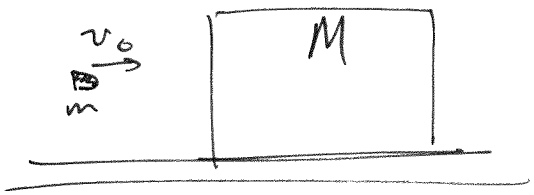
Chapter 9 Problem 37

bullet $m_0 = 200g = 0.200\,kg$

$v_0 = 400\,m/s$

Block $M = 1.50\,kg$

$v_{B0} = 0\,m/s$



a) What is the magnitude and direction velocity after the impact?

By conservation of momentum

$$P_0 = P_f$$

$$P_{Bullet_0} + P_{Block_0} = P_{Bullet_f} + P_{Block_f}$$

$$m_0 v_0 + 0 = m v_f + M v_f = (m+M) v_f$$

$$\frac{m v_0}{m+M} = v_f \rightarrow v_f = \frac{(0.200kg)(400m/s)}{0.200kg + 1.50kg} = 47.1\,\frac{m}{s}$$ to the right

b) What is the magnitude and direction of the impulse by the block on the bullet?

$$J = \Delta p_{Bullet} = p_{Bullet_f} - p_{Bullet_0} = m v_f - m v_0$$

$$J = m(v_f - v_0) = (0.200kg)[47.1 - 400]\,m/s$$

$$J = -70.6\ kg\,m/s$$ to the left

c) What is the magnitude and direction of the impulse by the bullet on the block?

$$J = \Delta p_{Block} = p_{Block_f} - p_{Block_0} = M v_f - 0 = (1.50kg)(47.1\,\frac{m}{s})$$

$$J = +70.6\ kg\,m/s$$ to the right

d) What is the average force if the impact took place over $\Delta t = 3\,m/s = 0.0030\,s$

$$J = F_{avg} \cdot \Delta t \rightarrow F_{avg} = \frac{J}{\Delta t} = \frac{70.6\ kg\,m/s}{0.0030\,s} = 23{,}500\,N$$