DPP

DAILY PRACTICE PROBLEMS

CLASS : XITH
DATE :

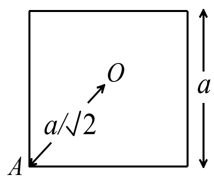
Solutions

SUBJECT : PHYSICS
DPP NO. : 10

Topic :- SYSTEM OF PARTICLES AND ROTATIONAL MOTION

1 **(c)**

M.I. of the plate about an axis perpendicular to its plane and passing through its centre



$I_0 = \frac{ma^2}{6}$

By parallel axes theorem

$I_A = I_0 + m\left(\frac{a}{\sqrt{2}}\right)^2 = \frac{2}{3}ma^2$

2 **(c)**

Moment of inertia of a disc

$I = \frac{1}{2}MR^2$

Disc is melted and recasted into a solid sphere.

$\therefore$ Volume of sphere=Volume of disc

$\frac{4}{3}\pi R_1^3 = \pi R^2 \times \frac{R}{6}$

$\frac{4}{3}R_1^3 = \frac{R^3}{6}$

$R_1^3 = \frac{R^3}{8} \quad \Rightarrow \quad R_1 = \frac{R}{2}$

$\therefore$ Moment of inertia of sphere

$I' = \frac{2}{5}MR_1^2 = \frac{2}{5}M\left(\frac{R}{2}\right)^2 = \frac{2}{5}\frac{MR^2}{4} = \frac{1}{5}\left(\frac{1}{2}MR^2\right) = \frac{I}{5}$

3 **(c)**

For solid cylinder, $\theta = 30°, K^2 = \frac{1}{2}R^2$

For hollow cylinder, $\theta = ?, K^2 = R^2$

Using we find,

$$\frac{\left(1+\frac{1}{2}\right)}{\sin 30°} = \frac{1+1}{\sin\theta}$$

$\therefore \ \sin\theta = \frac{2}{3} = 0.6667$

$\theta = 42°$

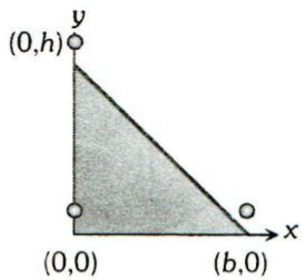
4 **(c)**

We can assume that three particles of equal mass m are placed at the corners of triangle

$\vec{r}_1 = 0\hat{i} + 0\hat{j}, \vec{r}_2 = b\hat{i} + 0\hat{j}$

and $\vec{r}_3 = 0\hat{i} + h\hat{j}$

$\therefore \overrightarrow{r_{cm}} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2 + m_3\vec{r}_3}{m_1 + m_2 + m_3}$



$= \frac{b}{3}\hat{i} + \frac{h}{3}\hat{j}$

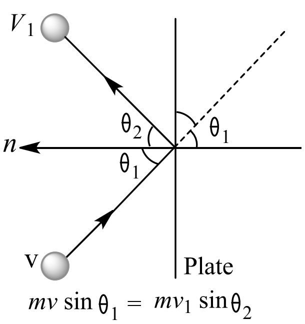
$i.e.$ coordinates of centre of mass is $\left(\frac{b}{3}, \frac{h}{3}\right)$

5 **(d)**

When a heavy body with velocity u collides with a lighter body at rest, then the heavier body remains moving in the same direction with almost same velocity. The lighter body moves in the same direction with a nearly velocity of $2u$

6 **(b)**

Since, no force is present along the surface of plane so, momentum conservation principle for ball is applicable along the surface of plate.



$mv \sin\theta_1 = mv_1 \sin\theta_2$

Or $\ v\sin\theta_1 = v_1 \sin\theta_2$

$e = \frac{v_1 \cos\theta_2}{v\cos\theta_1} = \frac{v_1 \cos\theta_2}{v\cos\theta}$

$\therefore \ v_1 \cos\theta_2 = ev\cos\theta$

$\therefore \ \frac{v_1 \sin\theta_2}{v_1\cos\theta_2} = \frac{v\sin\theta}{ev\ \cos\theta} = \frac{\tan\theta}{e}$

$\therefore\ \tan\theta = \dfrac{\tan\theta}{e}$

$\therefore\ \theta_2 = \tan^{-1}\left(\dfrac{\tan\theta}{e}\right)$

7 **(d)**

We know that angular momentum of spin $= I\omega$

By the conservation of angular momentum

$$\frac{2}{5}MR^2.\frac{2\pi}{T} = \frac{2}{5}M\left(\frac{R}{4}\right)^2.\frac{2\pi}{T'}$$

$$T' = \frac{T}{16} = \frac{24}{16} = 1.5\text{h}$$

8 **(d)**

Melting of ice produces water which will spread over larger distance away from the axis of rotation. This increases the moment of inertia so angular velocity decreases

9 **(c)**

Hence, $m_1 = 10$ kg, $m_2 = 4$ kg

$v_1 = 14\text{ms}^{-1}, v_2 = 0$

$$v_{\text{CM}} = \frac{m_1 v_1 + m_2 v_2}{m_1 + m_2}$$

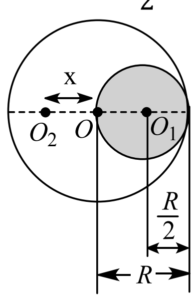
$$v_{\text{CM}} = \frac{10 \times 14 + 4 \times 0}{10 + 4} = 10\text{ms}^{-1}$$

10 **(b)**

Let centre of mass of lead sphere after hollowing be at point O_2, where $OO_2 = x$

Mass of spherical hollow $m = \dfrac{\frac{4}{3}\pi\left(\frac{R}{2}\right)^2 M}{\left(\frac{4}{2}\pi R^3\right)} = \dfrac{M}{8}$ and

$x = OO_1 = \dfrac{R}{2}$



$$\therefore\ x = \frac{M \times 0 - \left(\frac{M}{8}\right) \times \frac{R}{2}}{M - \frac{M}{8}} = \frac{\frac{MR}{16}}{\frac{7M}{8}} = -\frac{R}{14}$$

$\therefore$ shift $= \dfrac{R}{14}$

11 **(d)**

Angular momentum is given by

$$J = I\omega = \left(\frac{2MR^2}{5}\right)\omega$$

$$= \frac{2MR^2}{5} \times \frac{2\pi}{T} = \frac{4\pi MR^2}{5T}$$

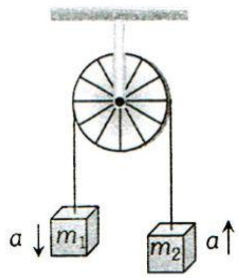
12 **(a)**

Acceleration of each mass $= a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)g$

Now acceleration of centre of mass of the system

$$A_{cm} = \frac{m_1\overrightarrow{a_1} + m_1\overrightarrow{a_2}}{m_1 + m_2}$$

As both masses move with same acceleration but in opposite direction so $\overrightarrow{a_1} = -\overrightarrow{a_2} = a$ (let)



$\therefore A_{cm} = \frac{m_1 a - m_2 a}{m_1 + m_2}$

$= \left(\frac{m_1 - m_2}{m_1 + m_2}\right) \times \left(\frac{m_1 - m_2}{m_1 + m_2}\right) \times g = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2 \times g$

13 **(c)**

If speed of man relative to plank be v, then it can be shown easily that speed of man relative to ground

$v_{\mathrm{mg}} = v\frac{M}{\left(M + \frac{M}{3}\right)} = \frac{3}{4}v$

$\therefore$ Distance covered by man relative to ground

$= L\frac{v_{\mathrm{mg}}}{v} = \frac{L}{v}\frac{3}{4}v = \frac{3L}{4}$

14 **(b)**

M.I. of disc $= \frac{1}{2}MR^2 = \frac{1}{2}M\left(\frac{M}{\pi t\rho}\right) = \frac{1}{2}\frac{M^2}{\pi t\rho}$

$\left(As\ \rho = \frac{M}{\pi R^2 t}\ \text{There fore } \mathrm{R}^2 = \frac{M}{\pi\ t\rho}\right)$

If mass and thickness are same then, $I \propto \frac{1}{\rho}$

$\therefore \frac{I_1}{I_2} = \frac{\rho_2}{\rho_1} = \frac{3}{1}$

15 **(a)**

If $M = M'$ then bullet will transfer whole of its velocity (and consequently 100% of its KE) to block and will itself come to rest as per theory of collision.

17 **(c)**

Acceleration $a = \frac{v - u}{t}$

Or $a = \frac{v - v_0}{t}$

Or $g = \frac{v - v_0}{t}$

$\therefore \quad v = 0$

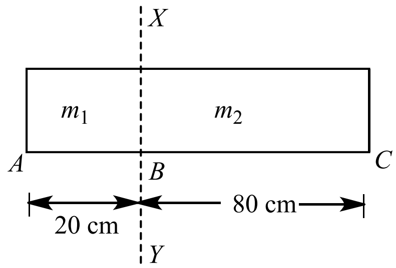
Speed before first bounce

$v_0 = -5 \text{ms}^{-1}$

$\therefore \quad t = \frac{v_B - v_A}{g} = \frac{0(-5)}{10} = \frac{5}{10} = 0.5 \text{ s}$

19 **(a)**

$m = 0.6$ kg



Mass per unit length $= \frac{0.6}{100} \text{kgcm}^{-1}$

Mass of part AB, $m_1 = \frac{0.6}{100} \times 20 = \frac{0.6}{5}$ kg

Mass of part BC, $m_2 = \frac{0.6}{100} \times 80$

Moment of inertia $= \frac{0.6 \times 4}{5} = \frac{2.4}{5}$ kg

$$I = m_1 \left(\frac{AB}{2}\right)^2 + m_2 \left(\frac{BC}{2}\right)^2$$

$$= \frac{0.6}{5} \times \left(\frac{20}{2} \times 10^{-2}\right)^2 + \frac{24}{5} \times \left(\frac{80}{2} \times 10^{-2}\right)^2$$

$$= \frac{0.6}{5} \times 10^{-2} + \frac{2.4}{5} \times \left(4 \times 10^{-1}\right)^2$$

$$= \frac{0.6}{5} \times 10^{-2} + \frac{2.4}{5} \times 16 \times 10^{-2}$$

$$= \left(\frac{0.6 + 38.4}{5}\right) \times 10^{-2}$$

$$= 7.8 \times 10^{-2} \text{kg-m}^2 = 0.078 \text{ kg-m}^2$$

20 **(a)**

$P = \sqrt{p_x^2 + p_y^2}$

$= \sqrt{(2 \cos t)^2 + (2 \sin t)^2} = 2$

If m be the mass of the body, then kinetic energy

$$= \frac{p^2}{2m} = \frac{(2)^2}{2m} = \frac{2}{m}$$

Since kinetic energy does not change with time, both work done and power are zero

Now Power $= Fv\cos\theta = 0$

As $F \neq 0, v \neq 0$

$\therefore \quad \cos\theta = 0$

Or $\theta = 90°$

As direction of $\vec{p}$ is same that $\vec{v}(\because \vec{p} = m\vec{v})$ hence angle between $\vec{F}$ and $\vec{p}$ is equal to $90°$

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