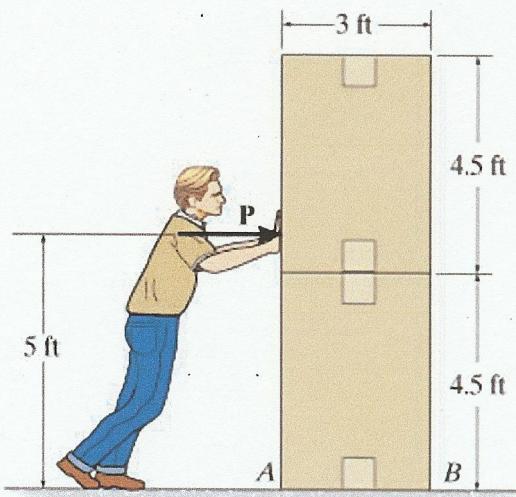


Engineering Mechanics – Statics Worksheets

Problem 3: Friction II

In an effort to move two stacked boxes, each weighing 100 lb, the man pushes horizontally on them at the base of the top box as shown. Determine the smallest force P that must be applied in order to cause impending motion. The coefficient of static friction between the boxes is $\mu_s = 0.7$ and between the box and the floor is $\mu'_s = 0.4$.



Assume Top Crate Slips

$$\begin{aligned}
 & \text{Free Body Diagram of Top Box (A):} \\
 & \quad \text{Vertical forces: } N_A \uparrow, F_A \downarrow, 100 \text{ lbs} \downarrow \\
 & \quad \text{Horizontal forces: } P \rightarrow, F_A \leftarrow \\
 & \quad \sum F_y = 0 = N_A - 100 \\
 & \quad N_A = 100 \text{ lbs} \\
 & \quad \sum F_x = 0 = P - F_A \\
 & \quad P = 0.7 N_A = 0.7(100) \\
 & \quad \underline{\underline{P = 70 \text{ lbs}}}
 \end{aligned}$$

Assume Both Tip

$$\begin{aligned}
 & \text{Free Body Diagram of Both Boxes:} \\
 & \quad \text{Vertical forces: } N_B \uparrow, F_B \downarrow, 200 \text{ lbs} \downarrow, 100 \text{ lbs} \downarrow \\
 & \quad \text{Horizontal forces: } P \rightarrow, F_B \leftarrow \\
 & \quad \sum M_B = 0 = 200(1.5) - P(5) \\
 & \quad P = 60 \text{ lbs}
 \end{aligned}$$

Assume Bottom Crate Slips

$$\begin{aligned}
 & \text{Free Body Diagram of Bottom Box (B):} \\
 & \quad \text{Vertical forces: } N_B \uparrow, F_B \downarrow, 200 \text{ lbs} \downarrow \\
 & \quad \sum F_y = 0 = N_B - 200 \\
 & \quad N_B = 200 \text{ lbs} \\
 & \quad \sum F_x = 0 = P - F_B \\
 & \quad P = 0.4 N_B = 0.4(200) \\
 & \quad \underline{\underline{P = 80 \text{ lbs}}}
 \end{aligned}$$

$$P_{\min} = 60.0 \text{ lbs}$$

both crates tip