

## Elementary Dynamics Example #48: (Rigid Body Kinetics – Impulse & Momentum #2)

Given: uniform cylindrical bag with mass  $m_{\text{bag}} = m = 100 \text{ (kg)}$

applied Impulse,  $I = 20 \text{ (N-s)}$

bag is at rest when the impulse is applied

Find:  $\omega$ , the angular velocity of bag just after impulse is applied  
 $d$ , the distance from top of bag to the instantaneous center

Solution:

The bag is at **rest** when the impulse  $I$  is applied. The tension and weight forces are in the  $y$ -direction only. Applying the principles of linear and angular impulse and momentum to the free body diagram gives

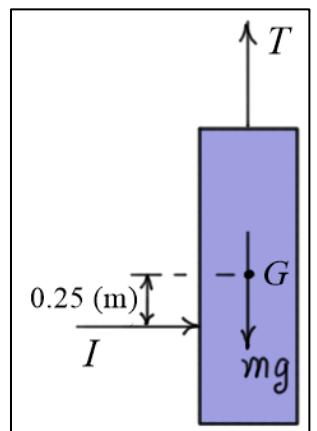
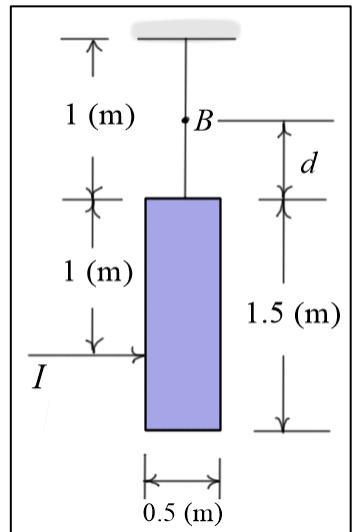
$$\underbrace{(L_1)_x}_{\text{zero}} + \sum(\text{Imp})_x = (L_2)_x$$

$$\underbrace{(H_G)_1}_{\text{zero}} + \sum \int M_G dt = (H_G)_2$$

$$\rightarrow I = m(v_G)_{2x} \Rightarrow (v_G)_{2x} = \frac{I}{m} \approx 0.266 \text{ (m/s)}$$

$$\therefore 0.25I = I_G \omega_2 = \frac{1}{12}m(3r^2 + h^2)\omega_2$$

$$\Rightarrow \omega_2 = \frac{0.25I}{\frac{1}{12}m(3r^2 + h^2)} \approx 0.328205 \approx 0.328 \text{ (rad/s)} \quad (\text{counterclockwise})$$



If  $B$  is the instantaneous center, then just after the impulse

$$(d + 0.75)\omega_2 = (v_G)_{2x} \Rightarrow d = \left( \frac{(v_G)_{2x}}{\omega_2} \right) - 0.75 \approx 0.0625 \text{ (m)}$$