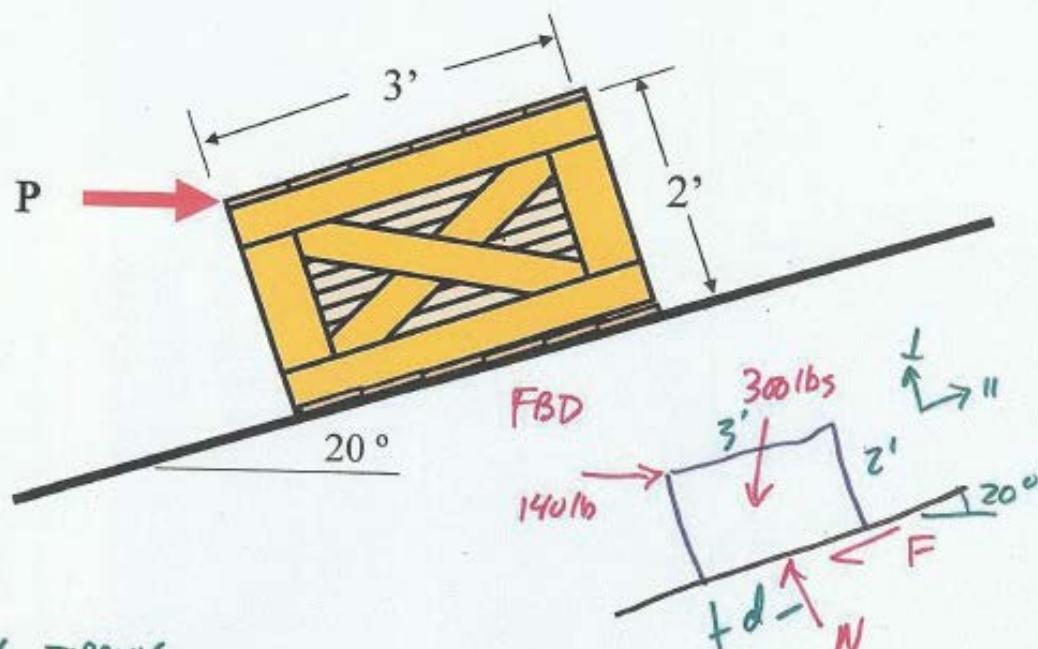


**Problem 1 – Friction I**

If the horizontal force  $P = 140$  lbs, determine the normal and frictional forces acting on the 300 lb crate. Take  $\mu_s = 0.3$  and  $\mu_k = 0.2$ . Consider sliding and tipping.



1) CHECK TIPPING

$$\sum M_B = 0 = 140 \text{ lb} \cos 20^\circ (z') + 300 \text{ lb} \cos 20^\circ (1.5') - 300 \text{ lb} \cdot 20^\circ (l) - N \cdot d$$

$$Nd = 583.8 \text{ lb} \cdot \text{ft}$$

$$\sum F_\perp = 0 = -300 \cos 20^\circ + N - 140 \sin 20^\circ \quad N = 329.8 \text{ lb}$$

$$d = \frac{583.8}{329.8} \Rightarrow d = 1.77' \quad 0 < d < 3' \quad \therefore \text{NO TIPPING}$$

2) CHECK SLIDING

$$\sum F_{\parallel} = 0 = -F - 300 \sin 20^\circ + 140 \cos 20^\circ$$

$$F = 20.95 \text{ lb} \swarrow$$

$$F_{\max} = \mu_s N = 0.3(330) = 99 \text{ lb}$$

$$F < F_{\max}$$

$$20.95 < 99$$

! NO SLIDING