From lecture 16: question 73

a) \( V_1 = -4.85 \text{ m/s} \)
\( V_3 = -4.85 \text{ m/s} \)

\[ \frac{1}{2} m_1 v_1^2 = m_1 g h \]
\[ v_3 = \sqrt{2gh} \] put in direction by hand

b) \( m_1 v_{1i} + m_2 v_{ai} = m_1 v_{1f} + m_2 v_{af} \)
\[ m_1 = m_a, \ v_1 = v_e' \]
\[ m_2 = m_t, \ v_2 = v_t \]
\[ m_2 v_{3f} + m_1 v_{i} = m_2 v_{1f} + m_1 v_{af} \]
\[ 0.59 (4.85) + 0.057 (-4.85) = 0.59 (v_{1f}) + 0.057 (v_{af}) \]
\[ 0.59 v_{1f} + 0.057 v_{af} = 2.58 \] ①

Elastic Collision:
\[ \frac{1}{2} m_1 v_{1i}^2 + \frac{1}{2} m_2 v_{ai}^2 = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{af}^2 \]
not linear variables squared

For 1D: \( m_1 v_{ai} - m_1 v_{1f} = -m_2 v_{al} + m_2 v_{af} \)
\[ m_1 (v_{1i} - v_{1f}) = m_2 (v_{af} - v_{ai}) \] ②

\[ m_1 v_{1i}^2 - m_1 v_{1f}^2 = -m_2 v_{ai}^2 + m_2 v_{af}^2 \]
\[ m_1 (v_{1i}^2 - v_{1f}^2) = m_2 (v_{af}^2 - v_{ai}^2) \]
\[ m_1 (v_{1i} - v_{1f}) (v_{ai} + v_{1f}) = m_2 (v_{af} - v_{ai}) (v_{af} - v_{ai}) \] can cancel from equation ②

Therefore: \( v_{1i} + v_{1f} = v_{ai} + v_{af} \)
\[ 4.85 + v_{1f} = -4.85 + v_{af} \]
\[ v_{1f} - v_{af} = -9.7 \] ③ now, 1 and 3 are simultaneous:
\[ v_{1f} = 3.11 \text{ m/s} \]
\[ v_{af} = 12.81 \text{ m/s} \]

b) \[ \frac{1}{2} m_1 v_{af}^2 = m_1 g h' \]
\[ h' = \frac{v_{af}^2}{2g} \]
\[ h' = 8.37 \text{ m} \]
Inelastic Equations
KE not conserved (some lost @ collision)
p still conserved

DEMO: Bullet shot at ballistic pendulum; perfectly inelastic because bullet sticks inside pendulum. After collision, \( V_{1f} = V_{af} \).
Part 1: p conservation when bullet hits, find \( v_f \)
Part 2: conservation of energy

Sometimes, \( KE_f > KE_i \), as in gun recoil so \( p_f = 0 \)

CQ: gun (mass \( M \)), bullet (mass \( m \)), \( V_b = + V_b \)
\( V_g = ??? \)
0 = \( m V_b + M V_g \)
\( V_g = -(m/M) V_b \)

CQ: \[ \frac{\Delta p}{0} \text{ and } \frac{\Delta KE}{\frac{1}{2} m V_b^2 (1 + \frac{m}{M})} \]

DEMO: To move, planes need air, changes \( p \). In space, there is no air. To move, the astronaut, she must throw something away from the shuttle (direction she wants to go)