PHYSICS

BOOKS - DHANPAT RAI & CO PHYSICS (HINGLISH)

System of particles & rotational Motion

EXAMPLE

1. What is meant by a particle, a system and internal and external Force?

2. What do you meant by centre of mass of a system? How does its differ from centre of gravity?

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

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4. Write an expression for the position vector of the centre of mass of n-particle system. Also write the equations of motion which govern the motion of the centre of mass

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5. Show that in the absence of any external force, the velocity of the centre of mass remains constant.

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6. Show that the total linear momentum of a system of particles is conserved in the absence of any external force. Also show that total linear momentum of the system is equal to the product of the total mass of the system and the velocity of its centre of mass.

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7. Find the centre of gravity of a triangular lamina, each side of which measures $9\sqrt{3}$ cm

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8. Three masses 3,4 and 5 kg are located at the corners of an equilateral triangle of side 1m. Locate to centre of mass of the system.

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9. Two particle of masses 100g and 300 g at a given time have positions $2\hat{i} + 5\hat{j} + 13\hat{k}$ and $-6\hat{i} + 4\hat{j} - 2\hat{k}$m respectively and velocities $10\hat{i} - 7\hat{j} - 3\hat{k}$ and $7\hat{i} - 9\hat{j} + 6\hat{k}$ms^{-1} respectively. Determine the instantaneous position and velocity of CM.

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10. 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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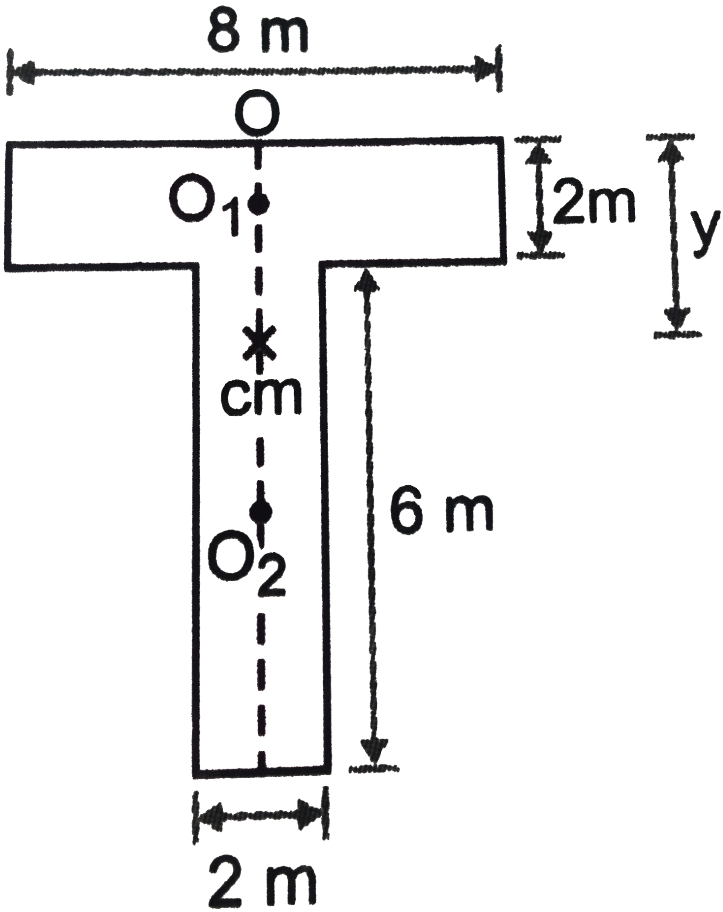
11. Find the position of centre of mass of the T-shaped plate from O, in Fig.



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12. 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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13. A uniform circular plate of uniform thickness has a diameter of 56 cm. A circular portion of diameter 42 cm is removed from the edge of the plate. Find the position of the centre of mass of the remaining portion.

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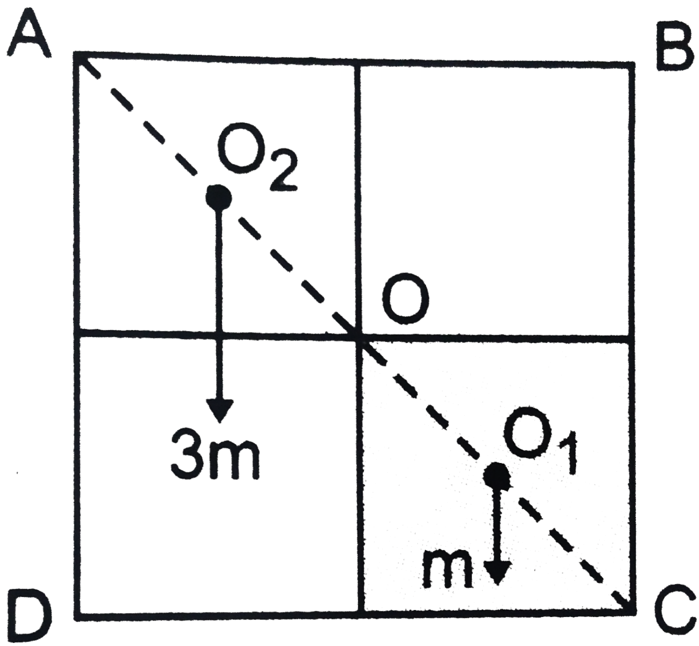
14. A square of side $4m$ having uniform thickness is divided into four equal squares as shown in Fig. If one of the squares is cut off, find



the position of centre of mass of the remaining portion from the centre O.

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15. Show that the centre of mass of uniform rod of mass M and length L lies at the middle point of the rod.

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16. Determine the position of the centre of mass of a hemisphere of radius R.

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17. Determine the coordinate of the centre of mass of a right circular solid cone of base radius R and height h.

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18. What is a rigit body? Give Examples.

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19. On what factors does the position of cm of a rigid body depend ?

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20. What do you mean by rotational motion of a rigid body?

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21. On the application of a constant torque , a wheel is turned from rest through 400 radians in 10 s. The angular acceleration is :

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22. ANGULAR ACCELERATION

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23. The angular speed of a motor wheel is increased from 120 rpm to 3120 rpm in 16 seconds. The angular acceleration of the motor wheel is

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24. A constant torque is acting on a wheel. If starting from rest, the wheel makes n rotations in t seconds, show that the angular acceleration is given by $\alpha = \frac{4\pi n}{t^2} rads^{-2}$.

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25. The radius of a wheel of car is $0.4m$. The car is accelerated from rest by an angular acceleration of $1.5 rad / s^2$ for $20s$. How much distance will the wheel cover in this time and what will be its linear velocity ?

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26. The turning effect of the applied force does NOT depend upon

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27. Find the term of an A.B is p and its common difference is q. Find its 10^th trem

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28. State and explain the principle of moments of rotational equilibrium. Define mechanical advantage.

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29. What is a couple ? What effect does it have on a body ?

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30. Obtain an expression for work done by a gas in an isothermal expansion.

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31. Explain how torque can be expressed as a vector product of two vectors. How is the direction of torque determined ?

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32. Define the term angular momentum. Give its units and dimensions.

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33. The relation between the torque τ and angular momentum L of a body of moment of inertia I rotating with angular velocity ω is

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34. Prove that the angular momentum of a particle is equal to twice the product of its mass and areal velocity.

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35. Prove that the rate of change of total angular momentum of a system of particles is equal to the total torque acting on the system.

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36. (i) Find the torque of a force $7\hat{i} + 3\hat{j} - 5\hat{k}$ about the origin. The force acts on a particle whose position vector is $\hat{i} - \hat{j} + \hat{k}$.

(ii) Show that moment of a couple does not depend on the point about which you take the moments.

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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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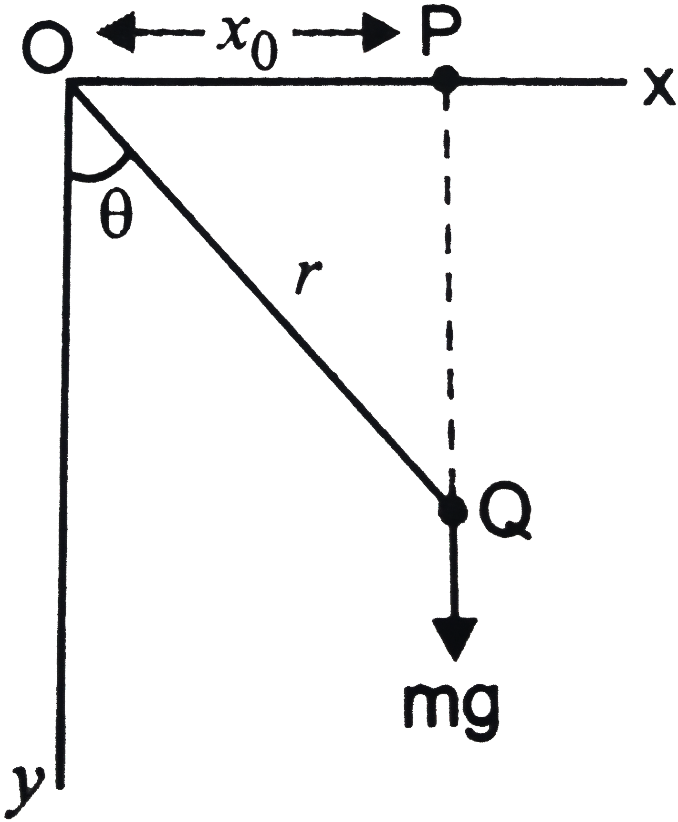
38. A particle of mass m is released from rest from point P at $x = x_0$ on X-axis from origin O and falls vertically along y-axis as shown in Fig. What is the magnitude of the torque acting on the particle at time t, when it is at the point $Qw.\,r.\,t.\,O$?



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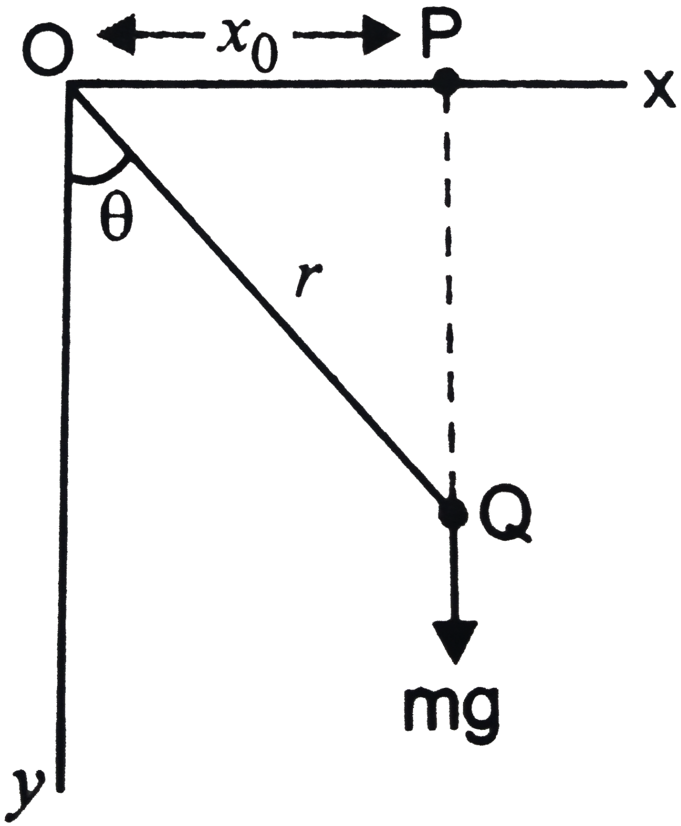
39. A particle of mass m is released from rest from point P at $x = x_0$ on X-axis from origin O and falls vertically along y-axis as shown in Fig. What is the magnitude of the torque acting on the particle at time t, when it is at the point $Q w.r.t. O$?



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40. An electron of mass 9×10^{-31} kg revolves in a circle of radius 0.53 Å around the nucleus of hydrogen with a velocity of $2.2 \times 10^{6} \mathrm{ms}^{-1}$. Show that its angular momentum is equal to $h/2\pi$, where h is Plank's constant of value $6.6 \times 10^{-34} Js$

.

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41. Show that angular momentum of a satellite of mass M_s revolving around earth of mass M_e in an orbit of radius r is $\sqrt{GM_s^2 M_e r}$.

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42. Define a rigid body. What is meant by the term equilibrium ?

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43. Distinguish between stable, unstable and neutral equilibria of a body.

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44. Moment of inertia of a body depends upon

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

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46. Mention some practical applications which make use of the property of moment of inertia

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47. A body is rotating with uniform angular velocity w about an axis. Establish the formula for its kinetic energy of rotation. Define moment of inertia of the body with respect to the axis of rotation on this basis

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48. The radius of gyration of a body depends upon

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49. State and prove theorem of perpendicular axes.

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50. State and prove theorem of parallel axes.

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51. Derive an expression for moment of inertia of a thin circular ring about an axis passing through its centre and perpendicular to the plane of the ring.

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

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53. Derive an expression for moment of inertia of a thin circular ring about an axis passing through its centre and perpendicular to the plane of the ring.

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

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

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56. Calculate the moment of inertia of a disc about its any diameter ?

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57. Derive an expression for moment of inertia of a thin circular ring about an axis passing through its centre and perpendicular to the plane of the ring.

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58. State the expression for the moment of inertia of a thin uniform disc about an axis perpendicular to its plane and through its centre. Hence deduce the expression for its moment of inertia about a tangential axis perpendicular to its plane.

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59. Derive an expression for moment of inertia of a thin circular ring about an axis passing through its centre and perpendicular to the plane of the ring.

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60. Derive an expression for moment of inertia of a thin circular ring about an axis passing through its centre and perpendicular to the plane of the ring.

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61. Moment of inertia of a hollow cylinder of mass M and radius R, about the axis of cylinder is

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62. State the expression for the moment of inertia of a solid cylinder of uniform cross section about an axis through its centre and perpendicular to its length.

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63. State the expression for the moment of inertia of a solid cylinder of uniform cross section about an axis through its centre and perpendicular to its length.

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

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65. A wheel of mass 8 kg and radius of gyration 25 cm is rotating at 300 rpm. What is its moment of inertia ?

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66. Three point masses m_1, m_2 and m_3 are located at the vertices of an equilateral triangle of side α. What is the moment of inertia of the system about an axis along the altitude of the triangle passing through m_1?

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67. Three balls of masses $1kg, 2kg$ and $3kg$ are arranged at the corners of an equilateral triangle of side $1m$. What will be the moment of inertia of the system and perpendicular to the plane of the triangle.

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68. Four particles of masses $4kg, 2kg, 3kg$ and $5kg$ are respectively located at the four corners A, B, C, D of a square of side $1m$. Calculate the moment of inertia of the system about

(i) the axis passing through point of intersection of the diagonals and perpendicular to the plane of the square. (ii) side AB (ii) diagonal BD.

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69. Four particles of masses $4kg, 2kg, 3kg$ and $5kg$ are respectively located at the four corners A, B, C, D of a square of side $1m$. Calculate the moment of inertia of the system about

(i) the axis passing through point of intersection of the diagonals and perpendicular to the plane of the square. (ii) side AB (ii) diagonal BD.

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70. Four particles of masses $4kg, 2kg, 3kg$ and $5kg$ are respectively located at

the four corners A, B, C, D of a square of side $1m$. Calculate the moment of inertia of the system about

(i) the axis passing through point of intersection of the diagonals and perpendicular to the plane of the square. (ii) side AB (ii) diagonal BD.

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71. Calculate the moment of inertia of a cylinder of length $1.5m$, radius $0.05m$ and density $8 \times 10^3 kg / m^3$ about the axis of the cylinder.

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72. Calculate the moment of inertia of the earth about its diameter, taking it to be a sphere of 10^{25} kg and diameter 12800 km.

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73. Four spheres of diameter 2a and mass M are placed with their centres on the four corners of a square of side b. Then moment of inertia of the system about an axis about one of the sides of the square is :-

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74. Two point masses of 2kg and 10 kg are connected by a weightless rod of length 1.2 m. Calculate the $M.I.$ of the system about axis pasing through the centre of mass and perpendicular to this system.

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75. Find the moment of inertia of a rectangular bar magnet about an axis passing through its centre and parallel to its thickness. Mass of magnet is

$100g$, its length is $12cm$, breadth is $3cm$ and thickness is $2cm$.

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76. 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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77. Find the radius of gyration of a hollow uniform sphere of radius R about its tangent.

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78. Find the radius of gyration and moment of inertia of a rod of mass $100g$ and length $1m$ about an axis passing through its centre and perpendicular to its length.

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79. A wheel is rotating at a speed of 1000 rpm and its $KEis10^6 J$. What is moment of inertia of the wheel about its axis of rotation ?

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80. Calculate the KE of rotation of a circular disc of mass $1kg$ and radius $0.2m$ rotating about an axis passing through its centre and perpendicular to its plane. The disc is making $30 / \pi$ rotations per minute.

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81. An energy of $484J$ is spent in increasing the speed of a flywheel from 60 rpm to 360 rpm. Calculate moment of inertia of flywheel.

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82. Calculate rotational $K.E.$ of earth about its own axis, taking it to be a sphere of mass $6 \times 10^{24} kg$ and radius $6400 km$.

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83. A metre stick is held vertically with one end on the floor and is then allowed to fall . Find the speed of the other end when it hits the floor , assuming that the end of the floor does not slip . Take g = 10 m/s^2.

$[\sqrt{30}m / s]$

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84. A uniform circular disc of mass m is set rolling on a smooth horizontal table with a uniform linear velocity v. Find the total K.E. of the disc.

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85. A solid sphere is rolling on a frictionless plane surface about the axis of symmetry. Find the rotational energy of the sphere. Also, find the ratio of rotational $K.E.$ to total energy.

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86. A wheel of mass $5kg$ and radius $0.40m$ is rolling on a road without sliding with angular velocity $10rads^{-1}$. The moment of ineria of the wheel about the axis of rotation is $0.65kgm^2$. The percentage of kinetic energy of rotate in the total kinetic energy of the wheel is.

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87. A solid cylinder rolls down an inclined plane. Its mass is $2kg$ and $radius 0.1m$. It the height of the inclined plane is $4m$, what is its rotational $K.E.$ when it reaches foot of the plane ? Assume that the surfaces are smooth. Take $M.I.$ of solid cylinder about its axis = $mr^2/2$.

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88. A bucket of mass $8kg$ is supported by a light rope wound around a solid wooden cylinder of mass $12kg$ and $radius20cm$, free to rotate about its axis. A man holding the free end of the rope with the bucket and the cylinder at rest initially, lets go the bucket freely downward in a well $50m$ deep. Neglecting friction, obtain the speed of bucket and angular speed of the cylinder just before the bucket enters water. Take $g = 10m/s^2$.

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89. Relate torque with angular acceleration

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

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91. A torque of 2.0×10^{-4} Nm is applied to produce an angular acceleration of 4rad s^{-2} in a rotating body. What is the moment of inertia of the body ?

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92. 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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93. A flywheel of mass 25 kg has a radius of 0.2 m. What force should be applied tangentially to the rim of the flywheel so that it acquires an angular acceleration of 2rad s^{-2} ?

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94. A torque of 10 Nm is applied to a flywheel of mass 10 kg and radius of gyration 50 cm. What is the resulting angular acceleration ?

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95. A grindstone has moment of inertia of $6kgm^2$. A constant torque is applied and the grindstone is

found to have a speed of 150 rpm, 10 second after satrting from rest. Calculate the torque.

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96. A flywheel of mass 25 kg has a radius of 0.2 m. It is making 240 r.p.m. what is the torque necessary to bring it to rest in 20 s ? If the torque is due to a force applied tangentially on the rim of the flywheel, what is the magnitude of the force ?

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97. A cord is wound around the circumference of a wheel of diameter 0.3 m. The axis of the wheel is horizontal. A mass of 0.5 kg is attached at the end of the cord and it is allowed to fall from rest. If the weight falls 1.5 m in 4s, what is the angular acceleration of the wheel ? Also find out the moment of inertia of the wheel.

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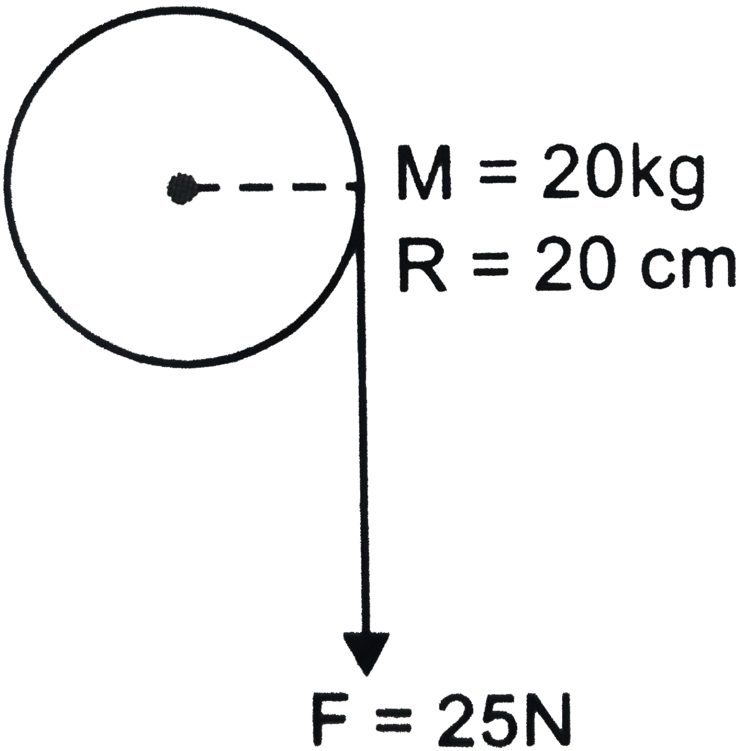
98. A cord of negligible mass is wound round the rim of a flywheel of mass $20kg$ and radius $20cm$. A steady pull of $25N$ is applied on the cord as shown in Fig. The flywheel is mounted on a horizontal axle with frictionless bearings.



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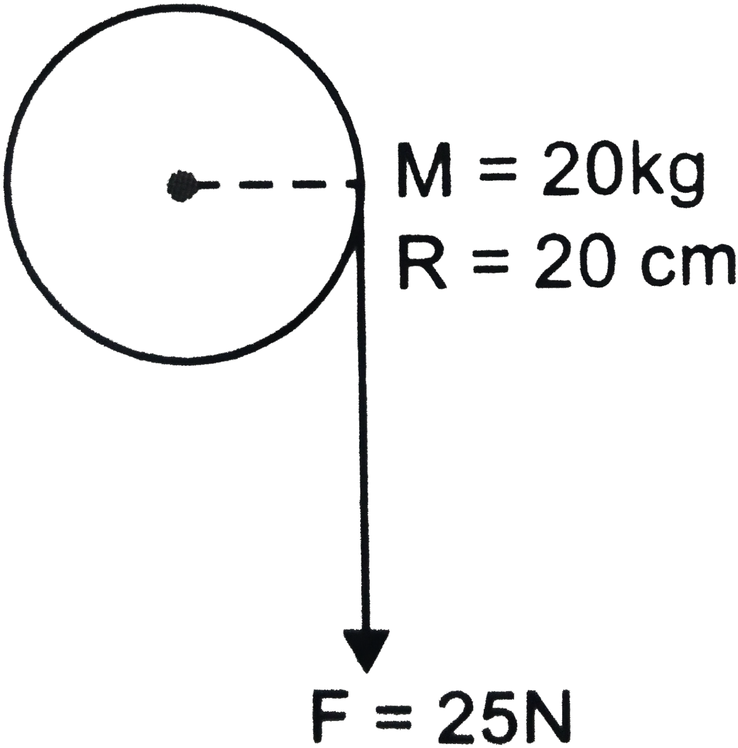
99. A cord of negligible mass is wound round the rim of a flywheel of mass $20kg$ and radius $20cm$. A steady pull of $25N$ is applied on the cord as shown in Fig. The flywheel is mounted on a horizontal axle with frictionless bearings.



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

A. 25 N

B.

C.

D.

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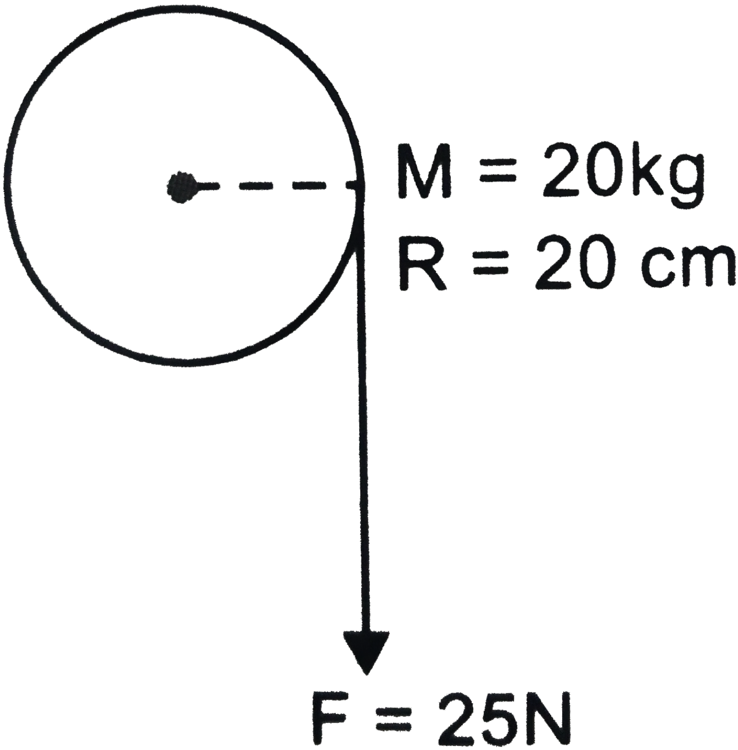
100. A cord of negligible mass is wound round the rim of a flywheel of mass $20kg$ and radius $20cm$. A steady pull of $25N$ is applied on the cord as shown in Fig. The flywheel is mounted on a horizontal axle with frictionless bearings.



(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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101. How much tangential force would be needed to stop the earth in one year, if it were rotating with angular velocity of $7.3 \times 10^{-5} \text{rad s}^{-1}$? Given the moment of inertia of the earth $= 9.3 \times 10^{37} \text{kg m}^2$ and radius of the earth $= 6.4 \times 10^6$ m.

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102. The angular momentum of a body is 31.4 Js and its rate of revolution is 10 cycles per second. Calculate the moment of inertia of the body about the axis of rotation.

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103. A $40kg$ flywheel in the from of a uniform circular disc of $1m$ radius is making 120 rpm. Calculate the angular momentum.

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104. A ring of diameter 0.4 m and of mass 10 kg is rotating about its axis at the rate 2100 rpm. Find (i) moment of inertia (ii) angular momentum

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105. A ring of diameter $0.4m$ and of mass $10kg$ is rotating about its axis at the rate of 2100 rpm. Calculate moment of inertia, angular momentum and rotational KE of the ring.

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106. A ring of diameter $0.4m$ and of mass $10kg$ is rotating about its axis at the rate of 2100 rpm. Calculate moment of inertia, angular momentum and rotational KE of the ring.

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107. Calculate the angular momentum of the earth rotating about its own axis. Mass of the earth $= 5.98 \times 10^{27}$ kg, mean radius of the earth $= 6.37 \times 10^6 m$, $M.I$ of the earth $= \frac{2}{5}MR^2$.

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108. A cylinder of mass $5kg$ and radius $30cm$ and free to rotate about its axis receives an angular impulse of $3kgm^2s^{-1}$ initially, followed by a similar impulse after every 4 second. What is the angular speed of the cylinder $30s$ after the initial impulse ? The cylinder is at rest initially.

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109. State the law of conservation of angular momentum.

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110. A small block is rotating in a horizontal circle at the end of a thread which passes down through a hole at the centre of table top. If the system is rotating at 2.5 rps in a circle of 30 cm radius, what will be the speed of rotation when the thread is pulled inwards to decrease the radius to 10 cm ? Neglect friction.

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111. A star of mass twice the solar mass and radius 10^6 km rotates about its axis with an angular speed of $10^{-6} \text{rad} s^{-1}$. What is the angular speed of the star when it collapses (due to inward gravitational) force) to a radius of $10^4 km$?

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

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113. What will be the duration of the day, if earth suddenly shrinks to 1/64 of its original volume, mass remaining the same ?

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114. The maximum and minimum distances of a comet from the sun are $1.4 \times 10^{12} m$ and 7×10^{10} m. If is velocity nearest to the sun is $6 \times 10^{4} ms^{-1}$, what is the velocity in the fartest position ? Assume that path of the comet in both the instantaneous positions is circular.

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115. A horizontal disc rotating about a vertical axis passing through its centre makes 180 rpm. A small piece of wax of mass 10 g falls vertically on the disc and adheres to it at a distance of 8 cm from its axis. If the frequency is thus reduced to 150 rpm, calculate the moment of inertia of the disc.

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116. Kinetic energy of a body rolling without slipping is

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117. A cylinder of mass $5kg$ and radius $30cm$ is rolling down an inclined plane at an angle of 45° with the horizontal. Calculate (i) force of friction (ii) acceleration of cylinder (iii) minimum value of coeff. of static friction so that cylinder does not slip while rolling down the plane.

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118. A cylinder of mass $5kg$ and radius $30cm$ is rolling down an inclined plane at an angle of 45° with the horizontal. Calculate (i) force of friction (ii) acceleration of cylinder (iii) minimum value of coeff. of static friction so that cylinder does not slip while rolling down the plane.

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119. A cylinder of mass 5kg and radius 30 cm is rolling down an inclined place at an angle of 45°

with the horizontal. Calculate (i) force of friction

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120. 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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121. A solid cylinder of radius 4 cm and mass 250 g rolls down an inclined plane (1 in 10). Calculate the acceleration and the total energy of the cylinder after 5 s.

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122. A solid cylinder of mass 8 kg and radius 50 cm is rolling down a plane inclined at an angle of 30° with the horizontal. force of friction on the cylinder is?

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123. A cylinder of mass $10kg$ is rolling perfectly on a plane of inclination 30°. Find the force of friction between the cylinder and the surface of inclined plane.

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124. A cylinder of mass 5kg and radius 30 cm is rolling down an inclined place at an angle of 45° with the horizontal. Calculate (i) force of friction

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125. A solid cylinder of mass 8 kg and radius 50 cm is rolling down a plane inclined at an angle of 30° with the horizontal. The minimum value of coefficient of friction so that cylinder does not slip while rolling down the plane.

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126. A sphere starting from rest rolls for 5.3s without slipping along a plane which is 1m in length. The upper end of the plane is 1 cm higher than the lower end. Find the accelerationi due to gravity.

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127. A rope is wound round a hollow cylinder of mass M and radius R. If the rope is pulled with a force F newton, then the angular acceleration of the cylinder will be

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

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129. A body of mass 5 kg is attached to a weightless string wound round a cylinder of mass 8 kg and radius 0.3 m. The body is allowed to fall. Calculate tension in the string

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130. A body of mass $5kg$ is attached to a weightless string wound round a cylinder of mass $8kg$ and radius $0.3m$. The body is allowed to fall. Calculate (i) tension in the string, (ii) acceleration with which the body falls and (iii) angular acceleration of the cylinder.

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131. A body of mass 5 kg is attached to a weightless string wound round a cylinder of mass 8 kg and radius 0.3 m. The body is allowed to fall. Calculate tension in the string

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132. What is the advantage of concept of centre of mass ?

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133. The centre of mass of a body

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134. Does centre of mass of a rigid body lie always on the body ?

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135. Is centre of mass of reality ?

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136. Two particles of masses m_1 and m_2 move with velocities v_1 and v_2 towards eachother on a smooth horizontal surface. What is the velocity of their centre of mass ?

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137. Name the physical quantity that corresponds to the moment of force. On what factors does it depend ?

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

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

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140. Why do we perfect to use a when with a long arm ?

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141. Why in hand driven grinding machine, handle is put near the circumference of the stone or wheel ?

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142. It is difficult to open or close the door by pushing/pulling it at the hinges. Why ?

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

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144. In Regnault's apparatus for measuring specific heat capacity of a solid, there is an inlet and an outlet in the steam chamber .The inlet is near the top and the outlet is near the bottom .Why is it better than the opposite choice where the inlet is near bottom and the outlet is near the top ?

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

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146. A faulty balance with unequal arms has its beam horizontal. Are the weights of the two pans equal ?

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

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148. A labourer standing near the top of an old wooden step ladder feels unstable. Why ?

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149. Which physical quantities are expressed by the following :

(i) rate of change of angular momentum

(ii) moment of linear momentum ?

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150. define the rate of change of angular momentum

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151. The moment of linear momentum is called

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152. If no external torque acts on a body, will its angular velocity remain conserved ?

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153. When a labourer cuts down a tree, he makes a cut on the side facing the direction in which he wants it to fall. Why ?

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154. What is angular impulse ?

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

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156. A particle revolves uniformly along a circular path, on a smooth horizontal table, by means of a string connected to it. Does its angular momentum change, if the string is suddenly cut ?

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157. Is a body in circular motion in equillibrium ?

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158. When will a magnet in an external magnetic field be in unstable equilibrium?

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159. Can combination reaction be an oxidation reaction ? If yes, give an example.

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160. The probability of selecting a rotten apple randomly from a heap of 900 apples is 0·18. What is the number of rotten apples in the heap ?

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161. Why does a ray of light while passing through a prism, bend towards its base?

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162. Some heavy boxes are to be loaded along with some empty boxes on a cart. Which boxes should be put on the cart first and why ?

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163. Standing is not allowed in a double decker bus. Why ?

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164. Why we cannot rise from a chair without bending a little forward ?

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165. A system is in stable equilibrium. What can we say about its potential energy?

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166. Why is moment of inertia called rotational inertia ?

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167. Explain the physical significance of moment of inertia and radius of gyration.

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

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

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

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171. Can mass of a body be taken concentrated at its centre of mass for the purpose of calculating its rotational inertia ?

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

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173. The radius of gyration depends on

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

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175. Two lenses of same mass and same radius are given. One is convex and other is concave. Which one will have greater moment of inertia, when rotating about an axis perpendicular to the plane and passing through the centre ?

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176. A solid disc is recast into a thin walled cylinder of same radus. Which will have larger moment of inertia ?

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177. Two solid spheres of the same mass are made of metals of different densities. Which of them has a larger moment of inertia about a diameter ?

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178. What is the advantage of a flywheel ?

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179. Why spokes are provided in a bicycle wheel ?

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180. if the radii of two spheres are in the ratio $2:3$, then the ratio of their respective volumes is ----------------.

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181. 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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182. Two satellites of equal masses, which can be considered as particles are orbiting the earth at different heights. Will their moment of inertia be same or different ?

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183. What is the advantage of a flywheel ?

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184. A meter stick, half of which is wood and the other half steel, is pivoted at the wooden end and same force isapplied to the steel end. Next, it is pivoted at the steel end and the same force is applied at the wooden end. Does one getthesame angular acceleration in eachcase ? Explain

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185. Is angular momentum of a system always conserved ?

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186. A flywheel is revolving with a constant angular velocity. A chip of its rim breaks and flies away. How is its angular velocity affected ?

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187. 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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188. Why there two propellers in a helicopter ?

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

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190. If the radius of earth contracts 1/n of its present day value, the length of the day will be approximately

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191. Two boys of the same weight sit at the opposite ends of a diameter of a rotating circular table. What happens to the speed of rotation if they move nearer to axis of rotation?

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192. A thin wheel can stay upright on its rim for a considerable length of time when rolled with a considerable velocity, while it falls from its upright position at the slightest disturbance, when stationary. Explain.

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193. A person is standing on a rotating table with metal spheres in his hands. If he withdraws his hands to his chest, then the effect on his angular velocity will be.

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194. A circular table rotates about a vertical axis with a constant angular speed ω. A circular pan rests on the turn table (with the centre coinciding with centre of table) and rotates with the table. The bottom of the pan is covered with a uniform small thick layer of ice placed at centre of pan. The ice starts melting. The angular speed of the turn table.

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

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

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196. 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 $K.E.$?

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

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

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199. A spinning ballet dancer changes the shape of her body by spreading her arms.

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

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201. A body A of mass M while falling wertically 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

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202. Two identical particles move towards each other with velocity 2 v and v respectively. The velocity of centre of mass is

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203. A particle moves in a circular path with decreasing speed. What happens to its angular momentum ?

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204. A particle performing uniform circular motion has angular momentum L. What will be the new angular momentum, if its angular frequencey is doubled and its kinetic energy halved?

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205. The angular velocity of earth around the sun increases when it comes closer to the sun. Why ?

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206. Why are not able to rotate a wheel by pulling or pushing along its radius ?

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207. Two solid spheres of the same mass are made of metals of different densities. Which of them has a larger moment of inertia about a diameter ?

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208. A planet revolves round a massive star in a highly elliptical orbit. Is its angular momentum constant over the entire orbit ?

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209. If no external torque acts on a body, will its angular velocity remain conserved ?

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210. Assertion : Newton's third law of motion is applicable only when bodies are in motion.

Reason : Newton's third law applies to all types of forces, e.g. gravitational, electric or magnetic forces etc.

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211. If only an external force can change the momentum of the centre of mass of an object, how can be internal force of an engine accelerate a car?

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212. Two men stand facing each other on two boats floating on still water at a distance apart. A rope is held at its ends by both. The two boats are found to meet always at the same point, whether each man pulls separately or both pull together, why ? Will the time taken be different in the two cases ? Neglect friction.

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213. Prove that the centre of mass of two particle divides the line joining the particles in the inverse ratio of their masses.

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214. Two balls of mass m each are placed at the two vertices of an equilateral triangle. Another ball of mass $2m$ is placed at the third vertex of the triangle. Locate the centre of mass of the system.

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215. What is the difference between centre of mass and centre of gravity?

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216. There are some passengers inside a stationary railway compartment. The track is frictionless. The centre of mass of the compartment itself (without the passengers) is C_1, while the centre of mass of the 'compartment plus passengers' system is C_2. If the passengers move about inside the compartment along the track.

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217. Will the position of CM of the compartment change ?

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218. Show that moment of a couple does not depend on the point about which you take the moments.

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219. Show that the angular momentum about any point of a single particle moving with constant velocity remains constant throughout the motion. Is there any external torque on the particle ?

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220. 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.

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

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222. When is a rigid body said to be in equilibrium ? State the necessary conditions for a body to be in equilibrium.

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

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

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225. Two circular discs A and B of equal masses and thicknesses. But are made of metals with densities d_A and $d_B(d_A > d_B)$. If their moments of inertia about an axis passing through the centre and normal to the circular faces be I_A and I_B, then.

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226. Which one is easier to turn— a log or a bench of equal weight and length ? The two have the same coefficient of friction with the ground. Explain.

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227. The Moment of inertia of a disc about an axis passing through its centre and perpendicular to its plane is 1 / $2MR^2$. Derive the values of moment of inertia of the disc about its diameter and about an axis tangential to the disc lying on its plane ?

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228. What is the moment of inertia of a rod of mass M, length 1 about an axis perpendicular to it through one end ? Given the moment of inertia about the centre of mass is $\frac{1}{12}Ml^2$.

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

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230. The moment of inertia of a uniform circular disc of radius R and mass M about an axis passing from the edge of the disc and normal to the disc is.

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231. The moment of inertia of a uniform circular disc about a tangent in its own plane is $\frac{5}{4}MR^2$, where M is mass and R is the radius of the disc. Find its moment of inertia about an axis through its centre and perpendicular to its plane.

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232. Using expressisions for power and kinetic energy of rotational motion, derive the relation $\tau = I\alpha$, where letters have their usual meaning.

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233. If all the ice on the polar caps of the earth melts, due to global warming then the duration of the day will be

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234. Two identical cylinders 'run a race' starting from rest at the top of an inclined plane, one slides without rolling and other rolls without slipping. Assuming that no mechanical energy is dissipated in heat, which one will win ?

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235. A uniform circular disc of radius R is rolling on a horizontal surface. Determine the tangential velocity : at the upper most point

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236. A uniform circular disc of radius R is rolling on a horizontal surface. Determine the tangential velocity : the centre of mass

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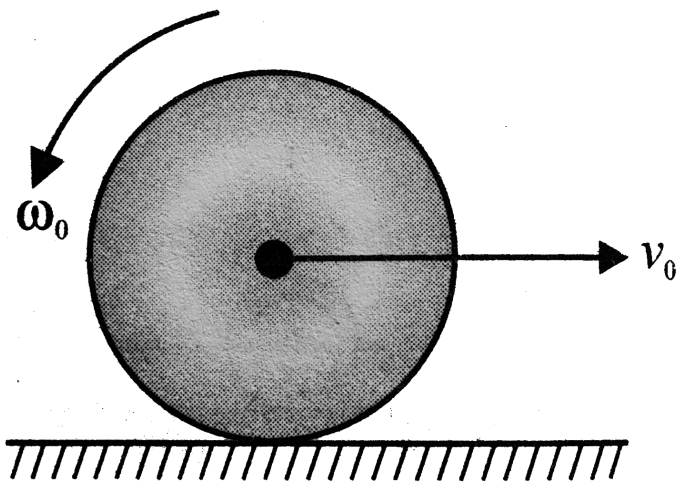
237. A uniform circular disc of radius r is placed on a rough horizontal surface and given a linear velocity v_0 and angular velocity ω_0 as shown. The disc comes to rest after moving some distance to the right. It follows that



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238. An isolated particle of mass m is moving in a horizontal plane (x-y), along the x-axis at a certain height above the ground. It suddenly explodes into two fragments of masses $m/4$ and $3m/4$. At instant later, the smaller fragment is at $y = +5cm$. What is the position of larger fragment at this instant ?

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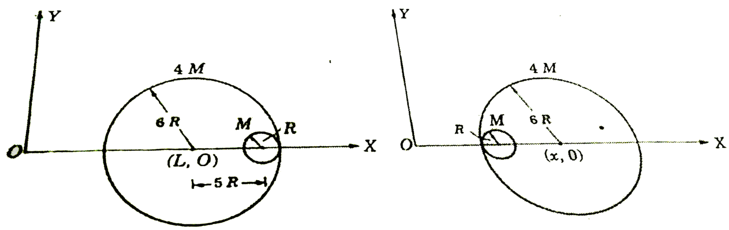
239. A small sphere of radius R is held against the inner surface of α larger sphere of radius 6R. The masses of large and small spheres are 4M and M, respectively. This arrangement is placed on a horizontal table. There is no friction between any surfaces of contact. The small sphere is now released. find the co-ordinations of the centre of the larger sphere when the smaller sphere reaches the other extreme position.



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240. A boat of $90kg$ is floating in still water. A boy of mass 30 kg walks from the stern to the bow. The length of the boat is 3 m. Calculate the distance through which the boat will move.

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241. A particle describes a horizontal circle on the smooth surface of an inverted cone. The height of the plane of the circle aove the vertex is 9.8 cm. Find the speed of the particle. Take $g = 9.8 ms^{-2}$.

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242. Point masses m_1 and m_2 are placed at the ends of a rigid rod of length L and negligible mass. The rod is to be set rotating about an axis perpendicular to its length. Locate a point on the rod through which the axis of rotation should pass in order that the work required to set the rod rotating with angular velocity ω_0 is minimum.

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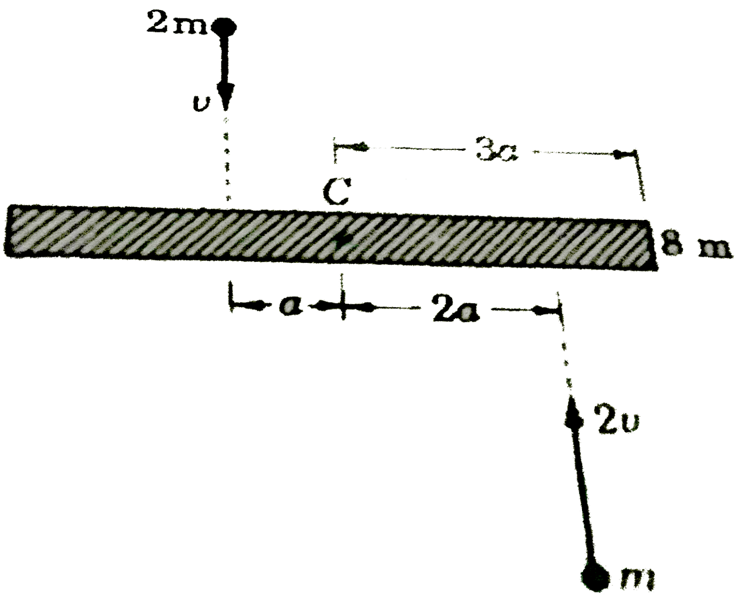
243. A uniform bar of length 6a and mass 8 m lies on a smooth horizontal table. Two point-masses m and 2m moving in the same horizontal plane with speeds 2v and v respectively strike the bar as shown in Fig, and stick to the bar after collision.



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244. A carpet of mass M is rolled along its length so as to from a cylinder of radius R and is kept on a rough floor. When a negligibly small push is given to the cylindrical carpet, it stars unrolling itself without sliding on the floor. Calculate horizontal velocity of cylindrical part of the carpet when its radius reduces to $R/2$.

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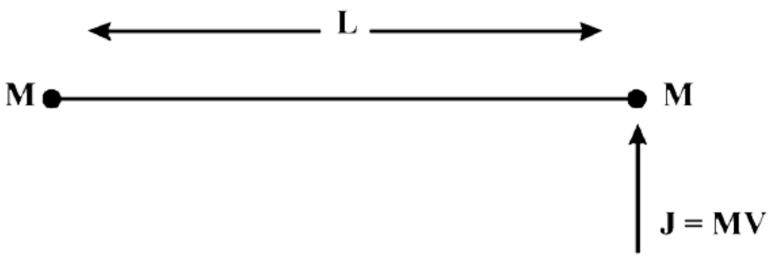
245. Consider a body, shown in figure, consisting of two identical balls, each of mass M connected by a light rigid rod. If an impulse J = MV is imparted to the body at one of its ends what would be it angular velocity?



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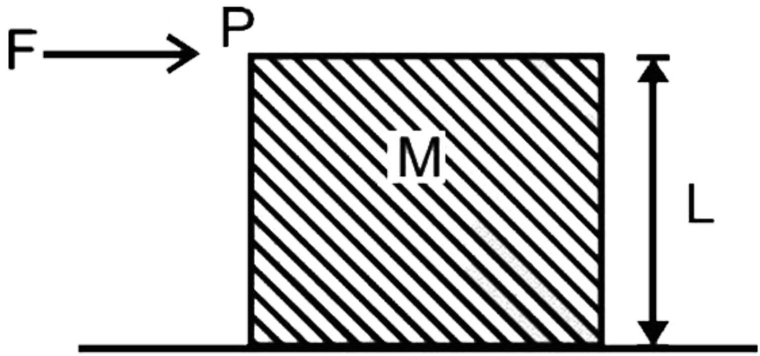
246. A cubical block of side L rests on a rough horizonta surface with coefficient of friction μ. A horizontal force F is applied on the block as shown. If the coefficient of friction is sufficiently high so that the block does not slide before toppling, the minimum force required to topple the block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



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

What is its moment of inertia about the axis of rotation ?

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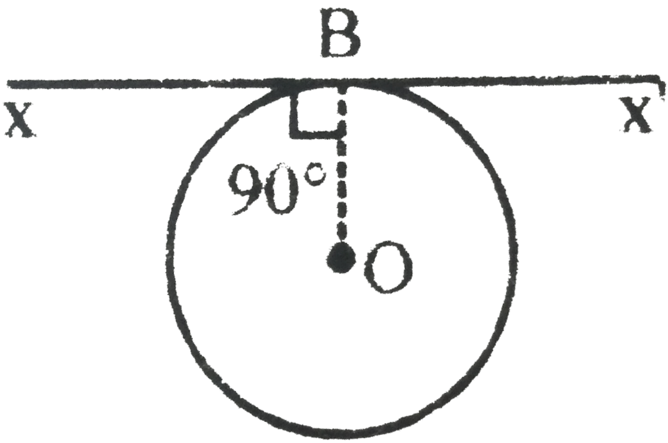
248. A thin wire of length L and uniform linear mass density ρ is bent into a circular loop with centre at O as shown. The moment of inertia of the loop about the axis XX' is :



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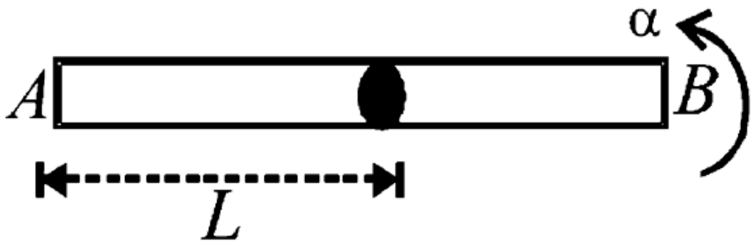
249. A long horizontal rod has a bead which can slide along its length and initially placed at a



distance L from one end A of the rod. The rod is set in angular motion about A with constant angular acceleration α. if the coefficient of friction between the rod and the bead is μ, and gravity is neglected, then the time after which the bead starts slipping is

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250. Initial angular velocity of a circular disc of mass M is ω_1. Then two small spheres of mass m are attached gently to two diametrically opposite points on the edge of the disc. What is the final angular velocity of the disc -

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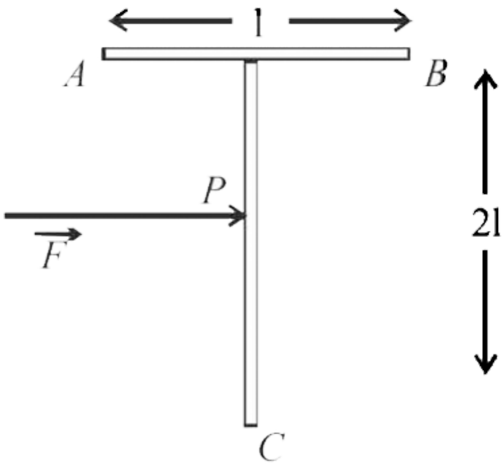
251. A 'T' shaped object with dimensions shown in the figure, is lying on a smooth floor. A force $'\overrightarrow{F}'$ is applied at the point P parallel to AB, such that the object has only the translational motion without rotation. Find the location of P with respect C.



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252. Find the coordination of the centre of mass of a uniform semicircular wire of radius R and mass M.

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253. 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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254. 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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255. 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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256. 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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257. 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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258. A child is sitting at one end of a long trolley moving with a uniform speed v on a smooth horizontal track. If the child starts running towards the other end of the trolley with a speed u (w.r.t. trolley), the speed of the centre of mass of the system will.

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259. Show that the area of the triangle contained between the vectors J and $ is one haif0fthe magnitude of $\vec{a} \times \vec{b}$.

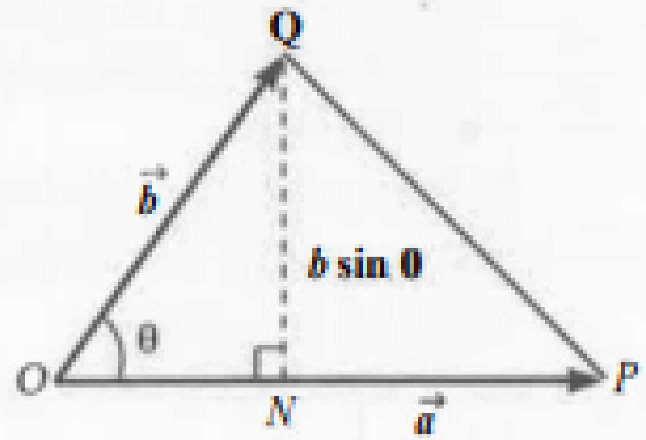

Fig. 7.97

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260. Show that $\vec{a} . \left(\vec{b} \times \vec{c}\right)$ is equal in magnitude to the volume of the parallelopiped formed on the three vectiors, $\vec{a}$, $\vec{b}$ and $\vec{c}$.

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261. Find the components along the x, y, z axes of the angular momentum $\overrightarrow{L}$ of a particle, whose position vector is $\overrightarrow{r}$ with components x, y, z and momentum is $\overrightarrow{p}$ 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.

262. 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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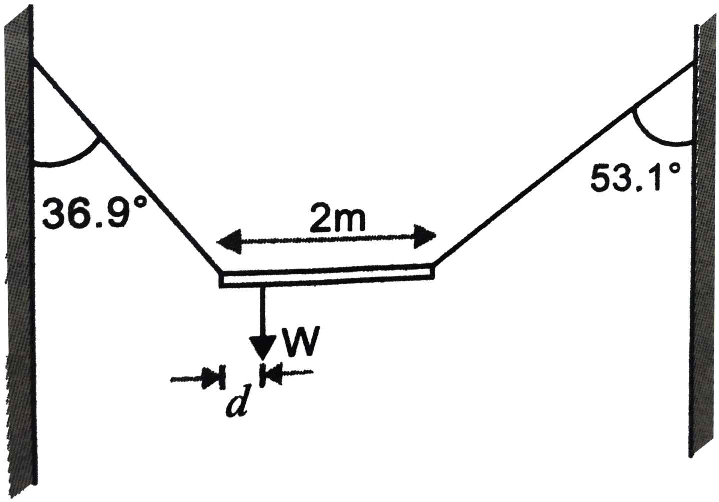
263. A non-uniform bar of weight W is suspended at rest by two strings of negligible weight as shown in Fig. The angles made by the strings with the vertical are 36.9° and 53.1° respectively. The bar is $2m$ long. Calculate the distance d of the centre of gravity of the bar from its left end.



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264. 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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265. (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 $2MR^2/5, where M$ 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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267. 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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268. 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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269. 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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270. 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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271. A rope of negligible mass is wound round a hollow cylinder of mass 3 kg and radius 40 cm. What is angular acceleration of the cylinder if the rope is pulled with a force of 30N? What is the linear acceleration of the rope? Assume that there is no slipping.

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272. 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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273. A metre stick is balanced on a knife edge at its centre. When two coins, each of mass 5g are 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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274. A solid wooden sphere rolls down two different inclined planes of the same height but of different inclinations. (a) Will it reach the bottom with same speed in each case ?

(b) Will it take longer to roll down one inclined plane than other ? Explain.

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

Watch Video Solution

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

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277. 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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278. 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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279. 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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280. 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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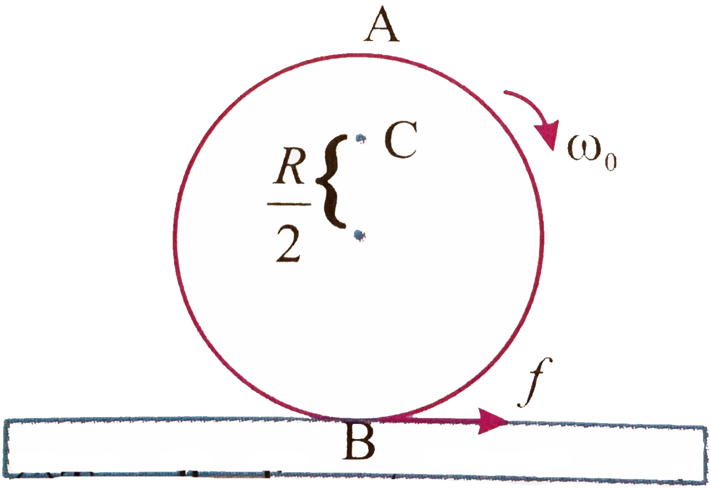
281. (i) Explain why friction is necessary to make the disc to roll in the direction indicated. (ii) Give the direction of frictional force at B, and the sense of frictional torque, before perfect rolling begins.

(iii) What is the force of friction after perfect rolling begins?



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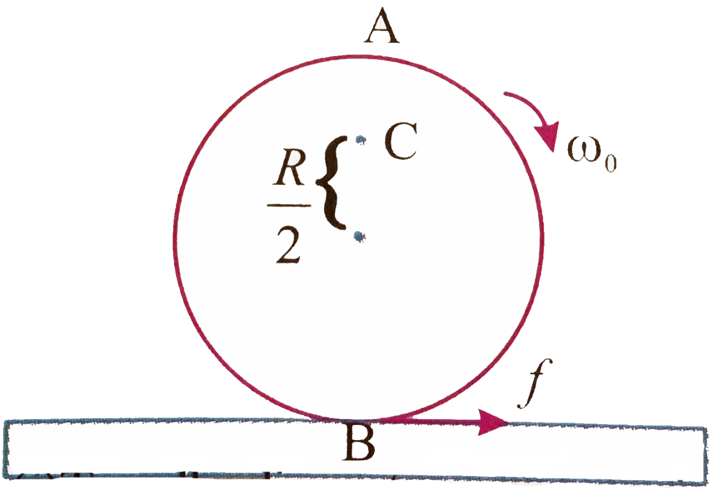

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283. A solid disc and a ring, both of radius $10cm$ are placed on a horizontal table simultaneously, with initial angular speed equal to $10\pi rad/s$. Which of the two will start to roll earlier ? The coefficient of kinetic friction is $\mu_k = 0.2$.

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284. A solid cylinder of mass 10 kg and radius 15 cm is rolling perfectly on a plane of inclination 30°. The coefficient of static friction, $\mu_s = 0.25$ (i) Find the force of friction acting on the cylinder. (ii) What is the work done against friction during rolling ?

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287. 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).

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290. 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).

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291. Read each statement below carefully, and state, with reasons, if it is true or false : A wheel moving down a perfectly frictionless inclined plane will undergo slipping (not rolling) motion

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EXERCISE

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

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2. 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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3. Three blocks of uniform thickness and masses m, m and $2m$ are placed at the corners of a triangle having co-ordinates $(2.5, 1.5), (3.5, 1.5)$ and $(3, 3)$ respectively. Find the co-ordinates of the centre of mass of the system.

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4. Find the centre of mass of three particle at the vertices of an equilateral triangle. The masses of the particle are $100g, 150g, \text{ and } 200g$ respectively. Each side of the equilateral triangle is $0.5m$ along.

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5. A gridstone has a constant acceleration of 4 rad s^{-1}. Starting from rest, calculate the angular speed of the grindstone 2.5 s later.

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6. The speed of a motor increases from 600 rpm to 1200 rpm in 20 s. What is the angular acceleration and how many revolution does it make during this time ?

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7. On the application of a constant torque, a wheel is turned from rest through an angle of 200 rad in 8s. Calculate its angular acceleration.

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8. The motor of an engine is erotating about its axis with an angular velocity of 100 rev/minute. It comes to rest in 15 s, after being switched off. Assumgn cnstant angular decelertion, calculate the number of revolutions made by it before coming to rest.

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9. A car is moving at a speed of $72 km h^{-1}$. The diameter of its wheel is 0.50m. If the wheels are stopped in 20 rotations by applying brakes, calculate the angular retardation produced by the brakes.

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10. A wheel starting from rest via rotating with a constant angular velocity of 3 rad s^{-1}. What is its angular acceleration after 4 s?

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11. Determine the angular momentum of a car of mass 1500 kg moving in a circuit truck of radius 50 m with a speed of $40ms^{-1}$.

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12. Mass of an electron is $9.0 \times 10^{-31}kg$. It revolves around the nucleus of an atom in a circular orbit of radius $4.0Å$ with a speed of $6.0 \times 10^{6}ms^{-1}$. Calculate the angular momentum of the electron.

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13. Find the moment fo inertia of the hydrogen molecules about an axis passing through its centre of mass and perpendicular to the internuclear axis. Given mass of H-atom $= 1.7 \times 10^{-27} kg$, interatomic distance $= 4 \times 10^{-10} m$

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14. Three particles each of mass 100 g are placed at the vertices of an equilateral triangle of side length 10 cm. Find the moment of inertia of the

system about an axis passing through the centroid of the triangle and perpendicular to its plane.

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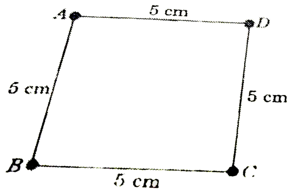
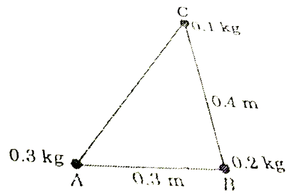
15. Four point masses of 20 g each are placed at the corners of a square ABCD of side 5 cm, as shown in Fig. 8.48. find the moment of inertia of the system (i) about an axis coinciding with the side BC and (ii) about an axis through A and perpendicular to the plane of the square.





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16. The point masses of 0.3 kg, 0.2 kg and 0.1 kg are placed at the corner of a right angles ΔABC, as shown in Fig. 8.49. find the moment of inertia of the system (i) about an axis through A and perpendicular to the plane of the diagram and (ii) about an axis along BC.

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17. Three particles of masses 0.50 kg, 1.0 kg and 1.5 kg are placed at the corners of a right angle triangle, as shown in fig. Locate the centre of mass of the system.

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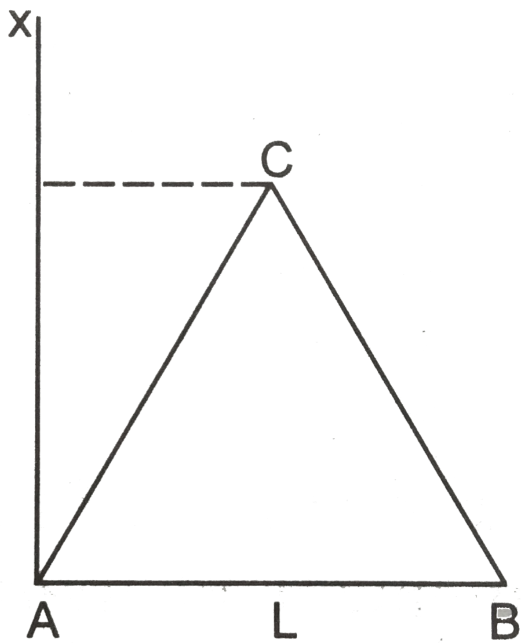
18. Three particles, each of mass m are situated at the vertices of an equilateral triangle ABC of side L figure. Find thee moment of inertia of the system about the line AX perpendicular to AB in the plane of ABC



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19. Four particles each of mass m are kept at the four corners of a square of edge a. Find the moment of inertia of the system about an axis perpendicular to the plane of the system and passing through the centre of the square.

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20. What is the moment of inertia of a ring of mass 2kg and radius 50 cm about an axis passing through its centre and perpendicular to its plane ? Also find the moment of inertia about a parallel axis through its edge.

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21. Calculate the moment of inertia of uniform circular disc of mass 500 g, radius 10 cm about : diameter of the disc

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22. Calculate the moment of inertia of uniform circular disc of mass 500 g, radius 10 cm about : the axis tangent to the disc and parallel to its diameter

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23. Calculate the moment of inertia of uniform circular disc of mass 500 g, radius 10 cm about : the axis through the centre of the disc and perpendicular to its plane

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24. Calculate the moment of inertia of a circular disc of radius $10cm$, thickness $5mm$ and uniform density $8gcm^{-3}$, about a transverse axis through the centre of the disc.

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25. The radius of a sphere is 5 cm. Calculate the radius of gyration about (i) its diameter and (ii) about any tangent.

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26. The radius of a sphere is 5 cm. Calculate the radius of gyration about any tangent.

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27. Calculate the radius of gyration of a cylindrical rod of mass M and length L about an axis of rotation perpendicular to its length and passing through its centre.

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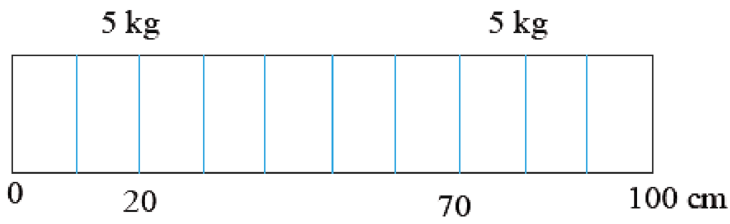
28. Two masses of 3kg and 5kg are placed at 20 cm and 70cm marks respectively on a light wooden meter scale. The M.I. of the system about an axis passign through 100cm mark and perpendicular to the meter scale is



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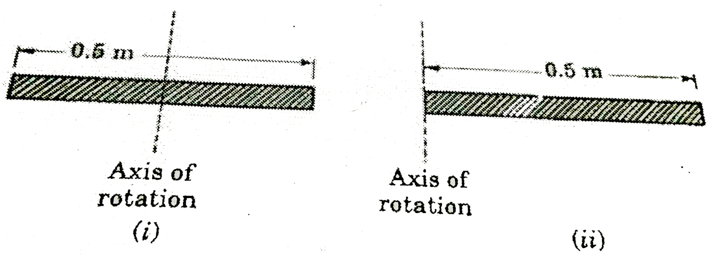
29. Calculate the moment of inertia of a rod of mass 2 kg and length 0.5 m in each of the following cases, as shown in Fig. 8.52.



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30. A body of mass 2 kg is revolving in a horizontal circle of radius 2 m at the rate of 2 revolutions per second. Determine (i) moment of inertia of the body and (ii) the rotational kinetic energy of the body.

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31. A body of mass 2 kg is revolving in a horizontal circle of radius 2 m at the rate of 2 revolutions per second. Determine (i) moment of inertia of the body and (ii) the rotational kinetic energy of the body.

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32. A flywheel of mass 500 kg and diameter 1 m makes 500 rpm. Assuming the mass to be concentrated along the rim, calculate (i) angular velocity (ii) moment of inertia and (ii) rotational K.E. of the flywheel.

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33. A flywheel of mass 500 kg and diameter 1 m makes 500 rpm. Assuming the mass to be concentrated along the rim, calculate (i) angular velocity (ii) moment of inertia and (ii) rotational K.E. of the flywheel.

Watch Video Solution

34. A flywheel of mass 500 kg and diameter 1 m makes 500 rpm. Assuming the mass to be concentrated along the rim, calculate (i) angular velocity (ii) moment of inertia and (ii) rotational K.E. of the flywheel.

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35. A thin hollow cylinder open at both ends and weighing $5kg$ (i) slides with a speed of $5m/s$ without rotating and (ii) rolls with the same speed without slipping. Compare the KE of the cylinder in the two cases.

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36. A thin hollow cylinder open at both ends and weighing $5kg$ (i) slides with a speed of $5m/s$

without rotating and (ii) rolls with the same speed without slipping. Compare the KE of the cylinder in the two cases.

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37. A thin metal hoop of radius $0.25m$ and mass $2kg$ stars from rest and rolls down an inclined plane. If its linear velocity on reaching the foot of the plane is $2m/s$, what is its rotational KE at that instant ?

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38. The earth has a mass of $6 \times 10^{24} kg$ and a radius of $6.4 \times 10^{6} m$. Calculate the amount of work that must be done to slow down its rotation so that duration of day becomes 30 hrs instead of 24 hours.

Moment of inertia of earth $= \frac{2}{5} MR^2$.

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39. A disc of mass 1 kg and radius 10 cm is rotating about its axis with an anuglar velocity of 2 rad/s. The linear momentum of the disc,

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40. The moment of inertia of a body is $2.5 kgm^2$. Calculate the torque required to produce an angular acceleration of $18 rads^{-2}$ in the body.

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41. A cylinder of length $20 cm$ and radius $10 cm$ is rotating about its central axis at an angular speed of $100 rad/s$. What tangential force will stop the cylinder at a unifrom rate is $10 s$? Given moment of inertia of the cylinder about its axis of rotation is $0.8kgm^2$.

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42. A flywheel of moment of inertia $10^7 gcm^2$ is rotating at a speed of 120 rotations per minute. Find the constant breaking torque required to stop the wheel in 5 rotations.

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43. If a constant torque of 500 Nm turns a wheel of moment of inertia $100kgm^2$ about an axis through its centre, find the gain in angular velocity in 2s.

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44. A sphere of mass 2 kg and radius 5 cm is rotating at the rate of 300 rpm. Calculate the torque required to stop it in 6.28 it in 6.28 revolution. Moment of inertia of the sphere about any diameter $= \frac{2}{5}MR^2$

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45. A body of mass 1.0 kg is rotating on a circular path of diameter 2.0 m at the rate of 10 rotations in 31.4 s. angular momentum of the body is?

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46. A circular disc of mass 2 kg and radius 0.1 m is rotating at an angular speed of 2 rad/s, about an axis passing through its centre and perpendicular to its plane. What is its rotational kinetic energy?

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47. A wheel, initially at rest, rotates for $2s$ under angular acceleration of $3rads^{-2}$. Find (i) angular velocity acquired in $2s$.

(ii) angular displacement in $2s$.

(ii) torque acting on the wheel if its moment of inertia is $12kgm^2$.

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48. A wheel, initially at rest, rotates for $2s$ under angular acceleration of $3rads^{-2}$. Find (i) angular velocity acquired in $2s$.

(ii) angular displacement in $2s$.

(ii) torque acting on the wheel if its moment of inertia is $12kgm^2$.

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49. A wheel, initially at rest, rotates for $2s$ under angular acceleration of $3rads^{-2}$. Find (i) angular velocity acquired in $2s$.

(ii) angular displacement in $2s$.

(ii) torque acting on the wheel if its moment of inertia is $12kgm^2$.

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50. An ice skater spins with arms outstretched at 1.9 rps. Her moment of inertia at this instant is 1.33 kg m^2. She pulls in her arms to increase her rate of spin. If the moment of inertia is 0.48 kg m^2 after she pulls in her arms, what is her new rate of rotation ?

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51. If 2 kg mass is rotating on a circular path of radius 0.8 m with angular velocity of 44 rad/sec. If radius of the parth becomes 1 m, then what will be the value of angular velocity?

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52. A ball tied to a string takes us to complete revolution along a horizontal circle. If, by pulling the cord, the radius of the circle is reduceed to half of the previous value, then how much time the ball will take in one revolution?

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53. The sun rotates round itself once in 27 days. What will be period of revolution if the sun were to expand to twice its present radius? Assume the sun to be a sphere of uniform density.

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54. If the earth suddenly contracts by one-fourth of its present radius, by how much would the day be shortened?

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55. Prove that for an earth satellite, the ratio of its velocity at apogee (when farthest from the earth) to its velocity at perigee (when nearest to the earth) is the inverse ratio of its distances from apogee and perigee.

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56. A uniform disc rotating freely about a vertical axis makes 90 rpm. A small piece of wax of mass m gram falls vertically on the disc and sticks to it at a distance rcm from the axis. If number of rotations per minute reduces to 60, find the moment of inertia of the disc.

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57. The separation between C and O atoms in CO is 1.2 A. The distance of carbon atom from the centre of mass is

A. $0.3\overset{\circ}{A}$

B. $0.7\overset{\circ}{A}$

C. $0.5\overset{\circ}{A}$

D. $0.9\overset{\circ}{A}$

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58. Three masses of 2 kg, 4 kg and 4 kg are placed at the three points (1, 0, 0), (1, 1, 0) and (0, 1, 0) respectively. The position vector of its centre of massis

A. $\frac{3}{5}\hat{i} + \frac{4}{5}\hat{j}$

B. $\left(3\hat{i} + \hat{j}\right)$

C. $\frac{2}{5}gati + \frac{4}{5}\hat{j}$

D. $\frac{1}{5}\hat{i} + \frac{3}{5}\hat{j}$

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59. Four particles of mass 2 kg, 3kg, 4 kg and 8 kg are situated at the comers of a square of side length 2 m. The centre of mass may be given as

A. $\left(\frac{30}{18}, \frac{28}{18}\right)$

B. *[Math Processing Error]*

C. $\left(\frac{14}{17}, \frac{24}{17}\right)$

D. $\left(\frac{34}{18}, \frac{34}{18}\right)$

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60. The centre of mass of a solid cone along the line form the center of the base to the vertex is at

A. one-fourth of the height

B. one-third of the height

C. one-fifth of the height

D.) none of the above

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61. The reduce mass of two particles having masses m and 2 m is

A. 2 m

B. 3 m

C. 2m/3

D. ml2

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62. Consider a sytem of two particles having masses m_1 and m_2. If the particle of mass m_1 is pushed towards the centre of mass of particles through a distance d, by what distance would the particle of mass m_2 move so as to keep the mass centre of particles at the original position?

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

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

C. d

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

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63. Two bodies of masses 2 kg and 4 kg are moving with velocities 2 m/s and 10 m/s respectively along same direction. Then the velocity of their centre of mass will be

A. $5.3m/s$

B. $7.3m/s$

C. $6.4m/s$

D. $8.1m/s$

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64. In a bicycle the radius of rear wheel is twice the radius of front wheel. If v_F and v_r are the speeds of top most points of front and rear wheels respectively, then :

A. $v_r = 2v_f$

B. $v_f = 2v_r$

C. $v_f = 2v_r$

D. $v_f = v_r$

Answer: $v_f > v_r$

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65. Two particles A and B initially at rest, move towards each other by mutual force of attraction. At the instant when the speed of A is n and the speed of B is $3n$, the speed of the centre of mass of the system is

A. 3v

B. 2v

C. 1.5v

D. zero

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66. 2 bodies of different masses of 2 kg and 4 kg are moving with velocities $20m/s$ and 10 m//s towards each other due to mutual gravitational attraction. What is the velocity of their centre of mass?

A. $5m/s$

B. $6m/s$

C. $8m/s$

D. zero

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67. Two racing cars of masses m and $4m$ are moving in circles of radii r and $2r$ respectively. If their speeds are such that each makes a complete circle in the same time, then the ratio of the angular speeds of the first to the second car is

A. $1:1$

B. $r_1 : r_2$

C. $m_1 : m_2$

D. $m_1 m_2 : r_1 r_2$

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68. Two wheels having radii in the ratio $1:3$ are connected by a common belt. If the smaller wheel is accelerated from rest at a rate $1.5 rads^2$ for 10 s, find the angular velocity of bigger wheel

A. $5 rads^{-1}$

B. $15 rads^{-1}$

C. $45 rads^{-1}$

D. none of these

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69. A disc, initially at rest, starts rotating about its own axis/ with a constant angular acceleration of 0*2 rad/s2. The time taken by the disc to rotate by 10 rad (in seconds) is

A. 7.07

B. 10

C. 14.14

D. 100

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70. A car is moving at a speed of $72km/h$. The diameter of its wheels is $0.5m$. If the wheels are stopped in 20 rotations by applying brakes, calcualte the angular retardation produced by the brakes.

A. $-25.5rad/s^2$

B. $-33.5rad/s^2$

C. $-29.5 rad / s 2$

D. $-45.5 rad / s^2$

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71. The motor of an engine is rotating about its axis with an angular velcoity of $100 rev \min^{-1}$. It comes to rest in 15 s, after being switched off. Assuming constant angualar decelearation . What are the numbers of revolutions made by it befor coming to rest ?

A. 12.5

B. 40

C. 32.6

D. 15.6

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72. Angular acceleration α of a body is given by the relation $a = 4at^3 - 3bt^2$. If initial angular velocity of the body is ω_0, then its velocity at time t will be

A. (o0 + at4 -bt3

B. od0 + 4at4 -4bt3

C. coQ +12«f2 -6bt

D. ft)Q -at 4 + bt3

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73. The front wheel on an ancient bicycle has radius 0.5 m. It moves with angular velocity given by the function $\omega(t) = 2 + 4t^2$, where t is in seconds. About how far does the bicycle move between t =2 and t =3 seconds ?

A. 36 m

B. 27 m

C. 21 m

D. 14 m

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

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

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

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

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

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75. Which one is a vector quantity?

A. energy

B. torque

C. both of these

D. none of these

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76. If force vector is along X-axis and radius vector is along Y-axis then the direction of torque is

A. $\overrightarrow{r} \times \overrightarrow{F}$

B. $\overrightarrow{r}.\overrightarrow{F}$

C. $\left|\overrightarrow{r}\right|\left|\overrightarrow{F}\right|$

D. none of these

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77. Find the torque of a force $\overrightarrow{F} = -3\hat{i} + \hat{j} + 5\hat{k}$ acting at the point $\overrightarrow{r} = 7\hat{i} + 3\hat{j} + \hat{k}$

A. $14\hat{i} - 38\hat{j} + 16\hat{k}$

B. $4\hat{i} + 4\hat{j} + 6\hat{k}$

C. $-14\hat{i}+38\hat{j}-16\hat{k}$

D. $21\hat{i}+3\hat{j}+5\hat{k}$

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78. If force acts on a body, whose line of action does not pass through its centre of gravity, then the body will experience

A. angular acceleration

B. linear acceleration

C. angular acceleration and linear acceleration

D. none of these

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

A. purely rotational motion

B. purely linear motion

C. purely rotational motion and linear motion

D. neither nor

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80. In order to balance a see-saw of total length 10.0m, two kids weighing 20 kg and 40 kg are sitting at an end and at a distance x from the fulcrum at the centre, respectively The value x (in cm) is

A. 125

B. 250

C. 450

D. 350

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81. a uniform beam, of length L and mass m = 1.8 kg, is at rest on two scales. A uniform block, with mass M = 2.7 kg, is at rest on the beam, with its center a distance $L/4$ from the beam's left end. What do the scales read?

A. 16 N

B. 27 N

C. 29 N

D. 45 N

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82. An automobile engine develops 100 kW when rotating at a speed of $1800 rev / \min$. What torque does it deliver ?

A. 350 Nm

B. 531Nm

C. 440Nm

D. 628 Nm

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83. Angular momentum is

A. moment of momentum

B. product of mass and angular velocity

C. product of M.I. and velocity

D. moment of angular motion

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84. Which is a vector quantity

A. angular momentum

B. work

C. potential energy

D. electric current

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85. Dimensions of angular momentum are

A. $[MLT^{-2}]$

B. $[ML2T^{-1}]$

C. $[ML2T^{-2}]$

D. $[ML2^{T}]$

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86. Joule-second is the unit of

A. momentum

B. angular momentum

C. work

D. pressure

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87. Under a constant torque, the angular momentum of a body changes from A to 4 A in 4 sec The torque on the body will be

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

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

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

D. 4A

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88. A particle of mass m is rotating in a plane in circular path of radius r. Its angular momentum is L. The centripetal force acting on the particle is

A. L^2 / mr

B. L^m / r

C. L^2 / m^3

D. L^2 / m^r

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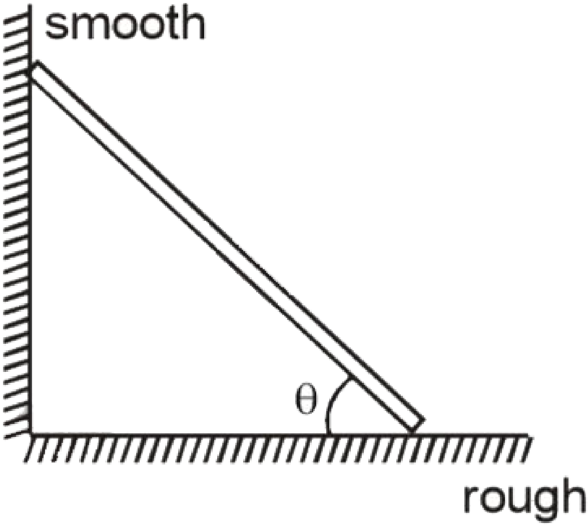
89. A stationary uniform rod of mass 'm', length 'l' leans against a smooth vertical wall making an angle θ with horizontal floor. Find the normal force & frictional force that is exerted by the floor on the rod ?



A. $F_N(L/2)$

B. $F_N.\ L\cos\theta$

C. $F_N l\sin\theta$

D. $F_N(L/2)\cos\theta$

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90. The torque $\vec{\tau}$ on a body about a given point is found to be equal to $\vec{A} \times \vec{L}$ where $\vec{A}$ is a constant vector and $\vec{L}$ is the angular momentum of the body about the point. From this its follows that -

A. $d\vec{L}$ is perpendicular to $\vec{L}$ at all instants of time

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

C. the magnitude of L does not change with time

D. all the above

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91. If a particle of mass m is moving with constant velocity v parallel to x-axis in $x-y$ plane as shown in fig. Its angular moment with respect to origin at any time t will be

A. $-mvb\hat{k}$

B. zero

C. $\frac{mvb}{2}\hat{k}$

D. $mvb\cos\theta\hat{k}$

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92. Analogue of mass in rotational motion is.

A. moment of inertia

B. angular momentum

C. gyration

D. none of the above

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93. Moment of inertia of body depends upon

A. axis of rotation

B. torque applied

C. angular speed

D. angular momentum

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94. Moment of inertia of a body does not depend on

A. mass of object

B. mass distribution

C. angular velocity

D. axis of rotation

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95. One circular ring and one circular disc, both are having the same mass and radius. The ratio of their moments of inertia about the axes passing through their centres and perpendicular to their planes, will be

A. $1:1$

B. $2:1$

C. $1:2$

D. $4:1$

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96. Moment of inertia of a thin circular plate of mass M, radius R about an axis passing through its diameter is I. The moment of inertia of a circular ring of mass M, radius R about an axis perpendicular to its plane and passing through its centre is

A. $1 : n^2$

B. $1 : n$

C. $1 : 2n$

D. $n^2 : 1$

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97. Two rings of radius R and nR made of same material have the ratio of moment of inertia about an axis passing through center is $1 : 8$. The value of n is

A. 2

B. $2\sqrt{2}$

C. 4

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

98. The moment of inertia of a thin circular disc of mass M and radius R about any diameter is

A. $\frac{MR^2}{4}$

B. MR^2

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

D. $2MR^2$

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99. Moment of inertia of a thin circular plate of mass M, radius R about an axis passing through its diameter is I. The moment of inertia of a circular ring of mass M, radius R about an axis perpendicular to its plane and passing through its centre is

A. $I/2$

B. 2I

C. $I/4$

D. 4I

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100. The moment of inertia of a circular loop of radius R, at a distance of $R/2$ around a rotating axis parallel to horizontal diameter of loop is

A. MR^2

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

C. $2MR^2$

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

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101. The moment of inertia of a ring about one of its diameters is I.What willbe its moment of inertia about a tangent parallel to the diameter ?

A. 4I

B. 2I

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

D. 3I

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102. Moment of inertia of a ring of mass M and radius R about an axis passing through the centre and perpendicular to the plane is I. What is the moment of inertia about its diameter ?

A. I

B. $I/2$

C. $I/\sqrt{2}$

D. $I+MR^2$

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103. A solid sphere and a hollow sphere are identical in mass and radius. The ratio of their moment of inertia about diameter is :

A. solid sphere

B. solid cylinder

C. solid sphere and solid cylinder

D. equal both

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104. Moment of inertia of a disc about an axis which is tangent and parallel to its plane is I . Then the moment of inertia of disc about a tangent, but perpendicular to its plane will be

A. $\frac{6}{5}I$

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

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

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

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105. A sphere of mass 10 kg and radius 0.5 m rotates about a tangent. The moment of inertia of the solid sphere about tangent is

A. $5kgm^2$

B. $2.7kgm^2$

C. $3.5kgm^2$

D. $4.5kgm^2$

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106. From a circular disc of radius R and 9M , a small disc of mass M and radius $\frac{R}{3}$ is removed concentrically .The moment of inertia of the remaining disc about and axis perpendicular to the plane of the disc and passing through its centre is

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

B. MR^2

C. $4MR^2$

D. $\frac{4}{9}MR^2$

107. Let I_1 and I_2 be the moments of inertia of two bodies of identical geometrical shapek, the first made of aluminium and the second of iron.

A. $I_1 > I_2$

B. $I_1 = I_2$

C. $4MR^2$

D. $\frac{4}{9}MR^2$

108. Two identical concentric rings each of mass m and radius R are placed perpendicularly. What is the moment of inertia of the system about the axis of one of the rings ?

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

B. MR^2

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

D. $2MR^2$

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109. Find the ratio of the radii of gyration of a circular disc and a circular ring of the same radii about a tangential axis in their planes.

A. $1:2$

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

C. $2:3$

D. $2:1$

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110. The radius of gyration of a disc of mass 100 g and radius 5 cm about an axis passing through its centre of gravity and perpendicular to the plane is

A. 1.52 cm

B. 3.54 cm

C. 2.51 cm

D. 6.54 cm

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111. A flywheel is attached to an engine to

A. increase its speed

B. decrease its speed

C. help in overcoming the dead point

D. decrease its energy

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112. The angular momentum of a body with mass (m) moment of inertia (I) and angular velocity

(ω) rad/s is equal to

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

B. $I\omega^2$

C. $I\omega$

D. none of these

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113. Moment of inertia of a body is 1 kg m2. If the body makes 2 revolutions per second, when its angular momentum is

A. $2\pi Js$

B. $4\pi Js$

C. $\pi/2Js$

D. πJs

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114. A constant torque of $31.4N-m$ id exterted on a pivoted wheel. If the angular acceleration of the wheel is $4\pi rad/s^2$, then the moment of inertia will be.

A. $2.5kgm^2$

B. $4.5kgm^2$

C. $3.5kgm^2$

D. $5.5kgm^2$

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115. A particle performs uniform circular motion with an angular momentum L.If the frequency of particle's motion is doubled and its kinetic energy halved,the angular momentum becomes

A. 2L

B. 4L

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

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

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116. Two bodies have their moments of inertia I and $2I$ respectively about their axis of rotation. If their kinetic energies of rotation are equal, their angular momenta will be in the ratio.

A. $1:2$

B. $\sqrt{:}1$

C. $2:1$

D. $1:\sqrt{2}$

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

A. when no external force acts upon the system

B. when no external torque acts upon the system

C. when no external impulse acts upon the system

D. when axis of rotation remains same

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118. The motion of planets in the solar system is an exmaple of the conservation of

A. conservation of kinetic energy

B. conservation of linear momentum

C. conservation of angular momentum

D. none of the above

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119. A diver in a swimming pool bends his head before diving, because it

A. increases his linear velocity

B. decreases his angular velocity

C. increases his moment of inertia

D. decreases his moment of inertia

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120. If a person standing on a rotating disc stretches out his hands, the angular speed will

A. increase

B. decrease

C. remain same

D. none of these

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121. A dancer is rotating on smooth horizontal floor with an angular momentum L The dancer folds her hands so that her moment of inertia decreases by 25%. The new angular momentum is

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

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

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

D. L

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122. A round disc of moment of inertia I_2 about its axis perpendicular to its plane and passing through its centre is placed over another disc of moment of inertia I_1 rotating with an angular velocity ω about the same axis. The final angular velocity of the combination of discs is.

A. $\frac{I_2\omega}{h+h}$

B. ω

C. $\frac{I_1\omega}{I_1+I_2}$

D. $\frac{(I_1+I_2)\omega}{I_1}$

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123. A uniform disc of mass M and radius R is rotating in a horizontal plane about an axis perpendicular to its plane with an angular velocity ω. Another disc of mass M/3 and radius R/2 is placed gently on the first disc coaxial. Then final angular velocity of the system is

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

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

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

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

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

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

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

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

D. $\dfrac{2\omega M}{M-2m}$

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125. A loop of mass M and radius R is rolling on a smooth horizontal surface with speed 'v'. It's total kinetic energy is

A. mv^2

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

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

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

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126. A sphere of moment of inertia 'I' and mass 'm' rolls down on an inclined plane without slipping its K.E. of rolling is

A. $\frac{1}{2}I\omega^2$

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

C. $I\omega + mv$

D. $\frac{I}{\omega}^2 + \frac{1}{2}mv^2$

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127. A disc is rolling without slipping. The ratio of its rotational kinetic energy and translational kinetic energy would be -

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

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

C. 1

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

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

A. $\frac{7}{10}mv^2$

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

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

D. $\frac{1}{4}mv2$

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129. A disc is rolling on the inclined plane. What is the ratio of its rotational KE to the total KE ?

A. $1:3$

B. $3:1$

C. $1:2$

D. $2:1$

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130. A disc of mass 4.8 kg and radius 1 m is rolling on a horizontal surface without sliding with angular velocity of 600 rotations/min. What is the total kinetic energy of the disc ?

A. 360J

B. $1440\pi^2 J$

C. $4000\pi^2 J$

D. $600\pi^2 J$

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131. A liquid is kept in a cylindrical jar, which is rotated about the cylindrical axis. The liquid rises at its sides. The radius of the jar is r and speed of rotation is ω the difference in height at the centre and the sides of the jar is

A. $\dfrac{r^2\omega^2}{\frac{g}{r^2g^2}}$

B. $\dfrac{r^2\omega^2}{\frac{g}{r^2g^g}}$

C. $\dfrac{g}{r^2g^2}$

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

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132. A sphere rolls down an inclined plane of inclination θ. What is the acceleration as the sphere reaches bottom ?

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

B. $\frac{3}{5} g \sin \theta$

C. $\frac{2}{7} g \sin \theta$

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

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133. An inclined plane makes an angle 30° with the horizontal. A solid sphere rolling down this inclined plane from rest without slipping has a linear acceleration equal to

A. $\frac{58}{14}$

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

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

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

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134. The acceleration of a solid cylinder rolling down an smooth inclined plane of inclination 30° is

A. $g/2$

B. $2g/2$

C. $g/3$

D. $g/4$

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135. A cylinder is rolling down on a inclined plane of inclination60°. What is iths acceleration?

A. $g/\sqrt{3}$

B. $g\sqrt{3}$

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

D. none of these

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136. A solid cylinder is rolling without slipping on a plane having inclination θ and the coefficient of static friction μ_s. The relation between θ and μ_s is

A. $\tan\theta > 3\mu_s$

B. $\tan\theta \geq 3\mu_s$

C. $\tan\theta < 3\mu_s^2$

D. none of these

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137. During rolling without slipping, what is the velocity of the point in contact with the surface.

A. ωr

B. $> \omega r$

C. $< \omega r$

D. zero

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138. The centre of a wheel rolling on a plaen surface moves with a speed v_0. A particle on the rim of the wheel at the same level as the centre will be moving at speed

A. zero

B. v_0

C. $\sqrt{2}v_0$

D. $2v_0$

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139. If a body moves through a distance greater than $2\pi R$ in one full rotation. Then,

A. $v_c m > R\omega$

B. $v_c m < R\omega$

C. $v_c m \geq \; = R\omega$

D. $v_c m \leq \; = R\omega$

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140. Centre of mass of a body is a point where its whole ______ acts whereasits centre of gravity is a point where its whole _______ acts

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141. The position vector of the centre of mass of a system of particles is the ________ of the position vectors of the particles, each particle making a contribution proportional to its ________

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142. Two particles of masses m_1 and m_2 move with velocities v_1 and v_2 towards eachother on a smooth horizontal surface. What is the velocity of their centre of mass ?

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143. Locate the centre of mass of uniform triangular lamina and a uniform cone.

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144. Show that the centre of mass of uniform rod of mass M and length L lies at the middle point of the rod.

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145. Show that the centre of mass of uniform rod of mass M and length L lies at the middle point of the rod.

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146. Total linear momentum of a system of particles is equal to ....of the system and velocity of ....

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147. Study of moving bodies under the action of forces ______

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148. Name the rotational analogue of force. What are its units ?

Watch Video Solution

149. The dimensional formula of torque is

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150. Square of the resultant of two forces of equal magnitude is equal to three times the product of their magnitude. The angle between them is

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151. A : For a body to be in rotational equilibrium the net torque acting on the body about any point is zero.

R : For net torque to be zero, net force should also be zero.

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152. Moment of couple is called

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

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154. Assertion : Torque is due to transverse componet is not perpendicular to radial component. Reason: This is because transverse component is not perpendicular to radial component.

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155. TORQUE

Watch Video Solution

156. TORQUE

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157. Angular momentum of a particle is the moment of ______ of the particle about the axis rotation.

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158. Angular momentum of a particle about the origin O is equal to the vector product of its _____ vector and ______vector.

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159. A body is moving in a circular path with a constant speed. It has .

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160. Write SI unit of angular momentum:

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161. The rate of change of angular momentum is called

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162. Which physical quantity is conserved when a planet revolves around the sun ?

Watch Video Solution

163. The units of angular momentum are

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164. Angular momentum of a body is the product of.

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165. A rigid body will be in equilibrium if both the ______ and ______ of the body remain constant with time.

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166. For a rigid body in equilibrium, linear acceleration of its centre of mass is ______ and the angular acceleration of the body is ______

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167. In a conservative field at stable equilibrium potential energy is:

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168. _______ is the rotational analogue of mass in linear motion.

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169. For translatory motion, F = ma. Its rotational analogue is ______.

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170. For translatory motion, p= mv. Its rotational analogue is _____

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171. Moment of inertia of rigid body is equal to ______ the rotational kinetic energy of the body rotating with unit angular velocity about the given axis.

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172. Radius of gyration of a body amount an axis of rotation is equal to the ________ distance of its particles from the axis of rotation

Watch Video Solution

173. Two identical particles move towards each other with velocity 2v and v respectively. The velocity of centre of mass is

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

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175. The moment of inertia of a disc about an axis through its centre and perpendicular to its plane is $\frac{1}{2}MR^2$. Its moment of inertia about any diameter will be _________

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176. A circular ring and circular disc of same radius have equal moments of inertia about axes through their centres and perpendicular to their planes. The ratio of their masses is

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

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178. A tangential force F is applied on a disc of radius R, due to which it deflects through an angle θ from its initial position. The work done by this force would be

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

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180. The centre of mass of a body should necessarily lie within the body.

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181. Statement-1 : The centre of mass of a system of n particles is the weighted average of the position vector of the n particles making up the system

. Statement-2 : The position of the centre of mass of a system is independent of coordinate system

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182. A boat is likely to capsize if the persons in the boat stand up

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183. If no external torque acts on a body, will its angular velocity remain conserved ?

Watch Video Solution

184. The centre of mass of a body changesits position with translatory as well as rotatory motion

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185. A planet revolves around the sun under the effect of its gravitational force. The torque acting on the planet due to the gravitational force is zero

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186. Statement-1 : To unscrew a rusted nut, we need a wrench with longer arm.

Statement-2 : $\vec{\tau} = \vec{r} \times \vec{F}$.

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187. Is angular momentum of a system always conserved ?

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188. Two satellites of equal masses, which can be considered as particles are orbiting the earth at different heights. Will their moment of inertia be same or different ?

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189. Statement-1: Two particles of mass 1 kg and 3 kg move towards each other under their mutual force of attraction. No other force acts on them. When the relative velocity of approach of the two particles is $2m/s$, their centre of mass has a velocity of $0.5m/s$. When the relative velocity of approach becomes $3m/s$ the velocity of the centre of mass is $0.75m/s$.

Statement-2: The total kinetic energy as seen from ground is $\frac{1}{2}\mu v_{rel}^2 + \frac{1}{2}mv_c^2$ and in absence of external force, total energy remains conserved.

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

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191. When a solid sphere and a hollow sphere of same mass and size roll down an inclined plane without slipping, the solid sphere reaches the bottom of the incline earlier than the hollow sphere.

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192. MATCH TYPE QUESTIONS

Shape of body	Location of centre of mass
(a) Long thin rod	(p) Geometrical centre
(b) Circular ring	(q) Centroid
(c) Triangular lamina	(r) Middle point of the body

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193. MATCH TYPE QUESTIONS

Shape of body	Location of centre of mass
(a) Cubical block	(p) Geometrical centre
(b) Hollow sphere	(q) Middle point of the axis
(c) Cylinder	(r) Point of intersection of diagonals

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194. MATCH TYPE QUESTIONS

(a) Torque	(p) Moment of linear moment
(b) angular momentum	(q) Moment of force
	(r) Rate of change of angular momentum

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195. MATCH TYPE QUESTIONS

(a)	M.I. of a disc about any diameter	(p)	$\frac{3}{2}MR^2$
(b)	M.I. of a disc about a tangent in its plane	(q)	$\frac{1}{4}MR^2$
(c)	M.I. of disc about a tangent perpendicular to its plane	(r)	$\frac{5}{4}MR^2$

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196. MATCH TYPE QUESTIONS

(a)	Bob of a pendulum at the mean position	(p)	Unstable equilibrium
(b)	A spherical ball placed on smooth table	(q)	Neutral equilibrium
(c)	A cone placed inverted on a table	(r)	Stable equilibrium

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197. MATCH TYPE QUESTIONS

Physical Quantity		Dimensions	
(a)	Torque	(p)	$[ML^2T^{-1}]$
(b)	Angular momentum	(q)	$[ML^2T^{-3}]$
(c)	Power	(r)	$[ML^2T^{-2}]$

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198. MATCH TYPE QUESTIONS

(a)	Theorem of parallel axes	(p)	$I_z^2 = I_x^2 + I_y^2$
(b)	Theorem of perpendicular axes	(q)	$I_z = I_x + I_y$
		(r)	$I = I_{CM} + Md^2$

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199. The centre of mass of a system of particles is at the origin. It follows that

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200. On what factors does the position of cm of a rigid body depend ?

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

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202. 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:

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203. What is nature of motion of cm of an isolated system ?

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204. Where does the centre of mass of a two particle system lie, if one particle ismore massive than the other ?

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205. Can the centre of mass of a body be at a point outside the body?

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206. Where does the centre of mass of a uniform rectangular lamina lie ?

Watch Video Solution

207. Write an expression for the centre of mass of& two partide system

Watch Video Solution

208. Write an expression for the velocity of the centre of mass of a system of particles.

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209. What is a rigid body?

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210. Name the rotational analogue of force. What are its units ?

Watch Video Solution

211. Is torque a scalar or vector ? If it is a vector, what rule is used to determine its direction ?

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212. The dimensional formula of torque is

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213. If 'muscle times speed equals power', then what is the ratio of the SI unit and the CGS unit of muscle?

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214. Under what condition, the three vectors (i) cannot giv zero resultant (ii) can give zero resultant ?

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215. When a steady toqrue or couple acts on a body, the body

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216. Write the dimensional formula of angular momentum. Is it scale or vector ?

Watch Video Solution

217. Write SI unit of angular momentum:

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218. What is the ratio of the SI unit to the CGS unit of angular momentum ?

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219. Name the physical quantity whose dimensions are same as that of angular momentum ?

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220. Which physical quantity is conserved when a planet revolves around the sun ?

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221. A planet revolves around the sun under the effect of gravitational force exerted by the sun. Why is the torque on the planet due to the gravitational force zero ?

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222. A boat is likely to capsize if the persons in the boat stand up. Why ?

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223. What is angular velocity of earth spinning around its own axis ?

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224. Is the angular speed of rotation of hour hand of a watch greater or smaller than the angular speed of earth's rotation about its axis ?

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225. Name the rotational analogue of linear acceleration.

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226. Is moment of inertia a scalar or a vector ?

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

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

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229. What is the moment of inertia of a hollow sphere about an axis passing through its centre ?

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230. Radius of gyration of a uniform solid sphere about its diamter is

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231. A circular ring and circular disc of same radius have equal moments of inertia about axes through their centres and perpendicular to their planes. The ratio of their masses is

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232. Where does the centre of mass of a uniform rectangular lamina lie ?

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

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234. Which physical quantity is represented by the product of the moment of inertia and the angular velocity ?

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235. The term moment of momentum is called

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

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237. Define mechanical advantage of a lever.

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238. Unit of moment of inertia in MKS system

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239. 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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240. What are the differences between internal and external sources of recruitment ?

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241. Define centre of gravity.

Watch Video Solution

242. The centre of mass of a system of particle is at the origin the number of particle to the left

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243. Give an expression for the velocity and acceleration of the centre of mass of a system of particles.

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244. Assertion : If there is no external torque on a body about its centre of mass, then the velocity of the centre of mass remains constant.

Reason : The linear momentum of an isolated system remains constant.

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245. Statement-1 : Total linear momentum of system in centre of mass frame is zero only when there is no net external force.

Statement-2 : Total linear momentum of system is conserved in absence of net external force.

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246. What will be the total linear momentum of a system of particles in a rotatory motion ?

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247. A double star is a system of two stars of masses m and $2m$, rotating about their centre of mass only under their mutual gravitational attraction. If r is the separation between these two stars then their time period of rotation about their centre of mass will be proportional to

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248. Centre of mass of the earth-moon system lies

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249. On what factors does the position of cm of a rigid body depend ?

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250. Define moment of force or torque.

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251. State the principle of moments.

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252. Angular momentum is

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253. The relation between the torque τ and angular momentum L of a body of moment of inertia I rotating with angular velocity ω is

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254. Starting from the definition of angular momentum in terms of position vector and linear momentum vectors. S.T. the time derivative of angular momentum is equal to the torque acting on the particle.

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255. The radius of gyration of a body depends upon

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256. On what factors does the radius of gyration of a body depend ?

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257. State theorem of parallel axes and therom of perpendi cular axes about moment of inertia.

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258. State and prove theorem of perpendicular axes.

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Watch Video Solution

259. State Kepler's 2nd law of planetary motion.

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260. What is the moment of inertia of a rod of mass M and length L about an axis perpendicular to it through one end ? Given the moment of inertia about the centre of mass is- $\frac{1}{12}ML2$

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261. Establish the relation between moment of inertia and torque on a rigid body

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

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263. Law of conservation of angular momentum

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264. By the theorem of parallel axes:

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

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266. Law of conservation of angular momentum

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267. State perpendicular axis theorem for calculation of moment of inertia using appropriate diagram. Also calculate moment of inertia about a diameter if that of an axis perpendicular to the plane of a disc and passing through its centre is given by MR^2.

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268. How moment of inertia of a circular disc around its axis will be affected by increasing its mass without changing its radius ? Justify your answers.

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269. Two rings of radii R and nR made from the same wire of same linear mass density and having the ratio of moments of inertia about an axis through centre equal to 1: 8. Find the value of n

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270. What is a couple ? What effect does it have on a body ? Show that moment of couple is same irrespective of the point of rotation of the body.

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271. Derive an expression for the work done by a torque. Hence write the expression for the power delivered by a torque.

Watch Video Solution

272. What is torque ? Give its unit. Show that it is equal to the product of force and the perpendicular distance of its line of action from the axis of rotation.

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273. Explain that torque is only due to transverse component of force. Radial component as nothing to do with torque.

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274. Define angular momentum. Prove that angular momentum of a particle is equal to twice the product of its mass and areal velocity

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

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276. Show that the moment of inertia of a body about the given axis of rotation is equal to twice the kinetic energy of rotation of the body rotating with unit angular velocity

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277. Obtain an expression for kinetic energy of rotation of a body. Hence define moment of inertia of the body. Explain its physical significance.

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278. Derive an expression for moment of inertia of a thin circular ring about an axis passing through its centre and perpendicular to the plane of the ring.

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279. Moment of inertia of a hollow cylinder of mass M and radius R, about the axis of cylinder is

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280. Thye angular momentum and the moment of inertia are respectively

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281. Derive an expression for moment of inertia of a thin circular ring about an axis passing through its centre and perpendicular to the plane of the ring.

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282. Acceleration of a solid cylinder rolling without slipping down an incline of inclination θ is

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283. The centre of mass of two particles system lies

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284. Define and explain the term acceleration . Derive the velocity-time relation of a body moving under constant acceleration.

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285. Define and explain the term acceleration . Derive the velocity-time relation of a body moving under constant acceleration.

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286. What do you understand by areal velocity of a planet ? State kepler's second law of planetary motion.what does it imply ?

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287. S.T. the time rate of the total angular momentum of a system of particles about a point is equal to the sum of the external torques acting on the system taken about the same point.

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288. When a rigid body is in motion, few particles of the body remain at rest at all times. What kind of motion is the rigid body having?

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289. Derive an expression for moment of inertia of a thin circular ring about an axis passing through its centre and perpendicular to the plane of the ring.

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290. Derive an expression for moment of inertia of a thin circular ring about an axis passing through its centre and perpendicular to the plane of the ring.

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291. Derive an expression for moment of inertia of a thin circular ring about an axis passing through its centre and perpendicular to the plane of the ring.

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292. The moment of inertia of a Thin rod about and axis passing through the centre and perpendicular to the length is _______.

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293. State the expression for the moment of inertia of a solid cylinder of uniform cross section about an axis through its centre and perpendicular to its length.

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294. Derive an expression for moment of inertia of a thin circular ring about an axis passing through its centre and perpendicular to the plane of the ring.

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

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296. Acceleration of a solid cylinder rolling without slipping down an incline of inclination θ is

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297. A lightstring is wound round a cylinder and carries a mass tied to it at the free end. When the mass is released, calculate the tension in the string. Show that the acceleration of the mass is less than g.

Watch Video Solution

298. Moment of inertia of disc about the tangent parallel to plane is I. The moment of inertia of disc about tangent and perpendicular to its plane is

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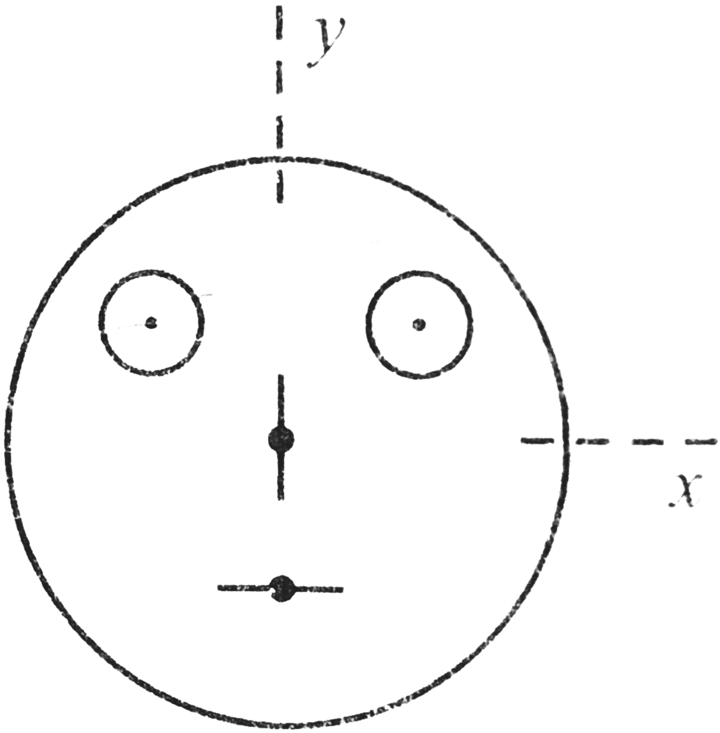
299. Moment of inertia of a disc about an axis passing through its centre and perpendicular to its plane is $\frac{1}{2}MR^2$. Determine the moment of inertia of this disc about its diameter and about a tangent perpendicular to its plane.

Watch Video Solution

300. Look at the drawing given in the figure which has been drawn with ink of uniform line-thickness. The mass of ink used to draw each of the two inner circles, and each of the two line segments is m. The mass of the ink used to draw the outer circle is

$6m$.

The coordinates of the centres of the different parts are: outer circle $(0, 0)$, left inner circle $(-a, a)$, right inner circle (a, a), vertical line $(0, 0)$ and horizontal line $(0, -a)$. The y-coordinate of the centre of mass of the ink in this drawing is



A. $\frac{a}{10}$

B. $\frac{a}{8}$

C. $\frac{a}{12}$

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

Watch Video Solution

301. Two particles A and B initially at rest, move towards each other by mutual force of attraction. At the instant when the speed of A is n and the speed of B is $3n$, the speed of the centre of mass of the system is

A. 3v

B. v

C. 1.5v

D. zero

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302. Two blocks of masses 10 kg and 4 kg are connected by a spring of negligible mass and placed on a frictionless horizontal surface. An impulse gives a velocity of $14m/s$ to the heavier block in the direction of the lighter block. The velocity of the centre of mass is

A. 30m/s

B. 20m/s

C. 10m/s

D. 5m/s

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303. An isolated particle of mass m is moving in horizontal planexy along the x-axis, at a certain height above the ground. It suddenly explodes into two fragment of masses $m/4$ and $3m/4$. An instant later, the smaller fragment is at $y = +15$ cm. The larger fragment at this instant is at

A. y=-5cm

B. y=+20cm

C. y=+5cm

D. y=-20cm

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304. A smooth sphere A is moving on a frictionless horizontal plane with angular speed ω and centre of mass velocity v. It collides elastically and head on with an identical sphere B at rest. Neglect friction everywhere. After the collision, their angular speeds are ω_A and ω_B respectively. Then

A. $\omega_A < \omega_B$

B. $\omega_A = \omega_B$

C. $\omega_A = \omega$

D. $\omega_B = \omega$

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305. A mass m is moving with a constant velocity along a line parallel to the x-axis, away from the origin. Its angular momentum with respect to the origin.

A. is zero

B. remains constant

C. goes on increasing

D. goes on decreasing

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306. A particle of mass m is projected with a velocity v making an angle of 45° with the horizontal. The magnitude of the angular momentum of the projectile abut the point of projection when the particle is at its maximum height h is.

A. zero

B. $\frac{mv^3}{4\sqrt{2}g}$

C. $\frac{mv^2}{\sqrt{2}g}$

D. $\left(m\sqrt{2gh^3}\right)$

Watch Video Solution

307. A particle undergoes uniform circular motion. About which point on the plane of the circle, will the angular momentum of the particle remain conserved?

A. centre of the circle

B. on the circumference of the circle

C. inside the circle

D. outside the circle

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308. A particle is confined to rotate in a circular path decreasing linear speed, then which of the following is correct?

A. $\vec{L}$ (angular momentum) is conserved about the centre

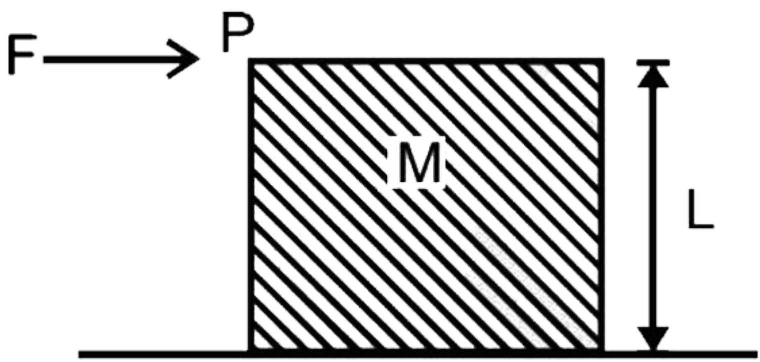
B. only direction of angular momentum $\vec{L}$ is conserved

C. it spirals towards the centre

D. its acceleration is towards the centre

Watch Video Solution

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



A. infinitesimal

B. mg /4

C. mg /2

D. mg(l-n)

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310. A piece of wire is bent in the shape of a parabola $y = kx^2$ (y-axis vertical) with a bead of mass m on it. The bead can slide on the wire without friction. It stays at the lowest point of the parabola when the wire is at rest. The wire is now accelerated parallel to the x-axis with a constant acceleration a. The distance of the new equilibrium position of the bead, where the bead can stay at rest with respect to the wire, from the y-axis is:

A. $\frac{a}{gk}$

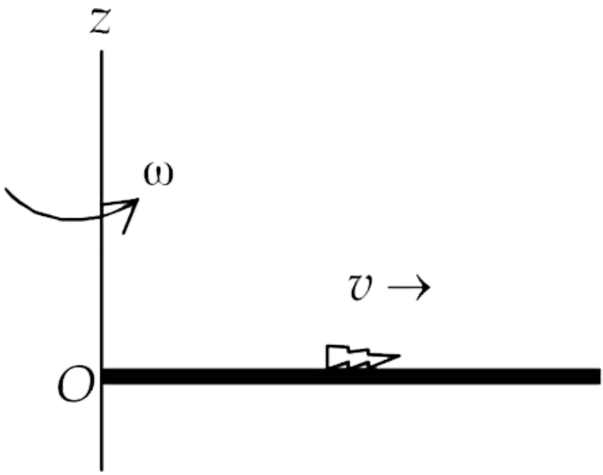
B. $\frac{a}{2gk}$

C. $\frac{2a}{gk}$

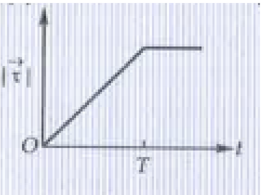
D. $\frac{a}{4gk}$

Watch Video Solution

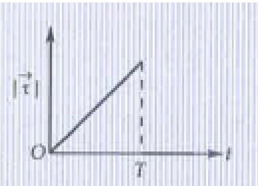
311. A thin uniform rod, pivoted at O, is rotating in the horizontal plane with constatn angular speed ω, as shown in the figure. At time t = 0, a small insect starts from O and moves with constant sped v, with respect to the rod towards the other end. It reaches the end of the rod at t =T and stops. The angular speed of the system remains ω throughout. The magnitude of the torque $\left(\left|\vec{\pi}\right|\right)$ about O, as a function of time is best represented by which plot?



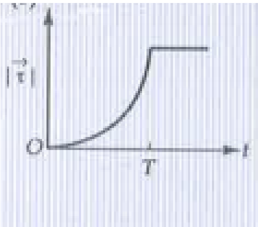
A.



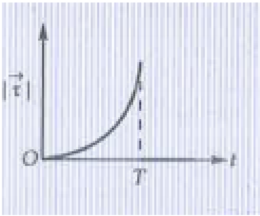
B.



C.



D.



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312. 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 $(g=10ms^2)$

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

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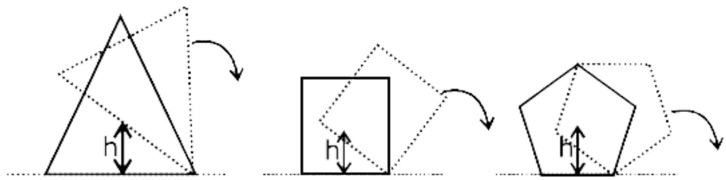
313. Consider regular polygons with number of sides n = 3, 4, 5 ...... as shown in the figure, The center of mass of all the polygons is at height h from the ground. They roll on a horizontal surface about the leading vertex without slipping and sliding as depicted,. The maximum increase in height of the locus of the center of mass for each polygton is Δ. Then Δ depends on n and h as



A. $\Delta = h\sin\left(\frac{2\pi}{n}\right)$

B. $\Delta = h\tan^2\left(\frac{\pi}{2n}\right)$

C. $\Delta = h\sin^2\left(\frac{\pi}{n}\right)$

D. $\Delta = h\left(\frac{1}{\cos(\pi/n)} - 1\right)$

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

$\overrightarrow{r}(t) = \alpha t^3 \hat{i} + \beta^2 \hat{j},$

where $\alpha = 10/3ms^{-3}$, $\beta = 5ms^{-2}$ and m = 0.1kg.

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

A. The velocity v isgivenby v =(10/ + 10 j)ms"1.

B. The angular momentum L with respect to the •— gt A origin is given by L = ~(5/3)k Nms

C. The force f- is given by T =(/ +2 j)N

D. The torque x with respect to the origin is given by x* (20 /3)k Nm

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315. A ball hits the floor and rebounds after an inelastic collision. In this case

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

B. the mechanical energy of the ball remains the same inthe collision

C.) the total momentum of theball and theearthis conserved

D. tine total energy of the ball and the earth is conserved.

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316. A shell is fired from a cannon with a velocity $v(m/\text{sec.})$ at an angle θ with the horizontal direction. At the highest point in its path it explodes into two pieces of equal mass. One of the pieces retraces its path to the cannon and the speed (in $m / \sec.$) of the other piece immediately after the explosion is

A. $3v \cos \theta$

B. $2v \cos \theta$

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

D. $\sqrt{\frac{3}{2}} v \cos \theta$

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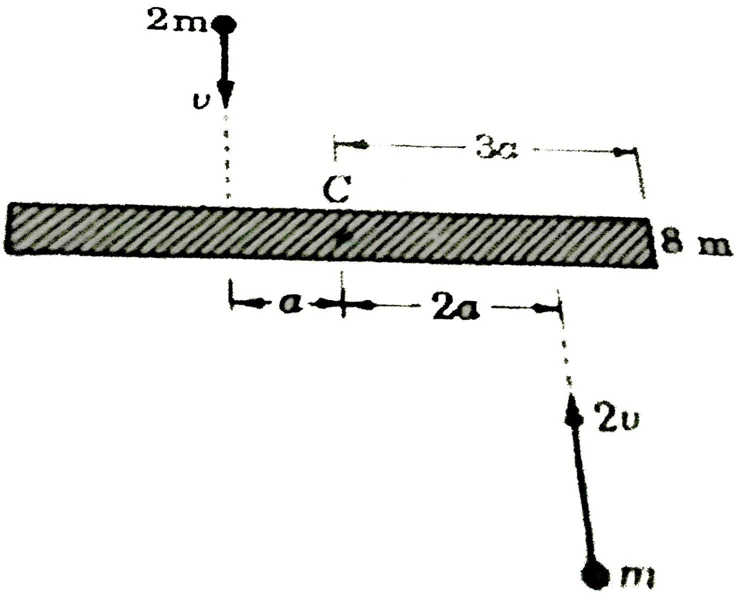
317. A uniform bar of length 6a and mass 8 m lies on a smooth horizontal table. Two point-masses m and 2m moving in the same horizontal plane with speeds 2v and v respectively strike the bar as shown in Fig, and stick to the bar after collision.



A. $v_C = 0$

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

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

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

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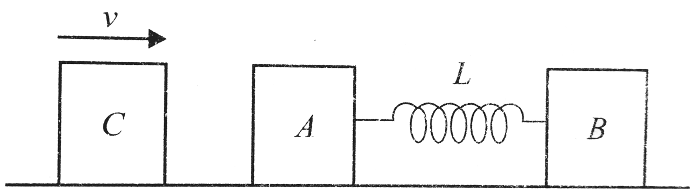
318. Two blocks A and H. each of mass m, are connected by a massless spring of natural length I. and spring constant K. The blocks are initially resting in a smooth horizontal floor with the spring at its natural length, as shown in Fig. A third identical block C, also of mass m, moves on the floor with a speed v along the line joining A and B. and collides elastically with A. Then



A. the kinetic energy of the A B system, at maxi mum compression of the spring, is zero.

B. the kinetic energy of the A-B system, at maxi mum compression of the spring, is tnv2 /4

C. the maximum compression of the spring is

vMm/.k)

D. the maximum compression of the spring is

vj(m/2k).

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319. 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. $\frac{M\omega^2 L}{2}$

B. $(M\omega^2 L)$

C. $\frac{M\omega^2 L}{4}$

D. $\frac{M\omega^2 L^2}{2}$

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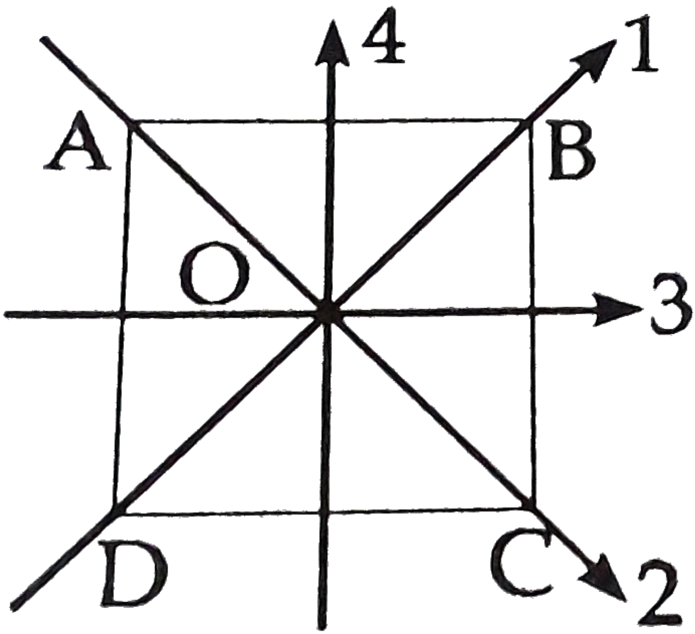
320. The moment of inertia of a thin square plate ABCD of uniform thickness about an axis passing through its center and perpendicular to its plane

will



A. $I_1 + I_2$

B. $I_3 + I_4$

C. $I_1 + I_3$

D. $I_1 + I_2 + I_3 + I_4$

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

A. I

B.

C. $I \sin^2 \theta$

D. $I \cos^2 \theta$

Answer: $I \frac{\cos^2 \theta}{2}$

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322. A solid cylinder is rolling down a rough inclined plane of inclination θ. Then

A. the friction force is dissipative

B. the friction force is necessarily changing

C. the friction force will aid rotation but hinder translation.

D. the friction force is reduced if 0 is reduced

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323. If the resultant of all the external forces acting on a system of particles is zero, then from an inertial frame, one can surely say that

A. linear momentum of the system does not change in time

B. kinetic energy of the system does not change in time

C. angular momentum of the system does not change in time

D. potential energy of the system does not change in time

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324. A point mass of 1kg collides elastically with a stationary point mass of 5 kg. After their collision, the 1kg mass reverses its direction and moves with a speed of $2ms^{-1}$. Which of the following statements (s) is (are) correct for the system of these two masses?

A. Total momentum of the system is 3 kg ms^{-1}

B. Momentum of 5 kg mass after collision is 4 kg ms^{-1}

C. Kinetic energy of the centre of mass is 0.75 J

D. Total kinetic energy of the system is 4 J

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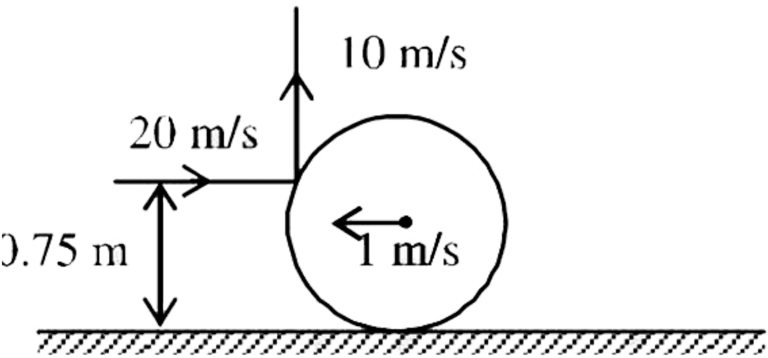
325. A thin ring of mass 2kg and radius 0.5 m is rolling without on a horizontal plane with velocity 1m/s. A small ball of mass 0.1kg, moving with velocity 20 m/s in the opposite direction hits the ring at a height of 0.75m and goes vertically up with velocity 10m/s. Immediately after the collision



A. the ring has pure rotation about itsstationary CM

B. the ring comes to a complete stop

C. friction between the ring and the ground is to the left

D. there is no friction between the ring and the ground.

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326. The figure shows a system consisting of (i) a ring the outer radius 3R rolling clockwise without slipping on a horizontal surface with angular speed ω and (ii) an inner disc of radius 2R rotating anti clockwise with angular speed $\omega/2$. The ring and disc are separted. The point P on the inner disc is at a distance R from the origin, where OP makes an angle of 30° with the horizontal. Then with respect to the horizontal surface,

A. The point O has a linear velocity 3Ron

B. The point P has a linear velocity $\frac{11}{4}R\omega\hat{I}+\frac{\sqrt{3}}{2}R\omega\hat{k}$

C. The point P has a linear velocity

$$\frac{13}{4}R\omega\hat{I}+\frac{\sqrt{3}}{4}R\omega\hat{k}$$

D. The point P has a linear velocity (3-sqrt3/4)RomegahatI+1/4Romegahatk`

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327. Two solid cylinders P and Q of same mass and same radius start rolling down a fixed inclined plane from the same height at the same time. Cylinder P has most of its mass concentrated near its surface, while Q has most its mass concentrated near the axis. Which statement(s) is (are) correct?

A. Both cylinders P and Q reach the ground at the same time.

B. Cylinder P has larger linear acceleration than cylinder Q.

C. Both cylinders reach the ground with same translational kinetic energy

D. Cylinder Q reaches the ground with larger angular speed.

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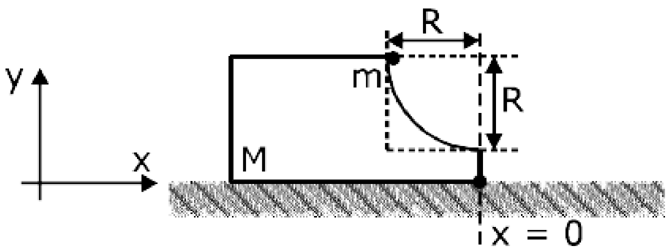
328. A block of mass M has a circular cut with a frictionless surface as shown. The block rests on the horizontal frictionless surface of a fixed table. Initially the right edge of the block is at x = 0, in a co-ordinate system fixed to the table. A point mass m is released from rest at the topmost point 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 mis:

$$v = \sqrt{2g\frac{R}{1+\frac{m}{M}}}$$

B. The x component of displacement of the

centre mR of mass of the block M is $\frac{mR}{M+m}$

C. The position of the point mass is :

$$x = -\sqrt{2}\frac{mR}{M+m}$$

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

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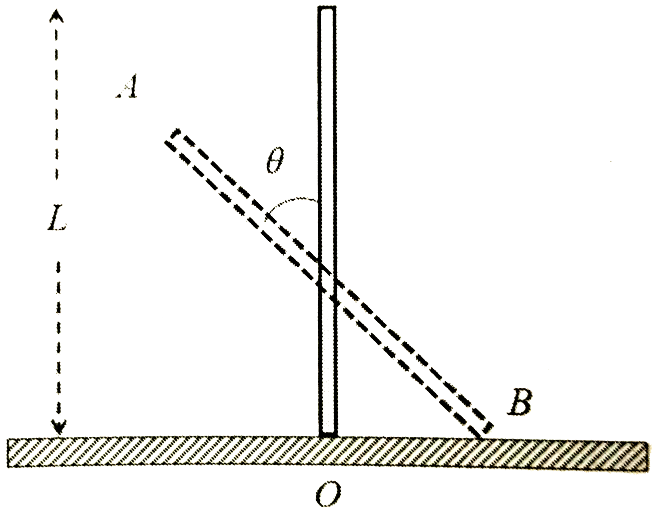
329. A rigid uniform bar AB of length ? is slipping from its vertical position on a frictionless floor (as shown in the figure). At some instant of time, the angle made by the bar with the vertical is θ. Which of the following statements about its motion is/are correct?



A. The trajectory of the point A is a parabola

B. Instantaneous torque about the point in contact with the floor is proportional to sin θ

C. The midpoint of the bar will fall vertically downward

D. When the bar makes ah lallffibj |o. mlnj vertical, the displacement of its midpoint from the initial position is proportional to (1 ~ cosO)

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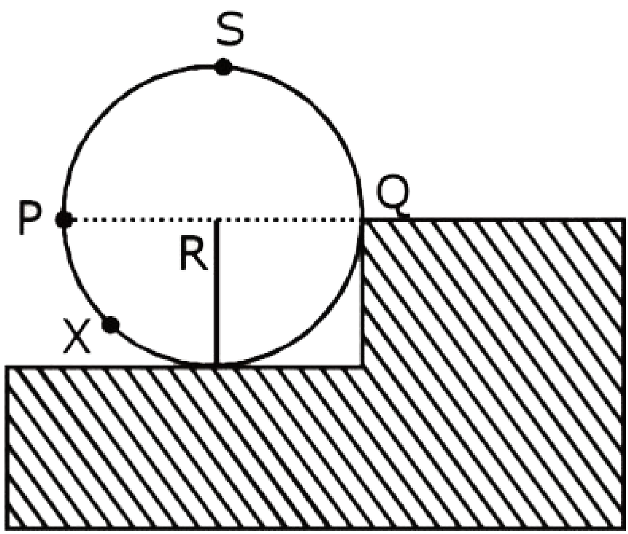
330. A wheel of radius R and mass M is placed at the bottom of a fixed step of height R as shown in the figure. A constant force is continuously applied on the surface of the wheel so that it just clims the

step without slipping. Consider the torque τ about an axis normal to the plane of the paper passing through the point Q. Which of the following options is/are correct?



A. U the force is applied normal to the oircum ference at point P, then r is zero

B. If the force is applied tangentially at point Sgtj then x ?ÿ 0 but tl »e w heel never climbs the step

C. If the force is applied at point P tangentially, then t decreases continuously as the wheel climbs

D. If the force is applied normal to the circunv ference al point X, then r is constant

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

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

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332. Consider a body of mass 1.0 at rest at the origin at time $t = 0$. A force $\overrightarrow{F} = \left(\alpha t\hat{i} + \beta\hat{J}\right)$ 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.)|T |=-Nm

B. The torque T* is in the direction of the unit A

vector + k

C. The velocity of the body at t =Is is

$$\vec{v} = \frac{1}{2}\left(\hat{i} + 2\hat{j}\right)ms^{-1}$$

D. The magnitude of displacement of the body

at £ = Is is 1/6m

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333. Satement-1: if there is no external torque on a

body about its centre of mass, then the velocity of the center of mass remains constant.

Statement-2: The linear momentum of an isolated system remains constant.

A. statements-1 and 2 are true and statement- 2 is a correct explanation for statement-1.

B. statements-1and 2 are true and statement-2 is not a correct explanation for statement-1.

C. statement-1 is true, statement- 2 is false.

D. statement-1 is false, statement- 2 is true

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334. Satement-1: two cylinder one hollow (metal) and the other side (wood) with the same mass and identical dimensions are simultaneously allowed to roll wihtout slipping down an inclined plane from the same height. The hollow cylinder will reach the bottom of the inclined plane first.

Statement-2: By the principle of conservation of energy, the total kinetic energies of both the cylinder are identical when they reach the bottom of the incline.

A. statements-1 and 2 are true and statement- 2 is a correct explanation for statement-1.

B. statements-1and 2 are true and statement-2 is not a correct explanation for statement-1.

C. statement-1 is true, statement- 2 is false.

D. statement-1 is false, statement- 2 is true

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335. The equations$x^2 + 5x^2 + px + q = 0$and x^3+ 7xa+ px+ r =0`have two roots in common. If the third root of each equation is xt and xa respectively then the ordered pair (x1, x2) is

A. 2

B. 44228

C. $\sqrt{2}$

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

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

When disc B is brought in contact with disc A, they acquire a common angular velocity in time t. The average frictional torque on one disc by the other during this period is

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

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

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

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

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

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

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

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

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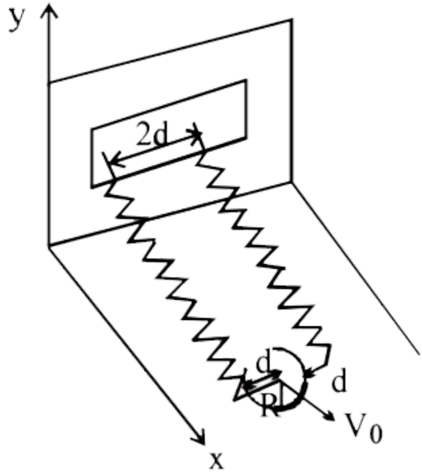
338. A uniform thin cylindrical disk of mass M and radius R is attaached to two identical massless springs of spring constatn k which are fixed to the wall as shown in the figure. The springs are attached to the axle of the disk symmetrically on either side at a distance d from its centre. The axle is massless and both the springs and the axle are in horizontal plane. the unstretched length of each spring is L. The disk is initially at its equilibrium position with its centre of mass (CM) at a distance L from the wall. The disk rolls without slipping with velocity $\overrightarrow{V}_0 = vacV_0\hat{i}$. The coefficinet of friction is μ.



The centre of mass of the disk undergoes simple harmonic motion with angular frequency ω equal to -

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

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

C. $\sqrt{2\frac{k}{3}M}$

D. $\sqrt{4\frac{k}{3}M}$

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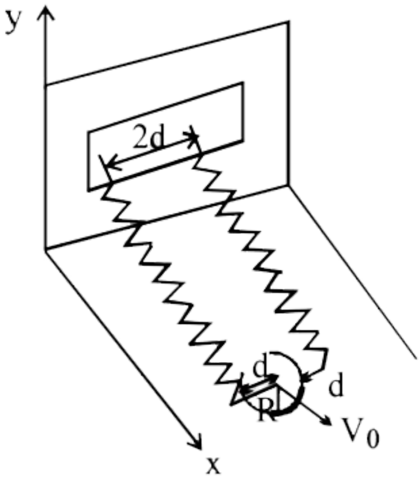

The maximum value of V_0 for whic the disk will roll without slipping is-

A. $\mu g\sqrt{\frac{M}{k}}$

B. $\mu g\sqrt{\frac{M}{2}k}$

C. $\mu g\sqrt{3\frac{M}{k}}$

D. $\mu g \sqrt{5 \frac{M}{2} k}$

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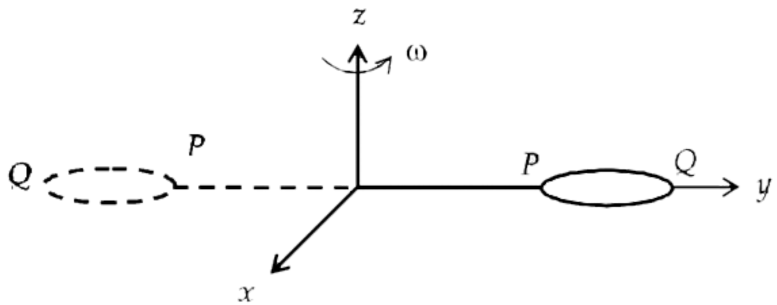
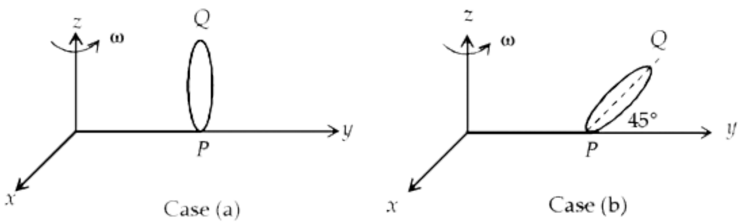
340. The general motion of a rigid body can be considered to be a combination of (i) a motion of its centre of mass about an axis, and (ii) its motion about an instantaneous exis passing through the centre of mass. These axes need not be stationary. Consider, for example, a thin uniform disc welded (rigidly fixed) horizontally at its rim to a massless, stick as shown in the figure. When the disc-stick system is rotated about the origin on a horizontal frictionless plane with angular speed ω the motion at any instant can be taken as a combination of (i) a rotation of the disc through an instantaneous vertical axis passing through its centre of mass (as is seen from the changed orientation of points P and Q). Both these motions have the same angular speed ω in this case



Now consider two similar system as shown in the figure: Case (a) the disc with its face vertical and parallel to x-z plane, Case (b) the disc with its face making an angle of 45° with x-y plane and its horizontal diameter parallel to x-axis. In both the cases, the disc is welded at point P, and the systems are rotated with constant angular speed ω about the z-axis.



Which of the following statements regarding the angular speed about the instantaneous axis (passing through the centre of mass) is correct?

A. It is v2i0) for both the cases

B. It is o) for case ,and for case

C.) It is (ofor case , and for case (/)

D. It is o) for both the cases

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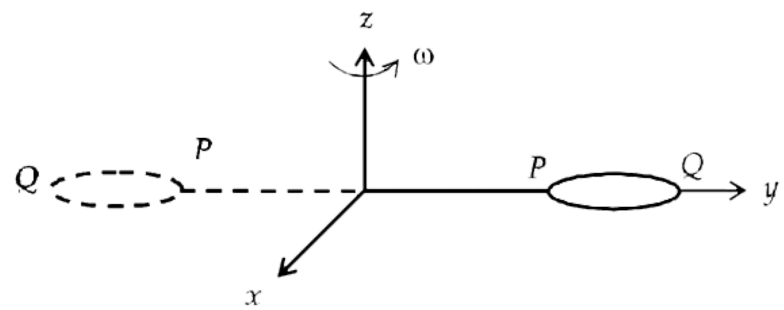

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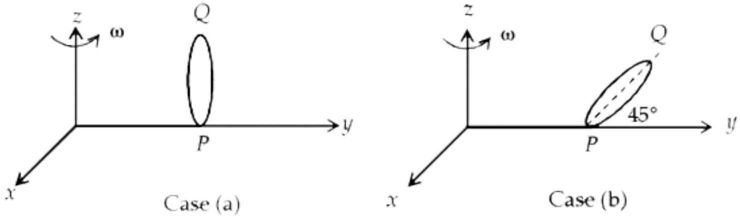

Which of the following statements regarding the angular speed about the instantaneous axis (passing through the centre of mass) is correct?

A. It is vertical for poth the cases (rr) ap

B.) It is vertical for case (/?) ,and is at 45º lo the x-z plane and lies in the plane of the disc for case

C. ft is horizontal for case ,and is at 45j*lo the x-z plane and is normal to the plane of the disc for case (t).

D. It is vertical for case {a plane and is normal to case gt

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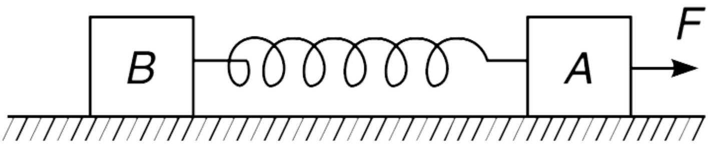
342. Two blocks A and B, each of mass m, are connected by a spring of force constant K. Initially, the spring is in its natural length. A horizontal constant force F starts acting on block A at time $t = 0$ and at time t , the extension in the spring is seen to be l. What is the displacement of the block A in time t ?



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. $\frac{R}{2}\cos \omega t$

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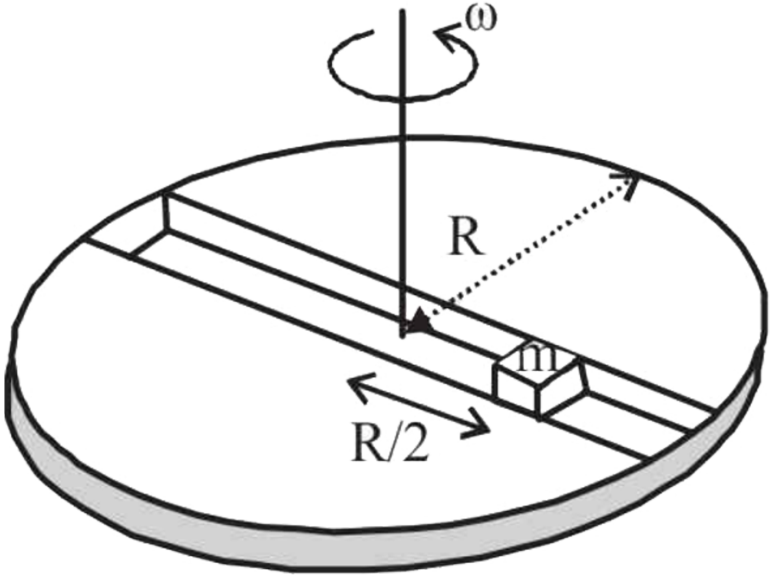
343. A frame of reference that is accelerated with respect to an inertial frame of reference is called a non-inertial frame of reference. A coordinate system fixed on a circular disc rotating about a fixed axis with a constant angular velocity ω is an example of non=inertial frame of reference. The relationship 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 $\left(\overrightarrow{\omega} = \omega\hat{k}\right)$. A small block of mass m is gently placed in the slot at $\overrightarrow{r}(R/2)\hat{\imath}$ at $t = 0$ and is constrained to move only along the slot.



The net reaction of the disc on the block is

A. $-m\omega^2 R\cos\omega t\hat{t} - mg\hat{k}$

B. $\frac{1}{2}m\omega\left(e^2\omega t - e^{-2\omega t}\hat{j} + mg\hat{k}\right.$

C. $m\omega^2 R\sin\omega t\hat{j} - mg\hat{k}$

D. $\frac{1}{2}m\omega^2 R\left(e^{wt}\right)j - mg\hat{k}$

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344. One twirls a circular ring (of mass and radius) near the tip of one's finger as shown in Figure 1. In the process the finger never loses contact with the inner rim of the ring. The finger traces out the surface of a cone, shown by the dotted line. The radius of the path traced out by the point where the ring and the finger is in contact is ?. The finger rotates with an angular velocity 2_0. The rotating ring rolls without slipping on the outside of a smaller circle described by the point where the ring and the finger is in contact (Figure 2). The coefficient of friction between the ring and the finger is μ and the acceleration due to gravity is g.

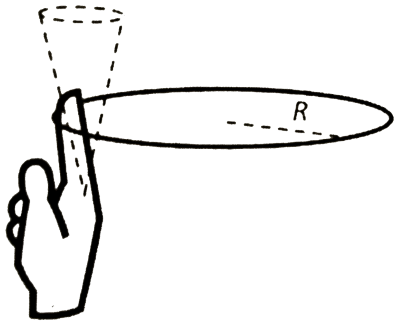

Figure 1

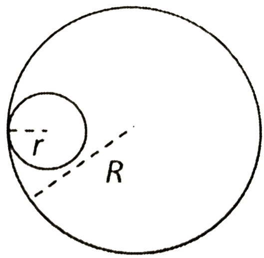

Figure 2

The minimum vlaue of ω_0 below which the ring will drop down is

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

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

C. $\sqrt{\dfrac{3g}{2\mu(R-r)}}$

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

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

A. $\frac{3}{2}M\omega_0^2(R-r)^2$

B. $\frac{1}{2}M\omega_0^2(R-r)^2$

C. $M\omega_0^2(R-r)^2$

D. $M\omega_0^2R^2$

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346. Four solid sphereas each of diameter $\sqrt{5}cm$ and mass $0.5kg$ are placed with their centres at the corners of a square of side $4cm$. The moment of inertia of the system about the diagonal of the square is $N \times 10^{-4}kg - m^2$, the N is -

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347. A binary star consists of two stars $A(mass 2.2 M_s)$ and B $(mass 11 M_s)$ 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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348. A uniform circular disc of mass 50kg and radius 0.4 m is rotating with an angular velocity of $10 rad s^{-1}$ about its own axis, which is vertical. Two uniform circular rings, each of mass 6.25 kg and radius 0.2 m, are gently placed symmetrically on the disc in such a manner that they are touching each other along the axis of the disc and are horizontal. Assume that the friction is large enough such that the rings are at rest relative to the disc and the system rotates about the original axis. The new angular velocity $\left(\in reds^{-1}\right)$ of the system is

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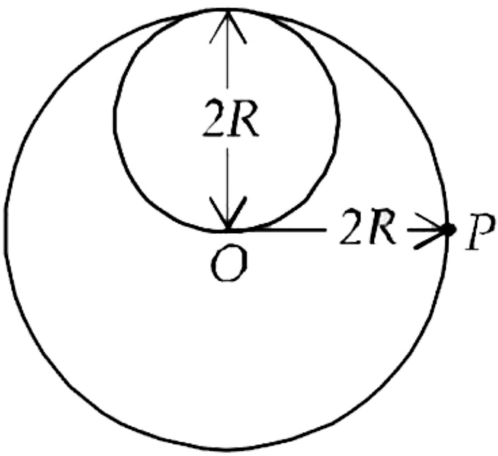
349. A lamina is made by removing a small disc of diameter 2R from a bigger disc of uniform mass density and radius 2R, as shown in the figure. The moment of inertia of this lamina about axes passing though O and P is I_O and I_P respectively. Both these axes are perpendiucalr to the plane of the lamina. The ratio $\frac{I_P}{I_O}$ ot the nearest integer is



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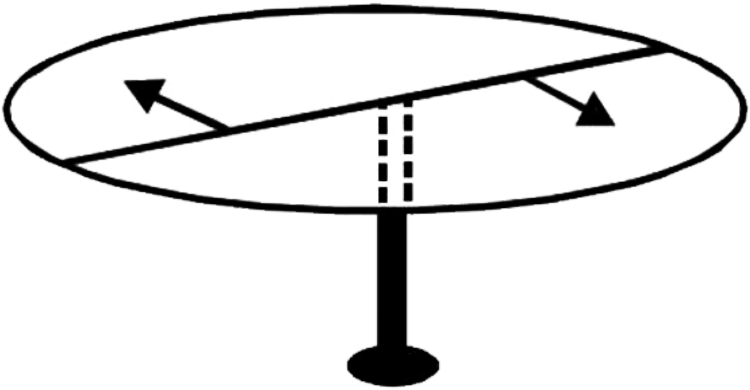
350. A horizontal circular platform of radius 0.5 m and mass axis. Two massless spring toy-guns, each carrying a steel ball of mass 0.05 kg are attached to the platform at a distance 0.25m from the centre on its either sides along its diameter (see figure). Each gun simultaneously fires the balls horizontally 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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351. 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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352. In the List-I below, four different paths of a particle are given as functions of time. In these functions, and are positive constants of appropriate dimensions and . In each case, the force acting on the particle is either zero or conservative. In List-II, five physical quantities of the particle are mentioned: is the linear momentum, is the angular momentum about the origin, is the kinetic energy, is the potential energy and is the total energy. Match each path in List-I with those quantities in List-II, which are conserved for that path.

LIST–I	LIST–II
P. $\vec{r}(t) = \alpha t\,\hat{\imath} + \beta t\,\hat{\jmath}$	1. $\vec{p}$
Q. $\vec{r}(t) = \alpha \cos \omega t\ \hat{\imath} + \beta \sin \omega t\ \hat{\jmath}$	2. $\vec{L}$
R. $\vec{r}(t) = \alpha\,(\cos \omega t\ \hat{\imath} + \sin \omega t\ \hat{\jmath})$	3. K
S. $\vec{r}(t) = \alpha t\,\hat{\imath} + \frac{\beta}{2} t^2\,\hat{\jmath}$	4. U
	5. E

A. p-1,2,3,4,5, Q-2,5, R-2,3,4,5,S-5

B. p-1,2,3,4,5, Q-3,5, R-2,3,4,5,S-2,5

C. p-2,3,4,5, Q-,5, R-1,S-2,5

D. p-1,2,3,5, Q-2,5, R-2,3,4,5,S-2,5

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353. 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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