SAMPLE PROBLEM F

Kinetic Energy in Perfectly Inelastic Collisions

PROBLEM

Two clay balls collide head-on in a perfectly inelastic collision. The first ball has a mass of 0.500 kg and an initial velocity of 4.00 m/s to the right. The second ball has a mass of 0.250 kg and an initial velocity of 3.00 m/s to the left. What is the decrease in kinetic energy during the collision?

SOLUTION

1. DEFINE

Given: $m_1 = 0.500 \text{ kg} \quad m_2 = 0.250 \text{ kg}$

$\mathbf{v_{1,i}} = 4.00 \text{ m/s to the right}, v_{1,i} = +4.00 \text{ m/s}$

$\mathbf{v_{2,i}} = 3.00 \text{ m/s to the left}, v_{2,i} = -3.00 \text{ m/s}$

Unknown: $\Delta KE = ?$

2. PLAN

Choose an equation or situation: The change in kinetic energy is simply the initial kinetic energy subtracted from the final kinetic energy.

$$\Delta KE = KE_f - KE_i$$

Determine both the initial and final kinetic energy.

Initial: $KE_i = KE_{1,i} + KE_{2,i} = \frac{1}{2}m_1 v_{1,i}^2 + \frac{1}{2}m_2 v_{2,i}^2$

Final: $KE_f = KE_{1,f} + KE_{2,f} = \frac{1}{2}(m_1 + m_2)v_f^2$

As you did in Sample Problem E, use the equation for a perfectly inelastic collision to calculate the final velocity.

$$\mathbf{v_f} = \frac{m_1\mathbf{v_{1,i}} + m_2\mathbf{v_{2,i}}}{m_1 + m_2}$$

3. CALCULATE

Substitute the values into the equation and solve: First, calculate the final velocity, which will be used in the final kinetic energy equation.

$$v_f = \frac{(0.500 \text{ kg})(4.00 \text{ m/s}) + (0.250 \text{ kg})(-3.00 \text{ m/s})}{0.500 \text{ kg} + 0.250 \text{ kg}}$$

$\mathbf{v_f} = 1.67 \text{ m/s to the right}$

Next calculate the initial and final kinetic energy.

$$KE_i = \tfrac{1}{2}(0.500 \text{ kg})(4.00 \text{ m/s})^2 + \tfrac{1}{2}(0.250 \text{ kg})(-3.00 \text{ m/s})^2 = 5.12 \text{ J}$$

$$KE_f = \tfrac{1}{2}(0.500 \text{ kg} + 0.250 \text{ kg})(1.67 \text{ m/s})^2 = 1.05 \text{ J}$$

Finally, calculate the change in kinetic energy.

$$\Delta KE = KE_f - KE_i = 1.05 \text{ J} - 5.12 \text{ J}$$

$$\boxed{\Delta KE = -4.07 \text{ J}}$$

4. EVALUATE

The negative sign indicates that kinetic energy is lost.