PHYSICS

41. (1)

Torque, $\vec{\tau} = \vec{r} \times \vec{F} = (\hat{i} + \hat{j} - \hat{k}) \times (5\hat{i} + 7\hat{j} - 3\hat{k})$

$= \hat{i}(-3+7) - \hat{j}(-3+5) + \hat{k}(7-5)$

$\vec{\tau} = 4\hat{i} - 2\hat{j} + 2\hat{k}$

42. (2)

43. (1)

When external torque acting on the system is zero then only the total angular momentum of system is considered to be conserved. $\vec{\tau} = \frac{d\vec{L}}{dt}$

If, $\vec{\tau} = 0, \frac{d\vec{L}}{dt} = 0 \Rightarrow \vec{L} = I\omega = \text{constant}$

44. (3)

Let M be the mass of circular disk.

The density of desk; $\sigma = \frac{M}{\pi a^2}$

Now let M′ be the mass of cut out disk.

$\therefore M' = \sigma \times \pi\left(\frac{a}{2}\right)^2$

$= \frac{M}{\pi a^2} \times \pi \frac{a^2}{4} = \frac{M}{4}$

$$X_{com} = \frac{M \times a + \frac{M}{4} \times \frac{3}{2}a}{M - \frac{M}{4}} = \frac{5}{6}a$$

45. (4)

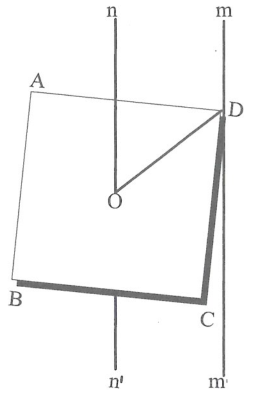
$I_{nn'} = \frac{1}{12}M(a^2 + a^2) = \frac{Ma^2}{6}$

Also, $DO = \frac{DB}{2} = \frac{\sqrt{2}a}{2} = \frac{a}{\sqrt{2}}$

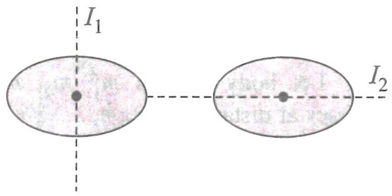
By parallel axes theorem, moment of inertia of plate about an axis through one of its corners.

$I_{mm'} = I_{nn'} + M\left(\frac{a}{\sqrt{2}}\right)^2 = \frac{Ma^2}{6} + \frac{Ma^2}{2}$

$= \frac{Ma^2 + 3Ma^2}{6} = \frac{2}{3}Ma^2$



46. (1)



$I_{centre} = I_1 = \frac{1}{2}MR^2$

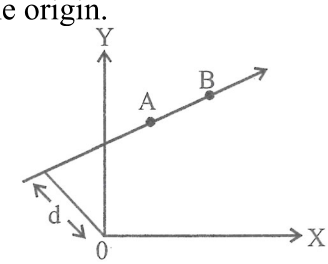
$\Rightarrow I_{diameter} = I_2 = \frac{1}{4}MR^2$

$\Rightarrow \frac{I_{centre}}{I_{diameter}} = \frac{\frac{1}{2}MR^2}{\frac{1}{4}MR^2} \Rightarrow \frac{MK_C^2}{MK_D^2} = 2$

$\Rightarrow \frac{K_C}{K_D} = \sqrt{2}$

47. (1)

Angular momentum = Linear momentum × distance of line of action of linear momentum about the origin.



$L_A = p_A \times d$, $L_B = p_B \times d$

As linear momenta are p_A and p_B equal, therefore, $L_A = L_B$.

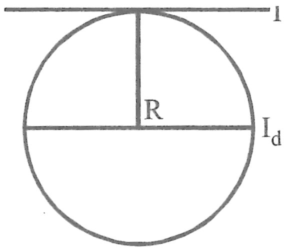
48. (3)

Moment of inertia of disc about its diameter is

$I_d = \frac{1}{4}MR^2$

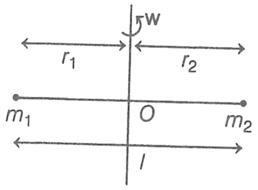
MI of disc about a tangent passing through rim and in the plane of disc is

$$I = I_d + MR^2 = \frac{1}{4}MR^2 + MR^2 = \frac{5}{4}MR^2R$$



49. (1)

COM of m_1 and m_2 masses lies at O and $r = \frac{m_1r_1 + m_2r_2}{m_1 + m_2}$, then $m_1r_1 = m_2r_2$ … (i)



and $r_1 + r_2 = l$ … (ii)

From Eqs. (i) and (ii), we get

$$r_1 = \frac{m_2 l}{m_1 + m_2} \text{ and } r_2 = \frac{m_1 l}{m_1 + m_2}$$

∴ Moment of inertia of the point masses about the given axis is

$$I = \sum m_i r_i^2 \Rightarrow I = m_1 r_1^2 + m_2 r_2^2$$

$$= m_1\left(\frac{m_2 l}{m_1 + m_2}\right)^2 + m_2\left(\frac{m_1 l}{m_1 + m_2}\right)^2$$

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

50. (4)

Moment of inertia of a hollow cylinder about its axis = Mr^2.