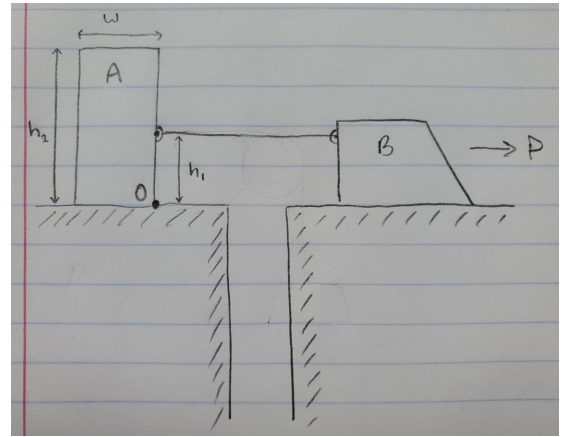


## 22-R-KIN-JL-13

You have set up the following block system such that blocks A and B are connected by a rope with tension  $T$ . You want to cause block A to either tip or slip first along the ground without touching it. So instead you decide to apply a force  $P$  on block B. Block A has a mass of 12 kg and block B has a mass of 8.5 kg. Block A has a height  $h_2 = 0.8$  m and a width  $w = 0.4$  m. The rope connects at a height  $h_1 = 0.4$  m and the coefficients of static and kinetic friction are given as  $\mu_s = 0.35$  and  $\mu_k = 0.3$ . Find the force  $P$  required to move the blocks and the tension  $T$  present in the ropes at that moment.



### Solution

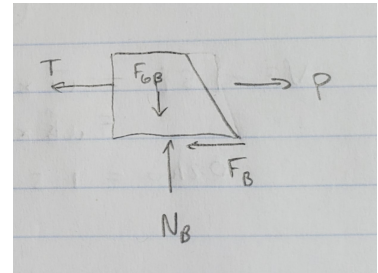
Begin by using the equations of motion for block B:

$$\begin{aligned}\sum F_{Bx} : P - F_B - T &= m_B(a_B)_x \\ \sum F_{By} : F_G - N_B &= m_B(a_B)_y = 0 \implies N_B = F_G = 83.4 \text{ N}\end{aligned}$$

For block B to slip:

$$P - F_B - T = 0$$

$$P = F_B + T = \mu_s N_B + T = 29.2 + T$$



Next use the equations of motion for block A:

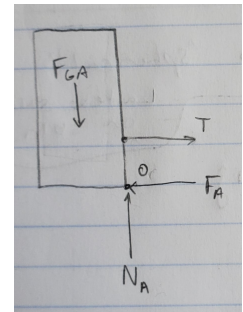
$$\begin{aligned}\sum F_{Ax} : T - F_A &= m_A(a_A)_x \\ \sum F_{Ay} : F_G - N_A &= m_A(a_A)_y = 0 \implies N_A = F_G = 177.7 \text{ N} \\ \sum M_O : T(h_1) - F_G(w/2) &= T(0.4) - 177.7(0.2) = I\alpha\end{aligned}$$

For block A to slip:

$$T - F_A = 0 \implies T = \mu_s N_A = 41.2 \text{ N}$$

For block A to tip:

$$T(h_1) - F_G(w/2) = 0 \implies T = \frac{177.7(0.2)}{0.4} = 58.9 \text{ N}$$



Since the tension to cause block A to slip is less, it will slip before tipping.

$$T = 41.2 \quad [\text{N}]$$

$$P = 29.2 + T = 70.4 \quad [\text{N}]$$