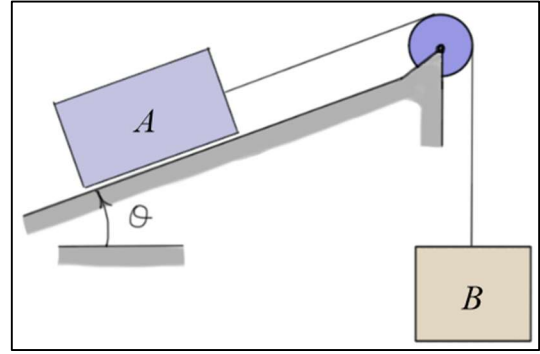


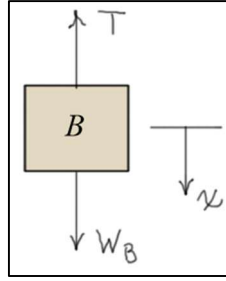
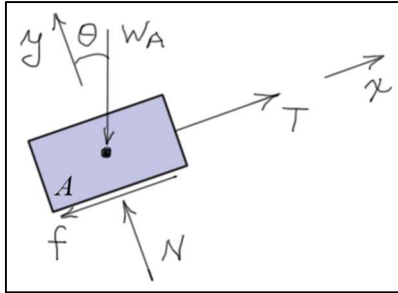
Elementary Dynamics Example #13: (Newton's Laws, Rectangular Components)

Given: $W_A = 100$ (lb), $\mu_s = 0.4$, $\mu_k = 0.3$, $\theta = 20$ (deg)
system is **released from rest**

Find: a) $(W_B)_{\min}$, the **minimum weight** for block B to make block A move up the plane.
b) s , the distance moved by the blocks after $\frac{1}{2}$ (sec) of motion if $W_B = 1.5(W_B)_{\min}$.



Solution:



Free body diagrams for motion or motion impending up the plane

For motion impending of block A up the plane:

$$A: \sum F_y = N - W_A \cos(\theta) = 0 \Rightarrow N = W_A \cos(\theta)$$

$$\sum F_x = T - W_A \sin(\theta) - \mu_s N = 0$$

$$\Rightarrow T = W_A \sin(\theta) + \mu_s N = W_A \sin(\theta) + \mu_s W_A \cos(\theta) \approx 71.7897 \approx 71.8 \text{ (lb)}$$

$$B: \sum F_x = (W_B)_{\min} - T = 0 \Rightarrow (W_B)_{\min} \approx 71.8 \text{ (lb)}$$

For motion of the block up the plane, set $W_B = 1.5(W_B)_{\min} \approx 107.685 \approx 108$ (lb)

$$A: \sum F_y = N - W_A \cos(\theta) = 0 \Rightarrow N = W_A \cos(\theta) \approx 93.969 \approx 94.0 \text{ (lb)}$$

$$\sum F_x = T - W_A \sin(\theta) - \mu_k N = \left(\frac{W_A}{g}\right) a_A$$

$$B: \sum F_x = W_B - T = \left(\frac{W_B}{g}\right) a_B$$

$$\left. \begin{array}{l} \sum F_x = T - W_A \sin(\theta) - \mu_k N = \left(\frac{W_A}{g}\right) a_A \\ \sum F_x = W_B - T = \left(\frac{W_B}{g}\right) a_B \end{array} \right\} a_A = a_B = a$$

Simultaneous equations:

$$\begin{array}{l} T - \left(\frac{W_A}{g}\right) a = W_A \sin(\theta) + \mu_k W_A \cos(\theta) \approx 62.3928 \\ T + \left(\frac{W_B}{g}\right) a = W_B = 108 \end{array}$$

$\Rightarrow$

$$\begin{array}{l} T \approx 84.3 \text{ (lb)} \\ a_A = a_B = a \approx 7.06 \text{ (ft/s}^2\text{)} \end{array}$$

For $\frac{1}{2}$ (sec) of constant acceleration of the blocks, we have

$$s(t) = s_0 + v_0 t + \frac{1}{2} a t^2 = \frac{1}{2} a \left(\frac{1}{2}\right)^2 \approx 0.8825 \approx 0.883 \text{ (ft)}$$