PHYSICS

BOOKS - CENGAGE PHYSICS (HINGLISH)

ROTATIONAL MOTION

Question Bank

1. 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

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2. Three rods each of mass m and length b form an equilatcral triangle and rotate about the median of the triangle. Its moment of inertia is

$\frac{amb^2}{16}$. Find a.

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3. Four rods each of mass m form a square having length of diagonal b, rotates about its diagonal. Its moment of inertia is $\frac{pmb^2}{18}$. Find p.

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4. If the velocity is $v = 2\hat{i} - 3\hat{j} + \hat{k}$ and the position vector is $r = \hat{i} + 2\hat{j} - 3\hat{k}$, the magnitude of angular momentum for a particle of mass m is L. Find $\left|\frac{L}{2\sqrt{3}m}\right|$.

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5. A horizontal platform with a mass of $100kg$ rotates at $10(r \pm)$ around a vertical axis passing through its centre. A man of mass $60kg$ is standing on its edge. The platform begins to rotaté with an angular velocity $\omega(r \pm)$, if the man "moves from the edge of the platform to its centre. Regard the platform as a circular homogeneous disk and the man as a point mass. Find the value of $\frac{3\omega}{11}$.

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6. The moment of inertia of a solid sphere of density ρ and radius R 'about its diameter is $\frac{\alpha}{\beta}R^5(p)$ then find $(\alpha - \beta)$.

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7. 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

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8. A circular cdotdisc of radius R and thickness $\frac{R}{6}$ has moment of inertia I about the axis perpendicular to the plane and passing through its centre. The disc is melted and recasted into a solid sphere. The moment of inertia of the sphere about its diameter is $\frac{I}{n}$. Find n.

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9. Three identical rods, each of length l, are joined to form a rigid equilateral triangle. Its radius of gyration about an axis pássing through a corner and perpendicular to the plane of the triangle is $\frac{l}{\sqrt{x}}$. Find x.

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10. A solid sphere and a disc of same mass and radius starts rolling down a rough inclined plane, from the same height, the ratio of the time taken in the two cases is $\sqrt{\frac{x}{y}}$ Find $(x+y)$.

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

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12. A particle of mass m is moving in yz -plane with a uniform velocity v as shown in figure. It collides elastically with the wall AB. The change in its angular momentum about the origin as it bounces elastically from the wall is $\sqrt{\alpha}$ mvai . Find α.

'(##CEN_KSR_PHY_JEE_C09_E01_012_Q03##)'

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13. A semi circular disc start rotating (at $t=0$) with constant angular acceleration $\alpha=2ra\frac{d}{(s)^2}$ about axis O as shown in figure. Mass and radius of semi-circular disc are $5kg$ and $2\pi m$ respectively. Magnitude of linear momentum of disc at `t=3 s(in kg m /s) is

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14. An ice skater spins at $4\pi\frac{rad}{s}$ with her arms extended.If her moment of inertia with arms folded is 80% of that with arms extended, find the tional change in kinetic energy.

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15. A light string is wound several times around a spool of mass M and radius R as shown. The free end of the string is attached to a fixed point and the spool is held so that the part of the string not in contact with it is vertical. If the spool is let go, the tension of the string is. $\frac{KMg}{12}$. Find K.

'(##CEN_KSR_PHY_JEE_C09_E01_015_Q05##)'

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16. A disc of mass $4kg$ and radius 6 metre is free to rotate in horizontal plane about a vertical fixed axis passing through its centre. There is a smooth groove along the diameter of the disc and two small balls of mass

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omega_(0)=12 (rad) / (s)` released. Find the angular speed of disc (in radian/s) when the balls reach the ends to disc.

'(##CEN_KSR_PHY_JEE_C09_E01_016_Q06##)'

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17. A disc of certain radius is cut from a disc of maiss $9M$ and radius R. Its moment of inertia about an axis passing through its centre C and perpendicular to its plane is pMR^2. Calculate p.

'(##CEN_KSR_PHY_JEE_C09_E01_017_Q07##)'

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18. A uniform rod AB which is free to swing in the vertical plane about a horizontal axis through A, is hanging freely as shown. A particle of equal mass strikes the rod with a velocity v_0 and gets stuck to it. Find the angular velocity (in rad / s) of the combination immediately after the collision. (Given v_(0)=14 cm / s, L=12 cm`

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19. Figure shows a uniform disk, with mass $M = 2.4kg$ and radius R=20 m, mounted on a fixed horizontal axle. A block of mass m=1.2 kg hangs from a massless cord that is wrapped around the rim of the disk. The tension (in newton) in cord. Is

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20. A rope of negligible mass is wound round. a hollow cylinder of mass $3kg$ and radius $40cm$. What is angular acceleration (in rad / s^2) of the cylinder if the rope is pulled with a force of $30N$? Assume that there is no slipping.

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21. A $60(\sim g)$ and an $80(\sim g)$ ball are fixed to the ends of a $28(\sim cm)$ rod of negligible mass as shown. The rod is balanced by a pivot such that it is horizontal and stays at rest. With what angular acceleration (in $\frac{rad}{(s)^2}$) does it start to move, if the pivot is shiftéd $2(\sim cm)$ closer to the heavier ball ? (Take g=9.8 m / s^2).

'(##CEN_KSR_PHY_JEE_C09_E01_021_Q10##)'

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22. In the given figure, thin uniform rod AB of mass kg moves translationally with acceleration $a = 2\frac{m}{}$s^(2) $due \rightarrow twoantiparal \leq lf$ or cesF_(1) ,F_(2) $. The dis\tan cebetweenthep \oint satwhichthesef$ or $cesareappliedisequal \rightarrow$ 0.2 m. Iff or ceF_(1)=8 N`, then find the length of the rod in meter.

'(##CEN_KSR_PHY_JEE_C09_E01_022_Q11##)'

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23. A pulley system is attached to a massless board as shown below. The board pivots only at the pivot point. A $10kg$ mass M sits exactly in the middle of the board.

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24. A uniform semicircular disc of mass ' M ' and radius ' R " hinged at point O shown in figure is released from rest from a vertical position as shown. If the initial magnitude of angular acceleration of the disc is $\frac{xg}{3\pi R}$, then the valuc of x is (Center of mass is at a distance $\frac{4R}{3\pi}$ from center of disc)

'(##CEN_KSR_PHY_JEE_C09_E01_024_Q13##)'

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

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26. A ball of mass $0.2kg$ and radius $0.5m$ starting from rest rolls down a 30° inclined plane. Find the time in second it would take to cover $7m$.

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27. A solid sphere of mass M and radius r slips on a rough horizontal plane. At some instant it has translational velocity v_0 and $rotational velocity about the centre$v_(0) / 2 r $. The translational velocity after the sphere \star ts pure roll \in g is$(x v_(0))/(y) $\in f$ or $ward direction. F \in d$(x+y)`.

'(##CEN_KSR_PHY_JEE_C09_E01_027_Q14##)'

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28. A uniform cube of side a & mass m rests on a rough horizontal table as shown. 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 $3\frac{a}{4}$ above the base. The minimum value of F for which the cube begins to tip about an edge is $\frac{\alpha m g}{\beta}$. Find (a $(a\beta)$ (assume that cube does not slide).

'(##CEN_KSR_PHY_JEE_C09_E01_028_Q15##)'

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29. An equilateral prism of mass m rests on a rough horizontal surface with coefficient of friction μ. A horizontal force F is applied on the prism as shown in the figure. If ihe coefficient of friction is sufficiently high so that the -prism does not slide before toppling, then the minimum force required to topple the prism is $\frac{mg}{\sqrt{n}}$. Find n.

'(##CEN_KSR_PHY_JEE_C09_E01_029_Q16##)'

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30. A tangential force F acts at the top of a thin spherical shell of mass m and radius R as shown. Find the acceleration of the shell if it rolls without slipping. If your answer is $\frac{\alpha F}{5m}$. Then find α.

'(##CEN_KSR_PHY_JEE_C09_E01_030_Q17##)'

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31. A horizontal force F acts at the centre of mass of a uniform disc with mass M and radius R. The maximum value of F for which the disc can roll without slipping is $k\mu_s Mg$. Find k. (μ, is coefficient of friction)

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32. Two particles, each of mass M and speed v, move, as shown. They simultaneously strike the ends of a uniform rod of mass M and length d which is pivoted at its center. The particles stick to the ends of the rod. Find the ratio of total initial kinetic energy of the two particles to the total loss in kinetic energy in the collision of the two.particles with the rod?

'(##CEN_KSR_PHY_JEE_C09_E01_032_Q18##)'

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33. A non-uniform bar of weight W is suspended at rest by two string of negligible weights as shown in figure. The angle made by the string with the vertical are 36.9° and 53.1° respectively. The bar $2m$ long. Calculate the distance of the centre of gravity (in cm) of the bar from it left end. '(##CEN_KSR_PHY_JEE_C09_E01_033_Q19##)'

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34. 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 (in newton) exerted by the level ground on each front wheel.

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35. A solid cylinder rolls up an inclined plane of angle of inclinátion 30°. At the bottom of the inclined plane the centre of mass of the cylinder has a speed of 5 m / s. How long (in seconds) will it take to return to the bottom? [Take g=10 m / $(s)^{2}$],

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36. A uniform solid ball rolls down a slope. If the ball has a diameter.of 0.5 (m) and a mass of 0.1 (kg). The coefficient of friction between the ball and the slope is 0.29. The maximum angle of inclination (in degree) for which the ball roll is (approx.)

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37. In figure, a sphere of radius $2(~m)$ rolls on a plank. The accelerations of the sphere and the plank are indicated. Find the valuie of α (in $\frac{rad}{(s)^2}$).

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38. A.uniform bar of length $6a$ and mass $8m$ lies on a smooth horizontal table. Two point masses m and $2m$ moving in the same horizontal plane with speed $2v$ and v, respectively, strike the bar and stick to the bar. The bar is set in rotation. The rotational energy $E = \frac{pmv^2}{q}$ then find $(p+q)$.

'(##CEN_KSR_PHY_JEE_C09_E01_038_Q20##)'

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39. As shown, a wheel of weight W and radius $1.0m$ is placed against a $0.4m$ height rectangular block fixed on the ground. The wheel has an axle of radius $0.1m$. A force F is applied tangentially to the axle to lift the wheel. The minimum value of F is given.by expression $F=\alpha\frac{W}{11}$. Then find the value of α.

'(##CEN_KSR_PHY_JEE_C09_E01_039_Q21##)'

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40. We apply a force of $10N$ on a cord wrapped around a solid cylinder of mass 20 kg as shown. The cylinder rolls without slipping on the floor. If its kinetic energy (in joule) after 6 s is 12 K, then find the value of K.

'(##CEN_KSR_PHY_JEE_C09_E01_040_Q22##)'

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