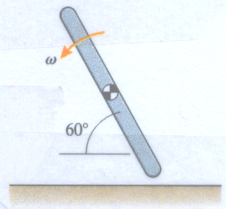
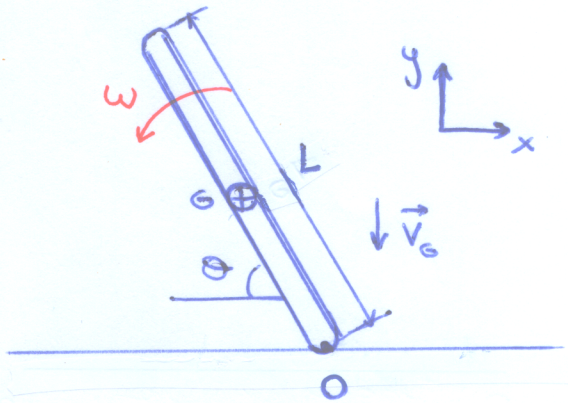
EX 19.81

Problem 19.81 The length of the bar is 1 m and its mass is 2 kg. Just before the bar hits the floor, its angular velocity is $\omega = 0$ and its center of mass is moving downward at 4 m/s. If the end of the bar adheres to the floor, what is the bar's angular velocity after the impact?



Solution



Data: $L = 1\ m$

$m = 2\ kg$

$\omega = 0$

$\vec{V} = 4\hat{j}\ m/s$

$\theta = 60°$

bar adheres to floor

The angular momentum about the point of contact O is conserved:

$$(\vec{H}_O)_{before} = (\vec{H}_O)_{after}$$

$$\Rightarrow \underbrace{(\vec{H})_{before} + \vec{r}_G \times m\vec{V}_G}_{\text{"}} = \underbrace{(\vec{H}_O)_{after}}_{\text{"}}$$

$$I\omega + \left(-\frac{L}{2}\cos\theta\,\hat{i} + \frac{L}{2}\sin\theta\,\hat{j}\right) \times m(-V_G)\hat{j} \qquad I_O\omega'\hat{k}$$

$\omega = 0$ (rotation about fixed point O)

$$\Rightarrow \quad m V_G \frac{L}{2}\cos\theta = I_O\omega' \Rightarrow \boxed{\omega' = \frac{3}{2}\frac{V_G}{L}\cos\theta} = 3\ rad/s$$

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