Question #14630

Let m_1, v_0 note the mass and initial velocity of arrow respectively. m_2 Is the mass of the block. Use the conservation of momentum and energy (v_1, v_2 are the velocities after collision of arrow and block respectively):

$$\text{Momentum: } m_1 v_0 = m_1 v_1 + m_2 v_2 \quad (1)$$
$$\text{Energy: } m_1 v_0^2 = m_1 v_1^2 + m_2 v_2^2 \quad (2)$$

From (1), $v_1 = v_0 - \frac{m_2}{m_1} v_2$, and substituting it into (2), obtain $v_2[-2\frac{m_2}{m_1} v_0 + (\frac{m_2}{m_1})^2 v_2 + m_2 v_2] = 0$

, which gives $v_2 = \frac{2\frac{m_2}{m_1} v_0}{[m_2 + (\frac{m_2}{m_1})^2]} \approx 3.6\, m/s$

For arrow, $v_1 = v_0 - \frac{m_2}{m_1} v_2 = -180\, m/s$ (At the moment of collision it changes the speed to the opposite, and gives some of its impulse to block).