PHYSICS

BOOKS - DC PANDEY ENGLISH

ROTATIONAL MOTION

JEE Main

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

A. $l_A > l_B$

B. $l_A = l_B$

C. $l_A < l_B$

D. depends on the actul values of t and r

Answer: C

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

A. 6 units

B. $3\sqrt{5}$ units

C. $6\sqrt{5}$ units

D. None of these

Answer: C

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

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

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

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

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

Answer: B

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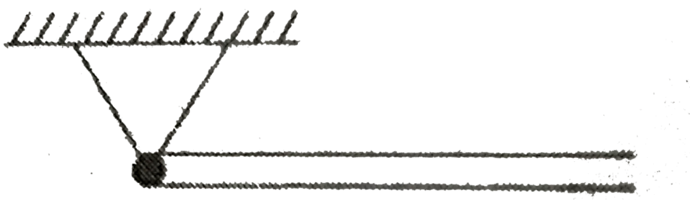
4. A uniform rod of mass 20 Kg and length 1.6 m is piovted at its end and swings freely in the vertical plane. Angular acceleration of the rod just after the rod is relased from rest in the horizontal position is



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

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

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

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

Answer: A

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5. In the above problem, if the rod is released from horizontal position, the angular velocity of the rod as it passes the vertical position is

(l=length fo rod)

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

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

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

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

Answer: C

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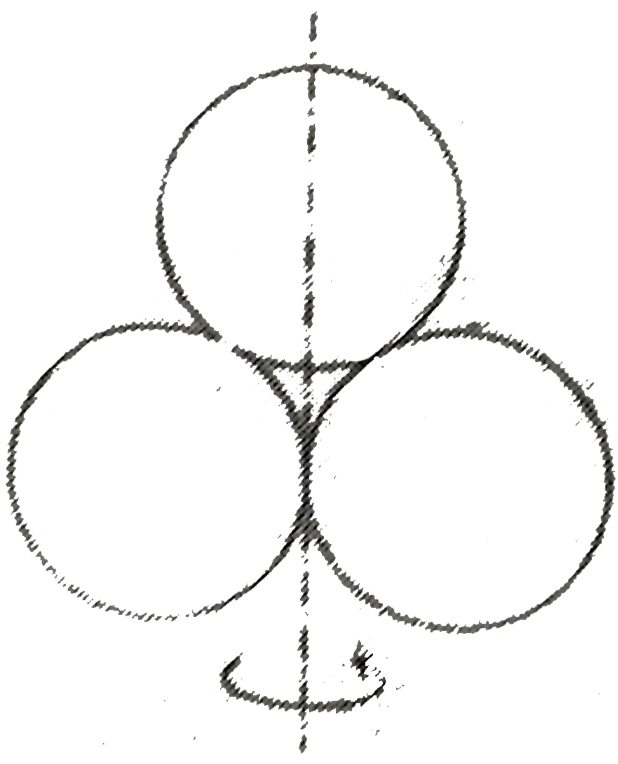
6. Three rings each of mass m and radius r are so placed that they touch each other. The radius of gyration of the system about the axis as shown in the figure is



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

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

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

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

Answer: D

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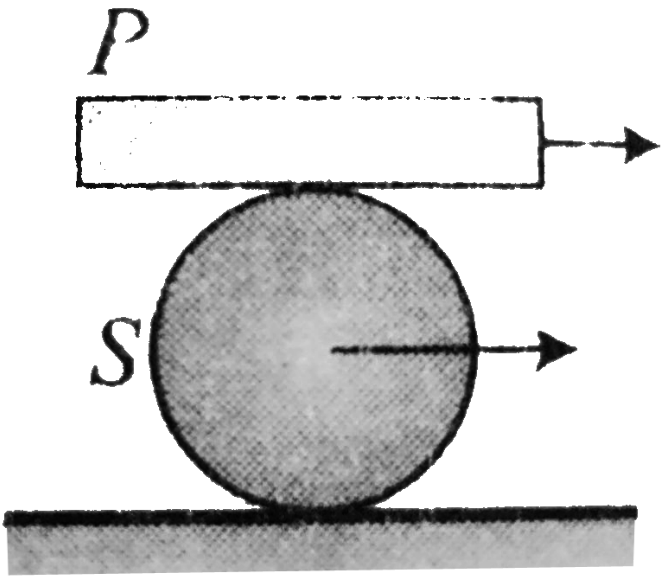
7. A plank P is placed on a solid cylinder S, which rolls on a horizontal surface. The two are of equal mass. There is no slipping at any of the surfaces in contact. The ratio of kinetic energy of P to the kinetic energy of S is:



A. $1:1$

B. $2:1$

C. $8:3$

D. $5:3$

Answer: C

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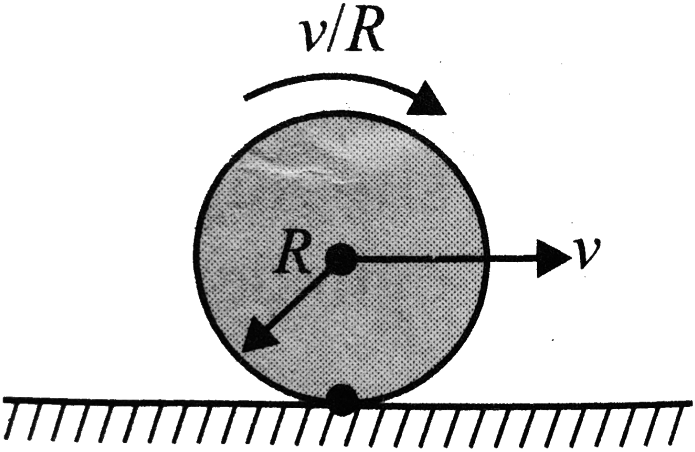
8. A disc is performing pure rolling on a smooth stationary surface with constant angular velocity as shown in Fig,. At any instant, for the lower most point of the disc,



A. velocity is v, acceleration is zero

B. velocity is zero, acceleration is zero

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

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

Answer: D

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

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

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

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

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

Answer: B

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

A. zero

B. $+8$

C. 12

D. -8

Answer: D

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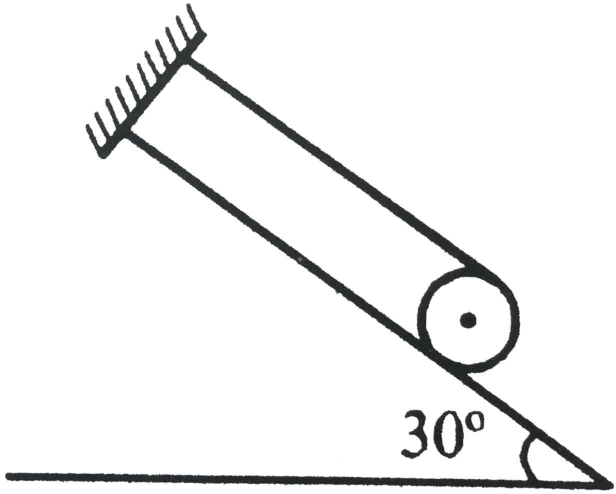
11. A thin hoop of weight $500N$ and radius $1m$ rest on a rought inclined plane as shown in the figure. The minimum coefficient of friction needed for this configuration is.



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

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

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

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

Answer: D

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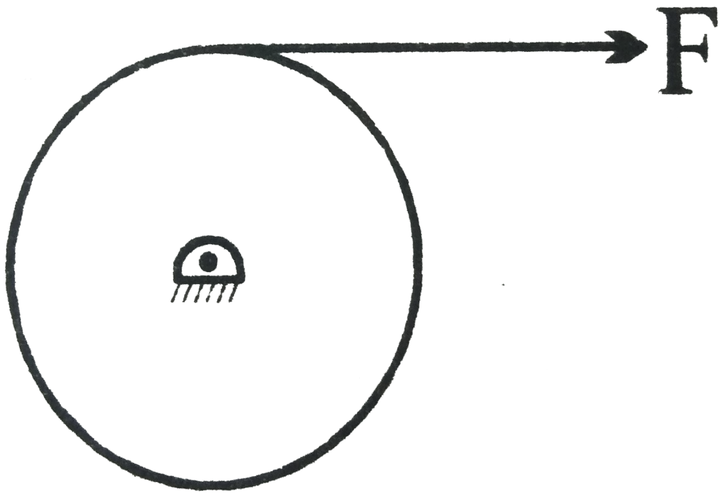
12. A pulley is hinged at the centre and a massless thread is wrapped around it. The thread is pulled with a contant froce F

starting from rest. As the time increases -



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

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

C. its angular velocity increases and force on hinge increases

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

Answer: A

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

A. 2 ma

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

C. ma

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

Answer: D

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

A. downwards at any point between A and B

B. downwards at mid point of AB

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

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

Answer: D

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

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

The x-coordinate of centre of mass is.

A. $x = 2$

B. $x = 0$

C. $x = 1$

D. $x = 3$

Answer: D

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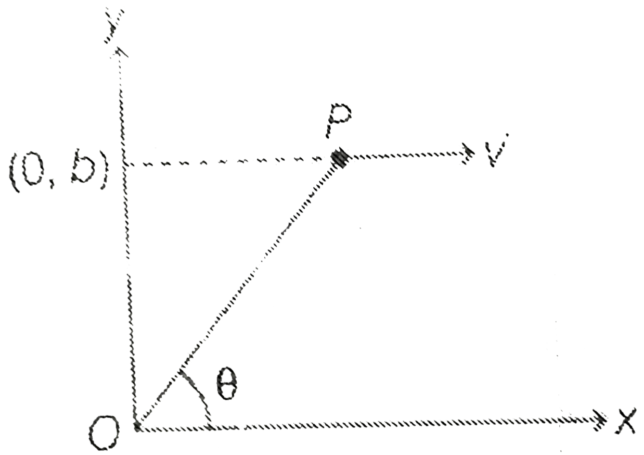
16. A particle is moving parallel to x-axis as shown in the figure. The angular velocity of the particle about the origin is



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

B. (v/b)

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

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

Answer: A

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

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

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

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

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

Answer: A

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

A. $(7/2)$ a

B. $(5/7)$ a

C. $(7/5)$ a

D. $(5/2)$ a

Answer: C

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

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

B. mr^2

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

D. 2mr^(2)`

Answer: C

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

A. $20mL^2$

B. $6mL^2$

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

D. $30mL^2$

Answer: A

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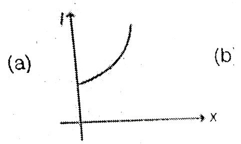
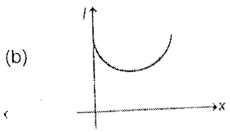
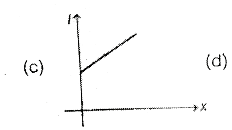
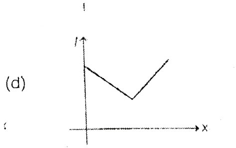
21. Moment of inertia I of a solid sphere about an axis parallel to a diameter and at a distance x from it varies as:

A. 

B. 

C. 

D. 

Answer: A

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

A. a straight line

B. a circle

C. a parabola

D. an ellipse

Answer: B

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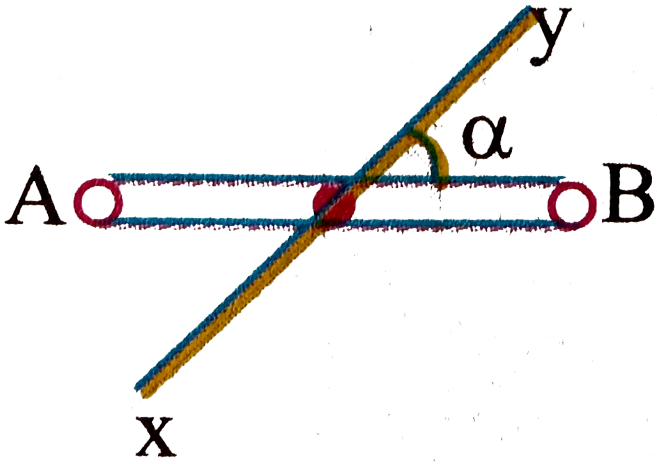
23. The moment of inertia of a uniform rod of length $2l$ and mass m about an axis xy passing through its centre and inclined at an enable α is



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

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

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

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

Answer: A

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

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

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

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

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

Answer: D

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

A. 2ω

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

C. ω

D. Not constant

Answer: A

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

A. the body is in equilibrium

B. the body will rotate about its centre of mass

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

D. the body cannot rotate about its centre of mass

Answer: B

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

A. $ml^2\omega$

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

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

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

Answer: B

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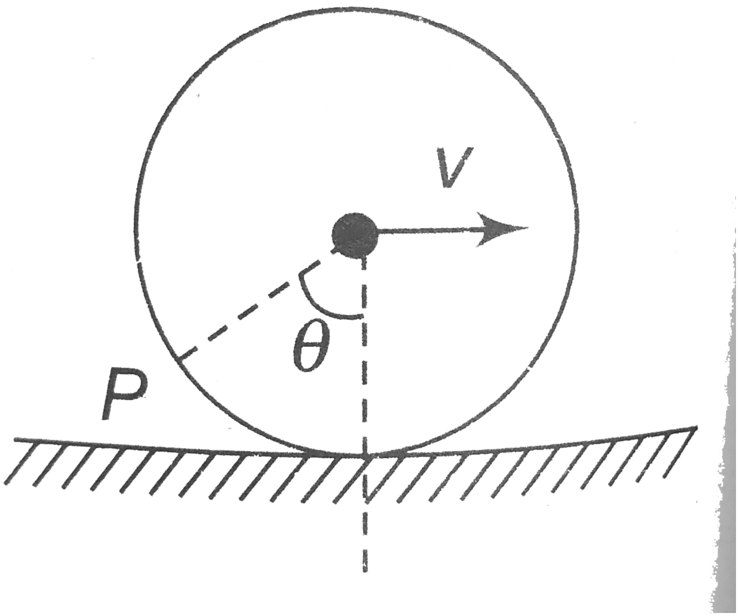
28. A hoop rolls on a horizontal ground without slipping with linear speed v. Speed of a particle P on the circumference of the hoop at angle θ is :



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

B. $v\sin\theta$

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

D. $v\cos\theta$

Answer: A

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

A. n

B. 2n

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

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

Answer: D

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

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

B. 2mg

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

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

Answer: D

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

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

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

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

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

Answer: B

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

A. -2%

B. -1%

C. -3%

D. 1%

Answer: A

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33. A circular platform is mounted on a vertical frictionless axle. Its radius is $r = 2m$ and its moment of inertia $I = 200 kgm^2$. It is initially at rest. A $70 kg$ man stands on the edge of the platform and begins to walk along the edge at speed $v_0 = 1ms^{-1}$ relative to the ground.

The angular velocity of the platform is: a) 1.2 rad/s b) 0.4 rad/s c) 0.7 rad/s d) 2 rad/s

A. $1.2rad / s$

B. $0.4rad / s$

C. $2.0rad / s$

D. $0.7rad / s$

Answer: D

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

A. (a) $\frac{6}{5}\pi$

B. (b) $\frac{5}{6}\pi$

C. (c) $\frac{4}{5}\pi$

D. (d) $\frac{5}{4}\pi$

Answer: B

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

A. the speed and time of descend will be same

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

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

D. the speed and time of descend will be different

Answer: B

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

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

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

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

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

Answer: C

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

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

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

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

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

Answer: B

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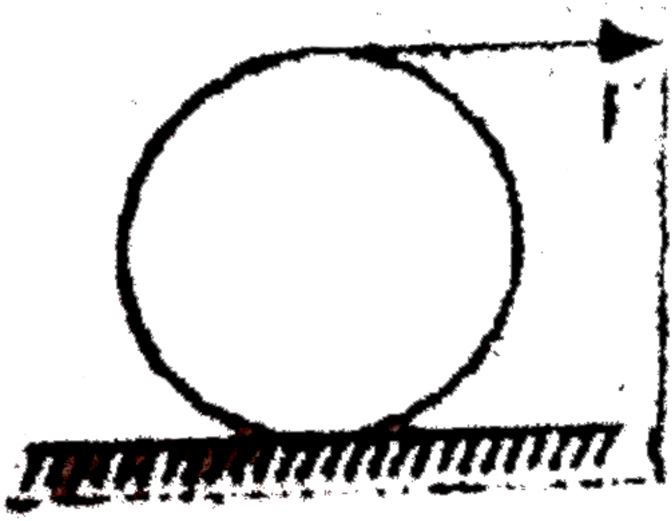
38. A force F is applied at the top of a ring of mass M and radius R placed on a rough horizontal surface as shown in figure. Friction is sufficient to prevent slipping. The friction force acting on the ring is:



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

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

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

D. zero

Answer: D

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

A. solid sphere

B. hollow sphere

C. disc

D. ring

Answer: C

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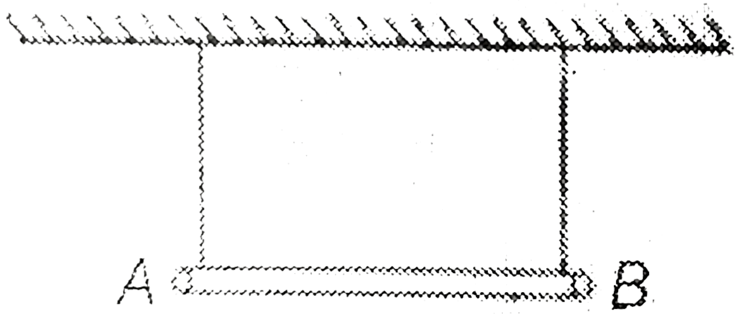
40. A uniform rod of mass m and length l is suspended by means of two light inextensible strings as shown in figure. Tension in one string immediately after the other string is cut



is

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

B. 2mg

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

D. mg

Answer: C

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

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

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

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

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

Answer: B

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

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

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

C. $4\hat{i}$

D. $-4\hat{i}$

Answer: B

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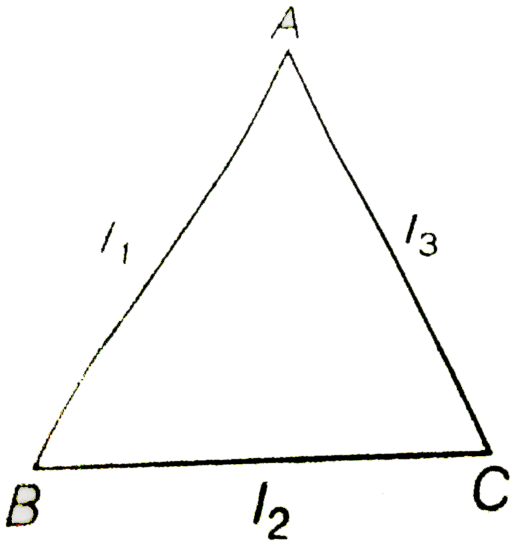
43. ABC is right angled triangular plane of uniform thickness The sides are such that AB gt BC as sshown in figure I_1, I_2, I_3 are moments of inertia about AB, BC and AC, respectively.Then which of the following relations is correct?



A. $l_1 = l_2 = l_3$

B. $l_2 > l_1 > l_3$

C. $l_3 < l_2 < l_1$

D. $l_3 > l_1 > l_2$

Answer: C

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

A. the solid sphere

B. the ring

C. the disc

D. all will take the same time

Answer: D

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45. Solid Sphere, Ring and Disc having same mass m and radius r the smallest kinetic energy at the bottom of the incline will be achieved by

1)Solid Sphere

2)Ring

3)Disc

4)All will achieve the same kinetic energy

A. the solid sphere

B. the ring

C. the disc

D. all will achieve the same kinetic energy

Answer: B

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

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

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

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

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

Answer: B

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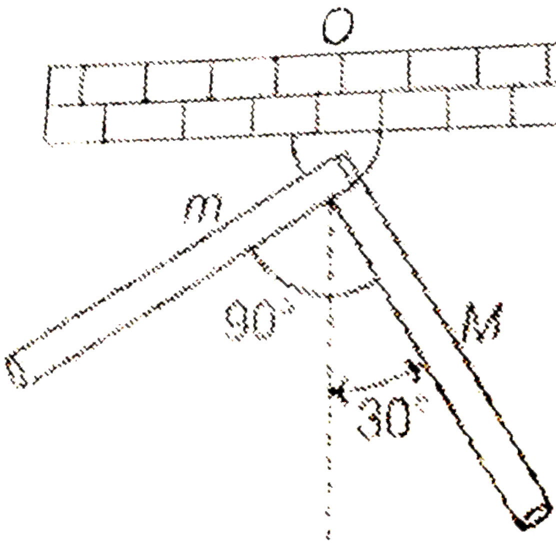
47. Two uniform rods of equal length but different masses are rigidly joined to form an L-shaped body, which is then pivoted as shwon. If in equilibrium, the body is in the shown configuration, ratio `M//m will be



A. 2

B. 3

C. $\sqrt{2}$

D. $\sqrt{3}$

Answer: D

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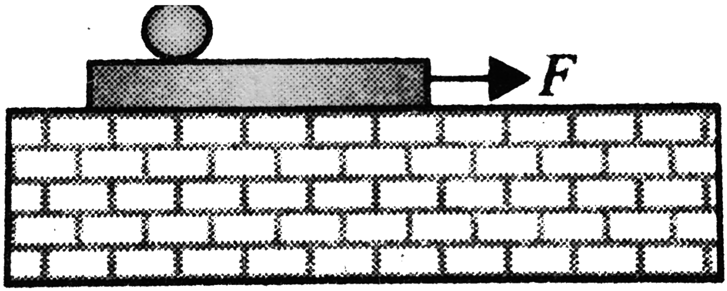
48. A plank with a uniform sphere placed on it resting on a smooth horizontal plane. Plank is pulled to right by a constant force F. If sphere does not slip over the plank. Which of the following is incorrect?



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

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

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

D. None of the above

Answer: D

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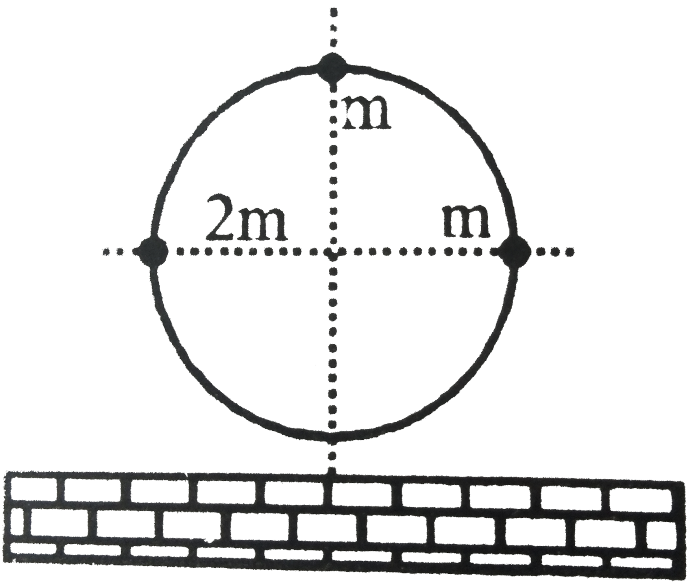
49. A ring mass m and radius R has three particle attached to the ring as shown in the figure. The centre of the centre v_0. Find the kinetic energy of the system. (Slipping is absent).



A. $6mv_0^2$

B. $12mv_0^2$

C. $4mv_0^2$

D. $8mv_0^2$

Answer: A

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

A. $E_1 = E_2 = E_3$

B. $E_1 > E_2 = E_3$

C. $E_1 > E_2 > E_3$

D. $E_1 < E_2 = E_3$

Answer: B

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

A. $2 : 3$

B. $7 : 5$

C. $14 : 15$

D. $15 : 14$

Answer: C

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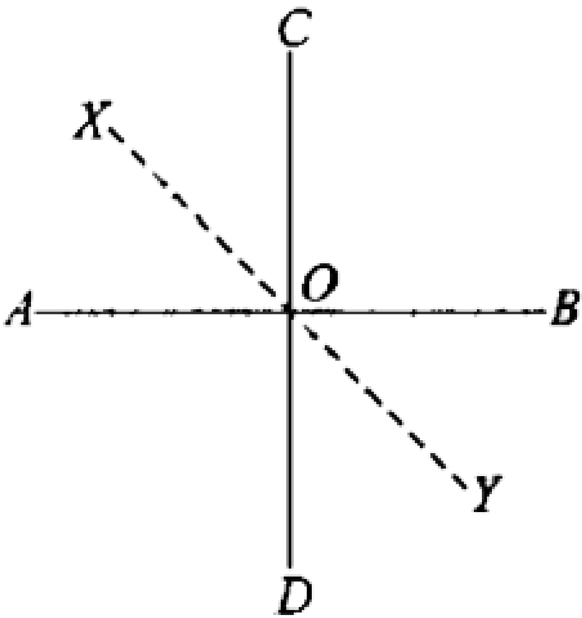
52. AB and CD are two indential rods each of length L and mass M joined to from a cross. Find the M.I. of the system about angle bisector between the rods (XY):



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

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

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

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

Answer: C

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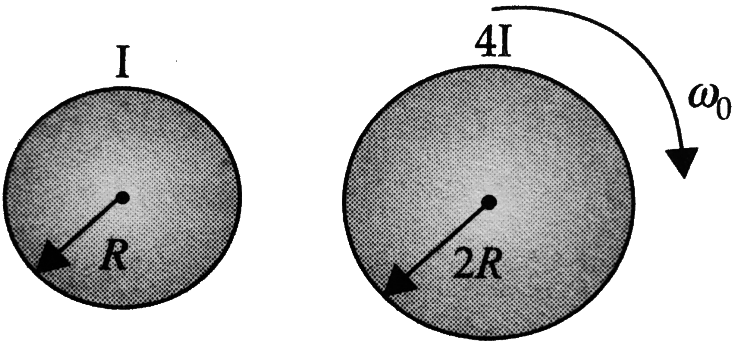
53. Two cylinders having radii $2R$ and R and moment of inertia $4I$ and I about their central axes are supported by axles perpendicular to their planes. The large cylinder is initially rotating clockwise with angular velocity ω_0. The small cylinder is moved to the right until it touches the large cylinder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



A. angular momentum of system is conserved

B. kinetic energy is conserved

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

D. both the angular momentum and kinetic energy are conserved

Answer: C

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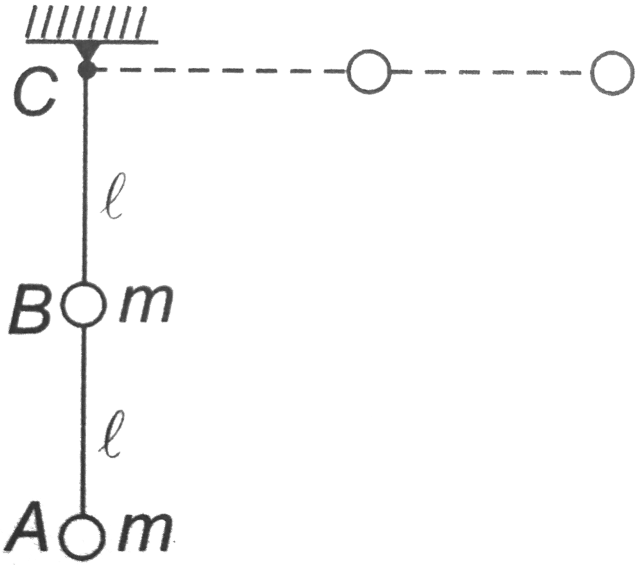
54. A weightless rod of length $2l$ carries two equal masses 'm', one tied at lower end A and the other at the middle of the rod at B. The rod can rotate in vertical plane about a fixed horizontal axis passing thriugh C . The rod of is released from rest in horizontal possion. The speed of the mass B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



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

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

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

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

Answer: C

Watch Video Solution

55. A uniform rod AB of mass m and length l at rest on a smooth horizontal surface . An impulse P is applied to the end B. The time taken by the rod to turn through a right angle is :

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

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

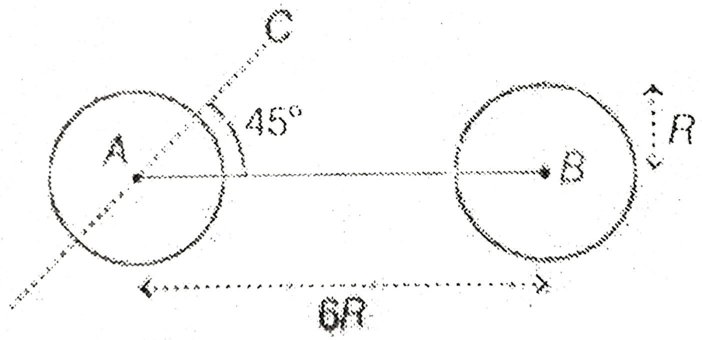
C. $\dfrac{\pi ml}{12P}$

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

Answer: C

Watch Video Solution

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



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

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

C. 31l

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

Answer: C

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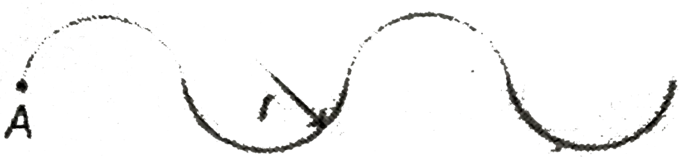
57. A uniform rod of mass 2M is bent into four adjacent semicircles each of radius r, all lying in the same plane. The moment of inertia of the bent rod about an axis through one end A and perpendicular to plane of rod is



A. $22Mr^2$

B. $88Mr^2$

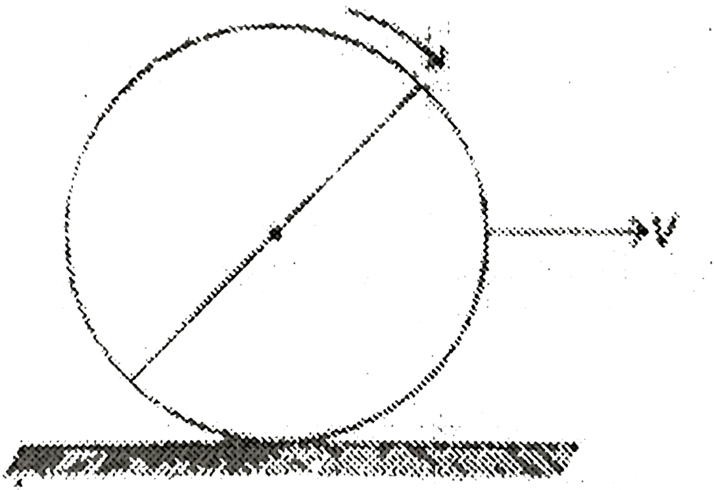
C. $44Mr^2$

D. $66Mr^2$

Answer: C

Watch Video Solution

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



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

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

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

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

Answer: C

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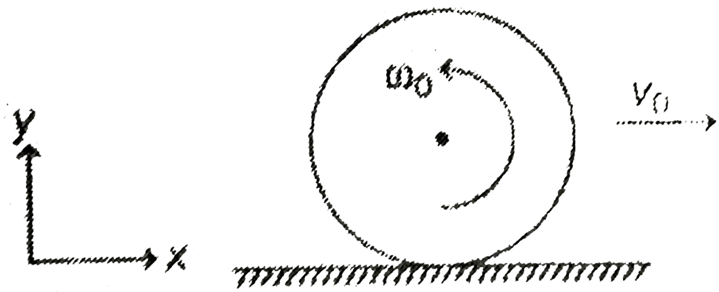
59. A disc is given an angular velocity ω_0 and a linear velocity v_0 as shown in the figure. It is released on a rough horizontal surface of friction coefficient μ. Mark the correct statement $(\omega_0 = 3v_0 / R)$



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

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

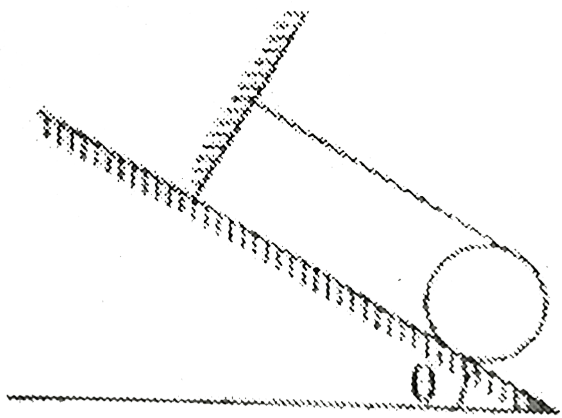
C. After some time the disc will start rolling without sliding along negative x-axis.

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

Answer: C

Watch Video Solution

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



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

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

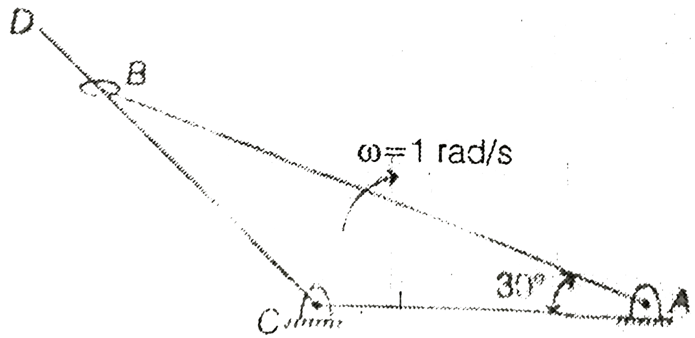
C. $\frac{2}{3}g\sin\theta$

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

Answer: C

Watch Video Solution

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



A. $1 rad / s$

B. $1 / 2 rad / s$

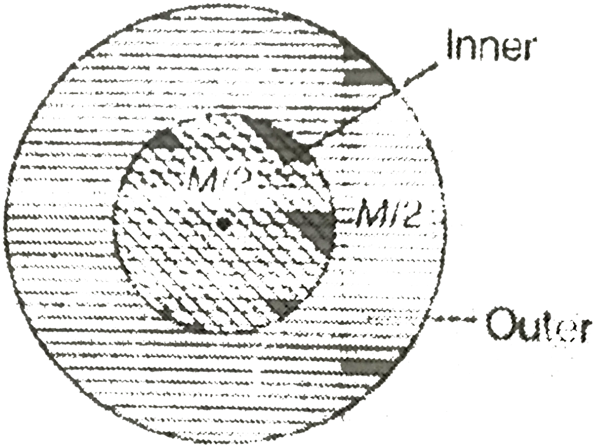
C. $\sqrt{3 / 2} rad / s$

D. $3 / 2 rad / s$

Answer: D

Watch Video Solution

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



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

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

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

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

Answer: C

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A Only One Option is Correct

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

A. $v_1 = v_2$

B. $v_1 > v_2$

C. $v_1 < v_2$

D. data is insufficient

Answer: C

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

A. $t_1 = t_2$

B. $t_1 < t_2$

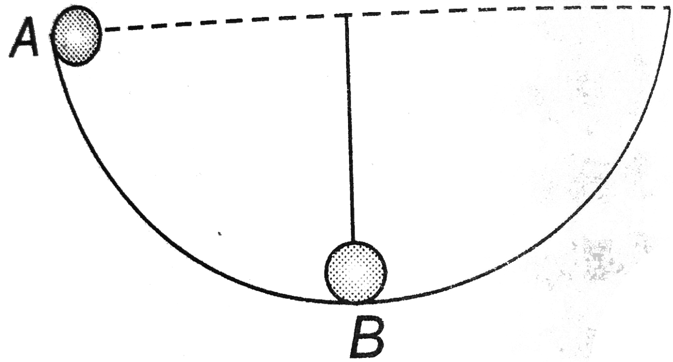
C. $t_1 > t_2$

D. None of these

Answer: B

Watch Video Solution

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



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

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

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

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

Answer: B

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

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

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

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

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

Answer: C

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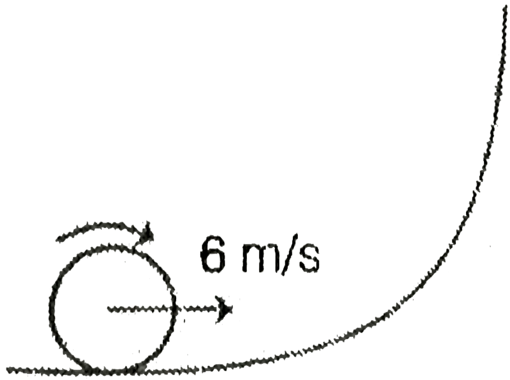
5. A disc of radius 0.1 mrolls without sliding on a horizontal suirface with a velocity of 6 m/s. It then ascends a smooth continous track as shown in figure. The height upto which it will ascend is (g=$10 m/s^2$)



A. 2.4 m

B. 0.9 m

C. 2.7 m

D. 1.8 m

Answer: D

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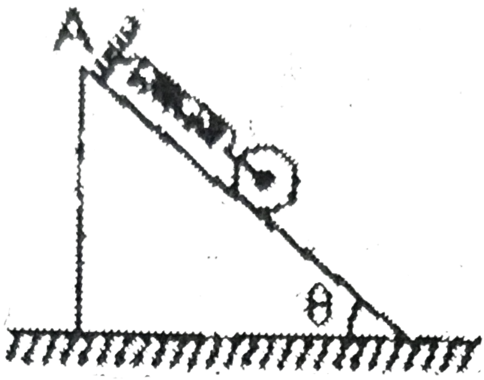
6. A uniform cylinder of mass M and radius R rolls without slipping down a slope of angle 8 with horizontal. The cylinder is connected to a spring of force constant k at the centre, the other side of which is connected to a fixed support at A. The cylinder is released when the spring is unstretched.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

:



A. always upwards

B. always downwards

C. initially upwards and then becomes downwards

D. initially upwards and then becomes zero

Answer: C

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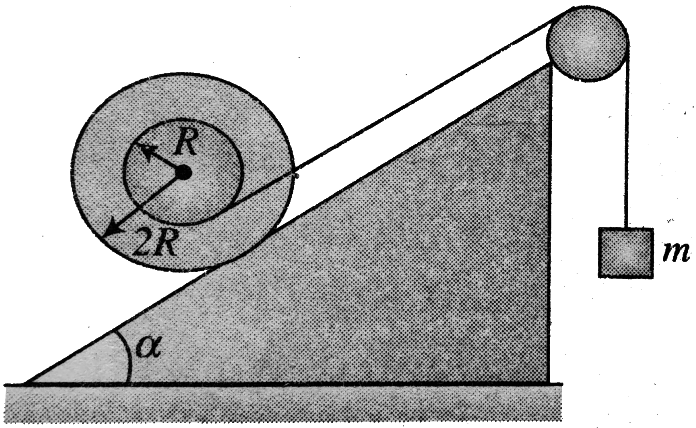
7. A spool of mass M and radius $2R$ lies on an inclined plane as shown in the figure. A light thread is wound around the connecting tube of the spool and its free end carries a weight of mass m. The value of m so that system is in equilibrium is



A. $2M \sin \alpha$

B. $M \sin \alpha$

C. $2M \tan \alpha$

D. $M \cos \alpha$

Answer: A

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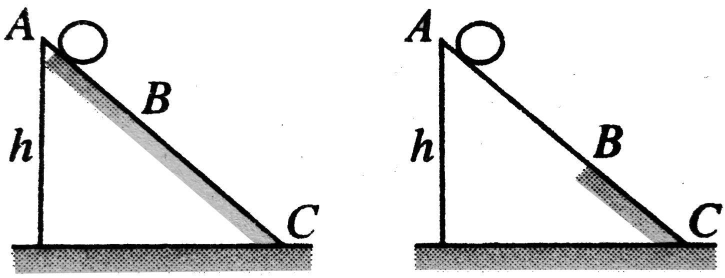
8. In both the figures all other factors are same, except that in figure (i) AB is rough and BC is smooth while in figure (ii) AB is smooth and BC is rough. In figure (i), if a sphere is released from rest it starts rolling. Now consider the figure (ii), if same sphere is A released from top of the inclined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



(i) (ii)

A. is same in both the cases

B. is greater in case (i)

C. is greater in case (ii)

D. information is unsufficent

Answer: B

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

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

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

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

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

Answer: D

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

A. zero

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

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

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

Answer: B

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

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

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

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

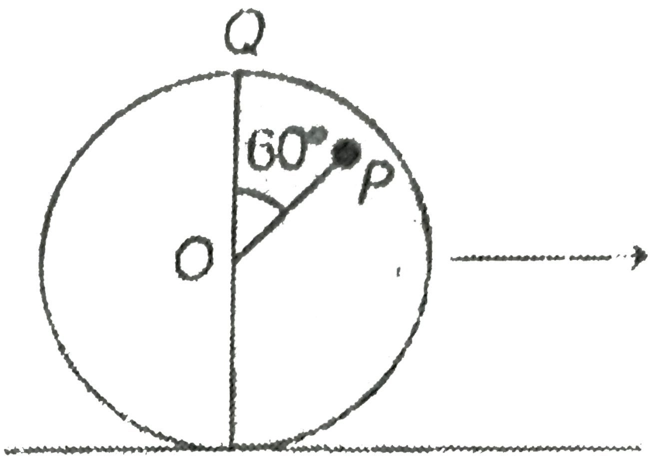
D. zero

Answer: B

Watch Video Solution

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

(OP=r / 2 and $\angle QOP = 60^\circ$)is



A. v_0

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

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

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

Answer: C

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13. A flat rail road car is accelerating along the positive x-axis with an acceleration a_p. A sphere is placed over the car. The friction between the car and the sphere is not sufficient to support pure rolling of sphere.

The correct statement is

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

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

C. Acceleration of sphere is along -x direction

D. None of the above

Answer: B

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

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

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

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

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

Answer: B

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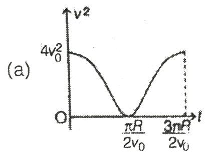
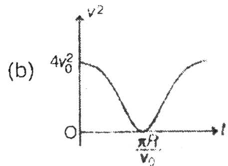
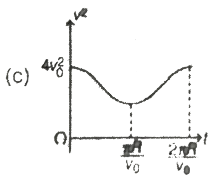
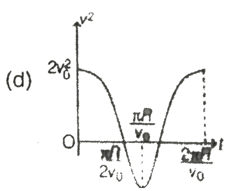
15. A wheel ios rolling without sliding on a horizontal surface. The centre of the wheelk moves with a constant speed v_0. Consider a point P on the rim which is at the top at time t=0. The square of speed of point P is plooted against time t. The correct plot is (R is radius of the wheel)

A. 

B. 

C. 

D. 

Answer: B

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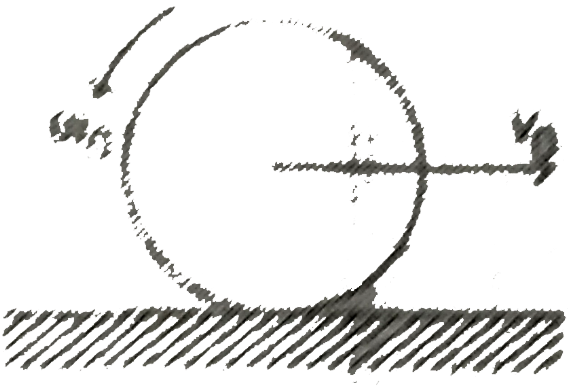
16. a uniform circular disc of radiu8s r placed on a roughn horizontal plane has initial velocity v_0 and an angul,ar velocity ω_0 has shown The disc comes to rest after moving some distance in the direction of motion. Then



A. the friction force acting in the towards direction

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

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

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

Answer: C

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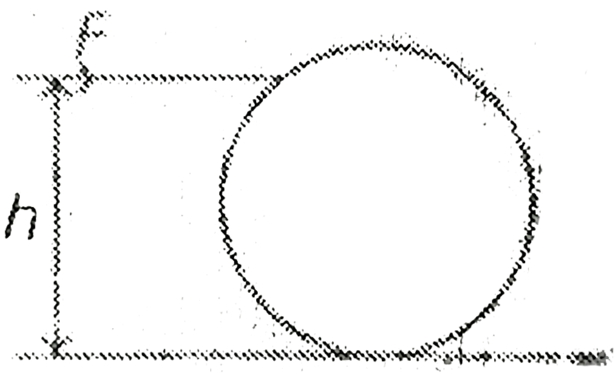
17. A solid sphere of radius R is resting on a smooth horizontal surface. A constant force F is applied at a height h from the bottom. Choose the correct alternative.



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

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

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

D. None of the above

Answer: C

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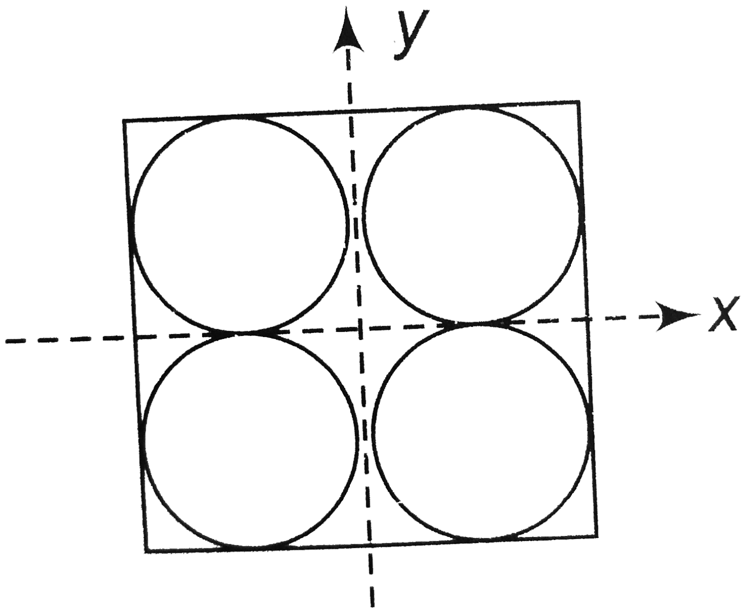
18. Four holes of radius R are cut from a thin square plate of side $4R$ and mass M. The moment of inertia of the remaining portion about z-axis is :



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

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

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

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

Answer: C

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19. Choose the correct option:

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

A. (a) $0.6ml^2$

B. (b) ml^2

C. (c) $0.2ml^2$

D. (d) $0.4ml^2$

Answer: D

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

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

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

C. $\sqrt{13}R$

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

Answer: B

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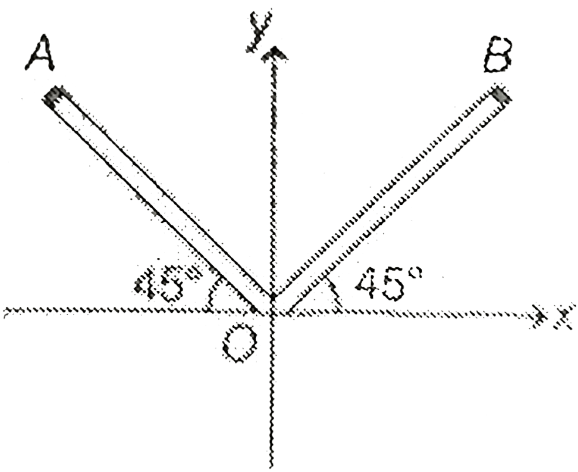
21. Two rods OA and OB of equal length and mass are lying on xy plane as shown in figure. Let I_x, I_y and I_z be the moment of inertia of both the rods bout x,y and z axis respectively. Then,



A. $l_x = l_y > l_z$

B. $l_x = l_y < l_z$

C. $l_x > l_y > l_z$

D. $l_z > l_y > l_x$

Answer: B

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22. Choose the correct option:

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

A. (a) I_1

B. (b) I_2

C. (c) I_3

D. (d) Data insufficient

Answer: A

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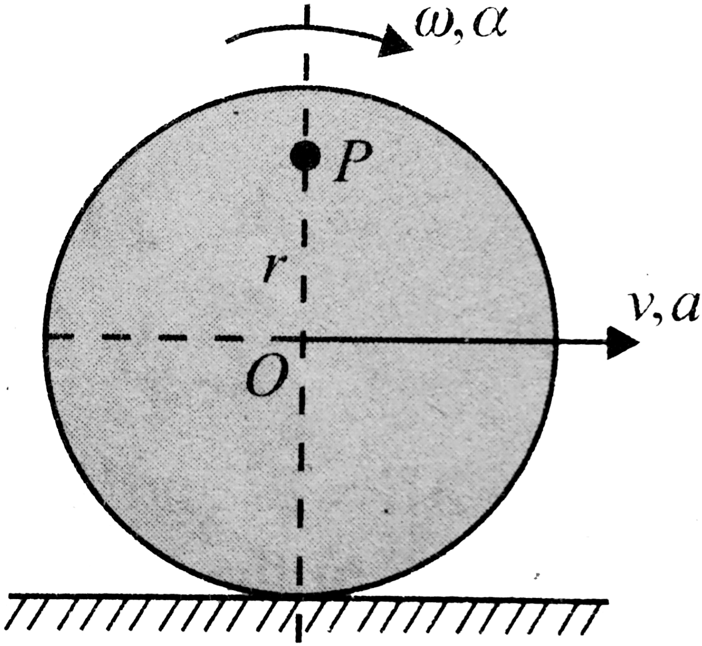
23. Choose the correct option:

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

B. (b) $\frac{ar}{R}$

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

D. (d) $r\alpha$

Answer: A

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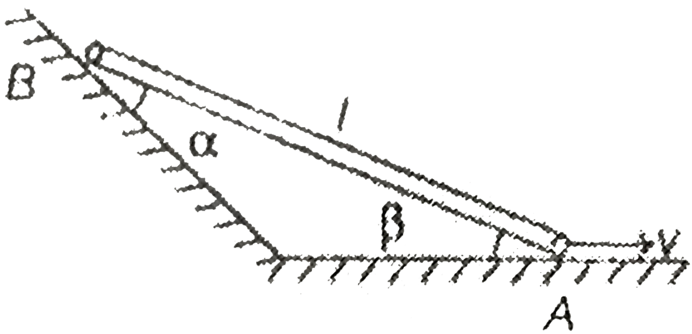
24. A rod of length l slided down along the inclined wall as shown in figure. At the instant shown in figure, the speed of end A is v, then the speed of B will be



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

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

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

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

Answer: C

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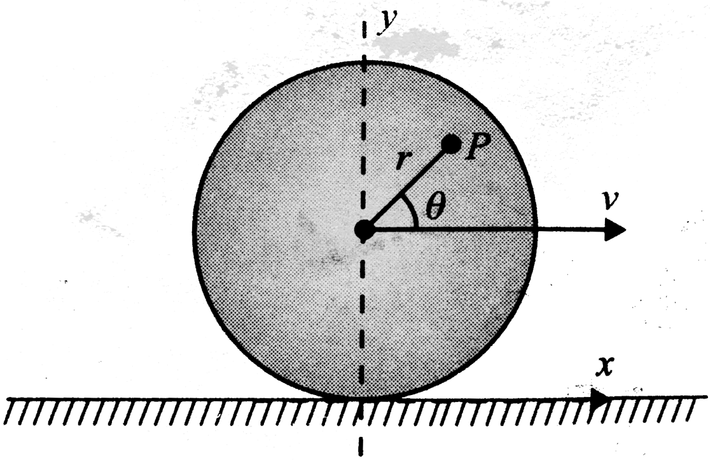
25. A disc of radius R rolls without slipping at speed v along positive x-axis. Velocity of point

P at the instant shown in Fig. is



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

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

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

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

Answer: B

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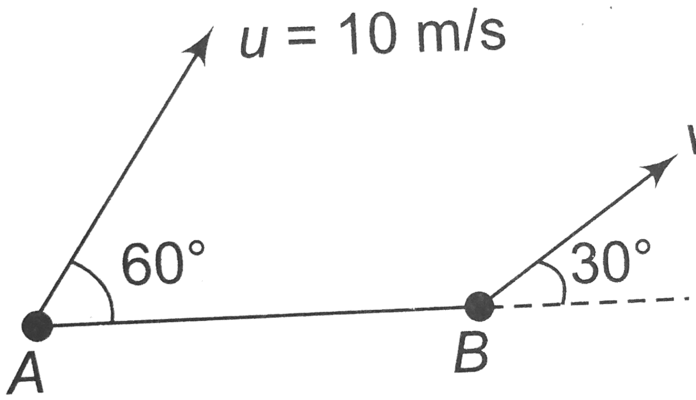
26. Two particles A and B are situated at a distance $d = 2m$ apart. Particle A has a velocity of $10m/s$ at an angle of 60° and particle B has a velocity v at an angle 30° as shown in figure. The distance d between A and B is constant. the angular velocity of B

with respect to A is :



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

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

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

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

Answer: B

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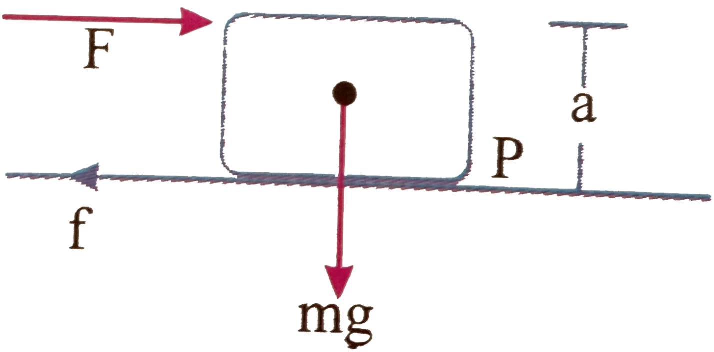
27. A force F is applied on the top of a cube as shown in the figure. The coefficient of friction between the cube and the ground is μ. If F is gradually increased, find the value of μ for which the cube will topple before sliding.



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

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

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

D. $\mu < 1$

Answer: C

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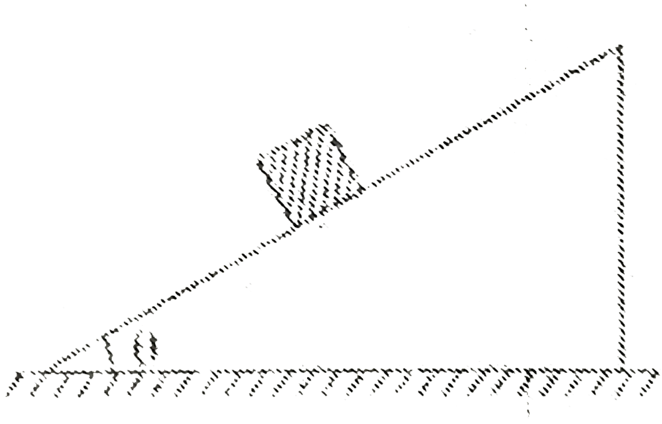
28. A cube is pplaced on an inclined plane of inclinbation θ as shown in figure. Cofficent of friction br=etween the cube and the plane is μ. As the angle θ is gradually increased, the cube slides before toppling if



A. $\mu > 1$

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

C. $\mu < 1$

D. None of the above

Answer: C

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

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

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

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

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

Answer: D

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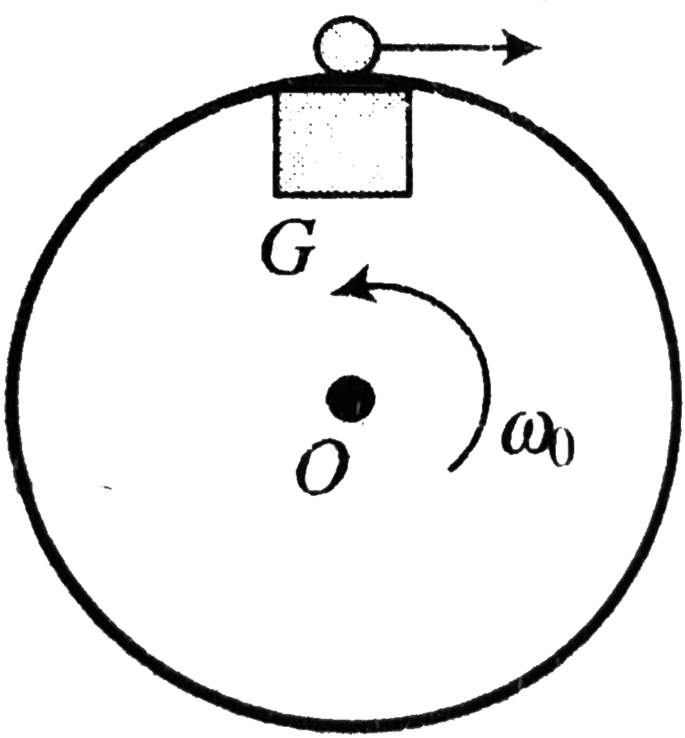
30. Choose the correct option:

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



A. (a) $\frac{mvr}{l_0 + mr^2}$

B. (b) $\frac{2mvr}{l_0}$

C. (c) $\frac{v}{2r}$

D. (d) $\frac{mvr}{2l_0}$

Answer: A

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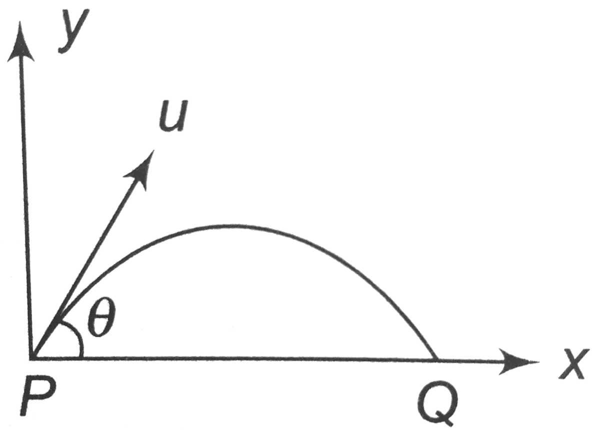
31. Average torque on a projectile of mass m (initial speed u and angle of projection θ) between initial and final positions P and Q as shown in figure, about the point of projection is :



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

B. $mu^2 \cos \theta$

C. $mu^2 \sin \theta$

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

Answer: A

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

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

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

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

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

Answer: D

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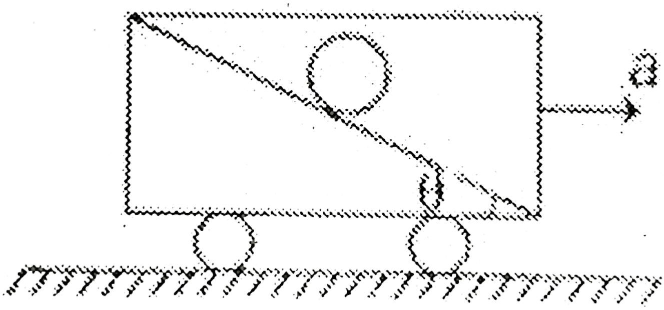
33. Figures shows a smooth inclined plane of inclination θ fixed ina car. A sphere is set in pure rolling on the incline. For what value of a (the acceleration of car in horizontal direction) the sphere will continue pure rolling ?



A. $g \cos \theta$

B. $g \sin \theta$

C. $g \cot \theta$

D. $g \tan \theta$

Answer: D

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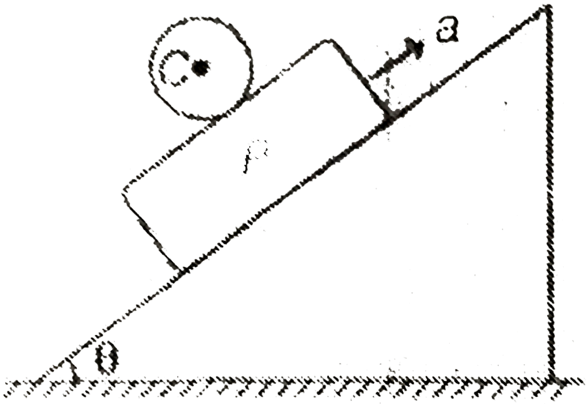
34. The acceleration a of the plank P required to keep the centre C of a cylinder in a fixed position during the motion is (no slipping take place between cylinder and plank)



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

B. $2g\sin\theta$

C. $g \sin \theta$

D. $g \tan \theta$

Answer: B

Watch Video Solution

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

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

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

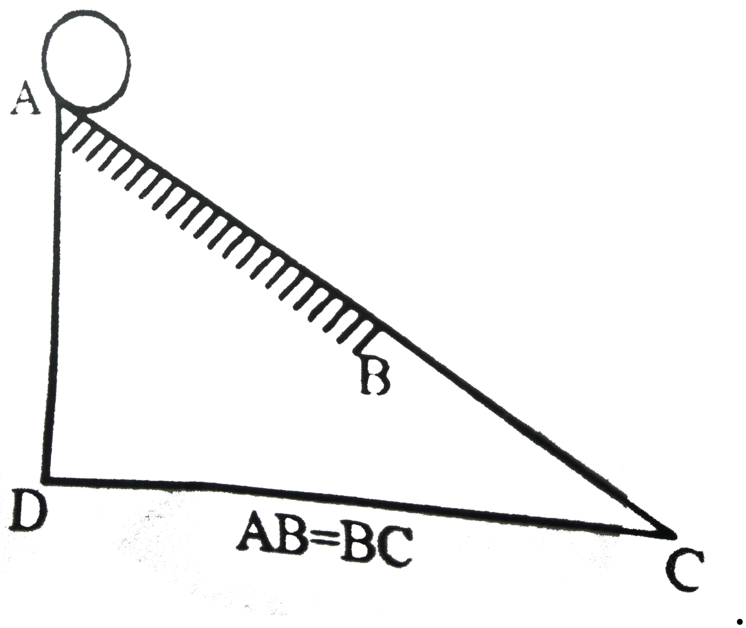
C. $\frac{5}{2}R$

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

Answer: B

Watch Video Solution

36. Portion AB of the wedge shown in figure is rough and BC is smooth. A solid cylinder rolld without slipping from A to B. Find the ratio of translational kinetic energy to rotational kinetic energy, when the cylinder reaches point C.



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

B. 5

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

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

Answer: B

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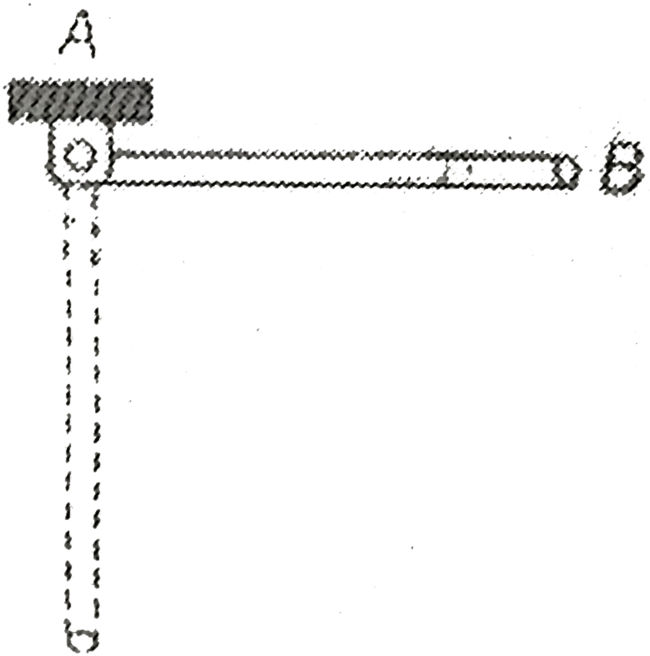
37. One end of a uniform rod of length l and mass m is hinged at A. It is released from the rest from horizontal position AB as shown in figure. The force exerted by the rod on the hinge when it becomes verticle is



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

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

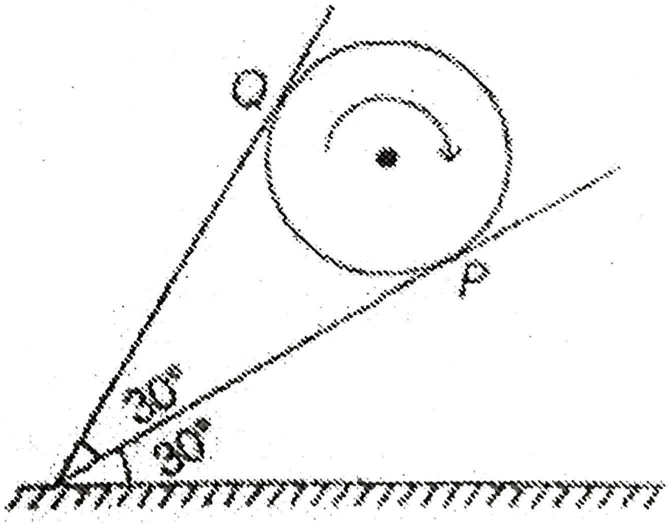
C. $3mg$

D. 5mg

Answer: B

Watch Video Solution

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



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

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

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

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

Answer: A

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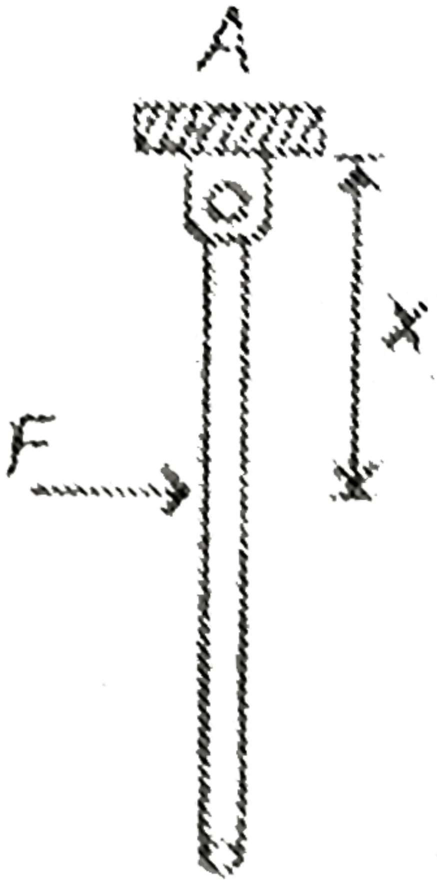
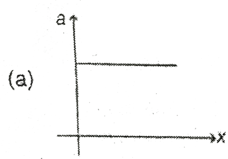
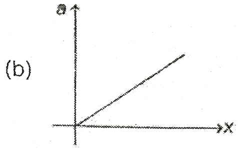
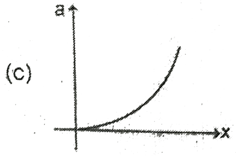
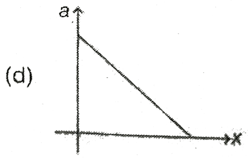
39. A rod of mass m and length l is hinged at one of its end A as shown in figure. A force F is applied at a distance x from A. The acceleration of centre of mass a varies with x as



A. 

B. 

C. 

D. 

Answer: B

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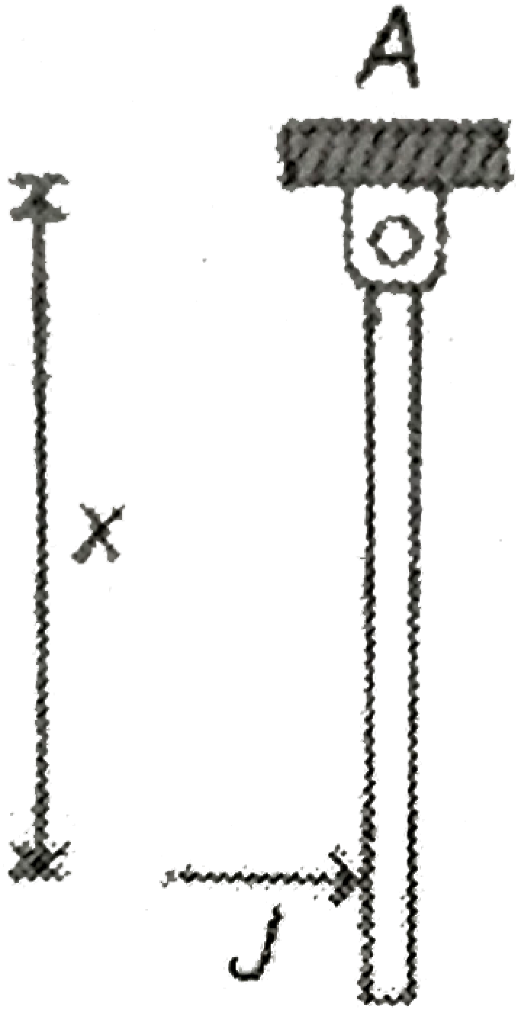
40. A uniform rod of length l is pivoted at point A. It struk n=by an horizontal force which delivers an ikmpulse J at a distance c from point A as shown in figure. Impulse delivered by pivot is zero, if x is equal to



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

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

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

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

Answer: C

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

The length of the rod is

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

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

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

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

Answer: A

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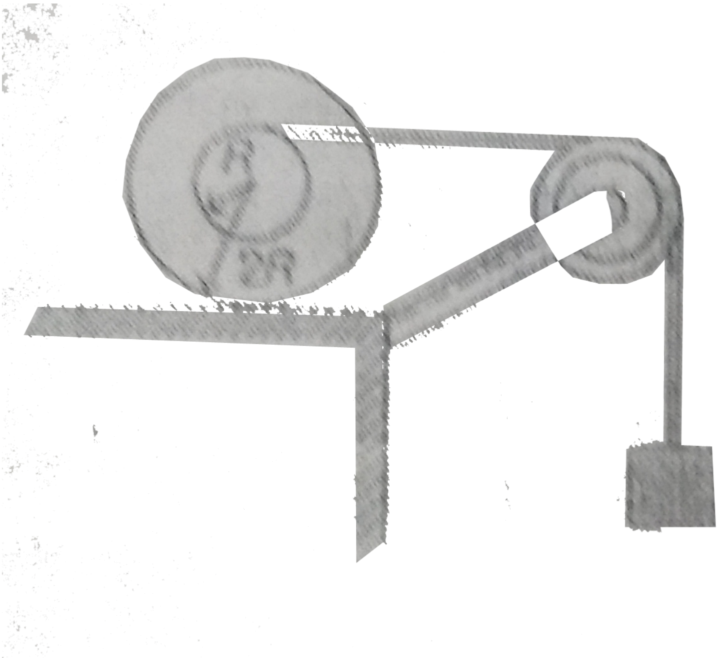
42. In the figure shown mass of both, the spherical body and blocks is m. Moment of inertia of the spherical body about centre of mass is $2mR^2$. The spherical body rolls on the horizontal surface. There is no sliping between any two surfaces in contact. The ratio of kinetic energy of the spherical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



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

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

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

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

Answer: C

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

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

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

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

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

Answer: D

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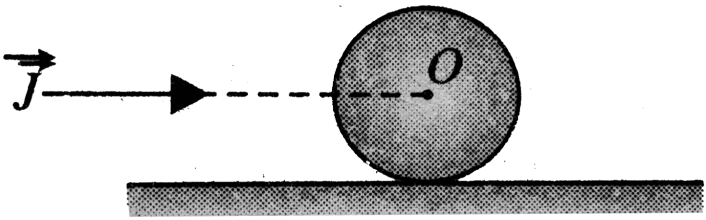
44. An impulse J is applied on a ring of mass m along a line passing through its centre O. The ring is placed on a rough horizontal surface. The linear velocity of centre of ring once it starts rolling without slipping is



A. $\dfrac{J}{m}$

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

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

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

Answer: B

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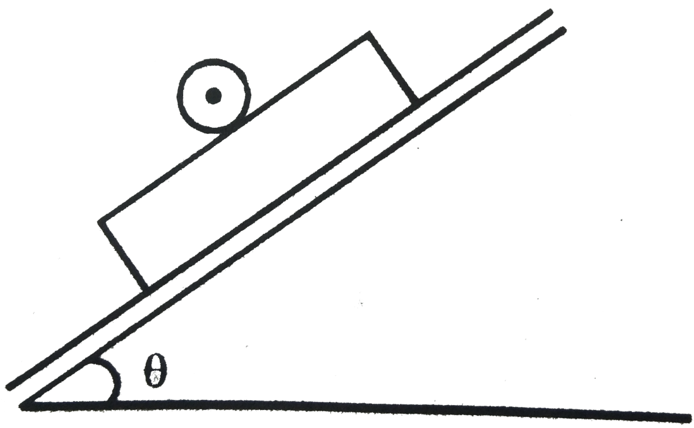
45. A plank of mass M is placed over smooth inclined plane and sphere is also placed over the plank. Friction is sufficient between sphere and plank. If plank and sphere are released from rest, the frictional force on sphere is -



A. up the plane

B. down the plane

C. zero

D. maybe up or down the plane

Answer: C

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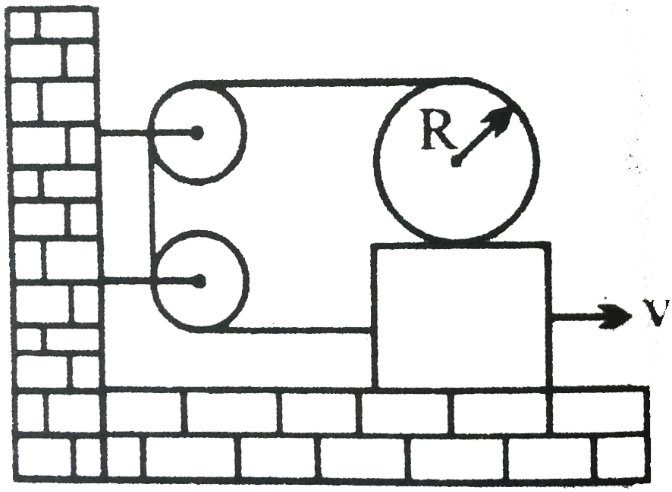
46. In the figure shown, the plank is being pulled to the right with a constant speed v. If the cylinder does not slip then:



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

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

C. The angular velocity of the cylinder is

v/R

D. The angular velocity of the cylinder is

zero

Answer: C

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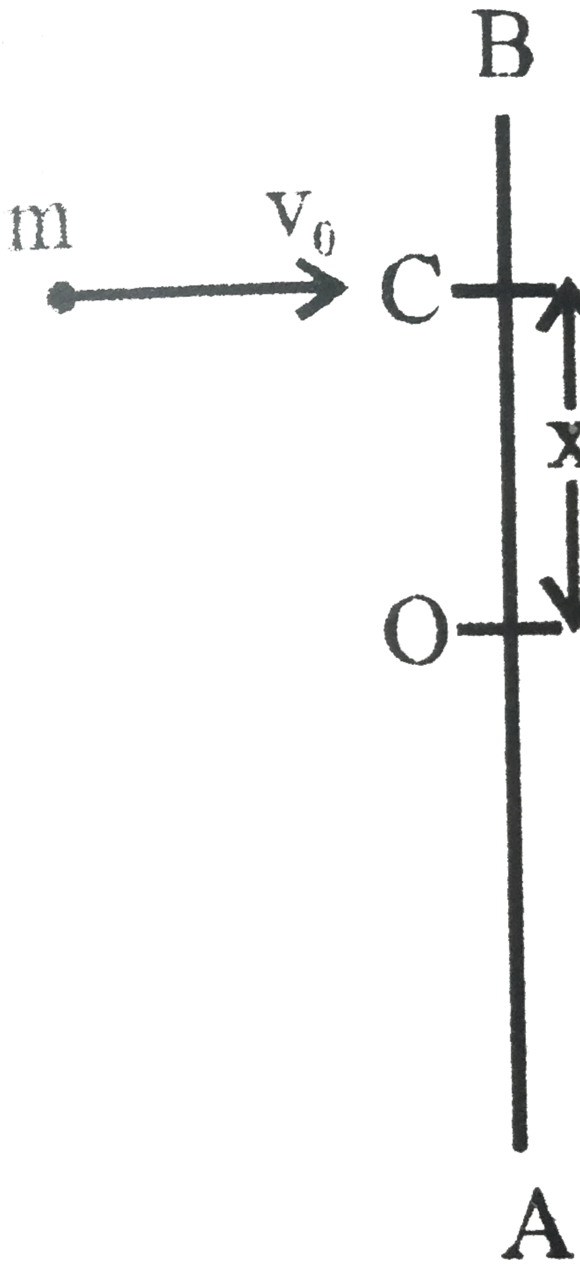
47. A uniform rod AB of length L and mass M is lying on a smooth table. A small particle if mass m strike the rod with velocity v_0 at point

C at a distance comes to rest after collision.

Then find the value of x, so that point A of the rod remains stationary just after collision.



A. L/3

B. L/6

C. L/4

D. L/12

Answer: B

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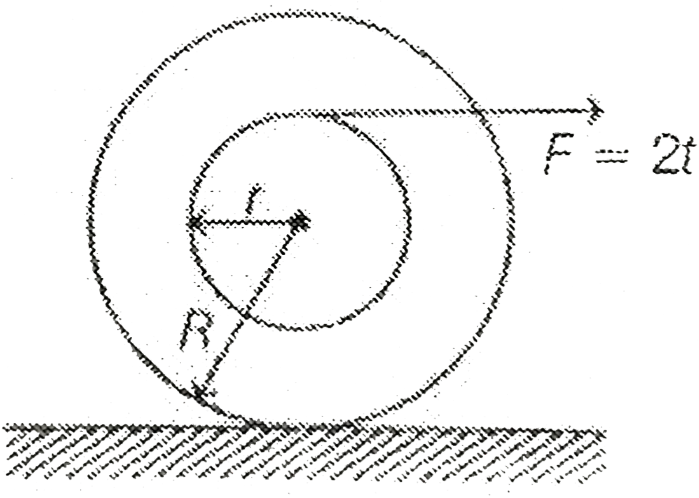
48. A time varying force F=2t is applied on a spool as shown in figure. The angular momentum of the spool at time t about bottommost point is



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

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

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

D. Data insufficent

Answer: C

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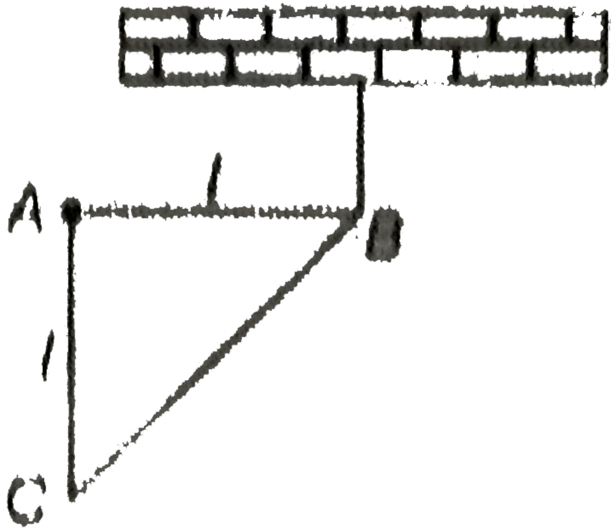
49. A right triangular plate ABC of mass m is free to rotate in the verticle plane about a fixed horizontal axis through A. It is supported by a string such that the side AB is horizontal.

The reaction at the support A is



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

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

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

D. mg

Answer: B

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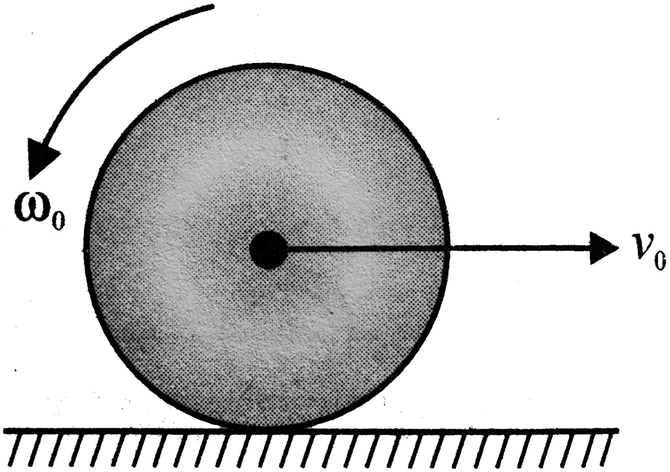
50. A uniform circular disc of radius r is placed on a rough horizontal surface and given a linear velocity v_0 and angular velocity ω_0 as shown. The disc comes to rest after moving some distance to the right. It follows that



A. $v_0 = \omega_0 R$

B. $2v_0 = 5\omega_0 R$

C. $5v_0 = 2\omega_0 R$

D. $2v_0 = \omega_0 R$

Answer: C

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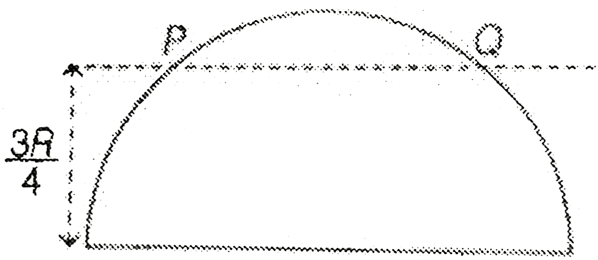
51. The radius of gyration of a solid hemisphere of mass M and radius Rn about an axis parallel to the diameter at a distance $\frac{3}{4}$R is given by (centre of mass of the hemisphere lies at a height $3R/8$ from the base.)



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

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

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

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

Answer: D

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52. Two particles A and B are moving with constant velocities $V_1 = \hat{j}$ and $v_2 = 2\hat{i}$ respectively in XY plane. At time t=0, the particle A is at co-ordinates (0,0) and B is at

(-4,0). The angular velocities of B with respect to A at t=2s is (all physical quantities are in SI units)

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

B. $2rad/s$

C. $4rad/s$

D. $1rad/s$

Answer: D

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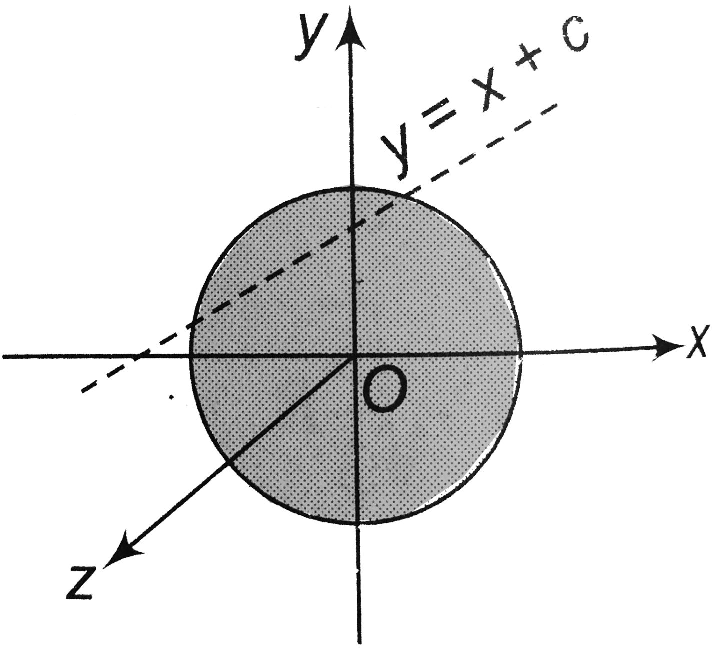
53. A uniform disc of radius R lies in the $x-y$ plane, with its centre at origin. Its moment of inertia about z-axis is equal to its moment of inertia about line $y=x+c$. The value of c will be.



A. $R/\sqrt{2}$

B. $-R/2$

C. $+R/4$

D. $-R$

Answer: A

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

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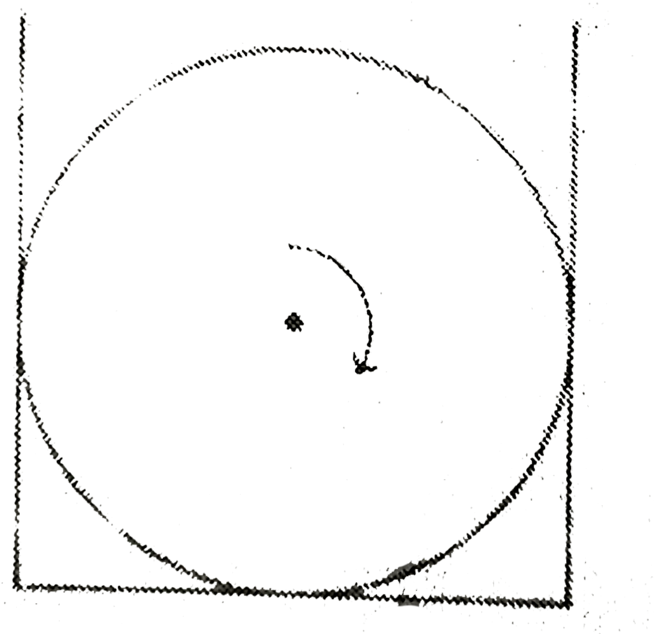
55. A solid sphere of mass 5 kg and and radius 1 m after rotating with angular speed $\omega_0 = 40 rad / s$ is placed between two smooth walls on a rough ground. Distance between the walls is slightely greater than the diameter of the sphere. Coffiecient of friction between the sphere and the ground is $\mu = 0.1$. sphere will stop rtotating after time t = ...s .



A. 8

B. 12

C. 20

D. 16

Answer: D

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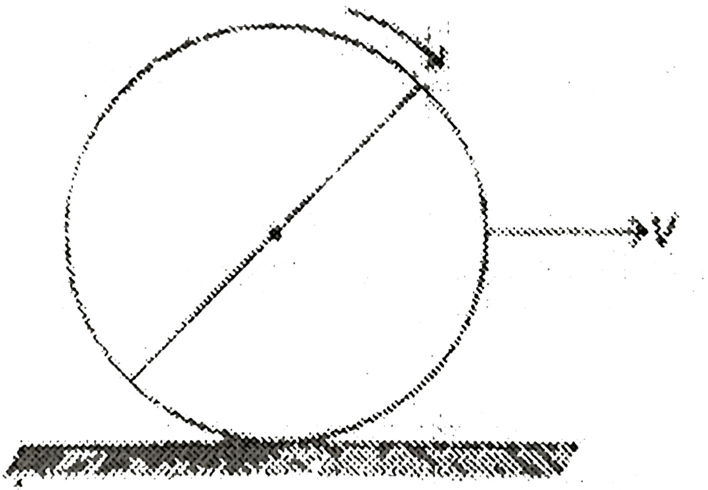
56. A ring of mass m is rolling without slipping with linear velocity v as shown is figure. A rod of identical mass is fixed alone one of its diameter. The total kinetic energy of the system is



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

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

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

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

Answer: D

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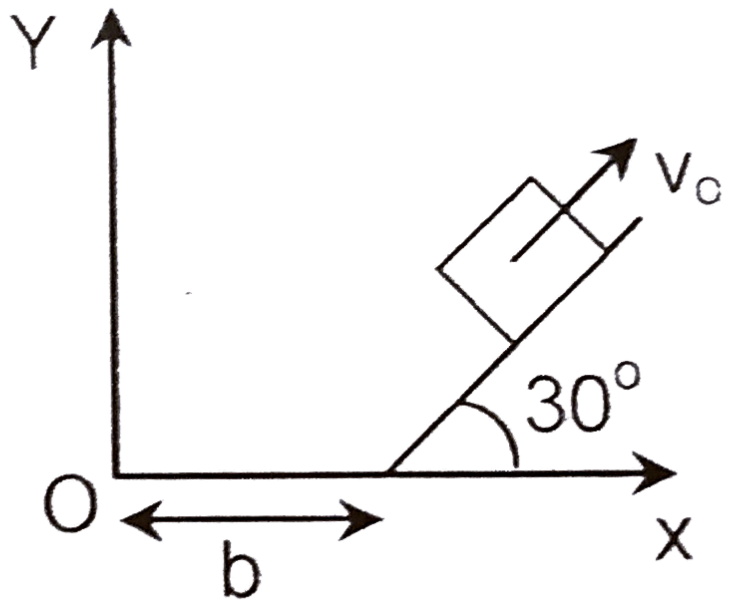
57. A cube of mass m and side a is moving along a plane with constant speed v_o as shown in figure. The magnitude of angular momentum of the cube about z -axis would be.



A. $\frac{mv_0 b}{2}$

B. $\frac{\sqrt{3} m v_0 b}{2}$

C. $m v_0 \left(b - \frac{a}{2}\right)$

D. none of these

Answer: D

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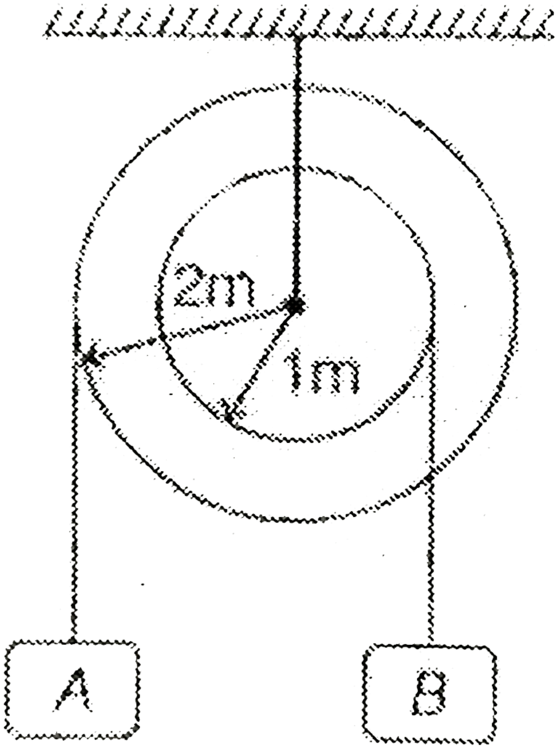
58. In the pully system shown, if radii of the bigger and smaller pulley are 2m and 1m respectively and the acceleration of block A is $5m/s^2$ in the downward direction, then the acceleration of block B will be



A. $0m / s^2$

B. $5m / s^2$

C. $10m / s^2$

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

Answer: D

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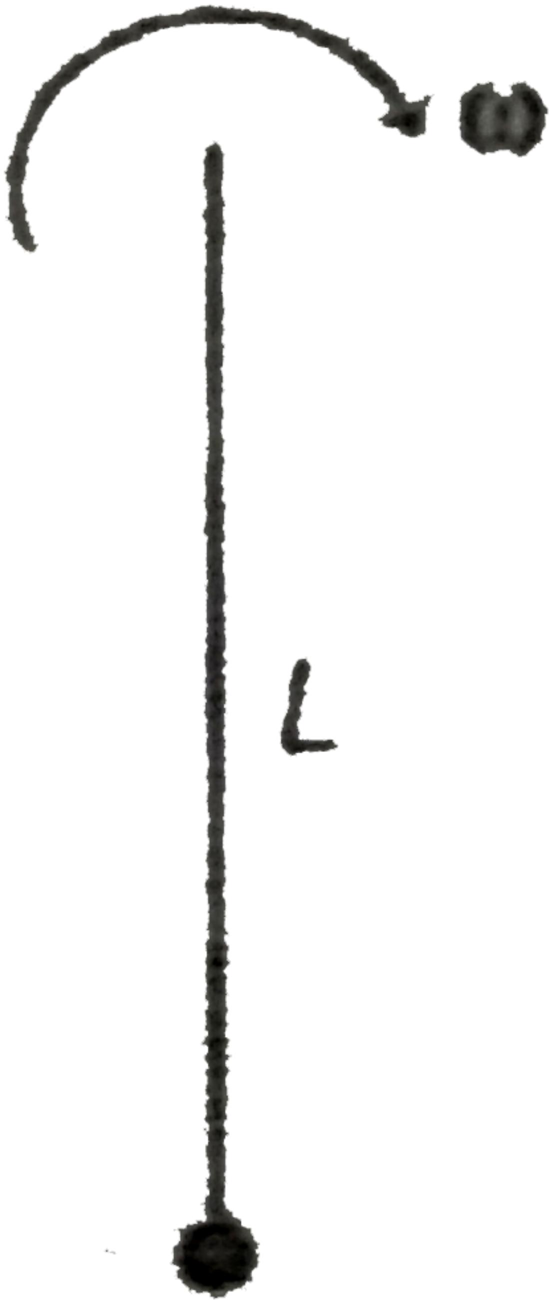
59. A uniform rod is hinged at its one end and is allowed to rotate in verticle plANE. Rod is given angular velocity ω in its verticle position as shown in figure. The value of ω for the force exerted by the hinge on rod is zero in this position is



ω
L

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

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

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

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

Answer: B

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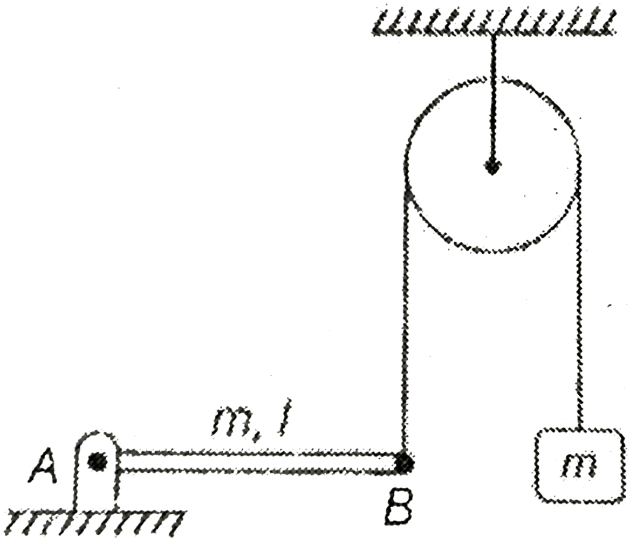
60. Uniform rod AB is hinged at the end A in the figure. The other end of the rod is connected to a block through a massless string as shown. The pulley is smooth and massless. Masses of the block and the rod are same and are equal to 'm'. Acceleration due to gravity is g. The tension in the thread and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



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

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

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

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

Answer: B

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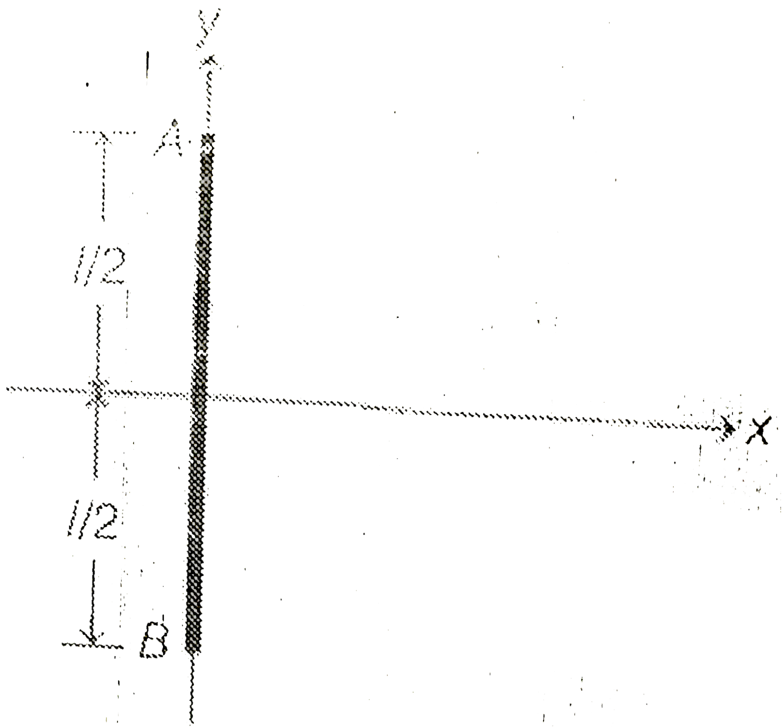
61. A uniform rod of mass m, length l is placed over a smooth horizontal surface along y -axis and is at rest as shown in figure. An impulsive force F is applied for a small time Δt along x-direction at point A. The x-coordinte of end A of the rod when the rod becomes parallel to x-axis for the first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



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

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

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

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

Answer: D

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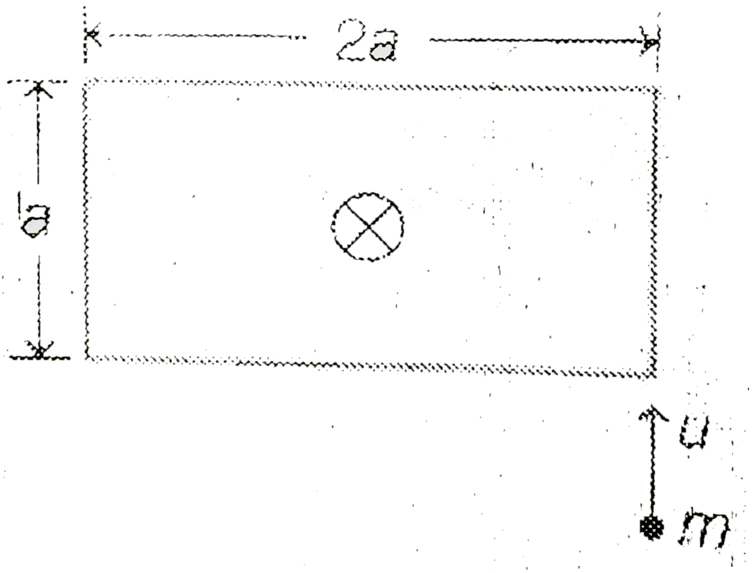
62. A uniform rectangular plate of mass m which is free to rotate about the smooth vwerticle hinge passing through the centre and perpendicular to the plate, is lying on a smooth horizontal surface. A particle of mass m is moving with speed 'u' collides with the plate and sticks to it as shown in figure. The angular velocity of the platye after colli9sion will be



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

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

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

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

Answer: D

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

A. 1 N

B. 2 N

C. $\sqrt{2}N$

D. $\sqrt{3}N$

Answer: C

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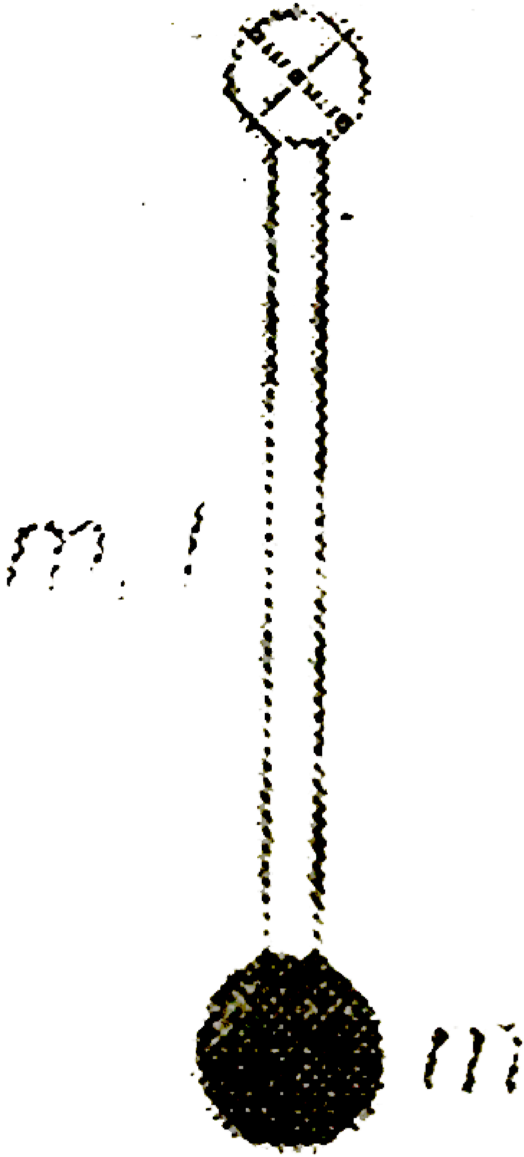
64. A particle is attached to the lower end of a uniform rod which is hinged at its other end as shown in the figure. Another identical particle moving horizontally, collides inelastically and sticks to it. The minimum speed of moving particle so that the rod with particle performs circular motion in a vertical plane will be: [length of the rod is l, consider masses of both particle and rod to be same]



A. $\sqrt{10gl}$

B. $\sqrt{20gl}$

C. $\sqrt{\frac{70}{3}gl}$

D. $\sqrt{\frac{175}{3}gl}$

Answer: C

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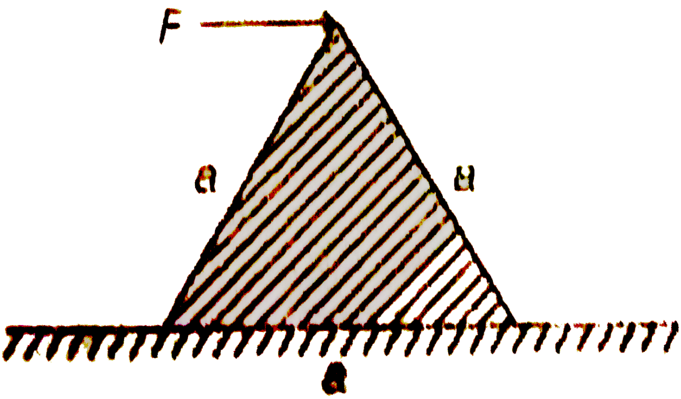
65. An equilateral prism of mass m rests on a rough horizontal surface with cofficent of friction μ. A horizontal force F is applied on the prism as shown in the figure. If the cofficent of the friction is sufficently high so that the prism does not slide before toppling, then the minimum force required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



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

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

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

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

Answer: A

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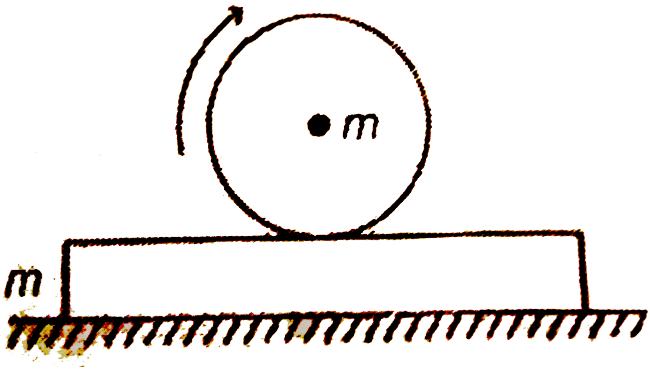
66. Choose the correct option:

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



A. (a) zero

B. (b) μg

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

D. (d) $2\mu g$

Answer: D

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

A. $20rad/s$

B. $10rad/s$

C. $30rad/s$

D. None of these

Answer: A

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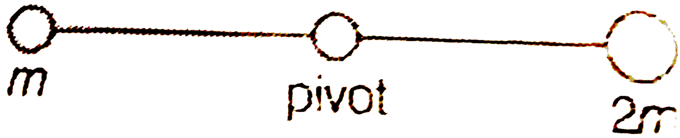
68. A rod of negligible mass and length l is pioveted at its centre. A particle of mass m is fixed to its left end and another particle of mass 2 m is fixed to the right end. If the system is released from rest and after sometime becomes verticle, The speed v of the two mases and angular velocity at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



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

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

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

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

Answer: A

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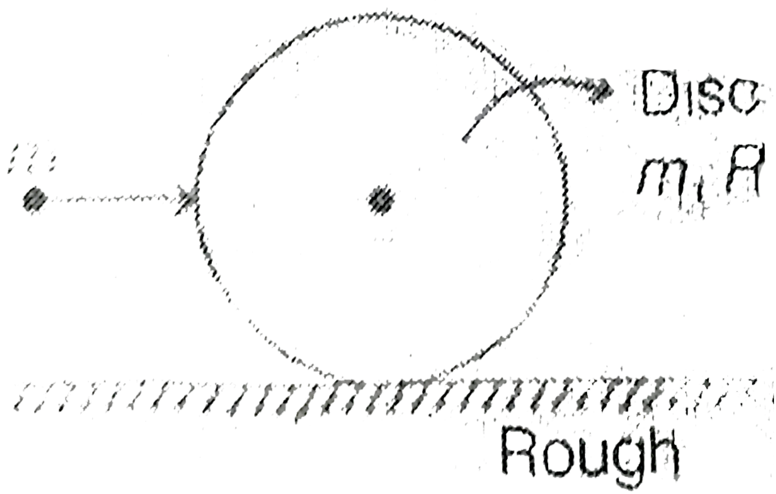
69. A point mass m collides with a disc of mass m and radius R resting on a rough horizontal surface as shown . Its collision is perfectly elastic. Find angular velocity of the disc after pure rolling starts



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

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

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

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

Answer: A

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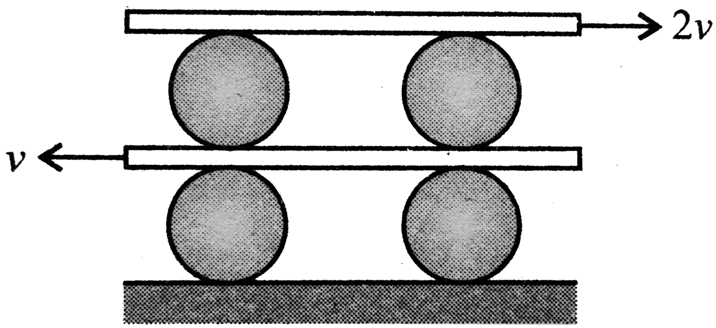
70. A system of identical cylinders and plates is shown in Fig. All the cylinders are identical and there is no slipping at any contact. The velocity of lower and upper plates are V and

$2V$, respectively, as shown in Fig. Then the ratio of angular speeds of the upper cylinders to lower cylinders is



A. (a) 3

B. (b) $\frac{1}{3}$

C. (c) 1

D. (d) $\frac{1}{2}$

Answer: A

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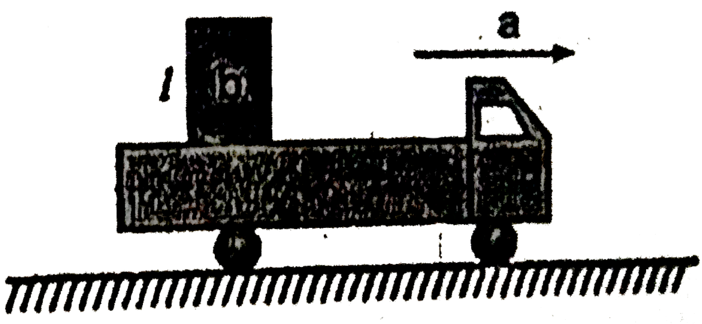
71. A box of dimensions l and b is kept on a truck moving with an acceleration a. if box does not slide, maximum acceleration for it to remain in equilibrium (w.r.t. truck) is



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

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

C. g

D. None of these

Answer: B

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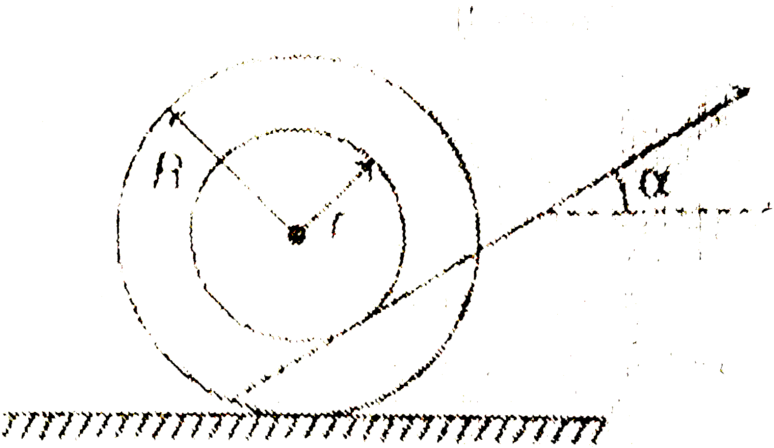
72. Choose the correct option:

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



A. (a) thread unwinds, spool rotates anticlockwise and friction leftwards

B. (b) thread winds, spool rotates clockwise and friction leftwards

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

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

Answer: B

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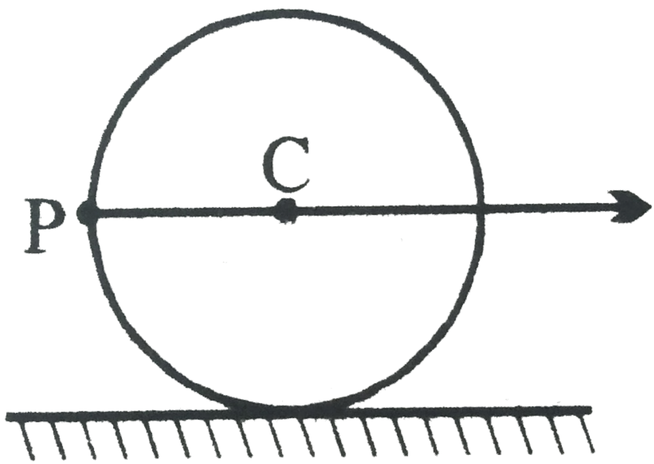
73. A disc of radius R is rolling purely on a flat horizontal surface, with a constant angular velocity. The angle between the velocity and acceleration vectors of point P is



A. Zero

B. 45°

C. 135°

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

Answer: B

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

A. $0.2N - m$

B. $2.0N - m$

C. $5.0N - m$

D. $10.0N - m$

Answer: C

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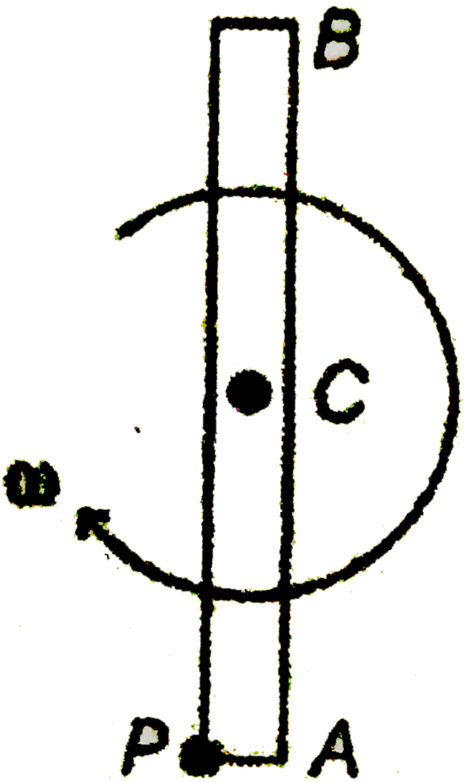
75. A rod lying on a frictionless horizontal surface is initially given an anglular velocity ω about vertical axis which passes through center of mass. The centre of mass is at rest but not fixed. The length of the rod is L. Subsequently, end A of the rod collides with nail P, which is near to A such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

Velocity of end B just after collision will be



A. ωL

B. $\omega L / 2$

C. $\omega L / 4$

D. $\omega L / 6$

Answer: C

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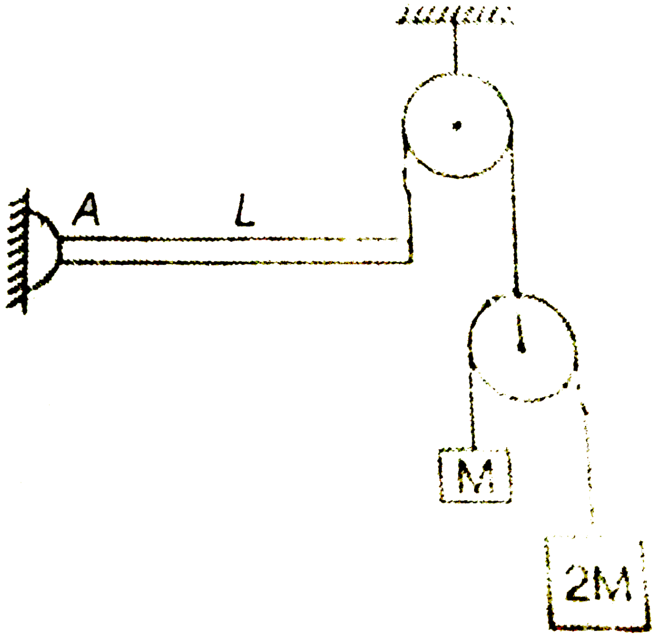
76. Consider the situation shown in the figure. Uniform rod of length L can rotat freely about the hinge A in vertical plane. Pulleys and stringa are light and frictionless. If the rod remains horizontal at rest when the system is released then the mass of the rod is



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

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

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

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

Answer: C

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

45 ∘

37 ∘

53 °

60 °

A. 45°

B. 37°

C. 53°

D. 60°

Answer: B

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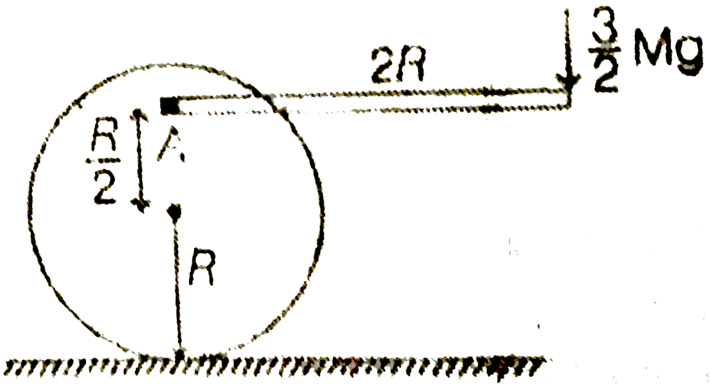
78. A disc of mass M and radius R is placed on a rough horizontald surface. A light rod of length 2R is fixed to the disc at pointt A as shown in figure and force $\frac{3}{2}$ Mg is applied at the other end of the rod. Find the minimum value of coefficient of friction (upto on decimal place) between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



A. 0.2

B. 0.4

C. 0.6

D. 0.8

Answer: D

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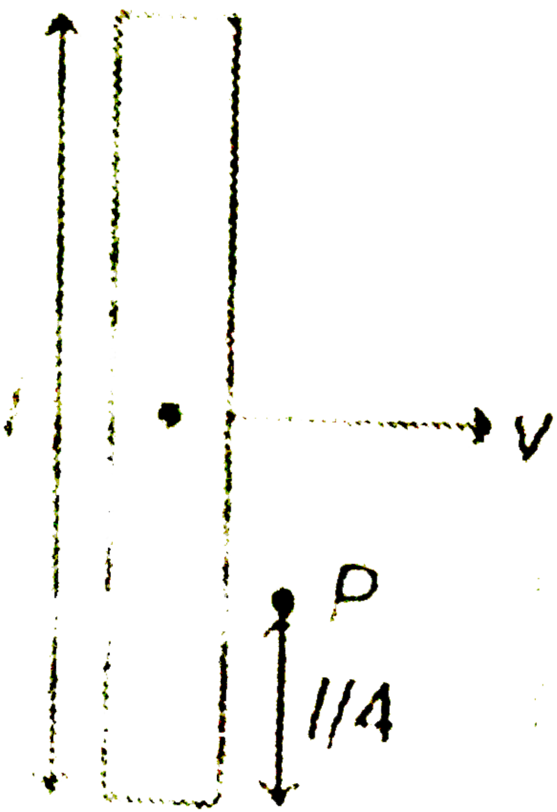
79. A uniform rod of mass m , length l moving with a velocity v (perpendicular to its length) on a smooth horizontal plane, encounters a fixed peg P at a distance l/4 from its nearer end. The rod collides with the peg. The duration of impact Δt is very small. The average force exerted by the peg on the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



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

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

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

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

Answer: A

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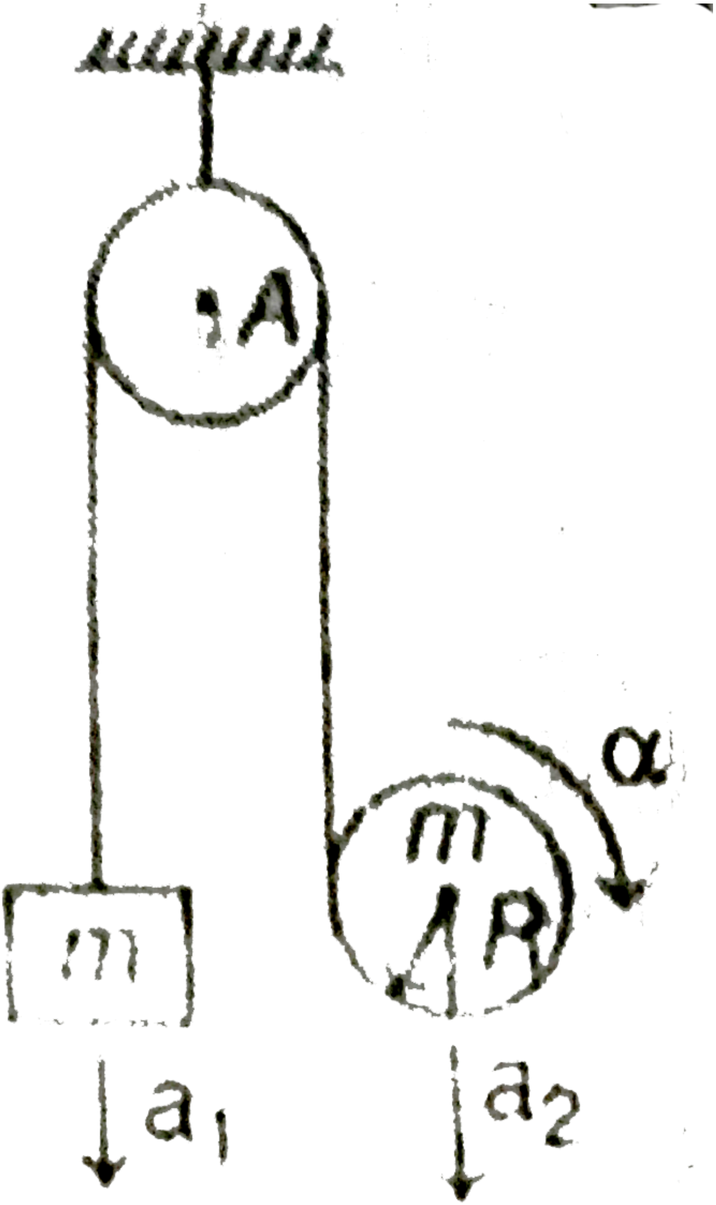
80. An ideal inextensible string is wrapped over the disc of mass m and radius R. The other end of the string is connected to mass

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



A. $a_1 = a_2$

B. $\alpha R > a_1$

C. $\alpha R > a_2$

D. $\alpha R < a_2$

Answer: D

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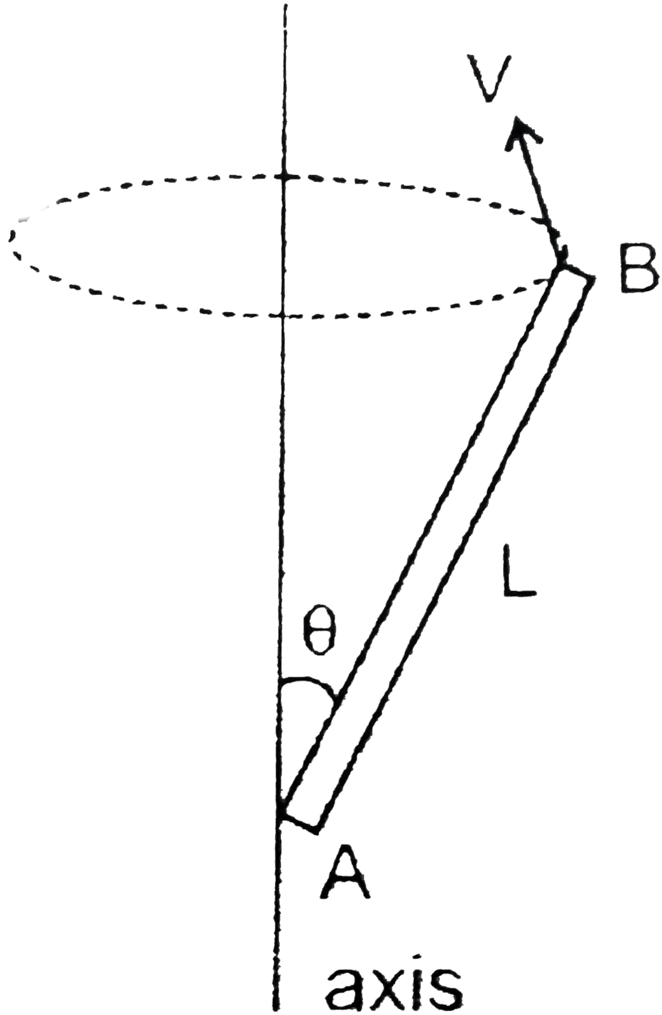

81.

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

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

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

C. $mvL \cos\theta$

D. none of these

Answer: A

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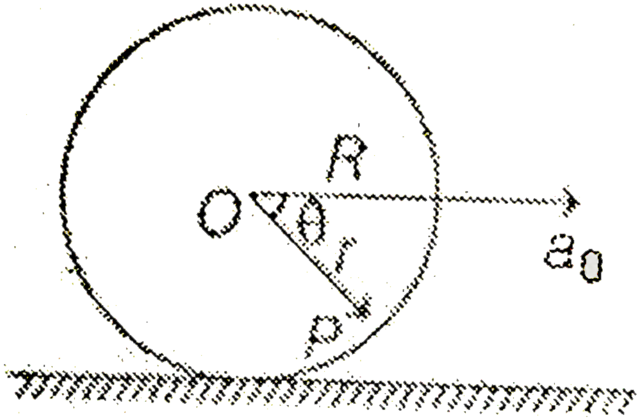
82. The wheel of radius R rolls wihtout slipping on horizontal rough surface and its centre O has an acceleration a_0 in forward direction. A point P on the wheel is a distance r from O and angular position θ from horizontal. Find the angle θ for which point P can have zero acceleration in this position .



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

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

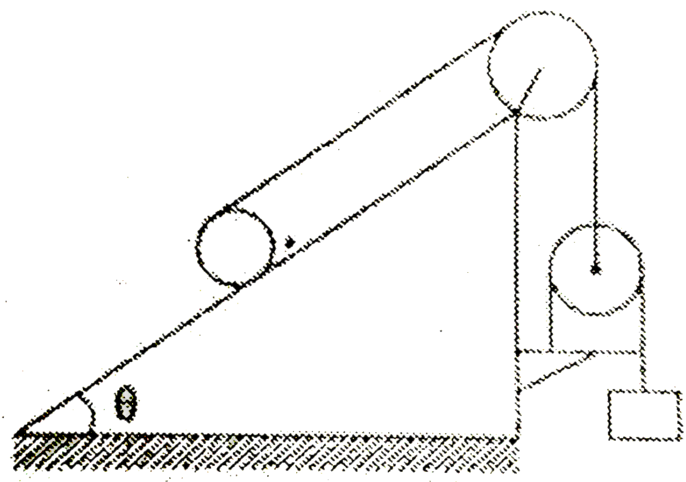
C. $\dfrac{\sin^{-1}(r)}{R}$

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

Answer: C

Watch Video Solution

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



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

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

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

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

Answer: B

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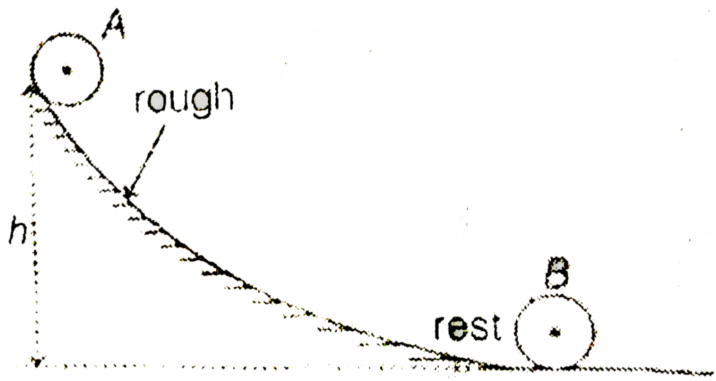
84. A small uniform solid sphere A rolls down a fixed surface starting at a height h and collides elastically with a sphere B which is identical in size to A but has twice its mass.

The speed of the sphere B, just after the collision is



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

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

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

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

Answer: D

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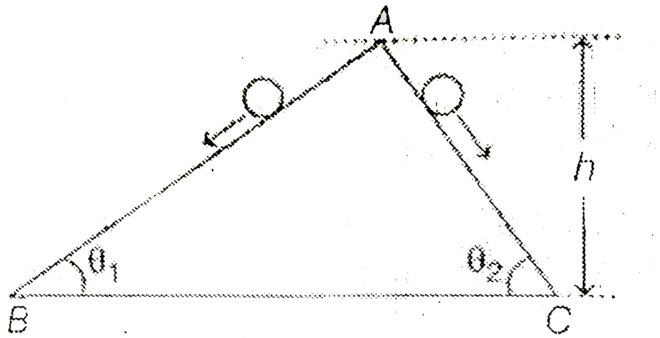
85. A small disc is released from rest at A on an inclined plane AB so that it rolls down without slipping. It reaches the bottom with linear velocity v_1 in time t_1. Next a small ring released form rest on the inclined plane AC so that it rolls down without slipping. It reaches the bottom with linear vlocity v_2 in time t_2.

Given $\theta_1 = 30^\circ, \theta_2 = 60^\circ$, and h=10m. Then,



A. $v_1 > v_2, t_1 < t_2$

B. $v_1 < v_2, t_1 > t_2$

C. $v_1 > v_2, t_1 > t_2$

D. $v_1 < v_2, t_1 < t_2$

Answer: C

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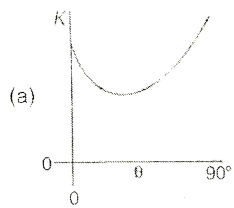
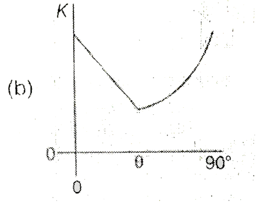
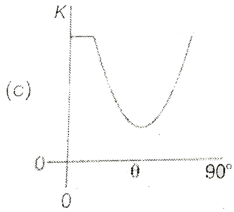
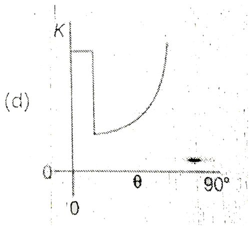
86. A solid ball is realeased from rest down inclines of various inclination angle θ but through a fixed vertical height h. The coefficient of static and kinetic friction are both equal to μ. Which of the following graph best represents the total kinetic energy K of the ball at the bottom of the incline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

A. 

B. 

C. 

D. 

Answer: C

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More than one option is correct

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

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

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

C. Friction force may or may be zero

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

Answer: B::C

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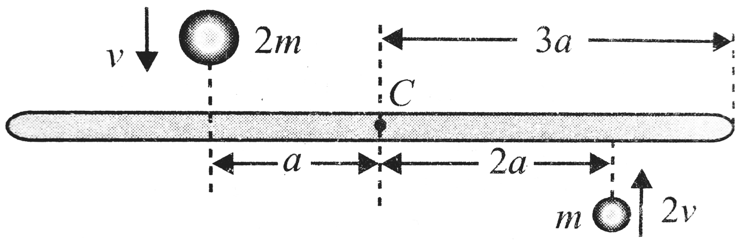
2. A uniform bar of length $6a$ and mass $8m$ lies on a smooth horizontal table. Two point masses m and $2m$ moving in the same horizontal plane with speeds $2v$ and v, respectively, strike the bar (as shown in the figure) and stick to the bar after collision. Denoting angular velocity (about the centre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



A. $v_c = 0$

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

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

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

Answer: A::C::D

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

A. $\omega \times v$

B. $v \times \omega$

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

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

Answer: A::C

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

A. L=constant

B. $L \neq \text{constant}$

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

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

Answer: A::D

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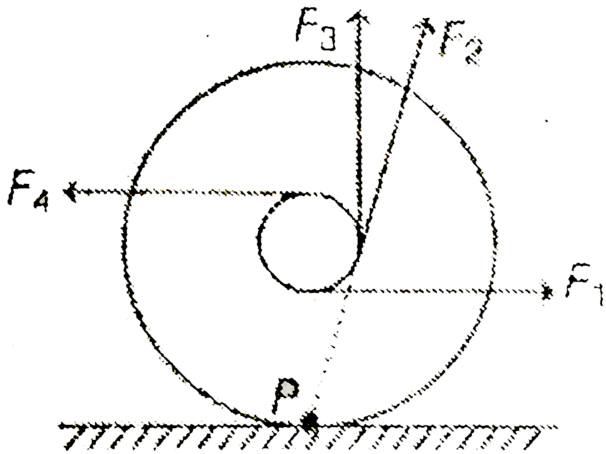
5. Choose the correct option:

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



A. (a) will rotate anticlockwise if F_1 is applied

B. (b) will not rotate if F_2 is applied

C. (c) will rotate anticlockwise if F_3 is applied

D. (d) will rotate clockwise if F_4 is applied

Answer: B::C

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

A. towards left if F_1 is applied

B. towards left if F_2 is applied

C. towards right if F_3 is applied

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

Answer: A::B::D

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

A. is constant

B. increases linearly with time

C. is 2F R t

D. decrease linearly with time

Answer: B::C

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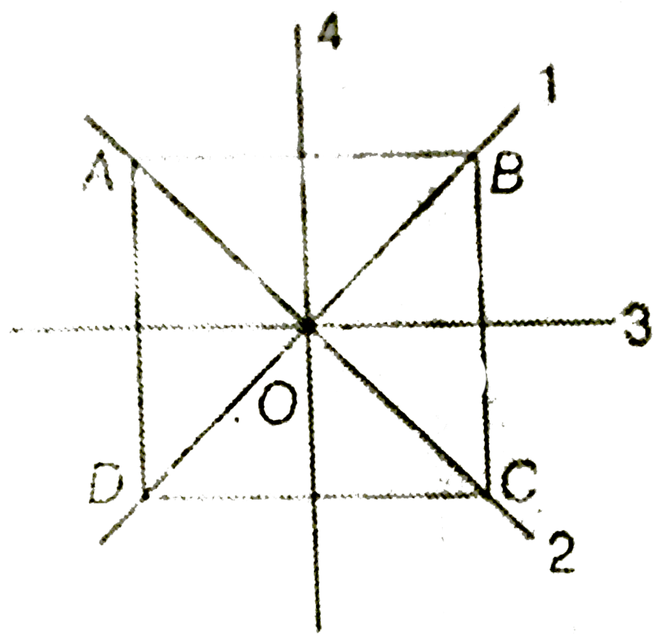
8. The moment of inertia of a thin square plate ABCD of uniform thickness about an axis passing through the centre O and perpendicular to plate is



A. $l_1 + l_2$

B. $l_2 + l_3$

C. $l_1 + l_3$

D. $l_3 + l_4$

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

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

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

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

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

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

Answer: A::D

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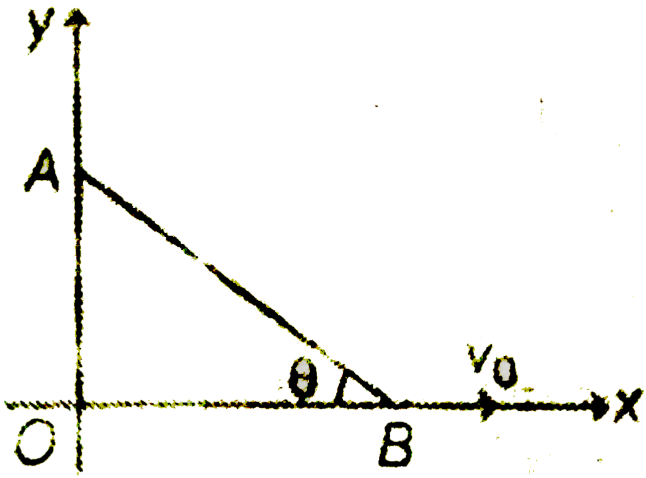
10. The end B of the rod AB which makes angle θ with the floor is being pulled with a constant velocity v_0 as shown. The length of the rod is l.

At the instant when $\theta = 37^\circ$



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

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

(C)angular velocity of rod is constant

(D)velocity of end A is constant

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

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

C. angular velocity of rod is constant

D. velocity of end A is constant

Answer: A::B::D

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

A. (a)rough inclined plane

B. smooth inclined plane

C. (c)rough horizontal surface

D. (d)smooth horizontal surface

Answer: A::C::D

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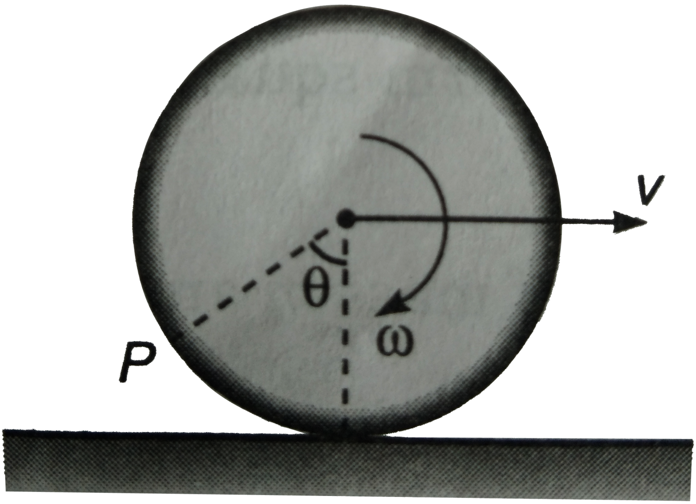
12. 

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

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

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

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

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

Answer: C::D

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

A. moment of inertia decreases

B. moment of inertia increases

C. radius of gyration increases

D. radius of gyration decreases

Answer: A::C

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

A. remaining disc remains unchanged

B. remaining disc decreases

C. remaining disc increases

D. broken away piece decrease initially and later

Answer: A::D

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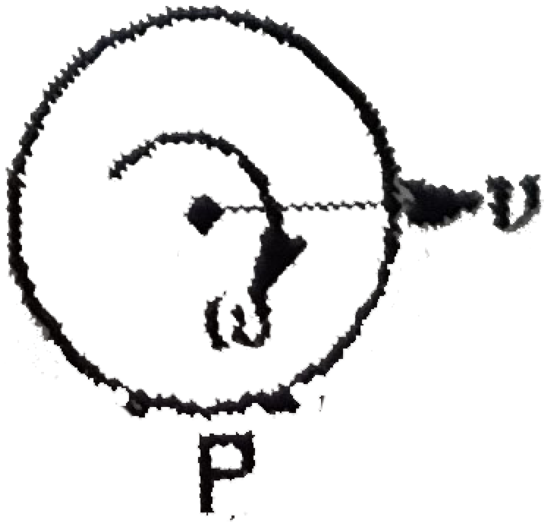
15. A spherical body of radius R rolls on a horizontal surface with linear velociltly v. Let L_1 and L_2 be the magnitudes of angular momenta of the body about centre of mass and point of contact P. Then:



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

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

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

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

Answer: A::C

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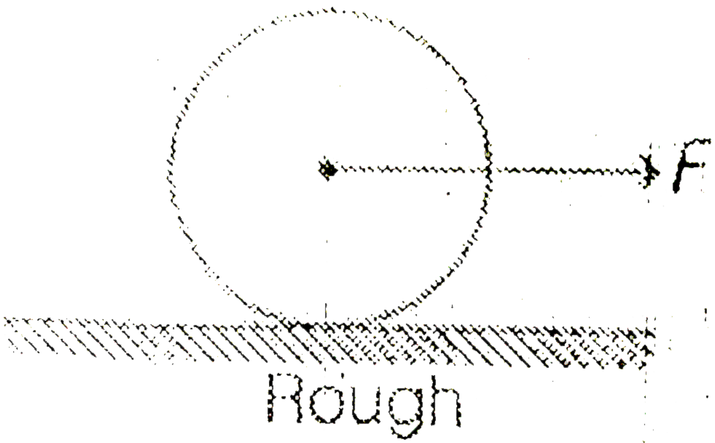
16. A solid cylinder of mass M and radius R pure rolls on a rough surface as shown in the figure. Choose the correct alternative (s).



A. The acceleration of the centre of mass is

$$\frac{F}{M}$$

B. The acceleration of the centre of mass is

$$\frac{2}{3}\frac{F}{M}$$

C. The friction force on the cylinder acts backward

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

Answer: B::C::D

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

(CM= centre of mass)

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

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

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

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

Answer: A::B

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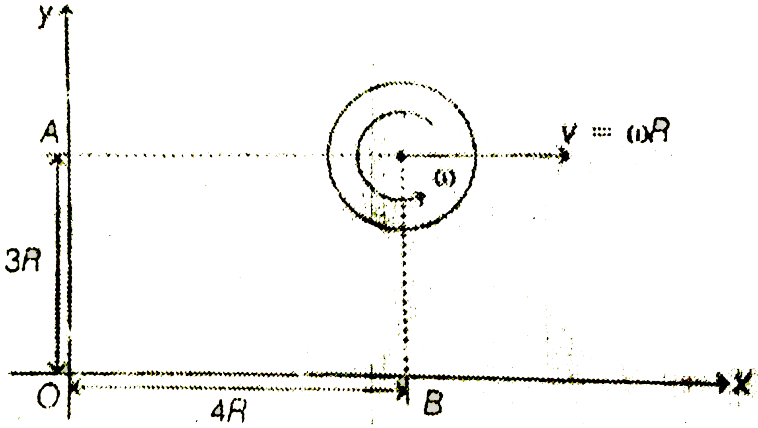
18. A disc of mass M and radius R moves in the x-y plane as shown in the figure. The angular momentum of the disc at tihe instant shows is



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

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

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

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

Answer: A::C

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

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

B. A and C is ma^2

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

D. O and parallel to CD is ma^2

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

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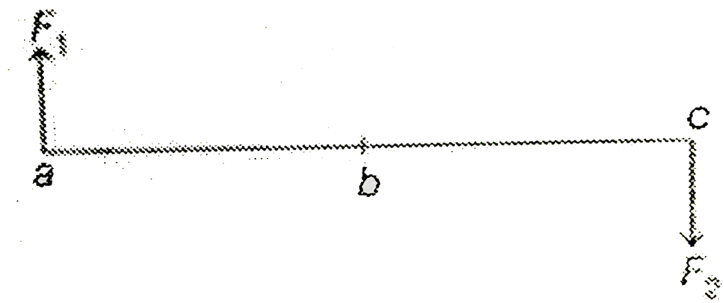
20. Two forces F_1 and F_2 are acting on a rod abc as shown in figure.



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

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

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

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

Answer: A::C

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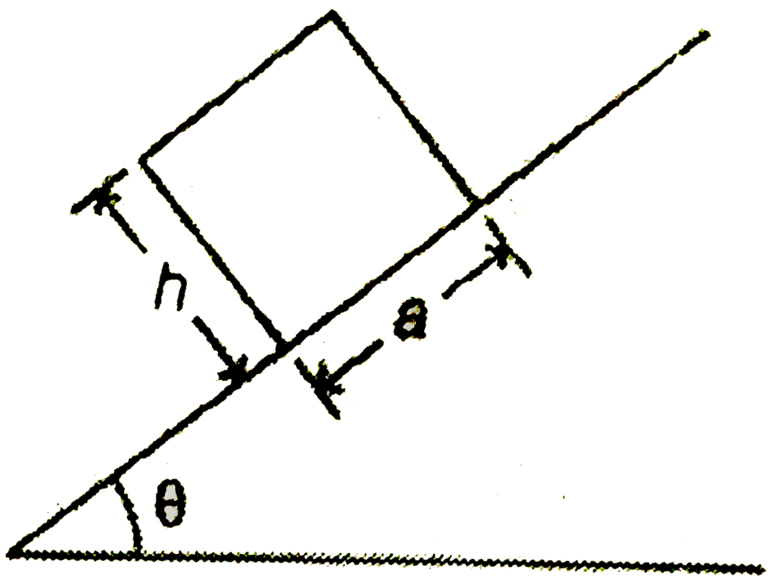
21. A block with a square base measuring $a \times a$ and height h, is placed on an inclined plane. The coefficient of friction is μ. The angle of inclination (θ) of the plane is gradually increased. The block will



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

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

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

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

Answer: A::D

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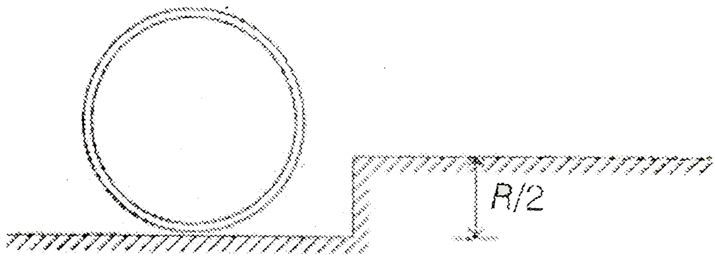
22. A wheel (to be considered as a ring) of mass m and radius R rolls without sliding on a horizontal surface with constant velocity v. It encounters a step of height R/2 at which it ascends without sliding



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

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

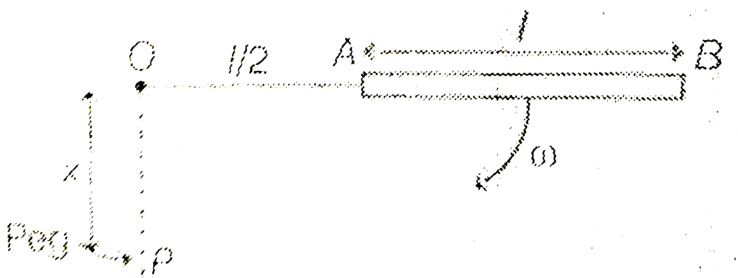
C. the normal reaction due to the step on the wheel increases as the wheel ascends.

D. the friction will be absent during the ascent.

Answer: A::B::C

Watch Video Solution

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



A. magnitude of angular momentum of rod

about O is $\frac{4}{3}l^2\omega$

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

C. Location of peg for rod coming to rest is

x $= \frac{13}{12}l$

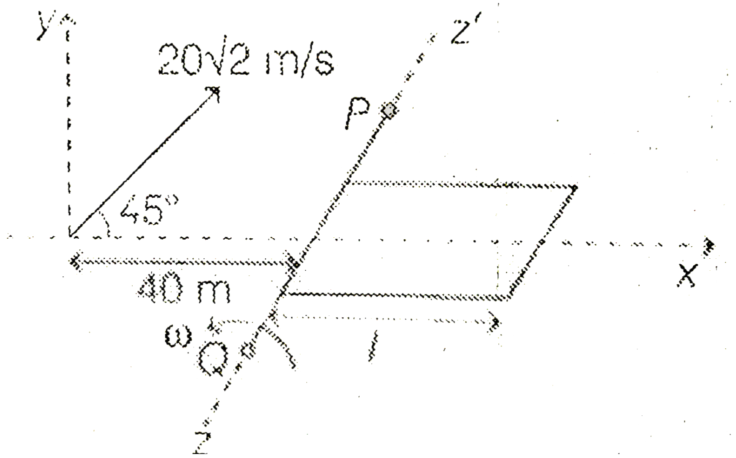
D. magnitude of angular impulse by peg on

the rod is $\frac{4}{3}l^2\omega$

Answer: B::C

Watch Video Solution

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



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

B. velocity of the ball just after collision with the plate is $10(2+\pi)$(SI unit)

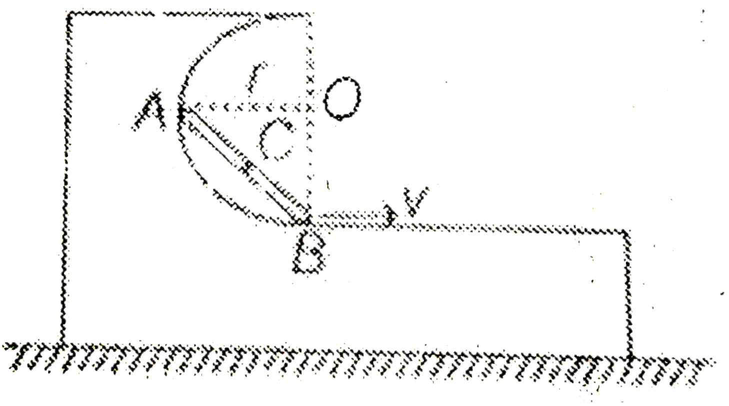
C. Distance of ball when it again collides on the ground surface from the projection point is 20π(SI unit)

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

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

Watch Video Solution

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



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

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

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

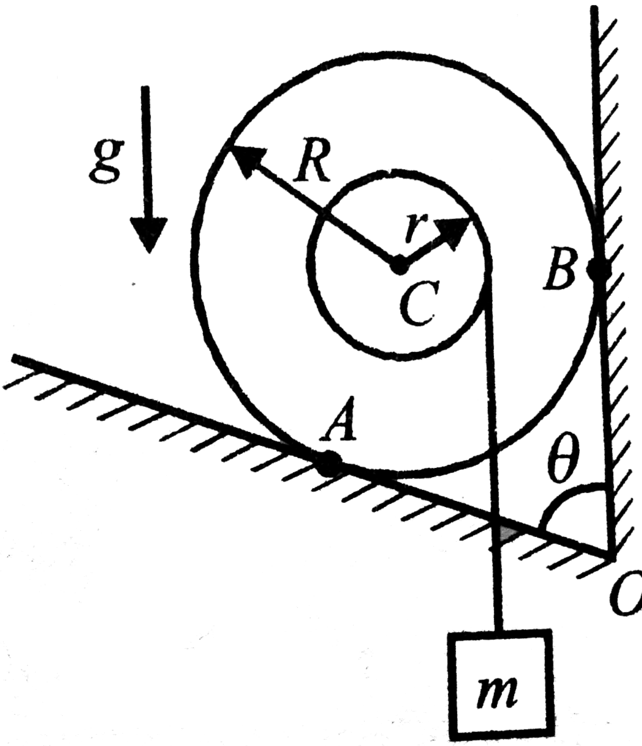
mvr

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

Answer: A::B::C

Watch Video Solution

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



A. The magnitude of force on the spool at

B in order ot maintain equilibrium is mg

$$\sqrt{\left(\frac{r}{R}\right)^2 + \left(1 - \frac{r}{R}\right)^2 \frac{1}{\tan^2\theta}}$$

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

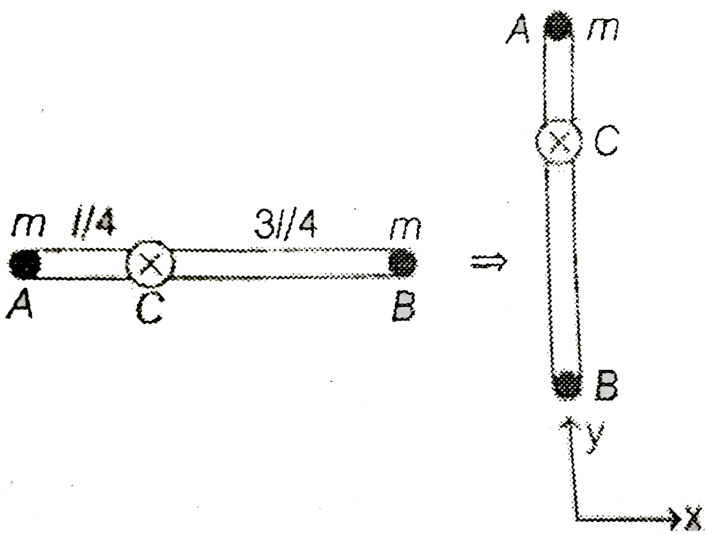
C. The minimum value of μ for the system to ramain in equilibrium is $\frac{\cot\theta}{(R/r)-1}$

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

Answer: A::D

Watch Video Solution

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



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

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

C. Angular acceleration of the system is zero.

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

Answer: A::B::C

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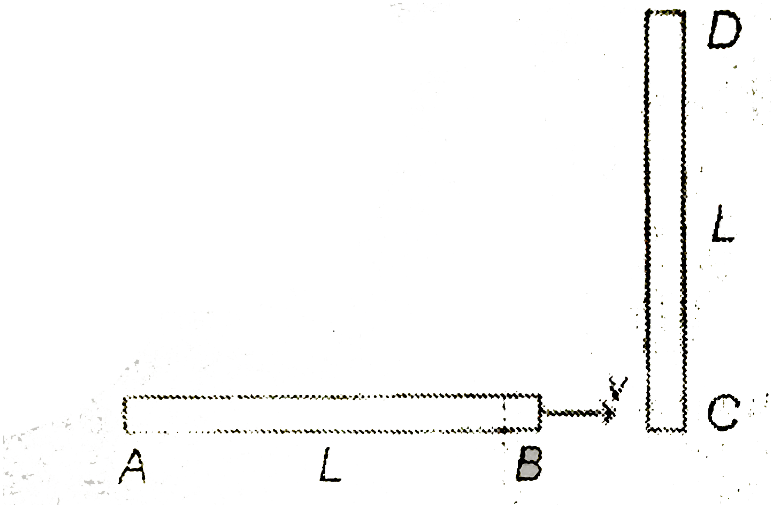
28. A rod CD of length L and mass m is placed horizontally on a frictionless horizontal surface as shown. A second identical rod AB which is also placed horizontally (perpendicular to CD) on the same horizontal surface is moving along the surface with a velocity v in a direction perpendicular to rod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



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

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

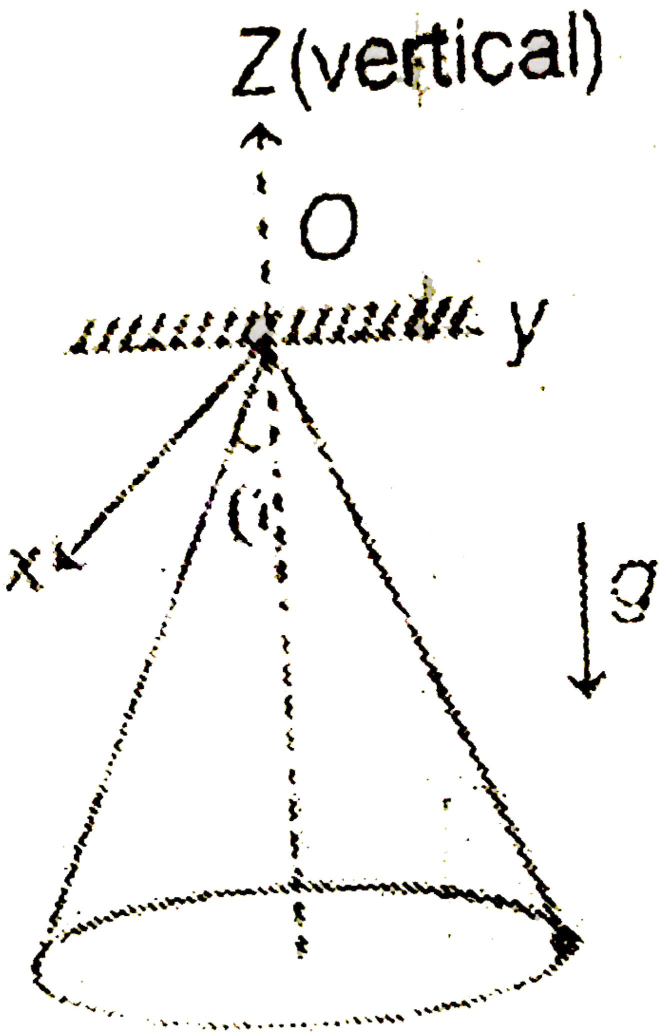
C. Velocity of centre of mass of the system just after collision is $\frac{v}{2}$

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

Answer: B::C

Watch Video Solution

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



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

B. magnitude of angular momentum about O remains constant

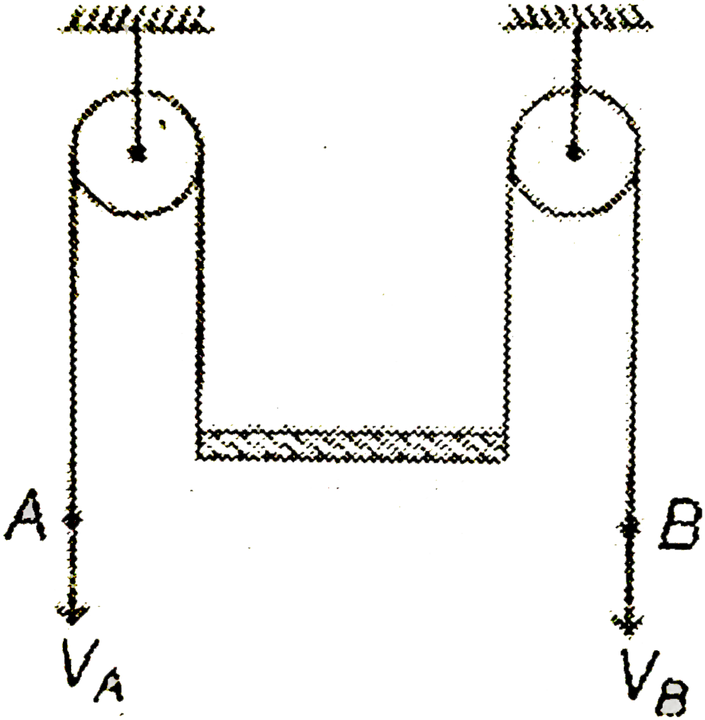
C. z component of the angular momentum remains conserved

D. z component of torque is always zero.

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

Watch Video Solution

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



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

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

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

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

Answer: A::B

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

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

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

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

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

Answer: A::C

Watch Video Solution

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

A. $v_0 = \omega R$

B. kinetic energy of the system is $\frac{11}{4} m v_0^2$.

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

D. $|v_C - v_B| = |v_B - v_D|$

Answer: A::B::D

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

A. angular momentum is equal to 5τ

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

C. angular momentum is equal to 2.5τ

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

Answer: A::D

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

A. Angular speed of the system just after the particle stick is $\frac{2mv_0d}{R^2(M+2m)}$

B. Mechanical energy is conserved

C. angular speed of the system just after the particle sticks is $\frac{mv_0d}{R^2(M+2m)}$

D. Mechanical energy is not conserved

Answer: A::D

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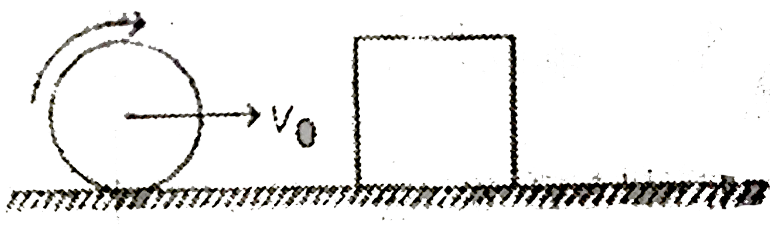
35. A cylinder is rolling towards a cube of same mass on rough horizontal surface (coefficient of friction = μ) with velocity v_0 as shown in figure. Assume elastic collision and friction is negligible between cube and cylinder. Then after collision



A. Cylinder will stop permanently

B. Cylinder will stop and then move towards right.

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

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

Answer: B::D

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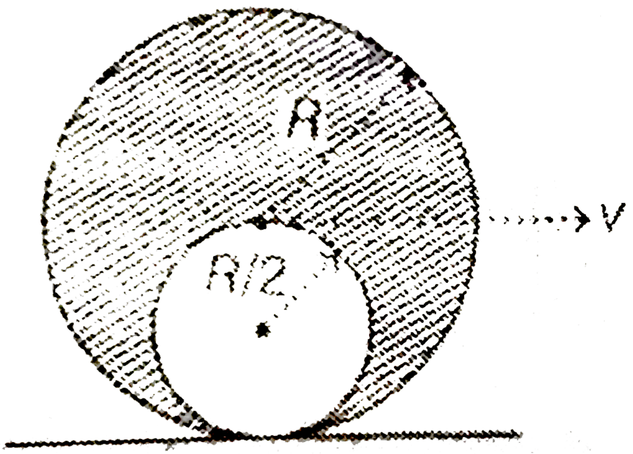
36. A uniform solid cylinder of radius 'R' has a circular cut of radius $\frac{R}{2}$ from the edge, Its mass is M. It is rolling wihtout slipping on a rough horizontal floor. When the cut part is at lowest position, centre of the disc is moving with horizontal velocity v. Choose the alternative:



A. Total kinetic energy at this moment is

$$\frac{15}{16}Mv^2$$

B. Total kinetic energy at this moment is

$$\frac{15}{9}Mv^2$$

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

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

Answer: A::D

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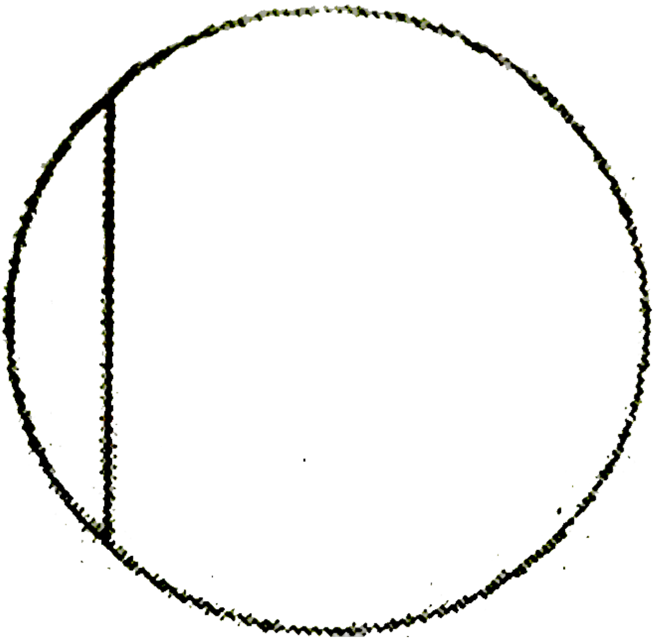
Comprehension Type Questions

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

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



A. 4.6

B. 5.8

C. 3.2

D. 7.2

Answer: C

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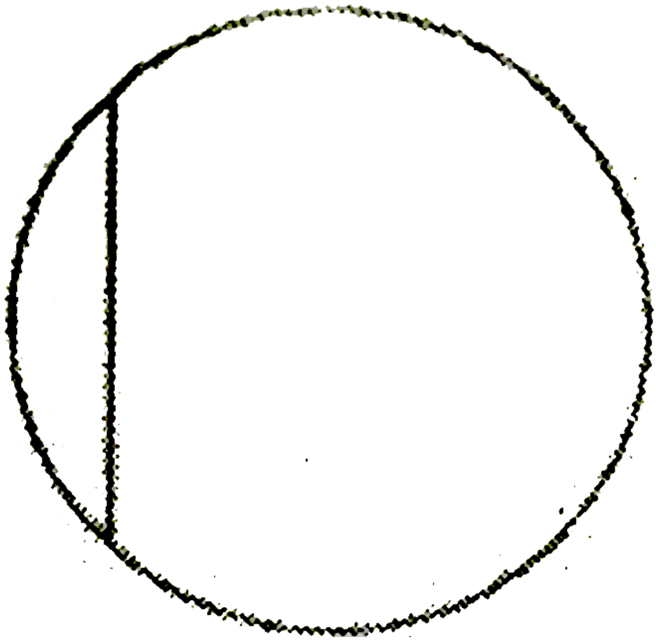
2. A rod of length 2 m is kept vertical inside a smooth spherical shell of radius 2m. The rod starts slipping inside the shell . Mass of the rod is 4 kg.

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



A. 5.5

B. 6.2

C. 3.2

D. 10.2

Answer: A

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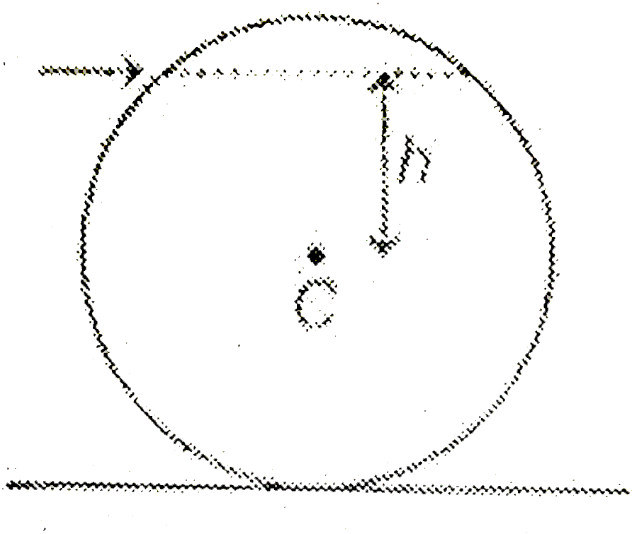
3. A solid sphere is kept over a smooth surface as shown in figure. It is hit by a cute at height h above the centre C.



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

A. $k_1 = k_2$

B. $k_1 > k_2$

C. $k_1 < k_2$

D. Data is sufficient

Answer: C

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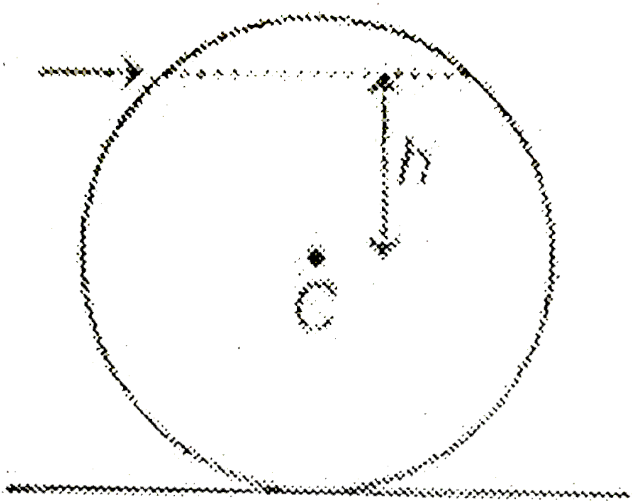
4. A solid sphere is kept over a smooth surface as shown in figure. It is hit by a cute at height h above the centre C.



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

A. In case 1

B. In case 2

C. In both the cases

D. In none of the cases

Answer: B

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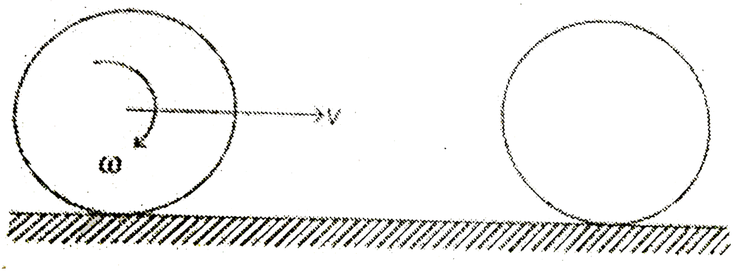
5. A solid sphere is rolling without slipping on rough ground as shown in figure. If collides elastically with an identical another sphere at rest. There is no friction between the two spheres . Radius of each sphere is R and mass is m.



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

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

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

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

D. $\frac{7}{5}\omega R$

Answer: B

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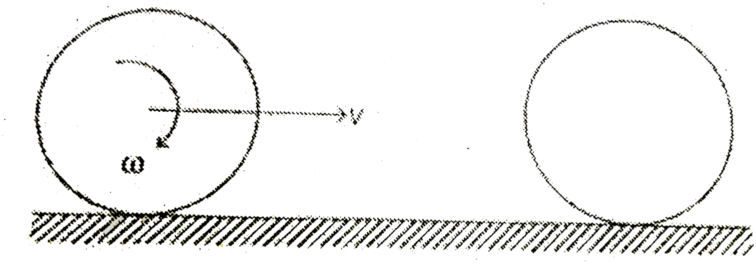
6. A solid sphere is rolling without slipping on rough ground as shown in figure. If collides elastically with an identical another sphere at rest. There is no friction between the two spheres . Radius of each sphere is R and mass is m.



What is the net angular impulse imparted to second sphere by the external forces?

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

B. $\frac{5}{7}mRv$

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

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

Answer: A

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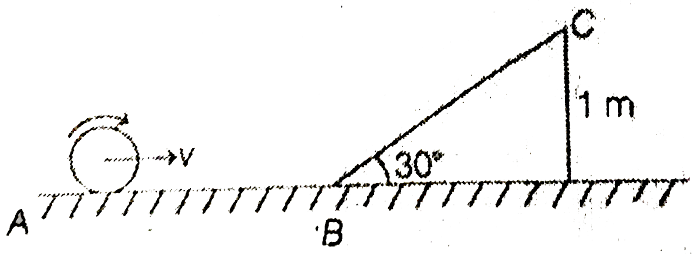
7. A small sphere of mass 1 kg is rolling without slipping with linear speed

$v=\sqrt{\frac{200}{7}}m/s$



It leaves the inclined plane at point C.

Find the linear speed at point C.

A. $\sqrt{\frac{100}{7}}$ m/s

B. $\sqrt{\frac{50}{7}}$ m/s

C. $\sqrt{\frac{100}{35}}$ m/s

D. $\sqrt{\frac{200}{35}}$ m/s

Answer: A

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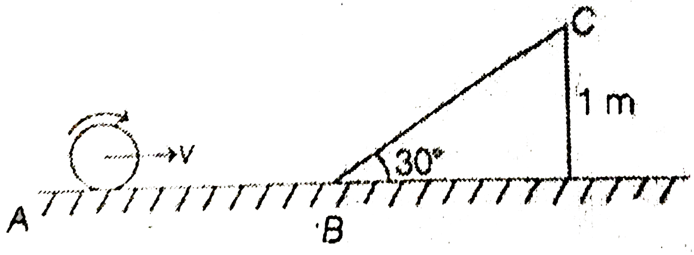
8. A small sphere of mass 1 kg is rolling without slipping with linear speed

$$v = \sqrt{\frac{200}{7}} m / s$$



It leaves the inclined plane at point C.

Find ratio of rotational and translational kinetic energy of the sphere when it strikes the ground after leaving from point C.

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

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

C. $\frac{1}{6}$

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

Answer: C

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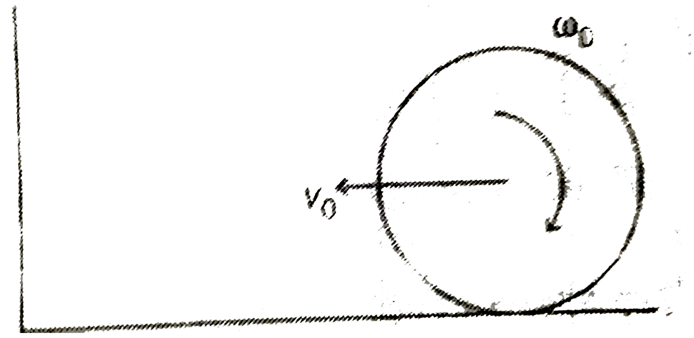
9. A solid sphere has linear velocity $v_0 = 4$ m/s and angular velocity $\omega_0 = 9$ rad/s as shown. Ground on which it is moving , is smooth . It collides elastically with a rough wall of coefficient of friction μ . Radius of the sphere is 1m and mass is 2 kg .



If the sphere after colliding with the wall rolls without slipping on opposite direction, then coefdicient of friction μ is

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

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

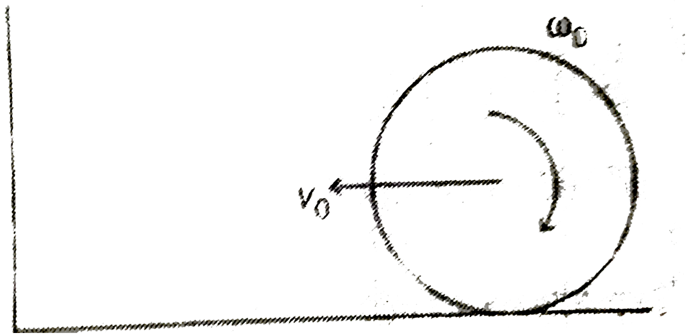
C. $\frac{1}{3}$

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

Answer: D

Watch Video Solution

10. A solid sphere has linear velocity $v_0 = 4$ m/s and angular velocity $\omega_0 = 9$ rad/s as shown. Ground on which it is moving , is smooth . It collides elastically with a rough wall of coefficient of friction μ . Radius of the sphere is 1m and mass is 2 kg .



What is net linear impulse imparted by the wall on the sphere during impact ?

A. a. $\sqrt{32}N - s$

B. b. $4\sqrt{17}N - s$

C. c. $4\sqrt{5}N - s$

D. d. $15\sqrt{2}N - s$

Answer: B

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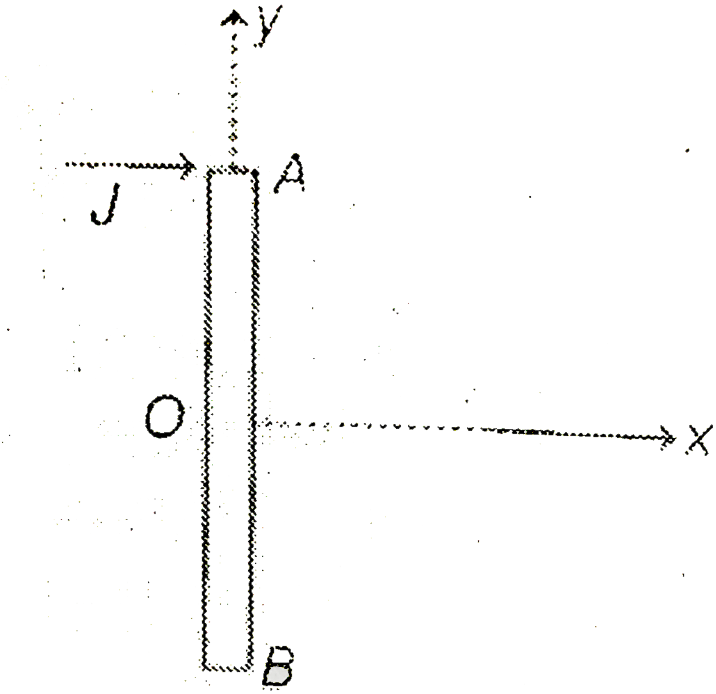
11. A rod AB of length 2 m and mass 2 kg is lying on a smooth horizontal x-y plane with its centre at origin O as shown in figure. An impulse J of magnitude 10 N-s is applied perpendicular to AB at A.



The distance of point P from centre of the rod which is at rest just after impact is

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

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

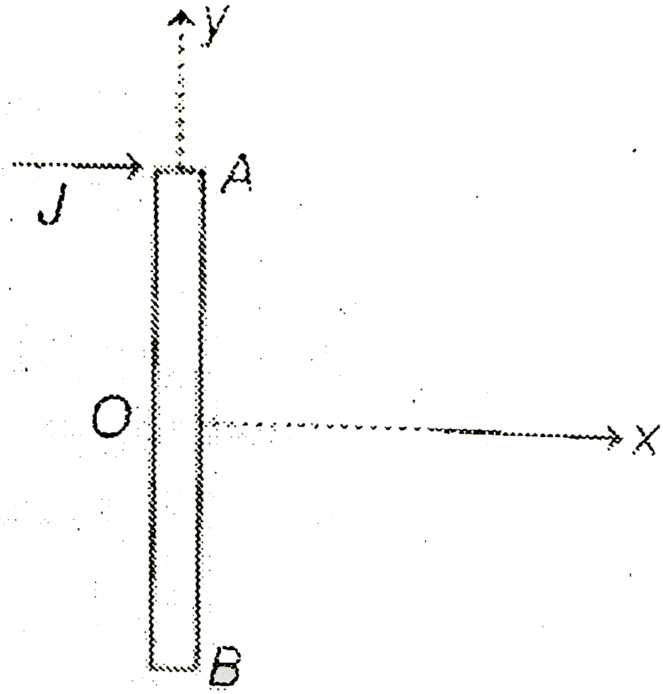
C. $\frac{1}{2}$ m

D. $\frac{1}{4}$m

Answer: B

Watch Video Solution

12. A rod AB of length 2 m and mass 2 kg is lying on a smooth horizontal x-y plane with its centre at origin O as shown in figure. An impulse J of magnitude 10 N-s is applied perpendicular to AB at A.



Co-ordinates of point A of the rod after time t

$= \frac{\pi}{45}$ s will be

A. $\left[\left(\frac{\pi}{9} + \frac{\sqrt{3}}{2}\right)m, \frac{1}{2}m\right]$

B. $\left[\frac{3}{4}m \quad \frac{3}{2}m\right]$

C. $\left[\left(\frac{\pi}{6} + \frac{1}{2}\right)m, \frac{1}{2}m\right]$

D. $\left[\frac{1}{2}m, \frac{1}{2}m\right]$

Answer: A

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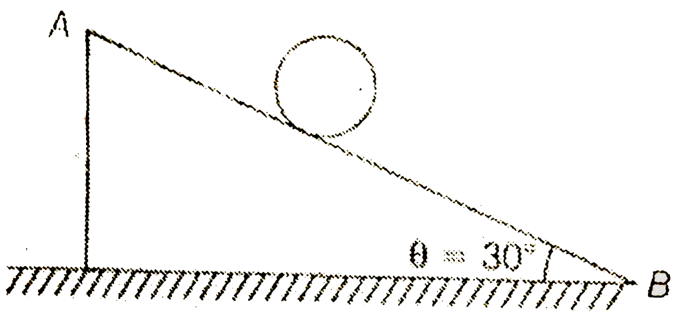
13. Length AB in the figure shown in 5 m. The body is released from A. Friction is sufficient for pure rolling to take place.



The maximum time which anybody (which can roll) can take to reach the bottom is

A. 8 s

B. 6s

C. 2 s

D. 4 s

Answer: C

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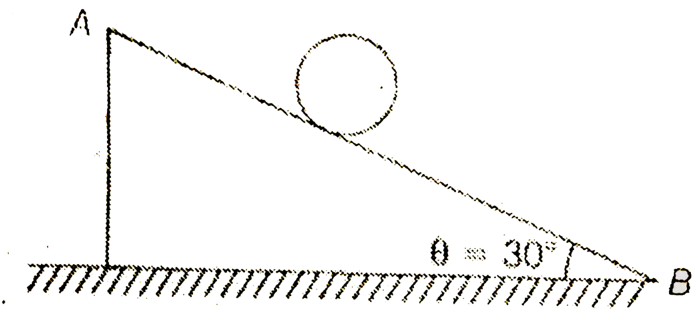
14. Length AB in the figure shown in 5 m. The body is released from A. Friction is sufficient for pure rolling to take place.



In the above case suppose we have four bodies ring, disc, solid sphere and hollow sphere. The angle θ is now gradually increased. Which body will start slipping very fast. All the bodies have same mass and radius. Coefficient of friction is also same ?

A. Ring

B. Disc

C. Solid sphere

D. Hollow sphere

Answer: A

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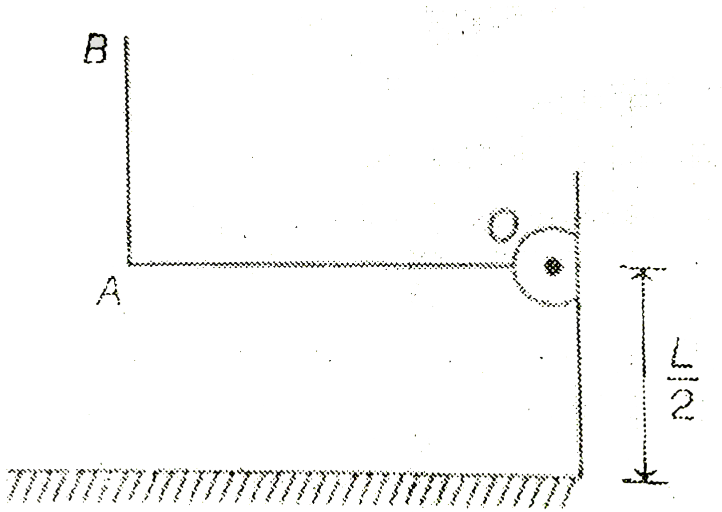
15. An L shaped frame is free to rotate in a vertical plane about a horizontal axis passing through a smooth hinge O. Each side of the frame has a length L and mass m. Frame is let to fall with one side horizontal and the other vertical.



Angular acceleration of the frame just after it is allowed to fall is

A. $\dfrac{4g}{3L}$

B. $\dfrac{9g}{10L}$

C. $\dfrac{g}{2L}$

D. $\dfrac{3g}{2L}$

Answer: B

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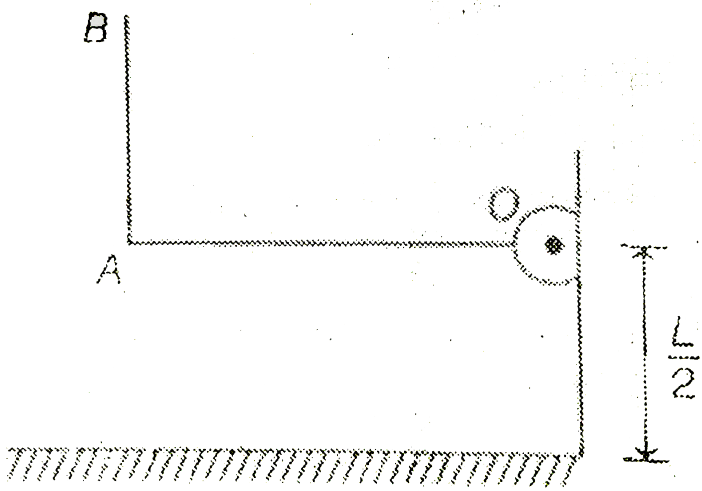
16. An L shaped frame is free to rotate in a vertical plane about a horizontal axis passing through a smooth hinge O. Each side of the frame has a length L and mass m. Frame is let to fall with one side horizontal and the other vertical.



With what speed the end A will strike the ground ?

A. $\sqrt{gL}$

B. $2\sqrt{gL}$

C. $3.2\sqrt{gL}$

D. $1.6\sqrt{gL}$

Answer: A

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17. Moment of inertia of a straight wire about an axis perpendicular to the wire passing through one of its end is I.

This wire is now framed into a circle (a ring) of single turn. The moment of inertia of this ring about an axis passing through centre and perpendicular to its plane would be

A. $\left(\frac{3}{\pi^2}\right)l$

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

C. $\left(\frac{\pi^2}{3}\right)l$

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

Answer: B

Watch Video Solution

18. Moment of inertia of a straight wire about an axis perpendicular to the wire passing through one of its end is I.

Now the same wire is bent into a ring of two turns , then the moment of inertia would be

A. $\left(\frac{\pi^2}{3}\right)l$

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

C. $\left(\frac{3}{16\pi^2}\right)l$

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

Answer: C

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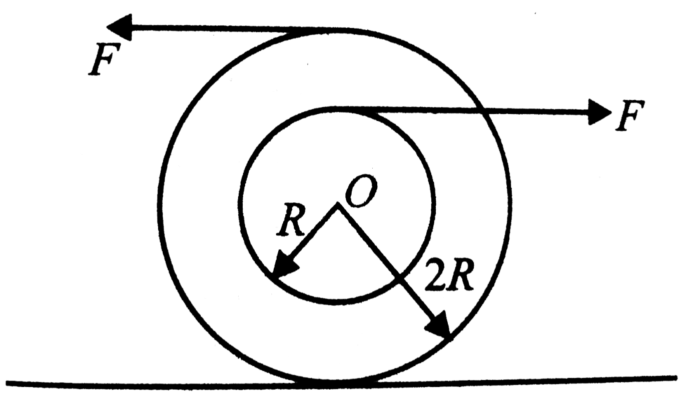
19. In the given figure $F = 10N$, $R = 1m$, mass of the body is $2kg$ and moment of inertia of the body about an axis passing through O and perpendicular to the plane of the body is $4kgm^2$. O is the centre of mass of the body.



If the ground is smooth, what is the total kinetic energy of the body after $2s$?

A. 25 J

B. 50 J

C. 16.67 J

D. 100 J

Answer: B

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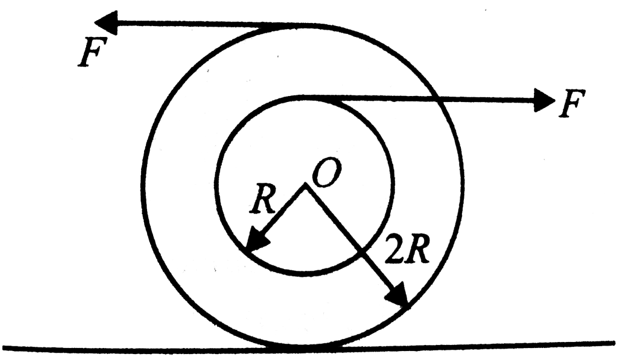
20. In the given figure $F = 10N$, $R = 1m$, mass of the body is $2kg$ and moment of inertia of the body about an axis passing through O and perpendicular to the plane of the body is $4kgm^2$. O is the centre of mass of the body.



If the ground is sufficiently rough to ensure rolling, what is the kinetic energy of the body now in the given time interval of $2s$?

A. 10.33 J

B. 25.67 J

C. 16.67 J

D. None of these

Answer: C

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21. A rod of mass m and length l in placed on a smooth table. An another particle of same mass m strikes the rod with velocity v_0 in a direction perpendicular to the rod at distance $x(<l/2)$ from its centre . Particle sticks to the end. Let ω be the angular speed of system after collision , then

As x is increased from 0 to l/2 , the angular speed ω.

A. will continuously increase

B. will continuously decrease

C. will first increase and then decrease

D. will first increase and then decrease

Answer: C

Watch Video Solution

22. A rod of mass m and length l in placed on a smooth table. An another particle of same mass m strikes the rod with velocity v_0 in a direction perpendicular to the rod at distance $x(< l/2)$ from its centre . Particle sticks to the end. Let ω be the angular speed of system after collision , then

Find the maximum possible value of impulse (by varying x) that can be imparted to the particle during collision. Particle still sticks to the rod.

A. $\frac{mv_0}{2}$

B. $\frac{2mv_0}{3}$

C. $\frac{3mv_0}{4}$

D. $\frac{4mv_0}{5}$

Answer: A

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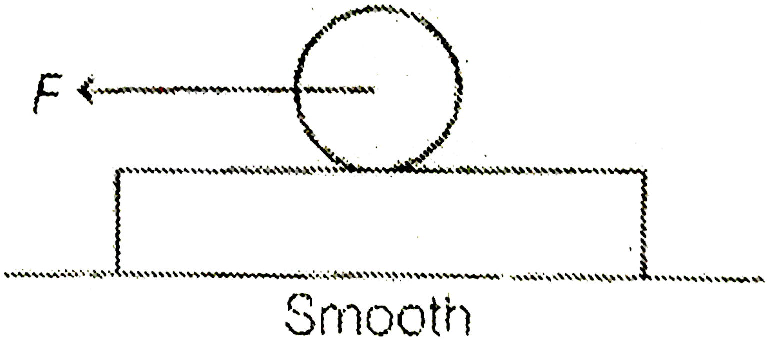
23. A disc of mass m and radius R is placed over a plank of same mass m. There is sufficient friction between disc and plank to prevent slipping. A force F is applied at the centre of the disc.



Acceleration of the plank is

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

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

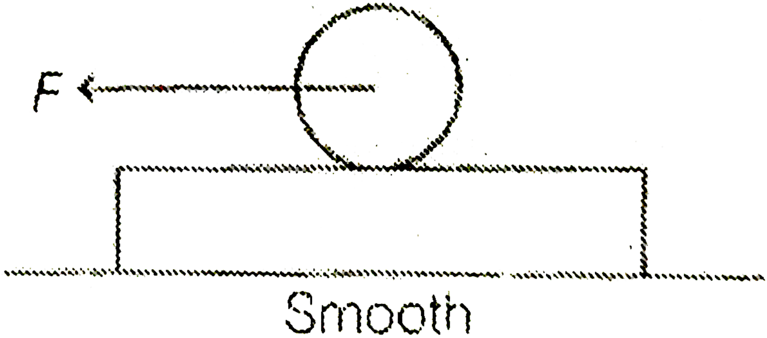
C. $\frac{F}{4m}$

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

Answer: C

Watch Video Solution

24. A disc of mass m and radius R is placed over a plank of same mass m. There is sufficient friction between disc and plank to prevent slipping. A force F is applied at the centre of the disc.



Force of friction between the disc and the plank is

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

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

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

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

Answer: B

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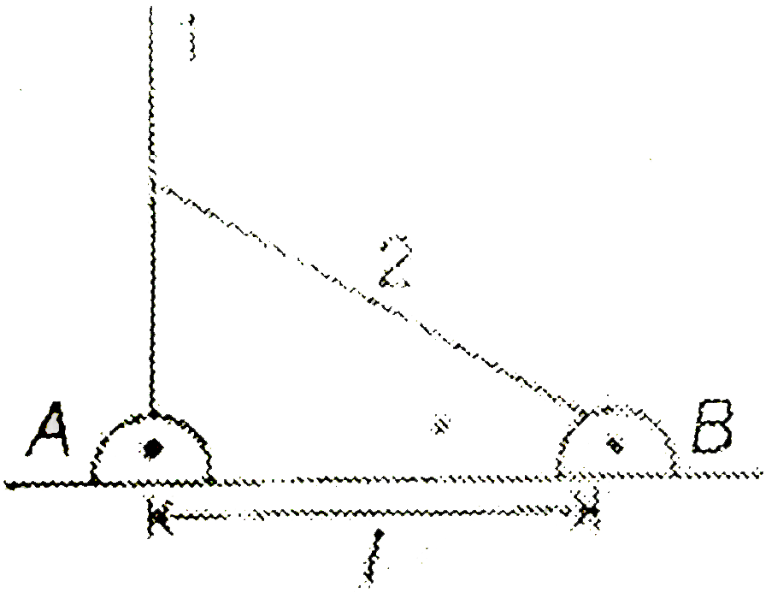
25. Two rod 1 and 2 are released from rest as shown in figure . Given, $l_1 = 4l, m_1 = 2m, l_2 = 2l \text{and } m_2 = m.$ There is no friction between the two rods . If α be the angular acceleration of rod 1 just after the rods are released . Then,

What is the normal reaction between the two rods at this instant ?



A. $16\sqrt{3}m/\alpha$

B. $\frac{4m/\alpha}{\sqrt{3}}$

C. $\frac{32m/\alpha}{3\sqrt{3}}$

D. $12\sqrt{3})m/\alpha$

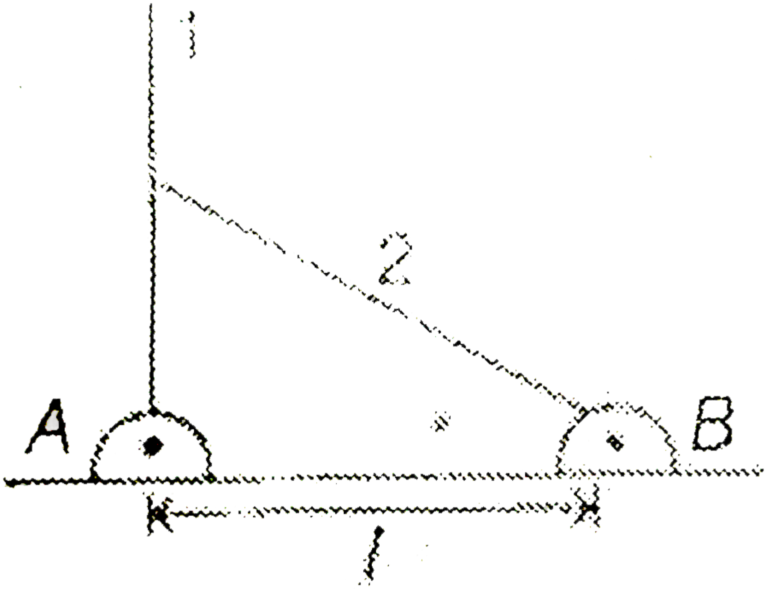
Answer: C

Watch Video Solution

26. Two rod 1 and 2 are released from rest as shown in figure . Given, $l_1 = 4l, m_1 = 2m, l_2 = 2l \text{and } m_2 = m$. There is no friction between the two rods . If α be the angular acceleration of rod 1 just after the rods are released . Then,

What is the horizontal force on rod 1 by hinge.

A at this instant ?



A. $\left(\dfrac{32-12\sqrt{3}}{3\sqrt{3}}m/\alpha\right.$

B. $\left(\dfrac{16-2\sqrt{3}}{\sqrt{3}}m/\alpha\right.$

C. $(14+2\sqrt{3})m/\alpha$

D. $\sqrt{3}m/\alpha$

Answer: A

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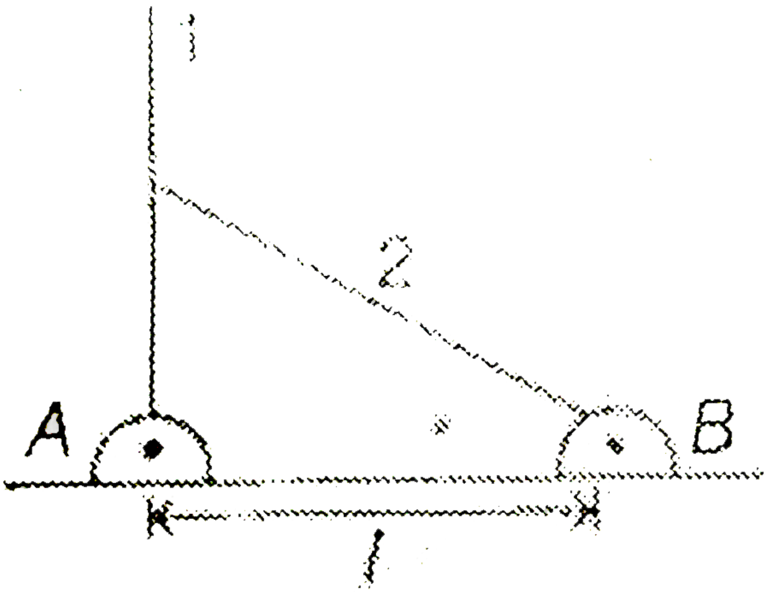
27. Two rod 1 and 2 are released from rest as shown in figure . Given, $l_1 = 4l, m_1 = 2m, l_2 = 2l \text{and } \ m_2 = m.$ There is no friction between the two rods . If α be the angular acceleration of rod 1 just after the rods are released . Then,

What is the initial angular acceleration of rod 2 in terms of the given parameters in the question ?



A. $\left[\frac{2\sqrt{3}g}{2l}+2\sqrt{3}\alpha\right]$

B. $\left[\frac{3\sqrt{3}g}{l}-\sqrt{3}\alpha\right]$

C. $\left[\frac{6\sqrt{3}g}{8l}+5\sqrt{3}\alpha\right]$

D. $\left[\frac{3\sqrt{3}g}{8l}-\frac{8}{\sqrt{3}}\alpha\right]$

Answer: D

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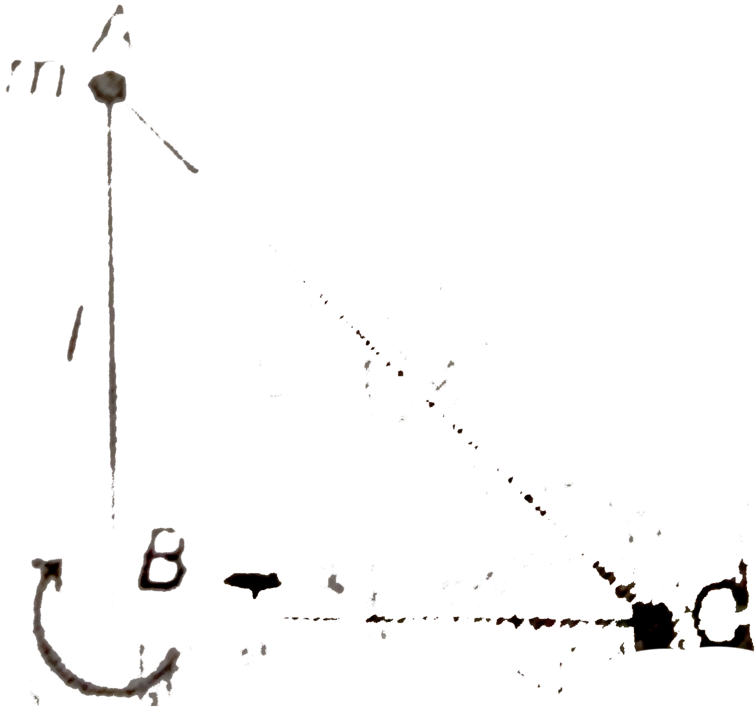
28. Three massless rods are fixed to form a right angled triangular frame such that AB=BC=1 . Two identical small objects of mass m are fixed at A and C . The frame is hinged about B such that the frame can rotate in vertical plane about an horizontal axis without friction. Initially AB is vertical and BC is horizontal and the system is released from rest.



The maximum shift of centre of mass of two mass system from its initial position is

A. $\sqrt{2}l$

B. 1.5 l

C. $l / \sqrt{2}$

D. 2 l

Answer: A

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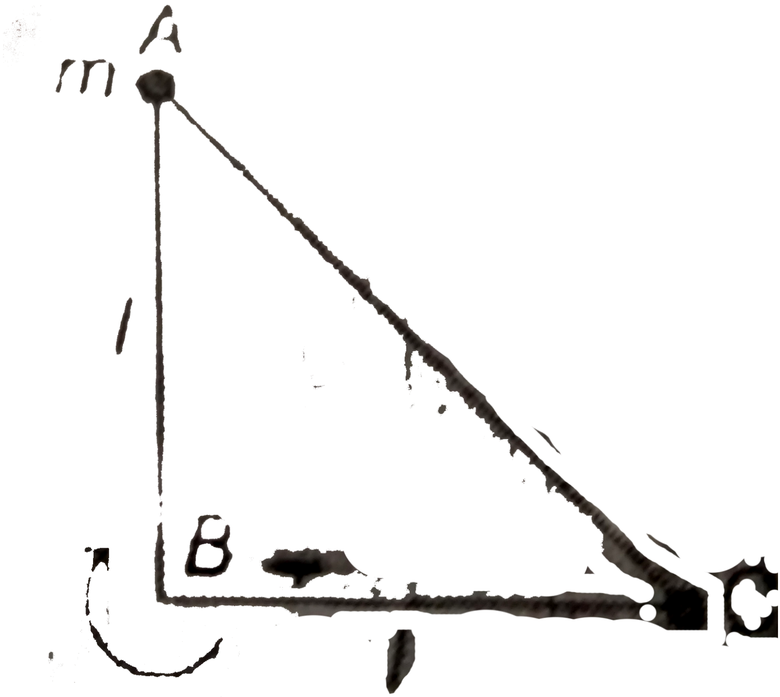
29. Three massless rods are fixed to form a right angled triangular frame such that AB=BC=1 . Two identical small objects of mass m are fixed at A and C . The frame is hinged about B such that the frame can rotate in vertical plane about an horizontal axis without friction. Initially AB is vertical and BC is horizontal and the system is released from rest.



The magnitude of acceleration of mass A when the rod AC becomes horizontal is

A. $g(1+\sqrt{2})$

B. $g(2+\sqrt{2})$

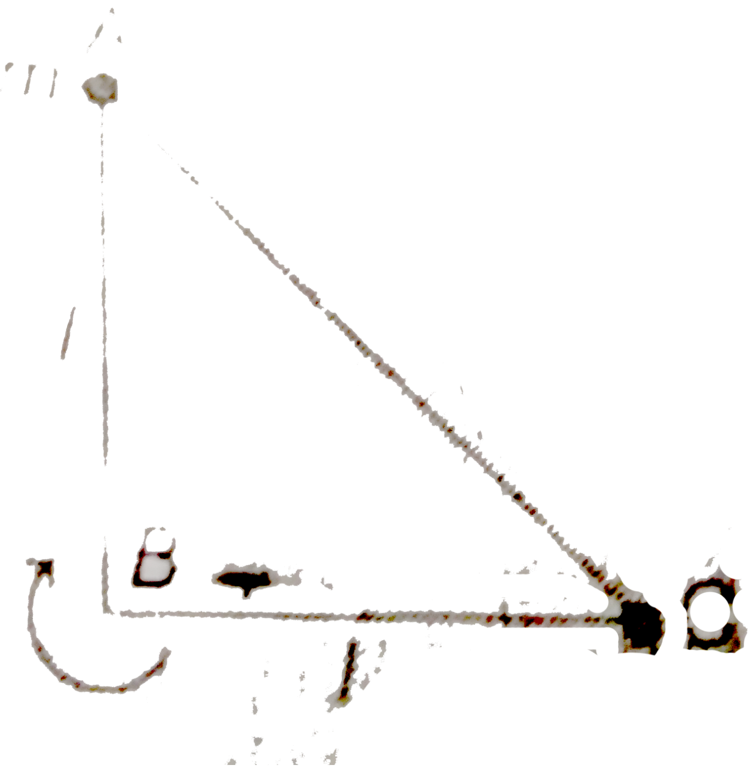
C. $2g(1+\sqrt{2})$

D. $g(\sqrt{2}-1)$

Answer: A

Watch Video Solution

30. Three massless rods are fixed to form a right angled triangular frame such that AB=BC=1 . Two identical small objects of mass m are fixed at A and C . The frame is hinged about B such that the frame can rotate in vertical plane about an horizontal axis without friction. Initially AB is vertical and BC is horizontal and the system is released from rest.



Tension in the rod AC when it (rod AC) becomes horizontal is

A. mg

B. $\sqrt{2}$mg

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

D. $\left(s\sqrt{2}-1\right)$ mg

Answer: A

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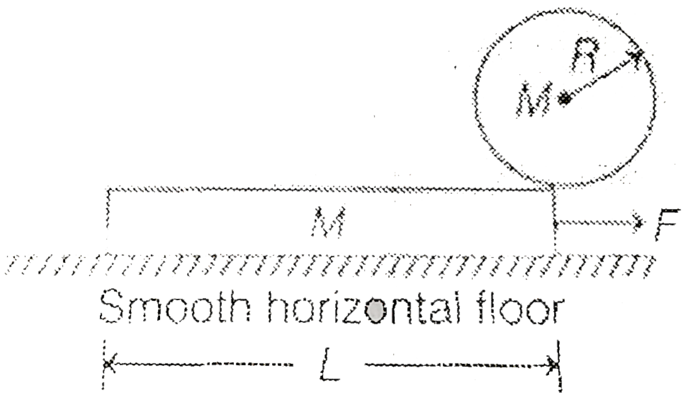
31. A uniform disc of mass M and radius R initially stands vertically on the right end of a horizontal plank of mass M and length L, as shown,



The plank rests on a smooth horizontal floor and friction between disc and plank is sufficiently high such that disc rolls on plank without slipping . The plank is pulled to right with a constant horizontal force of magnitude

F.

The magnitude of acceleration of plank is

F/ 6 M

F/ 4 M

3 F/ 2 M

3 F/ 4 M

A. $\frac{F}{6M}$

B. $\frac{F}{4M}$

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

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

Answer: C

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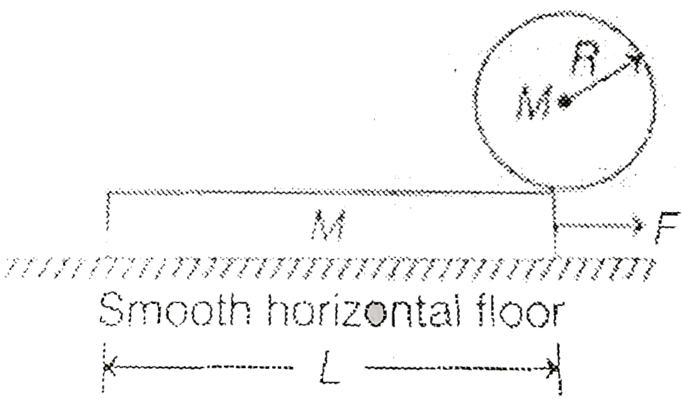
32. A uniform disc of mass M and radius R initially stands vertically on the right end of a horizontal plank of mass M and length L, as shown,



The plank rests on a smooth horizontal floor and friction between disc and plank is sufficiently high such that disc rolls on plank without slipping . The plank is pulled to right with a constant horizontal force of magnitude F.

The magnitude of angular acceleration of the disc is

A. $\frac{F}{4MR}$

B. $\frac{F}{8MR}$

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

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

Answer: C

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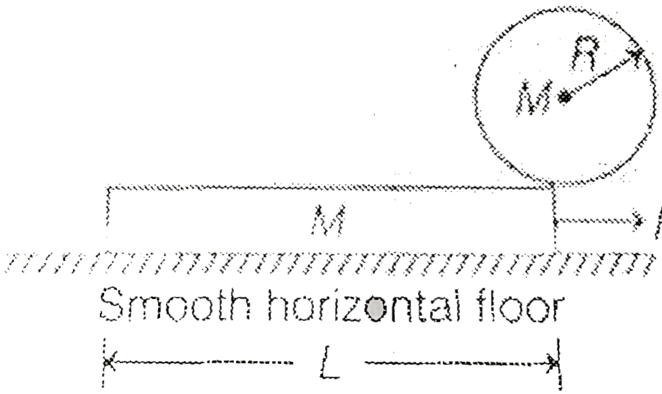
33. A uniform disc of mass M and radius R initially stands vertically on the right end of a horizontal plank of mass M and length L, as shown,



The plank rests on a smooth horizontal floor and friction between disc and plank is sufficiently high such that disc rolls on plank without slipping . The plank is pulled to right with a constant horizontal force of magnitude F.

The distance travelled by centre of disc from its initial position till the left end of plank comes vertically below the centre of disc is

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

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

C. $\frac{L}{8}$

D. L

Answer: A

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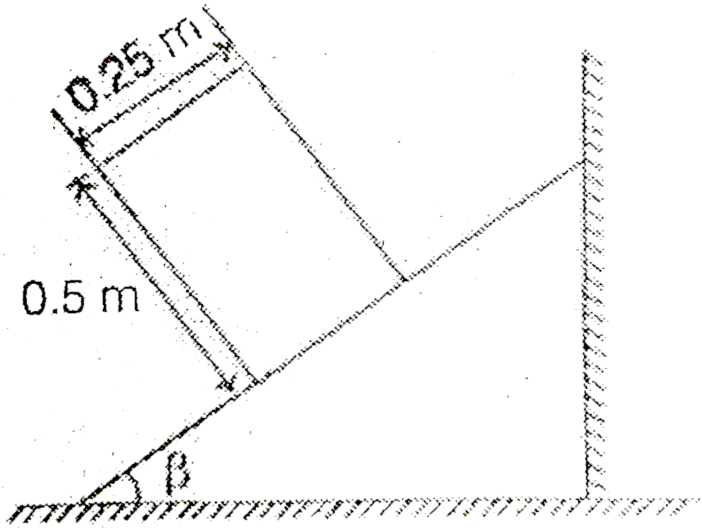
34. An engineer is designing a conveyor system for loading lay bales into a wagon. Each bale is 0.25 m high, and 0.80 m long (the dimension perpendicular to the plane of the figure), with mass 30.0 kg. The centre of gravity of each bale is at its geometrical centre. The coefficient of static friction between a bal and the conveyor belt is 0.60, and the belt moves with constant speed. The angle β of the conveyor is slowly increased. At some critical angle a bale will tip (if it doesn't slip first), and at some different critical it will slip (if it doesn't tip first).



Find the first critical angle (In the same conditions) at which it tips.

A. $\beta = \tan^{-1}(0.50)$

B. $\beta = \tan^{-1}(0.60)$

C. $\beta = \tan^{-1}(0.40)$

D. $\beta = \tan^{-1}(0.20)$

Answer: A

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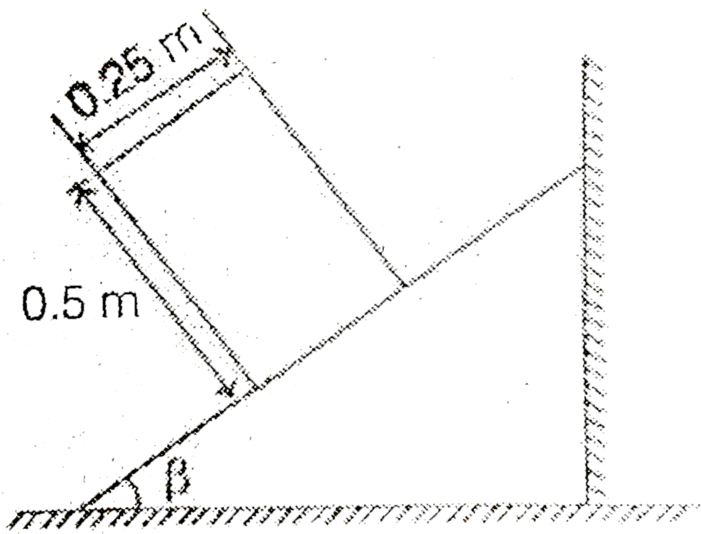
35. An engineer is designing a conveyor system for loading lay bales into a wagon. Each bale is 0.25 m high, and 0.80 m long (the dimension perpendicular to the plane of the figure), with mass 30.0 kg. The centre of gravity of each bale is at its geometrical centre. The coefficient of static friction between a bal and the conveyor belt is 0.60, and the belt moves with constant speed. The angle β of the conveyor is slowly increased. At some critical angle a bale will tip (if it doesn't slip first), and at some different critical it will slip (if it doesn't tip first).



Find the second critical angle (in the same conditions) at which it slips.

A. $\beta = \tan^{-1}(0.50)$

B. $\beta = \tan^{-1}(0.60)$

C. $\beta = \tan^{-1}(0.12)$

D. $\beta = \tan^{-1}(0.70)$

Answer: B

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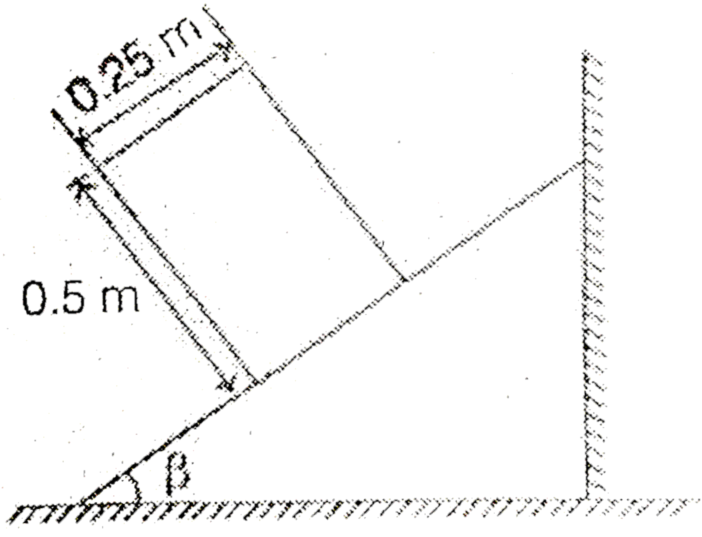
36. An engineer is designing a conveyor system for loading lay bales into a wagon. Each bale is 0.25 m high, and 0.80 m long (the dimension perpendicular to the plane of the figure), with mass 30.0 kg. The centre of gravity of each bale is at its geometrical centre. The coefficient of static friction between a bal and the conveyor belt is 0.60, and the belt moves with constant speed. The angle β of the conveyor is slowly increased. At some critical angle a bale will tip (if it doesn't slip first), and at some different critical it will slip (if it doesn't tip first).



Which statement is correct ?

A. It will tip first if $\mu_s = 0.6$

B. It will slide first if $\mu_s = 0.40$

C. Both are correct

D. Both are wrong

Answer: C

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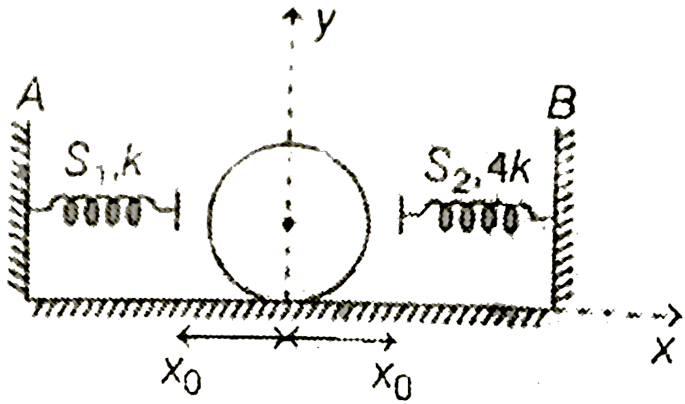
37. In the figure S_1 and S_2 are two light springs of stiffness k and 4k respectively. When springs are in relaxed state, seperation between their free ends is $2x_0$. A uniform solid cylinder of mass m and radius R$(< x_0)$ is placed exactly midway between the free ends of the springs with its axis horizontal and perpendicular to the springs . Now consider the two cases separately.



Case I : The cylinder is imparted speed v_0 towards left. When the cylinder comes to rest momentarily the co-ordinates of its centre are either $(-x_1, R)$ or (x_2, R) .

Case II: The Cylinder is imparted speed v_0 toward left and angular speed ω^0 in clockwise sense simultaneously . At the time of maximum compression in the springs the co-ordinates of centre of the cylinder are either $(-x_3, R)$ or (x_4, R) Now answer the following questions assuming that friction is absent every where.

Choose the correct option

A. $x_1 = x_2$

B. $x_1 = x_3$

C. $x_1 = x_4$

D. $x_3 = x_4$

Answer: B

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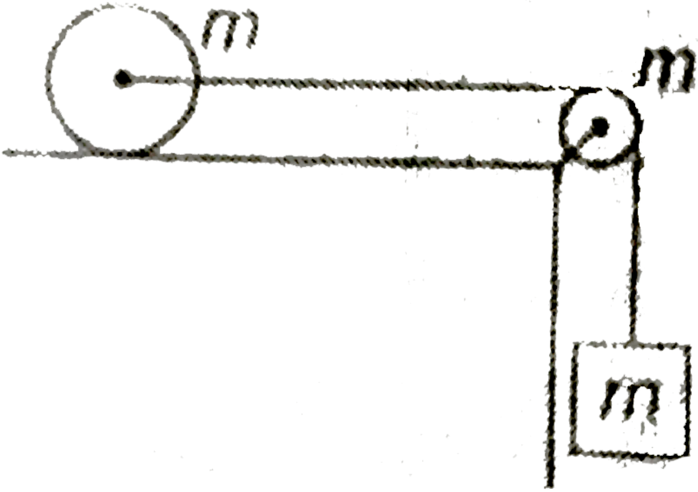
38. A uniform solid cylinder of mass m and radius 2R rests on a horizontal table. A string attached to it passes over a pulley (disc) of mass m and radius R that is mounted on a fricitonaless axle through its centre . A block of mass m is suspended from the free end of the spring . The string does not slip over the pulley surface and the cylinder rolls without slipping on the table.



Acceleration of the block is

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

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

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

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

Answer: A

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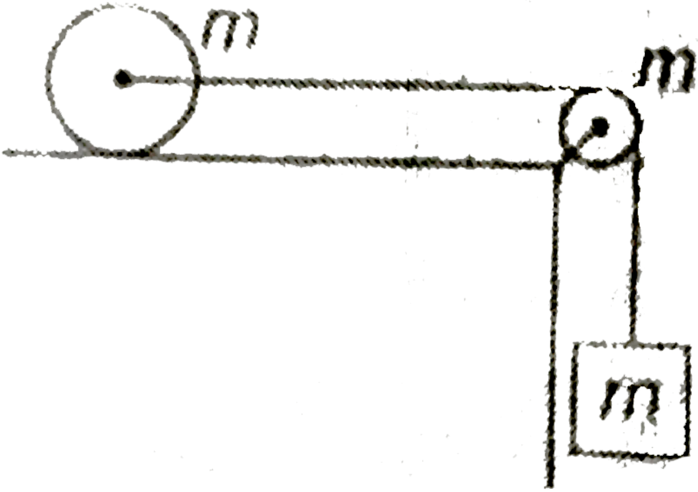
39. A uniform solid cylinder of mass m and radius 2R rests on a horizontal table. A string attached to it passes over a pulley (disc) of mass m and radius R that is mounted on a fricitonaless axle through its centre . A block of mass m is suspended from the free end of the spring . The string does not slip over the pulley surface and the cylinder rolls without slipping on the table.



Force of friction acting on the cylinder is

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

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

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

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

Answer: D

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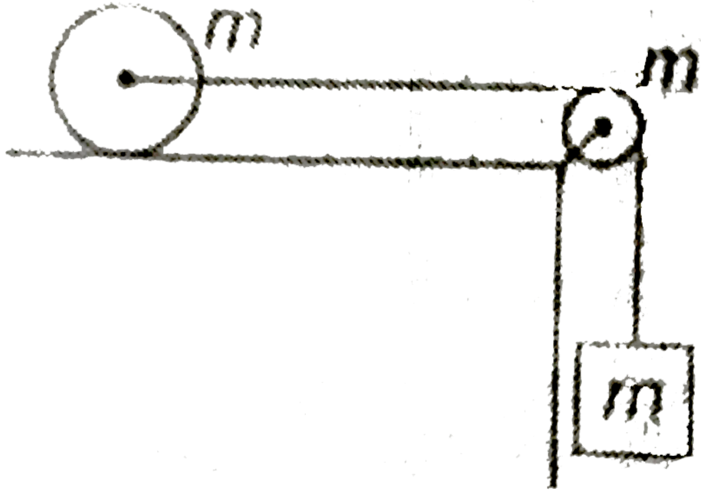
40. A uniform solid cylinder of mass m and radius 2R rests on a horizontal table. A string attached to it passes over a pulley (disc) of mass m and radius R that is mounted on a fricitonaless axle through its centre . A block of mass m is suspended from the free end of the spring . The string does not slip over the pulley surface and the cylinder rolls without slipping on the table.



Angular acceleration of the cylinder is

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

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

C. $\frac{g}{6R}$

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

Answer: C

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Matrix Matching Type Questions

1. Four rods of equal length l and mass m each form a square as shown in figure. Moment of inertia about three axes 1,2 and 3 are say I_1, I_2 and I_3. Then, match the following

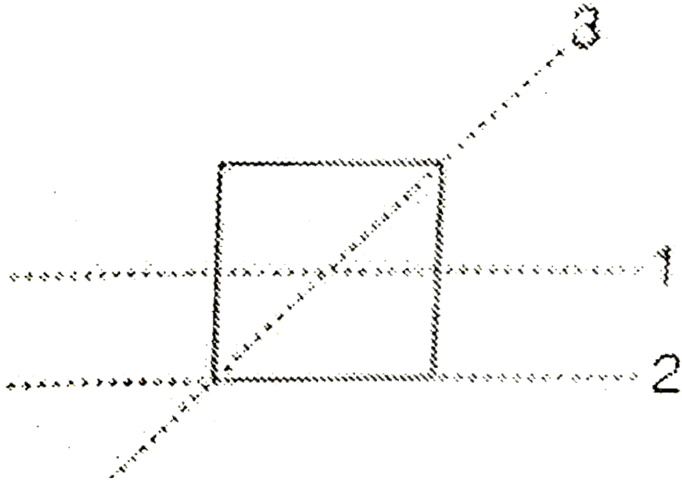

Table-1	Table-2
(A) I_1	(P) $\frac{4}{3}ml^2$
(B) I_2	(Q) $\frac{2}{3}ml^2$
(C) I_3	(R) $\frac{1}{2}ml^2$
	(S) None

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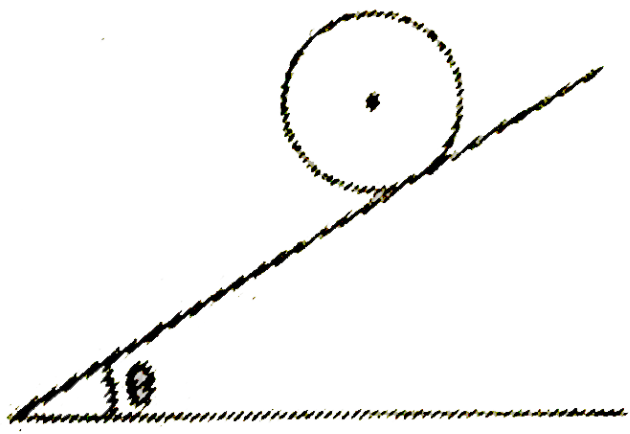
2. A ring of mass m and radius R is placed on a rough inclined plane so that it rolls without slipping . Match the following table.



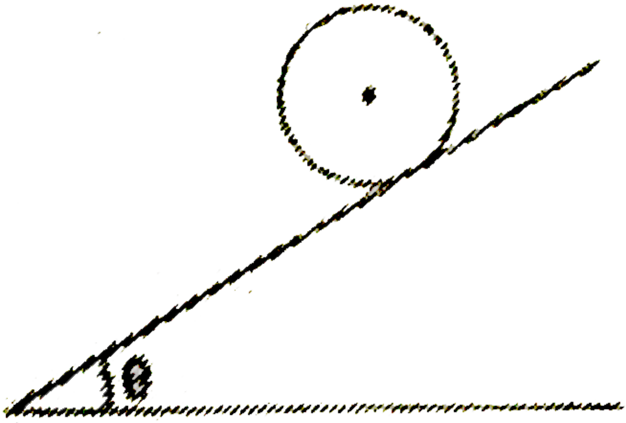


Table-1		Table-2	
(A)	Linear acceleration of centre of mass	(P)	is directly proportional to m
(B)	Angular acceleration	(Q)	is inversely proportional to m
(C)	Rotational kinetic energy at any instant	(R)	is directly proportional to R^2
(D)	Translational kinetic energy at any instant	(S)	is inversely proportional to R
		(T)	None

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3. The particle of mass 1 kg is projected with velocity $20\sqrt{2}$m/s at 45° with ground . When , the particle is at highest point $(g = 10m/s^2)$,

Table-1	Table-2
(A) Net torque on the particle about point of projection	(P) 200 SI unit
(B) Angular momentum of the particle about point of projection	(Q) 400 SI unit
(C) Angular velocity of the particle about point of projection	(R) 1.0 SI unit
	(S) None

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4. A disc rolls on ground without slipping . Velocity of centre of mass is v. There is a point

P on circumference of disc at angle θ . Suppose v_p is the speed of this point. Then, match the following the following table.

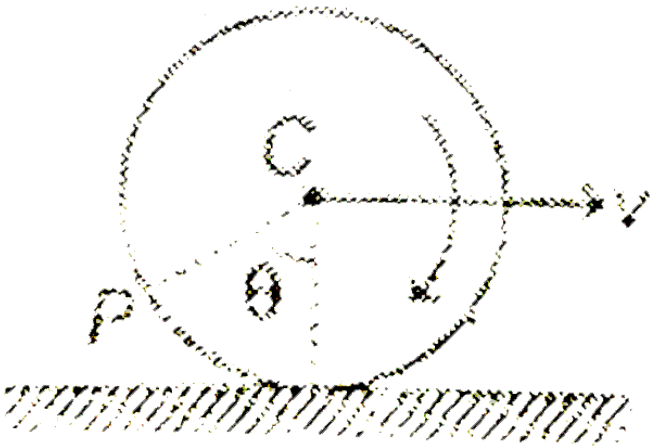

Table-1	Table-2
$\theta = 60^\circ$	(P) $v_P = \sqrt{2}v$
$\theta = 90^\circ$	(Q) $v_P = v$
$\theta = 120^\circ$	(R) $v_P = 2v$
$\theta = 180^\circ$	(S) $v_P = \sqrt{3}v$

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5. Match the following .

Table-1	Table-2
(A) In pure roiling work done by friction	(P) is always zero
(B) In forward slipping work done by friction	(Q) may be zero
(C) In backward slipping work done by friction	(R) is always negative
	(S) is always positive
	(T) may be negative
	(U) may be [illegible]

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6. A disc with linear velocity v and angular velocity ω is placed on rough ground. Suppose a and α be the magnitudes of linear and angular acceleration due to friction.

Table-1	Table-2
(A) When $v = R\omega$	(P) $a = R\alpha \ (a \neq 0)$
(B) When $v = \frac{R\omega}{2}$	(Q) $a > R\alpha$
(C) When $v = 2R\omega$	(R) $a < R\alpha$
	(S) None

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7. In net force on a rigid body is zero. Then, match the following table.

Table-1	Table-2
(A) Linear velocity of COM	(P) is zero
(B) Angular velocity of rigid body	(Q) is constant
(C) Angular momentum about an axis passing through COM	(R) may be varying
(D) Angular momentum about an axis not passing through COM	

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8. If radius of earth is reduced to half without changing its mass,

Table-1	Table-2
(A) Angular momentum of earth	(P) will become two times
(B) Time period of rotation of earth	(Q) will become four times
(C) Rotational kinetic energy of earth	(R) will remain constant
	(S) None

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9. A semi-circular ring has mass m and radius R as shown in figure. Let I_1, I_2, I_3 and I_4 be the moments of inertia about the four axes as shown . Axis 1 passes through centre and is perpendicular to plane of ring. Then , match the following.

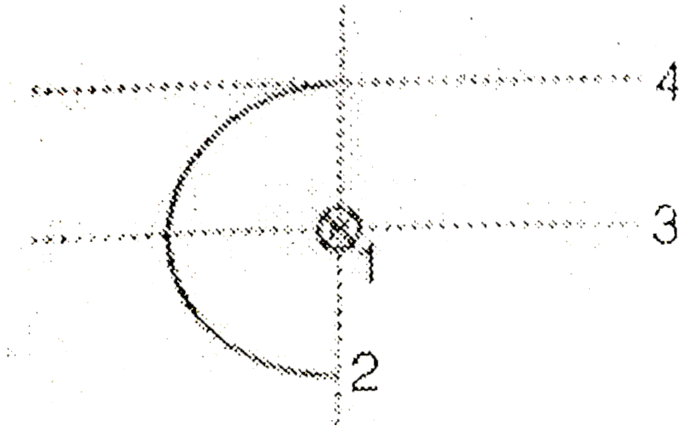

Table-1		Table-2	
(A)	I_1	(P)	$\frac{mR^2}{2}$
(B)	I_2	(Q)	$\frac{3}{2}mR^2$
(C)	I_3	(R)	mR^2
(D)	I_4	(S)	Data is insufficient

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10. A solid sphere is rotating about an axis as shown in figure. An insect follows the dotted path on the cricumference of sphere as shown

.

Match the following

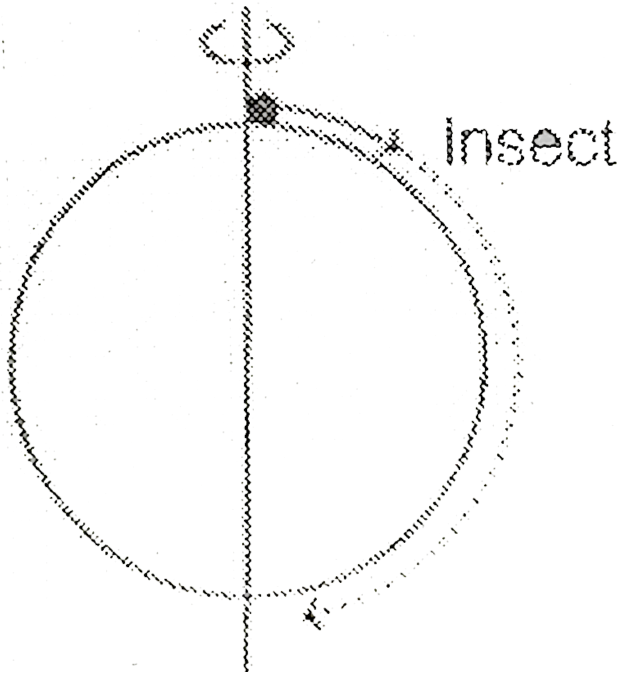

Table-1	Table-2
(A) Moment of inertia	(P) will remain constant
(B) Angular velocity	(Q) will first increase then decrease
(C) Angular momentum	(R) will first decrease then increase
(D) Rotational kinetic energy	(S) will continuously decrease
	(T) will continuously increase
	(U) Data is insufficient

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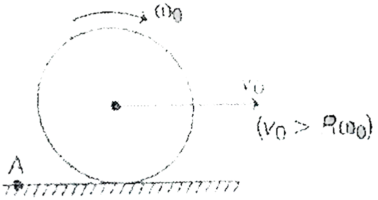
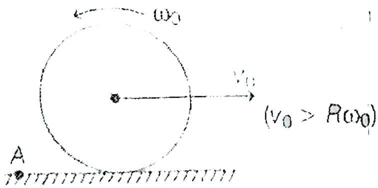
11. In each situation of Table-1, a uniform disc of mass m and radius R rolls on a rough fixed horizontal surface as shown. At, t=0 (initially) the angular velocity of disc is ω_0 and velocity of centre of mass of disc is v_0 (in horizontal direction). The relation between v_0 and ω_0 for each situation and also initial sense of rotation is given in Table-1 . Then match the statements in Table-1 with the corresponding results in Table-2.

Table-1

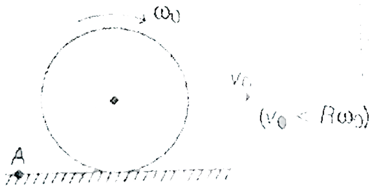
(A)



(B)



(C)



(D)

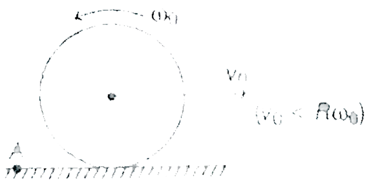


Table-2

(P) The angular momentum of disc about point A remains conserved.

(Q) The kinetic energy of disc after it starts rolling without slipping is less than its initial kinetic energy.

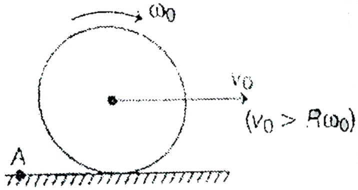
(R) In the duration, disc rolls with, slipping, the friction acts on disc towards left.

(S) In the duration disc rolls with slipping, the friction acts on disc for some time to right and for some time to left

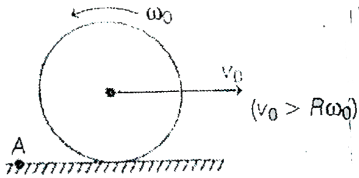
12. A solid sphere, a hollow sphere, a solid disc and a hollow cylinder are allowed to roll down a sufficiently rough inclined plane starting from rest. All have same mass and radius.

Table-1

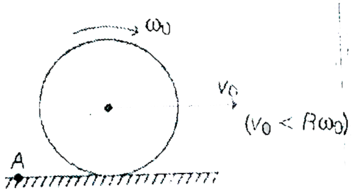
(A)



(B)



(C)



(D)

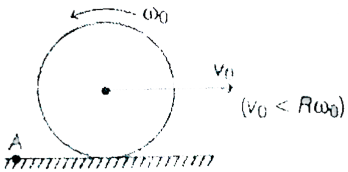


Table-2

(P) The angular momentum of disc about point A remains conserved.

(Q) The kinetic energy of disc after it starts rolling without slipping is less than its initial kinetic energy.

(R) In the duration, disc rolls with, slipping, the friction acts on disc towards left.

(S) In the duration disc rolls with slipping, the friction acts on disc for some time to right and for some time to left

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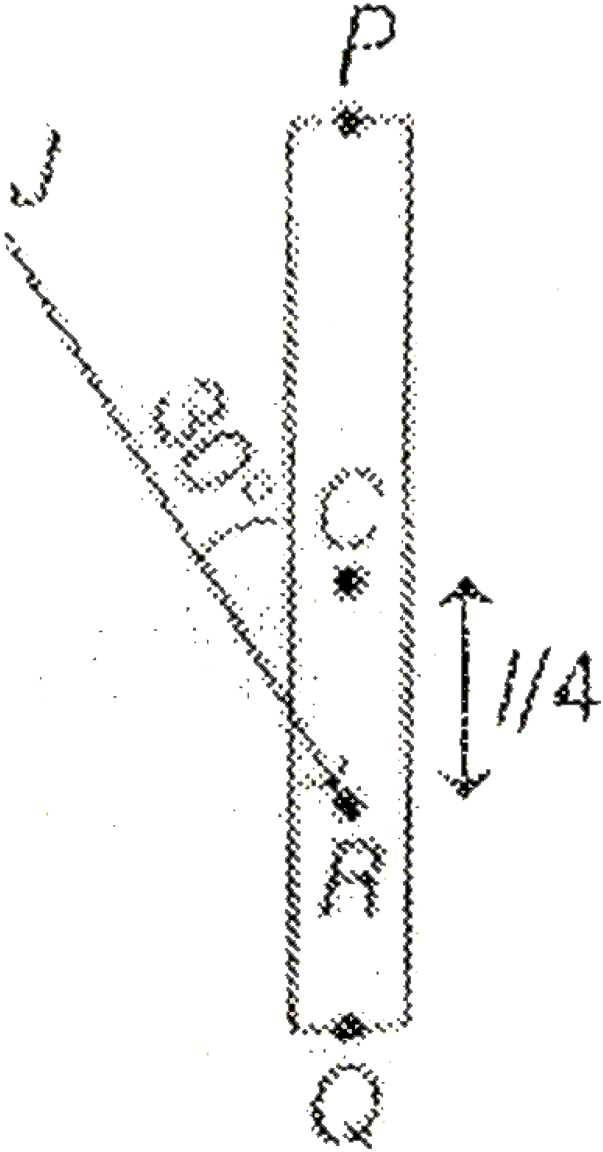
13. A uniform rod of mass m and length l is lying on a smooth table. An impulse J acts on the rod momentarily as shown in figure at point R. Just after that:



P
ω
θ
C
l/4
R
Q

Table-1	Table-2
(A) Speed of upper end P of rod	(P) $\frac{\sqrt{97}}{8}\left(\frac{J}{m}\right)$
(B) Speed of lower end Q of rod	(Q) $\frac{5}{4}\left(\frac{J}{m}\right)$
(C) Speed of point R of rod	(R) $\frac{\sqrt{13}}{4}\left(\frac{J}{m}\right)$
(D) Speed of upper end P after rod turns through 30°	(S) $\frac{\sqrt{37}}{4}\left(\frac{J}{m}\right)$

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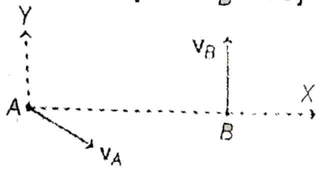
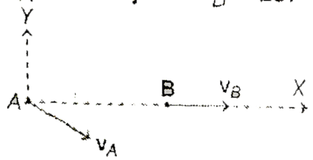
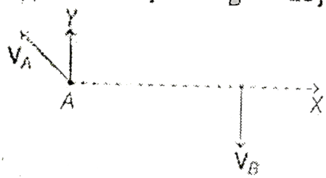
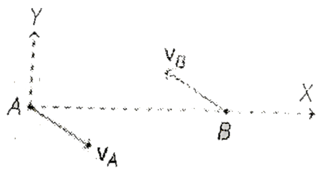
14. There are two point masses A and B, situated at origin and point (5m,0m) respectively . At a certain time v_A and v_B are respectively the velocities of point masses A and B . Match the situations under Table-1 with their correct option under Table-2

Table-1	Table-2
(A) $\mathbf{v}_A = 5\hat{i} - 5\hat{j}$ and $\mathbf{v}_B = 20\hat{j}$ 	(P) The speed of approach between point masses A and B at the given time is 5 m/sec
(B) $\mathbf{v}_A = 5\hat{i} - 5\hat{j}$ and $\mathbf{v}_B = 20\hat{i}$ 	(Q) The speed of separation between point masses A and B at the given time is 5 m/sec
(C) $\mathbf{v}_A = -5\hat{i} + 5\hat{j}$ and $\mathbf{v}_B = -20\hat{j}$ 	(R) At the given time, the magnitude of angular velocity of point mass A with respect to B is 3 rad/sec
(D) $\mathbf{v}_A = 5\hat{i} - 5\hat{j}$ and $\mathbf{v}_B = -10\hat{i} + 10\hat{j}$ 	(S) At the given time, the magnitude of angular velocity of point mass A with respect to B is 1 rad/sec

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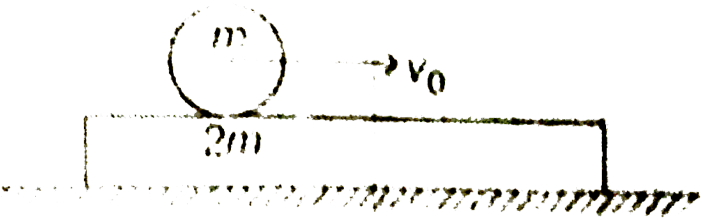
15. A thin but very large plank of mass 2 m is placed on a horziontal smooth surface. A solid cylinder of mass m and radius r is given only translational velocity v_0 and gently placed on the plank as shown in the figure. The coefficient of kinetic friciton between the plank and the cylinder is μ.



the cylinder given impluse t=0, than at what time pure rolling starts

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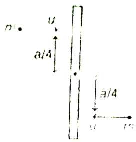
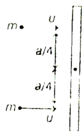
16. Match the following two Tables .

Table-1

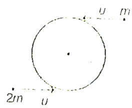
(A) Two point masses each of mass 'm' collide with a uniform rod of same mass 'm' and length 'a'. Initially the rod is at rest and lying on a smooth horizontal surface. Assuming collision to be perfectly inelastic the angular velocity of rod just after the collision is



(B) Two point masses each of mass 'm' collide with a uniform rod of same mass 'm' and length 'a'. Initially the rod is at rest and lying on a smooth horizontal surface. Assuming collision to be perfectly inelastic, the angular velocity of rod just after the collision is



(C) Two point masses of mass m and 2m collide with a uniform ring of mass 'm' and radius 'a'. The ring is hinged at its centre and free to rotate about its centre. Assuming collision to be perfectly inelastic, the angular velocity of ring just after the collision is



(D) A point mass 'm' collides with a uniform rod of same mass 'm' and length 'a'. Initially the rod is at rest and lying on a smooth horizontal surface. Assuming collision to be perfectly inelastic, the angular velocity of rod just after the collison is

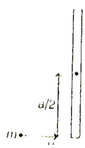


Table-2

(P) 0

(Q) $\frac{12u}{5a}$

(R) $\frac{6u}{5a}$

(S) $\frac{3u}{4a}$

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Integer Type Questions

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

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2. A wheel starting from rest is uniformly acceleration with angular acceleration of $4\text{rad}/s^2$ for 10 seconds . It is then allowed to rotate uniformly for next 10 seconds and finally brought to rest in next 10 seconds by uniform angular retardation. Total angle rotated is (100 n) radian. Find value of n.

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3. Radius of gyration of a body about an axis at a distance 6 cm from it COM is 10 cm . Its radius of gyration about a parallel axis passing through its COM is (n) cm . find value of n.

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4. A uniform rod of mass $2kg$ and length $1m$ lies on a smooth horizontal plane. A particle of mass 1 kg moving at a speed of $2ms^{-1}$ perpendicular to the length of the rod strikes it at a distance $\frac{1}{4}$ m from the centre and stops . Find the angular velocity of the rod about its centre just after the collision (in rad/s)

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5. A uniform rod of mass m, hinged at its upper end, is released from rest from a horizontal position. When it passes through the vertical position, the force on the hinge is

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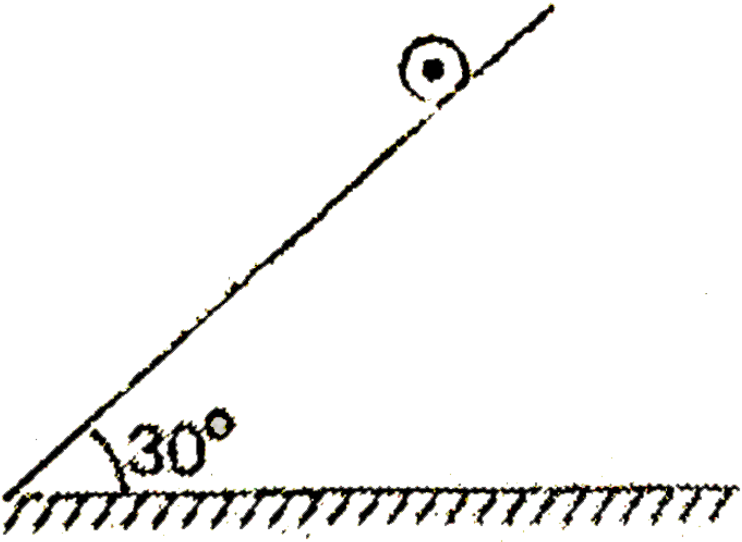
6. An uniform spherical shell of mass m and radius R starts from rest with pure rolling on long inclined plane as shown in figure. The angular momentum of shell about point of contact after 1 s of its starting is KmR.

Determine the value of $k\left(g = 10m / s^2\right)$.



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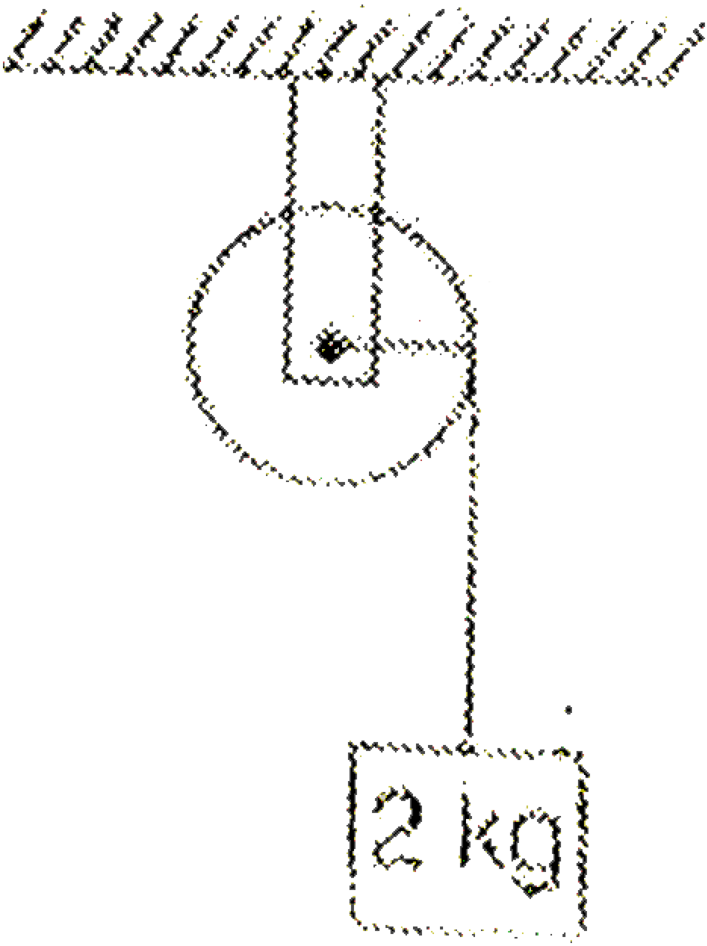
7. A small pulley of radius 20 cm and moment of inertia $0.32 kg - m^2$ is used to hang a 2 kg mass with the help of massless string. If the block is released, for no slipping condition find the acceleration of the block (in m/s^2).



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8. If a disc of mass m and radius r is reshaped into a ring a radius 2r,the mass remaining the same, the radius of gyration about centroidal axis perpendicular to plane goes up by a factor of $\sqrt{x}$. Find the value of x.

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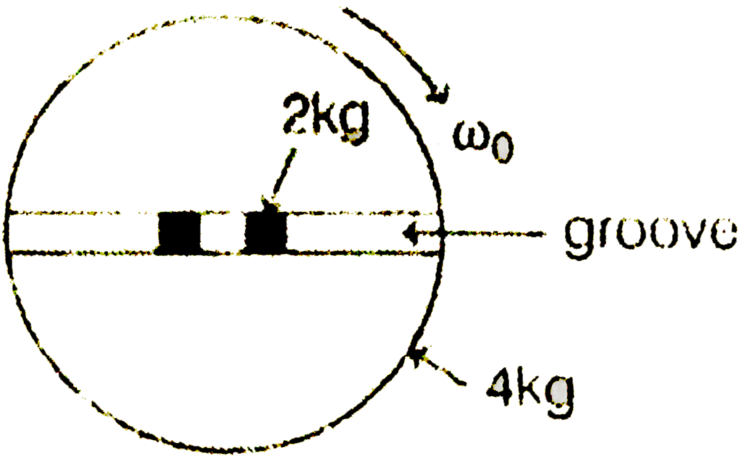
9. A disc of mass 4 kg and radius 6 metre is free to rotate in horizontal plane about a vertical fixed axis passing through its centre. There is a smooth groove along the diameter of the disc and two small blocks of masses 2 kg each are placed in it on either side of the centre of the disc as shown in figure. The disc is given initial angular velocity ω_0 =12 rad/sec and released. Find the angular speed of disc (in radian/sec) when the blocks reach the ends of the disc.



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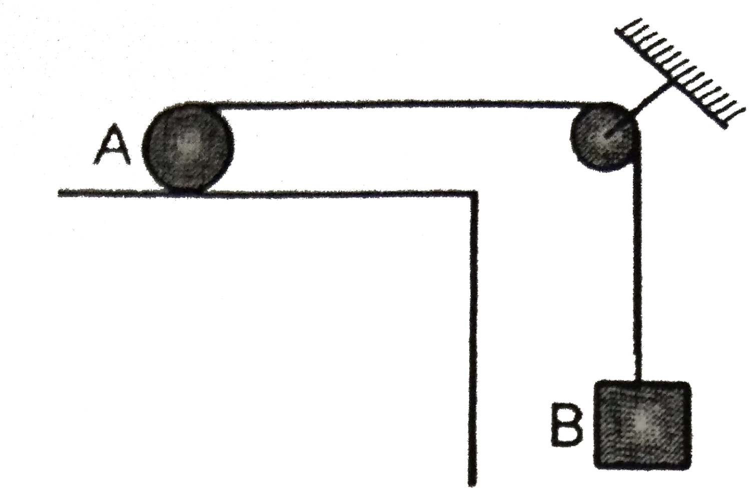
10. Find the acceleration of slid right circular roller A, weighing $12kg$ when it is being pulley by another weight $B(6kg)$ along the horizontal plane as in figure (pulley in massless). The weight B is attached to the end of a string wound around the circularference of roller. Assume there is no slipping of the roller and the string is inextensible.



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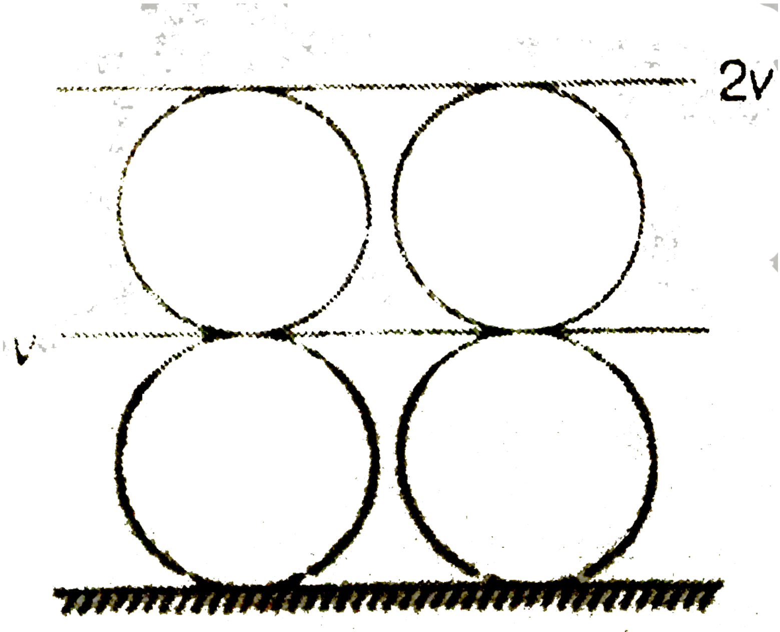
11. Two thin planks are moving on a four identical cylinders as shown. There is no slipping at any contact points. Calculate the ratio of angular speed of upper cylinder to lower cylinder



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12. A wheel of radius R=1 m rolls on ground with uniform velocity v=2 m/s . Calculate the relative acceleration of topmost point of

wheel with respect to bottom most point (in m/s^2).

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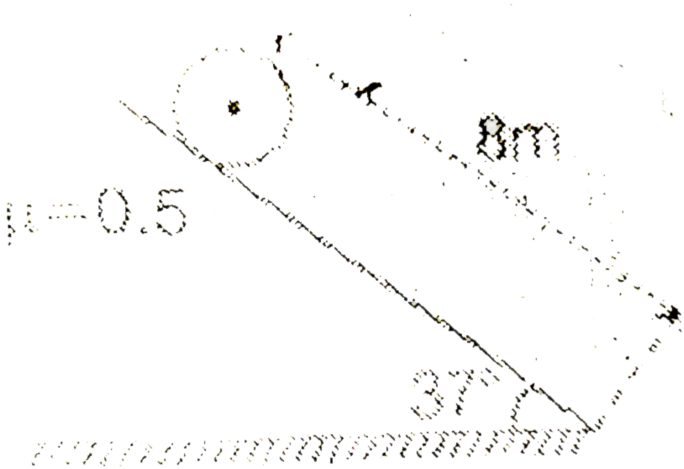
13. A cylinder rolls down on an inclined plane of inclination 37° from rest. Coefficient of friction between plane and cylinder is 0.5. Calculate the time (in s) of travelling down the incline 8 m as shown in figure .

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



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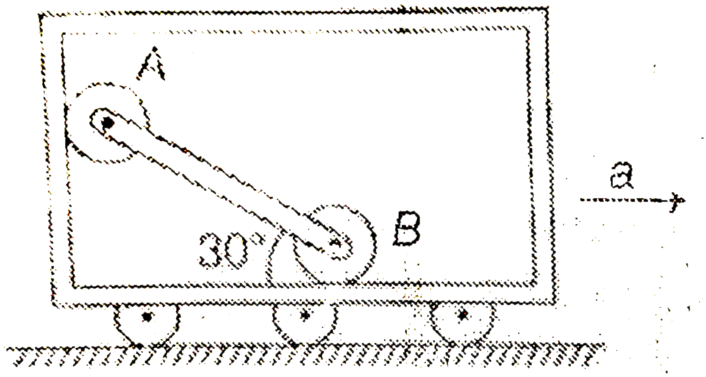
14. A car is moving rightward with acceleration $a = g\sqrt{k}m / s^2$. Find the value of k so that , rod maintains its orientation as shown in the figure. Neglect the friction and mass of the small rollers at A and B.



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15. A uniform thin rod has mass m and length l. One end of the rod lies over rough horizontal surface and the other end is connected to a light vertical string as shown in the figure. When string is cut, there is no slipping between rod and surface.Calculate the friction force (in N) on the rod immediately after the string is cut .(Given

$mg = \frac{16}{\sqrt{3}} N)$

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16. A wheel of radius R=2m performs pure rolling on a rough horizontal surface with speed v=10 m/s . In the figure shown, angle θ is angular position of point P on wheel reaches the maximum height from ground. Find the value of $\sec\theta$ (take $g = 10m/s^2$).

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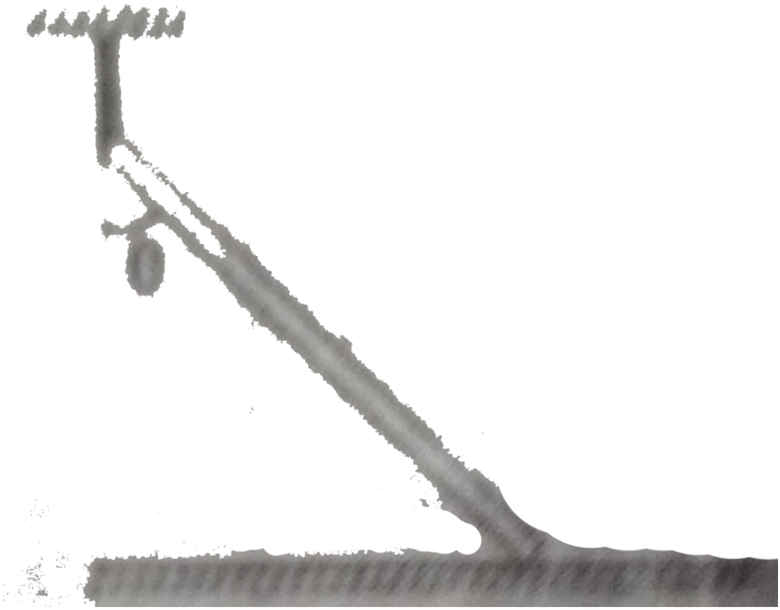
17. A uniform rod of length l and mass m is suspended from one end by inextensible string and other end less lies on smooth ground. The angle made by the rod with vertical is $\theta = \sin^{-1}(1/\sqrt{3})$. If N_1 and N_2 represent the contact force from ground on rod just before and just after cutting the string then the ratio of N_1/N_2 is 0.25 x. Find the value of x.



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