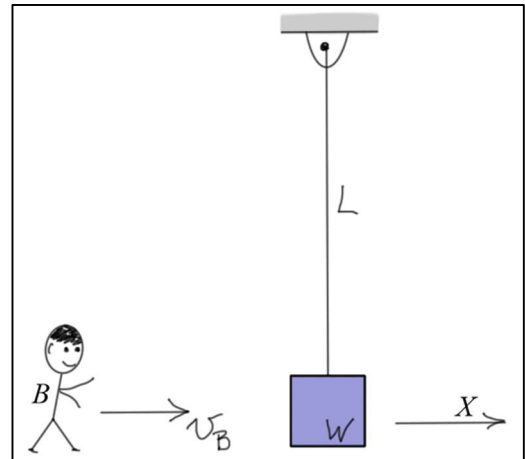Elementary Dynamics Example #26: (Conservation of Momentum)

Given: $W = 25$ (lb), $W_B = 100$ (lb),

$v_B = 10$ (ft/s), $L = 20$ (ft)

boy (B) has velocity v_B as he jumps onto weight W and both swing together
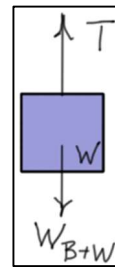
Find: h the **maximum height** they swing together

Solution: (*conservation of momentum and energy*)

Using **conservation of linear momentum** for the boy and weight in the X direction: (no external forces in the X direction)

$$m_B \left(v_{Bx} \right)_1 + \underbrace{m_W \left(v_{Wx} \right)_1}_{\text{zero}} = \left(m_B + m_W \right) \left(v_x \right)_2$$

Solving:

$$\left(v_x \right)_2 = \frac{m_B \left(v_{Bx} \right)_1}{\left(m_B + m_W \right)} = \frac{W_B v_B}{\left(W_B + W \right)} = 8 \text{ (ft/s)}$$

Using **conservation of energy**: (from bottom of swing to maximum height)

$$K_2 + \underbrace{V_2}_{\text{zero}} = \underbrace{K_3}_{\text{zero}} + V_3$$ (assuming datum is at the starting position)

where

$$K_2 = \tfrac{1}{2} \left(\frac{W_B + W}{g} \right) \left[\left(v_x \right)_2 \right]^2 \qquad V_3 = \left(W_B + W \right) h$$

Solving gives

$$h = \frac{\left[\left(v_x \right)_2 \right]^2}{2g} \approx 0.994 \text{ (ft)}$$