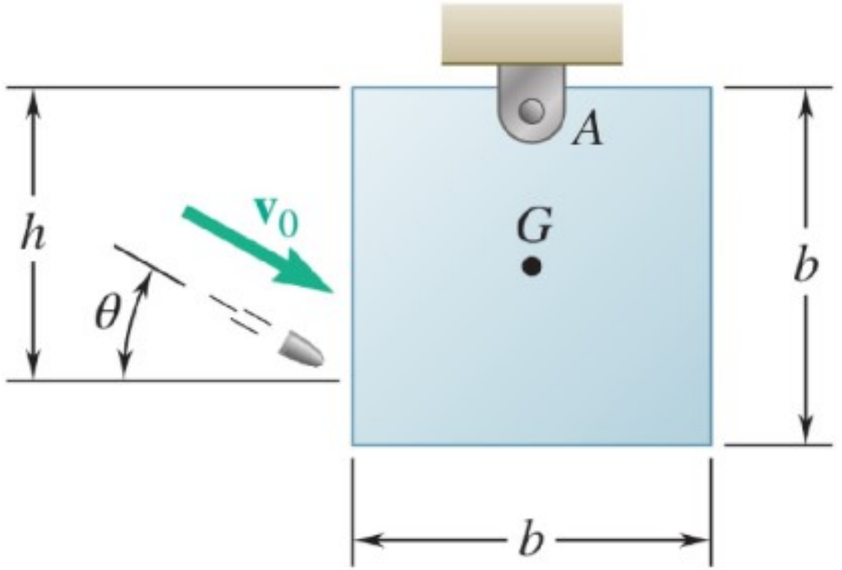
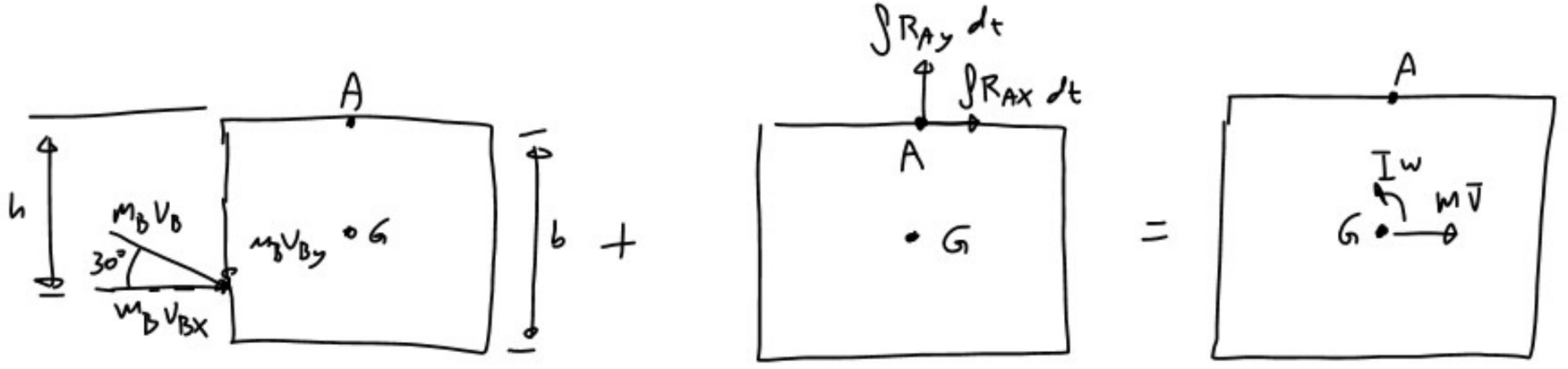
A 45-g bullet is fired with a velocity of 400 m/s at $\theta = 30°$ into a 9-kg square panel of side $b = 200$ mm. Knowing that $h = 150$ mm and that the panel is initially at rest, determine (*a*) the velocity of the center of the panel immediately after the bullet becomes embedded, (*b*) the impulsive reaction at *A*, assuming that the bullet becomes embedded in 2 ms.





$$\bar{v} = \omega \frac{b}{2}$$

$$I = \frac{1}{12} m (b^2 + b^2)$$

$$\sum H_{A1} + I_{mp_{1\to 2}} = \sum H_{A2}$$

$$m_B V_B \sin 30 \frac{b}{2} + m_B V_B \cos 30 \left(h - \tfrac{b}{2}\right) + 0 = I\omega + m\bar{v}\frac{b}{2}$$

$$= I\omega + m\omega\left(\frac{b}{2}\right)^2$$

$$= \left(I + m\left(\frac{b}{2}\right)^2\right)\omega$$

$$\frac{m_B V_B \sin 30 \frac{b}{2} + m_B V_B \cos 30 \left(h - \frac{b}{2}\right)}{I + m\left(\frac{b}{2}\right)^2} = \omega$$

$$\frac{0.045\ \text{kg}\ 400\ \text{m/s} \sin 30 \frac{0.2\ \text{m}}{2} + 0.045\ \text{kg}\ 400\ \text{m/s} \cos 30 \left(0.15\ \text{m} - \frac{0.2\ \text{m}}{2}\right)}{\frac{1}{12} 9\ \text{kg}\ (0.2\ \text{m})^2 2 + 9\ \text{kg}\left(\frac{0.2\ \text{m}}{2}\right)^2}$$

$$= 14\ \text{rad/s}$$

$$m_B V_{Bx} + \int R_{Ax}\, dt = m\bar{v}$$

$$m_B V_B \cos 30 + R_{Ax}\Delta t = m\,w\,\frac{b}{2}$$

$$R_{Ax}\Delta t = mw\frac{b}{2} - m_B V_B \cos 30$$

$$R_{Ax} = \frac{mw\frac{b}{2} - m_B V_B \cos 30}{\Delta t} = \frac{9\,kg\ 14\frac{rad}{s}\ \frac{0.2\,m}{2} - 0.045\,kg\ 400\,m/s\ \cos 30}{0.002\,s} = -1496\ \frac{kg\ m}{s^2} \approx \boxed{-1500\ N}$$

$$-m_B V_{By} + \int R_{Ay}\, dt = 0$$

$$-m_B V_B \sin 30 + R_{Ay}\Delta t = 0$$

$$R_{Ay}\Delta t = m_B V_B \sin 30$$

$$R_{Ay} = \frac{m_B V_B \sin 30}{\Delta t} = \frac{0.045\,kg\ 400\,m/s\ \sin 30}{0.002\,s} = \boxed{4500\ N}$$

A bullet weighing 0.08 lb is fired with a horizontal velocity of 1800 ft/s into the lower end of a slender 15-lb bar of length $L = 30$ in. Knowing that $h = 12$ in. and that the bar is initially at rest, determine (a) the angular velocity of the bar immediately after the bullet becomes embedded, (b) the impulsive reaction at C, assuming that the bullet becomes embedded in 0.001 s.

$\bar{I} = \frac{1}{12} mL^2$