PHYSICS

BOOKS - SHREE BALAJI PHYSICS (HINGLISH)

RIGID BODY MOTION

EXAMPLE_TYPE

1. A gyroscope is spinning at angular velocity ω_0. The power is shut off, and the gyroscope begins to slow down with its angular velocity described by

$$\omega = \omega_0 e^{-r/T}$$

with T a constant (a) How long does it take for the gyroscope to reach half its initial angular velocity? (b) What is the gyroscope's initial angular acceleration? (c) What is the gyroscope's average acceleration between the time the power through is cut of and the instant it reaches half speed? (d) Through how many revolutions does the gyroscope turn during this time?

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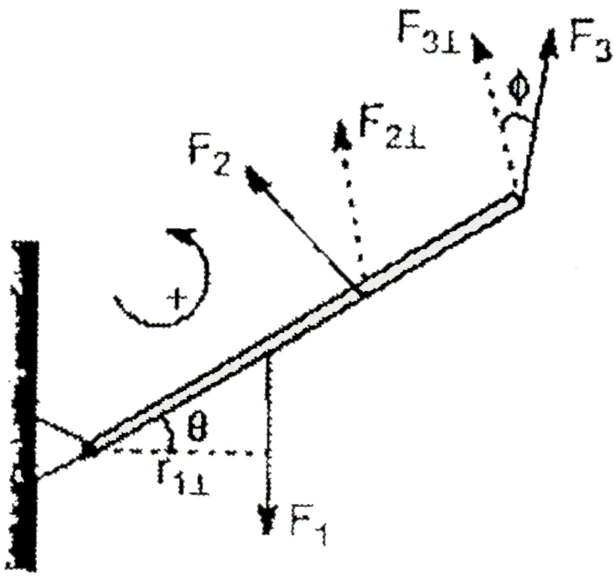
2. Fig shows three forces F_1, F_2 and F_3 acting on a rod pivoted at its end. Find the torque of each force about pivot.



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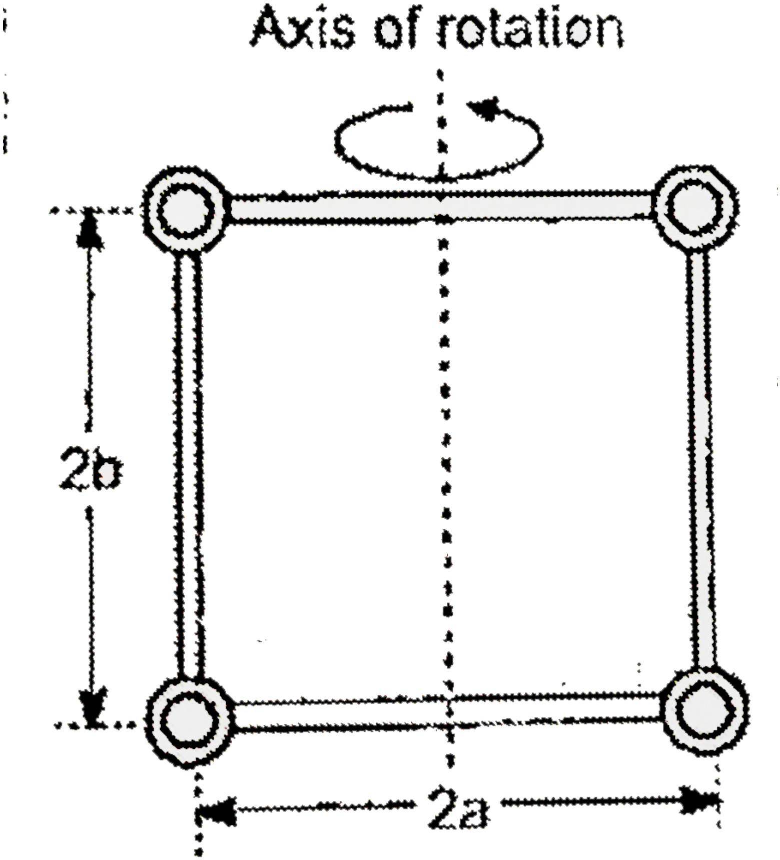
3. Four particles of mass m are connected by massless rods to form a rectangle-of sides $2a$ and $2b$ as shown. The assembly, rotates about an axis in the plane of the figure through the centre. Find the moment of inertia about the axis:,



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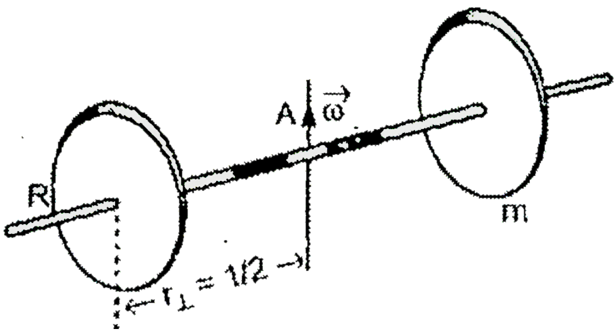
4. A weighlifter's barbell consists of two heavy discs of mass m and radius R connected by as light rod of lenth $l > > R$. Estimate its moment of inertia about an axis A through its CM and perpendicular to the rod. Determine its kinetic energy.



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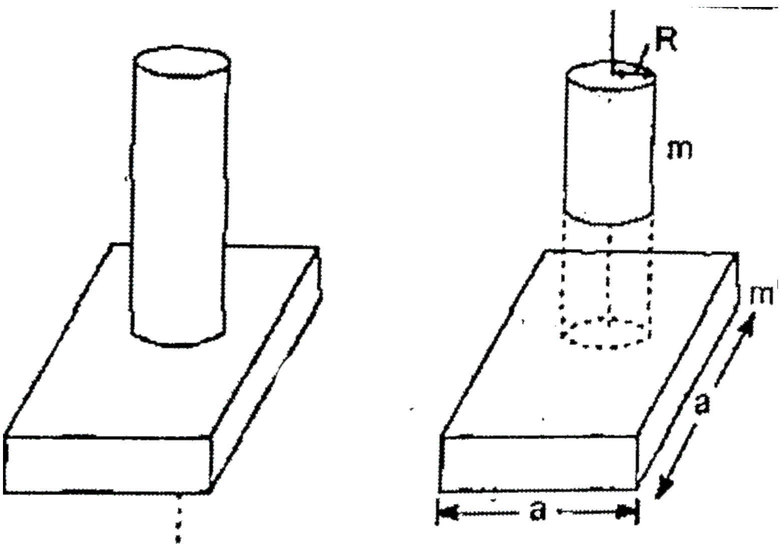
5. Calculate the moment of inertia of a thin rod of mass m and length l about a symmetry axis through the centre of mass and perpendicular to the length of the rod, as shown in Fig.



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6. A circular hole of radius $r/2$ is cut from a circular disc of radius $'r'$. The disc lies in the xy plane. Determine the moment of inertia about an axis passing through the centre and perpendicular to the plane of the disc.

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7. An object of mass m is tied to a light string wound around a pulley that has a moment of inertia I and radius R. The wheel bearing is fricrtionless and the string does not slip on

the run. Find the tension in the string and the acceleration of the object.

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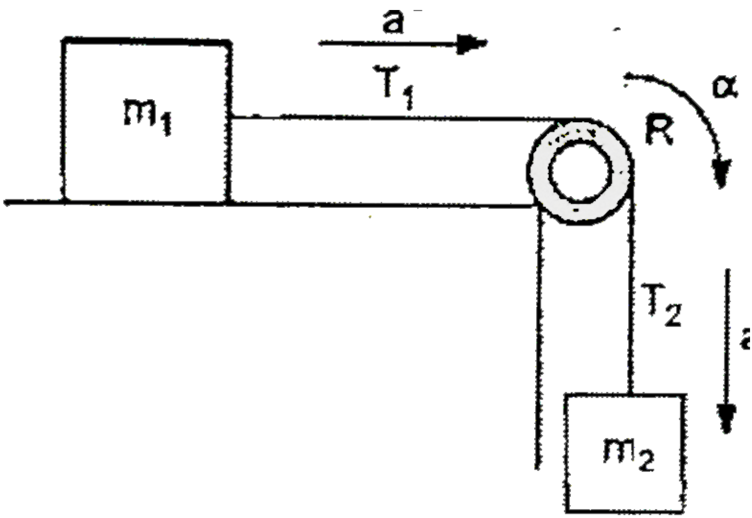
8. Two blocks are connected by a string that passes over a pulley of radius R and moment of inertia I. The block of mass m_1 sides on a frictionless, horizontal surface, the block of mass m_2 is suspended from the string. Find the acceleration a of the blocks and the tension T_1 and T_2 assuming that the string does not slip on the pulley.



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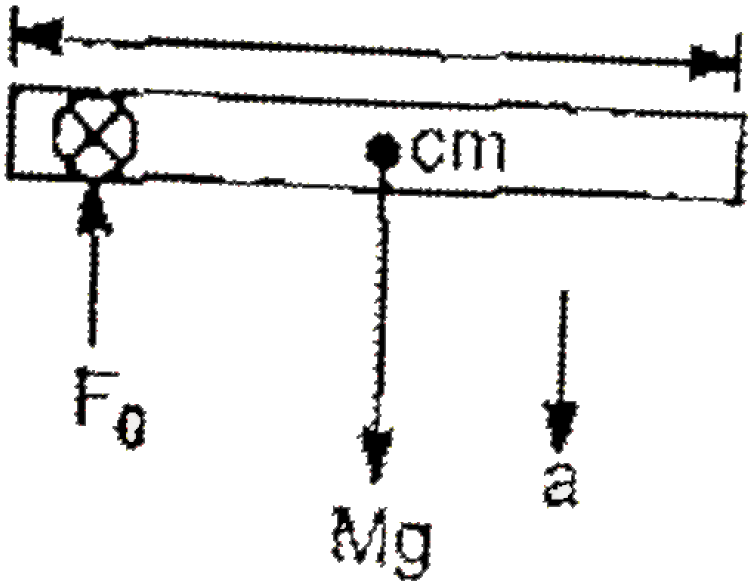
9. A uniform slender rod of length L and mass M is pivoted at one end. It is held horizontal and releasaed. Assume the pivot is frictionless. Find .

(a) the angular acceleration of the rod immediately after it is released, and

(b) the force F_0 exerted on the rod by the pivot immediately after release.



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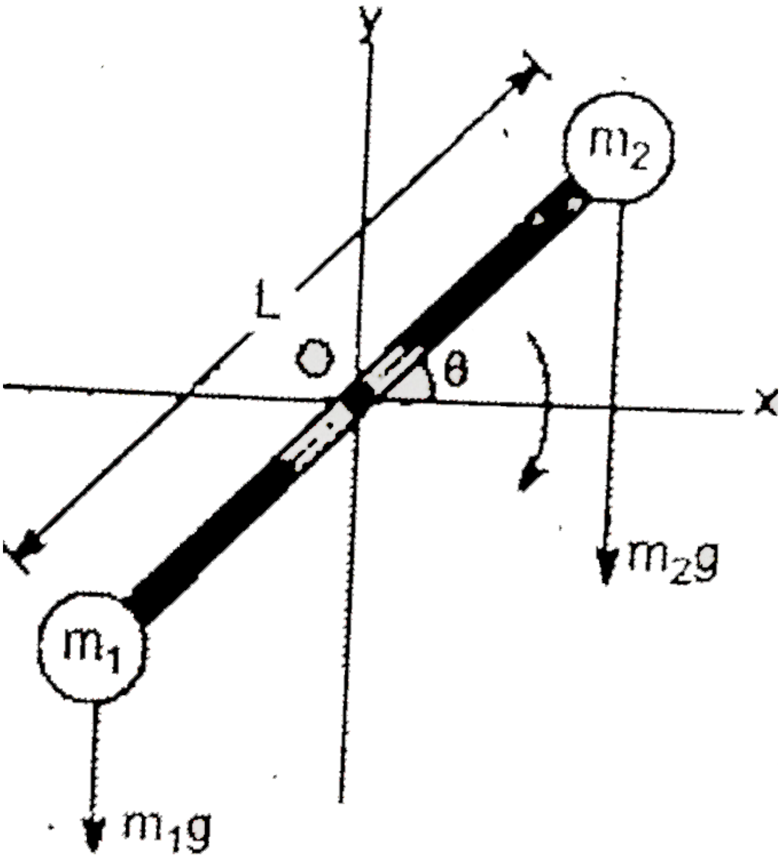
10. A uniform rod of mass M and length L with two particles m and m_2 attached to its ends, is pivoted at its centre. The system rotates in a vertical plane with angular velocity

ω.



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11. A uniform slender rod of mass M and length L is pivoted at its end. The rod is released from its nearly vertical position. What is the reaction at the pivot when the rod reaches the horizontal position? If the support is withdrawn at this instant, describe the subsequent motion of the rod.

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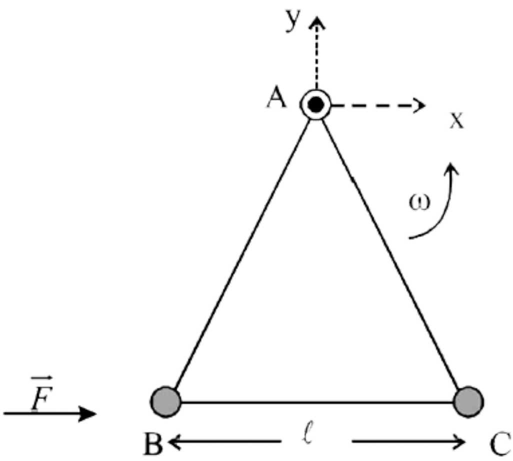
12. Three particles A, B and C each of mass m, are connected to each other by three massless rigid rods to form a rigid, equilateral triangular body of side l. This body is placed on a horizonta frictionsess table (x-y plane) and is hinged to it at the point A so that it can move without friction about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



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

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

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13. A uniform rod of length $2a$ is placed horizontally on the edge of a table. Initially the centre of mass of the rod is at a distance $a/3$ from the edge. The rod is released from rest. If the rod slips after it turned an angle θ, find the coefficient of friction between the rod and the table.

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14. A uniform board of mass M and length L rests on two spring scales. A person of mass m stands at a distance l from one end as shown in Fig. (a) The board and person are at rest. What is the reading of the two scales?

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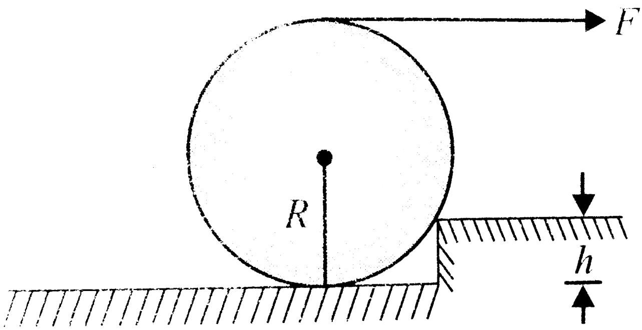
15. A cylinder of weight W and radius R is to be raised onto a horizontal step of height h as shown in Fig. A rope is wrapped around the cylinder and pulled horizontally with force F. Assuming the cylinder does not slip on the step, find the minimum force F necessary to raise the cylinder.



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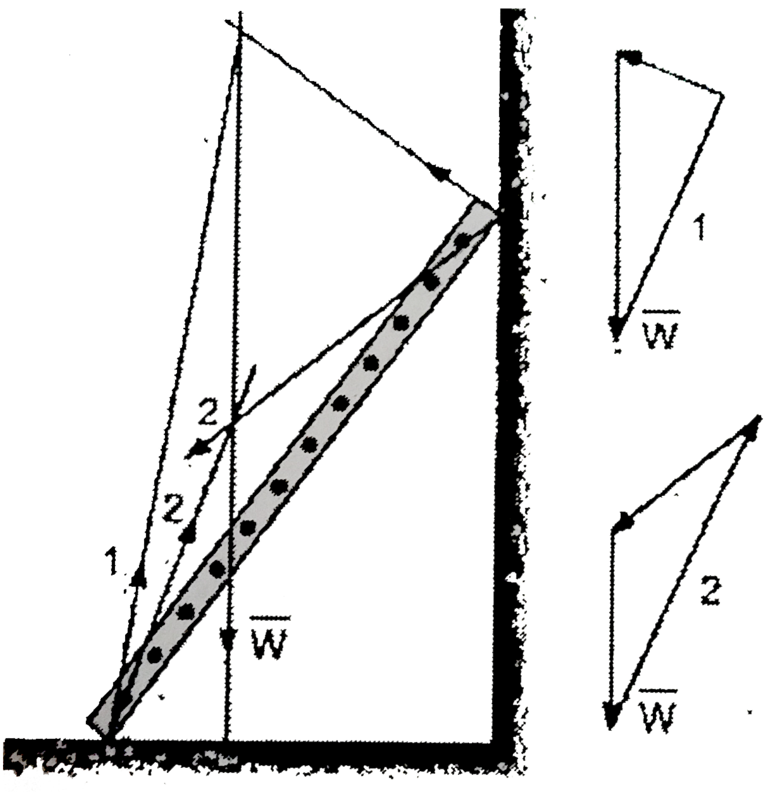
16. A ladder rests on the floor of a room, leaning agains a wall. If the coefficient of static

friction between the ladder the floor is μ_f and that between ladder and is μ_w, what is the minimum angle θ that the ladder can make with the floor if the ladder is not to slip? Assume that the mass of the ladder is distributed uniformly.



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17. A block of height h is projected along a rough surface of coefficient of friction μ. Find the point of application of the normal force on the block for $\mu_k = 0.5$.

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18. The block in figure has dimensions m by h and the ramp is inclined at θ to the horizontal.

Find the effective point of application of the normal force $\overrightarrow{n}$.(consider rotational equilibrium)

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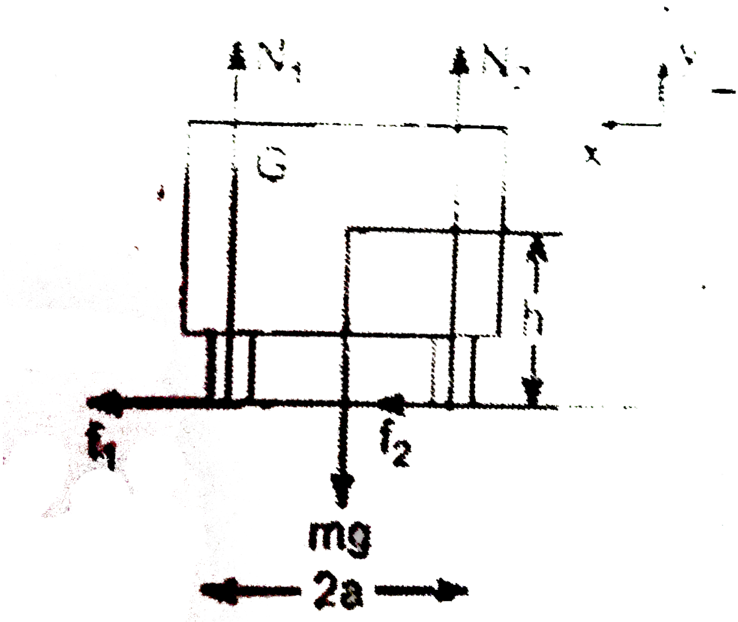
19. A car of mass m travelling at speed v moves on a horizontal track. The centre of mass of the car describes a circle of radius r. If $2a$ is the separation of the inner and outer wheels and h is the height of the centre of mass above the ground, show that the limiting speed beyond which the car will overturn in given by

$$v^2 = \frac{gra}{h}$$



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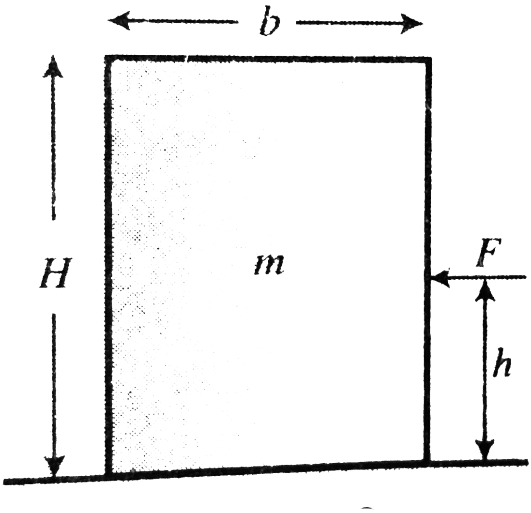
20. A horizontal force F is applied to a homogeneous rectangular block of mass m, width b and height H. The block moves with constant velocity, the coefficient of friction is μ_k.

a. What is the greater height h at which the force F can be applied so that the block will slide without tipping over ?



b. Through which point on the bottom face of the block will the resultant of the friction and normal forces act if $h = H/2$?

c. If the block is at rest and coefficient of static friction is μ_s what are the various criteria for which sliding or tipping occurs?

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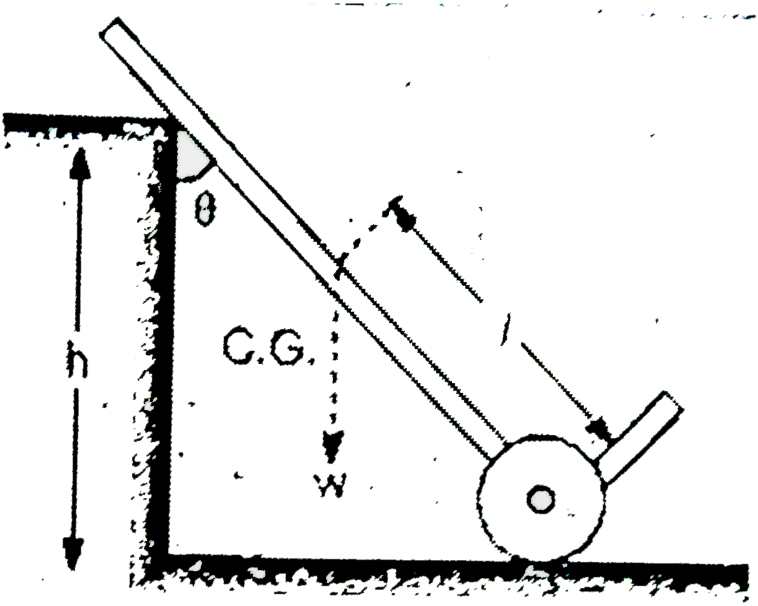
21. A baggage cart of weight w rests on a wall of height h. Its centre of gravity is at a distance L from the wheel as shown in fig.



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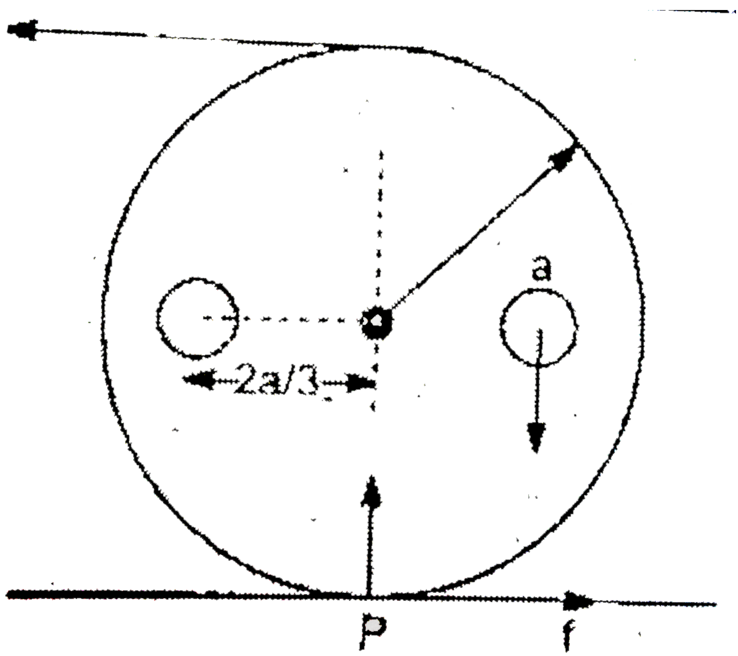
22. Fig shows a uniform cylinder of radius a weight $75N$. After on off axis cylindrical hole was drilled through it as shown, it weighed $60N$. The axes of the two cylinders are parallel. Assuming the cyliner does not slip on the table, determine what the tension T in the cord must be to keep it from moving.



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23. A light ladder rests onn te rough floor of a room, leaning against a smooth wall. The ladder touches the wall at height h above the

floor. A man climbs up the ladder until the base of the ladder is on the verge of slipping. The coefficint of static friction between the foot of the ladder and floor is μ.

(a) What is the horizontal distance moved by the man?

(b) Solve part (a) if the ladder is uniform and has the same weight as the man and the base of the ladder is at a distance l from the wall.

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24. The drum of a winch has mass M and radius R. A cable wound aroung the drum suspends a load of mass m. The entire cable has a length L and mass per unit length λ, with a total mass $m_c = L\lambda$. The load begins to fall all toward the ground, unwinding the cable as it goes. How fast is the load moving after it has falled a distance d?

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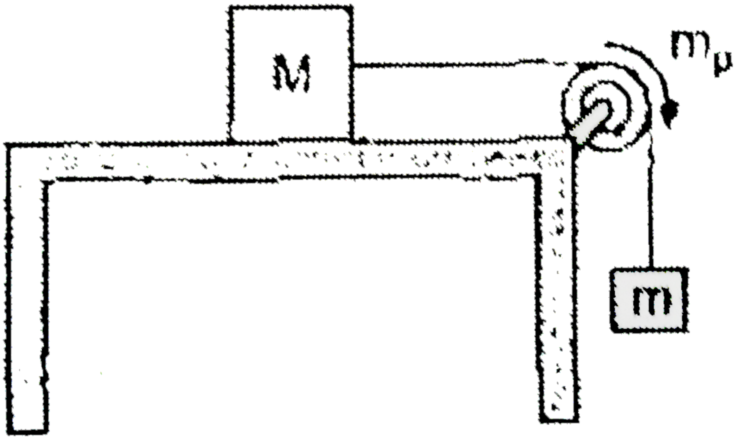
25. In the fig as shown a certain mass M is free to slide without friction on a horizontal table. This mass is connected by a light thread to a mass m that hangs over the edge of the table. The connecting thread passes over a frictionles pulley in the shape of a disk with radius R and mass m_p. Calculate the velocity of the string after the hanging mass has fallen a distance h starting from test.



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26. A wooden frame consists of seven thin rods as shown in fig.

(a) Calculate the moment of inertias of the frame for rotation about its lower edge. Take the mass and length of each rod to be m and l respectively.

(b) If the frame starts from vertical with zero speed and falls over how fast is the edge traveling just before it hits the ground?

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27. Suppose a person of mass m stands at the edge of a circular platform of radius R and moment of inertia I. The platform is at rest initially, but the platform begins to rotate when the person begins to move with velocity v. Determine the angular velocity of the platform.

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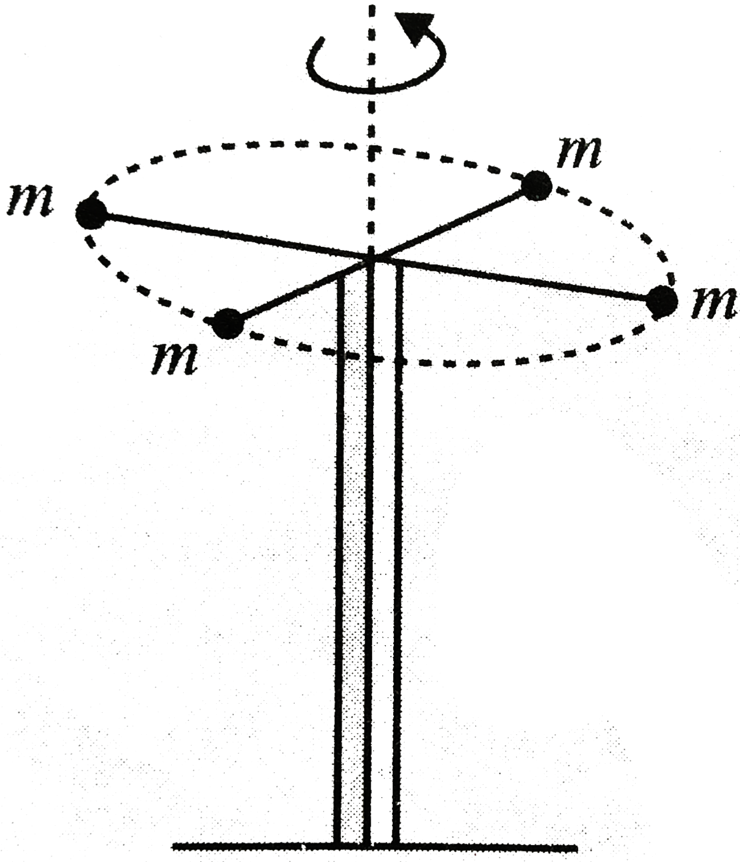
28. The device shown in Fig. rotates on the vertical axle as shown. The frame has negligible mass as compared to the four masses each of mass m. Initial angular velocity of the system is ω_0. Due to an internal mechanism the spokes in the frame lengthen so that the radii of the masses become $2a$. Initially,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



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29. A rotating star has a period of 30 days about an axis passing through its centre. The star undergoes an internal explosion and converts to a neutron star. Initial radius of the core was 1.0×10^4 km, whereas, final radius is $3.0 km$. Determine the period of rotation of the neutron star.

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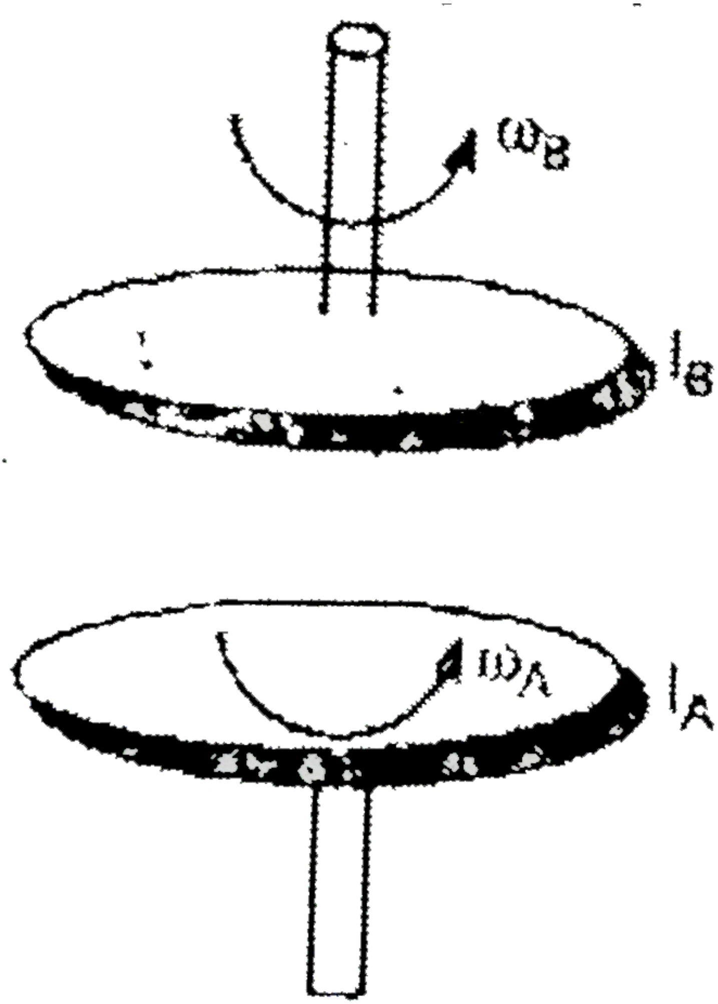
30. A clutch assembly consists of two discs A and B of moment of inertia $2I$ and I respectively, one being the engine fly wheel, the other one is the clutch plate. The discs are initially rotaing with angular velocities $\omega_A = \omega$ and $\omega_B = 2\omega$ as shown in fig. When the two disc are brought into contact the discs rub against each other and eventually reach a common angualr velocity ω.

(a) Derive an expressio for ω

(b) What is the angular impulse of friction on any one of the discs?



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31. 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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32. 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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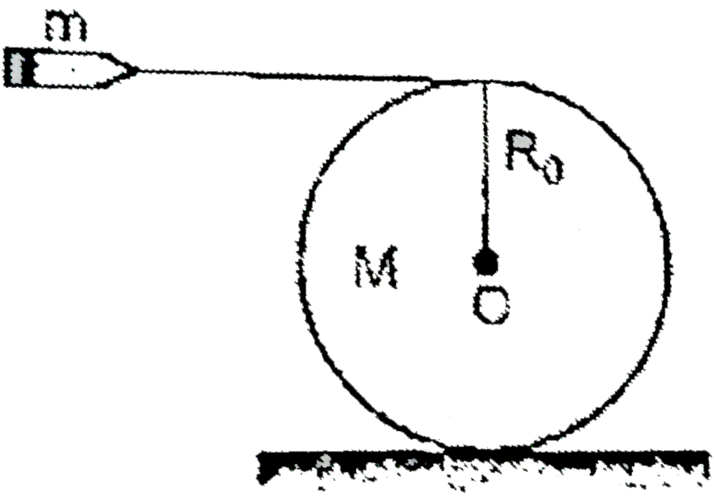
33. A bullet of mass m moving with velocity v strikes and becomes embedded at the edge of a cylinder of mass M and radius R_0 as shown in fig. The cylinder, initially at rest, begins to rotate about its symmetry axis, which remains fixed in position. Assuming no frictional torque, what is the angular velocity of the cylinder after this collision? Kinetic energy conseved?



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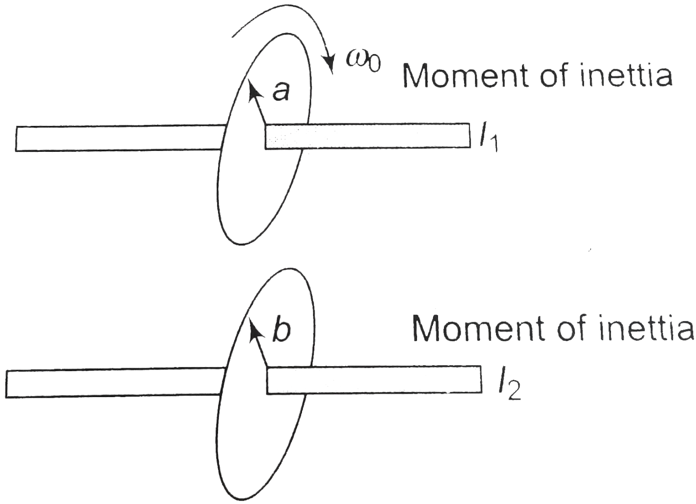
34. The two uniform discs rotate separately on parallel axles. The upper disc (radius a and momentum of inertia I_1) is given an angular velocity ω_0 and the lower disc of (radius b and momentum of inertia I_2) is at rest. Now the two discs are moved together so that their rims touch. Final angular velocity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



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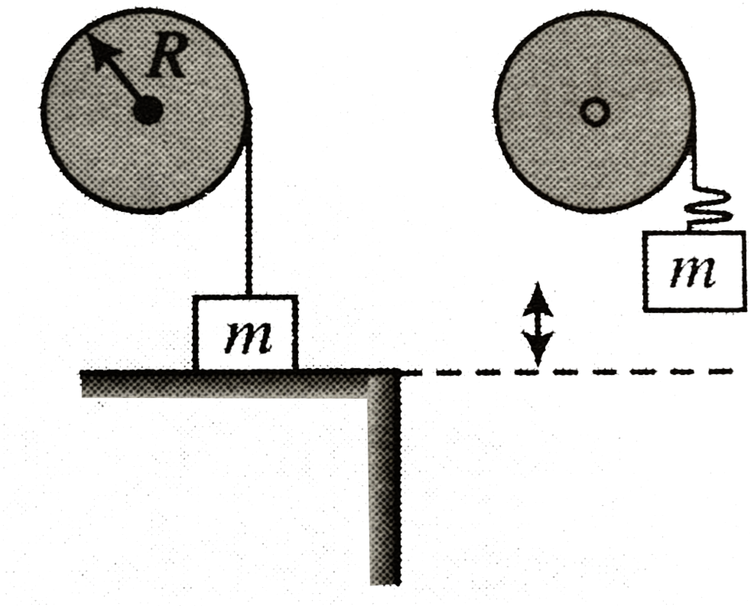
35. A string is wrapped several times on a cylinder of mass M and radius R. the cylinder is pivoted about its adxis of block symmetry. A block of mass m tied to the string rest on a support positioned so that the string has no slack. The block is carefully lifted vertically a distance h, and the support 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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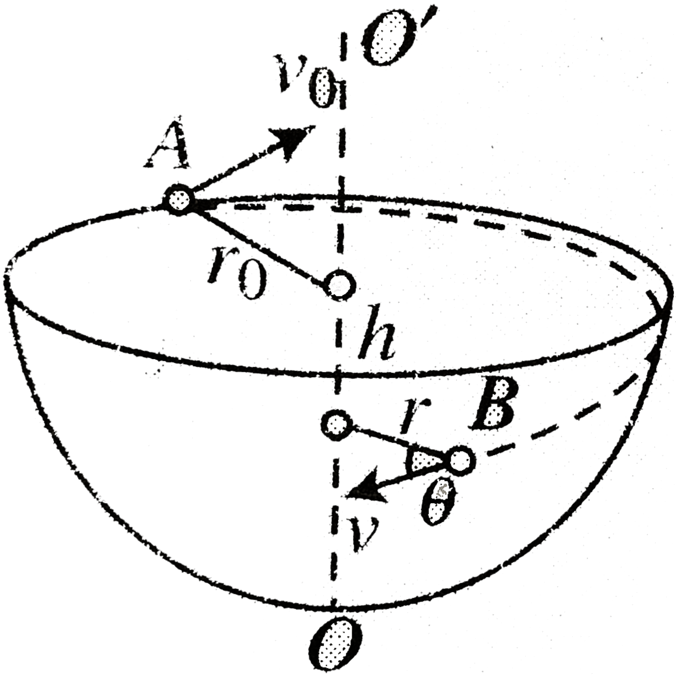
36. A small mass particle is projected with an initial velocity v_0 tangent to the horizontal rim of smooth hemisphereical bowl at a radius r_0 from the vertical centre line, as shown at point A. As the particle slide past point B, a distance h below A and distance r from the verticle centre line, its velocity v makes an angle θ with the horizontal tangent to the bowl through B.

Determine θ.



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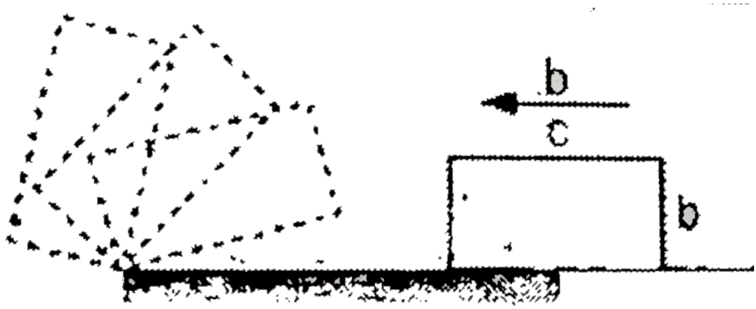
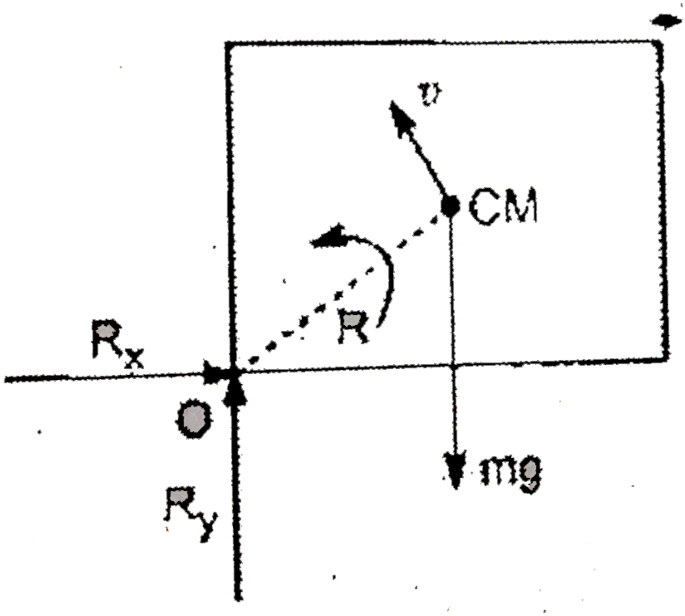
37. A uniform rectangular block of dimensions shown in fig is sliding on the horizontal surface with a velocity v when it strikes a small kerb in the surface. Determine the minimum value of v for which the block will pivot about the kerb and just reach the vertical position with no velocity. Assume negligible rebound at the step.





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38. 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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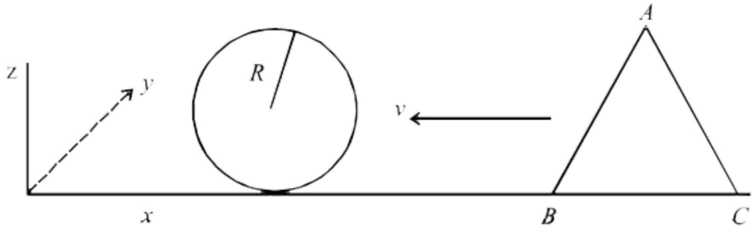
39. A wedge of mass m and triangular cross-section (AB = BC = CA = 2R) is moving with a constant velocity $-v\hat{I}$ towards a sphere of radius R fixed on a smooth horizontal table as shown in figure. The wadge makes an elastic collision with the fixed sphere and returns along the same path without any rotaion. Neglect all friction and suppose that the wedge remains in contact with the sphere for a very shot time. Δt, during which the sphere exerts a constant force F on the wedge.



(a) Find the force F and also the normal force N exerted by the table on the wedge during the time Δt.

(b) Ler h denote the perpendicular distance between the centre of mass of the wedge and the line of action of F. Find the magnitude of the torque due to the normal force N about the centre of the wedge, during the interval Δt.

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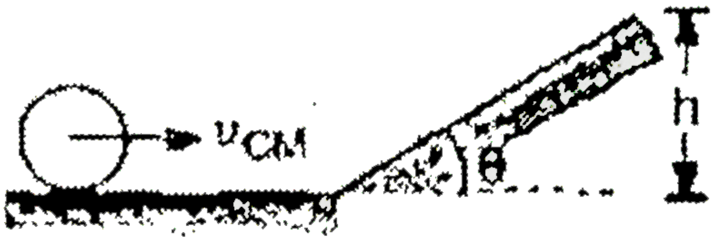
40. A ball of radius R and mass m is rolling without slipping on a horizontal surface with velocity of its centre of mass v_{CM}. It then rolls wilthout slippig up a hill to a height h before momentarily coming to rest. Find h



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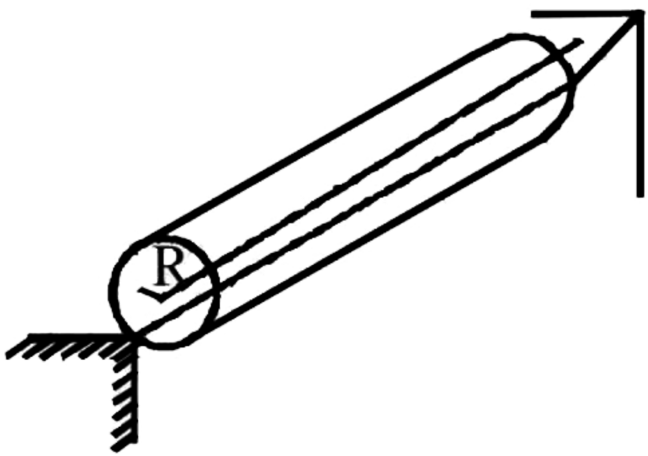
41. A rectangular rigid fixed block has a long horizontal edge. A solid homogeneous cylinder of radus R is placed horizontally at rest its length parallel to the edge such that the exis of the cylinder and the endg of the block are in the same vertical plane as shown in the figure below. Ther is sufficinet friction present at the edge s that a very small displacement causes the cylinder to roll off the edge without slipping. Determine:



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

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

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

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42. A solid cylinder has a thin string wrapped several times around its circumference. The string is fixed at one end and the cylinder is released. Find the downward acceleration of cylinder and tension in the string.

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43. A horizontal force P applied at a height h above the centre of a solid cylinder of mass M, radius R. Determine force of friction in terms of h show that friction force is zero for $h = R/2$. Assume that the cylinder rolls without slipping.

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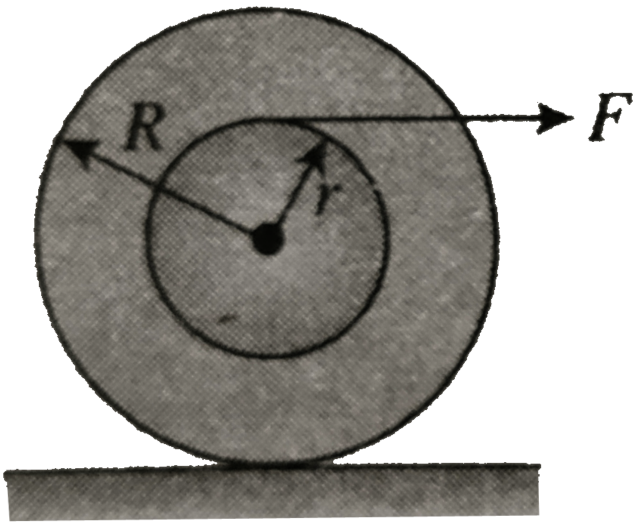
44. A wheel of radius R, mass m and moment of inertia I is pulled along a horizontal surface by application of force F to as rope unwinding from the axel of radius, r as shown in figure. Friction is sufficient for pure rolling of the wheel.



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 sphereicla ball of mass M and radius R is projected along a rough horizontal surface so that initially $(t = 0)$ it slides with a linear speed v_0 but does not rotate. As it slides, it begins to spin and eventually rolls without slipping. How long does it take to begin rolling without slipping?

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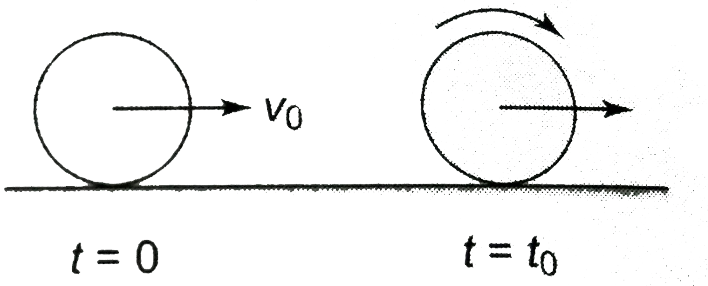
46. A uniform disc of mass m and radius R is projected horizontally with velocity v_0 on a rough horizontal floor so that it starts off with a purely sliding motion at $t = 0$. After t_0 seconds, it acquires pure rolling motion as shown in the figure.

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

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



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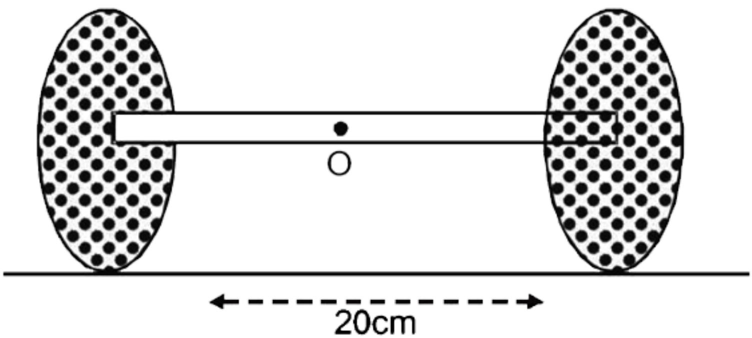
47. Two thin circular disks of mass 2kg and radius 10 cm each are joined by a rigid massless rod of length 20 cm. the axis of the rod is along the perpendicular to the planes of the disk through their centres. This object is kept on a truck in such a way that the axis of the object is horizontal and 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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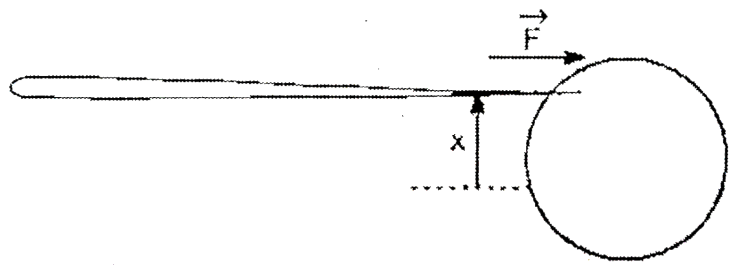
48. The cue stick hits a cue ball horizontally a distance x above the centre of the ball. Find the value of x for which the cue ball will instantaneously roll without slipping. Calculate the answer in terms of the radius R of the ball.



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49. A ball of radius r hits a cushion with a pure rolling motion and rebounds, with a pure rolling motion. Find the ratio of the height h of the cushion to the radius r of the ball. Assume that the foce exerted on the ball by the cushion is horizontal during the impact and that the ball hits the cushion normally.

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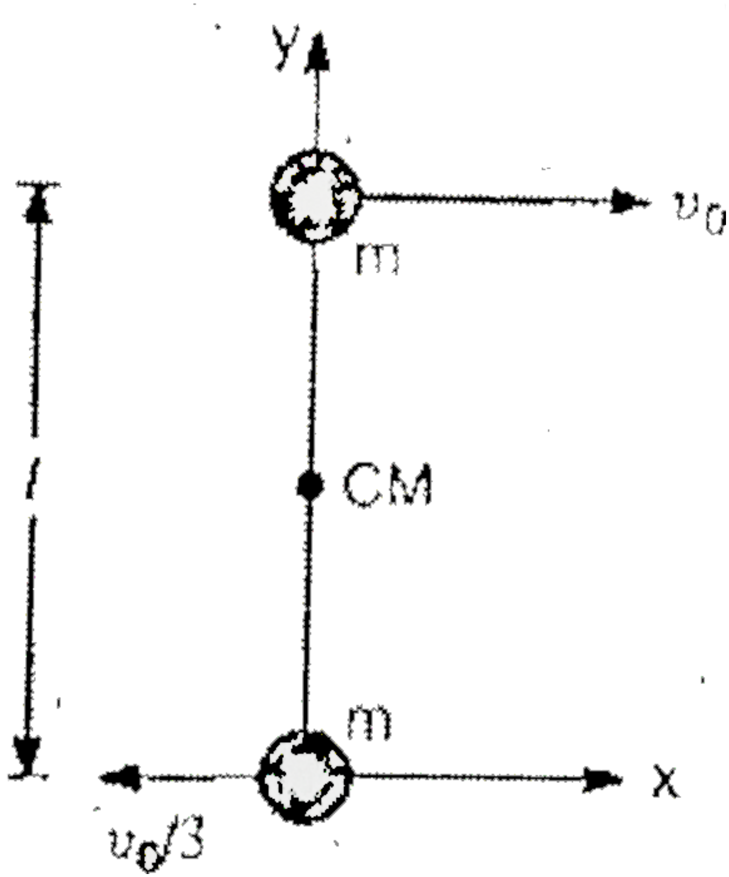
50. A diatomic molecule two identicla atoms of mass m bound together a distance l apart is confined in a lab reference frame. At a certain time one of the two atoms is observed to have speed v_0 and the other, moving in the opposite direction, speed $v_0 / 3$.



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

Determine

(a) the angular velocity of the system after collision,

(b) the position of the point on the rod which remains stationary immediately after collision,

(c) the chabge in kinetic energy of the system as a result of the collision.

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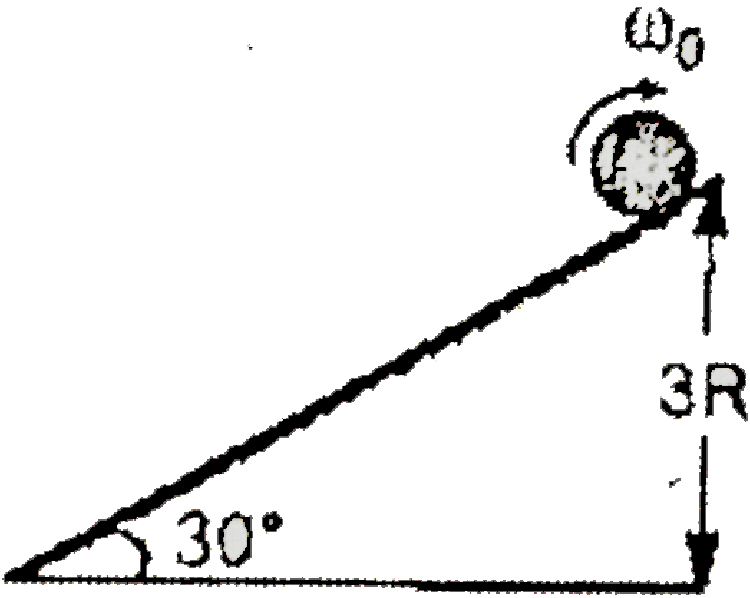
52. A spinning cylinder of mass m and radius R is lowered on a rough inclined plane of angle 30° with the horizontal and $\mu = 1\sqrt{3}$. The cylinder is released at a height of $3R$ from horizontal. Find the total time taken by the cylinder to reach the bottom of the incline.



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SCQ_TYPE

1. 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. $\eta > 6$

D. $\eta < 6$

Answer: D

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

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

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

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

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

Answer: B

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

A. $2n$

B. n

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

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

Answer: B

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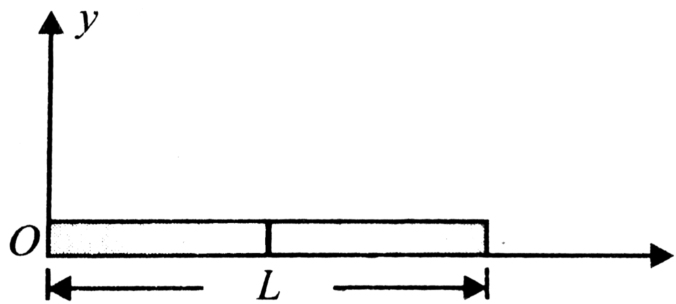
4. The figure shows a uniform rod lying along the x-axis. The locus of all the points lying on the $x - y$ plane, about which the moment of inertia of the rod is same as that about O, is



A. Circle

B. Parabola

C. Straight line

D. Ellipse

Answer: A

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5. The moment of inertia of a uniform semicircular disc of mass M and radius r about a line perpendicular to the plane of the disc through the center is

A. Mr^2

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

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

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

Answer: A

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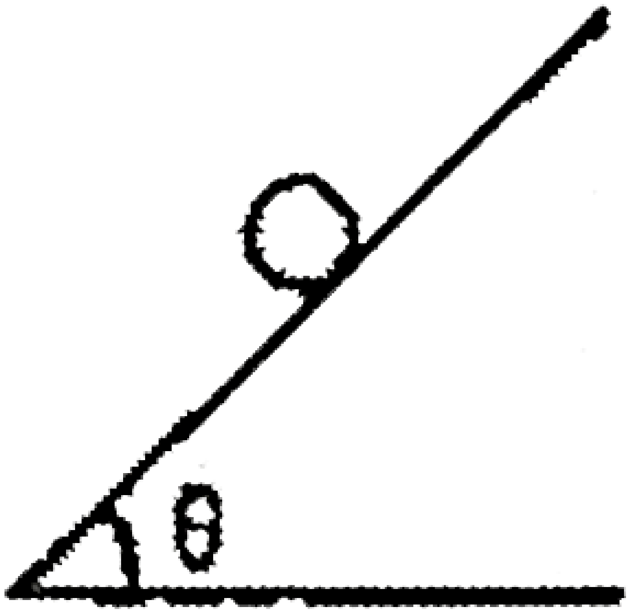
6. A ring of mass M and radius R is released on an inclined as shown. If the coefficient of friction $\mu < \frac{1}{2}\tan\theta$, then during a displacement l:



A. Acceleration of the ring $= g/2\sin\theta$

B. Acceleration of the ring

$= g\sin\theta - \mu g\cos\theta$

C. work done by the force of friction

$$= mgl(\sin\theta - u\cos\theta)$$

D. work done by the force of friction is zero

Answer: B

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7. The line of action of the resultant of two like parallel forces shifts by one-fourth of the distance between the forces when the two forces are interchanged. The ratio of the two forces is:

A. $1 : 2$

B. $2 : 3$

C. $3 : 4$

D. $3 : 5$

Answer: D

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8. A mass m moving with a constant velocity along a line parallel to the axis, away from the origin. Its anguarl 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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9. A person sitting firmly over a rotating stool has his arms stretched. If he folds his arms, his angular momentum about the axis of rotation

A. increases

B. decreases

C. remains unchanged

D. doubles

Answer: C

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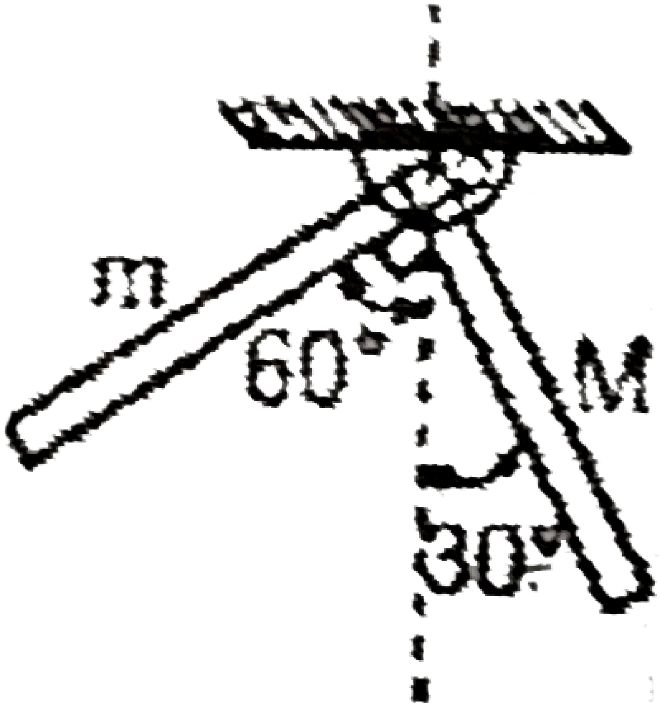
10. Two uniform rods of equal length but different masses are rigidly joined to form an L-shaped body, which is then pivoted about O as shown. If in equilibrium the body is in the shown configuration, ratio $\frac{M}{m}$ will be



A. 2

B. 3

C. $\sqrt{2}$

D. $\sqrt{3}$

Answer: D

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

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

C. $\frac{3}{\sqrt{15}}R$

D. $\sqrt{\frac{3}{15}}R$

Answer: A

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12. A mass m moving with a constant velocity along a line parallel to the axis, away from the origin. Its anguarl 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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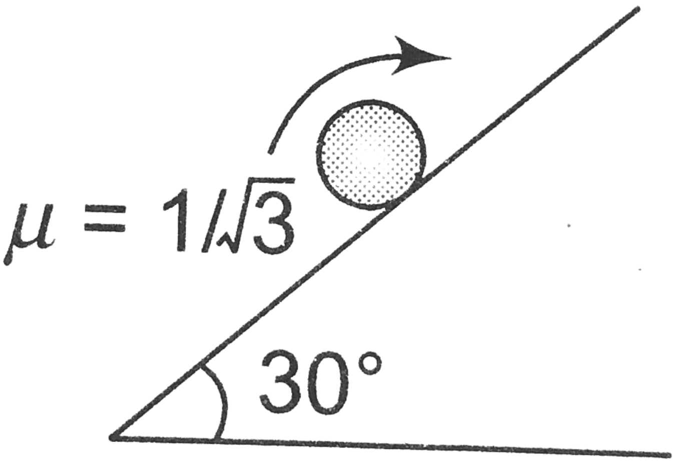
13. An cylinder of mass m is rotated about its axis by an angular velocity ω and lowered gently on an inclined plane as shown in figure. Then :



A. It will start going upward

B. It ,will first going upward anci then downward

C. It will go downward just after it is lowered

D. It can never go upward

Answer: D

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14. A wheel of radius R rolls without slipping on a horizontal ground. The distance travelled by a point on the rim in one complete rotation is:

A. $2\pi R$

B. $8R$

C. $2R$

D. πR

Answer: B

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15. Two identical rods are joined to form an $'X'$. The smaller angle between the rods is θ. The moment of inertia of the system about an axis passing through point of intersection of the rods and perpendicular to their plane is proportional to:

A. θ

B. $\sin^2\theta$

C. $\cos^2\theta$

D. independent of θ

Answer: D

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

A. $m\omega^2 l$

B. Zero

C. mg

D. $\frac{1}{2}m\omega^2 l$

Answer: D

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17. A large platform is moving with constant acceleration $'a'$ perpendicular to its plane in gravity free space. A particle of mass m is projected with speed u relative to the platform at an angle θ with its plane from a point O on it. The angular momentum of the particle about O:

A. Always increases

B. Always decreases

C. First decreases and then increases

D. First increases and then decreases

Answer: A

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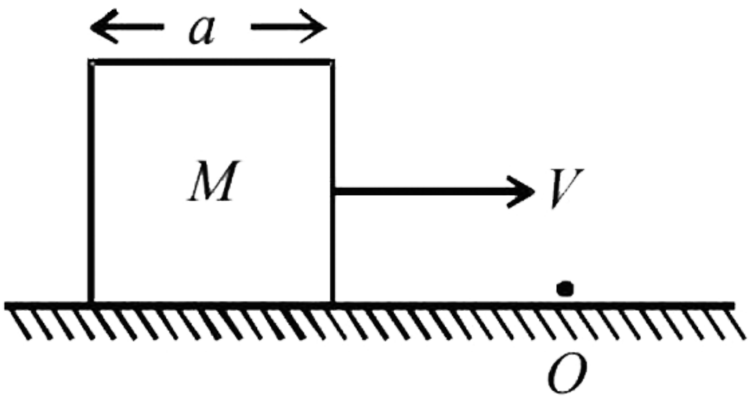
18. A cubical block of side a is moving with velocity V on a horizontal smooth plane as shown in Figure. It hits a ridge at point O. The angular speed of the block after it hits O is



A. $3v/(4a)$

B. $3v/(2a)$

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

D. Zero

Answer: A

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19. A wheel of radius r rolls without slipping with a speed v on a horizontal road. When it is at a point A on the road, a small blob of mud separates from'the wheel at- its highest point and lands at point B on the road:

A. $Ab = v\sqrt{\frac{r}{g}}$

B. $AB = 2v\sqrt{\frac{r}{g}}$

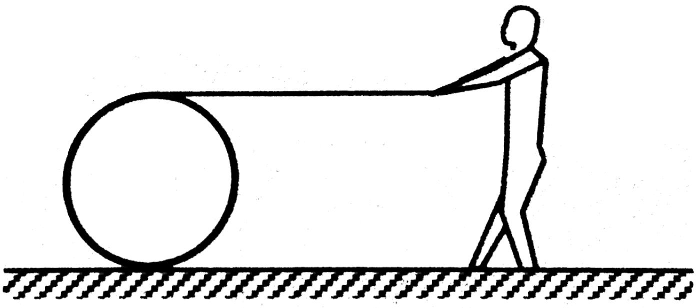
C. $AB = 4v\sqrt{\frac{r}{g}}$

D. If $v > \sqrt{4rg}$, the blob of mud land on the wheel and not on the road.

Answer: C

Watch Video Solution

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



A. l

B. $2l$

C. $3l$

D. $4l$

Answer: B

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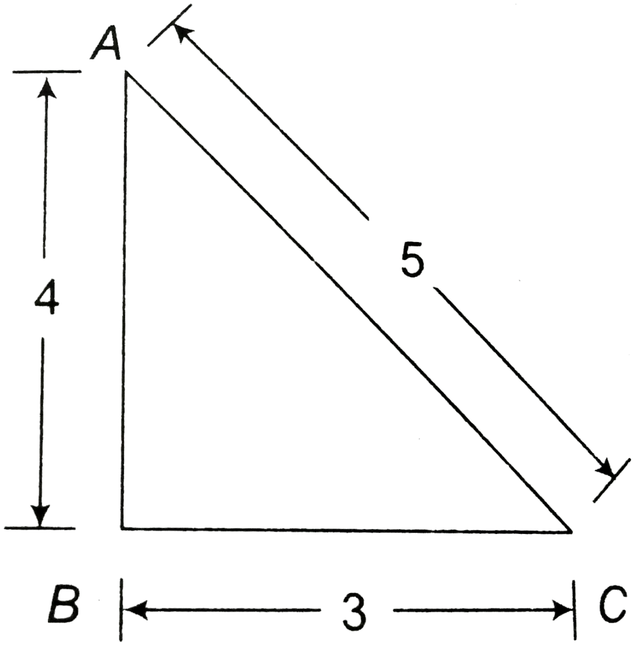
21. ABC is a traiangular plate of uniform thickness. The sides are in the ratio shown in the figure. I_{AB}, I_{BC} and I_{CA} are the moments of inertia of the plate about AB, BC and CA repectively. Which one of the following relations is correct?



A. I_{CA} is maximum

B. $I_{AB} > I_{BC}$

C. $I_{BC} > I_{AB}$

D. $I_{AB} + I_{BC} = I_{CA}$

Answer: B

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22. A solid homogeneous sphere of mass M and radius R is moving on a rough horizontal surface partly rolling and partly 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 center of mass is· conserved

D. Angular momentum about the center of mass is conserved

Answer: B

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

A. I

B. $I \sin^2 \theta$

C. $I \cos^2 \theta$

D. $I \cos^2 \left(\frac{\theta}{2}\right)$

Answer: A

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24. Two uniform solid spheres having unequal rdii are released from rest from the same height on a rough incline. Ilf the spheres roll without slipping

A. The heavier sphere reaches the bottom first

B. The bigger sphere reaches the bottom first

C. The two spheres reach the bottom together

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

Answer: C

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25. A particle of mass $m = 5kg$ is moving with a uniform speed $v = 3\sqrt{2}$ in the XOY plane along the line $Y = X + 4$. The magnitude of the angular momentum of the particle about the origin is

A. zero

B. 60

C. 7.5

D. $40\sqrt{2}$

Answer: B

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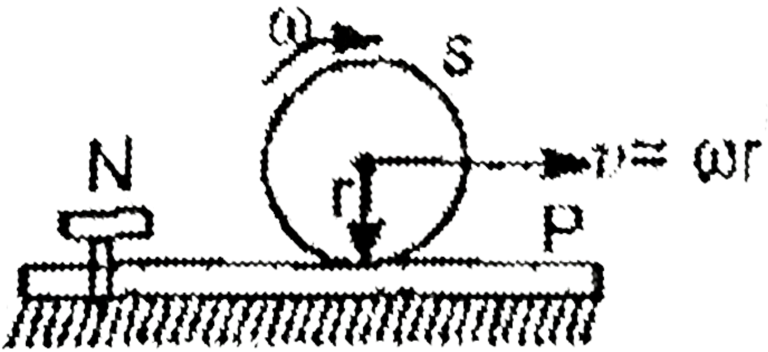
26. A sphere S rolls without slipping moving with a constant speed on a plank P. The friction between the upper surface of P and the sphere is sufficient to prevent slipping, while the lower surface of P is smooth and rest on the ground. Initially P is fixed on the ground by a pin N. If N is suddenly removed



A. S will begin to slip on P

B. P will begin to move backwards

C. The speed of S will decrease and its angular velocity with increase

D. There will be no change in the motion of S and P will still be in rest

Answer: D

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27. 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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28. A sphere is rotating about a diameter

A. The particles on the surface of the ·sphere do not have any linear acceleration

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

C. Different particles on the surface have different angular speeds

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

Answer: B

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

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

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

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

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

Answer: C

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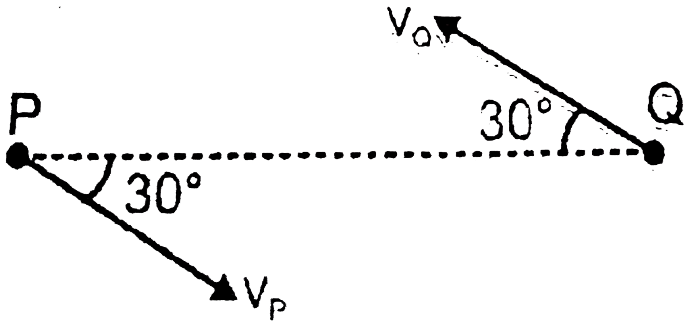
30. Two moving particles P and Q are 10cm apart at any instant. Velocity of P is $8m/s$ at 30°, from line joining the P and Q and velocity of Q is $6m/s$ at 30°. Calculate the angular velocity of P w.r.t. Q



A. $0 rad / s$

B. $0.1 rad / s$

C. $0.4 rad / s$

D. $0.7 rad / s$

Answer: D

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31. A uniform rod of mass m and length l_0 is rotating with a constant angular speed ω about a vertical axis passing through its point of suspension. Find the moment of inertia of the rod about the axis of rotation if it make an angle θ to the vertical (axis of rotation).

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

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

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

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

Answer: C

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32. A sphere can roll on a surface inclined at an angle θ if the friction coefficient is more than $\frac{2}{7} g \sin \theta$. Suppose the friction coefficient is $\frac{1}{7} g \sin \theta$, and a sphere is released from rest on the incline,

A. It will ,tay at rest

B. It will make pure translational motion

C. it will translate and rotate about the center

D. The angular momentum of the sphere about its center will remain constant

Answer: C

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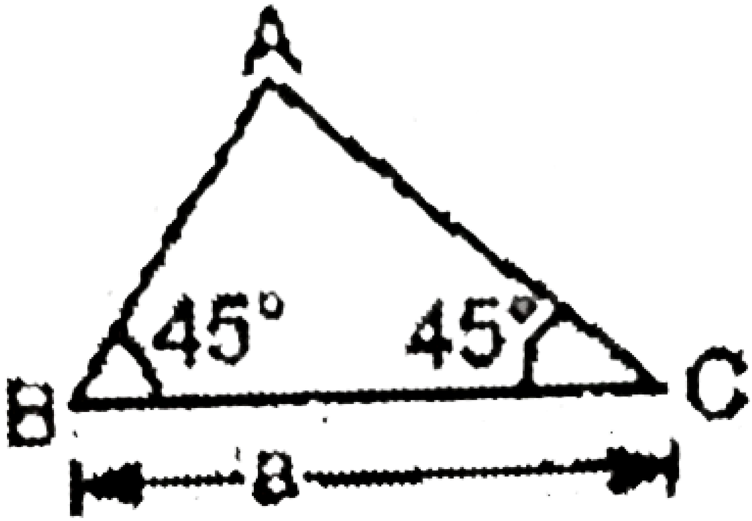
33. What is the moment of inertia of a triangular plate ABC of mass M and side $BC = 'a'$ about a axis passing through A

and perpedicular to the plane of the plate?



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

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

C. $\frac{Ma^2}{24}$

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

Answer: A

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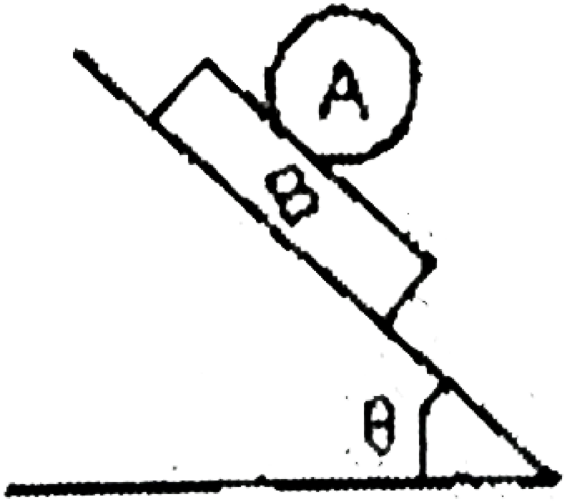
34. A rolling body is kept on a plank B. There is sufficient friction between A and B and no friction between B and the incline,d plane.

Then body:



A. A rolls

B. A 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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35. Three identical rods, each of length L, are joined to form a rigid equilateral triangle. Its radius of gyration about an axis passing thorugh a corner and perpendicular to plane of triangle is

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

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

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

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

Answer: C

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36. A sphere cannot roll on

A. A smooth horizontal surface

B. A smooth inclined plane

C. A rough horizontal surface

D. A rough inclined surface

Answer: B

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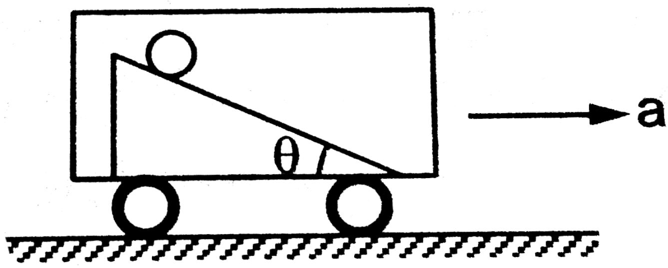
37. Figure shows smooth inclined plane fixed in a car accelerating on a horizontal road. The angle of incline θ is related to the acceleration a of the car as $a = \quad > an\theta$. If the sphere is set in pure rolling on the incline



A. It will continue pure rolling

B. It will slip down the plane

C. Its linear velocity will increase

D. Its linear velocity will decrease

Answer: A

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

A. At O

B. At a distance less than $\frac{l}{2}$ from$O$

C. At a distance $\frac{l}{2}$ from O

D. At a distance larger than $\frac{l}{2}$ from O

Answer: B

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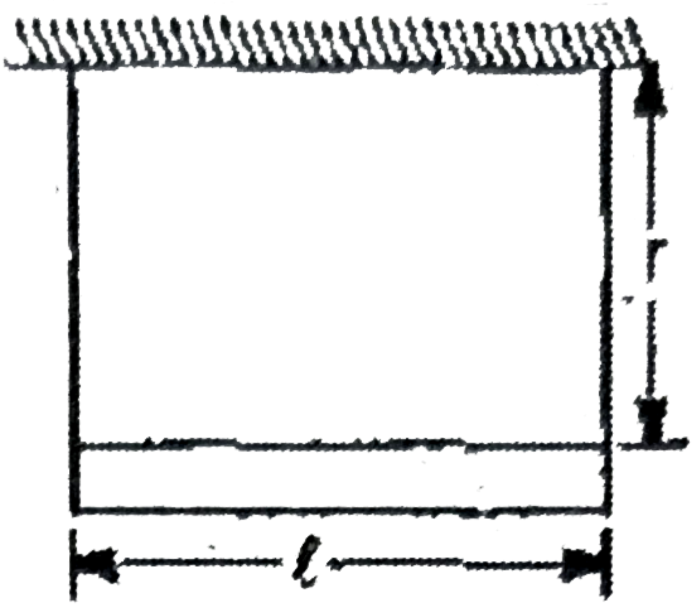
39. A uniform rod of length l and mass M is suspended on two vertical inextensible string as shown in figure. Then tension T in the left string at the instant, when right string snaps is?



A. $T = Mg$

B. $T = \frac{Mg}{2}$

C. $T = \frac{Mg}{4}$

D. $T =$ zero

Answer: C

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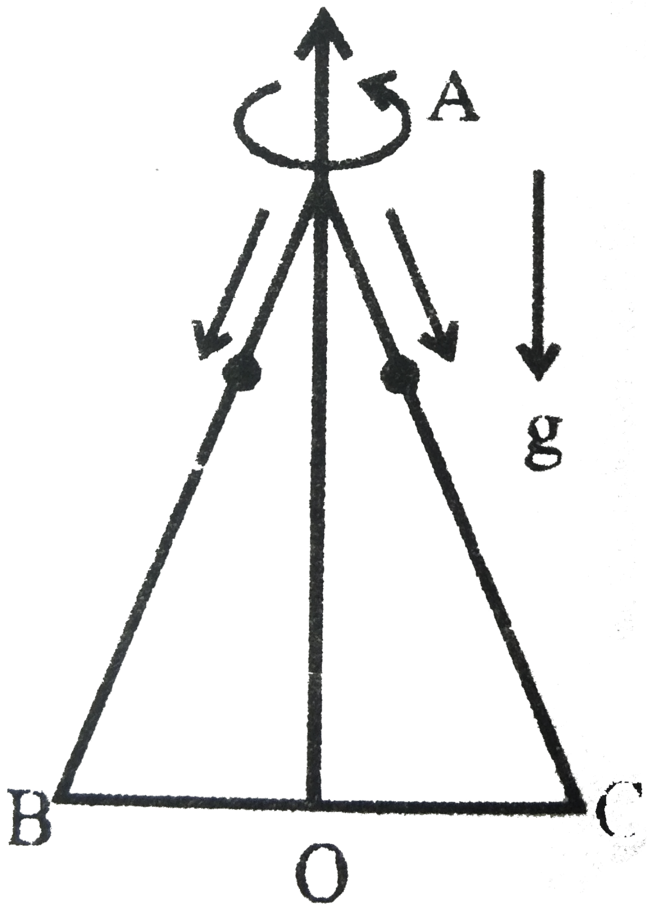
40. A equilateral triangle ABC formed from a uniform wire has two small identical beads initially located at A. The triangle is set rotating about the vertical axis AO. Then the beads are released from rest simultaneously and allowed to slide down. one long. AB and the other along AC as shown. Neglecting frictional effects, the quantities that are conserved as the beads slide down, are.



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41. A translational velocity v_0 is imparted in a horizontal direction to a hoop of radius r placed on a rough horizontal surface. What is angular velocity of hoop after it stops slipping?

A. $\frac{v_0}{r}$

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

C. $\frac{2v_0}{r}$

D. $Zero$

Answer: B

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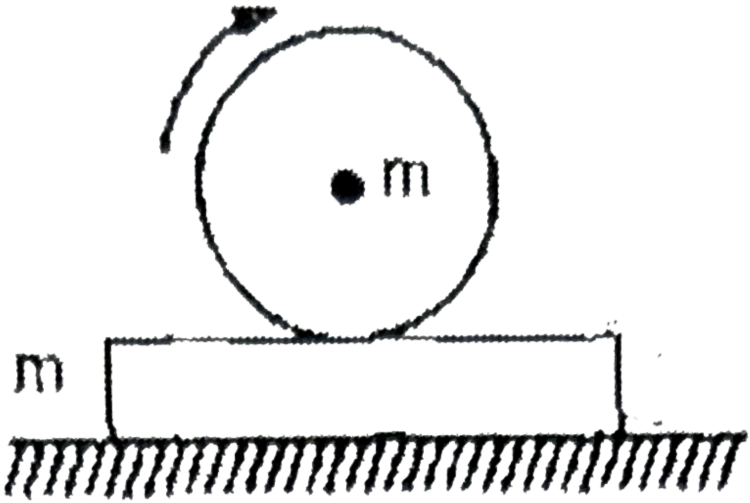
42. A sphere of mass m is given some angular velocity about a horizontal axis through the center, and gently placed on a plank of mass m. The coefficient of friction between the two is μ. The plank rests on a smooth horizontal surface. The intial acceleration of the sphere relative to the plank will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



A. zero

B. μg

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

D. $2\mu g$

Answer: D

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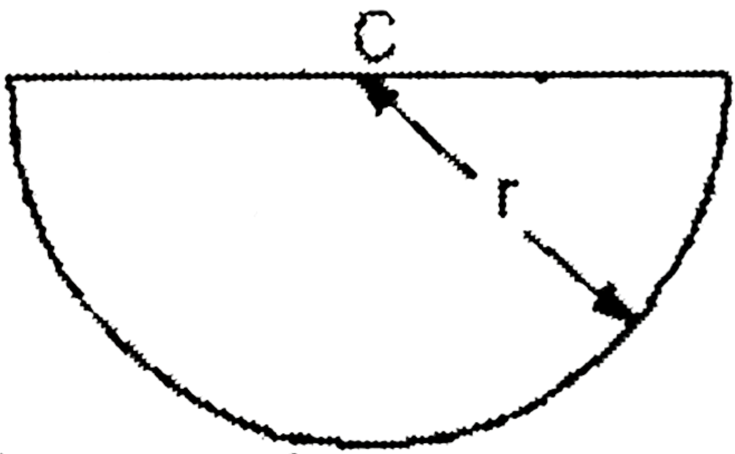
43. A semicircular lamina of mass m and radius $'r'$ and centre C. Its center of mass is at a distance $'x'$ from C. Its moment of inertia about an axis through its center of mass and perpendicular to its plane is:



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

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

C. $\frac{1}{2}mr^2 + mx^2$

D. $\frac{1}{2}mr^2 - mx^2$

Answer: D

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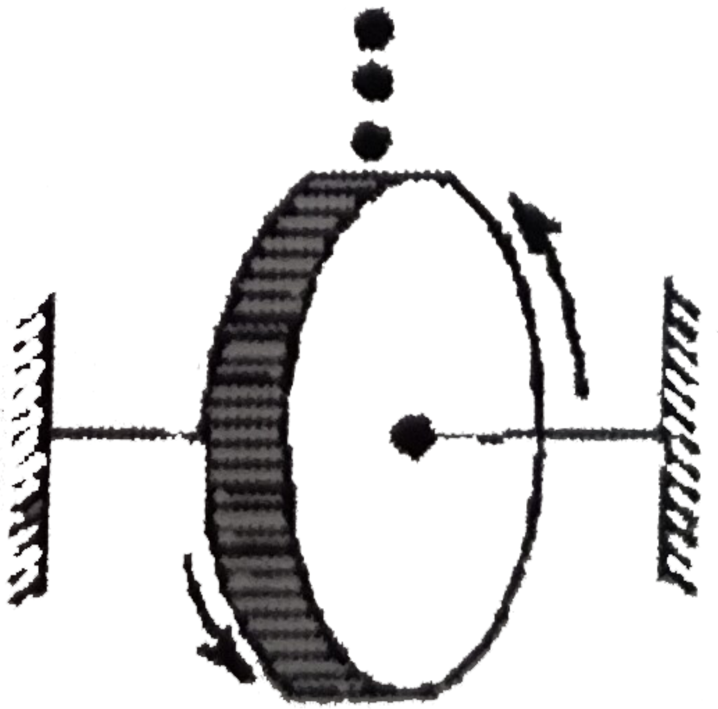
44. A disc of mass m0 rotates freely about a fixed horizontal axis through its center. A thin cotton pad is fixed to its rim, which can absorb water. The mass of water dripping onto the pad is μ per second. After what time will the angular velocity of the disc get reduced to half of its initial value:



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

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

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

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

Answer: D

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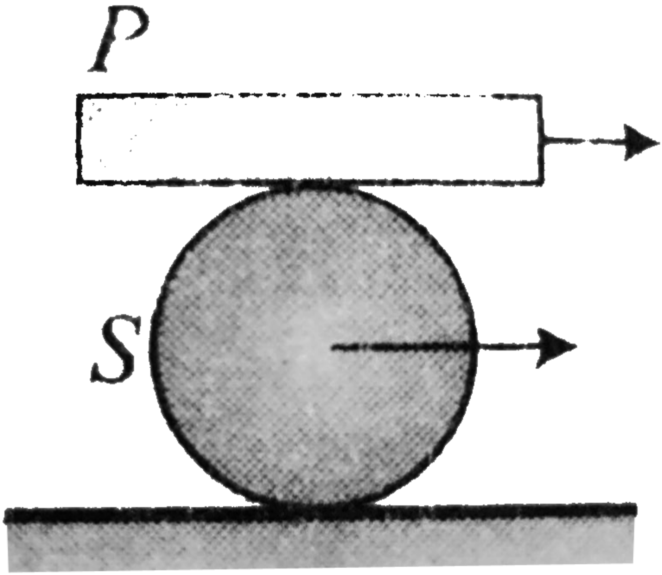
45. A plank P is placed on a solid cylinder S, which rolls on a horizontal surface. The two are of equal mass. There is no slipping at any of the surfaces in contact. The ratio of kinetic energy of P to the kinetic energy of S is:



A. $1:1$

B. $2:1$

C. $8:3$

D. $11:8$

Answer: C

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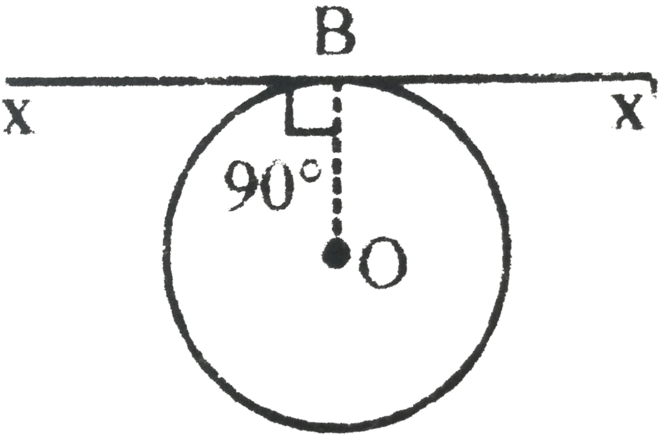
46. A thin wire of length L and uniform linear mass density ρ is bent into a circular loop with centre at O as shown. The moment of inertia of the loop about the axis XX' is :



A. $\frac{\rho L^{Y}(3)}{8\pi^2}$

B. $\frac{\rho L^3}{16\pi^2}$

C. $\frac{5\rho L^3}{16\pi^2}$

D. $\frac{3\rho L^3}{8\pi^2}$

Answer: D

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47. A round uniform body of radius R, mass M and moment of inertia 'I' rolls down (without slipping) and inclined plane making an angle θ with the horizontal. Then its acceleration is.

A. $\dfrac{g\sin\theta}{1+\frac{I}{MR^2}}$

B. $\dfrac{g\sin\theta}{1+\frac{MR^2}{I}}$

C. $\dfrac{g\sin\theta}{1-\frac{I}{MR^2}}$

D. $\dfrac{g\sin\theta}{1-\frac{MR^2}{I}}$

Answer: A

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48. A thin rod of mass m and length l is hinged at the lower end to a level floor and stands vertically. Then its upper end will strike the floor with a velocity given by:

A. $\sqrt{2gl}$

B. $\sqrt{3gl}$

C. $\sqrt{5gl}$

D. $\sqrt{mgl}$

Answer: B

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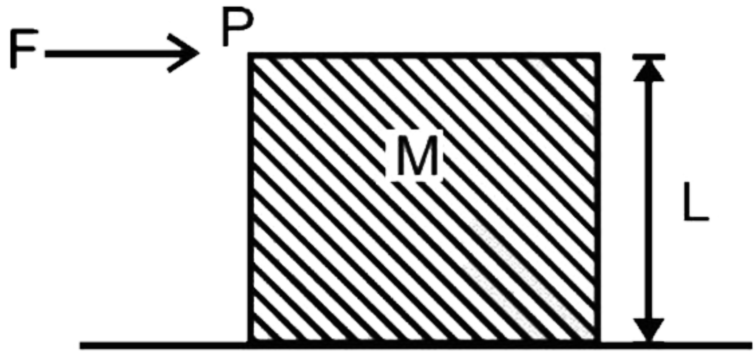
49. A cubical block of side L rests on a rough horizonta surface with coefficient of friction μ. A horizontal force F is applied on the block as shown. If the coefficient of friction is sufficiently high so that the block does not slide before toppling, the minimum force required to topple the block is



A. infinitesimal

B. $mg/4$

C. $mg/2$

D. $mg(1-\mu)$

Answer: C

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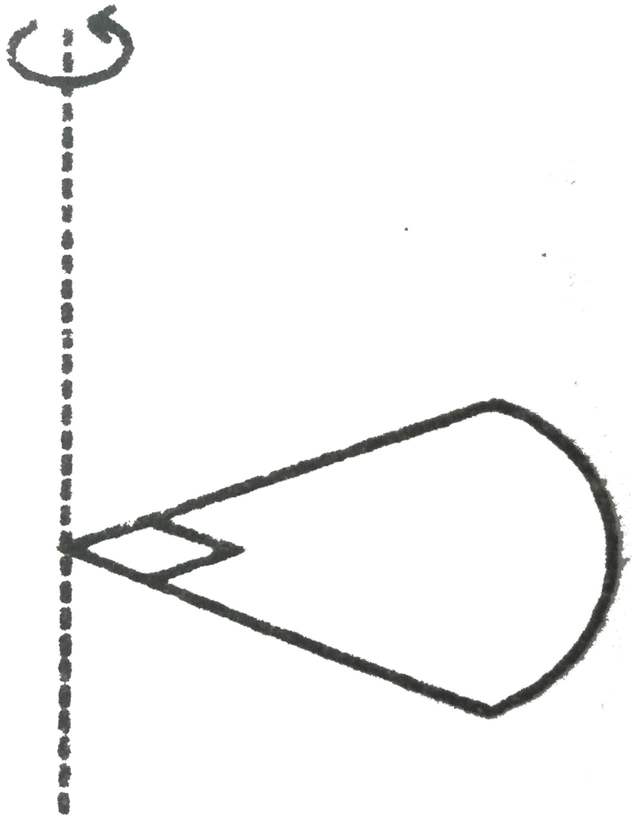
50. One quarter sector is cut from a uniform circular disc of radius R. This sector has mass M. It is made to rotate about a line perpendicular to its plane and passing through the centre of the original disc. It moment of inertia about the axis of rotation is.



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

A. 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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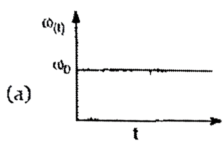
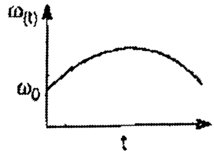
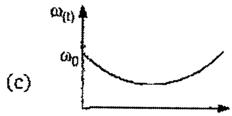
52. A circular platform is free to rotate in a horizontal plane about a vertical axis passing through its centre. A tortoise is sitting at the edge of the platform. Now the platform is given an angular velocity ω_0. When the tortoise move along a chord of the platform with a constant velocity (with respect to the platform),

A. 

B. 

C. 

D. 

Answer: B

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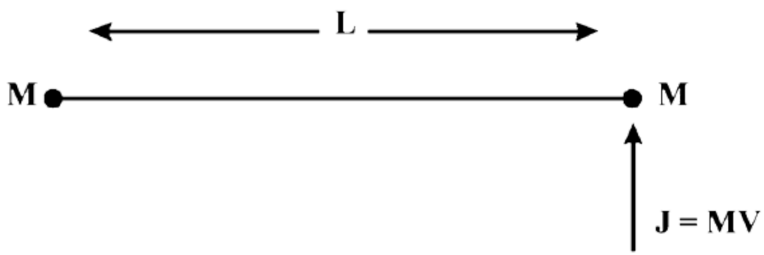
53. Consider a body, shown in figure, consisting of two identical balls, each of mass

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. V / L

B. $2V / L$

C. $V / 3L$

D. $V / 4L$

Answer: A

Watch Video Solution

54. 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. centre of the circle

B. on the circumference of the circle

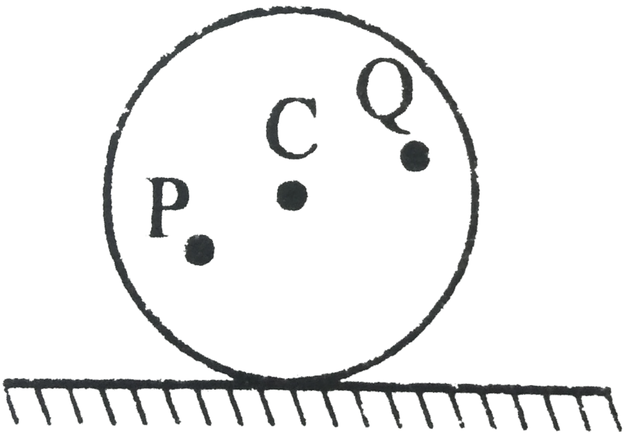
C. inside the circle

D. outside the circle

Answer: A

Watch Video Solution

55. 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. $V_Q > V_C > C_P$

B. $V_Q < V_C < V_P$

C. $V_Q = V_P = V_P / 2$

D. $V_Q < V_C < V_P$

Answer: A

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56. 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. $2K$

B. $K/2$

C. $K/4$

D. $4K$

Answer: B

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57. A particle moves in a circular path with decreasing speed . Choose the correct statement.

A. Angular moment remains constant

B. Acceleration $\overrightarrow{a}$ is towards the centre

C. Particle moves in a spiral path with decreasing radius

D. The direction of angular momentum remains constant

Answer: D

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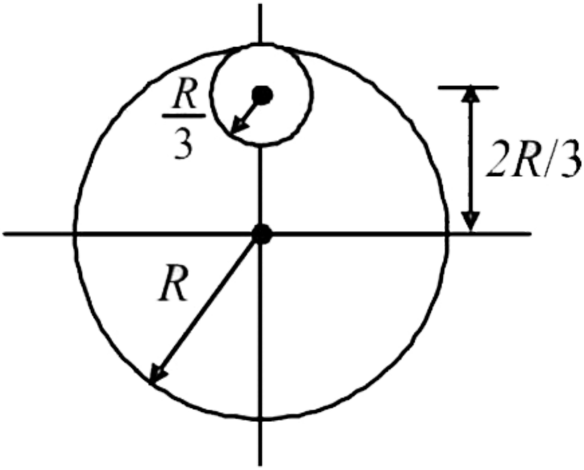
58. From a circular disc of radius R and mass 9 M , a small disc of radius R/3 is removed from the disc. The moment of inertia of the remaining disc about an axis perpendicular to the plane of the disc and passing through O is



A. $4MR^2$

B. $\frac{40}{9}MR^2$

C. $10MR^2$

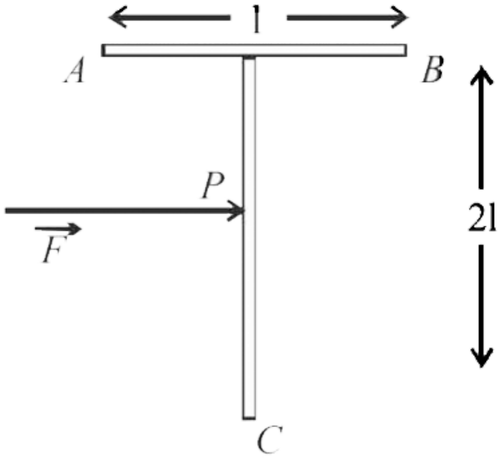
D. $\frac{37}{9}MR^2$

Answer: A

Watch Video Solution

59. A 'T' shaped object with dimensions shown in the figure, is lying on a smooth floor. A force '$\overrightarrow{F}$' is applied at the point P parallel to AB, such that the object has only the translational motion without rotation. Find the location of

P with respect C.



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

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

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

D. L

Answer: C

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60. 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 ring now rotates with an angular velocity $\omega' =$

A. $\dfrac{\omega m}{(m+M)}$

B. $\dfrac{\omega m}{(m+2M)}$

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

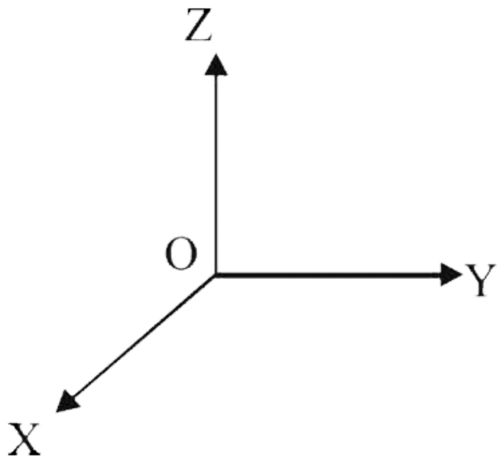
D. $\frac{\omega(m-2M)}{(m+2M)}$

Answer: B

Watch Video Solution

61. A force of $-F\hat{k}$ acts on O, the origin of the coodinate system. The torque about the point

(1,-1) is



A. $F\left(\hat{i}+\hat{j}\right)$

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

C. $F\left(\hat{i}-\hat{j}\right)$

D. $-F\left(\hat{i}+\hat{j}\right)$

Answer: D

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62. Four point masses, each of value m, are placed at the corners of square $ABCD$ of side l. The moment of inertia of this system about an axis passing through A and parallel to BD is -

A. $3ml^2$

B. ml^2

C. $2ml^2$

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

Answer: A

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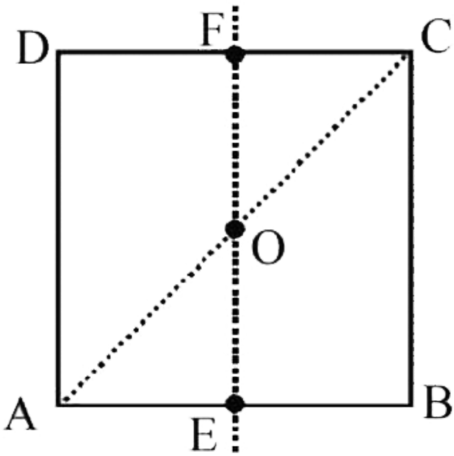
63. For the given uniform square lamina ABCD, whose centre is O,



A. $\sqrt{2}I_{AC} = I_{EF}$

B. $I_{AD} = 3I_{EF}$

C. $I_{AC} = I_{EF}$

D. $I_{AC} = \sqrt{2I}_{EF}$

Answer: C

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

A. $20mL^2$

B. $6mL^2$

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

D. $30mL^2$

Answer: A

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

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

B. mr^2

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

D. $2mr^2$

Answer: C

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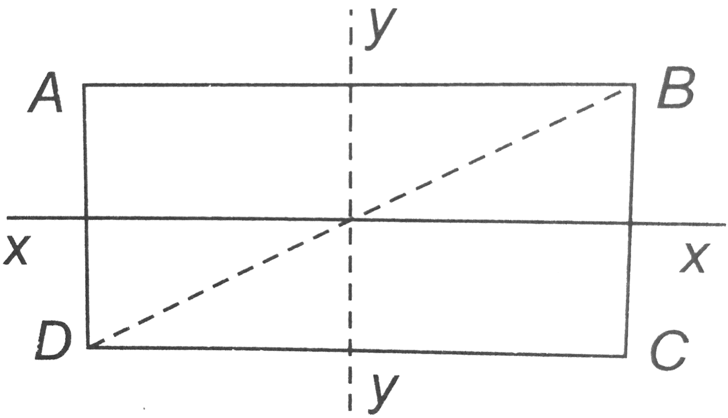
66. In a rectangle $ABCD, AB = 21$ and $BC = 1$. Axes $\times$ and yy pass through centre of the rectangle. The moment of inertia is least about :



A. DB

B. BC

C. xx

D. yy

Answer: C

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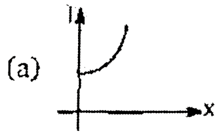
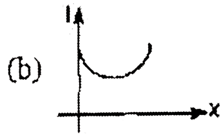
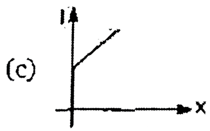
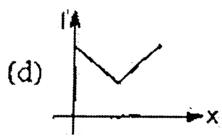
67. Moment of inertia I of a solid sphere about an axis parallel to a diameter and at a distance x from it varies as:

A. 

B. 

C. 

D. 

Answer: A

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

A. $\frac{22}{252}ml^2$

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

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

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

Answer: D

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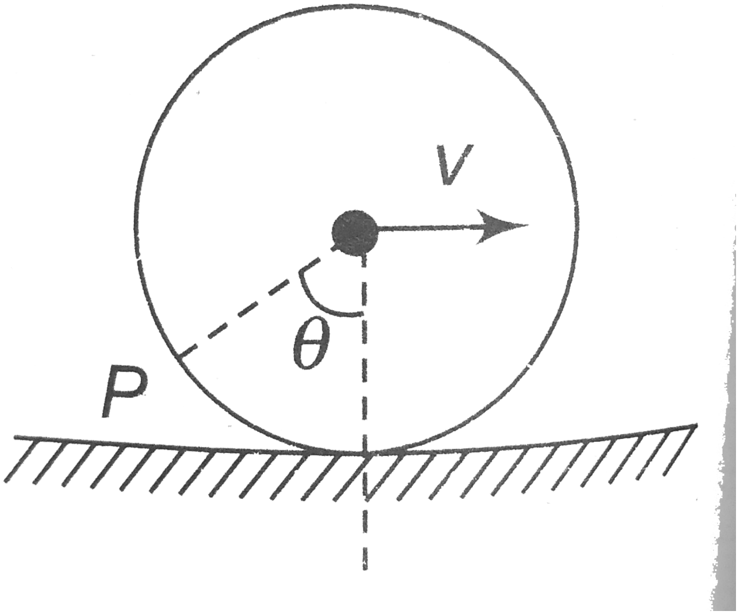
69. A hoop rolls on a horizontal ground without slipping with linear speed v. Speed of a particle P on the circumference of the hoop at angle θ is :



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

B. $v\sin\theta$

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

D. $v\cos\theta$

Answer: A

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

A. -2%

B. -1%

C. -3%

D. 1%

Answer: A

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

A. $v_1 = v_2$

B. $v_1 > v_2$

C. $v_1 < v_2$

D. data is insufficient

Answer: C

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72. A circular platform is mounted on a vertical frictionless axle. Its radius is $r = 2m$ and its moment of inertia is $I = 200kg - m^2$. It is initially at rest. A $70kg$ man stands on the edge at speed $v_0 = 1.0m / s$ relative to the ground. The angular velocity of the platform is:

A. $1.2rad / s$

B. $0.4rad / s$

C. $2.0rad / s$

D. $0.7rad/s$

Answer: D

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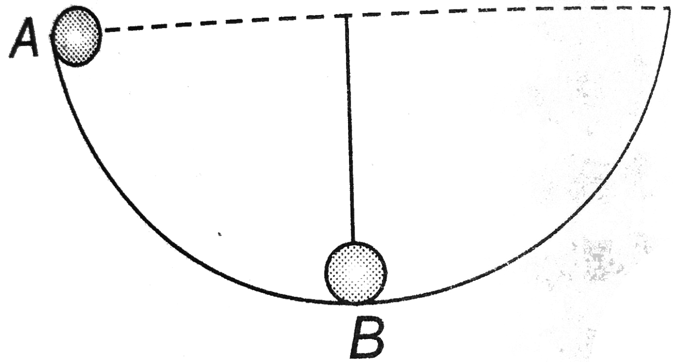
73. A ball of mass m and radius r rolls inside a hemispherical shell of radius R. It is released from rest from point A as shown in figure. The angular velocity of centre of the ball in position B about the centre of the shell is.



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

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

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

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

Answer: B

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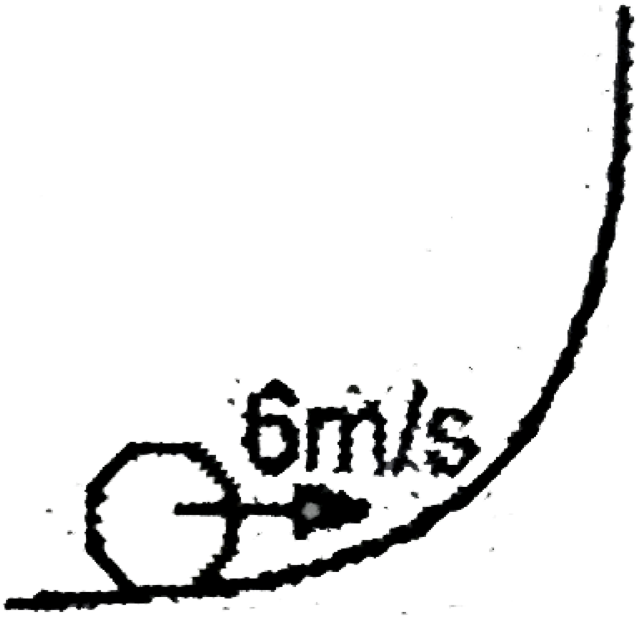
74. A disc of radius $0.1m$ rolls without sliding on a horizontal surface with a velocity of $6m/s$. It then ascends a smooth continuous track as shwon in figure. The height upto which it will ascend is $\left(g = 10m / s^2\right)$



A. $2.4m$

B. $0.9m$

C. $2.7m$

D. $1.8m$

Answer: D

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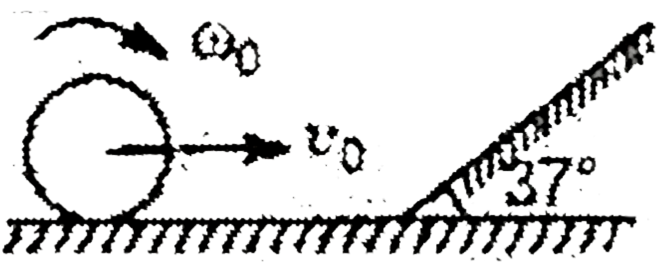
75. A sphere is moving on a smooth surface with linear speed v_0 and angular velocity ω_0. It finds a rough inclined surface and it starts climbing up:



A. if $v_0 > R\omega_0$ friction force will act downwards

B. if $v_0 < R\omega_0$, frictio force will act upwards

C. if $v_0 = R\omega_0$ no friction force will act

D. if all above case friction will act upwards

Answer: A

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76. An inclined plane makes an angle of 60° with horizontal. A disc rolling acceleration equal to:

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

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

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

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

Answer: C

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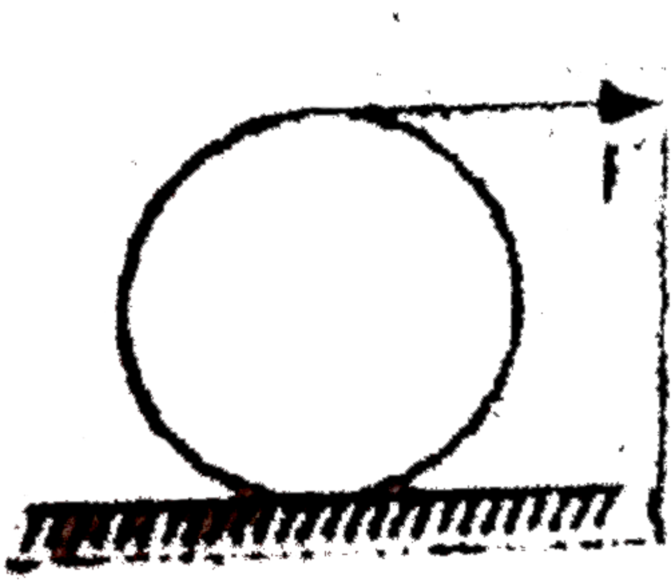
77. A force F is applied at the top of a ring of mass M and radius R placed on a rough horizontal surface as shown in figure. Friction is sufficient to prevent slipping. The friction force acting on the ring is:



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

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

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

D. Zero

Answer: D

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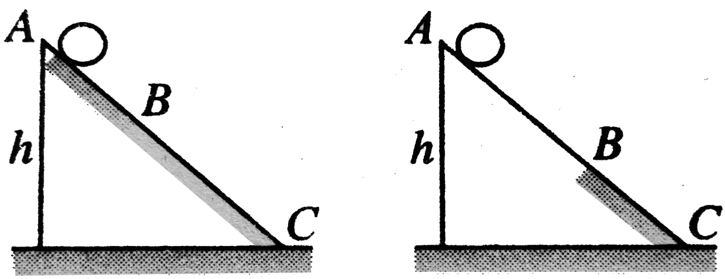
78. In both the figures all other factors are same, except that in figure (i) AB is rough and BC is smooth while in figure (ii) AB is smooth and BC is rough. In figure (i), if a sphere is released from rest it starts rolling. Now consider the figure (ii), if same sphere is A released from top of the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



(i) (ii)

A. is same in both the cases

B. is greater in case (i)

C. is greater in case (ii)

D. information insufficient

Answer: B

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

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

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

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

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

Answer: B

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

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

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

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

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

Answer: B

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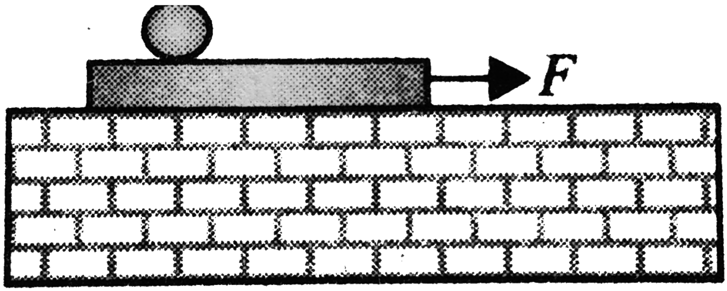
81. A plank with a uniform sphere placed on it resting on a smooth horizontal plane. Plank is pulled to right by a constant force F. If sphere does not slip over the plank. Which of the following is incorrect?



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

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

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

D. None of these

Answer: D

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82. A rod of length l is given two velocities v_1 & v_2 in opposite directions at its two ends at rigt angles to the length. The distance of the instantaneous axis of rotation from v_1 is:

A. zero

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

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

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

Answer: B

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83. Two particle of equal mass m at A and B are connected by a rigid light rod AB lying on a smooth horizontal table. An impulse J is applied at A in the plane of the table and perpendicular at AB. The velocity of particle at A is

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

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

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

D. zero

Answer: B

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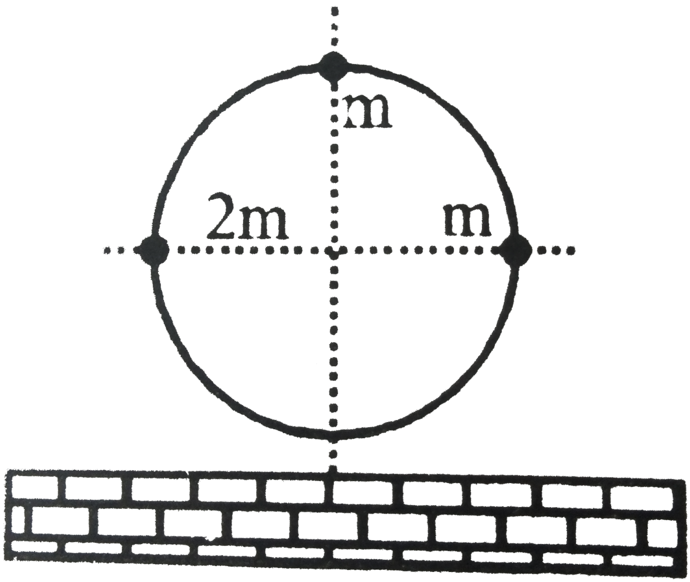
MCQ_TYPE

1. A ring mass m and radius R has three particle attached to the ring as shown in the figure. The centre of the centre v_0. Find the kinetic energy of the system. (Slipping is absent).



A. $6mv_0^2$

B. $12mv_0^2$

C. $2mv_0^2$

D. $8mv_0^2$

Answer: A

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2. A block of mass m moves on a horizontal rough surface with initial velocity v. The height of the centre of mass of the block is h from the surface. Consider a point A on the surface.

A. Angular momentum about A is mvh initially.

B. The velocity of the block decreases as time passes

C. Torque of the forces acting on block is zero about A

D. Angular momentum is not conserved about A

Answer: A::B::D

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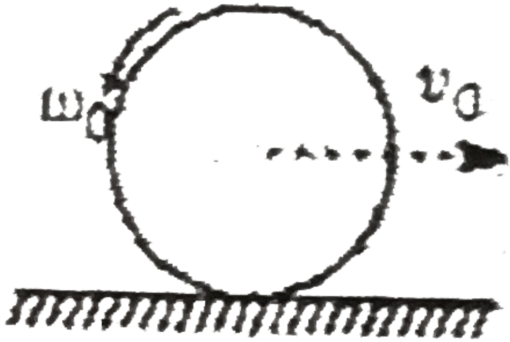
3. A uniform circular disc of radius r . 1placed on a rough horizontal plane has initial velocity v_0 and an angular velocity ω_0 as shown. The disc comes to rest after moving some distance in the direction of motion. Then



A. the friction force acts in the backwards direction

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

C. v_0 must be equal to $\frac{r\omega_0}{2}$ in magnitude

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

Answer: A::C

View Text Solution

4. A non-uniform ball of radius R and radius of gyration about geometric centre $= R/2$ is kept on a frictionless surface. The geometric centre coincides with the centre of mass. The ball is struck horizontally with a sharp impulse

$= J$ the point of application of the impulse is at a height h above the surface. then.

A. the ball will slip on surface for all cases

B. the ball will roll purely is $h = \frac{5R}{4}$

C. the ball will roll purely if $h = \frac{3R}{2}$

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

Answer: B::D

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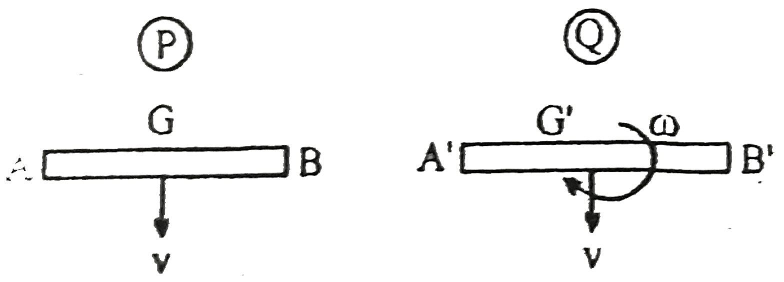
5. Two equal uniform rods P and Q move with the same velocity v as shown in the figure. The second rod has an angular velocity $\omega(< 6v/l)$ (clockwise) about G in addition to v.



A. If th ends A and A' are suddenly fixed simultanesouly, both rods will rotate with the same angular velocity

B. If the ends A and A' are suddenly fixed simultaneously, the rod Q will rotate with greater angular velocity

C. If the ends B and B' are suddenly fixed simultantaneously both rods will rotate with the same angular velocity

D. If the ends B and B' are suddenly fixed simultaneously, the rod P will rotate with greater angular velocity

Answer: B::D

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6. A thin uniform rod of mass m and length L rotates with the constant angular velocity ω about .the vertical axis passing through the rod's suspensjon point O. It describes a carried surface, then:

A. centrifugal force acting on rod is $m\frac{L}{2}\sin\theta\omega^2$ and will pass through centre of mass

B. centrifugal force acting on rod is $m\frac{L}{2}\sin\theta\omega^2$ and will not pass through centre of mass

C. $\theta = \cos^{-1}\left(\frac{3g}{2\omega^2 L}\right)$

D. $\theta = \cos^{-1}\left(\frac{g}{\omega^2 L}\right)$

Answer: B::C

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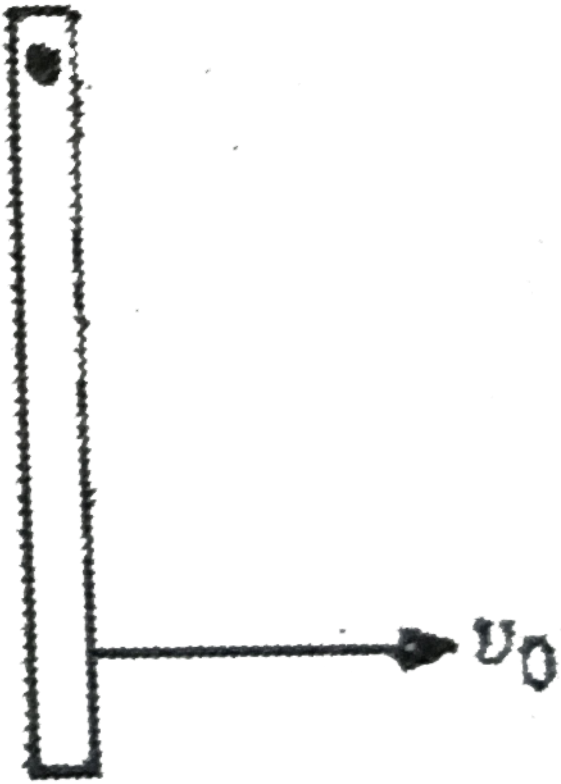
7. A thin uniform rigid rod of length l is hinged at one end so that it can move ina vertical plane by rotating about a horizontal axis through upper end. The lower end is given a sharp blow and made to acquire a linear velocity Maximum height attained by lower end of the rod is:



A. $\dfrac{v_0^2}{3g}$ for $v_0 < \sqrt{6gl}$

B. $\dfrac{3v_0^2}{g}$ for $v_0 < \sqrt{6gl}$

C. $2l$ for $v_0 \geq \sqrt{6gl}$

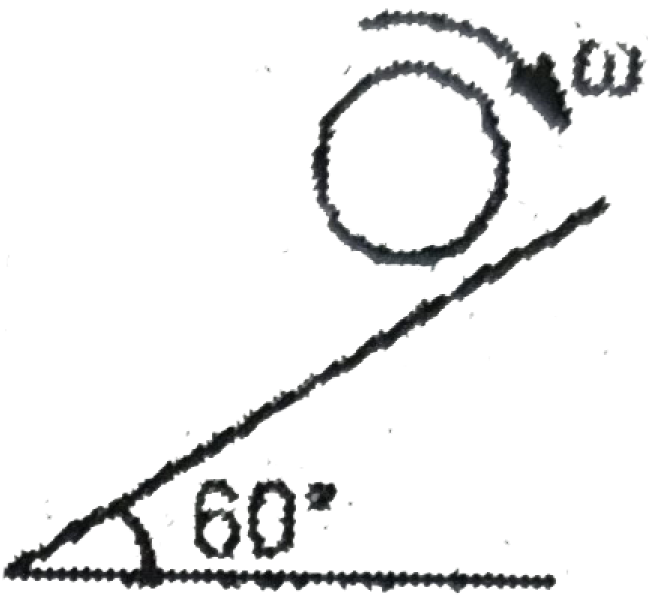
D. l for $v_0 = \sqrt{3gl}$

Answer: C::D

View Text Solution

8. A cylinder is rotated clockwise and lowered slowly on arough inclined plane with

$(\mu = 0.8)$. Then:



A. cylinder will start going upwards

B. cylinder will start going downwards

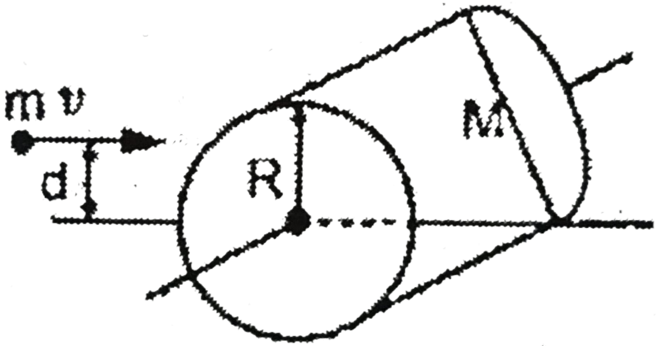
C. frictional force will act upwards

D. frictional force will act downwards

Answer: B::C

View Text Solution

9. A wad of sticky clay of mass m and velocity v_i is fired at a solid cylider of mass M and radius R figure. The cylinder is initially at rest and is mounted on a fixed horizontal axle that runs through the centre of mass. The line of motion of the projectile is perpendicular to the axle and at a distance d, less thant R, from the centre



A. Angular velocity just after collision is

$$\omega = \frac{2mv_i d}{(M + 2m)R^2}$$

B. Linear momentum of cylinder and clay is conserved

C. Angular momentum of cyliner and clay is conserved

D. Mechanical energy is conserved

Answer: A::C

View Text Solution

10. A uniform circular disc of radius R lies in the XY plane with its centre coinciding with the origin.The moment of inertia about an axis passing through a point on the X-axis at a distance $x = 2R$ and perpendicular to the X-Y plane is equal to its moment of inertia about an axis passing through a point on the Y-axis at a distance $y = d$ and parallel to the X-axis in the X-Y plane. The value of d is

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

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

C. $\sqrt{13}R$

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

Answer: B

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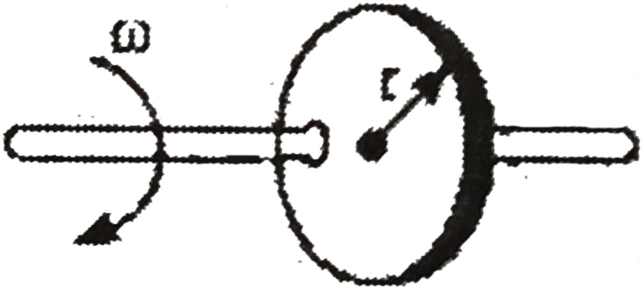
11. A uniform disc of mass M and radius R is pivoted about a horizontal axis passing through its edge. It is released from rest with its centre of mass at the same height as the pivot.



A. The angular velocity of disc when its centre of mass is directly below the pivot is $\sqrt{\frac{4g}{3r}}$

B. The force exerted by the pivot at this instant is $\frac{7}{3}mg$

C. Angular momentum of disc is conserved

D. Angular acceleration of disc at the given instant is zero

Answer: A::C

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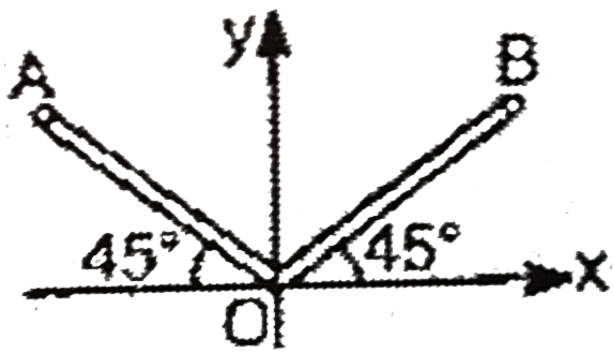
12. Two rods OA and OB of equal length and mass are lying on xy plane as shown in figure. Let I_x, I_y & I_z be the moment of inertias of both the rods abour x, y and z axis respectively. Then:



A. $I_x = I_y > I_z$

B. $I_x = I_y < I_z$

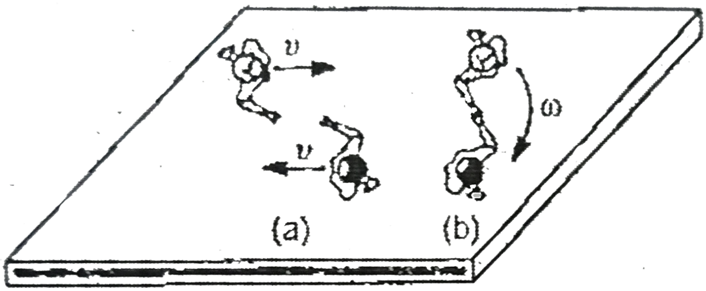
C. $I_x > I_y > I_z$

D. $I_z > I_y > I_x$

Answer: B

View Text Solution

13. Two skaters approach each other as shown in figure and lock hans. Given each has an initial speed of $2.50 m / s$ relative to ice. Each has a mass of $70.0kg$ and their centres of mass are $0.800m$ from their locked hands. You may approximate their momerits of inertia to be that of point masses at this radius:



A. Final angular velocity is $3.12rad/s$

B. Skaters begin to rotate about CM of system

C. There is a no loss of energy

D. If skaters pull each other and reduce their separation by half thei energy is increased

Answer: A::B::D

View Text Solution

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

A. I_1

B. I_2

C. I_3

D. data insufficient

Answer: A

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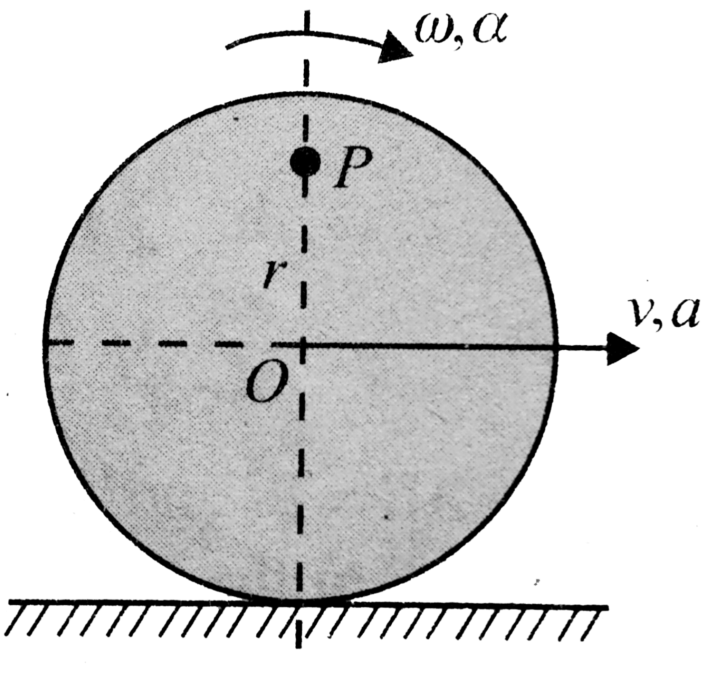
15. A disc of radius R rolls on a horizontal ground with linear acceleration a and angular acceleration α as shown in Fig. The magnitude of acceleration of point P as shown in the figure at an instant when its linear velocity is v and angular velocity is ω will be a



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

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

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

D. $r\alpha$

Answer: A

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16. A block with a square base measuring axa and height h, is placed on an inclined place. The coefficient of friction is m. The angle of inclination (θ) of the plane is gradually increased. The block will.

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

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

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

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

Answer: A::D

Watch Video Solution

17. A sphere is projected npon a rough inclined plane. The friction coefficient between the solid sphere and the incline isμ. The centre of the sphere is given an initial upward' velocity at $t=0$ without imparting any initial angular velocity. Then, which of the following statement (s) is/are true?

A. Pure rolling will defin!tely begin before the sphere reaches the highest point and the sphere will continue to roll purely after that, even while coming down.

B. Pure rolling will definitely begin before the sphere reaches the highest point but the sphere will continue to roll purely after that (even while coming down) only· if μ is greater- than a certain value.

C. The sphere will be rolling purely while coming down if $\mu > \frac{(2\tan\alpha)}{7}$

D. The sphere cannot roll purely while moving up the incline

Answer: B::C

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

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

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

C. the loss in kinetic enerlgy of the system as a whole as a result of the collision is $\frac{mv^2}{6}$

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

Answer: A::C

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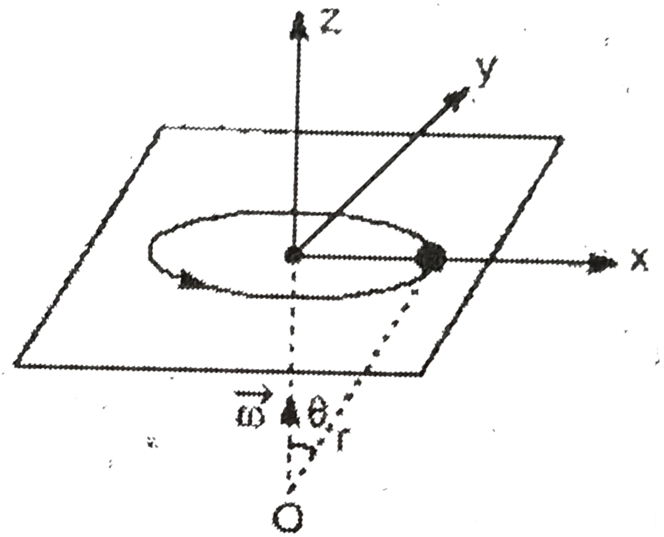
19. A mass m is attached to a rigid rod of negligible mass as shown in figure. The system is pivoted at point O and rotates about the indicated z-axis with angular velocity $\overrightarrow{\omega}$, maintaining a fixed angle θ with the axis.



A. Angular momentum $\vec{L}$ of mass m about pivot is parallel to vector $\vec{\omega}$

B. Angular momentum $\vec{L}$ of mass m about pivot is never parallel to $\vec{\omega}$

C.

$$\overrightarrow{L}_0 = -mr^2\omega\sin\theta\cos\theta\hat{i} + mr^2\omega\sin^2\theta\hat{k}$$

D. Angular momentum of particle about P

is parallel

Answer: B::C::D

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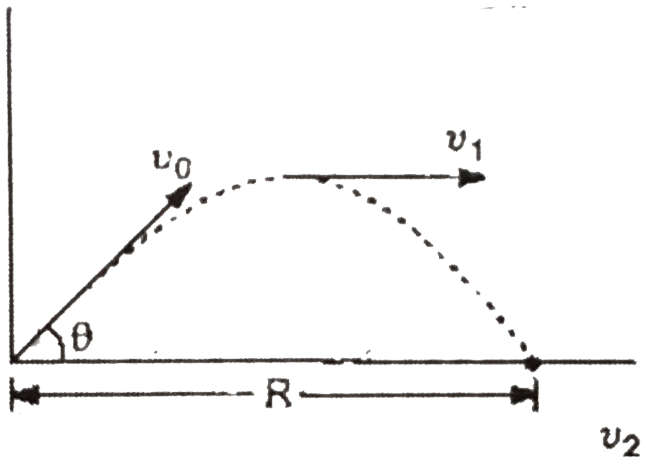
20. A projectile is projected with a velocity v_0 at an angle θ with the horizontal as shown in figure. The angular momentum of particle about the origin:



A. is zero when particle is at the origin

B. is $\dfrac{-mv^3\sin^2\theta\cos\theta}{2g}\hat{k}$ when particle is at the highest point of trajectory

C. is $\dfrac{-2mv^2\sin^2\theta\cos\theta}{g}\hat{k}$ when particle is just about to hit ground

D. downward force of gravity exerts a torque in $-z$ direction.

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

View Text Solution

21. A woman of mass m stands at the edge of ,a solid cylindrical platform of mass M and radius R. At $t=0$ the platform is rotating with negligible friction at angular velocity ω_0 about a vertical axis passing through the centre. The woman begins to walk with speed v, relative to the platform, towards the centre of the platform:

A. Angular velocity when woman reaches the centre is $\left(v + \frac{m}{M}\right)\omega_0$

B. Angular velocity as function of time is

$$\omega = \frac{M+m}{M+2m(1-vt/R)^2}$$

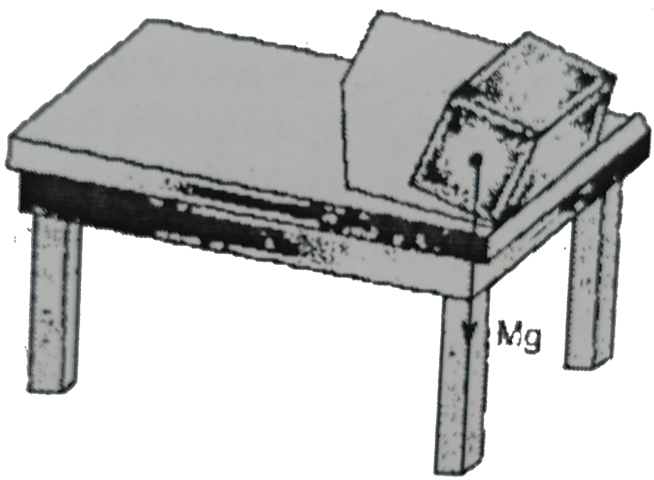
C. Energy of system is conserved

D. Momentum of woman increases in magnitude

Answer: A::B::D

View Text Solution

22. A solid cube of side $2a$ and mass M, sliding on a smooth surface with velocity v_0 , collides inelastically with the raised edge of the table:



A. Moment of inertia of cube about edge is

$$\frac{4Ma^2}{3}$$

B. Moment of inertia of cube about edge is

$$\frac{8Ma^2}{3}$$

C. Minimum value of v so that cube falls off

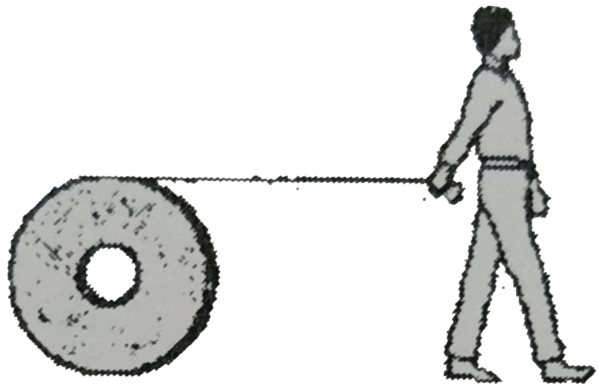
the table is $\sqrt{1.19g}$

D. Energy of system is conserved

Answer: B::C

View Text Solution

23. A large spool of rope stands on the ground with the end of the rope lying on the top edge of the spool. A person grabs the end of the rope and walks a distance, holding onto it figure. The spool rolls behind the person without slipping. What is the length of rope that unwinds from the spool? How far does the spool's CM move?



A. Length of rope that unwinds from the spool is l

B. Length of rope that unwinds from the spool $\frac{l}{2}$

C. Spool's CM moves through $\frac{l}{2}$

D. Spools's CM moves through l

Answer: B::C

View Text Solution

24. A constant power is suppied to a rotating disc. The relationship between the angular velocity (ω) of the disc and number of rotations (n) made by the disc is governed by

A. $\omega \propto n^{1/3}$

B. $\omega \propto n^{3/2}$

C. $\omega \propto n^{2/3}$

D. $\omega \propto n^2$

Answer: A

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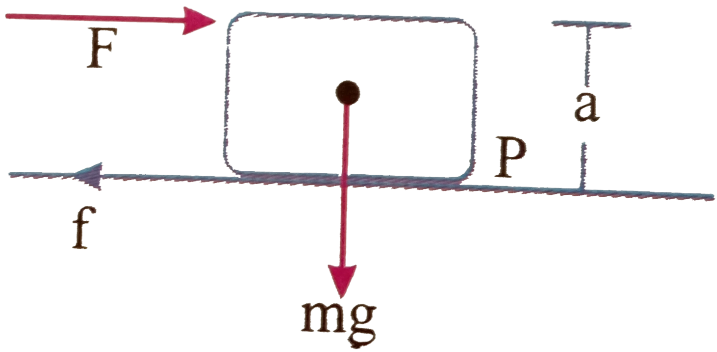
25. A force F is applied on the top of a cube as shown in the figure. The coefficient of friction between the cube and the ground is μ. If F is gradually increased, find the value of μ for which the cube will topple before sliding.



A. $\mu > 1$

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

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

D. $\mu < 1$

Answer: C

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

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

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

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

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

Answer: D

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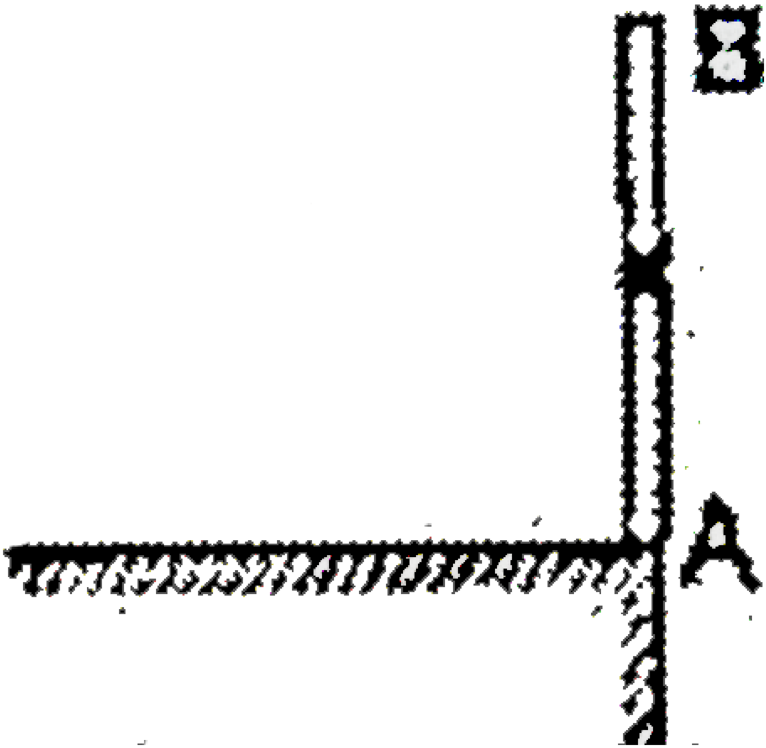
27. A rod AB of length $1m$ is placed at the edge for a smooth table as shown in figure. It is hit horizontally at point B. If the displacement of centre of mass m in $1s$ is $5\sqrt{2}m$. The angular velocity of the rod is

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



A. $30rad / s$

B. $20rad / s$

C. $10rad / s$

D. $5rad / s$

Answer: A

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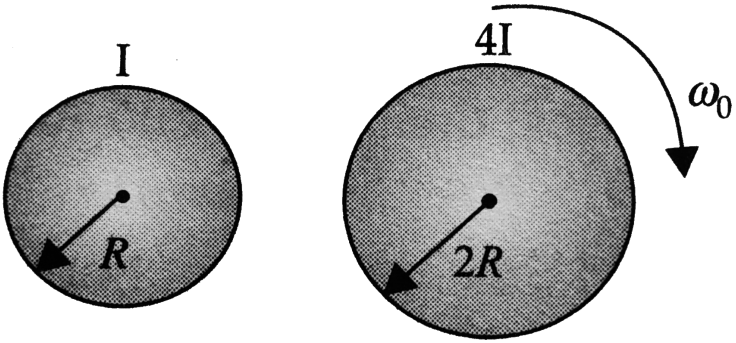
28. Two cylinders having radii $2R$ and R and moment of inertia $4I$ and I about their central axes are supported by axles perpendicular to their planes. The large cylinder is initially rotating clockwise with angular velocity ω_0. The small cylinder is moved to the right until it touches the large cylinder 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 moment of system is conserved

B. kinetic energy is conserved

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

D. both the angular momentum and kinetic energy are conserved

Answer: C

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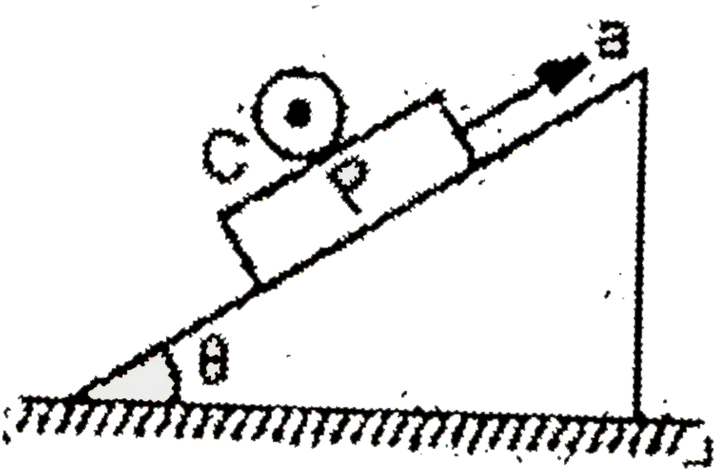
29. The acceleration α of the plank P required to keep the centre C of a cylinder in a fixed position during the motion is (no slipping takes place between cylinder and plank)



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

B. $2g \sin \theta$

C. $g \sin \theta$

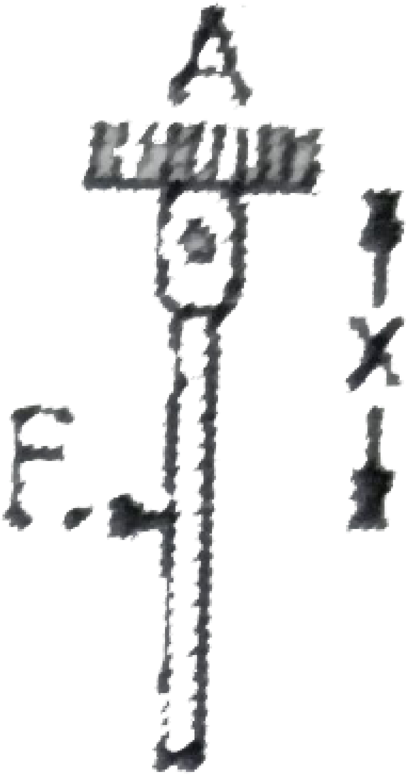
D. $\sqrt{2} g \sin \theta$

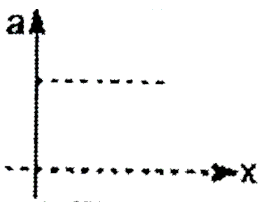
Answer: B

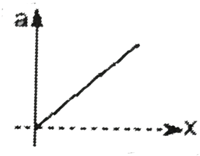
View Text Solution

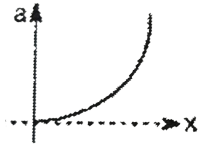
30. A rod of mass m and length l is hinged at one of its end A as shown in figure. A force F is applied at a distance x from A. The acceleration of centre of mass (a) variea with x

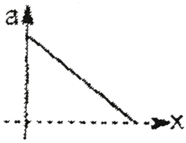
as:



A. 

B. 

C. 

D. 

Answer: B

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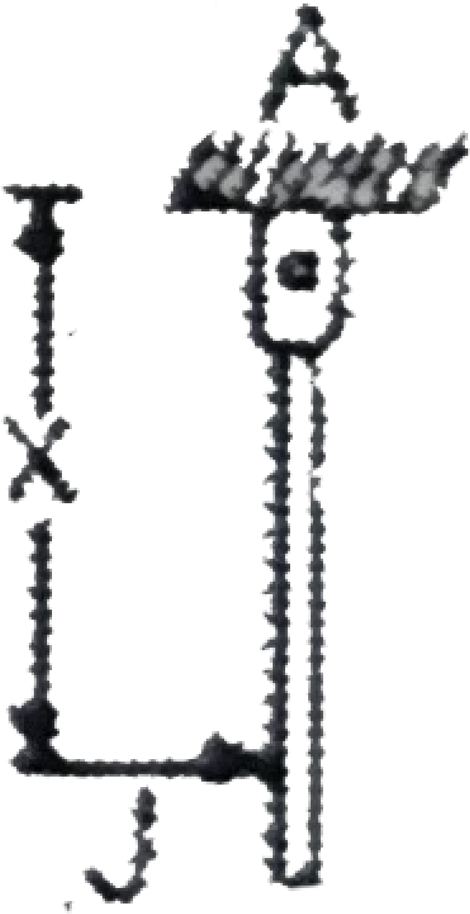
31. A uniform rod of length l is pivoted at point A. It is struck by a horizontal force which delivers an impulse J at a distance x from point A as shwon in figure, impulse delivered by pivot is zero if x is equal to



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

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

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

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

Answer: C

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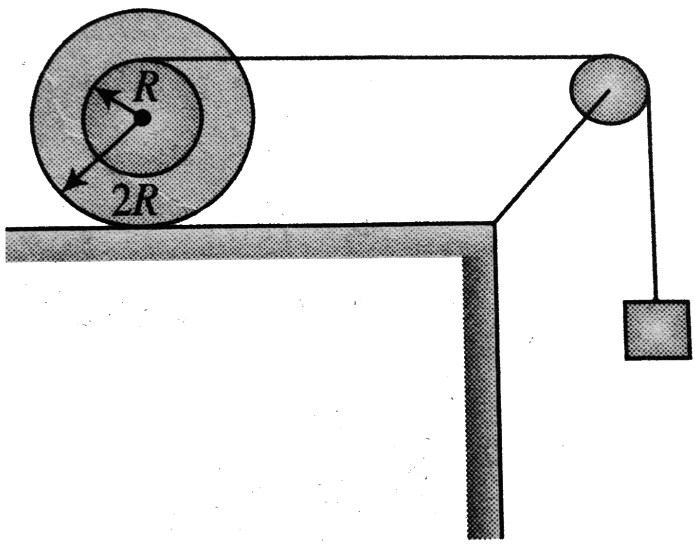
32. In the figure shown mass of both, the spherical body and block is m. Moment of inertia of the spherical body about centre of mass is $2mR^2$. The spherical body rolls on the horizontal surface. There is no slipping at any surfaces in contact. The ratio of kinetic energy of the spherical body to that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



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

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

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

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

Answer: C

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

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

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

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

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

Answer: D

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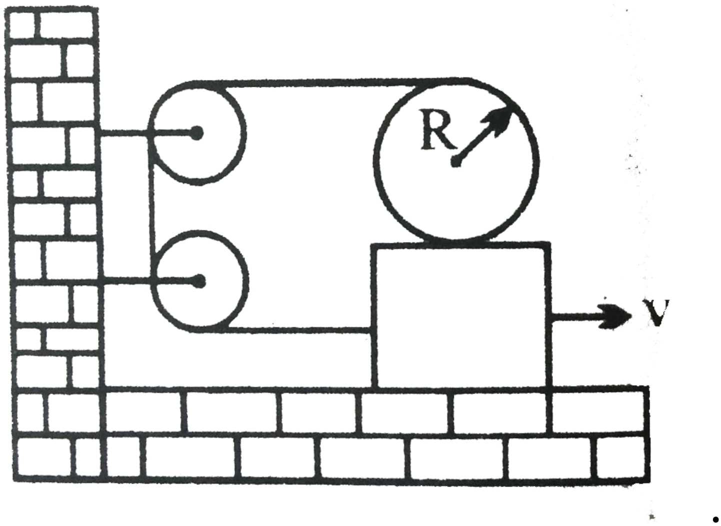
34. In the figure shown, the plank is being pulled to the right with a constant speed v. If the cylinder does not slip then:



A. the speed of the centre of mass of the cylinder is $2v$

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

C. the angular velocity of the cylinder is $\frac{v}{R}$

D. the angular velocity of the cylinder is zero

Answer: C

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

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

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

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

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

Answer: A

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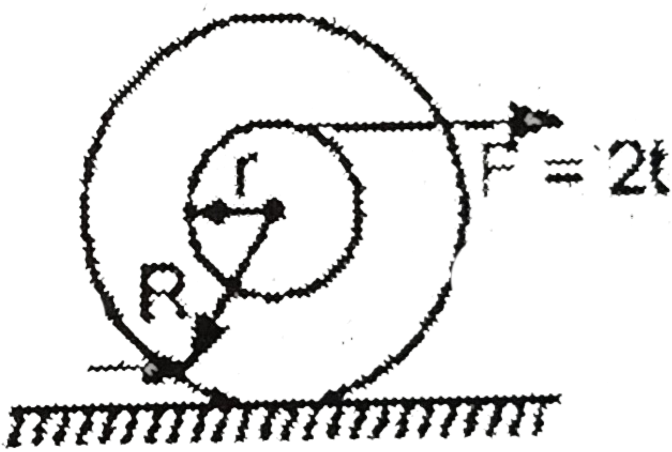
36. A time varying force $F = 2t$ is applied on a spool as shown in figure. The angular momentum of the spool at time t about bottommost point is:



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

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

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

D. data is insufficient

Answer: C

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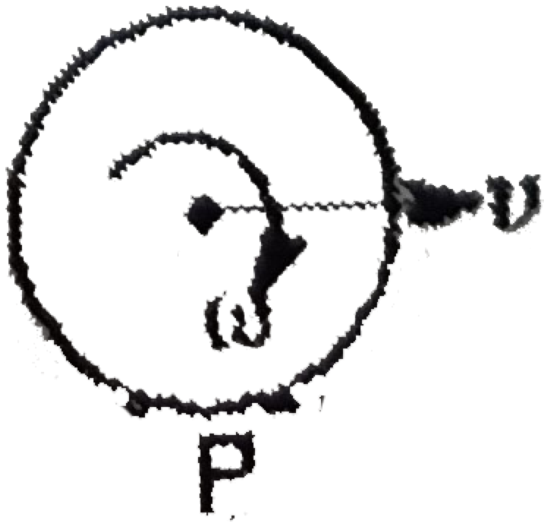
37. A spherical body of radius R rolls on a horizontal surface with linear velociltly v. Let L_1 and L_2 be the magnitudes of angular momenta of the body about centre of mass and point of contact P. Then:



A. $L_2 = 2L_1$ if radius of gyration $K = R$

B. $L_2 = 2L_1$ for all cases

C. $L_2 > 2L_1$ if radius of gyration $K < R$

D. $L_2 > 2L_1$ if radius of gyration $K > R$

Answer: A::D

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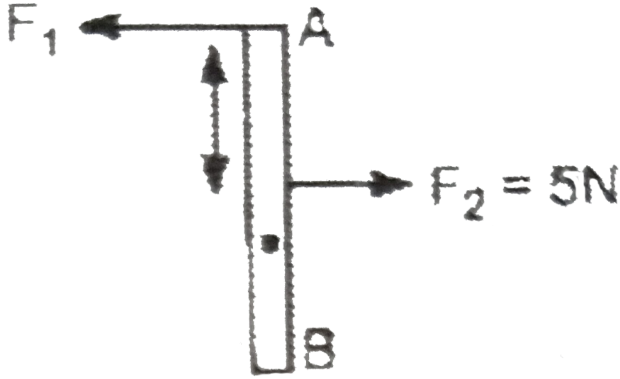
38. A thin uniform rod AB of mass $1kg$ move translationally with acceleration $a = 2m / s^2$ due to two antiparallel force as shown. If

$l = 20cm$ then:



A. $F_1 = 3N$

B. $F_1 = 5N$

C. Length of rod is $1m$

D. Length of rod is $80cm$

Answer: A::C

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39. 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. $d\vec{L}/dt$ is perpendicular to $\vec{L}$ at all instants to time

B. the component of $\overrightarrow{L}$ in the direction of $\overrightarrow{A}$ does not change with time.

C. the magnitude of $\overrightarrow{L}$ does not change with time.

D. $\overrightarrow{L}$ does not change with time.

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

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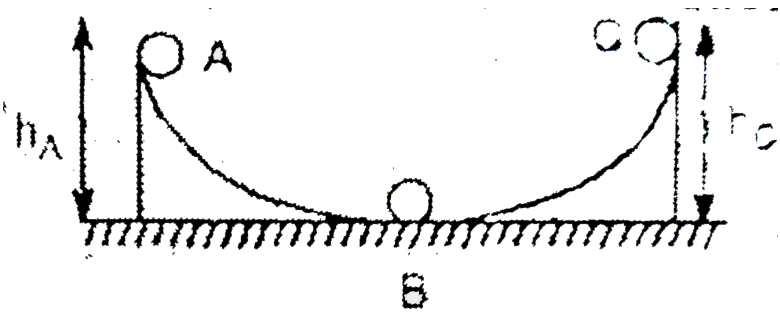
40. A ball moves over a fixed track as shown in the figure. From A and B the ball rolls without slipping. If surface B is frictionless and K_A, K_B and K_C are kinetic energies of the ball at A, B and C respectively then:



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. $h_A < h_C, K_B > K_C$

Answer: A::B

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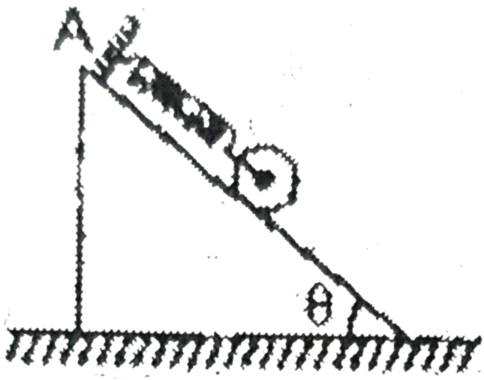
41. A uniform cylinder of mass M and radius R rolls without slipping down a slope of angle 8 with horizontal. The cylinder is connected to a spring of force constant k at the centre, the other side of which is connected to a fixed support at A. The cylinder is released when the spring is unstretched.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

:



A. is always upwards

B. is always downwards

C. is initially upwards and then becomes downwards

D. is initially upwards and then becomes zero

Answer: C

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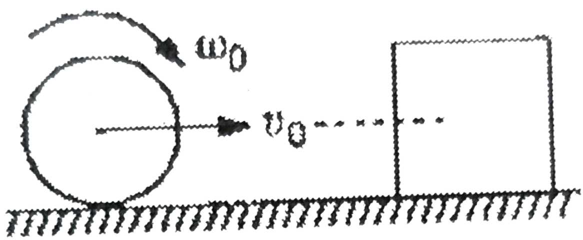
COMPREHENSION_TYPE

1. A solid cylinder of mass m rolls on a rough surface with velocity v_0. It collides elastically with a cubical block of same mass at rest. The centre of mass of both the bodies are at same height. Coefficient of friction between horizontal surface and cylinder as well as horizontal surface and cube is μ. No frictional exists between cylinder and cube. The cylinder collides the, cube at $t = 0$, then.



Percentage of energy of cylinder lost due to collision is:

A. zero

B. 50%

C. 66.67%

D. 33.33%

Answer: D

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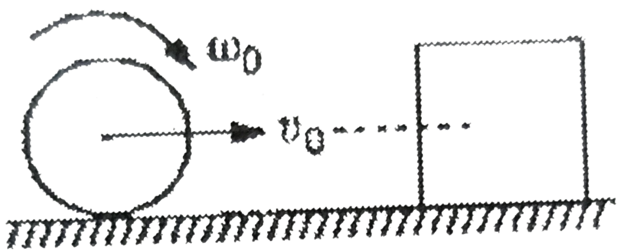
2. A solid cylinder of mass m rolls on a rough surface with velocity v_0. It collides elastically with a cubical block of same mass at rest. The centre of mass of both the bodies are at same height. Coefficient of friction between horizontal surface and cylinder as well as horizontal surface and cube is μ. No frictional exists between cylinder and cube. The cylinder collides the, cube at $t = 0$, then.



Regarding frictional force acting on cylinder we can say that:

A. before collision friction acts forward

B. before collision friction does not act

C. after collision friction acts backwards

D. after collision friction does not act

Answer: A

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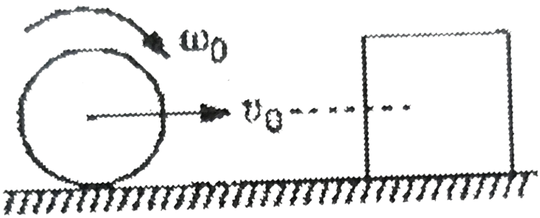
3. A solid cylinder of mass m rolls on a rough surface with velocity v_0. It collides elastically with a cubical block of same mass at rest. The centre of mass of both the bodies are at same height. Coefficient of friction between horizontal surface and cylinder as well as horizontal surface and cube is μ. No frictional exists between cylinder and cube. The cylinder collides the, cube at $t = 0$, then.



Time after which the cylinder starts pure rolling again:

A. $\frac{2v_0}{3\mu g}$

B. $\frac{v_0}{\mu g}$

C. $\frac{2v_0}{\mu g}$

D. $\frac{v_0}{3\mu g}$

Answer: D

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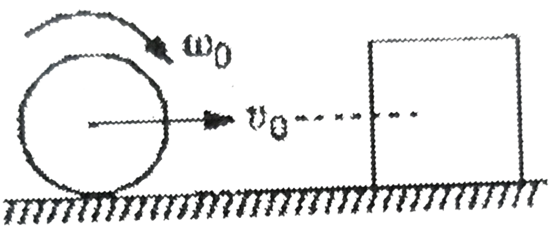
4. A solid cylinder of mass m rolls on a rough surface with velocity v_0. It collides elastically with a cubical block of same mass at rest. The centre of mass of both the bodies are at same height. Coefficient of friction between

horizontal surface and cylinder as well as horizontal surface and cube is μ. No frictional exists between cylinder and cube. The cylinder collides the, cube at $t=0$, then.



Velocity of cube when the cylinder starts pure rolling:

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

B. $\frac{v_0}{3}$

C. $\frac{2v_0}{3}$

D. $\frac{v_0}{4}$

Answer: C

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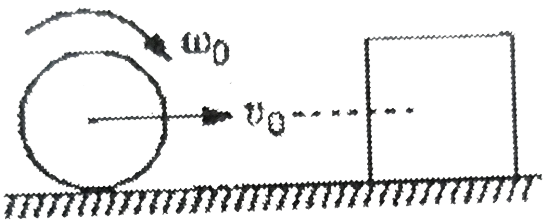
5. A solid cylinder of mass m rolls on a rough surface with velocity v_0. It collides elastically with a cubical block of same mass at rest. The centre of mass of both the bodies are at same height. Coefficient of friction between

horizontal surface and cylinder as well as horizontal surface and cube is μ. No frictional exists between cylinder and cube. The cylinder collides the, cube at $t = 0$, then.



Velocity of cylinder with which it will collide with cube again is:

A. v_0

B. $\frac{v_0}{3}$

C. $\frac{2v_0}{3}$

D. $\frac{v_0}{4}$

Answer: B

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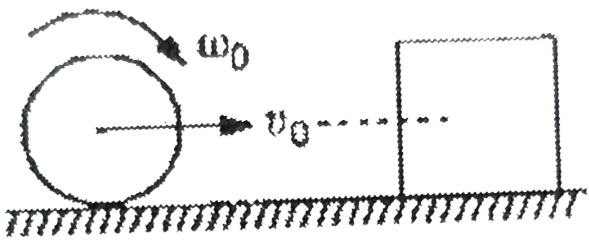
6. A solid cylinder of mass m rolls on a rough surface with velocity v_0. It collides elastically with a cubical block of same mass at rest. The centre of mass of both the bodies are at same height. Coefficient of friction between

horizontal surface and cylinder as well as horizontal surface and cube is μ. No frictional exists between cylinder and cube. The cylinder collides the, cube at $t = 0$, then.



Maximum separation between cylinder before it collide the cube again is:

A. $\frac{v_0(2)}{\mu g}$

B. $\frac{v_0^2}{4\mu g}$

C. $\frac{v_0^2}{4\mu g}$

D. zero

Answer: C

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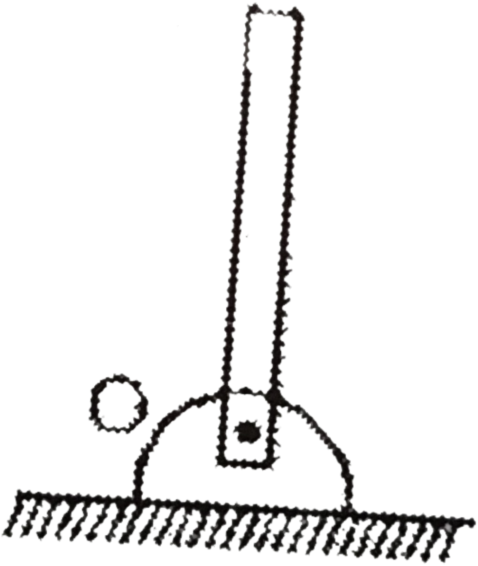
7. A uniform rod mass m and length L is free to rotate about hinge O. A slight disturbance cause the rod to rotate freely about O and it strikes the ground.



Velocity with which the non-hinged end of rod strikes the surface is:

A. $\sqrt{2gL}$

B. $\sqrt{3gL}$

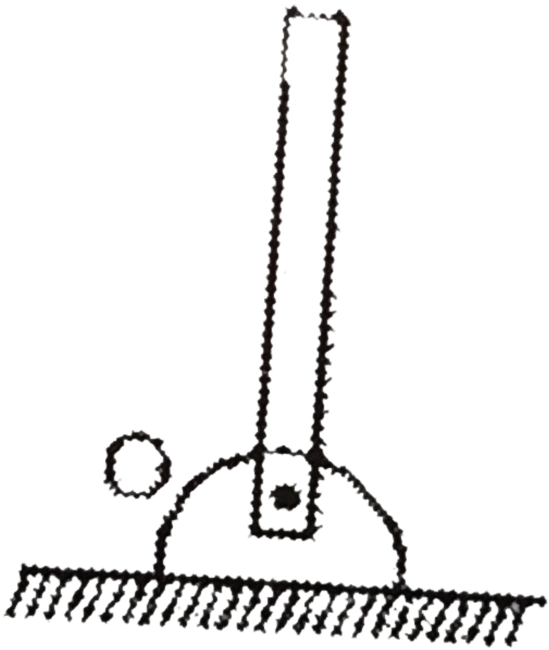
C. $\sqrt{6gL}$

D. $\sqrt{gL}$

Answer: B

Watch Video Solution

8. A uniform rod mass m and length L is free to rotate about hinge O. A slight disturbance cause the rod to rotate freely about O and it strikes the ground.



Horizontal force applied on rod by hinge just before the rod hits the surface is:

A. mg

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

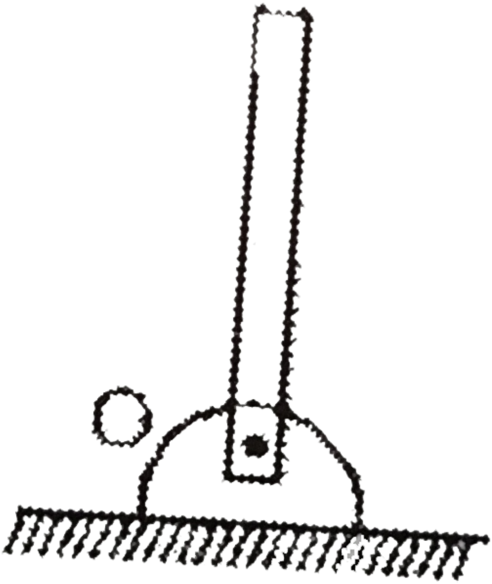
C. $\frac{3mg}{4}$

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

Answer: D

Watch Video Solution

9. A uniform rod mass m and length L is free to rotate about hinge O. A slight disturbance cause the rod to rotate freely about O and it strikes the ground.



Vertical force applied by hinge on rod at the moment it strikes the ground is:

A. mg

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

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

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

Answer: B

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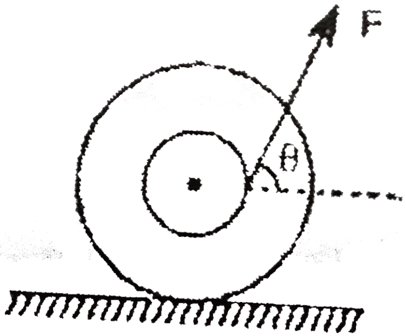
10. A spool of mass m has moment of inertia $I = 2mR^2$ about its axis of symmetry. The inner and outer radius of spool R and $2R$ respectively. Thread is wounded on the inner cylinder and its one end is pulled a force F acting at angle θ with horizontal. The surface is sufficiently rough and th.e spool never slides on the surface.



For $\theta = 0^\circ$, the acceletation of spool is

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

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

C. $\frac{F}{6m}$

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

Answer: D

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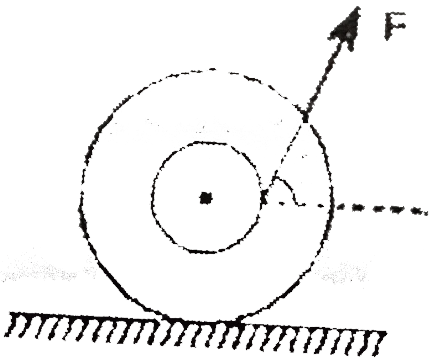
11. A spool of mass m has moment of inertia $I = 2mR^2$ about its axis of symmetry. The inner and outer radius of spool R and $2R$ respectively. Thread is wounded on the inner cylinder and its one end is pulled a force F acting at angle θ with horizontal. The surface is sufficiently rough and th.e spool never slides on the surface.



For $\theta = 60^\circ$ the acceleration of spool is

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

B. $\frac{F}{6m}$

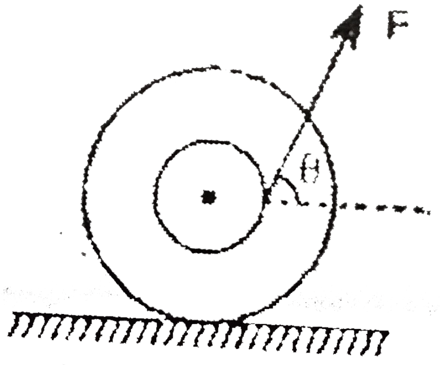
C. $\frac{F}{2m}$

D. zero

Answer: D

Watch Video Solution

12. A spool of mass m has moment of inertia $I = 2mR^2$ about its axis of symmetry. The inner and outer radius of spool R and $2R$ respectively. Thread is wounded on the inner cylinder and its one end is pulled a force F acting at angle θ with horizontal. The surface is sufficiently rough and th.e spool never slides on the surface.



Regarding to the direction of frictional force, which of the following statement is correct?

A. For $0 \leq \theta \leq 90^{\circ}$, it always acts leftwards

B. For $0 \leq \theta \leq 60^{\circ}$, it acts leftwards and for $60^{\circ} \leq \theta \leq 90^{\circ}$ it acts rightwards

C. it becomes zero at certain angle θ between 0 to 90°

D. None of these

Answer: A

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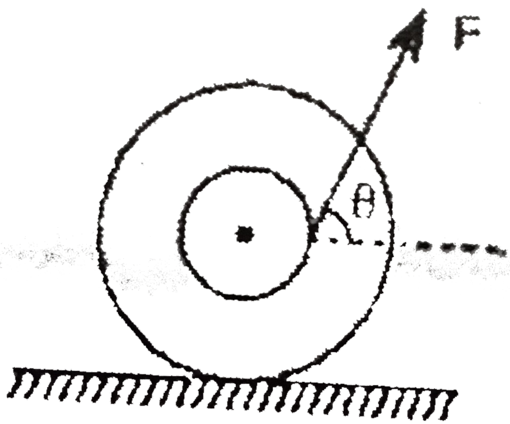
13. A spool of mass m has moment of inertia $I = 2mR^2$ about its axis of symmetry. The inner and outer radius of spool R and $2R$ respectively. Thread is wounded on the inner cylinder and its one end is pulled a force F acting at angle θ with horizontal. The surface is sufficiently rough and th.e spool never slides on the surface.



Regarding to the direction of rotation of spool which of the following statement is true?

A. spool rotates clockwise $0 < \theta < 90^\circ$

B. spool rotates anticlockwise $0 < \theta < 90^\circ$

C. spool rotates clockwise for $0 \leq \theta < 60^\circ$ and anticlockwise for $60^\circ < \theta \leq 90^\circ$

D. spool rotates anticlockwise for $0 \leq \theta < 60^\circ$ and clockwise for $60^\circ < \theta \leq 90^\circ$

Answer: C

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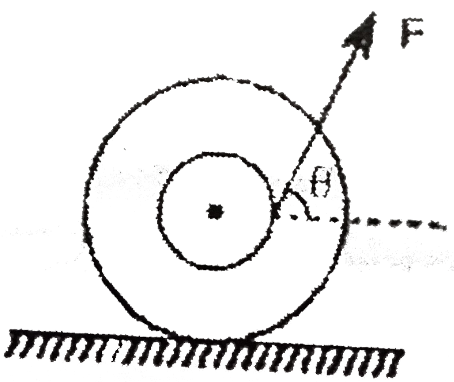
14. A spool of mass m has moment of inertia $I = 2mR^2$ about its axis of symmetry. The inner and outer radius of spool R and $2R$ respectively. Thread is wounded on the inner cylinder and its one end is pulled a force F acting at angle θ with horizontal. The surface is sufficiently rough and th.e spool never slides on the surface.



Maximum frictional force acting on the spool is:

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

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

C. $\frac{5F}{6}$

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

Answer: B

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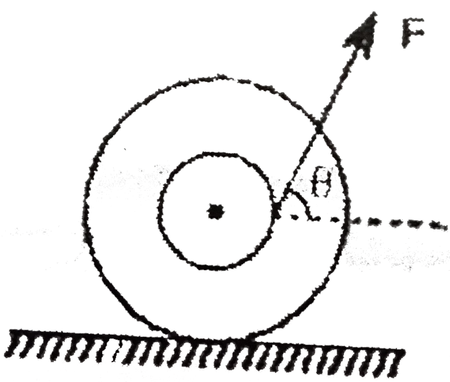
15. A spool of mass m has moment of inertia $I = 2mR^2$ about its axis of symmetry. The inner and outer radius of spool R and $2R$ respectively. Thread is wounded on the inner cylinder and its one end is pulled a force F acting at angle θ with horizontal. The surface is sufficiently rough and th.e spool never slides on the surface.



Maximum frictional force acting on the spool is:

A. `for position 1, spool will rotate clockwise

B. for position 2, spool will hot rotate

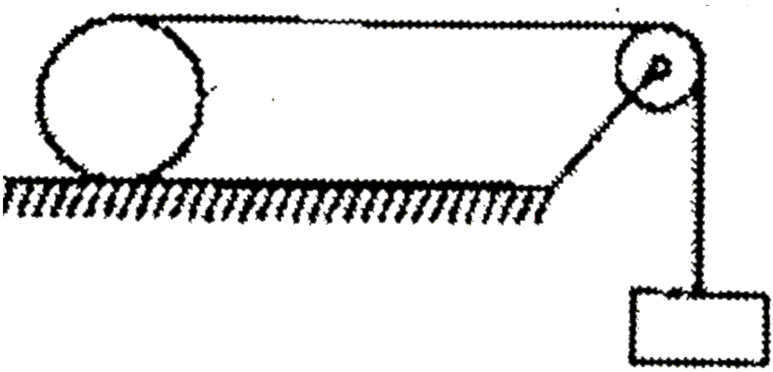
C. for position 3, spool will rota.te anticlockwise

D. all of the above

Answer: D

Watch Video Solution

16. A string wrapped around a cyliner of mass m and radius R. The end of the string is connected to block of same mass hanging vertically. No friction exists between the horizontal surface and cylinder.



Acceleration of hanging mass is:

A. g

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

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

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

Answer: D

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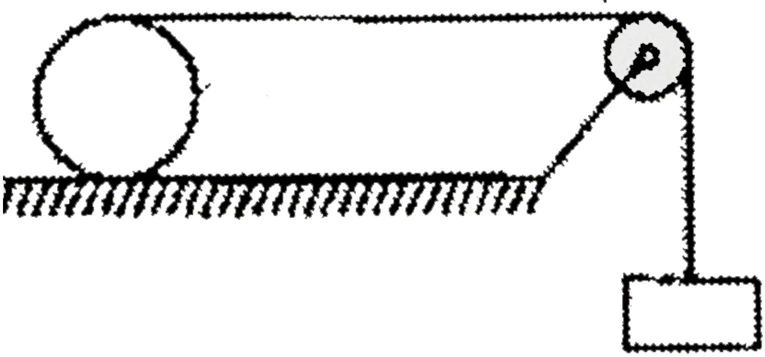
17. A string wrapped around a cyliner of mass m and radius R. The end of the string is connected to block of same mass hanging vertically. No friction exists between the horizontal surface and cylinder.



Acceleration of cylinder is:

A. g

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

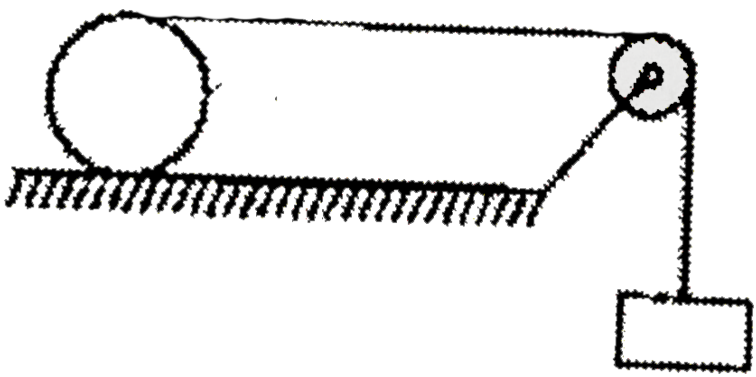
C. $\frac{g}{4}$

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

Answer: C

Watch Video Solution

18. A string wrapped around a cyliner of mass m and radius R. The end of the string is connected to block of same mass hanging vertically. No friction exists between the horizontal surface and cylinder.



Distance moved by cylinder during time taken by it to complete one rotation is:

A. $2\pi R$

B. πR

C. $3\pi R$

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

Answer: B

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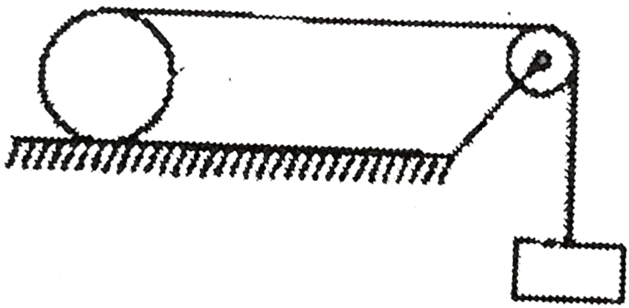
19. A string wrapped around a cylinder of mass m and radius R. The end of the string is connected to block of same mass hanging vertically. No friction exists between the horizontal surface and cylinder.



Distance moved by hanging mass during the above time interval is:

A. $2\pi R$

B. πR

C. $3\pi R$

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

Answer: C

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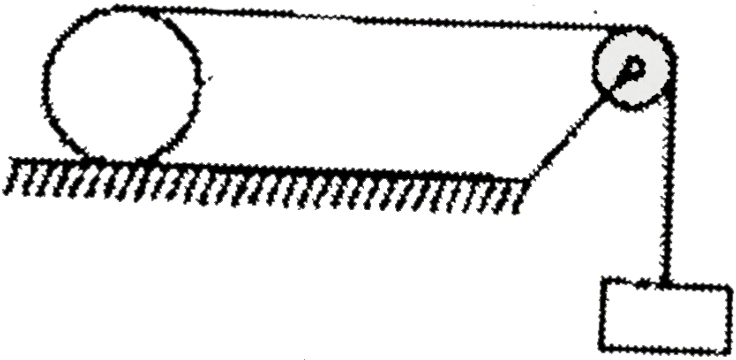
20. A string wrapped around a cyliner of mass m and radius R. The end of the string is connected to block of same mass hanging vertically. No friction exists between the horizontal surface and cylinder.



Velocity of point of contact 'of cylinder at this moment is:

A. zero

B. $\sqrt{\frac{\pi R g}{2}}$ left wards

C. $\sqrt{\frac{\pi R g}{2}}$ rightwards

D. $\sqrt{\pi R g}$

Answer: B

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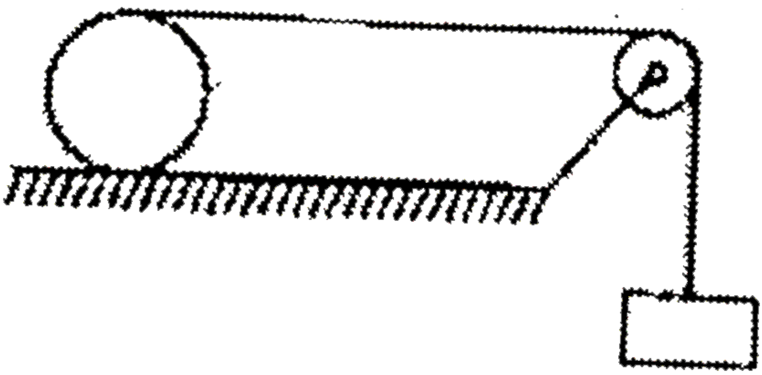
21. A string wrapped around a cyliner of mass m and radius R. The end of the string is connected to block of same mass hanging vertically. No friction exists between the horizontal surface and cylinder.



Velocity of hanging block at this moment is: is:

A. $\sqrt{2\pi Rg}$

B. $\sqrt{8\pi Rg}$

C. $\sqrt{\frac{\pi Rg}{2}}$

D. $\sqrt{45\pi Rg}$

Answer: D

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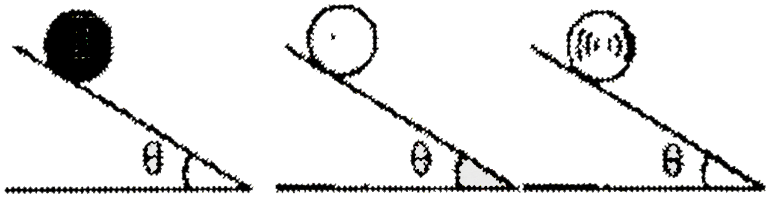
22. A sphere a ring and a disc of same mass and radius are allowed to roll down three similar sufficiently rough inclined planes as shown in the figure from same height.



Which of the follwing order is true for final KE of the bodies?

A. sphere $>$ disc $>$ ring

B. ring $>$ disc $>$ sphere

C. disc $>$ ring $>$ sphere

D. disc = ring = sphere

Answer: D

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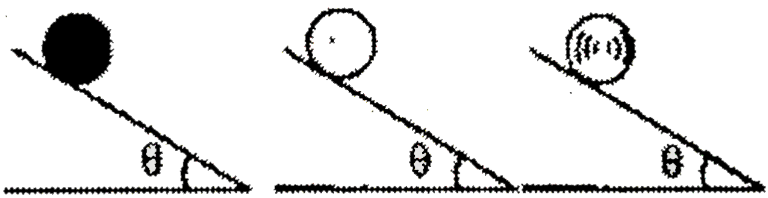
23. A sphere a ring and a disc of same mass and radius are allowed to roll down three similar sufficiently rough inclined planes as shown in the figure from same height.



Which of the following order is true for final linear velocity of the bodies?

A. sphere $>$ disc $>$ ring

B. ring $>$ disc $>$ sphere

C. disc $>$ ring $>$ sphere

D. disc = ring = sphere

Answer: A

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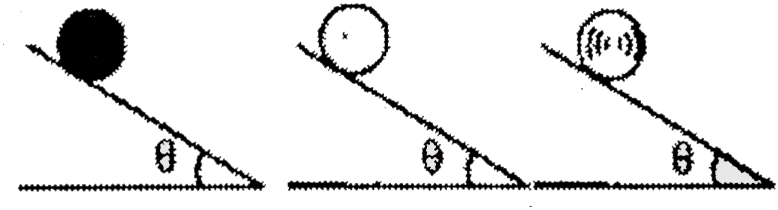
24. A sphere a ring and a disc of same mass and radius are allowed to roll down three similar sufficiently rough inclined planes as shown in the figure from same height.



Which of the following order is' true for tiine taken by the bodies to reach the bottom of incline?

A. sphere $>$ disc $>$ ring

B. ring $>$ disc $>$ sphere

C. disc $>$ ring $>$ sphere

D. disc = ring = sphere

Answer: D

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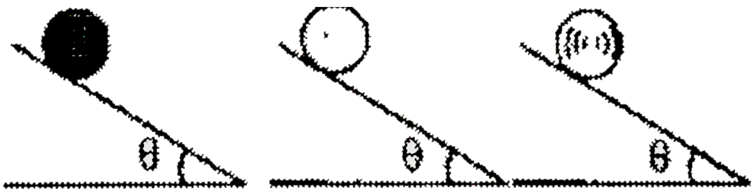
25. A sphere a ring and a disc of same mass and radius are allowed to roll down three similar sufficiently rough inclined planes as shown in the figure from same height.



Which of the following order is true for frjctional force acting on the bodies during their rolling?

A. sphere $>$ disc $>$ ring

B. ring $>$ disc $>$ sphere

C. disc $>$ ring $>$ sphere

D. disc = ring = sphere

Answer: B

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26. 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 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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27. 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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28. 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. $\frac{I\omega^2}{2}$

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

C. $\frac{I\omega^3}{4}$

D. $\frac{I\omega^3}{6}$

Answer: B

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29. Two discs A and B are mounted coaxially on a vertical axle. The discs have moments of inertia I and $2I$ 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.

A small object of uniform density rolls up a curved surface with an initial velocitiy 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

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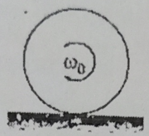
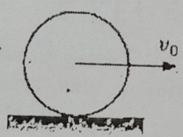
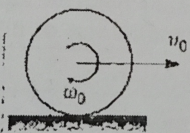
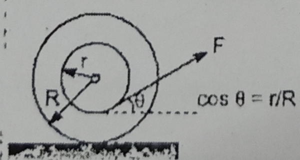
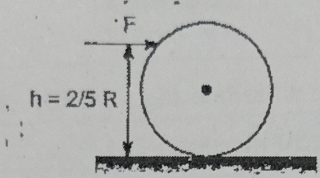
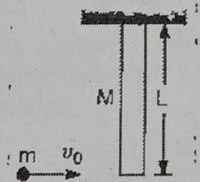
MATCH THE COLUMN

1. Match the statements, situations in Column I with that in Column II. One or more matching is possible.

1.

Column I	Column II
(A)  A spinning ball lowered on a rough surface	(P) Net work done by friction force is negative.
(B)  A ball is projected with velocity v_0 on a rough surface	(Q) Rotational work done by friction is negative.
(C)  A ball projected with velocity $v_0 = R\omega_0$, projected on a smooth horizontal surface.	(R) Work done by friction is positive.
(D)  A spool pulled by a force F, rolling without slipping on a rough surface.	(S) Net work done by friction is zero.

4.	Column I		Column II
(A)	 An impulsive force acts at a height $h = \frac{2}{5R}$ on a solid sphere, lying on a rough surface.	(P)	Momentum is conserved.
(B)	 A small particle of mass m moving horizontally collides with vertical hinged rod, inelastically; $e = 0$.	(Q)	Angular momentum is conserved.

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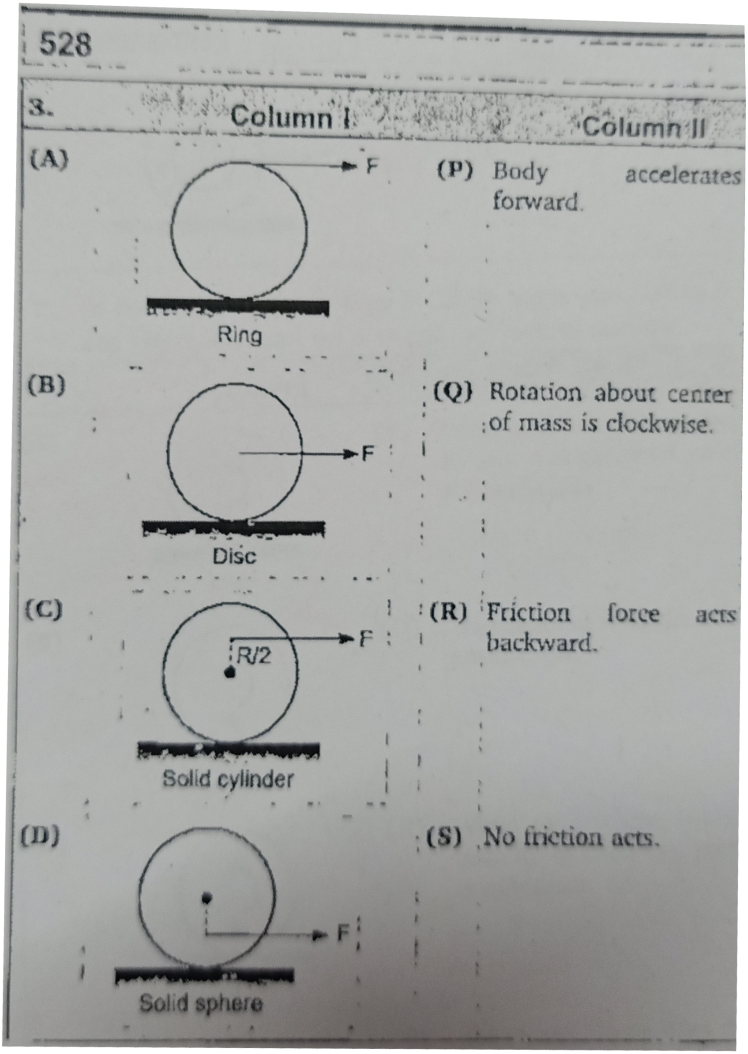
2. Match the statements, situations in Column I with that in Column II. One or more matching

is possible.



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3. Column I	Column II
(A) Ring (force F applied at top)	(P) Body accelerates forward.
(B) Disc (force F applied at centre)	(Q) Rotation about center of mass is clockwise.
(C) Solid cylinder (force F applied at R/2 above centre)	(R) Friction force acts backward.
(D) Solid sphere (force F applied below centre)	(S) No friction acts.

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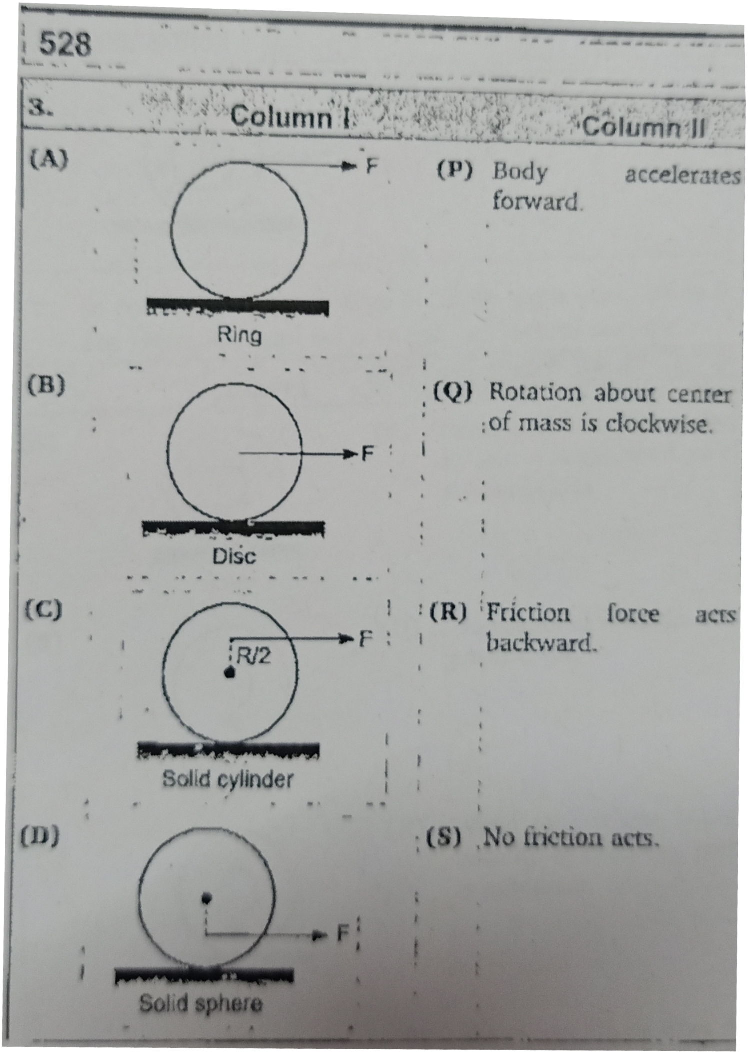
3. Match the statements, situations in Column I with that in Column II. One or more matching

is possible.



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3.

Column I	Column II
(A) F; Ring	(P) Body accelerates forward.
(B) F; Disc	(Q) Rotation about center of mass is clockwise.
(C) F; R/2; Solid cylinder	(R) Friction force acts backward.
(D) F; Solid sphere	(S) No friction acts.

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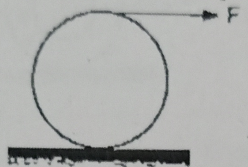
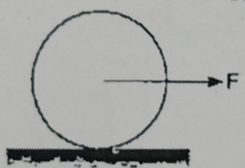
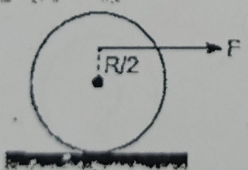
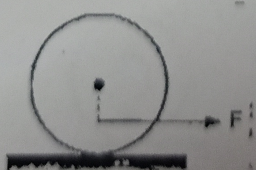
4. Match the statements, situations in Column I with that in Column II. One or more matching

is possible.

3.

Column I	Column II
(A)  Ring	(P) Body accelerates forward.
(B)  Disc	(Q) Rotation about center of mass is clockwise.
(C)  Solid cylinder	(R) Friction force acts backward.
(D)  Solid sphere	(S) No friction acts.

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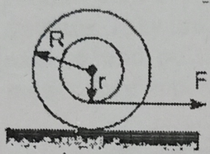
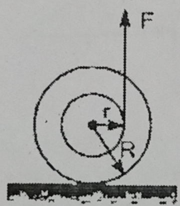
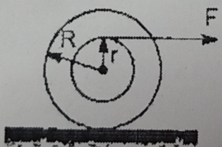
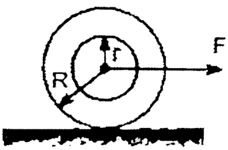
5. For different bodies of circular cross-section of same mass and radius R are situated at rest at the top of a rouogh inclined plane of height h.At $t = 0$ they all begin to roll without slipping wooden.

6.

Column I	Column II
(A) 	(P) On a frictionless surface rolling is toward left.
(B) 	(Q) On a rough surface friction acts toward right.
(C) 	(R) Friction force acts towards left.
(D) 	(S) Direction of friction force cannot be determined.

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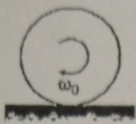
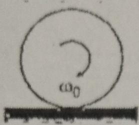
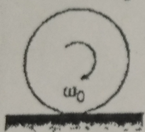
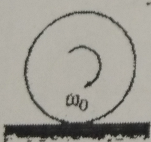
Column I		Column II
(A)  Ring	(P)	Rotational work done by friction is negative till pure rolling beings.
(B)  Cylinder	(Q)	Translational work done is positive till.
(C)  Solid sphere	(R)	When pure rolling beings velocity of centre of mass is minimum.
(D)  Hollow sphere	(S)	Takes maximum time for pure rolling to begin.

6.

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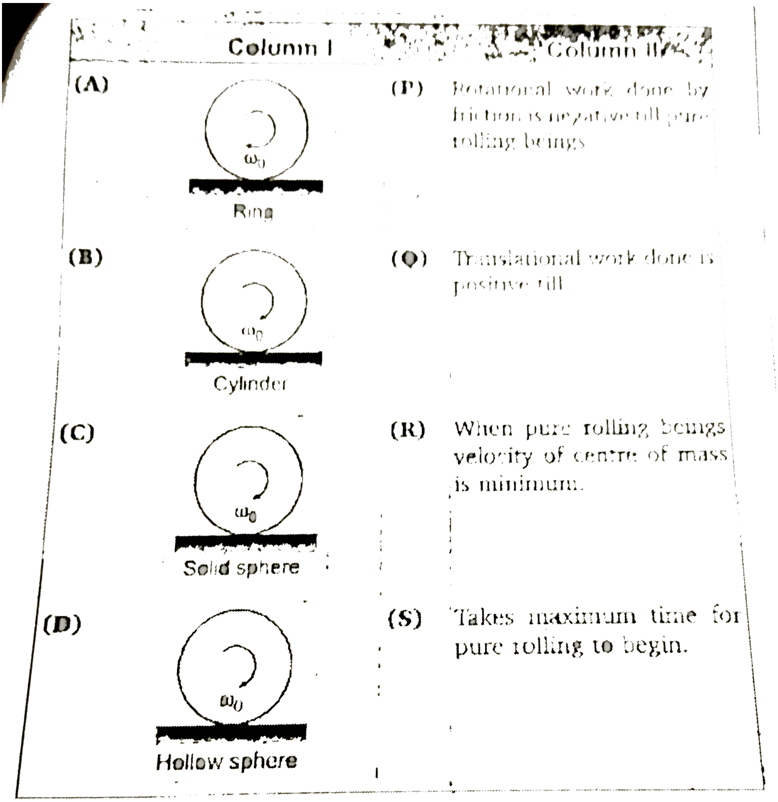
7. In column various bodies of same mass and radius R are being lowered on a rough horizontal surface.



Column I		Column II
(A)	Ring (ω_0)	(P) Rotational work done by friction is negative till pure rolling beings
(B)	Cylinder (ω_0)	(Q) Translational work done is positive till
(C)	Solid sphere (ω_0)	(R) When pure rolling beings velocity of centre of mass is minimum.
(D)	Hollow sphere (ω_0)	(S) Takes maximum time for pure rolling to begin.

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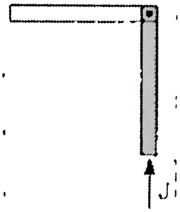
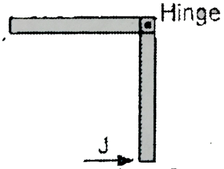
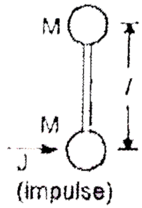
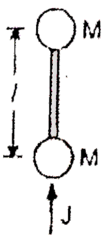
8. All the rigid bodies lie in smooth horizontal plane.

(C)		(R)	Angular momentum increases.
(D)		(S)	Linear momentum increases.

Column I		Column II	
(A)	 Rod is massless, dumb-bell is placed on a smooth horizontal surface.	(P)	Translation occurs.
(B)		(Q)	Rotation occurs.

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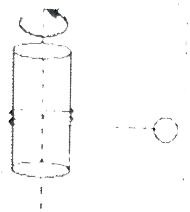
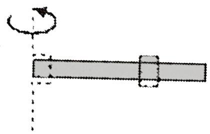
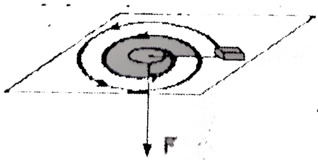
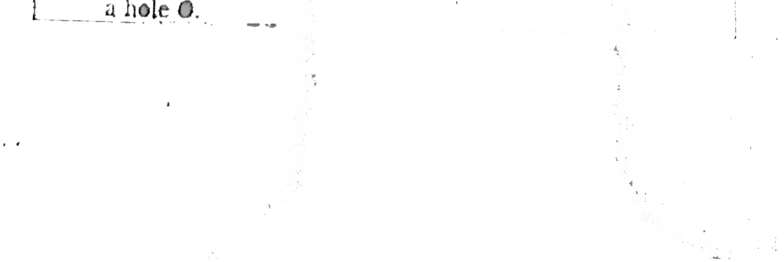
9 Column I	Column II
(A)  A small particle of mass m is given an initial velocity in horizontal plane and winds its cord around the fixed vertical shaft of radius a.	(P) Conservation of angular momentum.
(B)  A smooth rod rotates with angular velocity ω_0. A small sleeve starts sliding along the rod.	(Q) Conservation of kinetic energy.
(C) Two iceskaters approach each other at equal speeds along parallel path separated by some distance. They link hands as they pass by and pull each other to reduce their separation.	(R) Conservation of total mechanical energy.
(D)  A small body tied to a non stretchable thread moves over a smooth horizontal plane. Other end of thread is being drawn into…	(S) Work done by internal forces.



9.

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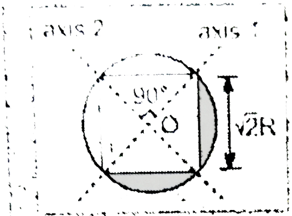
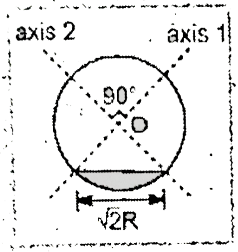
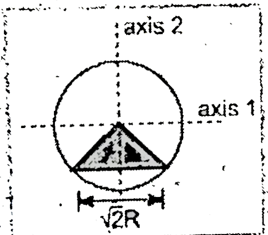
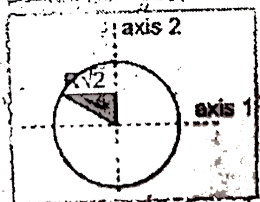
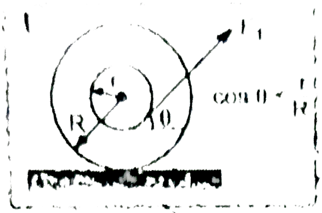
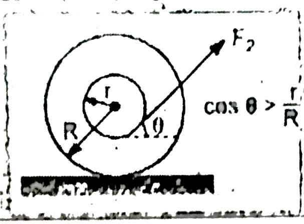
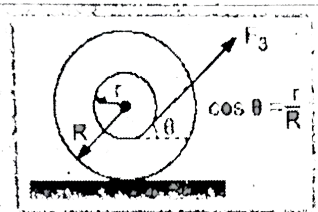
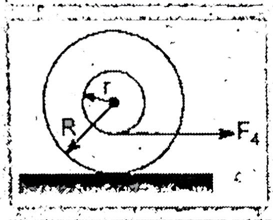
10. Each object shown in column I has mass $2m$. The ring has mass m and radius R. The other components rod, lamina have total mass m. The shaded part in any figure represent a lamina axis I and II are in plane of figure, moment of inertia about their axis is represented by I_1, I_2. Moment of inertia about axis through O and perpendicular to plane of figure is give by I_0.

given by I_0.

Column I		Column II	
(A)		(P)	$I_0 = I_1 + I_2$
(B)		(Q)	$I_1 = I_2$
(C)		(R)	Radius of gyration minimum.
(D)		(S)	$I_0 = \frac{MR^2}{g}$

11. A spol is lying on a rough horizontal surface. Forces F_1, F_2, F_3 and F_4 act in different directions, as represented in column I. Match the information in column I with II.

Column I		Column II	
(A)		(P)	Acceleration of center of mass is towards left.
(B)		(Q)	Acceleration of center of mass is towards right.
(C)		(R)	Friction acts towards left.
(D)		(S)	Friction acts towards right.

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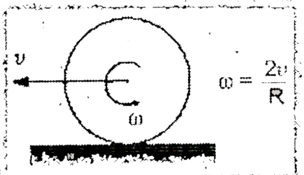
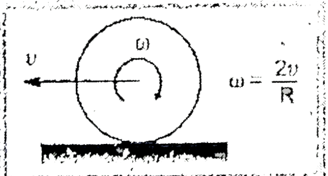
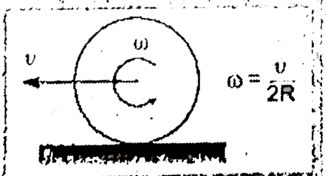
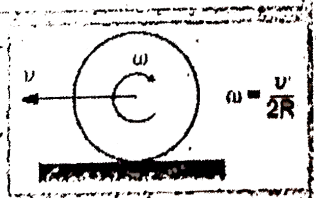
12. Column I shows a rigid body of circlar cross-section projected on a rough surface, with indicated velocity and angular velocity. Friction is sufficient for pure rolling.

	Column I		Column II
(A)		(P)	V_{CM} is towards left for a cylindrical shell.
(B)		(Q)	V_{CM} is towards left for a spherical shell.
(C)		(R)	V_{CM} is towards right for a ring.
(D)		(S)	V_{CM} is towards right for a solid sphere.

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