Q1. A heavy iron bar, of weight W is having its one end on the ground and the other on the shoulder of a person. The bar makes an angle θ with the horizontal. The weight experienced by the person is : ***09 Apr 2024 (M)***

(1) $W\cos\theta$ (2) $\frac{W}{2}$

(3) W (4) $W\sin\theta$

Q2. A string is wrapped around the rim of a wheel of moment of inertia 0.40kgm^2 and radius 10 cm. The wheel is free to rotate about its axis. Initially the wheel is at rest. The string is now pulled by a force of 40 N. The angular velocity of the wheel after 10 s is $x\text{rad/s}$, where x is _____ ***09 Apr 2024 (M)***

Q3. A circular disc reaches from top to bottom of an inclined plane of length l. When it slips down the plane, if takes t s. When it rolls down the plane then it takes $\left(\frac{\alpha}{2}\right)^{1/2}t$ s, where α is _____ ***09 Apr 2024 (E)***

Q4. A thin 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 angular velocity ω. If another disc of same dimensions but of mass $\text{M}/2$ is placed gently on the first disc co-axially, then the new angular velocity of the system is : ***08 Apr 2024 (E)***

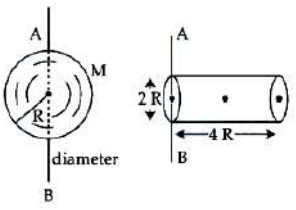
(1) $\frac{3}{2}\omega$ (2) $\frac{5}{4}\omega$

(3) $\frac{2}{3}\omega$ (4) $\frac{4}{5}\omega$

Q5. Three balls of masses 2 kg, 4 kg and 6 kg respectively are arranged at centre of the edges of an equilateral triangle of side 2 m. The moment of intertia of the system about an axis through the centroid and perpendicular to the plane of triangle, will be _____ kgm^2. ***06 Apr 2024 (E)***

Q6. If the radius of earth is reduced to three-fourth of its present value without change in its mass then value of duration of the day of earth will be _____ hours 30 minutes. ***06 Apr 2024 (M)***

Q7. Ratio of radius of gyration of a hollow sphere to that of a solid cylinder of equal mass, for moment of Inertia about their diameter axis AB as shown in figure is $\sqrt{8/x}$. The value of x is:



05 Apr 2024 (M)

(1) 51 (2) 34

(3) 17 (4) 67

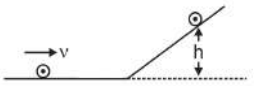
Q8. A hollow sphere is rolling on a plane surface about its axis of symmetry. The ratio of rotational kinetic energy to its total kinetic energy is $\frac{x}{5}$. The value of x is _____ . ***05 Apr 2024 (E)***

Q9. A solid sphere and a hollow cylinder roll up without slipping on same inclined plane with same initial speed v. The sphere and the cylinder reaches upto maximum heights h_1 and h_2, respectively, above the initial level. The ratio $h_1 : h_2$ is $\frac{n}{10}$. The value of n is_____. ***04 Apr 2024 (M)***

Q10. A ball of mass 0.5 kg is attached to a string of length 50 cm. The ball is rotated on a horizontal circular path about its vertical axis. The maximum tension that the string can bear is 400 N. The maximum possible value of angular velocity of the ball in rad s^{-1} is,: ***01 Feb 2024 (M)***

(1) 1600 (2) 40
(3) 1000 (4) 20

Q11. A disc of radius R and mass M is rolling horizontally without slipping with speed v. It then moves up an inclined smooth surface as shown in figure. The maximum height that the disc can go up the incline is:



01 Feb 2024 (E)

(1) $\frac{v^2}{g}$ (2) $\frac{3}{4}\frac{v^2}{g}$
(3) $\frac{1}{2}\frac{v^2}{g}$ (4) $\frac{2}{3}\frac{v^2}{g}$

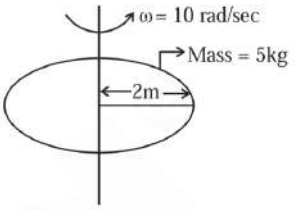
Q12. Two identical spheres each of mass 2 kg and radius 50 cm are fixed at the ends of a light rod so that the separation between the centers is 150 cm. Then, moment of inertia of the system about an axis perpendicular to the rod and passing through its middle point is $\frac{x}{20}$ kg m^2, where the value of x is ***31 Jan 2024 (E)***

Q13. A body of mass m is projected with a speed u making an angle of 45° with the ground. The angular momentum of the body about the point of projection, at the highest point is expressed as $\frac{\sqrt{2}mu^3}{Xg}$. The value of X is_____. ***31 Jan 2024 (E)***

Q14. Two discs of moment of inertia $I_1 = 4$ kg m^2 and $I_2 = 2$ kg m^2 about their central axes & normal to their planes, rotating with angular speeds 10 rad s^{-1} & 4 rad s^{-1} respectively are brought into contact face to face with their axe of rotation coincident. The loss in kinetic energy of the system in the process is _____J.

30 Jan 2024 (E)

Q15. Consider a disc of mass 5 kg, radius 2 m, rotating with angular velocity of 10 rad s^{-1} about an axis perpendicular to the plane of rotation. An identical disc is kept gently over the rotating disc along the same axis. The energy dissipated so that both the discs continue to rotate together without slipping is _____J.



30 Jan 2024 (M)

Q16. A body of mass 5 kg moving with a uniform speed $3\sqrt{2}$ m s^{-1} in $X-Y$ plane along the line $y = x + 4$. The angular momentum of the particle about the origin will be _____kg m^2 s^{-1}. ***29 Jan 2024 (E)***

Q17. A cylinder is rolling down on an inclined plane of inclination 60°. Its acceleration during rolling down will be $\frac{x}{\sqrt{3}}$ m s^{-2}, where x = _____(use $g = 10$ m s^{-2}). ***29 Jan 2024 (M)***

Q18. A ring and a solid sphere roll down the same inclined plane without slipping. They start from rest. The radii of both bodies are identical and the ratio of their kinetic energies is $\frac{7}{\mathrm{x}}$, where x is _____. ***27 Jan 2024 (E)***

Q19. Four particles, each of mass 1 kg are placed at four corners of a square of side 2 m. The moment of inertia of the system about an axis perpendicular to its plane and passing through one of its vertex is _____ kg m^2.

27 Jan 2024 (M)

Q20. A heavy iron bar of weight 12 kg is having its one end on the ground and the other on the shoulder of a man. The rod makes an angle 60° with the horizontal, the normal force applied by the man on bar is:

27 Jan 2024 (E)

(1) $6\ \text{kg} - \text{wt}$ (2) $12\ \text{kg} - \text{wt}$

(3) $3\ \text{kg} - \text{wt}$ (4) $6\sqrt{3}\ \text{kg} - \text{wt}$

Q21. A solid sphere and a solid cylinder of same mass and radius are rolling on a horizontal surface without slipping. The ratio of their radius of gyrations respectively $(k_{sph} : k_{cyl})$ is $2 : \sqrt{x}$. The value of x is _____.

15 Apr 2023 (M)

Q22. A light rope is wound around a hollow cylinder of mass 5 kg and radius 70 cm. The rope is pulled with a force of 52.5 N. The angular acceleration of the cylinder will be _____ rad s^{-2}. ***13 Apr 2023 (E)***

Q23. A solid sphere is rolling on a horizontal plane without slipping. If the ratio of angular momentum about axis of rotation of the sphere to the total energy of moving sphere is $\pi : 22$ then, the value of its angular speed will be _____rad s^{-1}.

13 Apr 2023 (M)

Q24. For rolling spherical shell, the ratio of rotational kinetic energy and total kinetic energy is $\frac{x}{5}$. The value of x is _____.

12 Apr 2023 (M)

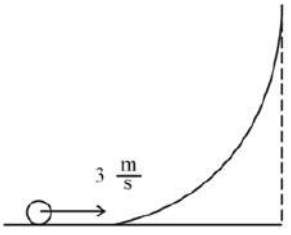
Q25. A solid sphere of mass 500 g radius 5 cm is rotated about one of its diameter with angular speed of 10 rad s^{-1}. If the moment of inertia of the sphere about its tangent is $x \times 10^{-2}$ times its angular momentum about the diameter. Then the value of x will be ***11 Apr 2023 (M)***

Q26. A circular plate is rotating in horizontal plane, about an axis passing through its centre and perpendicular to the plate, with an angular velocity ω. A person sits at the centre having two dumbbells in his hands. When he stretched out his hands, the moment of inertia of the system becomes triple. If E be the initial Kinetic energy of the system, then final Kinetic energy will be $\frac{E}{x}$. The value of x is ***11 Apr 2023 (E)***

Q27. A force of $-P\hat{k}$ acts on the origin of the coordinate system. The torque about the point $(2, -3)$ is $P\left(a\hat{i} + b\hat{j}\right)$, The ratio of $\frac{a}{b}$ is $\frac{x}{2}$. The value of x is ***10 Apr 2023 (E)***

Q28. The moment of inertia of a semicircular ring about an axis, passing through the center and perpendicular to the plane of ring, is $\frac{1}{\text{x}}\ \text{MR}^2$, where R is the radius and M is the mass of the semicircular ring. The value of x will be _____. ***08 Apr 2023 (M)***

Q29. A hollow spherical ball of uniform density rolls up a curved surface with an initial velocity $3\ \text{m s}^{-1}$ (as shown in figure). Maximum height with respect to the initial position covered by it will be _____ cm (take, $g = 10\ \text{m s}^{-2}$)



08 Apr 2023 (E)

Q30. Two identical solid spheres each of mass 2 kg and radii 10 cm are fixed at the ends of a light rod. The separation between the centres of the spheres is 40 cm. The moment of inertia of the system about an axis perpendicular to the rod passing through its middle point is_____ $\times 10^{-3}$ kg m^2.

06 Apr 2023 (M)

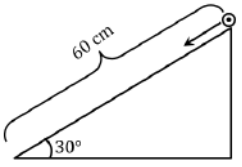
Q31. A ring and a solid sphere rotating about an axis passing through their centres have same radii of gyration. The axis of rotation is perpendicular to plane of ring. The ratio of radius of ring to that of sphere is $\sqrt{\frac{2}{x}}$. The value of x is _____.

06 Apr 2023 (E)

Q32. Moment of inertia of a disc of mass M and radius 'R' about any of its diameter is $\frac{MR^2}{4}$. The moment of inertia of this disc about an axis normal to the disc and passing through a point on its edge will be, $\frac{x}{2}MR^2$. The value of x is _____.

01 Feb 2023 (E)

Q33. A solid cylinder is released from rest from the top of an inclined plane of inclination 30° and length 60 cm. If the cylinder rolls without slipping, its speed upon reaching the bottom of the inclined plane is _____ m s^{-1}. (Given $g = 10\ \text{m s}^{-2}$)



01 Feb 2023 (M)

Q34. A solid sphere of mass 1 kg rolls without slipping on a plane surface. Its kinetic energy is 7×10^{-3} J. The speed of the centre of mass of the sphere is _____ cm s^{-1}.

31 Jan 2023 (M)

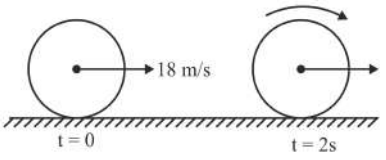
Q35. Two discs of same mass and different radii are made of different materials such that their thicknesses are 1 cm and 0.5 cm respectively. The densities of materials are in the ratio $3:5$. The moment of inertia of these discs respectively about their diameters will be in the ratio of $\frac{x}{6}$. The value of x is _____.

31 Jan 2023 (E)

Q36. A thin uniform rod of length 2 m, cross sectional area A and density d is rotated about an axis passing through the centre and perpendicular to its length with angular velocity ω. If value of ω in terms of its rotational kinetic energy E is $\sqrt{\frac{\alpha E}{Ad}}$, then the value of α is _____.

30 Jan 2023 (M)

Q37. A uniform disc of mass 0.5 kg and radius r is projected with velocity $18\ \text{m s}^{-1}$ at $t = 0$ s on a rough horizontal surface. It starts off with a purely sliding motion at $t = 0$ s. After 2 s it acquires a purely rolling motion (see figure). The total kinetic energy of the disc after 2 s will be _____ J. (given, coefficient of friction is 0.3 and $g = 10\ \text{m s}^{-2}$).

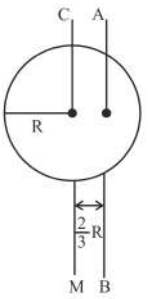


30 Jan 2023 (E)

Q38. A solid sphere of mass 2 kg is making pure rolling on a horizontal surface with kinetic energy 2240 J. The velocity of centre of mass of the sphere will be _____ m s^{-1}.

29 Jan 2023 (M)

Q39. I_{CM} is moment of inertia of a circular disc about an axis (CM) passing through its center and perpendicular to the plane of disc. I_{AB} is its moment of inertia about an axis AB perpendicular to plane and parallel to axis CM at a distance $\frac{2}{3}$R from center, where R is the radius of the disc. The ratio of I_{AB} and I_{CM} is $x:9$. The value of x is _____.

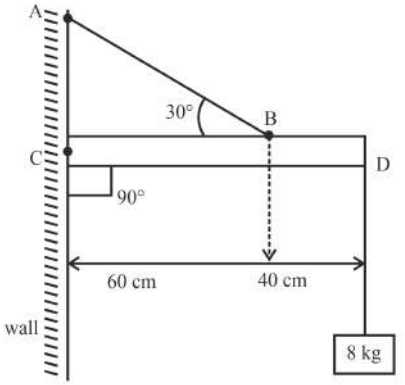


25 Jan 2023 (M)

Q40. If a solid sphere of mass 5 kg and a disc of mass 4 kg have the same radius, then the ratio of moment of inertia of the disc about a tangent in its plane to the moment of inertia of the sphere about its tangent will be $\frac{x}{7}$. The value of x is _____.

25 Jan 2023 (E)

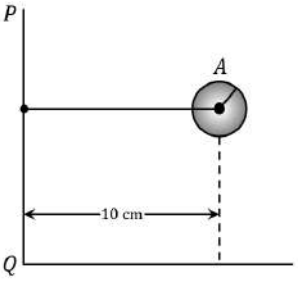
Q41. An object of mass 8 kg is hanging from one end of a uniform rod CD of mass 2 kg and length 1 m pivoted at its end C on a vertical wall as shown in figure. It is supported by a cable AB such that the system is in equilibrium. The tension in the cable is:
(Take $g = 10\ \text{m s}^{-2}$)



25 Jan 2023 (M)

(1) 240 N (2) 90 N
(3) 300 N (4) 30 N

Q42. Solid sphere A is rotating about an axis PQ. If the radius of the sphere is 5 cm, then its radius of gyration about PQ will be $\sqrt{x}$ cm. The value of x is _____.



24 Jan 2023 (M)

Q43. A uniform solid cylinder with radius R and length L has moment of inertia I_1, about the axis of cylinder. A concentric solid cylinder of radius $R' = \frac{R}{2}$ and length $L' = \frac{L}{2}$ is carved out of the original cylinder. If I_2 is the moment of inertia of the carved out portion of the cylinder then $\frac{I_1}{I_2} =$ _____.
(Both I_1 and I_2 are about the axis of the cylinder)

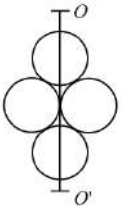
24 Jan 2023 (E)

Q44. The torque of a force $5\hat{i} + 3\hat{j} - 7\hat{k}$ about the origin is τ. If the force acts on a particle whose position vector is $2\hat{i} + 2\hat{j} + \hat{k}$, then the value of τ will be

29 Jul 2022 (E)

(1) $11\hat{i} + 19\hat{j} - 4\hat{k}$ (2) $-11\hat{i} + 9\hat{j} - 16\hat{k}$
(3) $-17\hat{i} + 19\hat{j} - 4\hat{k}$ (4) $17\hat{i} + 9\hat{j} + 16\hat{k}$

Q45. Four identical discs each of mass 'M' and diameter 'a' are arranged in a small plane as shown in figure. If the moment of inertia of the system about OO' is $\frac{x}{4}Ma^2$. Then, the value of x will be _____ .

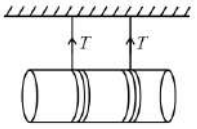


28 Jul 2022 (M)

Q46. A pulley of radius 1.5 m is rotated about its axis by a force $F = \left(12t - 3t^2\right)$ N applied tangentially (while t is measured in seconds). If moment of inertia of the pulley about its axis of rotation is 4.5 kg m^2, the number of rotations made by the pulley before its direction of motion is reversed, will be $\frac{K}{\pi}$. The value of K is _____ .

27 Jul 2022 (M)

Q47. A solid cylinder length is suspended symmetrically through two massless strings, as shown in the figure. The distance from the initial rest position, the cylinder should be unbinding the strings to achieve a speed of 4 m s^{-1}, is _____cm. (take $g = 10$ m s^{-2})



27 Jul 2022 (E)

Q48. The radius of gyration of a cylindrical rod about an axis of rotation perpendicular to its length and passing through the center will be _____ m. Given, the length of the rod is $10\sqrt{3}$ m. ***26 Jul 2022 (E)***

Q49. A disc of mass 1 kg and radius R is free of rotate about a horizontal axis passing through its centre and perpendicular to the plane of disc. A body of same mass as that of disc is fixed at the highest point of the disc. Now the system is released, when the body comes to the lowest position, its angular speed will be $4\sqrt{\frac{x}{3R}}$ rad s^{-1} where $x =$ _____ . ***26 Jul 2022 (M)***

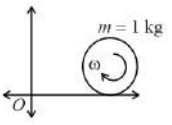
Q50. A solid cylinder and a solid sphere, having same mass M and radius R, roll down the same inclined plane from top without slipping. They start from rest. The ratio of velocity of the solid cylinder to that of the solid sphere, with which they reach the ground, will be ***25 Jul 2022 (M)***

(1) $\sqrt{\frac{5}{3}}$ (2) $\sqrt{\frac{4}{5}}$

(3) $\sqrt{\frac{3}{5}}$ (4) $\sqrt{\frac{14}{15}}$

Q51. The moment of inertia of a uniform thin rod about a perpendicular axis passing through one end is I_1. The same rod is bent into a ring and its moment of inertia about a diameter is I_2. If $\frac{I_1}{I_2}$ is $\frac{x\pi^2}{3}$, then the value of x will be _____. ***29 Jun 2022 (E)***

Q52. A spherical shell of 1 kg mass and radius R is rolling with angular speed ω on horizontal plane (as shown in figure). The magnitude of angular momentum of the shell about the origin O is $\frac{a}{3}R^2\omega$. The value of a will be

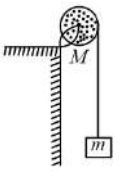


29 Jun 2022 (M)

(1) 2 (2) 3

(3) 5 (4) 4

Q53. A uniform disc with mass $M = 4$ kg and radius $R = 10$ cm is mounted on a fixed horizontal axle as shown in figure. A block with mass $m = 2$ kg hangs from a massless cord that is wrapped around the rim of the disc. During the fall of the block, the cord does not slip and there is no friction at the axle. The tension in the cord is _____ N. (Take $g = 10$ ms^{-2})



28 Jun 2022 (E)

Q54. The position vector of 1 kg object is $\vec{r} = \left(3\hat{\text{i}} - \hat{\text{j}}\right)$ m and its velocity $\vec{v} = \left(3\hat{\text{j}} + \hat{\text{k}}\right)$ m s^{-1}. The magnitude of

its angular momentum is $\sqrt{x}$ N m s, where x is ***28 Jun 2022 (M)***

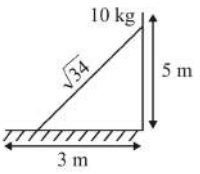
Q55. Match List-I with List-II

	List-I		**List-II**
(A)	Moment of inertia of solid sphere of radius R about any tangent.	(I)	$\frac{5}{3}MR^2$
(B)	Moment of inertia of hollow sphere of radius (R) about any tangent.	(II)	$\frac{7}{5}MR^2$
(C)	Moment of inertia of circular ring of radius (R) about its diameter.	(III)	$\frac{1}{4}MR^2$
(D)	Moment of inertia of circular disc of radius (R) about any diameter.	(IV)	$\frac{1}{2}MR^2$

28 Jun 2022 (M)

(1) A – II, B – I, C – IV, D – III
(2) A – I, B – II, C – IV, D – III
(3) A – II, B – I, C – III, D – IV
(4) A – I, B – II, C – III, D – IV

Q56. A $\sqrt{34}$ m long ladder weighing 10 kg leans on a frictionless wall. Its feet rest on the floor 3 m away from the wall as shown in the figure. If F_f and F_w are the reaction forces of the floor and the wall, then ratio of $\frac{F_w}{F_f}$ will be: (Use $g = 10$ m s^{-2}.)



28 Jun 2022 (E)

(1) $\frac{6}{\sqrt{110}}$
(2) $\frac{3}{\sqrt{113}}$
(3) $\frac{3}{\sqrt{109}}$
(4) $\frac{2}{\sqrt{109}}$

Q57. A thin circular ring of mass M and radius R is rotating with a constant angular velocity 2 rad s^{-1} in a horizontal plane about an axis vertical to its plane and passing through the center of the ring. If two objects each of mass m be attached gently to the opposite ends of a diameter of ring, the ring will then rotate with an angular velocity (in rad s^{-1}). ***26 Jun 2022 (M)***

(1) $\frac{M}{(M+m)}$
(2) $\frac{(M+2m)}{2M}$
(3) $\frac{2M}{(M+2m)}$
(4) $\frac{2(M+2m)}{M}$

Q58. A solid spherical ball is rolling on a frictionless horizontal plane surface about its axis of symmetry. The ratio of rotational kinetic energy of the ball to its total kinetic energy is ***26 Jun 2022 (E)***

(1) $\frac{1}{5}$
(2) $\frac{2}{5}$
(3) $\frac{2}{7}$
(4) $\frac{7}{10}$

Q59. If force $\overrightarrow{F} = 3\hat{i} + 4\hat{j} - 2\hat{k}$ acts on a particle having position vector $2\hat{i} + \hat{j} + 2\hat{k}$ then, the torque about the origin will be: ***25 Jun 2022 (M)***

(1) $-10\hat{i} + 10\hat{j} + 5\hat{k}$
(2) $3\hat{i} + 4\hat{j} - 2\hat{k}$
(3) $10\hat{i} + 5\hat{j} - 10\hat{k}$
(4) $10\hat{i} + \hat{j} - 5\hat{k}$

Q60. Moment of Inertia (M.I.) of four bodies having same mass M and radius $2R$ are as follows
$I_1 =$ M.I. of solid sphere about its diameter $I_2 =$ M.I. of solid cylinder about its axis

$I_3 =$ M.I. of solid circular disc about its diameter
$I_4 =$ M.I. of thin circular ring about its diameter
If $2(I_2 + I_3) + I_4 = xI_1$ then the value of x will be _____ . ***25 Jun 2022 (E)***

Q61. A metre scale is balanced on a knife edge at its centre. When two coins, each of mass 10 g are put one on the top of the other at the 10.0 cm mark the scale is found to be balanced at 40.0 cm mark. The mass of the metre scale is found to be $x \times 10^{-2}$ kg. The value of x is _____ . ***24 Jun 2022 (M)***

Q62. A fly wheel is accelerated uniformly from rest and rotates through 5 rad in the first second. The angle rotated by the fly wheel in the next second, will be : ***24 Jun 2022 (E)***

(1) 7.5 rad (2) 15 rad
(3) 20 rad (4) 30 rad

Q63. A 2 kg steel rod of length 0.6 m is clamped on a table vertically at its lower end and is free to rotate in the vertical plane. The upper end is pushed so that the rod falls under gravity. Ignoring the friction due to clamping at its lower end, the speed of the free end of the rod when it passes through its lowest position is _____m s^{-1}. (Take $g = 10$ m s^{-2}) ***01 Sep 2021 (E)***

Q64. Electric field of a plane electromagnetic wave propagating through a non-magnetic medium is given by $E = 20\cos(2 \times 10^{10}t - 200x)$ V m^{-1}. The dielectric constant of the medium is equal to:
(Take $\mu_r = 1$) ***01 Sep 2021 (E)***

(1) 2 (2) $\frac{1}{3}$
(3) 9 (4) 3

Q65. Angular momentum of a single particle moving with constant speed along circular path : ***31 Aug 2021 (M)***

(1) remains same in magnitude but changes in the direction
(2) remains same in magnitude and direction
(3) is zero
(4) changes in magnitude but remains same in the direction

Q66. A system consists of two identical spheres each of mass 1.5 kg and radius 50 cm at the ends of a light rod. The distance between the centres of the two spheres is 5 m. What will be the moment of inertia of the system about an axis perpendicular to the rod passing through its midpoint? ***31 Aug 2021 (E)***

(1) 1.905×10^5 kg m^2 (2) 18.75 kg m^2
(3) 19.05 kg m^2 (4) 1.875×10^5 kg m^2

Q67. Moment of inertia of a square plate of side l about the axis passing through one of the corner and perpendicular to the plane of square plate is given by:

27 Aug 2021 (M)

(1) $\frac{Ml^2}{6}$ (2) $\frac{2}{3}Ml^2$
(3) Ml^2 (4) $\frac{Ml^2}{12}$

Q68. A huge circular arc of length 4.4 ly subtends an angle 4s at the centre of the circle. How long it would take for a body to complete 4 revolution if its speed is 8 AU per second?
Given : 1 ly $= 9.46 \times 10^{15}$ m $\quad$ 1 AU $= 1.5 \times 10^{11}$ m

27 Aug 2021 (M)

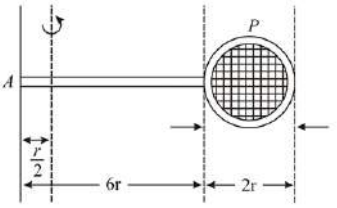
(1) 3.5×10^6 s
(2) 4.5×10^{10} s
(3) 4.1×10^8 s
(4) 7.2×10^8

Q69. Two discs have moments of intertia I_1 and I_2 about their respective axes perpendicular to the plane and passing through the centre. They are rotating with angular speeds, ω_1 and ω_2 respectively and are brought into contact face to face with their axes of rotation coaxial. The loss in kinetic energy of the system in the process is given by:

27 Aug 2021 (E)

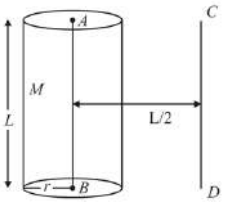
(1) $\frac{I_1 I_2}{(I_1+I_2)}(\omega_1-\omega_2)^2$
(2) $\frac{(\omega_1-\omega_2)^2}{2(I_1+I_2)}$
(3) $\frac{I_1 I_2}{2(I_1+I_2)}(\omega_1-\omega_2)^2$
(4) $\frac{(I_1-I_2)^2\omega_1\omega_2}{2(I_1+I_2)}$

Q70. Consider a badminton racket with length scales as shown in the figure. If the mass of the linear and circular portions of the badminton racket are same (M) and the mass of the threads are negligible, the moment of inertia of the racket about an axis perpendicular to the handle and in the plane of the ring at, $\frac{r}{2}$ distance from the end A of the handle will be _____Mr^2.



26 Aug 2021 (M)

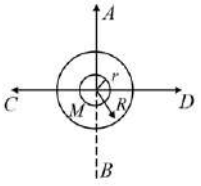
Q71. The solid cylinder of length 80 cm and mass M has a radius of 20 cm. Calculate the density of the material used if the moment of inertia of the cylinder about an axis CD parallel to AB as shown in figure is 2.7 kg m^2.



26 Aug 2021 (E)

(1) 1.49×10^2 kg m^{-3}
(2) 7.5×10^1 kg m^{-3}
(3) 14.9 kg m^{-3}
(4) 7.5×10^2 kg m^{-3}

Q72. The figure shows two solid discs with radius R and r respectively. If mass per unit area is the same for both, what is the ratio of MI of bigger disc around axis AB (Which is $\perp$ to the plane of the disc and passing through its centre) of MI of smaller disc around one of its diameters lying on its plane? Given M is the mass of the larger disc. (MI stands for a moment of inertia)



27 Jul 2021 (M)

(1) $R^2 : r^2$
(2) $2r^4 : R^4$
(3) $2R^2 : r^2$
(4) $2R^4 : r^4$

Q73. List-I

(a) MI of the rod (length L, Mass M, about an axis $\perp$ to the rod passing through the midpoint)

(b) MI of the rod (length L, Mass 2M, about an axis $\perp$ to the rod passing through one of its end)

(c) MI of the rod (length 2L, Mass M, about an axis $\perp$ to the rod passing through its midpoint)

List-II

(i) $\frac{8ML^2}{3}$

(ii) $\frac{ML^2}{3}$

(iii) $\frac{ML^2}{12}$

(d) MI of the rod (Length $2L$, Mass 2M, about an axis $\perp$ to the rod passing through one of its end) (iv) $\frac{2ML^2}{3}$

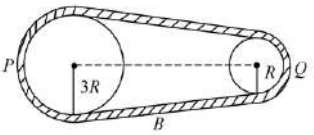
Choose the correct answer from the options given below:

27 Jul 2021 (M)

(1) (a) – (ii), (b) – (iii), (c) – (i), (d) – (iv) (2) (a) – (ii), (b) – (i), (c) – (iii), (d) – (iv)

(3) (a) – (iii), (b) – (iv), (c) – (ii), (d) – (i) (4) (a) – (iii), (b) – (iv), (c) – (i), (d) – (ii)

Q74. In the given figure, two wheels P and Q are connected by a belt B. The radius of P is three times that of Q. In the case of the same rotational kinetic energy, the ratio of rotational inertias $\left(\frac{I_1}{I_2}\right)$ will be $x:1$. The value of x will be _____.



27 Jul 2021 (E)

Q75. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: Moment of inertia of a circular disc of mass M and radius R about X, Y axes (passing through its plane) and Z-axis which is perpendicular to its plane were found to be I_x, I_y and I_z, respectively. The respective radii of gyration about all the three axes will be the same.

Reason R: A rigid body making rotational motion has fixed mass and shape. In the light of the above statements, choose the most appropriate answer from the options given below:

25 Jul 2021 (M)

(1) Both A and R are correct but R is not the correct explanation of A.

(2) A is not correct but R is correct.

(3) A is correct but R is not correct.

(4) Both A and R are correct and R is the correct explanation of A.

Q76. A solid disc of radius 20 cm and mass 10 kg is rotating with an angular velocity of 600 rpm, about an axis normal to its circular plane and passing through its centre of mass. The retarding torque required to bring the disc at rest in 10 s is _____ $\pi \times 10^{-1}$ N m ***25 Jul 2021 (E)***

Q77. The minimum and maximum distances of a planet revolving around the Sun are x_1 and x_2. If the minimum speed of the planet on its trajectory is v_0, then its maximum speed will be: ***25 Jul 2021 (M)***

(1) $\frac{v_0 x_1^2}{x_2^2}$ (2) $\frac{v_0 x_2^2}{x_1^2}$

(3) $\frac{v_0 x_1}{x_2}$ (4) $\frac{v_0 x_2}{x_1}$

Q78. A particle of mass m is moving in time t on a trajectory given by, $\vec{r} = 10\alpha t^2 \hat{i} + 5\beta(t-5)\hat{j}$ where α and β are dimensional constants. The angular momentum of the particle becomes the same as it was for $t = 0$ at time $t =$ _____ seconds.

25 Jul 2021 (M)

Q79. The centre of a wheel rolling on a plane surface moves with a speed v_0. A particle on the rim of the wheel at the same level as the centre will be moving at a speed $\sqrt{x}v_0$. Then the value of x is _____. ***22 Jul 2021 (M)***

Q80. Consider a situation in which a ring, a solid cylinder and a solid sphere roll down on the same inclined plane without slipping. Assume that they start rolling from rest and having identical diameter. The correct statement for this situation is ***22 Jul 2021 (M)***

(1) The sphere has the greatest and the ring has the least velocity of the centre of mass at the bottom of the inclined plane.
(2) The ring has the greatest and the cylinder has the least velocity of the centre of mass at the bottom of the inclined plane.
(3) All of them will have same velocity.
(4) The cylinder has the greatest and the sphere has the least velocity of the centre of mass at the bottom of the inclined plane.

Q81. A body rolls down an inclined plane without slipping. The kinetic energy of rotation is 50% of its translational kinetic energy. The body is: ***20 Jul 2021 (E)***

(1) solid sphere (2) solid cylinder
(3) hollow cylinder (4) ring

Q82. A body rotating with an angular speed of 600 rpm is uniformly accelerated to 1800 rpm in 10 sec. The number of rotations made in the process is ***20 Jul 2021 (E)***

Q83. A circular disc reaches from top to bottom of an inclined plane of length L. When it slips down the plane, it takes time t_1. When it rolls down the plane, it takes time t_2. The value of $\frac{t_2}{t_1}$ is $\sqrt{\frac{3}{x}}$. The value of x will be ***20 Jul 2021 (M)***

Q84. Two bodies, a ring and a solid cylinder of same material are rolling down without slipping an inclined plane. The radii of the bodies are same. The ratio of velocity of the centre of mass at the bottom of the inclined plane of the ring to that of the cylinder is $\frac{\sqrt{x}}{2}$. Then, the value of x is ***20 Jul 2021 (E)***

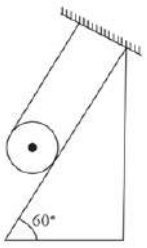
Q85. A thin circular ring of mass M and radius r is rotating about its axis with an angular speed ω. Two particles having mass m each are now attached at diametrically opposite points. The angular speed of the ring will become: ***18 Mar 2021 (M)***

(1) $\omega\frac{M}{M+m}$ (2) $\omega\frac{M+2m}{M}$ (3) $\omega\frac{M}{M+2m}$ (4) $\omega\frac{M-2m}{M+2m}$

Q86. Consider a uniform wire of mass M and length L. It is bent into a semicircle. Its moment of inertia about a line perpendicular to the plane of the wire passing through the centre is : ***18 Mar 2021 (E)***

(1) $\frac{1}{4}\frac{ML^2}{\pi^2}$ (2) $\frac{2}{5}\frac{ML^2}{\pi^2}$
(3) $\frac{ML^2}{\pi^2}$ (4) $\frac{1}{2}\frac{ML^2}{\pi^2}$

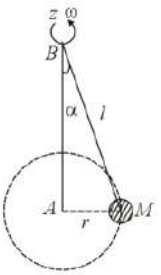
Q87. A solid cylinder of mass m is wrapped with an inextensible light string and, is placed on a rough inclined plane as shown in the figure. The frictional force acting between the cylinder and the inclined plane is: [The coefficient of static friction, μ_s, is 0.4]



18 Mar 2021 (E)

(1) $\frac{7}{2}mg$ (2) $5mg$
(3) $\frac{mg}{5}$ (4) 0

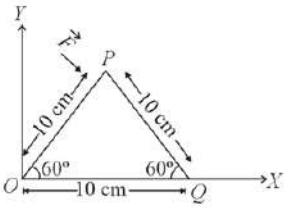
Q88. A mass M hangs on a massless rod of length l which rotates at a constant angular frequency. The mass M moves with steady speed in a circular path of constant radius. Assume that the system is in steady circular motion with constant angular velocity ω. The angular momentum of M about point A is L_A which lies in the positive z direction and the angular momentum of M about B is L_B. The correct statement for this system is:



17 Mar 2021 (M)

(1) L_A and L_B are both constant in magnitude and direction
(2) L_B is constant in direction with varying magnitude
(3) L_B is constant, both in magnitude and direction
(4) L_A is constant, both in magnitude and direction

Q89. A triangular plate is shown. A force $\vec{F} = 4\hat{i} - 3\hat{j}$ is applied at point P. The torque at point P with respect to point O and Q are:



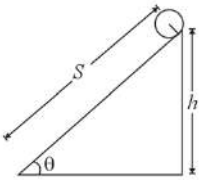
17 Mar 2021 (M)

(1) $-15 - 20\sqrt{3}, 15 - 20\sqrt{3}$
(2) $15 + 20\sqrt{3}, 15 - 20\sqrt{3}$
(3) $15 - 20\sqrt{3}, 15 + 20\sqrt{3}$
(4) $-15 + 20\sqrt{3}, 15 + 20\sqrt{3}$

Q90. The angular speed of truck wheel is increased from 900 rpm to 2460 rpm in 26 seconds. The number of revolutions by the truck engine during this time is _____.
(Assuming the acceleration to be uniform).

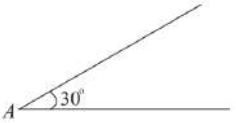
17 Mar 2021 (M)

Q91. The following bodies, (1) a ring, (2) a disc, (3) a solid cylinder, (4) a solid sphere, of same mass m and radius R are allowed to roll down without slipping simultaneously from the top of the inclined plane. The body which will reach first at the bottom of the inclined plane is [Mark the body as per their respective numbering given in the question]



17 Mar 2021 (M)

Q92. A sphere of mass 2 kg and radius 0.5 m is rolling with an initial speed of 1 m s^{-1} goes up an inclined plane which makes an angle of 30° with the horizontal plane, without slipping. How low will the sphere take to return to the starting point A?



17 Mar 2021 (E)

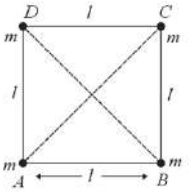
(1) 0.60 s
(2) 0.52 s
(3) 0.56 s
(4) 0.80 s

Q93. The maximum and minimum distances of a comet from the Sun are 1.6×10^{12} m and 8.0×10^{10} m respectively. If the speed of the comet at the nearest point is 6×10^4 m s^{-1}, the speed at the farthest point is

16 Mar 2021 (M)

(1) $1.5 \times 10^3\ \text{m s}^{-1}$ (2) $6.6 \times 10^3\ \text{m s}^{-1}$
(3) $3.0 \times 10^3\ \text{m s}^{-1}$ (4) $4.5 \times 10^3\ \text{m s}^{-1}$

Q94. Four equal masses, m each are placed at the corners of a square of length (l) as shown in the figure. The moment of inertia of the system about an axis passing through A and parallel to DB would be :



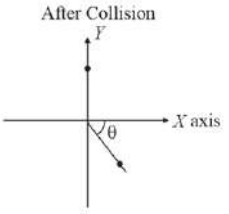
16 Mar 2021 (M)

(1) ml^2 (2) $2\ ml^2$
(3) $3\ ml^2$ (4) $\sqrt{3}\ ml^2$

Q95. A force $\vec{F} = 4\hat{i} + 3\hat{j} + 4\hat{k}$ is applied on an intersection point of $x = 2$ plane and x-axis. The magnitude of torque of this force about a point $(2, 3, 4)$ is _____.
(Round off to the Nearest Integer)

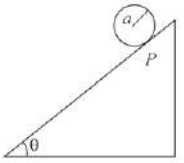
16 Mar 2021 (E)

Q96. A ball of mass 10 kg moving with a velocity $10\sqrt{3}\ \text{m s}^{-1}$ along X-axis, hits another ball of mass 20 kg which is at rest. After the collision, the first ball comes to rest and the second one disintegrates into two equal pieces. One of the pieces starts moving along Y-axis at a speed of $10\ \text{m s}^{-1}$. The second piece starts moving at a speed of $20\ \text{m s}^{-1}$ at an angle θ (degree) with respect to the X-axis. The configuration of pieces after the collision is shown in the figure. The value of θ to the nearest integer is _____.



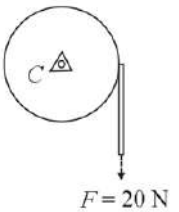
16 Mar 2021 (M)

Q97. A solid disc of radius a and mass m rolls down without slipping on an inclined plane making an angle θ with the horizontal. The acceleration of the disc will be $\frac{2}{b}g\sin\theta$, where b is _____. (Round off to the Nearest Integer) (g = acceleration due to gravity) (θ = angle as shown in figure)



16 Mar 2021 (E)

Q98. Consider a 20 kg uniform circular disk of radius 0.2 m. It is pin supported at its center and is at rest initially. The disk is acted upon by a constant force $F = 20$ N through a massless string wrapped around its periphery as shown in the figure. Suppose the disk makes n number of revolutions to attain an angular speed of 50 rad s^{-1}. The value of n, to the nearest integer, is _____ . [Given : In one complete revolution, the disk rotates by 6.28 rad]



16 Mar 2021 (M)

Q99. Four identical solid spheres each of mass m and radius a are placed with their centres on the four corners of a square of side b. The moment of inertia of the system about one side of square where the axis of rotation is parallel to the plane of the square is : ***26 Feb 2021 (M)***

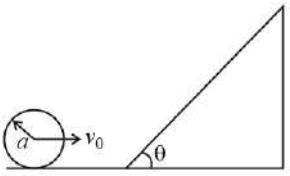
(1) $\frac{8}{5}ma^2 + mb^2$ (2) $\frac{4}{5}ma^2 + 2mb^2$
(3) $\frac{8}{5}ma^2 + 2mb^2$ (4) $\frac{4}{5}ma^2$

Q100. A cord is wound round the circumference of wheel of radius r, The axis of the wheel is horizontal and the moment of inertia about it is I. A weight mg is attached to the cord at the end. The weight falls from rest. After falling through a distance h, the square of angular velocity of wheel will be ***26 Feb 2021 (E)***

(1) $\frac{2mgh}{I+mr^2}$ (2) $\frac{2mgh}{I+2mr^2}$

(3) $2gh$ (4) $\frac{2gh}{I+mr^2}$

Q101. A sphere of radius a and mass m rolls along a horizontal plane with constant speed v_0. It encounters an inclined plane at angle θ and climbs upward. Assuming that it rolls without slipping, how far up the sphere will travel?



25 Feb 2021 (E)

(1) $\frac{2}{5}\frac{v_0^2}{g\sin\theta}$ (2) $\frac{7v_0^2}{10\,g\sin\theta}$

(3) $\frac{v_0^2}{5g\sin\theta}$ (4) $\frac{v_0^2}{2g\sin\theta}$

Q102. Moment of inertia $(\mathrm{M.I.})$ of four bodies, having same mass and radius, are reported as; $I_1 = \mathrm{M.I.}$ of thin circular ring about its diameter, $I_2 = \mathrm{M.I.}$ of circular disc about an axis perpendicular to disc and going through the centre, $I_3 = \mathrm{M.I.}$ of solid cylinder about its axis and $I_4 = \mathrm{M.I.}$ of solid sphere about its diameter. Then:

24 Feb 2021 (M)

(1) $I_1 + I_2 = I_3 + \frac{5}{2}I_4.$ (2) $I_1 + I_3 < I_2 + I_4$

(3) $I_1 = I_2 = I_3 > I_4$ (4) $I_1 = I_2 = I_3 < I_4$

Q103. A uniform thin bar of mass $6\ \mathrm{kg}$ and length 2.4 meter is bent to make an equilateral hexagon. The moment of inertia about an axis passing through the centre of mass and perpendicular to the plane of hexagon is _____ $\times 10^{-1}\ \mathrm{kg\ m^2}$. ***24 Feb 2021 (E)***

Q104. The linear mass density of a thin rod AB of length L varies from A to B as $\lambda(x) = \lambda_0\left(1 + \frac{x}{L}\right)$, where x is the distance from A. If M is the mass of the rod then its moment of inertia about an axis passing through A and perpendicular to the rod : ***06 Sep 2020 (E)***

(1) $\frac{5}{12}ML^2$ (2) $\frac{7}{18}ML^2$

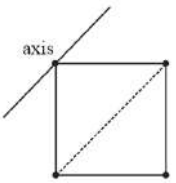
(3) $\frac{2}{5}ML^2$ (4) $\frac{3}{7}ML^2$

Q105. A satellite is in an elliptical orbit around a planet P. It is observed that the velocity of the satellite when it is farthest from the planet is 6 times less than that when it is closest to the planet. The ratio of distances between the satellite and the planet at closest and farthest points is : ***06 Sep 2020 (M)***

(1) $1:6$ (2) $1:3$

(3) $1:2$ (4) $3:4$

Q106. Four point masses, each of mass m, are fixed at the corners of a square of side I. The square is rotating with angular frequency ω, about an axis passing through one of the corners of the square and parallel to tis diagonal, as shown in the figure. The angular momentum of the square about the axis is

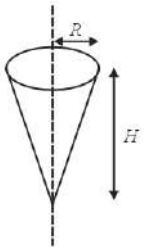


06 Sep 2020 (M)

(1) $\mathrm{m}\ell^2\omega$ (2) $4\mathrm{m}\ell^2\omega$

(3) $3\mathrm{m}\ell^2\omega$ (4) $2\mathrm{m}\ell^2\omega$

Q107. Shown in the figure is a hollow ice-cream cone (it is open at top). If its mass is M, radius of its top is R and height, H, then its moment of inertia about its axis is



06 Sep 2020 (M)

(1) $\frac{\mathrm{MR}^2}{2}$ (2) $\frac{\mathrm{M}(\mathrm{R}^2+\mathrm{H}^2)}{4}$

(3) $\frac{\mathrm{MH}^2}{3}$ (4) $\frac{\mathrm{MR}^2}{3}$

Q108. A force $\vec{F}=\left(\hat{i}+2\hat{j}+3\hat{k}\right)$ N acts at a point $\left(4\hat{i}+3\hat{j}-\hat{k}\right)$ m. Then the magnitude of torque about the point $\left(\hat{i}+2\hat{j}+\hat{k}\right)$ m will be $\sqrt{x}$ N $-$ m.The value of x is.....

05 Sep 2020 (M)

Q109. A wheel is rotating freely with an angular speed ω on a shaft. The moment of inertia of the wheel is I and the moment of inertia of the shaft is negligible. Another wheel of moment of inertia $3I$ initially at rest is suddenly coupled to the same shaft. The resultant fractional loss in the kinetic energy of the system is:

05 Sep 2020 (M)

(1) $\frac{5}{6}$ (2) $\frac{1}{4}$

(3) 0 (4) $\frac{3}{4}$

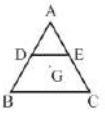
Q110. Consider two uniform discs of the same thickness and different radii $R_1=R$ and $R_2=\alpha R$ made of the same material. If the ratio of their moments of inertia I_1 and I_2, respectively, about their axes is $I_1:I_2=1:16$ then the value of α is :

04 Sep 2020 (E)

(1) $2\sqrt{2}$ (2) $\sqrt{2}$

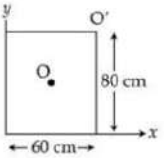
(3) 2 (4) 4

Q111. ABC is a plane lamina of the shape of an equilateral triangle. D, E are mid-points of AB, AC and G is the centroid of the lamina. Moment of inertia of the lamina about an axis passing through G and perpendicular to the plane ABC is I_0. If part ADE is removed, the moment of inertia of the remaining part about the same axis is $\frac{NI_0}{16}$ where N is an integer. Value of N is:



04 Sep 2020 (M)

Q112. For a uniform rectangular sheet shown in the figure, the ratio of moments of inertia about the axes perpendicular to the sheet and passing through O (the centre of mass) and O' (corner point) is:



04 Sep 2020 (E)

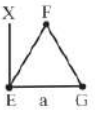
(1) $2/3$ (2) $1/4$

(3) $1/8$ (4) $1/2$

Q113. A circular disc of mass M and radius R is rotating about its axis with angular speed ω_1. If another stationary disc having radius $\frac{R}{2}$ and same mass M is dropped co-axially on to the rotating disc. Gradually both discs attain constant angular speed ω_2. The energy lost in the process is p% of the initial energy. Value of p is _____

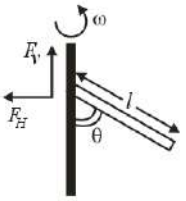
04 Sep 2020 (M)

Q114. An massless equilateral triangle EFG of side 'a' (As shown in figure) has three particles of mass m situated at its vertices. The moment of inertia of the system about the line EX perpendicular to EG in the plane of EFG is $\frac{N}{20}ma^2$ where N is an integer. The value of N is _____ .



03 Sep 2020 (E)

Q115. A uniform rod of length' ℓ' is pivoted at one of its ends on a vertical shaft of negligible radius. When the shaft rotates at angular speed ω the rod makes an angle $\theta$with it (see figure). To find θ equate the rate of change of angular momentum (direction going into the paper) $\frac{m\ell^2}{12}\omega^2 \sin\theta$ about the centre of mass (CM) to the torque provided by the horizontal and vertical forces F_H and F_v about the CM. The value of θ is then such that:



03 Sep 2020 (E)

(1) $\cos\theta = \frac{2g}{3\ell\omega^2}$ (2) $\cos\theta = \frac{g}{2\ell\omega^2}$

(3) $cos\theta = \frac{g}{\ell\omega^2}$ (4) $\cos\theta = \frac{3g}{2\ell\omega^2}$

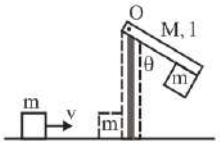
Q116. A person of 80 kg mass is standing on the rim of a circular platform of mass 200 kg rotating about its axis at 5 revolutions per minute (rpm). The person now starts moving towards the centre of the platform. What will be the rotational speed (in rpm) of the platform when the person reaches its centre.... ***03 Sep 2020 (M)***

Q117. Moment of inertia of a cylinder of mass m, length L and radius R about an axis passing through its centre and perpendicular to the axis of the cylinder is $I = M\left(\frac{R^2}{4} + \frac{L^2}{12}\right)$. If such a cylinder is to be made for a given mass of a material, the ratio $\frac{L}{R}$ for it to have minimum possible I is: ***03 Sep 2020 (M)***

(1) $\frac{2}{3}$ (2) $\frac{3}{2}$

(3) $\sqrt{\frac{3}{2}}$ (4) $\sqrt{\frac{2}{3}}$

Q118. A block of mass $m = 1$ kg slides with velocity $v = 6\ m\ s^{-1}$ on a frictionless horizontal surface and collides with a uniform vertical rod and sticks to it as shown. The rod is pivoted about O and swings as a result of the collision making angle θ before momentarily coming to rest. if the rod has mass $M = 2$ kg, and length $\ell = 1$ m, the value of θ is approximately$\left(\text{take } g = 10\ m\ s^{-2}\right)$

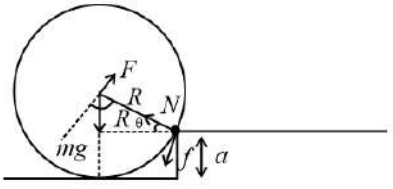


03 Sep 2020 (M)

(1) 63° (2) 55°

(3) 69° (4) 49°

Q119. A uniform cylinder of mass M and radius R is to be pulled over a step of height a $(a < R)$ by applying a force F at its centre 'O' perpendicular to the plane through the axes of the cylinder on the edge of the step (see figure). The minimum value of F required is :

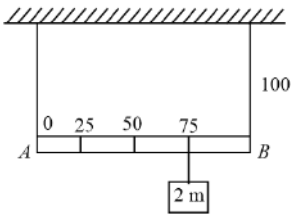


02 Sep 2020 (M)

(1) $\mathrm{Mg}\sqrt{1-\left(\frac{\mathrm{R-a}}{\mathrm{R}}\right)^2}$ (2) $\mathrm{Mg}\sqrt{\left(\frac{\mathrm{R}}{\mathrm{R-a}}\right)^2-1}$

(3) $\mathrm{Mg}\frac{\mathrm{a}}{\mathrm{R}}$ (4) $\mathrm{Mg}\sqrt{1-\frac{\mathrm{a}^2}{\mathrm{R}^2}}$

Q120. Shown in the figure is rigid and uniform one meter long rod AB held in horizontal position by two strings tied to its ends and attached to the ceiling. The rod is off mass 'm' and has another weight of mass 2 m hung at a distance of 75 cm from A. The tension in the string at A is:



02 Sep 2020 (M)

(1) $0.5\ mg$ (2) $2\ mg$

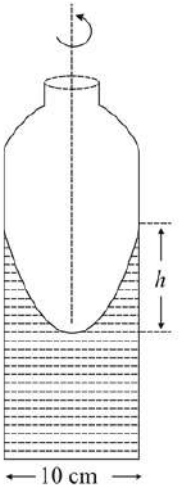
(3) $0.75\ mg$ (4) $1\ mg$

Q121. Two uniform circular discs are rotating independently in the same direction around their common axis passing through their centres. The moment of inertia and angular velocity of the first disc are $0.1\ \mathrm{kg-m^2}$ and 10 rad $\mathrm{s^{-1}}$ respectively while those for the second one are $0.2\ \mathrm{kg-m^2}$ and 5 rad s^{-1} respectively. At some instant they get stuck together and start rotating as a single system about their common axis with some angular speed. The kinetic energy of the combined system is : ***02 Sep 2020 (E)***

(1) $\frac{10}{3}$J (2) $\frac{20}{3}$J

(3) $\frac{5}{3}$J (4) $\frac{2}{3}$J

Q122. A cylindrical vessel containing a liquid is rotated about its axis so that the liquid rises at its sides as shown in the figure. The radius of vessel is 5 cm and the angular speed of rotation is ω rad $\mathrm{s^{-1}}$. The difference in the height, h (in cm) of liquid at the Centre of vessel and at the sides of the vessel will be :

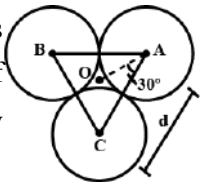


02 Sep 2020 (M)

(1) $\frac{2\omega^2}{25\mathrm{g}}$ (2) $\frac{5\omega^2}{2\mathrm{g}}$

(3) $\frac{25\omega^2}{2\mathrm{g}}$ (4) $\frac{2\omega^2}{5\mathrm{g}}$

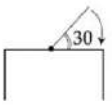
Q123. Three solid spheres each of mass m and diameter d are stuck together such that the lines connecting the centres form an equilateral triangle of side of length d. The ratio $\frac{I_0}{I_A}$ of moment of inertia I_0 of the system about an axis passing the centroid and about center of any of the spheres I_A and perpendicular to the plane of the triangle is:



09 Jan 2020 (M)

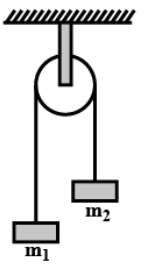
(1) $\frac{13}{23}$ (2) $\frac{15}{13}$
(3) $\frac{23}{13}$ (4) $\frac{13}{15}$

Q124. One end of a straight uniform $1m$ long bar is pivoted on horizontal table. It is released from rest when it makes an angle 30^o from the horizontal (see figure). Its angular speed when it hits the table is given as $\sqrt{n}\ rad\ s^{-1}$, where n is an integer. The value of n is _____



09 Jan 2020 (M)

Q125. A uniformly thick wheel with moment of inertia I and radius R is free to rotate about its centre of mass (see fig). A massless string is wrapped over its rim and two blocks of masses m_1 and $m_2(m_1 > m_2)$ are attached to the ends of the string. The system Is released from rest. The angular speed of the wheel when m_1 descends by a distance h is:



09 Jan 2020 (E)

(1) $\left[\frac{2(m_1-m_2)gh}{(m_1+m_2)R^2+I}\right]^{\frac{1}{2}}$ (2) $\left[\frac{2(m_1+m_2)gh}{(m_1+m_2)R^2+I}\right]^{\frac{1}{2}}$
(3) $\left[\frac{(m_1-m_2)}{(m_1+m_2)R^2+1}\right]^{\frac{1}{2}}gh$ (4) $\left[\frac{m_1+m_2}{(m_1+m_2)R^2+I}\right]^{\frac{1}{2}}gh$

Q126. A body A of mass m is moving in a circular orbit of radius R about a planet. Another body B of mass $\frac{m}{2}$ collides with A with a velocity which is half $\left(\frac{\vec{v}}{2}\right)$ the instantaneous velocity $\vec{v}$ of A. The collision is completely inelastic. Then, the combined body: ***09 Jan 2020 (M)***

(1) continues to move in a circular orbit
(2) Escapes from the Planet's Gravitational field
(3) Falls vertically downwards towards the planet
(4) starts moving in an elliptical orbit around the planet

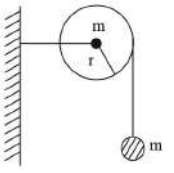
Q127. A uniform sphere of mass 500 g rolls without slipping on a plane horizontal surface with its centre moving at a speed of $5.00\ \text{cm s}^{-1}$. Its kinetic energy is: ***08 Jan 2020 (E)***

(1) $8.75 \times 10^{-4}\,\text{J}$ (2) $8.75 \times 10^{-3}\,\text{J}$
(3) $6.25 \times 10^{-4}\,\text{J}$ (4) $1.13 \times 10^{-3}\,\text{J}$

Q128. The radius of gyration of a uniform rod of length l, about an axis passing through a point $\frac{l}{4}$ away from the centre of the rod, and perpendicular to it, is: ***07 Jan 2020 (M)***

(1) $\frac{1}{4}l$ (2) $\frac{1}{8}l$
(3) $\sqrt{\frac{7}{48}}l$ (4) $\sqrt{\frac{3}{8}}l$

Q129. As shown in the figure, a bob of mass m is tied to a massless string whose other end portion is wound on a fly wheel (disc) of radius r and mass m. When released from rest the bob starts falling vertically. When it has covered a distance of h, the angular speed of the wheel will be:



07 Jan 2020 (M)

(1) $\frac{1}{\mathrm{r}}\sqrt{\frac{4\mathrm{gh}}{3}}$ (2) $\mathrm{r}\sqrt{\frac{3}{2\mathrm{gh}}}$

(3) $\frac{1}{\mathrm{r}}\sqrt{\frac{2\mathrm{gh}}{3}}$ (4) $\mathrm{r}\sqrt{\frac{3}{4\mathrm{gh}}}$

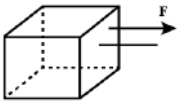
Q130. Mass per unit area of a circular disc of radius a depends on the distance r from its centre as $\sigma(r) = A + Br$. The moment of inertia of the disc about the axis, perpendicular to the plane and passing through its centre is:

07 Jan 2020 (E)

(1) $2\pi a^4\left(\frac{A}{4} + \frac{aB}{5}\right)$ (2) $2\pi a^4\left(\frac{aA}{4} + \frac{B}{5}\right)$

(3) $\pi a^4\left(\frac{A}{4} + \frac{aB}{5}\right)$ (4) $2\pi\mathrm{a}^4\left(\frac{\mathrm{A}}{4} + \frac{\mathrm{B}}{5}\right)$

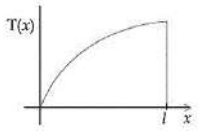
Q131. Consider a uniform cubical box of side a on a rough floor that is to be moved by applying minimum possible force F at a point b above its centre of mass (see figure). If the coefficient of friction is $\mu = 0.4$, the maximum possible value of $100 \times \frac{\mathrm{b}}{\mathrm{a}}$ for a box not to topple before moving is _____.

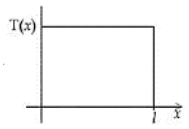


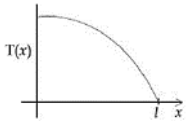
07 Jan 2020 (E)

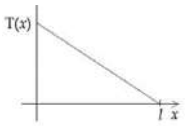
Q132. A uniform rod of length l is being rotated in a horizontal plane with a constant angular speed about an axis passing through one of its ends. If the tension generated in the rod due to rotation is $\mathrm{T}(x)$ at a distance x from the axis, then which of the following graphs depicts it most closely?

12 Apr 2019 (M)

(1) 

(2) 

(3) 

(4) 

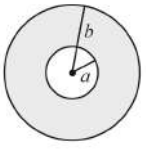
Q133. A person of mass M is sitting on a swing of length L and swinging with and an angular amplitude θ_0. If the person stands up when the swing passes through its lowest point, the work done by him, assuming that his centre of mass moves by a distance l $(l << L)$, is close to:

12 Apr 2019 (M)

(1) $Mgl\left(1 - \theta_0^2\right)$ (2) $Mgl\left(1 + \frac{\theta_0^2}{2}\right)$

(3) Mgl (4) $Mgl\left(1 + \theta_0^2\right)$

Q134. A circular disc of radius b has a hole of radius a at its centre(see figure). If the mass per unit area of the disc varies as $\left(\frac{\sigma_0}{r}\right)$ then, the radius of gyration of the disc about its axis passing through the center is

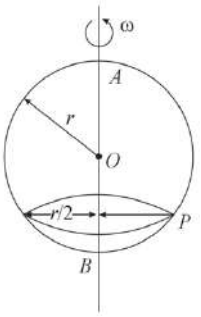


12 Apr 2019 (M)

(1) $\frac{a+b}{3}$ (2) $\sqrt{\frac{a^2+b^2+ab}{3}}$

(3) $\frac{a+b}{2}$ (4) $\sqrt{\frac{a^2+b^2+ab}{2}}$

Q135. A smooth wire of length $2\pi r$ is bent into a circle and kept in a vertical plane. A bead can slide smoothly on the wire. When the circle is rotating with angular speed ω about the vertical diameter AB, as shown in figure, the bead is at rest with respect to the circular ring at position P as shown. Then the value of ω^2 is equal to:



12 Apr 2019 (E)

(1) $2g/r$
(2) $\frac{\sqrt{3}g}{2r}$
(3) $2g/\left(r\sqrt{3}\right)$
(4) $\left(g\sqrt{3}\right)/r$

Q136. A thin disc of mass M and radius R has mass per unit area $\sigma(r) = kr^2$ where r is the distance from its centre. Its moment inertia about an axis going through its centre of mass and perpendicular to its plane is:

10 Apr 2019 (M)

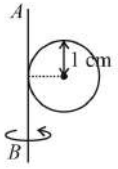
(1) $\frac{MR^2}{3}$
(2) $\frac{MR^2}{2}$
(3) $\frac{MR^2}{6}$
(4) $\frac{2MR^2}{3}$

Q137. A solid sphere of mass M and radius R is divided into two unequal parts. The first part has a mass of $\frac{7M}{8}$ and is converted into uniform disc of radius $2R$. The second part is converted into a uniform solid sphere. Let I_1 be the moment of inertia of the disc about its axis and I_2 be the moment of inertia of the new sphere about its axis. The ratio I_1/I_2 is given by:

10 Apr 2019 (E)

(1) 140
(2) 185
(3) 65
(4) 285

Q138. A metal coin of mass 5 g and radius 1 cm is fixed to a thin stick AB of negligible mass as shown in the figure. The system is initially at rest. The constant torque, that will make the system rotate about AB at 25 rotations per second in 5 s, is close to:



10 Apr 2019 (E)

(1) 1.6×10^{-5} N m
(2) 2.0×10^{-5} N m
(3) 7.9×10^{-6} N m
(4) 4.0×10^{-6} N m

Q139. Two coaxial discs, having moments of inertia I_1 and $\frac{I_1}{2}$, are rotating with respective angular velocities ω_1 and $\frac{\omega_1}{2}$, about their common axis. They are brought in contact with each other and thereafter they rotate with a common angular velocity. If E_f and E_i are the final and initial total energies, then $(E_f - E_i)$ is:

10 Apr 2019 (M)

(1) $\frac{I_1\omega_1^2}{6}$
(2) $\frac{3}{8}I_1\omega_1^2$
(3) $-\frac{I_1\omega_1^2}{12}$
(4) $-\frac{I_1\omega_1^2}{24}$

Q140. The time dependence of the position of a particle of mass $m = 2$ is given by $\vec{r}(t) = 2t\,\hat{i} - 3t^2\hat{j}$. Its angular momentum, with respect to the origin, at time $t = 2$ is:

10 Apr 2019 (E)

(1) $36\,\hat{k}$ (2) $48\left(\hat{i}+\hat{j}\right)$

(3) $-48\,\hat{k}$ (4) $-34\left(\hat{k}-\hat{i}\right)$

Q141. A particle of mass m is moving along a trajectory given by

$x = x_0 + a\cos\omega_1 t$

$y = y_0 + b\sin\omega_2 t$

The torque, acting on the particle about the origin, at $t = 0$ is: ***10 Apr 2019 (M)***

(1) $+my_0a\omega_1^2\hat{k}$ (2) $-m\left(x_0b\omega_2^2 - y_0a\omega_1^2\right)\hat{k}$

(3) Zero (4) $m(-x_0b + y_0a)\omega_1^2\hat{k}$

Q142. A stationary horizontal disc is free to rotate about its axis. When a torque is applied on it, its kinetic energy as a function of θ, where θ is the angle by which it has rotated, is given as $k\theta^2$. If its moment of inertia is I then the angular acceleration of the disc is: ***09 Apr 2019 (M)***

(1) $\frac{2k}{I}\theta$ (2) $\frac{k}{2I}\theta$

(3) $\frac{k}{4I}\theta$ (4) $\frac{k}{I}\theta$

Q143. Moment of inertia of a body about a given axis is 1.5 kg m^2. Initially the body is at rest. In order to produce a rotational kinetic energy of 1200 J, the angular acceleration of 20 rad/s^2 must be applied about the axis for a duration of: ***09 Apr 2019 (E)***

(1) 3 s (2) 2 s

(3) 2.5 s (4) 5 s

Q144. A thin smooth rod of length L and mass M is rotating freely with angular speed ω_0 about an axis perpendicular to the rod and passing through center. Two beads of mass m and negligible size are at the center of the rod initially. The beads of mass m and negligible size are at the center of the rod initially. The beads are free to slide along the rod. The angular speed of the system, when the beads reach the opposite ends of the rod, will be: ***09 Apr 2019 (E)***

(1) $\frac{M\omega_0}{M+3m}$ (2) $\frac{M\omega_0}{M+2m}$

(3) $\frac{M\omega_0}{M+6m}$ (4) $\frac{M\omega_0}{M+m}$

Q145. The following bodies are made to roll up (without slipping) the same inclined plane from a horizontal plane: (i) a ring of radius R, (ii) a solid cylinder of radius $\frac{R}{2}$ and (iii) a solid sphere of radius $\frac{R}{4}$. If, in each case, the speed of the center of mass at the bottom of the incline is same, the ratio of the maximum heights they climb is: ***09 Apr 2019 (M)***

(1) 2 : 3 : 4 (2) 20 : 15 : 14

(3) 4 : 3 : 2 (4) 14 : 15 : 20

Q146. A solid sphere and solid cylinder of identical radii approach an incline with the same linear velocity (see figure). Both roll without slipping all throughout. The two climb maximum heights h_{sph} and h_{cyl} on the inline. The ratio $\frac{h_{sph}}{h_{cyl}}$ is given by:

08 Apr 2019 (E)

(1) $\frac{2}{\sqrt{5}}$ (2) $\frac{4}{5}$

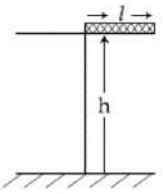
(3) $\frac{14}{15}$ (4) 1

Q147. A thin circular plate of mass M and radius R has its density varying as $\rho(r)=\rho_0 r$ with ρ_0 as constant and r is the distance from its centre. The moment of Inertia of the circular plate about an axis perpendicular to the plate and passing through its edge is $I = aMR^2$. The value of the coefficient a is: ***08 Apr 2019 (M)***

(1) $\frac{3}{5}$ (2) $\frac{1}{2}$

(3) $\frac{8}{5}$ (4) $\frac{3}{2}$

Q148. A rectangular solid box of length 0.3 m is held horizontally, with one of its sides on the edge of a platform of height 5 m . When released, it slips off the table in a very short time $\tau = 0.01$ s , remaining essentially horizontal. The angle by which it would rotate when it hits the ground will be (in radians) close to:



08 Apr 2019 (E)

(1) 0.5 (2) 0.3

(3) 0.02 (4) 0.28

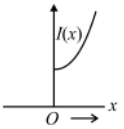
Q149. Let the moment of inertia of a hollow cylinder of length 30 cm (inner radius 10 cm and outer radius 20 cm), about its axis be I . The radius of a thin cylinder of the same mass such that its moment of inertia about its axis is also I, is: ***12 Jan 2019 (M)***

(1) 16 cm (2) 14 cm

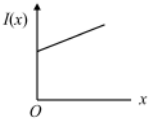
(3) 12 cm (4) 18 cm

Q150. The moment of inertial of a solid sphere, about an axis parallel to its diameter and at a distance of x from it, is $I(x)'$. Which one of the graphs represents the variation of $I(x)$ with x correctly? ***12 Jan 2019 (E)***

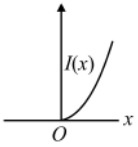
(1)



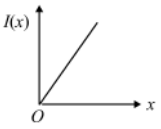
(2)



(3)



(4)



Q151. A long cylindrical vessel is half filled with a liquid. When the vessel is rotated about its own vertical axis, the liquid rises up near the wall. If the radius of vessel is 5 cm and its rotational speed is 2 rotations per second, then the difference in the heights between the center and the sides, in cm, will be: ***12 Jan 2019 (E)***

(1) 0.4 (2) 2.0

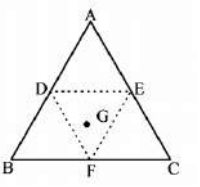
(3) 1.2 (4) 0.1

Q152. The magnitude of torque on a particle of mass 1 kg is 2.5 Nm about the origin. If the force acting on it is 1 N, and the distance of the particle from the origin is 5 m, the angle between the force and the position vector is (in radians): ***11 Jan 2019 (E)***

(1) $\frac{\pi}{6}$ (2) $\frac{\pi}{3}$

(3) $\frac{\pi}{8}$ (4) $\frac{\pi}{4}$

Q153. An equilateral triangle ABC is cut from a thin solid sheet of wood. (See figure) D, E and F are the mid-points of its sides as shown and G is the centre of the triangle. The moment of inertia of the triangle about an axis passing through G and perpendicular to the plane of the triangle is I_0. If the smaller triangle DEF is removed from ABC, the moment of inertia of the remaining figure about the same axis is I. Then

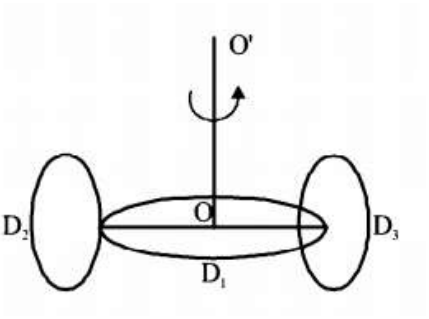


11 Jan 2019 (M)

(1) $I = \frac{15}{16} I_0$ (2) $I = \frac{3}{4} I_0$

(3) $I = \frac{9}{16} I_0$ (4) $I = \frac{I_0}{4}$

Q154. A circular disc D_1 of mass M and radius R has two identical discs D_2 and D_3 of the same mass M and radius R attached rigidly at its opposite ends (see figure). The moment of inertia of the system about the axis OO', passing through the centre of D_1, as shown in the figure, will be

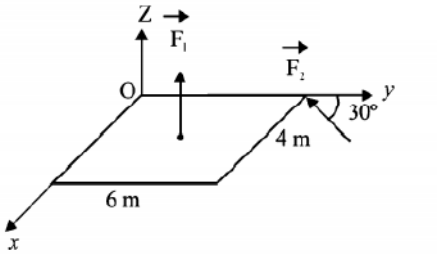


11 Jan 2019 (E)

(1) MR^2 (2) $3MR^2$

(3) $\frac{4}{5} MR^2$ (4) $\frac{2}{3} MR^2$

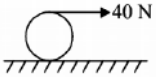
Q155. A slab is subjected to two forces $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ of same magnitude F as shown in the figure. Force $\overrightarrow{F_2}$ is in XY-plane while force F_1 acts along z -axis at the point $(2\hat{i} + 3\hat{j})$. The moment of these forces about point O will be:



11 Jan 2019 (M)

(1) $(3\hat{i} - 2\hat{j} + 3\hat{k})$ F (2) $(3\hat{i} - 2\hat{j} - 3\hat{k})$F (3) $(3\hat{i} + 2\hat{j} - 3\hat{k})$F (4) $(3\hat{i} + 2\hat{j} + 3\hat{k})$F

Q156. A string is wound around a hollow cylinder of mass 5 kg and radius 0.5 m. If the string is now pulled with a horizontal force of 40 N, and the cylinder is rolling without slipping on a horizontal surface (see figure), then the angular acceleration of the cylinder will be (Neglect the mass and thickness of the string)

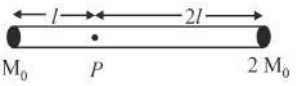


11 Jan 2019 (E)

(1) 20rad/s^2 (2) 16rad/s^2

(3) 12rad/s^2 (4) 10rad/s^2

Q157. A rigid massless rod of length $3l$ has two masses attached at each end as shown in the figure. The rod is pivoted at point P on the horizontal axis. When released from the initial horizontal position, its instantaneous angular acceleration will be



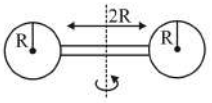
10 Jan 2019 (E)

(1) $\frac{g}{2l}$ (2) $\frac{7g}{3l}$
(3) $\frac{g}{3l}$ (4) $\frac{g}{13l}$

Q158. A homogeneous solid cylindrical roller of radius R and mass M is pulled on a cricket pitch by a horizontal force. Assuming rolling without slipping, angular acceleration of the cylinder is: ***10 Jan 2019 (M)***

(1) $\frac{F}{3\,mR}$ (2) $\frac{3F}{2\,m\,R}$
(3) $\frac{2F}{3\,m\,R}$ (4) $\frac{F}{2\,m\,R}$

Q159. Two identical spherical balls of mass M and radius R each are stuck on two ends of a rod of length $2R$ and mass M(see figure). The moment of inertia of the system about the axis passing perpendicularly through the centre of the rod is



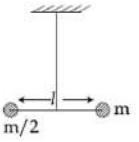
10 Jan 2019 (E)

(1) $\frac{209}{15}MR^2$. (2) $\frac{152}{15}MR^2$.
(3) $\frac{137}{15}MR^2$. (4) $\frac{17}{5}MR^2$.

Q160. To mop-clean a floor, a cleaning machine presses a circular mop of radius R vertically down with a total force F and rotates it with a constant angular speed about its axis. If the force F is distributed uniformly over the mop and if coefficient of friction between the mop and the floor is μ, the torque, applied by the machine on the mop is: ***10 Jan 2019 (M)***

(1) $2\,\mu FR/3$ (2) $\mu FR/3$
(3) $\mu FR/6$ (4) $\mu FR/2$

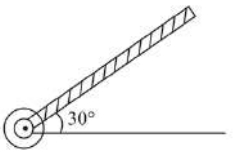
Q161. Two masses m and $\frac{m}{2}$ are connected at the two ends of a massless rigid rod of length l. The rod is suspended by a thin wire of torsional constant k at the centre of mass of the rod-mass system (see figure). Because of torsional constant k, the restoring torque is $\tau = k\theta$ for angular displacement θ. If the rod is rotated by θ_0 and released, the tension in it when it passes through its mean position will be:



09 Jan 2019 (M)

(1) $k\theta_0^2$ (2) $\frac{3k{\theta_0}^2}{l}$
(3) $\frac{2k{\theta_0}^2}{l}$ (4) $\frac{k{\theta_0}^2}{l}$

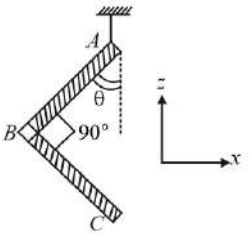
Q162. A rod of length 50 cm is pivoted at one end. It is raised such that it makes an angle of 30^o from the horizontal as shown and released from rest. Its angular speed when it passes through the horizontal (in $rad\ s^{-1}$) will be $\left(g = 10\ ms^{-2}\right)$



09 Jan 2019 (E)

(1) $\frac{\sqrt{20}}{3}$ (2) $\sqrt{30}$
(3) $\sqrt{\frac{30}{2}}$ (4) $\frac{\sqrt{30}}{2}$

Q163. An L -shaped object, made of thin rods of uniform mass density, is suspended with a string as shown in figure. If $AB = BC$, and the angle made by AB with downward vertical is θ, then:



09 Jan 2019 (M)

(1) $\tan\theta = \frac{2}{\sqrt{3}}$

(2) $\tan\theta = \frac{1}{3}$

(3) $\tan\theta = \frac{1}{2}$

(4) $\tan\theta = \frac{1}{2\sqrt{3}}$

ANSWER KEYS

1. (2)	**2.** (100)	**3.** (3)	**4.** (3)	**5.** (4)	**6.** (13)	**7.** (4)	**8.** (2)
9. (7)	**10.** (2)	**11.** (3)	**12.** (53)	**13.** (8)	**14.** (24)	**15.** (250)	**16.** (60)
17. (10)	**18.** (7)	**19.** (16)	**20.** (3)	**21.** (5)	**22.** (15)	**23.** (4)	**24.** (2)
25. (35)	**26.** (3)	**27.** (3)	**28.** (1)	**29.** (75)	**30.** (176)	**31.** (5)	**32.** (3)
33. (2)	**34.** (10)	**35.** (5)	**36.** (3)	**37.** (54)	**38.** (40)	**39.** (17)	**40.** (5)
41. (3)	**42.** (110)	**43.** (32)	**44.** (3)	**45.** (3)	**46.** (18)	**47.** (120)	**48.** (5)
49. (5)	**50.** (4)	**51.** (8)	**52.** (3)	**53.** (10)	**54.** (91)	**55.** (1)	**56.** (3)
57. (3)	**58.** (3)	**59.** (1)	**60.** (5)	**61.** (6)	**62.** (2)	**63.** (6)	**64.** (3)
65. (2)	**66.** (3)	**67.** (2)	**68.** (2)	**69.** (3)	**70.** (52)	**71.** (1)	**72.** (4)
73. (3)	**74.** (9)	**75.** (2)	**76.** (4)	**77.** (4)	**78.** (10)	**79.** (2)	**80.** (1)
81. (2)	**82.** (200)	**83.** (2)	**84.** (3)	**85.** (3)	**86.** (3)	**87.** (3)	**88.** (4)
89. (1)	**90.** (728)	**91.** (4)	**92.** (3)	**93.** (3)	**94.** (3)	**95.** (20)	**96.** (30)
97. (3)	**98.** (20)	**99.** (3)	**100.** (1)	**101.** (2)	**102.** (3)	**103.** (8)	**104.** (2)
105. (1)	**106.** (3)	**107.** (1)	**108.** (195)	**109.** (4)	**110.** (3)	**111.** (11)	**112.** (2)
113. (20)	**114.** (25)	**115.** (4)	**116.** (9)	**117.** (3)	**118.** (1)	**119.** (1)	**120.** (4)
121. (2)	**122.** (3)	**123.** (1)	**124.** (15)	**125.** (1)	**126.** (4)	**127.** (1)	**128.** (3)
129. (1)	**130.** (1)	**131.** (50)	**132.** (3)	**133.** (4)	**134.** (2)	**135.** (3)	**136.** (4)
137. (1)	**138.** (2)	**139.** (4)	**140.** (3)	**141.** (1)	**142.** (1)	**143.** (2)	**144.** (3)
145. (2)	**146.** (3)	**147.** (3)	**148.** (1)	**149.** (1)	**150.** (1)	**151.** (2)	**152.** (1)
153. (1)	**154.** (2)	**155.** (1)	**156.** (2)	**157.** (4)	**158.** (3)	**159.** (3)	**160.** (1)
161. (4)	**162.** (2)	**163.** (2)					