

A 8.75-g bullet is moving horizontally with a velocity of +351 m/s, where the sign + indicates that it is moving to the right (see part a of the drawing). The bullet is approaching two blocks resting on a horizontal frictionless surface. Air resistance is negligible. The bullet passes completely through the first block (an inelastic collision) and embeds itself in the second one, as indicated in part b. Note that both blocks are moving after the collision with the bullet. The mass of the first block is 1249 g, and its velocity is +0.731 m/s after the bullet passes through it. The mass of the second block is 1502 g.

(a) What is the velocity of the second block after the bullet imbeds itself? (b) Find the ratio of the total kinetic energy after the collision to that before the collision.

Solution

m_1 – mass of the first block, m_2 – mass of the second block, m_B – mass of the bullet,

v_B – velocity of the bullet, v_1 – velocity of the first block after the collision, v_2 - the velocity of the second block with bullet after the bullet imbeds itself.

According to the conservation of momentum law total momentum of system before the collision is equal to total momentum of system after the collision:

$$m_B v_B = m_1 v_1 + (m_2 + m_B) v_2.$$

The velocity of the second block after the bullet imbeds itself:

$$v_2 = \frac{m_B v_B - m_1 v_1}{(m_2 + m_B)} = \frac{8.75 * 10^{-3} * 351 - 1249 * 10^{-3} * 0.731}{(1502 * 10^{-3} + 8.75 * 10^{-3})} = 1.43 \frac{m}{s}.$$

Total kinetic energy after the collision:

$$K_{\text{after}} = \frac{m_1 v_1^2}{2} + \frac{(m_2 + m_B) v_2^2}{2}.$$

Total kinetic energy before the collision:

$$K_{\text{before}} = \frac{m_B v_B^2}{2}.$$

The ratio of the total kinetic energy after the collision to that before the collision:

$$\begin{aligned} \frac{K_{\text{after}}}{K_{\text{before}}} &= \frac{\frac{m_1 v_1^2}{2} + \frac{(m_2 + m_B) v_2^2}{2}}{\frac{m_B v_B^2}{2}} = \frac{m_1 v_1^2 + (m_2 + m_B) v_2^2}{m_B v_B^2} \\ &= \frac{1249 * 10^{-3} * 0.731^2 + (1502 * 10^{-3} + 8.75 * 10^{-3}) * 1.43^2}{8.75 * 10^{-3} * 351^2} = 3.48 * 10^{-3}. \end{aligned}$$

Answer: (a) $1.43 \frac{m}{s}$; (b) $3.48 * 10^{-3}$.