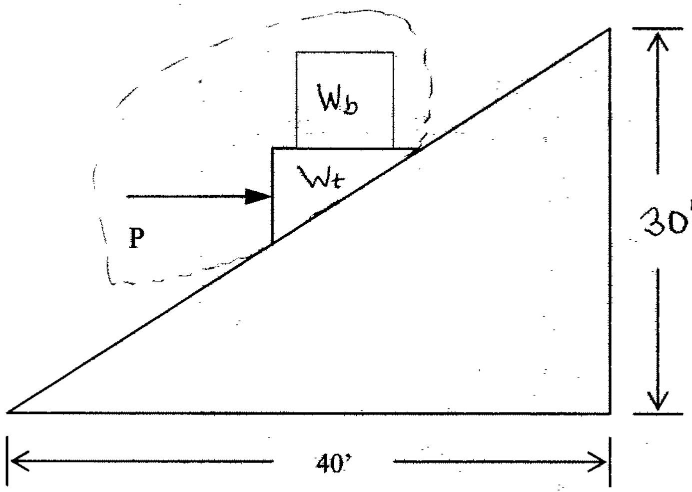
Problem 2 (35 points)

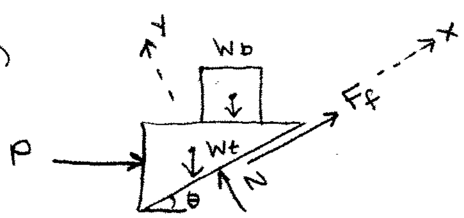
Consider the blocks on the inclined plane shown in the figure. The weights are given in the figure, as is the coefficient of static friction.

(a) What is the smallest force P that will hold the triangular block in place?
(b) Now assume that P=225 lb.
  i. What is the magnitude of the normal force between the triangular block and the inclined plane?
  ii. What is the friction force (magnitude and direction) between the triangular block and the inclined plane?



W_b=200 lb
W_t=100 lb
μ_s=1/3 (For all surfaces)

(25) (a)



$\cos\theta = \frac{4}{5}$

$\sin\theta = \frac{3}{5}$

FBD 9 pts

$\Sigma F_x = 0: \quad F_f + P\cos\theta - (W_b + W_t)\sin\theta = 0$ (1) 5 pts

$\Sigma F_y = 0: \quad N - P\sin\theta - (W_b + W_t)\cos\theta = 0$ (2) 5 pts

eqns match FBD

$F_f = \mu_s N$ (3) 5 pts

Solve $\Rightarrow P = (W_b + W_t)\left(\frac{\sin\theta - \mu_s\cos\theta}{\mu_s\sin\theta + \cos\theta}\right) = \frac{W_b + W_t}{3} = 100$ lb 1 pt

CM Box ___________

(10) (b) (i) From equation (2)

$$N = P\sin\theta + (W_b + W_t)\cos\theta$$ 4 pt

$$N = 225\left(\frac{3}{5}\right) + 300\left(\frac{4}{5}\right) = 135 + 240 = 375 \text{ lb}$$ 1 pt

(ii) From equation (1)

$$F_f = -P\cos\theta + (W_b + W_t)\sin\theta$$ 4 pt

$$F_f = -225\left(\frac{4}{5}\right) + (300)\left(\frac{3}{5}\right) = -180 + 180 = 0 \text{ lb}$$ 1 pt

Common mistakes:

(a) Friction force wrong way on FBD, resulting in $P_{max} = 433$ lb

-3 on FBD.

$\cos\theta$ / $\sin\theta$ mistakes -1 each up to -3

using just $P = (W_t + W_t)\mu_s$ (which = 100 lb, sadly) -16 if FBD ok

(b) if they use $F_f = \mu_s N$ - 5