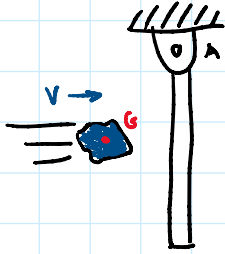


Beginner Impact

Inspiration: Hibbeler pg. 547



A $1\text{ m} \times 1\text{ m}$ plate is used as target practice at a firing range. This time a bean bag cannon is being used. If a bean bag has a mass of $m_{\text{bag}} = 2\text{ kg}$ and a radius of gyration $k_G = 0.1\text{ m}$, determine the angular velocity of the plate right after the bean bag strikes it in the center with a velocity of $v = 20\text{ m/s}$. The plate has a mass $m_{\text{plate}} = 20\text{ kg}$ and the coefficient of restitution is $e = 0.4$.

$$\sum (H_{A1}) = \sum (H_{A2})$$

$$H_B = \cancel{H_G^0} + r_{G/B} m v_B$$

$$\frac{I}{2} m_B v_{B1} = m_B v_{B2} \frac{I}{2} + m_P v_{P2} \frac{I}{2} + I_{G_P} \omega_2$$

$$\frac{1}{2}(2)(20) = (2)\left(\frac{1}{2}\right)v_{B2} + 20\left(\frac{1}{2}\right)v_{P2} + \frac{1}{12}(20)(1)^2 \omega_2$$

$$v_{P2} = \frac{I}{2} \omega_2 = \frac{1}{2} \omega_2$$

$$20 = v_{B2} + 5\omega_2 + \frac{20}{12}\omega_2 = v_{B2} + \frac{20}{3}\omega_2$$

$$e = \frac{v_{P2} - v_{B2}}{v_{B1} - v_{P1}}$$

$$0.4 = \frac{\frac{1}{2}\omega_2 - v_{B2}}{20 - 0}$$

$$8 = \frac{1}{2}\omega_2 - v_{B2} \quad v_{B2} = \frac{1}{2}\omega_2 - 8$$

$$20 = \frac{1}{2}\omega_2 - 8 + \frac{20}{3}\omega_2$$

$$\omega_2 = 3.906976 \text{ rad/s}$$