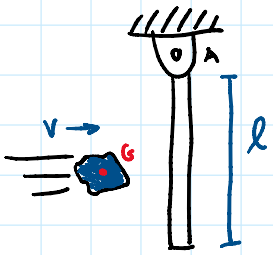
20-R-IM-DK-16

July 9, 2020 3:04 PM

Beginner Impact

Inspiration: Hibbeler pg. 547



A (x) 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=2 kg and a radius of gyration $k_G = 0.1$, determine the angular velocity of the plate right after the bean bag strikes it in the center with a velocity of v=20 m/s. The plate has a mass m=20 kg and the coefficient of restitution is e=0.4.

$$\Sigma(H_{A_1}) = \Sigma(H_{A_2}) \qquad H_B = H_G^{0} + r_{G/A} m v_B$$

$$\frac{\ell}{2} m_B v_{B_1} = m_B v_{B_2} \frac{\ell}{2} + m_p v_{p_2} \frac{\ell}{2} + I_{G_p} \omega_2$$

$$\frac{1}{2}(2)(20) = (2)\left(\tfrac{1}{2}\right) v_{B_2} + 20\left(\tfrac{1}{2}\right) v_{p_2} + \frac{1}{12}(20)(1)^2 \omega_2$$

$$v_{p_2} = \frac{\ell}{2}\omega_2 = \frac{1}{2}\omega_2$$

$$20 = v_{B_2} + 5\omega_2 + \frac{20}{12}\omega_2 = v_{B_2} + \frac{20}{3}\omega_2$$

$$e = \frac{v_{p_2} - v_{B_2}}{v_{B_1} - v_{p_1}} \qquad 0.4 = \frac{\frac{1}{2}\omega_2 - v_{B_2}}{20 - 0}$$

$$8 = \frac{1}{2}\omega_2 - v_{B_2} \qquad v_{B_2} = \frac{1}{2}\omega_2 - 8$$

$$20 = \frac{1}{2}\omega_2 - 8 + \frac{20}{3}\omega_2 \qquad \boxed{\omega_2 = 3.90697 \text{ rad/s}}$$