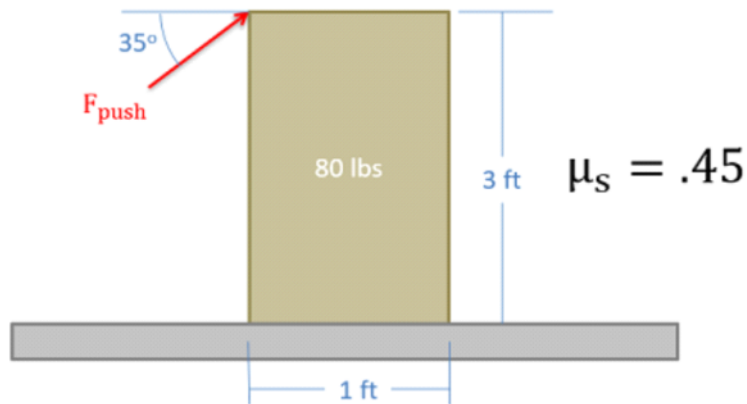
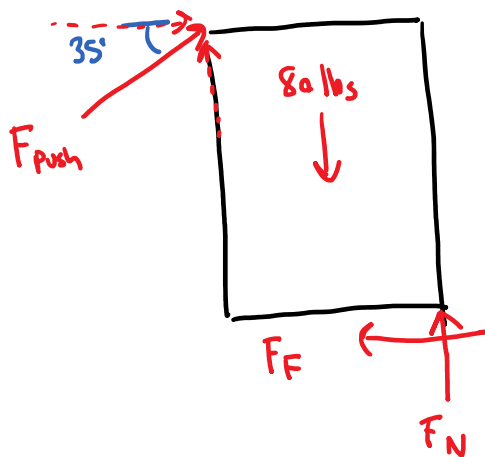


Problem 3

A pushing force is applied to the box as shown below. The magnitude of the force is increased until the box either tips over or begins to slide. Which will occur first? Assume the center of mass of the box is at the center point of the box.



Assume Slipping



$$F_F = .45 F_N$$

$$\sum F_x = F_{push} \cos(35) - .45 F_N = 0$$

$$\sum F_y = F_{push} \sin(35) - 80 + F_N = 0$$

$$F_{push} = \frac{.45}{\cos(35)} F_N$$

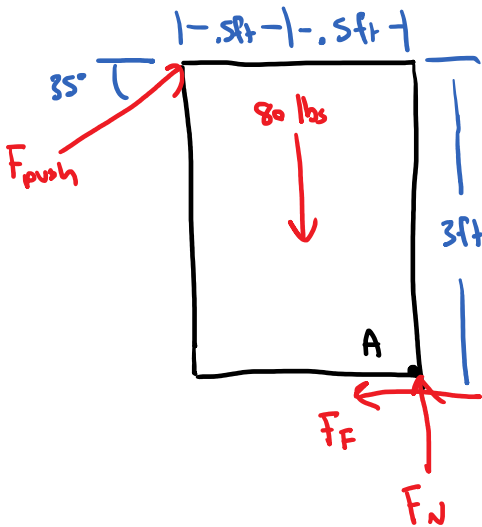
$$\left(\frac{.45}{\cos(35)} F_N \right) \sin(35) - 80 + F_N = 0$$

$$\left(\frac{.45}{\cos(35)} \sin(35) + 1 \right) F_N = 80$$

$$F_N = 60.83 \text{ lbs}$$

$$F_{push} = \underline{33.42 \text{ lbs}}$$

Assume Tipping



$$\sum M_A = F_{\text{push}} \cos(35)(3) + F_{\text{push}} \sin(35)(1)$$

$$-(80)(0.5) = 0$$

$$(\cos(35)(3) + \sin(35)(1))F_{\text{push}} = 40$$

$$\underline{F_{\text{push}} = 13.29 \text{ lbs}}$$

F_{push} lower for tipping. The box will tip first