DPP – 2

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/81

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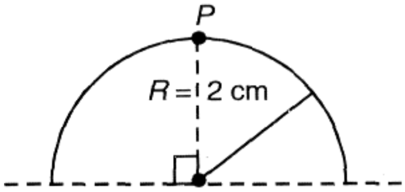
Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/18

Q 1. Moment of inertia of semicircular ring of mass 22/7 kg and radius 2 cm about the axis passing through point P and perpendicular to its plane is



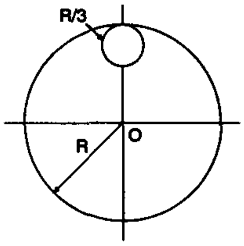
(a) 20.2×10^{-4} kgm^2
(b) 9.12×10^{-4} kgm^2
(c) 30.21×10^{-4} kgm^2
(d) 32.12×10^{-4} kgm^2

Q 2. Two rings of same radius (r) and mass (m) are placed such that their centres are at a common point and their planes are perpendicular to each other. The moment of inertia of the system about an axis passing through the centre and perpendicular to plane of one of the ring is:
(a) $\frac{1}{2}mr^2$ (b) mr^2 (c) $\frac{3}{2}mr^2$ (d) $2mr^2$

Q 3. A uniform thin bar of mass 6m and length 12 L is bent to make a regular hexagon. Its moment of inertia about an axis passing through the centre of mass and perpendicular to the plane of hexagon is:
(a) 20 mL^2 (b) 6 mL^2 (c) $\frac{12}{5}mL^2$ (d) 30 mL^2

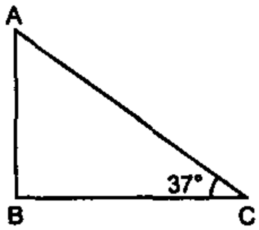
Q 4. Locus of all the points in a plane (axis is passing through points on locus and perpendicular to plane) about which the moment of inertia of a rigid body is same throughout is :
(a) a straight line (b) a circle
(c) a parabola (d) an ellipse

Q 5. From a circular disc of radius R and mass 9M, a small disc of radius $\frac{R}{3}$ is removed from the disc. The moment of inertia of the remaining disc about an axis perpendicular to the plane of the disc and passing through O is:



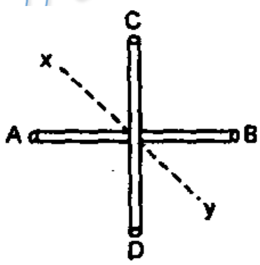
(a) 4 MR^2 (b) $\frac{40}{9}$ MR^2 (c) 10 MR^2 (d) $\frac{37}{9}$ MR^2

Q 6. ABC is a right angled triangular plate of uniform thickness. I_1, I_2 and I_2 are moments of inertia about AB, BC and AC respectively. Then which of the following relation is correct:



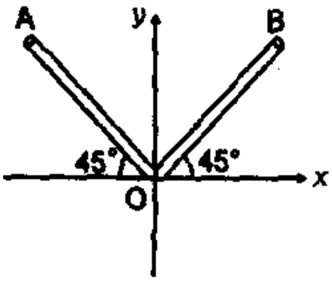
(a) $I_1 = I_2 = I_3$
(b) $I_2 > I_1 > I_3$
(c) $I_3 < I_2 < I_1$
(d) $I_3 > I_1 > I_2$

Q 7. AB and CD are two identical rods each of length l and mass m joined to form a cross. The moment of inertia of these two rods about a bisector of the angle between the rods (xy) is:



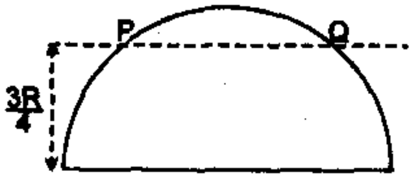
(a) $\frac{ml^2}{6}$ (b) $\frac{ml^2}{3}$ (c) $\frac{ml^2}{12}$ (d) $\frac{2ml^2}{3}$

Q 8. Two rods OA and OB of equal length and mass are lying on y plane as shown in figure. Let Ix, Iy and Iz. be the moment of inertias of both the rods about x, y and z axis respectively.
Then:



(a) $I_x = I_y > I_z$
(b) $I_x = I_y < I_z$
(c) $I_x > I_y > I_z$
(d) $I_z > I_y > I_x$

Q 9. The radius of gyration of a solid hemisphere of mass M and radius It about an axis parallel to the diameter at a distance $\frac{3}{4}$R from this plane is given by (cenue of mass of the hemisphere lies at a height 3R/8 from the base):



(a) $\frac{3R}{\sqrt{10}}$ (b) $\frac{5R}{4}$ (c) $\frac{5R}{8}$ (d) $\sqrt{\frac{2}{5}}R$

Q 10. A uniform disc of radius It lies in x-y plane with its centre at origin. Its moment of Inertia about z-axis is equal to its moment of inertia about line y = x + c. The value of c is:

(a) $R/\sqrt{2}$ (b) – R/2 (c) + R/4 (d) – R

Q 11. Let I be the moment of inertia of a uniform square plate about an axis AB that passes through its centre and is parallel to two of its sides. CD is a line in the plane of the plate that passes through the centre of the plate and makes an angle θ with AB. The moment of inertia of the plate about the axis CD is then equal to:

(a) I (b) $I \sin^2 \theta$
(c) $I \cos^2 \theta$ (d) $I\cos^2 (\theta/2)$

Q 12. Four rods of equal length *l* and mass in each from a square as shown in figure. Moment of inertia about three axes 1, 2 and 3 are say I_1, I_2 and I_3. Then, match the following:

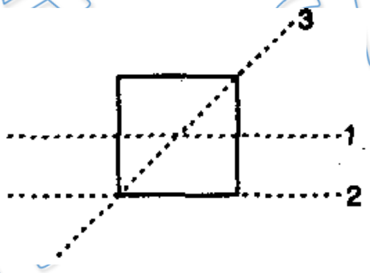


Table-1		Table-2	
(A)	I_1	(P)	$\frac{4}{3}ml^2$
(B)	I_2	(Q)	$\frac{2}{3}ml^2$
(C)	I_3	(R)	$\frac{1}{2}ml^2$
		(S)	**None**

Q 13. A semi-circular ring has mass m and radius R as shown in figure. Let I_1, I_2, I_3 and I_4 be the moments of inertias of the four axes as shown. Axis 1 passes through centre and is perpendicular to plane of ring. Then, match the following:

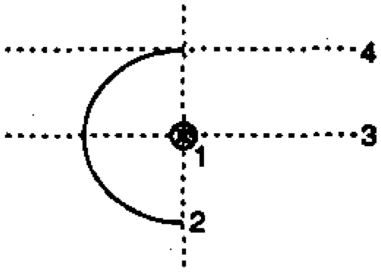
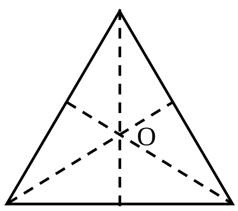


Table-1		**Table-2**	
(A)	I_1	(P)	$\frac{mR^2}{2}$
(B)	I_2	(Q)	$\frac{3}{2}mR^2$
(C)	I_3	(R)	mR^2
(D)	I_4	(S)	Data is insufficient

Q 14. Four identical rods, each of mass m and length l, are joined to form a rigid square frame. The frame lies in the xy plane, with its centre at the origin and the sides parallel to the x and y axes. Its moment of inertia about
(a) the x-axis is 2/3 ml^2
(b) the z - axis is 4/3 m l^2
(c) axis parallel to the z-axis and passing through a corner is 10/3ml^2
(d) one side is 5/2m l^2

Q 15. The moment of inertia of a solid cylinder of mass M, length L and radius R about the diameter of one of its faces will be
(a) $M\left(\frac{L^2}{12}+\frac{R^2}{4}\right)$ (b) $M\left(\frac{L^2}{3}+\frac{R^2}{4}\right)$
(c) zero (d) $\frac{MR^2}{2}$

Q 16. A rod of mass M kg and length L metre is bent in the form of an equilateral triangle as shown in the figure. The moment of inertia of triangle about a vertical axis to perpendicular to the plane of triangle and passing through the centre (in units of kg-m^2) is–

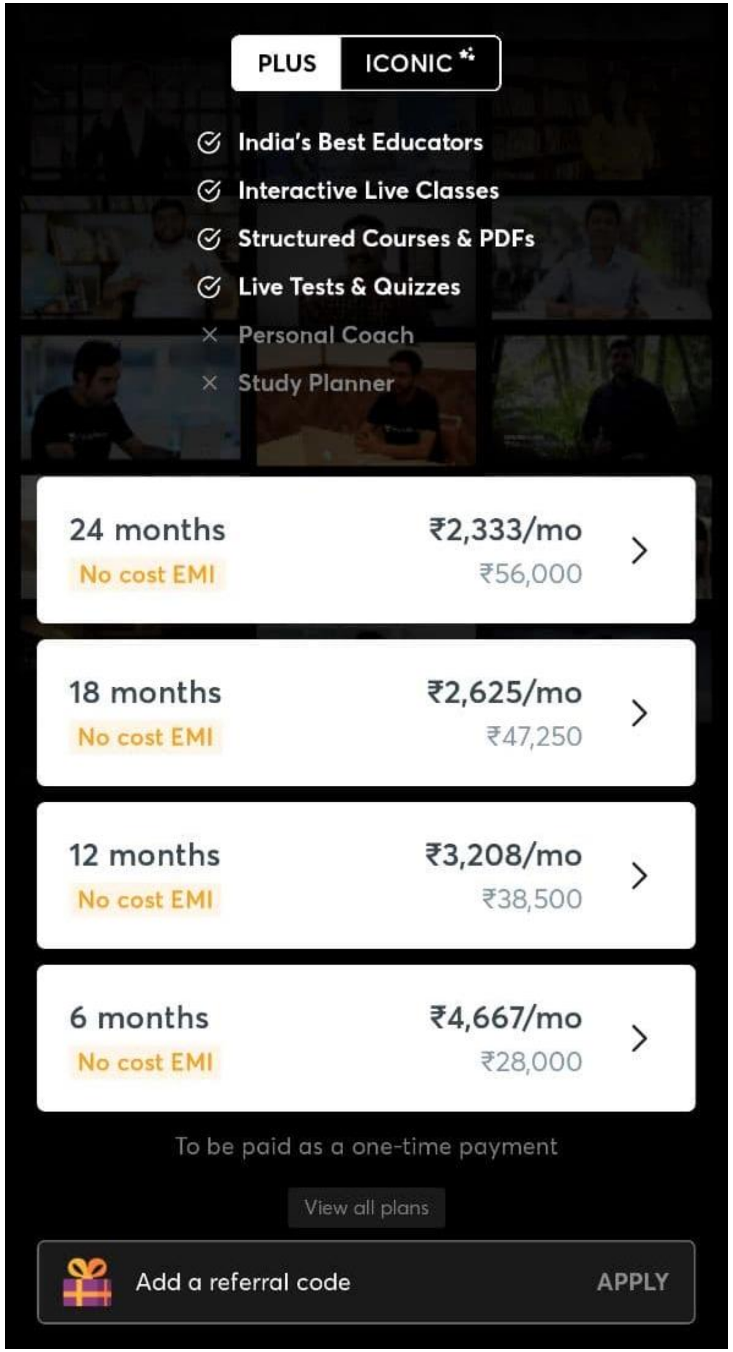


(a) $(ML^2)/12$ (b) $(ML^2)/54$
(c) $(ML^2)/162$ (d) $(ML^2)/108$

Answer Key

Q.1 b	Q.2 c	Q.3 a	Q.4 b	Q.5 a
Q.6 c	Q.7 c	Q.8 b	Q.9 d	Q.10 a
Q.11 a	Q.14 a, b, c	Q.15 b	Q.16 b	

Ans.12 (A) Q, (B) S, (C) Q
Ans.13 (A) R, (B) P, (C) P, (D) Q



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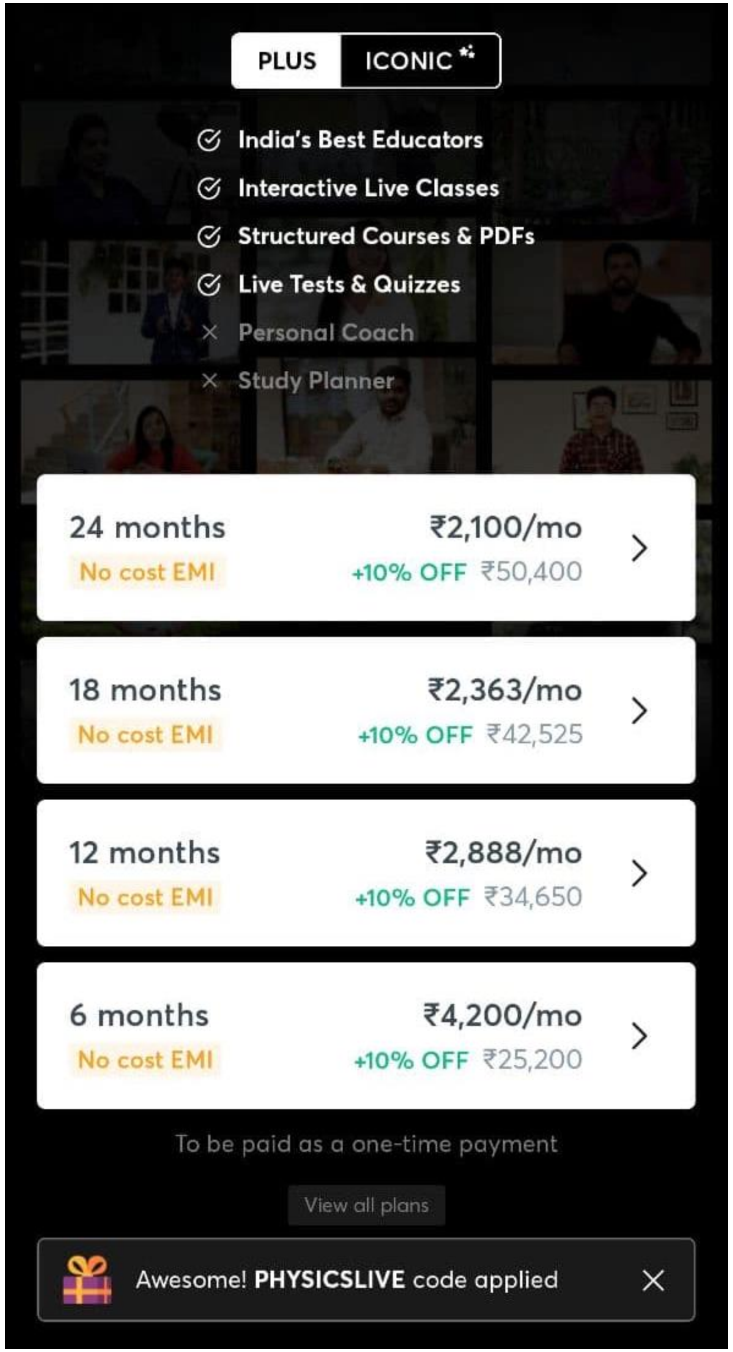


Written Solution

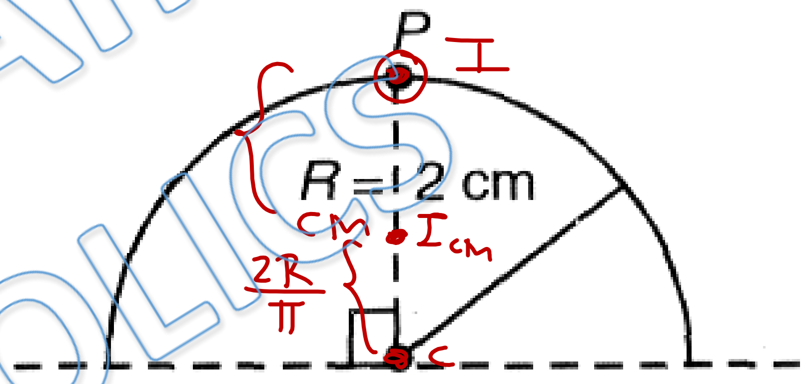
JEE Main & Advanced, NSEP, INPhO, IPhO

Physics DPP

DPP- 2 Rotation: Moment of Inertia

By Physicsaholics Team

Q1) Moment of inertia of semicircular ring of mass 22/7 kg and radius 2 cm about the axis passing through point P and perpendicular to its plane is



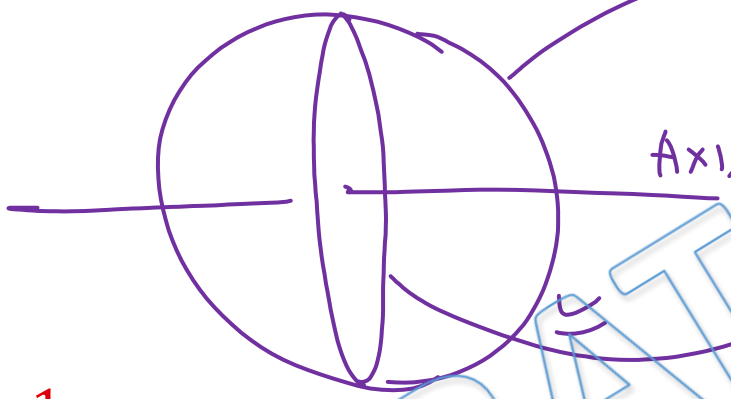
(a) 20.2×10^{-4} kgm^2

(b) 9.12×10^{-4} kgm^2

(c) 30.21×10^{-4} kgm^2

(d) 32.12×10^{-4} kgm^2

Q2) Two rings of same radius (r) and mass (m) are placed such that their centres are at a common point and their planes are perpendicular to each other. The moment of inertia of the system about an axis passing through the centre and perpendicular to plane of one of the ring is:

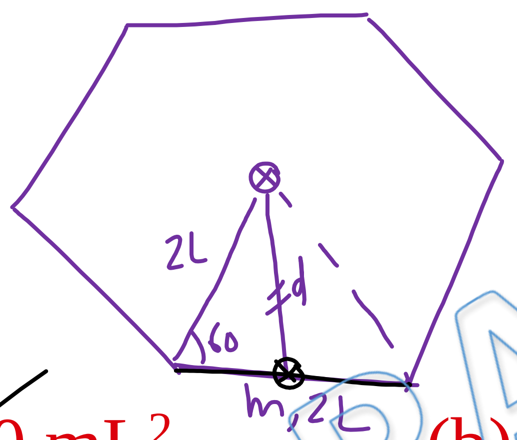


$I = mr^2 + \frac{mr^2}{2}$

$= \frac{3mr^2}{2}$

(a) $\frac{1}{2}mr^2$ (b) mr^2 (c) $\frac{3}{2}mr^2$ (d) $2mr^2$

Q3) A uniform thin bar of mass 6m and length 12 L is bent to make a regular hexagon. Its moment of inertia about an axis passing through the centre of mass and perpendicular to the plane of hexagon is:



$$I = \left[\frac{m(2L)^2}{12} + m(3L^2)\right]6$$

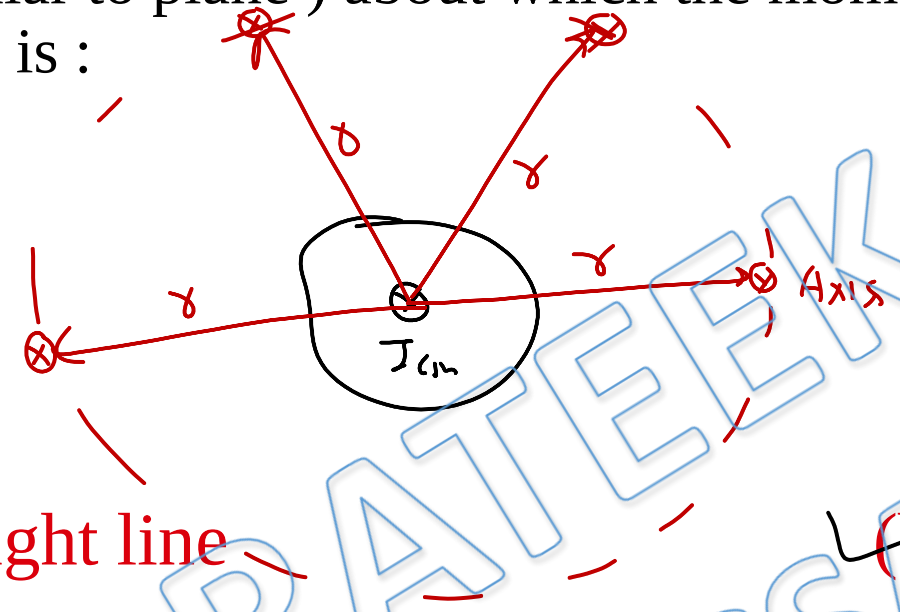
$$= 2mL^2 + 18mL^2$$

$$= 20mL^2$$

(a) 20 mL^2 ✓ (b) 6 mL^2 (c) $\frac{12}{5}$mL^2 (d) 30 mL^2

$d = 2L\sin 60 = L\sqrt{3}$

Q4) Locus of all the points in a plane (axis is passing through points on locus and perpendicular to plane) about which the moment of inertia of a rigid body is same throughout is :



(a) a straight line

(b) a circle

(c) a parabola

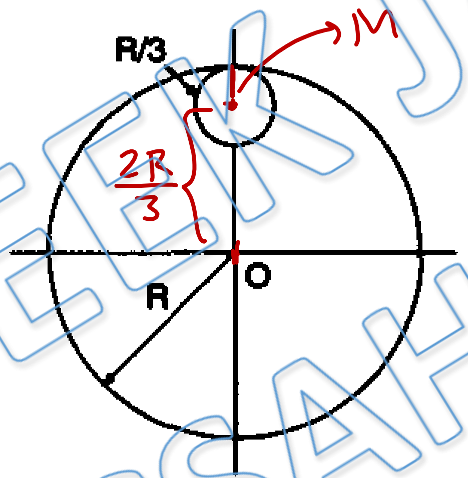
(d) an ellipse

$I = I_{cm} + mr^2$

Q5) From a circular disc of radius R and mass 9M, a small disc of radius $\frac{R}{3}$ is removed from the disc. The moment of inertia of the remaining disc about an axis perpendicular to the plane of the disc and passing through O is:

πR^2 ——— $9M$

$\frac{\pi R^2}{9}$ ——— M



$I = I_{complete} - I_{removed}$

$= \frac{9MR^2}{2} - \left[\frac{M(R/3)^2}{2} + M\left(\frac{2R}{3}\right)^2\right]$

$= \frac{9}{2}MR^2 - \left[\frac{MR^2}{18} + \frac{4MR^2}{9}\right]$

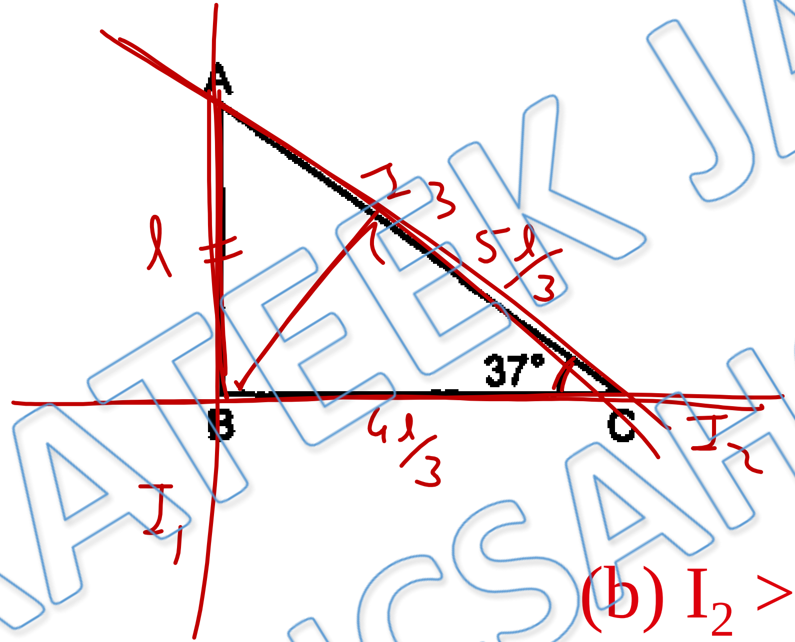
(a) $4\ MR^2$ (b) $\frac{40}{9}\ MR^2$ (c) $10\ MR^2$ (d) $\frac{37}{9}\ MR^2$

$I = \frac{9}{2}MR^2 - \frac{MR^2}{2}$

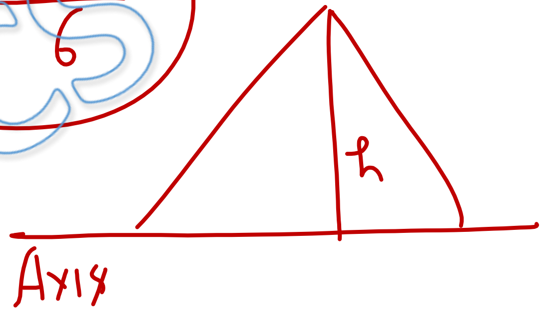
$= 4MR^2$

Q6) ABC is a right angled triangular plate of uniform thickness. I_1, I_2 and I_2 are moments of inertia about AB, BC and AC respectively. Then which of the following relation is correct:

$I_1 > I_2 > I_3$



$I = \frac{mh^2}{6}$



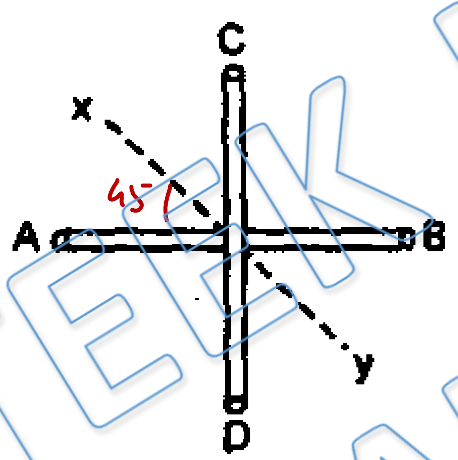
(a) $I_1 = I_2 = I_3$

(b) $I_2 > I_1 > I_3$

(c) $I_3 < I_2 < I_1$

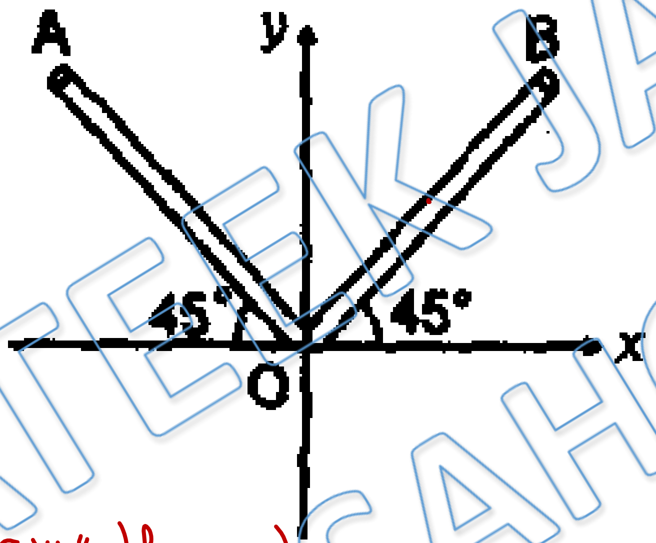
(d) $I_3 > I_1 > I_2$

Q7) AB and CD are two identical rods each of length l and mass m joined to form a cross. The moment of inertia of these two rods about a bisector of the angle between the rods (xy) is:



(a) $\frac{ml^2}{6}$ (b) $\frac{ml^2}{3}$ (c) $\frac{ml^2}{12}$ (d) $\frac{2ml^2}{3}$

Q8) Two rods OA and OB of equal length and mass are lying on y plane as shown in figure. Let Ix, Iy and Iz. be the moment of inertias of both the rods about x, y and z axis respectively.
Then:



Rods have equal angles with x and y axes

$I_x = I_y$.

$I_z = I_x + I_y$ (⊥ axis theorem)

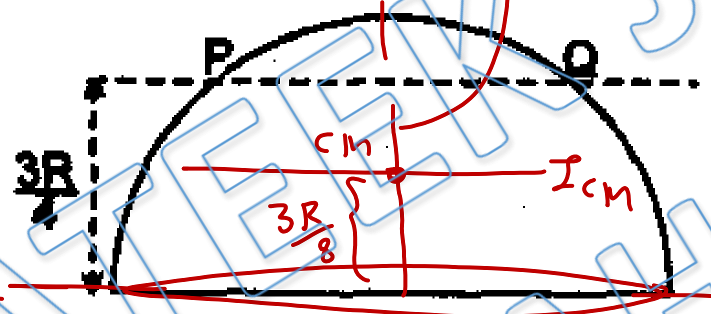
(a) $I_x = I_y > I_z$

(b) $I_x = I_y < I_z$

(c) $I_x > I_y > I_z$

(d) $I_z > I_y > I_x$

Q9) The radius of gyration of a solid hemisphere of mass M and radius It about an axis parallel to the diameter at a distance $\frac{3}{4}$R from this plane is given by (cenue of mass of the hemisphere lies at a height 3R/8 from the base):



$I_c = I_{cm} + m(3R/8)^2$

$I_{PQ} = I_{cm} + m(3R/8)^2$

$\frac{3R}{4} - \frac{3R}{8} = \frac{3R}{8}$

$I_{PQ} = I_c = \frac{2}{5}mR^2$

$I_{sphere} = \frac{2}{5}mR^2$

$2I_c = \frac{2}{5} \times 2mR$

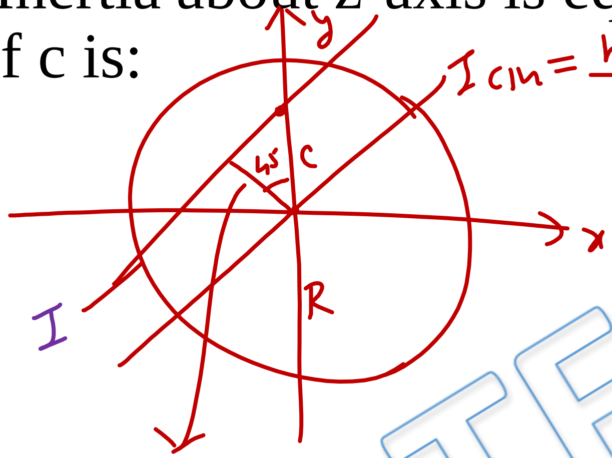
$I_c = \frac{2}{5}mR^2$

(a) $\frac{3R}{\sqrt{10}}$ (b) $\frac{5R}{4}$ (c) $\frac{5R}{8}$ (d) $\sqrt{\frac{2}{5}}R$

Radius of Gyration

$K = \sqrt{\frac{I}{m}} = \sqrt{\frac{\frac{2}{5}mR^2}{m}} = R\sqrt{\frac{2}{5}}$

Q10) A uniform disc of radius It lies in x-y plane with its centre at origin. Its moment of Inertia about z-axis is equal to its moment of inertia about line y = x + c. The value of c is:



$I_{cm} = \frac{mR^2}{4}$

$I_z = \frac{mR^2}{2}$

(a) $R/\sqrt{2}$ (b) – R/2 (c) + R/4 (d) – R

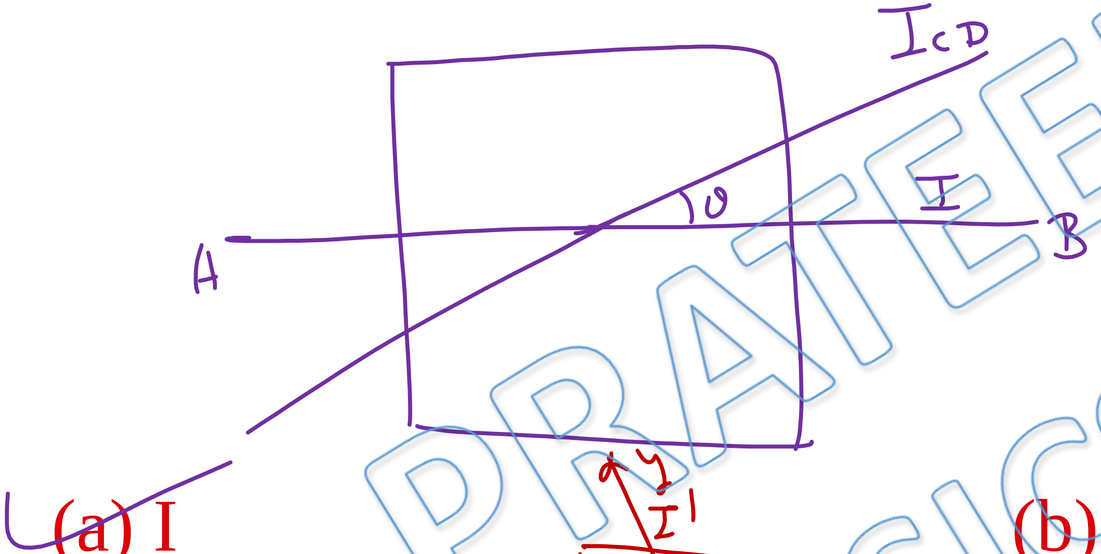
$I = I_{cm} + md^2 = \frac{mR^2}{4} + \frac{mc^2}{2} = \frac{mR^2}{2}$

$\frac{mc^2}{2} = \frac{mR^2}{4}$

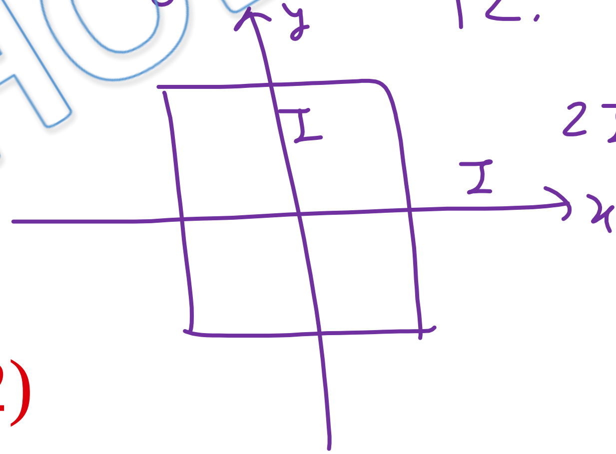
$c^2 = \frac{R^2}{2}$

$c = \frac{R}{\sqrt{2}}$

Q11) Let I be the moment of inertia of a uniform square plate about an axis AB that passes through its centre and is parallel to two of its sides. CD is a line in the plane of the plate that passes through the centre of the plate and makes an angle θ with AB. The moment of inertia of the plate about the axis CD is then equal to:



$$I_{CD} = I_{AB} = I = \frac{ml^2}{12}.$$



$$2I = I_z = \frac{ml^2}{6}$$

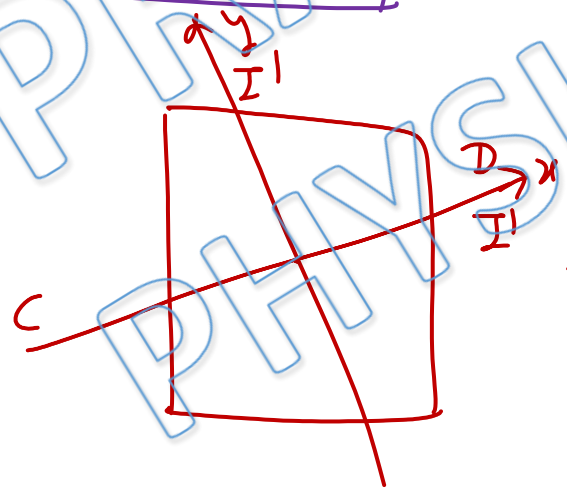
$$I = \frac{ml^2}{12}$$

(a) I

(b) $I \sin^2 \theta$

(c) $I \cos^2 \theta$

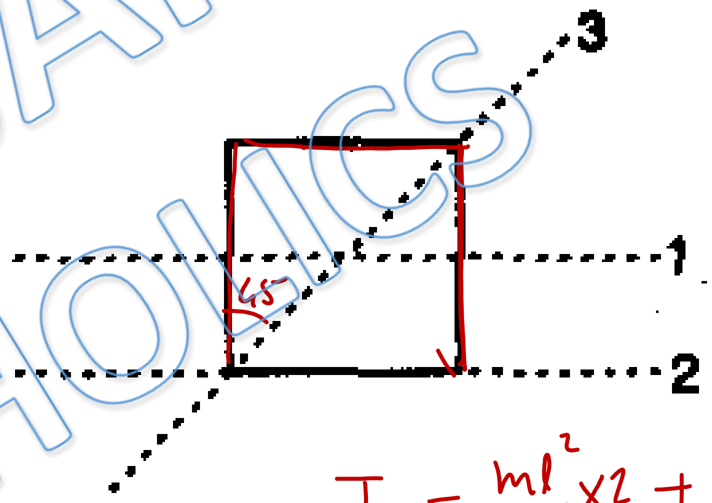
(d) $I\cos^2 (\theta/2)$



$$I_x + I_y = I_z = \frac{ml^2}{6}$$

$$2I' = \frac{ml^2}{6} \Rightarrow I' = \frac{ml^2}{12}$$

Q12) Four rods of equal length l and mass m in each from a square as shown in figure. Moment of inertia about three axes 1, 2 and 3 are say I_1, I_2 and I_3. Then, match the following:



$$I_2 = \frac{ml^2}{3}\times 2 + ml^2 = \frac{5}{3}ml^2$$

$$I_3 = \frac{ml^2}{3}\sin^2 45^\circ \times 4 = \frac{2ml^2}{3}$$

$$I_1 = \frac{ml^2}{12}\times 2 + \frac{ml^2}{4}\times 2 = \frac{ml^2}{6} + \frac{ml^2}{2} = \frac{4ml^2}{6} = \frac{2ml^2}{3}$$

Table-1	Table-2
(A) I_1	**(P)** $\frac{4}{3}ml^2$
(B) I_2	**(Q)** $\frac{2}{3}ml^2$
(C) I_3	**(R)** $\frac{1}{2}ml^2$
	(S) None

Q13) A semi-circular ring has mass m and radius R as shown in figure. Let I_1 , I_2, I_3 and I_4 be the moments of inertias of the four axes as shown. Axis 1 passes through centre and is perpendicular to plane of ring. Then, match the following:

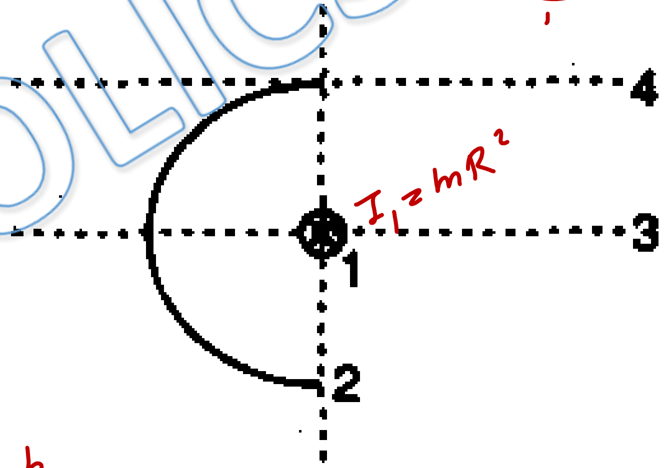
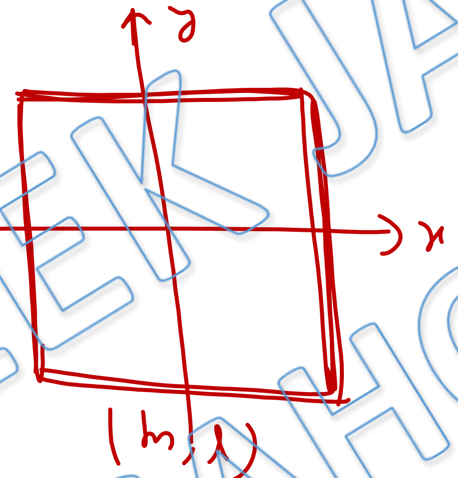


Table-1		Table-2	
(A)	I_1	(P)	$\frac{mR^2}{2}$
(B)	I_2	(Q)	$\frac{3}{2}mR^2$
(C)	I_3	(R)	mR^2
(D)	I_4	(S)	Data is insufficient

Q14) Four identical rods, each of mass m and length l, are joined to form a rigid square frame. The frame lies in the xy plane, with its centre at the origin and the sides parallel to the x and y axes. Its moment of inertia about

$$I_x = \frac{ml^2}{12}\times 2 + \frac{ml^2}{4}\times 2 = \frac{ml^2}{6} + \frac{ml^2}{2} = \frac{(1+3)ml^2}{6} = \frac{2}{3}ml^2$$



by symmetry

$$I_x = I_y$$

$$I_z = I_x + I_y = \frac{2}{3}ml^2 + \frac{2}{3}ml^2 = \frac{4}{3}ml^2$$

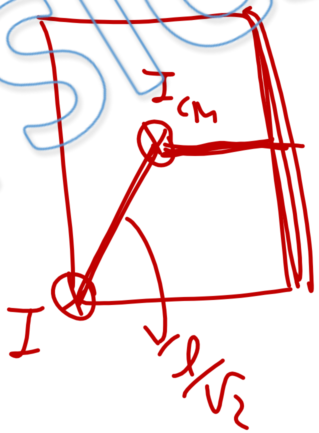
(a) the x-axis is 2/3 ml^2

(b) the z - axis is 4/3 m l^2

(c) axis parallel to the z-axis and passing through a corner is 10/3ml^2

(d) one side is 5/2m l^2

$$I_{side} = \frac{ml^2}{3}\times 2 + ml^2 = \frac{5}{3}ml^2$$

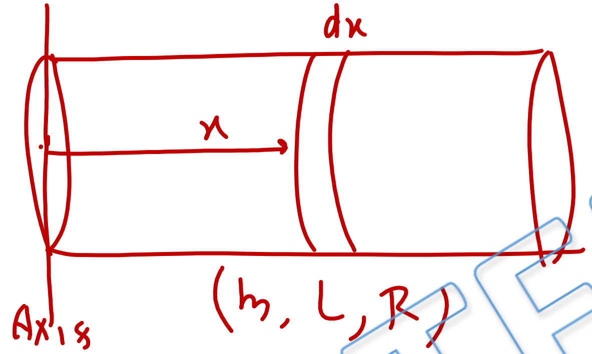


$$I_{CM} = \left(\frac{ml^2}{12} + \frac{ml^2}{4}\right)\times 4 = \frac{4}{3}ml^2$$

$$I = \frac{4}{3}ml^2 + \frac{4ml^2}{2} = \frac{10}{3}ml^2$$

Q15) The moment of inertia of a solid cylinder of mass M, length L and radius R about the diameter of one of its faces will be

mass of differential disc



$$dm = \frac{m}{l}\,dx$$

MOI of Disc

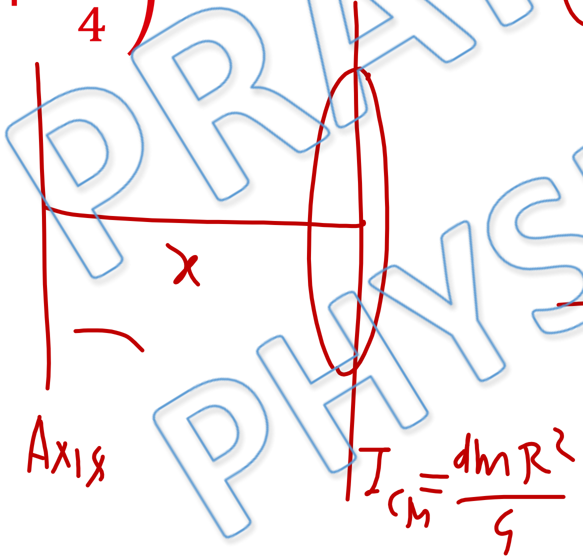
$$= \frac{dm\,R^2}{4} + dm\,x^2$$

(a) $M\left(\frac{L^2}{12}+\frac{R^2}{4}\right)$

(b) $M\left(\frac{L^2}{3}+\frac{R^2}{4}\right)$

(c) zero

(d) $\frac{MR^2}{2}$



MOI. of cylinder

$$I = \int \frac{dm\,R^2}{4} + \int dm\,x^2$$

$$= \frac{R^2}{4}\int dm + \frac{m}{l}\int_0^l x^2\,dx$$

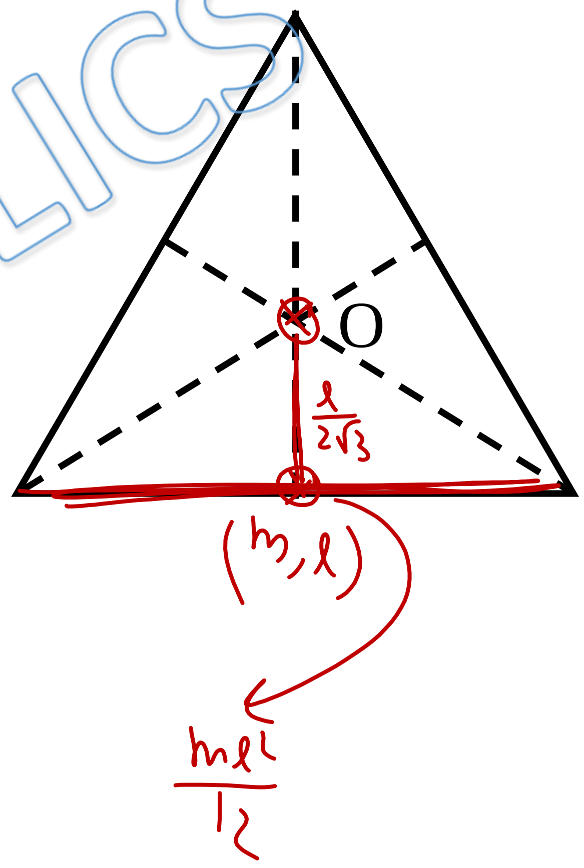
$$= \frac{mR^2}{4} + \frac{ml^2}{3}$$

Q16) A rod of mass M kg and length L metre is bent in the form of an equilateral triangle as shown in the figure. The moment of inertia of triangle about a vertical axis to perpendicular to the plane of triangle and passing through the centre (in units of kg-m^2) is–

$m = \frac{M}{3}$, $l = \frac{L}{3}$

$I_0 = \left[\frac{ml^2}{12} + m\left(\frac{l}{2\sqrt{3}}\right)^2\right] \times 3$

$= \frac{ml^2}{4} + \frac{ml^2}{4} = \frac{ml^2}{2} = \frac{ML^2}{54}$



(a) $(ML^2)/12$ (b) $(ML^2)/54$

(c) $(ML^2)/162$ (d) $(ML^2)/108$

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Chalo Niklo