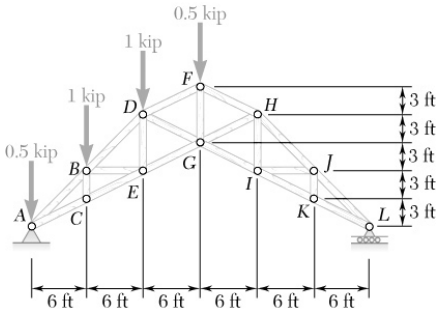
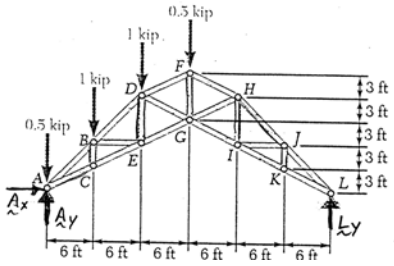
PROBLEM 6.19



Determine the force in each of the members located to the left of member *FG* for the scissor roof truss shown. State whether each member is in tension or compression.

SOLUTION

FBD Truss:



$$\circlearrowleft \Sigma M_A = 0: (6\text{ ft})\left[6L_y - 3(.5\text{ kip}) - 2(1\text{ kip}) - 1(1\text{ kip})\right] = 0$$

$$\mathbf{L}_y = 0.75\text{ kip} \uparrow$$

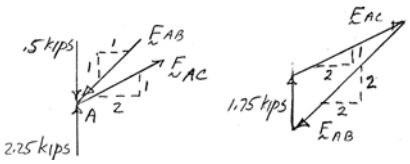
$$\uparrow \Sigma F_y = 0: A_y - 0.5\text{ kip} - 1\text{ kip} - 1\text{ kip} - 0.5\text{ kip} + 0.75\text{ kip} = 0$$

$$\mathbf{A}_y = 2.25\text{ kips} \uparrow$$

$$\rightarrow \Sigma F_x = 0: \mathbf{A}_x = 0$$

Joint FBDs:

Joint *A*:



$$\frac{1.75\text{ kips}}{1} = \frac{F_{AC}}{\sqrt{5}} = \frac{F_{AB}}{\sqrt{8}}$$

$F_{AB} = 4.95$ kips C ◀

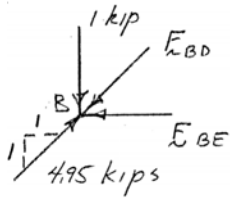
$F_{AC} = 3.913$ kips

$F_{AC} = 3.91$ kips T ◀

By inspection of joint *C*: $F_{BC} = 0$ ◀

and $F_{CE} = F_{AC}$ so $F_{CE} = 3.91$ kips T ◀

Joint *B*:



$$\uparrow \Sigma F_y = 0: \frac{4.95\text{ kips}}{\sqrt{2}} - 1\text{ kip} - \frac{F_{BD}}{\sqrt{2}} = 0$$

$F_{BD} = 3.536$ kips

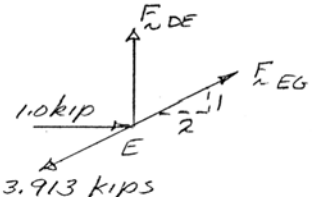
$F_{BD} = 3.54$ kips C ◀

$$\rightarrow \Sigma F_x = 0: (4.95\text{ kips} - 3.536\text{ kips})\frac{1}{\sqrt{2}} - F_{BE} = 0$$

$F_{BE} = 1.000$ kip

$F_{BE} = 1.000$ kip C ◀

Joint *E*:



$$\rightarrow \Sigma F_x = 0: \frac{2}{\sqrt{5}}\left[F_{EG} - 3.913\text{ kips}\right] + 1\text{ kip} = 0$$

$F_{EG} = 2.795$ kips

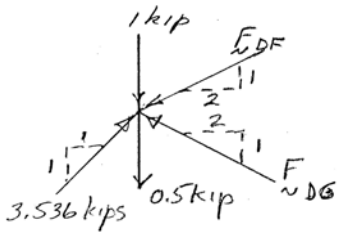
$F_{EG} = 2.80$ kips T ◀

$$\uparrow \Sigma F_y = 0: \frac{1}{\sqrt{5}}(2.795\text{ kips} - 3.913\text{ kips}) + F_{DE} = 0$$

$F_{DE} = 0.500$ kip T ◀

PROBLEM 6.19 CONTINUED

Joint *D*:



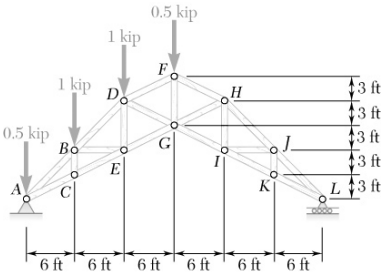
$$\rightarrow \Sigma F_x = 0: \frac{1}{\sqrt{2}}(3.536 \text{ kips}) - \frac{2}{\sqrt{5}}(F_{DF} + F_{DG}) = 0$$

$$\uparrow \Sigma F_y = 0: \frac{1}{\sqrt{2}}(3.536 \text{ kips}) - 1.5 \text{ kips} + \frac{1}{\sqrt{5}}(F_{DG} - F_{DF}) = 0$$

Solving:

$$F_{DF} = 2.516 \text{ kips} \quad \text{so} \quad F_{DF} = 2.52 \text{ kips C} \blacktriangleleft$$

$$F_{DG} = 0.280 \text{ kip} \quad F_{DG} = 0.280 \text{ kip C} \blacktriangleleft$$

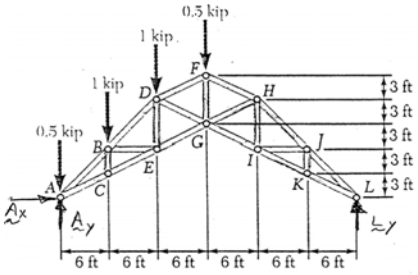


PROBLEM 6.20

Determine the force in member *FG* and in each of the members located to the right of member *FG* for the scissor roof truss shown. State whether each member is in tension or compression.

SOLUTION

FBD Truss:



$$\circlearrowleft \Sigma M_A = 0: (6\text{ ft})\left[6L_y - 3(0.5\text{ kip}) - 2(1\text{ kip}) - 1(1\text{ kip})\right] = 0$$

$$\mathbf{L}_y = 0.75\text{ kip} \uparrow$$

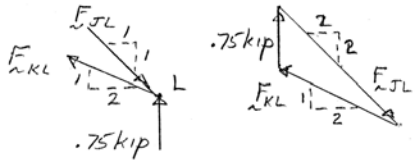
Inspection of joints *K*, *J*, and *I*, in order, shows that $F_{JK} = 0$ ◀

$F_{IJ} = 0$ ◀

$F_{HI} = 0$ ◀

and that $F_{IK} = F_{KL}$; $F_{HJ} = F_{JL}$ and $F_{GI} = F_{IK}$

Joint FBDs:

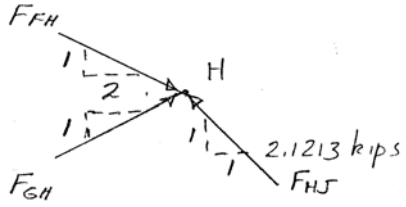


$$\frac{0.75}{1} = \frac{F_{JL}}{\sqrt{8}} = \frac{F_{KL}}{\sqrt{5}} \qquad F_{JL} = 2.1213\text{ kips} \qquad F_{JL} = 2.12\text{ kips C} \blacktriangleleft$$

$$F_{KL} = 1.6771\text{ kips} \qquad F_{KL} = 1.677\text{ kips T} \blacktriangleleft$$

and, from above: $F_{HJ} = 2.12\text{ kips C} \blacktriangleleft$

$F_{GI} = F_{IK} = 1.677\text{ kips T} \blacktriangleleft$



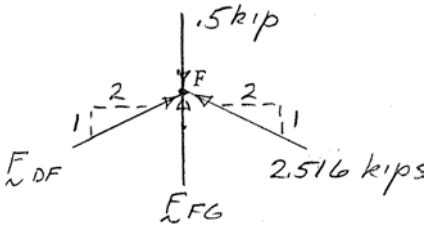
$$\rightarrow \Sigma F_x = 0: \frac{2}{\sqrt{5}}\left(F_{FH} + F_{GH}\right) - \frac{1}{\sqrt{2}}(2.1213\text{ kips}) = 0$$

$$\uparrow \Sigma F_y = 0: \frac{1}{\sqrt{5}}\left(F_{GH} + F_{FH}\right) + \frac{1}{\sqrt{2}}(2.1213\text{ kips}) = 0$$

Solving: $F_{FH} = 2.516\text{ kips}$ $\qquad F_{FH} = 2.52\text{ kips C} \blacktriangleleft$

$F_{GH} = -0.8383\text{ kips}$ $\qquad F_{GH} = 0.838\text{ kips T} \blacktriangleleft$

PROBLEM 6.20 CONTINUED

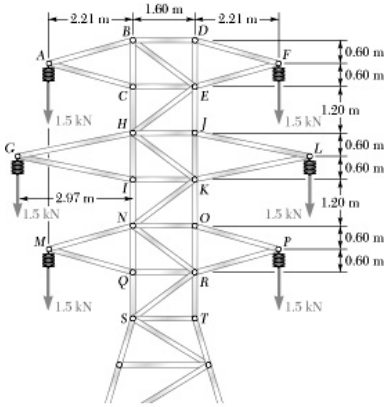


$$\rightarrow \Sigma F_x = 0: \frac{2}{\sqrt{5}}\left(F_{DF} - 2.516 \text{ kips}\right) = 0 \qquad F_{DF} = 2.52 \text{ kips C}$$

$$\uparrow \Sigma F_y = 0: F_{FG} - 0.5 \text{ kip} + \frac{1}{\sqrt{5}}(2)\left(2.516 \text{ kips}\right) = 0$$

$$F_{FG} = 1.750 \text{ kips T} \blacktriangleleft$$

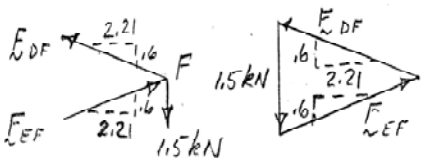
PROBLEM 6.21



The portion of truss shown represents the upper part of a power transmission line tower. For the given loading, determine the force in each of the members located above *HJ*. State whether each member is in tension or compression.

SOLUTION

Joint FBDs:



$$\frac{F_{DF}}{2.29} = \frac{F_{EF}}{2.29} = \frac{1.5\text{ kN}}{1.2}$$

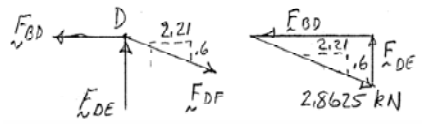
$$F_{DF} = F_{EF} = 2.8625\text{ kN} \qquad F_{DF} = 2.86\text{ kN T} \blacktriangleleft$$

$$F_{EF} = 2.86\text{ kN C} \blacktriangleleft$$

$$\frac{F_{BD}}{2.21} = \frac{F_{DE}}{0.6} = \frac{2.8625\text{ kN}}{2.29} = 1.25\text{ kN}$$

$$F_{BD} = 2.7625\text{ kN} \qquad F_{BD} = 2.76\text{ kN T} \blacktriangleleft$$

$$F_{DE} = 0.750\text{ kN C} \blacktriangleleft$$



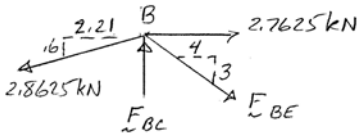
By symmetry of joint *A* vs. joint *F*

$$F_{AB} = 2.86\text{ kN T} \blacktriangleleft$$

$$F_{AC} = 2.86\text{ kN T} \blacktriangleleft$$

$$\rightarrow \Sigma F_x = 0\text{: } 2.7625\text{ kN} - \frac{2.21}{2.29}(2.8625\text{ kN}) + \frac{4}{5}F_{BE} = 0$$

$$F_{BE} = 0 \blacktriangleleft$$

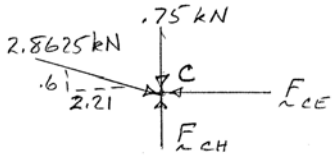


$$\uparrow \Sigma F_y = 0\text{: } F_{BC} - \frac{0.6}{2.29}(2.8625\text{ kN}) = 0;$$

$$F_{BC} = 0.750\text{ kN C} \blacktriangleleft$$

$$\rightarrow \Sigma F_x = 0\text{: } \frac{2.21}{2.29}(2.8625\text{ kN}) - F_{CE} = 0 \qquad F_{CE} = 2.7625\text{ kN}$$

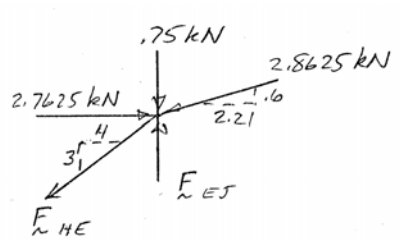
$$F_{CE} = 2.76\text{ kN C} \blacktriangleleft$$



$$\uparrow \Sigma F_y = 0\text{: } F_{CH} - 0.75\text{ kN} - \frac{0.6}{2.21}(2.8625\text{ kN}) = 0$$

$$F_{CH} = 1.500\text{ kN C} \blacktriangleleft$$

PROBLEM 6.21 CONTINUED



$$\rightarrow \Sigma F_x = 0: \; 2.7625 \text{ kN} - \frac{2.21}{2.29}(2.8625 \text{ kN}) - \frac{4}{5} F_{HE} = 0$$

$$F_{HE} = 0 \blacktriangleleft$$

$$\uparrow \Sigma F_y = 0: \; F_{EJ} - 0.75 \text{ kN} - \frac{0.6}{2.29}(2.8625 \text{ kN}) = 0$$

$$F_{EJ} = 1.500 \text{ kN} \blacktriangleleft$$

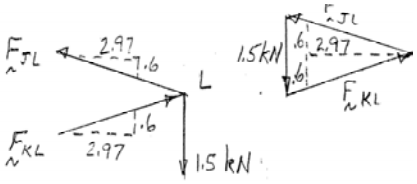
PROBLEM 6.22

For the tower and loading of Prob. 6.21 and knowing that $F_{CH} = F_{EJ} = 1.5$ kN C and $F_{EH} = 0$, determine the force in member HJ and in each of the members located between HJ and NO. State whether each member is in tension or compression.

SOLUTION

$$\frac{1.5 \text{ kN}}{1.2} = \frac{F_{JL}}{3.03} = \frac{F_{KL}}{3.03}$$

Joint FBDs:



$$F_{JL} = F_{KL} = 3.7875 \text{ kN}$$

$F_{JL} = 3.79$ kN T ◀

$F_{KL} = 3.79$ kN C ◀

By symmetry:

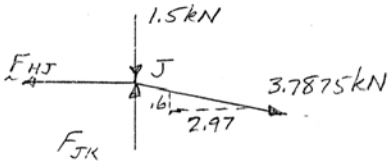
$F_{GH} = 3.79$ kN T ◀

$F_{GI} = 3.79$ kN C ◀

$$\rightarrow \Sigma F_x = 0: \frac{2.97}{3.03}(3.7875 \text{ kN}) - F_{HJ} = 0$$

$$F_{HJ} = 3.7125 \text{ kN}$$

$F_{HJ} = 3.71$ kN T ◀



$$\uparrow \Sigma F_y = 0: F_{JK} - \frac{0.6}{3.03}(3.7875 \text{ kN}) - 1.5 \text{ kN} = 0$$

$F_{JK} = 2.25$ kN C ◀

Knowing $F_{HE} = 0$; by symmetry

$F_{HK} = 0$ ◀

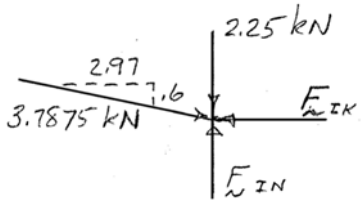
$F_{HI} = 2.25$ kN C ◀

$$\rightarrow \Sigma F_x = 0: \frac{2.97}{3.03}(3.7875 \text{ kN}) - F_{IK} = 0 \qquad F_{IK} = 3.7125$$

$F_{IK} = 3.71$ kN C ◀

$$\uparrow \Sigma F_y = 0: F_{IN} - 2.25 \text{ kN} - \frac{0.6}{3.03}(3.7875 \text{ kN}) = 0$$

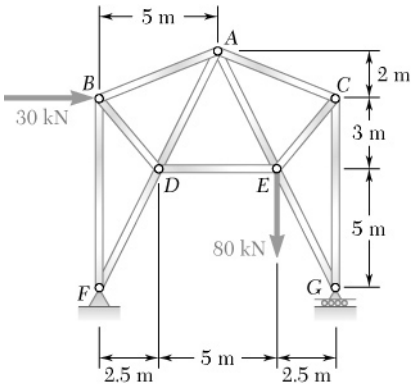
$F_{IN} = 3.00$ kN C ◀



Knowing that $F_{HK} = 0$, by symmetry

$F_{KO} = 3.00$ kN C ◀

$F_{KN} = 0$ ◀

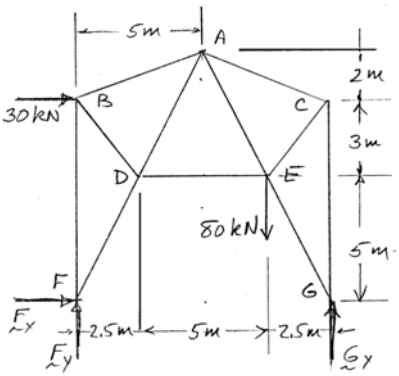


PROBLEM 6.23

Determine the force in each member of the truss shown. State whether each member is in tension or compression.

SOLUTION

FBD Truss:



$$\circlearrowleft \Sigma M_F = 0: (10\text{ m})G_y - (7.5\text{ m})(80\text{ kN}) - (8\text{ m})(30\text{ kN}) = 0$$

$$\mathbf{G}_y = 84\text{ kN} \uparrow$$

$$\rightarrow \Sigma F_x = 0: -F_x + 30\text{ kN} = 0 \qquad \mathbf{F}_x = 30\text{ kN} \leftarrow$$

$$\uparrow \Sigma F_y = 0: F_y + 84\text{ kN} - 80\text{ kN} = 0 \qquad \mathbf{F}_y = 4\text{ kN} \downarrow$$

By inspection of joint *G*: $F_{EG} = 0$ ◀

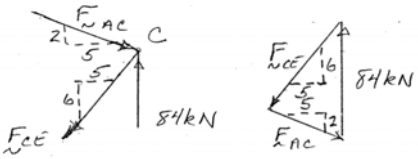
$F_{CG} = 84\text{ kN}$ C ◀

$$\frac{84\text{ kN}}{8} = \frac{F_{CE}}{\sqrt{61}} = \frac{F_{AC}}{\sqrt{29}} = 10.5\text{ kN}$$

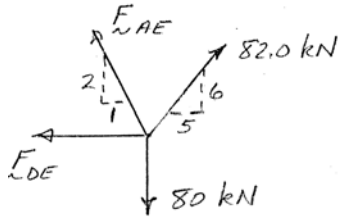
$F_{CE} = 82.0\text{ kN}$ T ◀

$F_{AC} = 56.5\text{ kN}$ C ◀

Joint FBDs:



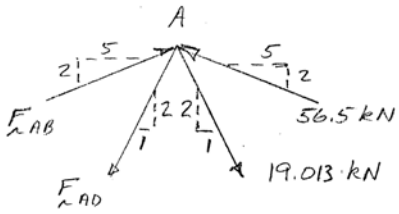
$$\uparrow \Sigma F_y = 0: \frac{2}{\sqrt{5}}F_{AE} + \frac{6}{\sqrt{61}}(82.0\text{ kN}) - 80\text{ kN} = 0$$



$$F_{AE} = 19.01312 \qquad F_{AE} = 19.01\text{ kN}\ \text{T} \blacktriangleleft$$

$$\rightarrow \Sigma F_x = 0: -F_{DE} - \frac{1}{\sqrt{5}}(19.013\text{ kN}) + \frac{5}{\sqrt{61}}(82.0\text{ kN}) = 0$$

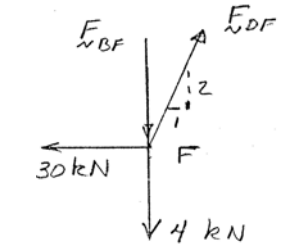
$$F_{DE} = 43.99\text{ kN} \qquad F_{DE} = 44.0\text{ kN}\ \text{T} \blacktriangleleft$$



$$\rightarrow \Sigma F_x = 0: \frac{1}{\sqrt{5}}F_{DF} - 30\text{ kN} = 0$$

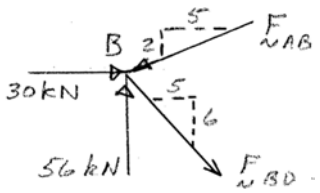
$$F_{DF} = 67.082\text{ kN} \qquad F_{DF} = 67.1\text{ kN}\ \text{T} \blacktriangleleft$$

PROBLEM 6.23 CONTINUED



$$\uparrow \Sigma F_y = 0: \frac{2}{\sqrt{5}}(67.082 \text{ kN}) - F_{BF} - 4 \text{ kN} = 0$$

$$F_{BF} = 56.00 \text{ kN} \qquad F_{BF} = 56.0 \text{ kN C} \blacktriangleleft$$



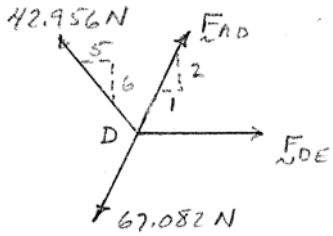
$$\rightarrow \Sigma F_x = 0: 30 \text{ kN} + \frac{5}{\sqrt{61}} F_{BD} - \frac{5}{\sqrt{29}} F_{AB} = 0$$

$$\uparrow \Sigma F_y = 0: 56 \text{ kN} - \frac{6}{\sqrt{61}} F_{BD} - \frac{3}{\sqrt{29}} F_{AB} = 0$$

Solving:

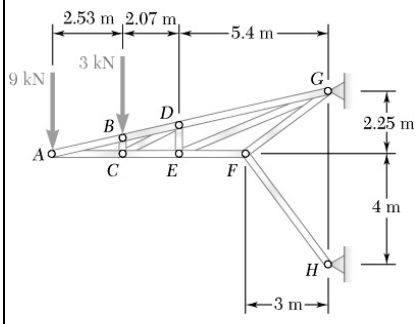
$$F_{BD} = 42.956 \text{ kN} \qquad F_{BD} = 43.0 \text{ kN T} \blacktriangleleft$$

$$F_{AB} = 61.929 \text{ kN} \qquad F_{AB} = 61.9 \text{ kN C} \blacktriangleleft$$



$$\uparrow \Sigma F_y = 0: \frac{6}{\sqrt{61}}(42.956 \text{ N}) + \frac{2}{\sqrt{5}}(F_{AD} - 67.082 \text{ N}) = 0$$

$$F_{AD} = 30.157 \text{ kN} \qquad F_{AD} = 30.2 \text{ N T} \blacktriangleleft$$

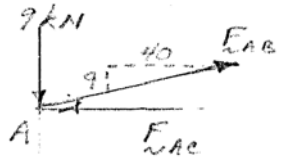


PROBLEM 6.24

Determine the force in each member of the truss shown. State whether each member is in tension or compression.

SOLUTION

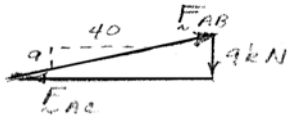
Joint FBDs:



$$\frac{9\text{ kN}}{9} = \frac{F_{AC}}{40} = \frac{F_{AB}}{41}$$

$$F_{AB} = 41.0\text{ kN T} \blacktriangleleft$$

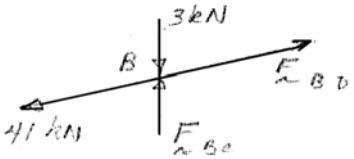
$$F_{AC} = 40.0\text{ kN C} \blacktriangleleft$$



By inspection of joint B:

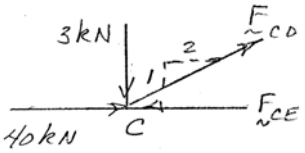
$$F_{BD} = 41.0\text{ kN T} \blacktriangleleft$$

$$F_{BC} = 3.00\text{ kN C} \blacktriangleleft$$

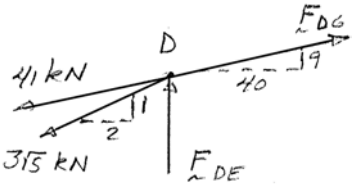


Note: to determine slope of *CD*: $DE = \frac{4.6}{10.0}(2.25\text{ m}) = 1.035\text{ m}$

$$\uparrow \Sigma F_y = 0: \quad \frac{1}{\sqrt{5}}F_{CD} - 3\text{ kN} = 0 \qquad F_{CD} = 3\sqrt{5}\text{ kN} = 6.71\text{ kN T} \blacktriangleleft$$



$$\rightarrow \Sigma F_x = 0: \quad \frac{2}{\sqrt{5}}\left(3\sqrt{5}\text{ kN}\right) + 40\text{ kN} - F_{CE} = 0 \qquad F_{CE} = 46.0\text{ kN C} \blacktriangleleft$$

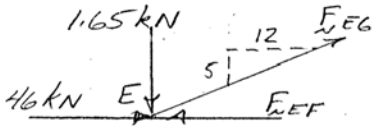


$$\rightarrow \Sigma F_x = 0: \quad \frac{40}{41}\left(F_{DG} - 41\text{ kN}\right) - \frac{2}{\sqrt{5}}\left(3\sqrt{5}\text{ kN}\right) = 0$$

$$F_{DG} = 47.15\text{ kN} \qquad F_{DG} = 47.2\text{ kN T} \blacktriangleleft$$

$$\uparrow \Sigma F_y = 0: \quad F_{DE} + \frac{9}{41}\left(47.15\text{ kN} - 41\text{ kN}\right) - \frac{1}{\sqrt{5}}\left(3\sqrt{5}\text{ kN}\right) = 0$$

$$F_{DE} = 1.650\text{ kN C} \blacktriangleleft$$

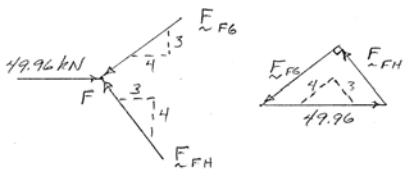


$$\uparrow \Sigma F_y = 0: \quad \frac{5}{13}F_{EG} - 1.65\text{ kN} = 0 \qquad F_{EG} = 4.29\text{ kN T} \blacktriangleleft$$

$$\rightarrow \Sigma F_x = 0: \quad 46\text{ kN} + \frac{12}{13}\left(4.29\text{ kN}\right) - F_{EF} = 0 \qquad F_{EF} = 49.96\text{ kN}$$

$$F_{EF} = 50.0\text{ kN C} \blacktriangleleft$$

PROBLEM 6.24 CONTINUED



$$\frac{49.96 \text{ kN}}{5} = \frac{F_{FG}}{4} = \frac{F_{FH}}{3}$$

$F_{FG} = 40.0 \text{ kN C}$ ◀

$F_{FH} = 30.0 \text{ kN C}$ ◀