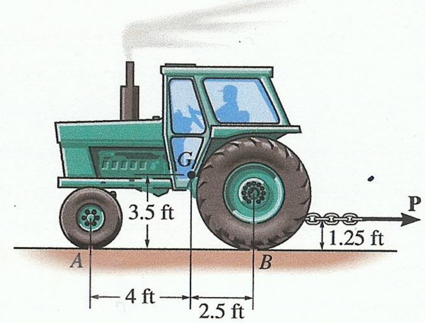
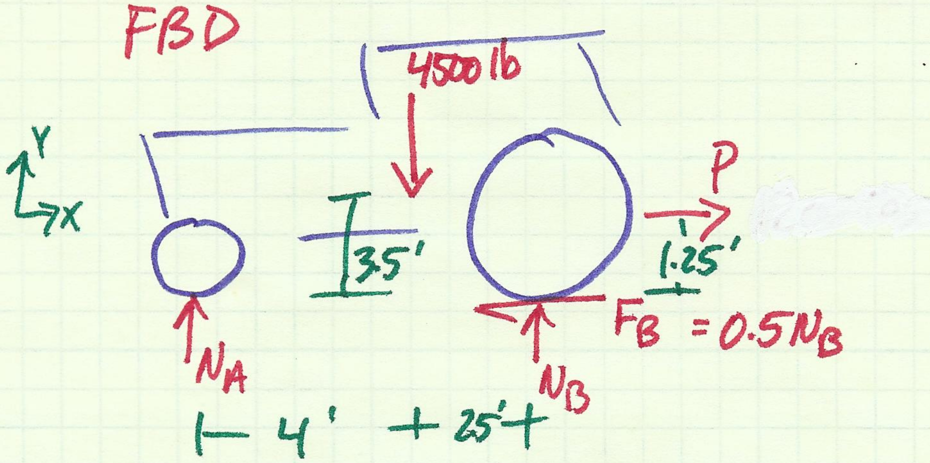
*8–4.

The tractor has a weight of 4500 lb with center of gravity at G. The driving traction is developed at the rear wheels B, while the front wheels at A are free to roll. If the coefficient of static friction between the wheels at B and the ground is $\mu_s = 0.5$, determine if it is possible to pull at $P = 1200$ lb without causing the wheels at B to slip or the front wheels at A to lift off the ground.



SOLUTION

FBD



ASSUME SLIPPING

$\circlearrowleft \Sigma M_A = 0 \qquad 4(4500) - 6.5 N_B + 1.25 P = 0$

$\rightarrow \Sigma F_x = 0 \qquad P - 0.5 N_B = 0$

$P = 1532 \text{ lb} \qquad N_B = 3060 \text{ lb}$

$> 1200 \text{ lb}$

ASSUME TIPPING

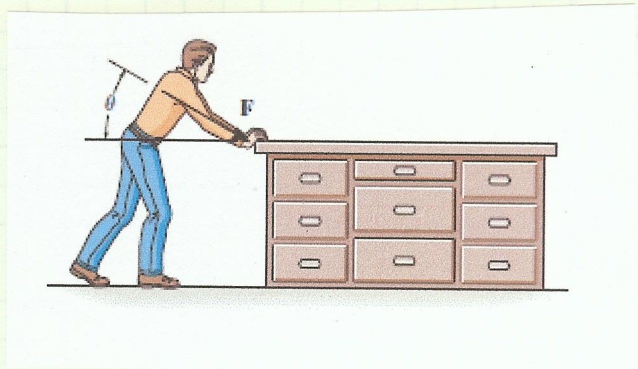
$\circlearrowleft \Sigma M_B = 0 \qquad -4500(2.5) + 1.25 P = 0$

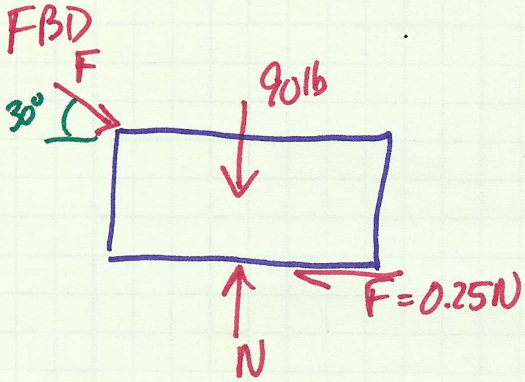
$P = 9000 \text{ lb} > 1200 \text{ lb}$

YES, POSSIBLE TO PULL 1200 lb w/o Tipping or Slipping

8–17.

The uniform dresser has a weight of 90 lb and rests on a tile floor for which $\mu_s = 0.25$. If the man pushes on it in the direction $\theta = 30°$, determine the smallest magnitude of force **F** needed to move the dresser. Also, if the man has a weight of 150 lb, determine the smallest coefficient of static friction between his shoes and the floor so that he does not slip.





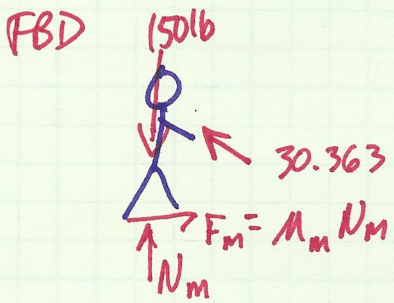
$\uparrow \Sigma F_y = 0$

$-F\sin 30 + N - 90 = 0$

$\rightarrow \Sigma F_x = 0$

$F\cos 30 - 0.25N = 0$

$F = 30.363\text{ lb} \qquad N = 105.1\text{ lb}$



$\uparrow \Sigma F_y = 0$

$N_m - 150 + 30.363\sin 30 = 0$

$N_m = 134.82$

$\rightarrow \Sigma F_x = 0$

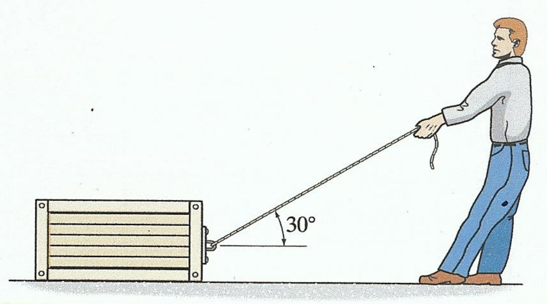
$F_m - 30.363\cos 30 = 0$

$\mu_m (134.82) - 30.363\cos 30 = 0$

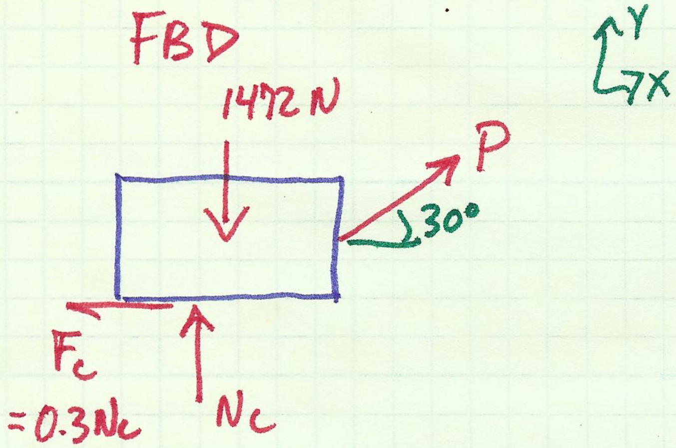
$\mu_m = 0.195$

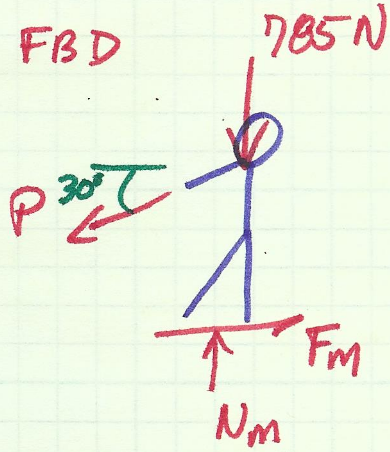
8–34.

The coefficient of static friction between the 150-kg crate and the ground is $\mu_s = 0.3$, while the coefficient of static friction between the 80-kg man's shoes and the ground is $\mu_s' = 0.4$. Determine if the man can move the crate.



SOLUTION





$\uparrow \Sigma F_y = 0$

$-1472 + N_c + P\sin 30° = 0$

$\rightarrow \Sigma F_x = 0$

$P\cos 30° - 0.3N_c = 0$

$N_c + .5P = 1472$

$-.3N_c + .866P = 0$

SOLVE

$$\begin{bmatrix} 1 & .5 \\ -.3 & .866 \end{bmatrix} \begin{Bmatrix} N_c \\ P \end{Bmatrix} = \begin{Bmatrix} 1472 \\ 0 \end{Bmatrix}$$

$N_c = 1254\text{ N}$

$P = 434\text{ N}$

$\uparrow \Sigma F_y = 0$

$N_m - 785 - 434\sin 30 = 0$

$N_m = 1002\text{ N}$

$\rightarrow \Sigma F_x = 0$

$-434\cos 30 + F_m = 0$

$F_m = 376\text{ N}$

SINCE $F_{MAX} = 0.4(1002) = 400\text{N}$

AND

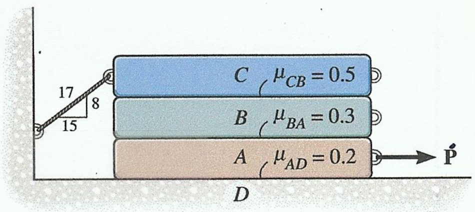
$F_m = 376\text{N} < F_{MAX}\ 400\text{N}$

MAN DOES NOT SLIP

+ CAN MOVE CRATE

8–45.

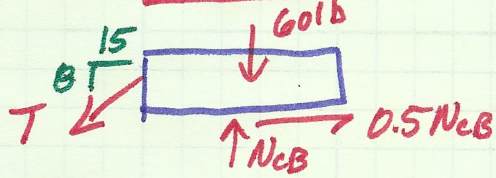
The three bars have a weight of $W_A = 20$ lb, $W_B = 40$ lb, and $W_C = 60$ lb, respectively. If the coefficients of static friction at the surfaces of contact are as shown, determine the smallest horizontal force P needed to move block A.



IF A + B MOVE TOGETHER, THEN SLIPPING OCCURS AT CONTACT SURFACES CB + AD. THEN $F_{CB} = \mu_{sCB} N_{CB} = 0.5 N_{CB}$ AND $F_{AD} = \mu_{sAD} N_{AD} = 0.2 N_{AD}$

$\uparrow y$, $\rightarrow x$

FBD "a"

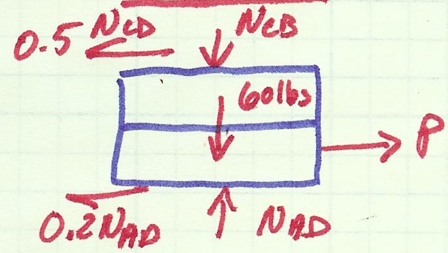


$$\uparrow \Sigma F_y = 0 \qquad N_{CB} - \frac{8}{17}T - 60 = 0$$

$$\rightarrow \Sigma F_x = 0 \qquad 0.5 N_{CB} - T\left(\frac{15}{17}\right) = 0$$

SOLVE $\quad T = 46.4$ lb $\quad N_{CB} = 81.8$ lb

FBD "b"



$$\uparrow \Sigma F_y = 0 \qquad -N_{CB} - 60 + N_{AD} = 0$$

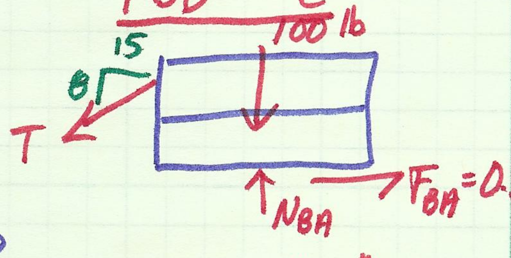
$$\rightarrow \Sigma F_x = 0 \qquad P - 0.5 N_{CB} - 0.2 N_{AD} = 0$$

SOLVE

$N_{AD} = 142$ lb $\quad \underline{P = 69.3 \text{ lb}}$

IF ONLY A MOVES, THEN SLIPPING OCCURS AT SURFACES BA AND AD. THEN $F_{BA} = \mu_{sBA} N_{BA} = 0.3 N_{BA}$ AND $F_{AD} = \mu_{sAD} N_{AD} = 0.2 N_{AD}$

FBD "c"

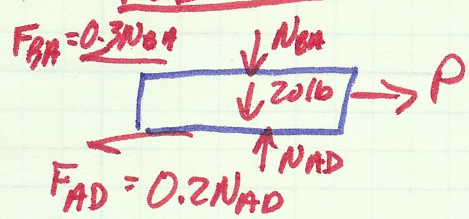


$$\uparrow \Sigma F_y = 0 \qquad N_{BA} - 100 - \frac{8}{17}T = 0$$

$$\rightarrow \Sigma F_x = 0 \qquad -\frac{15}{17}T + 0.3 N_{BA} = 0$$

SOLVE $\quad T = 40.5 \quad N_{BA} = 119$ lb

FBD "d"



$$\uparrow \Sigma F_y = 0 \qquad N_{AD} - N_{BA} - 20 = 0$$

$$\rightarrow \Sigma F_x = 0 \qquad P - 0.3 N_{BA} - 0.2 N_{AD} = 0$$

SOLVE $\quad \underline{P = 63.5 \text{ lb}} \quad N_{AD} = 139$ lb

CONTROLS