DPP
DAILY PRACTICE PROBLEMS

CLASS : XITH
DATE :

Solutions

SUBJECT : PHYSICS
DPP NO. : 9

Topic :- SYSTEM OF PARTICLES AND ROTATIONAL MOTION

1 **(d)**

Total kinetic energy $=\frac{1}{2}mv^2\left(1+\frac{K^2}{R^2}\right)=32.8\,J$

$\Rightarrow\frac{1}{2}\times10\times(2)^2\left(1+\frac{K^2}{(0.5)^2}\right)=32.8\Rightarrow K=0.4\,m$

2 **(a)**

Kinetic energy of rotating body $=\frac{1}{2}I\omega^2$

$=\frac{1}{2}\times3\times(3)^2=13.5\,J$

Kinetic energy of translating body $=\frac{1}{2}mv^2$

As both are equal according to problem *i.e.*

$\frac{1}{2}mv^2=13.5\Rightarrow\frac{1}{2}\times27\times v^2=13.5\Rightarrow\ \therefore v=1m/s$

3 **(d)**

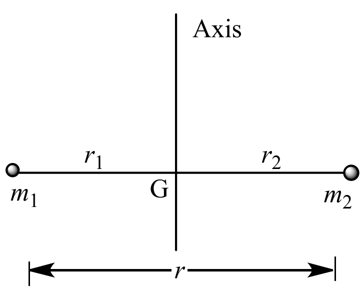
According to conservation of momentum

$5\times10=(955+5)v$

$v=\frac{50}{100}=\frac{1}{20}$ $\quad\therefore$ % KE lost $=\frac{K_1-K_2}{K_1}\times100=95.5\%$

4 **(d)**

Total moment of inertia will be equal to the sum of moment of inertia due to individual masses.



$I=\sum_{i=1}^{n}I_i$

where, $I_1=m_1r_1^2, I_2=m_2r_2^2$.

Given, $r = r_1 + r_2$

$$m_1 r_1 = m_2 r_2$$

$\therefore \quad m_1 r_1 = m_2 (r - r_1)$

$\Rightarrow \quad m_1 r_1 + m_2 r_1 = m_2 r$

$\Rightarrow \quad r_1 (m_1 + m_2) = m_2 r$

$\Rightarrow \quad r_1 = \frac{m_2 r}{(m_1 + m_2)}$

Also, $\quad r_2 = r - r_1$

$$r_2 = r - \frac{m_2 r}{(m_1 + m_2)^2} = \frac{m_2 r}{m_1 + m_2}$$

$\therefore \quad I = I_1 + I_2 = m_1 r_1^2 + m_2 r_2^2$

$$I = m_1 \frac{m_2^2 r^2}{(m_1 + m_2)^2} + m_2 \frac{m_1^2 r^2}{(m_1 + m_2)^2}$$

$$I = \frac{m_1 m_2 r^2}{(m_1 + m_2)} = \frac{m_1 m_2}{(m_1 + m_2)} . r^2$$

5 **(b)**

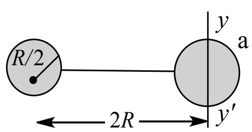
$$\alpha = \frac{\omega_2 - \omega_1}{t} = \frac{2\pi(n_2 - n_1)}{t} = \frac{2\pi \times \left[\frac{240}{60} - 0\right]}{10}$$

$$\therefore \alpha = 2.51\ rad/s$$

6 **(a)**

$$\alpha = \frac{\omega}{t} = \frac{2\pi n}{t} = \frac{2\pi\left(\frac{540}{60}\right)}{6} = 3\pi\ rad/s^2$$

7 **(a)**



Moment of inertia of the system about yy'

$I_{yy'} =$ Moment of inertia of sphere P about

$yy' +$ Moment of inertia of sphere Q about yy'

Moment of inertia of sphere P about yy''

$$= \frac{2}{5} M \left(\frac{R}{2}\right)^2 + M(x)^2$$

$$= \frac{2}{5} M \left(\frac{R}{2}\right)^2 + M(2R)^2$$

$$= \frac{MR^2}{10} + 4MR^2$$

Moment of inertia of sphere Q about yy'' is $\frac{2}{5} M \left(\frac{R}{2}\right)^2$

Now, $I_{yy'} = \frac{MR^2}{10} + 4MR^2 + \frac{2}{5} M \left(\frac{R}{2}\right)^2 = \frac{21}{5} MR^2$

8 **(b)**

$I = mR^2 = m\left(\frac{D^2}{4}\right) \Rightarrow I \propto mD^2$ or $m \propto \frac{I}{D^2}$

$$\therefore \frac{m_1}{m_2} = \frac{I_1}{I_2} \times \left(\frac{D_2}{D_1}\right)^2 = \frac{2}{1}\left(\frac{1}{2}\right)^2 = \frac{2}{4} = \frac{1}{2}$$

10 **(a)**

$$\vec{L} = \vec{r} \times \vec{p} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 2 & -1 \\ 3 & 4 & -2 \end{vmatrix} = -\hat{j} - 2\hat{k}$$

and the X - axis is given by $\hat{i} + 0\hat{j} + 0\hat{k}$

Dot product of these two vectors is zero *i.e.* angular momentum is perpendicular to X - axis

11 **(c)**

The rolling sphere has rotational as well as translational kinetic energy

$\therefore$ Kinetic energy $= \frac{1}{2}mu^2 + \frac{1}{2}I\omega^2$

$$= \frac{1}{2}mu^2 + \frac{1}{2}\left(\frac{2}{5}mr^2\right)\omega^2 = \frac{1}{2}mu^2 + \frac{mu^2}{5} = \frac{7}{10}mu^2$$

Potential energy = kinetic energy

$$\therefore mgh = \frac{7}{10}mu^2 \Rightarrow h = \frac{7u^2}{10g}$$

12 **(d)**

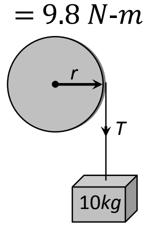
$\tau = r \times F$

$= r \times T$

$= r \times m \times g$

$= 0.1 \times 10 \times 9.8$

$= 9.8\ N\text{-}m$



13 **(d)**

The moment of inertia of a circular disc

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

According to theorem of parallel axes

$$I' = \frac{1}{2}MR^2 + MR^2 = \frac{3}{2}MR^2 = 3I$$

14 **(b)**

Rotational kinetic energy $= \frac{1}{2}I\omega^2$

$\therefore$ Rotational KE $= \frac{1}{2}\left[\frac{1}{2}mr^2\right]\frac{v^2}{r^2}$ (where $I = \frac{1}{2}mr^2$)

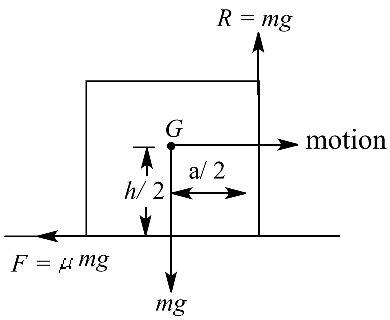
$$4 = \frac{1}{2}\left[\frac{1}{2}(2)r^2\right]\frac{v^2}{r^2}$$

$\Rightarrow$ $v^2 = 8$

$$v = 2\sqrt{2}\ \text{ms}^{-1}$$

16 **(b)**

As shown in figure normal reaction $R = mg$. Frictional force $F = \mu R = \mu\, mg$. To topple, clockwise moment must be more than the anticlockwise moment *ie*, $\mu mg \times \frac{h}{2} > mg \times \frac{a}{2} mg \times \frac{a}{2}$ or $\mu > a/h$



18 **(c)**

Angle turned in three second, $\theta_{3s} = 2\pi \times 10 = 20\pi\ rad$

From $\theta = \omega_0 t + \frac{1}{2}\alpha t^2 \Rightarrow 20\pi = 0 + \frac{1}{2}\alpha \times (3)^2$

$$\Rightarrow \alpha = \frac{40\pi}{9} rad/s^2$$

Now angle turned in 6 sec from the starting

$$\theta_{6s} = \omega_0 t + \frac{1}{2}\alpha t^2 = 0 + \frac{1}{2} \times \left(\frac{40\pi}{9}\right) \times (6)^2 = 80\pi\ rad$$

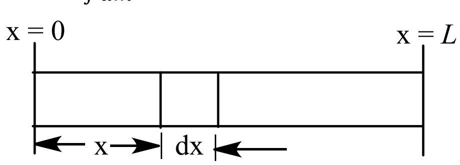
$\therefore$ angle turned between $t = 3s$ to $t = 6s$

$$\theta_{\text{last }3s} = \theta_{6s} - \theta_{3s} = 80\pi - 20\pi = 60\pi$$

Number of revolution $= \frac{60\pi}{2\pi} = 30\ rev$

19 **(a)**

$x_{\text{CM}} = \frac{\int x dm}{\int dm}$



If $n = 0$

Then $x_{\text{CM}} = \frac{L}{2}$

As n increases, the centre of mass shift away from $x = \frac{L}{2}$ which only option (a) is satisfying.

Alternately, you can use basic concept.

$$x_{\text{CM}} = \frac{\int_0^L k\left(\frac{x}{L}\right)^n \times x dx}{\int_0^L k\left(\frac{x}{L}\right)^n dx}$$

$$= L\left[\frac{n+1}{n+2}\right]$$

20 **(d)**

$$\vec{v}_{cm} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1 + m_2} = \frac{2 \times 3 + 3 \times 2}{2 + 3} = \frac{12}{5} = 2.4 m/s$$

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