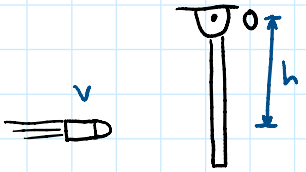
20-R-IM-DK-12

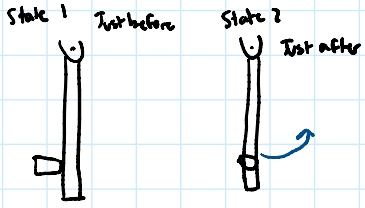
July 9, 2020 11:11 AM

Beginner Conservation of Momentum

Inspiration: Hibbeler Example 19.7



A ***1 m x 1 m*** thin plate is used as target practice at a firing range where participants are shooting for sport. If the plate has a mass of ***m = 20 kg*** and pinned at point O, determine the angular velocity of the plate just after a ***5 g*** bullet, shot at a velocity of ***v = 400 m/s***, is embedded in it. The bullet hits a vertical distance ***h = 0.75 m*** away from point O.



$$\Sigma (H_O)_1 = \Sigma (H_O)_2$$

$$m_{Bullet} v_{Bullet_1} h = m_{Bullet} v_{Bullet_2} h + m_{plate} v_{G_2} r_{G/O} + I_G \omega_2$$

$$(0.005)(400)(0.75) = (0.005) v_{B_2} (0.75) + (20) v_{G_2} (0.5) + \frac{1}{12}(20)(1)^2 \omega_2$$

$$1.5 = 0.00375\, v_{B_2} + 10\, v_{G_2} + \frac{20}{12} \omega_2$$

Pinned at O: $v_{G_2} = 0.5\, \omega_2$ $\quad v_{B_2} = 0.75\, \omega_2$

$$1.5 = 0.00375(0.75)\omega_2 + 10(0.5)\omega_2 + \frac{20}{12}\omega_2$$

$$\omega_2 = 0.2249 \text{ rad/s}$$