DPP
DAILY PRACTICE PROBLEMS

CLASS : XITH
DATE :

Solutions

SUBJECT : PHYSICS
DPP NO. : 1

Topic :- SYSTEM OF PARTICLES AND ROTATIONAL MOTION

1 **(c)**

Moment of inertia of uniform circular disc about diameter $= I$

According to theorem of perpendicular axes,

Moment of inertia of disc about its axis $= 2I\left(= \frac{1}{2}mr^2\right)$

Applying theorem of parallel axes

Moment of inertia of disc about the given axis

$$= 2I + mr^2 = 2I + 4I = 6I$$

2 **(d)**

Angular displacement during time

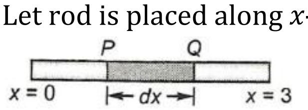
$$\theta = (\omega_2 - \omega_1)t$$
$$= (2\pi n_2 - 2\pi n_1)t$$
$$= (600\pi - 200\pi) \times 10$$
$$= 4000\,\pi \text{ rad}$$

Therefore, number of revolutions made during this time

$$= \frac{4000\pi}{2\pi} = 2000$$

3 **(b)**

Let rod is placed along x-axis. Mass of element PQ of length dx situated at $x = x$ is



$dm = \lambda\, dx = (2 + x)\, dx$

The CM of the element has coordinates $(x, 0, 0)$.

Therefore, x-coordinates of CM of the rod will be

$$x_{\text{CM}} = \frac{\int_0^3 x dm}{\int_0^3 dm}$$
$$= \frac{\int_0^3 x(2+x)dx}{\int_0^3 (2+x)dx}$$
$$= \frac{\int_0^3 (2x + x^2)dx}{\int_0^3 (2+x)dx}$$
$$= \frac{\left[\frac{2x^2}{2} + \frac{x^3}{3}\right]_0^3}{\left[2x + \frac{x^2}{2}\right]_0^3}$$

$$= \frac{\left[(3)^2 + \frac{(3)^3}{3}\right]}{\left[2 \times 3 + \frac{(3)^2}{2}\right]} = \frac{9+9}{6+9/2}$$

$$= \frac{18 \times 2}{21} = \frac{12}{7}\text{m}$$

4 **(d)**

$$I = MK^2 = 160 \Rightarrow K^2 = \frac{160}{M} = \frac{160}{10} = 16 \Rightarrow K = 4 metre$$

5 **(b)**

As the mass of disc is negligible therefore only moment of inertia of five particles will be considered

$$I = \sum mr^2 = 5mr^2 = 5 \times 2 \times (0.1)^2 = 0.1 kg\text{-}m^2$$

6 **(b)**

$\tau = I\alpha$, if $\tau = 0$ then $\alpha = 0$ because moment of inertia of any body cannot be zero

7 **(a)**

Since, no external torque is acting the angular (J) is conserved.

$J = I\omega =$ constant

Where $I(= mr^2)$ is moment of inertia and ω the angular velocity.

Given, $I_1 = I, I_2 = \frac{I}{n}, \omega_1 = \omega$

$\therefore \quad J = I_1\omega_1 = I_2\omega_2$

$I\omega = \frac{I}{n}\omega_2$

$\Rightarrow \quad \omega_2 = n\omega$

Hence, angular velocity increases by a factor of n.

8 **(c)**

Loss of kinetic energy $= \frac{1}{2}\frac{m_1 m_2}{m_1 + m_2}(v_1 - v_2)^2$

$= \frac{1}{2}\frac{M \times M}{(M+M)}(v_1 - v_2)^2$

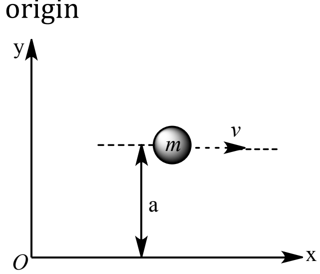
$= \frac{M \cdot M}{2(2M)}(v_1 - v_2)^2$

$= \frac{M}{4}(v_1 - v_2)^2$

9 **(b)**

Angular moment of particle w.r.t., origin

=linear momentum × perpendicular distance of line of action of linear momentum from origin



$= mv \times a = mva =$ constant

10 **(a)**

He decreases his Moment of inertia by this act and therefore increases his angular velocity

11 **(c)**

Let T be the tension in the string carrying

The masses m and $3m$

Let a be the acceleration, then

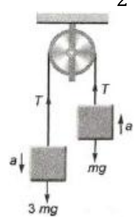
T - $mg = ma$ ...(i)

$3mg$ - $T = 3ma$ ...(ii)

Adding Eqs. (i) and (ii), we het

$2mg + 4ma$

$\Longrightarrow \quad a = \frac{g}{2}$



12 **(c)**

Let same mass and same outer radii of solid sphere and hollow sphere are M and R respectively. The moment of inertia of solid sphere A about its diameter

$I_A = \frac{2}{5}MR^2$ ...(i)

Similarly, the moment of inertia of hollow sphere (spherical shell) B about its diameter

$I_B = \frac{2}{3}MR^2$ ...(ii)

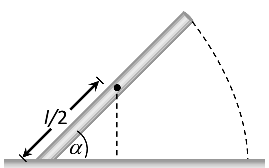
It is clear from Eqs. (i) and (ii), we get

$I_A < I_B$

13 **(a)**

By the conservation of energy

$P.E.$ of rod = Rotational $K.E.$



$$mg\frac{l}{2}\sin\alpha = \frac{1}{2}I\omega^2 \Rightarrow mg\frac{l}{2}\sin\alpha = \frac{1}{2}\frac{ml^2}{3}\omega^2$$

$$\Rightarrow \omega = \sqrt{\frac{3g\sin\alpha}{l}}$$

But in the problem length of the rod $2L$ is given

$$\Rightarrow \omega = \sqrt{\frac{3g\sin\alpha}{2L}}$$

14 **(c)**

Time taken in reaching bottom of incline is

$$t = \sqrt{\frac{2l(1 + K^2/R^2)}{g \sin \theta}}$$

For solid cylinder (SC), $K^2 = R^2/2$

For hollow cylinder (HC), $K^2 = R^2$

For solid sphere (S), $K^2 = \frac{2}{5}R^2$

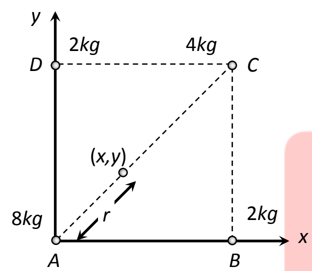
15 **(b)**

According to figure let A is the origin and co-ordinates of centre of mass be (x,y) then,

$$x = \frac{m_1x_1 + m_2x_2 + m_3x_3 + m_4x_4}{m_1 + m_2 + m_3 + m_4}$$

$$= \frac{0 + 2 \times \frac{80}{\sqrt{2}} + 4 \times \frac{80}{\sqrt{2}} + 0}{16} = \frac{30}{\sqrt{2}}$$

Similarly $y = \frac{30}{\sqrt{2}}$ so, $r = \sqrt{x^2 + y^2} = 30cm$



16 **(b)**

$I = MK^2 = \sum mR^2$

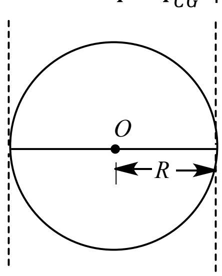
where M is the total mass of the body.

This means that

$$K = \sqrt{\left(\frac{I}{M}\right)}$$

According to thermo of parallel axis

$$I = I_{CG} + M(2R)^2$$



where, I_{CG} is moment of inertia about an axis through centre of gravity.

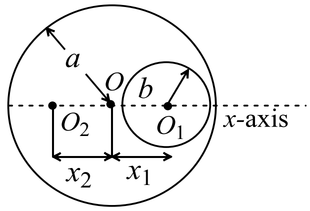
$\therefore \quad I = \frac{2}{5}MR^2 + 4MR^2 = \frac{22}{5}MR^2$

or $\quad MK^2 = \frac{22}{5}MK^2$

$\therefore \quad K = \sqrt{\frac{22}{5}}R$

17 **(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

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

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

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

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

18 **(b)**

$$v = \sqrt{\frac{2gh}{1 + \frac{K^2}{R^2}}} = \sqrt{\frac{2gh}{1 + \frac{1}{2}}} = \sqrt{\frac{4}{3} gh}$$

20 **(c)**

$I = \frac{2}{5} MR^2 = \frac{2}{5}\left(\frac{4}{3}\pi R^3 \rho\right) R^2 = \frac{8}{15} \times \frac{22}{7} R^5 \rho$

$I = \frac{176}{105} R^5 \rho$

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