DPP
DAILY PRACTICE PROBLEMS

CLASS : XITH
DATE :

Solutions

SUBJECT : PHYSICS
DPP NO. : 4

Topic :- SYSTEM OF PARTICLES AND ROTATIONAL MOTION

1 **(d)**

$I = \frac{2}{5}MR^2 \therefore I \propto R^2$

This relation shows that graph between I and R will be parabola symmetric to I-axis

3 **(a)**

$\frac{2}{5}MR^2 = \frac{1}{2}Mr^2 + Mr^2$

or $\frac{2}{5}MR^2 = \frac{3}{2}Mr^2$

$\therefore \quad r = \frac{2}{\sqrt{15}}R$

4 **(b)**

$\frac{I_{Ring}}{I_{Disc}} = \frac{MR^2}{1/2MR^2} = 2:1$

5 **(b)**

According to the theorem of perpendicular axes.

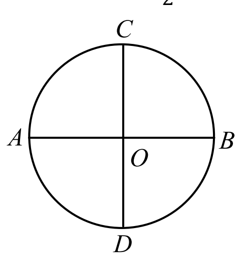
$I_{AB} + I_{CD} = MR^2$

$I_d + I_d = I$

$(\because I_{AB} = I_{CD} = I_d)$

$2I_d = I$

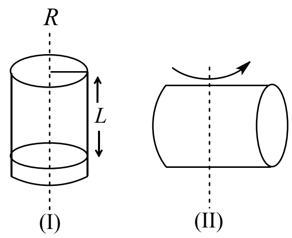
$I_d = \frac{I}{2}$



where, I_d = moment of inertia about diameter of the ring, I = moment of inertia about axes passing through to the ring.

6 **(b)**

(I) Moment of inertia of a cylinder about its centre and parallel to its length $= \frac{MR^2}{2}$



(II) Moment of inertia about its centre and perpendicular to its length $= M\left(\frac{L^2}{12} + \frac{R^2}{4}\right)$

$$\frac{ML^2}{12} + \frac{MR^2}{4} = \frac{MR^2}{2}$$

Or $L = \sqrt{3}R$

7 **(b)**

Let at the time explosion velocity of one piece of mass $m/2$ is $(10\hat{i})$. If velocity of other be $\vec{v}_2$, then from conservation law of momentum (since there is no force in horizontal direction), horizontal component of $\vec{v}_2$, must be $-10\,\hat{i}$.

$\therefore$ Relative velocity of two parts in horizontal direction $= 20\text{ms}^{-1}$

Time taken by ball to fall through 45m,

$= 20 = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \times 45}{10}} = 3s$ and time taken by ball to fall through first 20m, $t' = \sqrt{\frac{2h'}{g}} = \sqrt{\frac{2 \times 20}{10}} = 2$s. Hence time taken by ball pieces to fall from 25 m height to ground $= t - t' = 3 - 2 = 1$s.

$\therefore$ Horizontal distance between the two pieces at the time of striking on ground

$= 20 \times 1 = 20$m

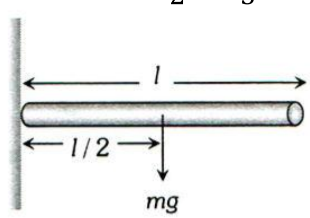
9 **(c)**

Graph should be parabola symmetric to I-axis, but it should not pass from origin because there is a constant value I_{cm} is present for $x = 0$

10 **(d)**

Weight of the rod will produce the torque

$$\tau = I\alpha \Rightarrow mg \times \frac{l}{2} = \frac{ml^2}{3} \times \alpha$$

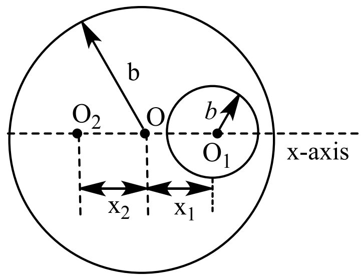


Angular acceleration

$$\alpha = \frac{3g}{2l}$$

11 **(a)**

The situation can be shown as



Let radius of complete disc is a and that of small disc is b. Also let centre of mass now shifts to O_2 at a distance x_2 from original centre.

The position of new centre of mass is given by

$$X_{\text{CM}} = \frac{-\sigma\pi b^2 x_1}{\sigma\pi a^2 - \sigma\pi b^2}$$

Here, $a = 6$ cm, $b = 2$ cm, $x_1 = 3.2$ cm

Hence, $X_{\text{CM}} = \frac{-\sigma \times \pi(2)^2 \times 3.2}{\sigma \times \pi \times (6)^2 - \sigma \times \pi \times (2)^2}$

$$= -\frac{12.8\pi}{32\pi} = -0.4 \text{ cm}$$

12 **(a)**

Initial acceleration of the system is zero. So it will always remain zero because there is no external force on the system

13 **(d)**

Rotational kinetic energy $= \frac{1}{2}I\omega^2 = \frac{1}{2}\left(\frac{1}{2}MR^2\right) \times \omega^2$

$= \frac{1}{2}\left(\frac{1}{2} \times 10 \times (0.5)^2\right) \times (20)^2 = 250\,J$

14 **(d)**

$\frac{1}{2}I\omega^2 = \frac{1}{2}mv^2 \Rightarrow \frac{1}{2} \times 3 \times (2)^2 = \frac{1}{2} \times 12 \times v^2$

$\Rightarrow v = 1m/s$

15 **(b)**

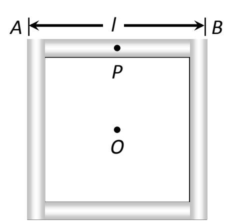
In doing so moment of inertia is decreased and hence angular velocity is increased

16 **(b)**

In the absence external force, position of centre of mass remain same therefore they will meet at their centre of mass

17 **(a)**

Moment of inertia of rod AB about point P and perpendicular to the plane $= \frac{Ml^2}{12}$



M.I. of rod AB about point $'O' = \frac{Ml^2}{12} + M\left(\frac{l}{2}\right)^2 = \frac{Ml^2}{3}$

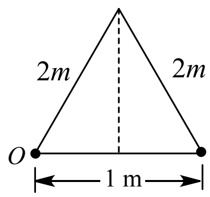
(By using parallel axis theorem)

But the system consists of four rods of similar type so by but the symmetry $I_{System} = 4\left(\frac{Ml^2}{3}\right)$

18 **(c)**

$x_{CM} = \frac{\sum m_i x_i}{\sum m_i}$, Refer to figure

$$= \frac{M \times 0 + M \times 1 + M \times 2}{M + M + M} = 1$$



$$y_{CM} = \frac{\sum m_i y_i}{\sum m_i}$$

$$= \frac{M \times 0 + M(2 \sin 60°) + M \times 0}{M + M + M}$$

$$= \frac{\sqrt{3}M}{3M} = \frac{1}{\sqrt{3}}$$

$\therefore$ Position vector of centre of mass is $\left(\hat{\mathbf{i}} + \frac{1}{\sqrt{3}}\hat{\mathbf{j}}\right)$

19 **(a)**

Angular velocity $= \omega$

Centripetal force $F = mr\omega^2$

or $r \propto \frac{1}{\omega^2}$

$\therefore$ $\frac{r_1}{r_2} = \frac{\omega_2^2}{\omega_1^2}$

or $\frac{4}{r_2} = \frac{4\omega^2}{\omega^2}$

or $r_2 = 1$ cm

20 **(b)**

Time of descent will be less for solid sphere *i.e.* solid sphere will reach first at the bottom of inclined plane

ANSWER-KEY										
Q.	1	2	3	4	5	6	7	8	9	10
A.	D	C	A	B	B	B	B	C	C	D
Q.	11	12	13	14	15	16	17	18	19	20
A.	A	A	D	D	D	B	A	C	A	B