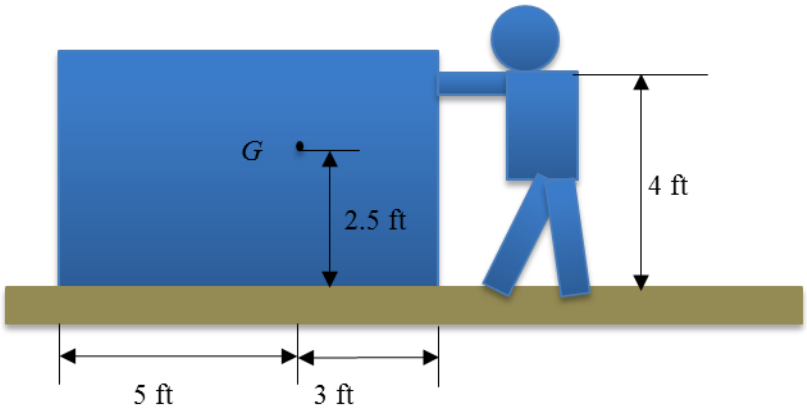
1. A man wants to push a crate of 250 lb to the left. The center of gravity of the crate is at *G*. The coefficient of static friction between the crate and the floor is $\mu_s = 0.25$ and the coefficient of static friction between his shoes and the floor is $\mu_s' = 0.4$.

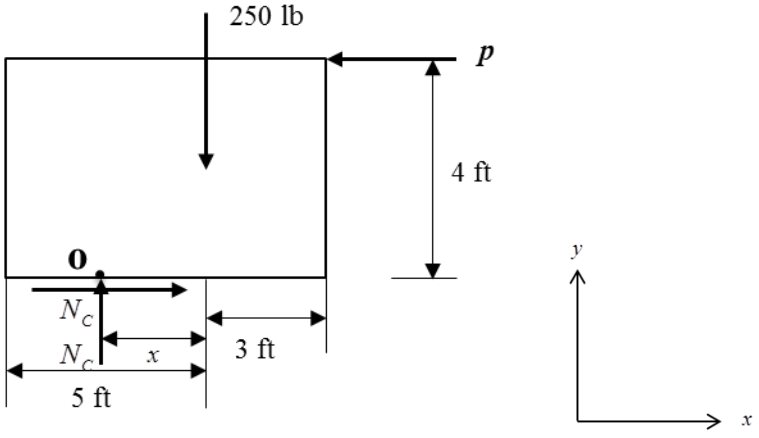
1) If the weight of the man is 171 lb, can he push the crate to the left? Assume the man exerts only a horizontal force on the crate.

2) If $G \sim N(250, 10^2)$ N, what is the probability that the man could be greater than 160 lb, if he needs to push the crate to the left on condition that the crate does not tip over?



Solution

1) Crate



$$\sum F_x = 0; \quad 0.25N_c - P = 0$$

$$\sum F_y = 0; \quad N_c - 250 = 0$$

$$\sum M_o = 0; \quad -250x + 4P = 0$$

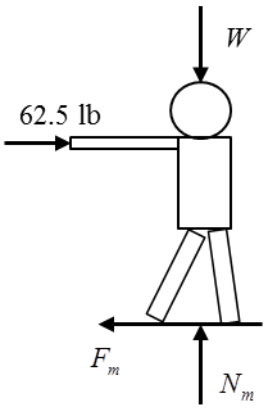
Solving

$$P = 62.5 \text{ lb}$$

$$N_c = 250 \text{ lb}$$

$$x = 1 \text{ ft} < 5 \text{ ft}$$ No tipping

Man



$$\sum F_x = 0; \ -F_m + P = 0$$

$$\sum F_y = 0; \ N_m - W = 0$$

Require

$$F_m = 0.4N_m$$

From above equations, we can obtain

$$W = N_m = 156.25 \text{ lb}$$

For $W = 156.25 \text{ lb} < 171 \text{ lb}$, the man can push the crate to the left. **Ans.**

2) From the figure, we have

$$\mu_s G = \mu_s' W$$

$$0.25G = 0.4W$$

$$W = \frac{\mu_s}{\mu_s'} G = 0.625G$$

We set

$$Y = 160 - W = 160 - 0.625G$$

$G \sim N(250, 10^2)$ N. Calculate μ_Y, σ_Y

$$\mu_Y = 160 - 0.625\mu_G = 3.75 \text{ lb}$$

$$\sigma_Y = 0.625\sigma_G = 6.25 \text{ lb}$$

Thus

$$P(W > 160) = P(Y < 0) = \Phi\left(-\frac{u_Y}{\sigma_Y}\right) = \Phi\left(-\frac{3.75}{6.25}\right) = 0.2743 \qquad \textbf{Ans.}$$