of mass $2kg$ and length m is placed on a smooth horizontal table. Two particles of masses $2kg$ and $1kg$ strike the rod simultaneously and stick to the rod after collision as shown in fig.



Angular velocity of the rod after collision is

A. $\frac{11}{17} rad/s$

B. $1 rad/s$

C. $\frac{19}{17} rad/s$

D. $\frac{30}{17} rad / s$

Answer: D

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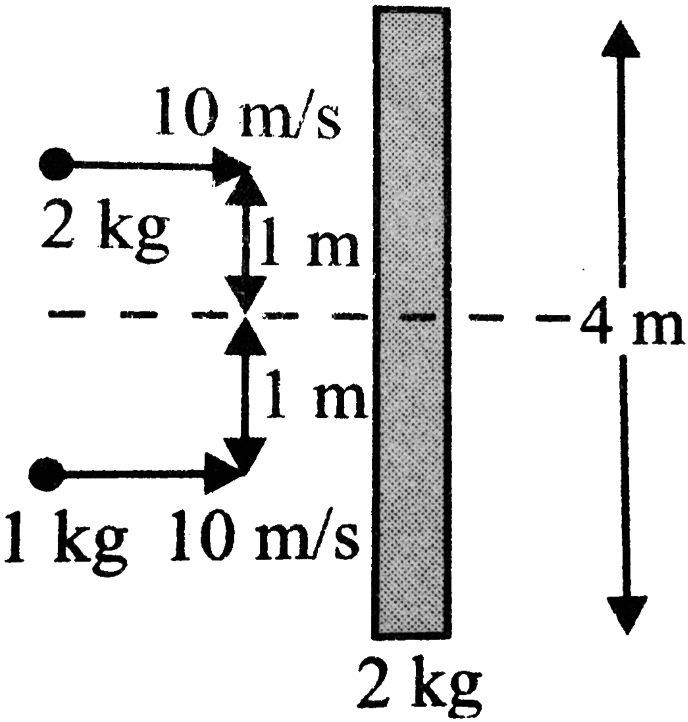
45. A long slender rod of mass $2kg$ and length m is placed on a smooth horizontal table. Two particles of masses $2kg$ and $1kg$ strike the rod simultaneously and stick to the rod after collision as shown in fig.



Angular velocity of the rod after collision is

A. rotate faster but translate at the same rate

B. show no change in linear or angular velocity

C. rotate slower and translate faster

D. rotate faster and translate slower

Answer: D

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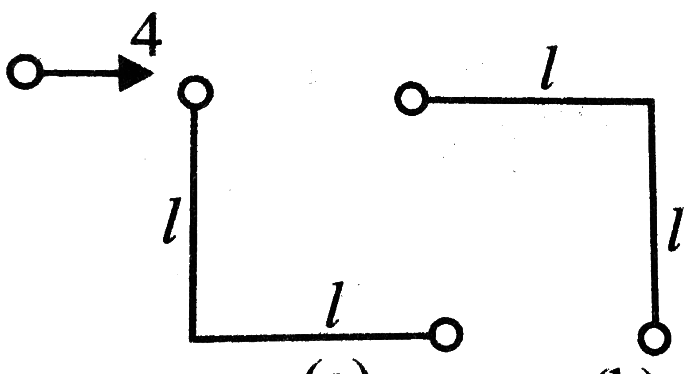
46. A spherical ball of mass M moving with initial velocity V collides elastically with another ball of mass M, which is fixed at one end of L shaped rigid massless frame as shown in Fig. (a). The L shaped frame contains another mass M connected at the other end.



(a) (b)

The speed of the striking mass after collision is

A. $u/2$ backwards

B. 0

C. $u/3$ in same direction

D. $u/7$ backwards

Answer: D

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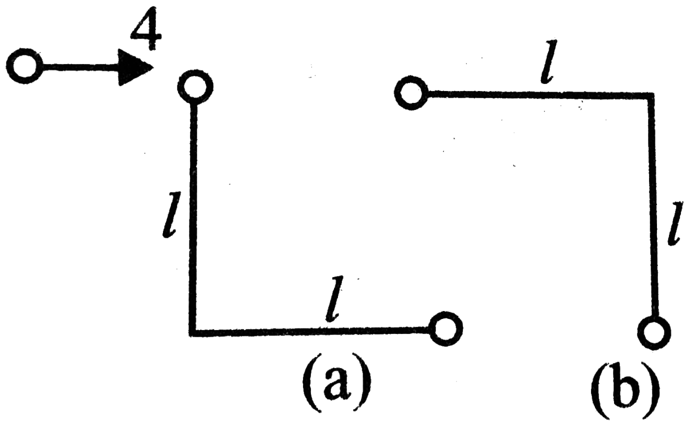
47. A spherical ball of mass M moving with initial velocity u collides elastically with another ball of mass M, which is fixed at one end of L shaped rigid massless frame as shown in Fig. (a). The L shaped frame contains another mass M connected at the other end.



The speed of the striking mass after collision

is

A. $\frac{4u}{7l}$

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

C. $\frac{4u}{2l}$

D. $\frac{u}{7l}$

Answer: A

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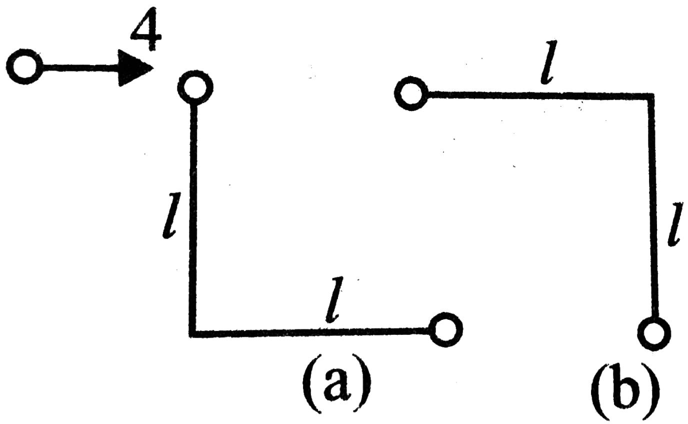
48. A spherical ball of mass M moving with initial velocity u collides elastically with another ball of mass M, which is fixed at one end of L shaped rigid massless frame as shown in Fig. (a). The L shaped frame contains another mass M connected at the other end.



The speed of the striking mass after collision

is

A. $\frac{\pi l}{4v}$

B. $\frac{7\pi l}{8v}$

C. $\frac{\pi l}{v}$

D. $\frac{7\pi l}{2v}$

Answer: D

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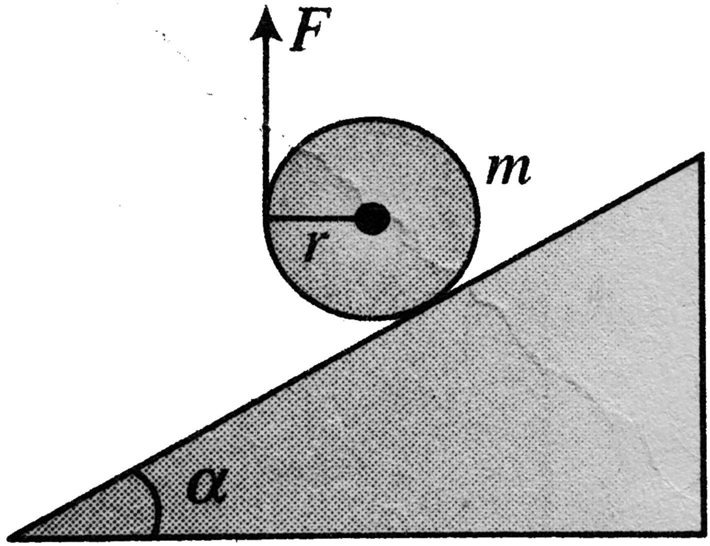
49. A solid cylinder of mass m is kept in balance on a fixed incline of angle $\alpha = 37^\circ$ with the help of a thread fastened to its jacket. The cylinder does not slip.



What force F is reqired to kep the cylinder in balance when the thread is held vertically?

A. $mg/2$

B. $3mg/4$

C. $3mg/8$

D. $5mg/8$

Answer: C

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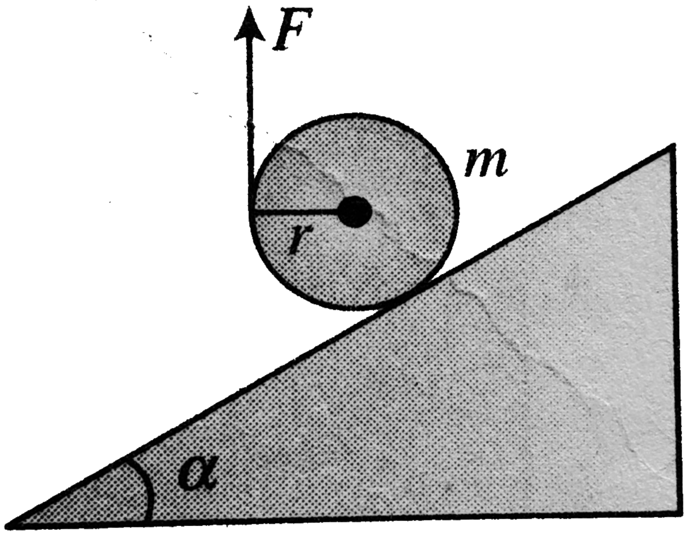
50. A solid cylinder of mass m is kept in balance on a fixed incline of angle $\alpha = 37^\circ$ with the help of a thread fastened to its jacket. The cylinder does not slip.



In what direction should the thread be pulled to minimise the force required to hold the cylinder? What is the magnitude of this force?

A. $3mg/10$ parallel to incline

B. vertical $3mg/8$

C. horizontal $mg/5$

D. $3mg/5$ perpendicular to incline

Answer: A

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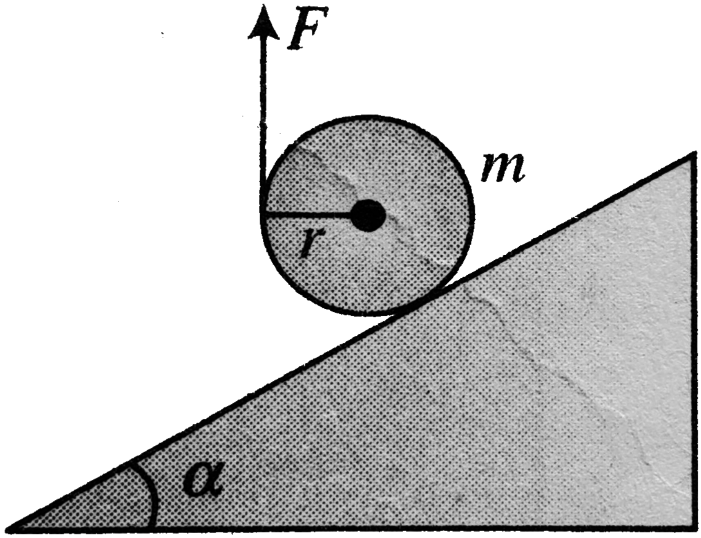
51. A solid cylinder of mass m is kept in balance on a fixed incline of angle $\alpha = 37^\circ$ with the help of a thread fastened to its jacket. The cylinder does not slip.



The values of minimum coefficient of static friction between cylinder and incline in the case when F is minimum.

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

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

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

D. none of these

Answer: B

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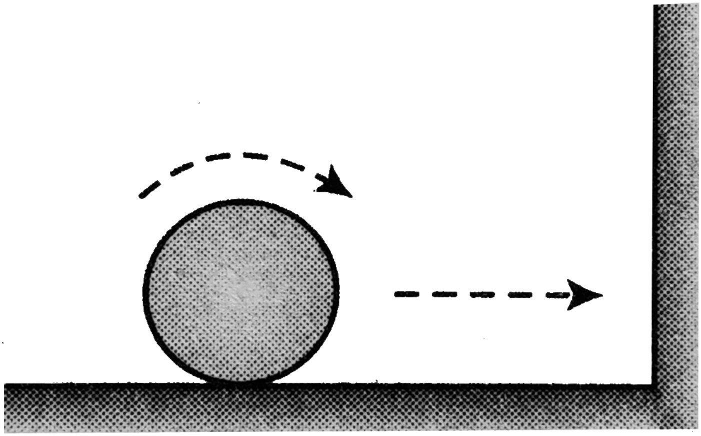
52. A ball, rolling purely on a horizontal floor with centre's speed v, hits a smooth vertical wall surface elastically. Answer the following questions.



Just after the collision is over, the velocity of the lowest point of the ball is

A. v, leftward

B. $2v$, leftward

C. v, rightward

D. $2v$, rightward

Answer: B

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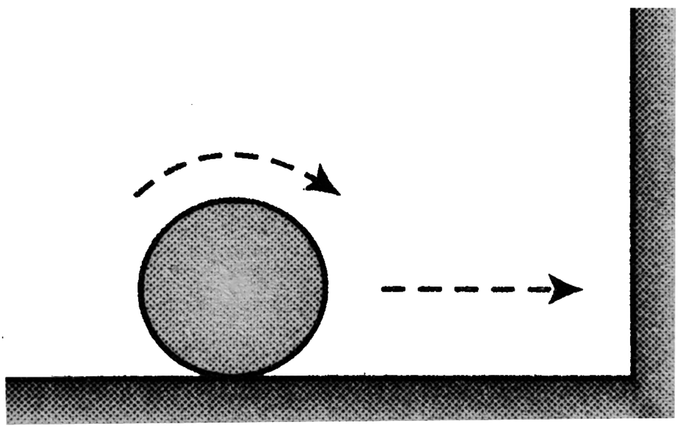
53. A ball, rolling purely on a horizontal floor with centre's speed v, hits a smooth vertical wall surface elastically. Answer the following questions.



The change in angular momentum of the solid ball (mass m, radius R), about the corner point of floor and wall, due to the collision is

A. $2mvR$

B. mvR

C. $mvR/2$

D. none of these

Answer: A

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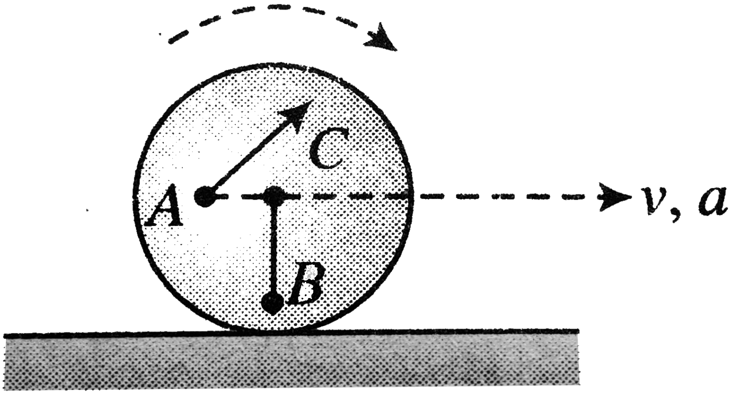
54. A uniform disc of mass $1kg$ and radius $20cm$ is rolling purely on a flat horizontal surface. Its centre C is moving with acceleration $a = 20ms^{-2}$ and velocity $v = 4m/s$ at a certain instant. At this instant. points A and B are located on the disc as shown in the diagram, with $AC = BC = 10cm$.



What is the kinetic energy of the disc?

A. $12J$

B. $8J$

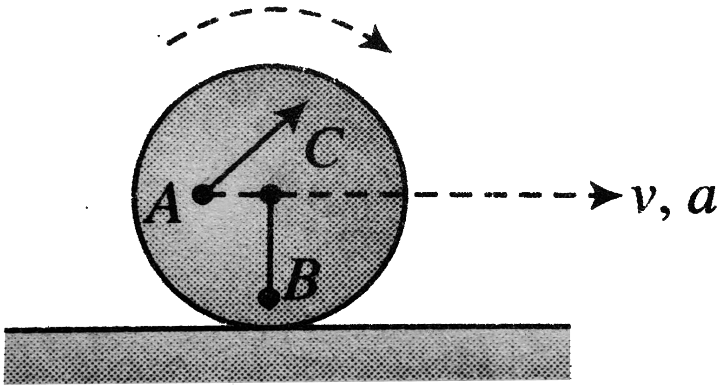
C. $20J$

D. $10J$

Answer: A

Watch Video Solution

55. A uniform disc of mass $1kg$ and radius $20cm$ is rolling purely on a flat horizontal surface. Its centre C is moving with acceleration $a = 20ms^{-2}$ and velocity $v = 4m/s$ at a certain instant. At this instant. points A and B are located on the disc as shown in the diagram, with $AC = BC = 10cm$.



What is the acceleration magnitude of point A

?

A. $10\sqrt{17} m s^{-2}$

B. $10\sqrt{37} m s^{-2}$

C. $10\sqrt{35} m s^{-2}$

D. $60\sqrt{17} m s^{-2}$

Answer: B

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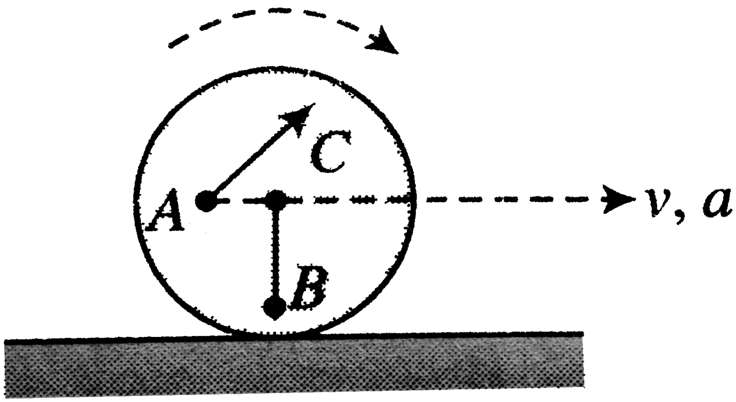
56. A uniform disc of mass $1kg$ and radius $20cm$ is rolling purely on a flat horizontal surface. Its centre C is moving with acceleration $a = 20ms^{-2}$ and velocity $v = 4m/s$ at a certain instant. At this instant. points A and B are located on the disc as shown in the diagram, with $AC = BC = 10cm$.



What is the acceleration magnitude of point B

?

A. $10\sqrt{17}ms^{-2}$

B. $10\sqrt{37}ms^{-2}$

C. $10\sqrt{35}ms^{-2}$

D. $60\sqrt{17}ms^{-2}$

Answer: A

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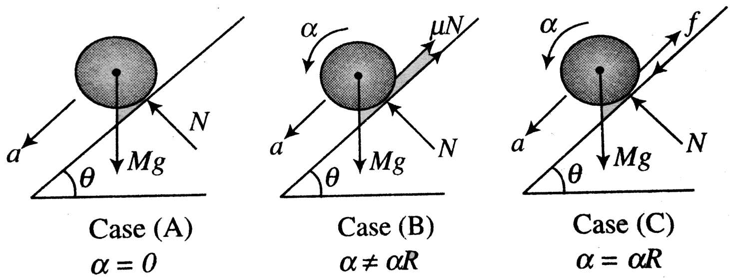
57. In this passage a brief idea is given of the motion of the rolling bodies on an inclined plane. We will consider three cases: objects are released on an incline plane

Case-A: which is smooth.

Case-B: where friction is insufficient to provide pure rolling.

Case-C: where friction is sufficient to provide pure rolling. Force diagram for three cases are as follows: (where symbols have their usual meanings)



If the four objects given in the above question are of same mass, same radius having the same friction coefficient and are released from the same height, then at the bottom the object which will have least kinetic energy for case B will be the:

A. all three masses

B. case A and B

C. only case C

D. depends on the mass of the spheres

Answer: A

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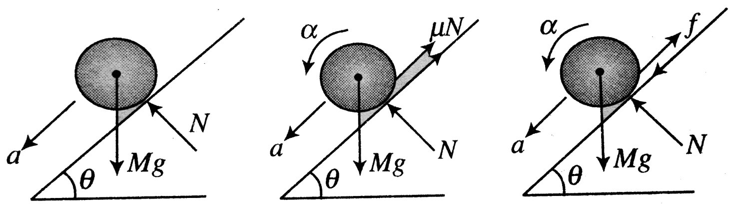
58. In this passage a brief idea is given of the motion of the rolling bodies on an inclined plane. We will consider three cases: objects are released on an incline plane

Case-A: which is smooth.

Case-B: where friction is insufficient to provide pure rolling.

Case-C: where friction is sufficient to provide pure rolling. Force diagram for three cases are as follows: (where symbols have their usual meanings)



Case (A) $\alpha = 0$ Case (B) $\alpha \neq aR$ Case (C) $\alpha = aR$

If the four objects given in the above question are of same mass, same radius having the same friction coefficient and are released from the same height, then at the bottom the object which will have least kinetic energy for case B will be the:

A. hollow sphere

B. solid sphere

C. ring

D. disc

Answer: C

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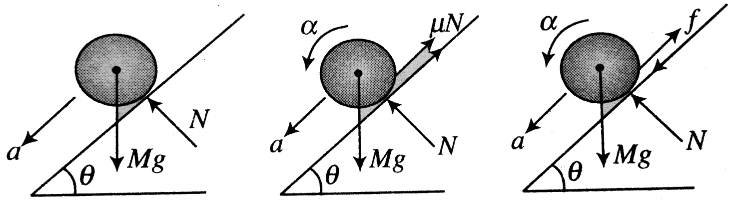
59. In this passage a brief idea is given of the motion of the rolling bodies on an inclined plane. We will consider three cases: objects are released on an incline plane

Case-A: which is smooth.

Case-B: where friction is insufficient to provide pure rolling.

Case-C: where friction is sufficient to provide pure rolling. Force diagram for three cases are as follows: (where symbols have their usual meanings)



Case (A)
$a = 0$

Case (B)
$a \neq \alpha R$

Case (C)
$a = \alpha R$

If the four objects given in the above question are of same mass, same radius having the same friction coefficient and are released from the same height, then at the bottom the object which will have least kinetic energy for case B will be the:

A. hollow sphere

B. solid sphere

C. ring

D. disc

Answer: C

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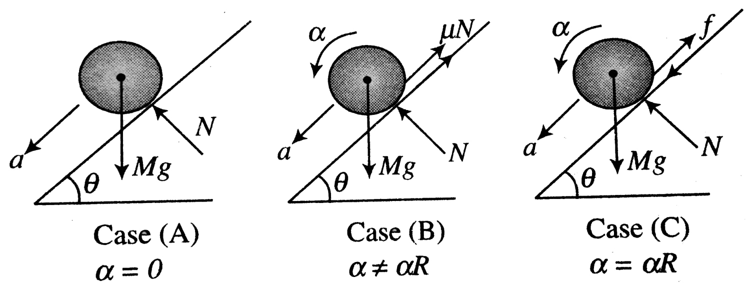
60. In this passage a brief idea is given of the motion of the rolling bodies on an inclined plane. We will consider three cases: objects are released on an incline plane

Case-A: which is smooth.

Case-B: where friction is insufficient to provide pure rolling.

Case-C: where friction is sufficient to provide pure rolling. Force diagram for three cases are as follows: (where symbols have their usual meanings)



Two children A and B use bicycles, having wheels of ring type and disc type respectively. During a race, bicycles are given the same velocity from the bottom of the inclined bridge to ascend the bridge without pedalling, then (assuming pure rolling).

A. both bicycles with reach up to same height

B. bicycle of child A will reach a greater height

C. bicycle of child B will reach a greater height

D. bicycle of child B will reach a greater height

Answer: B

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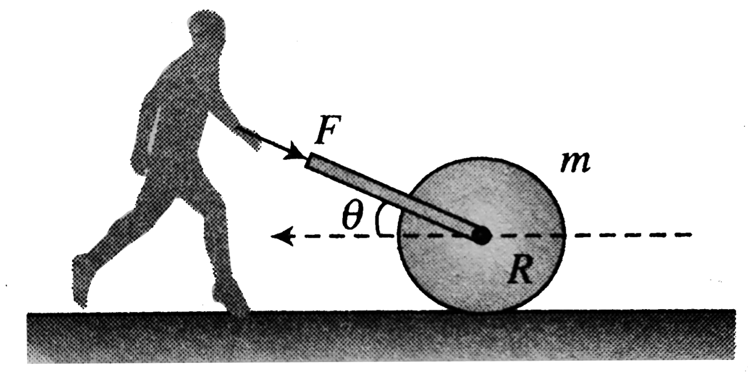
61. A gardener presses the grasscutter with a force F at an angle θ. Assume the motion of grasscutter as pure rolling. Find the:



friction between the grasscutter (assumed as a disc) and ground.

A. $\frac{F \sin \theta}{3}$

B. $\frac{F \cos \theta}{3}$

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

D. $\frac{2F \cos \theta}{3}$

Answer: B

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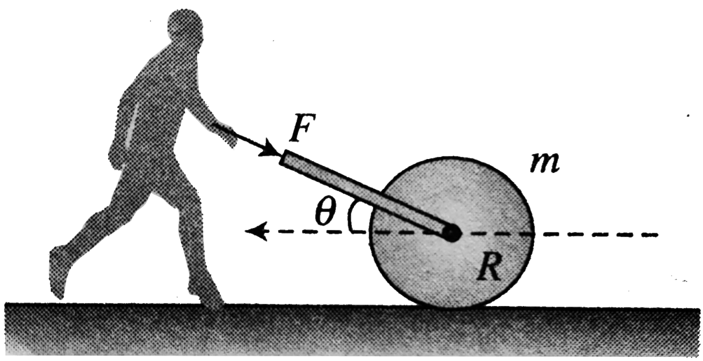
62. A gardener presses the grasscutter with a force F at an angle θ. Assume the motion of grasscutter as pure rolling. Find the:



Acceleration of CM of the roller (disc). Assume that the mass of the disc is m and neglect the mass of the connecting rod.

A. $\dfrac{2F\cos\theta}{3m}$

B. $\dfrac{F\sin\theta}{3m}$

C. $\dfrac{2F\sin\theta}{3m}$

D. $\dfrac{F\cos\theta}{3m}$

Answer: A

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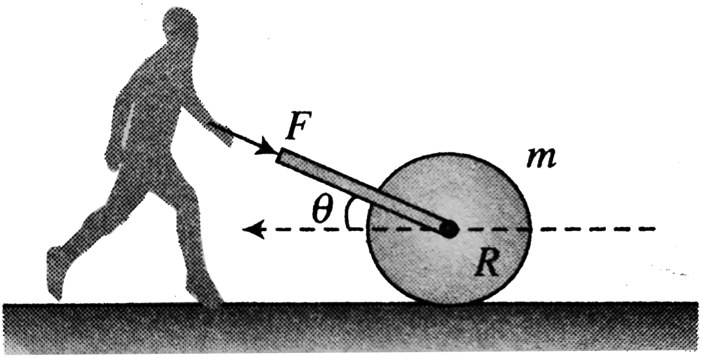
63. A gardener presses the grasscutter with a force F at an angle θ. Assume the motion of grasscutter as pure rolling. Find the:



Maximum force F for no relative slidng if th

coeficient of friction between the roller and

ground is μ

A. $\dfrac{\mu mg\cos\theta}{\cos\theta+3\mu\sin\theta}$

B. $\dfrac{\mu mg\sin\theta}{\cos\theta+3\mu\sin\theta}$

C. $\dfrac{3\mu mg}{\cos\theta-3\mu\sin\theta}$

D. $\dfrac{3\mu mg}{\cos\theta+3\mu\sin\theta}$

Answer: C

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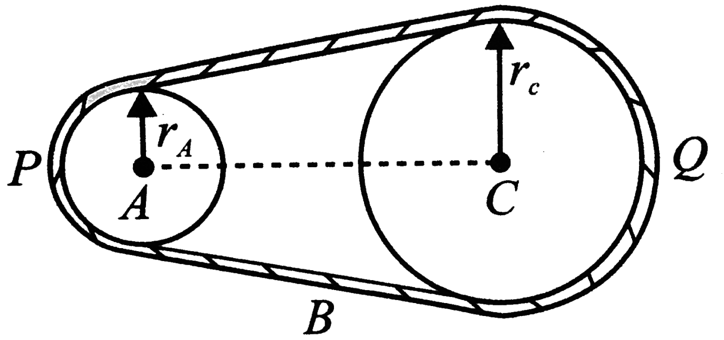
64. Two wheels A and C are connected by a belt B as shown in figure. The radius of C is three times the raedius of A. What would be the ratio of the rotational inertias (I_A / I_C) if both the wheels have the same rotational kinetic energy?



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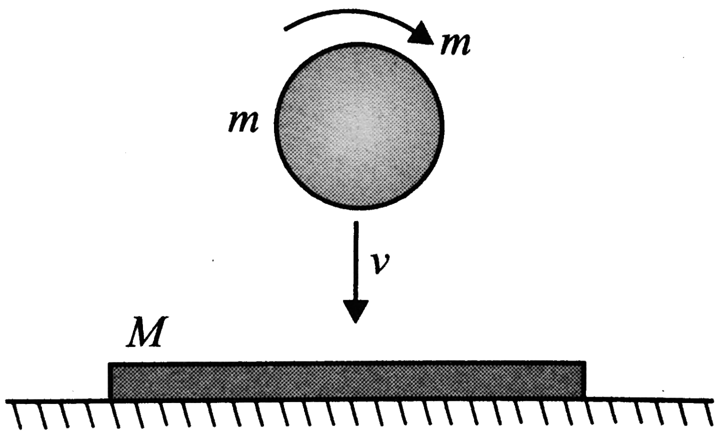
65. A solid ball of mass m and radius r spinning with angular velocity ω falls on a horizontal slab of mass M with rough upper surface (coefficient of friction μ) and smooth lower surface. Immediately after collision the normal component of velocity of the ball remains half of its value just before collision and it stops spinning. Find the velocity of the sphere in horizontal direction immediately after the impact (given: $R\omega = 5$).



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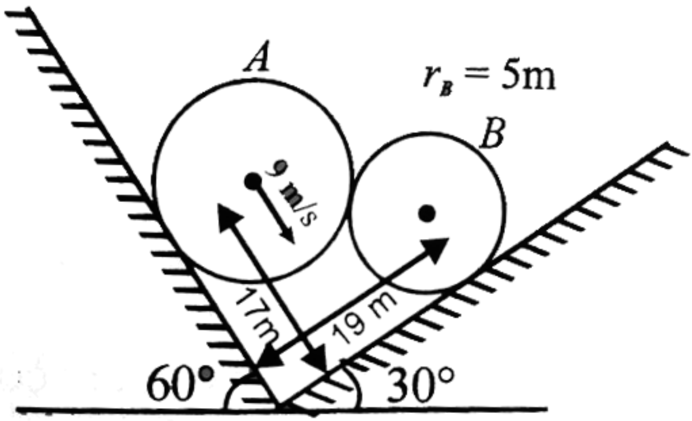
66. 

System is shown in the figure. Velocity of sphere A is 9 $\frac{m}{s}$. Find the speed of sphere B.

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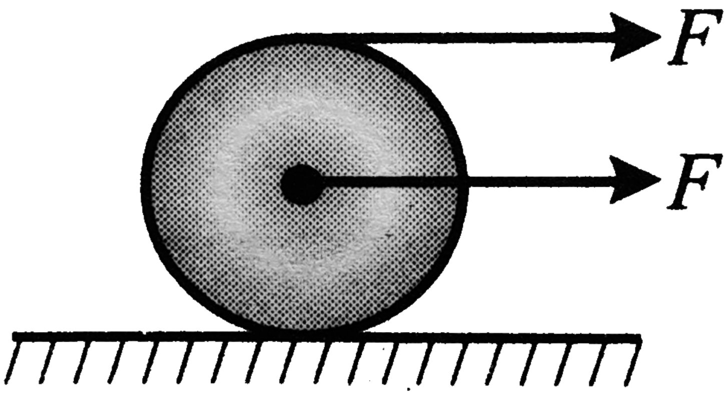
67. Two forces of magnitude F are acting on a uniform disc kept on a horizontal rough

surface as shown in the figure. Friction force by the horizontal surface on the disc is nF. Find the value of n.



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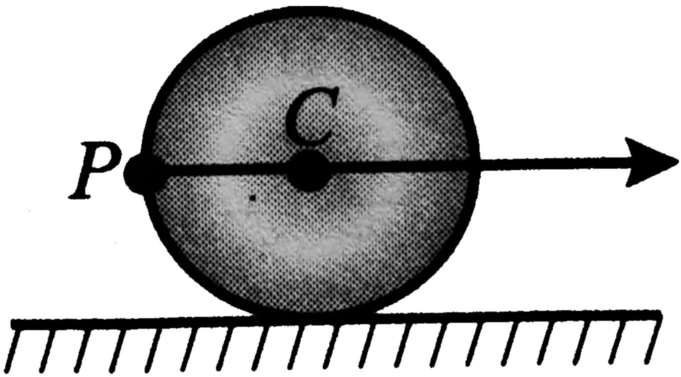
68. A disc of radius R is rolling purely on a flat horizontal, with a Constant angular velocity.

The angle between the of velocity and acceleration vectors point P is given by $\sin^{-1}(\sqrt{2}/n)$. What is the value of n?



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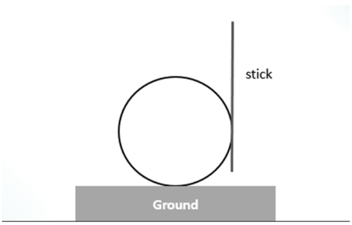
69. A boy is pushing a ring of mass 2 kg and radius 0.5 m with a stick as shown in the figure. The stick applies a force of 2 N on the ring and rolls it without slipping with an acceleration of $0.3m/s^2$. The coeffecient of friction between the ground and the ring is large enough that rolling always occur and the coefficient of friction between the stick and the ring



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70. A parabolic wire as shown in the figure is located in x-y plane and carries a current I=10 amp. A unifrom magnetic field of intensity $2\sqrt{2T}$, making an angle of 45° with x-axis exists throughout the plane. If the coordinates of end point 'P' of wire are $(2m, 1.5m)$ then the total force acting on the wire is:

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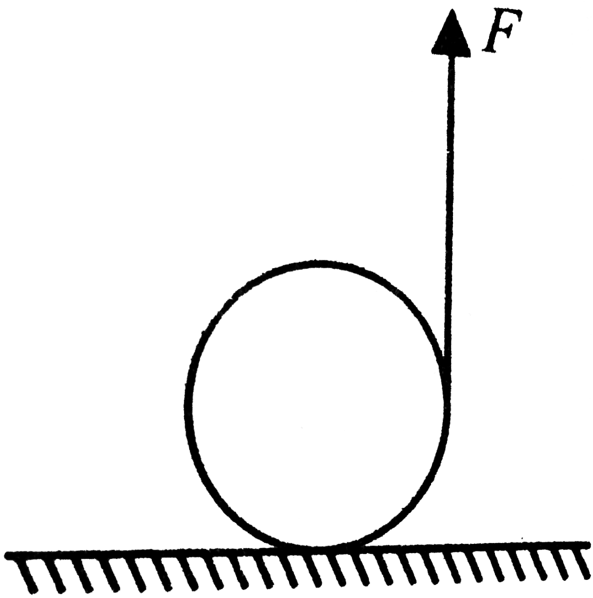
71. We apply a force of $10N$ on a cord wrapped around a cylinder of mass $2kg$. The cylinder rolls without slipping on the floor. What is the kinetic energy (in joule) when cylinder has moved by a distance of $3/5$ m?



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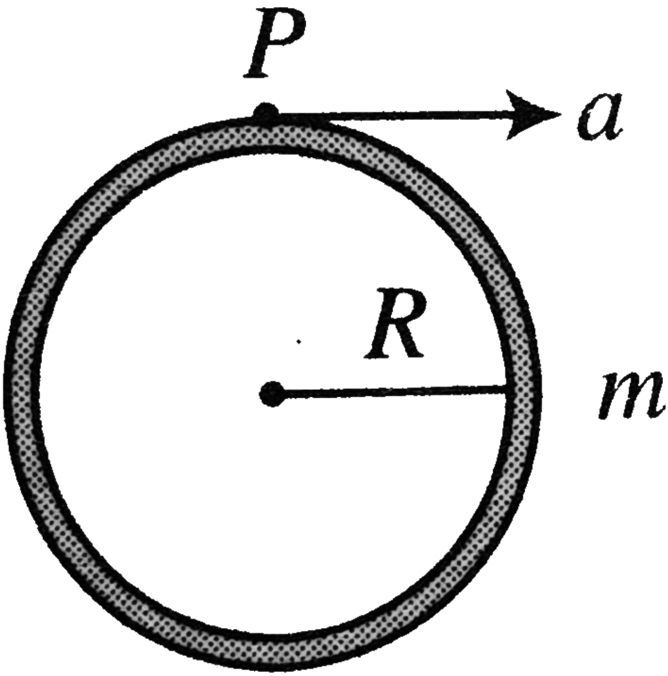
Integer

1. A smooth ring of mass m and radius $R = 1m$ is pulled at P with a constant acceleration $a = 4ms^{-2}$ on a horizontal surface such that the plane of the ring lies on the surface. Find the angular acceleration of the ring at the given position. (in rad/s^2)



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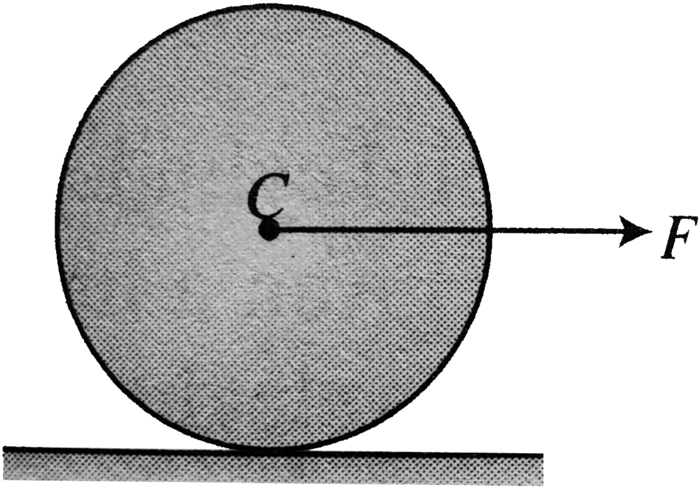
2. A horizontal force $F = 14N$ acts at the centre of mass of a sphere of mass $m = 1kg$.

If the sphere rolls without sliding, find the frictional force (in N)



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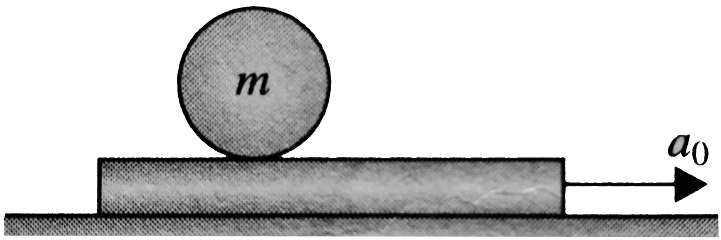
3. A rolling body of mass $m = 4kg$, radius R and radius of gyration $k = R / \sqrt{3}$ is placed as a plank which moves with an acceleration $a_0 = 1ms^{-2}$. Find the frictional force acting on body if it rolls without sliding. (in N).



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4. A solid sphere rolls on a smooth horizontal surface at $10m/s$ and then rolls up a smooth inclined plane of inclination 30° with horizontal. The mass of the sphere is $2kg$. Find the height attained by the sphere before it stops (in m).

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5. A ring and a disc having the same mass, roll without slipping with the same linear velocity. If the kinetic energy of the ring is 8 j , Find the kinetic energy of disc (in J)

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6. A ring of mass $3kg$ is rolling Without Slipping with linear velocity $1ms^{-1}$ on a smooth horizontal surface. A rod of same mass is fitted along its one diameter. Find total kinetic energy of the system (in J).

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7. A solid sphere of mass $3kg$ is kept on a horizontal surface. The coefficient of static friction between the surfaces in contact is $2/7$

. What maximum force can be applied at the highest point in the horizontal direction so that the sphere does not slip on the surface? (in N)

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Fill In The Blanks

1. A uniform cube of side a and mass m rests on a rough horizontal table. A horizontal force F is applied normal to one of the faces at a point directly above the centre of the face, at a height $\frac{3a}{4}$ above the base. What is the minimum value of F for which the cube begins to tip about an edge?

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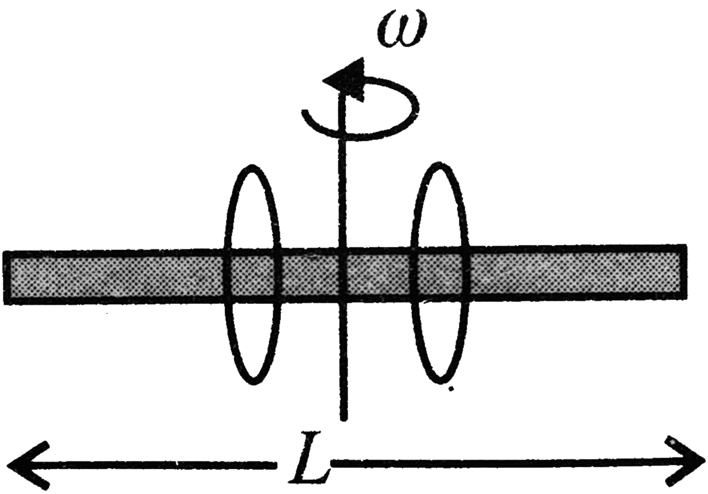
2. A smooth uniform rod of length L and mass M has two identical beads (1 and 2) of negligible size, each of mass m, which can slide freely along the rod. Initially the two beads are at the centre of the rod and the system is rotating with angular velocity ω_0 about an axis perpendicular to the rod and is passing through its midpoint. There are no external forces when the beads reach the ends of the rod, the angular velocity of the system is



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3. 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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4. A stone of mass m tied to the end of a string, is whirled around in a horizontal circle. (Neglect the force due to gravity). The length of the string is reduced gradually keeping the angular momentum of the stone about the centre of the circle constant. Then, the tension in the string is given by $T = Ar^n$ where A is a constant, r is the instantaneous radius of the circle and n=....

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5. A uniform disc of mass m and radius R is rolling up a rough inclined plane which makes an angle of 30° with the horizontal. If the coefficients of static and kinetic friction are each equal to μ and the only force acting are gravitational and frictional, then the magnitude of the frictional force acting on the disc is and its direction is .(write up or down) the inclined plane.

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

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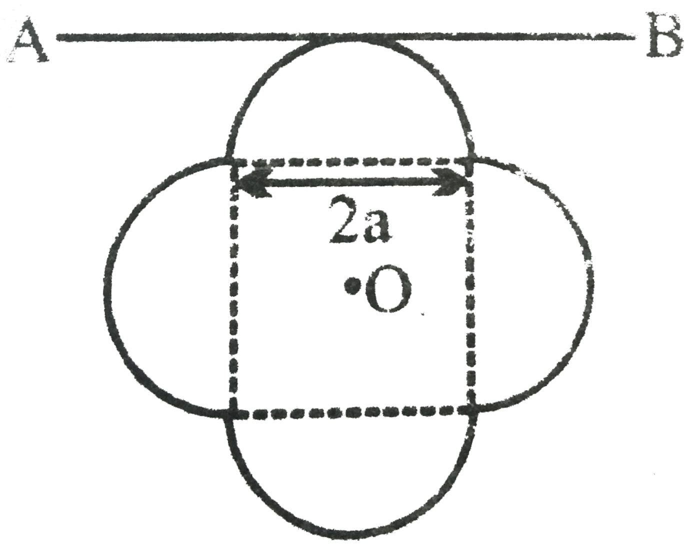
7. A symmetric lamina of mass M consists of a square shape with a semicircular section over each of the edge of the square as in fig. The side of the square is $2a$.

The moment of inertia of the lamina about an axis through its centre of mass and perpendicular to the plane is $1.6Ma^2$. The moment of inertia of the lamina about the tangent AB in the plane of lamina is.



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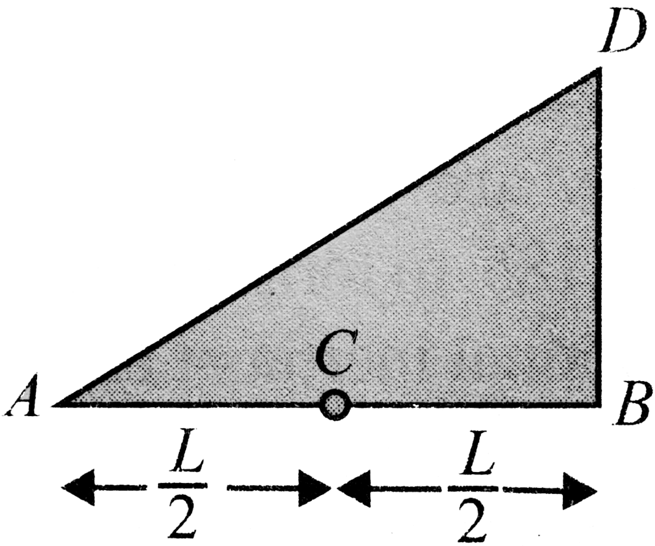
True/False

1. A triangular platge of uniform thickness and densilty ismade to rotate about an axis perpendicular to the plane of the paper an a. passing through A b. passing through B, by the application of some foce F at C (mid point of AB) as show in figure. In which case is angular acceleration more?



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2. A thin uniform circular disc of mass M and radius R is rotating in a horizontal plane about an axis passing through its centre and perpendicular to its plane with an angular velocity ω. another disc of the same dimensions but of mass M/4 is placed gently on the first disc coaxially. The angular velocity of the system now is $2\omega / \sqrt{5}$.

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3. A ring of mass 0.3 kg and radius 0.1 m and a solid cylinder of mass 0.4 kg and of the same radius are given the same kinetic energy and released simultaneously on a flat horizontal surface towards a wall which is at the same distance from the ring and the cylinder. The rolling friction in both cases is negligible. which of them will reach the wall first

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4. Two particles of masses $1kg$ and $3kg$ move towards each other under mutual force of attraction. No other force acts on them. When the relative velocity of approach of the two particles is $2m/s$. their centre of mass has a velocity of $0.5m/s$. When the relative velocity of approach becomes $3m/s$, the velocity of the centre of mass is $0.75m/s$.

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SCQ_TYPE

1. A thin circular ring of mass M and radius r is rotating about its axis with a constant angular velocity ω. Two objects each of mass m, are attached gently to the opposite ends of a diameter of the ring. The wheel now rotates with an angular velocity

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

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

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

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

Answer: C

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2. Two point masses of 0.3 kg and 0.7kg are fixed at the ends of a rod of length 1.4 m and of negligible mass. The rod is set rotating about an axis perpendicular to its length with a uniform angular speed. The point on the rod through which the axis should pass in order that the work required for rotation of the rod is minimum, is located at a distance of

A. $0.42m$ from the mass of $0.3kg$

B. $0.70m$ from the mass of $0.7kg$

C. $0.98m$ from the mass of $0.3kg$

D. $0.98m$ from the mass of $0.7kg$

Answer: C

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3. A mass M moving with a constant velocity parallel to the X-axis. Its angular momentum with respect to the origin

A. is zero

B. remains constant

C. goes on increasing

D. goes on decreasing

Answer: B

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4. 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. $\omega_A < \omega_B$

B. $\omega_A = \omega_B$

C. $\omega_A = \omega$

D. $\omega_B = \omega$

Answer: C

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

- $\left(\frac{1}{2}\right)MR^2\omega$
- $MR^2\omega$
- $\left(\frac{3}{2}\right)MR^2\omega$
- $2Mr^2\omega$

Answer: C

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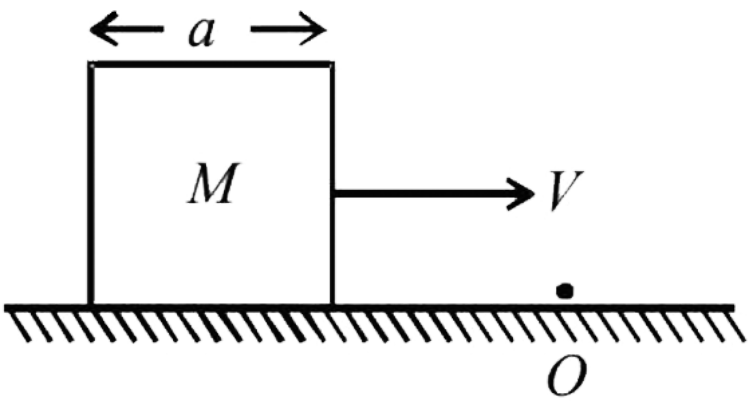
6. A cubical block of side a is moving with velocity V on a horizontal smooth plane as shown in Figure. It hits a ridge at point O. The angular speed of the block after it hits O is



A. $3V/(4a)$

B. $3V/(2a)$

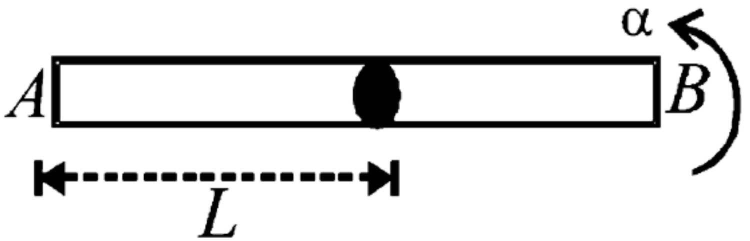
C. $\sqrt{3V} / (\sqrt{2}a)$

D. $zero$

Answer: A

Watch Video Solution

7. A long horizontal rod has a bead which can slide along its length and initially placed at a



distance L from one end A of the rod. The rod is set in angular motion about A with constant angular acceleration α. if the coefficient of friction between the rod and the bead is μ, and gravity is neglected, then the time after which the bead starts slipping is

A. a. $\sqrt{\mu / a}$

B. b.$\mu / \sqrt{\alpha}$

C. c. $1 / \sqrt{\mu \alpha}$

D. d. infinitesimal

Answer: A

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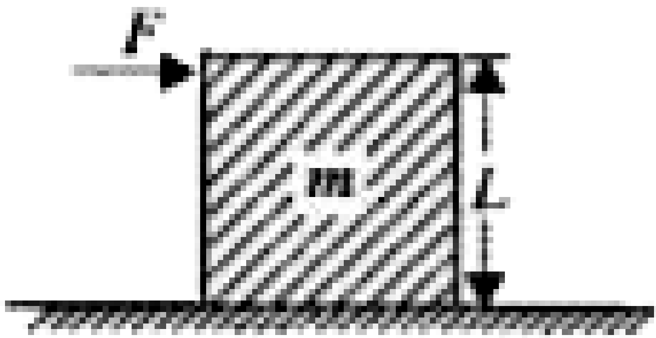
8. A cubical box of side L rests on a rough horizontal surface with coefficient of friction p. A horizontal force F is a applied on the block as shown in Fig. 15.4.6. If the coefficient of friction is sufficiently high so that the block does not slide before toppling, the minimum force required to topple the block is



A. a. infinitesimal

B. b. $mg/4$

C. c. $mg/2$

D. d. $mg(1-\mu)$

Answer: C

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

A. $\dfrac{\pi L^3}{8\pi^2}$

B. $\dfrac{\pi L^3}{16\pi^2}$

C. $\dfrac{5\pi L^3}{16\pi^2}$

D. $\frac{3\pi L^3}{8\pi^2}$

Answer: D

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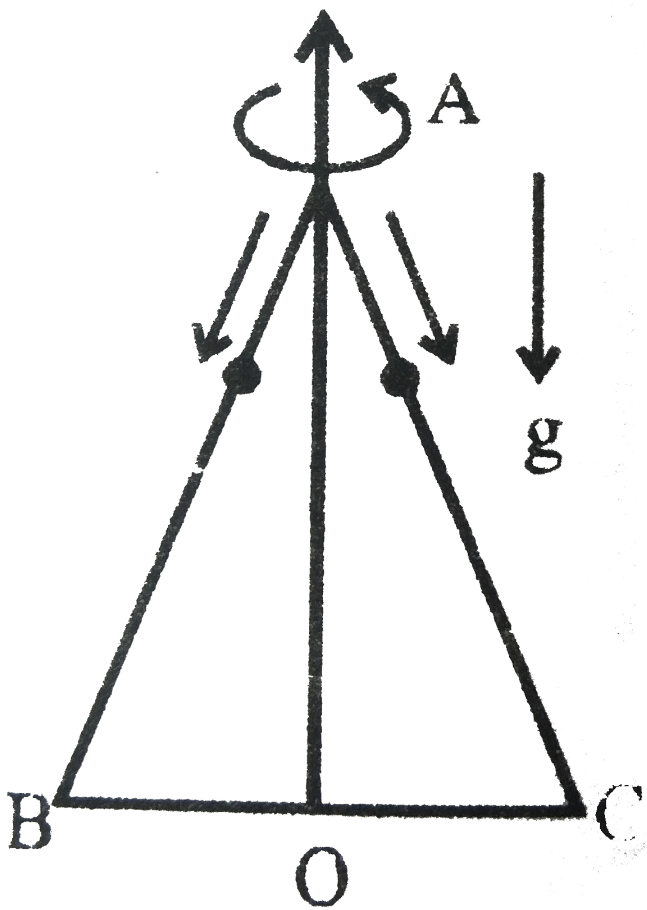
10. A equilaterial triangle ABC formed from a uniform wire has two small identical beads initially located at A. The triangle is set rotating about the vertical axis AO. Then the beads are released from rest simultaneously and allowed to slide down. one long. AB and the other along AC as shown. Neglecting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



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

B. total angular momentum and total energy

C. angular velocity and moment of inertia about the axis of rotation

D. total angular momentum and moment of inertia about the axis of rotation

Answer: B

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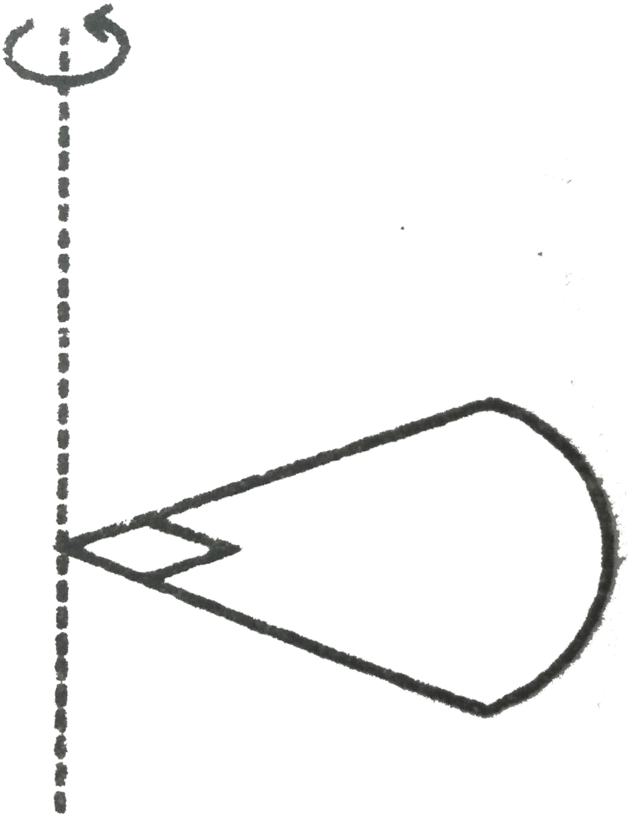
11. One quarter sector is cut from a uniform circular disc of radius R. This sector has mass M. It is made to rotate about a line perpendicular to its plane and passing through the centre of the original disc. It moment of inertia about the axis of rotation is.



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

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

C. $\frac{1}{8}MR^2$

D. $\sqrt{2}MR^2$

Answer: A

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

A. up the incline while ascending and down the incline while descending

B. up the incline while ascending as well as descending

C. down the incline while ascending and up the incline while descending

D. down the incline while ascending as well as descending

Answer: B

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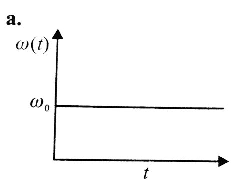
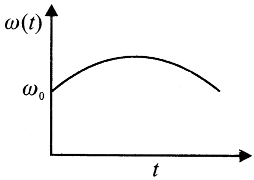
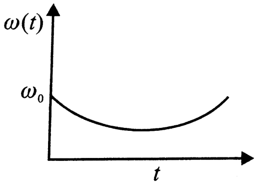
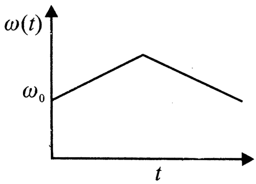
13. A circular platform is free to rotate in a horizontal plane about a vertical axis passing through its centre. A tortoise is sitting at the edge of the platform. Now the platform is given an angular velocity ω_0. When the tortoise move along a chord of the platform with a constant velocity (with respect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

A. 

B. 

C. 

D. 

Answer: B

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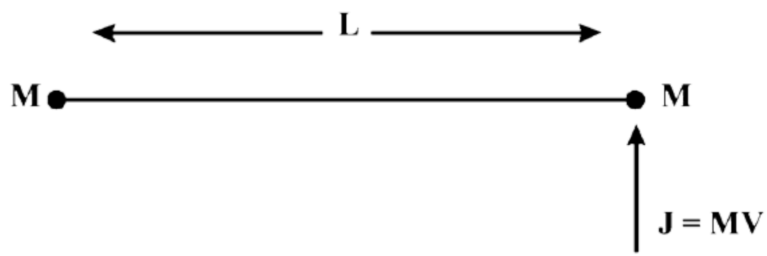
14. Consider a body, shown in figure, consisting of two identical balls, each of mass M connected by a light rigid rod. If an impulse J = MV is imparted to the body at one of its ends what would be it angular velocity?



A. a. $\frac{V}{L}$

B. b. $\frac{2V}{L}$

C. c. $\frac{V}{3L}$

D. d. $\frac{V}{4L}$

Answer: A

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15. A particle undergoes uniform circular motion. About which point on the plane of the circle, will the angular momentum of the particle remain conserved?

A. a. Centre of the circle

B. b. On the circumference of the circle

C. c. Inside the circle

D. d. Outside the circle

Answer: A

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16. A horizonral circular plate is rotating about a vertical axis passing through its centre with an angular velocity ω_0. A man sitting at the centre having two blocks in his hands stretches out his hands so that the moment of inertia of the system doubles. If the kinetic energy of the system is K intially, its final kinetic energy will be

A. a, $2K$

B. b. $K/2$

C. c, K

D. d, $K/4$

Answer: B

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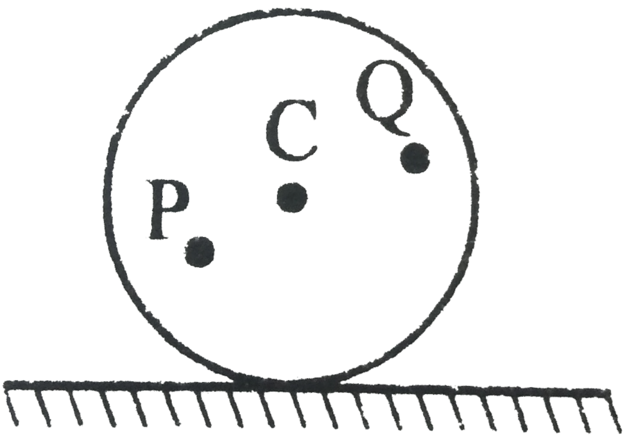
17. A disc is rolling (without slipping) on a horizontal surface. C is its center and Q and P are two points equidistant from C. Let V_P, V_Q and V_C be the magnitude of velocities of points P, Q and C respectively, then



A. $V_Q > V_C > V_P$

B. $V_P > V_C > V_Q$

C. $V_Q = V_P, V_C = V_P / 2$

D. $V_P < V_C < V_Q$

Answer: C

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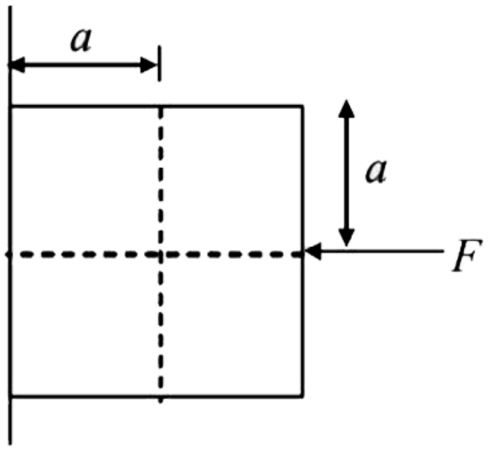
18. A block of mass m is at rest under the action of force F against a wall as shown in figure. Which of the following statement is incorrect?



A. $f = mg$[where f is the friction force]

B. $F = N$ [where N is the normal force]

C. F will not produce torque

D. N will not produce torque

Answer: D

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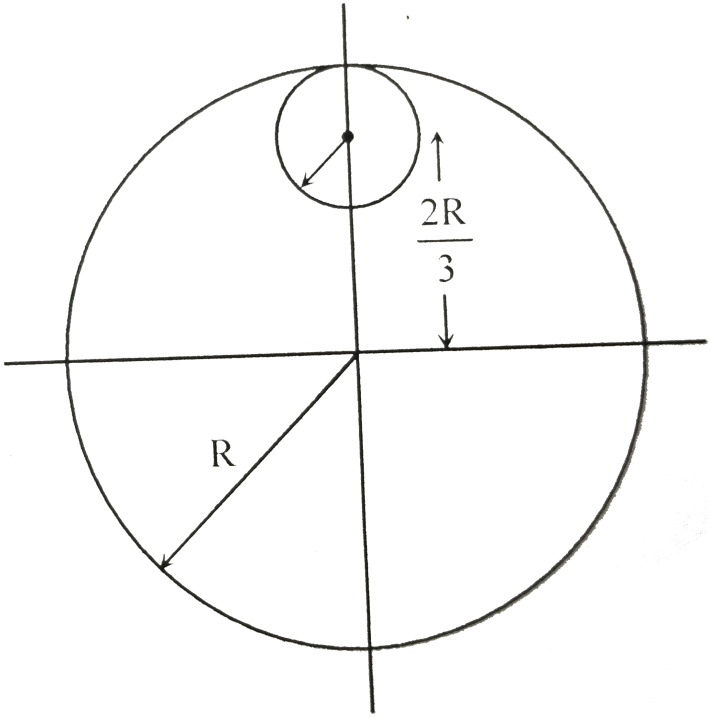
19. From a uniform circular disc of radius R and mass 9M, a small disc of radius $\frac{R}{3}$ is removed as shown in the figure. The moment of inertia of the remaining disc about an axis perpendicular to the plane of the disc and passing through centre of disc is :



A. $4MR^2$

B. $\frac{40}{4}MR^2$

C. $10MR^2$

D. $\frac{37}{9}MR^2$

Answer: A

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20. A particle is confined to rotate in a circular path decreasing linear speed, then which of the following is correct?

A. $\vec{L}$ (angular momentum) is conserved about the centre

B. Only direction of angular momentum $\overrightarrow{L}$ is conserved

C. It spirals towards the centre

D. Its acceleration is towards the centre

Answer: B

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21. A solid sphere of mass M, radius R and having moment of inertia about as axis passing through the centre of mass as I, is recast into a disc of thickness t, whose moment of inertia about an axis passing through its edge and perpendicular to its plance remains I. Then, radius of the disc will be.

A. $r = \sqrt{\frac{2}{15}}R$

B. $r = 2\sqrt{\frac{1}{15}}R$

C. $r = \frac{2}{15}R$

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

Answer: B

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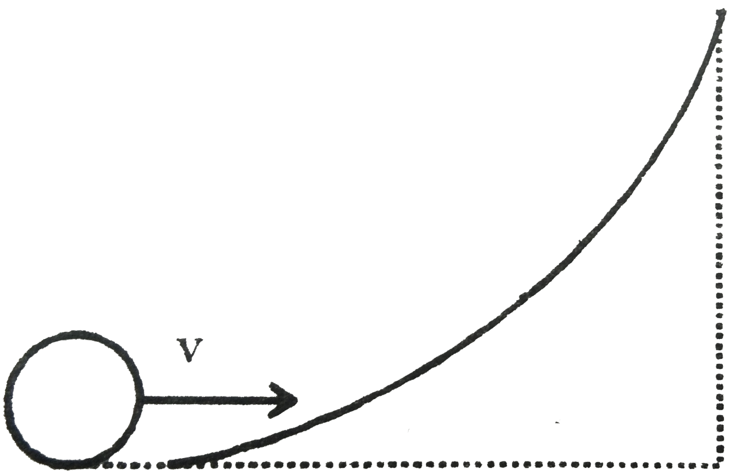
22. A small object of uniform density rolls up a curved surface with an initial velocity v. It reached upto maximum height of $3v^2/4g$ with respect to the initial position. The object is -



A. ring

B. solid sphere

C. hollow sphere

D. disc

Answer: D

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23. If the resultant of all the external forces acting on a system of particles is zero. Then from an inertial frame, one can surely say that

A. linear momentum of the system does not change time

B. kinetic energy of the system does not change in tire.

C. angular momentum of the system does not change time

D. potential energy of the system does not change in time

Answer: A

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24. A block of base $10cm \times 10cm$ and height 15cm is kept on an inclined plane. The coefficient of friction between them is $\sqrt{3}$. The inclination θ of this inclined plane from the horizontal plane is gradually increased from 0° Then

A. at $\theta = 30^{\circ}$ the block will start sliding down the plane

B. the block will remain at rest on the plane up to certain θ and ten it will topple

C. at $\theta = 60^\circ$ the block will start slidng down the plane and continue to do so at higher angles

D. at $\theta = 60^\circ$ the block will start sliding down the plane and on further increasing θ, it will topple at certain θ

Answer: B

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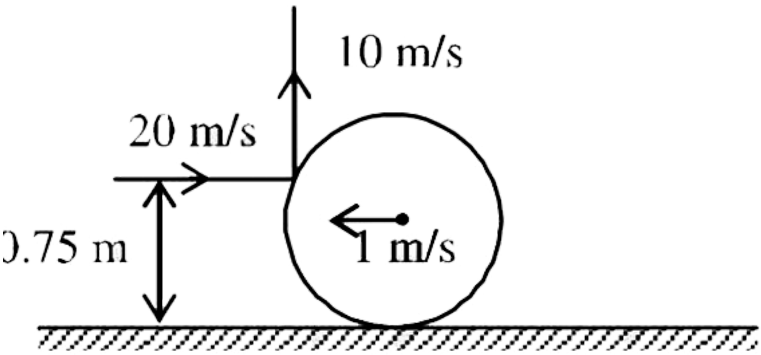
25. A thin ring of mass 2kg and radius 0.5 m is rolling without on a horizontal plane with velocity 1m/s. A small ball of mass 0.1kg, moving with velocity 20 m/s in the opposite direction hits the ring at a height of 0.75m and goes vertically up with velocity 10m/s.

Immediately after the collision



A. the ring has pure rotation about its stationary

B. the ring comes to a complete stop

C. friction between the ring and the ground is to the left

D. there is no friction between the ring and the ground

Answer: C

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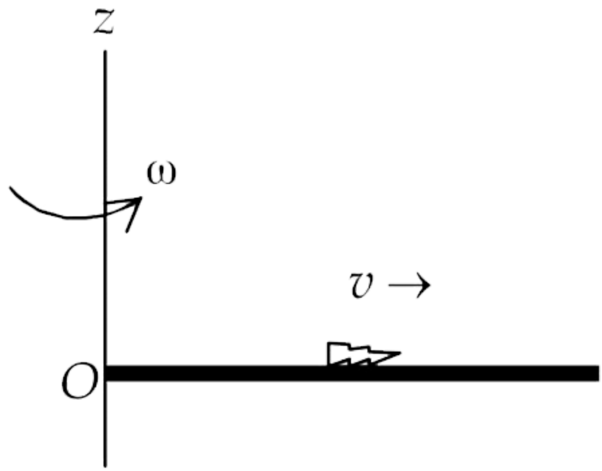
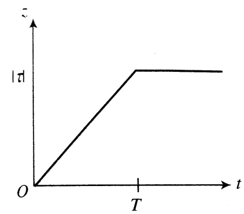
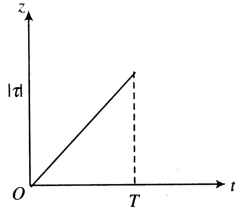
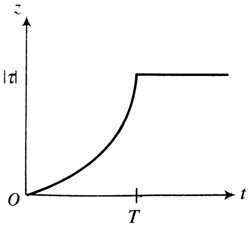
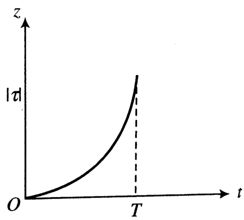
26. A thin uniform rod, pivoted at O, is rotating in the horizontal plane with constatn angular speed ω, as shown in the figure. At time t = 0, a small insect starts from O and moves with constant sped v, with respect to the rod towards the other end. It reaches the end of the rod at t =T and stops. The angular speed of the system remains ω throughout. The magnitude of the torque $\left(|\vec{\pi}|\right)$ about O, as a function of time is best represented by which plot?



A. 

B. 

C. 

D. 

Answer: B

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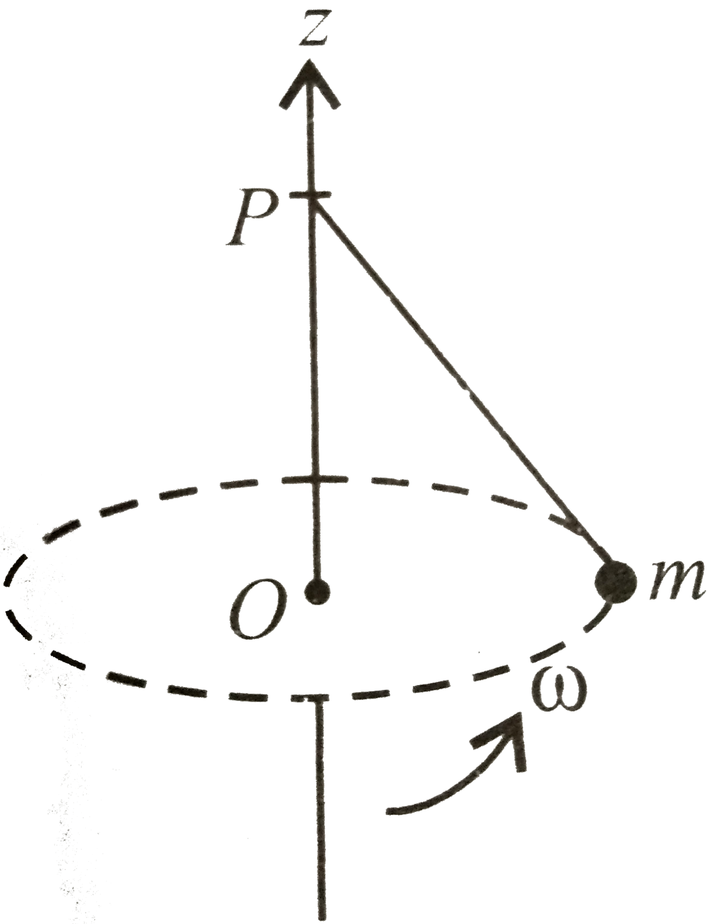
27. A small mass m is attached to a massless string whose other end is fixed at P as shown in figure. The mass is undergoing circular motion in x-y plane with centre O and constant angular speed ω. If the angular momentum of the system, calculated about O and P and denoted by



A. $\overrightarrow{L}_O$ and $\overrightarrow{L}_P$ do not vary with time

B. $\overrightarrow{L}_O$ varies with time while $\overrightarrow{L}_P$ remains constant.

C. $\overrightarrow{L}_O$ remains constant while $\overrightarrow{L}_P$ varies with time.

D. $\overrightarrow{L}_O$ and $\overrightarrow{L}_P$ both vary with time

Answer: C

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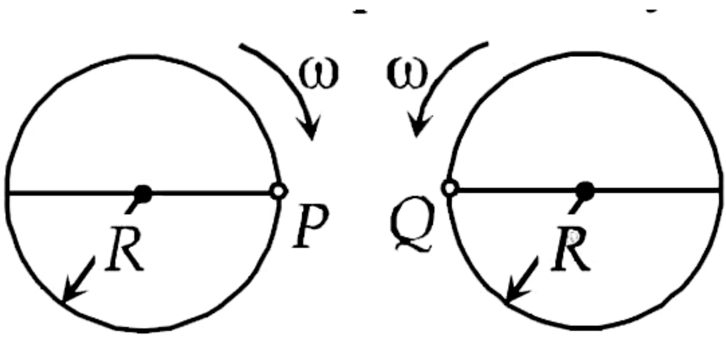
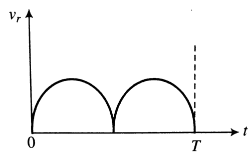
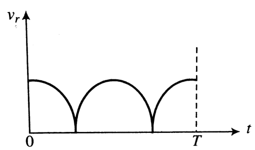
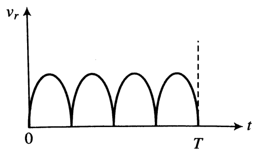
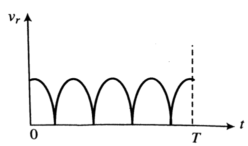
28. Two identical discs of same radius R are rotating about their axes in opposite directions with the same constant angular speed ω . The discs are in the same horizontal plane. At time $t = 0$, the points P and Q are facing each other as shown in the figure. The relative speed between the two points P and Q is v_r. In one time period (T) of rotation of the discs , v_r as a function of time is best represented by



A. 

B. 

C. 

D. 

Answer: A

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29. Two solid cylinders P and Q of same mass and same radius start rolling down a fixed inclined plane from the same height at the same time. Cylinder P has most of its mass concentrated near its surface, while Q has most its mass concentrated near the axis. Which statement(s) is (are) correct?

A. Both cylinders P and Q reach the ground at the same time

B. Cylinder P has larger linear acceleration than cylinder Q

C. Both cylinders reach the ground with same translational kinetic energy

D. Cylinder Q reaches the ground with larger angular speed.

Answer: D

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MCQ_TYPE

1. Two particles A and B intiallly at rest, move towards each other under a mutual force of attraction. AT the instant when the speed of A is v and the speed of B is 2 v, the speed of the centre of mass of the system is

A. $3V$

B. V

C. $1.5V$

D. zero

Answer: D

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2. A mass M moving with a constant velocity parallel to the X-axis. Its angular momentum with respect to the origin

A. is zero

B. remains constant

C. goes on increasing

D. goes on decreasing

Answer: B

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3. When a bicycle is in motion, the force of friction exerted by the ground on the two wheels is such that it acts

A. in the backward direction on the front wheel and in the forward direction on the rear wheel

B. in the forward direction on the front wheel and in the backward direction on the rear wheel

C. in the backward direction on both the front and the rear wheels

D. in the forward direction on both the front and the rear wheels

Answer: C

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

A. zero

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

C. $\frac{mV^3}{\sqrt{2g}}$

D. $\frac{mV}{\sqrt{2gh^3}}$

Answer: B::D

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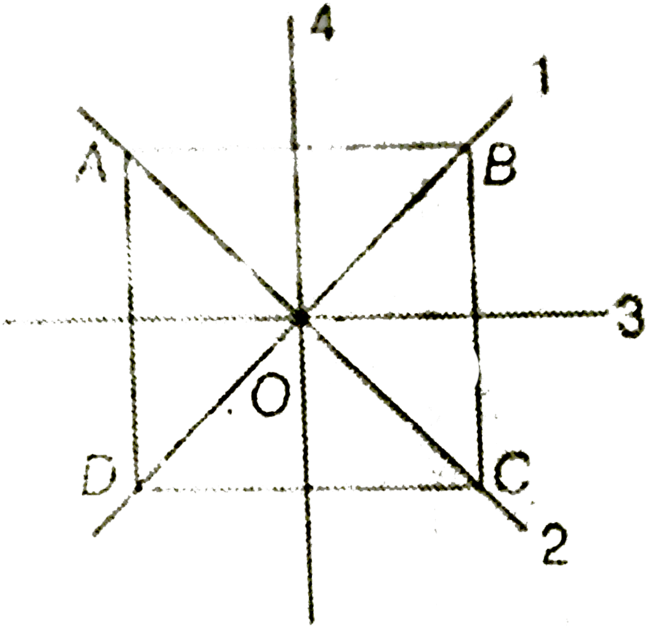
5. The moment of inertia of a thin square plate ABCD of uniform thickness about an axis passing through the centre O and perpendicular to plate is



A. $I_1 + I_2$

B. $I_3 + I_4$

C. $I_1 + I_3$

D. $I_1 + I_2 + I_3 + I_4$

Answer: A::B::C

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6. A tube of length L is filled completely with an incompressible liquid of mass M and closed at both the ends. The tube is then rotated in a horizontal plane about one of its ends with a uniform angular velocity ω. The force exerted by the liquid at the other end is

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

B. $M\omega^2 L$

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

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

Answer: A

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7. A car is moving in a circular horizontal track of radius 10 m with a constant speed of $10 ms^{-1}$. A plumb bob is suspended from the roof of the car by a light rigid rod of length 1 m. The angle made by the rod with track is

A. zero

B. 30°

C. 45°

D. 60°

Answer: C

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

A. I

B. $I \sin^2 \theta$

C. $I \cos^2 \theta$

D. $I\cos^2\left(\frac{\theta}{2}\right)$

Answer: A

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9. The torque τ on a body about a given point is found to be equal to AxxL where A is a constant vector, and L is the angular momentum of the body about that point. From this it follows that

A. dL/dt is perpendiclar to L at all instants of time

B. the component of L in the direction of A does not change with time

C. magnitude of L does not change with time

D. L does not change with time

Answer: A::B::C

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10. A solid cylinder is rolling down a rough inclined plane of inclination θ. Then

A. the friction force is dissipative

B. the friction force is necessarily changing

C. the friction force will aid rotation but hinder translation

D. the friction force is reduced if θ is reduced

Answer: C::D

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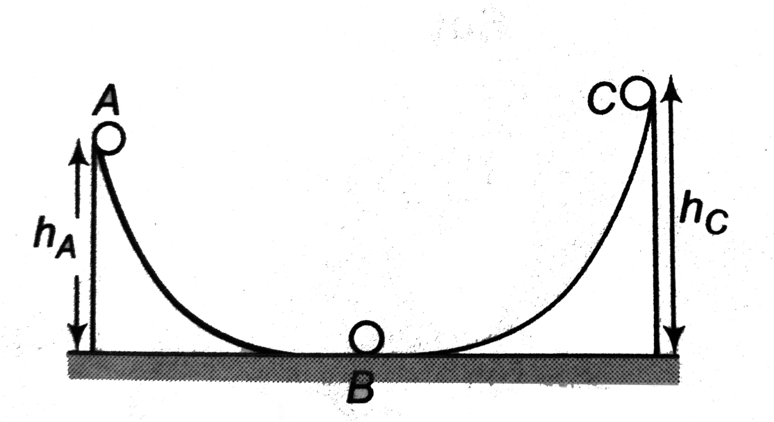
11. 

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

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

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

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

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

A. $h_A > h_C, K_B > K_C$

B. $h_A < h_C, K_C > K_A$

C. $h_A = h_C, K_B = K_C$

D. $h_A < h_C, K_B > K_C$

Answer: A::D

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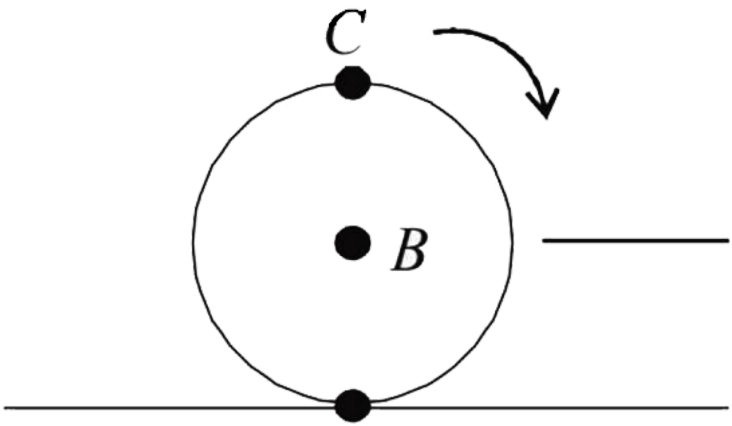
12. A sphere is rolling without slipping on a fixed horizontal plane surface. In the figure, A is the point of contact, B is the centre of the sphere and C is its topmost point. Then



A. $\vec{V}_C = \vec{V}_A = 2\left(\vec{V}_B - \vec{V}_C\right)$

B. $\vec{V}_C - \vec{V}_B = \vec{V}_B - \vec{V}_A$

C. $\left|\vec{V}_C - \vec{V}_A\right| = 2\left|\vec{V}_B - \vec{V}_C\right|$

D. $\left|\overrightarrow{V}_C - \overrightarrow{V}_A\right| = 4\left|\overrightarrow{V}_B\right|$

Answer: B::C

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13. Two spherical planets P and Q have the same uniform density ρ, masses M_p and M_Q and surface areas A and 4A respectively. A spherical planet R also has uniform density ρ and its mass is $(M_P + M_Q)$. The escape velocities from the plantes P,Q and R are $V_P V_Q$ and V_R respectively. Then

A. $V_Q > V_R > V_P$

B. $V_R > V_Q > V_P$

C. $V_R / V_P = 3$

D. $V_P / V_Q = \frac{1}{2}$

Answer: B::D

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14. The figure shows a system consisting of (i) a ring the outer radius 3R rolling clockwise without slipping on a horizontal surface with angular speed ω and (ii) an inner disc of radius 2R rotating anti clockwise with angular speed $\omega/2$. The ring and disc are separted. The point P on the inner disc is at a distance R from the origin, where OP makes an angle of 30° with the horizontal. Then with respect to the horizontal surface,

A. The point O has a linear velocity $3R\omega\hat{\imath}$

B. The point P has a linear velocity

$$\frac{11}{4}R\omega\hat{i}+\frac{\sqrt{3}}{4}R\omega\hat{k}$$

C. The point P has a linear velocity

$$\frac{13}{4}R\omega\hat{i}+\frac{\sqrt{3}}{4}R\omega\hat{k}$$

D. The point P has a linear velocity

$$\left(3-\frac{\sqrt{3}}{4}\right)R\omega\hat{i}+\frac{1}{4}R\omega\hat{k}$$

Answer: A::B

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AR_TYPE

1. Statement-1: if there is no external torque on a body about its centre of mass, then the velocity of the center of mass remains constant.

Statement-2: The linear momentum of an isolated system remains constant.

A. Statement I is True, Statement II is True, Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True, Statement II is NOT a correct explanation for Statement I

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: D

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2. Two cylinders, one hollow (metal) and the other solid (wood) with the same mass identical dimensions are simulataneously allowed to roll without slipping down an inclined plane from the same height. The hollow cylinder will reach the bottom of the inclined plane first.

by the principle of conservation of energy, the total kinetic energies of both the cylinders are identical when they reach the bottom of the incline.

A. Statement I is True, Statement II is True, Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True, Statement II is NOT a correct explanation for Statement I

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: D

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LC_TYPE

1. Two discs A and B are mounted co-axially one vertical axle. The discs have moments of inertia l and $2l$ respectively about the common axis. Disc A is imparted an initial angular velocity 2ω using the centre potential energy of a spring compressed by a distance x_1. Disc B is imparted angular velocity ω by a spring having the same spring constant and compressed by a distance x_2. Both the disc rotate in the clockwise direction.

The rotation x_1 / x_2 is.

A. 2

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

C. $\sqrt{2}$

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

Answer: C

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2. Two discs A and B are mounted coaxiallay on a vertical axle. The discs have moments of inertia I and 2 I respectively about the common axis. Disc A is imparted an initial angular velocity 2ω using the entire potential energy of a spring compressed by a distance x_1 Disc B is imparted an angular velocity ω by a spring having the same spring constant and compressed by a distance x_2 Both the discs rotate in the clockwise direction.

When disc B is brought in contact with disc A, they acquire a common angular velocity in time t. The average frictional torque on one disc by the other during this period is

A. $\frac{2I\omega}{3t}$

B. $\frac{9I\omega}{2t}$

C. $\frac{9I\omega}{4t}$

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

Answer: A

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3. Two discs A and B are mounted coaxially ona vertical axle. The discs have moments of inertia l and $2l$ respectively about the common axis. Disc A is imparted an initial angular velocity 2ω using the centre potential energy of a spring compressed by a distance x_1. Disc B is imparted angular velocity ω by a spring having the same spring constant and compressed by a distance x_2. Both the disc rotate in the clockwise direction.

The loss of kinetic energy the above process is

-

A. $\dfrac{I\omega^3}{2}$

B. $\dfrac{I\omega^2}{3}$

C. $\dfrac{I\omega^2}{4}$

D. $\dfrac{I\omega^2}{6}$

Answer: B

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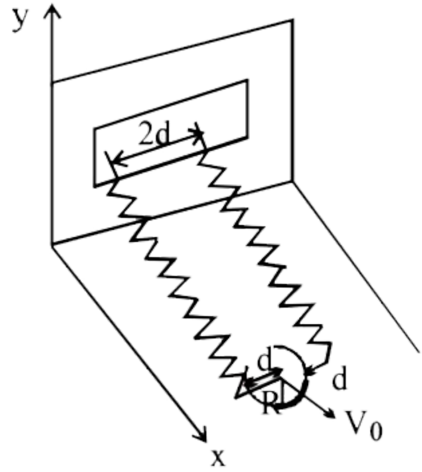
4. A uniform thin cylindrical disk of mass M and radius R is attaached to two identical massless springs of spring constatn k which are fixed to the wall as shown in the figure. The springs are attached to the axle of the disk symmetrically on either side at a distance d from its centre. The axle is massless and both the springs and the axle are in horizontal plane. the unstretched length of each spring is L. The disk is initially at its equilibrium position with its centre of mass (CM) at a distance L from the wall. The disk rolls without slipping with velocity $\overrightarrow{V}_0 = vacV_0\hat{i}$. The coefficinet of friction is μ.



The net external force acting on the disk when its centre of mass is at displacement x with respect to its equilibrium position is.

A. $-kx$

B. $-2kx$

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

D. $-\frac{4kx}{3}$

Answer: D

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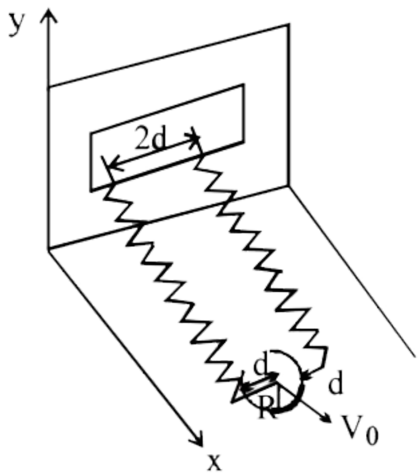
5. A uniform thin cylindrical disk of mass M and radius R is attaached to two identical massless springs of spring constatn k which are fixed to the wall as shown in the figure. The springs are attached to the axle of the disk symmetrically on either side at a distance d from its centre. The axle is massless and both the springs and the axle are in horizontal plane. the unstretched length of each spring is L. The disk is initially at its equilibrium position with its centre of mass (CM) at a distance L from the wall. The disk rolls without slipping with velocity $\overrightarrow{V}_0 = vacV_0\hat{\imath}$. The coefficinet of friction is μ.



The centre of mass of the disk undergoes simple harmonic motion with angular frequency ω equal to -

A. $\sqrt{\frac{k}{M}}$

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

C. $\sqrt{\frac{2K}{3M}}$

D. $\sqrt{\frac{4K}{3M}}$

Answer: D

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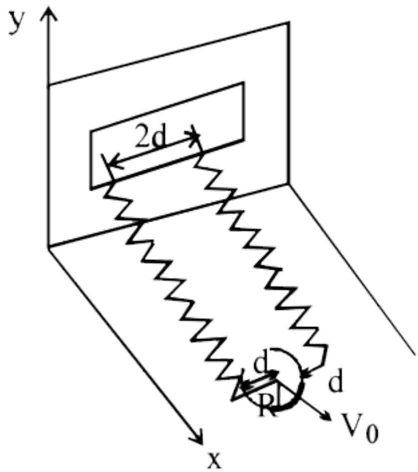
6. A uniform thin cylindrical disk of mass M and radius R is attaached to two identical massless springs of spring constatn k which are fixed to the wall as shown in the figure. The springs are attached to the axle of the disk symmetrically on either side at a distance d from its centre. The axle is massless and both the springs and the axle are in horizontal plane. the unstretched length of each spring is L. The disk is initially at its equilibrium position with its centre of mass (CM) at a distance L from the wall. The disk rolls without slipping with velocity $\overrightarrow{V}_0 = vacV_0\hat{i}$. The coefficinet of

friction is μ.



The maximum value of V_0 for whic the disk will

roll without slipping is-

A. $\mu g\sqrt{\frac{M}{k}}$

B. $\mu g\sqrt{\frac{m}{2K}}$

C. $\mu g\sqrt{\frac{3M}{k}}$

D. $\mu g \sqrt{\frac{5M}{2k}}$

Answer: C

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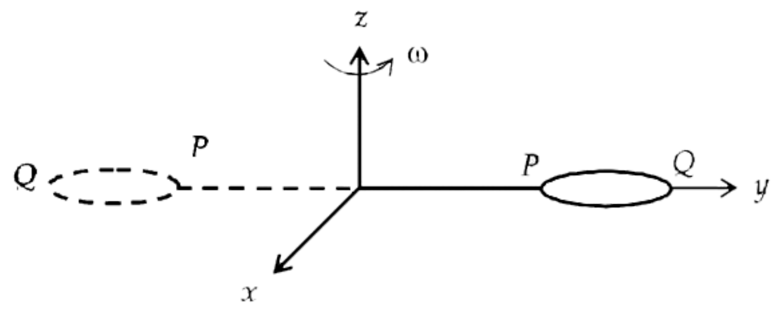
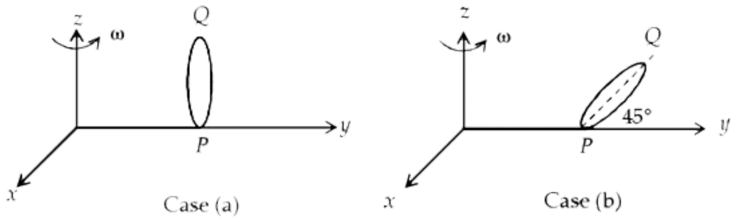
7. The general motion of a rigid body can be considered to be a combination of (i) a motion of its centre of mass about an axis, and (ii) its motion about an instantaneous exis passing through the centre of mass. These axes need not be stationary. Consider, for example, a thin uniform disc welded (rigidly fixed) horizontally at its rim to a massless, stick as shown in the figure. When the disc-stick system is rotated about the origin on a horizontal frictionless plane with angular speed ω the motion at any instant can be taken as a combination of (i) a rotation of the disc through an instantaneous vertical axis passing through its centre of mass (as is seen from the changed orientation of points P and Q). Both these motions have the same angular speed ω in this case



Now consider two similar system as shown in the figure: Case (a) the disc with its face vertical and parallel to x-z plane, Case (b) the disc with its face making an angle of 45° with x-y plane and its horizontal diameter parallel to x-axis. In both the cases, the disc is welded at point P, and the systems are rotated with constant angular speed ω about the z-axis.



Which of the following statements regarding the angular speed about the instantaneous axis (passing through the centre of mass) is correct?

A. It is $\sqrt{2}\omega$ for both the cases

B. It is ω for case a and $\frac{\omega}{\sqrt{2}}$ for case b

C. It is ω force case a and $\sqrt{2}\omega$ for case b

D. It is ω for both the case

Answer: D

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8. The general motion of a rigid body can be considered to be a combination of (i) a motion .... of its centre of mass about an axis, and (ii) its motion about an instantaneous axis passing through the centre of mass. These axes need not be stationary. Consider, for example, a thin uniform disc welded (rigidly fixed) horizontally at its rim to a massless stick, as shown in the figure. When the disc-stick system is rotated about the origin on a horizontal frictionless plane with angular speed ω , the motion at any instant can be taken as a combination of (i) a rotation of the centre of mass of the disc about the z-axis, and (ii) a rotation of the disc through an instantaneous vertical axis passing through its centre of mass (as is seen from the changed orientation of points P and Q). Both these motions have the same angular speed ω in this case.

Now consider two similar systems as shown in the figure: case (a) the disc with its face vertical and parallel to x-z plane, case (b) the disc with its face making an angle of 45° with x-y plane and its horizontal diameter parallel to x-axis. In both the cases, the disc is welded at point P, and the system are rotated with constant angular speed ω about the z-axis

Which of the following statement regarding the angular speed about the instantaneous axis (passing through the centre of mass) is correct ?

A. (A) It is vertical for both the cases (a) and (b)

B. (B) It is vertical for case (a), and is at 45° to the $x - z$ plane and lies in the plane of the disc for case (b)

C. (C) It is horizontal for case (a), and is at 45° to the $x - z$ plane and is normal to the plane of the disc for case b

D. (D) It is vertical for case (a), and is at 45° to the $x - z$ plane and is normal to the plane of the disc for case (b)

Answer: A

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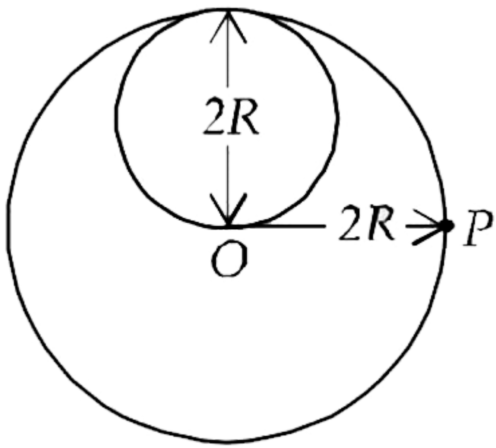
Interger

1. A lamina is made by removing a small disc of diameter 2R from a bigger disc of uniform mass density and radius 2R, as shown in the figure. The moment of inertia of this lamina about axes passing though O and P is I_O and I_P respectively. Both these axes are perpendicular to the plane of the lamina. The ratio $\frac{I_P}{I_O}$ is



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2. A uniform circular disc of mass 50kg and radius 0.4 m is rotating with an angular velocity of $10 rads^{-1}$ about its own axis, which is vertical. Two uniform circular rings, each of mass 6.25 kg and radius 0.2 m, are gently placed symmetrically on the disc in such a manner that they are touching each other along the axis of the disc and are horizontal. Assume that the friction is large enough such that the rings are at rest relative to the disc and the system rotates about the original axis.

The new angular velocity $\left(\in reds^{-1} \right)$ of the system is

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