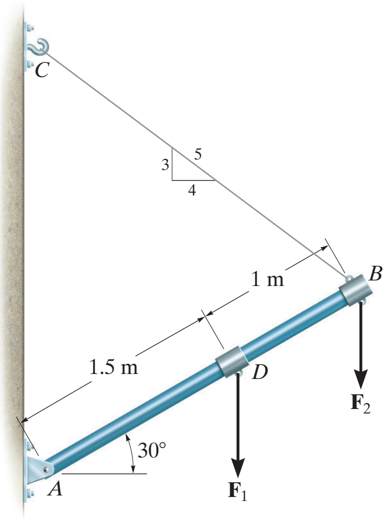
5–37.

The boom supports the two vertical loads. Neglect the size of the collars at D and B and the thickness of the boom, and compute the horizontal and vertical components of force at the pin A and the force in cable CB. Set $F_1 = 800$ N and $F_2 = 350$ N.



SOLUTION

$\circlearrowleft + \Sigma M_A = 0;$ $\quad -800(1.5\cos 30°) - 350(2.5\cos 30°)$

$$+\frac{4}{5}F_{CB}(2.5\sin 30°) + \frac{3}{5}F_{CB}(2.5\cos 30°) = 0$$

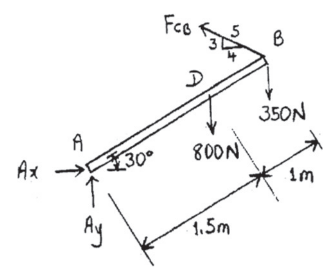
$F_{CB} = 781.6 = 782$ N **Ans.**

$\xrightarrow{+} \Sigma F_x = 0;$ $\quad A_x - \frac{4}{5}(781.6) = 0$

$A_x = 625$ N **Ans.**

$+\uparrow \Sigma F_y = 0;$ $\quad A_y - 800 - 350 + \frac{3}{5}(781.6) = 0$

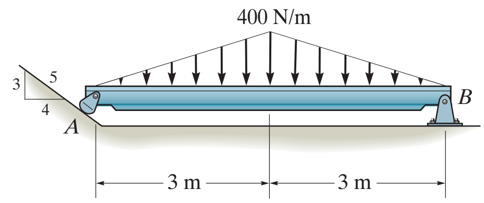
$A_y = 681$ N **Ans.**



Ans:
$F_{CB} = 782$ N
$A_x = 625$ N
$A_y = 681$ N

***5–12.**

Determine the reactions at the supports.



SOLUTION

Equations of Equilibrium. $\mathbf{N}_A$ and $\mathbf{B}_y$ can be determined directly by writing the moment equations of equilibrium about points B and A, respectively, by referring to the beam's *FBD* shown in Fig. *a*.

$$\zeta+\Sigma M_B = 0; \quad \frac{1}{2}(400)(6)(3) - N_A\left(\frac{4}{5}\right)(6) = 0$$

$$N_A = 750 \text{ N} \qquad \textbf{Ans.}$$

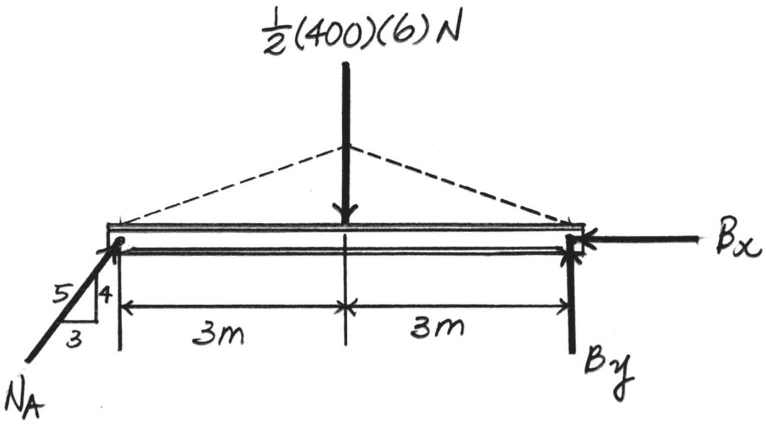
$$\zeta+\Sigma M_A = 0; \quad B_y(6) - \frac{1}{2}(400)(6)(3) = 0$$

$$B_y = 600 \text{ N} \qquad \textbf{Ans.}$$

Using the result of $\mathbf{N}_A$ to write the force equation of equilibrium along the x axis,

$$\xrightarrow{+} \Sigma F_x = 0; \quad 750\left(\frac{3}{5}\right) - B_x = 0$$

$$B_x = 450 \text{ N} \qquad \textbf{Ans.}$$

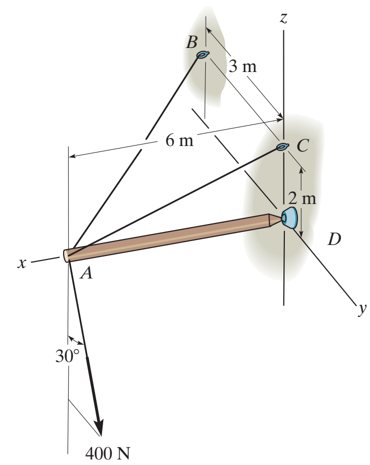


(a)

Ans:
$N_A = 750$ N
$B_y = 600$ N
$B_x = 450$ N

***5–64.**

Determine the tension in each cable and the components of reaction at D needed to support the load.



SOLUTION

Force And Position Vectors. The coordinates of points A, B, and C are $A(6, 0, 0)$ m, $B(0, -3, 2)$ m and $C(0, 0, 2)$ m respectively.

$$\mathbf{F}_{AB} = F_{AB}\left(\frac{\mathbf{r}_{AB}}{r_{AB}}\right) = F_{AB}\left[\frac{(0-6)\mathbf{i} + (-3-0)\mathbf{j} + (2-0)\mathbf{k}}{\sqrt{(0-6)^2 + (-3-0)^2 + (2-0)^2}}\right] = -\frac{6}{7}F_{AB}\mathbf{i} - \frac{3}{7}F_{AB}\mathbf{j} + \frac{2}{7}F_{AB}\mathbf{k}$$

$$\mathbf{F}_{AC} = F_{AC}\left(\frac{\mathbf{r}_{AC}}{r_{AC}}\right) = F_{AC}\left[\frac{(0-6)\mathbf{i} + (2-0)\mathbf{k}}{\sqrt{(0-6)^2 + (2-0)^2}}\right] = -\frac{6}{\sqrt{40}}F_{AC}\mathbf{i} + \frac{2}{\sqrt{40}}F_{AC}\mathbf{k}$$

$$\mathbf{F} = 400\,(\sin 30°\mathbf{j} - \cos 30°\mathbf{k}) = \{200\mathbf{j} - 346.41\mathbf{k}\}\text{N}$$

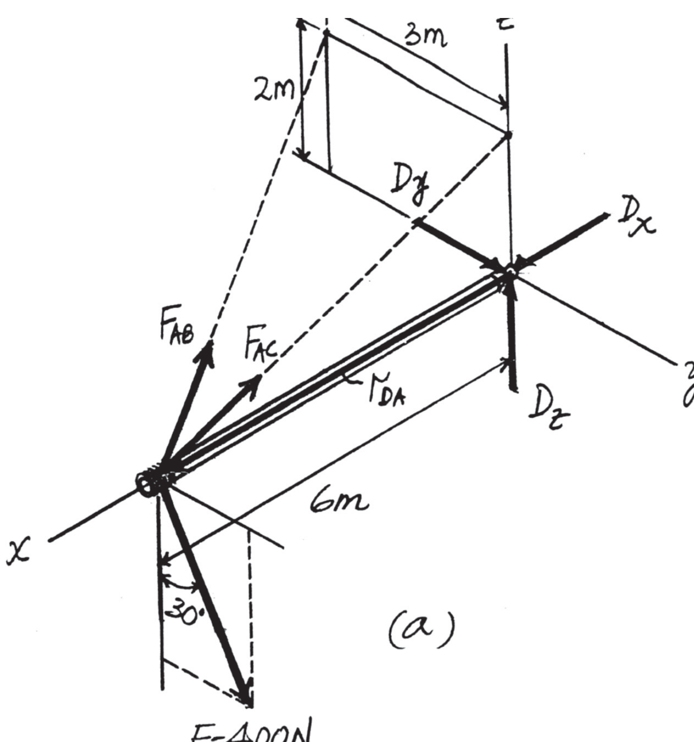
$$F_D = D_x\mathbf{i} + D_y\mathbf{j} + D_z\mathbf{k}$$

$$\mathbf{r}_{DA} = \{6\mathbf{i}\}\text{ m}$$

Referring to the *FBD* of the rod shown in Fig. *a*, the force equation of equilibrium gives

$$\Sigma\mathbf{F} = 0; \qquad \mathbf{F}_{AB} + \mathbf{F}_{AC} + \mathbf{F} + \mathbf{F}_D = 0$$

$$\left(-\frac{6}{7}F_{AB} - \frac{6}{\sqrt{40}}F_{AC} + D_x\right)\mathbf{i} + \left(-\frac{3}{7}F_{AB} + D_y + 200\right)\mathbf{j}$$
$$+\left(\frac{2}{7}F_{AB} + \frac{2}{\sqrt{40}}F_{AC} + D_z - 346.41\right)\mathbf{k} = 0$$



(a)

5–64. Continued

Equating **i**, **j** and **k** components,

$$-\frac{6}{7}F_{AB} - \frac{6}{\sqrt{40}}F_{AC} + D_x = 0 \qquad \textbf{(1)}$$

$$-\frac{3}{7}F_{AB} + D_y + 200 = 0 \qquad \textbf{(2)}$$

$$\frac{2}{7}F_{AB} + \frac{2}{\sqrt{40}}F_{AC} + D_z - 346.41 = 0 \qquad \textbf{(3)}$$

Moment equation of equilibrium gives

$\Sigma \mathbf{M}_D = 0; \qquad \mathbf{r}_{DA} \times (\mathbf{F}_{AB} + \mathbf{F}_{AC} + \mathbf{F}) = 0$

$$\begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 6 & 0 & 0 \\ \left(-\frac{6}{7}F_{AB} - \frac{6}{\sqrt{40}}F_{AC}\right) & \left(-\frac{3}{7}F_{AB} + 200\right) & \left(\frac{2}{7}F_{AB} + \frac{2}{\sqrt{40}}F_{AC} - 346.41\right) \end{vmatrix} = 0$$

$$-6\left(\frac{2}{7}F_{AB} + \frac{2}{\sqrt{40}}F_{AC} - 346.41\right)\mathbf{j} + 6\left(-\frac{3}{7}F_{AB} + 200\right)\mathbf{k} = 0$$

Equating **j** and **k** Components,

$$-6\left(\frac{2}{7}F_{AB} + \frac{2}{\sqrt{40}}F_{AC} - 346.41\right) = 0 \qquad \textbf{(4)}$$

$$6\left(-\frac{3}{7}F_{AB} + 200\right) = 0 \qquad \textbf{(5)}$$

Solving Eqs. (1) to (5)

$F_{AB} = 466.67 \text{ N} = 467 \text{ N}$ **Ans.**

$F_{AC} = 673.81 \text{ N} = 674 \text{ N}$ **Ans.**

$D_x = 1039.23 \text{ N} = 1.04 \text{ kN}$ **Ans.**

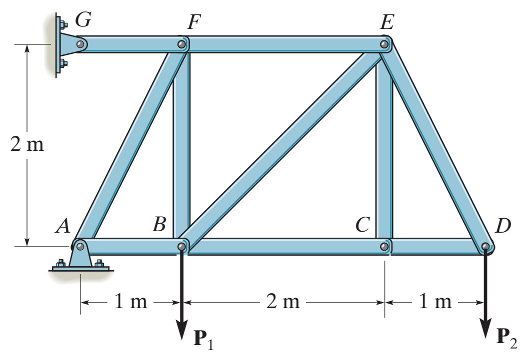
$D_y = 0$ **Ans.**

$D_z = 0$ **Ans.**

Ans:
$F_{AB} = 467 \text{ N}$
$F_{AC} = 674 \text{ N}$
$D_x = 1.04 \text{ kN}$
$D_y = 0$
$D_z = 0$

6–21.

Determine the force in each member of the truss and state if the members are in tension or compression. Set $P_1 = 8$ kN, $P_2 = 12$ kN.



SOLUTION

Support Reactions. Not required.

Method of Joints. We will perform the joint equilibrium according to the sequence of joints D, C, E, B and F.

Joint *D*. Fig. *a*

$+\uparrow \Sigma F_y = 0; \quad F_{DE}\left(\frac{2}{\sqrt{5}}\right) - 12 = 0 \quad F_{DE} = 6\sqrt{5}\text{ kN (T)} = 13.4\text{ kN (T)}$ **Ans.**

$\xrightarrow{+} \Sigma F_x = 0; \quad F_{DC} - \left(6\sqrt{5}\right)\left(\frac{1}{\sqrt{5}}\right) = 0 \quad F_{DC} = 6.00\text{ kN (C)}$ **Ans.**

Joint *C*. Fig. *b*

$\xrightarrow{+} \Sigma F_x = 0; \quad F_{CB} - 6.00 = 0 \quad F_{CB} = 6.00\text{ kN (C)}$ **Ans.**

$+\uparrow \Sigma F_y = 0; \quad F_{CE} = 0$ **Ans.**

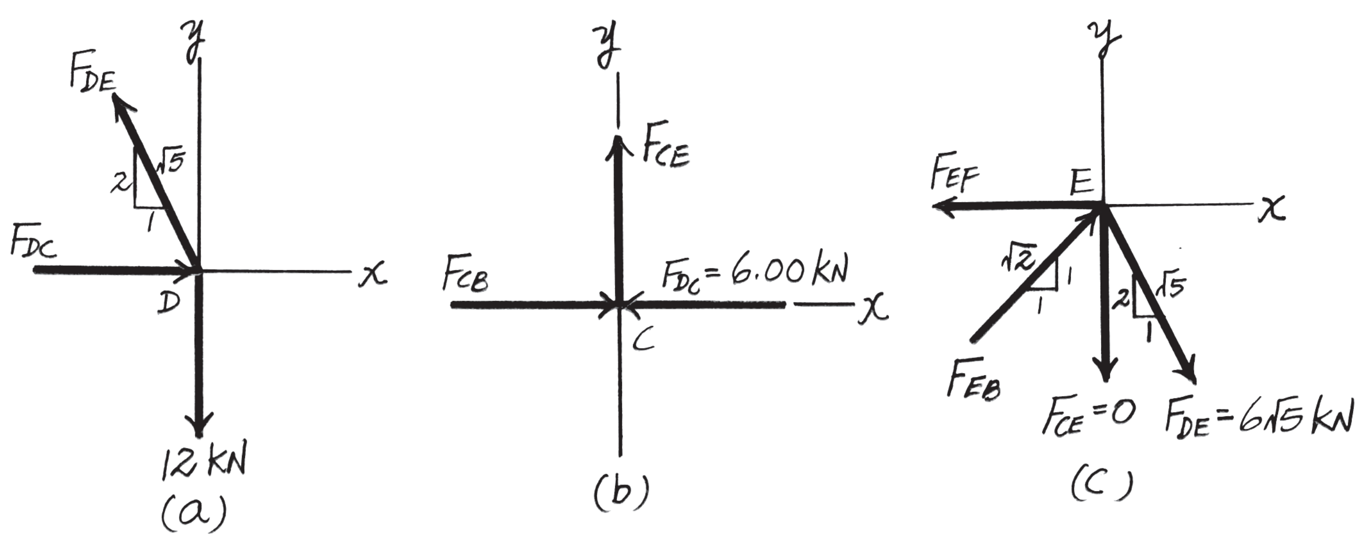
Joint *E*. Fig. *c*

$+\uparrow \Sigma F_y = 0; \quad F_{EB}\left(\frac{1}{\sqrt{2}}\right) - \left(6\sqrt{5}\right)\left(\frac{2}{\sqrt{5}}\right) = 0$

$F_{EB} = 12\sqrt{2}\text{ kN (C)} = 17.0\text{ kN (C)}$ **Ans.**

$\xrightarrow{+} \Sigma F_x = 0; \quad \left(12\sqrt{2}\right)\left(\frac{1}{\sqrt{2}}\right) + \left(6\sqrt{5}\right)\left(\frac{1}{\sqrt{5}}\right) - F_{EF} = 0$

$F_{EF} = 18.0\text{ kN (T)}$ **Ans.**



6–21. Continued

Joint *B*. Fig. *d*

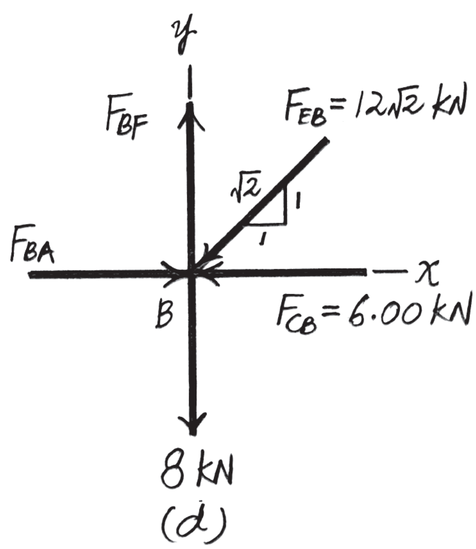
$\xrightarrow{+} \Sigma F_x = 0; \quad F_{BA} - 6.00 - \left(12\sqrt{2}\right)\left(\frac{1}{\sqrt{2}}\right) = 0 \quad F_{BA} = 18.0 \text{ kN (C)}$ **Ans.**

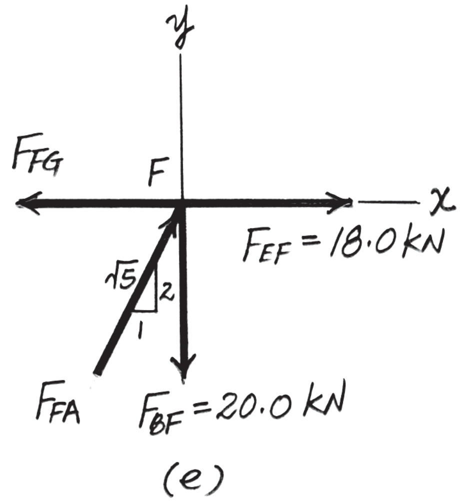
$+\uparrow \Sigma F_y = 0; \quad F_{BF} - 8 - \left(12\sqrt{2}\right)\left(\frac{1}{\sqrt{2}}\right) = 0 \quad F_{BF} = 20.0 \text{ kN (T)}$ **Ans.**

Joint *F*. Fig. *e*

$+\uparrow \Sigma F_y = 0; \quad F_{FA}\left(\frac{2}{\sqrt{5}}\right) - 20.0 = 0 \quad F_{FA} = 10\sqrt{5} \text{ kN (C)} = 22.4 \text{ kN (C)}$ **Ans.**

$\xrightarrow{+} \Sigma F_x = 0; \quad \left(10\sqrt{5}\right)\left(\frac{1}{\sqrt{5}}\right) + 18.0 - F_{FG} = 0 \quad F_{FG} = 28.0 \text{ kN(T)}$ **Ans.**

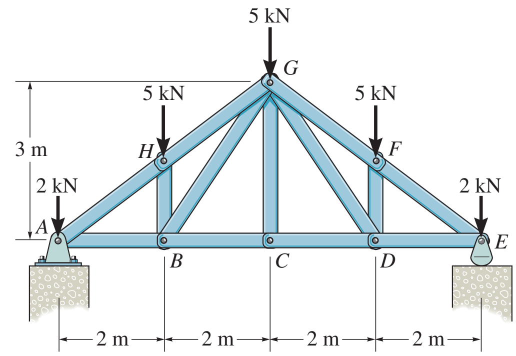




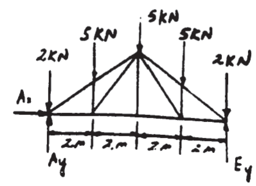
Ans:
$F_{DE} = 13.4$ kN (T)
$F_{DC} = 6.00$ kN (C)
$F_{CB} = 6.00$ kN (C)
$F_{CE} = 0$
$F_{EB} = 17.0$ kN (C)
$F_{EF} = 18.0$ kN (T)
$F_{BA} = 18.0$ kN (C)
$F_{BF} = 20.0$ kN (T)
$F_{FA} = 22.4$ kN (C)
$F_{FG} = 28.0$ kN (T)

***6–36.**

The *Howe truss* is subjected to the loading shown. Determine the force in members *GF*, *CD*, and *GC*, and state if the members are in tension or compression.



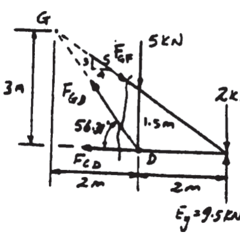
SOLUTION



$\zeta + \Sigma M_A = 0; \qquad E_y(8) - 2(8) - 5(6) - 5(4) - 5(2) = 0 \qquad E_y = 9.5\text{kN}$

$\zeta + \Sigma M_D = 0; \qquad -\frac{4}{5}F_{GF}(1.5) - 2(2) + 9.5(2) = 0$

$F_{GF} = 12.5 \text{ kN (C)}$ **Ans.**

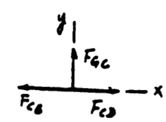


$\zeta + \Sigma M_G = 0; \qquad 9.5(4) - 2(4) - 5(2) - F_{CD}(3) = 0$

$F_{CD} = 6.67 \text{ kN (T)}$ **Ans.**

Joint *C*:

$+\uparrow \Sigma F_y = 0; \qquad F_{GC} = 0$ **Ans.**



Ans:
$F_{GF} = 12.5 \text{ kN (C)}$
$F_{CD} = 6.67 \text{ kN (T)}$
$F_{GC} = 0$