PHYSICS

BOOKS - UNIVERSAL BOOK DEPOT

1960 PHYSICS (HINGLISH)

ROTATIONAL MOTION

Problems

1. The distance between the carbon atom and the oxygen atom in a carbon monoxide

molecule is 1.1Å. Given, mass of carbon atom is 12 a.m.u. and mass of oxygen atom is 16 a.m.u., calculate the position of the centre of mass of the carbon monoxide molecule

A. 6.3 Å from the carbon atom

B. 1 Å from the oxygen atom

C. 0.63 Å from the carbon atom

D. 0.12 Å from the oxygen atom

Answer: C

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2. The velocities of three particles of masses 20 g, 30 g and 50 g are $10\hat{i}$, $10\hat{j}$ and $10\hat{k}$ respectively. The velocity of the centre of mass of the three particles is

A. $2\overrightarrow{i} + 3\hat{j} + 5\hat{k}$

B. $10\left(\hat{i} + \hat{j} + \hat{k}\right)$

C. $20\hat{i} + 30\hat{j} + 5\hat{k}$

D. $2\hat{i} + 30\hat{j} + 50\hat{k}$

Answer: A

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3. 4 Masses 8 kg, 2 kg, 4 kg and 2 kg are placed at the corners A, B, C, D respectively of a square ABCD of diagonal 80 cm. The distance of centre of mass from A will be

A. 20 cm

B. 30 cm

C. 40 cm

D. 60 cm

Answer: B

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4. The coordinates of the positions of particles of mass 7, 4 and 10 gm are (1, 5,-3) , (2, 5, 7) and (3, 3,-1) respectively. Find the position of the center of mass of the system?

A. $\left(-\frac{15}{7}, \frac{85}{17}, \frac{1}{7}\right) cm$

B. $\left(\frac{15}{7}, -\frac{85}{17}, \frac{1}{7}\right) cm$

C. $\left(\frac{15}{7}, \frac{85}{21}, -\frac{1}{7}\right) cm$

D. $\left(\frac{15}{7}, \frac{85}{21}, \frac{7}{3}\right) cm$

Answer: C

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5. The angular velocity of second's hand of a watch will be.

A. $\frac{\pi}{60}$ rad/sec

B. $\frac{\pi}{30}$ rad/sec

C. π rad/sec

D. 30π rad/sec

Answer: B

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6. The wheel of a car is rotating at the rate of 1200 revolutions per minute. On pressing the accelerator for 10 seconds, it starts rotating at 4500 revolutions per minute. The angular acceleration of the wheel is

A. $30\ \text{radians}/\text{sec}^2$

B. $1880\ \text{degrees}/\text{sec}^2$

C. $40\ \text{radians}/\text{sec}^2$

D. $1980\ \text{degrees}/\text{sec}^2$

Answer: D

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7. Angular displacement (θ) of a flywheel varies with time as $\theta = at + bt^2 + ct^3$ then angular acceleration is given by

A. $a + 2bt - 3ct^2$

B. $2b - 6t$

C. $a + 2b - 6t$

D. $2b + 6ct$

Answer: D

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8. A wheel completes 2000 revolutions to cover the 9.5km distance , then the diameter of the wheel is

A. 1.5 m

B. 1.5 cm

C. 7.5 cm

D. 7.5 cm

Answer: A

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9. A wheel is at rest. Its angular velocity increases uniformly and becomes 60 rad/sec after 5 sec. The total angular displacement is

A. 600 rad

B. 75 rad

C. 300 rad

D. 150 rad

Answer: D

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10. A wheel initially at rest, is rotated with a uniform angular acceleration. The wheel rotates through an angle θ_1 in first one second

and through an additional angle θ_2 in the next one second. The ratio θ_2 / θ_1 is :

A. 4

B. 2

C. 3

D. 1

Answer: C

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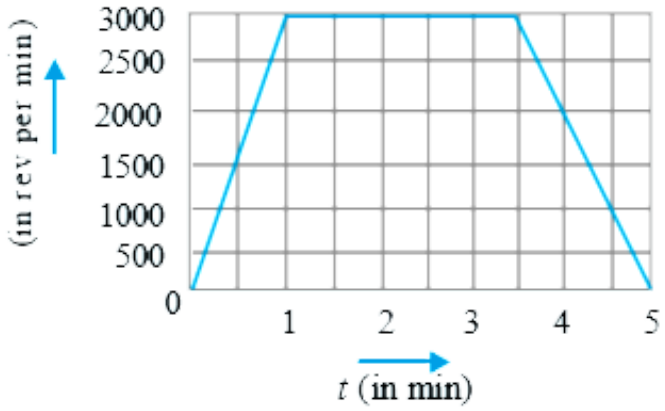
11. As a part of a maintenance inspection the compressor of a jet engine is made to spin according to the graph as shown. Find the number of revolutions made by the compressor during the test?



A. 9000

B. 16570

C. 12750

D. 11250

Answer: D

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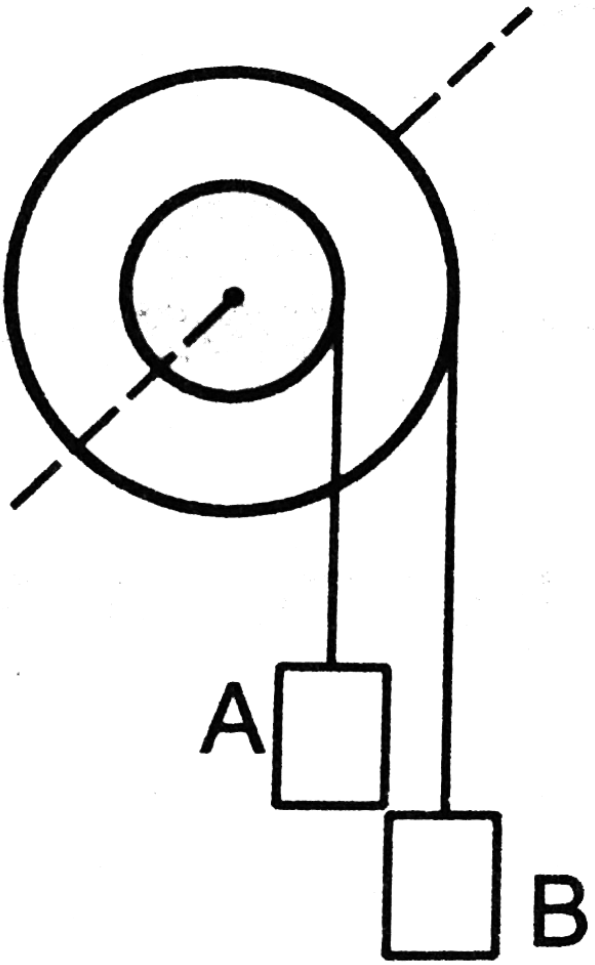
12. Figure shows a small wheel fixed coaxially on a bigger one of double the radius. The system rotates about the common axis. The strings supporting A and B do not slip on the wheels. If x and y be the distances travelled by

A and B in the same time interval, then



A. $x = 2y$

B. x = y

C. y = 2x

D. None of these

Answer: C

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13. The position vector of a particle is $\overrightarrow{r} = \left(3\hat{i} + 4\hat{j}\right)$ metre and its angular velocity $\overrightarrow{\omega} = \left(\hat{j} + 2\hat{k}\right) rads^{-1}$ then its linear velocity is (in ms^{-1})

A. $\left(8\hat{i}-6\hat{j}+3\hat{k}\right)$

B. $\left(3\hat{i}+6\hat{j}+8\hat{k}\right)$

C. $-\left(3\hat{i}+6\hat{j}+6\hat{k}\right)$

D. $\left(6\hat{i}+8\hat{j}+3\hat{k}\right)$

Answer: A

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14. Five particles of mass 2 kg each are attached to the rim of a circular disc of radius 0.1 m and negligible mass. Moment of inertia

of the system about the axis passing through the centre of the disc and perpendicular to its plane is

A. $1kgm^2$

B. $0.1kgm^2$

C. $2kgm^2$

D. $0.2kgm^2$

Answer: B

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15. A circular disc X of radius R is made from an iron plate of thickness t, and another disc Y of radius 4R is made from an iron plate of thickness $\frac{t}{4}$. Then the relation between the moment of inerita I_X and I_Y is

A. $I_Y = 64I_X$

B. $I_Y = 32I_X$

C. $I_Y = 16I_X$

D. $I_Y = I_X$

Answer: A

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16. Moment of inertia of a uniform circular disc about a diameter is I. Its moment of inertia about an axis perpendicular to its plane and passing through a point on its rim will be.

A. 5 I

B. 6 I

C. 3 I

D. 4 I

Answer: B

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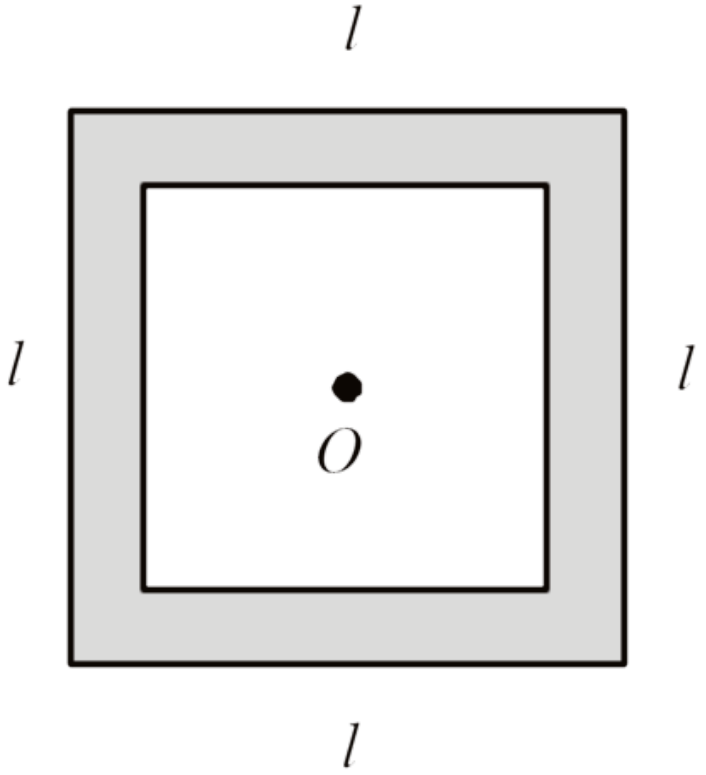
17. Four thin rods of same mass M and same length l, form a square as shown in figure. Moment of inertia of this system about an axis through centre O and perpendicular to its

plane is



A. $\frac{4}{3}Ml^2$

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

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

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

Answer: A

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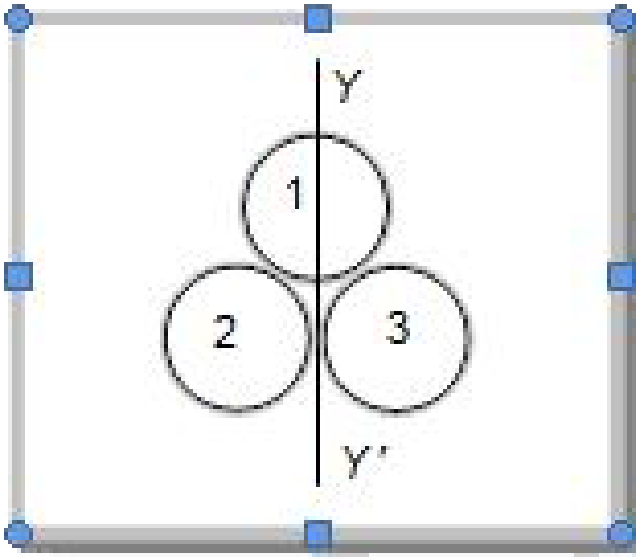
18. Three rings each of mass M and radius R are arranged as shown in the figure. The moment of inertia of the system about YY¢ will

be



A. $3MR^2$

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

C. $5MR^2$

D. $\frac{7}{2}MR^2$

Answer: D

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19. 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. $l \sin^2 \theta$

C. $l \cos^2 \theta$

D. $l \cos^2 \frac{\theta}{2}$

Answer: A

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20. Three rods each of length L and mass M are placed along X, Y and Z axis in such a way that one end of each of the rod is at the

origin. The moment of inertia of this system about Z axis is

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

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

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

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

Answer: A

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21. Three point masses each of mass m are placed at the corners of an equilateral triangle of side 'a'. Then the moment of inertia of this system about an axis passing along one side of the triangle is

A. ma^2

B. $3ma^2$

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

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

Answer: C

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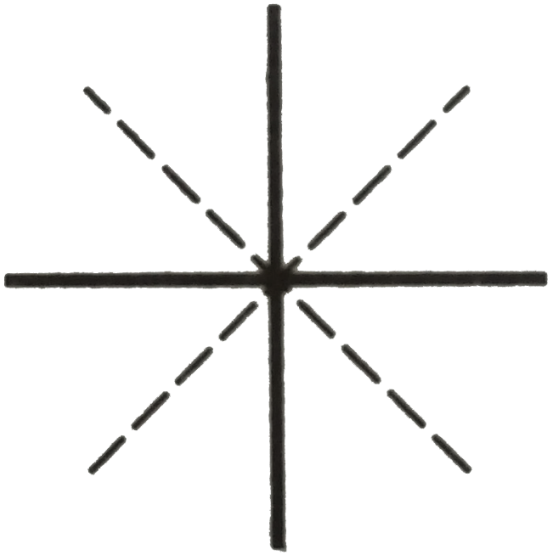
22. Two uniform identical rods each of mass M and length l are joined to form a cross as shown in figure. Find the moment of inertia of the cross about a bisector as shown doted in

the figure



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

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

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

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

Answer: B

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23. The moment of inertia of a rod of length l about an axis passing through its centre of mass and perpendicular to rod is I. The moment of inertia of hexagonal shape formed by six such rods, about an axis passing through its centre of mass and perpendicular to its plane will be

A. 16l

B. 40l

C. 60l

D. 80l

Answer: C

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24. The moment of inertia of HCl molecule about an axis passing through its centre of mass and perpendicular to the line joining the

H^+ and Cl^- ions will be (if the inter atomic distance is $1A^\circ$)

A. $0.61 \times 10^{-47} kg.\, m^2$

B. $1.61 \times 10^{-47} kg.\, m^2$

C. $0.061 \times 10^{-47} kg.\, m^2$

D. 0

Answer: B

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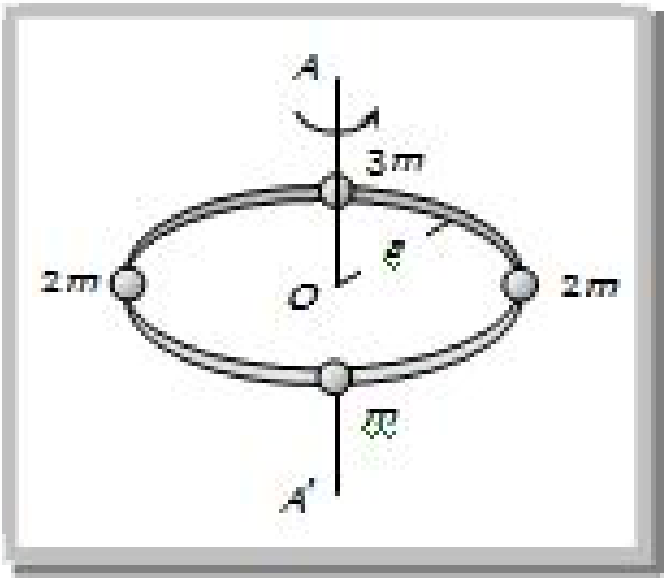
25. Four masses are joined to a light circular frame as shown in the figure. The radius of gyration of this system about an axis passing through the centre of the circular frame and perpendicular to its plane would be



A. $a/\sqrt{2}$

B. $a/2$

C. a

D. 2a

Answer: C

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26. Four particles each of mass m are placed at the corners of a square of side length l. The radius of gyration of the system about an axis

perpendicular to the plane of square and passing through its centre is

A. $\frac{5}{2}M\left(4r^2+5R^2\right)$

B. $\frac{2}{5}M\left(4r^2+5R^2\right)$

C. $\frac{2}{5}M\left(4r^2+5r^2\right)$

D. $\frac{5}{2}M\left(4r^2+5r^2\right)$

Answer: B

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27. What is the moment of inertia of a solid sphere of density ρ and radius R about its diameter ?

A. $\frac{105}{176}R^5\rho$

B. $\frac{105}{176}R^2\rho$

C. $\frac{176}{105}R^5\rho$

D. $\frac{176}{105}R^2\rho$

Answer: C

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28. 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.

A. $I_A = I_B$

B. $I_A > I_B$

C. $I_A < I_B$

D. $I_A \geq < I_B$

Answer: C

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29. A force of $\left(2\hat{i}-4\hat{j}+2\hat{k}\right)$N act a point $\left(3\hat{i}+2\hat{j}-4\hat{k}\right)$ metre form the origin. The magnitude of torque is

A. Zero

B. 24.4 N-m

C. 0.244 N-m

D. 2.444 N-m

Answer: B

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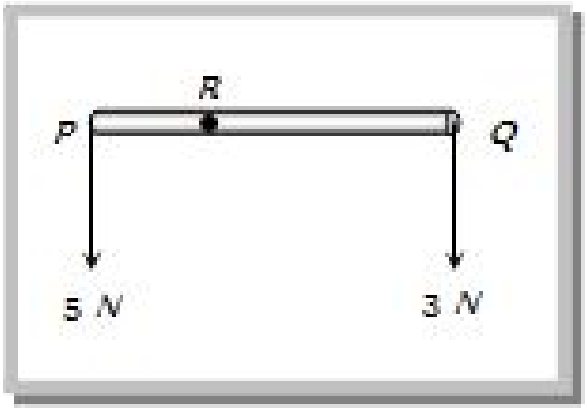
30. The resultant of the system in the figure is a force of 8 N parallel to the given force through R. The value of PR equals to



A. $1/4RQ$

B. $3/8RQ$

C. $3/5RQ$

D. $2/5RQ$

Answer: C

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31. A horizontal heavy uniform bar of weight W is supported at its ends by two men. At the instant, one of the men lets go off his end of

the rod, the other feels the force on his hand changed to

A. W

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

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

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

Answer: D

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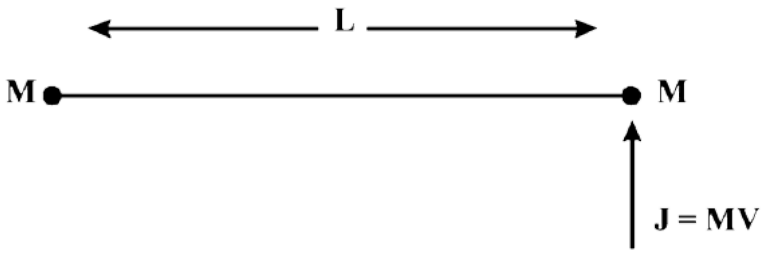
32. Consider a body, shown in figure, consisting of two identical balls, each of mass M connected by a light rigid rod. If an impulse J = MV is imparted to the body at one of its ends what would be it angular velocity?



A. v/L

B. $2v/L$

C. $v/3L$

D. $v/4L$

Answer: A

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33. A thin circular ring of mass M and radius R is rotating about its axis with a constant angular velocity omega. Four objects each of mass m, are kept gently to the opposite ends

of two perpendicular diameters of the ring.

The angular velocity of the ring will be

A. $\frac{M\omega}{M+4m}$

B. $\frac{(M+4m)\omega}{M}$

C. $\frac{(M-4m)\omega}{M+4m}$

D. $\frac{M\omega}{4m}$

Answer: A

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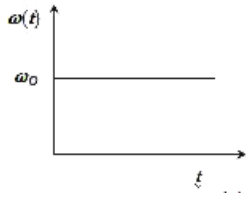
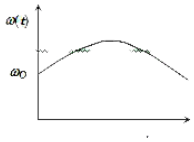
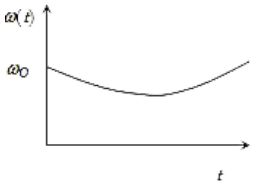
34. A circular platform is free to rotate in a horizontal plane about a vertical axis passing through its centre. A tortoise is sitting at the edge of the platform. Now the platform is given an angular velocity ω_0. When the tortoise move along a chord of the platform with a constant velocity (with respect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

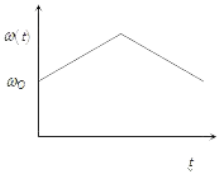
A. 

B. 

C.



D.



Answer: B

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35. The position of a particle is given by $\overrightarrow{r} = \hat{i} + 2\hat{j} - \hat{k}$ and its momentum is

$\overrightarrow{p} = 3\hat{i} + 4\hat{j} - 2\hat{k}$. The angular momentum is perpendicular to

A. X-axis

B. Y-axis

C. Z-axis

D. Line at equal angles to all the three axes

Answer: A

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36. Two discs of moment of inertia I_1 and I_2 and angular speeds ω_1 and ω_2 are rotating along the collinear axes passing through their center of mass and perpendicular to their plane. If the two are made to rotate combindly along the same axis the rotational $K.E.$ of system will be

A. $\dfrac{I_1\omega_1 + I_2\omega_2}{2(I_1 + I_2)}$

B. $\dfrac{(I_1 + I_2)(\omega_1 + \omega_2)^2}{2}$

C. $\dfrac{(I_1\omega_1 + I_2\omega_2)^2}{2(I_1 + I_2)}$

D. None of these

Answer: C

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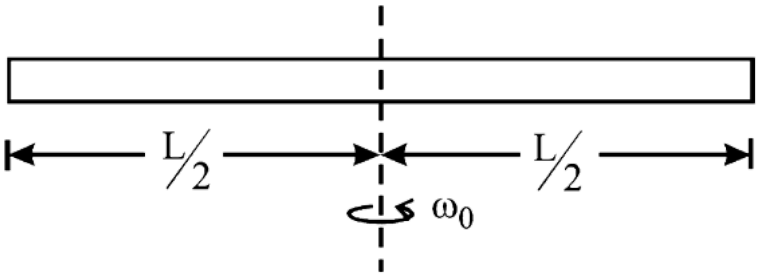
37. A smooth uniform rod of length L and mass M has two identical beads of negligible size each of mass m which can slide freely along the rod. Initially the two beads are at the centre of the rod and the system is rotating with an angular velocity ω_0 about an axis

perpendicular to the rod and passing through the midpoint of the rod. There are no external forces. When the beads reach the ends of the rod, the angular velocity of the system is .....



A. ω_0

B. $\dfrac{M\omega_0}{M+12m}$

C. $\dfrac{M\omega_0}{M+2m}$

D. $\frac{M\omega_0}{M+6m}$

Answer: D

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38. Moment of inertia of uniform rod of mass M and length L about an axis through its centre and perpendicular to its length is given by $\frac{ML^2}{12}$. Now consider one such rod pivoted at its centre, free to rotate in a vertical plane. The rod is at rest in the vertical position. A

bullet of mass M moving horizontally at a speed v strikes and embedded in one end of the rod. The angular velocity of the rod just after the collision will be

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

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

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

D. $\frac{6v}{L}$

Answer: C

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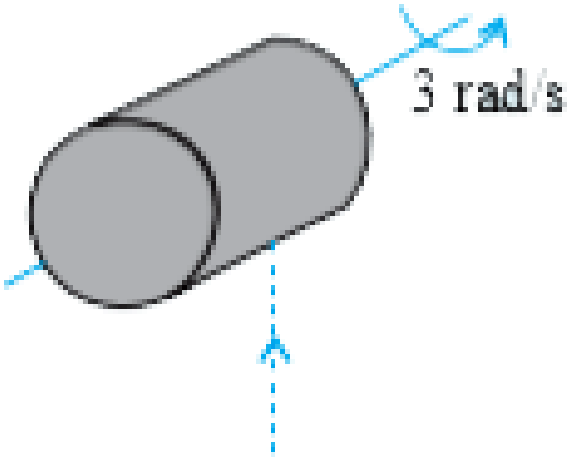
39. A solid cylinder of mass 2 kg and radius 0.2m is rotating about its own axis without friction with angular velocity 3 rads/s. A particle of mass 0.5 kg and moving with a velocity 5 m/s strikes the cylinder and sticks to it as shown in figure. The angular momentum of the cylinder before collision will be?



A. 0.12 J-s

B. 12 J-s

C. 1.2 J-s

D. 1.12 J-s

Answer: A

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40. In the above problem the angular velocity of the system after the particle sticks to it will be?

A. 0.3 rad/s

B. 5.3 rad/s

C. 10.3 rad/s

D. 89.3 rad/s

Answer: C

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41. A ring of radius 0.5 m and mass 10 kg is rotating about its diameter with angular velocity of 20 rad/s. Its KE is :-

A. 10J

B. 100J

C. 500J

D. 250J

Answer: D

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42. An automobile engine develops 100 kW, when rotating at a speed of $1800\ rev/\ \min$. Find the torque developed by it.

A. 350N-m

B. 440N-m

C. 531 N-m

D. 628N-m

Answer: C

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43. A body of moment of inertia of $3kgm^2$ rotating with an angular velocity or 2rad//s

has the same kinetic energy as a mass of 12kg moving with a velocity of

A. 8m/s

B. 0.5m/s

C. 2m/s

D. 1m/s

Answer: D

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44. A disk and a ring of the same mass are rolling to have the same kinetic energy. What is ratio of their velocities of centre of mass

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

B. $\sqrt{3}:\sqrt{4}$

C. $\sqrt{3}:\sqrt{2}$

D. $\sqrt{2}:\sqrt{3}$

Answer: A

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45. A wheel rotating at an angular speed of 20 rad/s ils brought to rest by a constant trouque in 4.0 secons. If the moiment of inertia of the wheel about the axis of rotation is 0.20 $kg - m^2$ find the work done by the torque in the first two seconds.

A. 10J

B. 20J

C. 30J

D. 40J

Answer: C

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46. If the angular momentum of any rotating body increases by 200%, then the increase in its kinetic energy

A. 4

B. 8

C. 2

D. 1

Answer: B

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47. A ring, a solid sphere and a thin disc of different masses rotate with the same kinetic energy. Equal torques are applied to stop them. Which will make the least number of rotations before coming to rest?

A. Disc

B. Ring

C. Solid sphere

D. All will make same number of rotations

Answer: D

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48. The angular velocity of a body is $\vec{\omega} = 2\hat{i} + 3\hat{j} + 4\hat{k}$ and a torque $\vec{\tau} = \hat{i} + 2\hat{j} + 3\hat{k}$ acts on it. The rotational power will be

A. 20W

B. 15W

C. $\sqrt{17}W$

D. $\sqrt{14}W$

Answer: A

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49. A fly wheel of M.I. $0.32kgm^2$ is rotated steadily at 120 rad/s by 50 w electric motor.

Then the value of the frictional couple opposing rotation is,

A. 4608J

B. 1152J

C. 2304J

D. 6912J

Answer: C

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50. A solid cylinder of mass M and radius R rolls without slipping down an inclined plane of length L and height h. What is the speed of its center of mass when the cylinder reaches its bottom

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

B. $\sqrt{\frac{4}{3}gh}$

C. $\sqrt{4gh}$

D. $\sqrt{2gh}$

Answer: B

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51. A sphere rolls down on an inclied 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. $\frac{2}{5}g\sin\theta$

Answer: A

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52. A solid ring, sphere and a disc are rolling down from the top of the same height, then the sequence to reach on the surface is

A. Ring, disc, sphere

B. sphere, disc, ring

C. Disc, ring, sphere

D. Sphere, ring, disc

Answer: B

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53. A thin uniform circular ring is rolling down an inclined plane of inclination 30° without slipping. Its linear acceleration along the inclined plane will be

A. g/2

B. g/3

C. g/4

D. 2g/3

Answer: C

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54. A sphere and circular disc of same mass and radius are allowed to roll down an inclined plane from the same height without slipping. Find the ratio of times taken by these two to come to the bottom of incline :

A. $15:14$

B. $\sqrt{15}:\sqrt{14}$

C. $14:15$

D. $\sqrt{14}:\sqrt{15}$

Answer: D

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55. A solid sphere of mass 0.1kg and radius 2cm rolls down an inclined plane 1.4m in length (slope 1 in 10). Starting from rest, what will be its final velocity?

A. 1.4m/sec

B. 0.14 m/sec

C. 14m/sec

D. 0.7 m/sec

Answer: A

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56. A solid sphere rolls down an inclined plane and its velocity at the bottom is v_1. Then same sphere slides down the plane (without

friction) and let its velocity at the bottom be v_2. Which of the following relation is correct

A. $v_1 = v_2$

B. $v_1 = \frac{5}{7}v_2$

C. $v_1 = \frac{7}{5}v_2$

D. None of these

Answer: D

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57. A cord is wound round the circumference of wheel of radius r. The axis of the wheel is horizontal and fixed and moment of inertia about it is I. A weight mg is attached to the end of the cord and falls from rest. After falling through a distance h, the angular velocity of the wheel will be.

A. $\sqrt{\dfrac{2gh}{I+mr}}$

B. $\sqrt{\dfrac{2mgh}{I+mr^2}}$

C. $\sqrt{\dfrac{2mgh}{I+2mr^2}}$

D. $\sqrt{2gh}$

Answer: B

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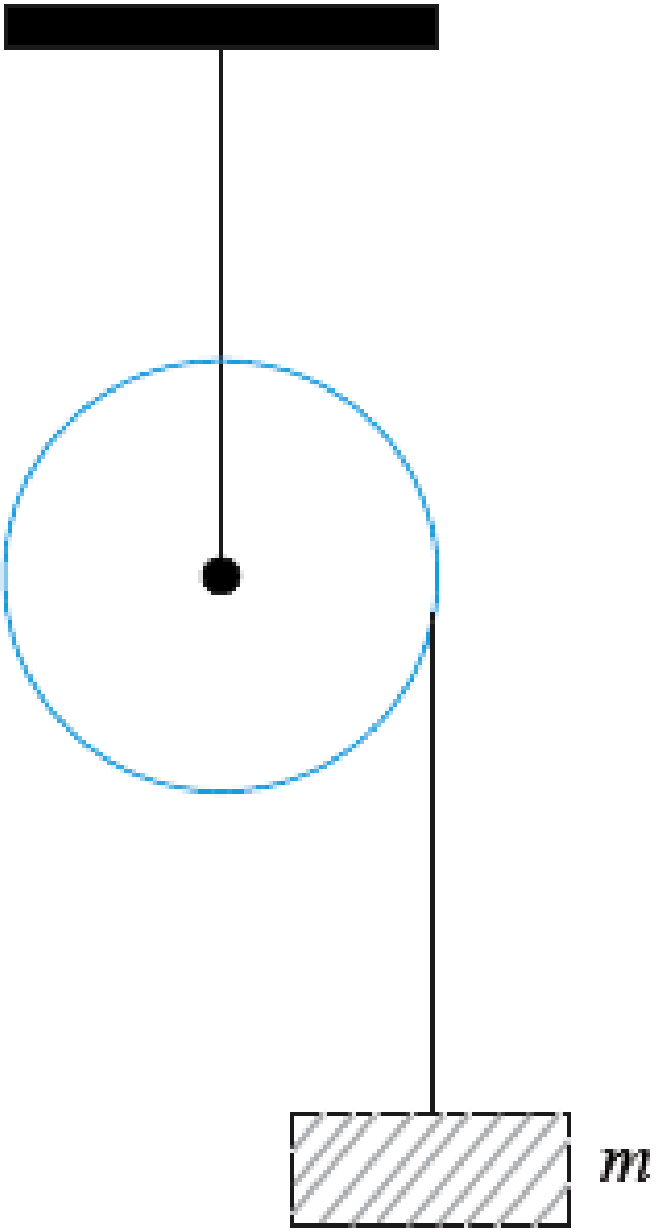
58. In the following figure, a body of mass m is tied at one end of a light string and this string is wrapped around the solid cylinder of mass M and radius R. At the moment t = 0 the system starts moving. If the friction is

negligible, angular velocity at time t would be



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

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

C. $\frac{2mgt}{R(M-2m)}$

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

Answer: D

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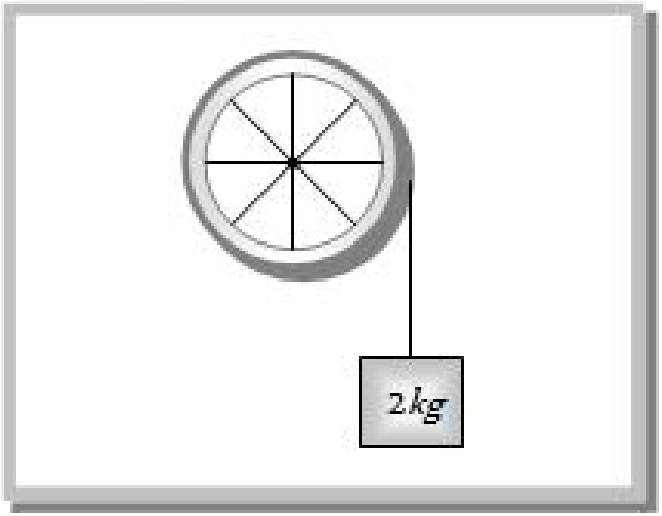
59. A block of mass 2kg hangs from the rim of a wheel of radius 0.5m. On releasing from rest the block falls through 5m height in 2s. The

moment of inertia of the wheel will be



A. $1kg - m^2$

B. $3.2kg - m^2$

C. $2.5kg - m^2$

D. $1.5kg - m^3$

Answer: D

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60. A ring whose diameter is 1 meter, oscillates simple harmonically in a vertical plane about a nail fixed at its circumference. The time period will be

A. 1/4 sec

B. 1/2sec

C. 1 sec

D. 2sec

Answer: D

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61. A number of holes are drilled along a diameter of a disc of radius R. To get minimum time period of oscillations the disc should be suspended from a horizontal axis passing through a hole whose distance from the centre should be

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

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

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

D. zero

Answer: B

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Practice Problems Problems Based On Centre Of Mass

1. Where will be the centre of mass on combining two masses m and $M(M > m)$?

A. Towards m

B. Towards M

C. Between m and M

D. Anywhere

Answer: B

Watch Video Solution

2. Two objects of masses 200 g and 500 g possess velocities $10\hat{i}ms^{-1}$ and $3\hat{i}+5\hat{j}ms^{-1}$ respectively. The velocity of their centre of mass in ms^{-1} is

A. $5\hat{i}-25\hat{j}$

B. $\frac{5}{7}\hat{j}-25\hat{j}$

C. $5\hat{i}+\frac{25}{7}\hat{j}$

D. $25\hat{j}-\frac{5}{7}\hat{j}$

Answer: C

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3. 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 ?

A. 1 Å

B. 2.5 Å

C. 1.24 Å

D. 1.5 Å

Answer: C

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4. Four particles of masses m, 2m, 3m and 4m are arranged at the corners of a parallelogram with each side equal to a and one of the angle between two adjacent sides is 60°. The parallelogram lies in the x-y plane with mass m

at the origin and 4 m on the x-axis. The centre of mass of the arrangement will be located at

A. $\left(\frac{\sqrt{3}}{2}a, 0.95a\right)$

B. $\left(0.95a, \frac{\sqrt{3}}{4}a\right)$

C. $\left(\frac{3a}{4}, \frac{a}{2}\right)$

D. $\left(\frac{a}{2}, \frac{3a}{4}\right)$

Answer: B

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5. A system consists of 3 particles each of mass 'm' are located at (1, 1) (2, 2) and (3, 3). The co-ordinates of the centre of mass are

A. (6, 6)

B. (3, 3)

C. (2, 2)

D. (1, 1)

Answer: C

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6. If a bomb is thrown at a certain angle with the horizontal and after exploding on the way the different fragments move in different directions then the centre of mass

A. Would move along the same parabolic path

B. Would move along a horizontal path

C. Would move along a vertical line

D. None of these

Answer: A

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7. Four identical spheres each of mass m are placed at the corner of square of side 2 m. Taking the point of intersection of the diagonals as the orgin the coordinates of the centre of mass are ?

A. (0,0)

B. (1,1)

C. (-1,1)

D. `(1,-1)

Answer: A

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8. 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. Zero

B. v

C. 1.5v

D. 3v

Answer: A

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9. 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.

A. 3 cm

B. 6 cm

C. 9 cm

D. 12 cm

Answer: C

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10. Two point masses m and M are separated by a distance L . The distance of the centre of mass of the system from m is

A. $L(m/M)$

B. $L(M/m)$

C. $L\left(\frac{M}{m+M}\right)$

D. $L\left(\frac{m}{m+M}\right)$

Answer: C

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11. Three identicle particle each of mass $1kg$ are placed with their centres on a straight line. Their centres are marked A, B and C respectively. The distance of centre of mass of the system from A is.

A. $\frac{KL + KM + LM}{3}$

B. $\frac{KL + KM}{3}$

C. $\frac{KL + LM}{3}$

D. $\frac{KM + LM}{3}$

Answer: B

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12. 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 0.5 m/s. When the relative velocity of approach becomes 3m/s, the velocity of the centre of mass is 0.75 m/s.

A. 0.5 m/s

B. 0.75 m/s

C. 1.25 m/s

D. Zero

Answer: A

 Watch Video Solution

Practice Problems Problems Based On Angular Displacement Velocity And Acceleration

1. In rotational motion of a rigid body, all particles move with

A. Same linear and angular velocity

B. Same linear and different angular velocity

C. With different linear velocities and same angular velocities

D. With different linear velocities and different angular velocities

Answer: C

Watch Video Solution

2. The angula speed of a fly-wheel making 120 revolutions /minute is :

A. π rad/sec

B. 2π rad/sec

C. 4π rad/sec

D. 4π ' rad/sec

Answer: C

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

A. 3π rad/sec

B. 9π rad/sec

C. 18π rad/sec

D. 54π rad/sec

Answer: A

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4. 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. -25.5 rad/s

B. -29.5 rad/s

C. -33.5 rad/s

D. -45.5 rad/s

Answer: A

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5. A wheel is rotating at 900 rpm about its axis. When the power is cut off, it comes to rest in 1 min. The angular retardation (in rad s^{-2}) is

A. $\pi/2$

B. $\pi/4$

C. $\pi/6$

D. $\pi/8$

Answer: A

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6. A particle P is moving in a circle of radius r with a uniform speed u. C is the centre of the

circle and AB is diameter. The angular velocity of P about A and V are in the ratio :

A. $1:1$

B. $1:2$

C. $2:1$

D. $4:1$

Answer: B

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7. Two particles having mass 'M' and 'm' are moving in a circular path having radius R & r respectively. If their time period are same then the ratio of angular velocity will be : -

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

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

C. 1

D. $\sqrt{\frac{R}{r}}$

Answer: C

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8. A ody is in pure rotation. The linear speed v of a particle, the distance r of the particle from the axis and the angular velocity ω of the body are related as $\omega = \frac{v}{r}$. Thus

A. $\omega \propto \frac{1}{r}$

B. $\omega \propto r$

C. $\omega = 0$

D. ω in independent of r

Answer: D

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9. A strap is passing over a wheel of radius 30 cm. During the time the wheel moving with initial constant velocity of 2 rev/sec. comes to rest the strap covers a distance of 25 m. The deceleration of the wheel in rad/s is

A. 0.94

B. 1.2

C. 2.0

D. 2.5

Answer: A

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10. A particle starts rotating from rest. Its angular displacement is expressed by the following equation $\theta = 0.025t^2 - 0.1t$ where θ is in radian and t is in seconds. The angular acceleration of the particle is

A. 0.5 rad/sec at the end of 10 sec

B. 0.3 rad/sec at the end of 2 sec

C. 0.05 rad/sec at the end of 1 sec

D. Constant 0.05 rad/sec

Answer: D

Watch Video Solution

11. The planes of two rigid discs are perpendicular to each other. They are rotating about their axes. If their angular velocities are

3 rad/sec and 4 rad/sec respectively, then the resultant angular velocity of the system would be

A. 1 rad/sec

B. 7 rad/sec

C. 5 rad/sec

D. $\sqrt{12}$ rad/sec

Answer: C

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12. A sphere is rotating about a diameter

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

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

C. Different particles on the surface have different angular speeds

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

Answer: B

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13. A rigid body rotates about a fixed axis with variable angular velocity equal to (a - bt) at time t where a and b are constants. The angle through which it rotates before it comes to rest is

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

B. $\frac{a^2}{2b}$

C. $\frac{a^2-b^2}{2b}$

D. $\frac{a^2-b^2}{2a}$

Answer: B

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14. When a ceiling fan is switched on, it makes 10 rotations in the first 3 seconds. Assuming a

uniform angular acceleration, how many rotation it will make in the next 3 seconds?

A. 10

B. 20

C. 30

D. 40

Answer: C

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15. When a ceiling fan is switched off, its angular velocity reduces to 50% while it makes 36 rotations. How many more rotations will it make before coming to rest?(Assume uniform angular retardation)

A. 36

B. 24

C. 18

D. 12

Answer: D

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16. Let $\vec{A}$ be a unit vecrtor along the axis of rotation of a purely rotating body and $\vec{B}$ be a unit vector along the velocity of a particle P of the body away from the axis. The value of $\vec{A} . \vec{B}$ is

A. 1

B. -1

C. 0

D. None of these

Answer: C

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Practice Problems Problems Based On Torque Couple

1. Let $\overrightarrow{F}$ be the force acitng on a paritcle having positon vector $\overrightarrow{r}$ and $\overrightarrow{T}$ be the torque of this force about the origin. Then

A. $\vec{r} . \vec{T} = 0$ and $\vec{F} . \vec{T} = 0$

B. $\vec{r} . \vec{T} = 0$ and $\vec{F} . \vec{T} \neq 0$

C. $\vec{r} . \vec{T} \neq 0$ and $\vec{F} . \vec{T} = 0$

D. $\vec{r} . \vec{T} \neq 0$ and $\vec{F} . \vec{T} \neq 0$

Answer: A

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2. A couple produces.

A. Purely linear motion

B. Purely rotational motion

C. Linear and rotational motion

D. No motion

Answer: B

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3. For a system to be in equilibrium, the torques acting on it must balance. This is true only if the torques are taken about

A. The centre of the system

B. The centre of mass of the system

C. Any point on the system

D. Any point on the system or outside it

Answer: D

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4. The torque of the force $\vec{F} = \left(2\hat{i} - 3\hat{j} + 4\hat{k}\right)N$ acting at the point $\vec{r} = \left(3\hat{i} + 2\hat{j} + 3\hat{k}\right)m$ about the origin be

A. $-17\hat{i}+6\hat{j}+13\hat{k}$

B. $-6\hat{i}+6\hat{j}-12\hat{k}$

C. $17\hat{i}-\hat{j}-13\hat{k}$

D. $6\hat{i}-6\hat{j}+12\hat{k}$

Answer: C

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5. Two men A and B are carrying a uniform bar of length L on their shoulders. The bar is held horizontally such that A gets one-fourth

load. If A is at one end of the bar, the distance of B from that end is

A. $L/3$

B. $L/2$

C. $2L/3$

D. $3L/4$

Answer: C

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6. A uniform meter scale balances at the 40 cm mark when weights of 10g and 20g are suspended from the 10cm and 20cm marks. The weight of the metre scale is

A. 50 g

B. 60 g

C. 70 g

D. 80 g

Answer: C

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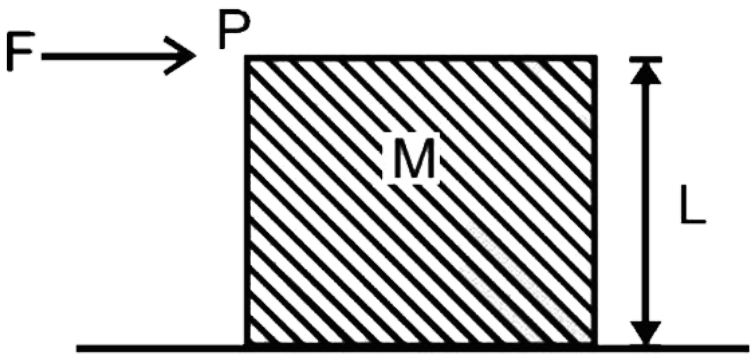
7. A cubical block of side L rests on a rough horizonta surface with coefficient of friction μ. A horizontal force F is applied on the block as shown. If the coefficient of friction is sufficiently high so that the block does not slide before toppling, the minimum force

required to topple the block is



A. Infinitesimal

B. $mg/4$

C. $mg/2$

D. $mg(1-\mu)$

Answer: C

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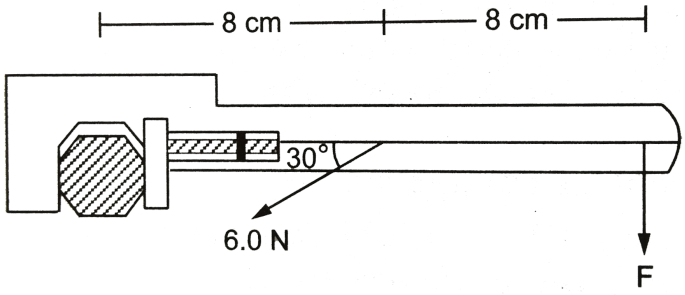
8. When a force of 6.0 N is exerted at 30° to a wrench at a distance of 8 cm from the nut, it is just able to loosen the nut. What force F would be sufficient to loosen it if it acts perpendicularly to the wrench at 16 cm from the nut?



A. 3N

B. 6N

C. 4N

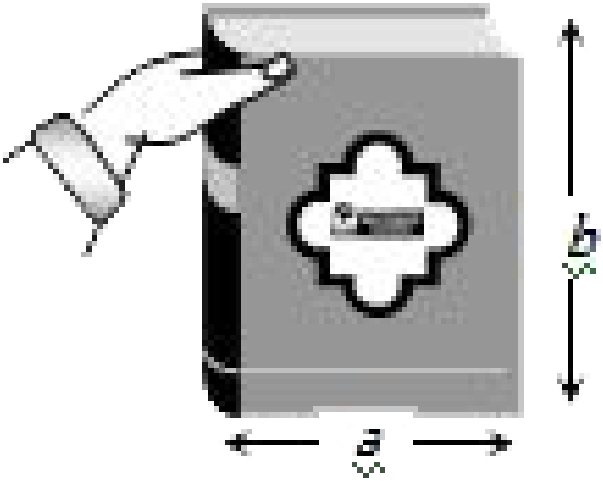
D. 1.5 N

Answer: D

Watch Video Solution

9. A person supports a book between his finger and thumb as shown (the point of grip is assumed to be at the corner of the book). If

the book has a weight of W then the person is producing a torque on the book of



A. $W\frac{a}{2}$ anticlockwise

B. $W\frac{b}{2}$ anticlockwise

C. Wa anticlockwise

D. Wa clockwise

Answer: A

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10. Particles of masses 1g, 2g, 3g, ... 100g re kept at the marks 1 cm, 2cm, 3cm,..... 100 cm, respectively on a metre scale. Find the moment of inertia of the system of particle about a perpendicular bisector of the metre scale.

A. 55 cm mark

B. 60 cm mark

C. 66 cm mark

D. 72 cm mark

Answer: C

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11. A uniform cube of side a and mass m rests on a rough horizontal table. A horizontal force F is applied normal to one of the faces at a point that is directly above the centre of the

face, at a height 3a/4 above the base. The minimum value of F which the cube begins to tip about the edge is ....(Assume that the cube does not slide).

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

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

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

D. mg

Answer: B

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Practice Problems Problems Based On Moment Of Inertia

1. A circular disc of radius R and thickness $R/6$ has moment of inertia I about an axis passing through its centre and perpendicular to its plane. It is melted and recast into a solid sphere. The $M.I$ of the sphere about its diameter as axis of rotation is

A. I

B. $\frac{2I}{8}$

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

D. $\frac{I}{10}$

Answer: C

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2. The moment of inertia of a meter scale of mass 0.6 kg about an axis perpendicular to the scale and located at the 20 cm position on the scale in kg m is (Breadth of the scale is negligible)

A. 0.074

B. 0.104

C. 0.148

D. 0.208

Answer: B

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3. Two discs of the same material and thickness have radii 0.2 m and 0.6 m. Their

moments of inertia about their axes will be in the ratio of

A. $1:81$

B. $1:27$

C. $1:9$

D. $1:3$

Answer: A

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

A. Iron and aluminium layers in alternate order

B. Aluminium at interior and iron surrounding it

C. Iron at interior and aluminium surrounding it

D. Either (a) or (c)

Answer: B

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5. The moment of inertia of semicircular ring about its centre is

A. MR^2

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

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

D. None of these

Answer: A

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6. Moment of inertia of a disc about its own axis is I. Its moment of inertia about a tangential axis in its plane is

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

B. $3I$

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

D. $2I$

Answer: A

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7. A wheel of mass 10 kg has a moment of inertia of $160kg - m^2$ about its own axis, the radius of gyration will be

A. 10m

B. 8m

C. 6m

D. 4m

Answer: D

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8. Four particles each of mass m are placed at the corners of a square of side length l. The radius of gyration of the system about an axis

perpendicular to the plane of square and passing through its centre is

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

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

C. l

D. $(\sqrt{2})l$

Answer: A

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9. The moment of inertia of a straight thin rod of mass M and length l about an axis perpendicular to its length and passing through its one end, is

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

B. $\frac{7}{48}ml^2$

C. $\frac{13}{48}ml^2$

D. $\frac{19}{48}ml^2$

Answer: B

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10. 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 ?

A. $(m_2 + m_3)\frac{a^2}{4}$

B. $(m_1 + m_2 + m_3)a^2$

C. $(m_1 + m_2)\frac{a^2}{2}$

D. $(m_2 + m_3)a^2$

Answer: A

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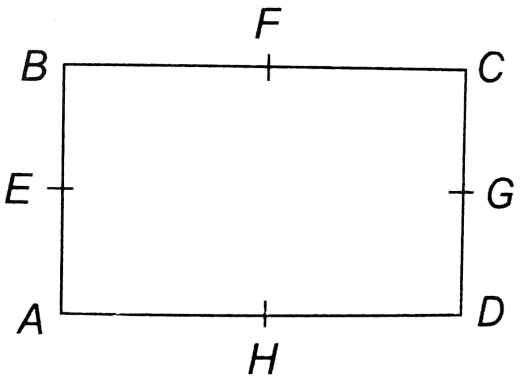
11. In a rectangle $ABCD$ $(BC = 2AB)$. The moment of inertia along which the axis will be minimum



A. BC

B. BD

C. HF

D. EG

Answer: D

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12. Two loops P and Q are made from a uniform wire. The redii of P and Q are r_1 and r_2 respectively, and their moments of

inertia are I_1 and I_2 respectively, If $I_2 = 4I_1$, then $\frac{r_2}{r_1}$ equals-

A. $4^{2/3}$

B. $4^{1/3}$

C. $4^{-2/3}$

D. $4^{-1/3}$

Answer: B

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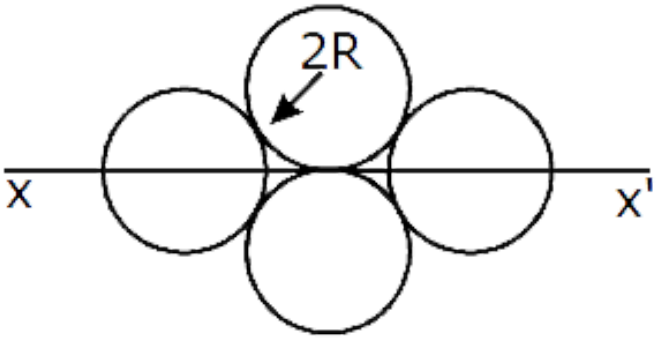
13. The moment of inertia of a sphere about its diameter is I. Four such spheres are arranged as shown in figure. Find the moment of inertia of the system about the axis XX'. (radius of each sphere is 2R).



A. 3I

B. 5I

C. 7I

D. 9I

Answer: D

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14. Three identical thin rods each of length l and mass M are joined together to from a letter H. What is the moment of inertia of the system about one of the sides of H ?

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

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

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

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

Answer: D

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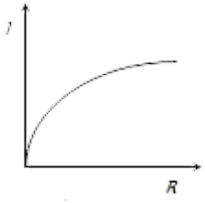
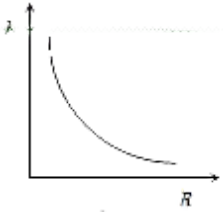
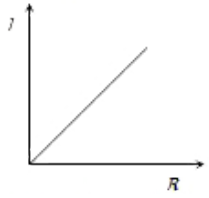
15. Moment of inertia of a sphere of mass M and radius R is I. Keeping M constant if a

graph is plotted between I and R, then its form would be

A. 

B. 

C. 

D. 

Answer: D

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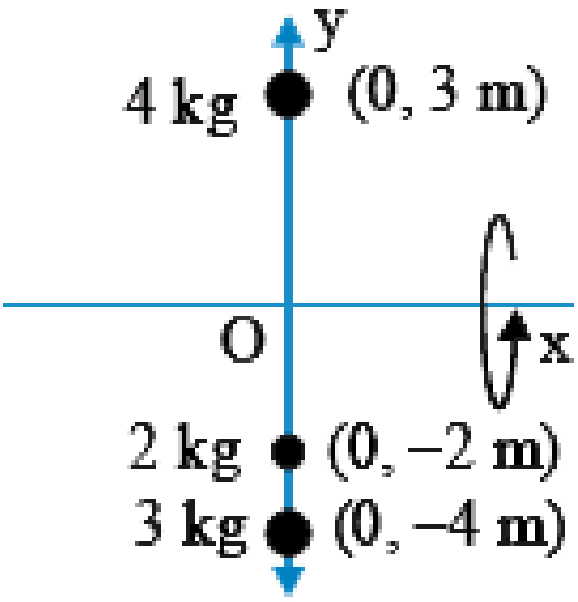
16. Three particles are situated on a light and rigid rod placed along Y-axis. If the system rotates about X-axis, the M.I. of the system is :



A. 92J

B. 184J

C. 276J

D. 46J

Answer: B

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17. On account of melting of ice at the north pole the moment of inertia of spinning earth -

A. Increases

B. Decreases

C. Remains unchanged

D. Depends on the time

Answer: A

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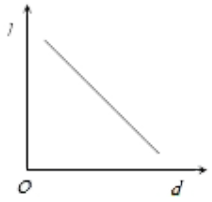
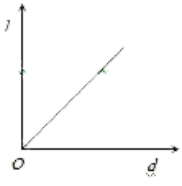
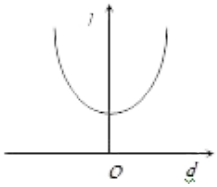
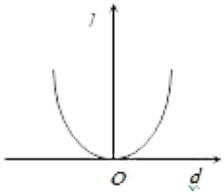
18. According to the theorem of parallel axes $I = I_{\text{cm}} + Mx^2$, the graph between I and x will be

A. 

B. 

C. 

D. 

Answer: C

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19. What is the moment of inertia of a square sheet of side l and mass per unit area μ about an axis passing through the centre and perpendicular to its plane

A. $\frac{\mu l^2}{12}$

B. $\frac{\mu l^2}{6}$

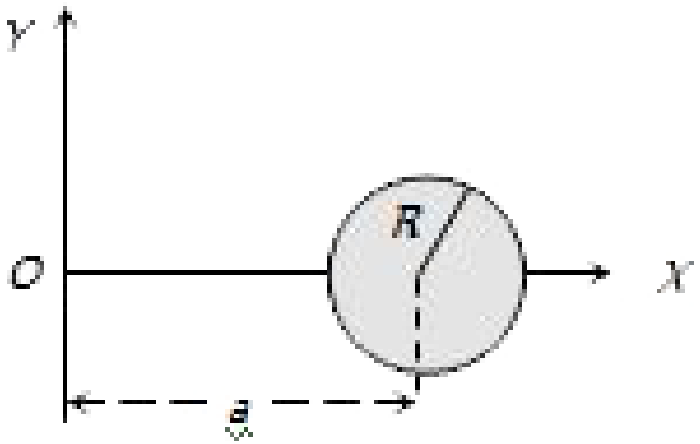
C. $\frac{\mu l^4}{12}$

D. $\frac{\mu l^4}{6}$

Answer: D

Watch Video Solution

20. The adjoining figure shows a disc of mass M and radius R lying in the X-Y plane with its centre on X - axis at a distance a from the origin. Then the moment of inertia of the disc about the X-axis is



A. $M\left(\frac{R^2}{2}\right)$

B. $M\left(\frac{R^2}{4}\right)$

C. $M\left(\frac{R^2}{4}+a^2\right)$

D. $M\left(\frac{R^2}{2}+a^2\right)$

Answer: B

Watch Video Solution

21. We have two spheres, one of which is hollow and the other solid. They have identical masses and moment of intertia about their

respective diameters. The ratio of their radius is given by.

A. $5:7$

B. $3:5$

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

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

Answer: C

Watch Video Solution

22. From a uniform wire, two circular loops are made (i) P of radius r and (ii) Q of radius nr. If the moment of inertia of Q about an axis passing through its center and perpendicular to tis plane is 8 times that of P about a similar axis, the value of n is (diameter of the wire is very much smaller than r or nr)

A. 8

B. 6

C. 4

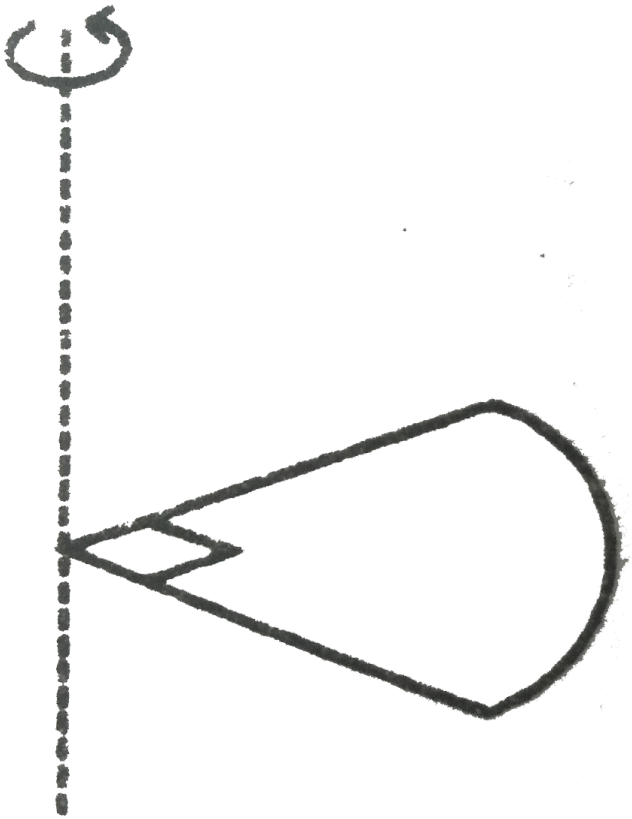
D. 2

Answer: D

Watch Video Solution

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

is.



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

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

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

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

Answer: A

Watch Video Solution

24. Two discs of same thickness but of different radii are made of two different materials such that their masses are same. The densities of the materials are in the ratio of $1:3$. The moments of inertia of these discs

about the respective axes passing through their centres and perpendicular to their planes will be in the ratio of

A. $1:3$

B. $3:1$

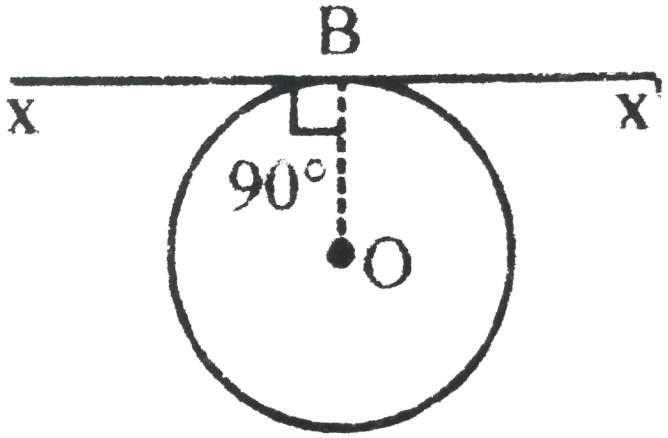
C. $1:9$

D. $9:1$

Answer: B

Watch Video Solution

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



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

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

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

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

Answer: D

Watch Video Solution

26. If a solid sphere and solid cylinder of same mass and radius rotate about their own axis the M.I. will be greater for

A. Solid sphere

B. Solid cylinder

C. Both

D. Equal both

Answer: A

Watch Video Solution

27. Two point masses of 0.3 kg and 0.7kg are fixed at the ends of a rod of length 1.4 m and of negligible mass. The rod is set rotating about an axis perpendicular to its length with

a uniform angular speed. The point on the rod through which the axis should pass in order that the work required for rotation of the rod is minimum, is located at a distance of

A. 0.4 m from mass of 0.3 kg

B. 0.98 from mass of 0.3 kg

C. 0.70 m from mass of 0.7 kg

D. 0.98 m from mass of 0.7 kg

Answer: B

 Watch Video Solution

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

A. $I_A > I_B$

B. $I_A = I_B$

C. $I_A < I_B$

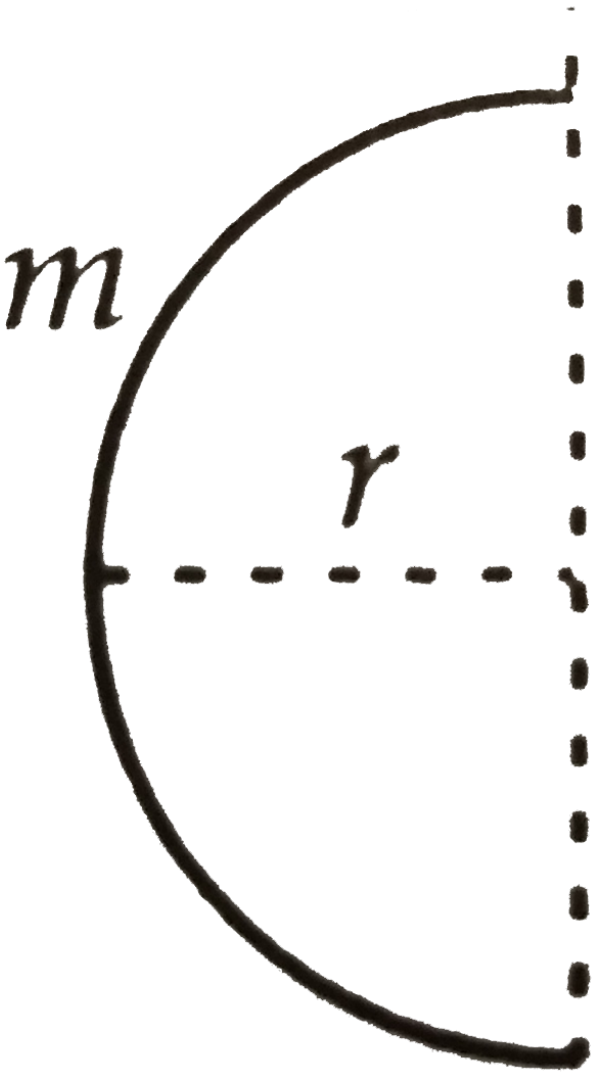
D. Depends on the actual values of t and r

Answer: C

Watch Video Solution

29. A thin wire of length l and mass m is bent in the form of a semicircle as shown in the figure. Its moment of inertia about an axis

joining its free ends will be



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

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

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

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

Answer: D

Watch Video Solution

30. If l_1 is the moment of inertia of a thin rod about an axis perpendicular to its length and passing through its centre of mass and l_2 is

the moment of inertia (about central axis) of the ring formed by bending the rod, then the ratio of I_1 to I_2 is

A. $l : l = 1 : 1$

B. $l : l = \pi : 3$

C. $l : l = \pi : 4$

D. $l : l = 3 : 5$

Answer: B

Watch Video Solution

31. Four solids are shown in cross section. The sections have equal heights and equal maximum widths. They have the same mass. The one which has the largest rotational inertia about a perpendicular through the centre of mass is

A. 

B. 

C. 

D. 

Answer: A

View Text Solution

32. The moment of inertia I of a solid sphere having fixed volume depends upon its volume V as

A. $I \propto V$

B. $I \propto V^{2/3}$

C. $I \propto V^{5/3}$

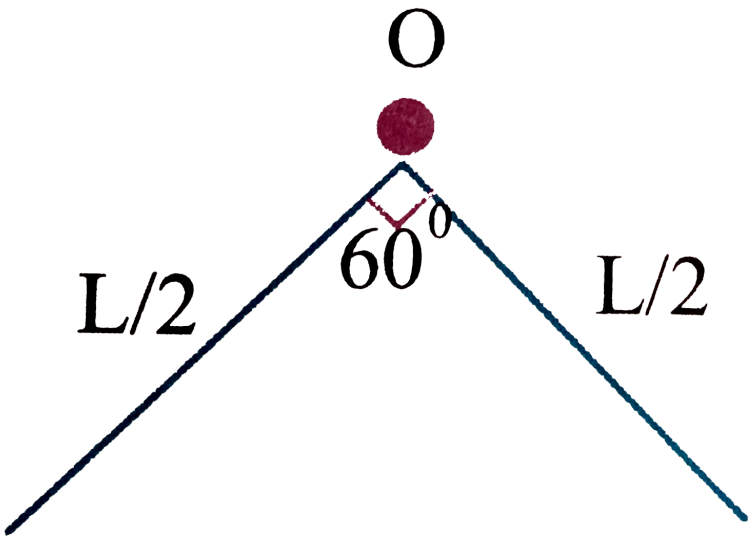
D. $I \propto V^{3/2}$

Answer: C

Watch Video Solution

33. A thin rod of length L of mass M is bent at the middle point O at an angle of 60°. The moment of inertia of the rod about an axis passing through O and perpendicular to the

plane of the rod will be



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

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

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

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

Answer: B

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Practice Problems Problems Based On Angular Momentum

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

A. Mass

B. Linear momentum

C. Angular momentum

D. Energy

Answer: C

Watch Video Solution

2. A disc is rotating with angular velocity ω. If a child sits on it, what is conserved?

A. Kinetic energy

B. Potential energy

C. Linear momentum

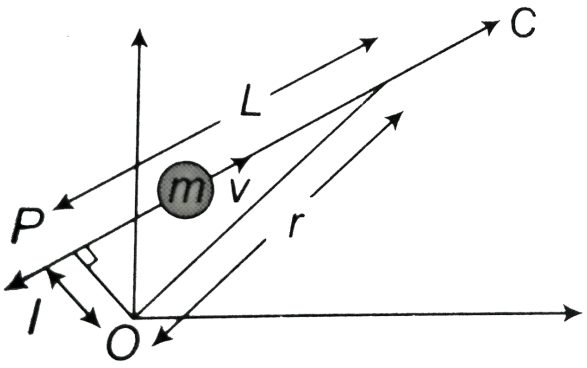
D. Angular momentum

Answer: D

Watch Video Solution

3. A particle of mass m moves along line PC with velocity v as shown. What is the angular

momentum of the particle about O?



A. mvL

B. mvl

C. mvr

D. Zero

Answer: B

Watch Video Solution

4. Two rigid bodies A and B rotate with rotational kinetic energies E_A and E_B respectively. The moments of inertia of A and B about the axis of rotation are I_A and I_B respectively. If $I_A = I_B/4$ and E_(A)= 100 E_(B), the ratio of angular momentum (L_(A)) of A to the angular momentum (L_(B)) of B is

A. 25

B. $5/4$

C. 5

D. $1/4$

Answer: C

Watch Video Solution

5. A uniform heavy disc is rotating at constant angular velocity ω about a vertical axis through its centre and perpendicular to the plane of the disc. Let L be its angular momentum. A lump of plasticine is dropped

vertically on the disc and sticks to it. Which of the following will be constant?

A. ω

B. ω and L both

C. L only

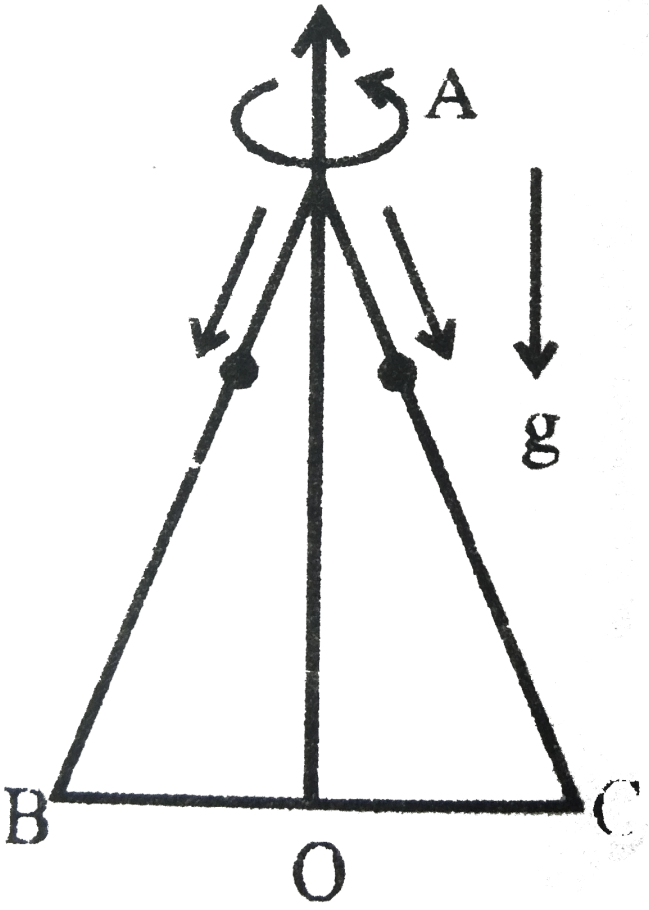
D. Neither ω nor L

Answer: C

Watch Video Solution

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

conserved as the beads slide down, are.



A. Angular velocity and total energy (kinetic and potential)

B. Total angular momentum and total energy

C. Angular velocity and moment of inertia about the axis of rotation

D. Total angular momentum and moment of inertia about the axis of rotation

Answer: B

Watch Video Solution

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

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

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

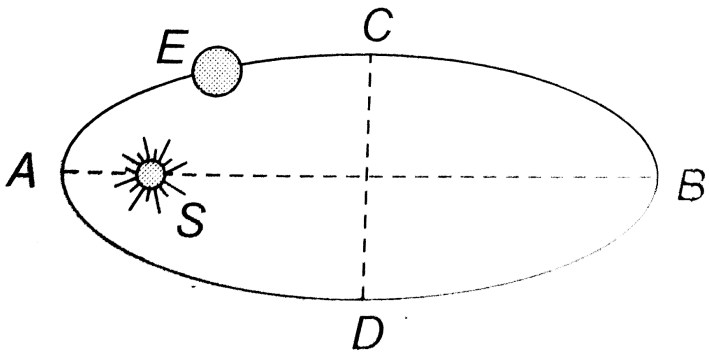
C. $\dfrac{\omega M}{M+m}$

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

Answer: B

Watch Video Solution

8. The earth E moves in an elliptical orbit with the sun S at one of the foci as shown in figure. Its speed of motion will be maximum at the point



A. C

B. A

C. B

D. D

Answer: B

Watch Video Solution

9. A rigid spherical body is spinning around an axis without any external torque. Due to change in temperature, the volume increases

by 1%. What will be the percentage change in angular velocity?

A. Will increase approximately by 1%

B. Will decrease approximately by 1%

C. Will decrease approximately by 0.67%

D. Will decrease approximately by 0.33%

Answer: C

Watch Video Solution

10. A uniform disc of mass M and radius R is rotating about a horizontal axis passing through its centre with angular velocity ω . A piece of mass m breaks from the disc and flies off vertically upwards. The angular speed of the disc will be

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

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

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

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

Answer: A

Watch Video Solution

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

A. Centre of the circle

B. On the circumference of the circle

C. Inside the circle

D. Outside the circle

Answer: A

Watch Video Solution

12. 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 the same dimensions but of mass M/4 is placed gently

on the first disc coaxially. The angular velocity of the system now is

A. $2\omega/5$

B. $2\omega/\sqrt{5}$

C. $4\omega/5$

D. $4\omega/\sqrt{5}$

Answer: C

Watch Video Solution

13. 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 $\omega_A \text{ and } \omega_B$ respectively. Then

A. $\omega_A < \omega_B$

B. $\omega_A = \omega_B$

C. $\omega_A = \omega$

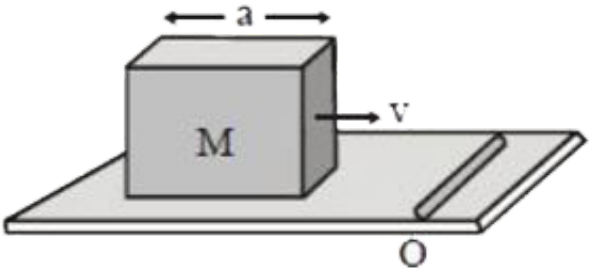
D. $\omega = \omega_B$

Answer: C

Watch Video Solution

14. A cubical block of side a is moving with velocity v on a horizontal smooth plane as shown. It hits a ridge at point O. The angular

speed of the block after it hits O is:



A. 3v//4a

B. 3v//2a

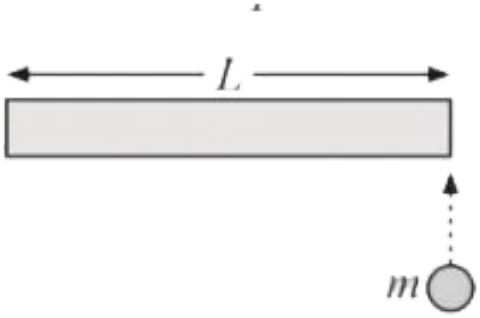
C. $\frac{\sqrt{3v}}{\sqrt{2a}}$

D. Zero

Answer: A

Watch Video Solution

15. A stick of length L and mass M lies on a frictionless horizontal surface on which it is free to move in any way. A ball of mass m moving with speed v collides elastically with the stick as shown in the figure. If after the collision the ball comes to rest, then what would be the mass of the ball?



A. $m=2M$

B. $m=M$

C. $m=M/2$

D. $m=M/4$

Answer: D

Watch Video Solution

16. In a playground there is a merry-go-round of mass 120 kg and radius 4 m. The radius of gyration is 3m. A child of mass 30 kg runs at a

speed of 5 m/sec tangent to the rim of the merry-go-round when it is at rest and then jumps on it. Neglect friction and find the angular velocity of the merry-go-round and child

A. 0.2 rad/sec

B. 0.1 rad/sec

C. 0.4 rad/sec

D. 0.8 rad/sec

Answer: C

Watch Video Solution

Practice Problems Problems Based On Kinetic Energy Work And Power

1. A ball rolls without slipping. The radius of gyration of the ball about about an axis passing through its center of mass is K. If radius of the ball be R, then the fraction of total energy associated with its rotational energy be

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

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

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

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

Answer: B

Watch Video Solution

2. 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=2 v

B. v=2 v

C. v=v

D. $v > v$

Answer: C

Watch Video Solution

3. The total kinetic energy of a body of mass 10 kg and radius 0.5 m moving with a velocity of 2

m/s without slipping is 32.8 joule. The radius of gyration of the body is

A. 0.25 m

B. 0.2 m

C. 0.5 m

D. 0.4 m

Answer: D

View Text Solution

4. The moment of inertia of a body about a given axis is $2.4kg-m^2$. To produce a rotational kinetic energy of 750 J, an angular acceleration of 5 rad/s2 must be applied about that axis for

A. 6 sec

B. 5 sec

C. 4 sec

D. 3 sec

Answer: B

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5. A solid sphere of mass 500 gm and radius 10 cm rolls without slipping with the velocity 20cm/s. The total kinetic energy of the sphere will be

A. 0.028 J

B. 280 J

C. 140 J

D. 0.014 J

Answer: D

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6. The ratio of rotational and translatory kinetic energies of a solid sphere is

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

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

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

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

Answer: C

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

A. $1:1$

B. $4:1$

C. $1:2$

D. $2:1$

Answer: C

Watch Video Solution

8. If a spherical ball rolls on a table without slipping, the fraction of its total energy associated with rotation is

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

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

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

D. $\frac{3}{7}$

Answer: B

Watch Video Solution

9. A body si rolling without slipping on a horizontal plane. If the rotational energy of the body is $40\,\%$ of the total kinetic energy then the body might be:

A. Cylinder

B. Hollow sphere

C. Solid cylinder

D. Ring

Answer: B

Watch Video Solution

10. A body of moment of inertia of $3kgm^2$ rotating with an angular velocity or 2rad//s

has the same kinetic energy as a mass of 12kg moving with a velocity of

A. 1 m/s

B. 2 m/s

C. 4 m/s

D. 8 m/s

Answer: A

Watch Video Solution

11. What is the ratio of the rolling kinetic energy and rotational kinetic energy in the motion of a disc ?

A. $1:1$

B. $2:7$

C. $1:2$

D. $3:1$

Answer: D

Watch Video Solution

12. A solid sphere is moving on a horizontal plane. Ratio of its translational kinetic energy and rotational kinetic energy is

A. $1/5$

B. $5/2$

C. $3/5$

D. $5/7$

Answer: B

Watch Video Solution

13. The speed of rolling of a ring of mass m changes from V to 3V . What is the change in its kinetic energy

A. $3MV^2$

B. $4MV^2$

C. $6MV^2$

D. $8MV^2$

Answer: D

Watch Video Solution

14. A disc of mass 4 kg and of radius 1 m rolls on a horizontal surface without slipping such that the velocity of its centre of mass is $10 \ \ \mathrm{cm\ sec}^{-1}$, Its rotatonal kinetic energy is

A. 0.01 erg

B. 0.02 joule

C. 0.03 joule

D. 0.01 joule

Answer: D

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15. The ratio of kinetic energies of two spheres rolling with equal centre of mass velocities is 2 : 1. If their radii are in the ratio 2 : 1, then the ratio of their masses will be

A. $2:1$

B. $1:8$

C. $1:7$

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

Answer: A

Watch Video Solution

16. A symmetrical body of mass M and radius R is rolling without slipping on a horizontal surface with linear speed v. Then its angular speed is

A. v/R

B. Continuously increasing

C. Dependent on mass M

D. Independent of radius (R)

Answer: C

Watch Video Solution

17. A solid sphere of mass 1 kg rolls on a table with linear speed 1 m/s. Its total kinetic energy is

A. 1 J

B. 0.5 J

C. 0.7 J

D. 1.4 J

Answer: C

 Watch Video Solution

18. A circular disc has a mass of 1kg and radius 40 cm. It is rotating about an axis passing through its centre and perpendicular to its plane with a speed of 10rev/s. The work done in joules in stopping it would be-

A. 4

B. 47.5

C. 79

D. 158

Answer: D

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19. The rotational kinctic energy of a body rotating about proportional to

A. Time period

B. (Time period)

C. (Time period)–

D. (time period)-

Answer: D

Watch Video Solution

20. If a body completes one revolution in π sec then the moment of inertia would be

A. Equal to rotational kinetic energy

B. Double of rotational kinetic energy

C. Half of rotational kinetic energy

D. Four times the rotational kinetic energy

Answer: C

 Watch Video Solution

21. 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

A. FR

B. $F\theta$

C. $\frac{FR}{\theta}$

D. $FR\theta$

Answer: D

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22. If the rotational kinetic energy of a body is increased by 300 %, then determine percentage increase in its angular momentum.

A. 6

B. 1.5

C. 1

D. 15

Answer: C

Watch Video Solution

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

A. 100 J

B. 131.4 J

C. 13.4 J

D. 0.131 J

Answer: B

Watch Video Solution

24. A flywheel has moment of inertia $4kg - m^2$ and has kinetic energy of 200 J. Calculate the number of revolutions it makes before coming to rest if a constant opposing couple of 5N-m is applied to the flywheel

A. 12.8 rev

B. 24 rev

C. 6.4 rev

D. 16 rev

Answer: C

Watch Video Solution

25. An engine develops 100 kW, when rotating at 1800 rpm. Torque required to deliver the power is

A. 531 N-m

B. 570 N-m

C. 520 N-m

D. 551 N-m

Answer: A

Watch Video Solution

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

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

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

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

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

Answer: C

Watch Video Solution

27. A fly wheel of moment of inertia I is rotating at n revolutions per sec. The work needed to double the frequency would be -

A. $2\pi^2 \ln^2$

B. $4\pi^2 \ln^2$

C. $6\pi^2 \ln^2$

D. $8\pi^2 \ln^2$

Answer: C

Watch Video Solution

28. If L, M and P are the angular momentum, mass and linear momentum of a particle respectively, which of the following represents

the kinetic energy of the particle when the particle rotates in a circle of radius R?

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

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

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

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

Answer: C

Watch Video Solution

29. A uniform thin rod of length l is suspended from one of its ends and is rotated at f rotations per second. The rotational kinetic energy of the rod will be

A. $\frac{2}{3}\pi^2 f^2 m l^2$

B. $\frac{4}{3} f^2 m l^2$

C. $4\pi^2 f^2 m l^2$

D. Zero

Answer: A

Watch Video Solution

Watch video solution

30. A body rotating at $20rad/s$ is acted upon by a constant torque providing it a deceleration of $2rad/s^2$. At what time will the body have kinetic energy same as the initial value if thhe torque continues to act?

A. 20 sec

B. 40 sec

C. 5 sec

D. 10 sec

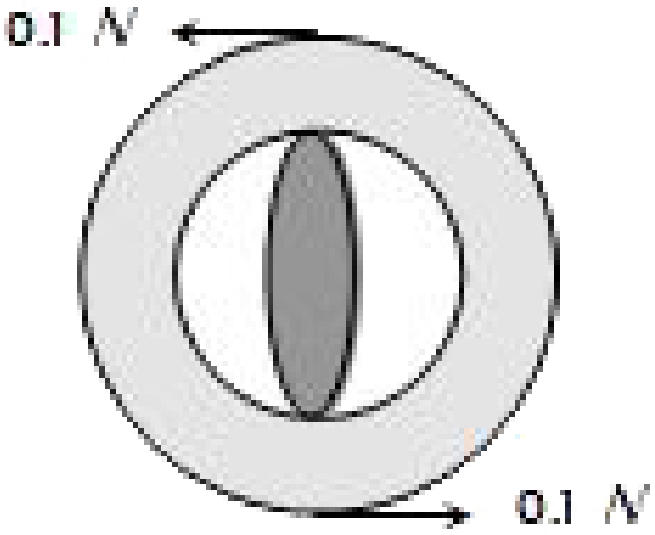
Answer: A

Watch Video Solution

Practice Problems Problems Based On Rolling On Incline Plane

1. Part of the tuning arrangement of a radio consists of a wheel which is acted on by two parallel constant forces as shown in the fig. If the wheel rotates just once, the work done will

be about (diameter of the wheel = 0.05m)



A. 0.062 J

B. 0.031 J

C. 0.015 J

D. 0.057 J

Answer: B

Watch Video Solution

2. A solid sphere, a hollow sphere and a ring are released from top of an inclined plane (frictionless) so that they slide down the plane. Then maximum acceleration down the plane is for (no rolling)

A. Solid sphere

B. hollow sphere

C. Ring

D. All same

Answer: D

Watch Video Solution

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

A. Solid sphere will reach the bottom first

B. Hollow spherical shell will reach the bottom first

C. Both will reach at the same time

D. None of these

Answer: A

Watch Video Solution

4. A hollow cylinder and a solid cylinder having the same mass and diameter are released from rest simultaneously from the top of an

inclined plane. They roll without slipping which will reach the bottom firstly

A. The solid cylinder

B. The hollow cylinder

C. Both will reach the bottom together

D. The greater density

Answer: A

Watch Video Solution

5. The speed of a homogeneous solid sphere after rolling down an inclined plane of vertical height h from rest without sliding is

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

B. $\sqrt{gh}$

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

D. $\sqrt{\frac{4}{3}gh}$

Answer: A

Watch Video Solution

6. A solid cylinder rolls down an inclined plane from a height h. At any moment the ratio of rotational kinetic energy to the total kinetic energy would be

A. $1:2$

B. $1:3$

C. $2:3$

D. $1:1$

Answer: B

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7. An inclined plane makes an angle 30^{o} with the horizontal. A solid sphere rolling down this inclined plane from rest without slipping has a linear acceleration equal to

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

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

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

D. $\frac{5g}{14}$

Answer: D

Watch Video Solution

8. 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.

A. $\sqrt{2gh}$

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

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

D. $\sqrt{4\frac{g}{h}}$

Answer: B

Watch Video Solution

9. Solid cylinders of radii r_1, r_2 and r_3 roll down an inclined plane from the same place simultaneously. $r_1 > r_2 > r_3$, which one would reach the bottom first

A. Cylinder of radius r_1

B. Cylinder of radius r_2

C. Cylinder of radius r_3

D. All the three cylinders simultaneously

Answer: D

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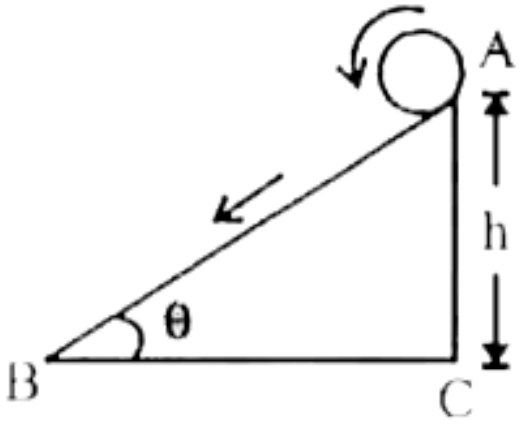
10. A solid sphere of mass M and radius R, rolling down a smooth inclined plane, without slipping, reaches the bottom with a velocity v. What is the height of the inclined plane in

terms of the velocity v ?



A. A cylinder of same mass but of smaller radius

B. A cylinder of same mass but of larger radius

C. A cylinder of same radius but of smaller mass

D. A hollow cylinder of same mass and same radius

Answer: D

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11. A body starts rolling down an inclined plane of length L and height h. This body reaches

the bottom of the plane in time t. The relation between L and t is?

A. $t \propto L$

B. $t \propto 1/L$

C. $t \propto L^2$

D. $t \propto \frac{1}{L^2}$

Answer: A

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12. A hollow cylinder is rolling on an inclined plane, inclined at an angle of 30° to the horizontal. Its speed after travelling a distance of 10 m will be

A. 49 m/sec

B. 0.7 m/sec

C. 7 m/sec

D. Zero

Answer: C

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13. If a ring, a disc, a solid sphere and a cyclinder of same radius roll down an inclined plane, the first one to reach the bottom will be:

A. Solid sphere and solid cylinder

B. Solid cylinder and disc

C. Disc and ring

D. Solid sphere and ring

Answer: B

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14. A ball of radius 11 cm and mass 8 kg rolls from rest down a ramp of length 2m. The ramp is inclined at 35° to the horizontal. When the ball reaches the bottom, its velocity is $(\sin 35 = 0.57)$

A. 2 m/s

B. 5 m/s

C. 4 m/s

D. 6 m/s

Answer: C

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15. From an inclined plane a sphere, a disc, a ring and a shell are rolled without slipping. The order of their reaching at the base will be

A. Ring, shell, disc, sphere

B. Shell, sphere, disc, ring

C. Sphere, disc, shell, ring

D. Ring, sphere, disc, shell

Answer: C

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16. A solid cylinder 30 cm in diameter at the top of an inclined plane 2.0 m high is released and rolls down the incline without loss of

energy due to friction. Its linear speed at the bottom is

A. 5.29 m/sec

B. 41 m/sec

C. 51 m/sec

D. 51 cm/sec

Answer: A

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17. A cylinder of mass M and radius R rolls on an inclined plane. The gain in kinetic energy is

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

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

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

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

Answer: C

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18. A disc of radius R is rolling down an inclined plane whose angle of inclination is θ Its acceleration would be

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

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

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

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

Answer: B

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19. A solid cylinder (i) rolls down (ii) slides down an inclined plane. The ratio of the accelerations in these conditions is

A. $3:2$

B. $2:3$

C. $\sqrt{3}:\sqrt{2}$

D. $\sqrt{2}:\sqrt{3}$

Answer: B

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20. The acceleration of a body rolling down on an inclined plane does not depend upon

A. Angle of inclination of the plane

B. Length of plane

C. Acceleration due to gravity of earth

D. Radius of gyration of body

Answer: B

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21. If a ring, a disc, a solid sphere and a cyclinder of same radius roll down an inclined plane, the first one to reach the bottom will be:

A. Ring

B. Disc

C. Solid sphere

D. Solid cylinder

Answer: A

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22. A ring is rolling on an inclined plane. The ratio of the linear and rotational kinetic energies will be

A. $2:1$

B. $1:2$

C. $1:1$

D. $4:1$

Answer: C

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23. The M.I. of a solid cylinder about its axis is I. It is allowed to rool down an incline plane without slipping. If its angular velocity at the bottom be ω, then kinetic energy of rolling cylinder will be

A. $I\omega^2$

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

C. $2I\omega^2$

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

Answer: B

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24. 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.

A. $\sqrt{gR}$

B. $\sqrt{5gR}$

C. $\sqrt{10gR}$

D. $\sqrt{3gR}$

Answer: C

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25. A ring takes time t_1 in slipping down an inclined plane of length L, whereas it takes time t_2 in rolling down the same plane. The ratio of t_1 and t_2 is -

A. $\sqrt{2}:1$

B. $1:\sqrt{2}$

C. $1:2$

D. $2:1$

Answer: B

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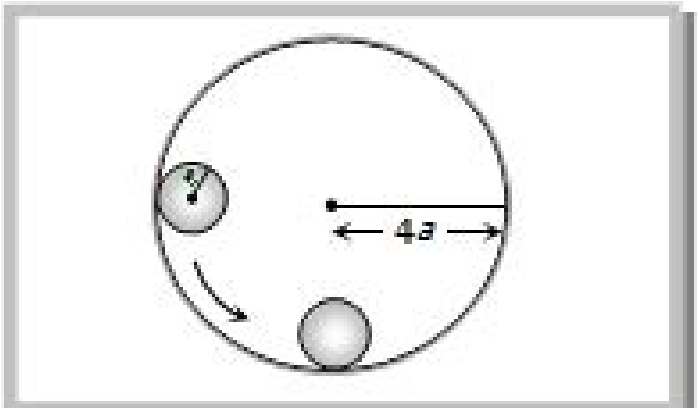
26. A ring of radius 4a is rigidly fixed in vertical position on a table. A small disc of mass m and radius a is released as shown in the fig. When the disc rolls down, without slipping, to the

lowest point of the ring, then its speed will be



A. $\sqrt{ga}$

B. $\sqrt{2ga}$

C. $\sqrt{3ga}$

D. $\sqrt{4ga}$

Answer: D

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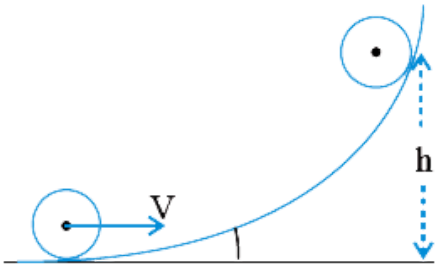
27. A disc of mass M and radius R rolls on a horizontal surface and then rolls up an inclined plane as shown in the figure. If the velocity of the disc is v, the height to which the disc will rise will be:



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

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

C. $\frac{v^2}{4g}$

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

Answer: B

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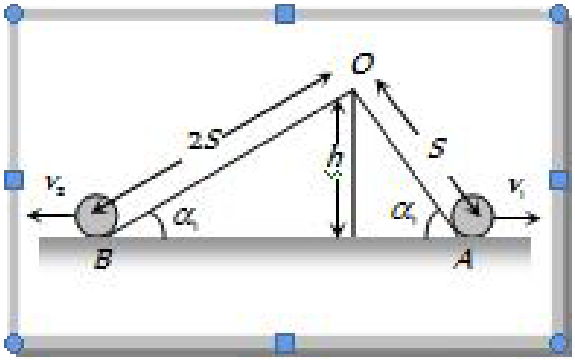
28. Two uniform similar discs roll down two inclined planes of length S and 2S respectively as shown is the fig. The velocities of two discs at the points A and B of the inclined planes

are related as



A. $v = v$

B. $v_1 = 2v_2$

C. $v_1 = v_1 \frac{v_2}{4}$

D. $v_1 = \frac{3}{4} v_2$

Answer: A

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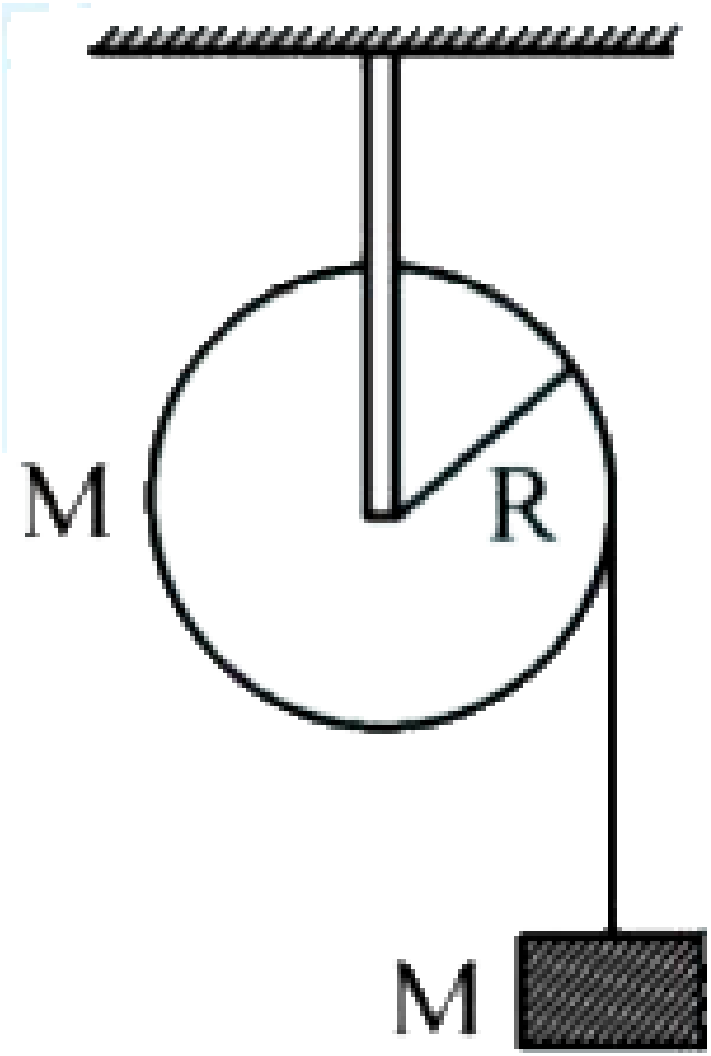
Practice Problems Problems Based On Motion Of Connected Mass

1. A mass M is supported by a massless string wound round a uniform cylinder ofmass M and radius R. On releasing the mass from rest, it

will fall with acceleration?



A. g

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

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

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

Answer: D

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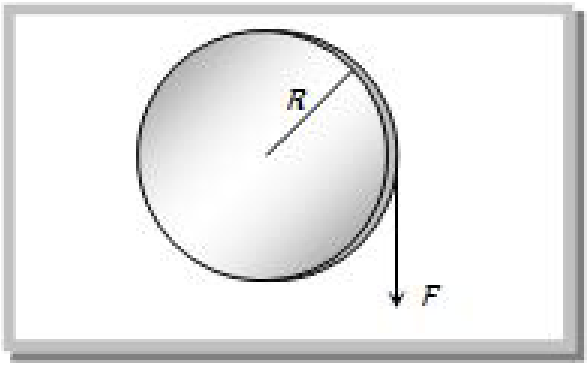
2. A uniform disc of radius R and mass M can rotate on a smooth axis passing through its centre and perpendicular to its plane. A force F is applied on its rim. See fig. What is the

tangential acceleration



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

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

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

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

Answer: A

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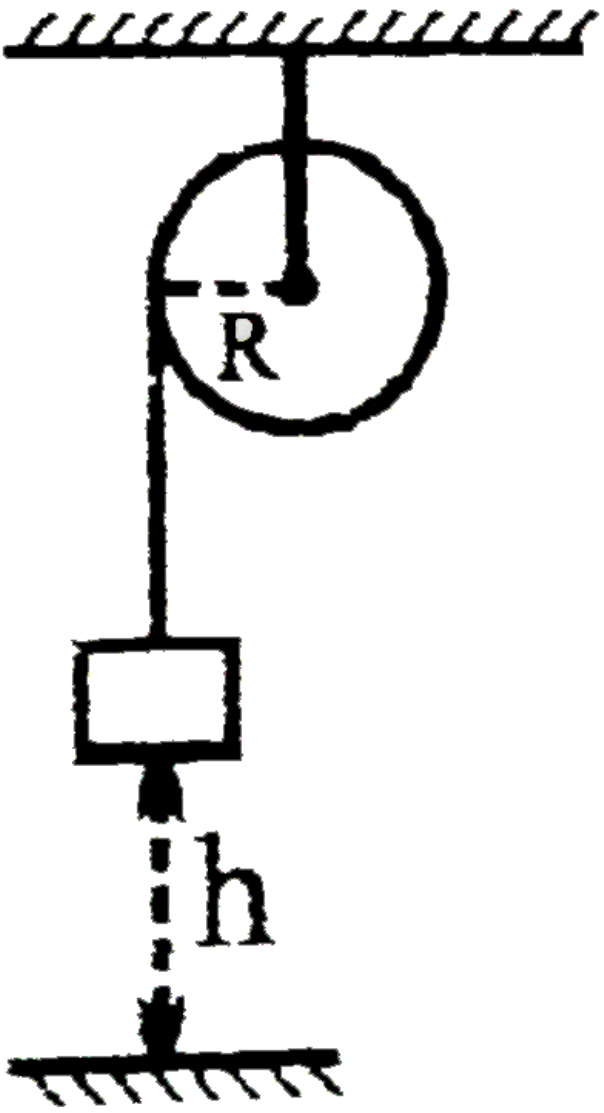
3. A massless rope is wrapped several times on a disc of mass M and radius R. The other end is tied to a mass m which at the beginning is at a height of h above ground as shown in the figure. When released the velocity of the mass

as it touches the ground is



A. $\sqrt{2gh}$

B. $\sqrt{2gh}\frac{M}{m}$

C. $\sqrt{2ghm/M}$

D. $\sqrt{4gh/2m+M}$

Answer: D

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4. A solid cylinder of mass M and of radius R is fixed on a frictionless axle over a well. A rope negligible mass is wrapped around the

cylinder. A bucket of uniform mass m is suspended from it. The linear acceleration bucket will:

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

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

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

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

Answer: D

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5. A solid cylinder of mass M and of radius R is fixed on a frictionless axle over a well. A rope negligible mass is wrapped around the cylinder. A bucket of uniform mass m is suspended from it. The linear acceleration bucket will:

A. $\frac{4mg}{M+2m}$

B. $\frac{4mg}{M+4m}$

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

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

Answer: B

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6. In the above problem the angular velocity of the system after the particle sticks to it will be?

A. $\frac{1}{R}\sqrt{8mgh/(M+4m)}$

B. $\frac{1}{R}\sqrt{8mgh/(M+m)}$

C. $\frac{1}{R}\sqrt{mgh/(M+m)}$

D. $\frac{1}{R}\sqrt{8mgh/(M+2m)}$

Answer: A

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7. A metre scale is suspended vertically from a horizontal axis passing through one end of it. Its time period would be

A. 1.64 sec

B. 2 sec

C. 2.5 sec

D. 3.2 sec

Answer: A

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8. A disc is made to oscillate about a horizontal axis passing through mid point of its radius. Determine time period.

A. $2\pi\sqrt{\frac{3R}{2g}}$

B. $2\pi\sqrt{\frac{2R}{3g}}$

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

D. $2\pi\sqrt{\frac{2R}{g}}$

Answer: A

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9. A solid cube of side l is made to oscillate about a horizontal axis passing through one of its edges. Its time period will be

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

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

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

D. $2\pi\sqrt{\frac{2}{\sqrt{3}}\frac{l}{g}}$

Answer: A

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10. The string of a simple pendulum replaced by a uniform rod of length L and mass M while the bob has a mass m. It is allowed to make small oscillation. Its time period is

A. $2\pi\sqrt{\frac{2(M+3m)L}{3(M+2m)g}}$

B. $2\pi\sqrt{\frac{(M+2m)L}{3(M+3m)g}}$

C. $2\pi\sqrt{\left(\frac{2M}{3m}\right)\frac{L}{g}}$

D. $2\pi\sqrt{\left(\frac{M+m}{M+3m}\right)\frac{L}{g}}$

Answer: A

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