PHYSICS

AAKASH INSTITUTE ENGLISH

SYSTEM OF PARTICLES AND ROTATIONAL MOTION

Example

1. Two bodies of masses 1kg and 2kg are lying in xy plane at (-1,2) and (2,4) respectively. What are the coordinates of the center of mass?

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2. The coordinates of a triangle ABC are $A(1, 2)$, $B(4, 6)$ and $C(-3, -2)$. Three particles of masses $1kg$, $2kg$ and mkg are placed the vertices of the triangle. If the coordinate of the centre of mass are $\left(\frac{3}{5}, 2\right)$, calculate the mass m.

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3. A disc of radius r is cut from a larger disc of radius 4r in such a way that the edge of the hole touches the edge of the disc. The centre of mass of the residual disc will be a distance from centre of larger disc :-

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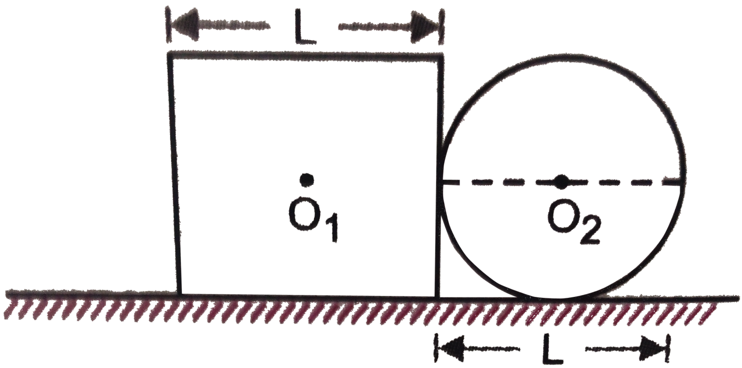
4. A uniform square plate and a disc having same mass per unit area are kept in contact as shown in Fig. The side of square and diameter of circle are both equal to L. Locate the position of centre of mass of the system w.r.t. the centre of the square.



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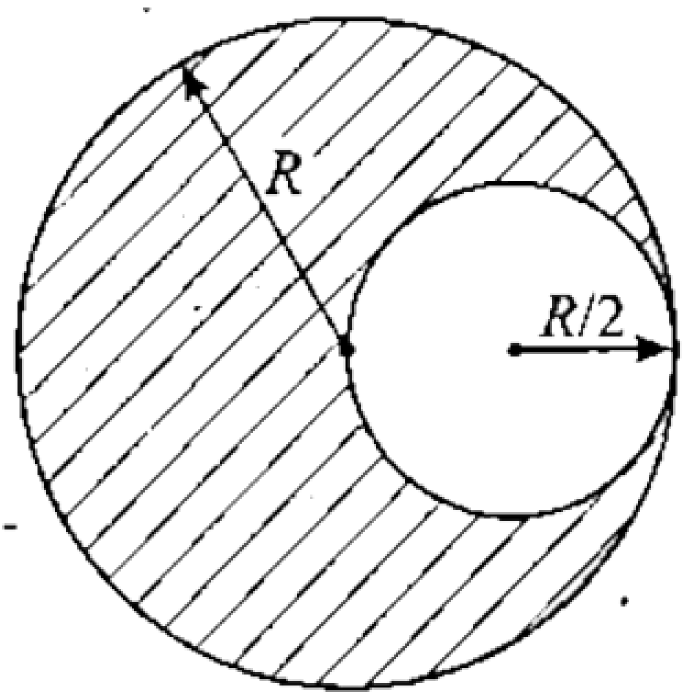
5. Figure-4.11 shows a circular a disc of radius R from which a small disc is cut such that the periphery of the small disc touch the large disc and whose radius is $R/2$. Find the centre of mass of the remaining part of the disc.



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6. Two particles of mass $1kg$ and $2kg$ are moving along the same line with speeds

$2m/s$ and $4m/s$ respectively. Calculate the speed of the centre of mass of the system if both the particles are moving in the same direction.

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7. If no external force acts on a system

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8. A man of mass m stands at the left end of a uniform plank of length L and mass M, which lies on a frictionaless surface of ice. If the man walks to the other end of the plank, then by what distance does the plank slide on the ice?

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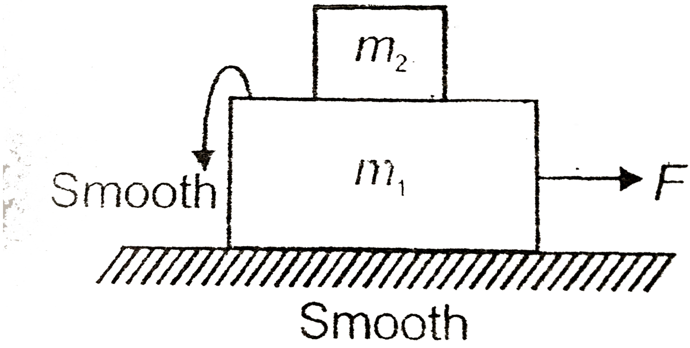
9. An arrangement of two blocks placed one above the other is shown. There is no fricition any where. A horizontal force F acts on one of the blocks as shown. It is required to calculate the acceleration of centre of mass.



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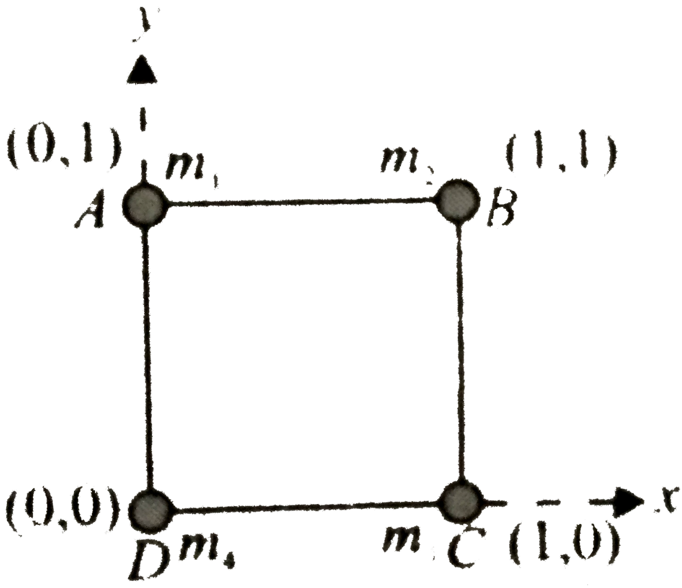
10. Four particles of masses $1kg$, $2kg$, $3kg$ and $4kg$ are placed the four vertices A, B, C and D, respectively, of a square of side $1m$. Find the position of centre of mass of the particles.



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11. Three bodies A, B and C having masses $10kg$, $5kg$ and $15kg$ respectively are projected from top of a tower with A vertically upward

with $10m/s$, B with $20m/s 53^\circ$ above east horizontal and C horizontally southward with $15m/s$. Find

(a) Velocity of centre of mass of the system.

(b)Acceleration of centre of mass of the system.

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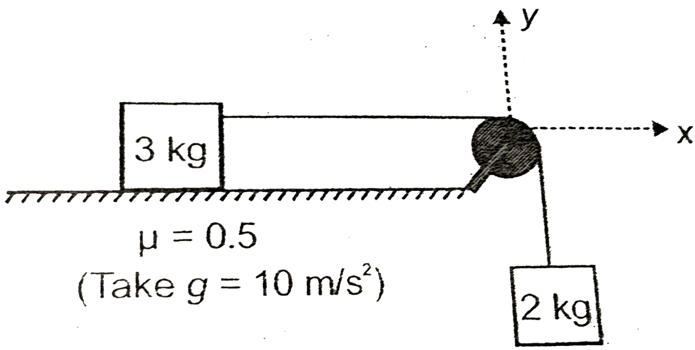
12. (1) Find the acceleration of centre of mass of the system shown.



(ii) Find the normal reaction applied by the pulley on the thread.

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13. Find the scalar and vector products of two vectors $\vec{a} = \left(2\hat{i} - 3\hat{j} + 4\hat{k}\right)$ and $\vec{b}\left(\hat{i} - 2\hat{j} + 3\hat{k}\right)$.

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14. Find a unit vector perpendicular to each of the vectors $\hat{i} + 2\hat{j} - 3\hat{k}$ and $\hat{i} - 2\hat{j} + \hat{k}$.

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15. The angular position of a particle changes from 3 rad to 7 rad in 2 seconds. Calculate the angular velocity of the particle.

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16. A particle is moving along a circle of radius $20cm$, with a linear velocity of `2m//s. Calculate the angular velocity of the particle.

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17. A particle is moving with constant speed v along the line y = a in positive x -direction. Find magnitude of its angular velocity about orgine when its position makes an angle θ with x-axis.

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18. The angular velocity of a flywheel change from 6 rad s^{-1} to 18 rad s^{-1} in 6 seconds. Calculate its angular acceleration.

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19. A force $\left(\hat{i} - 2\hat{j} + 3\hat{k}\right)$ acts on a particle of position vector $\left(3\hat{i} + 2\hat{j} + \hat{k}\right)$. Calculate the torque acting on the particle.

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20. A particle of mass m is projected with speed u at an angle θ with the horizontal. Find the torque of the weight of the particle about the point of projection when the particle is at the highest point.

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21. A car of mass 300 kg is travelling on a circular track of radius 100 m with a constant speed of 60 m/s

Calculate the angular momentum ?

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22. A torque of 10 Nm is applied on a wheel having angular momentum of $2kgm^2s^{-1}$, calculate the angular momentum of the wheel after 4 seconds.

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23. A particle of mass m has been thrown with intial speed u making angle θ with the horizontal ground. Find the angular momentum of the projectile about an axis perpendicular to the plane and passing through the point of projection when the projectile is

(a) At the highest point

(b) About to hit the ground

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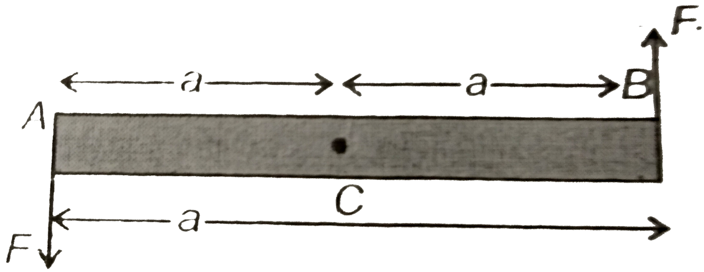
24. In the figure given below, what is the equilibrium of the rod i.e., is it translational or rotational ?



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25. If the Mechanical Advantage of a lever of 100, when a force of $10N$ acts as a distance of $20cm$ from the point of fulcrum. Calculate the force acting on the other side of the fulcrum and the distance of that force from the fulcrum.

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26. A metal rod of length $50cm$ having mass $2kg$ is supported on two edges placed $10cm$ from each end. A $3kg$ load is suspended at $20cm$ from one end. Find the reactions at the edges (take $g = 10m/s^2$)

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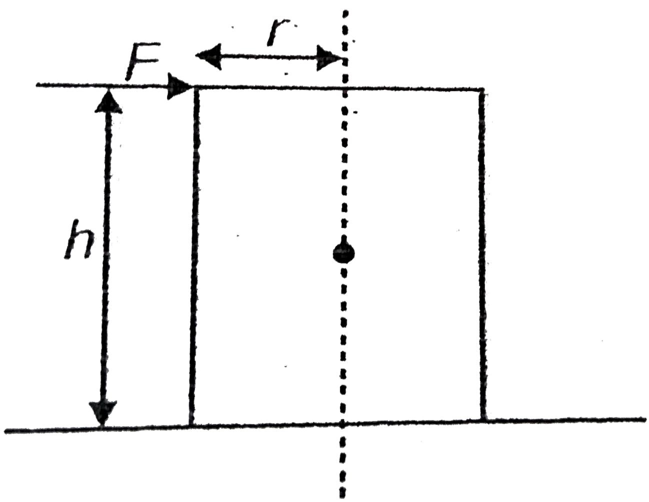
27. A force -F is applied at the topmost point of a cylinder of radius r and height h.

(a) If the cylinder remains at rest, then find distance of line of action of normal reaction from center of mass.

(b) Find coefficient of friction required so that the cylinder tooples before sliding.



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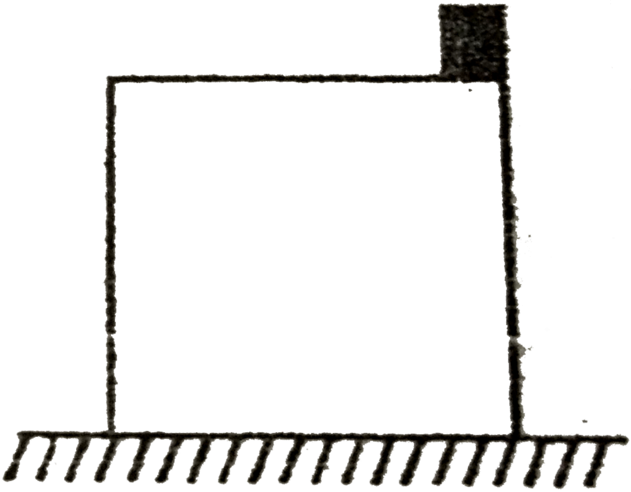
28. A uniform square block of side 'a' and mass 'm' is lying on a horizontal surface. A small block of mass m is placed on the top block. Find the distance by which normal reaction is

shifted.



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29. A cubical block of side 'a' is held at rest, against a rough vertical wall by applying a force F acting along the centre. The mass of

the block is m. Taking acceleration due to gravity as 'g' , determine

(i) The minimum coefficient of friction between the block and wall

(ii) The torque by normal reaction about the centre of mass

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30. The mass of a uniform circular ring of radius $0.2m$ is $0.1kg$. Calculate the moment of inertia of the ring about an axis passing through its center and perpendicular to its surface.

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31. The moment of inertia of a solid cylindrer about its axis of ratation is $\frac{MR^2}{2}$. What is the value if the radius of gyration of the cylinder about this axis ?

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32. What is the moment of inertia of a uniform circular ring about its diameters ?

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33. Calculate the moment of inertia of a rod of mass M, and length l about an axis perpendicular to it passing through one of its ends.

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34. The angular velocity of a particle changes from 100 rad s^{-1} to 200 rad s^{-1} in $4s$. Calculate the angular accelertion of the particle ?

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35. The angular speed of a motor wheel is increased from 600rpm to 1200rpm in 4 seconds. Calculate how many revolutions does the engine make during this time.

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36. Calculate the instantenous power of a wheel rotating with an angular velocity of $20\text{rad}/s$, when a torque of $10Nm$ is applied to it.

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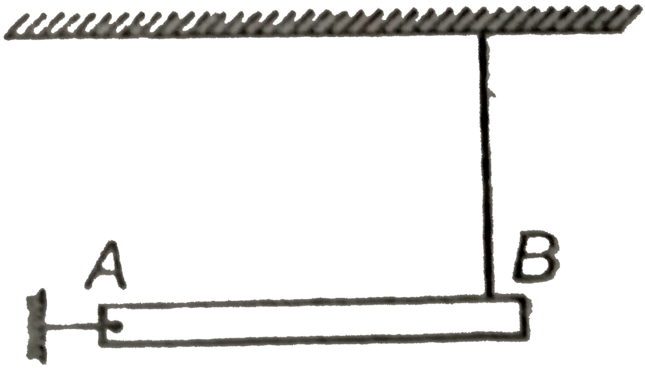
37. A unifrom rod AB of length L and mass M is held horizontally with the help of one light string and a hinge as shown. If string at B is burnt suddenly, find out the initial angular acceleration of the rod and the intial reaction force at the hinge.



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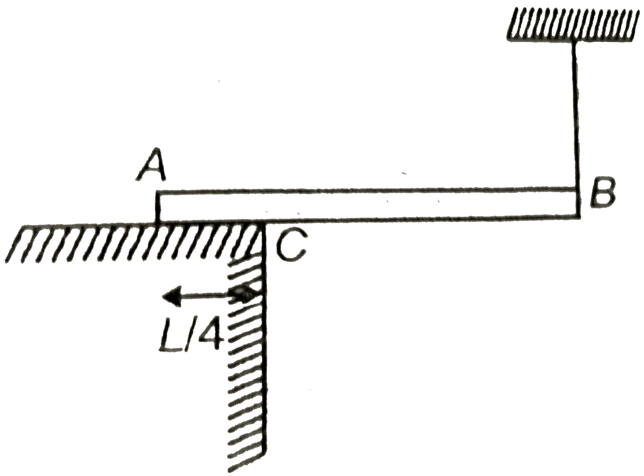
38. A unifrom rod of mass m and length L is kept on a horizontal table with $\frac{L}{4}$ length on the table. The end B is tied to a string as shown in the figure. The string attached to the end B is cut and the rod starts rotating about point C. Find the normal reaction from the table on the earth as soon as the string is cut.



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39. A thin uniform rod AB of mass m and length L is placed on a smooth horizontal table. A constant horizontal force of magnitude F starts acting on the rod at one of the ends AB, Initially, the force is perpendicular to the length of the rod. Taking the moment at which force starts acting as $t = 0$, find.

(a) Distance moved by centre of mass of the rod in time t_0.

(b) Magnitude of initial acceleration of the end A of the rod.

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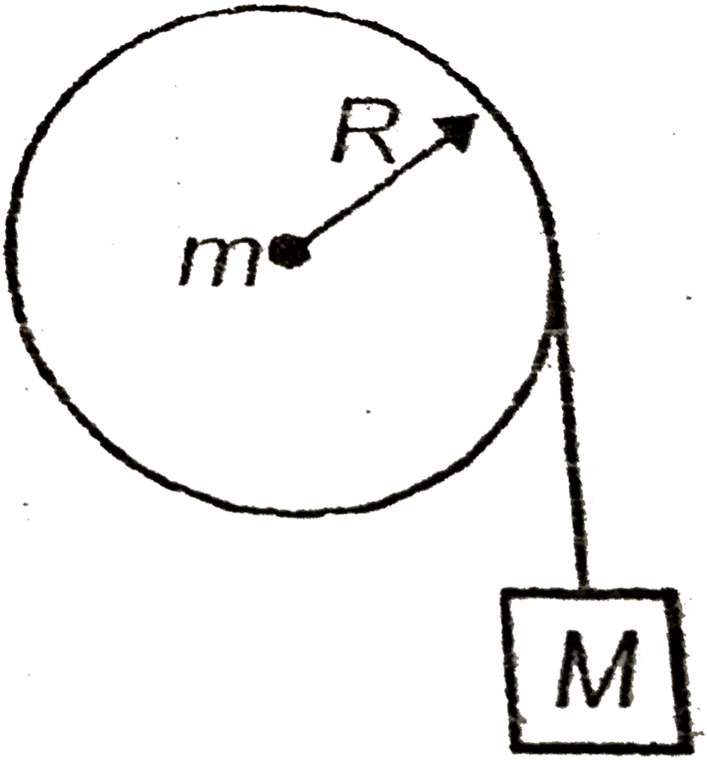
40. A disc shaped pulley of mass $'m' = 4kg$ and radius $R = 0.5m$ can rotate freely about its center. A block of mass $M = 2kg$ hangs from the pulley through is massless string that is tightly wrapped around the pulley. When the system is released, there is no slipping between pulley and string.



(a) Calculate the angular accelerating of the pulley

(b) Calculate the tension in the string

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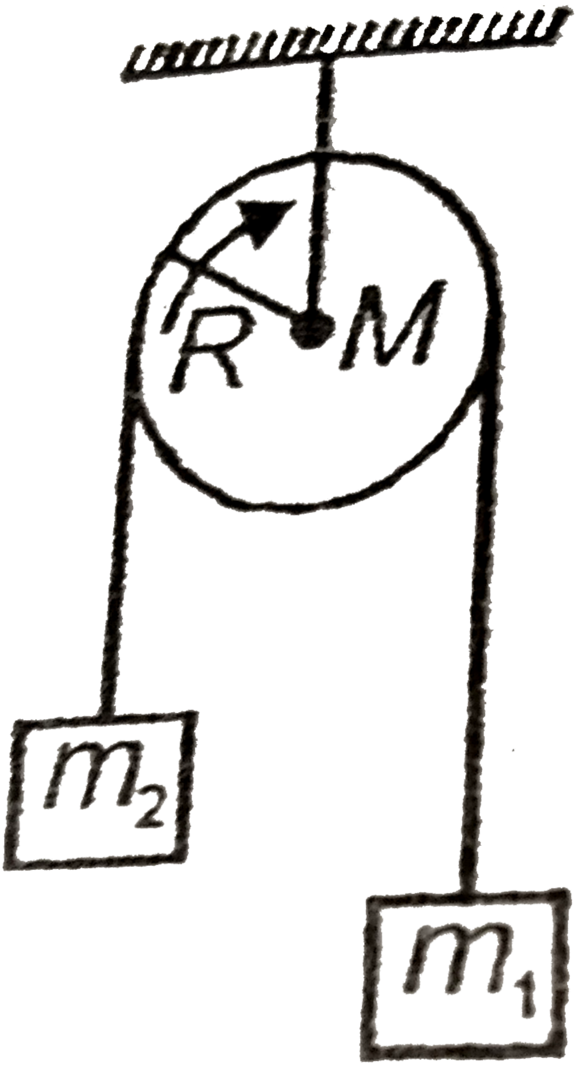
41. Two masses m_1 and m_2 are joined with the help of massless string passing over a pulley of Radius R and mass M. Assume that string doesn't slip over the pulley. Take $m_1 = 10kg$, $m_2 = 5kg, M = 10kg, R = 1m$.



(a) Calculate the acceleration of each book.

(b) Calculate the tensions in the thread.

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42. Compute the angular acceleration of a wheel having moment of inertia $20kgm^2$, when a torque of $10Nm$ is applied on the wheel.

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43. A flywheel having moment of inertia $20kgm^2$ rotates about its axis with an angular velocity of $100rads^{-1}$. If the moment of inertia of the flywheel is reduced to $10kgm^2$

without applying external torque, calculate the new angular velocity of the Flywheel.

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44. A particle of mass m is projected with a speed v at an angle θ with the horizontal. Find the angular momentum of the particle about an axis passing through point of projection and perpendicular to the plane of motion of the particle.

(a) When the particle is at maximum height

and

(b) When the particle is just about to collide with the horizontal surface

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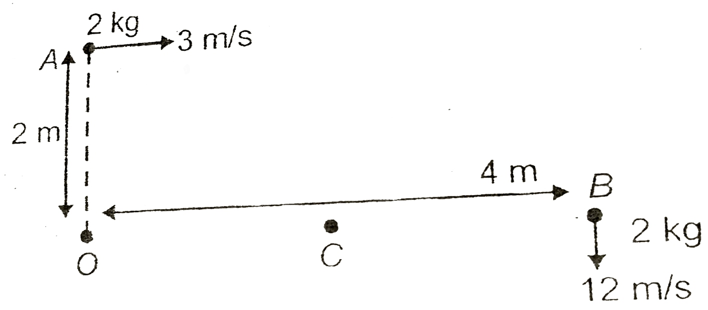
45. Three particles are moving as shown in the figure, Calculate the angular momentum of the third particle C, so that the angular momentum of system about point O becomes zero.



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46. A cylinder of mass $5kg$ and radius $10cm$ is moving on a horizontal surface with speed. $5m/s$ and angular speed about axis through $C.M.$ $10rad/s$. Find the angular momentum of the cylinder about point of contact.

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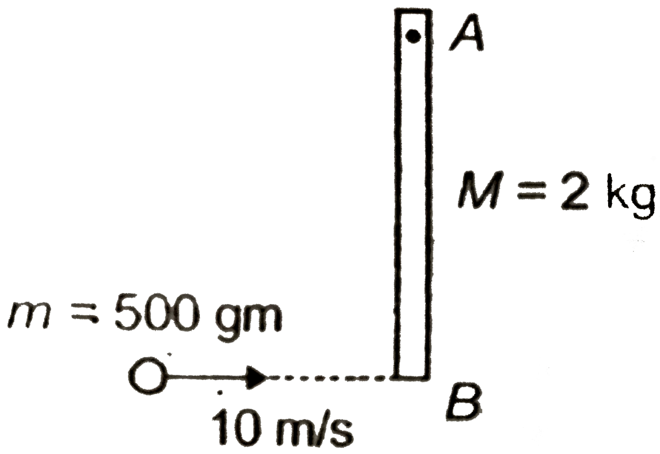
47. A rod of mass $2kg$ and length $1m$ is pivoted at one end A and kept on a smooth surface. A particle of mass $500gmstrikestheotherendB$ of the rod and sticks to the rod. If particle was moving with the speed of $10m/s$, what is the angular speed of the rod after collision ?



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

(a). Find the ratio m / M

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

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

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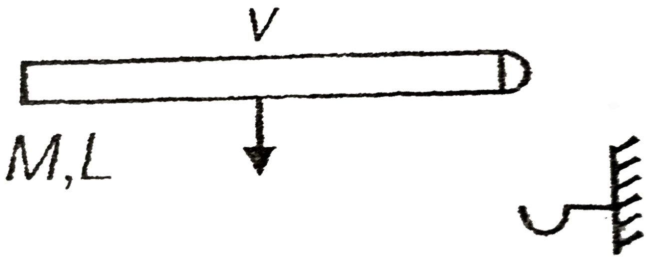
49. A rod of mass M and length L is falling vertically with speed v. Suddenly its one end gets stuck in a friciitonless hook. Find the angular velocity of the rod just after its end gets struck.



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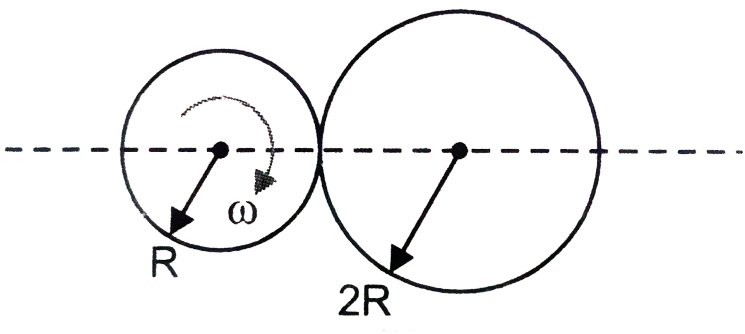
50. Two discs of radii R and $2R$ are pressed against each other. Initially, disc with radius R is rotating with angular velocity ω and other disc is stationary. Both discs are hinged at their respective centres and are free to rotate about them. Moment of inertia of smaller disc is I and of bigger disc is $2I$ about their respective axis of rotation. Find the angular velocity of bigger disc after long time.



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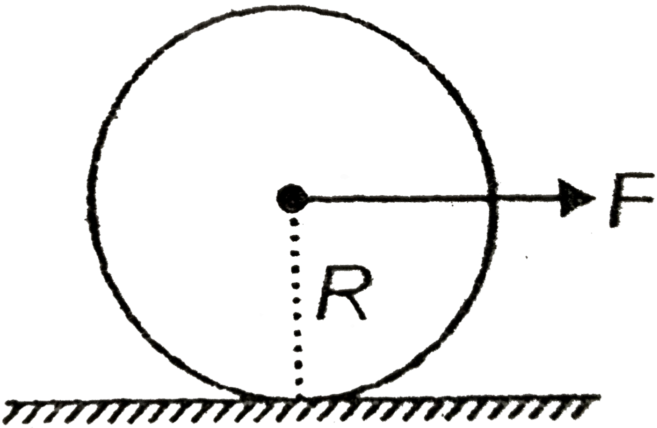
51. A force F is applied at center of a uniform round object of mass m radius R and moment of inertia about its centre of mass I_{cm}. Find (if $\frac{I_{cm}}{mR^2} = k$).

(a) Acceleration of center of the round object if it rolls without slipping.

(b) Minimum coefficient of fricition required so that the round object rolls without slipping.



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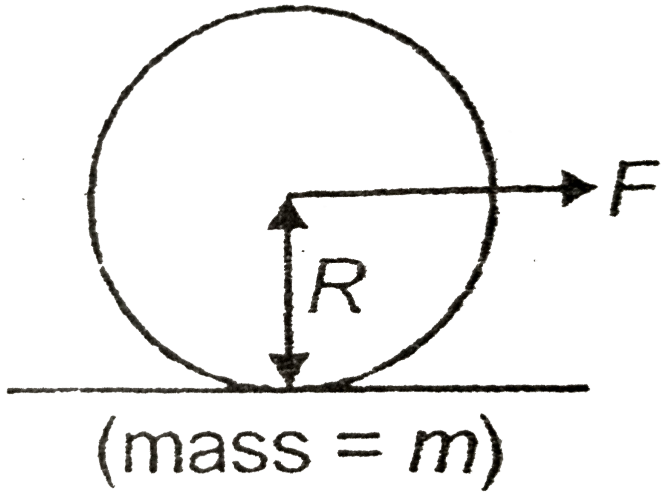
52. A force F is applied on a disc at it's centre. Find acceleration of center of mass in the case of pure rolling and also find minimum coefficient of fricition required for pure rolling.



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53. A uniform round object of mass M, radius R and moment of inertia about its centre of mass I_{cm} has a light, thin string wrapped several times around its circumference. The free end of string is attaced to the celling and the object is released from rest. Find the acceleration of centre of the object and tension n the string. [Take $\frac{I_{cm}}{MR^2} = k$]

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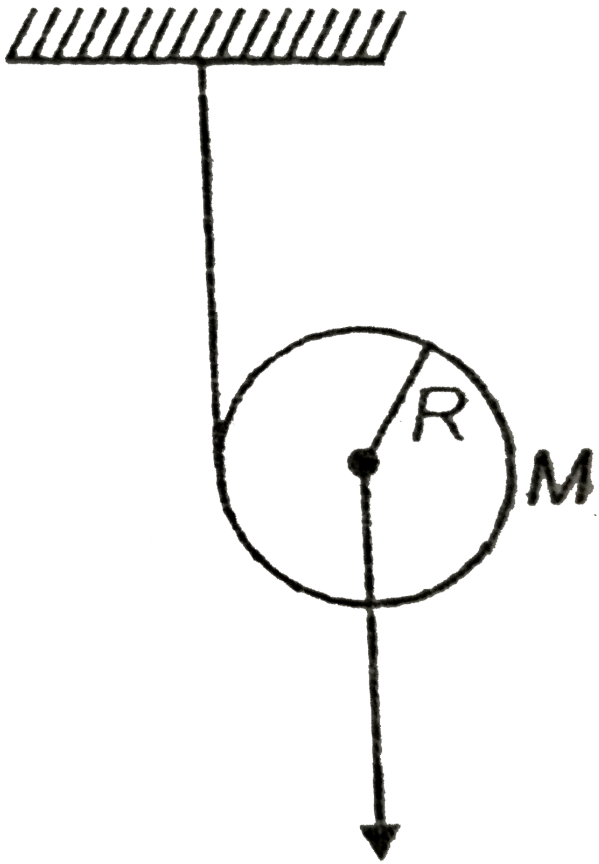
54. A disc of mass M has a light, thin string wrapped several times around its circumference. The free end of string is attaced to the ceiling and the disc is released from rest. Find the acceleration of the disc and the tension in the string.



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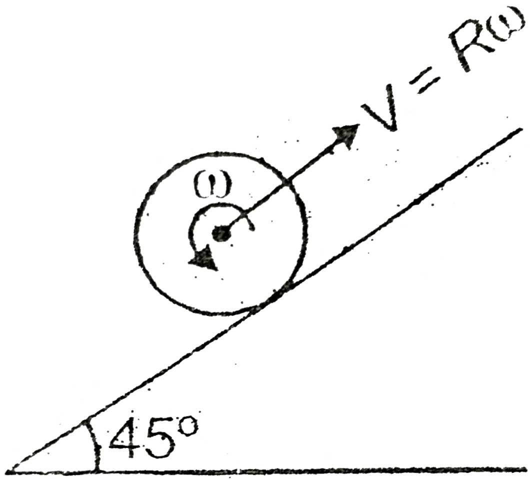
55. A solid sphere is projected along an inclined plane according to diagram. If coefficient of friction is $\mu = 0.5$ and radius R, then find

(a) Time when linear velocity becomes zero

(b) Angular velocity at that instant



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56. A uniform round object of mass m, radius R and moment of inertia about its centre of mas I_{cm} is thrown with speed v. (Without any rotation) on a rough horizontal surface of coefficient of fricition μ. Find (take $\frac{I_{cm}}{mR^2} = k$)

(a) Time after which slipping stops

(b) Speed of the round object after slipping stops

(c) Angular speed of the round object after slipping stops

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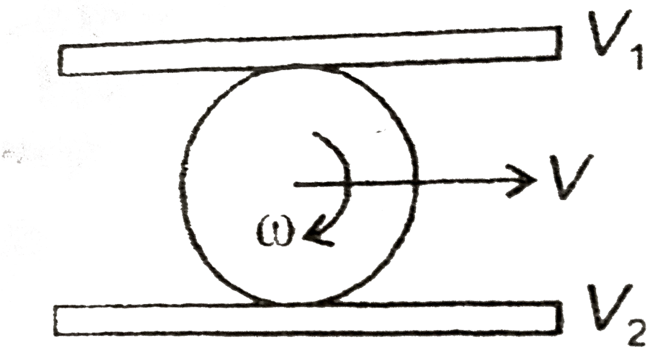
57. A sphere of radius R rolls without slipping between two planks as shown in figure. Find

(a) Speed of centre of sphere

(b) Angular velocity of the sphere



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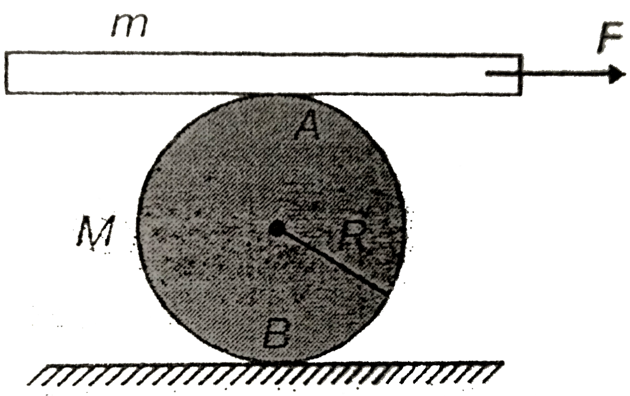
58. Consider a cylinder of mass M and radius R lying on a rough horizontal plane. It has a plank lying on its top as shown in the figure. A force F is applied on the plank such that the plank moves and causes the cylinder to roll. The plank always remains horizontal. There is no slipping at any point to contact.



(a) what are the directions of the fricition forces acting at A and B on the plank and the cylinder ?

(b) Calculate the acceleration of the cylinder.

(c) Find the value of frictional force at A & B.

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59. Calculate the kinetic energy of rolling ring of mass 0.2 kg about an axis passing through its centre of mass and perpendicular to it, if centre of mass is moving with a velocity of 3 m/s.

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60. A solid sphere is rolling down an inclined plane without slipping of height 20 m. Calculate the maximum velocity with which it will reach the bottom of the plane $\left(g = 10m/s^2\right)$

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61. A cylinder of mass m and radius R is kept on a rough surface after giving its centre a horizontal speed v_0. Find the speed of the centre of the cylinder when it stops slipping.

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62. A disc of radius r is cut from a larger disc of radius 4r in such a way that the edge of the hole touches the edge of the disc. The centre of mass of the residual disc will be a distance from centre of larger disc :-

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63. The linear density of a thin rod of length 1m lies as $\lambda = (1 + 2x)$, where x is the distance from its one end. Find the distance of its center of mass from this end.

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64. Two bodies of masses 1 kg and 2 kg are located at (1,2) and (-1,3), respectively. Calculate the coordinates of center of mass.

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65. The coordinates of a triangle ABC are $A(1, 2)$, $B(4, 6)$ and $C(-3, -2)$. Three particles of masses $1kg$, $2kg$ and mkg are placed the vertices of the triangle. If the coordinate of the centre of mass are $\left(\frac{3}{5}, 2\right)$, calculate the mass m.

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66. Three point masses $m_1 = 2Kg, m_2 = 4kg$ and $m_3 = 6kg$ are kept at the three corners of an equilateral triangle of side 1 m. Find the locationo of their center of mass.

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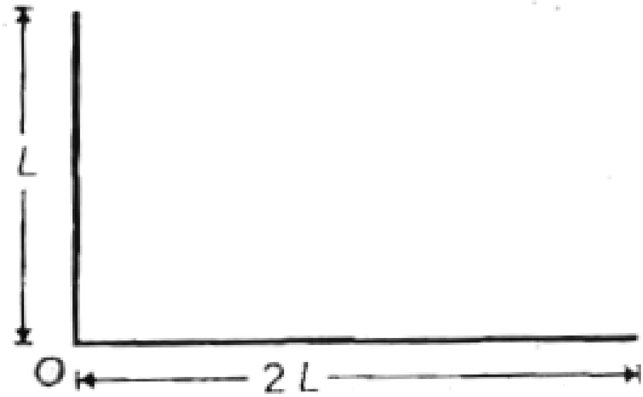
67. The object shown in figure is constructed of uniform rods of same material. Find the position of centre of mass w.r.t. its corner O.



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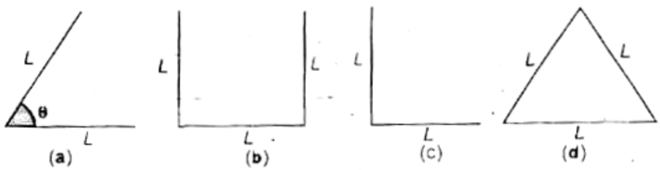
68. The objects in the figure are constructed of uniform wire bent into the shape shown. Find the position of the position of the centre of mass of each shape.



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70. If no external force acts on a system

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71. A man of mass M stands at one end of plank of length L which lies at rest on a frictionless surface. The man walks to the other end of the plank. If the mass of the plank is $\left(\frac{M}{3}\right)$, the distance that the man move relative to the ground is

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72. Find the scalar and vector products of two vectors $\overrightarrow{a} = \left(2\hat{i} - 3\hat{j} + 4\hat{k}\right)$ and $\overrightarrow{b} = \left(\hat{i} - 2\hat{j} + 3\hat{k}\right)$.

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76. The angular velocity of a flywheel change from 6 rad s^{-1} to 18 rad s^{-1} in 6 seconds. Calculate its angular acceleration.

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77. A fan is rotating with a speed of 450 rec/minute. After being switched off it comes to rest in 10s. Assuming constant angular deceleration, calculate the number of revolutions made by it before coming to rest.

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79. A force $\left(\hat{i} - 2\hat{j} + 3\hat{k}\right)$ acts on a particle of position vector $\left(3\hat{i} + 2\hat{j} + \hat{k}\right)$. Calculate the torque acting on the particle.

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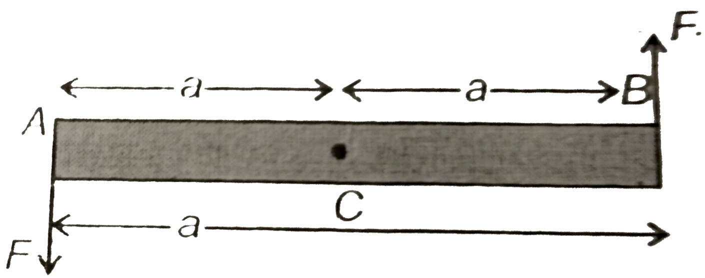

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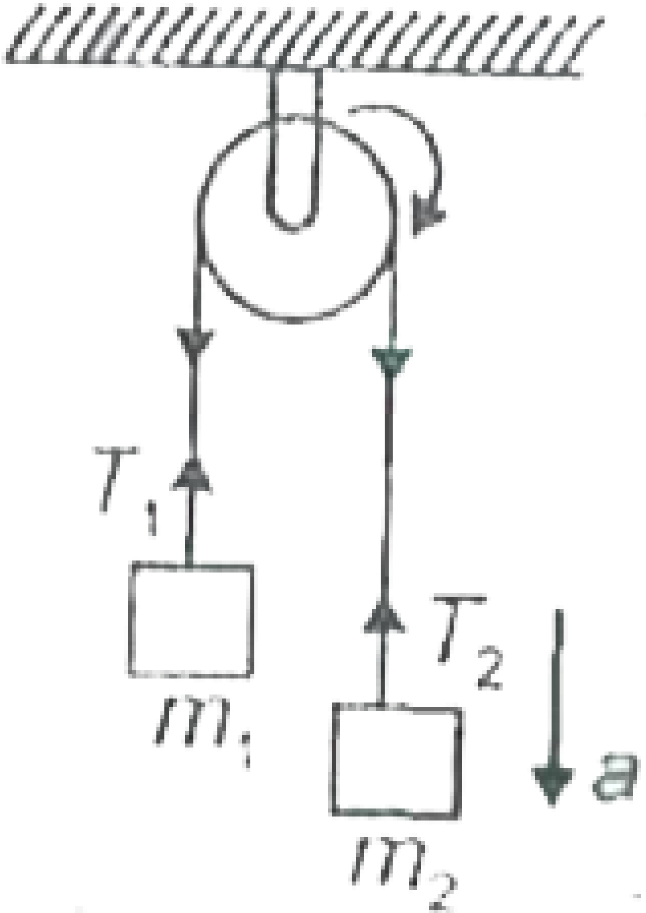
91. Figure shows a pulley of mass m and radius r with two blocks of masses m_1 and m_2 attached with a light and unstretchable string. Find the acceleration of the blocks, tensions in the string and the force exerted by the pulley on the celling from which it is hanging. Assume no slipping between the string and the wheel.



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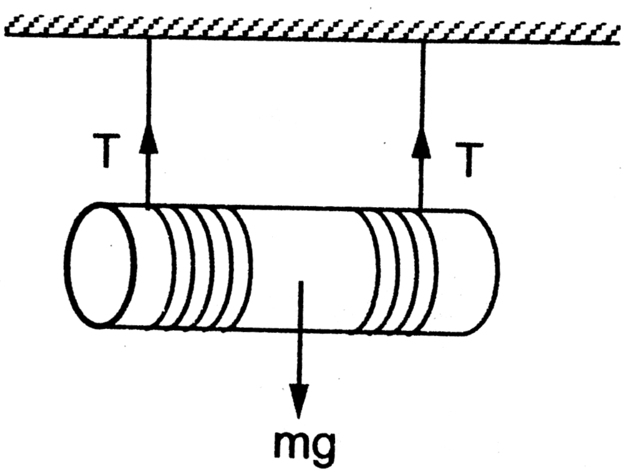
92. A cylinder of mass m is suspended through two strings wrapped around it as shwon in figure . Find (a). the tension T in the string and (b). the speed o the cylinder as it falls through a distance h.



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93. Two boys are holding a horizontal rod of length L and weight W through its two ends. If now one of the boys suddenly leaves the rod, what is the instantaneous reaction force experienced by the other boy ?

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94. Calculate the instantenous power of a wheel rotating with an angular velocity of $20\text{rad}/s$, when a torque of $10Nm$ is applied to it.

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95. Compute the angular acceleration of a wheel having moment of inertia $20kgm^2$, when a torque of $10Nm$ is applied on the wheel.

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96. A flywheel having moment of inertia $20kgm^2$ rotates about its axis with an angular velocity of $100rads^{-1}$. If the moment of inertia of the flywheel is reduced to $10kgm^2$ without applying external torque, calculate the new angular velocity of the Flywheel.

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97. The moment of inertia of a copper disc, rotating about an axis passing through its centre and perpendicular to its plane

Watch Video Solution

98. Calculate the kinetic energy of rolling ring of mass 0.2 kg about an axis passing through its centre of mass and perpendicular to it, if centre of mass is moving with a velocity of 3 m/s.

Watch Video Solution

99. A solid sphere is rolling down an inclined plane without slipping of height 20 m. Calculate the maximum velocity with which it will reach the bottom of the plane $(g = 10m/s^2)$

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100. A solid sphere is rolling without slipping on a level surface at a constant speed of

$2ms^{-1}$. How far can it roll up a 30° ramp before its stops ?

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101. When a body is under pure rolling, the fraction of its total kinetic energy which is the purely rotational is 2/5. Identify the body.

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Illustration

1. A square plate of side 'a' and mass 'm' is lying on a horizontal floor. A force F is applied at the top. Find the maximum force that can be applied on the square plate so that the plate does not topple about A.

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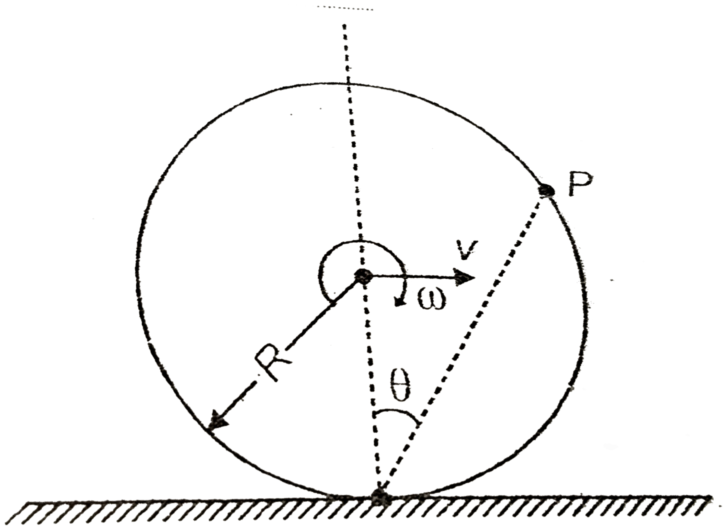
2. The velocity of a point P on the surface of a pure rolling disc as shown in figure, can be calculated as given below.



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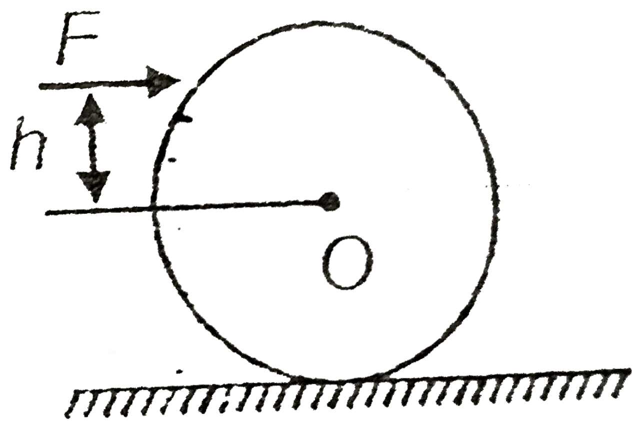
3. A uniform round body of radius R and mass m and its moment of inertia about centre of mass O is I_{cm} is given. A force F is applied at a height h above the centre of the round body.

Find the height h at which force should be applied so that it rolls without friction.



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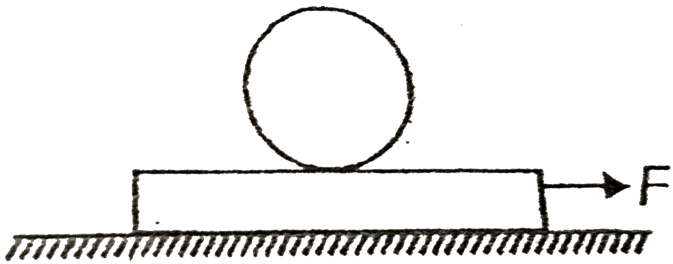
4. Consider a disc of mass m and radius R placed on a rough plank of mass M which is

turn is place on a smooth horizontal surface. Now plank is pulled by a force F and disc starts to roll on the plank.

If there is no friction any where then find

(a) Fricition force acting on the disc

(b) Angular acceleration of the disc



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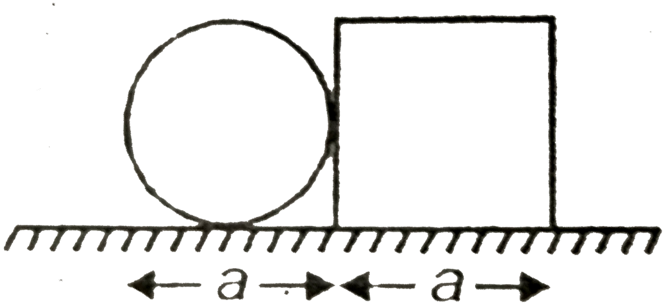
Assignment (Section - A) Objective Type Questions (One option is correct)

1. A circular plate of diameter $'a'$ is kept in contact with a square plate of side a as shown. The density of the material and the thickness are same everywhere. The centre of mass of composite system will be



A. Inside the circular plate

B. Inside the square plate

C. At the point of contact

D. Outside the system

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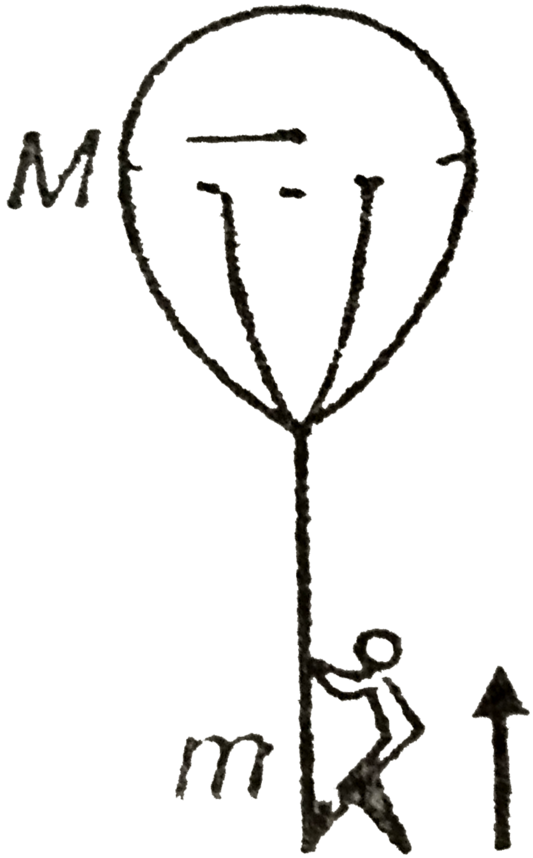
2. A man of mass m is suspended in air by holding the rope of a ballon of mass M. As the man climbs up the rope, the ballon



A. Moves upward

B. Moves downward

C. Remains stationary

D. Cannot say

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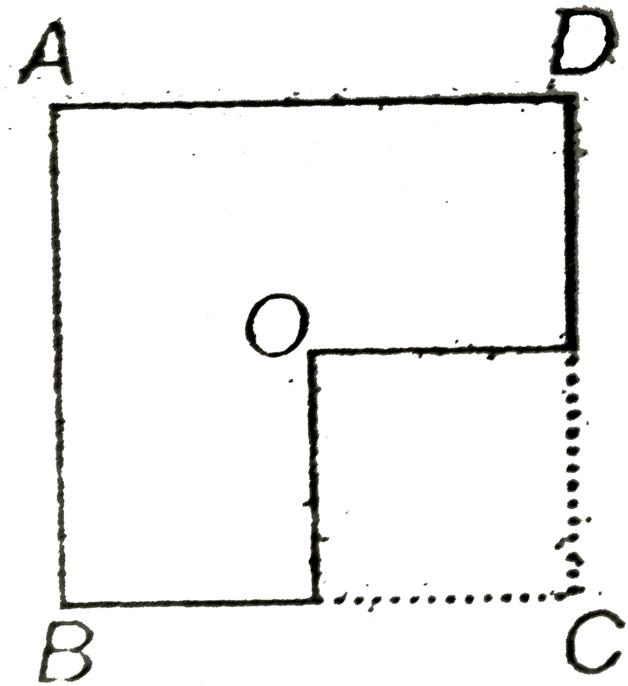
3. From a uniform square plate, one-fourth part is removed as shown. The centre of mass of remaining part will lie on



A. OC

B. OA

C. OB

D. OD

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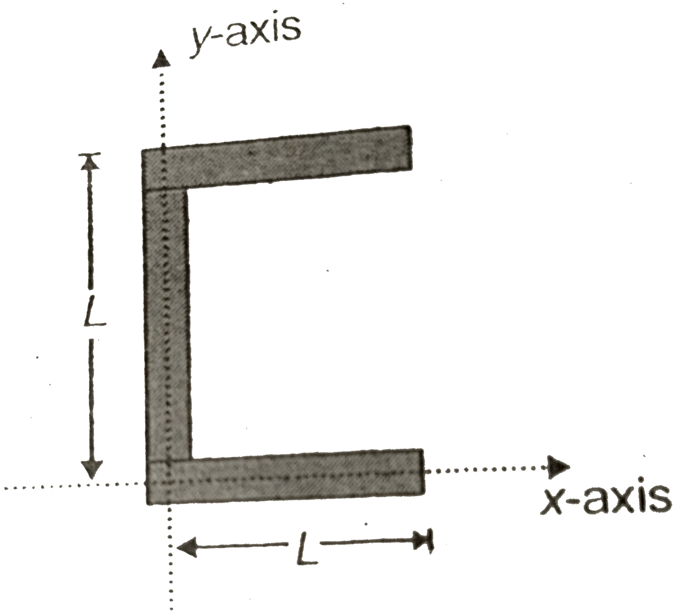
4. Locate the centre of mass of arrangement shown in figure. The three rods are identical in mass and length



A. $\left(\frac{L}{2}, \frac{L}{2}\right)$

B. $\left(\frac{L}{3}, 0\right)$

C. $\left(\frac{L}{3}, \frac{L}{2}\right)$

D. $\left(0, \frac{L}{3}\right)$

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5. A particle of mass m is thrown horizontally from the top of a tower and anoher particle of mass $2m$ is thrown vertically upward. The acceleration of centre of mass is

A. g

B. $\frac{9g}{3}$

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

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

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6. A child is standing at one end of a long trolley moving with a speed v on a smooth horizontal floor. If the child starts running towards the other end of the trolley with a speed u, the centre of mass of the system (trolley + child) will move with a speed

A. Zero

B. $(v + u)$

C. v

D. $(v - u)$

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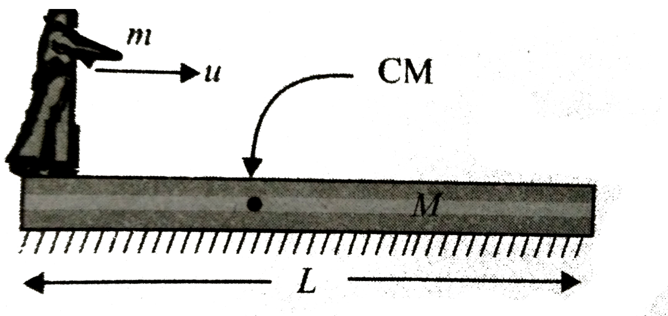
7. A man of mass m moves on a plank of mass M with a constant velocity u with respect to the plank, as shown in figure.

a.If the plank rests on smooth horizontal surface, determine the velocity of the plank. .



A. $\dfrac{Mv}{m+M}$

B. $\dfrac{mv}{M}$

C. $\dfrac{Mv}{m}$

D. $\dfrac{mv}{m+M}$

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8. Two blocks of masses 5kg and 2kg are connected by a spring of negligible mass and placed on a frictionless horizontal surface. An

impulse provides a velocity of 7m/s to the heavier block in the direction of the lighter block. The velocity of the centre of mass is :-

A. $4m/s$

B. $5m/s$

C. $2m/s$

D. $3m/s$

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9. A body falling vertically downwards under gravity breaks in two parts of unequal masses. The centre of mass of the two parts taken together shifts horizontally towards

A. Shifts horizontally towards heavier piece

B. Shifts horizontally towards lighter piece

C. Doesn't shift horizontally

D. Shifts horizontally if initial speed is zero

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10. A body at rest breaks into two pieces of equal masses. The parts will move

A. Arbitrarily

B. In the same direction

C. In opposite directions with equal speeds

D. In opposite directions with unequal speeds

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11. Let I_A and I_B be moments of inertia of a body about two axes A and B respectively. The axis A passes through the centre of massof the body but B does not. Choose the correct option.

A. $I_A < I_B$

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

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

D. If the axes are not parallel, then $I_A \geq I_B$

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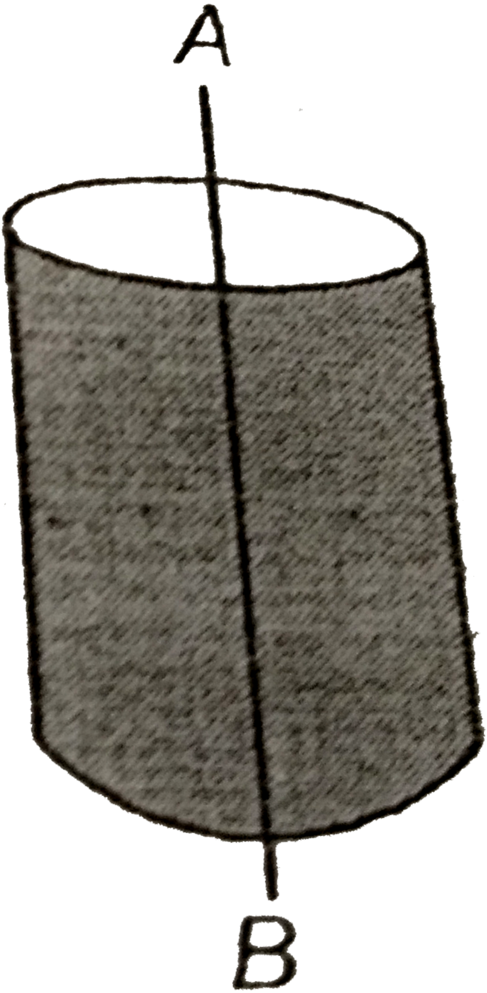
12. The moment of inertia of a cylinder of mass $1000gm$ and radius $20cm$ about the axis AB

shown in figure is



A. $0.04 kgm^2$

B. $0.02 kgm^2$

C. $0.026 kgm^2$

D. $0.016 kgm^2$

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13. The angular momentum changes from 4 unit to 10 unit in 2 seconds. The torque is

A. 3 unit

B. 12 unit

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

D. $\frac{1}{3}$ unit

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14. A constant torque of $400Nm$ turns a wheel of moment of inertia $100kgm^2$ about an axis through its centre. The angular velocity gained in 4 second is

A. 12 radian s^{-1}

B. 16 radian s^{-1}

C. 20 radian s^{-1}

D. 24 radian s^{-1}

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15. The masses of two uniform discs are in the ratio $2:1$ and their radii are in the ratio $1:2$. The ratio of their moments of inertia about the axis passing through their respective centres normal to plane is

A. $1:1$

B. $2:1$

C. $1:2$

D. $1:4$

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16. If the torque acting on a system is zero then, which of the followin quantities is conserced ?

A. Angular momentum

B. Kinetic energy

C. Linear momentum

D. Angular kinetic energy

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17. The moment of inertia of a thin uniform rod about an axis passing through its centre and perpendicular to its length is I_0. What is the moment of inertia of the rod about an axis passing through one end and perpendicular to the rod ?

A. $\frac{1}{2}I_0$

B. $3I_0$

C. $5I_0$

D. $4I_0$

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18. A rigid body of moment of inertia l has an angular acceleration α. If the instantaneous power is P then, the instantaneous angular velocity of the body is

A. $Pl\alpha$

B. $\frac{P}{l\alpha}$

C. $\frac{Pl}{\alpha}$

D. $\frac{P\alpha}{l}$

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19. A flywheel rotates about a fixed axis and slows down from 300 r.p.m to 100 r.p.m in 2 minutes. The angular retardation of the flywheel (in $\text{radian}/\text{minute}^2$) is

A. $\frac{100}{\pi}$

B. 100

C. 100π

D. 200π

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20. A body starting from rest gains an angular speed of 540 r.p.m in 6 second. The angular acceleration of the body is

A. $3\pi \text{radian}s^{-2}$

B. $6\pi \text{radian}s^{-2}$

C. $9\pi \text{radian}s^{-2}$

D. $12\pi \text{radian}s^{-2}$

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21. A ring of mass $6kg$ and radius $40cm$ is revolving at the rate of 300 rpm about an axis passing through its diameter. The kinetic energy of rotation of the ring is

A. $24\pi^2 J$

B. $48\pi^2 J$

C. $12\pi^2 J$

D. $6\pi^2 J$

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22. A ring of mass $10kg$ and diameter $0.4m$ is rotated about an axis passing through its centre. If it makes 1800 revolutions per minute then , the angular momentum of the ring is

A. $44\pi kgm^2 / s$

B. $88\pi kgm^2 / s$

C. $24\pi kgm^2 / s$

D. $48\pi kgm^2 / s$

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23. If radius of the earth contracts to half of its present value without change in its mass, what will be the new duration of the day?

A. 24 hours

B. 18hours

C. 6 hours

D. 3 hours

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24. A wheel whose moment of inertia is $10kgm^2$ has an initial angular velocity of $20rad/s$. A constant torque of $20Nm$ acts on the wheel. The time in which wheel is acceleration to $100rad/s$ is

A. $4s$

B. $40s$

C. $80s$

D. $8s$

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25. Two solid spheres are made up of the same material of density ρ. The ratio of their radii is $1:2$. The ratio of their moments of inertia about their respective diameters is

A. $1:4$

B. $1:2$

C. $1:16$

D. $1:32$

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26. A fan of moment of inertia $0.6kgm^2$ is moving with a speed of 0.5 r.p.s. The angular momentum of the fan is

A. $0.6\pi kgm^2s^{-1}$

B. $6\pi kgm^2s^{-1}$

C. $3\pi kgm^2s^{-1}$

D. $\frac{\pi}{6}kgm^2s^{-1}$

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27. A hollow cylinder open at both ends slides without rotating, and then rolls without slipping with the same speed. The ratio of the kinetic energy in the two cases is (taken in order)

A. $1:1$

B. $1:2$

C. $2:1$

D. $1:4$

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28. A solid sphere of mas $2kg$ rolls on a table with linear speed of $1m/s$. Its total kinetic energy is

A. $1J$

B. $0.5J$

C. $0.7J$

D. $1.4J$

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29. The moment of inertia of a uniform cicrular disc about its diameter is $200gcm^2$. Its moment of inertia about an axis passing through its centre and perpendicular to its circular face is

A. $100gcm^2$

B. $200gcm^2$

C. $400gcm^2$

D. $1000cm^2$

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30. A flywheel rotating about a fixed axis has a kinetic energy of $360J$ when its angular speed is 30 radian s^{-1} . The moment of inertia of the wheel about the axis of rotation is

A. $0.6kgm^2$

B. $0.15kgm^2$

C. $0.8kgm^2$

D. $0.75kgm^2$

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

A. $5:7$

B. $3:5$

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

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

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32. The moment of inertia of a body about a given axis is $1.2 kgm^2$. Initially, the body is at rest. In order to produce a rotational KE of $1500J$, for how much duration, an acceleration of $25 rads^{-2}$ must be applied about that axis ?

A. $4s$

B. $2s$

C. $8s$

D. $10s$

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33. A solid cylinder of mass $20kg$ rotates about its axis with angular velocity of 100 radian s^{-1}. The radius of the cylinder is $0.25m$. The magnitude of the angular momentum of the cylinder about its axis of rotation is

A. $62.5Js$

B. $625Js$

C. $0.625s$

D. $6.25s$

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34. A solid sphere is rolling without slipping on a horizontal plane. The ratio of its rotational kinetic energy and translational kinetic energy is

A. $2:3$

B. $2:5$

C. $2:7$

D. $2:9$

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35. If I_1 is the moment of inertia of a thin rod about an axis perpendicular to its length and passing through its centre of mass and I_2 is the moment of inertia (about central axis) of the ring formed by bending the rod, then the ratio of I_1 to I_2 is

A. $1:1$

B. $\pi^2:3$

C. $\pi:4$

D. $3:5$

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36. A wheel of moment of inertia $30kgm^2$ is rotating at 10 rotations per minute. The work done in increasing its speed to 5 times its initial value will be

A. $10\pi^2 J$

B. $20\pi^2 J$

C. $30\pi^2 J$

D. $40\pi^2 J$

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37. A ring of mass $1kg$ and radius $1m$ is moving with a velocity of $1m/s$ by rolling on a frictionless inclined plane. The total kinetic energy of the ring is

A. $1J$

B. $2J$

C. $4J$

D. $8J$

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38. A disc and a ring of the same mass are rolling down frictionless inclined plane, with the same kinetic energy. The ratio of the velocity of disc to the velocity of ring is

A. $1 : \sqrt{3}$

B. $2 : \sqrt{3}$

C. $3 : \sqrt{3}$

D. $4 : \sqrt{3}$

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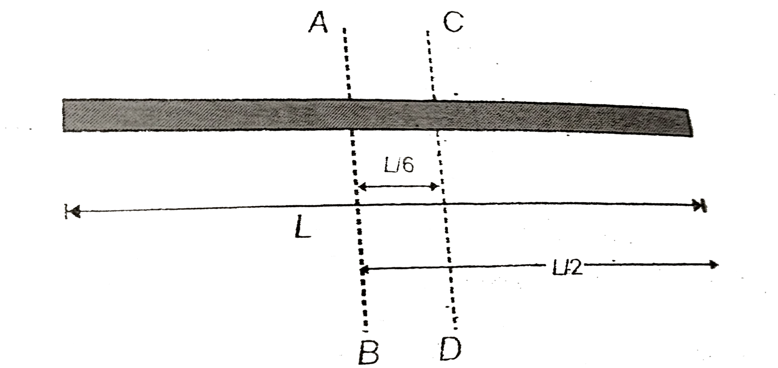
39. The moment of inertia of a thing uniform rod of length L and mass M, about axis CD (as shown in figure) is



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

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

C. $\frac{ML^2}{9}$

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

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40. Two bodies with moment of inertia l_1 and l_2 $(l_1 > l_2)$ have equal angular momentum. If E_1 and E_2 are the rotational kinetic energies, then

A. $E_1 = E_2$

B. $E_1 > E_2$

C. $E_1 < E_2$

D. $E_1 \geq E_2$

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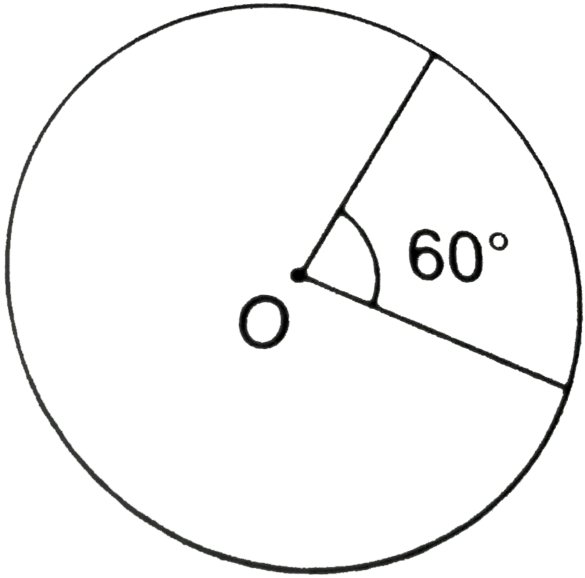
41. From a circular disc of mass M and radius R, a part of 60° is removed. The $M.I.$ of the remaining portion of disc about an axis passing through the center and perpendicular to plane of disc is



A. $\dfrac{MR^2}{12}$

B. $\dfrac{5}{12}MR^2$

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

D. $\dfrac{MR^2}{6}$

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

A. Ring

B. Disc

C. Hollow cylinder

D. Hollow sphere

Watch Video Solution

43. The angular velocity of a body is $\overrightarrow{\omega} = 3\hat{i} + 5\hat{j} + 6\hat{k}(\text{radian}/s)$. A torque $\overrightarrow{\tau} = \hat{i} + 2\hat{j} + 3\hat{k}(Nm)$ acts on it. The rotational power (in watt) is

A. 31

B. 18

C. 28

D. 3

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44. When a solid cylinder rolls without slipping the ratio of kinetic energy of translation to its total kinetic energy is

A. $2:1$

B. $1:2$

C. $2:3$

D. $3:2$

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45. The torque required to stop a wheel having moment of inertia $5 \times 10^{-3} kgm^2$ from a speed of 10 radian s^{-1} in $20s$ is

A. $2.5Nm$

B. $2.5 \times 10^{-2} Nm$

C. $2.5 \times 10^{-3} Nm$

D. $0.25 Nm$

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46. The position vector of a point is $\left(3\hat{i} - 2\hat{j} + 6\hat{k}\right)m$. The i^{th} component of torque of force $\left(2\hat{i} + 3\hat{j} - 6\hat{k}\right)N$ acting at the point about origin in (Nm) is

A. -6

B. 30

C. 13

D. 2

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47. A particle performing uniform circular motion gas angular momentum L. If its angular frequency is double and its kinetic energy halved, then the new angular momentum is :

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

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

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

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

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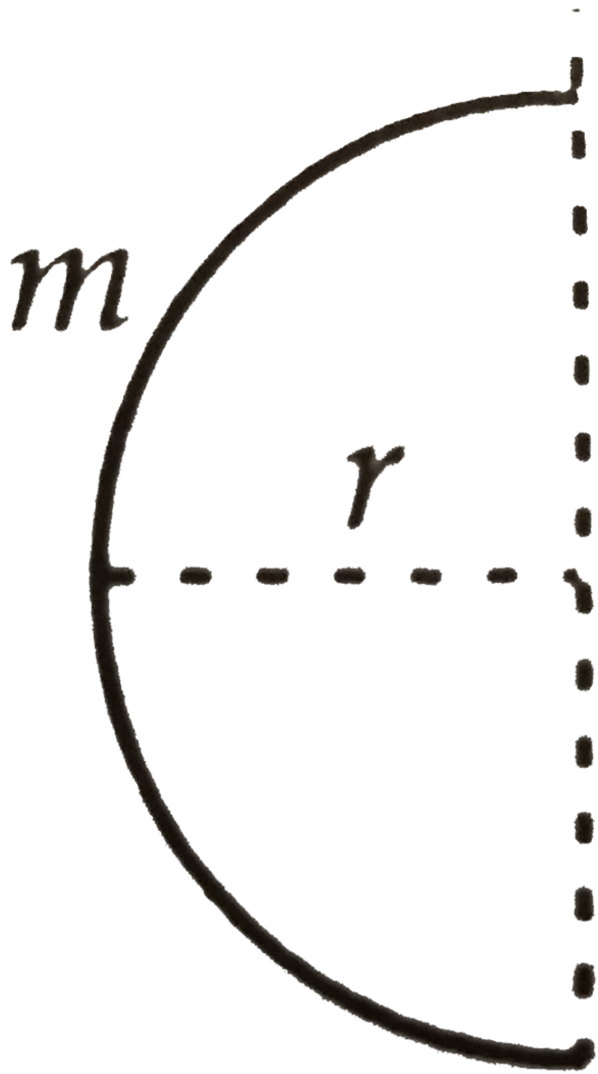
48. A thin wire of length l and mass m is bent in the form of a semicircle as shown in the figure. Its moment of inertia about an axis joining its free ends will be



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

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

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

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

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49. A constant torque acting on a uniform circular wheel changes its angular momentum from A_0 to $2A_0$ in $1s$. The magnitude of this torque is

A. $2A_0$

B. A_0

C. $\frac{A_0}{2}$

D. Zero

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50. Which of the following is correct ?

(symbols have their ususal meanings)

A. $\tau = l\alpha$

B. $\tau = l\omega$

C. $l = \tau\omega$

D. $\alpha = \tau\omega$

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51. A dancer on ice spins faster when she folds her arms due to

A. Decrease in friction

B. Constant angular momentum

C. Decrease in angular momentum and decrease in kinetic energy

D. Increase in angular momentum and increase in kinetic energy

Watch Video Solution

52. A solid sphere of radius r and mass m rotates about an axis passing through its centre with angular velocity ω. Its $K.E.$ Is

A. $mr^2\omega^2$

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

C. $\frac{1}{2}mr^2\omega^2$

D. $\frac{1}{5}mr^2\omega^2$

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53. The moment of inertia of a solid cylinder of density ρ, radius of base r, and height h about an axis passing through its centre of mass and parallel to length is

A. $\frac{\pi}{2} r^4 h \rho$

B. $\frac{\pi}{2} r^2 h \rho$

C. $\frac{\pi}{2} r^3 h \rho$

D. $\frac{\pi}{2} r h \rho$

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

A. Increase

B. Decrease

C. Remain the same

D. Become double

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55. Radius of gyration has the unit

A. m

B. kg

C. $kg - m$

D. $kg - m^2$

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56. A bomb at rest explodes. The centre of mass

A. Moves along a parabolic path

B. Moves along an elliptical path

C. Moves along a straight line

D. Remains at rest

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57. If $\vec{A} \cdot \vec{B} = \left|\vec{A} \times \vec{B}\right|$. Then angle between $\vec{A}$ and $\vec{B}$ is

A. Zero

B. $\dfrac{\pi}{2}$

C. π

D. $\dfrac{\pi}{4}$

58. Write SI unit of angular momentum:

A. Nm

B. $kgm^{-1}s^{-1}$

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

D. $kg^{2}m^{2}s^{-1}$

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59. If $\vec{\omega} = 2\hat{i} - 3\hat{j} + 4\hat{k}$ and $\vec{r} = 2\hat{i} - 3\hat{j} + 2\hat{k}$ then the linear velocity is

A. $6\hat{i} + 4\hat{j}$

B. $2\hat{i} - 3\hat{j} + 4\hat{k}$

C. $6\hat{i} + 4\hat{k}$

D. $2\hat{i} - 3\hat{j} + 2\hat{k}$

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60. The moment of inertia of a body does not depend on

A. Axis of rotation

B. Mass of the body

C. Distribution of mass

D. Angular velocity

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61. A solid sphere, disc and solid cylinder all of the same mass and made of the same material are allowed to roll down (from rest) on the inclined plane, then

A. The cylinder will reach the bottom first

B. The disc will reach the bottom first

C. The sphere will reach the bottom first

D. All will reach the bottom at the same time

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

A. v

B. $\sqrt{2}v$

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

D. $\left(\sqrt{\frac{2}{5}}\right)v3$

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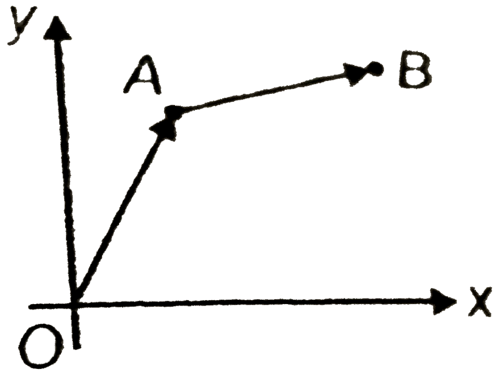
Assignment (Section - B) Objective Type Questions (One option is correct)

1. Two masses $2kg$ and $5kg$ are placed at points $'A'$ and $'B'$ as shown in the figure



$\vec{O A} = 2\hat{i} + 3\hat{j}$

$\vec{A B} = 5\hat{i} + 8\hat{j}$

Find the co-ordinates of centre of mass.

A. $\left(\frac{39}{7}, \frac{61}{7}\right)$

B. $\left(\frac{36}{7}, \frac{58}{7}\right)$

C. $\left(\frac{39}{7}, \frac{63}{7}\right)$

D. $\left(\frac{29}{7}, \frac{61}{7}\right)$

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2. A shell following a parabolic path explodes somewhere in its flight. The centre of mass of fragements will move in

A. Tangential direction

B. Radial direction

C. Horizontal direction

D. Same parabolic path

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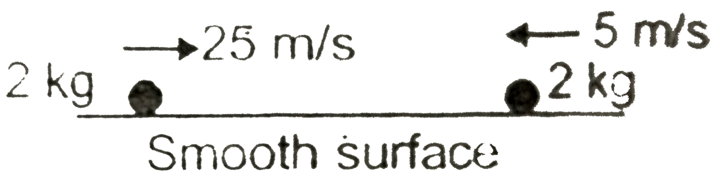
3. The velocity of the centre of mas of the system of two particle each of mass $2kg$, as shown in figure, is



A. $5m/s$

B. $10m/s$

C. $2.5 m/s$

D. $15 m/s$

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4. When a stick of length L mass M intially upright on a fricitionless floor starts falling the

A. Center of mass will fall vertically down

B. Center of mass will follow a circular path

C. Center of mass will follow any curved path

D. All of these

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5. If two particles of masses m_1 and m_2 are projected vertically upwards with speed v_1 and v_2, then the acceleration of the centre of mass of the system is

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

B. g

C. $\frac{m_1 g}{m_1 + m_2}$

D. $\frac{m_2 g}{m_1 + m_2}$

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6. Two parrticles A and B intially at rest move towards each other under a mutual force of attraction. The instant at which velocity of A is

$4v$ and velocity of B is $2v$, the velocity of centre of mass of the system at that instant will be

A. v

B. $2v$

C. $3v$

D. Zero

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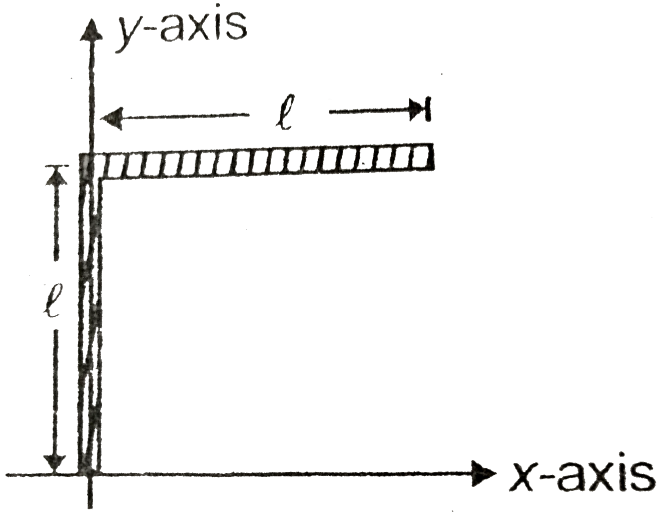
7. A rod of length $2l$ is bent as shown in figure.

Coordinates of centre of mass are



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

B. $\left(\frac{l}{8}, \frac{l}{8}\right)$

C. $\left(\frac{l}{4}, \frac{3l}{4}\right)$

D. $\left(\frac{l}{3}, \frac{l}{6}\right)$

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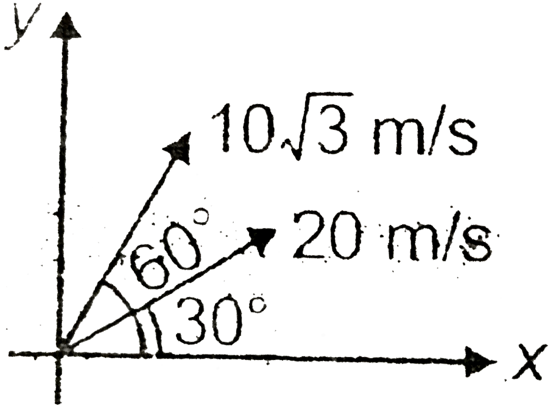
8. Two particles of equal mass are projected simultaneously with speeds $20m / s$ end $10\sqrt{3}m / s$ as shown in figure. Find the maximum height reached by the centre of mass of the particles



A. $\frac{25}{4}m$

B. $\frac{75}{16}m$

C. $\frac{125}{16}m$

D. $\frac{125}{4}m$

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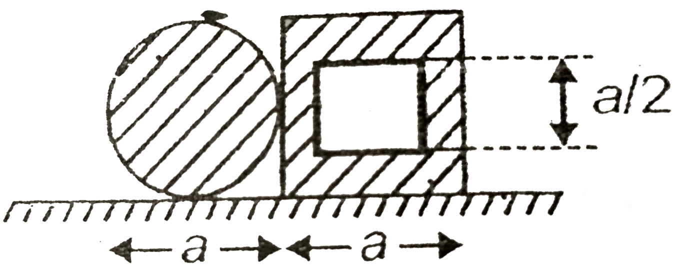
9. A circular plate of diameter $'a'$ is kept in contact with a square plate of side a as shown. The density of the material and the thickness are same everywhere. The centre of mass of composite system will be



A. Inside the circular plate

B. Inside the square plate

C. At the point of contact

D. Outside the system

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10. A body of mass m is projected from ground for horizontal range R. At the highest point it is fragmented into two identical parts. If one parts returns back to the point of projection, then other part will have the horizontal range

A. R

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

C. $2R$

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

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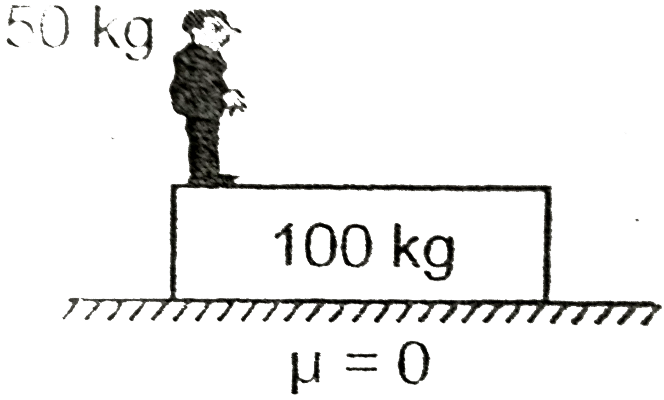
11. A man of mass $50kg$ us standing on a $100kg$ plank kept on a fricitonless horizontal floor. Initially both are at rest. If the man starts walking on the plank with speed $6m/s$ towards right relative to the plank, then amount of muscle energy spent by the man is



A. $600J$

B. $200J$

C. $400J$

D. $500J$

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12. A man of mass m jumps onto a boat which has a mass M. If the person has a horizontal component of velocity v relative to boat, just before he enters the boat and the boat is travelling at speed v_0 away from the pier when he makes the jump, the resulting speed of man and boat is

A. $\dfrac{mv + (M+m)v_0}{M+m}$

B. $\dfrac{mv}{M+m}$

C. $\dfrac{Mv_0}{M+m} + \dfrac{mv}{M+m}$

D. $\dfrac{mv + Mv_0}{M+m}$

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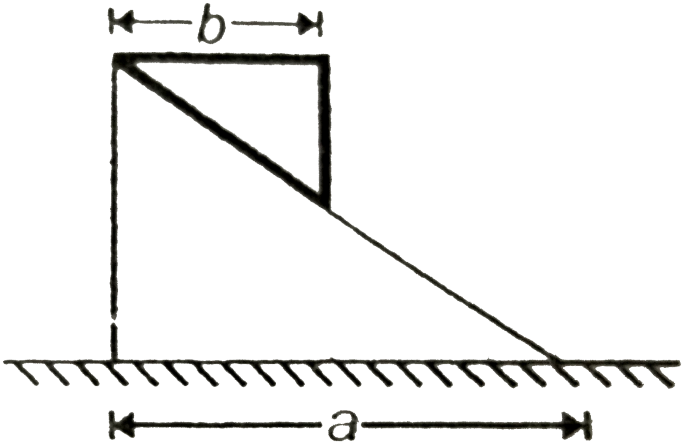
13. Two smooth prisms of similar right-triangular sections are arranged on a smooth horizontal plane as shown in figure. The lower prism has a mass η times the upper prism. The prisms are held in an initial position as shown and are then released. As the upper prism touches the horizontal plane, the distance moved by the lower prism is



A. $(a-b)$

B. $\dfrac{a-b}{\eta}$

C. $\dfrac{a-b}{(1-\eta)}$

D. $\dfrac{a-b}{1+\eta}$

Answer: D

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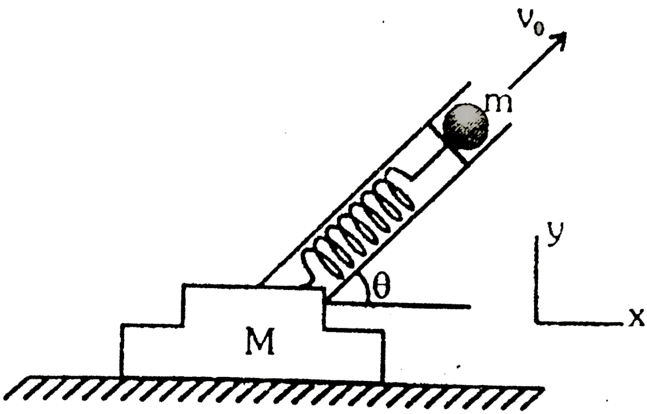
14. Spring Gun Recoil

A loaded spring gun, initially at rest on a horizontal frictionless surface, fires a marble at angle of elevation theta. The mass of the gun is M, the mass of the marble is m, and the muzzle velocity of the marble is v_0. What is the final motion of the gun ?



A. $\dfrac{mv_0 \cos\theta}{M}$

B. $\dfrac{mv_0}{m+M}$

C. $\dfrac{mv_0 \sin\theta}{m+M}$

D. $\dfrac{mv_0 \cos\theta}{(m+M)}$

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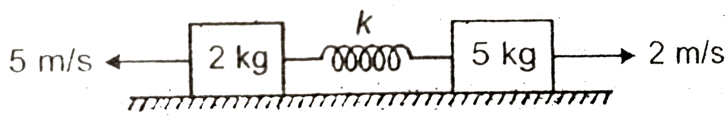
15. Two blocks of mass $2kg$ and $5kg$ are given speed as shown in the figure. System is lying on a frictionless surface and the blocks are connected by a massless spring if spring constant $35\frac{N}{m}$. Find the maximum compression in the spring.



A. $2\sqrt{2}m$

B. $\sqrt{2}m$

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

D. $2(\sqrt{2}+1)m$

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16. A ball is allowed to fall from rest on a horizontal floor from a height of $10m$. If there is 20% loss of energy due to impact, then after one impact ball will go upto

A. $10m$

B. $8m$

C. $4m$

D. $6m$

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17. A particle is dropped from rest from a height h_0 on a horizontal floor. The coefficient of restitution between the floor and particle is

e. Maximum height attained by the particle after first rebound is

A. eh_0

B. e^2h_0

C. e^3h_0

D. e^4h_0

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18. During collision between the objects.

A. The kinetic energy of centre of mass of the system remains constant

B. The kinetic energy of centre of mass of the system increase

C. The kinetic energy of centre of mass of the system decreases

D. The kinetic energy of centre of mass of the system can increase or decrease depending upon the situation

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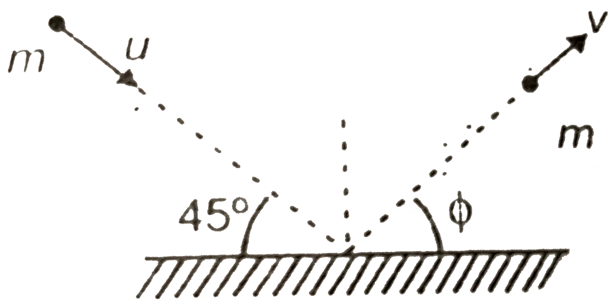
19. A particle of mass m moving with a speed u strikes a smooth horizontal surface at an angle 45°. The particle rebounds at an angle ϕ with speed v. If coefficient of restituion is $\frac{1}{\sqrt{3}}$, then angle ϕ is



A. 30°

B. 45°

C. 60°

D. 37°

Answer: option 1

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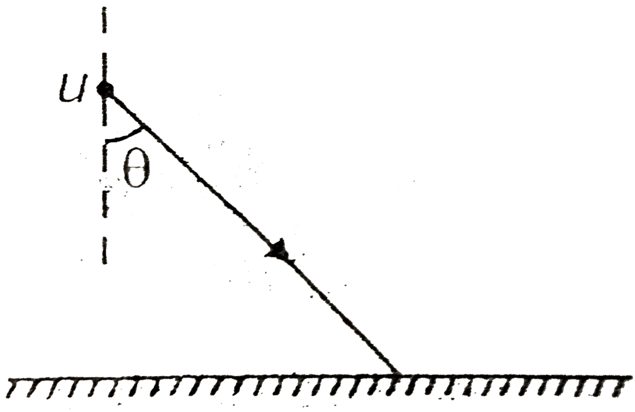
20. A particle collides with a smooth, surface with speed u at an angle θ. Coefficient of restitution is e. Find the ratio of the horizontal ranges of two consecutive projectile motions



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

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

C. $\frac{1}{e\cos\theta}$

D. $\frac{1}{e^2\cos\theta}$

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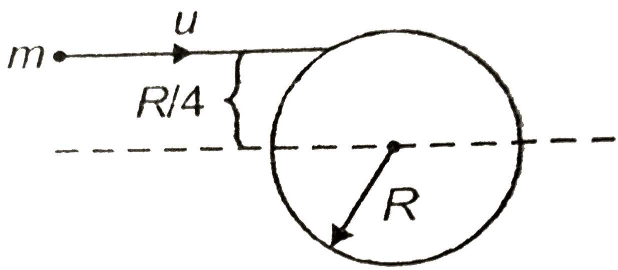
21. A particle of mass m strikes a disc of radius R and mass m with a speed u as shown in the figure. What is the speed of the particle just after the collision if the collision is perfectly inelastic ?



A. $\frac{u\sqrt{21}}{4}$

B. $\frac{u\sqrt{19}}{4}$

C. $\frac{u\sqrt{19}}{8}$

D. $\frac{u\sqrt{21}}{8}$

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22. Two identical billiard balls are in contact on a table. A third identical ball strikes them symmetrically and comes to rest after impact. The coefficient of restitution is :

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

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

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

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

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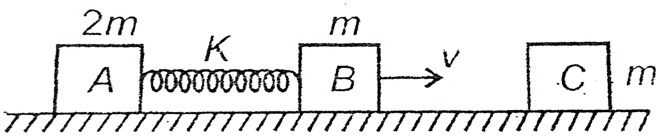
23. Two blocks A and B of mass $2m$ and m respectively are connected to a massless spring of force constant K as shown in figure A and B are moving on the horizontal frcitionless surface with velocity v to right with underformed spring. If B collides with C elastically, then maximum compression of the spring will be



A. $\sqrt{\frac{2m}{3K}}v$

B. $\sqrt{\frac{m}{K}}v$

C. $\sqrt{\frac{4m}{3K}}v$

D. $\sqrt{\frac{5m}{3K}}v$

Answer: 1

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24. A ball of mass M moving with speed v collides perfectly inelastically with another ball of mass m at rest. The magnitude of impulse imparted to the first ball is

A. mv

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

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

D. None of these

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25. A body of mass m moving with a velocity v is approaching a second object of same mass but at rest. The kinetic energy of the two objects as viewed from the centre of mass is

A. mv^2

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

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

D. $\frac{1}{8}mv^2$

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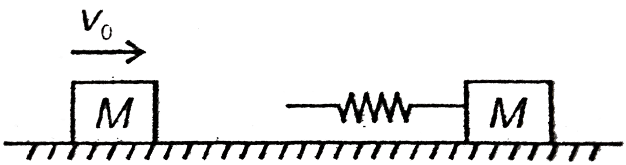
26. A body of mass M is moving on a smooth surface with speed v_0. Another body of same mass M attached to a spring is kept on the same surface as shown. The moving mas makes an impact with the spring of spring constant k and starts compressing it. What is the maximum compression in the spring ?



A. $v_0\sqrt{\frac{M}{k}}$

B. $\sqrt{\frac{v_0 M}{k}}$

C. $v_0\sqrt{\frac{M}{2k}}$

D. $v_0\sqrt{\frac{2M}{k}}$

Answer: 3

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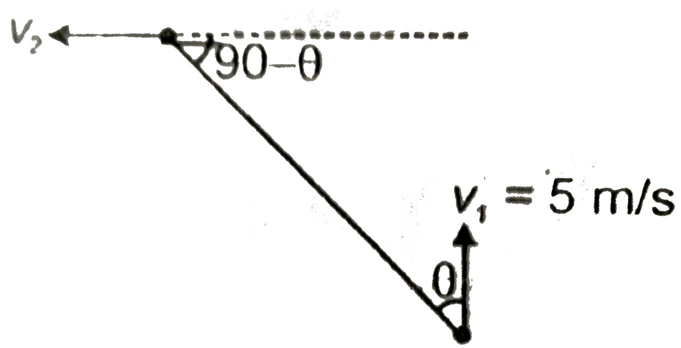
27. A rigid rod is rotating as well as translating on a smooth horizontal surface. The velocities of its ends at any moment are as shown in figure. If $\theta = 60^\circ$ find the value of v_2



A. $8.66 m/s$

B. $5 m/s$

C. $4 m/s$

D. $2.88m/s$

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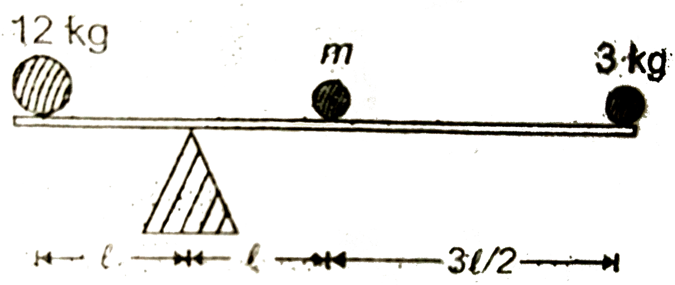
28. For the equilibrium of the system shown, the value of mass m should be



A. $9kg$

B. $12kg$

C. $21kg$

D. $4.5kg$

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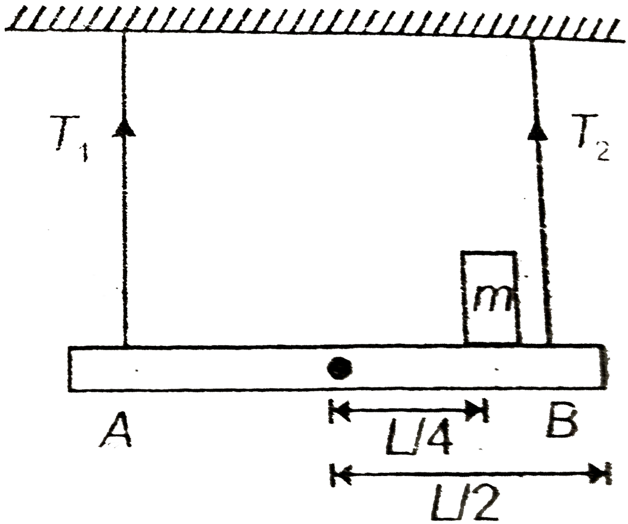
29. A rod AB of mass m is hung by two ideal threads. Find the ratio of tensions in the two threads $\left(\frac{T_1}{T_2}\right)$.



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

B. (1)/(3)

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

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

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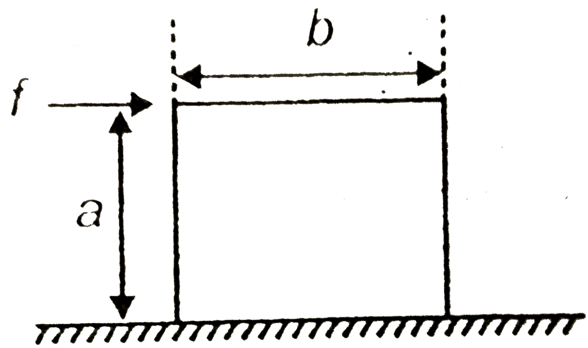
30. A cubical block of height a and width b is placed on the horizontal surface with sufficient fricition. For a given force.



A. Probability of toppling is more if $b > a$

B. Probability of toppling is more if $a > b$

C. Probability of toppling is more if $a = b$

D. Block will not topple at all

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31. A uniform solid cylinder having height l and diameter d is placed on a rough horizontally plank which is being pulled horizontal with an acceleration. Find the maximum value of the acceleration for which the cylinder remain in equilibrium

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

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

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

D. $\frac{gl}{2d}$

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32. The moment of inertia of a flat angular ring is having mass M, inner radius a and outer radius b about the perpendicular axis through the centre is

A. $M(b^2 - a^2)$

B. $\frac{M}{2}(b^2 - a^2)$

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

D. $\frac{M}{2}(b - a)$

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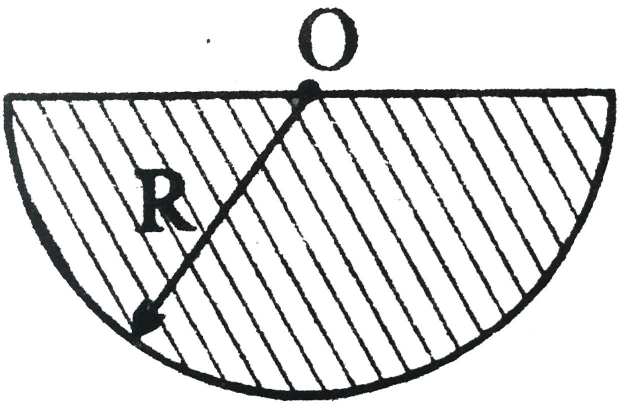
33. Moment of inertia of a thin semicircular disc $(mass - M\&radius = R)$ about an axis through point O and perpendicular to plane of disc, is given by :



A. MR^2

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

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

D. $2MR^2$

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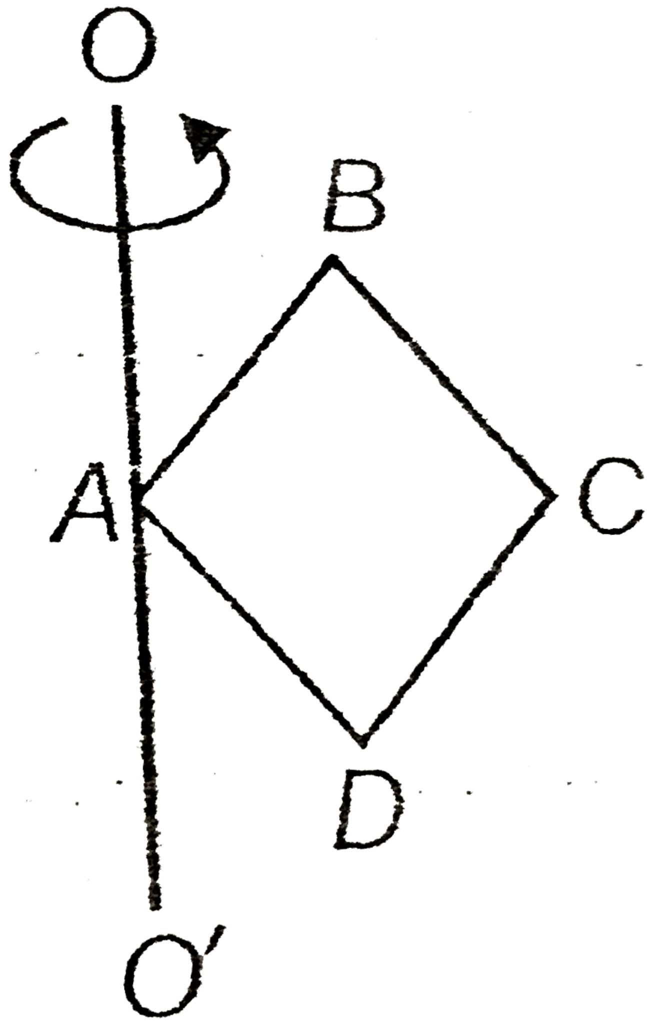
34. Four rods of equal mass m and length L. Forms a square $ABCD$ as shown in figure. The moment of inertia of $ABCD$ about the axis OO' passing through the point A is



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

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

C. $4mL^2$

D. $\frac{8}{3}mL^2$

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35. Moment of inertia of a disc about an axis parallel to diameter and at a distance x from the centre of the disc is same as the moment of inertia of the disc about its centre axis. The radius of disc is R. The value of x is

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

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

C. R

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

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36. Two spheres each of mass M and radius $R/2$ are connected with a massless rod of length R. Find the moment of inertia of the system about an axis passing through the centre of one of the sphere and perpendicular to the rod

A. $\frac{21}{5}MR^2$

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

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

D. $\frac{2}{21}MR^2$

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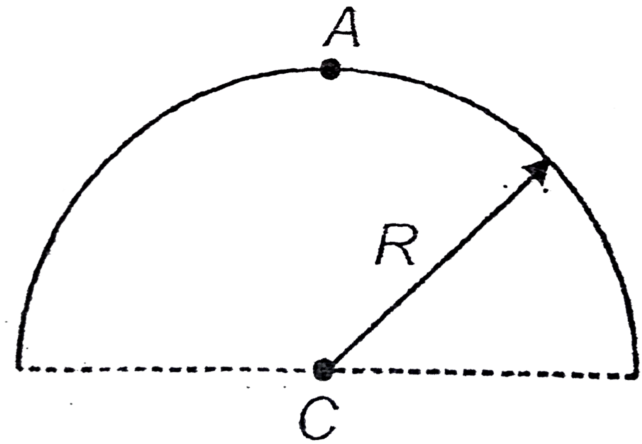
37. Moment of inertia of a half ring of mass m and radius R about an axis passing through point A perpendicular to the plane of the paper is I_A. If I_C is the moment of inertia of the ring about an axis perpendicular to the plane of paper and passing through point C, then



A. $I_A = I_C + mR^2$

B. $I_A > I_C + mR^2$

C. $I_A < I_C + mR^2$

D. None of these

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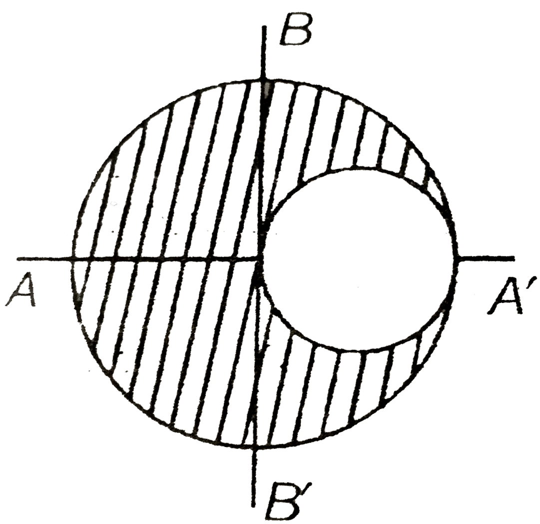
38. From a uniform sphere of mass M and radius R a cavity of diameter R is created as shown. Find the ratio of moment of inertia of the sphere left about AA' and BB'.



A. $\frac{15}{28}$

B. $\frac{28}{15}$

C. $\frac{31}{30}$

D. $\frac{62}{57}$

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39. The ratio of the radii of gyration of a spherical shell and solid sphere of the same mass and radius about a tangential axis is

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

B. $\sqrt{5}:\sqrt{6}$

C. $\sqrt{25}:\sqrt{21}$

D. $\sqrt{21}:\sqrt{25}$

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40. The centre of a wheel rolling without slipping on a plane surface moves with a speed v_0. A particle on the rim of the wheel at the same level as the centre of wheel will be moving with speed

A. v_0

B. $2v_0$

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

D. $\sqrt{2}v_0$

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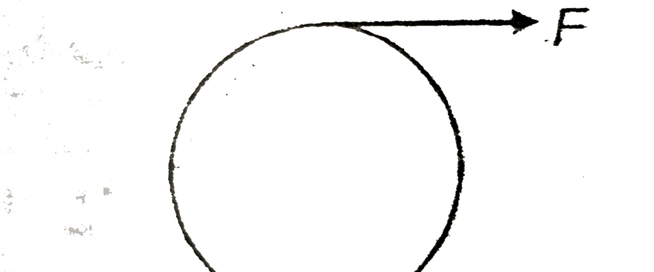
41. A disc of radius R and mass M is under pure rolling under the action of a force F applied at the topmost point as shown in figure. There is sufficient friciton between the disc and the horizontal surface. The acceleration is given as



A. $a_{cm} = \frac{F}{M}$

B. $a_{cm} < \frac{F}{M}$

C. $a_{cm} > \frac{F}{M}$

D. None of these

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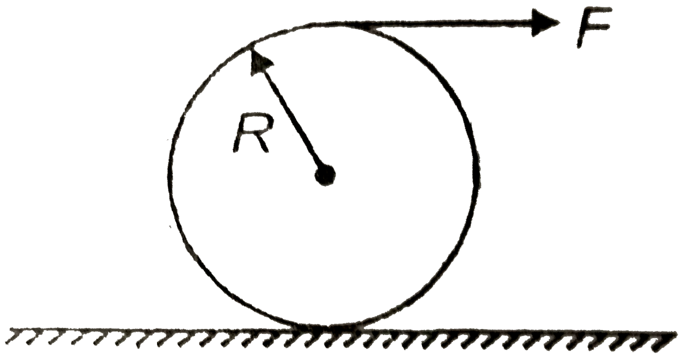
42. A ring of mass m and radius R is acted upon by a force F as shown in the figure. There os sufficient friction between the ring and the ground. The force of friciton force necessary for pure rolling is



A. $\dfrac{F}{2}$ forward

B. $\dfrac{F}{3}$ forward

C. Zero

D. $\dfrac{F}{4}$ backward

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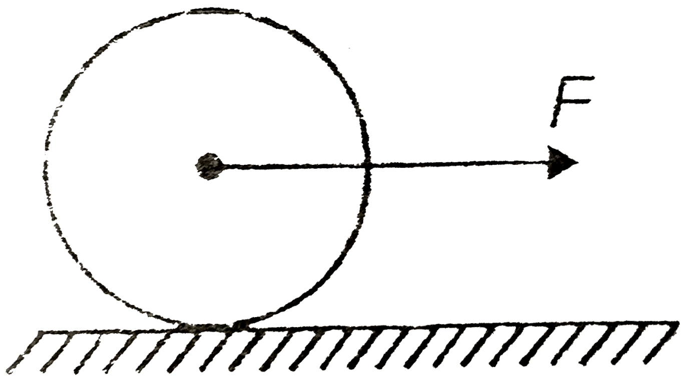
43. A solid sphere of mass $2kg$ is pulled by a constant force acting at its centre on a rough surface having co-efficient of friciton 0.5. The maximum value of F so that the sphere rolls without slipping is



A. $70N$

B. $25N$

C. $40N$

D. $35N$

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44. A hollow sphere is rolling without slipping on a rough surface. The ratio of translational kinetic energy to rotational kinetic energy is

A. $3:2$

B. $2:3$

C. $2:5$

D. $5:2$

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45. A cylinder is released from the top of an incline making angle $\theta = 45^\circ$ with the horizontal. The length of the incline is $2.82m$ and mass of cylinder is $1kg$. The coefficient of friciton is 0.2 between the cylinder and the incline. When the cylinder reaches the bottom of the incline, its total kinetic energy is $(g = 10m / s^2)$

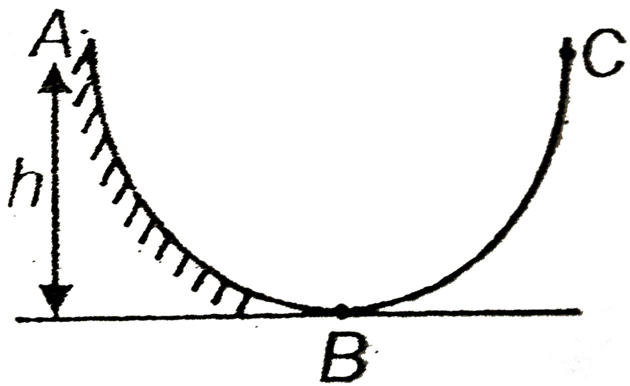
A. Equal to 20 joule

B. Greater than 20 joule

C. Less than 20 joule

D. 28.2 joule

46. A hollow spherical ball rolls down on a parabolic path AB from a height $'h'$ as shown in the figure. Path AB is rough enough to prevent slipping of ball and path BC is frictionless. The height to which the ball will climb in BC is



A. h

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

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

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

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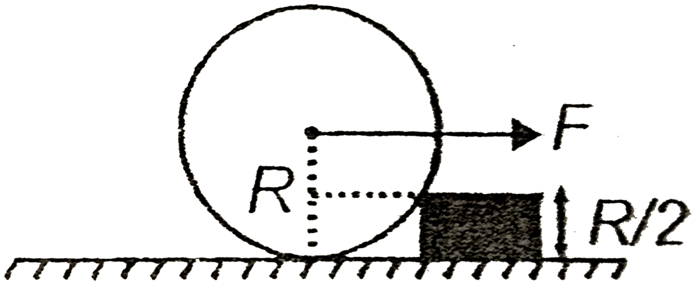
47. The minimum horizontal force applied to the centre of wheel of radius R and weight w

to pull it over a step of height $R/2$



A. w

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

C. $w\sqrt{3}$

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

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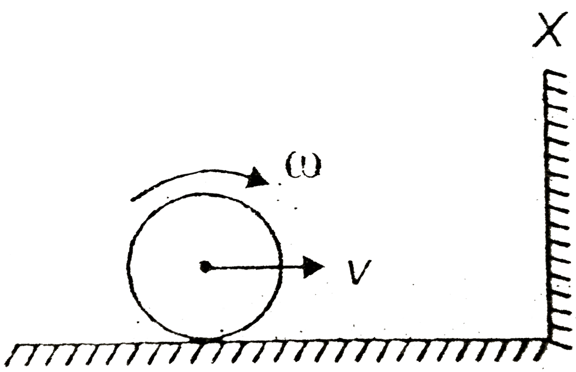
48. A solid cylinder is rolling without slipping with velocity of its centre of mass v and angular velocity about its centre of mass ω on a horizontal frictionless surface as shown in figure. If it collides with a frictionless vertical wall X, then after collision its velocity and angular velocity respectively become



A. $\frac{v}{2}, \frac{\omega}{2}$

B. $-v, -\omega$

C. $-v, \omega$

D. $v, -\omega$

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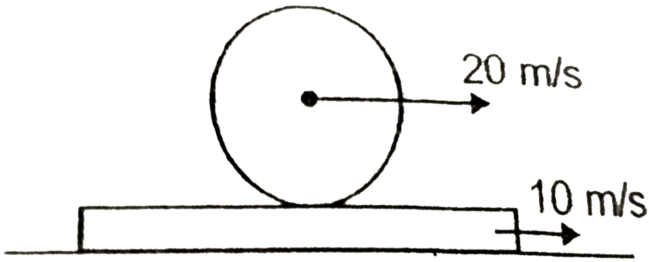
49. A cylinder is rolling without slipping on a plank which is also moving with speed $10m/s$ on a horizontal surface as shown. The speed of centre of the cylinder is $20m/s$. The mass of cylinder is $2kg$. The kinetic energy of the cylinder when observed from ground is



A. $450J$

B. $500J$

C. $600J$

D. $800J$

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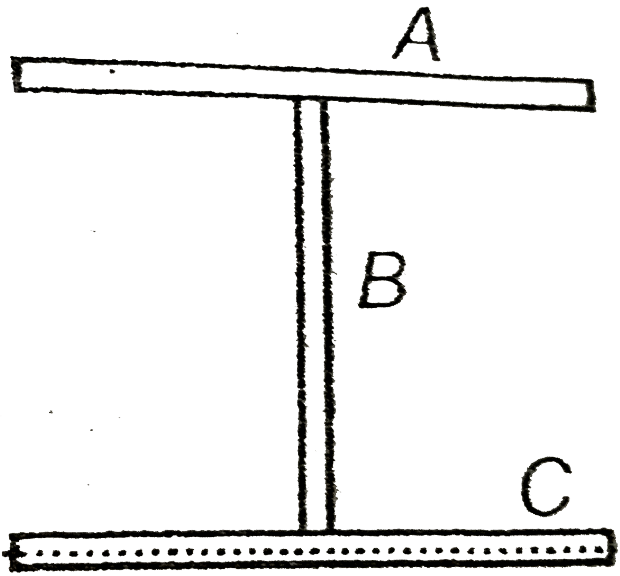
50. Three identical rods A, B and C each having length l are in shape of letter H as shown in the figure and free to move in vertical plane. Find he velocity of A at the lowest position when the system is disturbed slightly



A. $\sqrt{gl}$

B. $\sqrt{\frac{9gl}{2}}$

C. $\sqrt{9gl}$

D. $\sqrt{5gl}$

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51. A particle of mass $m = 3kg$ is projected at an angle of 45° with the horizontal with a speed of $20\sqrt{2}m/s$. The angular momentum of the particle at the highest point of trajectory about a horizontal axis passing through the origin and perpendicular to the plane of motion is

A. $1200 Js$

B. $1600 Js$

C. $1500 Js$

D. $2000 Js$

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52. A thin circular ring of mass M and radius r is rotating about its axis with an angular speed ω. Two particles having mass m each are now attached at diametrically opposite points.

The angular speed of the ring will become

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

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

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

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

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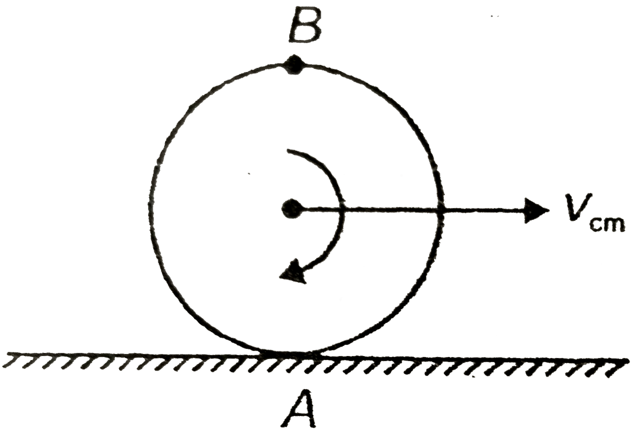
53. A disc is undergoing rolling on a horizontal surface. Which of the statement about angular momentum of the disc is incorrect ?



A. Angular momentum about A is conserved for any amount of roughness of surface

B. Angular momentum about B is conserved only if surface is smooth

C. Angular momentum about any point on the disc is conserved

D. All of these

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54. A theif is running with speed of $10m/s$ along the line $y = 10m$. The $x - y$ plane is horizontal. A searchlight kept at the origin is always aimed at the theif. To do so its has to be continuosly rotated with some angular speed $om \geq a$. When the line joining the thief with origin is making an angle $\theta = 45^\circ$ with the y axis, the value of ω is

A. $1 rad / s$

B. $2 rad / s$

C. $\frac{1}{4} rad / s$

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

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55. A rod AB of mass m and length L is rotating in horizontal plane about one of its ends which is pivoted. The constant angular speed with which the rod is rotating is ω. The force applied on the rod by the pivot is

A. $m\omega L^2$

B. $m\omega^2 L$

C. $m\omega^2 \frac{L}{2}$

D. $2m\omega^2 L$

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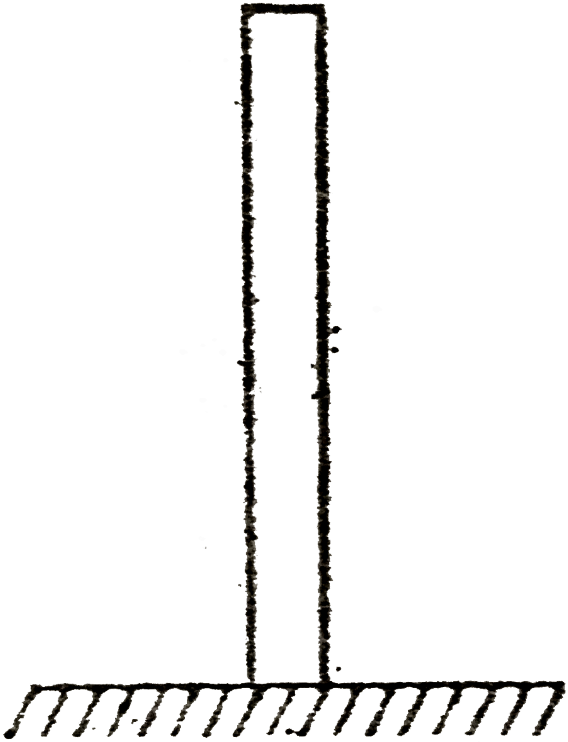
56. A uniform rod of mass M and length L is standing vertically along the y-axis on a smooth horizontal surface as shown. A small disturbance causes the lower end to slip on the smooth horizontal surface and rod starts falling. The path followed by centre of mass of the rod during the fall is



A. Circular

B. Elliptical

C. Straight line

D. Parabolic

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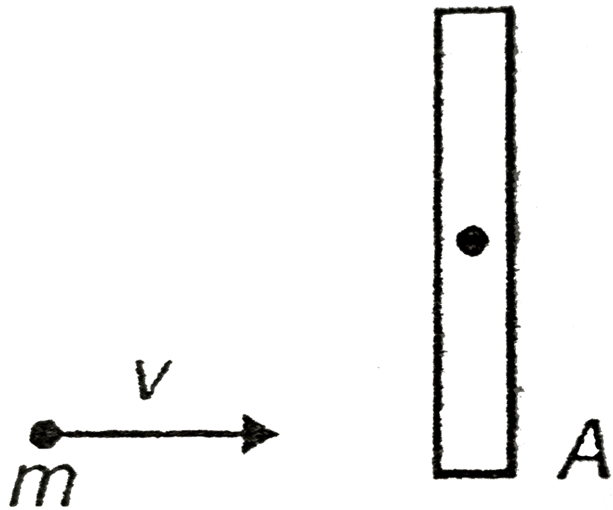
57. A rod of mass m and length l hinged at the centre is placed on a horizontal surface. A bullet of mass m moving with velocity v strikes the end A of the rod and gets embedded in it. The angular velocity with which the systems rotates about its centre of mass after the bullet strikes the rod



A. $\omega = \frac{3v}{2l}$

B. $\omega = \frac{5v}{4l}$

C. $\omega = \frac{2v}{3l}$

D. $\omega = \frac{v}{3l}$

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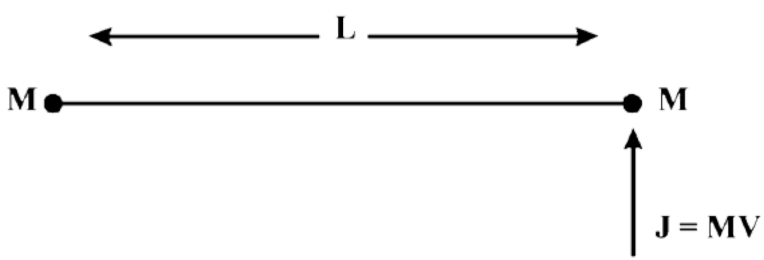
58. Consider a body, shown in figure, consisting of two identical balls, each of mass M connected by a light rigid rod. If an impulse J = MV is imparted to the body at one of its ends what would be it angular velocity?



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

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

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

D. $\frac{V}{4L}$

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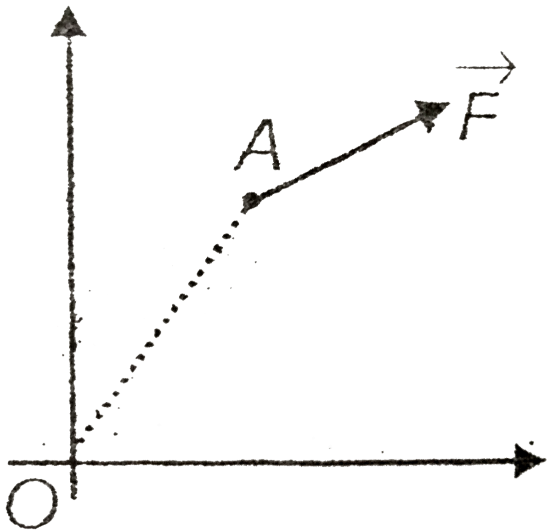
59. A force $\vec{F} = \left(3\hat{i} + 4\hat{j}\right)N$ is acting on a point mass $m = \left(\frac{1}{2}\right)kg$ at a point $A(2m, 2m)$. Find the angular acceleration of the line OA at this instant.



A. $1 rad/s^2$

B. $\frac{1}{2} rad/s^2$

C. $\frac{1}{4} rad/s^2$

D. $\frac{1}{8} rad/s^2$

60. If the earth shrinks to half its present radius, without any change in its mass, then the duration of the day becomes

A. $48h$

B. $24h$

C. $12h$

D. $6h$

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Assignment (Section - C) Objective Type Questions (More than one option are correct)

1. If a large number of particles are distributed on YZ plane and their centre of mass is at origin of coordinates, then

Sum of moments of masses of all particles about the origin is zero

Sum of momentum of masses of all particles w.r.t. the origin is zero

Sum of moments of masses of all particles about Y axis is zero.

Sum of moments of masses of all particles about Z axis is zero.

A. Sum of moments of masses of all particles about the origin is zero

B. Sum of momentum of masses of all particles w.r.t. the origin is zero

C. Sum of moments of masses of all particles about Y axis is zero.

D. Sum of moments of masses of all particles about Z axis is zero.

Answer: B

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2. A system of particles is acted upon by a constant nonzero external force. If v and a are instantaneous velocity and acceleration of the centre of mass, then it is possible that at a given instant

A. $v = 0, a = 0$

B. $v \neq 0, a = 0$

C. $v = 0, a \neq 0$

D. $v \neq 0, a \neq 0$

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3. Select the correct alternative. When there is no external force acting on a system of particles,

A. The centre of mass does not move

B. The centre of mass does not accelerate

C. The momentum of the system remains same

D. The kinetic energy of the system does not change

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4. When a stick of length L mass M intially upright on a fricitionless floor starts falling the

A. Path of its centre of mass is elliptical

B. Path of the centre of mass of the stick is vertical straight line

C. Poin tof contact of the stick with the ground will move in parabolic path

D. Point of contact of the stick with the ground will move in straight line

Answer: B,D

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5. The weight of an object on the surface of the Earth is 40 N. Its weight at a height equal to the radius of the Earth is

A. a. When they meet, speed of A is $0.67ms^{-1}$

B. b. When they meet, speed of B is $1.33ms^{-1}$

C. c. They will meet after a time $2.50s$

D. d. Speed of A will be zero, while that of B will be $2m / s$

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6. When a bullet is fired from a gun

A. Momentum of the system is conserved in ground frame

B. Momentum of the system is conserved in gun frame

C. Momentum of the gun is conserved in gun frame

D. Momentum of the bullet is conserved in gun frame

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7. A bomb is falling vertically downwards into the air it explodes in air, then

A. Centre of mass will move in straight line before any of the fragments hit the ground

B. Centre of mass will always move in straight line

C. Centre of mass will always move in straight line if the ground is smooth

D. Centre of mass not move in straight line even if the ground is smooth

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8. A small metallic spherical ball is dropped from a height h. If it collides with the ground inelastically and rebounds, then

A. The momentum of the ball just after the collision is same as that just before the collision

B. Force on the ball is same (in magnitude) as the force on the ground during the collision

C. Total momentum of ball and Earth system is conserved

D. Total kinetic energy of the ball and the earth remains the same

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9. If a sphere of mass m moving with velocity u collides with another identical sphere at rest on a frictionless surface, then which of the following is correct ?

A. A) Angle between their final velocities may be 90°

B. B) Loss of kinetic energy due to their collision lies between 0 to $\frac{1}{4}\mu^{2}$

C. C)Colliding sphere may return back

D. D)There is a possibility of final kinetic energy being more than $\frac{1}{2}\mu^2$

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10. Two projectiles collide in air, then for just after and before the collision

A. The momentum of the system is conserved in all directions

B. The momentum of the system is conserved only in horizontal direction as gravity is acting in vertical direction

C. The momentum of individual particles will not be conserved in all directions

D. The path of centre of mass after collision will depend on coefficient of restitution of collision

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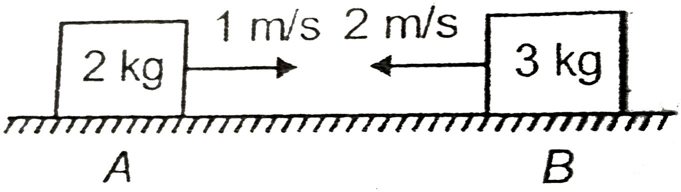
11. Two particles A and B of masses $2kg$ and $3kg$ moving on a smooth horizontal surface with speed $1m/s$ and $2m/s$ collides perfectly inelastically, then



A. Both the particles will move with same speed towards right after collision

B. Both the particles will move with same speed towards left after collision

C. The speed of the particles after collision wil be $\frac{3}{5}m/s$

D. Loss in kinetic energy of block A is $\frac{16}{25}J$

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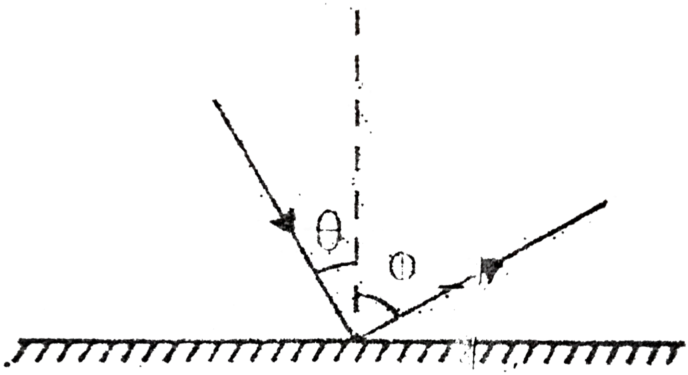
12. A particle strikes a smooth horizontal surface at an angle $\theta > 0$ and it rebounds at an angle ϕ as shown



A. If collision is perfectly inelastic, then particle will stop immediately after the collision and ϕ will not be defined

B. If collision is perfectly inelastic, then particle will not stop after the collision

C. $\theta = \phi$, if collision is perfectly elastic

D. $\phi = 90^{\circ}$, if collision is perfectly inelastic

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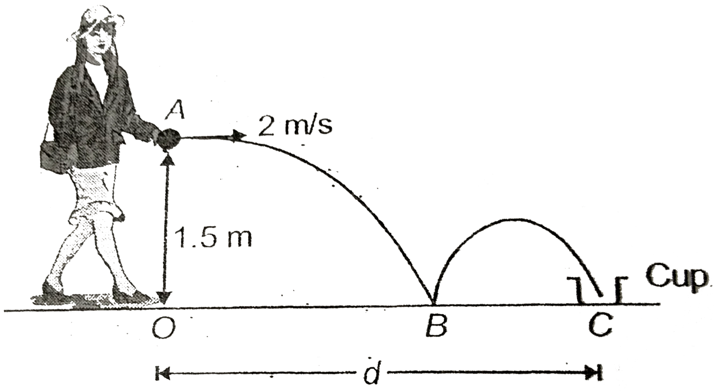
13. A girl throws the ball with horizontal velocity $2m/s$ at the moment $t = 0$. The ball bounces once on the smooth floor and then lands into cup C. The coefficient of restitution for the collision is 0.8. Select the correct alternative $\left(g = 10m / s^2\right)$



A. The time taken by the ball to reach B is

$$\sqrt{\frac{3}{10}} s$$

B. The time taken by the ball to reach C is

$$2.6\sqrt{\frac{3}{10}} s$$

C. The ratio $\dfrac{OC}{OB} = 2.6$

D. The distance d is $\dfrac{52\sqrt{3}}{10\sqrt{10}} m$

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14. A fan is switched on and it accelerates at a constant angular acceleration of $2rad/s^2$ till it attains an angular velocity of $18rad/s$. At this instant power is switched off, Assuming there is no dissipative force, the angular displacement made by it in 20 seconds is

A. 64radians

B. 44.4 revolutions

C. 279 radians

D. 400 revolutions

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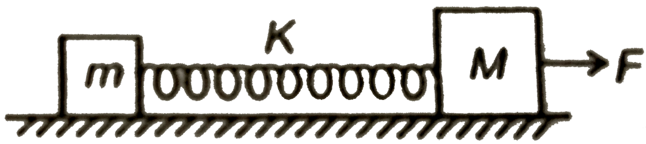
15. A block of mass m is connected to another block of mass M by a massless spring of spring constant K. Blocks are kept on a smooth horizontal plane. Initally both the blocks the at rest and spring is unstressed. Force F is applied on M to right as shownin the figure then which of the following is correct ?



A. Acceleration of the centre of mass is

$$\frac{F}{M+m}$$

B. At the instant of maximum elongation of the spring, acceleration of centre of mass is zero.

C. At maximum extension of the spring acceleration of centre of mass is

$$\frac{F}{(M+m)}$$

D. At maximum extension, velocity of both the blocks will be same.

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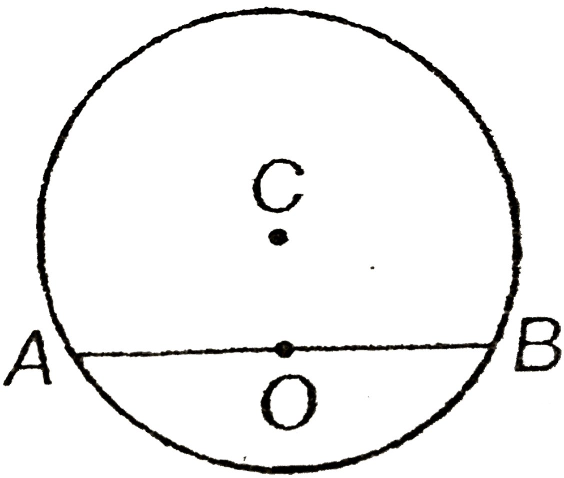
16. A disc of mass M and radius R as shown in figure has some points on it. C is the cenre of disc, AB is the chord and O is mid point of chord. The notation I_A means moment of inertia of the disc about axis passing through point A and pependicular to the plane of disc.

Choose the correct option(s)



A. $I_A = I_C + M(AO)^2$

B. $I_B = I_C + M(BC)^2$

C. $I_A = I_0 + M(OA)^2$

D. $I_B = I_0 + M(OA)^2$

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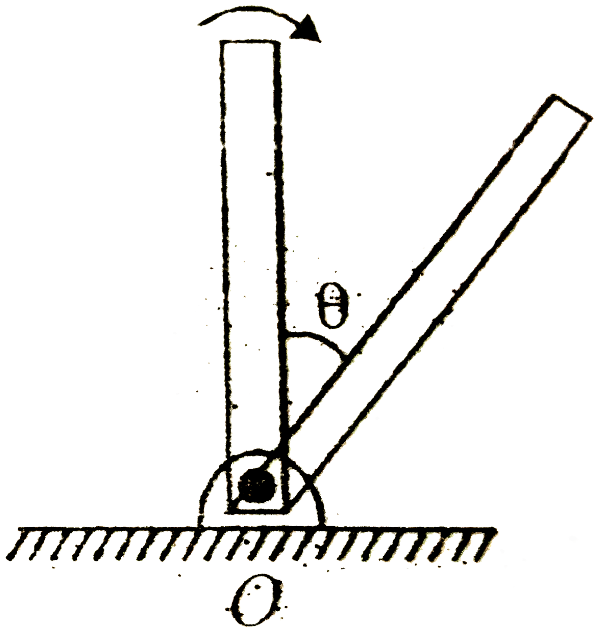
17. A rod of mass m and length L is pivoted at the bottommost point O and can freely rotate about the point O. The rod is disturbed from the vertical position so that it starts rotating about O. When it makes an angle θ with the vertical



A. The angular acceleration of rod will be

$$\frac{3}{2L}g\sin\theta$$

B. Acceleration of centre of mass of rod can

be in vertical direction

C. Net acceleration of centre of mass of rod can't be in horizontal direction

D. The tangential acceleration of centre of mass of rod will be $\frac{3}{2}g\sin\theta$

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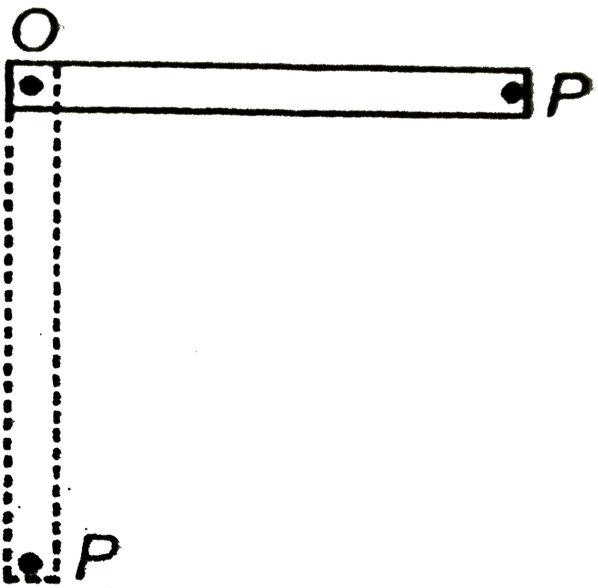
18. A rod of mass m and length L is pivoted at a point O and kept in horizontal position as shown in figure. Now it is released from this position so that it can rotates freely about the point O in downward direction. When it becomes vertical



A. Angular velocity of rod will be $\sqrt{\frac{6g}{L}}$

B. Angular velocity of rod will be $\sqrt{\frac{3g}{L}}$

C. The velocity of point P will be $\sqrt{3gL}$

D. The velocity of point P will be $\sqrt{6gL}$

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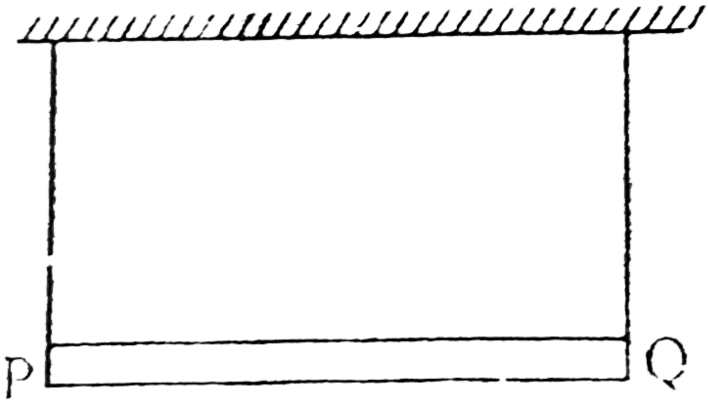
19. A horizontal rod of mass M and length L is tied to two verticle string symmetrically as shown in the figure. One of the strings at end Q is cut at $t = 0$ and the rod starts rotating about the other and P then



A. At $t = 0$, angular acceleration of rod about P is $\frac{3g}{2L}$

B. At $t = 0$, angular acceleration of rod about centre of mass of rod is $\frac{3g}{2L}$

C. At $t = 0$, acceleration of centre of mass of rod is $\frac{3g}{4}$ in downward direction

D. The tension in the other string through A at $t = 0$ is $\frac{mg}{4}$ (m the mass of rod)

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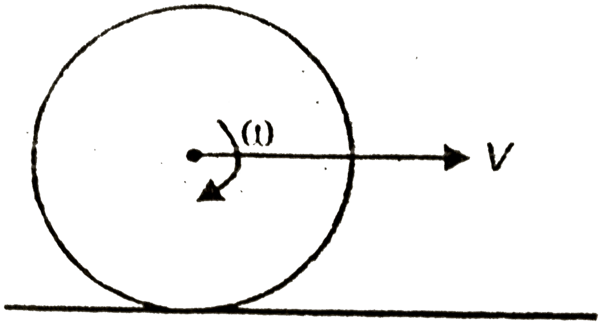
20. A disc of radius R is moving on a rough horizontal surface with velocity v and angular speed ω at an instant as shown in figure.

Choose the correct statement.



A. If $v > \omega R$, the force of friction will act in backward direction

B. If $v < \omega R$, the force of friction will act in forward direction

C. If $v = \omega R$ the force of friction must be zero.

D. If $v = \omega R$ the force of friction will not be zero.

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21. A disc of given some velocity up the incline so that it goes up, stops momentarily and comes down the incline. The disc never slips during its entire motion. The force of friction

A. Acts downward along the incline when the disc goes up the incline

B. Acts upward along the incline when the disc goes up the incline

C. Acts upward along the incline when the disc comes down in the incline

D. Acts downward along the incline when the disc comes down in the incline

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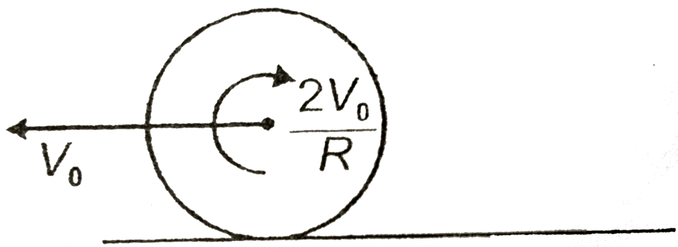
22. A ring of mass m and radius R is placed on a rough horizontal surface (co-efficient of friction μ) with velocity of $C.M.\, v_0$ and angular speed $\frac{2V_0}{R}$ as shown in figure. Initially the ring is rolling with slipping but attains pure rolling motion after some time t. Then



A. After time t, the ring is moving rightward with angular speed $\frac{V_0}{2R}$

B. After time t, the ring is moving leftward with angular speed $\frac{3V_0}{2R}$

C. $t = \frac{V_0}{2\mu g}$

D. $t = \frac{3V_0}{2\mu g}$

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23. A solid sphere of mass m and radius R is released from top of an incline having co-efficent of friction μ and making an angle of

45° with the horizontal. Choose the correct alternative (s)

A. The force of friction acting on the sphere is $\frac{\mu mg}{\sqrt{2}}$ if $\mu < 0.25$

B. The force of friction acting on the sphere is $\frac{\sqrt{2}}{7} mg$ if $\mu > 0.3$

C. Work done by force of friction is zero if $\mu > 0.3$

D. Work done by force of friction is non-zero if $\mu > 0.3$

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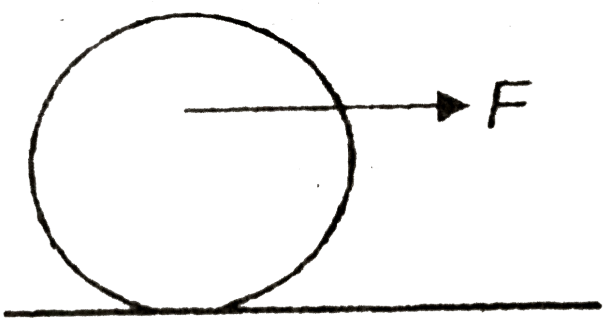
24. On an uniform cylinder of mass m and radius R a constant horizontal force F is applied at any point. Choose the correct alternative if cylinder is rolling without slipping in rightward direction



A. If F is acting at the centre, force of frictionon cylinder is zero

B. If F is acting at the centre, force of friction is acting in backward direction

C. If F is acting at a distance of $\frac{R}{2}$ above centre of mass of cylinder, then force of friction is zero

D. If F is acting at the highest point of cylinder then force of friction acts in forward direction

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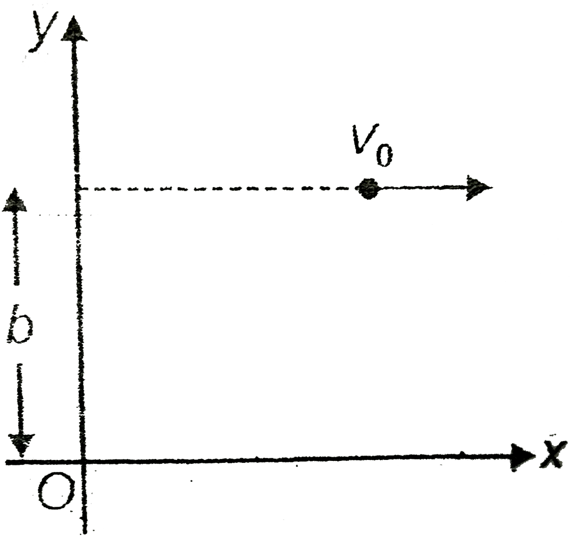
25. A particle of mass m is moving with constant velocity v_0 along the line $y = b$. At time $t = 0$ it was at the point $(0, b)$. At time $t = \frac{b}{v_0}$, the



A. Angular momentum of particle about origin is $\sqrt{2}mv_0b$

B. Angular momentum of particle about origin is having value equal to mv_0b

C. Torque acting on particle about origin is zero

D. Torque acting on particle about origin is non-zero

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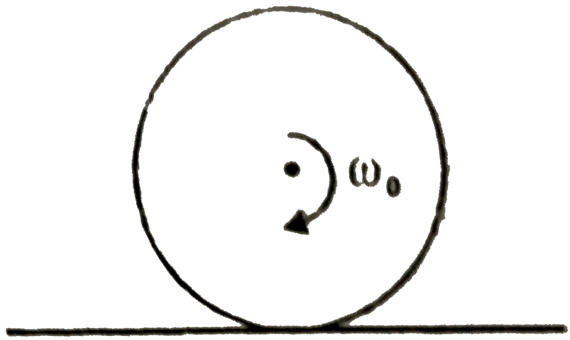
26. A disc of mass m and radius R rotating with angular speed ω_0 is placed on a rough surface (co-officient of friction $= \mu$). Then



A. The angular momentum of disc is conserved about centre of disc

B. The angular momentum of disc is conserved about point of contact of disc.

C. Initially the force of fricition acting on the disc is μmg leftward.

D. Initally the force of friction acting on the disc is μmg rightward

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27. A block of mass m moves on a horizontal rough surface with initial velocity v. The height

of the centre of mass of the block is h from the surface. Consider a point A on the surface.

A. A)Angular momentum about A is mvh initially

B. B)Angular momentum about A is conserved

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

D. D)Block will eventually stop and angular momentum conservation is not applicable here

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

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

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

C. C)The loss in kinetic energy of whole system in collision is $\frac{mv^2}{6}$

D. D)The loss in kinetic energy of whole system in collision is $\frac{7mv^2}{24}$

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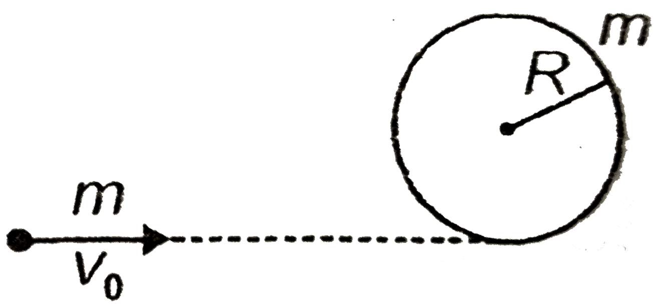
29. A disc of mass m and radius R is kept on a smooth horizontal surface with its plane parallel to the surface. A particle of same mass m travelling with speed v_0 collides with the stationery disc and gets embedded into it as shown in the figure. Then



A. Angular momentum of (disc + particle) system can be conserved only about cenre of the disc

B. The speed of centre of mass of the system is $\frac{v_0}{2}$ after collision

C. The angular speed of the system after collision is $\frac{v_0}{2R}$ about $C.M.$ of the disc + particle system

D. The K.E. of the system is conserved during the collision.

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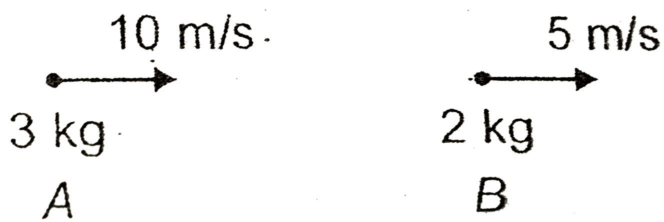
Assignment (Section - D) Linked Comprehension Type Questions

1. Two particles A and B of mass $3kg$ and $2kg$ moving with speed $10m/s$ and $5m/s$ as shown in figure.



Find the maximum momentum that particles A can have after collision with B.

A. 30 kg m/s

B. 24 kg m/s

C. 18 kg m/s

D. None of these

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2. Two particles A and B of mass $3kg$ and $2kg$ moving with speed $10m/s$ and $5m/s$ as shown in figure.

Find the maximum momentum that particle B

can have after collision with A

A. $16kgm/s$

B. $20kgm/s$

C. $22kgm/s$

D. $24kgm/s$

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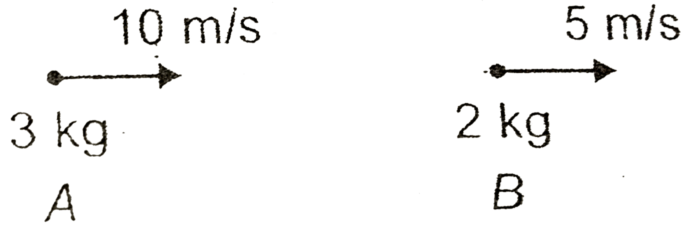
3. Two particles A and B of mass $3kg$ and $2kg$ moving with speed $10m/s$ and $5m/s$ as shown in figure.



Kinetic energy of particle A when particle B has the maximum momentum

A. $50J$

B. $54J$

C. $58J$

D. $96J$

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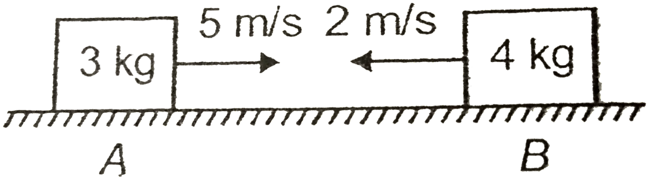
4. Two particles A and B of mass $3kg$ and $4kg$ moving on a smooth horizontal surface with speed $5m/s$ and $2m/s$ respectively collides each other. Coefficient of restitution is $e = \frac{1}{2}$, then



Velocity of A after collision

A. $1m/s$ backwards

B. $1m/s$ forwards

C. $2m/s$ backwards

D. $2m/s$ forwards

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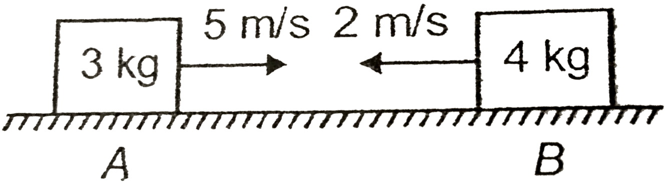
5. Two particles A and B of mass $3kg$ and $4kg$ moving on a smooth horizontal surface with speed $5m/s$ and $2m/s$ respectively collides each other. Coefficient of restitution is $e = \frac{1}{2}$, then



Velocity of B after collision

A. $\frac{7}{2} m/s$ forward

B. $\frac{7}{2} m/s$ backward

C. $\frac{5}{2} m/s$ forward

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

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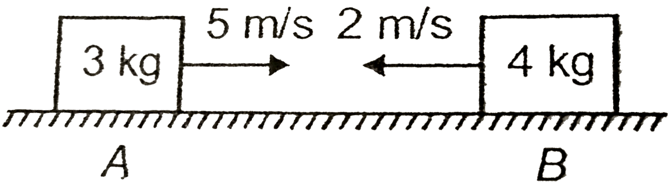
6. Two particles A and B of mass $3kg$ and $4kg$ moving on a smooth horizontal surface with speed 5m/s and 2m/s respectively collides each other. Coefficient of restitution is $e = \frac{1}{2}$, then



Loss in kinetic energy in collision

A. $31.5J$

B. $21.5J$

C. $25.5J$

D. $27.5J$

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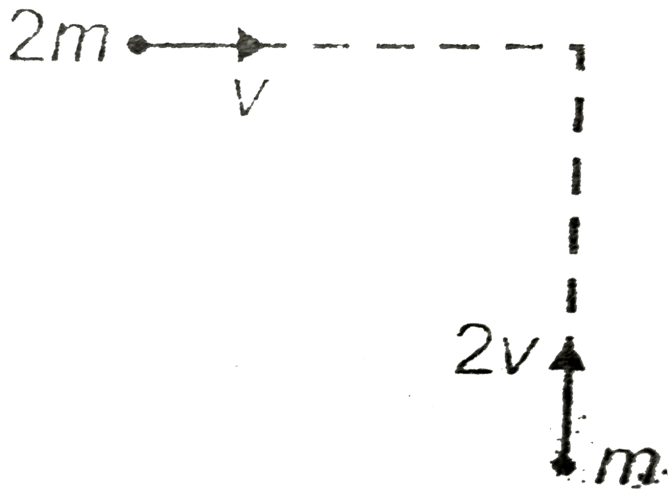
7. Two particles of mass $2m$ and m moving with speed v and $2v$ respectively pependicular to each other collides perfectly inelastically, then



Speed of the particles after collision

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

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

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

D. $\frac{4\sqrt{2}v}{3}$

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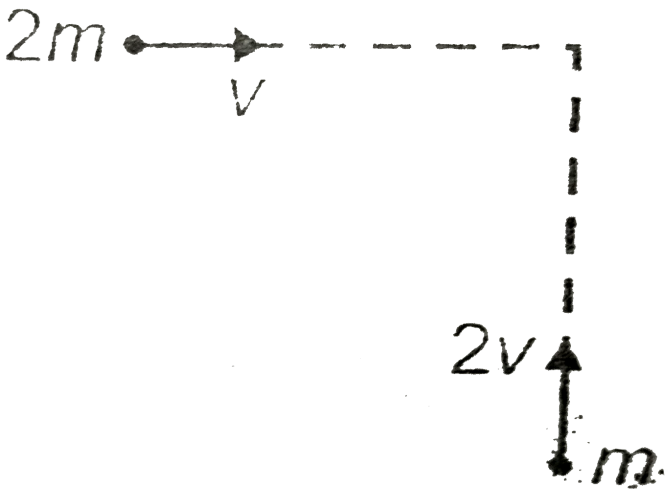
8. Two particles of mass $2m$ and m moving with speed v and $2v$ respectively pependicular to each other collides perfectly inelastically, then



Speed of the particles after collision

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

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

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

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

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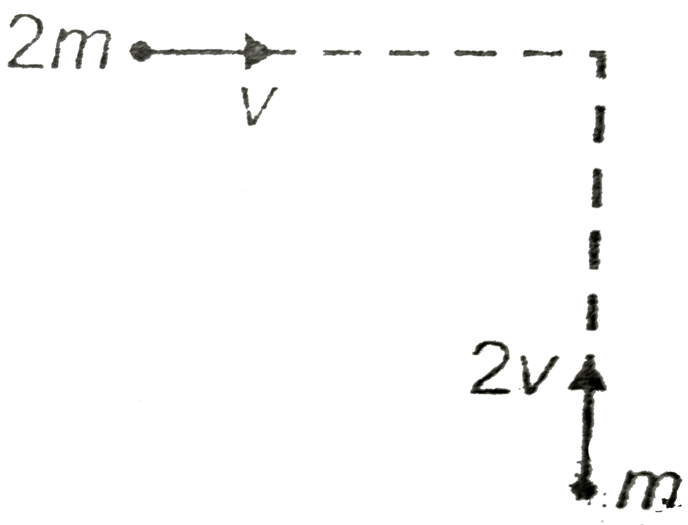
9. Two particles of mass $2m$ and m moving with speed v and $2v$ respectively pependicular to each other collides perfectly inelastically, then



Find the angle with the horizontal to which the particles move after collision.

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

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

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

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

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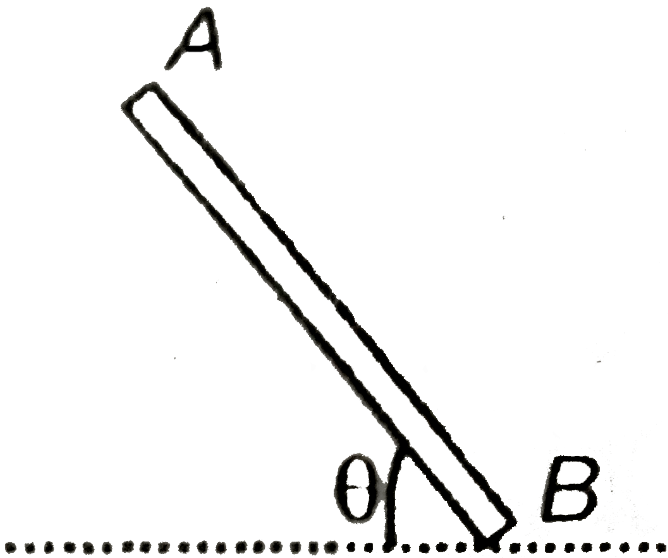
10. A rod AB of mass M and length L is shown in figure. End A of rod is hinged and end B is lying on the ground. Find the Normal reaction by ground on the rod



A. mg

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

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

D. Cannot be determined

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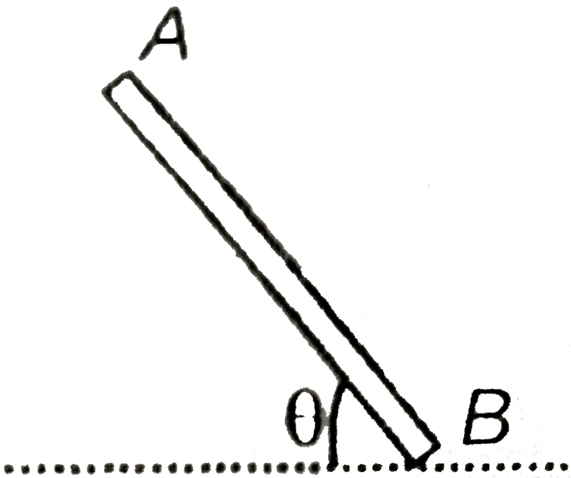
11. A rod AB of mass M and length L is shown in figure. End A of rod is hinged and end B is lying on the ground. Find the Horizontal component of the force applied by the hinge



A. Zero

B. $\sqrt{2}mg$

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

D. Cannot be determined

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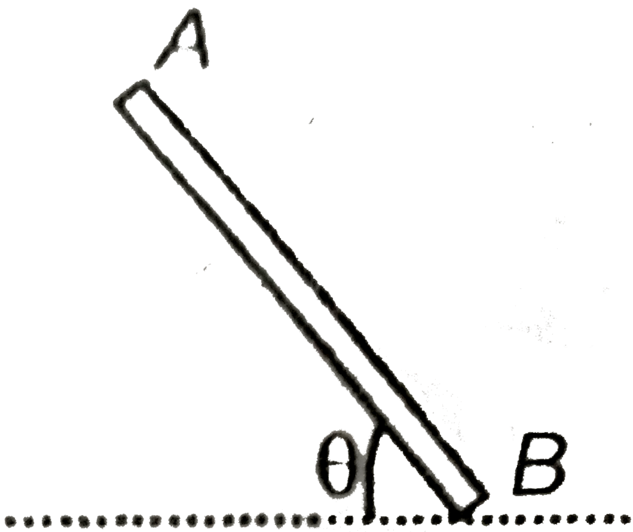
12. A rod AB of mass M and length L is shown in figure. End A of rod is hinged and end B is lying on the ground. Find the Vertical component of the force applied by the hinge



Vertical component of the force applied by the hinge

A. mg

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

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

D. Cannot be determined

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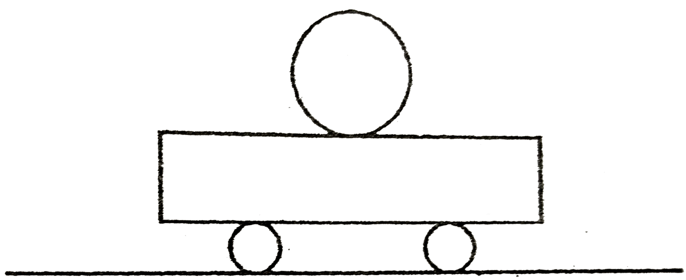
13. A solid sphere of mass m and radius R is placed over a plank of same mass m. There is sufficient friction between sphere and plank to prevent slipping.When a horizontal force F is applied at centre of sphere, acceleration of the plank is



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

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

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

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

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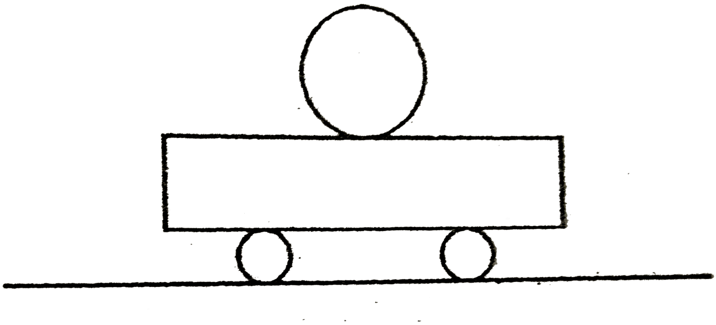
14. A solid sphere of mass m and radius R is placed over a plank of same mass m. There is sufficient friction between sphere and plank to prevent slipping. Force of friction between sphere and plank is



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

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

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

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

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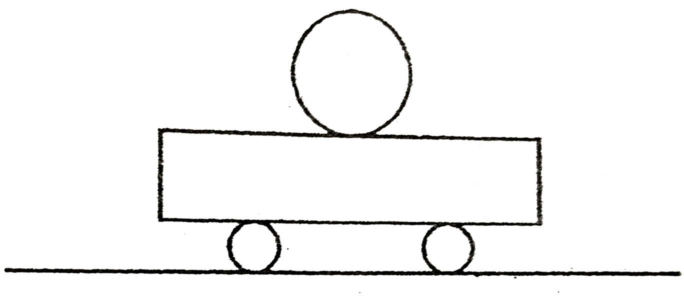
15. A solid sphere of mass m and radius R is placed over a plank of same mass m. There is sufficient friction between sphere and plank to prevent slipping.



Acceleration of centre of mass of sphere is

A. $\dfrac{2F}{9m}$

B. $\dfrac{7F}{9m}$

C. $\frac{9F}{6m}$

D. $\frac{5F}{9m}$

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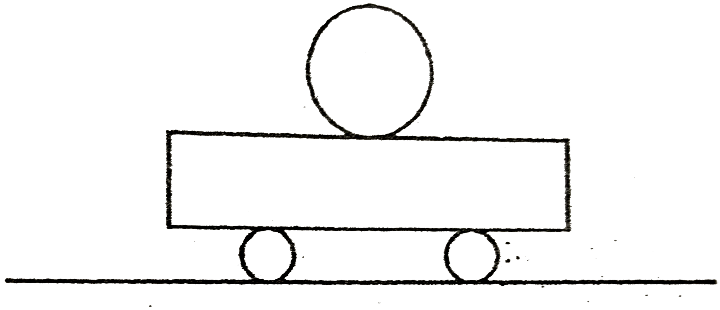
16. A solid sphere of mass m and radius R is placed over a plank of same mass m. There is sufficient friction between sphere and plank to prevent slipping.



Angular acceleration of sphere is

A. $\frac{2F}{9mR}$

B. $\frac{5F}{9mR}$

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

D. $\frac{9F}{mR}$

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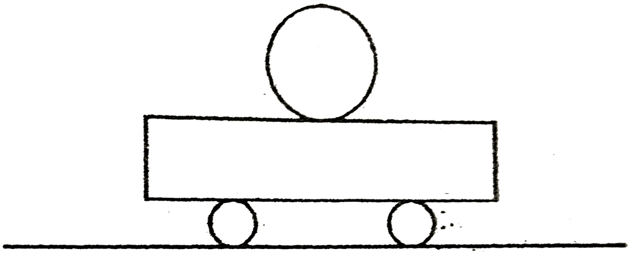
17. A solid sphere of mass m and radius R is placed over a plank of same mass m. There is sufficient friction between sphere and plank to prevent slipping.



A Horizontal force F is applied on the plank. What is the maximum value of F, if μ is coefficient of friction between sphere movment and plank and there is no slipping ?

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

B. μmg

C. $\frac{9}{2}\mu mg$

D. $\frac{5}{2}\mu mg$

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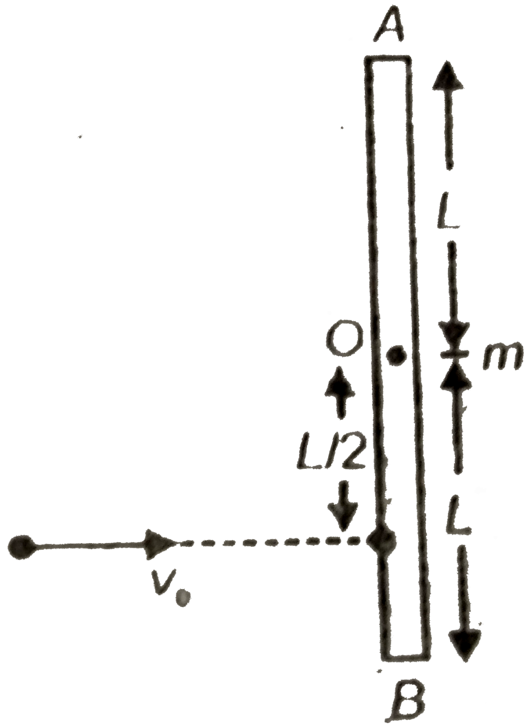
18. A rod AB of length $2L$ and mass m is lying on a horizontal frictionless surface. A particle of same mass m travelling along the surface hits the rod at distance $\frac{L}{2}$ from COM with a velocity v_0 in a direction perpendicular to rod and sticks to it.



Angular velocity of rod just after collision is

A. $\frac{6v_0}{11L}$

B. $\frac{12v_0}{11L}$

C. $\frac{24v_0}{11L}$

D. None of these

Answer: A

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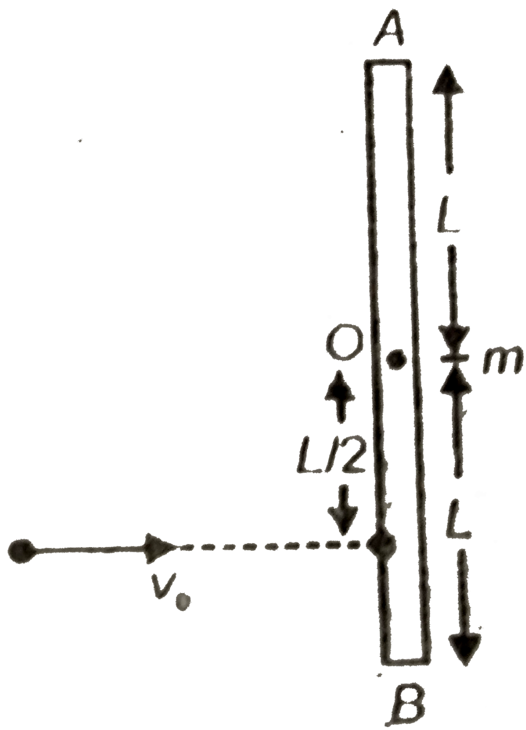
19. A rod AB of length $2L$ and mass m is lying on a horizontal frictionless surface. A particle of same mass m travelling along the surface hits the rod at distance $\frac{L}{2}$ from COM with a velocity v_0 in a direction perpendicular to rod

and sticks to it.



Angular velocity of rod just after collision is

A. a. $\dfrac{11L}{6}$

B. b. $\dfrac{11L}{12}$

C. c. $\frac{23L}{11}$

D. d. $\frac{5L}{3}$

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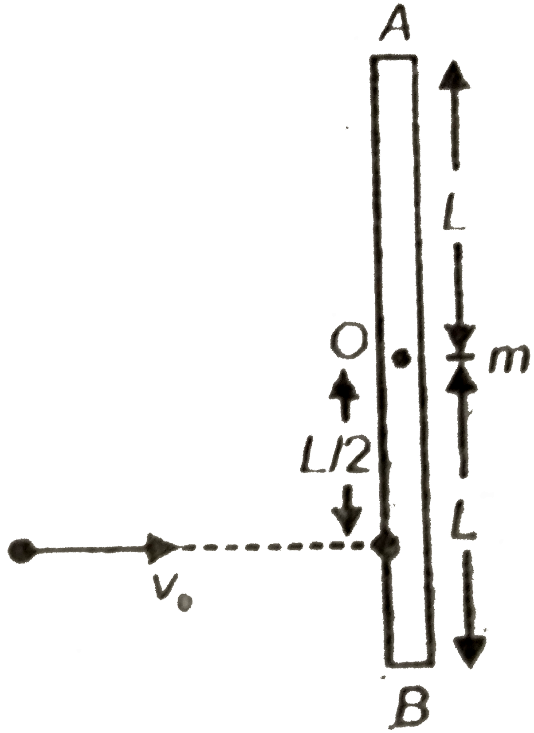
20. A rod AB of length $2L$ and mass m is lying on a horizontal frictionless surface. A particle of same mass m travelling along the surface hits the rod at distance $\frac{L}{2}$ from COM with a velocity v_0 in a direction perpendicular to rod and sticks to it.



Distance of point P on rod from B which is at rest immediately afte collision is

A. A)$v_0\sqrt{2}$

B. B)Zero

C. C)$2\sqrt{2}v_0$

D. D)$6\frac{v_0}{11}L$

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Assignment (Section - E) Assertion-Reason Type Questions

1. Two particles mass m_1 and m_2 are kept at rest at $t = 0$. They start attracting each other due to their gravitational pull, then

STATEMENT-1 : The toal mometum of the

system is zero at any instant.

and

STATEMENT-2 : Both are particles gain equal momentum in opposite direction in equl interval of time as both are acted upon equal and opposite forces.

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1

B. Statement -1 is True, Statement-2 is True, Statement 2 is NOT a correct explanation for Statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

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2. STATEMENT-1 : The total momentum of a system in C-frame is always zero.

and

STATEMENT-2 : The total kinetic energy of a system in C-frame is always zero.

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1

B. Statement -1 is True, Statement-2 is True, Statement is NOT a correct explanation for Statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

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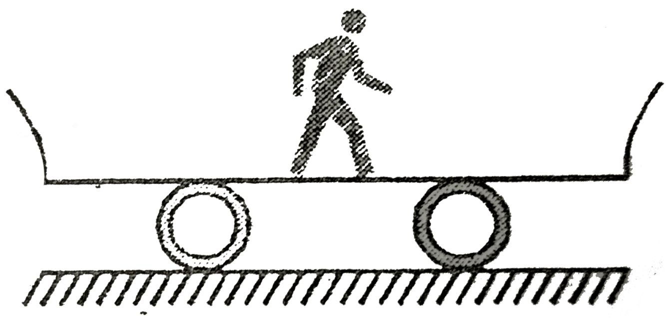
3. STATEMENT-1 : A person standing on a stationary trolley placed on rough ground walks for a moment and then stops. The system acquires a net velocity due to this.



and

STATEMENT-2 : In the present situation, law of conservation of linear momentum is violated.

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1

B. Statement -1 is True, Statement-2 is True, Statement is NOT a correct explanation for Statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

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4. STATEMENT-1 : In the decay of a free neutron at rest, into a proton and electron, it has been predicated that a third particle must also be emitted because the emitted electrons do not have a definite kinetic energy.

and

STATEMENT-2 : For the simple decay of a stationary particle into two moving particles, the kinetic energies of the particle must have a sharply defined value.

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1

B. Statement -1 is True, Statement-2 is True, Statement is NOT a correct explanation for Statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

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5. STATEMENT-1 : In an elastic collision between two balls, the total kinetic energy of the two bodies does not remain conserved during the collision.

and

STATEMENT-2 : As the balls collide, they compress each other.

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1

B. Statement -1 is True, Statement-2 is True, Statement 2 is NOT a correct explanation for Statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

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6. STATEMENT-1 : In an elastic collision between two bodies, the relative velocity of separation equals relative velocity of approach.

and

STATEMENT-2 : In a elastic collision , the coefficient of restitution is 1.

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1

B. Statement -1 is True, Statement-2 is True, Statement 2 is NOT a correct explanation for Statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

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7. STATEMENT-1 : In elastic, collisions total kinetic energy is lost.

and

STATEMENT-2 : In inelastic, collisions kinetic energies of both individual particles is lost.

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1

B. Statement -1 is True, Statement-2 is True, Statement is NOT a correct explanation for Statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

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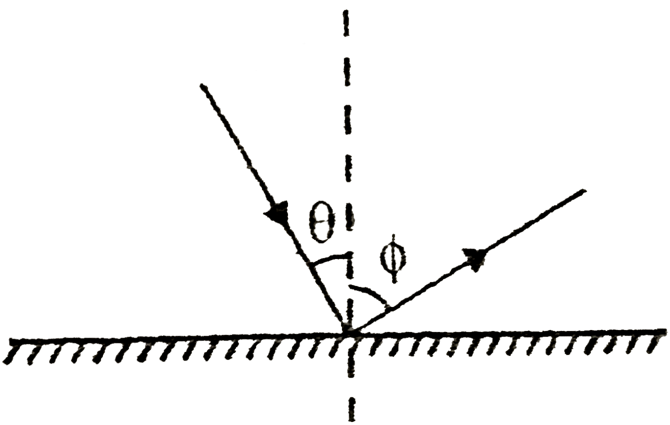
8. A particles strikes a smooth surface at an angle θ and rebounds at an angle ϕ. Coefficient of restitution is $0 < e < 1$, then



STATEMENT-1 : If the same particle is thrown at angle ϕ , it will rebound at an angle θ.

and

STATEMENT-2 : ϕ is greater than θ.

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1

B. Statement -1 is True, Statement-2 is True, Statement is NOT a correct explanation for Statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

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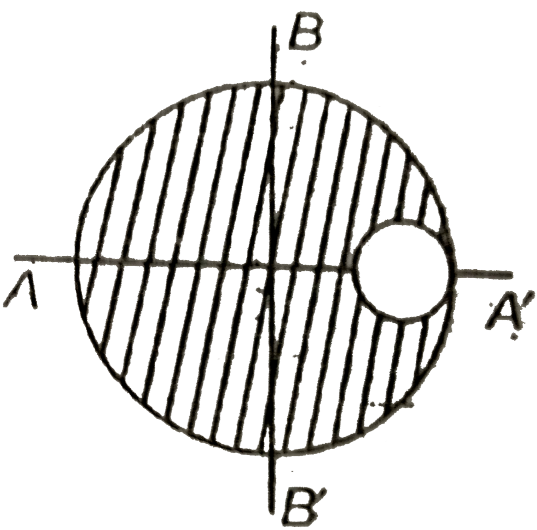
9. For a uniform sphere a small cavity is formed as shown



STATEMENT-1 : Moment of inertia of the sphere about AA is greater than moment of inertia about BB'.

and

STATEMENT-2 : Mass removed was more closer to the axis AA.

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1

B. Statement -1 is True, Statement-2 is True, Statement is NOT a correct explanation for Statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

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10. STATEMENT-1 : Two disks having same radius but different masses roll down without slipping from rest, on a rough inclined plane. They will take the same time to reach the bottom.

and

STATEMENT-2 : The heavier disc will have greater kinetic energy than the lighter disc, at the bottom.

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1

B. Statement -1 is True, Statement-2 is True, Statement is NOT a correct explanation for Statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

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11. STATEMENT-1 : The relation $\overrightarrow{\tau} = \frac{d\overrightarrow{L}}{dt}$ is applicable in centre of mass frame, even though the centre of mass is accelerating.

and

STATEMENT-2 : The relation $\vec{\tau} = \frac{d\vec{L}}{dt}$ can be directly applied in a non-inertial frame.

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1

B. Statement -1 is True, Statement-2 is True, Statement is NOT a correct explanation for Statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

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12. An uniform disc is rotating at a constant 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 upwards, then about the fixed axis.

STATEMENT-1 : Angular speed of the disc about the aixs of rotation will increase.

and

STATEMENT-2 : Moment of inertia of the disc is decreased about the axis of rotation.

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1

B. Statement -1 is True, Statement-2 is True, Statement is NOT a correct explanation for Statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

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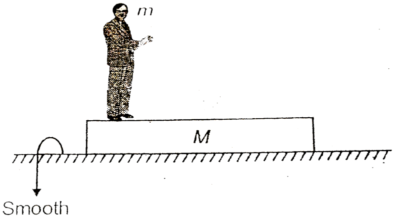
Assignment (Section - F) Matrix-Match Type Questions

1. A man of mass $m = 2kg$ is standing on a platform of mass $M = 5kg$, then at any instant.



Column I	Column II
(A) Ratio of distance travelled by man to distance travelled by platform	(p) $\frac{2}{5}$
(B) Ratio of speed of platform to speed of mass	(q) $\frac{5}{2}$
(C) Ratio of distance travelled by man w.r.t. platform and distance travelled by platform	(r) $\frac{2}{7}$
(D) Ratio of speed of platform and speed of man w.r.t. platform	(s) $\frac{7}{2}$
	(t) 1

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2. A shell is projected by a cannon at an angle 30° with the vertical for a horizontal range R.

It explodes at the highest point of its trajectory. Now match the column I and II.

Column I	Column II
(A) Along horizontal	(p) Work done by gravity is/may be positive
(B) On explosion of shell	(q) Chemical energy is converted to kinetic energy
(C) After explosion	(r) Kinetic energy of centre of mass increases gradually
(D) When the potential energy of center of mass decreases	(s) Linear momentum of centre of mass does not change

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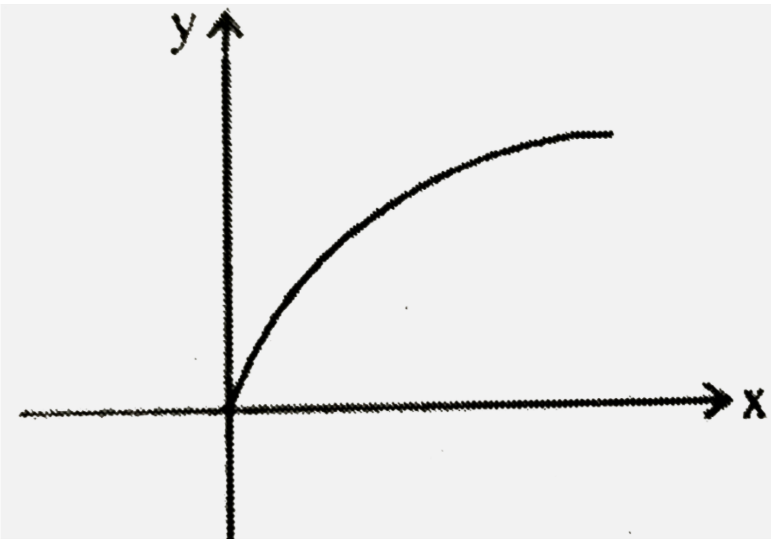
3. 

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4. A particle of mass m_1 experiences a perfectlly elastic collision with a stationary particle of mass m_2. Match the entries in column I to all the entries in column II.

Column I	Column II
(A) Fraction of the kinetic energy lost by m_1	(p) $\frac{4m_1m_2}{(m_1+m_2)^2}$ for head on collision
(B) Force between the particles	(q) $\frac{2m_1}{m_1+m_2}$; if m_1 recoils perpendicular to the initial direction.
(C) Momentum of the system	(r) Internal forces
(D) Sum of kinetic energy of the balls	(s) Unchanged

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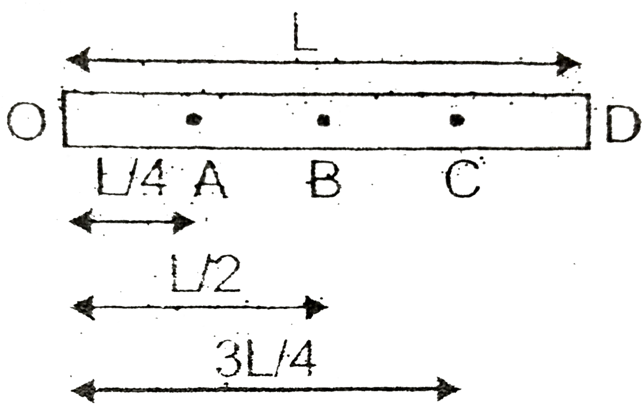
5. A uniform rod of length L is free to rotate about an axis passing through O. Inititally the rod is horizontal. The rod is relased from this position. Match column I with column II



Column I		Column II
(A) Acceleration of A will be $\frac{15\sqrt{10}}{8}$ m/s² when the rod has rotated through an angle	(p)	180°
(B) Acceleration of B will be $\frac{15}{4}\sqrt{7}\ m/s^2$ when the rod has rotated through an angle	(q)	150
(C) Acceleration of C will be $\frac{45}{8}\sqrt{10}\ m/s^2$ when the rod has rotated through an angle	(r)	135°
(D) Acceleration of D will be 15 m/s² when the rod has rotated through an angle	(s)	45°
	(t)	30°

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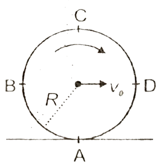
6. A wheel is executing pure rolling on a horizontal surface with a speed $v_0 (v_0 = R\omega)$. The positions of points A, B, C and D at $t = 0$ are shown in figure. Match the entries given in column I with those given in column II.



Column I		Column II
(A) Speed of A with respect to the bottom-most point is $\sqrt{2}v$ at time	(p)	$t = \pi/\omega$
(B) Speed of B with respect to the topmost point is zero at time	(q)	$t = \pi/2\omega$
(C) Speed of C with respect to the topmost point is $2v$ at time	(r)	$t = 3\pi/2\omega$
(D) Speed of D with respect to the bottom-most point is $\sqrt{2}v$ at time	(s)	$t = 5\pi/2\omega$
	(t)	$t = 3\pi/\omega$

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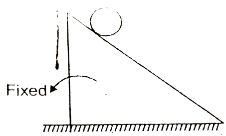
7. A solid sphere hollow sphere disc, ring and hollow cylinder are relased from the top of a fixed inclined when all of them have same mass and radius



Column I	Column II
(A) Will reach the bottom first.	(p) Ring
(B) Will reach the bottom last	(q) Hollow cylinder
(C) Will have maximum K.E at the bottom of the inclined plane	(r) Solid sphere
(D) Will have maximum angular velocity at the bottom of the inclined plane	(s) Disc
	(t) All of these

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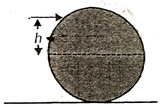
8. A solid spherical ball kept on a horizontal surface is struck by a que at height h above the central line



Column-I	Column-II
(A) If $h = 0.4R$	(p) No slipping
(B) If $h > 0.4R$	(q) Forward slipping
(C) If $h < 0.4R$	(r) Backward slipping
(D) If $h = 0$	
(E) If h is negative	

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Assignment (Section - G) Integer Type Questions

1. In an atwood machine the two blocks have massess $1kg$ and $3kg$. The pulley is massless and frictionless and string is light. The acceleration of the centre of mass (in m/s^2) of this system is $0.5x$. Find the value of x.

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2. A body projected with a speed u at an angle of 60° with the horizontal explodes in two equal pieces at a point where its velocity

makes an angle of 30° with the horizontal for 1^{st} time. One piece start moving vertically upward with a speed of $\frac{u}{2\sqrt{3}}$ after explosion. what is velocity of one piece with respect to other in the vertical direction just after the explosion ?

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3. A cubical tanker completely filled with water is moving with a constant velocity. A hole develops at the bottom in its horizontal surface through which water comes out. $4kg$ of water leaks out in 30 seconds. If the velocity of truck becomes x times of its initial velocity then find x.

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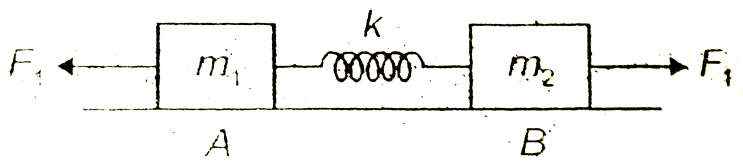
4. Two blocks A and B of mass $16kg$ and $64kg$ are placed on a smooth horizontal surface. Blocks are connected by a spring of spring constant $100N/m$. Find the ratio of maximum speed of block A to maximum speed of block

B.



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5. A body of mass $5/6kg$ kept at rest in horizontal plane is acted upon by a variable force given by $F = 5e^{-1}$ newton in the same horizontal plane. Find the terminal velocity attained by the body.

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6. The moment of inertia of a uniform semicircular wire of mass M and radius R about an axis passing through its centre of mass and perpendicular to its plane is $x\dfrac{MR^2}{10}$. Find the value of x? (Take $\pi^2 = 10$)

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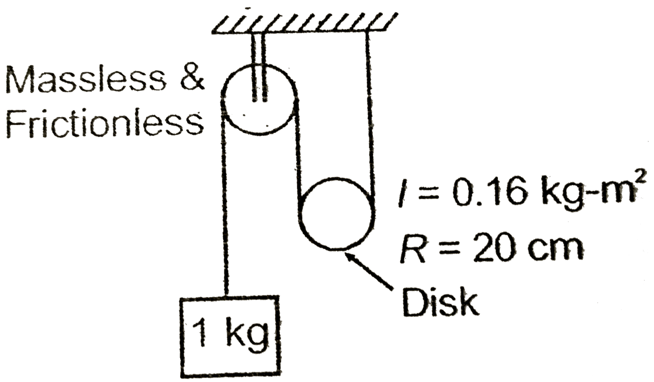
7. In the arrangement shown the fixed pulley is massless and frictionless. If the acceleration of block of mass $1kg$ is $\dfrac{30}{x} m/s^2$. Find the value of x.



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8. A solid sphere of radius $2.45m$ is rotating with an angular speed of $10 rad / s$. When this rotating sphere is placed on a rough horizontal surface then after sometime it starts pure rolling. Find the linear speed of the sphere after it starts pure rolling.

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9. A body is projected with a speed u at an angle of 30° with the horizontal at $t=0$. The angular momentum of the body about the point of projection is $\frac{x\sqrt{3}\mu^3}{64g}$ at $t=\frac{3u}{4g}$. Find the value of x ?

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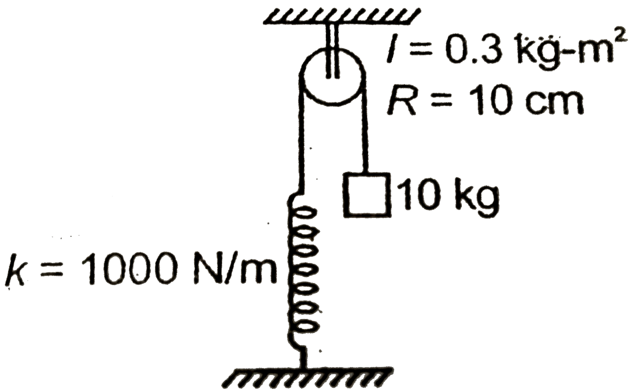
10. In the given arrangement the block is released from the position where the spring is unstretched. The speed of the block when it has descended through $2cm$ is $\frac{x}{10}$. Find the value of x.



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Assignment (Section - H) Multiple True-False Type Questions

1. STATEMENT-1 : When a projectile explodes in mid air the centre of mass follows circular path after explosion.

STATEMENT-2 : In an elastic collision velocities can't be interchanged it colliding bodies have different masses.

STATEMENT-3 : During a perfectly elastic collision the kinetic energy of the system remains constant.

A. TTF

B. FFT

C. TFT

D. FTF

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2. STATEMENT-1 : Two bodies of mass M and $2M$ released from rest and they move towards each other due to their mutual gravitational force of attraction and collide at mid point.

STATEMENT-2 : If the total mechanical energy of a body is zero than its linear momentum is necessarily non zero at any point other than reference point.

STATEMENT-3 : The linear momentum of the bob of a simple pendulum suspended by the roof of a car accelerating on a horizontal road increases due to tension in the string of the pendulum.

A. TTF

B. FTT

C. TFT

D. FFT

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3. STATEMENT-1 : When a sphere rotates about a diameter, the particles on the surface of sphere have different linear speeds.

STATEMENT-2 : When a ring rotates about its own axis, the particles on the circumference of ring have different linear velocities.

STATEMENT-3 : Linear acceleration of all the particles lying on the surface of a sphere rotating uniformly about its diameter are equal.

A. TTT

B. TFT

C. TTF

D. FFT

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

A. FTT

B. TFF

C. FTF

D. TTF

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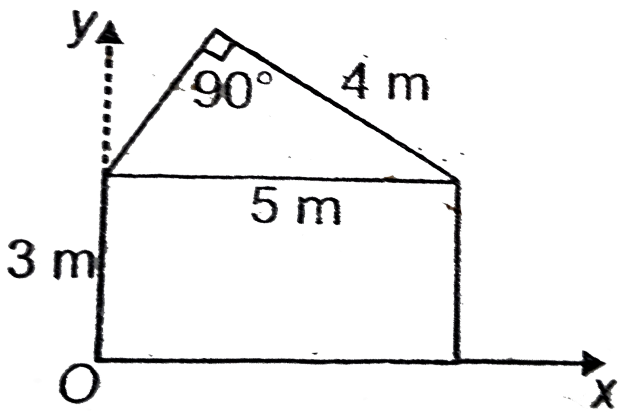
Assignment (Section - I) Subjective Type Questions

1. Figure shows a right angled triangle of uniform mass per unit area, attached with rectangular lamina of sides $3m$ and $5m$ made of same material. Find the centre of mass of the system.

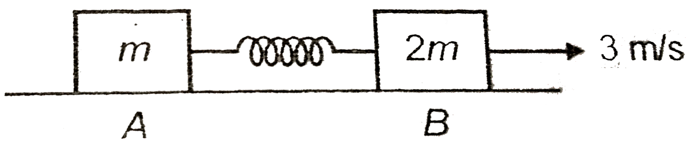


2. A particle of mass m is moving anticlockwise, in a circle of radius R in $x-y$ plane with centre at $(R, 0)$ with a constant speed v_2. If is located at point $(2R, 0)$ at time $t=0$. A man starts moving with a velocity v_1 along the positive y-axis from origin at $t=0$. Calculate the linear momentum of the particle w.r.t. man as a function of time.

3. Two blocks A and B of masses m and $2m$ are placed on a smooth horizontal surface. Block B is given a speed of $3m/s$. Find

(i) The maximum speed of A

(ii) The minimum speed of B.



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4. A ball is projected from ground with a speed $70m/s$ at an angle 45° with the vertical so that it strikes a vertical wall at horizontal distance $\frac{490}{3}m$ from the point of projection. If the ball returns back to the poin tof projection without any collision with ground then find the coefficient of restitution between the ball and wall.

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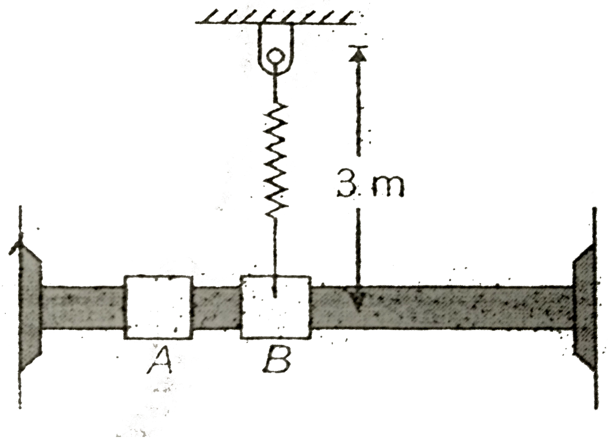
5. A collar B of mass m is at rest and when it is in the position shown, the spring is unstretched. If another collar A of mass $\frac{m}{n}$

strikes it so that B slides a distance $4m$ on the smooth rod before momentarily stopping, determine the velocity of A just after the impact. The coefficient of restitution is e. The spring constant is k.



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6. A uniform disc (of mass M and radius a) has a hole (of radius b) drilled through it. The centre of the hole is at a distance c from the centre of the original disc. What is the moment of inertia of the disc about an axis through the centre of the disc and perpendicular to its plane ?

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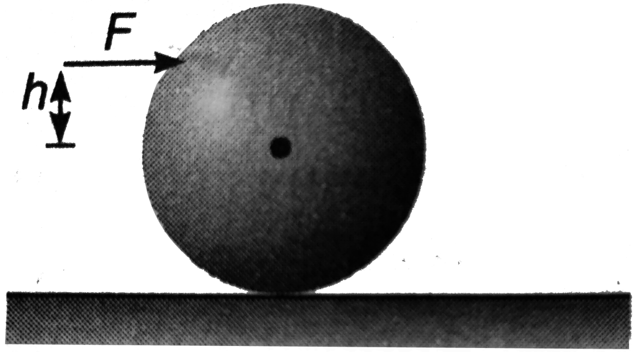
7.



A billiard ball, initially at rest, is given a sharp impulse by a cue. The cue is held horizontally a distance h above the centre line as shown in figure. The ball leaves the cue with a speed v_0 and because of its backward slipping eventually acquires a final speed $\frac{9}{7}v_0$ show that $h = \frac{4}{5}R$

Where R is the radius of the ball.

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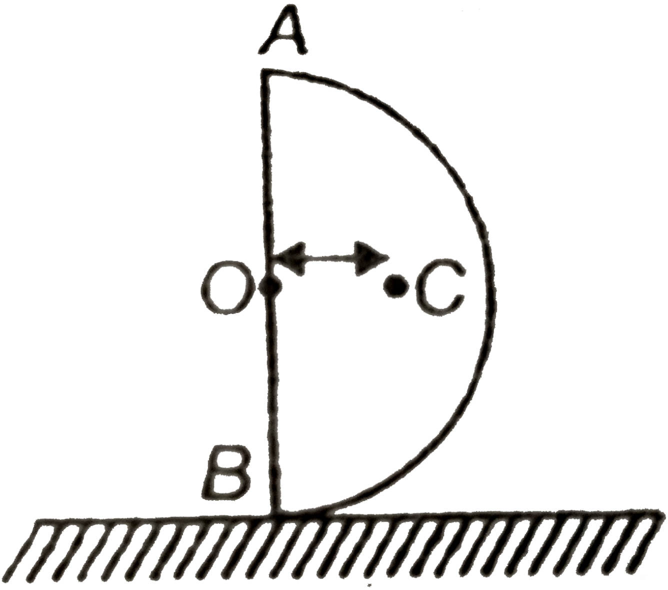
8. A semicircle disc of mass M and radius R is held on a rough horizontal surface as shown in figure. The centre of mass C of the disc is at a distance of $\frac{4R}{3\pi}$ from the point O. Now the disc is released from this position so that it starts rolling without slipping. Find



(a) The angular acceleration of the disc at the moment it is relased from the given position.

(b) The minimum co-efficient of fricition between the disc and ground so that it can roll without slipping.

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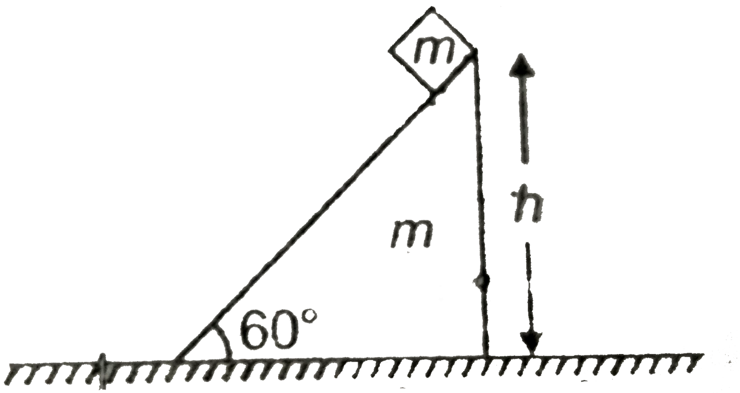
Assignment (Section - J) Aakash Challengers Questions

1. A block of mass m is released from a wedge of mass m as shown in figure . Find the time taken by the block to reach the end of the wedge.



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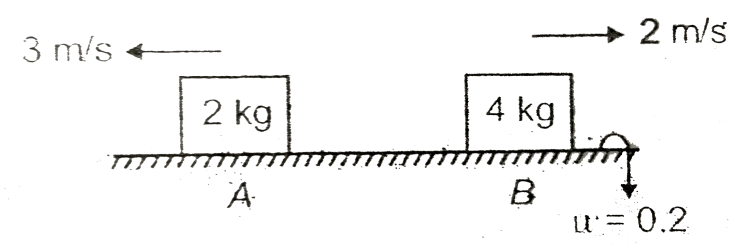
2. Two blocks of mass $2kg$ and $4kg$ are given speed $3m/s$ and $2m/s$ respectively on a rough surface with coefficient of friciton 0.2. Find the distance travelled and displacement of the centre of mass after a long time.



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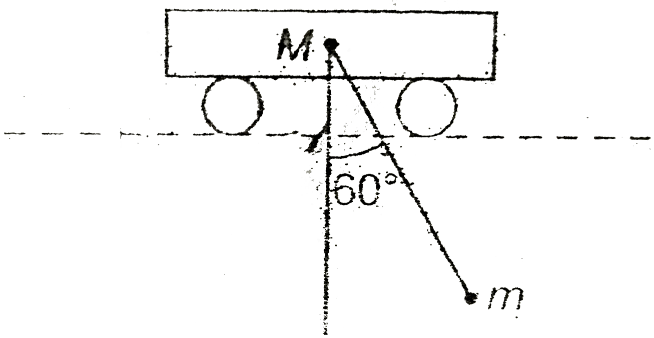
3. A bob of mass m is hanging from a cart of mass M. System is relased from rest from the position shown. Find the maximum speed of the cart with respect to ground.



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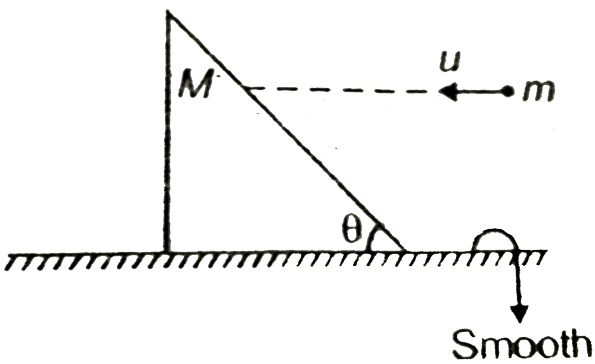
4. A particle of mass m moving with speed u hits a wedge of mass M as shown in figure. If coefficient of restitution is e and friciton can be neglected, then find the speed of the wedge with respect to ground just after the collision.



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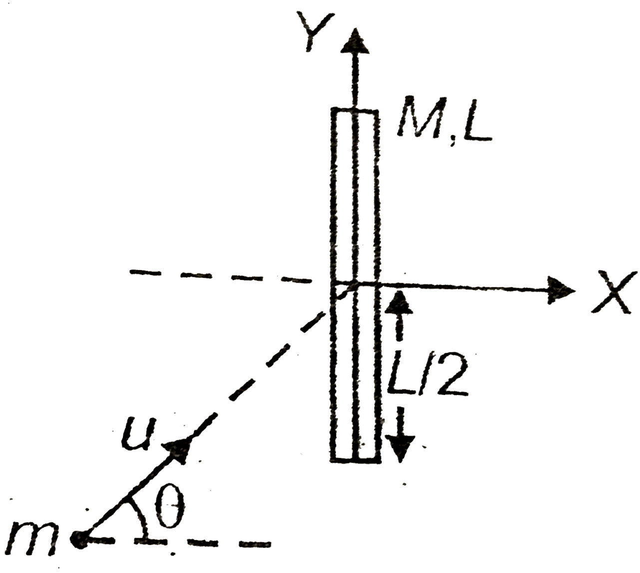
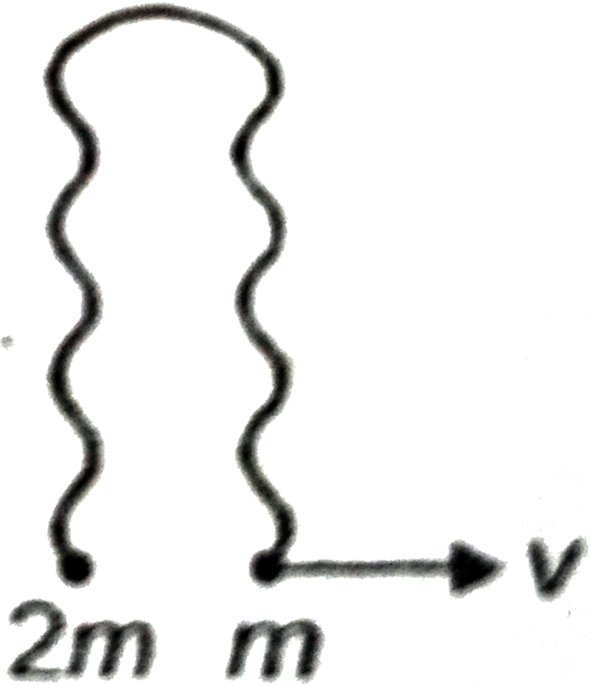
5. A particle of mass m collides with a uniform rod of mass M and length L as shown in figure. If initial speed of the particle was u. Find the final velocity vector of the rod and particle just after collision.(The complete system is in horizontal plane)



6. Two particles of a mass 2m and m are tied with an inextensible string the particle of mass m is given a speed V as shown in the figure. Find the speed with which the particle of mass 2m starts moving.



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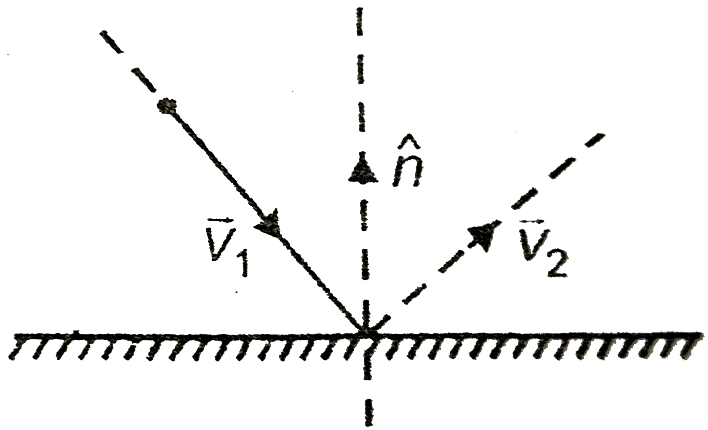
7. A particle collides a horizontal smooth surface with velocity $\vec{v}_1$, $\hat{n}$ is the unit vector

perpendicular to the surface. If e is the coefficient of restitution, then find the velocity vector in which particle is rebounded.



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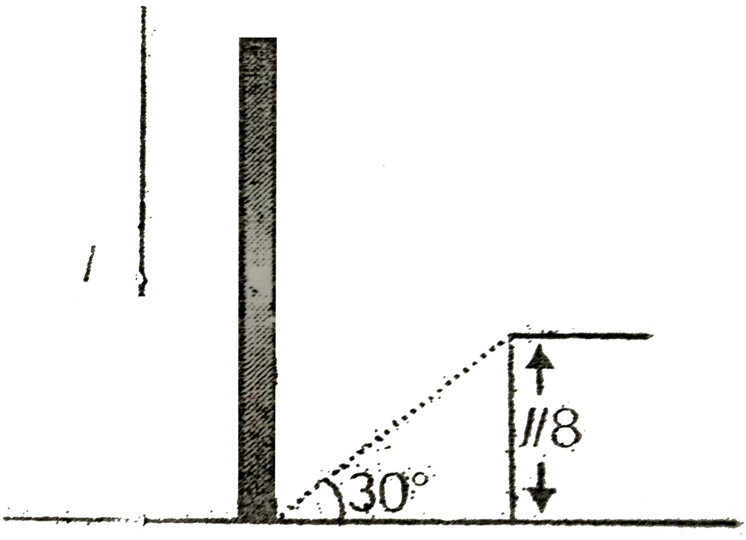
8. A uniform rod of length l is slightly disturbed from its vertical position. Find the

angular velocity of the rod just after if hits the step. (Friction is sufficient everywhere to prevent slipping)



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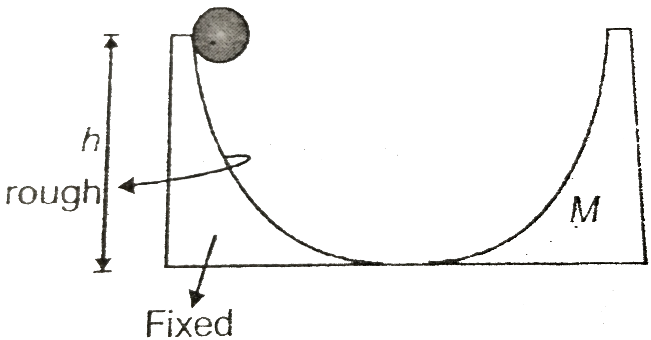
9. A sphere of mass m and radius R is dropped from the top of a fixed rough wedge of height h. Find the maximum height to which the sphere rises on a smooth movable wedge of mass M lying adjacent to the fixed wedge on smooth ground.



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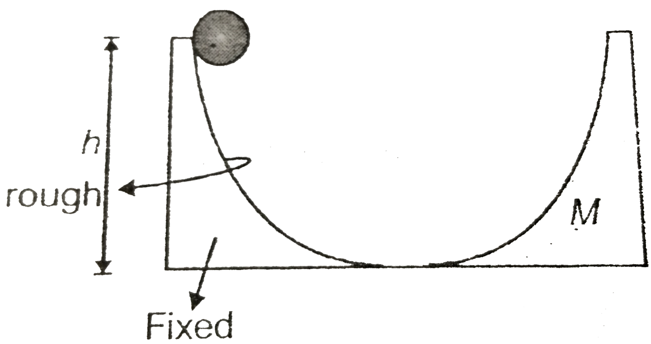
10. A sphere of mass m and radius R is dropped from the top of a fixed rough wedge of height h. Find the maximum height to which the sphere rises on a smooth movable wedge of mass M lying adjacent to the fixed wedge on smooth ground.



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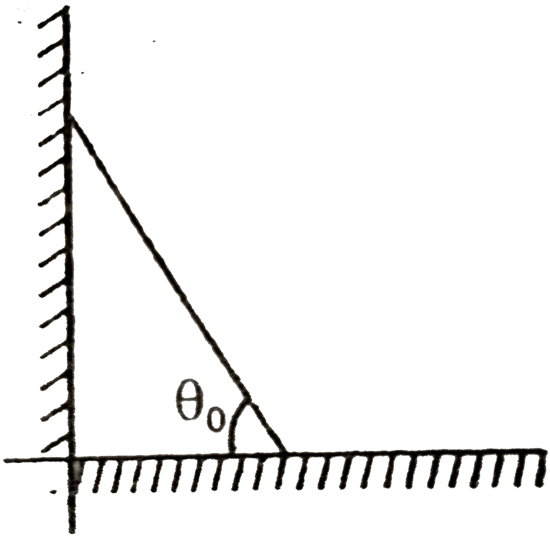
11. A uniform rod is lying against a smooth wall and on a smooth floor. It is relased from rest when it makes an angle θ_0 with the ground. Find the angle rod will make with the ground it just leaves the contact with the walls.



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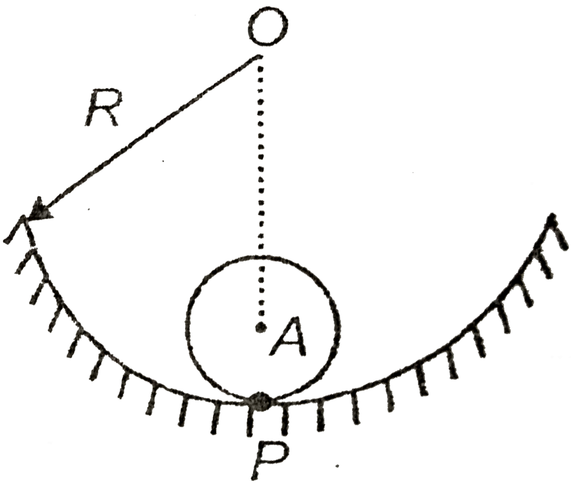
12. A sphere of radius r is rolling without slipping on a hemispherical surface of radius R. Angular velocity and angular acceleration of line OA is ω and α respectively. Find the acceleration of point P on sphere.



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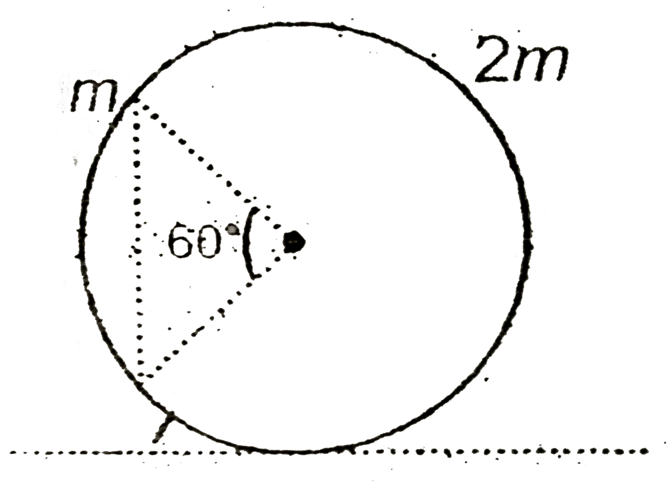
13. A particle of mass m is dropped in side a spherical shell of mass $2m$ and radius R as shown in figure. If the collision is perfectly in elastic and fricition is absent everywhere then find the maximum speed of the centre of the sphere.



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Try Yourself

1. Two bodies of masses $1kg$ and $3kg$ are lying in xy plane at $(0, 0)$ and $(2, -1)$ respectively. What are the coordinates of the centre of mass ?

Hint. $x_{cm} = \frac{m_1 x_1 + m_2 x_2}{m_1 + x_2}$, $y_{cm} = \frac{m_1 y_1 + m_2 y_2}{m_1 + m_2}$

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2. Three point masses of $1kg$, $2kg$ and $3kg$ lie at $(0, 0)$, $(1, 2)$, $(3, -1)$ respectively. Calculate the coordinates of the centre of mass of the system.

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3. Three particles of masses m,m and $4kg$ are kept at a verticals of triangle ABC. Coordinates of A, B and C are $(1, 2)$, $(3, 2)$ and $(-2, -2)$ respectively such that the centre of mass lies at origin. Find the value of mass m.

Hint. $x_{cm} = \frac{\sum_{i-1}^{3} m_i x_i}{\sum_{i=1}^{3} m_i}, y_{cm} = \frac{\sum_{i=1}^{3} m_i y_i}{\sum_{i=1}^{3} m_i}$

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4. Three particles having their masses in the ratio $1:3:5$ are kept at the vertices of a triangle ABC. Coordinate of A, B and C are $(9, -3)$, $(3, 4)$ and $(0, 0)$. Find the coordinates of the centre of mass.

Hint. $x_{cm} = \frac{\sum_{i-1}^{3} m_i x_i}{\sum_{i=1}^{3} m_i}, y_{cm} = \frac{\sum_{i=1}^{3} m_i y_i}{\sum_{i=1}^{3} m_i}$

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5. Centre of mass of the system lies inside disc or square plate and why ?

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6. Two particles of equal mass are moving along the same line with the same speed in the same direction. What is the speed of the centre of mass of the system ?

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7. Two particles of equal mass are moving along the same straight line with the same speed in opposite direction. What is the speed of the centre of mass of the system ?

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8. A shell following a parabolic path explodes somewhere in its flight. The centre of mass of fragements will move in

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9. All the particles are situated at a distance R from the origin. The distance of centre of mass of the body from the origin will be

(1) More than R

(2) Less than R

(3) Equal to R

(4) At the origin

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10. Will the velocity and acceleration of centre of mass change if particles A, B and C are projected from different locations but with same velocities ?

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11. $\overrightarrow{A} = \left(3\hat{i} + 2\hat{j} - 6\hat{k}\right)$ and $\overrightarrow{B} = \left(\hat{i} - 2\hat{j} + \hat{k}\right)$, find the scalar product $\overrightarrow{A}$ and $\overrightarrow{B}$

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12. $\overrightarrow{A} = \left(\hat{i} - 2\hat{j} + 6\hat{k}\right)$ and $\overrightarrow{B} = \left(\hat{i} - 2\hat{j} + \hat{k}\right)$, find the cross product between $\overrightarrow{A}$ and $\overrightarrow{B}$.

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13. Find a unit vector in the direction of vector $\overrightarrow{A} = \left(\hat{i} - 2\hat{j} + \hat{k}\right)$

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14. Find a vector perpendicular to vector $\overrightarrow{A} = \left(\hat{i} + 2\hat{j} - 3\hat{k}\right)$ as well as $\overrightarrow{B} = \left(\hat{i} + \hat{j} - \hat{k}\right)$

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15. The angular displacement of a particle is 24 rad in 10 seconds. Calculate its angular velocity.

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16. The angular velocity of a rigid body is 24 rad s^{-1}, Calculate the time it will take to rotate 72 rad.

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17. The angular velocity of circular disc of radius $2cm$ is 20 rad s^{-1}. Calculate the linear velocity of the disc.

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18. What is the angular velocity of a particle lying on the axis of rotation ?

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19. What is the angular acceleration of a particle moving with constant angular velocity ?

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20. A wheel is rotating with an angular velocity of $3rads^{-1}$. If the angular acceleration is $2rads^{-1}$ then calculate its angular velocity after 5 second.

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21. A force $\left(\hat{i} - 2\hat{j} + 3\hat{k}\right)$ acts on a particle lying at origin. What is the torque acting on the particle about the origin.

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22. A force $\left(\hat{i} - 2\hat{j} + 3\hat{k}\right)$ acts on a particle of position vector $\left(3\hat{i} + 2\hat{j} + \hat{k}\right)$. Calculate the $\hat{j}^{th}$ component of the torque acting on the particle.

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23. A particle of mass $1kg$ is moving about a circle of radius $1m$ with a speed of $1m/s$. Calculate the angular momentum of the particle.

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24. What is the angular momentum of a particle at rest ?

Hint. $\vec{v} = 0.$

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25. A torque of $5Nm$ is applied on a particle for 2 seconds, calculate the change in its angular momentum.

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26. The angular momentum of a particle changes from $4kgm^2s^{-1}$ to $8kgm^2s^{-1}$ is 2 seconds. Calcualte the torque acting on the particle

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27. Give an example of a body in rotational equilibrium but not in translational equilibrium.

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28. Give conditions for mechanical equilibrium.

Watch Video Solution

29. If the parallel forces acting on a lever are in the ratio $3:5$ then what is the mechanical advantage of the lever ?

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30. Define mechanical advantage of a lever.

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31. Define the term centre of gravity of a body?

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32. Why the centre of gravity coincides with the centre of mass only if the size of the body is small ?

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33. Calculate the moment of inertia of a ring of mass $2kg$ and radius $2cm$ about an axis passing through its centre and perpendicular to its surface.

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34. The moment of inerta of a ring of mass $1kg$ about an axis passing through its centre perpendicular to its surface is $4kgm^2$.

Calculate the radius of the ring.

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35. Calculate the radius of gyration of a uniform circular ring about an axis passing through its diameter.

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36. Calculate the radius of gyration of a circular disc about its diameter.

Watch Video Solution

37. Calculate the moment of inertia of a disc about its any diameter ?

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38. The moment of inertia of a uniform ring about an axis passing through its centre and perpendicular to its plane is $100 kgm^2$. What is the moment of inertia of the ring about its diameter ?

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39. Calculate the moment of inertia of a ring about a tangent to the circle of the ring normal to its plane.

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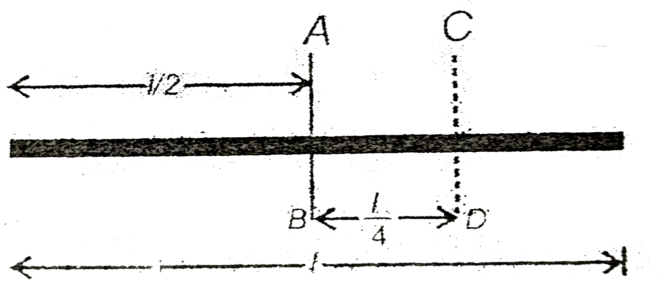
40. Calculate the moment of inertia of the given rod about an axis CD



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41. What is the angular acceleration of a particle if the angular velocity of a particle becomes 4 times of its initial angular velocity 1 rad s in 2 seconds

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42. A particle moving with an angular velocity of 200 rad s^(-1) and $\star tdeae \leq rat \in gatarateof2rads^{-2}$.

Calculate the time in which it will come to rest.

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43. The angular velocity of a motor wheel changes from 180 rpm to 300 rpm in 4 seconds. Calculate the no. of revolutions does the engine make during this time.

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44. The angular velocity of flywheel changes from 240 rpm to 120 rpm in 6 seconds. Calculate the no of revolutions it will make before coming to rest.

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45. Calculate the angular velocity with which a wheel is rotating. If its instanteous power is $500W$, and an external torque of $50Nm$ is applied to it.

Hint : $P = \tau\omega$

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46. Calculate the instantaneous power of a body rotating with angular velocity of

$20 rad / s^{-2}$, when an external torque of $5 Nm$ is applied to it.

Hint : $P = \tau\omega$.

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47. Find the speed of the block after moving down by x

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48. What are the forces acting on the disc?

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49. Two masses M and m are connect by a light string gong over a pulley of radis r. The pulley is free to rotate about its axis which is kept horizontal. The moment of inertia of the pulley about the axis is I. The system is releaed from rest. Find the angular momentum fo teh system when teh mass Mhas descended through a height h. The string does not slip over the pulley.

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50. What is the torque acting on a body moving with constant angular velocity ?

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51. Compute the torque acting on a wheel of moment of inertia $10 kgm^2$, moving with angular acceleration $5 rads^{-2}$.

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52. An ice skater having moment of inertia l rotating with angular speed ω suddenly opens her arms, which reduces her angular velocity to $\frac{\omega}{4}$. Calculate the change in moment of inertia of the dancer.

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53. The moment of inertia of a body moving with angular velocity ω decreases from I to $\frac{I}{3}$

without any external torque. Calculate the new angular velocity of the body.

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54. Find the kinetic energy of the disc when it is fallen of a height h.

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55. A solid sphere and a hollow cylinder have the same radius and the same mass. They start from rest at the top of an incline. Which reaches the bottom first? Which has the greater speed at the bottom? Which has the greater total kinetic energy of the bottom ? Which has the greater rotational KE?

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56. Two spheres look identical and have the same mass. However one is hollow and the other is solid. Describe an experiment to determine which is which.

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57. Will the ring roll purely if force F is applied in between topmost point and centre and the surface is smooth.

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58. If the ring slips then will it be backward slipping or forward slipping.

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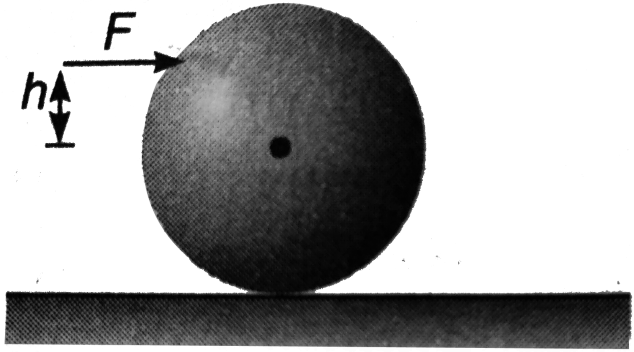
59.



A billiard ball, initially at rest, is given a sharp impulse by a cue. The cue is held horizontally a distance h above the centre line as shown in figure. The ball leaves the cue with a speed v_0 and because of its backward slipping eventually acquires a final speed $\frac{9}{7}v_0$ show that $h = \frac{4}{5}R$

Where R is the radius of the ball.

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60. Calculate the kinetic energy of a solid sphere of mass $2kg$ rolling down an inclined plane with a velocity of $2m/s$ about an axis passing through its diameter.

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61. The kinetic energy of a rolling solid cylinder of mass $4kg$ about it axis of rotation is $20kgm^2s^{-2}$. Calculate the velocity with which it is moving.

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62. Calculate the velocity with which a solid cylinder rolls down an inclined plane of height $10m$ with slipping (take $g = 10m/s^2$)

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63. A uniform ring rolls down an inclined plane without slipping. If it reaches the bottom of a speed of $2m/s$, then calculate the height of the inclined plane (use $g = 10m/s^2$)

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64. From a uniform circular disc of mass M and radius R a small circular disc of radius R/2 is removed in such a way that both have a common tangent. Find the distance of centre of mass of remaining part from the centre of original disc.

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65. A non–uniform thin rod of length L is placed along x-axis as such its one of ends at the origin. The linear mass density of rod is $\lambda = \lambda_0 x$. The distance of centre of mass of rod from the origin is :

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66. Two bodies of masses 1 kg and 3 kg are lying in xy plane at (0, 0) and (2, -1) respectively. What are the coordinates of the centre of mass ?

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67. Three point masses of $1kg, 2kg$ and $3kg$ lie at $(0, 0)$, $(1, 2)$, $(3, -1)$ respectively. Calculate the coordinates of the centre of mass of the system.

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68. Three particles of masses m,m and $4kg$ are kept at a verticals of triangle ABC. Coordinates of A, B and C are $(1, 2)$, $(3, 2)$ and $(-2, -2)$ respectively such that the centre of mass lies at origin. Find the value of mass m.

Hint. $x_{cm} = \frac{\sum_{i-1}^{3} m_i x_i}{\sum_{i=1}^{3} m_i}, y_{cm} = \frac{\sum_{i=1}^{3} m_i y_i}{\sum_{i=1}^{3} m_i}$

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69. Three particles having their masses in the ratio $1:3:5$ are kept at the vertices of a triangle ABC. Coordinate of A, B and C are $(9, -3)$, $(3, 4)$ and $(0, 0)$. Find the coordinates of the centre of mass.

Hint. $x_{cm} = \dfrac{\sum_{i-1}^{3} m_i x_i}{\sum_{i=1}^{3} m_i}, y_{cm} = \dfrac{\sum_{i=1}^{3} m_i y_i}{\sum_{i=1}^{3} m_i}$

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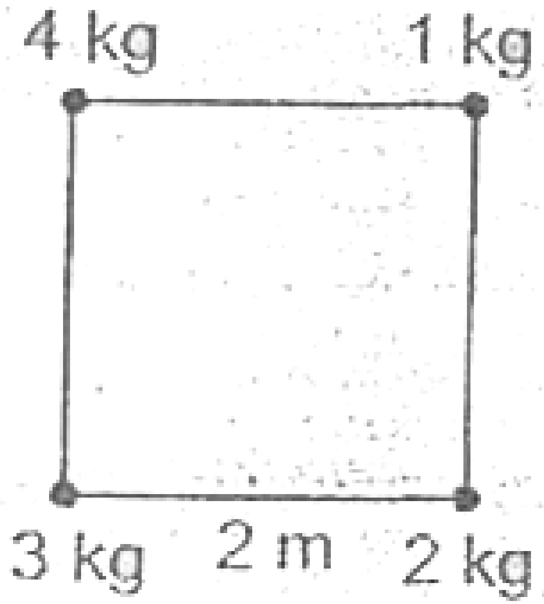
70. Four point masses are placed at the corners of a square of side 2 m as shown in the figure. Find the centre of mass of the system w.r.t. the centre of square.



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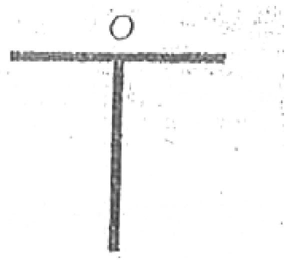
71. Two uniform thin rods each of length L and mass m are joined as shown in the figure. Find the distance of centre of mass the system from point O



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72. Two particles of equal mass are moving along the same line with the same speed in the same direction. What is the speed of the centre of mass of the system ?

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73. Two particles of equal mass are moving along the same straight line with the same speed in opposite direction. What is the speed of the centre of mass of the system ?

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74. A shell following a parabolic path explodes somewhere in its flight. The centre of mass of fragments will move in

A. Move along the horizontal direction

B. Move along the vertical direction

C. Continue to move along the same parabolic path

D. Move in any direction

Answer: C

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75. All the particles of a body are situated at a distance R from the origin. The distance of the centre of mass of the body from the origin is

A. More than R

B. Less than R

C. Equal to R

D. At the origin

Answer: B

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76. $\overrightarrow{A} = \left(3\hat{i} + 2\hat{j} - 6\hat{k}\right)$ and $\overrightarrow{B} = \left(\hat{i} - 2\hat{j} + \hat{k}\right)$ find the scalar product of $\overrightarrow{A}$ and $\overrightarrow{B}$.

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77. $\overrightarrow{A} = \left(\hat{i} - 2\hat{j} + 6\hat{k}\right)$ and $\overrightarrow{B} = \left(\hat{i} - 2\hat{j} + \hat{k}\right)$, find the cross product between $\overrightarrow{A}$ and $\overrightarrow{B}$.

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78. Find a unit vector in the direction of vector $\overrightarrow{A} = \left(\hat{i} - 2\hat{j} + \hat{k}\right)$.

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79. Find a vector perpendicular to vector $\overrightarrow{A} = \left(\hat{i} + 2\hat{j} - 3\hat{k}\right)$ as well as $\overrightarrow{B} = \left(\hat{i} + \hat{j} - \hat{k}\right)$

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80. The angular displacement of a particle is 24 rad in 10 seconds. Calculate its angular velocity.

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81. The angular velocity of a rigid body is 24 rad s^{-1}, Calculate the time it will take to rotate 72 rad.

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82. The angular velocity of circular disc of radius $2cm$ is 20 rad s^{-1}. Calculate the linear velocity of the disc.

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83. What is the angular velocity of a particle lying on the axis of rotation ?

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84. What is the angular acceleration of a particle moving with constant angular velocity ?

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85. A wheel is rotating with an angular velocity of $3rads^{-1}$. If the angular acceleration is $2rads^{-1}$ then calculate its angular velocity after 5 second.

Watch Video Solution

86. A particle is moving with constant speed v along x - axis in positive direction. Find the angular velocity of the particle about the point (0, b), when position of the particle is (a, 0).

Watch Video Solution

87. A force $\left(\hat{i} - 2\hat{j} + 3\hat{k}\right)$ acts on a particle lying at origin. What is the torque acting on the particle about origin?

Watch Video Solution

88. A force $\left(\hat{i}-2\hat{j}+3\hat{k}\right)$ acts on a particle of position vector $\left(3\hat{i}+2\hat{j}+\hat{k}\right)$. Calculate the $\hat{j}^{th}$ component of the torque acting on the particle.

View Text Solution

89. A particle of mass $1kg$ is moving about a circle of radius $1m$ with a speed of $1m/s$.

Calculate the angular momentum of the particle.

Watch Video Solution

90. What is the angular momentum of a particle at rest ?

Hint. $\overrightarrow{v} = 0.$

Watch Video Solution

91. A torque of $5Nm$ is applied on a particle for 2 seconds, calculate the change in its angular momentum.

Watch Video Solution

92. The angular momentum of a particle changes from $4kgm^2s^{-1}$ to $8kgm^2s^{-1}$ is 2 seconds. Calcualte the torque acting on the particle

Watch Video Solution

93. Give an example of a body in rotational equilibrium but not in translational equilibrium.

Watch Video Solution

94. Give conditions for mechanical equilibrium.

Watch Video Solution

95. If the parallel forces acting on a lever are in the ratio $3:5$ then what is the mechanical advantage of the lever ?

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96. Define mechanical advantage of a lever.

View Text Solution

97. Define the centre of gravity of a homogenous rigid body.

Watch Video Solution

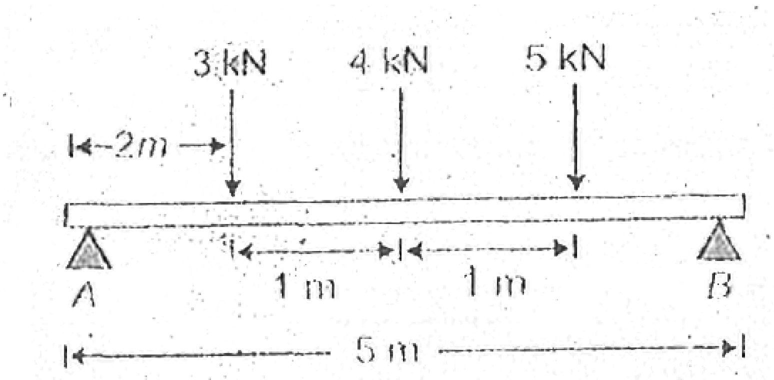
98. Why the centre of gravity coincides with the centre of mass only if the size of the body is small ?

Watch Video Solution

99. A uniform ladder of length 3.25 m and weight 250 N is placed against a smooth vertical wall with its lower end 1.25 m from the wall. If coefficient of friction between the ladder and the floor is 0.3, then, find the frictional force acting on the ladder at the point of contact between ladder and floor.

Watch Video Solution

100. A massless beam of langth 5 m is placed on two wedges A and B. If three forces 3 kN, 4 kN and 5 kN are applied on the beam as shown in the figure, then find normal reaction at A and B.



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101. Calculate the moment of inertia of a ring of mass $2kg$ and radius $2cm$ about an axis passing through its centre and perpendicular to its surface.

Watch Video Solution

102. The moment of inerta of a ring of mass $1kg$ about an axis passing through its centre perpendicular to its surface is $4kgm^2$. Calculate the radius of the ring.

Watch Video Solution

103. Calculate the radius of gyration of a uniform circular ring about an axis passing through its diameter.

Watch Video Solution

104. Calculate the radius of gyration of a circular disc about its diameter.

Watch Video Solution

105. Calculate the moment of inertia of a disc about its any diameter ?

Watch Video Solution

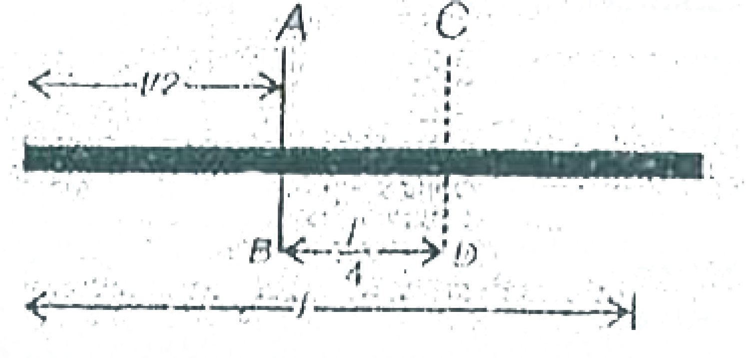
106. The moment of inertia of a uniform ring about an axis passing through its centre and perpendicular to its plane is $100 kgm^2$. What is the moment of inertia of the ring about its diameter ?

Watch Video Solution

107. Calculate the moment of inertia of a ring about a tangent to the circle of the ring normal to its plane.

Watch Video Solution

108. Calculate the moment of inertia of the given rod about an axis CD.



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109. What is the angular acceleration of a particle if the angular velocity of a particle becomes 4 times of its initial angular velocity 1 rad s in 2 seconds

Watch Video Solution

110. A particle moving with an angular velocity of 200 rad s^(-1) and $\star tdeae \leq rat \in gatarateof2rads^{-2}$.

Calculate the time in which it will come to rest.

Watch Video Solution

111. The angular velocity of a motor wheel changes from 180 rpm to 300 rpm in 4 seconds. Calculate the no. of revolutions does the engine make during this time.

Watch Video Solution

112. The angular velocity of flywheel changes from 240 rpm to 120 rpm in 6 seconds. Calculate the no of revolutions it will make before coming to rest.

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113. Calculate the angular velocity with which a wheel is rotating. If its instantaneous power is $500W$, and an external torque of $50Nm$ is applied to it.

Hint : $P = \tau\omega$

Watch Video Solution

114. Calculate the instantaneous power of a body rotating with angular velocity of $20 rad/s^{-1}$, when an external torque of $5 Nm$ is applied to it.

Hint : $P = \tau\omega$.

Watch Video Solution

115. What is the torque acting on a body moving with constant angular velocity ?

Watch Video Solution

116. Compute the torque acting on a wheel of moment of inertia $10kgm^2$, moving with angular acceleration $5rads^{-2}$.

Watch Video Solution

117. An ice skater having moment of inertia l rotating with angular speed ω suddenly opens her arms, which reduces her angular velocity to $\frac{\omega}{4}$. Calculate the change in moment of inertia of the dancer.

Watch Video Solution

118. The moment of inertia of a body moving with angular velocity ω decreases from l to $\frac{l}{3}$

without any external torque. Calculate the new angular velocity of the body.

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119. What is the velocity of the highest point of a rotating wheel of a car moving with a velocity of 20 m/s ?

Watch Video Solution

120. During rolling without slipping, what is the velocity of the point in contact with the surface.

Watch Video Solution

121. Calculate the kinetic energy of a solid sphere of mass $2kg$ rolling down an inclined plane with a velocity of $2m/s$ about an axis passing through its diameter.

Watch Video Solution

122. The kinetic energy of a rolling solid cylinder of mass $4kg$ about it axis of rotation is $20kgm^2s^{-2}$. Calculate the velocity with which it is moving.

Watch Video Solution

123. Calculate the velocity with which a solid cylinder rolls down an inclined plane of height $10m$ with slipping (take $g = 10m/s^2$)

Watch Video Solution

124. A uniform ring rolls down an inclined plane without slipping. If it reaches the bottom of a speed of $2m/s$, then calculate the height of the inclined plane (use $g = 10m/s^2$)

Watch Video Solution

Content Builder (Example)

1. A particle of mass m is projected with velocity v at an angle θ with the horizontal. Find its angular momentum about the point of projection when it is at the highest point of its trajectory.

Watch Video Solution

2. A particle of mass m has been thrown with intial speed u making angle θ with the horizontal ground. Find the angular momentum of the projectile about an axis perpendicular to the plane and passing through the point of projection when the projectile is

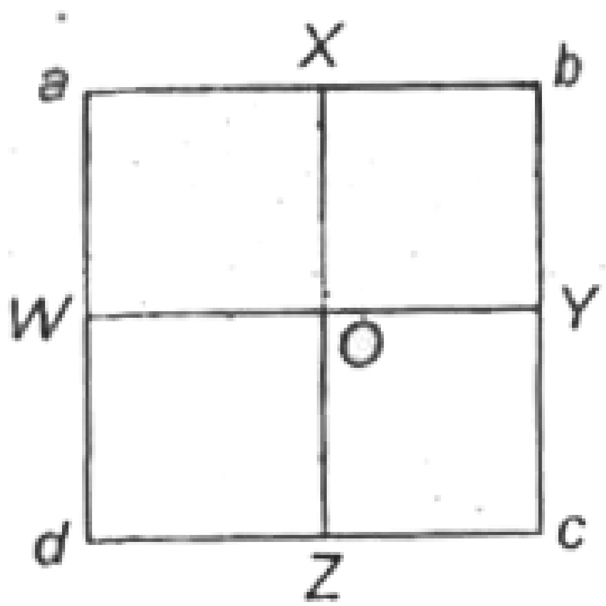
(a) At the highest point

(b) About to hit the ground

Watch Video Solution

EXERCISE

1. A uniform plate abcd has a mass of 1 kg. If two point masses each of 20 g are placed at the corners b and c as shown, then centre of mass shifts on the line



A. OW

B. OX

C. OY

D. OZ

Answer: C

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2. In a carbon monoxide molecule, the carbon and the oxygen atoms are separated by a distance $1.2 \times 10^{-10} m$. The distance of the centre of mass from the carbon atom is

A. 0.48 Å

B. 0.51 Å

C. 0.56 Å

D. 0.69 Å

Answer: D

Watch Video Solution

3. Consider a system of two identical particles. One of the particles is at rest and the other has an acceleration. The centre of mass has an acceleration.

A. Zero

B. $\overrightarrow{f}$

C. $\frac{\overrightarrow{f}}{2}$

D. $2\overrightarrow{f}$

Answer: C

Watch Video Solution

4. Two blocks of masses 5kg and 2kg are connected by a spring of negligible mass and placed on a frictionless horizontal surface. An impulse provides a velocity of 7m/s to the heavier block in the direction of the lighter block. The velocity of the centre of mass is :-

A. 4 m/s

B. 5 m/s

C. 2 m/s

D. 3 m/s

Answer: B

Watch Video Solution

5. A body falling vertically downwards under gravity breaks in two parts of unequal masses. The centre of mass of the two parts taken together shifts horizontally towards

A. Shifts horizontally towards heavier piece

B. Shifts horizontally towards lighter piece

C. Doesn't shift horizontally

D. Shifts horizontally if initial speed is zero

Answer: C

Watch Video Solution

6. A body at rest breaks into two pieces of equal masses. The parts will move

A. Arbitrarily

B. In the same direction

C. In opposite directions with equal speeds.

D. In opposite directions with unequal speeds

Answer: D

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7. A point object of mass m is kept at (a, 0) along x-axis. What mass should be kept at (-3a,0), so that centre of mass lies at origin ?

A. m

B. 2m

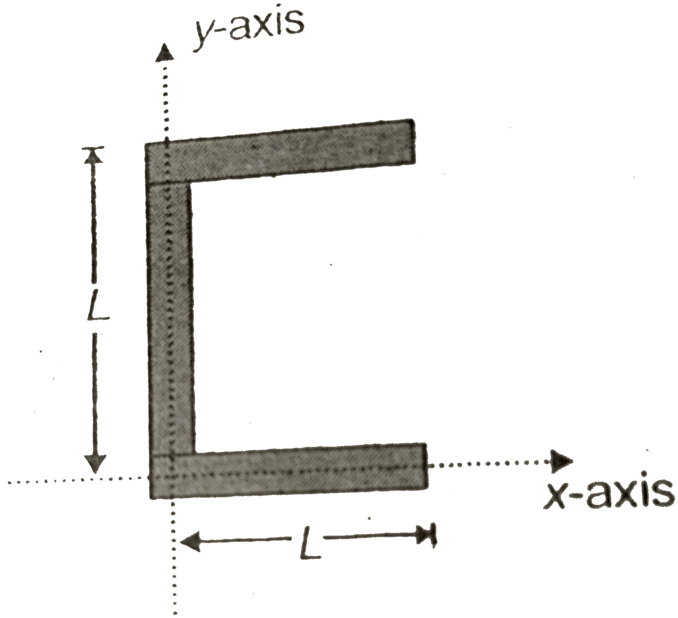
C. $\frac{m}{3}$

D. 3m

Answer: C

Watch Video Solution

8. Locate the centre of mass of arrangement shown in figure. The three rods are identical in mass and length



A. $\left(\frac{L}{2}, \frac{L}{2}\right)$

B. $\left(\frac{L}{3}, 0\right)$

C. $\left(\frac{L}{3}, \frac{L}{2}\right)$

D. $\left(0, \frac{L}{3}\right)$

Answer: C

Watch Video Solution

9. A particle of mass m is thrown horizontally from the top of a tower and anoher particle of mass $2m$ is thrown vertically upward. The acceleration of centre of mass is

A. g

B. $\frac{9g}{3}$

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

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

Answer: A

Watch Video Solution

10. A child sits stationary at one end of a long trolley moving u8niformly with a speed V on a smooth horizontal floor. If the child gets up and runs about on the trolley in any manner, what is the speed of the CM of the trolley + child) system ?

A. Zero

B. (v + u)

C. v

D. (v - u)

Answer: C

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11. In a clokwise system

A. $\hat{k} \times \hat{i} = \hat{j}$

B. $\hat{j}\hat{i} = 1$

C. $\hat{i} \times \hat{i} = 1$

D. $\hat{i}.\,\hat{j} = 0$

Answer: A

Watch Video Solution

12. A vector $\vec{A}$ points vertically upward and $\vec{B}$ points towards north. The vector product $\vec{A} \times \vec{B}$ is

A. East

B. West

C. North

D. South

Answer: A

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13. If $\vec{A} + \vec{B} + \vec{C} = 0$ then $\vec{A} \times \vec{B}$ is

A. $\vec{C} \times \vec{B}$

B. $\overrightarrow{B} \times \overrightarrow{C}$

C. $\overrightarrow{A} \times \overrightarrow{C}$

D. Zero

Answer: B

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14. The angle between A and B is θ.The value of the triple product A .(B x A) is

A. Zero

B. $CD^2 \sin\theta$

C. $CD^2 \cos\theta$

D. $CD^2 \sin\theta \cos\theta$

Answer: A

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15. A disc rotating about its axis, from rest it acquires a angular speed 100rev/s in 4 second. The angle rotated by it during these seconds (in radian) is :-

A. 100π

B. 200π

C. 300π

D. 400π

Answer: D

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16. A body rotating with uniform angular acceleration covers 100π (radian) in the first 5 s after the start. Its angular speed at the end of 5 s (in rad/s) is

A. 40π

B. 30π

C. 20π

D. 10π

Answer: A

Watch Video Solution

17. A wheel starting from rest is uniformly accelerated at $2re\frac{d}{s^2}$ for 20 seconds. It is allowed to rotate uniformly for the next 10 seconds and is finally brought to rest in next 20 seconds. The total angle rotated by the wheel (in radian) is :-

A. 600

B. 1200

C. 1800

D. 300

Answer: B

Watch Video Solution

18. A body rotates about a fixed axis with an angular acceleration of $3rad/s^2$. The angle rotated by it during the time when its angular velocity increases frm 10 rad/s to 20 rad/s (in radian) is

A. 50

B. 100

C. 150

D. 200

Answer: A

Watch Video Solution

19. The torque of a force $F = -2\hat{i} + 2\hat{j} + 3\hat{k}$ acting on a point $r = \hat{i} - 2\hat{k} + \hat{k}$ about origin will be

A. $8\hat{i} + 5\hat{j} + 2\hat{k}$

B. $-8\hat{i} - 5\hat{j} - 2\hat{k}$

C. $8\hat{i} - 5\hat{j} + 2\hat{k}$

D. $-8\hat{i} + 5\hat{j} - 2\hat{k}$

Answer: B

Watch Video Solution

20. Moment of a force of magnitude 20 N acting along positive x-direction at point $(3m, 0, 0)$ about the point $(0, 2, 0)$ (in N-m) is

A. 20

B. 60

C. 40

D. 30

Answer: C

Watch Video Solution

21. A flywheel of moment of inertia 2kg-m^2 is rotated at a speed of $30\text{rad}/\text{s}$. A tangential force at the rim stops the wheel in 15 second.

Average torque of the force is

A. 4 Nm

B. 2 Nm

C. 8 Nm

D. 1 Nm

Answer: A

Watch Video Solution

22. A torque T acts on a body of moment of inertia I rotating with angular speed ω. It will be stopped just after time

A. $\frac{lT}{\omega}$

B. $\frac{l\omega}{T}$

C. $\frac{T\omega}{l}$

D. $l\omega T$

Answer: B

Watch Video Solution

23. A disc is rotating with angular velocity $\widehat{\omega}$ about its axis. A force $\overrightarrow{F}$ acts at a point whose position vector with respect to the axis of rotation is $\overrightarrow{r}$. The power associated with the torque due to the force is given by

A. $\left(\overrightarrow{r} \times \overrightarrow{F}\right)\overrightarrow{\omega}$

B. $\left(\overrightarrow{r} \times \overrightarrow{F}\right) \times \omega$

C. $\overrightarrow{r} \times \left(\overrightarrow{F} . \overrightarrow{\omega}\right)$

D. $\overrightarrow{r} . \left(\overrightarrow{F} \times \overrightarrow{\omega}\right)$

Answer: A

Watch Video Solution

24. A particle is rotating in circle with uniform speed as shown. The angular momentum of the particle w.r.t. origin is :-

A. Constant in magnitude as well as direction

B. Constant in magnitude only

C. Constant in direction only

D. Variable in magnitude as well as direction

Answer: D

Watch Video Solution

25. When a torque acting upon a system is zero. Which of the following will be constant?

A. Moment of inertia

B. Angular velocity

C. Kinetic energy

D. Moment of linear momentum

Answer: D

Watch Video Solution

26. A particle is moving along a straight line parallel to x-axis with constant velocity. Find angular momentum about the origin in vector form :

A. $+mv^2b\hat{k}$

B. $-mvb\hat{k}$

C. $-2mvb\hat{k}$

D. $-mvb\hat{j}$

Answer: B

Watch Video Solution

27. A particle is moving along a straight line with increasing speed. Its angular momentum about a fixed point on this line :

A. Goes on increasing

B. Goes on decreasing

C. May be increasing or decreasing depending on direction of motion

D. Remains zero

Answer: D

Watch Video Solution

28. When a body is spinning on its axis in absence of any external torque, then choose the wrong statement

A. $\vec{\omega}$ can be changed by keeping $\vec{L}$ same

B. $\vec{L}$ can be changed by keeping $\vec{\omega}$ same

C. I can be change by keeping $\vec{L}$ same

D. I and $\vec{\omega}$ both can be changed by keeping $\vec{L}$ same

Answer: B

Watch Video Solution

29. Two dises having masses in the ratio $1:2$ and radii in the ratio $1:8$ roll down without slipping one by one from an inclined plane of height h. The ratio of their linear velocities on reaching the ground is :-

A. $1:16$

B. $1:128$

C. $1:8\sqrt{2}$

D. $1:1$

Answer: D

Watch Video Solution

30. Which of the following (if mass and radius are assumed to be same) have maximum percentage of total K.E. in rotational form while pure rolling ?

A. Disc

B. Sphere

C. Ring

D. Hollow sphere

Answer: C

Watch Video Solution

31. A solid cylinder of mass M and radius R rolls down an inclined plane of height h. The angular velocity of the cylinder when it reaches the bottom of the plane will be :

A. $\frac{1}{2R}\sqrt{gh}$

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

C. $\frac{2}{R}\sqrt{\frac{gh}{3}}$

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

Answer: C

Watch Video Solution

32. If radius of the earth contracts to half of its present value without change in its mass, what will be the new duration of the day?

A. $\frac{24}{n^2}$

B. $24n^2$

C. $24\left(1 - \frac{1}{n^2}\right)$

D. $24(1 - n^2)$

Answer: B

Watch Video Solution

33. Due to global warming, ice on polar caps is likely to melt in large quantity. Due to this effect :

A. Moment of inertia of earth shall decrease

B. Length of the day shall decrease

C. Angular velocity of earth shall decrease

D. Angular momentum of earth shall decrease

Answer: C

Watch Video Solution

34. Fly-wheel is used with an engine because it

A. Increases the efficiency of engine

B. Converts linear motion into rotatory motion

C. Is computsory by law

D. Makes the motion smooth and cuts down the vibrations

Answer: D

Watch Video Solution

35. Different minerals are being mined from within the earth and multi - storeyed complexes are being constructed. Due to this activity theoretically

A. Angular speed of earth would increase

B. Angular momentum would increase

C. Time period of earth would decrease

D. Length of day would increase

Answer: D

Watch Video Solution

36. A disc of mass 1 kg and radius 0.1 m is rotating with angular velocity 20 rad/s. What is angular velocity (in rad/s) if a mass of 0.5 kg is put on the circumference of the disc ?

A. 10

B. 20

C. 40

D. 30

Answer: A

Watch Video Solution

37. A solid sphere of diameter 0.1 m and 5 kg is rolling down an inclined plane with a speed of 4 m/s. The total kinetic energy of the sphere is :

A. 28 J

B. 56 J

C. 84 J

D. 112 J

Answer: B

Watch Video Solution

38. The speed of a homogenous solid sphere after rolling down an inclined plane of vertical height h, from rest without sliding is

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

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

C. $\sqrt{gH}$

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

Answer: D

Watch Video Solution

39. A disc of mass M kg and radius R metre is rotating at an angular speed of ω rad/s when the motor is switched off. Neglecting the friction at the axie, the force that must be applied tangentially to the wheel to bring it to

rest time t is

A. $\frac{MR\omega}{2t}$

B. $\frac{MR\omega}{t}$

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

D. $\frac{MR^2\omega}{2t}$

Answer: A

Watch Video Solution

40. Choose the correct statement

A. A sphere can do pure rolling on smooth horizontal surface

B. A sphere can't do pure rolling on a fixed smooth wedge

C. Rolling friction can act parallel or antiparallel to the direction of motion

D. All of these

Answer: D

Watch Video Solution

41. A thin uniform circular ring is rolling down an inclined plane of inclination 30° without slipping. Its linear acceleration along the inclined plane is :

A. g

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

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

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

Answer: D

Watch Video Solution

42. The solid cylinder is rolling without slipping on a plane having inclination θ and the coeffecient of static friction μ_s. The relation between θ and μ_s is

A. $\tan^{-1}\mu$

B. $\tan^{-1}2\mu$

C. $\tan^{-1}3\mu$

D. $\tan^{-1}\frac{\mu}{3}$

Answer: C

Watch Video Solution

43. A physical balance has its arms of unequal length. A body weight 18 kg if kept in one pan and weight 8 kg. If kept in the other pan. The true weight of the body is

A. 13 kg

B. 12 kg

C. 10 kg

D. 16 kg

Answer: B

Watch Video Solution

44. A solid cylinder and a solid sphere, both having the same mass and radius, are released from a rough inclined plane of inclination θ

one by one. They roll on the inclined plane without slipping. The force of friction that acts

A. Same for both the bodies

B. More for cylinder

C. More for sphere

D. Double for sphere than for cylinder

Answer: B

Watch Video Solution

45. A solid sphere is thrown up a rough incline. The sphere rolls up without slipping and eventually comes down rolling without slipping. The direction of friction during upward and downward motion respectively is :-

A. Downward upward

B. Upward, downward

C. Downward, downward

D. Upward, upward

Answer: D

Watch Video Solution

46. Two solid spheres of different mass, radii and denisty roll down a rough inclined plane under indentical situation. Their time to come down is independent o their :-

A. Mass

B. Radius

C. Density

D. All of these

Answer: D

Watch Video Solution

47. A thin circular ring first slips down a smooth incline then rolls down a rough incline of identical geometry from same height. Ratio of time taken in the two motion is :

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

B. 1

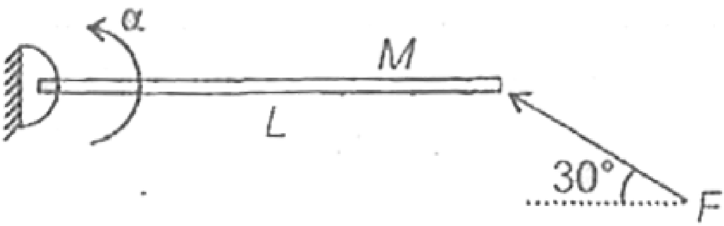
C. $\frac{1}{\sqrt{2}}$

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

Answer: C

Watch Video Solution

48. The thin rod shown below has mases M and length L. A force F acts at one end as shown and the rod is free to rotate about the other end in horizontal plane. Initial angular acceleration of the rod is :



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

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

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

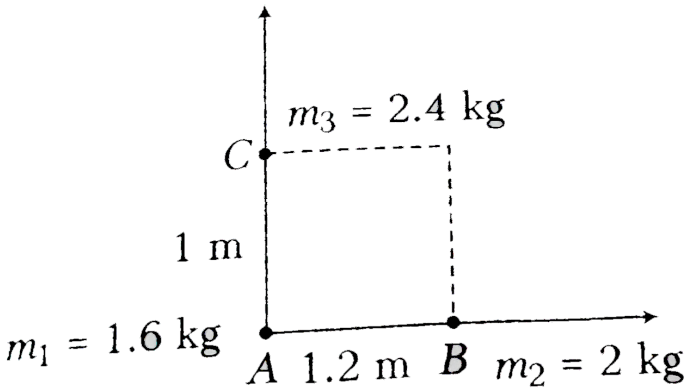
D. $\frac{F}{2ML}$

Answer: A

Watch Video Solution

ASSIGNMENT (SECTION - A)

1. Three point masses m_1, m_2 and m_3 are placed at the corners of a thin massless rectangular sheet $1.2m \times 1m)$ as shown. Center of mass will be located at the point.



A. (0.8, 0.6) m

B. (0.6, 0.8) m

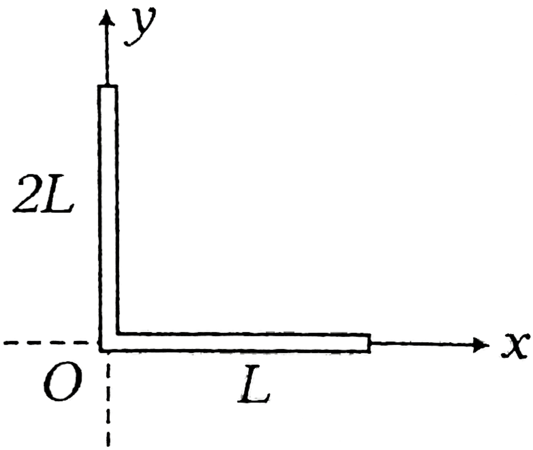
C. (0.4, 0.4) m

D. (0.5, 0.6) m

Answer: C

Watch Video Solution

2. Figure shows a composite system of two uniform rods of lengths as indicated. Then the coordinate of the center of mass of the system of rods are



A. $\left(\frac{L}{2}, \frac{2L}{3}\right)$

B. $\left(\frac{L}{4}, \frac{2L}{3}\right)$

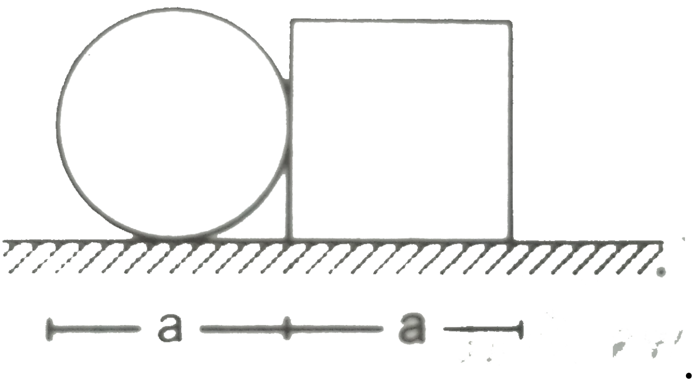
C. $\left(\frac{L}{6}, \frac{2L}{3}\right)$

D. $\left(\frac{L}{6}, \frac{L}{3}\right)$

Answer: C

Watch Video Solution

3. A circular plate of diameter d is kept in contact with a square plate of edge d as shown in figure. The densit of the material and the thickness are same



Everywhere. The centre of mass of the composite system will be

A. Inside the circular plate

B. Inside the square plate

C. At the point of contact

D. Outside the system

Answer: B

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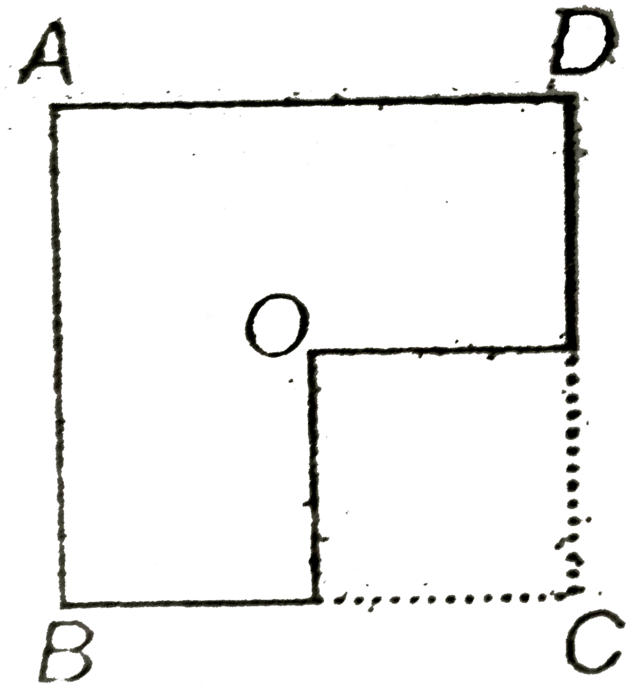
4. From a uniform square plate, one-fourth part is removed as shown. The centre of mass of remaining part will lie on



A. OC

B. OA

C. OB

D. OD

Answer: B

Watch Video Solution

5. Two particles A and B intiallly at rest, move towards each other under a mutual force of attraction. AT the instant when the speed of A is v and the speed of B is 2 v, the speed of the centre of mass of the system is

A. v

B. 2v

C. 3v

D. Zero

Answer: D

Watch Video Solution

6. A shell following a parabolic path explodes somewhere in its flight. The centre of mass of fragements will move in

A. Vertical direction

B. Any direction

C. Horizontal direction

D. Same parabolic path

Answer: D

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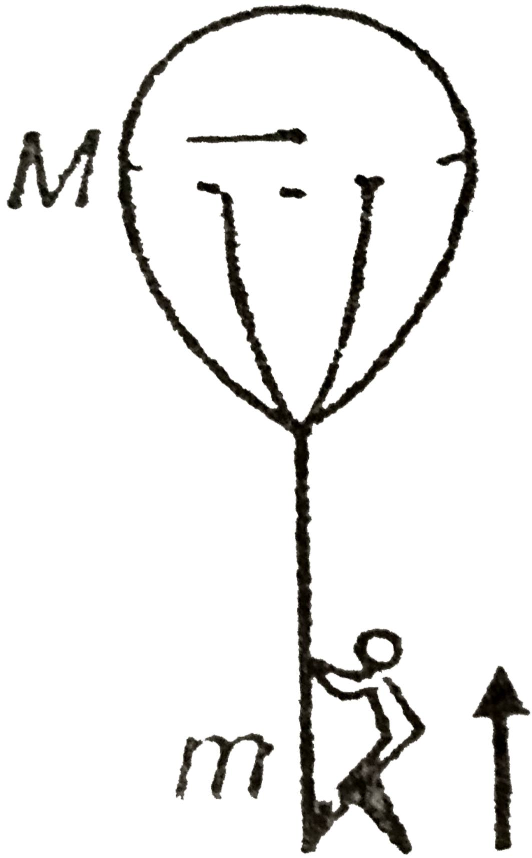
7. A man of mass m is suspended in air by holding the rope of a ballon of mass M. As the man climbs up the rope, the ballon



A. Moves upward

B. Moves downward

C. Remains stationary

D. Cannot say

Answer: B

Watch Video Solution

8. A ball of mass m is thrown upward and another ball of same mass is thrown downward so as to move freely gravity. The acceleration of centre of mass is

A. g

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

C. 2g

D. Zero

Answer: A

Watch Video Solution

9. A man of mass m starts moving on a plank of mass M with constant velocity v with respect to plank. If the plank lies on a smooth horizontal surface, then velocity of plank with respect to ground is

A. $\dfrac{Mv}{m+M}$

B. $\dfrac{mv}{M}$

C. $\dfrac{Mv}{m}$

D. $\dfrac{mv}{m+M}$

Answer: D

Watch Video Solution

10. The moment of interia of a body depends upon

A. The mass of the body

B. The distribution of the mass in the body

C. The axis of rotation of the body

D. All of these

Answer: D

Watch Video Solution

11. The moment of inertia of thin uniform circular disc about one of the diameter is I. Its moment of inertia about an axis perpendicular to the circular surface and passing through its centre is

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

B. 2l

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

D. 6l

Answer: D

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

A. $5:7$

B. $3:5$

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

D. $3:7$

Answer: C

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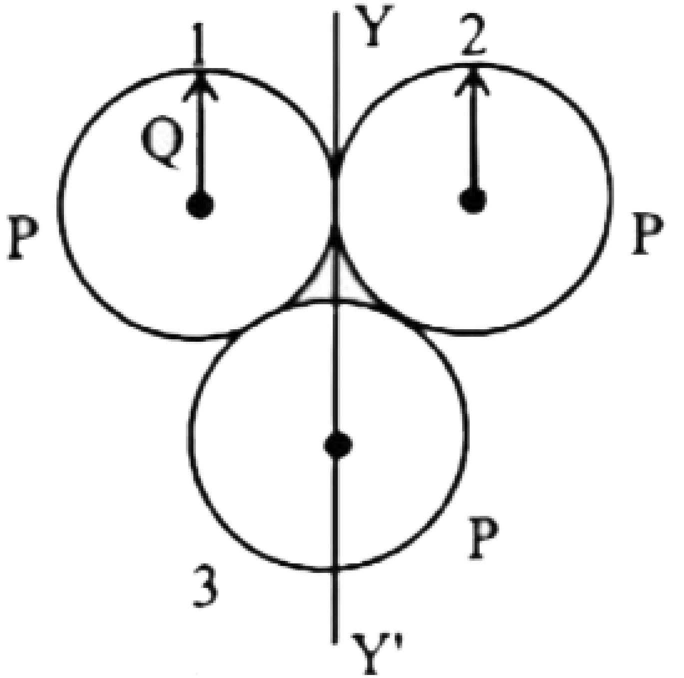
13. Three rings, each of mass P and radius Q are arranged as shown in the figure. The moment of inertia of the arrangement about

YY' axis will be



A. $\dfrac{7}{5}PQ^2$

B. $\dfrac{14}{5}PQ^2$

C. $\dfrac{16}{5}PQ^2$

D. $\dfrac{7}{2}PQ^2$

Answer: C

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14. There are four solid balls with their centres at the four corners of a square of side a. the mass of each sphere is m and radius is r. Find the moment of inertia of the system about one of the sides of the square

A. $Ma^2 + 2Mb^2$

B. Ma^2

C. $Ma^2 + 4Mb^2$

D. $\frac{8}{5}Ma^2 + 2Mb^2$

Answer: D

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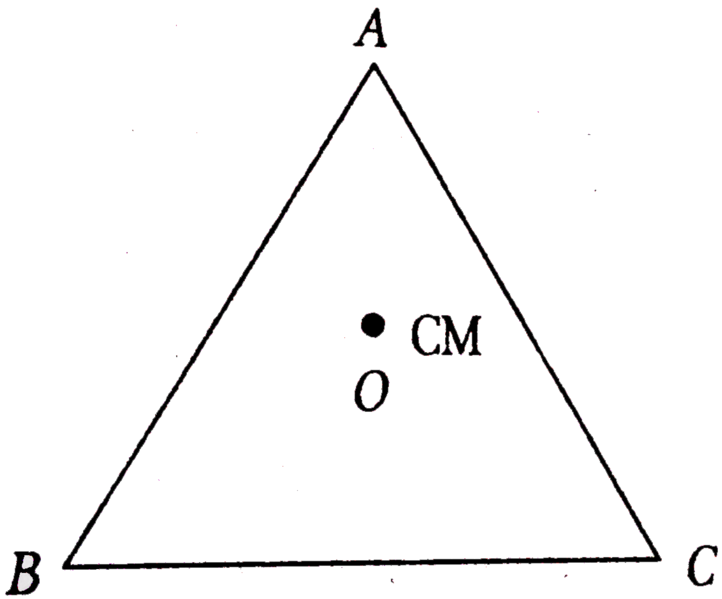
15. Three rods each of mass m and length l are joined togther to form an equilateral triangle as shown in figure. Find the moment of inertia of the system about on axis passing through its centre of mass and perpendicular to the plane of the triangle



A. $2mL^2$

B. $\frac{mL^2}{2}$

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

D. $\frac{mL^2}{6}$

Answer: B

Watch Video Solution

16. A circular disc is to be made using iron and aluminium. To keep its moment of inertia maximum about a geometrical axis, it should be so prepared that

A. Aluminium at interior and iron surrounding it

B. Iron at interior surrounded by aluminium

C. Using ironUsing iron and aluminium layers in alternate order

D. Sheet of iron is used at both external surface and aluminium as interior layer

Answer: A

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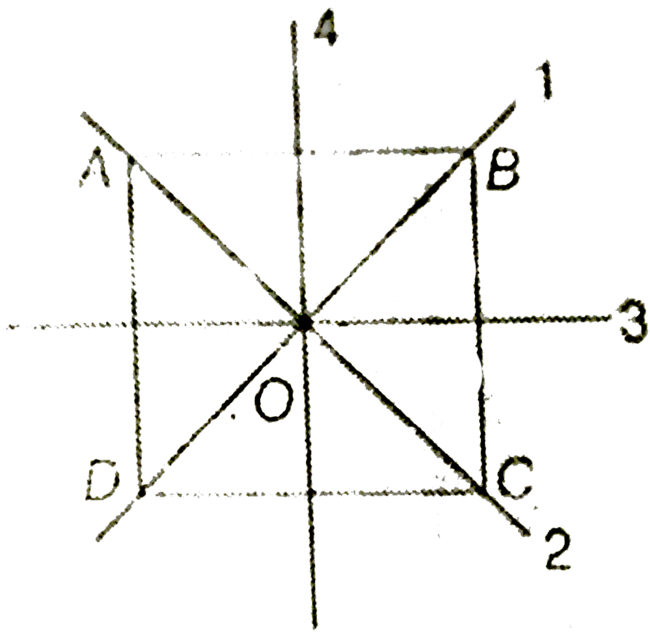
17. The moment of inertia of a thin square plate ABCD of uniform thickness about an axis passing through the centre O and perpendicular to plate is



A. $I = I_1 + I_2$

B. $l = l_1 + l_3$

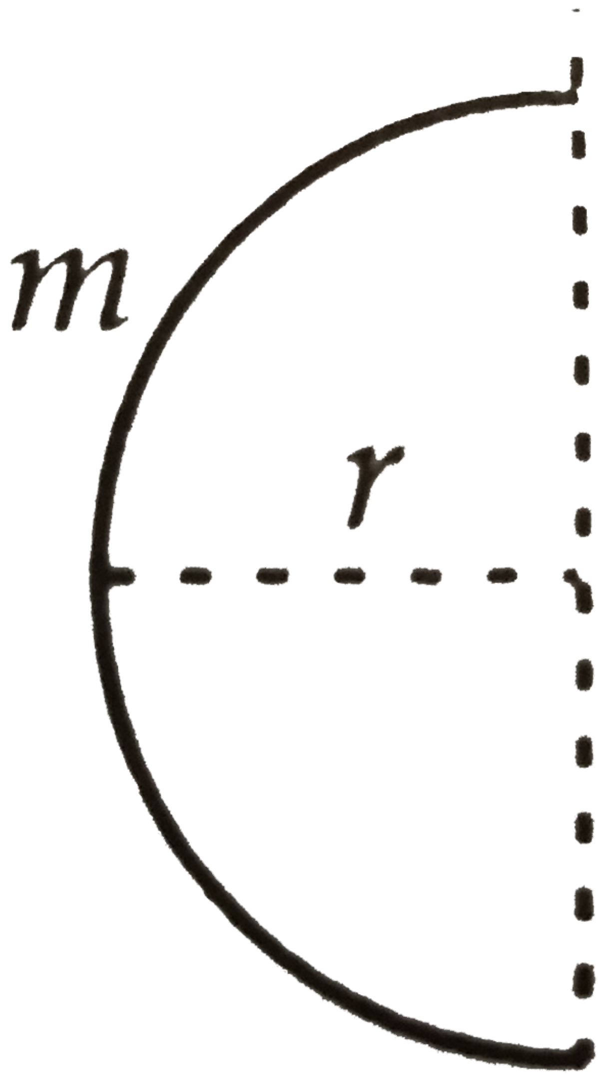
C. $l = l_4 + l_2$

D. $l = l_1 + l_2 + l_3 + l_4$

Answer: D

Watch Video Solution

18. A thin wire of length l and mass m is bent in the form of a semicircle as shown in the figure. Its moment of inertia about an axis joining its free ends will be



A. ml^2

B. Zero

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

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

Answer: D

Watch Video Solution

19. four thin rods each of mass m and length l are joined to make a square. Find moment of inertia of all the four rods about any side of the square.

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

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

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

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

Answer: B

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20. Two point masses m and 3m are placed at distance r. The moment of inertia of the system about an axis passing through the centre of mass of system and perpendicular to the joining the point masses is

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

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

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

D. $\frac{6}{7}mr^2$

Answer: B

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21. A wheel starts from rest and attains an angular velocity of 20 radian/s after being uniformly accelerated for 10 s. The total angle in radian through which it has turned in 10 second is

A. 20π

B. 40π

C. 100

D. 100π

Answer: C

Watch Video Solution

22. An angular impulse of 20 Nms is applied to a hollow cylinder of mass 2 kg and radius 20 cm. The change in its angular speed is :

A. 25 rad/s

B. 2.5 rad/s

C. 250 rad/s

D. 2500 rad/s

Answer: C

Watch Video Solution

23. A hollow sphere of mass 1 kg and radius 10 cm is free to rotate about its diameter. If a force of 30 N is applied tangentially to it, its angular acceleration is (in rad/s^2)

A. 5000

B. 450

C. 50

D. 5

Answer: B

Watch Video Solution

24. Two equal and opposite forces F are allplied tangentially to a uniform disc of mass M and radius R . If the disc is pivoted at its centre and free to rotate in its plane, the angular acceleration of the disc is :

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

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

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

D. Zero

Answer: C

Watch Video Solution

25. A wheel having moment of inertia 4 kg m^2 about its axis, rotates at rate of 240 rpm about it. The torque which can stop the rotation of the wheel in one minute is :-

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

B. $\frac{8\pi}{15} Nm$

C. $\frac{2\pi}{9} Nm$

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

Answer: B

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26. A force $\overrightarrow{F} = \left(2\hat{i} + 3\hat{j} - 5\hat{k}\right)N$ acts at a point $\overrightarrow{r}_1 = \left(2\hat{i} + 4\hat{j} + 7\hat{k}\right)m$. The torque of the force about the point $\overrightarrow{r}_2 = \left(\hat{i} + 2\hat{j} + 3\hat{k}\right)m$ is

A. $\left(17\hat{j} + 5\hat{k} - 3\hat{i}\right)Nm$

B. $\left(2\hat{j} + 4\hat{j} - 6\hat{k}\right)Nm$

C. $\left(12\hat{i} - 5\hat{j} + 7\hat{k}\right)Nm$

D. $-\left(-13\hat{j} + 22\hat{i} + \hat{k}\right)Nm$

Answer: D

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27. Two like parallel force 20 N and 30 N act at the ands A and B of a rod 1.5 m long. The resultant of the forces will act at the point

A. 90 cm from A

B. 75 cm from B

C. 20 cm from B

D. 85 cm from A

Answer: A

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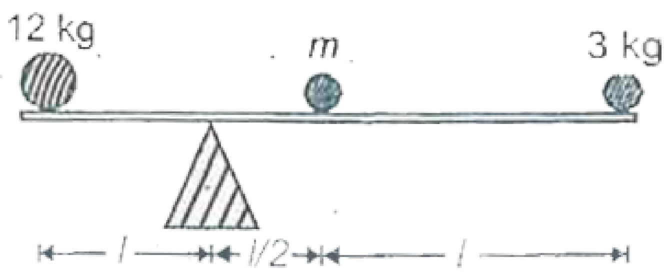
28. For equilibrium of the system, value of mass m should be



A. 9 kg

B. 15 kg

C. 21 kg

D. 1 kg

Answer: B

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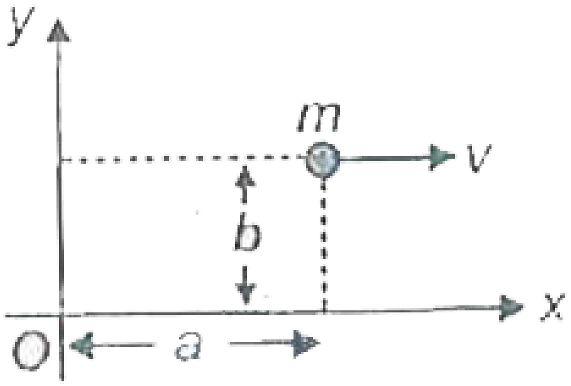
29. A particle of mass m is moving with constant velocity v parallel to the x-axis as shown in the figure. Its angular momentum about origin O is



A. mvb

B. mva

C. $mv\sqrt{a^2 + b^2}$

D. $mv(a + b)$

Answer: A

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30. A particle of mass $m=5$ units is moving with a uniform speed $v=3\sqrt{2}$ units in the XY-plane along the $y=x+4$. The magnitude of the angular momentum about origin is

A. 40 units

B. 60 units

C. Zero

D. $40\sqrt{2}$ units

Answer: B

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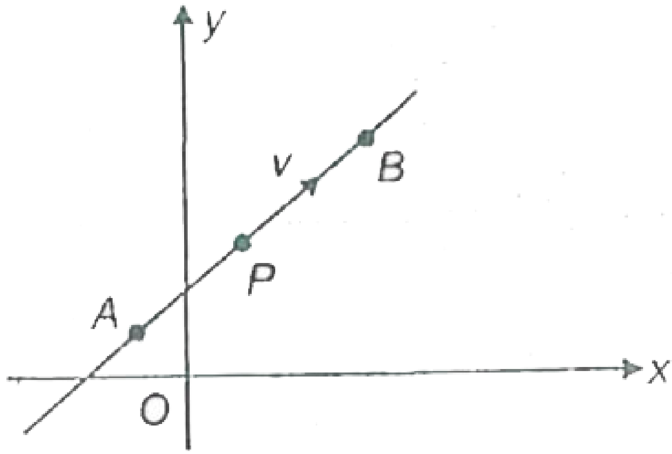
31. A particle P is moving along a straight line as shown in the figure. During the motion of the particle from A to B the angular momentum of the particle about O



A. Increases

B. Decreases

C. Remains constant

D. First increases and then decreases

Answer: C

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32. A particle performing uniform circular motion has angular momentum L. If its angular frequency is double and its kinetic energy halved, then the new angular momentum is :

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

B. 2L

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

D. 4L

Answer: D

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33. A solid sphere, disc and solid cylinder all of the same mass and made of the same material are allowed to roll down (from rest) on the inclined plane, then

A. Solid sphere

B. Sphereical shell

C. Ring

D. Disc

Answer: A

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34. When a torque acting upon a system is zero. Which of the following will be constant?

A. Force

B. Linear momentum

C. Angular momentum

D. Angular velocity

Answer: C

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35. The angular momentum of a rotating body changes from A_0 to $4A_0$ in 4 min. The torque acting on the body is

A. $\frac{3A_0}{4}$

B. A_0

C. $4A_0$

D. $12A_0$

Answer: A

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36. A meter stick is held vertically with one end on the floor and is allowed to fall. The speed of the other end when it hits the floor assuming that the end at the floor does not slip is $(g = 9.8m/s^2)$

A. 3.2 m/s

B. 5.4 m/s

C. 7.6 m/s

D. 9.2 m/s

Answer: B

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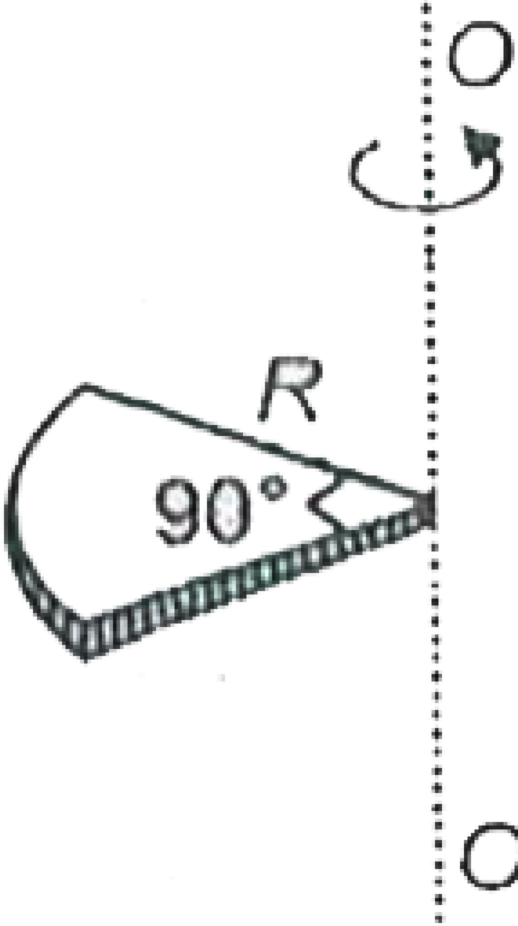
37. A quarter disc of radius R and mass m is rotating about the axis OO' (perpendicular to the plane of the disc) as shown. Rotational kinetic energy of the quarter disc is



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

B. $\frac{1}{4}mR^2\omega^2$

C. $\frac{1}{8}mR^2\omega^2$

D. $\frac{1}{16}mR^2\omega^2$

Answer: B

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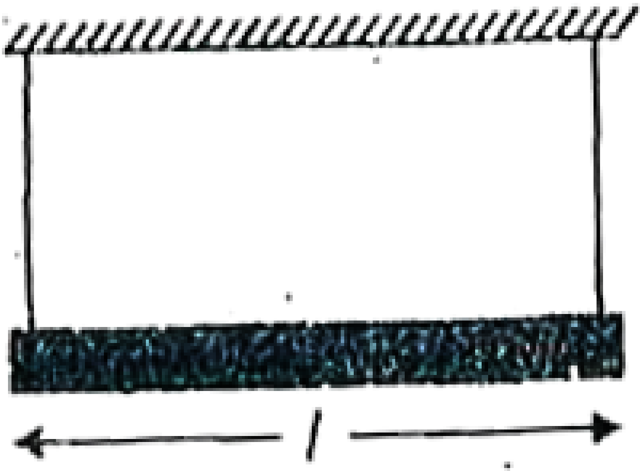
38. A uniform rod of mass and length l is suspended by two strings at its ends shown. When one of the strings is cut, the rod starts falling with an initial angular acceleration.



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

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

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

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

Answer: C

Watch Video Solution

39. A metre stick is pivoted about its centre. A piece of wax of mass 20 g travelling horizontally and perpendicular to it at 5 m/s strikes and adheres to one end of the stick so that the stick starts to rotate in a horizontal circle. Given the moment of inertia of the stick and wax about the pivot is 0.02 kg m^2, the initial angular velocity of the stick is :

A. 1.58 rad/s

B. 2.24 rad/s

C. 2.50 rad/s

D. 5.00 rad/s

Answer: C

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40. A circular disc of mass 2 kg and radius 10 cm rolls without slipping with a speed 2 m/s. The total kinetic energy of disc is

A. 10 J

B. 6 J

C. 2 J

D. 4 J

Answer: B

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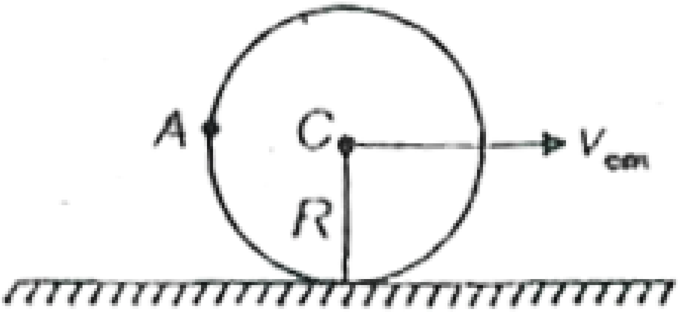
41. In case of pure rolling what will be velocity of point A of the ring of radius R ?



A. V_{cm}

B. $\sqrt{2}V_{cm}$

C. $\frac{V_{cm}}{2}$

D. $2V_{cm}$

Answer: B

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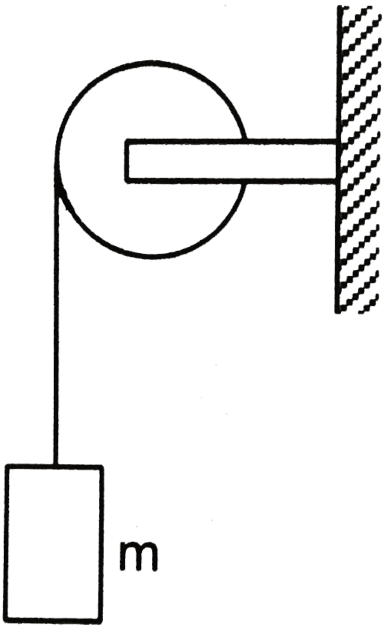
42. A wheel of moment of inertia I and radius r is free to rotate about its centre as shown in figure. A string is wrapped over its rim and a block of mass m is attached to the free end of the string. The system is released from rest. Find the speed of the block as it descends through a height h.



A. $\sqrt{2gh}$

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

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

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

Answer: C

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43. When a body is rolling without slipping on a rough horizontal surface, the work done by friction is :

A. Always zero

B. May be zero

C. Always positive

D. Always negative

Answer: A

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44. A solid spherical ball is rolling without slipping down an inclined plane. The fraction of its total kinetic energy associated with rotation is

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

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

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

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

Answer: B

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

A. $\sqrt{2gh}$

B. $\sqrt{\frac{4}{3}gh}$

C. $\sqrt{\frac{3}{4}gh}$

D. $\sqrt{\frac{4gh}{h}}$

Answer: B

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46. An inclined plane makes an angle of 30° with the horizontal. A solid sphere rolling down this inclined plane from rest without slipping has a linear acceleration equal to

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

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

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

D. $\frac{5g}{14}$

Answer: D

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47. What is the minimum coefficient of friction for a solid sphere to roll without slipping on an inclined plane of inclination θ ?

A. $\frac{2}{7}\tan\theta$

B. $\frac{1}{3}g\tan\theta$

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

D. $\frac{2}{5}\tan\theta$

Answer: A

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

A. v

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

C. 2 v

D. $\sqrt{2}v$

Answer: B

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49. How is the swimmer jumping into water from a height be able to make loop in air ?

A. He pulls his arms and legs in

B. He spreads his arms and legs

C. He keeps himself straight

D. None of these

Answer: A

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50. A thin circular ring of mass M and radius r is rotating about its axis with a constant angular velocity ω. Two objects each of mass m are attached gently to the opposite ends of a diameter of the ring. The ring will now rotate with an angular velocity of

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

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

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

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

Answer: C

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51. A uniform disc rotating freely about a vertical axis makes 90 rpm. A small piece of wax of mass m gram falls vertically on the disc and sticks to it at a distance rcm from the axis. If number of rotations per minute reduces to 60, find the moment of inertia of the disc.

A. m^2

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

C. $2mr^2$

D. $3mr^2$

Answer: C

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52. If two disc of moment of inertia l_1 and l_2 rotating about collinear axis passing through their centres of mass and perpendicular to their plane with angular speeds ω_1 and ω_2 respectively in opposite directions are made to rotate combinedly along same axis, then the magnitude of angular velocity of the system is

A. $\dfrac{l_1\omega_1 + l_2\omega_2}{l_1 + l_2}$

B. $\dfrac{l_1\omega_1 - l_2\omega_2}{l_1 + l_2}$

C. $\dfrac{l_1\omega_1 + l_2\omega_2}{\omega_1 + \omega_2}$

D. $\dfrac{l_1\omega_1 - l_2\omega_2}{\omega_1 - \omega_2}$

Answer: B

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ASSIGNMENT (SECTION - B)

1. Linear mss density (mass/length) of a rod depends on the distanec from one end (say A) as $\lambda_x = (\alpha x + \beta)$ here α and β are constants, find the moment of inertia of this rod about an axis passing through A and perpendicular to the rod. Length of the rod is l

.

A. $\dfrac{(2\beta + 3\alpha L)L}{2(2\beta + \alpha L)}$

B. $\frac{(3\alpha + 2\beta L)L}{3(2\alpha + \beta L)}$

C. $\frac{(3\beta + 2\alpha L)L}{3(2\beta + \alpha L)}$

D. $\frac{(3\beta + 2\alpha L)L}{3\beta + 2\alpha}$

Answer: B

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2. A man of mass 60 kg is standing on a boat of mass 140 kg, which is at rest in still water. The man is initially at 20 m from the shore. He starts walking on the boat for 4 s with constant speed 1.5 m/s towards the shore. The final distance of the man from the shore is

A. 15.8 m

B. 4.2 m

C. 12.6 m

D. 14.1 m

Answer: A

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3. A bomb of mass m is projected from the ground with speed v at angle θ with the horizontal. At the maximum height from the ground it explodes into two fragments of equal mass. If one fragment comes to rest immediately after explosion, then the horizontal range of centre of mass is

A. $\dfrac{v^2 \sin^2 \theta}{g}$

B. $\dfrac{v^2 \sin \theta}{g}$

C. $\dfrac{v^2 \sin \theta}{2g}$

D. $\frac{v^2 \sin 2\theta}{g}$

Answer: D

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4. Two blocks of masses 5kg and 2kg are connected by a spring of negligible mass and placed on a frictionless horizontal surface. An impulse provides a velocity of 7m/s to the heavier block in the direction of the lighter block. The velocity of the centre of mass is :-

A. 30 m/s

B. 5 m/s

C. 10 m/s

D. 20 m/s

Answer: D

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5. The moment of inertia of a uniform semicircular wire of mass m and radius r, about an axis passing through its centre of mass and perpendicular to its plane is $mr^2\left(-\frac{k}{\pi^2}\right)$. Find the value of k.

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

B. mr^2

C. $mr^2\left(1-\frac{4}{\pi^2}\right)$

D. $mr^2\left(1+\frac{4}{\pi^2}\right)$

Answer: C

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6. A solid sphere is rotating about a diameter at an angular velocity ω. If it cools so that its radius reduces to $1/n$ of its original value, its angular velocity becomes

A. $\eta\omega_0$

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

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

D. $\eta^2\omega_0$

Answer: D

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7. Moment of inertia of a uniform circular disc about a diameter is I. Its moment of inertia about an axis perpendicular to its plane and passing through a point on its rim will be

A. 3I

B. 4I

C. 5I

D. 6I

Answer: C

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8. Two discs of same mass and same thickness have densities as $17g/cm^3$ and $51g/cm^3$. The ratio of their moment of inertia about their central axes is

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

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

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

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

Answer: C

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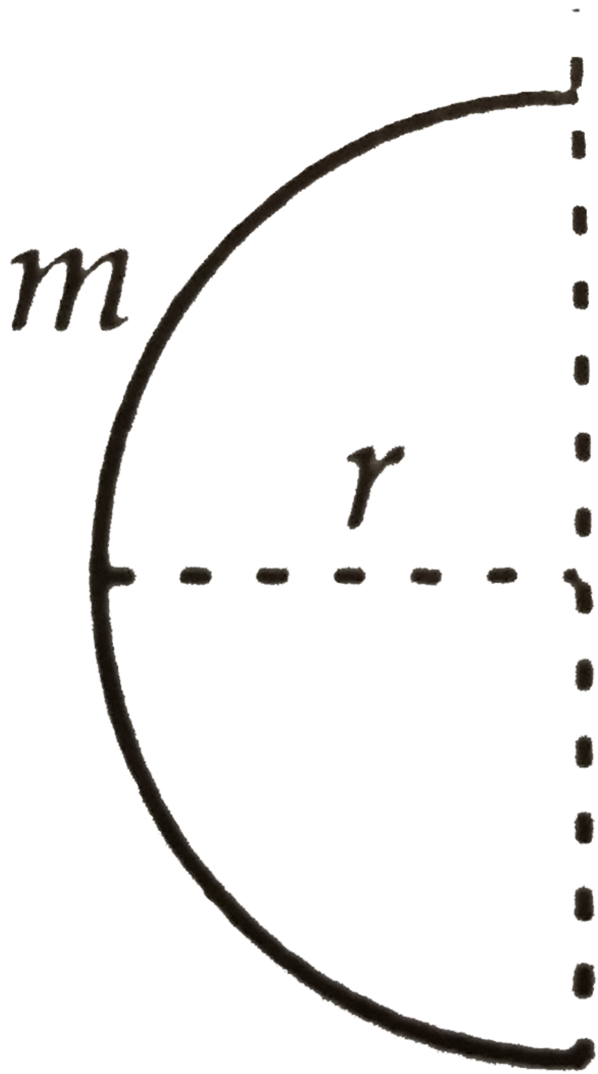
9. A thin wire of length l and mass m is bent in the form of a semicircle as shown in the figure. Its moment of inertia about an axis joining its free ends will be



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

B. $2ml^2$

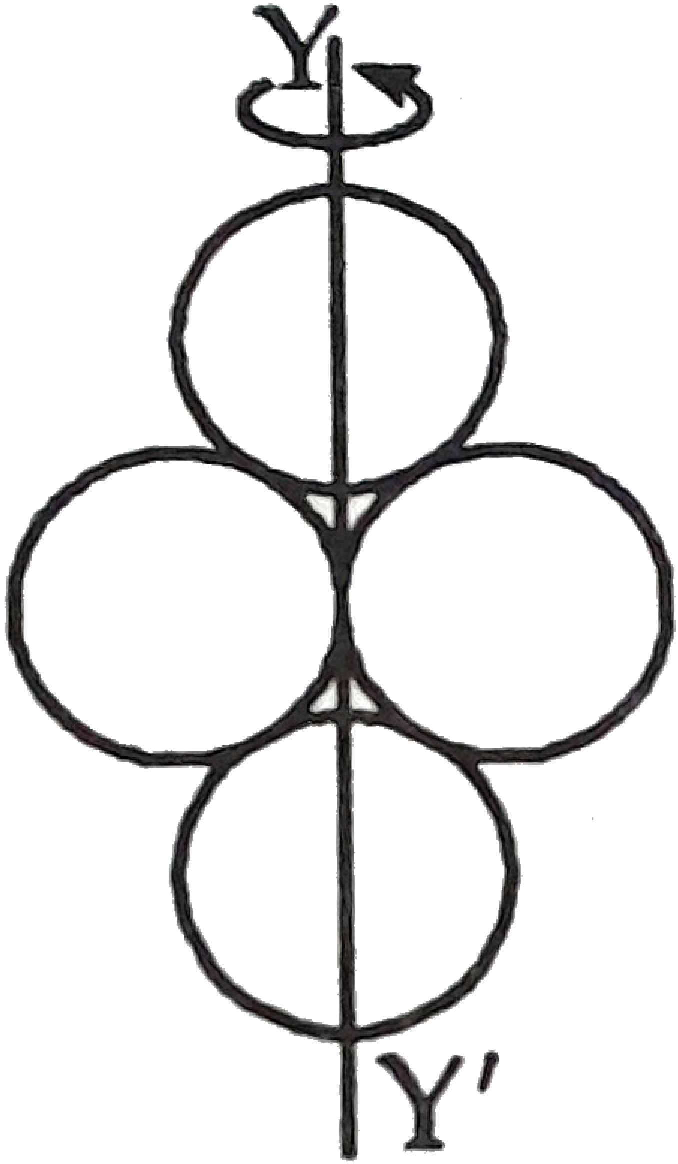
C. $\frac{ml^2}{\pi^2}$

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

Answer: D

Watch Video Solution

10. Four rings each of mass M and radius R are arranged as shown in the figure. The moment of inertia of the system about YY' will be



A. $2MR^2$

B. $3MR^2$

C. $4MR^2$

D. $5MR^2$

Answer: C

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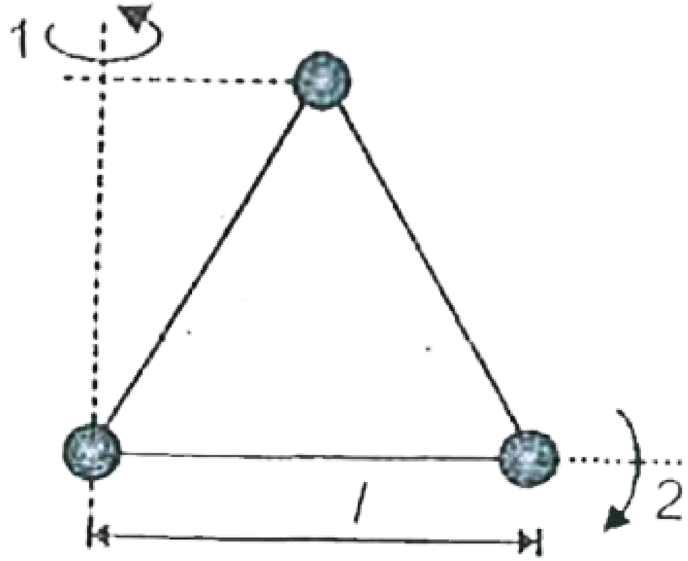
11. Three particle each of mass m are placed at the corners of equilateral triangle of side l



Which of the following is/are correct ?

A. Moment of inertia about axis '1' is $\frac{5}{4}ml^2$

B. Moment of inertia about axis '2' is $\frac{3}{4}ml^2$

C. Moment of inertia about an axis passing through one corner and perpendicular to the plane is $2ml^2$

D. All of these

Answer: D

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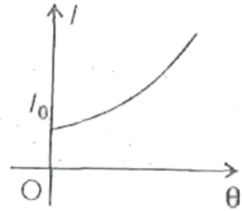
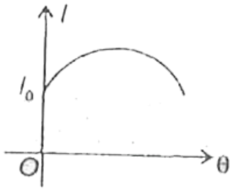
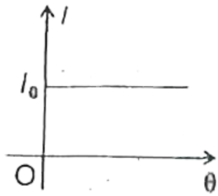
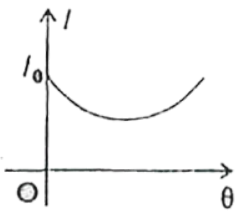
12. A square plate has a moment of inertia I_0 about an axis lying in its plane, passing through its centre and making an angle θ with one of the sides. Which graph represents the variation of I with θ ?

A. 

B. 

C. 

D. 

Answer: C

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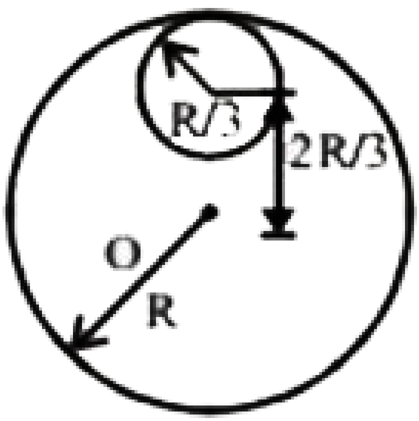
13. A disc has mass 9 m. A hole of radius R/3 is cut from it as shown in the figure. The moment of inertia of remaining part about an axis passing through the centre 'O' of the disc and perpendicular to the plane of the disc is :



A. $\frac{32}{9}MR^2$

B. $10MR^2$

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

D. $4MR^2$

Answer: D

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14. Two rods of equal lengths(l) and equal mass M are kept along x and y axis respectively such that their centre of mass lie at origin. The moment of inertia about an line y = x, is

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

B. $\frac{ml^2}{4}$

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

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

Answer: C

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15. Two rings of same mass and radius R are placed with their planes perpendicular to each other and centre at a common point. The radius of gyration of the system about an axis passing through the centre and perpendicular to the plane of one ring is

A. 2R

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

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

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

Answer: D

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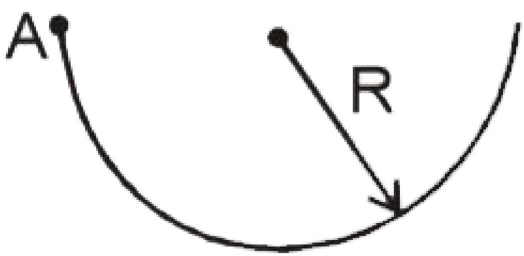
16. A uniform rod of mass m is bent into the form of a semicircle of radius R. The moment of inertia of the rod about an axis passing through A and perpendicular to the plane of the paper is



A. $\frac{2mL^2}{\pi^2}$

B. $\frac{mL^2}{\pi^2}$

C. $\frac{mL^2}{2\pi^2}$

D. $\frac{mL^2}{3\pi^2}$

Answer: C

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17. The angular velocity of a body changes from ω_1 to ω_2 without applying torque. The ratio of initial radius of gyration to the final radius of gyration is :

A. $\omega_1 : \omega_2$

B. $\sqrt{\omega_1} : \sqrt{\omega_2}$

C. $\omega_2 : \omega_1$

D. $\sqrt{\omega_2} : \sqrt{\omega_1}$

Answer: D

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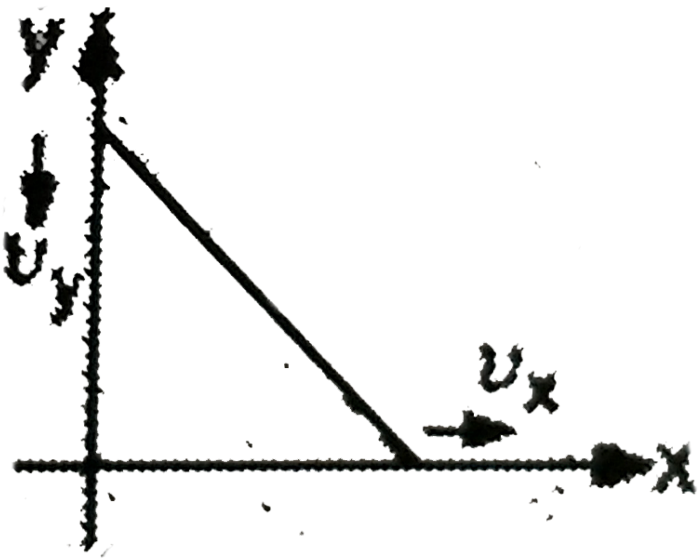
18. A rod of length l leans by its upper end against a smooth vertical wall, while its other end leans against the floor. The end that leans against the wall moves uniformly downward. Then:



A. The speed of lower end increases at a constant rate

B. The speed of the lower end decreases but never becomes zero

C. The speed of the lower and gets smaller and smaller and vanishes when the upper end touches the ground

D. The speed of the lower end remain constant till upper end touches the ground

Answer: C

Watch Video Solution

19. A thin rod of mass m and length l is suspended from one of its ends. It is set into oscillation about a horizontal axis. Its angular speed is ω while passing through its mean position. How high will its centre of mass rise from its lowest position ?

A. $\dfrac{\omega^2 l^2}{2g}$

B. $\frac{\omega^2 l^2}{3g}$

C. $\frac{\omega^2 l^2}{g}$

D. $\frac{\omega^2 l^2}{6g}$

Answer: D

Watch Video Solution

20. A force F is applied at the centre of a disc of mass M. The minimum value of coefficient of friction of the surface for rolling is

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

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

C. $\frac{2F}{5Mg}$

D. $\frac{2F}{7Mg}$

Answer: B

Watch Video Solution

21. A solid body rotates about a stationary axis, so that its angular velocity depends on the rotational angle ϕ as $\omega = \omega_0 - k\phi$ where

ω_0 and K are positive constants. At the moment $t = 0, \phi = 0$ Find the dependence of rotation angle.

A. $\theta = kt$

B. $\theta = 2kt$

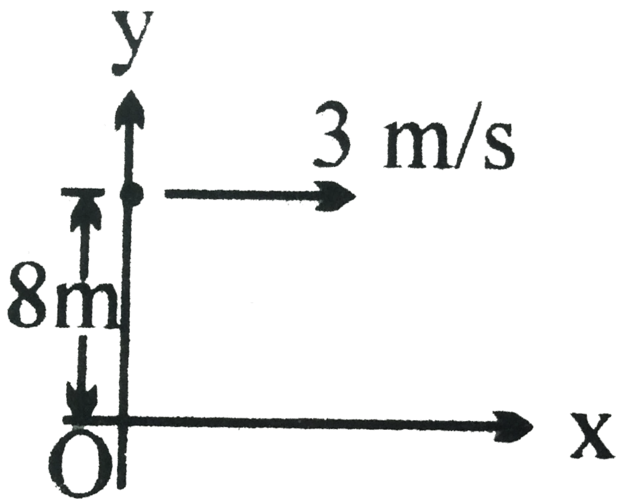
C. $\theta = \sqrt{kt}$

D. $\theta = \sqrt{2kt}$

Answer: D

Watch Video Solution

22. A particle starts from the point $(0m, 8m)$ and moves with uniform velocity of $3\hat{i}m/s$. After 5 seconds, the angular velocity of the particle about the origin will be :



A. $\dfrac{8}{289}$ rad/s

B. $\dfrac{3}{8}$ rad/s

C. $\frac{24}{289}$ rad/s

D. $\frac{8}{17}$ rad/s

Answer: B

Watch Video Solution

23. A ball is projected with $20\sqrt{2}m/s$ at angle 45° with horizontal.The angular velocity of the particle at highest point of its journey about point of projection is

A. 1 rad/s

B. 0.2 rad/s

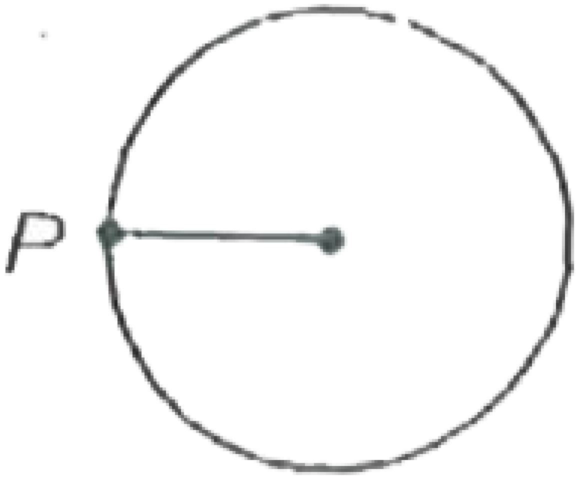
C. 0.3 rad/s

D. 0.4 rad/s

Answer: A

Watch Video Solution

24. A uniform disc of mass m and radius R is pivoted at point P and is free rotate in vertical plane. The centre C of disc is initially in horizontal position with P as shown in figure. If it is released from this position, then its angular acceleration when the line PC is inclined to the horizontal at an angle θ is



A. $\dfrac{2g\cos\theta}{3R}$

B. $\dfrac{g\sin\theta}{2R}$

C. $\dfrac{2g\sin\theta}{R}$

D. $\frac{2g\sin\theta}{3R}$

Answer: A

Watch Video Solution

25. A particle undergoes uniform circular motion. About which point on the plane of the circle, will the angular momentum of the particle remain conserved?

A. Centre of the circle

B. On the circumference of the circle

C. Inside the circle other than centre

D. Outside the circle

Answer: A

Watch Video Solution

26. When a planet moves around sun, its

A. Angular velocity is constant

B. Areal velocity is constant

C. Linear velocity is constant

D. Linear momentum is conserved

Answer: B

Watch Video Solution

27. When a rolling body enters onto a smooth horizontal surface, it will

A. Continue rolling

B. Starts slipping

C. Come to rest

D. Slipping as well as rolling

Answer: A

Watch Video Solution

28. A hollow sphere of mass m and radius R is rolling downdard on a rough inclined plane of inclination θ. If the coefficient of friction between the hollow sphere and incline is μ, then

A. Friction opposes its translation

B. Friction supports rotation motion

C. On decreasing θ, frictional force decreases

D. All of these

Answer: D

Watch Video Solution

29. A heavy solid sphere is thrown on a horizontal rough surface with initial velocity u without rolling. What will be its speed, when it starts pure rolling motion ?

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

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

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

D. $\frac{2u}{7}$

Answer: C

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Watch Video Solution

30. A cylinder rolls down two different inclined planes of the same height but of different inclinations

A. In both cases the speed and time of descent will be different

B. In both cases the speed and time of descent will be same

C. The speed will be different but time of descent will be same

D. The time of descent will be different but speed will be same

Answer: D

Watch Video Solution

31. A disc of mass 3 kg rolls down an inclined plane of height 5 m. The translational kinetic energy of the disc on reaching the bottom of the inclined plane is

A. 50 J

B. 100 J

C. 150 J

D. 175 J

Answer: B

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ASSIGNMENT (SECTION - C)

1. A rope is wound around a hollow cylinder of mass 3 kg and radius 40 cm .What is the angular acceleration of the cyklinder, if the rope is pulled with a force of 30 N?

A. $25m/s^2$

B. $0.25rad/s^2$

C. $25rad/s^2$

D. $5m/s^2$

Answer: C

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2. Which of following statements are correct ?

I (a) Centre of mass of a body always coincides with the centre of gravity of the body

(b) Central of mass of a body is the point at which the total garvitational torque on the body is zero

(c) Couple on a body produces both trasnlational and rotation motion in a body

(d) Mechinical advantage greater than one means that small efforts can be used to lift a large load

A. (b) and (d)

B. (a) and (b)

C. (b) and (c)

D. (c) and (d)

Answer: A

Watch Video Solution

3. Two discs of same moment of inertia rotating about their regular axis passing through centre and perpendicular to the plane of disc with angular velocities ω_1 and ω_2. They are brought into contact face to face coinciding the axis of rotation. The expression for loss of energy during this process is

A. $\frac{1}{2}l(\omega_1+\omega_2)^2$

B. $\frac{1}{4}l(\omega_1-\omega_2)^2$

C. $l(\omega_1-\omega_2)^2$

D. $\frac{l}{8}(\omega_1-\omega_2)^2$

Answer: B

Watch Video Solution

4. Two rotating bodies A and B of masses m and $2m$ with moments of inertia I_A and $I_B (I_B > I_A)$ have equal kinetic energy of rotation. If L_A and L_B be their angular momenta respectively, then

A. $L_A = \dfrac{L_B}{2}$

B. $L_A = 2L_B$

C. $L_B > L_A$

D. $L_A > L_B$

Answer: C

Watch Video Solution

5. A solid sphere of mass m and radius R is rotating about its diameter. A solid cylinder of the same mass and same radius is also rotating about its geometrical axis with an angular speed twice that of the sphere. The ratio of their kinetic energies of rotation $\left(E_{\text{sphere}} / E_{\text{cylinder}}\right)$ will be

A. $2:3$

B. $1:5$

C. $1:4$

D. $3:1$

Answer: B

Watch Video Solution

6. A light rod of length l has two masses m_1 and m_2 attached to its two ends. The moment of inertia of the system about an axis perpendicular to the rod and passing through the centre of mass is

A. $\frac{m_1 m_2}{m_1 + m_2} l^2$

B. $\frac{m_1 + m_2}{m_1 m_2} l^2$

C. $(m_1 + m_2) l^2$

D. $\sqrt{m_1 m_2} l^2$

Answer: A

Watch Video Solution

7. From a disc of radius R and mass M, a circular hole of diameter R, whose rim passes through the centre is cut. What is the moment of inertia of the remaining part of the disc about a perpendicular axis, passing through the centre?

A. $\frac{9MR^2}{32}$

B. $\frac{15MR^2}{32}$

C. $\frac{13MR^2}{32}$

D. $\frac{11MR^2}{32}$

Answer: C

Watch Video Solution

8. A disc and a sphere of same radius but different masses roll off on two inclined planes of the same altitude and length. Which one of the two objects gets to the bottom of the plane first ?

A. Depends on their masses

B. Disk

C. Sphere

D. Both reach at the same time

Answer: C

Watch Video Solution

9. An automobile moves on a road with a speed of $54 kmh^{-1}$. The radius of its wheels is $0.45 m$ and the moment of inertia of the wheel about its axis of rotation is $3 kgm^2$. If the vehicle is brought to rest in $15 s$, the magnitude of average torque transmitted by its brakes to the wheel is

A. $2.86 kgm^2 s^{-2}$

B. $6.66 kgm^2 s^{-2}$

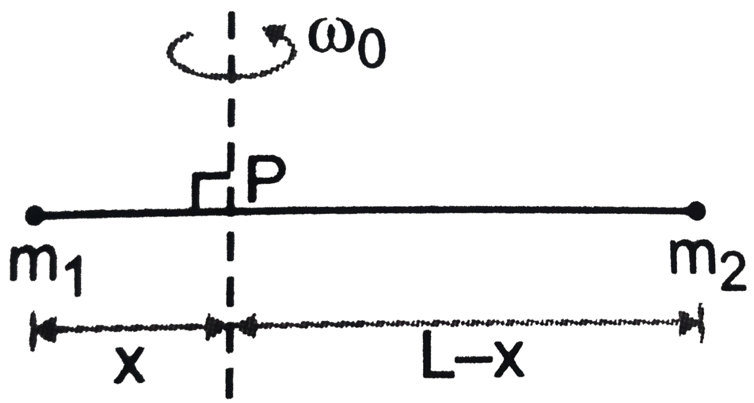
C. $8.58 kgm^2 s^{-2}$

D. $10.86 kgm^2 s^{-2}$

Answer: B

Watch Video Solution

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



A. $x = \dfrac{m_2 L}{m_1 + m_2}$

B. $x = \dfrac{m_1 L}{m_1 + m_2}$

C. $x = \dfrac{m_1}{m_2} L$

D. $x = \dfrac{m_2}{m_1} L$

Answer: A

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11. A Force $F = \alpha \hat{i} + 3\hat{j} + 6\hat{k}$ is acting at a point $r = 2\hat{i} - 6\hat{j} - 12\hat{k}$. The value of α for which angular momentum about origin is conserved is

A. 1

B. -1

C. 2

D. Zero

Answer: B

Watch Video Solution

12. 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

A. $\frac{W(d-x)}{d}$

B. $\frac{Wx}{d}$

C. $\frac{Wd}{x}$

D. $\frac{W(d-x)}{x}$

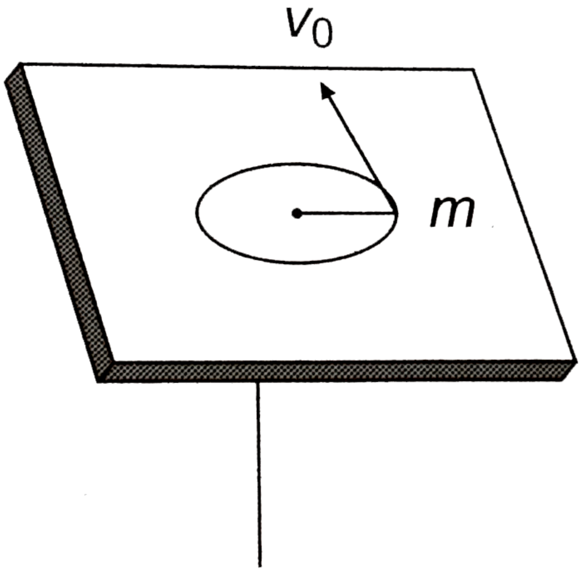
Answer: A

Watch Video Solution

13. A mass m moves in a circles on a smooth horizontal plane with velocity v_0 at a radius R_0. The mass is attached to string which passes through a smooth hole in the plane as shown.

The tension in string is increased gradually and finally m moves in a circle of radius $\frac{R_0}{2}$.

the final value of the kinetic energy is



A. $\frac{1}{2}mv_0^2$

B. mv_0^2

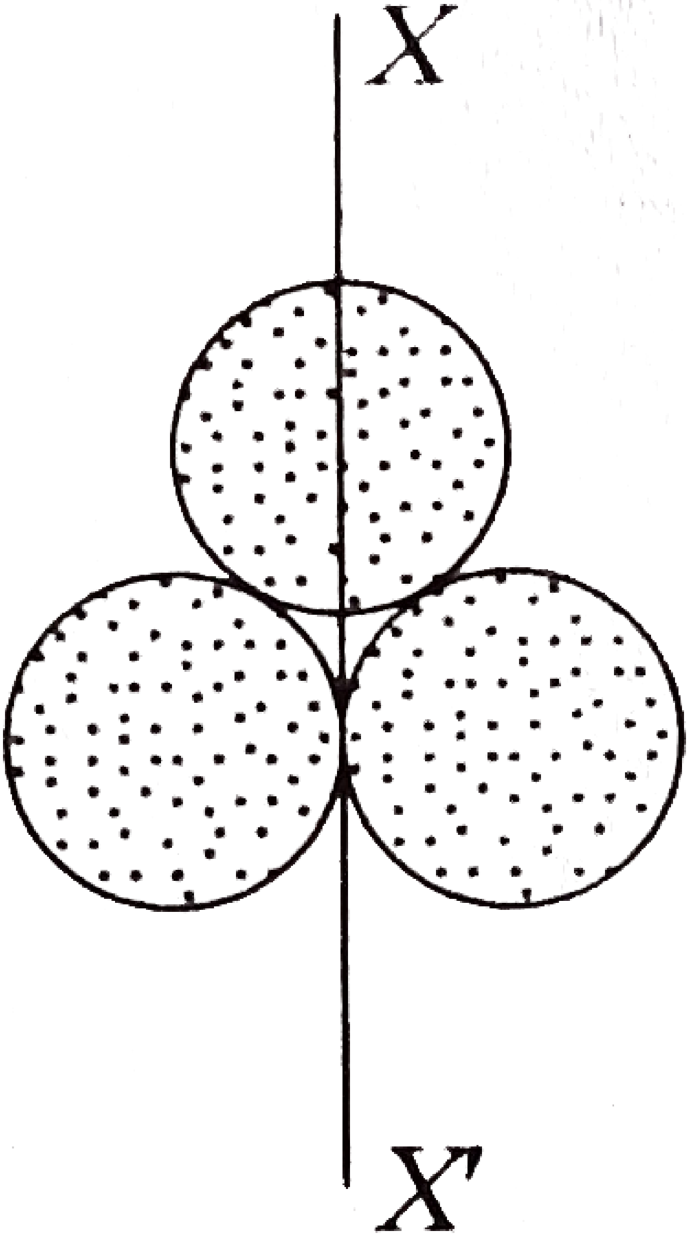
C. $\frac{1}{4}mv_0^2$

D. $2mv_0^2$

Answer: D

Watch Video Solution

14. Three identical spherical shells, each of mass m radius r are placed as shown in figure. Consider an axis XX', which is touching to two shells and passing through diameter of third shell. Moment of inetia of the system cosisting of these three spherical shells about XX' axis is



A. $4mr^2$

B. $\frac{11}{5}mr^2$

C. $3mr^2$

D. $\frac{16}{5}mr^2$

Answer: A

Watch Video Solution

15. Two spherical bodies of masses M and 5M and radii R and 2R are released in free space with initial separation between their centres equal to 12 R. if they attract each other due to gravitational force only, then the distance convered by the smaller body before collision is

A. 1.5 R

B. 2.5 R

C. 4.5 R

D. 7.5 R

Answer: D

Watch Video Solution

16. A solid cylinder of mass 50 kg and radius $0.5m$ is free to rotate about the horizontal axis. A massless string is wound round the cylinder with one end attached to it and other hanging freely. Tension in the string required to produce an angular

acceleration of $2 \ \text{rev} / s^2$ is

A. 25 N

B. 50 N

C. 78.5 N

D. 157 N

Answer: D

Watch Video Solution

17. The ratio of the acceleration for a solid sphere (mass m and radius R) rolling down an incline of angle θ without slipping and slipping down the incline without rolling is

A. $5:7$

B. $2:3$

C. $2:5$

D. $7:5$

Answer: A

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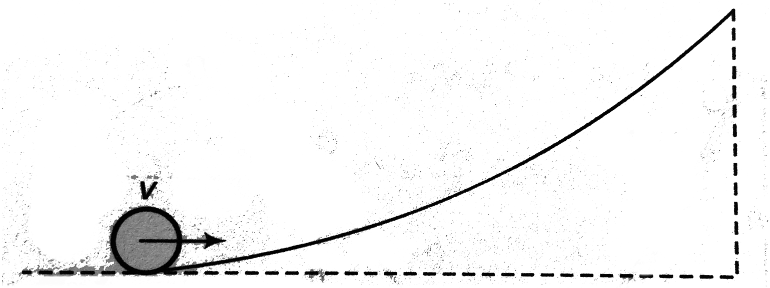
18.



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

(a). Ring

(b). solid sphere

(c). hollow sphere

(d). disc

A. Solid sphere

B. Hollow sphere

C. Disc

D. Ring

Answer: C

Watch Video Solution

19. A rod PQ of mass M and length L is hinged at end P. The rod is kept horizontal by a massless string tied to a point Q as shown in figure. When string is cut, the initial angular acceleration of the rod is

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

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

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

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

Answer: D

Watch Video Solution

20. ABC is an equilateral triangle with O as its centre $\vec{F_1}$, $\vec{F_2}$ and $\vec{F_3}$ represent three forces acting along the sides AB, BC and AC respectively. If the torque about O is zero then the magnitude of $\vec{F_3}$ is

A. $\frac{F_1 + F_2}{2}$

B. $2(F_1 + F_2)$

C. $F_1 + F_2$

D. $F_1 - F_2$

Answer: C

Watch Video Solution

21. When a mass is rotating in a plane about a fixed point, it angular momentum is directed along

A. The radius

B. The tangent to the orbit

C. A line perpendicular to plane of rotation

D. The line making an angle of 45° to the plane of rotation

Answer: C

Watch Video Solution

22. Two persons of masses 55 kg and 65 kg respectively. Are at the opposite ends of a boat. The length of the boat is 3 m and weighs 100kg. The 55 kg man walks up to the 65 kg man and sits with him. If the boat is in still water the center of mass of the system shifts by

A. Zero

B. 0.75 m

C. 3.0 m

D. 2.3 m

Answer: A

Watch Video Solution

23. A circular platform is mounted on a frictionless vertical axle. Its radius R=2m and its moment of inertia about the axle is 200 kg m^2. It is initially at rest. A 50 kg man stands on the edge of the platform and begins to walk along the edge at the speed of 1 ms^{-1} relative to the ground. Time taken by the man to complete one revolution is :

A. πs

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

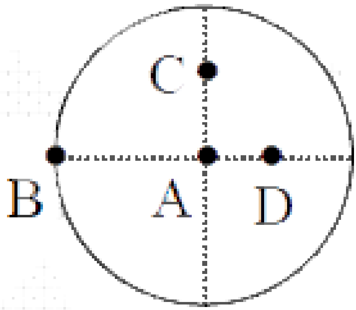
C. $2\pi s$

D. $\frac{\pi}{2}s$

Answer: C

Watch Video Solution

24. The moment of inertia of a uniform circular disc is maximum about an axis perpendicular to the disc and passing through -



A. B

B. C

C. D

D. A

Answer: A

Watch Video Solution

25. Three masses are placed on the x-axis : 300 g at origin, 500 g at x = 40 cm and 400 g at x = 70 cm. The distance of the centre of mass from the origin is -

A. 40 cm

B. 45 cm

C. 50 cm

D. 30 cm

Answer: A

Watch Video Solution

26. A mass m moving horizontal (along the x-axis) with velocity v collides and sticks to mass of $3m$ moving vertically upward (along the y-axis) with velocity $2v$. The final velocity of the combination is

A. $\frac{2}{3}v\hat{i}+\frac{1}{3}v\hat{j}$

B. $\frac{3}{2}v\hat{i}+\frac{1}{4}v\hat{j}$

C. $\frac{1}{4}v\hat{i} + \frac{3}{2}v\hat{j}$

D. $\frac{1}{3}v\hat{i} + \frac{2}{3}v\hat{j}$

Answer: C

Watch Video Solution

27. The moment of inertia of a thin uniform rod of mass M and length L about an axis passing through its mid-point and perpendicular to its length is I_0. Its moment of inertia about an axis passing through one of its ends and perpendicular to its length is

A. $l_0 + ML^2$

B. $l_0 + \frac{ML^2}{2}$

C. $l_0 + \frac{ML^2}{4}$

D. $l_0 + 2ML^2$

Answer: C

Watch Video Solution

28. The instantaneous angular position of a point on a rotating wheel is given by the equation $Q(t) = 2t^3 - 6t^2$. The torque on the wheel becomes zero at

A. t = 2 s

B. t = 1 s

C. t = 0.5 s

D. t = 0.25 s

Answer: B

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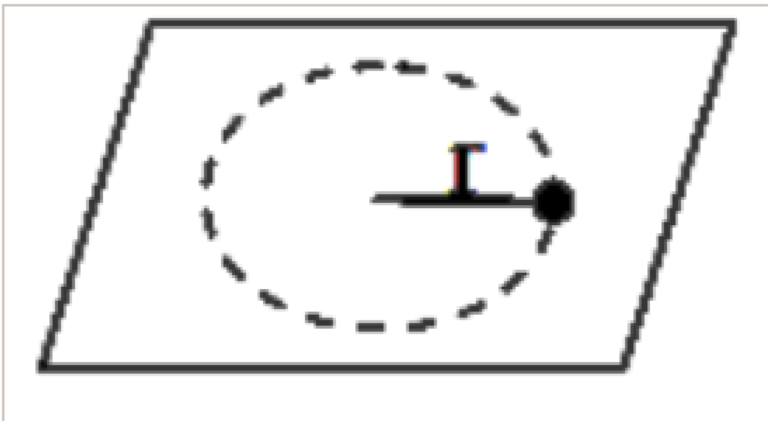
Watch Video Solution

29. A small mass attached to a string rotates on a frictionless table top as shown. If the tension in the string is increased by pulling the string causing the radius of the circular motion to decrease by a factor of 2, the kinetic energy of the mass will



A. Increase by a factor of 4

B. Decrease by a factor of 2

C. Remain constant

D. Increase by a factor of 2

Answer: A

Watch Video Solution

30. A circular disc of moment of inertia I_t is rotating in a horizontal plane, about its symmetry axis, with a constant angular speed

ω_i. Another disc of moment of inertia I_b is dropped coaxially onto the rotating disc. Initially the second disk has zero angular speed. eventually both the disc rotate with a constant angular speed ω_f. The energy lost by initially rotating disc due to friction is

A. $\frac{1}{2}\frac{l_b^2}{(l_t+l_b)}\omega_1^2$

B. $\frac{1}{2}\frac{l_t^2}{(l_t+l_b)}\omega_1^2$

C. $\frac{l_b-l_t}{(l_t+l_b)}\omega_1^2$

D. $\frac{1}{2}\frac{l_b-l_t}{(l_t+l_b)}\omega_1^2$

Answer: D

Watch Video Solution

31. Two particles A and B intiallly at rest, move towards each other under a mutual force of attraction. AT the instant when the speed of A is v and the speed of B is 2 v, the speed of the centre of mass of the system is

A. 2v

B. Zero

C. 1.5 v

D. v

Answer: B

Watch Video Solution

32. A ball moving with velocity 2 ms^{-1} collides head on with another stationary ball of double the mass. If the coefficient of restitution is 0.5, then their velocities (in ms^{-1}) after collision will be

A. 0.2

B. 0.1

C. 1.1

D. 1.05

Answer: B

Watch Video Solution

33. A man of 50 kg mass is standing in a gravity free space at a height of 10 m above the floor. He throws a stone of 0.5 kg mass downwards with a speed 2 ms^{-1}. When the stone reaches the floor, the distance of the man above the floor will be

A. 20 m

B. 9.9 m

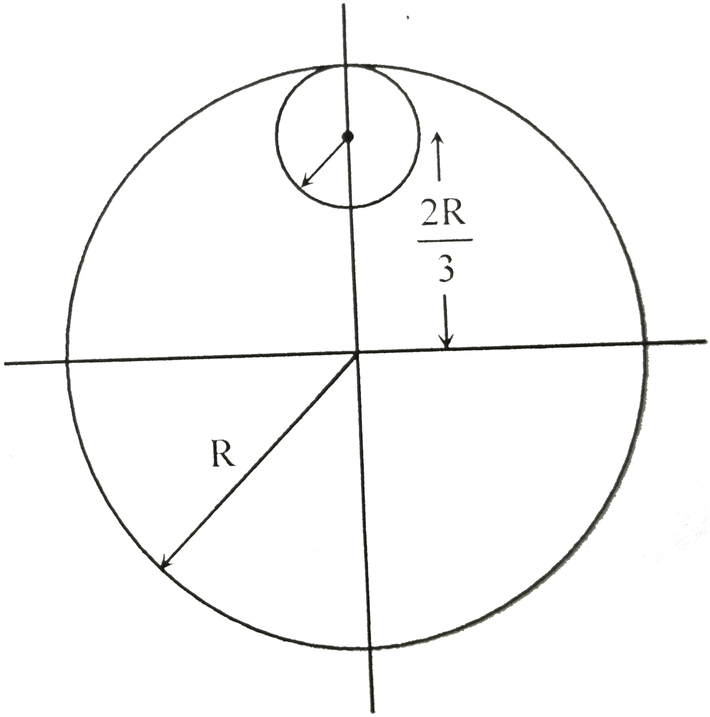
C. 10.1 m

D. 10 m

Answer: C

Watch Video Solution

34. From a uniform circular disc of radius R and mass 9M, a small disc of radius $\frac{R}{3}$ is removed as shown in the figure. The moment of inertia of the remaining disc about an axis perpendicular to the plane of the disc and passing through centre of disc is :



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

B. mr^2

C. $4MR^2$

D. $\frac{4}{9}MR^2$

Answer: A

Watch Video Solution

35. A solid cylinder and a hollow cylinder both of the same mass and same external diameter are released from the same height at the same time on an inclined plane. Both roll down without slipping. Which one will reach the bottom first-

A. Both together only when angle of inclination of plane is 45°

B. Both together

C. Hollow cylinder

D. Solid cylinder

Answer: D

Watch Video Solution

36. (1) Centre of gravity (C.G.) of a body is the point at which the weight of the body acts,

(2) Centre of mass coincides with the centre of gravity if the earth is assumed to have infinitely large radius,

(3) To evaluate the gravitational field intensity due to any body at an external point, the entire mass of the body can be considered to be concentrated at its C.G..,

(4) The radius of gyration of any body rotating about an axis is the length of the perpendicular dropped from the C.G. of the

body to the axis. which one of the following pairs of statements is correct ?

A. (d) and (a)

B. (a) and (b)

C. (b) and (c)

D. (c) and (d)

Answer: A

Watch Video Solution

37. A thin circular ring of mass M and radius r is rotating about its axis with a constant angular velocity ω. Two objects each of mass m are attached gently to the opposite ends of a diameter of the ring. The ring will now rotate with an angular velocity of

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

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

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

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

Answer: D

Watch Video Solution

38. A thin circular ring of mass M and radius R is rotating in a horizontal plane about an axis vertical to its plane with a constant angular velocity ω , If two objects each mass m be attached gently to the opposite ends of a diameter of the ring, the ring, will then rotate with an angular velocity :

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

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

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

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

Answer: A

Watch Video Solution

39. An explosion breaks a rock into three parts in a horizontal plane. Two of them go off at right angles to each other. The first part of mass 1kg moves with a speed of $12 ms^{-1}$ and the second part of mass 2 kg moves with speed of $8 ms^{-1}$. If the third part flies off with speed of $4 ms^{-1}$, then its mass is

A. 7 kg

B. 17 kg

C. 3 kg

D. 5 kg

Answer: D

Watch Video Solution

40. Let $\overrightarrow{F}$ be the force acting on a particle having position vector $\overrightarrow{r}$ and $\overrightarrow{T}$ be the torque of this force about the origin. Then

A. $\overrightarrow{r}.\overrightarrow{\tau} > 0$ and $\overrightarrow{F}.\overrightarrow{\tau} < 0$

B. $\overrightarrow{r}.\overrightarrow{\tau} = 0$ and $\overrightarrow{F}.\overrightarrow{\tau} = 0$

C. $\overrightarrow{r}.\overrightarrow{\tau} = 0$ and $\overrightarrow{F}.\overrightarrow{\tau} \neq 0$

D. $\overrightarrow{r}.\overrightarrow{\tau} \neq 0$ and $\overrightarrow{F}.\overrightarrow{\tau} = 0$

Answer: B

Watch Video Solution

41. Four identical thin rods each of mass M and length l, form a square frome. Moment of inertia of this frame about an axis through the centre of the square and perpendicular to its plane is

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

B. $\frac{13}{3}Ml^2$

C. $\frac{1}{3}Ml^2$

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

Answer: D

Watch Video Solution

42. Two bodies of mass $1kg$ and $3kg$ have position vectors $\hat{i} + 2\hat{j} + \hat{k}$ and $-3\hat{i} - 2\hat{j} + \hat{k}$, respectively. The centre of mass of this system has a position vector.

A. $-2\hat{i} - \hat{j} + \hat{k}$

B. $2\hat{i} - \hat{j} - 2\hat{k}$

C. $-\hat{i} + \hat{j} + \hat{k}$

D. $-2\hat{i}+2\hat{k}$

Answer: A

Watch Video Solution

43. The ratio of the radii of gyration of a circular disc to that of a circular ring, each of same mass and radius, around their respective axes is

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

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

C. $1:\sqrt{2}$

D. $\sqrt{2}:1$

Answer: C

Watch Video Solution

44. A thin rod of length L and mass M is bent at its mid-point into two halves so that the angle between them is 90°. The moment of inertia of the bent rod about an axis passing through the bending point and perpendicular to the plane defined by the two halves of the rod is

A. $\dfrac{\sqrt{2}ML^2}{24}$

B. $\dfrac{ML^2}{24}$

C. $\dfrac{ML^2}{12}$

D. $\dfrac{ML^2}{6}$

Answer: C

Watch Video Solution

45. A wheel has angular acceleration of $3.0 rad / s^2$ and an initial angular speed of $2.00 rad / s$. In a time of $2s$ it has rotated through an angle (in radian) of

A. 4

B. 6

C. 10

D. 12

Answer: C

Watch Video Solution

46. A particle of mass m in the XY-plane with a velocity v along the straight line AB. If the angular momentum of the particle with respect to origin O is L_A when it is at A and L_B when it is at B, then

A. $L_A < L_B$

B. $L_A > L_B$

C. $L_A = L_B$

D. The relationship between L_A and L_B depends upon the slope of the line AB

Answer: C

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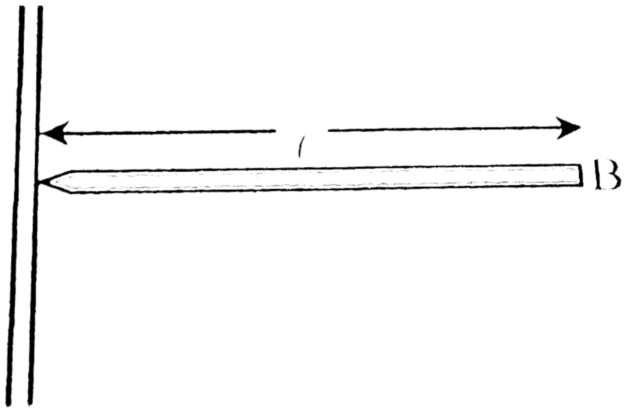
47. A uniform rod AB of length l and mass m is free to rotate about point A. The rod is released from rest in the horizontal position. Given that the moment of inertia of the rod about A is $\frac{ml^2}{3}$, the initial angular acceleration of the rod will be:-



A. $\dfrac{3g}{2l}$

B. $\dfrac{2g}{3l}$

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

D. $\dfrac{3}{2}gl$

Answer: A

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48. The moment of inertia of a uniform circular disc of radius R and mass M about an axis passing from the edge of the disc and normal to the disc is

A. MR^2

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

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

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

Answer: C

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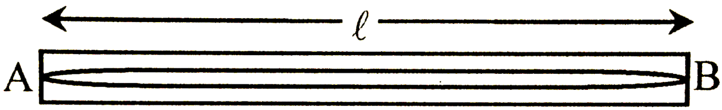
49. A uniform rod of length l and mass m is free to rotate in a vertical plane about A. The rod initially in horizontal position is released. The initial angular acceleration of the rod is (Moment of inertia of rod about A is $\frac{ml^2}{3}$):



A. $\frac{3g}{2l}$

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

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

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

Answer: A

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50. A drum of radius R and mass M, rolls down without slipping along an inclined plane of angle θ . The frictional force-

A. Converts translational energy to rotational energy

B. Dissipates energy as heat

C. Decreases the rotational motion

D. Decreases the rotational and translational motion

Answer: A

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51. Two bodies have their moments of inertia I and 2I respectively about their axis of rotation. If their kinetic energies of rotation are equal, their angular momentum will be in the ratio:

A. $1:2$

B. $\sqrt{2}:1$

C. $2:1$

D. $1:\sqrt{2}$

Answer: D

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52. The moment of inertia of a uniform circular disc of radius R and mass M about an axis passing from the edge of the disc and normal to the disc is

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

B. MR^2

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

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

Answer: D

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53. A solid cylinder of mass 3 kg is rolling on a horizontal surface with velocity $4ms^{-1}$. It collides with a horizontal spring of force constant $200Nm^{-1}$. The maximum compression produced in the spring will be

A. 0.7 m

B. 0.2 m

C. 0.5 m

D. 0.6 m

Answer: D

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54. The centre of mass of a solid cone along the line form the center of the base to the vertex is at

A. One-fourth of the height

B. One-third of the height

C. One-fifth of the height

D. None of these

Answer: A

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55. The center of mass a system of particles does not depend on

A. Position of the particles

B. Relative distances between the particles

C. Masses of the particles

D. Forces acting on the particles

Answer: D

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56. Consider a system of two particles having masses m_1 and m_2. If the particle of mass m_1 is pushed towards the mass centre of particles through a distance 'd', by what distance would the particle of mass m_2 move so as to keep the mass centre of particles at the original position :-

A. $\frac{m_1}{m_1 + m_2} d$

B. $\frac{m_1}{m_2} d$

C. d

D. $\frac{m_2}{m_1} d$

Answer: B

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57. Three identical metal balls each of radius r are placed touching other on a horizontal surface such that an equilateral triangle is formed with centers of three balls joined. The centre of mass of the system is located at

A. Line joining centres of any two balls

B. Centre of one of the balls

C. Horizontal surface

D. Point of intersection of the medians

Answer: D

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58. A rod of length is 3m and its mass acting per unit length is driectly proportional to distance x from one of its end then its centre of gravity from that end will be at : -

A. 1.5 m

B. 2 m

C. 2.5 m

D. 3.0 m

Answer: B

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59. The ratio of radii of gyration of a circular ring and a circular disc, of the same mass and radius about an axis passing through their centres and perpendicular to their planes are

A. $\sqrt{2}:1$

B. $1:\sqrt{2}$

C. $3:2$

D. $2:1$

Answer: A

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60. ABC is a triangular plate of uniform thickness. The sides are in the ratio shown in the figure. I_{AB}, I_{BC} and I_{CA} are the moment of inertia of the plate about AB, BC and CA as axes respectively. Which one of the following relations is correct?

A. $l_{AB} + l_{BC} = l_{CA}$

B. l_{CA} is maximum

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

D. $l_{BC} > l_{AB}$

Answer: D

61. Three particles, each of mass m grams situated at the vertices of an equilateral ΔABC of side l cm (as shown in the figure). The moment of inertia of the system about a line AX perpendicular to AB and in the plane of ABC in $g - cm^2$ units will be

A. $\frac{3}{4}ml^2$

B. $2ml^2$

C. $\frac{5}{4}ml^2$

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

Answer: C

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62. A circular disc is to be made using iron and aluminium. To keep its moment of inertia maximum about a geometrical axis, it should be so prepared that

A. Aluminium at interior and iron surround to it

B. Iron at interior and aluminium surround to it

C. Using iron and aluminium layers in alternate order

D. Sheet of iron is used at both external surface and aluminium sheet as interna layers

Answer: A

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63. The ratio of the radii of gyration of a circular disc about a tangential axis in the plane of the disc and of a circular ring of the same radius about a tangential axis in the plane of the ring is:-

A. $2:3$

B. $2:1$

C. $\sqrt{5}:\sqrt{6}$

D. $1, \sqrt{2}$

Answer: C

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64. The reduce mass of two particles having masses m and 2 m is

A. 2m

B. 3m

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

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

Answer: C

Watch Video Solution

65. Find the torque of the force $\overrightarrow{F} = \left(2\hat{i} - 3\hat{j} + 4\hat{k}\right)$ N acting at the point $\overrightarrow{r} = \left(3\hat{i} - 2\hat{j} + 3\hat{k}\right)$m about the origion.

A. $-6\hat{i} + 6\hat{j} - 12\hat{k}$

B. $-17\hat{i} + 6\hat{j} + 13\hat{k}$

C. $6\hat{i} - 6\hat{j} + 12\hat{k}$

D. $17\hat{i} - 6\hat{j} - 13\hat{k}$

Answer: D

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66. A couple produces

A. Linear and rotational motion

B. No motion

C. Purely linear motion

D. Purely rotational motion

Answer: D

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67. The angular speed of a fly wheel making 120 revolutions / minute is

A. 4π rad/s

B. $4\pi^2$ rad/s

C. π rad/s

D. 2π rad/s

Answer: A

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68. A large disc has mass 2kg and radius 0.2 m and initial angular velocity 50 rad/s and small disc has mass 4kg and radius 0.1 m and initial angular velocity 200 rad/s both rotating about their common axis. Then the common final angular velocity after discs are in contact is,

A. 40

B. 60

C. 100

D. 120

Answer: C

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69. A wheel having moment of inertia $2kgm^2$ about its vertical axis, rotates at the rate of $60r \pm$ about this axis. The torque which can stop the wheel's rotation in one minute would be

A. $\frac{2\pi}{15} Nm$

B. $\frac{\pi}{12} Nm$

C. $\frac{\pi}{15} Nm$

D. $\frac{\pi}{18} Nm$

Answer: C

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70. What is the value of linear velocity, if $\vec{\omega} = 3\hat{i} - 4\hat{j} + \hat{k}$ and $\vec{R} = 5\hat{i} - 6\hat{j} + 6\hat{k}$.

A. $4\hat{i} - 13\hat{j} + 6\hat{k}$

B. $-18\hat{i} - 13\hat{j} + 2\hat{k}$

C. $6\hat{i} + 2\hat{j} + 3\hat{k}$

D. $6\hat{i} - 2\hat{j} + 8\hat{k}$

Answer: B

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71. If $\left|\overrightarrow{A} \times \overrightarrow{B}\right| = \sqrt{3}\overrightarrow{A} . \overrightarrow{B}$, then the value of $\left|\overrightarrow{A} + \overrightarrow{B}\right|$ is

A. $(A^2 + B^2 + AB)^{1/2}$

B. $\left(A^2 + B^2 + \frac{AB}{\sqrt{3}}\right)^{1/2}$

C. $A + B$

D. $(A^2 + B^2\sqrt{3} + AB)^{1/2}$

Answer: A

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72. The angle between A and B is θ.The value of the triple product A .(B x A) is

A. $BA^2 \sin \theta$

B. $BA^2 \cos \theta$

C. $BA^2 \sin \theta \cos \theta$

D. Zero

Answer: D

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73. A round disc of moment of inertia I_2 about its axis perpendicular to its plane and passing through its centre is placed over another disc of moment of inertia I_1 rotating with an angular velocity ω about the same axis. The final angular velocity of the combination of discs is :-

A. $\frac{l_2\omega}{l_1 + l_2}$

B. ω

C. $\frac{l_1\omega}{l_1 + l_2}$

D. $\frac{(l_1 + l_2)\omega}{l_1}$

Answer: A

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74. A disc is rotating with angular velocity ω. If a child sits on it, what is conserved?

A. Linear momentum

B. Angular momentum

C. Kinetic energy

D. Potential energy

Answer: B

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75. A solid cylinder is rolling without slipping on a plane having inclination θ and the coefficient of static friction μ_s. The relation between θ and μ_s is

A. $\tan\theta > 3\mu_s$

B. $\tan\theta \leq 3\mu_s$

C. $\tan\theta < 3\mu_s^2$

D. None of these

Answer: B

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76. A solid spherical ball rolls on a table. Ratio of its rotational kinetic energy to total kinetic energy is

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

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

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

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

Answer: D

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77. A hollow cylinder and a solid cylinder are rolling without slipping down an inclined plane, then which of these reaches earlier ?

A. Solid cylinder

B. Hollow cylinder

C. Both simultaneously

D. Can't say anything

Answer: A

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78. A disc is rolling the velocity of its centre of mass is V_{cm} then which one will be correct : -

A. The veocity of highest point is $2V_{cm}$ and point of contact is zero

B. The velocity of highest point is V_{cm} and point of constant is V_{cm}

C. The velocity of highest point is $2V_{cm}$ and point of contact is V_{cm}

D. The velocity of highest point is $2V_{cm}$ and point of contact is $2V_{cm}$

Answer: A

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79. A solid sphere of radius R is placed on a smooth horizontal surface. A horizontal force F is applied at height h from the lowest point. For the maximum acceleration of the centre of mass

A. h = R

B. h = 2R

C. h = 0

D. Centre of mass has same acceleration in each case

Answer: D

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80. A point P consider at contact point of a wheel on ground which rolls on ground without sliping then value of displacement of point P when wheel completes half of rotation (If radius of wheel is 1m) : -

A. 2 m

B. $\sqrt{\pi^2 + 4m}$

C. πm

D. $\sqrt{\pi^2 + 2m}$

Answer: B

Watch Video Solution

81. A solid cylinder of mass M and radius R rolls without slipping down an inclined plane of length L and height h. What is the speed of its centre of mass when the cylinder reaches

its bottom:

A. $\sqrt{2gh}$

B. $\sqrt{\frac{3}{4}gh}$

C. $\sqrt{\frac{4}{3}gh}$

D. $\sqrt{gh}$

Answer: C

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82. A drum of radius R and mass M, rolls down without slipping along an inclined plane of angle θ . The frictional force-

A. Dissipates energy as heat

B. Decreases the rotational motion

C. Decrease the rotational and translational motion

D. Converts translational energy to rotational energy

Answer: D

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

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

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

C. $\dfrac{K^2}{K^2 + R^2}$

D. $\dfrac{R^2}{K^2 + R^2}$

Answer: C

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84. The moment of inertia of a disc of mass M and radius R about an axis. Which is tangential to sircumference of disc and parallel to its diameter is.

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

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

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

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

Answer: A

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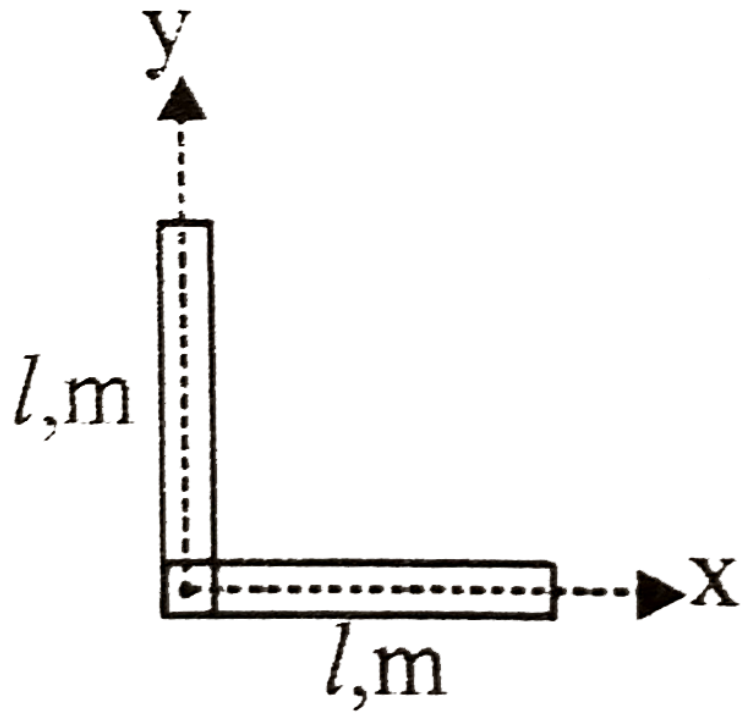
ASSIGNMENT (SECTION - D)

1. Calculate centre of mass of the system



A. If both Assertion & Reason are true and the reason is the correct explanation of the assertion,

B. If both Assertion & Reason are true but the reason is not the correct explanation of the assertion,

C. If Assertion is true statement but Reason is false,

D. If both Assertion and Reason are false statements,

Answer: A

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2. Assertion : Position of centre of mass is independent of the reference frame

. Reason : Centre of mass is same for all bodies

A. If both Assertion & Reason are true and the reason is the correct explanation of the assertion,

B. If both Assertion & Reason are true but the reason is not the correct explanation of the assertion,

C. If Assertion is true statement but Reason is false,

D. If both Assertion and Reason are false statements,

Answer: C

Watch Video Solution

3. A : A bomb at rest explodes. The centre of mass of fragments moves along parabolic path.

R : Under the effect of gravity only the path followed by centre of mass is always parabolic.

A. If both Assertion & Reason are true and the reason is the correct explanation of the assertion,

B. If both Assertion & Reason are true but the reason is not the correct explanation of the assertion,

C. If Assertion is true statement but Reason is false,

D. If both Assertion and Reason are false statements,

Answer: D

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4. A : If an object is taken to the centre of earth, then its centre of gravity cannot be defined.

R : At the centre of earth acceleration due to gravity is zero.

A. If both Assertion & Reason are true and the reason is the correct explanation of the assertion,

B. If both Assertion & Reason are true but the reason is not the correct explanation of the assertion,

C. If Assertion is true statement but Reason is false,

D. If both Assertion and Reason are false statements,

Answer: A

Watch Video Solution

5. A : It is very difficult to open or close a door if force is applied near the hinge.

R : The moment of applied force is minimum near the hinge.

A. If both Assertion & Reason are true and the reason is the correct explanation of the assertion,

B. If both Assertion & Reason are true but the reason is not the correct explanation of the assertion,

C. If Assertion is true statement but Reason is false,

D. If both Assertion and Reason are false statements,

Answer: A

Watch Video Solution

6. A : The moment of force is maximum for a point if force applied on it and its position vector w.r.t. the point of rotation are perpendicular.

R : The magnitude of torque is independent of the direction of application of force.

A. If both Assertion & Reason are true and the reason is the correct explanation of the assertion,

B. If both Assertion & Reason are true but the reason is not the correct explanation of the assertion,

C. If Assertion is true statement but Reason is false,

D. If both Assertion and Reason are false statements,

Answer: C

Watch Video Solution

7. A : If angular momentum of an object is constant about a point then net torque on it about that point is zero.

R : Torque is equal to the rate of change of angular momentum.

A. If both Assertion & Reason are true and the reason is the correct explanation of the assertion,

B. If both Assertion & Reason are true but the reason is not the correct explanation of the assertion,

C. If Assertion is true statement but Reason is false,

D. If both Assertion and Reason are false statements,

Answer: A

Watch Video Solution

8. A : Two rings of equal mass and radius made of different materials, will have same moment of inertia.

R : Moment of inertia depends on mass as well as distribution of mass in the object.

A. If both Assertion & Reason are true and the reason is the correct explanation of the assertion,

B. If both Assertion & Reason are true but the reason is not the correct explanation of the assertion,

C. If Assertion is true statement but Reason is false,

D. If both Assertion and Reason are false statements,

Answer: A

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9. A : In purc rolling motion all the points of a rigid body have same linear velocity.

R : Rolling motion is not possible on smooth surface.

A. If both Assertion & Reason are true and the reason is the correct explanation of the assertion,

B. If both Assertion & Reason are true but the reason is not the correct explanation of the assertion,

C. If Assertion is true statement but Reason is false,

D. If both Assertion and Reason are false statements,

Answer: D

Watch Video Solution

10. A : For an object in rolling motion rotational kinetic energy is always equal to translational kinetic energy.

R : For an object in rolling motion magnitude of linear speed and angular speed are equal.

A. If both Assertion & Reason are true and the reason is the correct explanation of the assertion,

B. If both Assertion & Reason are true but the reason is not the correct explanation of the assertion,

C. If Assertion is true statement but Reason is false,

D. If both Assertion and Reason are false statements,

Answer: D

Watch Video Solution

11. A : The work done by friction on an object during pure rolling motion is zero.

R : In pure rolling motion, there is relative motion at the point of contact.

A. If both Assertion & Reason are true and the reason is the correct explanation of the assertion,

B. If both Assertion & Reason are true but the reason is not the correct explanation of the assertion,

C. If Assertion is true statement but Reason is false,

D. If both Assertion and Reason are false statements,

Answer: C

Watch Video Solution

12. A : When a rigid body rotates about any fixed axis, then all the particles of it move in circles of different radii but with same angular velocity.

R : In rigid body relative position of particles are fixed.

A. If both Assertion & Reason are true and the reason is the correct explanation of the assertion,

B. If both Assertion & Reason are true but the reason is not the correct explanation of the assertion,

C. If Assertion is true statement but Reason is false,

D. If both Assertion and Reason are false statements,

Answer: A

Watch Video Solution

13. A : rigid body can't be in a pure rolling on a rough inclined plane without giving any external force.

R : Since there is no torque providing force acting on the body in the above case, the body can't come in a rolling condition.

A. If both Assertion & Reason are true and the reason is the correct explanation of the assertion,

B. If both Assertion & Reason are true but the reason is not the correct explanation of the assertion,

C. If Assertion is true statement but Reason is false,

D. If both Assertion and Reason are false statements,

Answer: D

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14. A : When a ring moves in pure rolling condition on ground it has 50% translational and 50% rotational energy.

R :

$$\frac{KE_{\text{trans}}}{KE_{\text{rot}}} = \frac{\frac{1}{2}MV^2}{\frac{1}{2}l\omega^2} = \frac{\frac{1}{2}MV^2}{\frac{1}{2}(MR^2)\frac{V^2}{R^2}} = 1:1$$

A. If both Assertion & Reason are true and the reason is the correct explanation of the assertion,

B. If both Assertion & Reason are true but the reason is not the correct explanation of the assertion,

C. If Assertion is true statement but Reason is false,

D. If both Assertion and Reason are false statements,

Answer: A

Watch Video Solution

15. A : For a body to be in rotational equilibrium the net torque acting on the body about any point is zero.

R : For net torque to be zero, net force should also be zero.

A. If both Assertion & Reason are true and the reason is the correct explanation of the assertion,

B. If both Assertion & Reason are true but the reason is not the correct explanation of the assertion,

C. If Assertion is true statement but Reason is false,

D. If both Assertion and Reason are false statements,

Answer: C

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