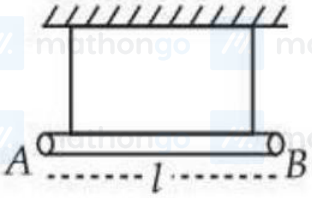
**Q1. 21 January Shift 1**

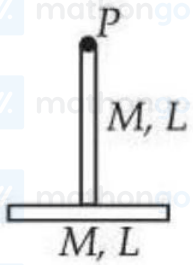
A uniform rod of mass $m$ and length $l$ suspended by means of two identical inextensible light strings as shown in figure. Tension in one string immediately after the other string is cut, is ____. ($g$ acceleration due to gravity)




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

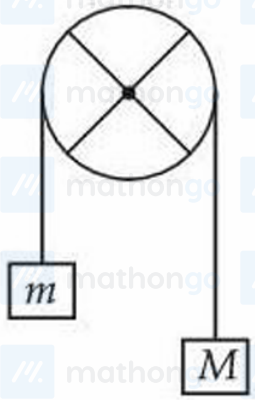
**Q2. 21 January Shift 1**

Two identical thin rods of mass $M$ kg and length $L$ m are connected as shown in figure. Moment of inertia of the combined rod system about an axis passing through point $P$ and perpendicular to the plane of the rods is $\frac{x}{12}ML^2$ kg m$^2$. The value of $x$ is ____.




**Q3. 21 January Shift 2**

The pulley shown in figure is made using a thin rim and two rods of length equal to diameter of the rim. The rim and each rod have a mass of $M$. Two blocks of mass of $M$ and $m$ are attached to two ends of a light string passing over the pulley, which is hinged to rotate freely in vertical plane about its center. The magnitudes of the acceleration experienced by the blocks is ____ (assume no slipping of string on pulley).




(1) $\frac{(M-m)g}{[(\frac{13}{6})M+m]}$ (2) $\frac{(M-m)g}{[(\frac{8}{3})M+m]}$ (3) $\frac{(M-m)g}{2M+m}$ (4) $\frac{(M-m)g}{M+m}$

**Q4. 21 January Shift 2**

Two cars $A$ and $B$ each of mass $10^3$ kg are moving on parallel tracks separated by a distance of 10 m, in same direction with speeds 72 km/h and 36 km/h. The magnitude of angular momentum of car $A$ with respect to car $B$ is ____ J.s.

(1) $2 \times 10^5$ (2) $10^5$ (3) $3.6 \times 10^5$ (4) $3 \times 10^5$

**Q5. 22 January Shift 1**

A solid sphere of mass 5 kg and radius 10 cm is kept in contact with another solid sphere of mass 10 kg and radius 20 cm. The moment of inertia of this pair of spheres about the tangent passing through the point of contact is ____ kg. $m^2$.

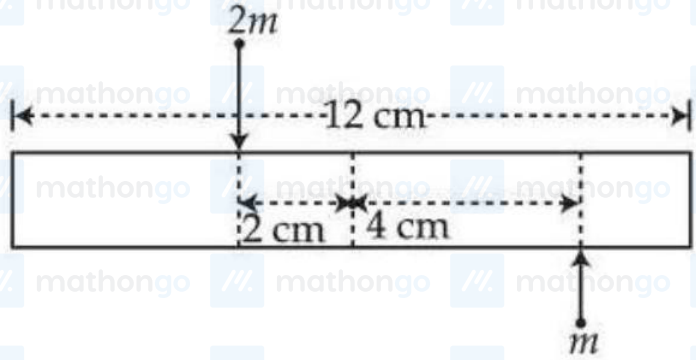
(1) 0.72 (2) 0.36 (3) 0.18 (4) 0.63

**Q6. 22 January Shift 1**

A circular disc has radius $R_1$ and thickness $T_1$. Another circular disc made of the same material has radius $R_2$ and thickness $T_2$. If the moment of inertia of both discs are same and $\frac{R_1}{R_2} = 2$ then $\frac{T_1}{T_2} = \frac{1}{\alpha}$. The value of $\alpha$ is ____.

**Q7. 22 January Shift 2**

A uniform bar of length 12 cm and mass $20m$ lies on a smooth horizontal table. Two point masses $m$ and $2m$ are moving in opposite directions with same speed of $v$ and in the same plane as the bar, as shown in figure. These masses strike the bar simultaneously and get stuck to it. After collision the entire system is rotating with angular frequency $\omega$. The ratio of $v$ and $\omega$ is :




(1) 66 (2) 33 (3) 32 (4) $2\sqrt{88}$

**Q8. 22 January Shift 2**

Two masses $m$ and 2 m are connected by a light string going over a pulley (disc) of mass 30 m with radius $r = 0.1$ m. The pulley is mounted in a vertical plane and it is free to rotate about its axis. The 2 m mass is released from rest and its speed when it has descended through a height of 3.6 m is ____ m/s. (Assume string does not slip and g = 10 m/$s^2$)

**Q9. 23 January Shift 1**

Two small balls with masses $m$ and 2 m are attached to both ends of a rigid rod of length $d$ and negligible mass. If angular momentum of this system is $L$ about an axis ($A$) passing through its centre of mass and perpendicular to the rod then angular velocity of the system about $A$ is :

(1) $\frac{2L}{5md^2}$ (2) $\frac{4}{3}\frac{L}{md^2}$ (3) $\frac{3}{2}\frac{L}{md^2}$ (4) $\frac{2L}{md^2}$

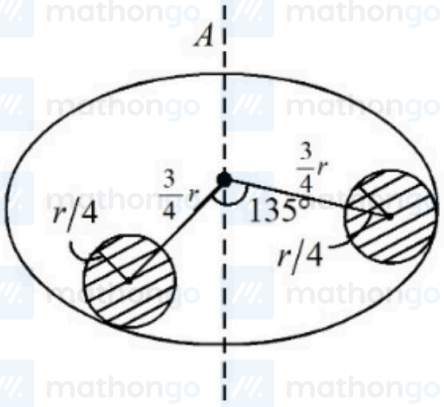
**Q10. 23 January Shift 1**

The moment of inertia of a square loop made of four uniform solid cylinders, each having radius $R$ and length $L(\mathrm{R} < \mathrm{L})$ about an axis passing through the mid points of opposite sides, is (Take the mass of the entire loop as $M$) :

(1) $\frac{3}{4}MR^2 + \frac{7}{12}ML^2$ (2) $\frac{3}{8}MR^2 + \frac{1}{6}ML^2$
(3) $\frac{3}{4}MR^2 + \frac{1}{6}ML^2$ (4) $\frac{3}{8}MR^2 + \frac{7}{12}ML^2$

**Q11. 23 January Shift 2**

Suppose there is a uniform circular disc of mass $M$ kg and radius $r$ m shown in figure. The shaded regions are cut out from the disc. The moment of inertia of the remainder about the axis $A$ of the disc is given by $\frac{x}{256}Mr^2$. The




value of $x$ is ____.

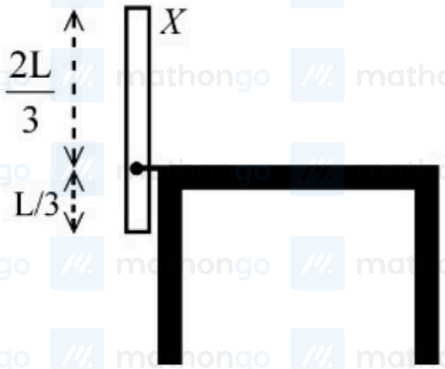
**Q12. 24 January Shift 1**

Two masses 400 g and 350 g are suspended from the ends of a light string passing over a heavy pulley of radius 2 cm. When released from rest the heavier mass is observed to fall 81 cm in 9 s. The rotational inertia of the pulley is ____ $\mathrm{kg \cdot m^2}$. $\left(\mathrm{g} = 9.8\ \mathrm{m/s^2}\right)$

(1) $4.75 \times 10^{-3}$ (2) $9.5 \times 10^{-3}$ (3) $1.86 \times 10^{-2}$ (4) $8.3 \times 10^{-3}$

**Q13. 24 January Shift 2**

A thin uniform rod $(X)$ of mass $M$ and length $L$ is pivoted at a height $\left(\frac{L}{3}\right)$ as shown in the figure. The rod is allowed to fall from a vertical position and lie horizontally on the table. The angular velocity of this rod when it hits




the table top, is ____. (g = gravitational acceleration)

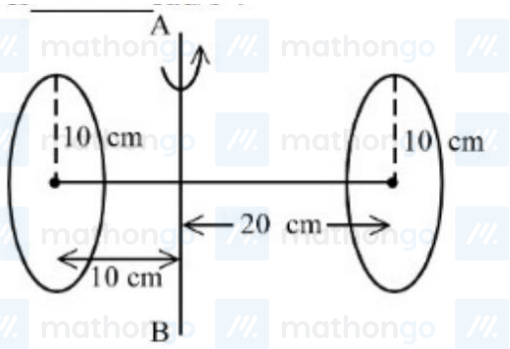
(1) $\frac{3}{\sqrt{2}}\sqrt{\frac{g}{L}}$ (2) $\frac{1}{\sqrt{2}}\sqrt{\frac{g}{L}}$ (3) $\sqrt{\frac{3}{2}\frac{g}{L}}$ (4) $\sqrt{\frac{3g}{L}}$

**Q14. 24 January Shift 2**

A uniform solid cylinder of length $L$ and radius $R$ has moment of inertia about its axis equal to $I_1$. A small co-centric cylinder of length $L/2$ and radius $R/3$ carved from this cylinder has moment of inertia about its axis equals to $I_2$. The ratio $I_1/I_2$ is ____.

**Q15. 28 January Shift 1**

Two circular discs of radius each 10 cm are joined at their centres by a rod of length 30 cm and mass 600 gm as shown in figure. If the mass of each disc is 600 gm and applied torque between two discs is $43 \times 10^5$ dyne. cm, the angular acceleration of the discs about the given axis $AB$ is ____ $\text{rad/s}^2$.




(1) 11 (2) 22 (3) 100 (4) 27

**Q16. 28 January Shift 1**

A solid sphere of radius 10 cm is rotating about an axis which is at a distance 15 cm from its centre. The radius of gyration about this axis is $\sqrt{n}$ cm. The value of $n$ is

**Q17. 28 January Shift 2**

When the position vector $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ changes sign as $-\vec{r}$, which one of the following vector will not flip under sign change ?

(1) Angular momentum
(2) Velocity
(3) Acceleration
(4) Linear momentum

**Q18. 28 January Shift 2**

A fly wheel having mass 3 kg and radius 5 m is free to rotate about a horizontal axis. A string having negligible mass is wound around the wheel and the loose end of the string is connected to 3 kg mass. The mass is kept at rest initially and released. Kinetic energy of the wheel when the mass descends by 3 m is ____ J. $\left(g = 10\ m/s^2\right)$

## ANSWER KEYS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1.** (1) | **2.** 17 | **3.** (2) | **4.** (2) | **5.** (4) | **6.** 16 | **7.** (2) | **8.** 2 |
| **9.** (3) | **10.** (2) | **11.** 109 | **12.** (2) | **13.** (4) | **14.** 162 | **15.** (1) | **16.** 265 |
| **17.** (1) | **18.** 30 | | | | | | |