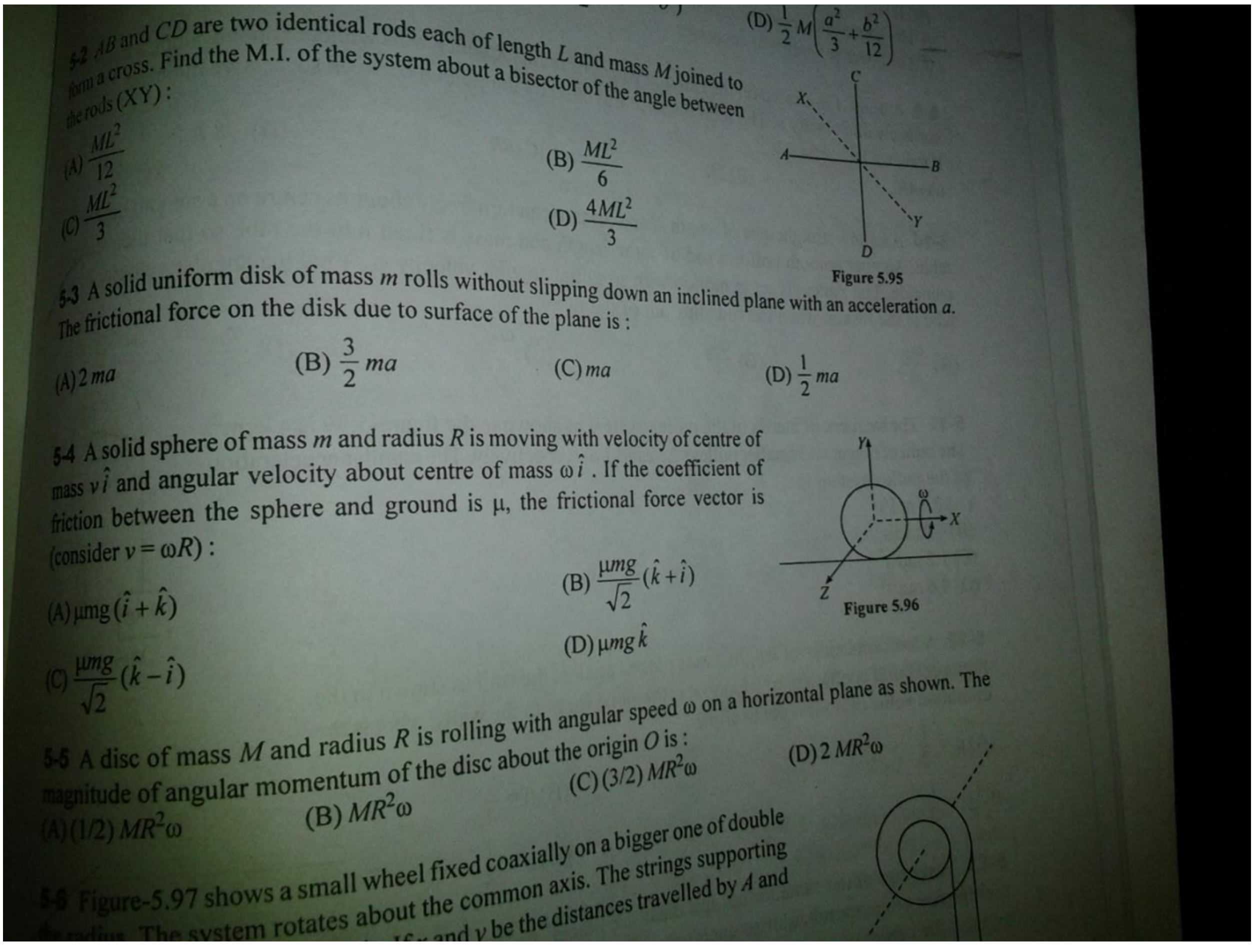
Answer on Question#56568 - Physics - Mechanics - Relativity



5-2 AB and CD are two identical rods each of length L and mass M joined to form a cross. Find the M.I. of the system about a bisector of the angle between the rods (XY) :

(A) $\frac{ML^2}{12}$ (B) $\frac{ML^2}{6}$

(C) $\frac{ML^2}{3}$ (D) $\frac{4ML^2}{3}$

Figure 5.95

5-3 A solid uniform disk of mass m rolls without slipping down an inclined plane with an acceleration a. The frictional force on the disk due to surface of the plane is :

(A) $2ma$ (B) $\frac{3}{2}ma$ (C) ma (D) $\frac{1}{2}ma$

5-4 A solid sphere of mass m and radius R is moving with velocity of centre of mass $v\hat{i}$ and angular velocity about centre of mass $\omega\hat{i}$. If the coefficient of friction between the sphere and ground is μ, the frictional force vector is (consider $v = \omega R$) :

(A) $\mu mg(\hat{i}+\hat{k})$ (B) $\frac{\mu mg}{\sqrt{2}}(\hat{k}+\hat{i})$

(C) $\frac{\mu mg}{\sqrt{2}}(\hat{k}-\hat{i})$ (D) $\mu mg\,\hat{k}$

Figure 5.96

5-5 A disc of mass M and radius R is rolling with angular speed ω on a horizontal plane as shown. The magnitude of angular momentum of the disc about the origin O is :

(A) $(1/2)MR^2\omega$ (B) $MR^2\omega$ (C) $(3/2)MR^2\omega$ (D) $2MR^2\omega$

5-6 Figure-5.97 shows a small wheel fixed coaxially on a bigger one of double the radius. The system rotates about the common axis. The strings supporting ... If x and y be the distances travelled by A and

<u>Solution:</u>

(2) The moment of inertia of one rod is $I_r = \frac{1}{12}ML^2$. The moment of inertia of the cross about the axis z perpendicular to it and passing through it center is

$$I_z = 2I_r = \frac{1}{6}ML^2$$

Due to the symmetry of this cross relatively to z-axis, the moments of inertia of the cross about the axes perpendicular to z-axis and passing through its center are all the same and equal to half the I_z (there is a corresponding theorem). Thus the required moment of inertia is

$$I = \frac{1}{2}I_z = \frac{1}{12}ML^2$$

(4) The direction of the force of friction is opposite to the direction of the velocity vector of the point on the sphere that touches the ground. The direction of this velocity (taking into account that $v = \omega r$) is

$$\boldsymbol{\tau}_v = \frac{1}{\sqrt{2}}(\hat{\imath} - \hat{k})$$

Therefore, the direction of the force of friction is

$$\boldsymbol{l}_f = -\boldsymbol{\tau}_v = \frac{1}{\sqrt{2}}(\hat{k} - \hat{\imath})$$

The magnitude of the force of friction is

$$F_f = mg\mu$$

Thus the frictional force vector is

$$\boldsymbol{F_f} = F_f \cdot \boldsymbol{l_f} = \frac{mg\mu}{\sqrt{2}}\left(\hat{k} - \hat{\imath}\right)$$

(5) The moment of inertia of the disk about its center is

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

According to the parallel axis theorem the moment of inertia about the origin is

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

Answer:

(2) (A)
(4) (C)
(5) (C)