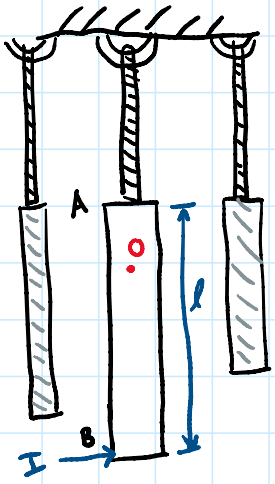
20-R-IM-DK-9

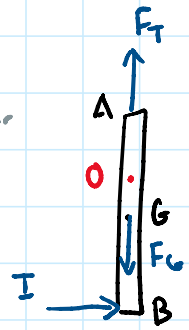
July 7, 2020 10:01 AM

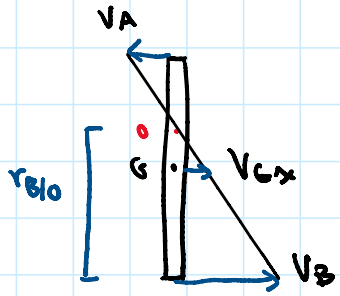
Intermediate Principle of Impulse and Momentum Video

Inspiration: 19-13 Hibbeler



Fade out the other rods, focus on central rod





A windchime consists of several slender rods, each suspended on one end by a rope and each with mass ***m***. Consider a singular rod for this problem. As the wind blows, the rod is subjected to an impulse ***I*** at its bottom. Determine the vertical location of point O in which the rod appears to rotate.

$$x: \quad m v_{Gx_1} + \sum \int_{t_1}^{t_2} F_x \, dt = m v_{Gx_2}$$

$$0 + I = m v_{Gx_2}$$

$$M: \quad I_G \omega_1 + \sum \int_{t_1}^{t_2} M_G \, dt = I_G \omega_2$$

$$0 + I\left(\frac{l}{2}\right) = \frac{1}{12} m l^2 \omega_2 \qquad I = \frac{1}{6} m l \omega_2$$

$$\frac{1}{6} m l \omega_2 = m v_{Gx_2} \qquad v_{Gx_2} = \frac{1}{6} l \omega_2$$

Point O acts as the ICEV $\Rightarrow v_B = \omega r_{B/O}$

$$\frac{v_B}{r_{B/O}} = \frac{v_{Gx}}{r_{B/O} - \frac{l}{2}} \qquad \frac{\omega r_{B/O}}{r_{B/O}} = \frac{\frac{1}{6} l \omega}{r_{B/O} - \frac{l}{2}}$$

$$\omega r_{B/O} - \omega \frac{l}{2} = \frac{1}{6} l \omega$$

$$r_{B/O} - \frac{l}{2} = \frac{1}{6} l$$

$$\boxed{r_{B/O} = \frac{2}{3} l}$$