PHYSICS

BOOKS - MODERN PUBLISHERS PHYSICS (HINGLISH)

SYSTEMS OF PARTICLES AND ROTATIONAL MOTION

Solved Examples

1. The distance between the centres of carbon and oxygen atoms in the carbon monoxide molecule is 1.130Å . Locate the centre of mass of the molecule relative to the carbon atom .

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2. If three point masses m_1, m_2 and m_3 are situated at the vertices of an equilateral triangle of side a, then what will be the co-ordinates of the centre of mass of this system ?

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3. Position vector of two particles of masses 200 g and 400 g at a given time are $3\hat{i} + \hat{j} + 9\hat{k}$ m and $-2\hat{i} + 6\hat{j} - \hat{k}$, respectively. Find the instantaneous position of the centre of mass of the system.

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4. Find the centre of mass of a uniform L shaped lamina (a thin flat plate) with dimension as shown in Fig. The mass of the lamina is $3kg$.

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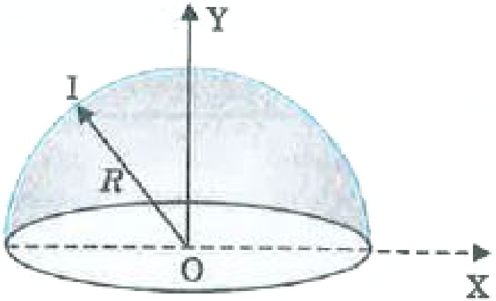
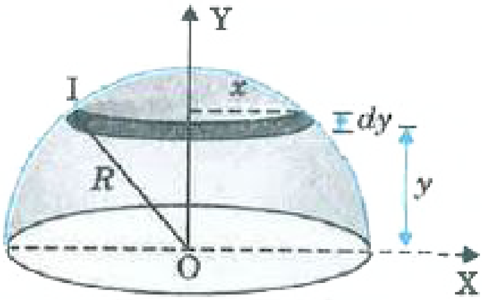
5. Locate the position of the centre of mass of a hemisphere of radius R as shown in the following figure:





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6. The instantaneous velocities of two particles of masses 200 g and 400 g at a given time are $12\hat{i} - 7\hat{j} - 5\hat{k}$ m/s and $8\hat{i} - 9\hat{j} - 5\hat{k}$ m/s, respectively. Calculate the instantaneous velocity of the centre of mass of the system.

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7. A wheel is turned from rest through 500 radians in 20 s by applying a constant torque.

(a) Calculate the angular acceleration of wheel

(b) ind the angular velocity of the wheel after 40s from start if its angular acceleration is same.

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8. A wheel of a bicycle is rotating about its axis with an angular velocity of 100 rpm. When the brakes are applied, the wheel comes to rest in 10 s. Calculate the number of revolutions made by the wheel before coming to rest. Assume that the deceleration is constant.

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9. A car moves on a road with a speed of $54kmh^{-1}$. The radius of its wheels is $0.35m$. What is the average negative torque transmitted by its brakes to the wheels if the car is brought to rest in $15s$? Moment of inertia of the wheels about the axis of rotation is $3kgm^2$.

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10. A cylinder of length 10 cm and radius 5 cm is rotating with an angular speed of 50 rad/s about its central axis. Calculate the uniform tangential force which will stop the cylinder in 8 s. The moment of inertia of the cylinder about its axis of rotation is $0.6kgm^2$.

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11. A cord of negligible mass is wound around the rim of a wheel of radius 20 cm. An object of mass 600 g is attached to the end of the cord and is allowed to fall from rest. It took 5 s for the object to fall by 2 m. Calculate the angular acceleration and moment of inertia of the wheel. Assume that the axis of wheel is horizontal.

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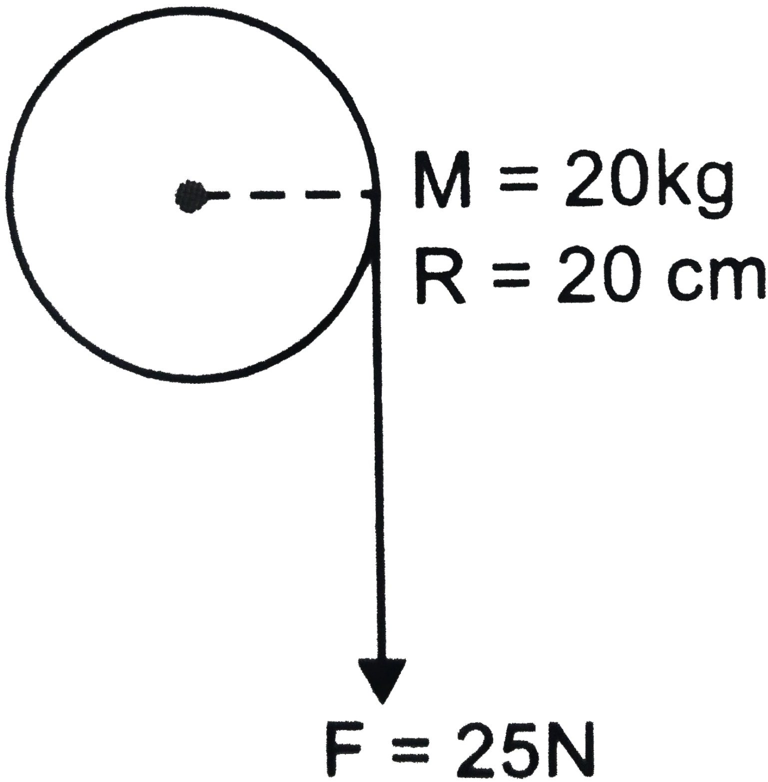
12. A cord of negligible mass is wound round the rim of a flywheel of mass $20kg$ and radius $20cm$. A steady pull of $25N$ is applied on the cord as shown in Fig. The flywheel is mounted on a horizontal axle with frictionless bearings.



(a) Compute the angular acceleration of the wheel.

(b) Find the work done by the pull, when $2m$ of the cord is unwound.

(c) Find also the kinetic energy of the wheel at this point. Assume that the wheel stars from rest.

(d) Compare answers to parts (b)and (c).

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13. Calculate the moment of inertia of an oxygen molecule about an axis passing through its centre of mass and perpendicular to the internuclear axis. Take

Mass of O-atom $= 2.67 \times 10^{-26} kg$

Interatiomic distance $= 1.2 \times 10^{-10} m$

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14. Three particles each of mass 12 g are located at the vertices of an equilateral triangle of side 10 cm. Calculate the moment of inertia of the system about an axis passing through the centroid and perpendicular to the plane of the triangle?

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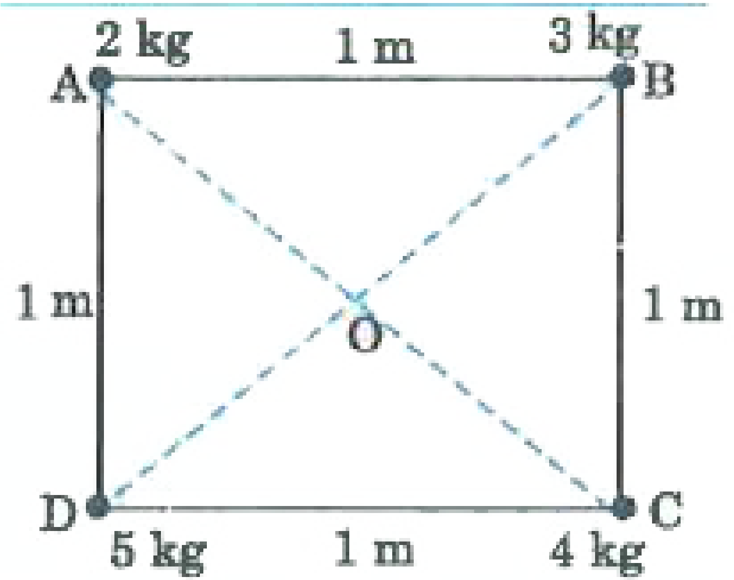
15. Four point masses 2 kg, 3 kg, 4 kg and 5 kg are respectively located at the four corners A, B, C and D of a square of side 1 m as shown in the following figure. Calculate the moment of inertia of the system about

(i) an aris coinciding with side BC

(ii) an axis coinciding with diagonal BD

(iii) an axis passing through A and perpendicular to the plane of the square.



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16. For a uniform circular disc the moment of inertia about its diameter is $150 gcm^2$. Calculate its moment of inertia about

(i) its tangent parallel to diameter.

(ii) an axis perpendicular to its plane and passing through centre.

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17. Calculate the moment of inertia of a circular disc of radius 8 cm, thickness 2 mm and uniform density $10 gcm^{-3}$, about a transverse axis passing through its centre.

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18. Four spheres of diameter a and mass m each are arranged at the corners of a square of side 1. Calculate the moment of inertia of the system about CD taken as its axis.

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19. A rectangular bar magnet of mass 100 g has length, breadth and thickness of 10 cm, 4 cm and 2 cm, respectively. Calculate its moment of inertia about an axis passing through its centre and parallel to its thickness.

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20. The radius of a sphere is 8 cm. What will be its radius of gyration about (i) its diameter and (ii) about any tangent?

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21. Calculate the moment of inertia of a body about its axis of rotation if its angular momentum is 62.8 Js and it has 10 revolutions per second.

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22. Calculate the angular momentum of earth rotating about its own axis.

Take

Radius of earth $= 6.4 \times 10^6 m$

Mass of earth $= 5.97 \times 10^{24} kg$

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23. A wheel of mass 2 kg and radius 20 cm initially at rest is free to rotate about its axis. It receives an angular impulse of $4 kgm^2 s^{-1}$ initially and similar impulse after every 5 s of initial one. Calculate the angular speed of the wheel 22 s after the initial impulse.

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24. Calculate the angular momentum of a bike of mass 500 kg moving in a circular track of radius 20 m with a speed of 30 m/s.

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25. A satellite of mass M_s is revolving around the earth (Mass M) in a orbit of radius R. Find its angular momentum.

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26. An ice skater has her arms outstretched and is spinning with a rate of 2 rotations per second. Her moment of inertia at this instant is $1.48 kgm^2$. She then pulls her arms inside to increase her rate of spin and her moment of inertia becomes $0.56 kgm^2$. Calculate her new rate of rotation.

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27. Imagine that the earth suddenly contracts to one-third of its present radius, without any external torque on it. By what duration the day on the earth will decrease considering the earth to be a perfect solid sphere.

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28. The sun rotates about its axis once in 27 days. If it suddenly shrinks to one-eighth of its original volume, mass remaining same, then what will be its new period of rotation?

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29. A uniform disc is rotating freely about a vertical axis passing through its centre and makes 100 rpm. A small piece of gum of mass 8 g falls vertically on the disc and sticks to it at a distance of 5 cm from its axis. If the number of rotations per minute reduces to 80 rpm find the moment of inertia of the disc.

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30. Determine the moment of inertia of a wheel rotating at a rate of 1200 rpm about its axis of rotation. Given that the kinetic energy of the wheel is $3 \times 10^6 J$.

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31. To increase the speed of a flywheel from 60 rpm to 360 rpm, energy of 490 J is spent. Calculate the moment of inertia of wheel.

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32. A rod of length 2 m is held vertically with one of its end on the floor. It is then allowed to fall. Calculate the speed of the other end when it strikes the floor. Assume that the end of the rod which is on the floor does not slip.

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33. A solid sphere of mass 10 kg and radius 0.5 m is rolling on a road without sliding with an regular velocity of 12 rad/s. What is the percentage of rotational kinetic energy in the total kinetic energy of the wheel?

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34. A solid cylinder of mass 8 kg is rolling perfectly down an inclined plane of inclination 30. Calculate the force of friction between the cylinder and inclined plane and acceleration of the cylinder down the inclined plane.

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35. Three bodies, a ring, a soild cylinder and a soild sphere roll down the same inclined plane without slipping. They start from rest. The radii of the bodies are identical. Which of the bodies reaches the ground with maximum velocity ?

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36. A solid cylinder of mass 500 g and radius 10 cm rolls down an inclined plane of inclination 1 in 10. Calculate its acceleration and total energy after 6 s.

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37. A metal bar $70cm$ long and $4.00kg$ in mass is supported on two knife edges placed $10cm$ from each end. A $6.00kg$ weight is suspended at $30cm$ from one end. Find the reactions at the knife edges. Assume the bar to be of uniform cross-section and homogeneous.

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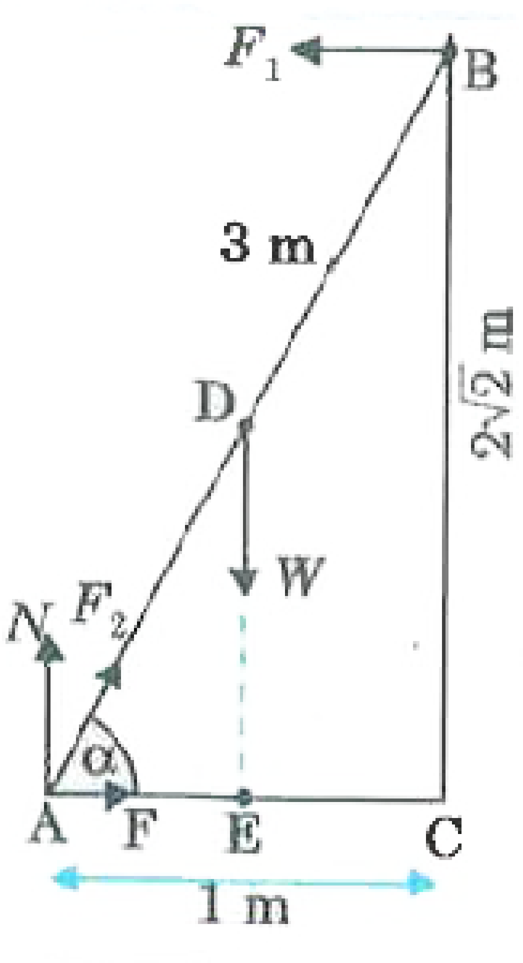
38. A 3 m long ladder weighing 20 kg leans on a frictionless wall. Its feet rest on the floor 1 m from the wall as shown in the following figure, Find the reaction forces of the wall and the floor.



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Practice Problems

1. Three bodies of masses m, 2m and 3m are placed at the corners of a triangle having coordinates (1, 1.5), (2.5, 1.5) and (3, 3) respectively. Calculate the coordinates of the centre of mass.

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2. Three bodies of masses 5 kg, 4 kg and 2 kg have the position vectors as $2\hat{i} + 3\hat{j} - 3\hat{k}$, $\hat{i} + \hat{j} + \hat{k}$ and $3\hat{i} - 3\hat{j} - 4haktk$. Find the coordinates of centre of mass.

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3. Find the coordinates of centre of mass of a square of side 1 m in which four particles of masses 2m, 2m, 3m, 5m are placed at four corners.

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4. The coordinates of centre of mass of three particles of masses 1 kg, 2 kg, 3 kg are (2m, 2m, 2m). Where should a fourth particle of mass 4 kg be placed so that the coordinates of centre of mass are (4m, 4m, 4m)?

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5. A circular disc of radius $\frac{R}{4}$ is cut from a uniform circular disc of radius R.

The centre of cut portion is at a distance of $\frac{R}{2}$ from the centre of the disc from which it is removed. Calculate the centre of mass of remaining portion of the disc.

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6. A motor increases its speed from 500 rpm to 1000 rpm in 10 s. Calculate its angular acceleration and the number of revolutions made by it in this time.

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7. The speed of a moving car is $60 km h^{-1}$. The wheels having diameter of 0.60 m are stopped in 10 rotations by applying brakes. What will be the angular retardation produced by brakes?

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8. The motor of engine rotating at an angular velocity of 500 rpm slows down at a constant rate of $2.5 rad s^{-2}$. Calculate the time required to stop the motor.

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9. Three masses 1 kg, 2 kg and 3 kg are located at the vertices of an equilateral triangle of length 1. Calculate the moment of inertia of the triangle about an axis along the altitude of triangle passing through the 1 kg mass.

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10. Four point masses of 10 kg each are placed at the corners of a square PQRS of side 3 cm. Calculate the moment of inertia of the square about an axis coinciding with the side PQ of the square.

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11. In the above problem, calculate the moment of inertia about an axis passing through point Q and perpendicular to the plane of square.

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12. What will be the moment of inertia (a) about the diameter, (b) about the tangent perpendicular to the plane of a uniform circular ring of mass 2 kg and diameter 60 m.

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13. Calculate the ration of radii of gyration of circular ring and a disc of the same radius about the axis passing through their centres and perpendicular to their planes.

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14. A fly wheel (disc form) of mass 50 kg and diameter 100 cm is making 150 revolutions/ min. What will be the angular momentum of flywheel?

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15. A sphere of moment of inertia $10kgm^2$ is rotating at a speed of 100 rad/s. Calculate the torque required to stop it in 10 minutes. Also calculate the angular momentum of the wheel two minutes before it stops rotating.

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16. A rotor rotating with an angular speed of $100 rad s^{-1}$. To make it rotate with same speed, an engine has to transmit a torque of 200 Nm. Calculate the power of engine.

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17. A hollow cylinder of mass 5 kg rolls down with a speed of 20 m/s without slipping. What will be its kinetic energy?

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18. A solid sphere (initially at rest) of mass 7 kg and radius 40 cm which is free to rotate about its axis is given an angular impulse of $5 kg m^2 s^{-1}$ followed by the similar impulse after every 5 second. Calculate the angular speed of sphere 50 s after the initial impulse.

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19. Calculate the radius of gyration of a sphere (a) about its diameter (b) about any tangent. The radius of sphere is 10 cm.

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20. Calculate the rotational kinetic energy of a body of mass 2 kg rotating on a circular path of diameter 4 m at the rate of 50 rotations in 20 seconds.

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21. The time period of rotation of the sun about its axis is 27 days. If the sun expands to thrice of its present diameter, what will be its new period of rotation?

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22. Mass remaining constant, if the earth suddenly contracts to one third of its present radius, the length of the day would be shorted by

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23. A body completes one revolution along a horizontal circle in 10 s when tied to a cord. If the radius of the circle is decreased to one-third of its original value, then what will be the time period of revolution of the body?

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24. A flywheel is rotating at an angular speed of 150 rpm. If the moment of inertia of the flywheel somehow decreases from $10kgm^2$ to $4kgm^2$, then what will be the new angular speed of the flywheel?

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25. Calculate the acceleration of a hollow cylinder rolling down an inclined plane of inclination 30.

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26. A body rolls without slipping. The radius of gyration of the body about an axis passing through its centre of mass is K. The radius of the body is R. The ratio of rotational kinetic energy to translational kinetic energy is.

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Conceptual Questions

1. Does centre of mass of a body actually exist in reality? Does centre of mass of a solid body lie necessarily Inside it ?

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2. A body is in rotational motion. Is it necessary that a torque be acting on it ?

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3. Why are doors provided with handles near the outer edges, far away from the hinges ?

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4. To open or close a heavy door, why force is applied at right angles to the door.

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5. A boy climbed an old step ladder (which has a tendency to slip) and observed that he feels more unstable when standing at the top of the ladder than at the bottom most step. Explain the observation with reasoning

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6. We cannot rise from a chair without bending a little forward. Give reason

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7. Give reason for the following

(a) Bicycle wheels are provided with spokes

(b) There are two fan a helicopter.

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8. Some solid cubes are to be loaded along with some hollow cubes of same material on cart. Which cubes should be put on the cart first and

why?

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9. What can be said about the potential energy of a system in stable equilibrium?

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10. If only an external force can change the state of motion of CM of a body then how does the internal force of the brakes bring bicycle to rest?

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11. Two boats are floating on still worst meditace apart from each other. The best on each boa are standing heling each other and holding a rope, one at each end. When the repels pulled whether by each man separately or both together, the two fronts always meet at a some point. Why?

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12. Torque and work are both equal to force time distance. How do they differ ?

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13. How will the duration of a day on earth be affected if the ice of polar caps of the earth melt.

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14. Explain why the speed of a whirl wind in a tornado is alarmingly high ?

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15. A dise of radiu Rin reonat into a thin cylinder of same radius. Will their moments of inertin be equal.

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16. State whether the below given statement is true or false with proper reasoning. A Sphere moving down a perfectly smooth inclined plane will undergo slipping, not rolling motion

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17. Explain how is a cat able to land on its feet after a fall taking advantage of the principle of conservation of angular momentum ?

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18. Two cylinders Aando m sine but different masses of Am f , Initially at restare rolling down an inclined plan. Which cylinder will reach the bottorat.

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19. Two particles , each of mass m and charge q, are attached to the two ends of a light rigid rod of length $2R$. The rod is rotated at constant angular speed about a perpendicular axis passing through its centre. The ratio of the magnitudes of the magnetic moment of the system and its angular momentum about the centre of the rod is

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20. If angular momentum is conserved in a system whose moment of inertia is decreased, will its rotational kinetic energy be also conserved ? Explain.

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21. Why is it easier to open a tap with two fingers than with one finger ?

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22. Torque acting on a particle about an arbitrary origin is zero, What can be said about the angular momentum of the particle about the origin ?

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23. An acrobatora balletdancer is able to change his her angular speed with the help of law of conservation of angular momentum. How?

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24. When rivers flow towards equator, what effect they bring to the rotation of the earth on carrying the sediments with them?

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Problems Tough Tricky

1. A body is projected with a speed 160 m/s at an angle 53° with the horizontal, At the highest point, body explodes into two pieces with mass ratio 1:3. Smaller piece comes to rest immediately after explosion. Find the distance of point from point of projection where heavier piece strikes the horizontal surface.

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2. A uniform rod of length L rests against a smooth roller as shown in figure. Find the friction coefficeint between the ground and the lower end if the minimum angle that rod can make with the horizontal is θ.

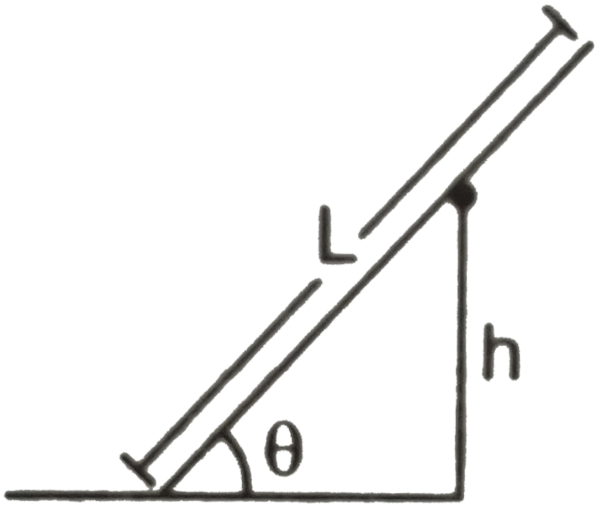

Figure 10-E9

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3. A particle of mass m is projected with a speed u at an angle θ with the horizontal. Find angular momentum of particle after time t about point of projection.

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4. A rod of mass M and length L is kept on a frictionless horizontal floor. A particle of mass m moving perpendicular to the rod with a speed v strikes at the end of the rod and sticks there. Calculate angular velocity acquired by the combined system.

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5. A rod of mass m and length L is kept on a frictionless horizontal floor. A particle of same mass m moving perpendicular to the rod with a speed v strikes at the end of the rod. If coefficient of elasticity for the collision is 1 then calculate angular velocity acquired by the rod.

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6. A cylinder rotating with angular velocity ω_0 is put on a rough horizontal floor so that edge touches a vertical rough wall. Rotational motion of the cylinder is retarded and after some time cylinder comes to rest. If m is mass of cylinder and R is its radius then calculate number of revolutions made by the cylinder before it comes to rest. Assume μ is coefficient of friction for floor as well as wall.

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7. A sphere of mass m and radius R is kept on a rough floor. A sharp impulse is applied in the horizontal direction at the height of centre of sphere so that sphere acquires a linear velocity v_0 without any angular velocity. Calculate the velocity of sphere when pure rolling starts.

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8. A cylinder is rotating with angular velocity ω_0 and is gently put on a rough horizontal floor. Assume mass of the cylinder is m and radius R. Calculate the velocity of cylinder when it starts pure rolling on the surface.

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Ncert File Ncert Textbook Exercises

1. Given the location of the centre of mass of a (i) sphere, (ii) cylinder, (iii) ring, and (iv) cube, each of uniform mass density. Does the centre of mass of a body necessarily lie on the body ?

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2. In the HCI molecule, the separation between the nuclei of the two atoms is about $1.27\text{Å}\left(1\text{Å}=10^{-10}m\right)$. Find the approximate location of the c.m of the molecule, given that a chlorine atom is about 35.5 times as massive as a hydrogen atom and nearly all the mass of an atom is concentrated in its nucleus ?

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3. A child is standing at one end of a long trolley moving with a speed v on a smooth horizontal track. 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 :

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4. Show that the area of the triangle contained between the $\overrightarrow{a}$ and $\overrightarrow{b}$ is is one half of the magnitude of $\overrightarrow{a} \times \overrightarrow{b}$.

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5. Show that $\overrightarrow{a}.\left(\overrightarrow{b} \times \overrightarrow{c}\right)$ is equal in magnitude to the volume of the parallelpiped formed by the vectors $\overrightarrow{a}$, $\overrightarrow{b}$ and $\overrightarrow{c}$

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6. Find the components along the x, y, z axes of the angular momentum $\vec{L}$ of a particle, whose position vector is $\vec{r}$ with components x, y, z and momentum is $\vec{p}$ with components p_x, p_y and p_z. Show that if the particle moves only in the $x - y$ plane, the angular momentum has only a z-component.

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7. Two particles each of mass m and speed v, travel in opposite direction along parallel lines separated by a distance d. Show that the vector angular momentum of this system of particles is the same about any point taken as origin.

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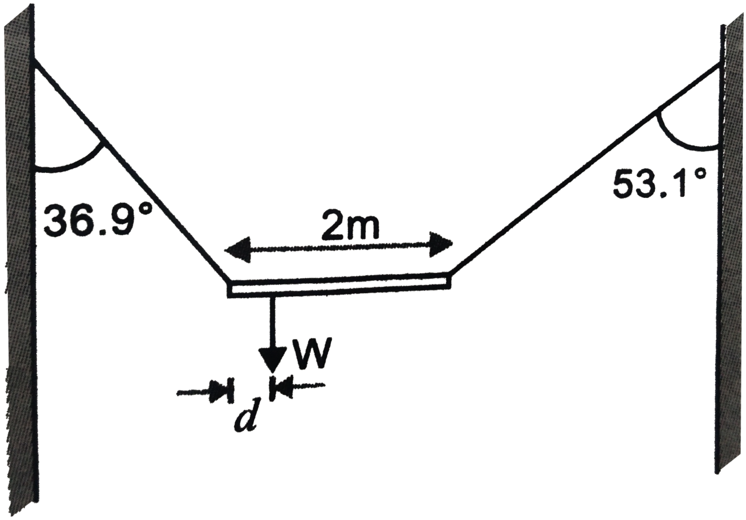
8. A non-uniform bar of weight W is suspended at rest by two strings of negligible weight as shown in Fig. The angles made by the strings with the vertical are 36.9° and 53.1° respectively. The bar is $2m$ long.

Calculate the distance d of the centre of gravity of the bar from its left end.



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9. A car weighs $1800kg$. The distance between its front and back axles is $1.8m$. Its centre of gravity is $1.05m$ behind the front axle. Determine the force exerted by the level ground on each front wheel and each back wheel.

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10. (a) Find the moment of inertia of a sphere about a tangent to the sphere, given the moment of inertia of the sphere about any of its diameters to be $2MR^2/5, whereM$ is the mass of the sphere and R is the radius of the sphere.

(b) Given the moment of inertia of a disc of mass M and radius R about any of its diameters to be $\frac{1}{4}MR^2$, find the moment of inertia about an axis normal to the disc passing through a point on its edge.

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11. Torques of equal magnitude are applied to hollow cylinder and a solid sphere, both having the same mass and same radius. The cylinder is free to rotate about its standard axis of symmetry, and the sphere is free to rotate about an axis passing through its centre. which of the two will acquire a greater angular speed after a given time ?

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12. A solid cylinder of mass $20kg$ rotates about its axis with angular speed $100s^{-1}$. The radius of the cylinder is $0.25m$. What is the kinetic energy associated with the rotation of the cylinder ? What is the magnitude of angular momentum of the cylinder about its axis ?

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13. A child stands at the centre of turntable with his two arms out stretched. The turntable is set rotating with an angular speed of 40 rpm. How much is the angular speed of the child if he folds his back and thereby reduces his moment of inertia to $\frac{2}{3}$ times the initial value ? Assume that the turntable rotates without friction

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14. A rope of negligible mass is wound round a hollow cylinder of mass 3 kg and radius 40 cm. What is the angular acceleration of the cylinder if the rope is pulled with a force of 30 N. ? What is the linear acceleration of the rope ? Assume that there is no slipping.

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15. To maintain a rotor at a uniform angular speed of 200rad s^{-1}, an engine needs to transmit a torque of 180 Nm. What is the power of the engine required ?

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16. From a uniform disc of radius R, a circular section of radius $R/2$ is cut out. The centre of the hole is at $R/2$ from the centre of the original disc. Locate the centre of mass of the resulting flat body.

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17. A metre stick is balanced on a knife edge at its centre. When two coins, each of mass 6 g put one on top of the other at the 12.0 cm mark, the stick is found to be balanced at 45.0 cm. What is the mass of the metre stick?

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

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19. A hoop of radius 2m, weight 100 kg. It rolls along horizontal floor so that its center of mass has a speed of $20c\frac{m}{s}$. How much work has to be done to stop it?

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20. The oxygen molecule has a mass of $5.30 \times 10^{-26} kg$ and a moment of inertia of $1.94 \times 10^{-46} kgm^2$ about an axis through its centre perpendicular to the line joining the two atoms. Suppose the mean speed of such a molecule in a gas is $500 m/s$ and that its kinetic energy of rotation is two thirds of its kinetic energy of translation. Find the average angular velocity of the molecule.

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21. A sphere rolls up an inclined plane whose inclination is 30°. At the bottom of the inclined plane, the center of mass of the sphere has a translational speed of $5ms^{-1}$ (a) How far does the sphere travel up the plane? (b) How long does it take to return to the bottom?

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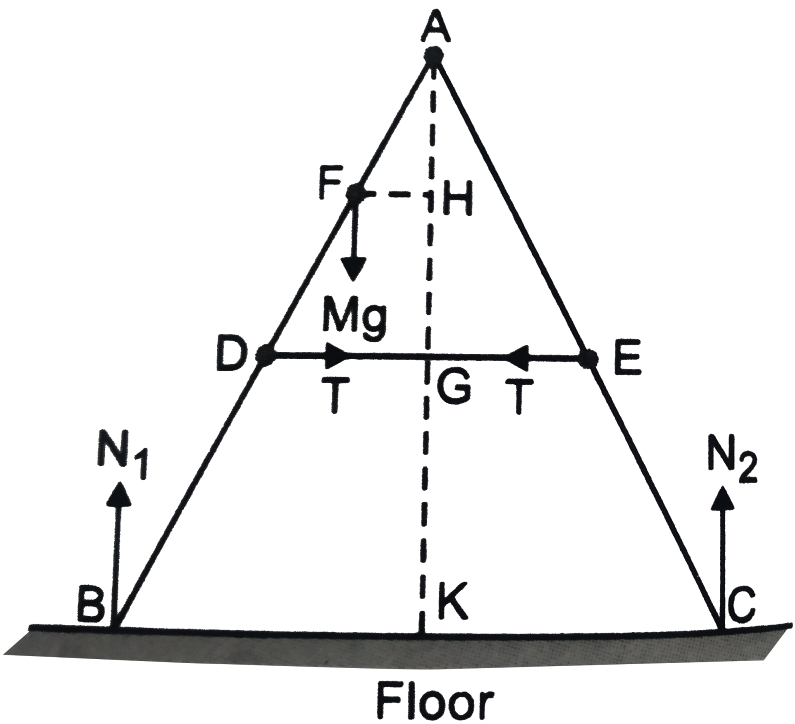
Ncert File Ncert Additional Exercises

1. As shown in Fig. the two sides of a step ladder BA and CA are $1.6m$ long and hinged at A. A rope DE, $0.5m$ is tied half way up. A weight $40kg$ is suspended from a point F, $1.2m$ from B along the ladderBA. Assuming the floor to be fricionless and neglecting the weight of the ladder, find the tension in the rope and forces exerted by the floor on the ladder. (Take $g = 9.8m/s^2$)

(Hint. Consider the eqilibrium of each side of the ladder separately.)



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2. A man stands on a rotating platform, with his arms stretched horizontal holding a $5kg$ weight in each hand. The angular speed of the platform is 30 revolutions per minute. The man then brings his arms close to his body with the distance of each weight from the axis changing from $90cm$ to $20cm$. moment of inertia of the man together with the platform may be taken to be constant and equal t $7.6kgm^2$. (a) What is the his new angular speed ? (Neglect friction.)

(b) Is kinetic energy conserved in the process ? If not, from where does the change come about ?

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3. A bullet of mass $10g$ and speed $500m/s$ is fired into a door and gets embedded exactly at the centre of the door. The door is $1.0m$ wide and weight $12kg$. It is hinged at one end and rotates about a vertical axis practically without friction. Find the angular speed of the door just after the bullet embeds into it.(Hint. The moment of inertia of the door about the vertical axis at one end is $ML^2/3$)

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4. Two discs of moments of inertia I_1 and I_2 about their respective axes (normal to the disc and passing through the centre), and rotating with angular speed ω_1 and ω_2 are brought into contact face to face with their axes of rotation coincident . What is the angular speed of the two-disc system ?

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5. (a) Prove the theorem of perpendicular axes.

(Hint : Square of the distance of a point (x, y) in the x-y plane from an axis through the origin and perpendicular to the plane is $(x^2 + y^2)$.

(b) Prove the theorem of parallel axes.

(Hint : If the centre of mass of a system of n particles is chosen to be the origin $\sum m_i r_i = 0$).

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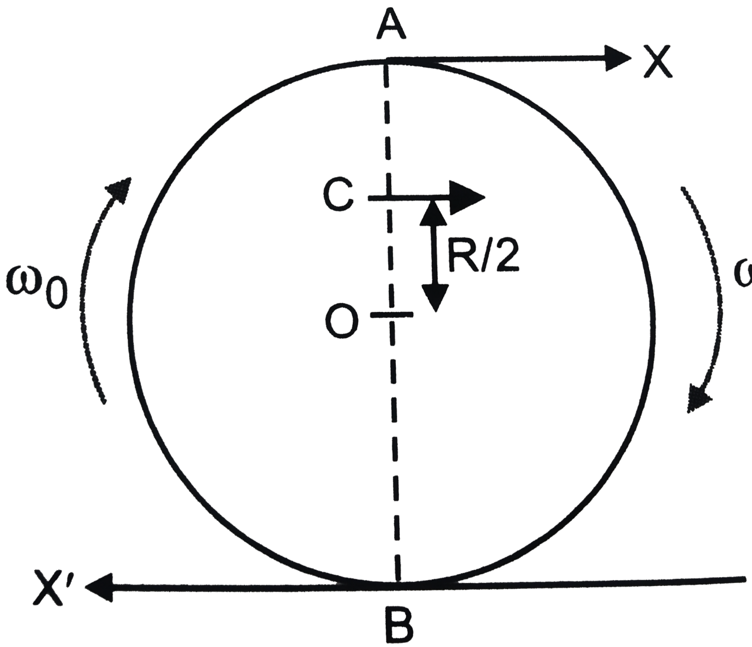
6. Prove the result that the velocity v of translation of a rolling body (like a ring, disc, cylinder or sphere) at the bottom of an inclined plane of a height h is given by $v^2 = \frac{2gh}{(1 + k^2 / R^2)}$ using dynamical consideration (i.e. by consideration of forces and torque). Note k is the radius of gyration of the body about its symmetry axis, and R is the radius of the body. The body starts from rest at the top of the plane.

Watch Video Solution

7. A disc rotating about its axis with angular speed ω_0 is placed lightly (without any translational pull) on a perfectly frictionless table. The radius of the disc is R. What are the linear velocities of the points A, B and C on the disc shown in Fig. Will the disc roll in the direction indicated ?



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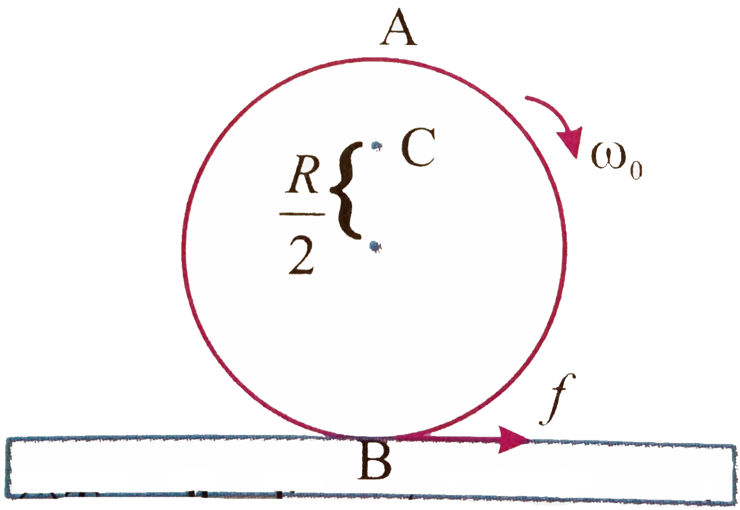
8. (i) Explain why friction is necessary to make the disc to roll in the direction indicated. (ii) Give the direction of frictional force at B, and the sense of frictional torque, before perfect rolling begins. (iii) What is the force of friction after perfect rolling begins?



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9. A solid disc and a ring, both of radius $10cm$ are placed on a horizontal table simultaneously, with initial angular speed equal to $10\pi rad/s$. Which of the two will start to roll earlier ? The coefficient of kinetic friction is $\mu_k = 0.2$.

Watch Video Solution

10. A cylinder of mass $10kg$ and radius $15cm$ is rolling perfectly on a plane of inclination 30°. The coefficient of static friction is $\mu_s = 0.25.$

(a) How much is the force of friction acting on the cylinder ?

(b) What is the work done against friction during rolling ?

(c) If the inclination θ of plane is increased, at what value of θ does the cylinder begin to skid and not roll perfectly ?

Watch Video Solution

11. Read each statement below carefully and state with reasons, if it is true ot false. (a) During rolling the force of friction acts in the same direction as the direction of motion of c.m of the body. (b) The instantaneous speed of the point of contact during rolling is zero. (c) The instantaneous acceleration of the point of contact during rolling is zero. (d) For perfect rolling motion, work done against friction is zero. (e) A wheel moving down a perfectly frictionless inclined plane will undergo slipping (not rolling motion).

Watch Video Solution

12. Separation of motion of a system of particles into motion of the centre of mass and motion about the centre of mass:

(a)n Show $\overrightarrow{p} = \overrightarrow{p}_i + m_i \overrightarrow{V}$ where $\overrightarrow{p}_i$ is the momentum of the i^{th} particle (of mass m_i) and $\overrightarrow{p}_i = m_i \overrightarrow{v}_i$, Not $\overrightarrow{v}_i$ is the velocity of the i^{th} particle relative to the centre ofmass.

Also, prove using the definition of the centre of mass $\sum \overrightarrow{p}_i = 0$

(b) Show $K = K' + {}_{1/2}MV^2$ where K is the total kinetic energy of the system of particles, K is the total kinetic energy of the system when the particle velocities are taken with respect to the centre of mass and $MV^2/2$ is the kinetic energy of the translation of the system as a whole (i.e. of the centre of mass motion of the system)

(c) Show $\overrightarrow{L} = \overrightarrow{L} + \overrightarrow{R} \times MV$

where $\overrightarrow{L}' = \sum \overrightarrow{r}_i \times \overrightarrow{p}_i$ is the angular momentum of the system about the centre of mass with velocities taken relative to the centre of mass. Remember $\overrightarrow{r}_i = \overrightarrow{r}_i - \overrightarrow{R}$, reat of the notation is the standard notation used in the chapter. Note $\overrightarrow{L}'$ and $M\overrightarrow{R} \times \overrightarrow{V}$ can be said to be angular momenta, respectively, about and of the centre of mass of the system of particles.

(d) Show $\frac{d\overrightarrow{L}}{dt} = \sum \overrightarrow{r}_i \times \frac{d\overrightarrow{p}}{dt}$, Further show that $\frac{d\overrightarrow{L}}{dt} = \overrightarrow{\tau}_{ext}$, where Text is the sum of all external torques acting on the system about the centre of mass. (Hint: Use the definition of centre of mass and Newton's Third Law. Assume the internal forces between any two particles aet along the line joining the particles.)

View Text Solution

Ncert File Ncert Exemplar Problems Objectives Questions Multiple Choice Questions Type I

1. For which of the following does the centre of mass lie outside the body ?

A. A pencil

B. A shotput

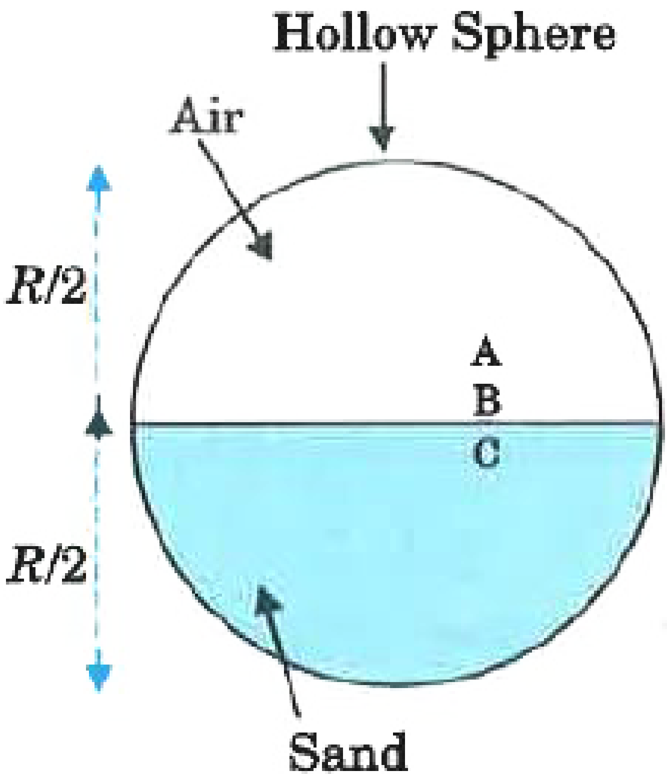
C. A dice

D. A bangle.

Answer: D

Watch Video Solution

2. Which of the following points is the likely position of the centre of mass of the system shown in figure?



A. A pencil

B. B

C. C

D. D

Answer: C

Watch Video Solution

3. A particle of mass m is moving in yz-plane with a unifrom velocity v with its trajectory running parallel to +ve y-axis and intersecting z-axis at $z = a$ Fig. The change in its angular momentum about the origin as it bounces elastically from a wall at y = constant is :

A. $mva\hat{i}$

B. $2mva\hat{i}$

C. $ymv\hat{i}$

D. $2ymv\hat{i}$

Answer: B

Watch Video Solution

4. When a disc rotates with uniform angular velocity, which of the following is not true ?

A. The sense of rotation remains same.

B. The orientation of the axis of rotation remains same.

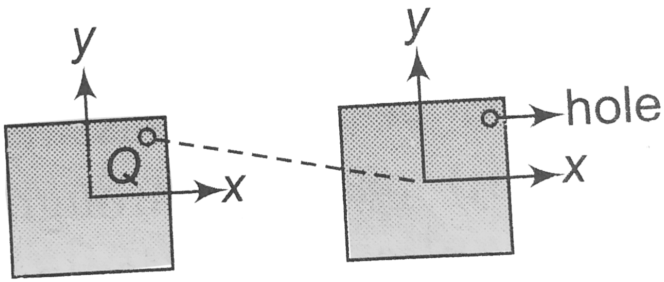
C. The speed of rotation is non-zero and remains same.

D. The angular acceleration is non-zero and remains same

Answer: D

Watch Video Solution

5. A uniform square plate has a small piece Q of an irregular shape removed and guled to the centre of the plate leaving a hole behind in figure. The moment of inertia about the z-axis is then,



A. increased

B. decreased

C. the same

D. cahnged in unpredictd manner.

Answer: B

Watch Video Solution

6. In problem 5, $theCM$ of the plate is now in the following quadrant of $x - y$ plane.

A. I

B. II

C. III

D. IV

Answer: C

Watch Video Solution

7. The density of a non-uniform rod of length $1m$ is given by $\rho(x) = a\left(1 + bx^2\right)$

where a and b are constants and $0 \leq x \leq 1$.

The centre of mass of the rod will be at

A. $\frac{3(2+b)}{4(3+b)}$

B. $\frac{4(2+b)}{3(3+b)}$

C. $\frac{3(3+b)}{4(2+b)}$

D. $\frac{4(3+b)}{3(2+b)}$

Answer: A

Watch Video Solution

8. A Merry -go-round, made of a ring-like plarfrom of radius R and $mass M$, is revolving with angular speed ω. A person of mass M is standing on it. At one instant, the person jumps off the round, radially awaay from the centre of the round (as see from the round). The speed of the round after wards is

A. 2ω

B. ω

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

D. 0

Answer: A

Watch Video Solution

9. Choose the correct alternatives:

A. For a general rotational motion, angular momentum $\overrightarrow{L}$ and angular velocity $\overrightarrow{\omega}$ need not be parallel

B. For a rotational motion about a fixed axis, angular momentum L and angular velocity are always parallel

C. For a general translational motion, momentum P and velocity v are always parallel.

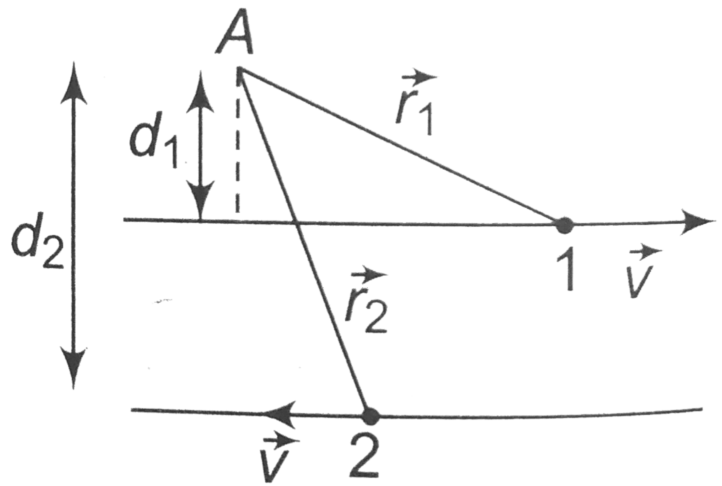
D. For a general translational motion, acceleration and velocity are always parallel.

Answer: A,C

Watch Video Solution

10. Figure shows two identical particles 1 and 2, each of mass m, moving in opposite directions with same speed $\vec{V}$ along parallel lines. At a particular instant, $\vec{r}_1$ and $\vec{r}_2$ are their respective position vectors drawn from point A which is in the plane of the parallel lines. Which of the following is the correct statement ?

,



.

A. Angular momentum l_1 of particle 1 about A is $l_1 = \mu d_1$

B. Angular momentum l_2 of particle 2 about A is $l_2 = mvr_2$

C. Total angular momentum of the system about a is $l = mv(r_1 + r_2)$

D. Total angular momentum of the system about A is

$l = mg(d_2 - d_1) \oplus$

Answer: A,D

Watch Video Solution

11. The net external torque on a system of particles about an axis is zero. Which of the following are compatible with it ?

A. The forces may be acting radially from a point on the axis.

B. The forces may be acting on the axis of rotation

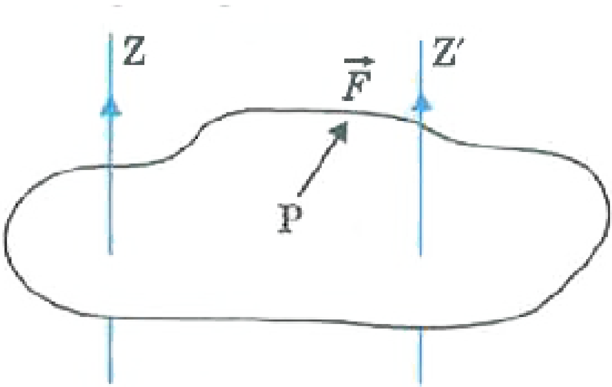
C. The forces may be acting parallel to the axis of rotation

D. The torque caused by some forces may be equal and opposite to that caused by other forces.

Answer: A,B,C,D

Watch Video Solution

12. Below given figure shows a lamina in X-Y plane. Two axes Z and Z1 pass perpendicular to its plane. A force $\vec{F}$ acts in the plane of lamina at point P as shown. Which of the following are true? (The point Pis closer to Z1-axis than the Z-axis.)



A. Torque τ caused by F about Z axis is along $-\hat{k}$

B. Torque τ caused by F about Z1 axis is along$-\hat{k}$

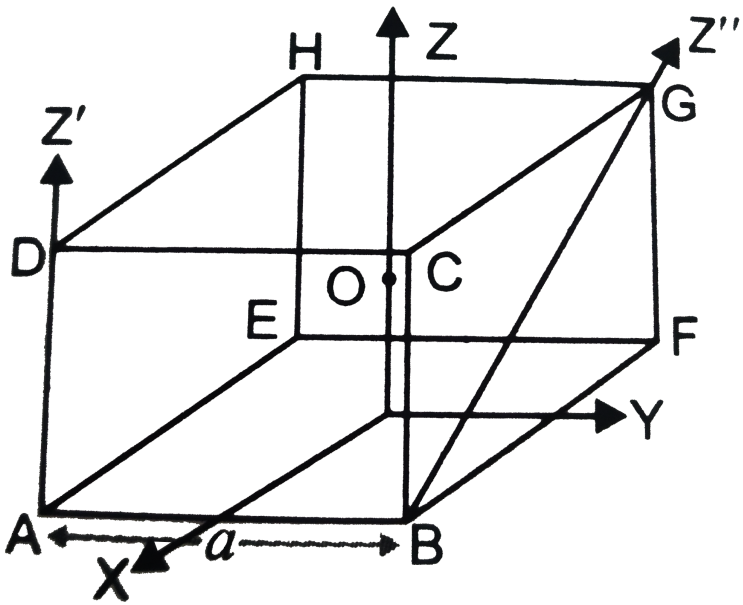
C. Torque τ caused by Fabout Z axis is greater in magnitude than that about Z axis.

D. Total torque is given $\tau = \tau + \tau$'

Answer: B,C

Watch Video Solution

13. With reference to Fig. of a cube of edge a and mass m, state whether the following are true or false. (O is the centre of the cube.)



A. The moment of inertia of cube about Z-axis is $I_z = I_x + I_Y$

B. The moment of inertia of cube about Z' is $I_s = I_x = \frac{ma^2}{2}$

C. The moment of inertia of cube about Z is $I_s'' = I_z + \frac{ma^2}{2}$

D. $I_x = I_y$

Answer: B,D

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Ncert File Ncert Exemplar Problems Subjectives Questions Very Short Answer Type Questions

1. the centre of gravity of a body on the earth coincides with its centre of mass for a small object whereas for an extended object it may not ,what is the qualitaitve meaning of small and extended in this regard ?

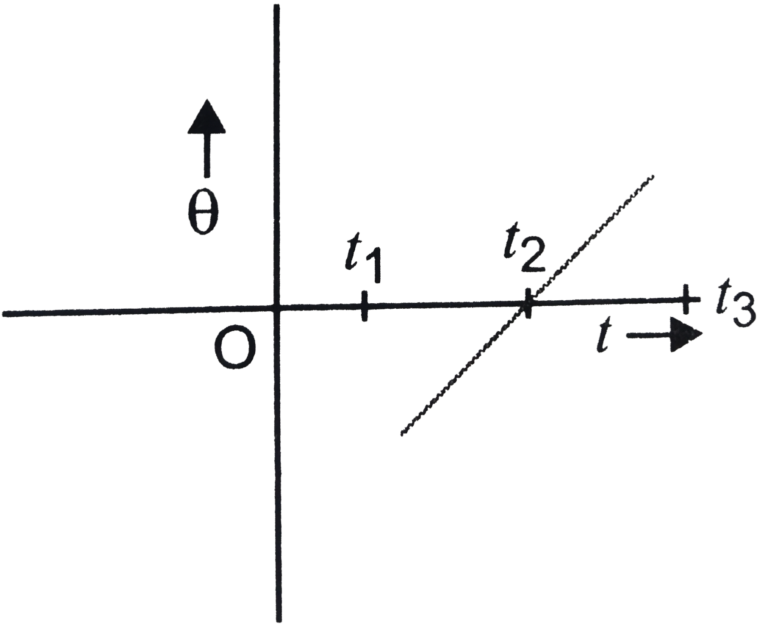
for which of the following two coincides ? A building , a pond , a lake ,a mountain ?

Watch Video Solution

2. Why does a solid sphere have smaller moment of inertia than a hollow cylinder of same mass and radius, about an axis passing through their axes of symmentry ?

Watch Video Solution

3. The variation of angular position θ, of a point on a rotating rigid body, with time t is shown in Fig. Is the body rotating clock wise or anti-clockwise ?



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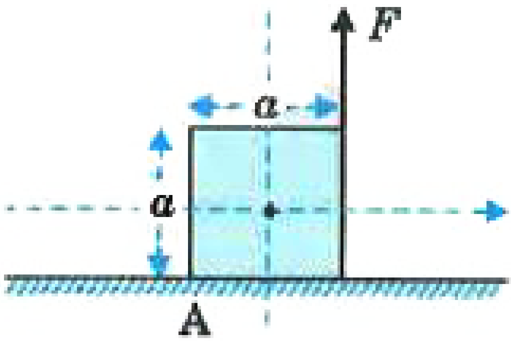
4. A uniform cube of mass m and side a is placed on a frictionless horizontal surface. A vertical force Fis applied to the edge as shown in figure. Match the following (most appropriate choice).

(a) $mg/4 < F < mg/2$	(i) Cube will move up.
(b) $F > mg/2$	(ii) Cube will not exhibit motion.
(c) $F > mg$	(iii) Cube will begin to rotate and slip at A.
(d) $F = mg/4$	(iv) Normal reaction effectively at 3 from A, no motion.



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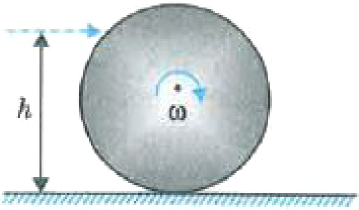
5. A uniform sphere of mass m and radius R is placed on a rough horizontal surface. The sphere is struck horizontally at a heighth from the floor. Match the following:



(a) $h = R/2$	(i) Sphere rolls without slipping with a constant velocity and no loss of energy.
(b) $h = R$	(ii) Sphere spins clockwise, loses energy by friction.
(c) $h = 3R/2$	(iii) Sphere spins anticlockwise, loses energy by friction.
(d) $h = 7R/5$	(iv) Sphere has only a translational motion, looses energy by friction.

View Text Solution

6. The vector sum of a system of non-collinear forces acting on a rigid body is given to be non-zero. If the vector sum of all torques due to the system of forces about a certain point is found to be zero, does this mean that it is necessarily zero about any arbitrary point ?

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7. A wheel in uniform motion about an axis passing through its centre and perpendicular plus is considered to be in mechanical (translational plus rotational) equilibrium because no net external force or torqure is reqired to sustain its motion However , the particles than constitute the wheel do experience a centripeteal the acceleration wheel being in equilibrium ?

how would you set a half wheel into unifrom motion about an axis passing throgh the centre of mass of the wheel and perpendicular to its plane ? will ypu require external forces to sustain the motion ?

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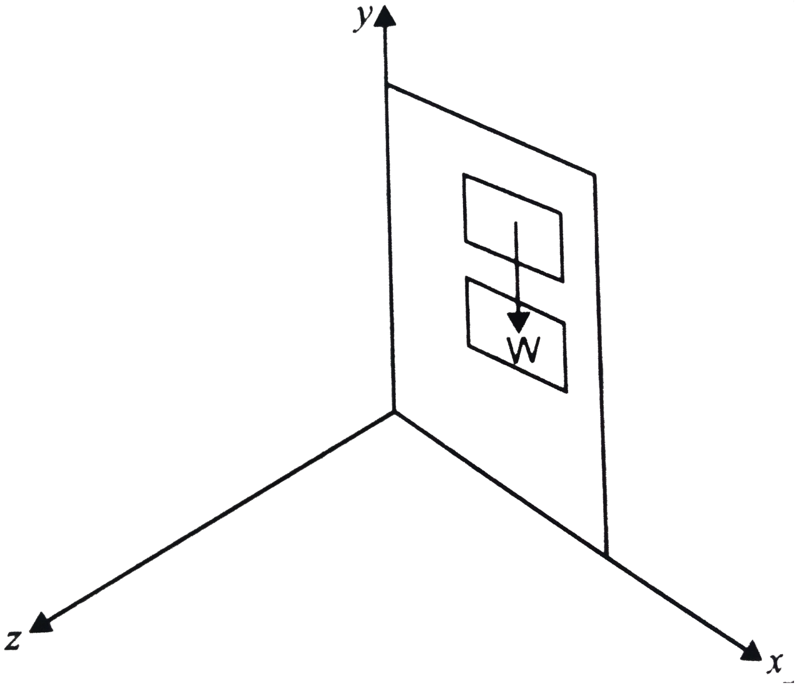
8. A door is hinged at one and is free to rotate about a vertical axis [Fig.] Does its weight cause any torque the axis ? Given reason for you answer.



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9. $(n-1)$ equal point masses each of mass m are placed at the vertices of a angular n-polygon. The vacant vertex has a position vector a with respect to the centre of the polygon. Find the position vector of centre of mass.

Watch Video Solution

1. Two charged particles of masses m and 2m are placed distane d apart on a smooth horizontal table. Because of their mutual attraction, they move towards each other and collide. Where will the collision occure with respect to the initial positions?

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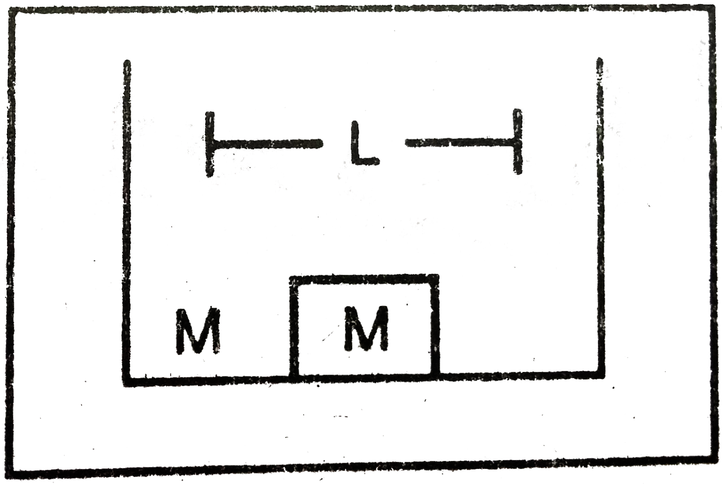
2. Consider a gravity free hall in which a tray of mas M, carrying a cubical block of icce of mas m and edge L, is at rest in the middle.. If the ice melts, by what distnce does the centre of mass of the tray plus the ice system descend?



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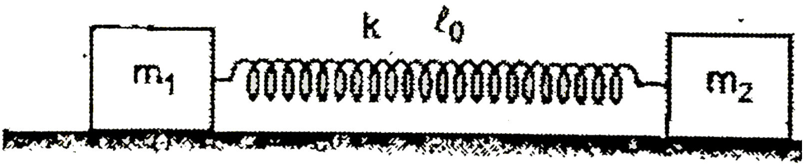
3. Two blocks m_1 and m_2 are connected by a spring of force constant K and are placed on a frictionless horizontal surface. Initially the spring is given extension x_0 when the sysetem is released from rest, find the distance moved by two blocks before they again comes to rest.



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4. The system described in previous question is kept on a frictionless horizontal floor with spring at its natural length. Now a sharp impulse is applied on the block m2 to impart it a speed of v. Calculate velocity acquired by the centre of mass just after the impulse is applied on the block m2. Also calculate maximum possible elongation suffered by the spring.

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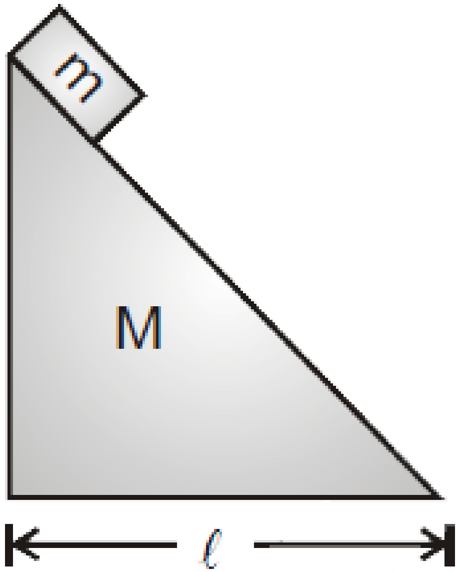
5. A particle of mass m is placed at rest on the top of a smooth wedge of mass M, which in turn is placed at rest on a smooth horizontal surface as shown in figure. Then the distance moved by the wedge as the particle reaches the foot of the wedge is :



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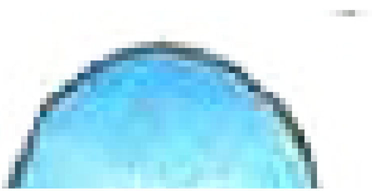
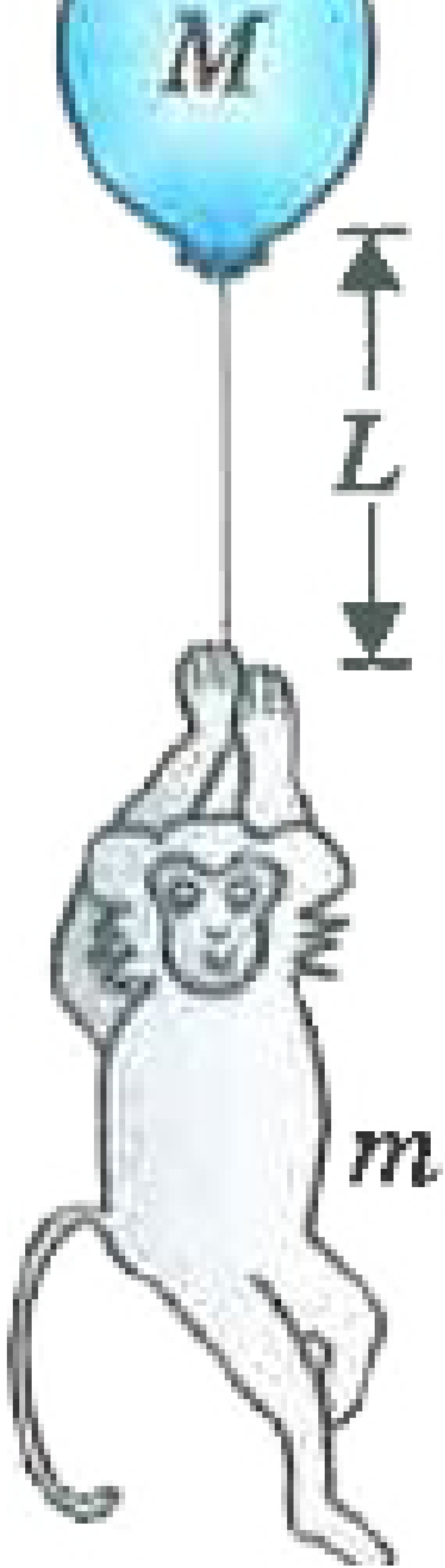
6. Monkey of mass m is holding the end of string connected to a balloon of mans M. Length of the string is L and the complete system remains at rest in mid air as shown in figure. Monkey starts to climb to catch the balloon. Calculate distance travelled by balloon by the time monkey reaches the balloon.




M
L
m

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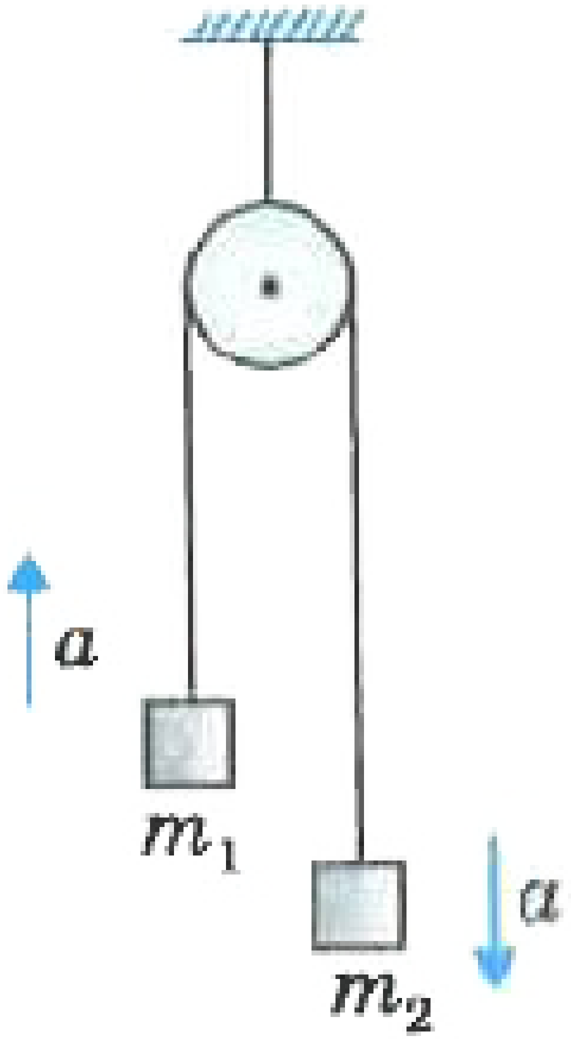
7. String going over a pulley connects two blocks of masses m, and my. String and pulley are light. Calculate acceleration of centre of mass of blocks system.



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8. A disc of radis R is cut out from a larger disc of radius 2R in such a way that the edge of the hole touches the edge of the disc. Locate the centre of mass of the residual disc.

Watch Video Solution

9. Two blocks of masses m, and m, are connected to the ends of a spring of spring constant k. System is kept at rest on a frictionless horizontal floor with spring in its natural length. Both the blocks are pulled along opposite directions with forces of same magnitude F. Calculate maximum elongation of spring and distances travelled by the blocks during this motion.

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10. A ladder of mass 20 kg is resting against a vertical smooth wall. Ladder makes an angle 37° with the wall. Other end of the ladder is resting on a rough horizontal floor. Find normal force and force of friction applied on the ladder by horizontal surface.

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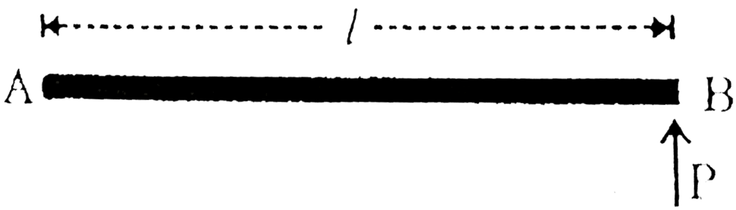
11. A uniform rod of mass m and length l is at rest on smooth horizontal surface. An impulse P is applied to end B as shown.



Distance travelled by the centre of the rod, while rod rotates by 90°

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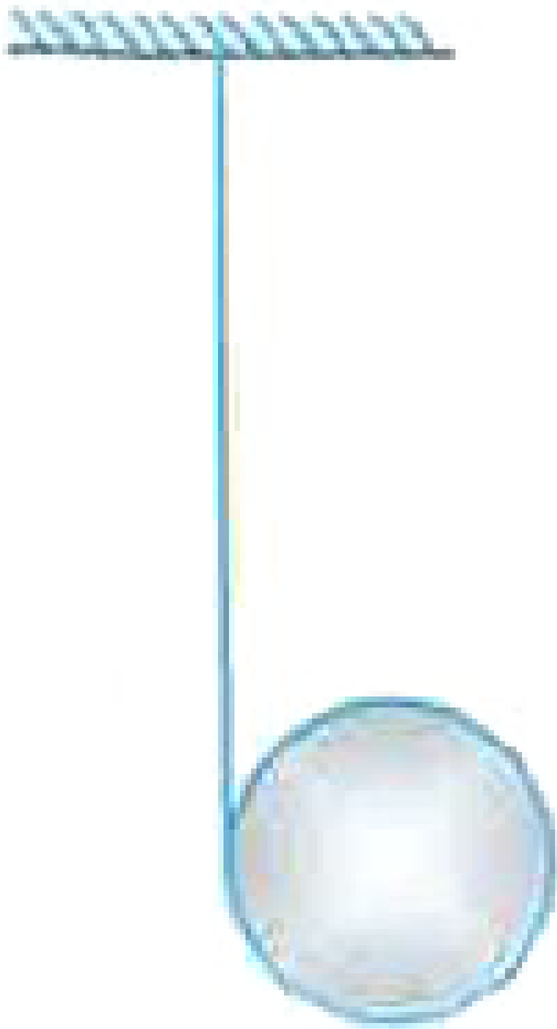
12. A sphere of mass m and radius R is kept on a rough horizontal floor. Constant force Facts at the top point of sphere along tangent. If there is sufficient friction on the floor to support pure rolling then calculate acceleration of sphere.

Watch Video Solution

13. String is wrapped over a pulley and free end is fixed to the ceiling as shown in figure. Mass of the pulley is m and its radius is R. Assume that pulley is identical to dise. Calculate acceleration of pulley as it is allowed to fall by unwinding the string. Assume that string does not slip over the pulley.



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Revision Exercises Very Short Answer Questions Carrying 1 Mark

1. Is centre of mass of reality ?

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2. The centre of mass of two particles system lies

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3. Can centre of mass of a body lie where there is absolutely no mass ?

Watch Video Solution

4. If one of the particles is heavier than mass other, to which side will their centre of mass shift?

Watch Video Solution

5. Which physical quantity corresponds to the moment of the force?

Watch Video Solution

6. What is an isolated system ?

Watch Video Solution

7. Which component of linear momentum does not contribute to angular momentum ?

Watch Video Solution

8. The moment of linear momentum is called

Watch Video Solution

9. Can the couple acting on a rigid body produce translatory motion ?

Watch Video Solution

10. What is the position of the centre of mass of a cubical or rectangular block?

Watch Video Solution

11. Can a body moving in a circular path be at equilibrium?

Watch Video Solution

12. Why the bottom of a ship is made heavy?

Watch Video Solution

13. Find the centre of mass of a uniform triangula lamina.

Watch Video Solution

14. What can we conclude for the potential energy of a system in stable equilibrium?

Watch Video Solution

15. What is the physical significance of moment of inertia?

Watch Video Solution

16. Does the moment of inertia of a body change with the speed of rotation ?

Watch Video Solution

17. Does the moment of inertia of a rigid body change with the axis of rotation?

Watch Video Solution

18. Does the radius of gyration depend on the speed of the rigid body?

Watch Video Solution

19. About which axis would the moment of inertia of a body be minimum ?

Watch Video Solution

20. What are the units and dimensions of moment of inertia ? Is it a vector ?

Watch Video Solution

21. Two lenses one convex and one concave are of same mass and same radius. Which will have greater moment of inertia about its pole?

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22. A disc is recast into a hollow sphere of having half radius? How moment of inertia will be affected by the change of shape?

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23. The angular momentum of a system of particles is conserved

Watch Video Solution

24. Is radius of gyration of a body constant quantity ?

Watch Video Solution

25. Why there two propellers in a helicopter ?

Watch Video Solution

26. What is moment of inertia of a solid sphere about its diameter ?

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27. There are two spheres of same mass and same radius, one is solid and other is hollow. Which of them has a larger moment of inertia about its diameter ?

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28. About what axis would a uniform cube have its minimum moment of inertia?

Watch Video Solution

29. What do you mean by angular impulse?

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Revision Exercises Additional Questions Carrying 1 Mark

1. Torque is

A. the rate of change of linear momentum.

B. the rate of change of angular momentum

C. angular impulse x time

D. angular impulse x distance

Answer: B

Watch Video Solution

2. The centre of gravity

A. is the point where gravitational torque is zero

B. is the point where weight of a body acts.

C. coincides with centre of mass for same acceleration due to gravity for all particles.

D. all of above are correct

Answer: D

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3. The dimensional formula for angular momentum is

A. ML^2T^{-2}

B. M^2T^{-1}

C. ML^{-2}

D. $ML^{-2}T^{-2}$

Answer: B

Watch Video Solution

4. The centre of mass

A. coincides always with the geometrical centre of the body.

B. always lies on a given body.

C. of two-particle system always lies on the line joining two particles.

D. is the average of the position vectors of all the

Answer: C

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Revision Exercises Fill In The Blanks Carrying 1 Mark

1. The ......component of force does not contribute to its torque.

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2. A ballet-dancer stretches her hands out for slowing down. This is based on principle of conservation of ... .

Watch Video Solution

3. _____________ is a pair of equal and parallel forces acting in opposite directions at two different points of a given body

Watch Video Solution

4. Statement-1 : Radius of gyration of a body is a constant quantity.

Statement-2 : The radius of gyration of a body about an axis of rotation may be defined as the root mean square distance of the particles of the body from the axis of rotation.

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5. .... in linear motion is analogous to moment of inertia in rotational motion.

Watch Video Solution

6. The product of moment of inertia (I) and angular acceleration (α) is called

Watch Video Solution

7. The dimensions of power divided by torque is equal to the dimensions of angular ....

Watch Video Solution

8. The moment of inertia of a circular dise about a tangent in its plane is ....times its moment of inertia about any diameter.

Watch Video Solution

9. Find the centre of mass of a uniform triangula lamina.

Watch Video Solution

Revision Exercises Short Answer Questions Carrying 2 Or 3 Marks

1. What do you mean by centre of mass of a system? How it differs from the centre of gravity?

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2. Show that centre of mass of an isolated system moves with a uniform velocity along a straight line path.

Watch Video Solution

3. What are binary stars? Describe their motion in terms of centre of mass.

Watch Video Solution

4. A fire cracker following a parabolic path explodes in mid air. The centre of mass of all the fragments will follow a path

Watch Video Solution

5. What are the factors on which centre of mass of a system depends?

Watch Video Solution

6. Show that the angular momentum of a particle is equal to twice the product of mass and areal velocity.

Watch Video Solution

7. Prove that the rate of change of angular momentum is equal to torque acting on the particle

Watch Video Solution

8. Why are doors provided with handles near the outer edges, far away from the hinges ?

Watch Video Solution

9. We cannot open or close the door by applying force at the hinges. Why?

Watch Video Solution

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

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11. Distinguish between stable, unstable and neutral equilibrium of a body

Watch Video Solution

12. What are the factors on which moment of inertia of a body depend ?

Watch Video Solution

13. What is radius of gyration? Derive an expression for the radius of gyration of n particle system.

Watch Video Solution

14. Establish a relation between angular momentum and moment of inertia of a rigid body.

Watch Video Solution

15. Establish a relation between angular momentum and moment of inertia of a rigid body.

Watch Video Solution

16. State and explain parallel axis theorem and perpendicular axis theorem.

Watch Video Solution

17. Derive the relation between kinetic energy and moment of inertia of a body in rotation motion.

Watch Video Solution

18. What will happen to the duration of the day if the ice on polar caps of earth melts?

Watch Video Solution

19. How will you distinguish between a hard boiled egg and a raw egg by spinning each on a table top ?

Watch Video Solution

20. If earth were to shrink suddenly, what would happen to the length of the day ?

Watch Video Solution

21. How does an ice-skater, a ballet dancer or an acrobat take advantage of the principle of conservation of angular momentum ?

Watch Video Solution

22. Two rotating bodies have same angular momentum but their moments of inertia are I1 and I2 respectively $(I_1 > I_2)$. Which body will have higher kinetic energy of rotation :-

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Revision Exercises Long Answer Questions Carrying 5 Marks

1. Obtain an expression for the position vector of centre of mass of a two particle system.

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2. State and Prove the law of conservation of angular momentum. Also discuss, at least two applications.

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3. MOTION WITH CONSTANT ANGULAR ACCELERATION

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4. What is the moment of inertia of a ring about a tangent to the circle of the ring ?

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5. What is moment of inertia of a solid sphere about its diameter ?

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6. Derive an expression for the moment of inertia of a (i) hollow cylinder (ii) solid cylinder about its own axis.

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7. Derive an expression for the moment of inertia of thin uniform rod about an axis passing through its one end. Also find the radius of gyration.

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8. Derive an expression for the acceleration of a solid cylinder rolling without slipping down an inclined plane. Also find the minimum coefficient of friction required for pure rolling

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Revision Exercises Numerical Problems

1. Two particles having masses of 2 kg and 3 kg are moving along the same straight line with velocities of $3ms^{-1}$ and $6ms^{-1}$ respectively. Calculate the speed of centre of mass of system if particles are moving in (a) same direction. (b) in opposite direction.

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2. Three point masses m1, m2, m3 are placed at the corners of an equilateral triangle of side 2 m. Locate the centre of mass of the system.

$m_1 = 2kg, m_2 = 3kg, m_3 = 4kg$

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3. Two bodies of masses 3 kg and 4 kg are moving along X axis. At a time t, the bodics are at a distance of 2 m and 3 m from the origin and has velocities of $2ms^{-1}$ and $-3ms^{-1}$. Calculate the position and velocity of centre of mass. What will be the total momentum of the system?

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4. Four particles of masses 1 kg, 2 kg, 3 kg, 4 kg are placed at the corners of a square of side 2 m. Find the coordinates of centre of mass.

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5. A torque τ applied to a dise of mass 2 kg and radius of gyration 15 cm produces an angular acceleration of $5\text{rad}/\text{sec}^2$. Find the value of τ.

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6. The speed of the motor of an engine is 300 rpm. In 2 s, the speed increases to 420 rpm. Calculate the number of revolutions made by the motor.

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7. Calculate the angular momentum of a truck of mass 2000 kg moving in a circular track of radius 2000 cm with a speed of $50ms^{-1}$.

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8. Calculate the angular momentum if $\overrightarrow{r} = 2\hat{i} - 3\hat{j} - 4\hat{k}$ and $\overrightarrow{P} = \hat{i} + \hat{j} - 5\hat{k}$.

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9. Calculate the moment of inertia of a ring of mass 0.5 kg and radius 0.1 m rotating about a tangent (a) in its plane (b) perpendicular to its plane.

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10. Calculate the moment of inertia of a rectangular bar about an axis passing through the centre and perpendicular to its length. Mass of bar is 0.2 kg and length is 10 cm

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11. Find the ratio of radii of gyration of a hollow cylinder and a solid cylinder about an axis passing through their centres and parallel to length.

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12. A circular ring rotating about an axis passing through its centre and perpendicular to its plane is making 300 revolutions/min. What will be the kinetic energy of rotation of the ring if mass of ring is 0.3 kg and radius 0.4 m.

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13. How much tangential force is required to stop a cylinder in 5 & which is rotating about its central axis with a speed of 50 rad/s. The length, radius and moment of inertia of cylinder are 10 cm, 5 cm and $0.6kgm^2$ respectively.

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14. If earth suddenly shrinks to $(1/27)^{th}$ of its original volume, mass remaining unchanged then what will be the duration of the day.

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15. The mass of earth is $6 \times 10^{24} kg$ and radius is 6400 km. How much amount of work will be done to make the duration of day its 20 hours rather than 24 hours.

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16. The wheel of a car, accelerated uniformly from rest, rotates through 1.5 rad during the first second. Find the angle rotated during the next second.

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17. How much decrease will occur in duration of day if earth contracts to one third of its present radius?

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18. A 90 kg man is standing in contact with the wall of a cylindrical drum of radius 2 m. The drum is rotating about its vertical axis with an angular speed of 100 rpm. Calculate the minimum rotational speed of the cylinder to enable the man to remain stuck to the wall when the floor is suddenly removed. The coefficient of friction between wall and clothing is 0.1.

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19. Calculate the acceleration of a solid cylinder of radius 2 cm and mass 150 g which is rolling down an incline plane of 1 in 20 Also find the total energy of cylinder after 10 s.

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20. Three bodies a disc, a ring, a solid sphere of same radius, same mass are rolling down the same inclined plane without slipping. Which of three will reach the ground with minimum velocity ?

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Competition File Objective Type Questions Multiple Choice Questions Multiple Choice Questions With Only One Correct Answer

1. A large number of particles are placed around the origin, each at a distance R from the origin. The distance of the center of mass of the system from the origin is

A. $r = d$

B. $r \leq d$

C. $r \geq d$

D. $r = 0$

Answer: B

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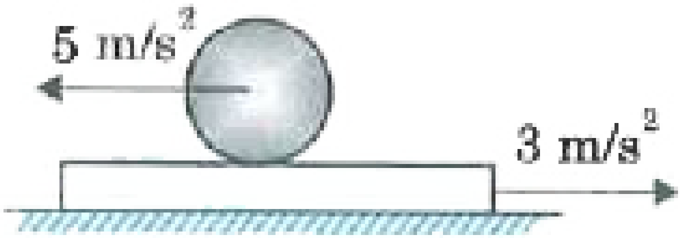
2. A sphere of radius 1 m is kept on a plank kept on horizontal surface. Accelerations of plank and centre of sphere are indicated in the figure.



If sphere is not slipping on the plank then its angular acceleration is

A. $8\text{rad}/s^2$

B. $6\text{rad}/s^2$

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

D. $2\text{rad}/s^2$

Answer: A

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3. Consider the following two statements:

A. Linear momentum of a system of partcles is zero.

B. Kinetic energ of a system of particles is zero.

A. A does not imply B and B does not imply A

B. A implies B and B implies A

C. A implies B but B does not imply A

D. A does not imply B but B implies A

Answer: D

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4. The radius of gyration of an uniform rod of length L about an axis passing through its centre of mass and perpendicular to its length is.

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

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

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

D. l

Answer: A

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5. A particle of mass m is moving on the XY-plane along a straight line y = d, with constant velocity v. Its angular momentum about the origin

A. is zero

B. remains constan

C. increases with time

D. may increase or decrease depending on direction of motion of particle.

Answer: B

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6. A person is sitting on a rotating chair which is rotating with some angular velocity. Person is sitting on the chair with his arms folded. Now he slowly stretches his arm then

A. Angular momentum of the system decreases (

B. Angular momentum of the system increases

C. Angular momentum remains constant

D. Angular speed of the system increases

Answer: C

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

A. at a distance less than 1/2 from

B. at a distance greater than 1/2 from P

C. at P

D. at a distance 1/2 from P AS.

Answer: D

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8. A ring performs pure rolling on a horizontal fixed surface with its centre moving with speed v.

A. Maximum possible speed that any particle of ring may have is $v/\sqrt{2}$

B. Minimum possible speed that any particle of ring may have is $v/\sqrt{2}$

C. particles on the ring may have speed anywhere between 0 and 2u.

D. None of these

Answer: C

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9. In above question, what will be the speed of the particle on the ring which is at the same height as that of the centre?

A. v

B. 2v

C. $v\sqrt{2}$

D. zero

Answer: C

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10. Four identical rods each of mass m and length l are joined to form a rigid square frame. The frame lies in the xy plane, with its centre at the origin and the sides parallel to the x and y axes. Its moment of inertial about

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

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

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

D. $\frac{3}{7}ml^2$

Answer: A

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11. A block of mass m is sliding down an inclined plane with uniform velocity v. Angle that the plane makes with the horizontal is θ. Assume edge of the cube to be a, calculate torque of the normal reaction about the centre of the block.

A. $\frac{1}{2}mga\cos\theta$

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

C. mga

D. zero

Answer: B

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12. Two particles of masses m_1 and m_2 are joined y a light rigid rod of length r. The system rotates at an angular speed ω about an axis through the centre of mass of the systemand perpendicular to the rod. Shwo thast the angular momentum of the system $isL = \mu r^2 \omega where \mu$ is the reduced mass of the system defined as $\mu = \frac{m_1 m_2}{m_1 + m_2}$

A. $\mu = m_1 + m_2$

B. $\mu = \frac{m_1 m_2}{m_1 + m_2}$

C. $\mu = \sqrt{m_1 m_2}$

D. $\mu = \frac{m_1 + m_2}{m_1 m_2}$

Answer:

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13. A solid sphere, disc and hollow sphere are placed at the top of an inclined plane. Surface is sufficiently rough to provide pure rolling. All the objects are released from a state of rest

A. Solid sphere reaches the bottom first

B. Disc reaches the bottom first

C. Hollow sphere reaches the bottom first

D. All three objects reach the bottom simultaneously.

Answer:

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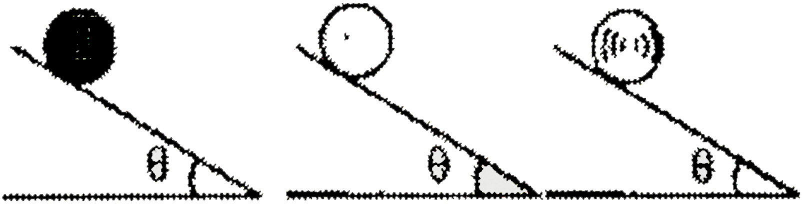
14. A sphere a ring and a disc of same mass and radius are allowed to roll down three similar sufficiently rough inclined planes as shown in the figure from same height.



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

A. Solid sphere reaches the bottom with minimum K.E.

B. Disc reaches the bottom with minimum K.E.

C. Hollow sphere reaches the bottom with minimum K.E.

D. All three objects reach the bottom with same K.E.

Answer:

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15. A solid sphere, disc and hollow sphere of same masa and radius are placed at the top of an inclined plane. Surface is sufficiently rough to provide pure rolling. All the objects are released from a state of rest.

A. Solid sphere reaches the bottom first

B. Disc reaches the bottom first

C. Hollow sphere reaches the bottom first

D. All three objects reach the bottom simultaneously.

Answer:

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16. A large trolley is kept at rest on a frictionless horizontal surface. There are same peple standing on the trolley. Initially no one is moving.C_1 is centre of mass of trolley and C_2 is centre of mass of trolley plus people. Now people start moving on the trolley.

A. Both $C_1 \text{ and } C_2$ will be displaced with respect to ground.

B. Both $C_1, \text{ and } C_2$ will remain at rest with respect to ground.

C. C_1 will move but C_2 will remain at rest with respect to ground

D. C_1 will move but C_2 will remain at rest with respect to ground

Answer:

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17. Let I_A and I_B be moments of inertia of a body about two axes A and B respectively. The axis A passes through the centre of mass of the body but B does not. Then

A. $I_A n > I_B$

B. $I_A < I_B$

C. $I_A = I_B$

D. $I_A = I_B$ only if both the axes A and B are parallel to each other

Answer:

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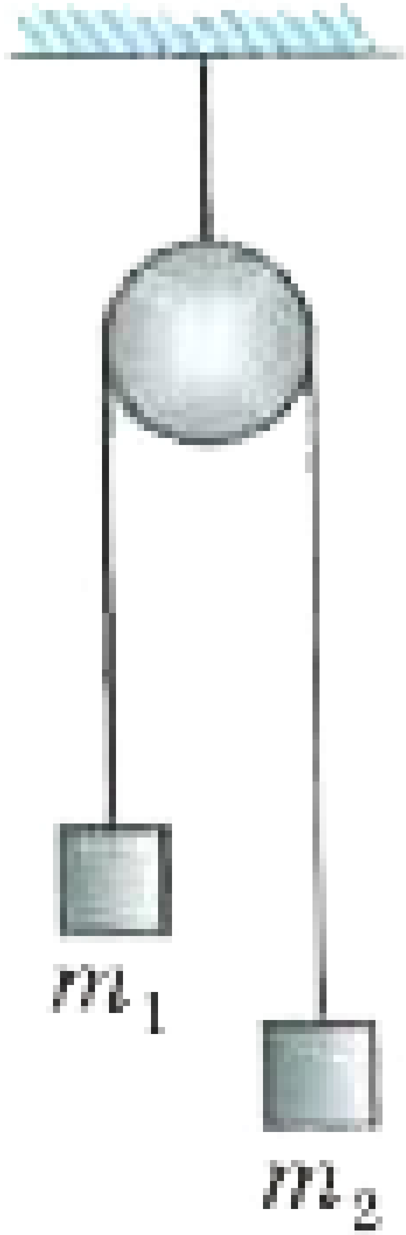
18. Two' blocks of masses m, and m, are connected to the two ends of a string passing over a pulley as shown in figure. System hans vertically and blocks are held at rest. Assume that $m_1 > m_2$. Find the speed attained by the blocks when m, descends through a height h. Moment of inertia of the pulley is I and its radius is r. There is enough friction between string and pulley so that there is no slipping between them.



A. $\sqrt{\dfrac{2(m_1 - m_2)gh}{m_1 m_2 + \frac{I}{r^2}}}$

B. $\sqrt{\dfrac{2(m_1 + m_2)gh}{m_1 m_2 + \frac{I}{r^2}}}$

C. $\sqrt{\dfrac{2m_1 m_2 mgh}{m_1 + m_2 + \frac{I}{r^2}}}$

D. $\sqrt{\dfrac{(2m_1 - m_2)mgh}{m_1 + m_2 + \frac{I}{r^2}}}$

Answer:

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19. In which of the following cases it is certainly not possible for the diac to perform pure rolling.

A. A rough inclined plane

B. A smooth inclined plane

C. A smooth horizontal surface

D. A rough horizontal surface

Answer:

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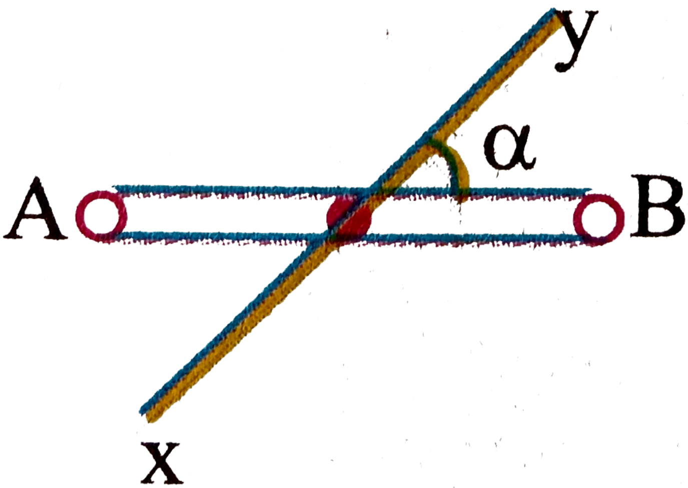
20. The moment of inertia of a uniform rod of length $2l$ and mass m about an axis xy passing through its centre and inclined at an enable α is



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

B. $\frac{ml^2}{12}\cos^2\theta$

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

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

Answer:

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21. Motion of the rigid body is observed from an inertial frame of reference. Rigid body is rotating with constant angular speed about a fixed vertical axis. If we consider a particle of the rigid body not lying on its axis of rotation then net force acting on this particle is.

A. parallel to axis of rotation

B. perpendicular to the axis of rotation and intersecting with it

C. perpendicular to the axis of rotation and not intersecting with it

D. none of these

Answer:

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22. Motion of the rigid body is observed from an inertial frame of reference. Rigid body is rotating with nonuniform angular speed about a fixed vertical axis. If we consider a particle of the rigid body not lying on its axis of rotation then net force acting on this particle is

A. parallel to axis of rotation

B. perpendicular to the axis of rotation and intersecting with it

C. perpendicular to the axis of rotation and not intersecting with it

D. none of these

Answer:

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23. If the 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. 6h

B. 12 h

C. 36 h

D. 144 h

Answer:

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24. A particle is going around in a circular path with constant speed. Angular momentum of particle is conserved about

A. a point on the circumference of the circle

B. any point inside the circle on the plane of the circle.

C. about any point outside the circle on the plane of the circle

D. about centre of the circle

Answer:

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25. The direction of the angular velocity vector is along

A. Along the tangent to the circular path

B. Radially outward

C. Radially inward

D. Along the axis of rotation

Answer:

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26. The moments of inertia of two rotating bodies A and B are I_A and I_B. $(I_A > I_B)$ and their angular momenta are equal. Which one has greater $K.E.$?

A. K.E. of A=K.E. of B

B. K.E. of A gt K.E. of B

C. K.E. of A $>$ K.E. of B

D. None of these

Answer:

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27. A solid sphere rolls on a table without any slipping. What is the fraction of total K.E. associated with rotational K.E.?

A. $2/7$

B. $2/5$

C. $3/5$

D. $5/7$

Answer:

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28. There is a solid sphere of mass m. Moment of inertia about the axis passing through the centre of sphere is I. If the material of the sphere is recast to a disc of same radius then what would be its moment of inertia?

A. $2I/5$

B. $4I/5$

C. $3I/4$

D. $5I/4$

Answer:

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29. Calculate the moment of Inertia of a semicircular disc of mass M and radius R about an axis passing through its centre and perpendicular to its plane.

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

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

C. $\frac{1}{8}mr^2$

D. mr^2

Answer:

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30. There is a square planar object. Moment of inertia of this object about an axis passing through its centre and parallel to its edge is I. What will be moment of inertia about one of its diagonals?

A. I

B. $I/2$

C. $2I$

D. $I/4$

Answer: A

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31. A solid sphere is rotating freely about its symmetry axis in free space. The radius of the sphere is increased keeping its mass same. Which of the following physical quantities would remain constant for the sphere?

A. Rotational kinetic energy

B. Moment of inertia

C. Angular velocity

D. Angular momentum

Answer: D

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32. 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. No relation between h and R

Answer: D

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33. A circular disc is to be made by using iron and aluminium, so that it acquires maximum moment of inertia about its geometrical axis. It is possible with

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 internal layers.

Answer: A

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34. Three objects, A (a solid sphere), B (a thin circular disc) and C (a circular ring), each have the same mass M and radius R. They all spin with the same angular speed ω about their own symmetry axes. The amounts of work (W) required to bring them to rest, would satisfy the relation

A. $W_B > W_A > W_C$

B. $W_A > W_B > W_C$

C. $W_C > W_B > W_A$

D. $W_A > W_C > W_B$

Answer: C

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35. A solid sphere (mass 2M) and a thin spherical shell (mass M) both of the same size roll down an inclined plane, then:

A. Solid sphere will reach the bottom first

B. Hollow spherical shell will reach the bottom first

C. Both will reach at the same time

D. Cannot he predicted as the data is insufficient

Answer: A

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36. If the earth were to suddenly contract to half of its present radius (without any external torque on it), by what duration would the day be decreased ? Assume earth to be perfect solid sphere of radius $\frac{2}{5}MR^2$.

A. 8 hours

B. 6 hours

C. 4 hours

D. 2 hours

Answer: B

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37. A solid sphere is in rolling motion. In rolling motion a body prosseses translational kinetic energy (K_t) as well as rotational kinetic energy (K_r) simutaneously. The ratio

$K_t : (K_t + K_r)$ for the sphere is

A. $10 : 7$

B. $5 : 7$

C. $7 : 10$

D. $2 : 5$

Answer: B

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38. A solid cylinder of mass 2 kg and radius 50 cm rolls up an inclined plane of angle of inclination 30°. The centre of mass of the cylinder has speed of 4 m/s. The distance travelled by the cylinder on the inclined surface will be, [take $g = 10m/s^2$]

A. $2.4m$

B. $2.2m$

C. $1.6m$

D. $1.2m$

Answer: A

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39. A thin rod of length L and mass M is bent at its midpoint 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. $\frac{ML^2}{12}$

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

C. $\frac{\sqrt{2}ML^2}{24}$

D.

Answer: A

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40. cricket bat is cut at the location of its centre of mass as shown in the fig. Then

A. the two pieces will have the same mass

B. the bottom piece will have larger mass

C. the handle piece will have larger mass

D. cannot say.

Answer: B

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41. Four identical thin rods each of mass M and length l, from a square frame. 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

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42. If is the force acting on a particle having position vector and be the torque of this force about the origin, then-

A. $\overrightarrow{t} . \overrightarrow{\tau} > 0$ and $\overrightarrow{f} . Vec\tau < 0$

B. $r . \tau = 0$ and $\overrightarrow{F} . \overrightarrow{\tau} = 0$

C. $\overrightarrow{r} . \overrightarrow{\tau} = 0$ and $\overrightarrow{F} . Vecv \neq 0$

D. $\overrightarrow{r} . Vec\tau \neq 0$ and $\overrightarrow{F} . Vecr = 0$

Answer: B

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43. The moment of the force, $\overrightarrow{F} = 4\hat{i} + 5\hat{j} - 6\hat{k}$ at $(2, 0, -3)$. About the point $(2, -2, -2)$ is given by

A. $-7\hat{i} - 8\hat{j} - 4\hat{k}$

B. $-4\hat{i} - \hat{j} - 8\hat{k}$

C. $-8\hat{i}-4\hat{j}-7\hat{k}$

D. $-7\hat{i}-4\hat{j}-8\hat{k}$

Answer: D

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44. Two particle which are initially at rest move towards each other under the action of their internal attraction. If their speeds are v and $2v$ at any instant, then the speed of centre of mass of the system will be

A. $1.5v$

B. v

C. 2v

D. zero

Answer: D

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45. A circular disc of moment of inertia I_t is rotating in a horizontal plane about its symmetry axis with a constant angular velocity ω_i. Another disc of moment of inertia I_b is dropped co-axially onto the rotating disc. Initially, the second disc has zero angular speed. Eventually, both the discs rotate with a constant angular speed ω_f. Calculate the energy lost by the initially rotating disc due to friction.

A. $\frac{I_b - I_t}{(I_t + I_b)}\omega_i^2$

B. $\frac{1}{2}\frac{I_b - I_t}{(I_t + I_b)}\omega_i^2$

C. $\frac{1}{2}\frac{I_t^2}{2(I_t + I_b)}\omega_i^2$

D. $\frac{1}{2}\frac{I_t^2}{2(I_t + I_b)}\omega_i^2$

Answer: B

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46. From a given sample of uniform wire, two circular loops P and Q are made, P of radius r and Q of radius nr. If the M.I. of Q about its axis is four times that of P about its axis (assuming the wire to be of diameter much smaller than either radius), the value of n is

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

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

C. $4^{\frac{1}{3}}$

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

Answer: C

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47. A disc of radius 2 m and mass 100kg rolls on a horizontal floor, its centre of mass has speed of $20cm / s$. How much work is needed to stop it ?

A. 3 J

B. 30 kJ

C. 2 J

D. 1 J

Answer: A

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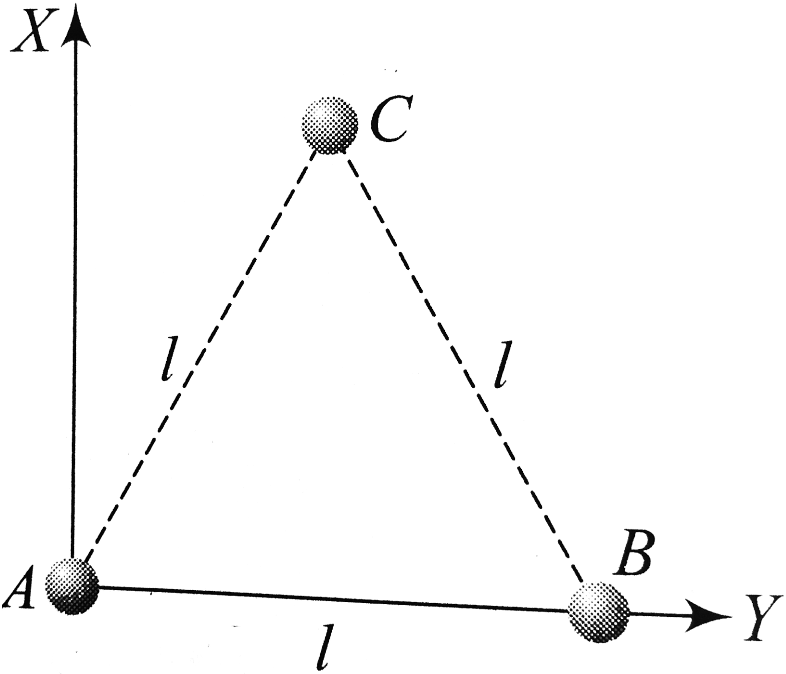
48. Three particles, each of mass m grams situated at the vertices of an equilateral triangle AbC of side I cm (as shown in the figure). The moment of inertia of the system about a line AX perpendicular to AB

and in the plane of ABC, in gram-cm^2 units will be.



A. $2ml^2$

B. $\frac{5}{4}ml^2$

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

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

Answer: B

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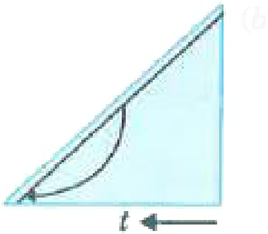
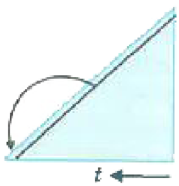
49. A ladder is leaned against a smooth wall and it is allowed to slip on a frictionless floor. Which figure represents the track of its centre of mass ?



A.



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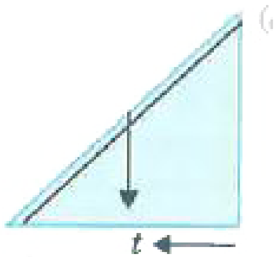
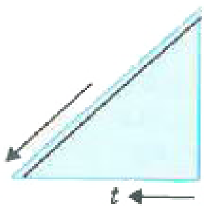


C.



D.

Answer: A

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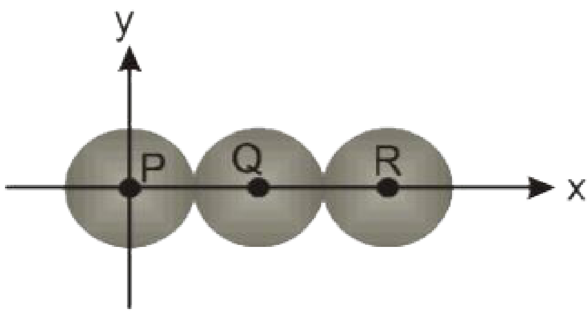
50. Three identical spheres, each of mass 1 kg are kept as shown in figure, touching each other, with their centres on a straight line. If their centres are marked P, Q, R respectively, the distance of centre of mass of the system from P (origin) is



A. $\frac{PQ + PR + QR}{3}$

B. $\frac{PQ + PR}{3}$

C. $\frac{PQ + QR}{3}$

D. $\frac{PQ + QR + PR}{3}$

Answer: B

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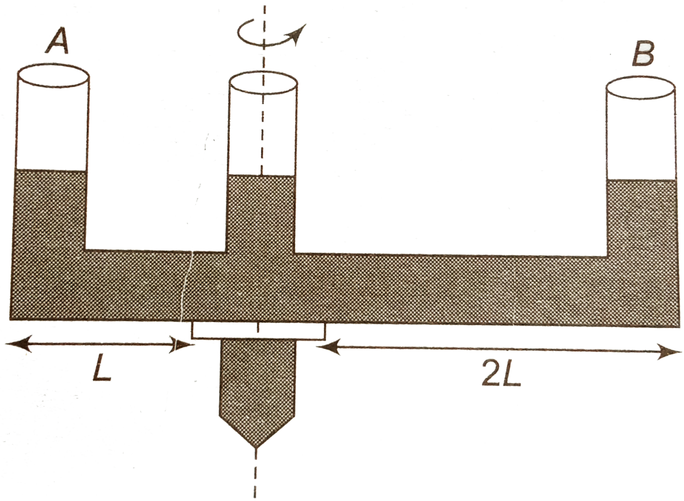
51. A given shaped glass tube having uniform cross-section is filled with water and is mounted on a rotatable shaft as shown in figure. If the tube is rotated with a constant angular velocity ω then :



A. water levels in both sections A and B go up

B. water level in section A goes up and that in section B comes down

C. water level in section A comes down and that in B goes up

D. water level remains the same in both the sections.

Answer: A

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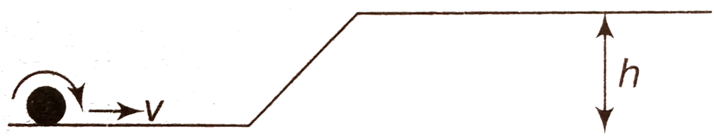
52. A solid sphere is rolling on a frictionless surface, shown in figure with a translational velocity $v m / s$. If it is to climb the inclined surface then v should be :



A. $\geq \sqrt{\frac{10gh}{7}}$

B. $\geq \sqrt{2gh}$

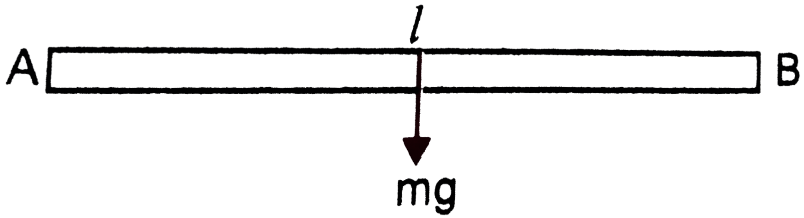
C. $2gh$

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

Answer: A

Watch Video Solution

53. A unifrom rod of length l and mass m is free to rotate in a vertical plane about A, Fig. The rod initially in horizontal position is released. The initial angular acceleration of the rod is $\left(MI \text{of rod about} A \text{is} \frac{ml^2}{3}\right)$



A. $m\frac{g(l)}{2}$

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

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

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

Answer: B

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54. A tube of length L is filled completely with an incompressible liquid of mass M and closed at both ends. The tube is then roted in a horizontal plane about one of its ends with a uniform angular velocity ω The force exerted by the liquid at the other end is

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

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

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

D. $ML\omega^2$

Answer: B

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55. The moment of inertia of a rod about an axis through its centre and perpendicular to it, is $\frac{1}{12}ML^2$ (where, M is the mass and L is length of the rod). The rod is bent in the middle, so that two halves make an angle of 60°. The moment of inertia of the bent rod about the same axis would be

A. $\frac{1}{48}Ml^2$

B. $\frac{1}{12}Ml^2$

C. $\frac{1}{24}Ml^2$

D. $\frac{Ml^2}{8\sqrt{3}}$

Answer: B

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56. 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 of 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. $\frac{o\Omega}{M+2m}$

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

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

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

Answer: A

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57. The instantaneous angular position of a point on a rotating wheel is given by the equation

$\theta(t) = 2t^3 - 6t^2$

The torque on the wheel becomes zero at

A. t=1s

B. $t = 0.5s$

C. $t = 0.25s$

D. $t = 2s$

Answer: A

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58. 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 isI_0. Its moment of inertia about an axis passing through one of its ends perpendicular to its length is.

A. $I_0 + ML^2/2$

B. $(I_0 + ML^2/4$

C. $I_0 + 2ML^2$

D. $I_0 = ML^2$.

Answer: B

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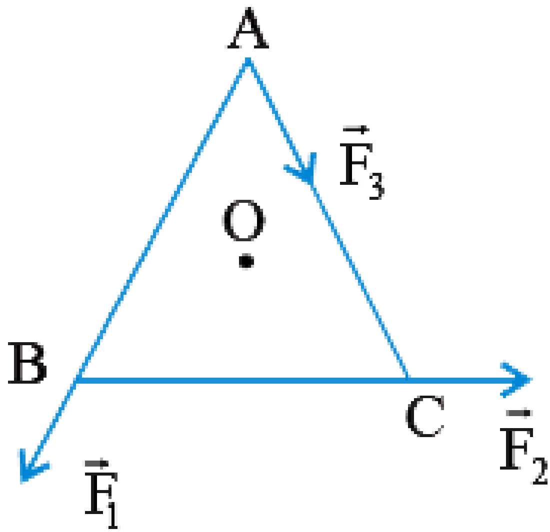
59. ABC is an equilateral with O as its centre $\overrightarrow{F}_1, \overrightarrow{F}_2$ and $\overrightarrow{F}_3$ represent three forces acting along the sides AB, BC and AC respectively. If the total torque about O is zero then the magnitude of $\overrightarrow{F}_3$ is :



A. $2(F_1 + F_2)$

B. $F_1 + F_2$

C. $F_1 - F_2$

D. $\frac{F_1 + F_2}{2}$

Answer: B

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60. Two persons of masses $55kg$ and $65kg$ respectively are at the opposite ends of a boat. The length of the boat is $3.0m$ and weights $100kg$. The $55kg$ man walks up to the $65kg$ man and sits with him. If the boat is in still water the centre of mass of the system shifts by.

A. $0.75m$

B. $3.0m$

C. $2.3m$

D. zero

Answer: D

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61. A solid cylinder of mass $50kg$ 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 end hanging freely. Tension in the string required to produce an angular acceleration of 2 revolution s^{-2} is

A. 25 N

B. 50 N

C. $78.5N$

D. $157N$

Answer: D

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62. The ratio of the accelerations for a solid sphere (mass $m, \text{ and } radius R$) 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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63. 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 a distance x from A.

A. $\frac{Wx}{d}$

B. $\frac{Wd}{x}$

C. $\frac{W(d-x)}{x}$

D. $\frac{W(d-x)}{d}$

Answer: D

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64. A solid cylinder of mass 2 kg and radius 4 cm rotating about its axis at the rate of 3 rpm. The torque required to stop after 2π revolutions is :

A. $2 \times 10^{6} Nm$

B. $2 \times 10^{-6} Nm$

C. $2 \times 10^{-3} Nm$

D. $2 \times 10^{-4} Nm$

Answer: B

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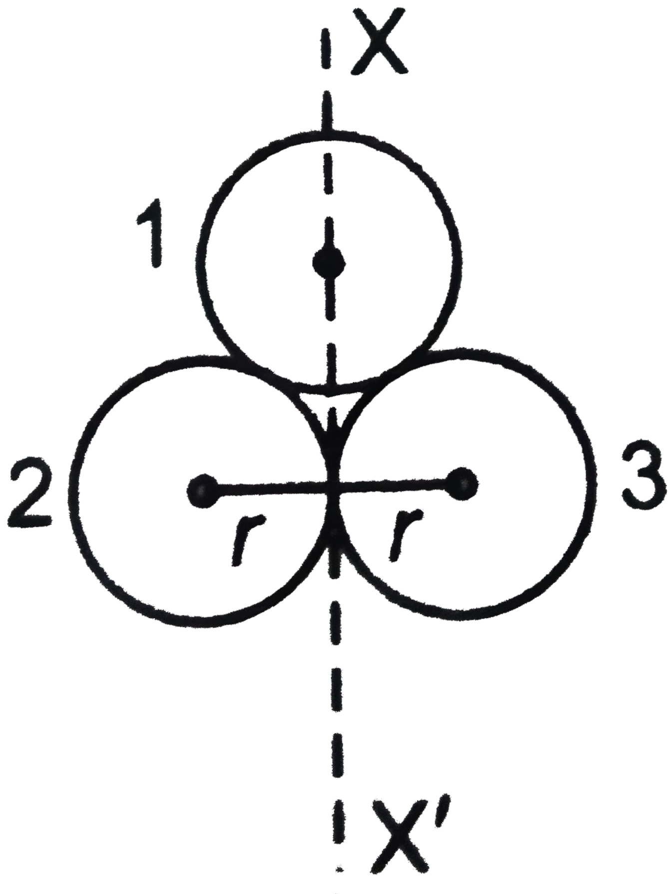
65. Three idential spherical shells each of mass m and radius r are placed as shown in Fig. Consider an axis XX' which is touching the two shells and passing through diameter of third shell. Moment of Inertia of the system consisting of these three spherical shells about XX' as axis is :



A. $\frac{11}{5}mr^2$

B. $3mr^2$

C. $\frac{16}{5}mr^2$

D. $4mr^2$

Answer: D

Watch Video Solution

66. From a disc of radius R and mass m, a circular hole of diamter 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. $13MR^2/32$

B. $11MR^2/32$

C. $9MR^2/32$

D. $15MR^2/32$

Answer: A

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67. Two discs of same moment of inertia rotating 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 the face coinciding the axis of rotation. The expression for loss of enregy during this process is :

A. $\frac{1}{2}I(\omega_1 + \omega_2)^2$

B. $\frac{1}{4}I(\omega_1 - \omega_2)^2$

C. $2I(\omega_1 - \omega_2)^2$

D. $\frac{1}{8}I(\omega_1 - \omega_2)^2$

Answer: B

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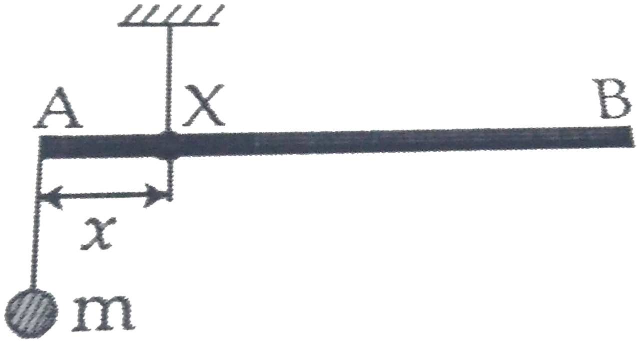
1. 

A uniform rod AB is suspended from a point X, at a variable distance x from A, as shown. To make the rod horizontal , a mass m is suspended from its end A. A set of (m, x) value is recorded that give a straight line, when plotted, are :

A. m, x^2

B. $m, \frac{1}{x^2}$

C. $m, \frac{1}{x}$

D. m, x

Answer: C

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2. A body A of mass M while falling vertically downwards under gravity brakes into two parts, a body B of mass $\frac{1}{3}$ M and a body C of mass $\frac{2}{3}$ M. The center of mass of bodies B and C taken together shifts compared to that of body A towards

A. depends on the height of breaking

B. does not shift

C. body C

D. body B

Answer: B

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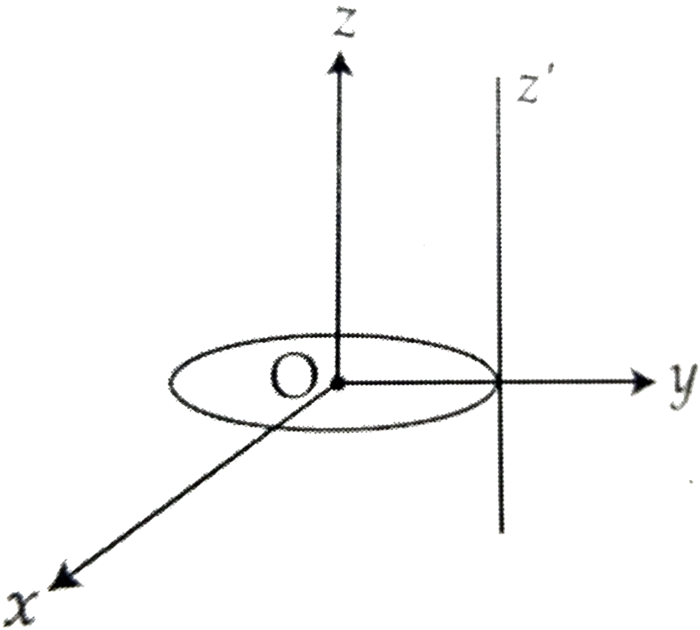
3. A thin circular disk is in the xy plane as shown in the figure. The ratio of its moment of inertia about z and z' axes will be :



A. $1:4$

B. $1:5$

C. $1:3$

D. $1:2$

Answer: C

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4. Consider a two particle system with particles having masses m_1 and m_2 if the first particle is pushed towards the centre of mass through a distance d, by what distance should the second particle is moved, so as to keep the center of mass at the same position?

A. $\frac{m_2}{m_1}d$

B. $\frac{m_1}{m_1 + m_2}d$

C. $\frac{m_1}{m_2}d$

D. d

Answer: C

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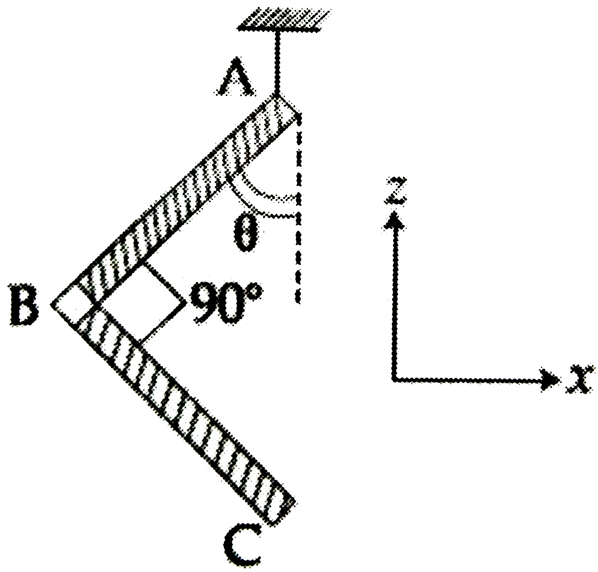
5. An L-shaped object, made of thin rods of uniform mass density, is suspended with a string as shown in figure. If AB=BD, and the angle made by AB with downward vertical is θ, then :



A. $\tan\theta = \frac{1}{2}$

B. $\tan\theta = \frac{1}{\sqrt{3}}$

C. $\tan\theta = \frac{1}{3}$

D. $\tan\theta = \frac{1}{2\sqrt{3}}$

Answer: C

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6. Seven identical circular planar disks, each of mass M and radius R are welded symmetrically as shown. The moment of inertia of the arrangement about the axis normal to the plane and passing through the point P is :

A. $\frac{73}{2}MR^2$

B. $\frac{181}{2}MR^2$

C. $\frac{19}{2}MR^2$

D. $\frac{55}{2}MR^2$

Answer: B

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7. A circular disc of radius R is removed from a bigger circular dise of radius such that the circumferences of the discs coincide. The centre of mass of the new disc is αR from the centre of the bigger disc. The value of a is:

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

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

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

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

Answer: D

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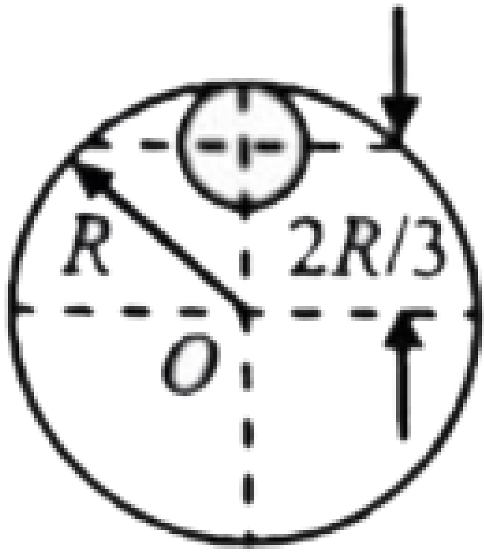
8. A thin disc of mass 9M and radius R from which a disc of radius R/3 is cut shown in figure. Then moment of inertia of the remaining disc about

O, perpendicular to the plane of disc is -



A. $10MR^2$

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

C. $4MR^2$

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

Answer: C

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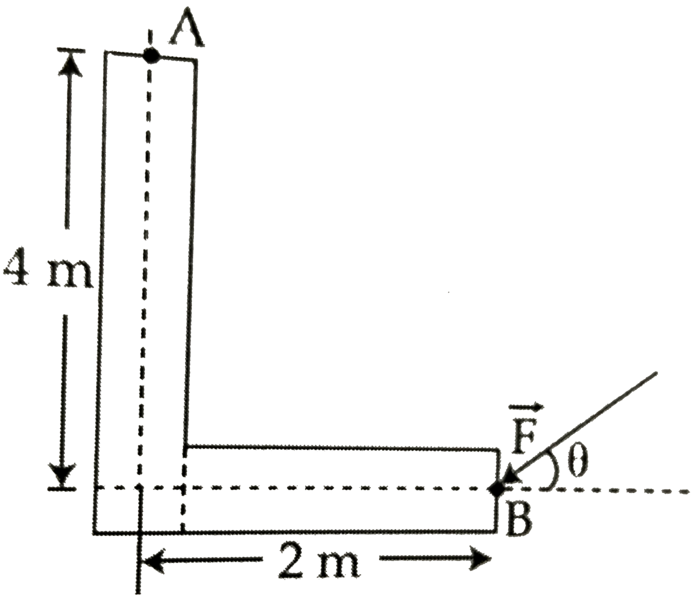
9. A force of 40 N acts on a point B at the end of the L-shaped object, as shown in the figure. The angle $t\hat{a}$ that will produce maximum moment of the force about point A is given by :



A. $\tan\theta = 4$

B. $\tan\theta = \frac{1}{4}$

C. $\tan\theta = \frac{1}{2}$

D. $\tan\theta = 2$

Answer: C

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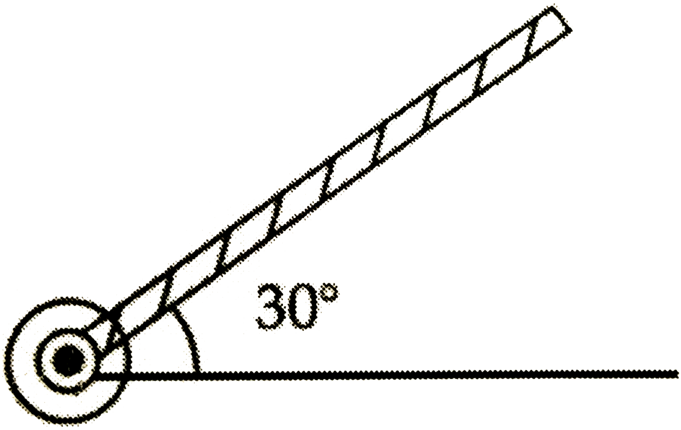
10. A rod of length 50cm is pivoted at one end. It is raised such that if makes an angle of 30° from the horizontal as shown and released from rest. Its angular speed when it passes through the horizontal (in rads^{-1}) will be ($g = 10ms^{-2}$)



A. $\sqrt{30}$

B. $\frac{\sqrt{20}}{3}$

C. $\sqrt{\frac{30}{2}}$

D. $\frac{\sqrt{30}}{2}$

Answer: A

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11. A thin uniform rod of length l and mass m is swinging freely about a horizontal axis passing through its end. Its maximum angular speed is ω. Its centre of mass rises to a maximum height of -

A. $\frac{1}{2}\frac{l^2\omega^2}{g}$

B. $\frac{1}{6}\frac{l^2\omega^2}{g}$

C. $\frac{1}{6}\frac{l^2\omega^2}{g}$

D. $\frac{1}{6}\frac{l^2\omega}{g}$

Answer: B

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12. A thin circular ring of mass m and radius R is rotating about its axis with a constant angular velocity ω. Two objects each of mass M are attached gently to the opposite ends of a diameter of the ring. The ring now rotates with an angular velocity $\omega' =$

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

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

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

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

Answer: D

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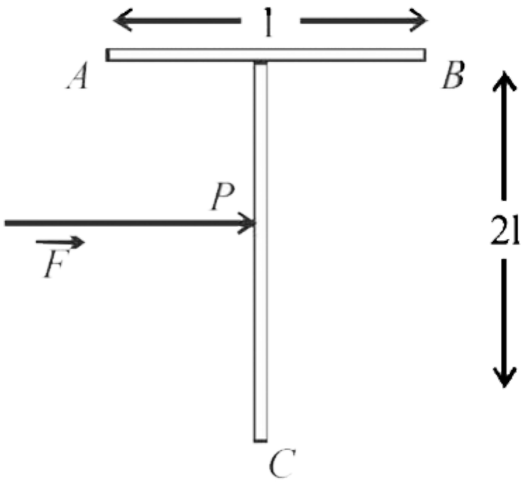
13. A 'T' shaped object with dimensions shown in the figure, is lying on a smooth floor. A force $'\vec{F}'$ is applied at the point P parallel to AB, such that the object has only the translational motion without rotation. Find the location of P with respect C.



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

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

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

D. l

Answer: C

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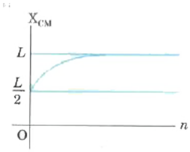
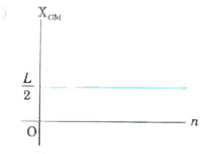
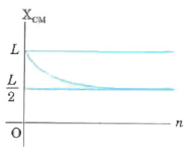
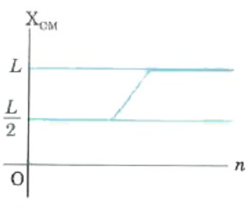
14. A thin rod of length L is lying along the x-axis with its ends at x = 0 and x = L. Its linear density (mass/length) varies with x as $k\left(\frac{x}{L}\right)^n$ where n can be zero or any positive number. If the position X_{CM} of the centre of mass of the rod is plotted against n, which of the following graphs best approximates the dependence of X_{CM} on n?

A. 

B. 

C. 

D. 

Answer: A

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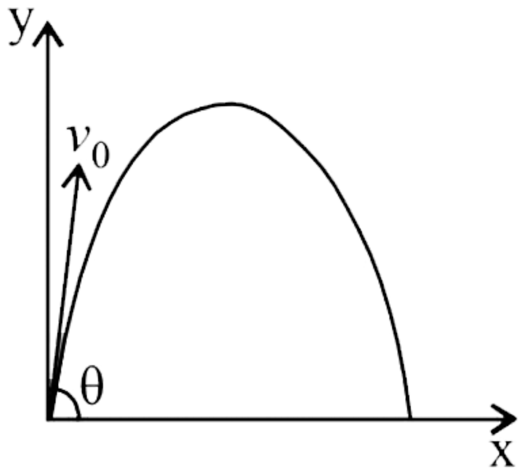
15. A small particle of mass m is projected at an angle θ with the x- axis with an initial velocity v_0 in the $x - y$plane as shown in the figure . At a time $t < \frac{v_0 \sin\theta}{g}$, the angular momentum of the particle is where $\hat{i}$, $\hat{j}$ and $\hat{k}$ are unit vectors along x, y and z - axis respectively.



A. $\frac{1}{2} mgv_0 t^2 \cos\theta \hat{i}$

B. $-mgv_0 t^2 \cos\theta \hat{i}$

C. $mgv_0 t \cos\theta \hat{k}$

D. $-\frac{1}{2} mgv_0 t^2 \cos\theta \hat{k}$

Answer: D

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16. A mas m hangs with help of a string wraped around a pulley on a frictionless bearling. The pulley has mass m and radius R. Assuming pulley to be a perfect uniform circular disc, the acceleration of the mass m, if the string does not slip on the pulley, is:

A. g

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

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

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

Answer: B

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17. A thin horizontal circular disc is roating about a vertical axis passing through its centre. An insect is at rest at a point near the rim of the disc.

The insect now moves along a diameter of the disc to reach its other end.

During the journey of the insect, the angular speed of the disc.

A. continuously decreases

B. continuously increases

C. first increases and then decreases

D. remains unchanged

Answer: C

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18. A pulley os radius 2m is rotated about its axis by a force $F = (20t - 5t^2)$ newton (where t is measured in seconds) applied tangentially. If the moment of inertia of the pulley about its axis of rotation is $10kgm^2$ the number of rotaitons made by the pulley before its direction of motion is reversed, is:

A. more than 3 but less than

B. more than 6 but less than 9

C. more than 9

D. less than 3

Answer: A

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19. A diatomic molecule is made of two masses m_1 and m_2 which are separated by a distance r . If we calculate its rotational energy by applying Bohr's rule of angular momentum quantization it energy will be (n is an integer)

A. $\frac{(m_1 + m_2)n^2h^2}{2m_1m_2r^2}$

B. $\frac{(m_1 + m_2)n^2h^2}{2m_1^2m_2^2r^2}$

C. $\frac{n^2h^2}{2(m_1 + m_2)r^2}$

D. $\frac{n^2h^2}{(m_1 + m_2)r^2}$

Answer: A

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20. A hoop of radius r and mass m rotating with an angular velocity ω_0 is placed on a rough horizontal surface. The initial velocity of the centre of the hoop is zero. What will be the velocity of the centre of the hoop when it ceases to slip?

A. $\frac{r\omega_0}{3}$

B. $\frac{r\omega_0}{2}$

C. $r\omega_0$

D. $\frac{r\omega_0}{4}$

Answer: B

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21. A bob of mass m attached to an inextensible string of length l is suspended from a vertical support. The bob rotates in a horizontal circle with an angular speed ω red/s about the vertical. About the point of suspension:

A. Angular momentum changes in direction but not in magnitude.

B. Angular momentum changes both in direction and magnitude.

C. Angular momentum is conserved

D. Angular momentum changes in magnitude but not in direction.

Answer: A

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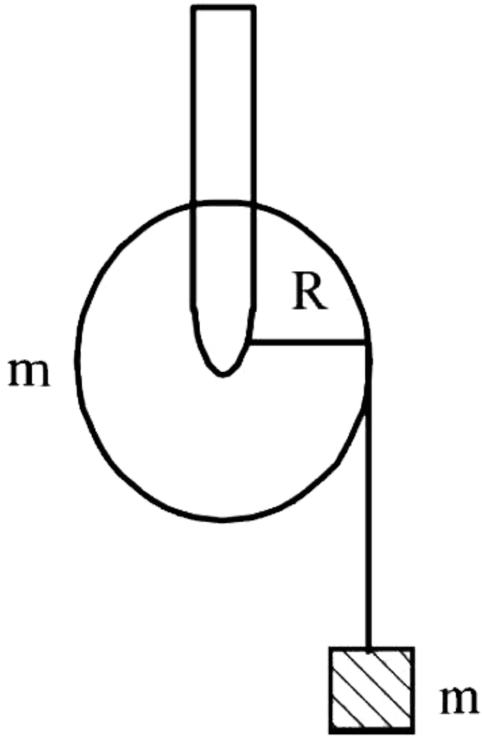
22. A mass 'm' is supported by a massless string wound around a uniform hollow cylinder of mass m and radius R. If the string does not slip on the cylinder, with what acceleration will the mass fall or release?



A. g

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

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

D. $\frac{5g}{6}$

Answer: C

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23. Distance of the centre of mass of a solid uniform cone from its vertex is z_0 . If the radius of its base is R and its height is h then z_0 is equal to:

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

B. $\frac{5h}{8}$

C. $\frac{3h^2}{8R}$

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

Answer: A

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24. From a solid sphere of M and radius R a cube of maximum possible volume is cut. Moment of inertia of cube about an axis passing through its centre and perpendiular to one of its faces is:

A. $\frac{MR^2}{16\sqrt{2}\pi}$

B. $\dfrac{4MR^2}{9\sqrt{2}\pi}$

C. $\dfrac{4MR^2}{3\sqrt{2}\pi}$

D. $\dfrac{4MR^2}{32\sqrt{2}\pi}$

Answer: B

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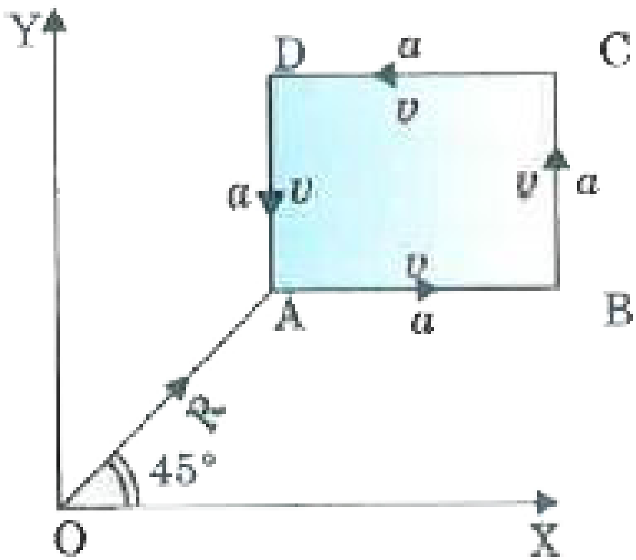
25. A particle of mass of m is moving along the side of square of side 'a' with a uniform speed u in the X-Y plane as shown in the figure.



Which of the following statements is false for the angular momentum $\vec{L}$ about the origin ?

A. $\vec{L} = -\frac{mv}{\sqrt{2}}R\hat{k}$ when the particle is moving from A to B.

B. $\vec{L} = mv\left[\left(\frac{R}{\sqrt{2}} - a\right]\hat{k}$ when the particle is moving from C to D.

C. $\vec{L} = mv\left[\left(\frac{R}{\sqrt{2}} + a\right]\hat{k}$ when the particle is moving from B to C.

D. $\vec{L} = \frac{mv}{\sqrt{2}}R\hat{k}$ when the particle is moving from D to A.

Answer: D

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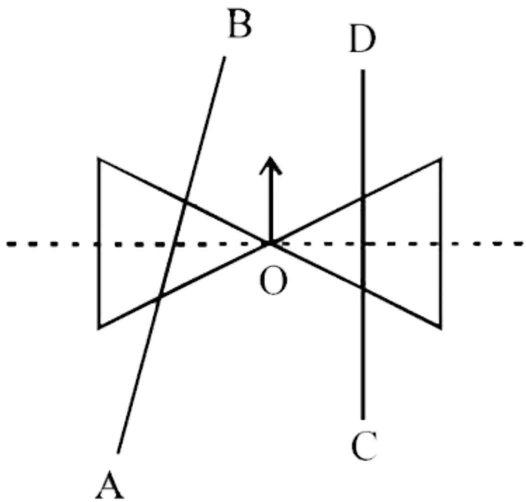
26. A roller is made by joining together two cones at their vertices O, ti is kept on two rails AB and CD, which are placed asymmetrically with its axis perpendiuclar to CD and its center O at the centre of line joining AB and Cd it is given a light push so that it starts rolling with its centre O moving parallel to CD in the direction shown As it moves, the roller wil tand to:



A. turn left

B. turn right

C. go striaight

D. turn left and right alternately.

Answer: A

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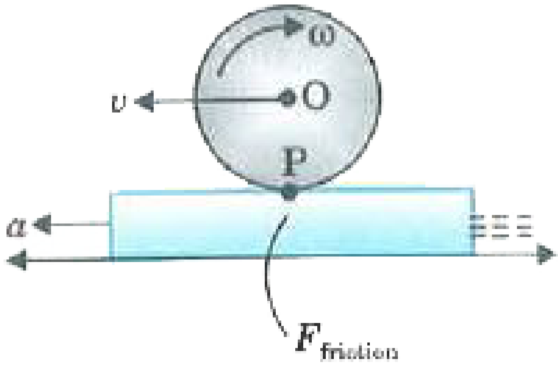
27. Consider a cylinder of mass M resting on a rough horizontal rug that is pulled out from under it with acceleration 'a' perpendicular to the axis of the cylinder. What is F_{friction} at point P? It is assumed that the cylinder does not slip.



A. Mg

B. Ma

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

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

Answer: D

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28. A thin bar of length L has a mass per unit length λ, that increases linerarly with distance from one end. If its total mass is M and its mass per unit length at the lighter end is λ_0, then the distance of the centre of mass from the lighter end is

A. $\frac{L}{2} - \frac{\lambda_0 L^2}{4M}$

B. $\frac{L}{2} + \frac{\lambda_0 L^2}{4M}$

C. $\frac{L}{3} + \frac{\lambda_0 L^2}{4M}$

D. $\frac{2L}{3} - \frac{\lambda_0 L^2}{4M}$

Answer: D

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29. The coordinates of a particle of mass $'m'$ as function of time are given by $x = x_0 + a_1 \cos(\omega t)$ and $y = y_0 + a_2 \sin(\omega_2 t)$. The torque on particle about origin at time $t = 0$ is :

A. $m(-x_0b + y_0a)\omega_1^2\hat{k}$

B. $my_0a\omega_1(2)\hat{k}$

C. Zero

D. $-m\left(x_0b\omega_2^2 - y_0a\omega_1^2\right)\hat{k}$

Answer: B

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30. A thin disc of mass M and radius R has mass per unit area $\sigma(r) = kx^2$ where r is the distance from its centre. Its moment of inertia about an axis going through its centre of mass and perpendicular to its plane is:

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

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

C. $\frac{MR^2}{6}$

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

Answer: B

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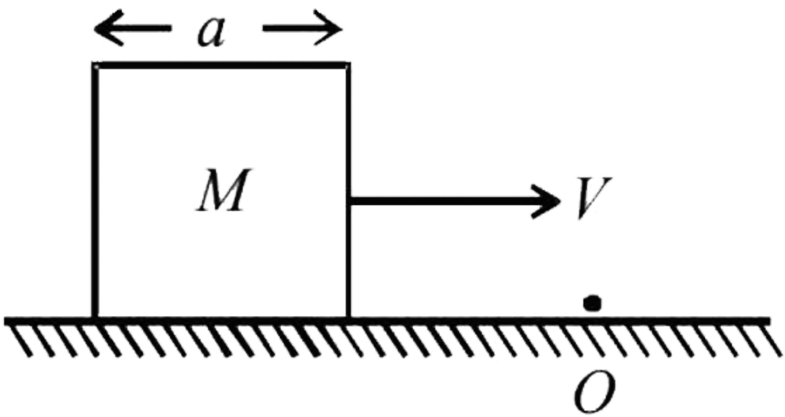
31. A cubical block of side a is moving with velocity V on a horizontal smooth plane as shown in Figure. It hits a ridge at point O. The angular speed of the block after it hits O is



A. 5.0

B. 6.7

C. 9.4

D. 13.3

Answer: A

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32. Cement, sand and seree are dropped in rotating cylidrical drum to make concrete mixture. If rotating speed of drum is very high then contents are attached to wall of drum and mixture is not formed correctly. If radius of drum is 1.25 m and its axis is horizontal, then the required maximum rotating speed to make good mixture in rpm is -

A. 0.4

B. 1.3

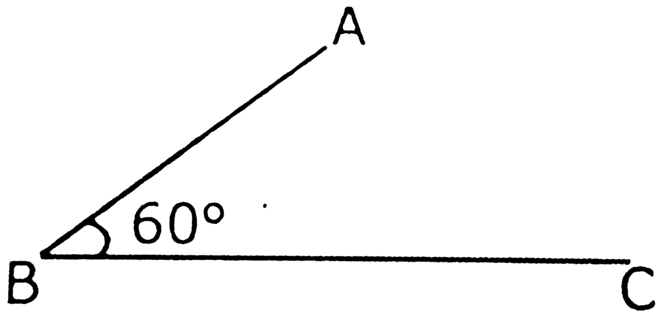
C. 8.0

D. 27.0

Answer: D

Watch Video Solution

33.



In the figure shown ABC is a uniform wire. If centre of mass of wire lies vertically below point A, then $\frac{BC}{AB}$ is close to :

A. 1.85

B. 1.37

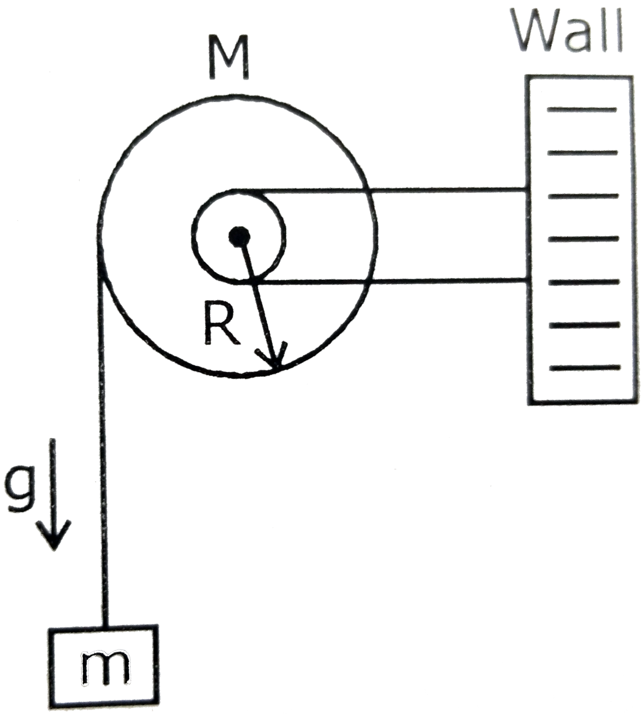
C. 1.5

D. 3

Answer: B

Watch Video Solution

34. A uniform disc of radius R and mass M is free to rotate only about its axis. A string is wrapped over its rim and a body of mass m is tied to the free end of the string as shown in the figure. The body is released from rest. Then the acceleration of the body is



A. $\dfrac{2mg}{2m+M}$

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

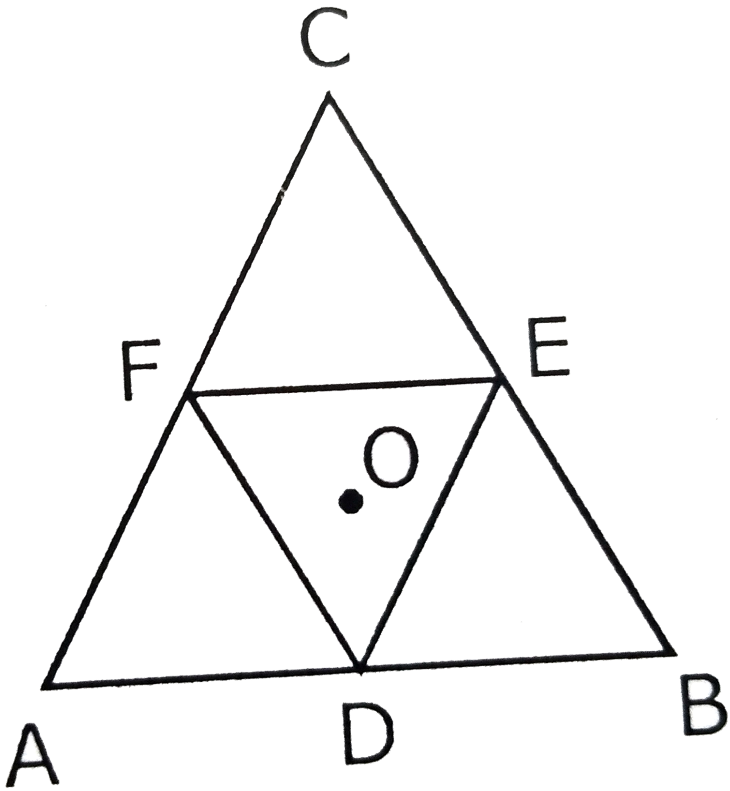
C. $\dfrac{2Mg}{2M+m}$

D. $\frac{2Mg}{2M+m}$

Answer: A

Watch Video Solution

35. Moment of inertia of an equilateral triangular lamina ABC, about the axis passing through its centre O and perpendicular to its plane is I_0 as shown in the figure. A cavithy DEF is cut out from the lamina, where D,E,F are the mid points of the sides. Moment of inertia of the remaining part of lamina about the same axis is -



A. $\frac{7}{8}I_0$

B. $\frac{15}{16}I_0$

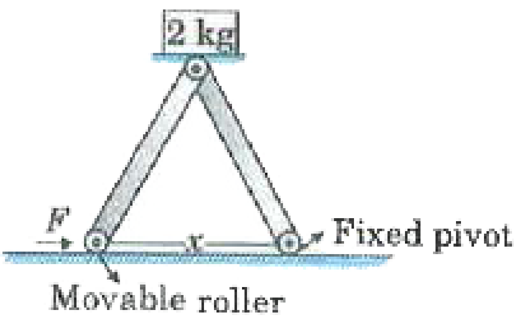
C. $\frac{3}{4}I_0$

D. $\frac{31}{32}I_0$

Answer: B

Watch Video Solution

36. The machine as shown has 2 rods of length 1 m connected by a pivot at the top. The end of one rod is connected to the floor by a stationary pivot and the end of the other rod has a roller that rolls along the floor in a slot. As the roller goes back and forth, a 2 kg weight moves up and down. If the roller is moving towards right at a constant speed, the weight moves up with a:



A. constant speed

B. decreasing speed

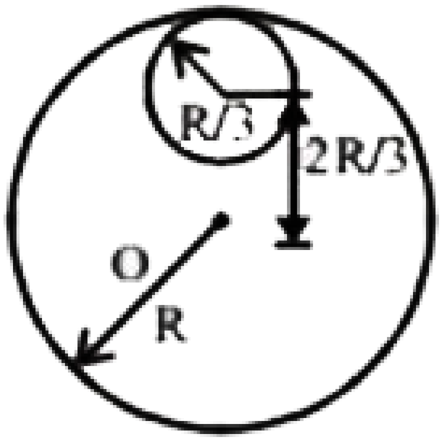
C. increasing speed

D. Speed which is $\frac{3}{4}$ th of that of the roller when the weight is 0.4 m above the ground

Answer: B

Watch Video Solution

37. 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. $\frac{219MR^2}{256}$

B. $\frac{237MR^2}{512}$

C. $\frac{19MR^2}{512}$

D. $\frac{197MR^2}{256}$

Answer: B

Watch Video Solution

38. The moment of inertia of a uniform cylinder of length l and $radius R$ about its perpendicular bisector is I. What is the ratio l / R such that the moment of inertia is minimum ?

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

B. $\frac{sqr(3)}{2}$

C. 1

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

Answer: A

Watch Video Solution

39. Two coaxial discs, having moments of inertia l_1 and $\frac{I_1}{2}$ are rotating with respective angular velocities ω and $\frac{\omega_1}{2}$ about their common axis. They are brought in contact with each other and thereafter they rotate with a common angular velocity. If E_f and E_i are the final and initial total energies, then $(E_f - E_i)$ is:

A. $\frac{-I_1\omega_1^2}{12}$

B. $\frac{I_1\omega_1^2}{6}$

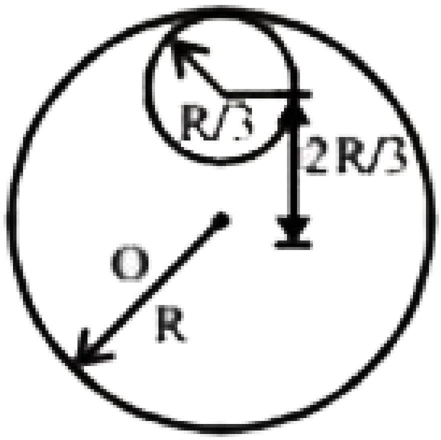
C. $\frac{3}{8}I_1\omega_1^2$

D. $\frac{-I_1\omega_1^2}{24}$

Answer: D

Watch Video Solution

40. 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. $\frac{37}{9}mR^2$

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

C. $4MR^2$

D. $8mR^2$

Answer: C

Watch Video Solution

41. A particle moves in circular path with decreasing speed. Which of the following is correct.

A. It will move in a spiral and finally reach the centre

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

C. Only direction of $\vec{L}$ is constant

D. $\vec{L}$ is constant.

Answer: C

Watch Video Solution

42. A solid sphere of mass M and radius R having tmoment of inertia I about its diameter is recast into a solid dise of radius r and thickness t. The moment of inertia of the disc about an axis passing the edge and perpendicular to the plane remains I. Then R and r are related as

A. $r = \sqrt{\frac{2}{15}} R$

B. $r = \frac{2}{\sqrt{15}}R$

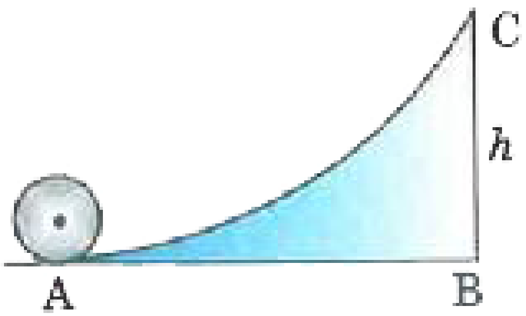
C. $r = \frac{2}{15}R$

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

Answer: B

Watch Video Solution

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



A. ring

B. solid sphere

C. hallow sphere

D. disc.

Answer: D

Watch Video Solution

44. Two discs A and B are mounted coaxiallay on a vertical axle. The discs have moments of inertia I and 2 I respectively about the common axis. Disc A is imparted an initial angular velocity 2ω using the entire potential energy of a spring compressed by a distance x_1 Disc B is imparted an angular velocity ω by a spring having the same spring constant and compressed by a distance x_2 Both the discs rotate in the clockwise direction.

The ratio x_1 / x_2 is

A. 2

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

C. $\sqrt{2}$

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

Answer: C

Watch Video Solution

45. In the above question disc B is brought in contact with disc A, they acquire a common angular velocity in time t. The average frictional torque on one disc by the other during this periodis:

A. $\frac{2I\omega}{3t}$

B. $\frac{9I\omega}{2t}$

C. $\frac{9I\omega}{4t}$

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

Answer: A

View Text Solution

46. Two discs A and B are mounted coaxially on a vertical axle. The discs have moments of inertia I and 2I respectively about the common axis. Disc A is imparted an initial angular velocity 2ω using the entire potential energy of a spring compressed by a distance x_1. Disc B is im parted an angular velocity ω by a spring having the same spring constant and compressed by a distance x_2. Both the discs rotate in the clockwise direction.The loss of kinetic energy during the above proces is

A. $\frac{I\omega^2}{2}$

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

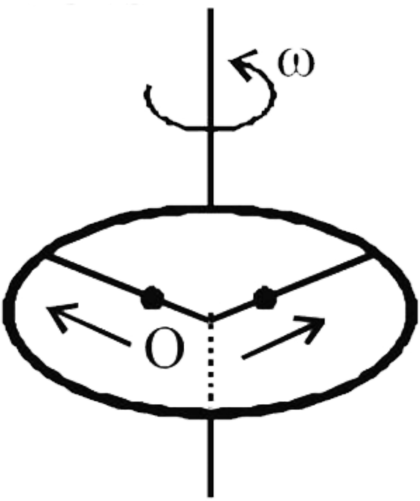
C. $\frac{I\omega^2}{4}$

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

Answer: B

Watch Video Solution

47. A ring of mass M and radius R is rotating with angular speed ω about a fixed vertical axis passing through its centre O with two point masses each of mass $\frac{M}{8}$ at rest at O. These masses can move radially outwards along two massless rods fixed on the ring as shown in the figure. At some instant the angular speed of the system is $\frac{8}{9}\omega$ and one fo the masses is at a distance of $\frac{3}{5}R$ from O. At this instant the distance of the other mass from O is



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

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

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

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

Answer: D

Watch Video Solution

48. A uniform wooden stick of mass 1.6 kg and length l rests in an inclined mannar on a smooth, vertical wall of height $h(< l)$ such that a small portion of the stick extends beyond the wall. The reaction force of th wall on the stick is perpendicular to the stick. The stick makes an angle of 30° with the wall and the bottom of the stick is on a rough floor. The reaction of the wall on the stick is equal in magnitude to the reaction of the floor on the stick. The ratio h/l and the friectional force f at the bottom of the stick are $\left(g = 10ms^2\right)$

A. $\frac{h}{l} = \frac{\sqrt{3}}{16}, f = \frac{16\sqrt{3}}{3}N$

B. $\frac{h}{l} = \frac{3}{16}, f = \frac{16\sqrt{3}}{3}N$

C. $\frac{h}{l} = \frac{3\sqrt{3}}{16}, f = \frac{8\sqrt{3}}{3}N$

D.

Answer: D

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Competition File Objective Type Questions Multiple Choice Questions With More Than One Correct Answer

1. A thin and uniform rod of mass M and length L is held vertical on a floor with large friction. The rod is released from rest so that it falls by rotating about its contact-point with the floor without slipping. Which of the following statement(s) is(are) correct, when the rod makes an angle 60° with vertical? [g is the acceleration due to gravity]

A. The radial acceleration of the rod's center of will be $\frac{3g}{4}$

B. The angular acceleration of the rod will be $\frac{2g}{L}$

C. The angular speed of the rod will be $\sqrt{\frac{3g}{2L}}$

D. The normal reaction force from the floor on the rod will be $\frac{Mg}{16}$

Answer: A::C::D

Watch Video Solution

2. The potential energy of a particle of mass ? at a distance ? from a fixed point ? is given by $V(r) = kr^2/2$, where ? is a positive constant of appropriate dimensions. This particle is moving in a circular orbit of radius ? about the point ?. If ? is the speed of the particle and ? is the magnitude of its angular momentum about ?, which of the following statements is (are) true?

A. $v = \sqrt{\frac{k}{2m}}R$

B. $v = \sqrt{\frac{k}{m}}R$

C. $L = R^2\sqrt{mK}$

D. $L = \sqrt{\frac{mk}{2}}R^2$

Answer: B::C

Watch Video Solution

3. A cylinder is kept at rest on a sufficiently rough horizontal surface. A horizontal constant force is applied at the centre of mass of cylinder.

A. Acceleration of centre of cylinder is F/m

B. Acceleration of centre of mass of cylinder is 2/3m

C. Force of friction is F/3

D. Force of friction acts in the direction of motion

Answer: B::C

Watch Video Solution

4. Angular impulse J is applied on a system which can rotate about an axis for which its moment of inertia is I. System is initially at rest.

A. Angular momentum of the system becomes J

B. Angular velocity acquired by the system is J/I

C. Kinetic energy acquired by the system is $\frac{J^2}{2I}$

D. Angular momentum of the system becomes J/I

Answer: A::B::C

Watch Video Solution

5. there is a rod AB of uniform cross section and its centre is C. In which of the following case(s) centre of mass of the rod may lie at C.

A. Density of the material of rod increases continuously from A to B.

B. Density of the material of rod increases continuously from B to A.

C. Density of the material of rod increases from A to C and then decreases from C to B

D. Density of the material of rod decreases from A to C and then increases from C to B.

Answer: C::D

Watch Video Solution

6. A sphere is rolling down on a sufficiently rough inclined surface.

A. Direction of friction is up the plane

B. Total mechanical energy of the sphere remains constant

C. Angular momentum of sphere remains conserved about instantaneous point of contact

D.

Answer: A::B::C

View Text Solution

7. Net external force acting on a system of particle is not equal to zero. If velocity and acceleration of the centre of mass of the system of particles at some instant of time are found to be v and a respectively select possible option (s).

A. $v = 0 \text{ and } a = 0$

B. $v \neq 0 \text{ and } a \neq 0$

C. $v \neq 0 \text{ and } a = 0$

D. $v = 0 \text{ and } a \neq 0$

Answer: B::D

Watch Video Solution

8. There are two inclined planes A and B of same dimensions. A is sufficiently rough but B is smooth A round shaped object is released from rest at the top point of inclined plane A and acceleration the object is found to be a, and v1 is the velocity of centre of object when it reaches the bottom. When the same process is repeated with B then corresponding values are found to be $a_2 \text{ and } v_2$.

A. $a_1 > a_2$

B. $a_1 < a_2$

C. $v_1 > v_2$

D. $v_1 < v_2$

Answer: B::D

Watch Video Solution

9. Two particles of different masses are thrown simultaneously in air. Centre of mass of two balls while both are in mid air.

A. Move in a straight line independent of initial velocities of particles

B. Move in straight line when both the particles are thrown along same vertical line

C. Have acceleration equal to g

D. Have acceleration depending on initial velocities of particles

Answer: B::C

Watch Video Solution

10. Block a of mass 4 kg is to be kept at rest against a smooth vertical wall by applying a force F as shown in figure. The force required is :- $(g = 10m/s^2)$

A. Net acceleration of sphere is in the direction of applied force F

B. Net acceleration of point of contact of sphere with plank is equal to acceleration of plank

C. Work done by friction on plank is equal to its linear kinetic energy.

D. Total kinetic energy acquired by the system is equal to work done by force F.

Answer: A::B::D

Watch Video Solution

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

A. Moment of inertia of the body

B. Angular momentum of the body

C. Linear momentum of the body

D. Kinetic energy of the body

Answer: A::C

Watch Video Solution

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

A. Moment of inertia of the body

B. Angular momentum of the body

C. Linear momentum of the body

D. Kinetic energy of the body

Answer: A::D

Watch Video Solution

13. A solid sphere is rolled on a rough surface and it is found that sphere stops after some time.

A. Friction decreases the linear speed

B. Torque of friction tries to increase the angular speed

C. Torque of normal reaction tries to decrease the angular speed

D. Normal reaction decreases the linear speed

Answer: A::B::C

Watch Video Solution

14. A disc of mass m and radius r is rotating with angular velocity, on a frictionless horizontal plane about a vertical axis passing through its centre. A ring of same mass and radius is gently placed on it in such a way that centres of both coincide. After some time it is found that both attain a common angular velocity

A. If we consider disc and ring in a single system then its angular momentum is conserved.

B. $\omega = \frac{\omega_0}{3}$

C. Loss in K.E. is double to that of final K.E. of the system

D. Loss in K.E. is 2/3 of initial K.E. of the system.

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

Watch Video Solution

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

A. After the impulse is applied, centres of both the spheres acquire same velocity.

B. Total kinetic energy of Q will be more than that of P.

C. Angular velocity of P will remain zero whereas Q will start rotating,

D. Motion of both the spheres will be identical in all respects

Answer: A::B::C

Watch Video Solution

16. A sphere and a block both are released from rest at the top of an inclined plane. After some time they reach the bottom. For all the options assume that angle made by the plane with the horizontal is more than angle of repose.

A. If surface is frictionless then sphere and block reach the bottom simultaneously.

B. If surface is rough but not sufficient for pure rolling of sphere then sphere and block reach the bottom simultaneously.

C. If surface is sufficiently rough then sphere and block may not reach the bottom simultaneously.

D. If surface is sufficiently rough then at the bottom kinetic energy of sphere will be more than that of the block.

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

View Text Solution

17. Consider a body of mass 1.0 at rest at the origin at time $t = 0$. A force $\vec{F} = \left(\alpha t\hat{i} + \beta\hat{j}\right)$ is applied on the body, where $\alpha = 1.0Ns^{-1}$ and $\beta = 1.0N$. The torque acting on the body about the origin at time $t = 1.0s$ is $\overrightarrow{\tau}$. Which of the following statements is (are) true?

A. $|\tau| = \frac{1}{3} Nm$

B. The torque is in the direction of the unit vector $+\hat{k}$

C. The velocity of the body at t=1 s is $\overrightarrow{v} = \frac{1}{2}\left(\hat{i} + 2\hat{j}\right)ms^{-1}$

D. The magnitude of displacement of the body at $t = 1 sis$(1)/(6)` m.

Answer: A::C

Watch Video Solution

18. State of the sphere at some instant of time is shown in figure. Surface below the sphere is rough. At the given instant, speed of the centre of the sphere is u and angular velocity about the centre is u/2r. Select correct statement (s)

A. Direction of friction on the sphere is towards left

B. Direction of friction on the sphere is towards right

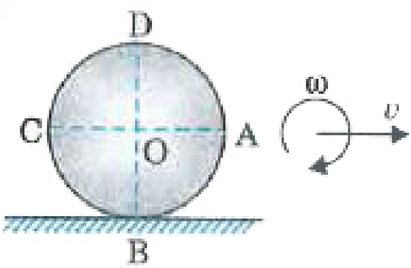
C. Angular momentum about point o remains conserved

D. Angular momentum about point B remains conserved

Answer: A::D

View Text Solution

19. A ring performs pure rolling on a horizontal surface and its state at some instant of time is shown in figure.



A. K.E. stored in the portion AB is same as K.E. stored in the portion CD

B. K.E. stored in the portion AB is same as KE. stored in the portion BC

C. K.E. stored in the portion ABC is same as K.E. stored in the portion CDA

D. K.E. stored in the portion ABC is less than K.E. stored in the portion CDA

Answer: B::D

View Text Solution

20. Two solid spheres P and Q are released from rest from the same point on an inclined plane. Plane is sufficiently rough to provide pure rolling Mass of P is greater than the mass of Q whereas radius of Q is greater than the radius of P

A. Both the spheres will reach the bottom simultaneously

B. Sphere Preaches the bottom first

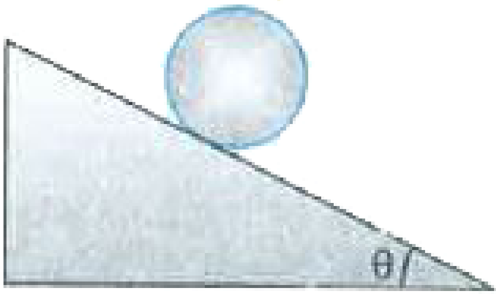
C. Sphere Q reaches the bottom first

D. K.E. of P will be more than K.E. of Q when they reach the bottom

Answer: A::D

Watch Video Solution

21. A solid cylinder is rolling down the inclined plane without slipping. Which of the following isare correct?



A. The friction force is dissipative

B. The friction force is necessarily changing

C. The friction force will aid rotation but hinder translation

D. The friction force is reduced, if ~theta~ reduced

Answer: C::D

Watch Video Solution

22. The position vector $\vec{r}$ of a particle of mass m is given by the following equation

$\vec{r}(t) = at^3\hat{i} + \beta t^2\hat{j}$ where $\alpha = 10/3ms^{-3}, \beta = 5ms^{-2}$ and $m = 0.1kg$

. At t = 1 s, which of the following statement (s) is (are) true about the particle ?

A. The velocity $\vec{v}$ is given by $\vec{v} = \left(10\hat{i} + 10\hat{j}\right)ms^{-1}$

B. The angular momentum $\vec{L}$ with respect to the origin is given by $\vec{L} = -(5/3)\hat{j}Nms$

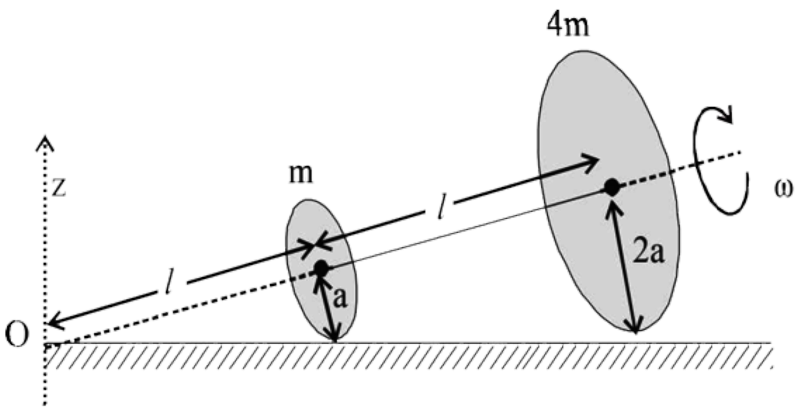
C. the forece $\vec{F}$ n is given by $\vec{F} = \left(\hat{i} + 2\hat{j}\right)N$

D. The torque $\vec{\tau}$ with respect to the origin is given by $\vec{\tau} = -(20/3)\hat{k}Nm$

Answer: A::B::D

Watch Video Solution

23. Two thin circular discs of mass m and 4m, having radii of a and 2a, respectively, are rigidly fixed by a massless, rigid rod of length $l=\sqrt{24a}$ through their centres. This assembly is laid on a firm and flat surface, and set rolling without slipping on the surface so that the angular speed about the axis of the rod is ω. The angular momemtum of the entire assembly about the point 'O' is $vacL$ (see the figure). Which of the follwing statement (s) is (are) true?



A. The magnitude of angular momentum of the assembly about its centre of mass is $17ma^2\omega/2$

B. The centre of mass of the assembly rotates about the Z-axis with an angular speed of $\omega/5$

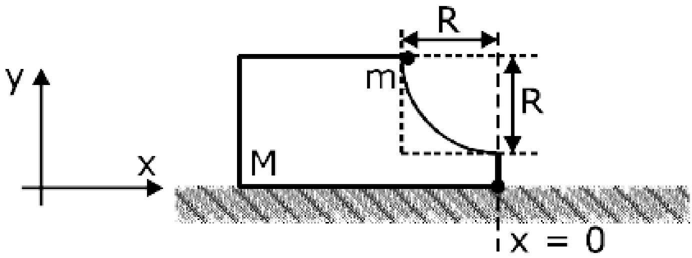
C. The magnitude of the Z-component of $\vec{L}$ is $55ma^2\omega$

D. The magnitude of angular momentum of centre of mass of the assembly about the point is $81ma^2\omega$

Answer: A::B

Watch Video Solution

24. A block of mass M has a circular cut with a frictionless surface as shown. The block rests on the horizontal frictionless surface of a fixed table. Initially the right edge of the block is at x = 0, in a co-ordinate system fixed to the table. A point mass m is released from rest at the topmost point of the path as shown and it slides down. When the mass loses contact with the block, its position is x and the velocity is v. At that instant, which of the following options is/are correct?



A. The velocity of the point mass m is : $v = \sqrt{\frac{2gR}{1 + \frac{m}{M}}}$

B. The x component of displacement of the centre of mass of the block M is : $-\frac{mR}{M + m}$

C. The position of the point mass is: $= -\sqrt{2}\frac{mR}{M + m}$

D. The velocity of the block M is $V = -\frac{m}{M}\sqrt{2gR}$

Answer: A::B

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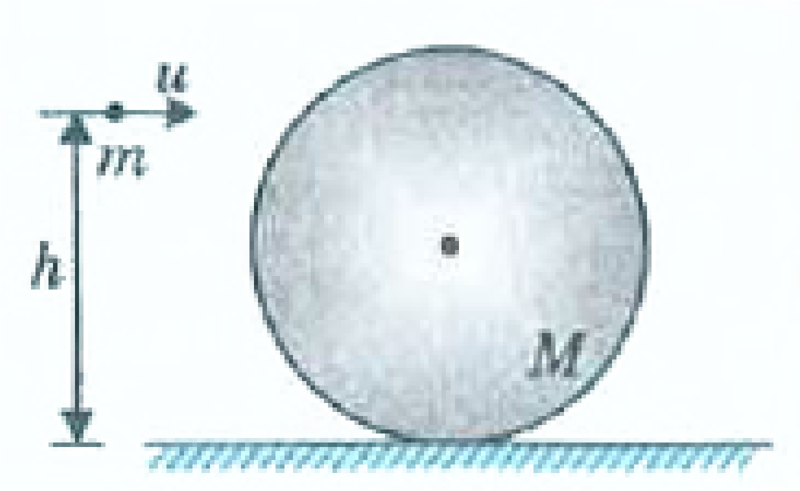
25. Sphere of mass M and radius R is kept on a rough horizontal floor. A small particle of mass m, moving horizontally with velocity, collides with the sphere and sticks to it. Line of motion of particle before collision is at a heighth above the floor. Assume that mase of sphere is very large in comparison to particle so that we may assume that centre of mass of the combined system remains at the centre of the sphere after the collision.



What will be the approximate velocity of combined system after the collision?

A. $\frac{\mathrm{mu}}{M}$

B. $\frac{\mathrm{mu}}{2M}$

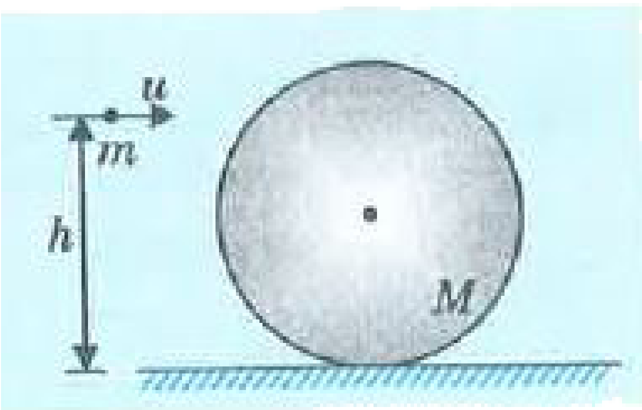
C. $\frac{2\mathrm{mu}}{M}$

D. zero

Answer: A

Watch Video Solution

26. Sphere of mass M and radius R is kept on a rough horizontal floor. A small particle of mass m, moving horizontally with velocity, collides with the sphere and sticks to it. Line of motion of particle before collision is at a heighth above the floor. Assume that mase of sphere is very large in comparison to particle so that we may assume that centre of mass of the combined system remains at the centre of the sphere after the collision.



Angular velocity of the sphere just after the collision is

A. $\frac{5\text{mu}}{2MR}$

B. $\frac{5\text{mu}(h-R)}{2MR^2}$

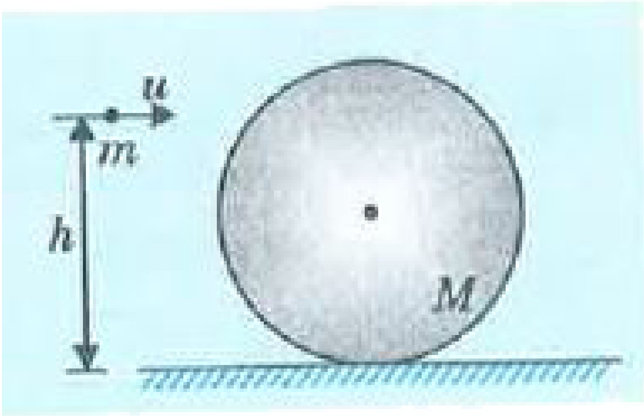
C. $\frac{2\text{mu}(h-R)}{5MR^2}$

D. $\frac{2\text{Mu}(h-R)}{2mR^2}$

Answer: B

View Text Solution

27. Sphere of mass M and radius R is kept on a rough horizontal floor. A small particle of mass m, moving horizontally with velocity, collides with the sphere and sticks to it. Line of motion of particle before collision is at a heighth above the floor. Assume that mase of sphere is very large in comparison to particle so that we may assume that centre of mass of the combined system remains at the centre of the sphere after the collision.



At what height h above the floor, particle should hit the sphere so that it may start pure rolling after the collision.

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

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

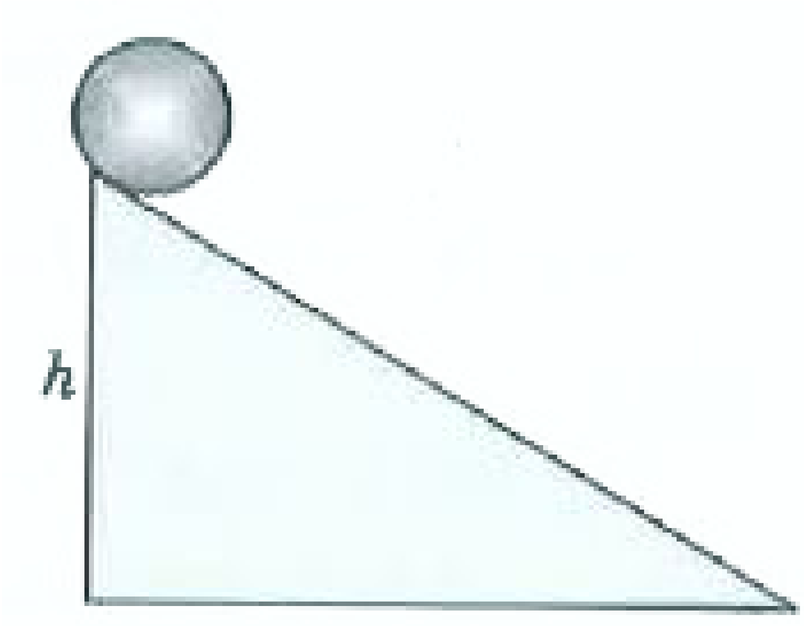
C. $\frac{3R}{7}$

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

Answer: D

View Text Solution

28. Small sphere of mass m and radius r is kept on fixed inclined rough surface. Surface makes an angle with the horizontal. Initially centre of sphere is at a height h above the horizontal floor. Coefficient of friction between the sphere and surface is u. Sphere is released from the state of rest.



Assume that friction is sufficiet enough to provide pure rolling. Speed of the sphere as it reaches the bottom is

A. $\sqrt{2gh}$

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

C. $\sqrt{\frac{10gh}{7}}$

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

Answer: C

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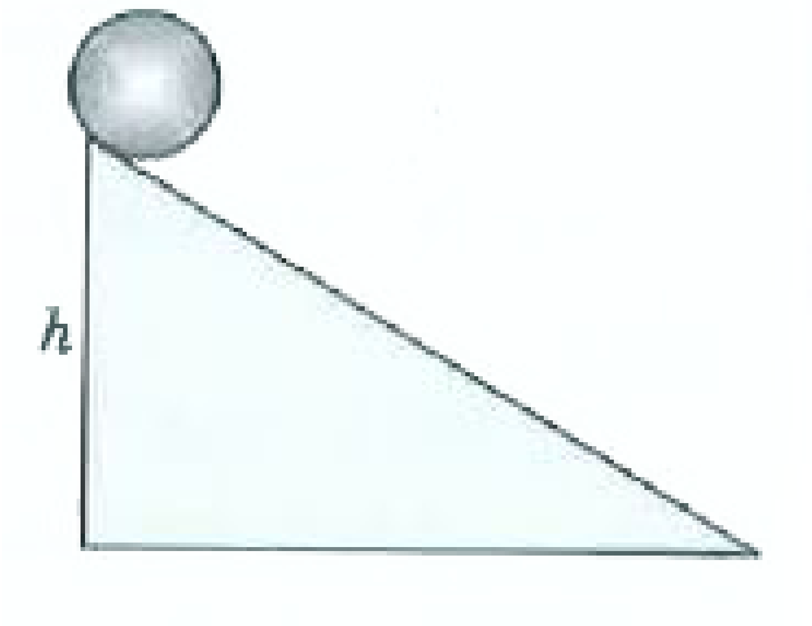
29. Small sphere of mass m and radius r is kept on fixed inclined rough surface. Surface makes an angle with the horizontal. Initially centre of sphere is at a height h above the horizontal floor. Coefficient of friction between the sphere and surface is u. Sphere is released from the state of rest.



Assume that friction is sufficient engough for pure rolling. Accleeration of the shpere is

A. $g \sin \theta$

B. $\frac{5g \sin \theta}{7}$

C. $\frac{7g \sin \theta}{5}$

D. $\frac{2g \sin \theta}{5}$

Answer: B

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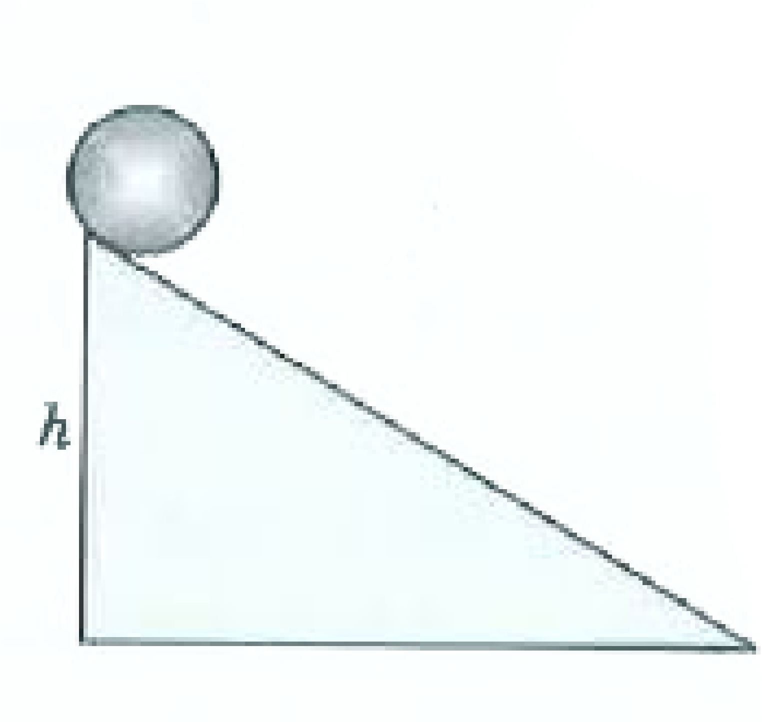
30. Small sphere of mass m and radius r is kept on fixed inclined rough surface. Surface makes an angle with the horizontal. Initially centre of sphere is at a height h above the horizontal floor. Coefficient of friction between the sphere and surface is u. Sphere is released from the state of rest.



Assume friction is not sufficient to provided pure rolling. Acceleration of the sphere is

A. $g \sin \theta - \mu g \cos \theta$

B. $g \sin \theta$

C. $\mu g \cos \theta$

D. $\frac{5}{7} g \sin \theta - \mu g \cos \theta$

Answer: A

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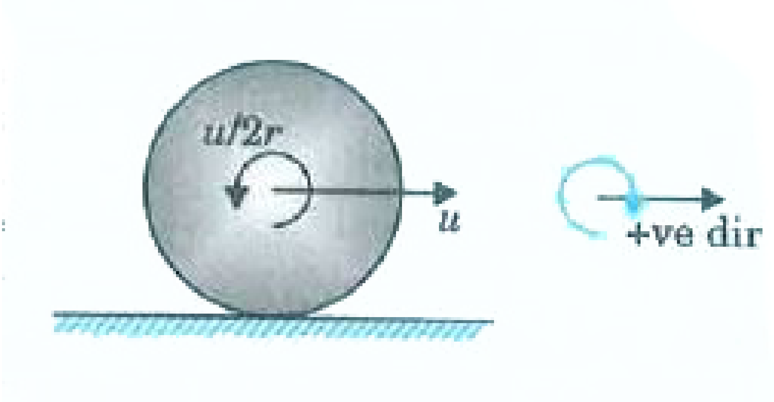
31. State of motion of the sphere at t = 0 is described in figure, Centre of the sphere is moving towards right with a speed u and angular velocity of the sphere is u/2r in the anticlockwise sense. Here r is the radius of sphere. We can understand that it is a case of slipping and after some time sphere starts pure rolling due to friction from the surface. We can assume direction towards right as positive and thus clockwise sense should be treated positive for rotational motion. Assuming coefficient of friction between sphere and the surface. Mass of sphere is m.



At what time sphere stops rotating for a moment?

A. $\frac{u}{5\mu g}$

B. $\frac{2u}{5\mu g}$

C. $\frac{3u}{7\mu g}$

D. $\frac{2u}{7\mu g}$

Answer: A

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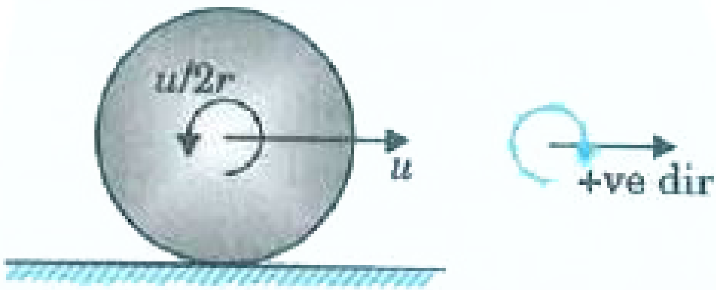
32. State of motion of the sphere at t = 0 is described in figure, Centre of the sphere is moving towards right with a speed u and angular velocity of the sphere is u/2r in the anticlockwise sense. Here is the radius of sphere. We can understand that it is a case of slipping and after some time sphere starts pure rolling due to friction from the surface. We can assume direction towards right as positive and thus clockwise sense should be treated positive for rotational motion. Assume ng coefficient of friction between sphere and the surface. Mass of sphere is m.



At what time sphere starts pure rolling?

A. $\frac{2u}{7\mu g}$

B. $\frac{3u}{5\mu g}$

C. $\frac{3u}{7\mu g}$

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

Answer: C

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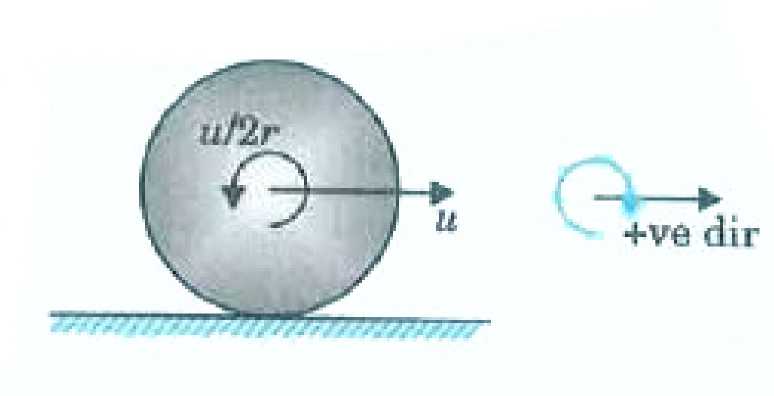
33. State of motion of the sphere at t = 0 is described in figure, Centre of the sphere is moving towards right with a speed u and angular velocity of the sphere is u/2r in the anticlockwise sense. Here is the radius of sphere. We can understand that it is a case of slipping and after some time sphere starts pure rolling due to friction from the surface. We can assume direction towards right as positive and thus clockwise sense should be treated positive for rotational motion. Assume ng coefficient of friction between sphere and the surface. Mass of sphere is m.



What will be the speed of sphere when it starts pure rolling?

A. $\frac{4u}{7}$

B. $\frac{3u}{7}$

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

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

Answer: A

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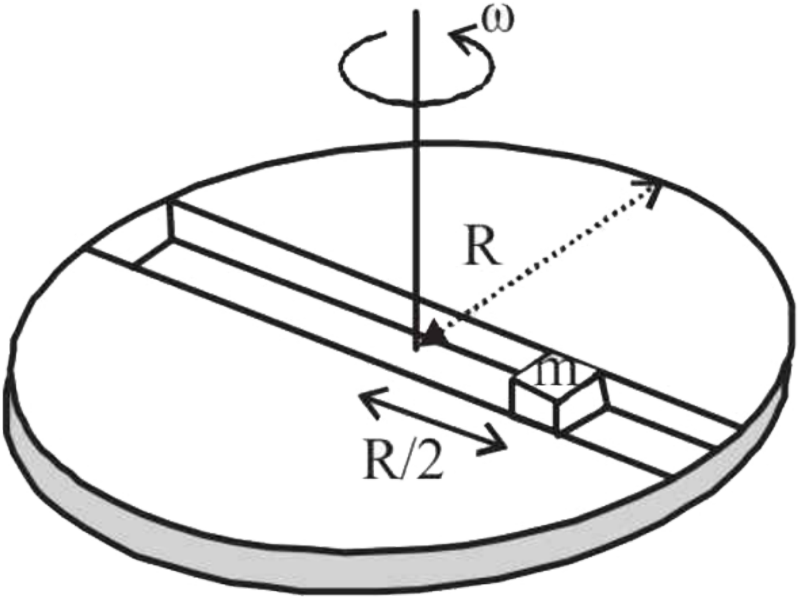
34. A frame of reference that is accelerated with respect to an inertial frame of reference is called a non-inertial frame of reference. A coordinate system fixed on a circular disc rotating about a fixed axis with a constant angular velocity ω is an example of non=inertial frame of reference. The relationship between the force $\overrightarrow{F}_{rot}$ experienced by a particle of mass m moving on the rotating disc and the force $\overrightarrow{F}_{\in}$ experienced by the particle in an inertial frame of reference is

$$\overrightarrow{F}_{rot} = \overrightarrow{F}_{in} + 2m\left(\overrightarrow{v}_{rot} \times \overrightarrow{\omega}\right) + m\left(\overrightarrow{\omega} \times \overrightarrow{r}\right) \times \overrightarrow{\omega}.$$

where $\overrightarrow{v}_{rot}$ is the velocity of the particle in the rotating frame of reference and $\overrightarrow{r}$ is the position vector of the particle with respect to the centre of the disc.

Now consider a smooth slot along a diameter fo a disc of radius R rotating counter-clockwise with a constant angular speed ω about its vertical axis through its center. We assign a coordinate system with the origin at the center of the disc, the x-axis along the slot, the y-axis perpendicular to the slot and the z-axis along the rotation axis $\left(\vec{\omega} = \omega\hat{k}\right)$. A small block of mass m is gently placed in the slot at $\vec{r}\,(R/2)\hat{\imath}$ at $t = 0$ and is constrained to move only along the slot.



The distance r of the block at time is

A. $\frac{R}{4}\left(e^{2\omega t}+e^{-2\omega t}\right)$

B. $\frac{R}{4}\left(e^{\omega t}+e^{-\omega t}\right)$

C. $\frac{R}{2}\cos 2\omega t$

D. $\frac{R}{2}\cos \omega t$

Answer: B

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35. A frame of reference that is accelerated with respect to an inertial frame of reference is called a non-inertial frame of reference. A coordinate system fixed on a circular disc rotating about a fixed axis with a constant angular velocity ω is an example of non=inertial frame of reference. The relationship between the force $\vec{F}_{rot}$ experienced by a particle of mass m moving on the rotating disc and the force $\vec{F}_{\in}$ experienced by the particle in an inertial frame of reference is

$$\vec{F}_{rot}=\vec{F}_{in}+2m\left(\vec{v}_{rot}\times\vec{\omega}\right)+m\left(\vec{\omega}\times\vec{r}\right)\times\vec{\omega}.$$

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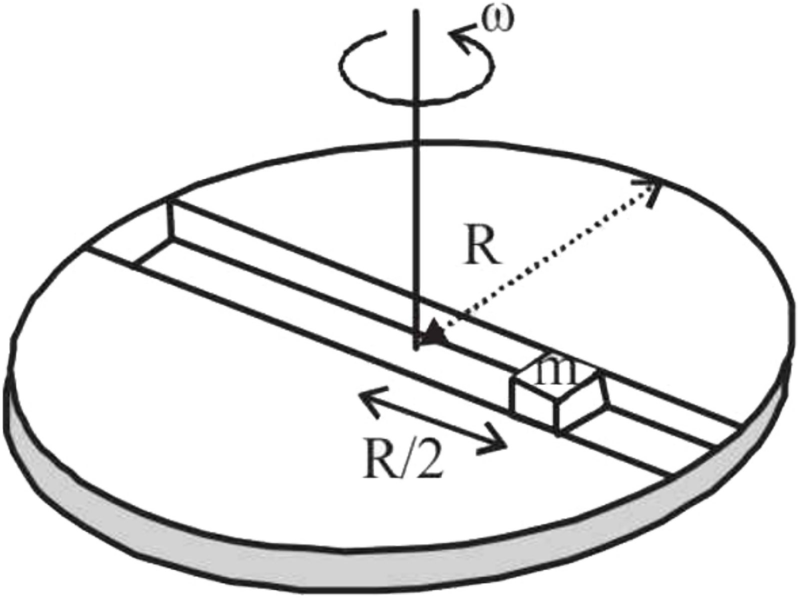

The net reaction of the disc on the block is

A. $-m\omega^2 R\cos\omega t\hat{j} - mg\hat{k}$

B. $-\omega^2 R\left(e^{2\omega t} - e^{-2\omega t}\right)\hat{j} + mg\hat{k}$

C. $m\omega^2 R\sin\omega t\hat{j} - mg\hat{k}$

D. $\frac{1}{2}m\omega^2 R\left(e^{\omega t - e^{-\omega t}}\hat{j} + mg\hat{k}\right)$

Answer: D

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Competition File Objective Type Questions Assertion Reason Type Questions

1. Assertion: When a solid sphere rolls down a sufficiently rough inclined surface then its mechanical energy remains constant.

Reason: Work done by the friction in pure rolling is zero.

A. If both assertion and reason are correct and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct

Answer: A

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2. Assertion: A boy is rotating in a rotating chair with some angular speed. Initially arma of the boy are stretched out. When boy folds his hands then angular speed increases

Reason: Angular momentum of the system is conserved in absence of external torque.

A. If both assertion and reason are correct and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct

Answer: A

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3. Assertion: We can apply $\tau = I\alpha$ about the centre of mass of the system in non-inertial frame of reference.

Reason: Torque of pseudo forces about centre of mass is zero

A. If both assertion and reason are correct and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct

Answer: A

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4. A : Work done by friction can increase the kinetic energy of the body.

R : Friction is a type of contact force and it always opposes the relative motion or tendency of relative motion.

A. If both assertion and reason are correct and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct

Answer: A

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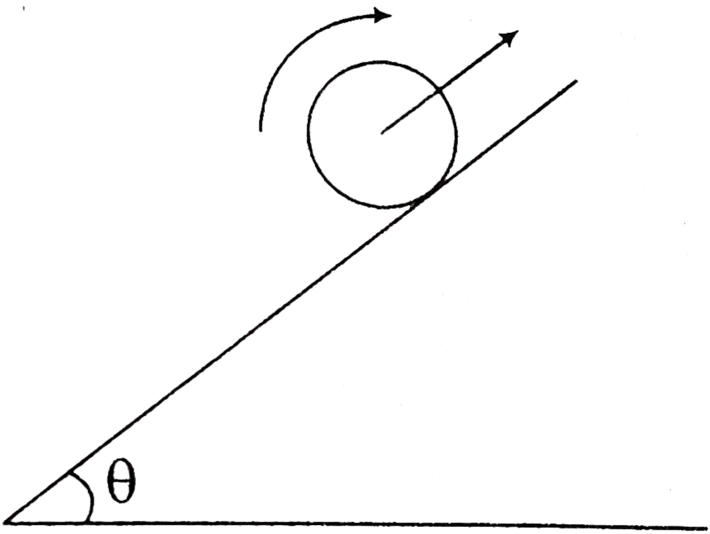
5. Assertion : A sphere is placed in pure rolling condition over a rough inclined surface.Then, force of friction will act in downward direction



Reason : Angular acceleration (actually retardation) due to friction is anti-clockwise.

A. If both assertion and reason are correct and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct

Answer: C

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6. Assertion: A carpet is wrapped like a cylinder and is pushed on a horizontal surface to unwrap. As the carpet unwraps its angular speed is found to increase.

Reason: Angular momentum of rolling part remains conserved

A. If both assertion and reason are correct and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct

Answer: C

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7. Assertion: When a sphere of perfectly hard material is rolled on a perfectly hard surface then sphere never stops.

Reason: Friction becomes zero at the contact

A. If both assertion and reason are correct and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: A

Watch Video Solution

8. Assertion: A sphere can perform pure rolling on a amooth surface.

Reason: When a sphere performs pure rolling on sufficiently rough surface then acceleration of point of contact is not equal to zero.

A. If both assertion and reason are correct and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct

Answer: B

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9. A cubical block of ice of maas m and edge L is placed in a large tray of maas M. If the ie melts, how far does the centre of maas of the system "ice plus tray" come down?

A. If both assertion and reason are correct and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect.

D. If both assertion and reason are incorrect.

Answer:

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

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

A. If both assertion and reason are correct and reason is the correct explanation of the assertion.

B.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct

Answer: B

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Competition File Objective Type Questions Matching Type Questions

1. First list includes the name of object rolling down an inclined plane. Inclined plane makes an angle with the horizontal. Friction is sufficient enough for pure rolling Second list includes linear acceleration of object along the plane. Match the two lists.

List-I		List-II	
P	Ring	1	$\frac{5}{7} g \sin \theta$
Q	Hollow sphere	2	$\frac{1}{2} g \sin \theta$
R	Disc	3	$\frac{2}{3} g \sin \theta$
S	Solid sphere	4	$\frac{3}{5} g \sin \theta$

A. $\begin{matrix} P & Q & R & S \\ 4 & 1 & 2 & 3 \end{matrix}$

B. $\begin{matrix} P & Q & R & S \\ 1 & 3 & 4 & 2 \end{matrix}$

C. $\begin{matrix} P & Q & R & S \\ 2 & 4 & 3 & 1 \end{matrix}$

D. $\begin{matrix} P & Q & R & S \\ 4 & 2 & 1 & 3 \end{matrix}$

Answer: C

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2. First list includes the name of object kept on a frictionless horizontal surface. Radius of the object is r. A constant horizontal force is applied on the object at a heighth above the centre. Object is found to perform pure rolling Second list includes possible value of h according to nature of object. Match the two lists.

List-I		List-II	
P	Ring	1	$2r/3$
Q	Hollow sphere	2	$r/2$
R	Disc	3	$2r/5$
S	Solid sphere	4	r

A. $\begin{matrix} P & Q & R & S \\ 4 & 1 & 2 & 3 \end{matrix}$

B. $\begin{matrix} P & Q & R & S \\ 3 & 1 & 2 & 4 \end{matrix}$

C. $\begin{matrix} P & Q & R & S \\ 3 & 4 & 2 & 1 \end{matrix}$

D. $\begin{matrix} P & Q & R & S \\ 4 & 2 & 1 & 3 \end{matrix}$

Answer: A

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3. A person in a lift is holding a water jar, which has a small hole at the lower end of its side. When the lift is at rest, the water jet coming out of the hole hits the floor of the lift at a distance d of 1.2 m from the person. In the following, state of the lift's motion is given in List I and the distance where the water jet hits the floor of the lift is given in List II. Match the statements from List I with those in List II and select the correct answer using the code given below the lists.

List-I	List-II
P Lift is accelerating vertically up.	1 $d = 1.2$ m
Q Lift is accelerating vertically down with an acceleration less than the gravitational acceleration.	2 $d > 1.2$ m
R Lift is moving vertically up with constant speed.	3 $d < 1.2$ m
S Lift is falling freely.	4 No water leaks out of the jar

A. $\begin{matrix} P & Q & R & S \\ 2 & 3 & 2 & 4 \end{matrix}$

B. $\begin{matrix} P & Q & R & S \\ 2 & 3 & 1 & 4 \end{matrix}$

C. $\begin{matrix} P & Q & R & S \\ 1 & 1 & 1 & 4 \end{matrix}$

D. $\begin{matrix} P & Q & R & S \\ 2 & 3 & 1 & 1 \end{matrix}$

Answer: C

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1. Each question contains statements given in two columns, which have to be matched. Statements in column-I are labelled as A and D whereas statements in column-II CP are labelled as p, q, r and S. Match the entries of DP S column-I with appropriate entries of column-II. Each entry in column-I may have one or more than one correct option from column-II. The answers to these questions have to be appropriately bubbled as illustrated in the given example, if the correct matches are $A \to (q, r), B \to (p, s), C \to (r, s)$ and $D \to (q)$.

Column-I		Column-II	
(A)	A sphere is rolling down a sufficiently rough inclined plane.	(p)	Mechanical energy is conserved
(B)	A sphere is performing pure rolling on a smooth horizontal surface	(q)	Angular momentum about the centre remains conserved
(C)	A sphere is rolling down an inclined rough plane with slipping	(r)	Angular momentum about the point of contact with the surface remains conserved
(D)	A sphere is slipping on a rough horizontal surface	(s)	Energy dissipates in the form of heat

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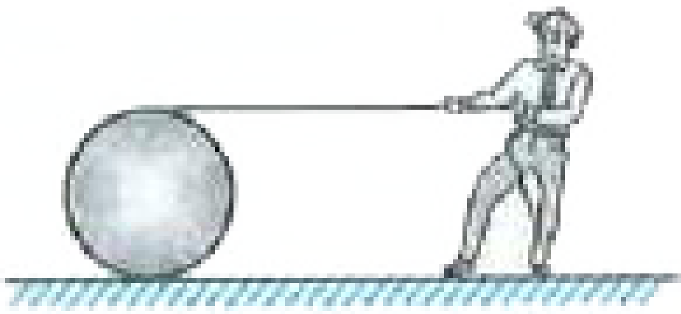
1. String is wrapped on a cylinder and free end of the string is pulled by a man as shown in figure. Horizontal surface is sufficiently rough. Person pulls l_1 length of string and centre of the cylinder is found to move by a distance l_2. Calculate l_1 / l_2.



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2. A hollow cylinder of mass m and radius r is kept on a smooth horizontal surface. Horizontal force F is applied at a height above the centre. Find the value of h/R so that ring performs pure rolling on the surface.

A. 1

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

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

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

Answer: A

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3. A very small solid sphere is set rolling on a rough horizontal track which becomes circular after certain distance. Radius of the circular portion of the track is R which is large compared to radius r of the sphere. Ifaim is that sphere should complete the circle successfully then minimum required speed at the bottom is found to be $\sqrt{\frac{27gR}{n}}$ Calculate

.

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4. A solid sphere is rolling on a horizontal surface such that speed of the centre of sphere is u. Mase of the sphere is m and radius R. Magnitude of angular momentum about the point of contact is found to be $\frac{7}{n} mvR/$. Find the value of n

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5. A ring is set to rotate with angular speed ω_0 in gravity-free space. Ring is made from flexible material and due to centrifugal action its radius starts increasing slowly. After some time radius of ring becomes twice of its initial value and its angular velocity is found to be ω . Calculate ω_0 / ω.

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6. Atube is completely filled with some incompressible liquid having total mass m. Length of the tube is L. Tube is rotated in horizontal plane, about one of its ends and force exerted by the tube on liquid on the other end is found to be $\frac{1}{n}mL\omega^2$. Here ω is uniform angular velocity of tube. Calculate the value of n.

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7. Moment of inertia of the rod about an axis passing through the end and perpendicular to the length of the rod is I_0. If axis of rotation is inclined at an angle 30° with the length then moment of inertia is found to be I. Calculate value of I_0 / I

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8. A ring and a disc are initially at rest, side by side, at the top of an inclined plane which makes an angle 60° with the horizontal. They start to roll without slipping at the same instant of time along the shortest path. If the time difference between their reaching the ground is $(2 - \sqrt{3}) / \sqrt{10s}$ 2– 3 / 10s, then the height of the top of the inclined plane, in metres, is ___________ . Take $g = 10ms^{-2}$

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9. A solid sphere is released from the state of rest on an inclined plane. Mass of the sphere is m and its radius is r. Inclined plane makes an angle with the horizontal. If minimum coefficient of friction required for pure rolling is $\frac{n}{7}\tan\theta$ then calculate value of n.

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10. A particle of mass m is moving perpendicular to a rod of length L kept on a frictionless horizontal surface and collides at a distance L/4 from the centre of rod. Particle comes to state of rest just after collision. Mass of rod is M and speed of particle before collision is u. Let v is the velocity of centre of rod after collision and is angular velocity attained by the rod. Find $\frac{L\omega}{v}$

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11. A binary star consists of two stars $A(mass 2.2M_s)$ and B $(mass 11M_s)$ where M_s is the mass of the sun, they are separted by distane d and are rotating about their center of mass, which is stationary. The ratio of the total angular momentum of the binary to the angular momentum of star B about the centre of mass is

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12. A uniform circular disc of mass 50kg and radius 0.4 m is rotating with an angular velocity of $10 rads^{-1}$ about its own axis, which is vertical. Two uniform circular rings, each of mass 6.25 kg and radius 0.2 m, are gently placed symmetrically on the disc in such a manner that they are touching each other along the axis of the disc and are horizontal. Assume that the friction is large enough such that the rings are at rest relative to the disc and the system rotates about the original axis. The new angular velocity $(\in reds^{-1})$ of the system is

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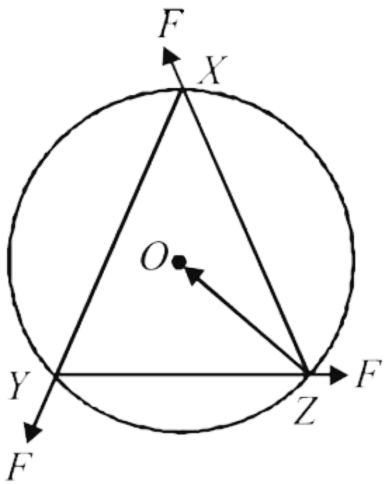
13. A uniform circular disc of mass 1.5 kg and raius 0.5 m is initially ar rest on a horioznatal frictonless surface. Three forces of equal matgnitude F = 0.5 N are applied simultaneously along the three sides of an equilateral triangle XYZ with its vertices on the perimeter of the disc (see figure). One second after applying the forces the angular speed of the disc in $rads^{-1}$ is



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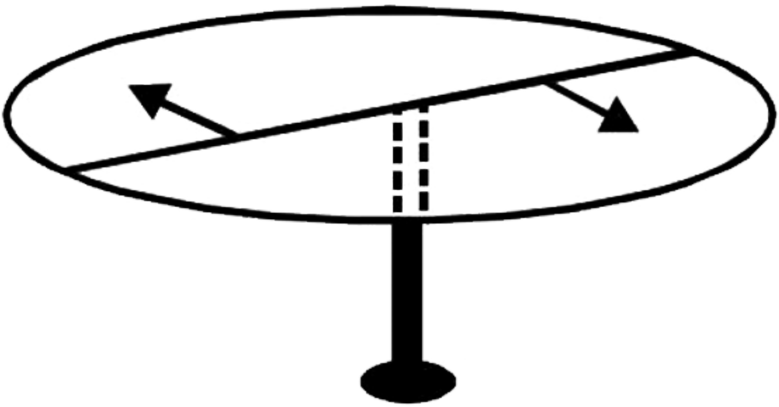
14. A horizontal circular platform of radius 0.5 m and mass axis. Two massless spring toy-guns, each carrying a steel ball of mass 0.05 kg are attached to the platform at a distance 0.25m from the centre on its either sides along its diameter (see figure). Each gun simultaneously fires the balls horizontally and perpendicular to the diameter in opposite directions. After leaving the platform, the balls have horizontal speed of $9ms^{-1}$ with respect to the ground. The rotational speed of the platform in $rads^{-1}$ after the balls leace the platform is



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15. The densitis of two solid spheres A and B of the same radii R very with radial distance $rasp_A(r) = k\left(\frac{r}{R}\right)$ and $p_B(r) = k\left(\frac{r}{(R)^5}\right.$, respectively, where k is a constant . The moments of inertia of the inividual spheres about axes passing throgh their centres are I_A and I_B respectively. if $\frac{I_B}{I_A} = \frac{n}{10}$, the value of n is

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Chapter Practice Test For Board Examination

1. Can centre of mass of a body lie where there is absolutely no mass ?

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2. Which component of linear momentum does not contribute to angular momentum ?

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3. Can a body moving in a circular path be at equilibrium?

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4. Does the moment of inertia of a body change with the speed of rotation ?

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5. Two lenses, one convex and other concave, are of same mass and same radius. Which will have greater moment of inertia?

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6. Why the handles of the doors are at maximum distance from the hinges?

Watch Video Solution

7. State and explain parallel axis theorem and perpendicular axis theorem.

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8. If earth were to shrink suddenly, what would happen to the length of the day ?

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9. The angular momenta of two bodies X and Y are equal and moment of inertia of X is greater than that of Y. Which of the two will have greater kinetic energy?

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

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

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11. Show that the angular momentum of a particle is equal to twice the product of mass and areal velocity.

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12. Establish a relation between angular momentum and moment of inertia of a rigid body.

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13. Write the relation between electric power (W) of a device with potential differnece (Volt) across it and current (amp) flowing through it.

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14. How will you distinguish between a hard boiled egg and a raw egg by spinning each on a table top ?

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15. The speed of the motor of an engine is 300 rpm. In 2 s, the speed increases to 420 rpm. Calculate the number of revolutions made by the motor.

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16. Derive an expression for the acceleration of a solid cylinder rolling without slipping down an inclined plane. Also find the minimum coefficient of friction required for pure rolling

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