

Elementary Dynamics Example #26: (Conservation of Momentum)

Given: $W = 25 \text{ (lb)}$, $W_B = 100 \text{ (lb)}$,

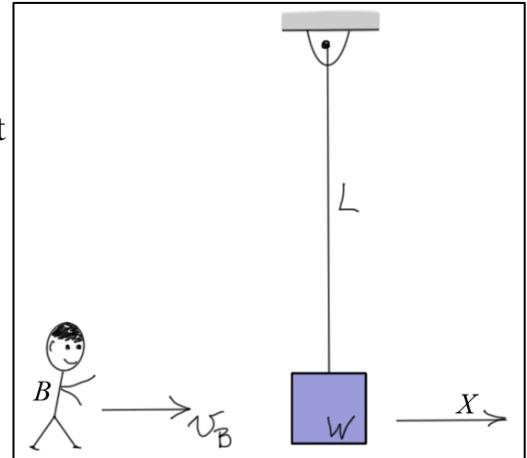
$v_B = 10 \text{ (ft/s)}$, $L = 20 \text{ (ft)}$

boy (B) has velocity v_B as he jumps onto weight W and both swing together

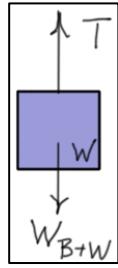
Find: h the **maximum height** they swing together

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)



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



Solving:

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

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

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

where

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

$$V_3 = (W_B + W) h$$

Solving gives

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