

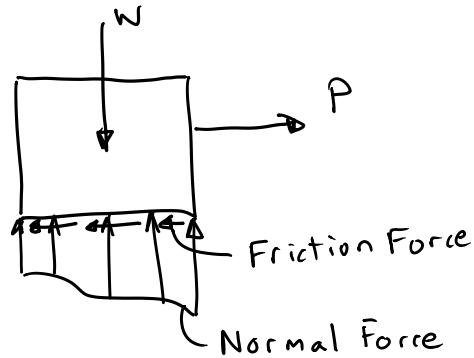
Friction

Force of resistance acting on a body that prevents slipping

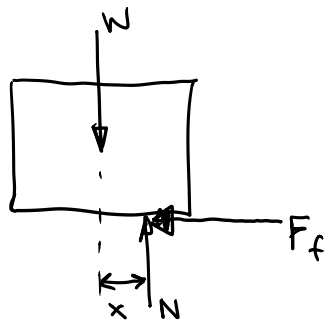
Dry Friction

No Lubrication

Free-Body Diagram



Simplified Free-Body Diagram



Maximum Frictional Resistance

$$F_{max} = \mu_s N$$

(Coefficient of Static Friction)

For Static Equilibrium

$$F_f < F_{max}$$

Impending Motion

$$F_f = F_{\max} \quad (\text{Onset of Motion})$$

If $F_f > F_{\max} \Rightarrow$ Motion Occurs

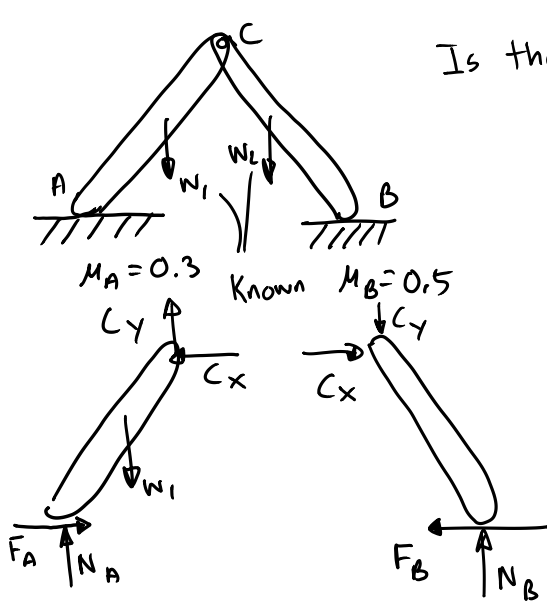
Then $F_f = \mu_k N$
 (Coefficient of Kinetic Friction)

$$\mu_k \approx 0.75 \mu_s$$

Types of Friction Problems

Case 1: Equilibrium

Number of unknowns is equal to the number of equilibrium equations



Is the structure in equilibrium?

Unknowns
 $F_A, N_A, F_B, N_B, C_x, C_y$ (6)

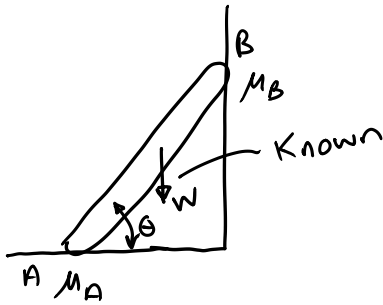
Equilibrium
 $(\sum F_x = 0, \sum F_y = 0, \sum M = 0) \times 2$ (6)

Friction
 $F_{A\max} = \mu_A N_A$
 $F_{B\max} = \mu_B N_B$

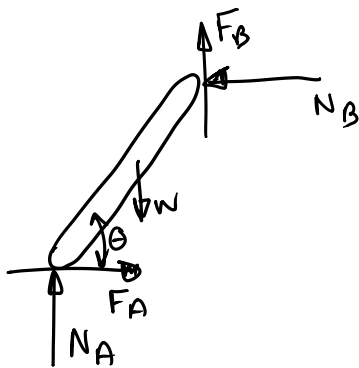
Equilibrium \Rightarrow Solve for the Unknowns
 Friction \Rightarrow Checks
 $F_A \stackrel{?}{<} F_{A\max}$ $F_B \stackrel{?}{<} F_{B\max}$

Case 2: Impending Motion at all Points

Number of Unknowns is equal to the number of unknowns plus all of the friction equations



Find the smallest θ for impending motion



Unknowns

$$\theta, F_A, N_A, F_B, N_B \quad (5)$$

Equilibrium

$$\sum F_x = 0, \sum F_y = 0, \sum M = 0 \quad (3)$$

Friction

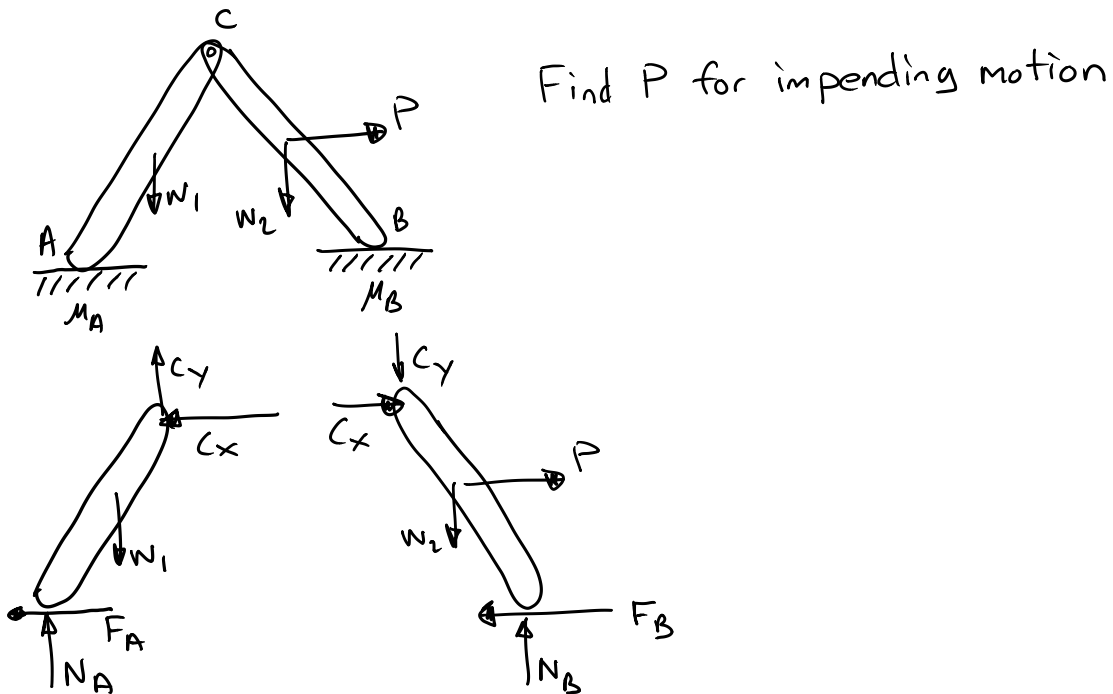
$$F_{Amax} = \mu_A N_A, F_{Bmax} = \mu_B N_B \quad (2)$$

$$\text{Set } F_A = F_{Amax}, F_B = F_{Bmax}$$

Think about your answers. Do they make sense? Is the normal force positive? Is the location of the normal force under the object? Slipping or tipping is possible. If your answers don't make sense, then you are assuming the wrong phenomenon. Change your assumption, and resolve.

Case 3: Impending Motion at Some Points

Number of unknowns is equal to the number of equilibrium equations plus some of the friction equations



Unknowns

$$F_A, N_A, F_B, N_B, C_x, C_y, P \quad (7)$$

Equilibrium

$$(\sum F_x = 0, \sum F_y = 0, \sum M = 0) \times 2 \quad (6)$$

Friction

$$F_{A_{max}} = \mu_A N_A, F_{B_{max}} = \mu_B N_B \quad (2)$$

Need 1 friction equation to solve for the unknowns,

Which one?

Either: P causes slipping at A, and no slipping at B

$$\text{Set } F_A = F_{A\max}$$

$$\text{Check } F_B \stackrel{?}{<} F_{B\max}$$

OR: P causes slipping at B, and no slipping at A

$$\text{Set } F_B = F_{B\max}$$

$$\text{Check } F_A \stackrel{?}{<} F_{A\max}$$