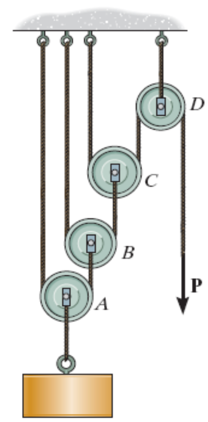
HW 9 SOLUTIONS

6–67. Determine the force **P** required to hold the 100-lb weight in equilibrium.



Equations of Equilibrium: Applying the force equation of equilibrium along the y axis of pulley A on the free-body diagram, Fig. a,

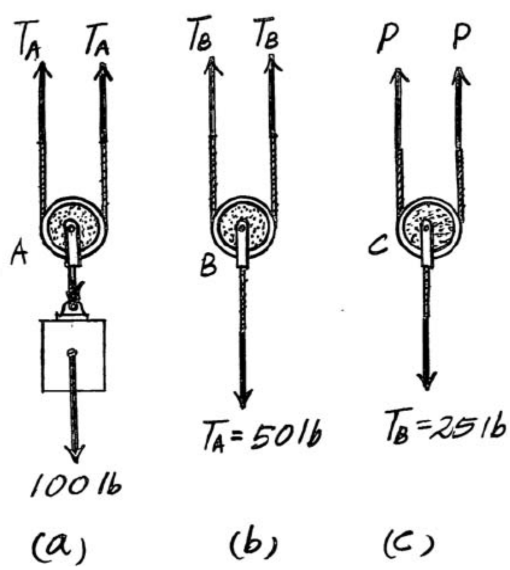
$+\uparrow \Sigma F_y = 0;\quad 2T_A - 100 = 0\qquad T_A = 50\text{ lb}$

Applying $\Sigma F_y = 0$ to the free-body diagram of pulley B, Fig. b,

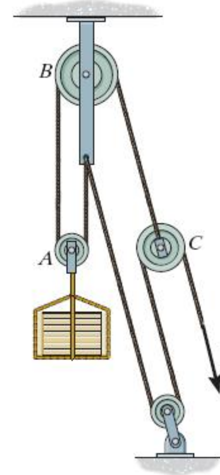
$+\uparrow \Sigma F_y = 0;\quad 2T_B - 50 = 0\qquad T_B = 25\text{ lb}$

From the free-body diagram of pulley C, Fig. c,

$+\uparrow \Sigma F_y = 0;\quad 2P - 25 = 0\qquad P = 12.5\text{ lb}$ **Ans.**



*6–68. Determine the force **P** required to hold the 150-kg crate in equilibrium.

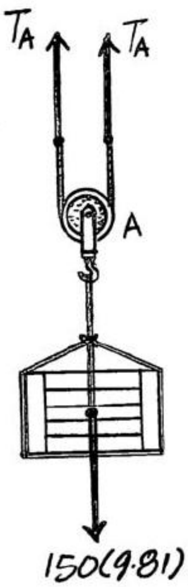


Equations of Equilibrium: Applying the force equation of equilibrium along the y axis of pulley A on the free-body diagram, Fig. a,

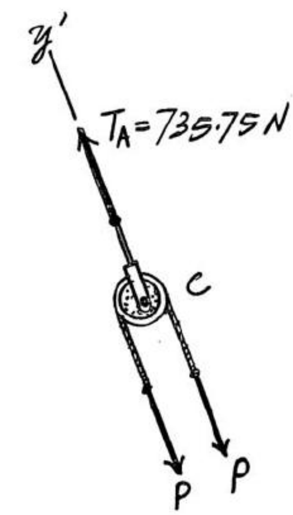
$+\uparrow \Sigma F_y = 0;\qquad 2T_A - 150(9.81) = 0 \quad T_A = 735.75\text{ N}$

Using the above result and writing the force equation of equilibrium along the y' axis of pulley C on the free-body diagram in Fig. b,

$\Sigma F_{y'} = 0;\quad 735.75 - 2P = 0 \qquad P = 367.88\text{ N} = 368\text{ N}$ **Ans.**

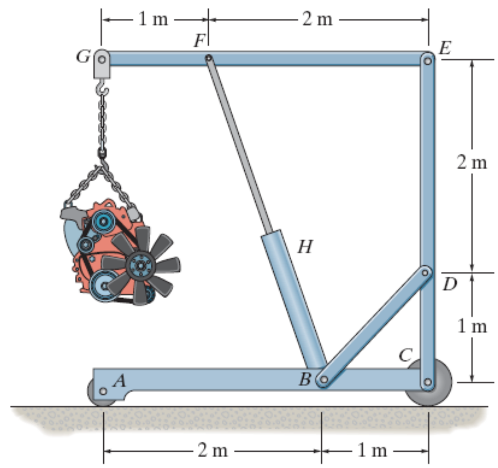


(a)



(b)

6–87. The hoist supports the 125-kg engine. Determine the force the load creates in member DB and in member FB, which contains the hydraulic cylinder H.



Free Body Diagram : **The solution for this problem will be simplified if one realizes that members FB and DB are two-force members.**

Equations of Equilibrium : **For FBD(a).**

$$\curvearrowleft + \Sigma M_E = 0; \quad 1226.25(3) - F_{FB}\left(\frac{3}{\sqrt{10}}\right)(2) = 0$$

$$F_{FB} = 1938.87 \text{ N} = 1.94 \text{ kN} \qquad \textbf{Ans}$$

$$+\uparrow \Sigma F_y = 0; \quad 1938.87\left(\frac{3}{\sqrt{10}}\right) - 1226.25 - E_y = 0$$

$$E_y = 613.125\text{N}$$

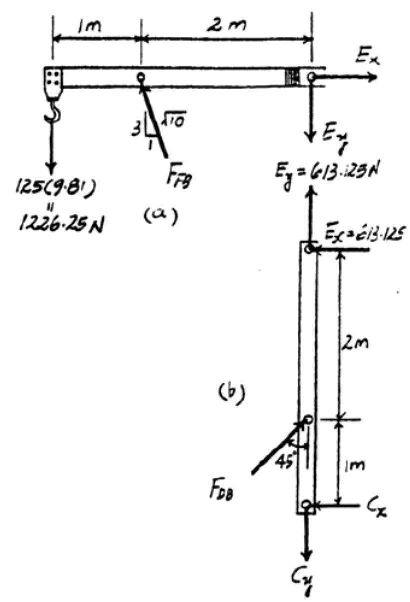
$$\xrightarrow{+} \Sigma F_x = 0; \quad E_x - 1938.87\left(\frac{1}{\sqrt{10}}\right) = 0$$

$$E_x = 613.125 \text{ N}$$

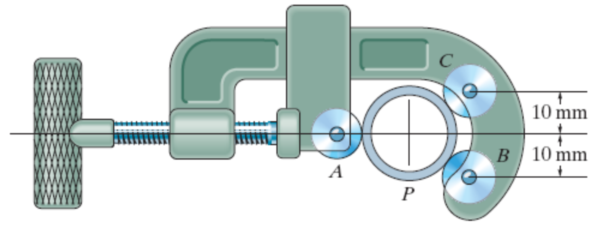
From FBD (b).

$$\curvearrowleft + \Sigma M_C = 0; \quad 613.125(3) - F_{BD}\sin 45°(1) = 0$$

$$F_{BD} = 2601.27 \text{ N} = 2.60 \text{ kN} \qquad \textbf{Ans}$$



•6–97. The pipe cutter is clamped around the pipe P. If the wheel at A exerts a normal force of $F_A = 80$ N on the pipe, determine the normal forces of wheels B and C on the pipe. The three wheels each have a radius of 7 mm and the pipe has an outer radius of 10 mm.



$\theta = \sin^{-1}\left(\frac{10}{17}\right) = 36.03°$

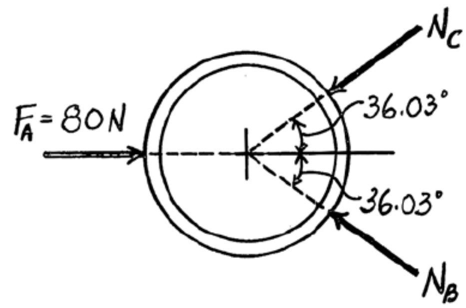
Equations of Equilibrium:

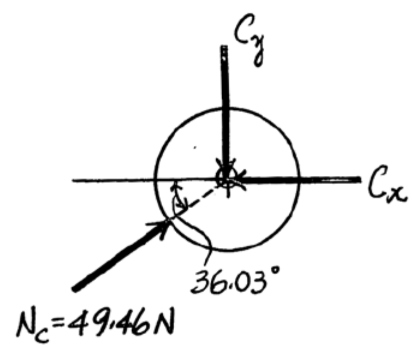
$+\uparrow \Sigma F_y = 0; \quad N_B \sin 36.03° - N_C \sin 36.03° = 0$

$N_B = N_C$

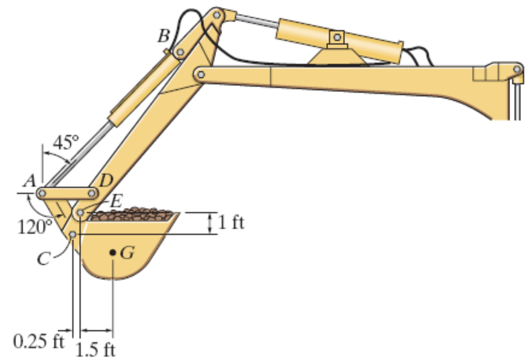
$\xrightarrow{+} \Sigma F_x = 0; \quad 80 - N_C \cos 36.03° - N_C \cos 36.03° = 0$

$N_B = N_C = 49.5 \text{ N}$ **Ans**

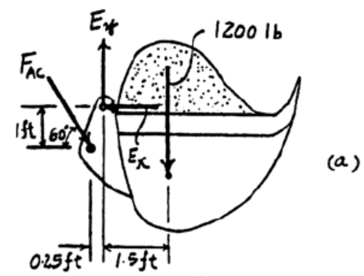




6–106. The bucket of the backhoe and its contents have a weight of 1200 lb and a center of gravity at G. Determine the forces of the hydraulic cylinder AB and in links AC and AD in order to hold the load in the position shown. The bucket is pinned at E.



Free Body Diagram : The solution for this problem will be simplified if one realizes that the hydraulic cylinder AB, links AD and AC are two-force members.

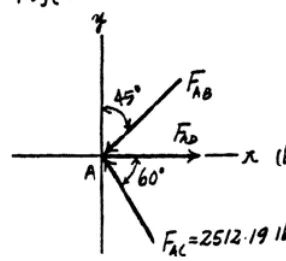


Equations of Equilibrium : From FBD (a),

$$\circlearrowleft + \Sigma M_E = 0; \quad F_{AC} \cos 60°(1) + F_{AC} \sin 60°(0.25) - 1200(1.5) = 0$$

$$F_{AC} = 2512.19 \text{ lb} = 2.51 \text{ kip} \qquad \textbf{Ans}$$

Using method of joint [FBD (b)],



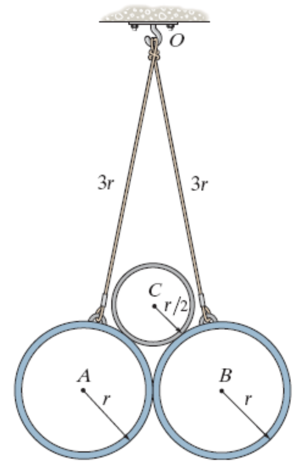
$$+\uparrow \Sigma F_y = 0; \quad 2512.19 \sin 60° - F_{AB} \cos 45° = 0$$

$$F_{AB} = 3076.79 \text{ lb} = 3.08 \text{ kip} \qquad \textbf{Ans}$$

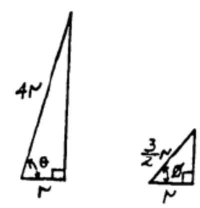
$$\xrightarrow{+} \Sigma F_x = 0; \quad F_{AD} - 3076.79 \sin 45° - 2512.19 \cos 60° = 0$$

$$F_{AD} = 3431.72 \text{ lb} = 3.43 \text{ kip} \qquad \textbf{Ans}$$

6–111. Two smooth tubes A and B, each having the same weight, W, are suspended from a common point O by means of equal-length cords. A third tube, C, is placed between A and B. Determine the greatest weight of C without upsetting equilibrium.



Free Body Diagram : When the equilibrium is about to be upset, the reaction at B must be zero ($N_B = 0$). From the geometry, $\phi = \cos^{-1}\left(\frac{r}{\frac{3}{2}r}\right) = 48.19°$ and $\theta = \cos^{-1}\left(\frac{r}{4r}\right) = 75.52°$.



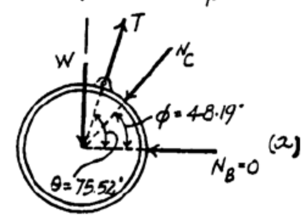
Equations of Equilibrium : From FBD (a),

$$\xrightarrow{+} \Sigma F_x = 0; \qquad T\cos 75.52° - N_C \cos 48.19° = 0 \qquad [1]$$

$$+\uparrow \Sigma F_y = 0; \qquad T\sin 75.52° - N_C \sin 48.19° - W = 0 \qquad [2]$$

Solving Eq.[1] and [2] yields,

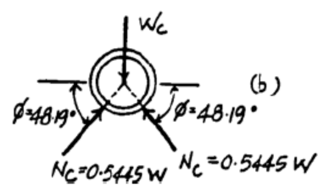
$$T = 1.452W \qquad N_C = 0.5445W$$



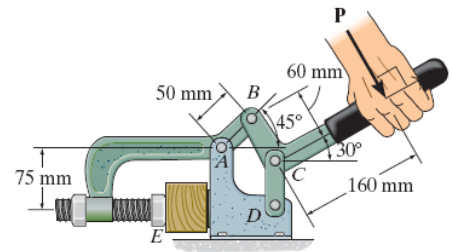
From FBD (b),

$$+\uparrow \Sigma F_y = 0; \qquad 2(0.5445W\sin 48.19°) - W_C = 0$$

$$W_C = 0.812W \qquad \textbf{Ans}$$



*6–116. If the horizontal clamping force that the toggle clamp exerts on the smooth wooden block at E is $N_E = 200$ N, determine the force **P** applied to the handle of the clamp.



Equations of Equilibrium: First, we will consider the free-body diagram of the handle in Fig. *a*.

$$\circlearrowleft + \Sigma M_B = 0; \qquad F_{CD} \sin 30°(60) - P(160) = 0$$

$$F_{CD} = 5.333P$$

$$\xrightarrow{+} \Sigma F_x = 0; \qquad P \sin 30° - B_x = 0$$

$$B_x = 0.5P$$

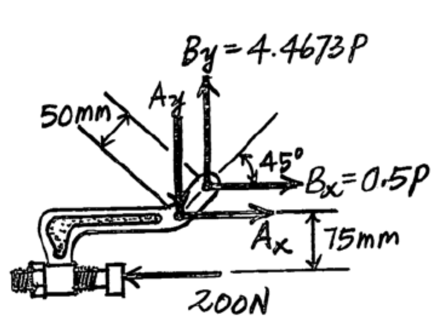
$$+\uparrow \Sigma F_y = 0; \qquad 5.333P - P \cos 30° - B_y = 0$$

$$B_y = 4.4673P$$

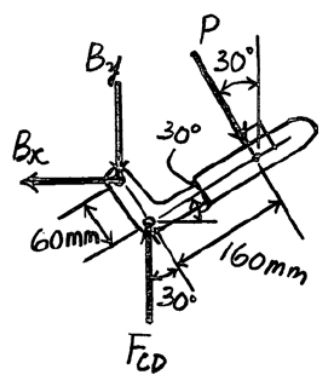
Using the results of B_x and B_y obtained above and applying the moment equation of equilibrium about point A on the free-body diagram of the clamp in Fig. *b*,

$$\circlearrowleft + \Sigma M_A = 0; \qquad 4.4673P(50 \cos 45°) - 0.5P(50 \sin 45°) - 200(75) = 0$$

$$P = 106.94 \text{ N} = 107 \text{ N}$$ **Ans.**



(b)



(a)