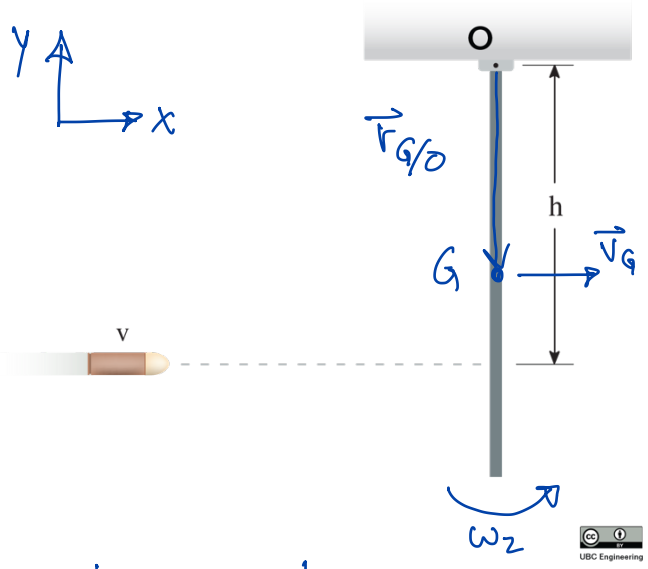
Consider the uniform thin rod shown with mass m_r = 3.3 kg and angular velocity just after impact from the bullet of ω_2 = 12 rad/s. Find the linear momentum and angular momentum about O for the rod. The distance h = 0.6 m and the total length of the rod is L = 0.8 m.



Just after impact, rod only.

linear momentum

always $\vec{v}_{COG}$

$\vec{J} = m\vec{v}_G$

kinematics:

$\vec{v}_G = \vec{v}_O^{\,0} + \vec{\omega}_2 \times \vec{r}_{G/O}$

$\vec{r}_{G/O} = \frac{L}{2}(-\hat{j})$

$\vec{\omega}_2 = \omega_2 \hat{k}$

$\Rightarrow \vec{v}_G = \omega_2 \hat{k} \times \frac{L}{2}(-\hat{j})$

$= \frac{\omega_2 L}{2}\hat{i}$

$\vec{J} = 3.3\,kg\left(\frac{12\,rad/s\,(0.8\,m)}{2}\hat{i}\right)$

$\boxed{\vec{J} = 15.84\,kg\,m/s\,\hat{i}}$

angular momentum about O

because O is a pin

$\therefore \vec{K}_O = I_O\vec{\omega}_2$

$I_O = \frac{1}{3}mL^2$

$\vec{K}_O = \frac{1}{3}mL^2(\omega_2\hat{k})$

$= \frac{1}{3}(3.3\,kg)(0.8\,m)^2(12\,rad/s\,\hat{k})$

$\boxed{\vec{K}_O = 8.45\,\frac{kg\,m^2}{s}\hat{k}}$