Part B Combined momentum-energy problems

Given:
- \( m_1 = 0.440 \text{ kg} \)
- \( m_2 = 0.0720 \text{ kg} \)
- \( v_{2i} = 5.74 \text{ m/s} \)

System: 2 blocks
Goal: Compare final and initial kinetic energy.

External forces: gravity does not change velocity at instant of impact = 0

Notes:
- Initial: before inelastic collision
- Final: after inelastic collision

\[
\begin{align*}
P_f &= P_i \\
P_{1f} + P_{2f} &= P_{1i} + P_{2i} \\
0 + m_2 v_{2f} &= (m_1 + m_2) v_f \\
v_f &= \frac{m_2 v_{2i}}{m_1 + m_2} \\
v_f &= \frac{0.0720 \text{ kg}(5.74 \text{ m/s})}{0.440 \text{ kg} + 0.0720 \text{ kg}} \\
v_f &= 0.892 \text{ m/s}
\end{align*}
\]

\[
\begin{align*}
k_i &= \frac{1}{2} m_1 v_{2i}^2 \\
k_f &= \frac{1}{2} (m_1 + m_2) v_f^2 \\
k_i &= \frac{1}{2} (0.0720 \text{ kg})(5.74 \text{ m/s})^2 \\
k_f &= \frac{1}{2} ((0.440 \text{ kg} + 0.0720 \text{ kg})(0.892 \text{ m/s})^2 \\
k_i &= 1.19 \text{ J} \\
k_f &= 0.167 \text{ J}
\end{align*}
\]

Mechanical Energy was not conserved because the kinetic energy before the collision does not equal the kinetic energy after the collision. However, potential energy is not considered because the system remains at the same height above the Earth throughout the collision.
Goal: Find $h_f$.

Given: $m_1 = 0.440$ kg, $m_2 = 0.0720$ kg
Found: $v = 0.307$ m/s

System: block, putty, Earth

External Forces: normal force and gravity of block on putty add to 0
Ignore air friction

States: Initial: mass moves upward at velocity $v_i$
Final: mass stops rising due to gravity.

\[
\begin{align*}
\text{Work} &= \Delta E_{sys} \\
0 &= \Delta E_{gy} \\
0 &= \Delta K + \Delta U \\
0 &= \frac{1}{2} (m_1 + m_2) v_i^2 - \frac{1}{2} (m_1 + m_2) v_f^2 + (m_1 + m_2) g h_f - (m_1 + m_2) g h_i \\
0 &= (m_1 + m_2) g h_f - \frac{1}{2} (m_1 + m_2) v_i^2 \\
0 &= \frac{1}{2} v_i^2 \\
0 &= \frac{1}{2} \left(0.307 \text{ m/s}\right)^2 \\
9.81 \text{ m/s}^2 \\
h_f &= 0.0332 \text{ m}
\end{align*}
\]