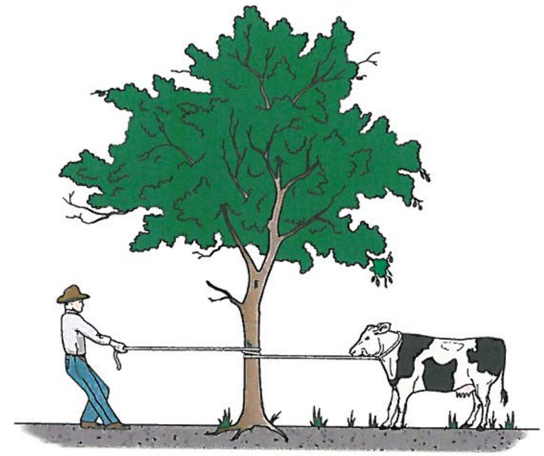
8-85

A 180-lb farmer tries to restrain the cow from escaping by wrapping the rope two turns around the tree trunk as shown. If the cow exerts a force of 250 lb on the rope, determine if the farmer can successfully restrain the cow. The coefficient of static friction between the rope and the tree trunk is $\mu_s = 0.15$, and between the farmer's shoes and the ground $\mu_s' = 0.3$.



SOLUTION

Since the cow is on the verge of moving, the force it exerts on the rope is $T_2 = 250$ lb and the force exerted by the man on the rope is T_1. Here, $\beta = 2(2\pi) = 4\pi$ rad. Thus,

$$T_2 = T_1 e^{\mu_s \beta}$$

$$250 = T_1 e^{0.15(4\pi)}$$

$$T_1 = 37.96 \text{ lb}$$

Using this result and referring to the free - body diagram of the man shown in Fig. a,

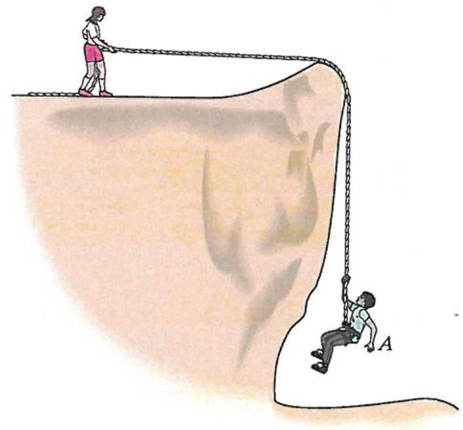
$+\uparrow \Sigma F_y = 0;$ $\quad N - 180 = 0$ $\quad N = 180$ lb

$\xrightarrow{+} \Sigma F_x = 0;$ $\quad 37.96 - F = 0$ $\quad F = 37.96$ lb

Since $F < F_{max} = \mu_s' N = 0.3(180) = 54$ lb, the man will not slip, and he will successfully restrain the cow.

8–87.

The 100-lb boy at A is suspended from the cable that passes over the quarter circular cliff rock. What horizontal force must the woman at A exert on the cable in order to let the boy descend at constant velocity? The coefficients of static and kinetic friction between the cable and the rock are $\mu_s = 0.4$ and $\mu_k = 0.35$, respectively.



SOLUTION

$$\beta = \frac{\pi}{2}$$

$$T_2 = T_1\, e^{\mu\beta}; \qquad 100 = T_1\, e^{0.35\frac{\pi}{2}}$$

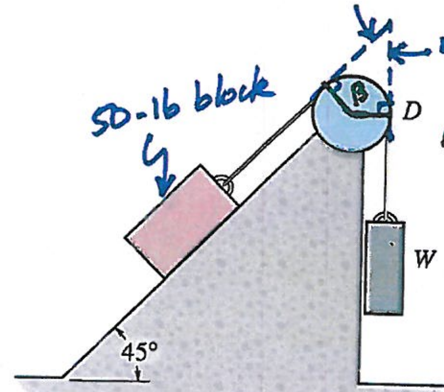
$$T_1 = 57.7 \text{ lb}$$ **Ans.**

Ans:
$T_1 = 57.7$ lb

8-96

~~8-88~~

Determine the maximum and the minimum values of weight W which may be applied without causing the 50-lb block to slip. The coefficient of static friction between the block and the plane is $\mu_s = 0.2$, and between the rope and the drum D $\mu_s' = 0.3$.



$\beta = 135°$
$= 135 \frac{\pi}{180}$
$= \frac{3}{4}\pi$ rad.

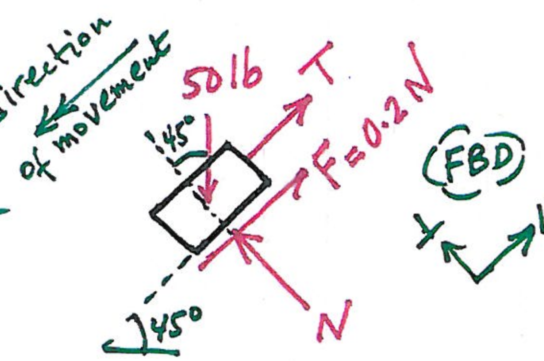
Case (1) 50-lb block is on the verge of sliding down

$\nwarrow \Sigma F_{\perp} = 0 = -50\cos 45 + N$

$N = 35.36\,lb \nwarrow$

$\nearrow \Sigma F_{\parallel} = 0 = T + 0.2(35.36) - 50\sin 45$

$T = 28.28\,lb$



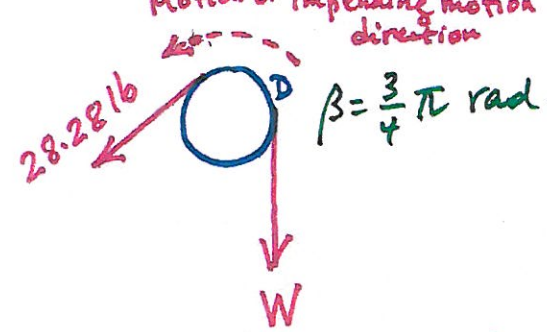
Since $T_2 = T_1 e^{\mu_s \beta}$

T_1 ↳ opposes the direction of motion

T_2 ↳ in the direction of motion (or impending motion)

$\therefore\ 28.28\,lb = W e^{0.3 \times \frac{3}{4}\pi}$

28.28 lb ↳ is in the direction of impending motion



$W = 13.95\,lb$ $\Rightarrow \therefore$ if W is <u>less than</u> 13.95 lb the 50-lb block will slide down

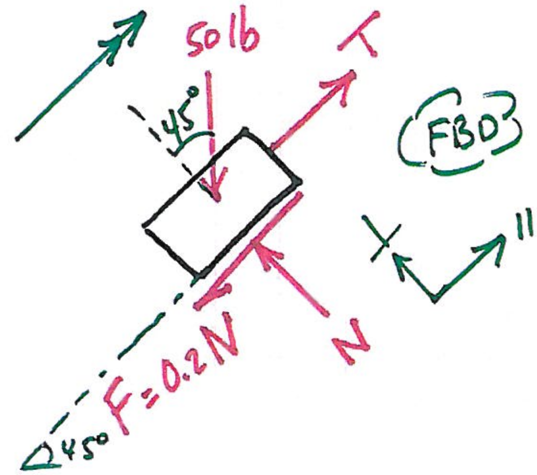
Case (2) 50-lb block is on the verge of sliding up

$\nwarrow \Sigma F_{\perp} = 0 = -50\cos 45 + N$

$N = 35.36\ \text{lb} \nwarrow$

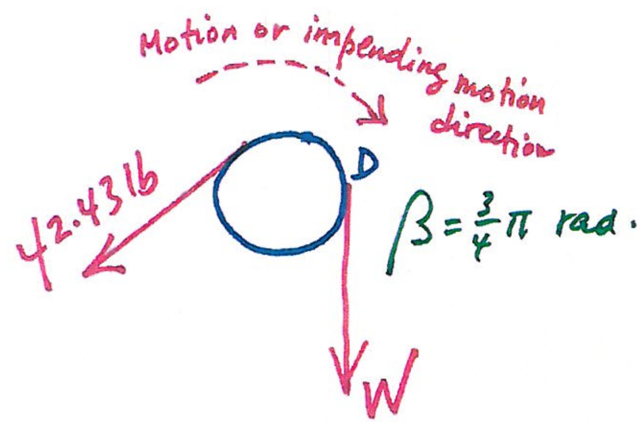
$\nearrow \Sigma F_{\parallel} = 0 = T - 0.2(35.36) - 50\sin 45$

$T = 42.43\ \text{lb} \nearrow$



$$T_2 = T_1 e^{\mu_s' \beta}$$

Note that in this case W is in the direction of the impending motion



$$\therefore W = 42.43\, e^{0.3 \times \frac{3}{4}\pi}$$

$W = 86.0\ \text{lb} \Rightarrow \therefore$ if W is greater than 86.0 lb the 50-lb block will slide up.

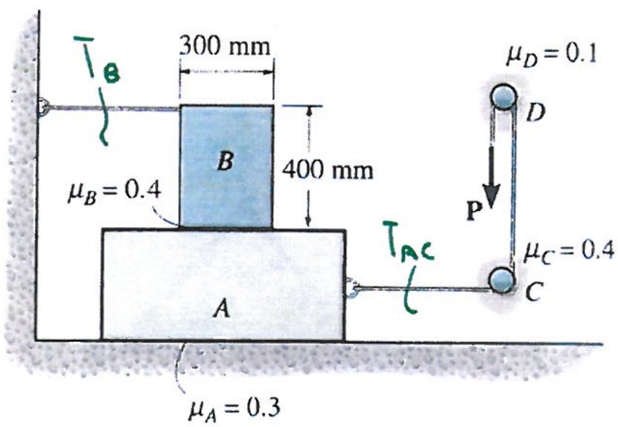
$\Rightarrow \therefore$ For the 50-lb block NOT to slide

$$13.95\ \text{lb} \leq W \leq 86.0\ \text{lb}$$

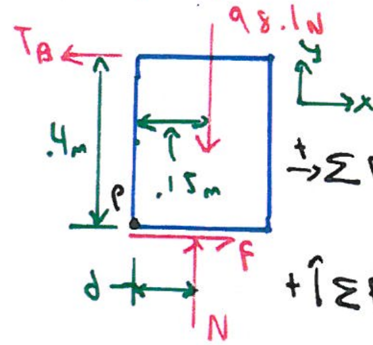
$\therefore W_{max} = \underline{\underline{86.0\ \text{lb}}}$

and $W_{min} = \underline{\underline{13.95\ \text{lb}}}$

8-100 Blocks A and B have a mass of 7 kg and 10 kg respectively. Using the coefficients of static friction shown, determine the largest force P which can be applied without causing motion.



FBD of B



$\overset{+}{\rightarrow}\Sigma F_x = 0 = F - T_B$

$F = T_B$

$+\uparrow \Sigma F_y = 0 = N - 98.1$

$N = 98.1N$

@ Impending Slip

$F = \mu N = 0.4(98.1)$

$\therefore T_B = 39.24N$

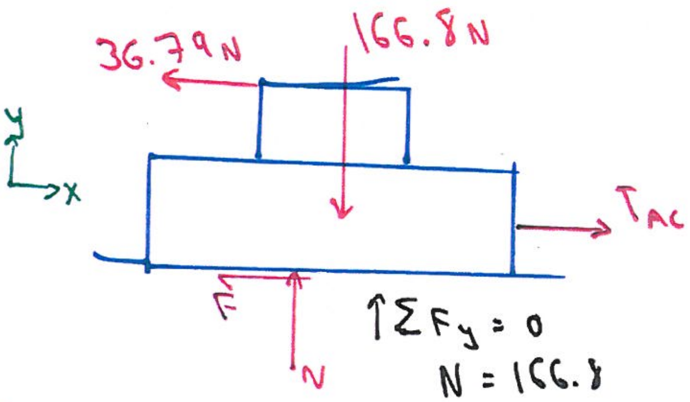
@ Impending Tip ($d = 0$)

$\circlearrowleft + \Sigma M_P = 0 = 98.1 \cdot 0.15 - .4 T_B$

$\therefore T_B = 36.79\,N$

* Will Tip First $T_{B\,max} = 36.79N$

* Assuming A will not Tip:



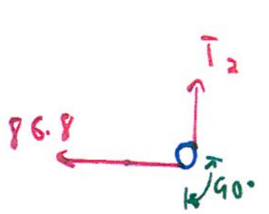
$\uparrow \Sigma F_y = 0$

$N = 166.8$

@ Impending Slip

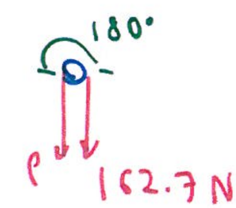
$\overset{+}{\rightarrow}\Sigma F_x = 0 = T_{AC} - 36.79N - 0.3 \cdot 166.8N$ $\quad \therefore T_{AC} = 86.8N$

@ C



$T_2 = 86.8 e^{.4 \cdot \frac{\pi}{2}} = 162.7N$

@ D



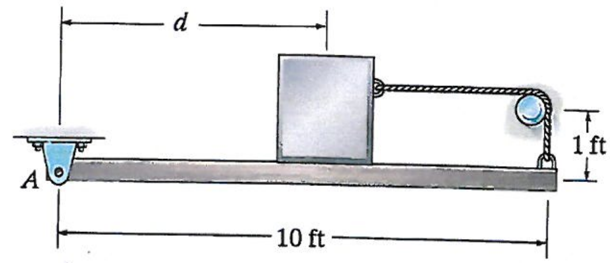
$P = 162.7 e^{.1(\pi)} = 223N \downarrow$

$\boxed{\therefore P = 223N \downarrow}$

R8-7 P.463 Book

~~8-139~~

The uniform 50-lb beam is supported by the rope which is attached to the end of the beam, wraps over the rough peg, and is then connected to the 100-lb block. If the coefficient of static friction between the beam and the block, and between the rope and the peg, is $\mu_s = 0.4$, determine the maximum distance that the block can be placed from A and still remain in equilibrium. Assume the block will not tip.



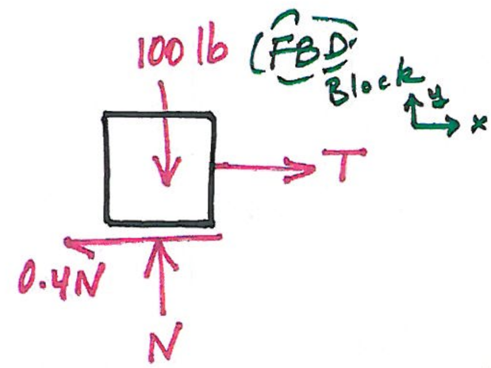
Block

$+\uparrow \Sigma F_y = 0 = -100\text{ lb} + N$

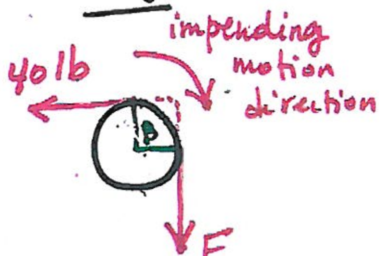
$N = 100\text{ lb} \uparrow$ on Block

$\xrightarrow{+} \Sigma F_x = 0 = T - 0.4(100\text{lb})$

$T = 40\text{ lb} \rightarrow$ on Block



Peg



$F = 40\, e^{0.4 \times \frac{\pi}{2}}$

$F = 74.98\text{lb}$

$\beta = 90° = \frac{\pi}{2}$ rad.

Block & Beam

$\circlearrowleft \Sigma M_A = 0 = -50\text{lb}(5\text{ft}) - 40\text{lb}(1\text{ft})$
$\quad - 100\text{ lb}(d) + 74.98\text{lb}(10\text{ft})$

$\underline{\underline{d = 4.60\text{ft}}} = d_{max}$