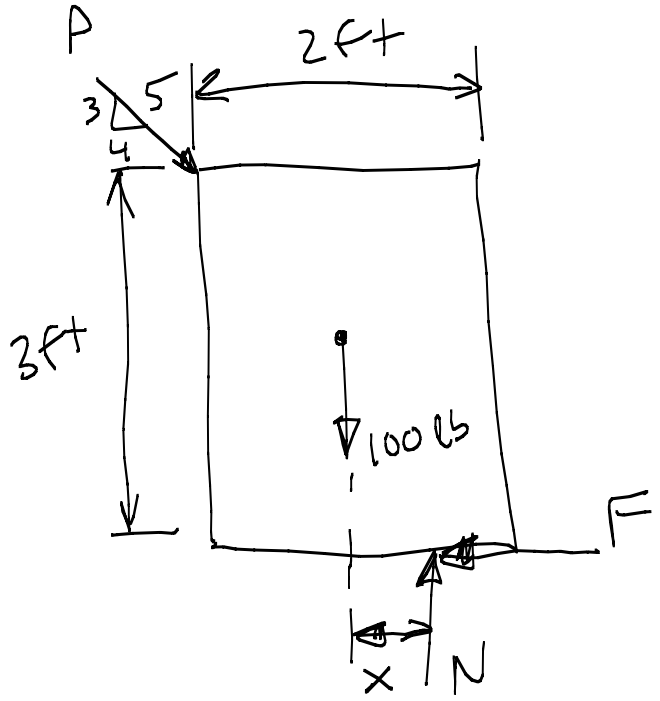
3

Assume Tipping

Set $x = 1\,ft$



$\mu_s = 0.6$

$+\circlearrowleft \sum M_{\substack{\text{Bottom}\\ \text{Right}\\ \text{Corner}\\ (x=1)}} = 0 \Rightarrow (100\,lb)(1\,ft) - \left(\frac{4}{5}P\right)(3\,ft) + \left(\frac{3}{5}P\right)(2\,ft) = 0$

$\boxed{P = 83.3\,lb}$

$\overset{+}{\rightarrow} \sum F_x = 0 \Rightarrow \left(\frac{4}{5}\right)(83.3\,lb) - F = 0$

$\boxed{F = 66.7\,lb}$

$+\uparrow \Sigma F_y = 0 \Rightarrow \quad N - 100\,lb - \left(\frac{3}{5}\right)(83.3\,lb) = 0$

$$\boxed{N = 150\,lb}$$

Check $\quad F \overset{?}{<} \mu_s N$

$66.7\,lb \overset{?}{<} (0.6)(150\,lb)$

$66.7\,lb < 90\,lb$ ✓ Tipping Occurs

$$\boxed{P = 83.3\,lb}$$

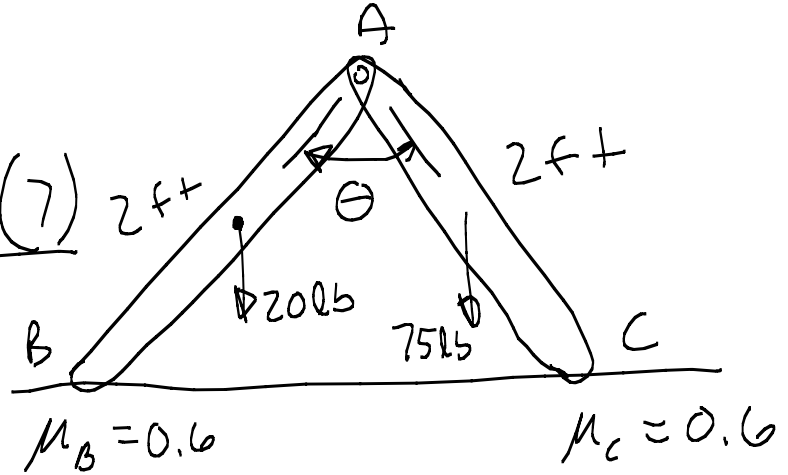
4) Unknowns

$A_x, A_y, \theta, N_B, F_B, F_C, N_C$ (7)

Equilibrium (6)

Friction (2)

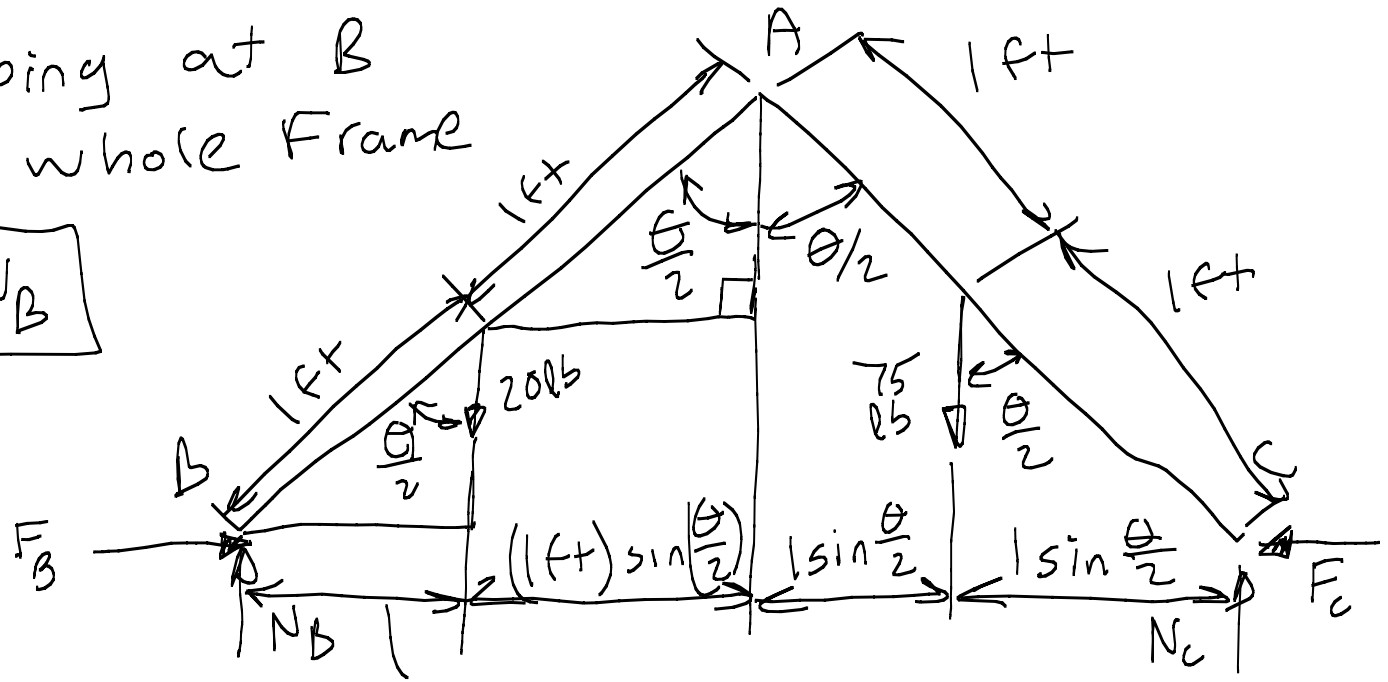
$F_B = \mu_B N_B$, $F_C = \mu_C N_C$



Assume Slipping at B

FBD of the whole Frame

Set $\boxed{F_B = \mu_B N_B}$



$$+\circlearrowleft \Sigma M_C = 0 \Rightarrow (75\,lb)\underbrace{(1\,ft\sin\tfrac{\theta}{2})}_{(1\,ft)\sin(\frac{\theta}{2})} + (20\,lb)(3\times 1\,ft\sin\tfrac{\theta}{2}) - N_B(4\times 1\sin\tfrac{\theta}{2}) = 0$$

$$\cancel{\sin\tfrac{\theta}{2}}\left((75)(1) + (20)(3) - N_B(4)\right) = 0$$

$$\boxed{N_B = 33.75\,lb}$$

$$F_B = \mu_B N_B = (0.6)(33.75\,lb) = 20.25\,lb$$

$$+\uparrow \Sigma F_y = 0 \Rightarrow 33.75\,lb - 20\,lb - 75\,lb + N_C = 0$$

$$\boxed{N_C = 61.25\,lb}$$

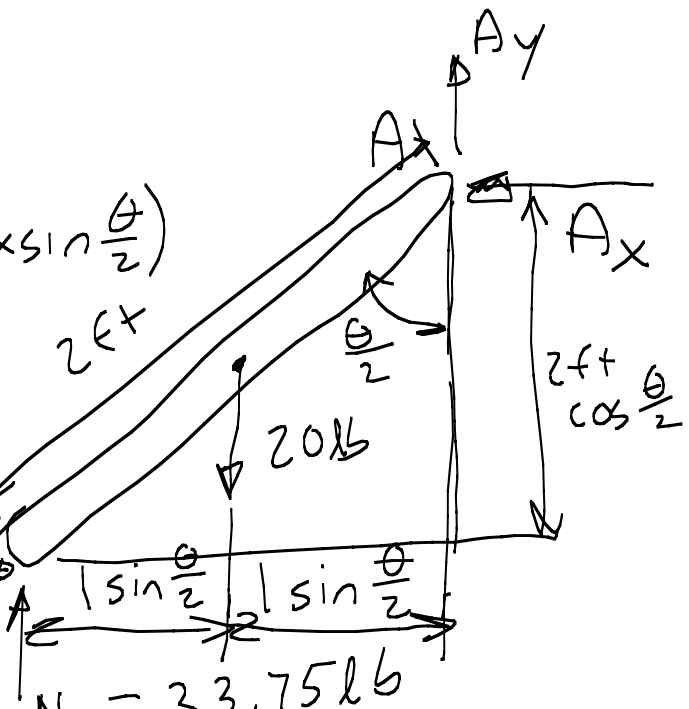
$$\overset{+}{\rightarrow} \Sigma F_x = 0 \Rightarrow F_B - F_C = 0$$

$$20.25\,lb - F_C = 0 \qquad \boxed{F_C = 20.25\,lb}$$

Check $F_C \overset{?}{<} \mu_C N_C$

$20.25\,lb \leq (0.6)(61.25\,lb)$

$20.25 < 36.75\,lb$ ✓ Slipping at B



AB

$\curvearrowleft \Sigma M_A = 0 \Rightarrow (20\,lb)(1\sin\frac{\theta}{2}) - (33.75\,lb)(2\times\sin\frac{\theta}{2}) + (20.25\,lb)(2\cos\frac{\theta}{2}) = 0$

$(20lb)\frac{\sin\frac{\theta}{2}}{\cos\frac{\theta}{2}} - (33.75)(2)\frac{\sin\frac{\theta}{2}}{\cos\frac{\theta}{2}} + (20.25)(2) = 0$

$20\tan\frac{\theta}{2} - (33.75)(2)\tan\frac{\theta}{2} + (20.25)(2) = 0$

$\frac{\theta}{2} = 40.45°$

$\boxed{\theta = 80.9°}$