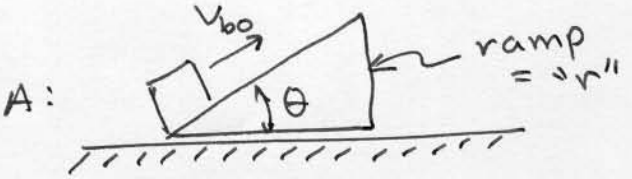
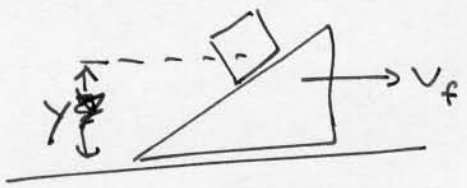
Problem 3

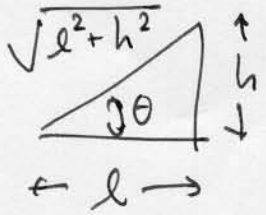
$E_A = E_B$ (only conservative forces)





$$\frac{1}{2} m_b v_{bo}^2 = \frac{1}{2}(m_b + m_r) v_f^2 + m_b g y$$

$p_{Ax} = p_{Bx}$ (no external forces in x dir)



$$m_b v_{bo} \cos\theta = (m_b + m_r) v_f$$

$$\cos\theta = \frac{l}{\sqrt{l^2+h^2}}$$

$$m_b v_{bo} \frac{l}{\sqrt{l^2+h^2}} = (m_b + m_r) v_f$$

Elim v_f: $$v_f = \frac{m_b}{m_b + m_r} \frac{l}{\sqrt{l^2+h^2}} v_{bo}$$

$$\frac{1}{2} m_b v_{bo}^2 = \frac{1}{2} (m_b + m_r) \frac{m_b^2}{(m_b + m_r)^2} \frac{l^2}{l^2+h^2} v_{bo}^2 + m_b g y$$

$$\frac{1}{2} m_b \left(1 - \frac{m_b}{m_b + m_r} \frac{l^2}{l^2+h^2}\right) v_{bo}^2 = m_b g y$$

$$y = \frac{1}{2g}\left(1 - \frac{m_b}{m_b + m_r} \frac{l^2}{l^2+h^2}\right) v_{bo}^2 = 1.9 \times 10^{-3}\ \text{m}$$

(1.9 mm)