Physics 151 Class Exercise: Momentum II-KEY

1. A 0.43 kg red hockey puck slides at 5.5 m/s into a 0.62 kg blue hockey puck that is at rest on the ice as is shown in the diagram. Find the velocities of the pucks after the inelastic collision.

\[ p_{xi} = p_{xf} \]
\[ m_A v_A = m_A v'_A \cos 65^\circ + m_B v'_B \cos 37^\circ \]
\[ p_{yi} = p_{yf} \]
\[ 0 = m_A v'_A \sin 65^\circ - m_B v'_B \sin 37^\circ \]

Let’s solve the \( p_y \) equation for \( v_{A'} \) and substitute into the \( p_x \) equation where we will solve for \( v_{B'} \).

\[ 0 = m_A v'_A \sin 65^\circ - m_B v'_B \sin 37^\circ \]
\[ v'_A = \frac{m_B v'_B \sin 37^\circ}{m_A \sin 65^\circ} \]
\[ m_A v'_A = m_A v'_A \cos 65^\circ + m_B v'_B \cos 37^\circ \]
\[ m_A v'_A = m_A \left( \frac{m_B v'_B \sin 37^\circ}{m_A \sin 65^\circ} \cos 65^\circ + m_B \cos 37^\circ \right) \]

\[ v'_B = \frac{m_A v'_A}{m_B \left( \frac{\sin 37^\circ}{\tan 65^\circ} + \cos 37^\circ \right)} = \frac{(0.43 \text{ kg}) \left( 5.5 \frac{m}{s} \right)}{(0.62 \text{ kg})(1.079)} = 3.53 \frac{m}{s} \approx 3.5 \frac{m}{s} \]

Now plug this value back into the \( p_y \) equation and solve for \( v_{A'} \).

\[ 0 = m_A v'_A \sin 65^\circ - m_B v'_B \sin 37^\circ \]
\[ v'_A = \frac{m_B v'_B \sin 37^\circ}{m_A \sin 65^\circ} = \frac{(0.62 \text{ kg}) \left( 3.53 \frac{m}{s} \right) \sin 37^\circ}{(0.43 \text{ kg}) \sin 65^\circ} = 3.38 \frac{m}{s} \approx 3.4 \frac{m}{s} \]
2. A 0.430-kg block is attached to a horizontal spring that is at its equilibrium length, and whose force constant is 20.0 N/m. The block rests on a frictionless surface. A 0.0500-kg wad of putty is thrown horizontally at the block, hitting it with a speed of 2.30 m/s and sticking.

(a) How far does the putty-block system compress the spring?

Use momentum conservation to determine the speed of the putty-block system just after the collision.

\[ m_b(0) + m_p v_p = (m_b + m_p) v_f \]

\[ v_f = \frac{m_p}{m_p + m_b} v_p \]

Use \( v_f \) to determine \( K_f \) and equate \( K_f \) with the spring potential energy.

\[ \frac{1}{2} (m_p + m_b) \left( \frac{m_p}{m_p + m_b} \right)^2 v_p^2 = \frac{1}{2} k \Delta x^2 \]

\[ \Delta x = \sqrt{\frac{m_p^2 v_p^2}{k(m_p + m_b)}} = \sqrt{\frac{(0.0500 \text{ kg})^2 (2.30 \text{ m/s})^2}{20.0 \text{ N/m}(0.0500 \text{ kg} + 0.430 \text{ kg})}} = 3.71 \text{ cm} \]