QUIZ#10- CHAPTER 11
DATE: 4/12/17

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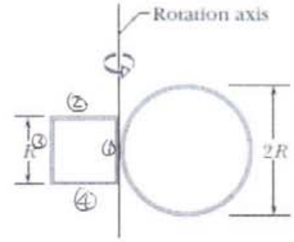
The figure shows a rigid structure consisting od a cirular hoop of radius R = 10 cm and mass M = 1.0 kg and a square made pf four thin rods of length L = R = 10 cm and mass m = M = 1.0 kg. The structure rotates about the axis with angular speed of 50 rad/s.
Calcluate the angular momentum about the axis of rotation.



$I_{hoop} = I_{cm} + mh^2 = \frac{1}{2} mR^2 + mR^2 = \frac{3}{2} mR^2$

$I_{square} = I_{rod1} + I_{rod2} + I_{rod3} + I_{rod4}$

$I_{rod1} = 0 \qquad I_{rod2} = I_{rod4} = I_{cm} + mh^2$

$= \frac{1}{12} mR^2 + m\left(\frac{R}{2}\right)^2 = \frac{1}{3} mR^2$

$I_{rod3} = I_{cm} + mh^2 = 0 + mR^2$

$I_{square} = \frac{1}{3} mR^2 + \frac{1}{3} mR^2 + mR^2 = \frac{5}{3} mR^2$

$I_{structure} = I_{hoop} + I_{square} = \frac{3}{2} mR^2 + \frac{5}{3} mR^2 = \frac{19}{6} mR^2$

$= 0.0317 \text{ Kg} \cdot \text{m}^2$

$L = I\omega = (0.0317)(50) = \boxed{1.59 \text{ Kg } \frac{m^2}{s}}$

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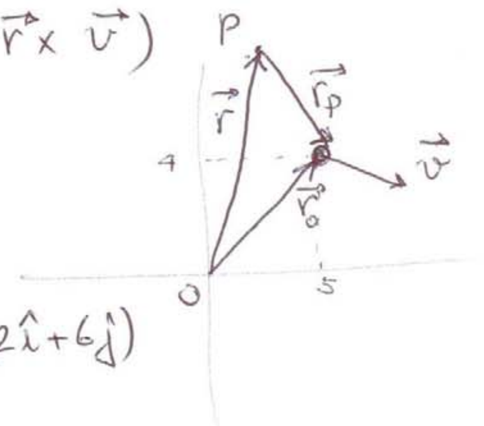
A particle of mass m = 2.0 kg located at a position **r** = 5**i** +4**j** (m) moves with a velocity **v** = 4**i** – 10**j** (m/s). Calculate the angular momentum of the particle about point P located at (2, 6) m.

$$\vec{\ell} = \vec{r} \times \vec{p} = m(\vec{r} \times \vec{v})$$



$$\vec{r} + \vec{r_p} = \vec{r_o}$$

$$\vec{r_p} = \vec{r_o} - \vec{r}$$

$$= (5\hat{i} + 4\hat{j}) - (2\hat{i} + 6\hat{j})$$

$$= 3\hat{i} - 2\hat{j}$$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & -2 & 0 \\ 4 & -10 & 0 \end{vmatrix} = 0\hat{i} + 0\hat{j} + (-30 + 8)\hat{k}$$

$$= -22\hat{k}$$

$$\vec{\ell} = 2 \times (-22)\hat{k} = -44\hat{k} \ \ \text{Kg} \cdot \frac{m^2}{s}$$

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The figure shows an overhead view of a horizontal rod of mass 3.0 kg and length 2.0 m at rest and the axis of rotation is at one end. A ball of mass 10 g and moves with a speed of 100 m/s hits the rod at the other end and sticks to it. The system rotates about the pivot point after collision. Calculate the angular speed of the sytem just after the collision.

$$L_i = L_f$$

$$L_i = I_i\,\omega_i \qquad L_f = I_f\,\omega_f$$

$$L_i = m_b v_b r_b \sin 90^\circ = (0.01)(100)(2) = 2\ \mathrm{kg}\,\frac{m^2}{s}$$

$$L_f = \left(I_{rod} + m_b r_b^2\right)\omega_f$$

$$= \left(\frac{1}{3} m_{rod} L^2 + m_b r_b^2\right)\omega_f$$

$$= \left(\frac{1}{3}\times(3)(2)^2 + (0.01)(2)^2\right)\omega_f$$

$$= (4 + 0.04)\,\omega_f = 4.04\,\omega_f$$

$$2 = 4.04\,\omega_f \Rightarrow \boxed{\omega_f = 0.495\ \mathrm{rad/s}}$$