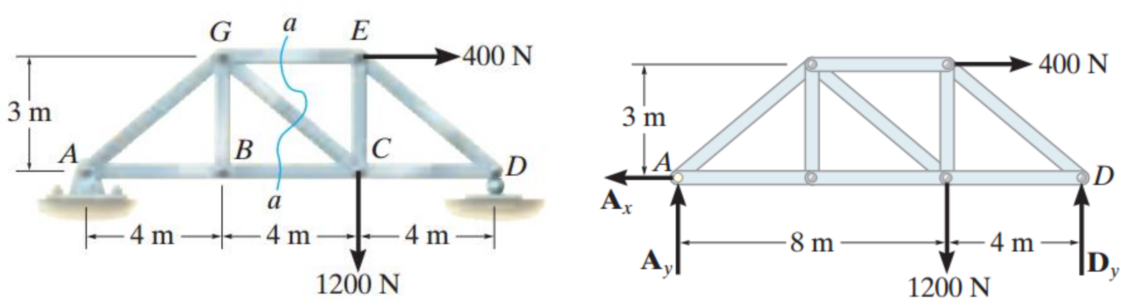
4.1.2. The Method of Sections

When we need to find the force in only a few members of a truss, we can analyze the truss using ***the method of sections***. It is based on the principle that if the truss is in equilibrium then any segment of the truss is also in equilibrium.

Example: Determine the force in members GE, GC, and BC of the truss shown in Fig. a. Indicate whether the members are in tension or compression.



(a) (b)

Solution:

Section a a in Fig. a has been chosen since it cuts through the three members whose forces are to be determined. In order to use the method of sections, however, it is first necessary to determine the external reactions at A or D. Why? A free-body diagram of the entire truss is shown in Fig. b. applying the equations of equilibrium, we have:

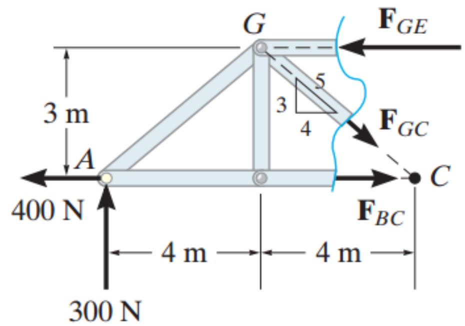
$$\overset{+}{\rightarrow}\Sigma F_x = 0; \qquad 400\text{ N} - A_x = 0 \qquad A_x = 400\text{ N}$$

$$\circlearrowleft +\Sigma M_A = 0; \qquad -1200\text{ N}(8\text{ m}) - 400\text{ N}(3\text{ m}) + D_y(12\text{ m}) = 0$$

$$D_y = 900\text{ N}$$

$$+\uparrow\Sigma F_y = 0; \qquad A_y - 1200\text{ N} + 900\text{ N} = 0 \qquad A_y = 300\text{ N}$$

Free-Body Diagram. For the analysis the free-body diagram of the left portion of the sectioned truss will be used, since it involves the least number of forces, Fig. c.



(c)

Equations of Equilibrium. Summing moments about point G eliminates F_{GE} and F_{GC} and yields a direct solution for F_{BC}.

$$\circlearrowleft +\Sigma M_G = 0; \quad -300\text{ N}(4\text{ m}) - 400\text{ N}(3\text{ m}) + F_{BC}(3\text{ m}) = 0$$

$$F_{BC} = 800\text{ N} \quad (\text{T}) \qquad \textit{Ans.}$$

In the same manner, by summing moments about point C we obtain a direct solution for F_{GE}.

$$\circlearrowleft +\Sigma M_C = 0; \quad -300\text{ N}(8\text{ m}) + F_{GE}(3\text{ m}) = 0$$

$$F_{GE} = 800\text{ N} \quad (\text{C}) \qquad \textit{Ans.}$$

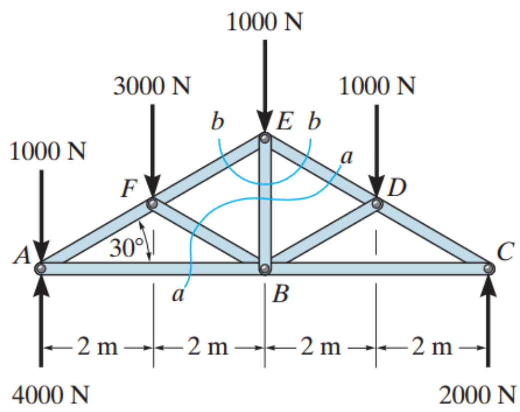
Since $\mathbf{F}_{BC}$ and $\mathbf{F}_{GE}$ have no vertical components, summing forces in the y direction directly yields F_{GC}, i.e.,

$$+\uparrow \Sigma F_y = 0; \qquad 300\text{ N} - \tfrac{3}{5}F_{GC} = 0$$

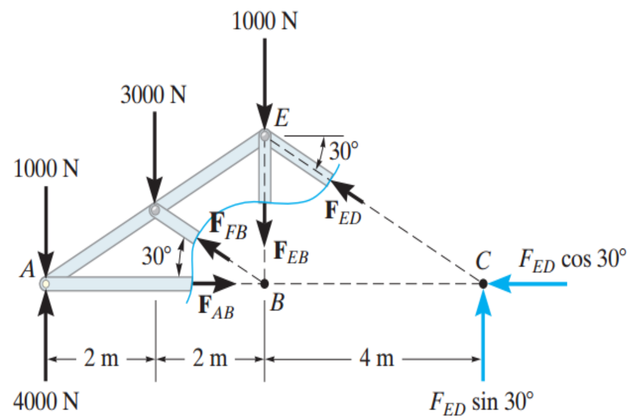
$$F_{GC} = 500\text{ N} \quad (\text{T}) \qquad \textit{Ans.}$$

NOTE: Here it is possible to tell, by inspection, the proper direction for each unknown member force. For example, $\Sigma M_C = 0$ requires $\mathbf{F}_{GE}$ to be *compressive* because it must balance the moment of the 300-N force about C.

Example: Determine the force in member EB of the roof truss shown in Fig. a. Indicate whether the member is in tension or compression.



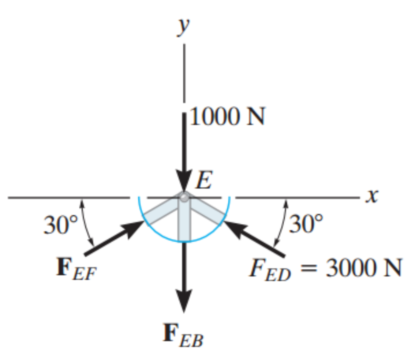
(a)



(b)

Solution:

Free-Body Diagrams. By the method of sections, any imaginary section that cuts through EB, Fig.a, will also have to cut through three other members for which the forces are unknown. For example, section aa cuts through ED, EB, FB, and AB. If a free-body diagram of the left side of this section is considered, Fig. b, it is possible to obtain F_{ED} by summing moments about B to eliminate the other three unknowns; however, F_{EB} cannot be determined from the remaining two equilibrium equations. One possible way of obtaining F_{EB} is first to determine F_{ED} from section aa, then use this result on section bb, Fig. 6–18a, which is shown in Fig. c. ***Here the force system is concurrent and our sectioned free-body diagram is the same as the free-body diagram for the joint at E.***



(c)

Equations of Equilibrium. In order to determine the moment of F_{ED} about point B, Fig. b, we will use the principle of transmissibility and slide the force to point C and then resolve it into its rectangular components as shown. Therefore,

$$\circlearrowleft + \Sigma M_B = 0; \qquad 1000\text{ N}(4\text{ m}) + 3000\text{ N}(2\text{ m}) - 4000\text{ N}(4\text{ m}) + F_{ED}\sin 30^\circ(4\text{ m}) = 0$$

$$F_{ED} = 3000\text{ N} \quad \text{(C)}$$

Considering now the free-body diagram of section bb, Fig. c, we have:

$$\overset{+}{\rightarrow} \Sigma F_x = 0; \qquad F_{EF}\cos 30^\circ - 3000\cos 30^\circ\text{ N} = 0$$

$$F_{EF} = 3000\text{ N} \quad \text{(C)}$$

$$+\uparrow \Sigma F_y = 0; \qquad 2(3000\sin 30^\circ\text{ N}) - 1000\text{ N} - F_{EB} = 0$$

$$F_{EB} = 2000\text{ N} \quad \text{(T)} \qquad \textit{Ans.}$$

HW: Determine the force in members AF, BF, and BC, and state if the members are in tension or compression.