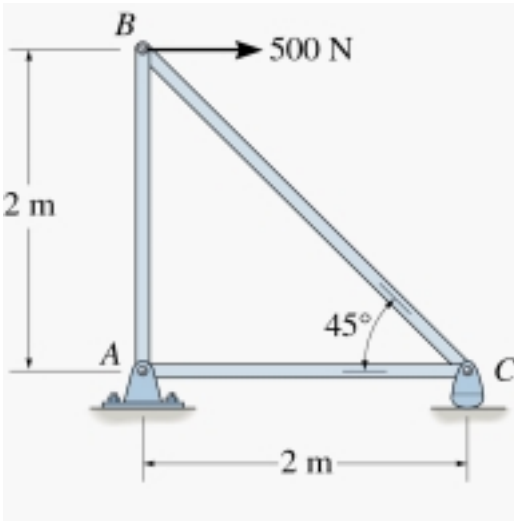
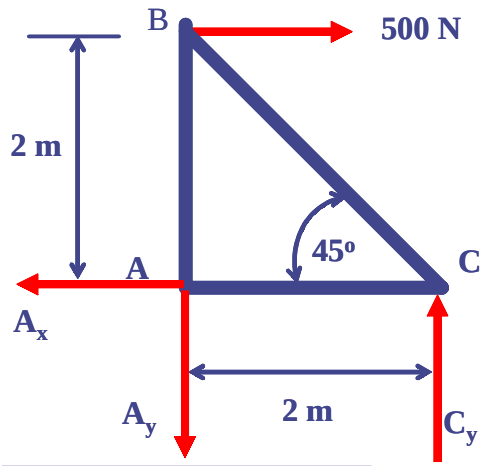
Problem 1:

Determine the support reactions in the joints of the following truss. Calculate the force in each member.



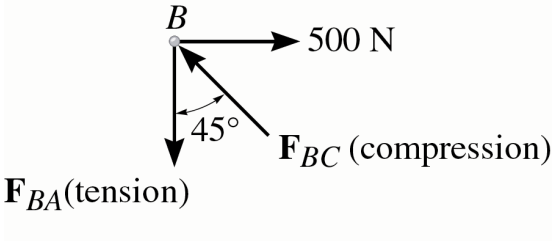
Solution:

1. Draw FBD of entire truss and solve for support reactions:



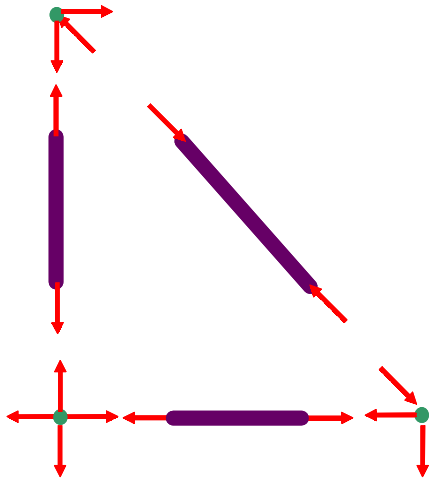
$$\sum F_x = 0 \qquad \sum F_y = 0$$
$$500 - A_x = 0 \qquad C_y - A_y = 0$$
$$A_x = 500 \text{ N} \qquad A_y = C_y$$
$$\sum M_A = 0$$
$$-500(2) + C_y(2) = 0$$
$$A_y = C_y = 500 \text{ N}$$

2. Draw FBD of a joint with at least one known force and at most two unknown forces. We choose joint B. Assume BC is in compression.



$$\sum F_x = 0$$
$$500 - F_{BC} \sin 45^o = 0$$
$$F_{BC} = 707.1 \text{ N } (C)$$
$$\sum F_y = 0$$
$$F_{BC} \cos 45^o - F_{BA} = 0$$
$$F_{BA} = 500 \text{ N } (T)$$

3. Either assume all unknown member forces are tensile. Positive results indicate tension and negative results indicate compression. Otherwise determine the correct sense for unknowns by inspection. Positive results indicate correct assumption and negative results indicate incorrect assumption. Continue selecting joints where there are at least one known force and at most two unknown forces.



$$\sum F_x = 0$$

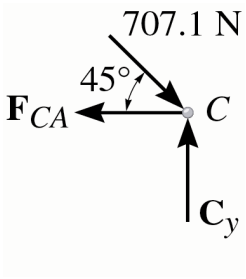
$$-F_{CA} + 707.1\cos 45^o = 0$$

$$F_{CA} = 500\ \text{N} \quad (\text{T})$$

$$\sum F_y = 0$$

$$C_y - 707.1\sin 45^o = 0$$

$$C_y = 500\ \text{N}$$



$$\sum F_x = 0$$

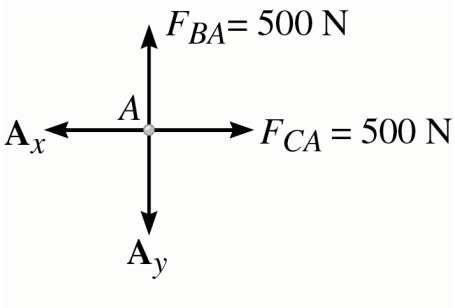
$$-A_x + 500 = 0$$

$$A_x = 500\ \text{N}$$

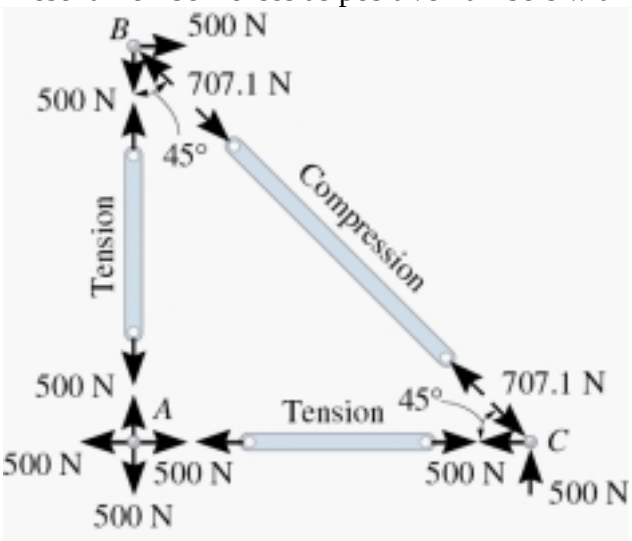
$$\sum F_y = 0$$

$$-A_y + 500 = 0$$

$$A_y = 500\ \text{N}$$

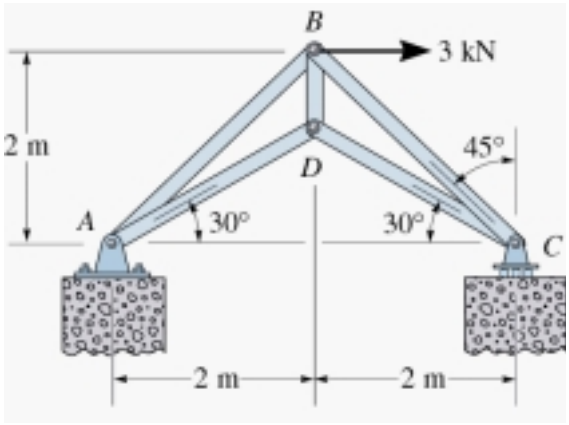


Present member forces as positive numbers with (T) or (C) indicating tension or compression.

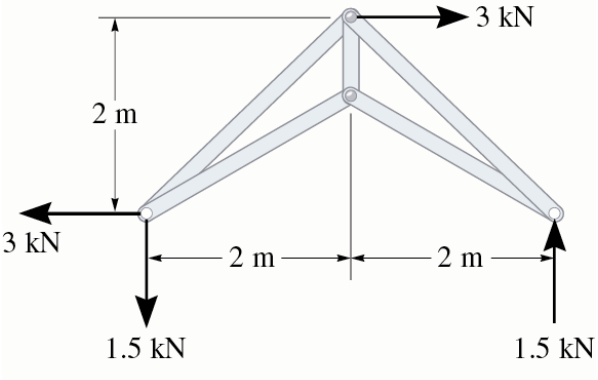


Problem 2:

Determine the support reactions in the joints of the following truss. Calculate the force in each member.



Solution: We start with FBD and calculate the support reactions at A and C:



$$\sum F_x = 0 \qquad \sum M_A = 0$$

$$-A_x + 3\ \text{kN} = 0 \qquad C_y(4) - 3\ \text{kN}(2) = 0$$

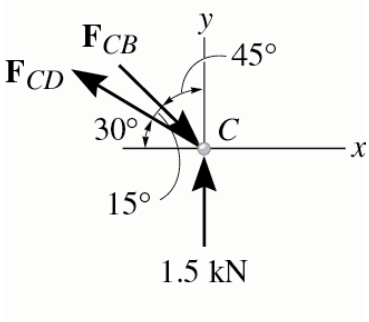
$$A_x = 3\ \text{kN} \qquad C_y = 1.5\ \text{kN}$$

$$\sum F_y = 0$$

$$C_y - Ay = 0$$

$$A_y = 1.5\ \text{kN}$$

Joint C has the minimum number of unknowns:



$$\sum F_x = 0$$

$$-F_{CD}\cos 30^o - F_{CB}\sin 45^o = 0$$

$$\sum F_y = 0$$

$$F_{CD}\sin 30^o + F_{CB}\cos 45^o + 1.5 = 0$$

$$-0.866\,F_{CD} = 0.7071\,F_{CB}$$

$$F_{CD} = -\frac{0.7071}{0.866}F_{CB} = -0.817\,F_{CB}$$

$$-0.817\,F_{CB}(0.5) + 0.7071F_{CB} + 1.5 = 0$$

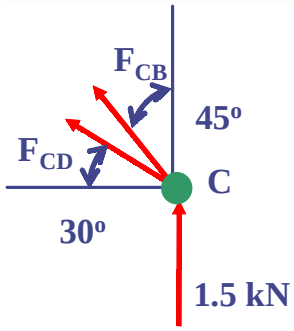
$$0.299\,F_{CB} = -1.5$$

$$F_{CB} = -5.02\ \text{kN}$$

$$F_{CD} = -0.817\,F_{CB} = -0.817(-5.02\ \text{kN}) = 4.10\ \text{kN}$$

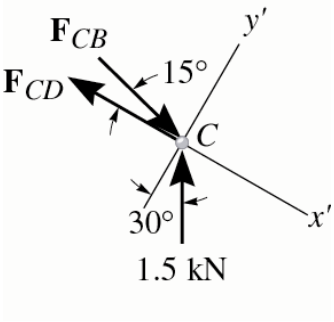
$$F_{CB} = 5.02\ \text{kN}\ \ (\text{C})$$

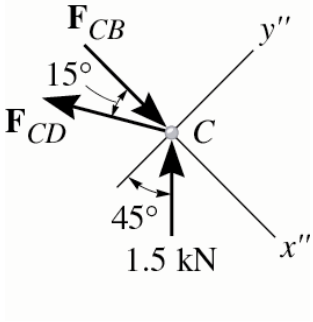
$$F_{CD} = 4.10\ \text{kN}\ \ (\text{T})$$



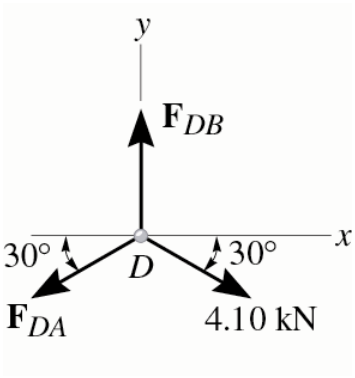
Since F_{CB} is negative, it means that a force is exerted from joint C on member CB (see the following figure), so CB is under compression.

Notice that there are always some alternatives for choosing your axes of coordinates.





For joint D:



$$\sum \mathbf{F}_x = 0$$

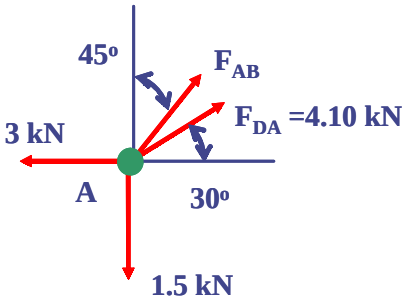
$$-\mathbf{F}_{DA}\cos 30^o + 4.10\cos 30^o = 0$$

$$\mathbf{F}_{DA} = 4.10\ \text{kN} \quad (\text{T})$$

$$\sum \mathbf{F}_y = 0$$

F_{DB} = 2(4.10) sin 30 = 4.10 kN (T)

And joint A:



$$\sum \mathbf{F}_x = 0$$

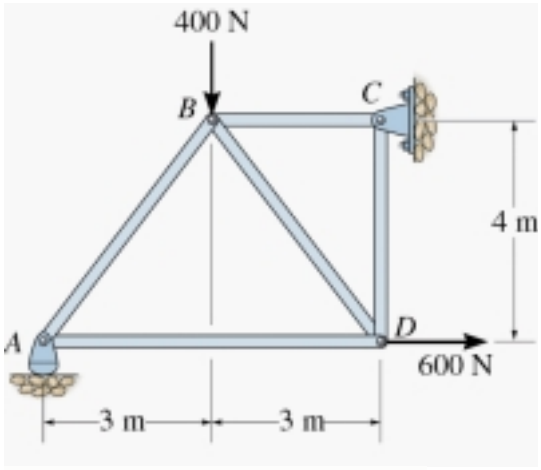
$$4.10\cos 30^o + \mathbf{F}_{AB}\sin 45^o - 3 = 0$$

$$\mathbf{F}_{AB} = -0.776\ \text{kN}$$

$$\mathbf{F}_{AB} = 0.776\ \text{kN} \quad (\text{C})$$

Problem 3:

Determine the support reactions in the joints of the following truss. Calculate the force in each member.



Solution: We start with FBD and calculate the support reactions at A and C:

$$\sum F_x = 0$$

$$600 - C_x = 0$$

$$C_x = 600 \text{ N}$$

$$\sum M_C = 0 \quad (+\text{ccw})$$

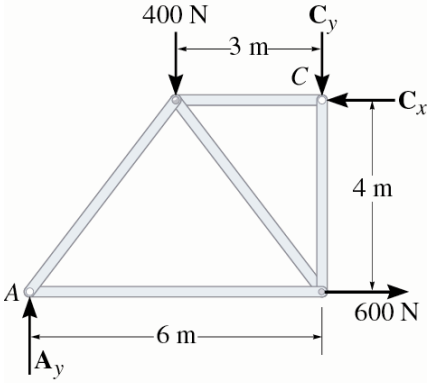
$$-A_y(6) + 400(3) + 600(4) = 0$$

$$A_y = 600 \text{ N}$$

$$\sum F_y = 0$$

$$A_y - 400 - C_y = 0$$

$$C_y = 200 \text{ N}$$



$$\mathbf{\sum F_x = 0}$$

$$\mathbf{F_{AD} + F_{AB}\left(\frac{3}{5}\right) = 0}$$

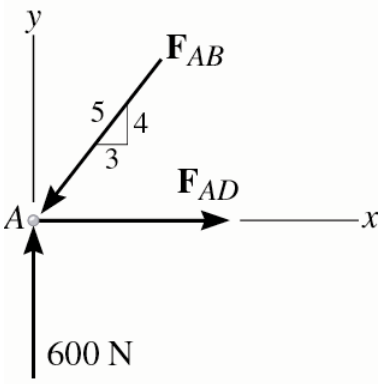
$$\mathbf{\sum F_y = 0}$$

$$\mathbf{600 + F_{AB}\left(\frac{4}{5}\right) = 0}$$

$$\mathbf{F_{AB} = -750 \text{ N}}$$

$$\mathbf{F_{AB} = 750 \text{ N} \quad (C)}$$

$$\mathbf{F_{AD} = 450 \text{ N} \quad (T)}$$

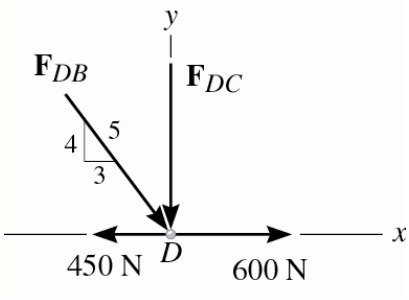


$$\mathbf{\sum F_x = 0}$$

$$\mathbf{600 - 450 - F_{DB}\left(\frac{3}{5}\right) = 0}$$

$$\mathbf{F_{DB} = +250 \text{ N}}$$

$$\mathbf{F_{DB} = 250 \text{ N} \quad (T)}$$



$$\mathbf{\sum F_y = 0}$$

$$\mathbf{F_{DC} + F_{DB}\left(\frac{4}{5}\right) = 0}$$

$$\mathbf{F_{DC} + 250\left(\frac{4}{5}\right) = 0}$$

$$\mathbf{F_{DC} = -200 \text{ N}}$$

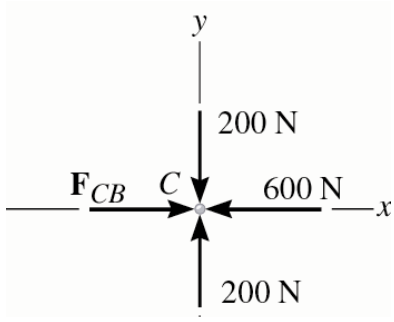
$$\mathbf{F_{DB} = 250 \text{ N} \quad (T)}$$

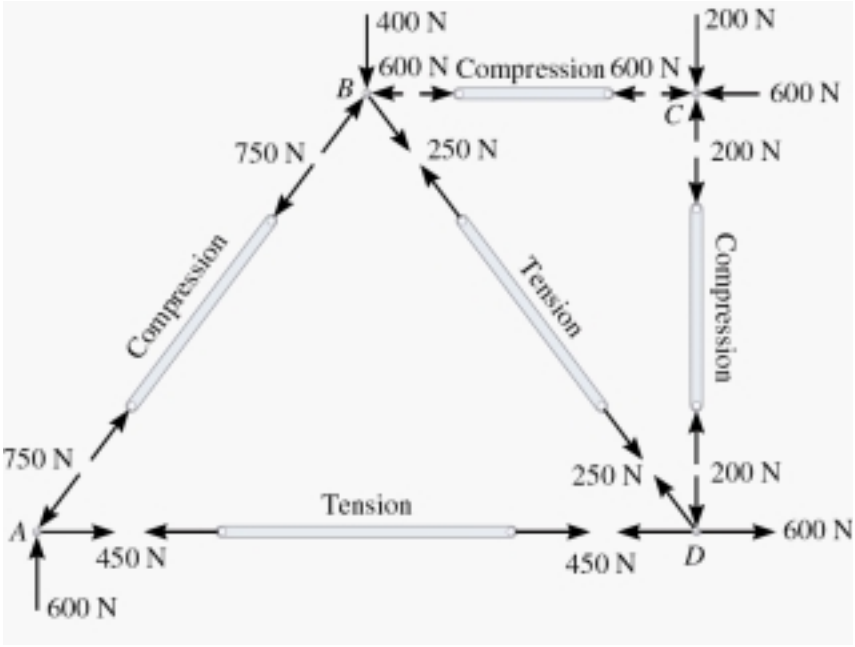
$\sum F_x = 0$

$-600 + F_{CB} = 0$

$F_{DB} = 600\ N$

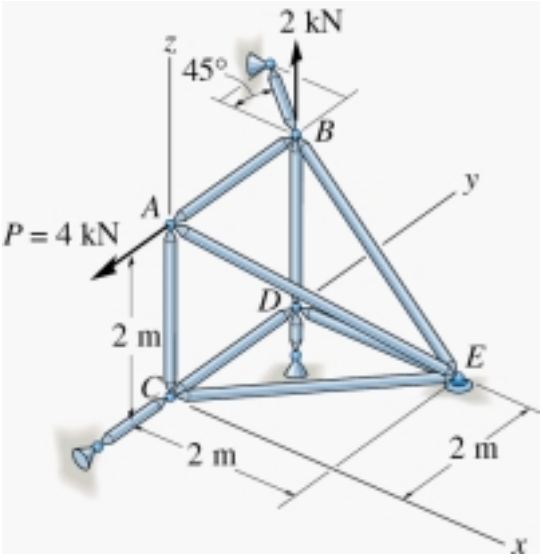
$F_{DB} = 600\ N \quad (C)$





Problem 4:

Spaces trusses:
Determine the support reactions in the joints of the following truss. Calculate the force in member DB.



Solution: We start with FBD and calculate the support reactions at A and B:

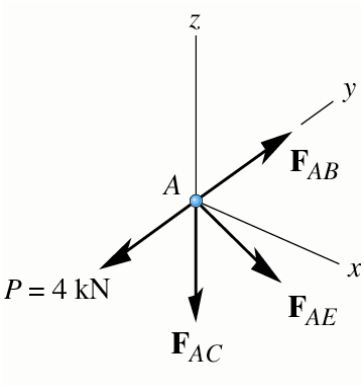
$$\bar{\mathbf{P}} = -4\hat{\mathbf{j}}$$

$$\vec{\mathbf{F}}_{AB} = F_{AB}\hat{\mathbf{j}}$$

$$\vec{\mathbf{F}}_{AC} = -F_{AC}\hat{\mathbf{k}}$$

$$\vec{\mathbf{F}}_{AE} = F_{AE}\left(\frac{\vec{\mathbf{r}}_{AE}}{|\vec{\mathbf{r}}_{AE}|}\right) = F_{AE}\left(\frac{2\hat{\mathbf{i}} + 2\hat{\mathbf{j}} - 2\hat{\mathbf{k}}}{\sqrt{4+4+4}}\right)$$

$$\vec{\mathbf{F}}_{AE} = F_{AE}\left(0.577\hat{\mathbf{i}} + 0.577\hat{\mathbf{j}} - 0.577\hat{\mathbf{k}}\right)$$



$$\sum \vec{\mathbf{F}} = \bar{\mathbf{P}} + \vec{\mathbf{F}}_{AB} + \vec{\mathbf{F}}_{AC} + \vec{\mathbf{F}}_{AE}$$

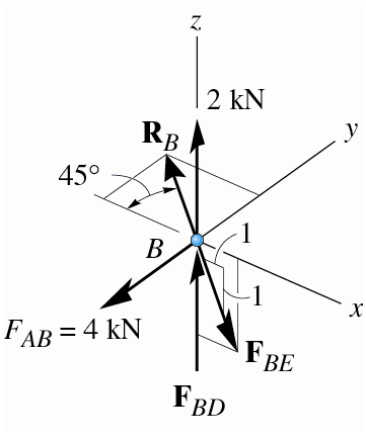
$$\sum \mathbf{F}_x = 0.577F_{AE} = 0$$

$$\sum \mathbf{F}_y = -4 + F_{AB} + 0.577F_{AE} = 0$$

$$\sum \mathbf{F}_z = -F_{AC} - 0.577F_{AE} = 0$$

$$F_{AC} = F_{AE} = 0$$

$$F_{AB} = 4\text{kN} \quad (\text{T})$$



$$\sum \mathbf{F}_x = -\mathbf{R}_B \cos 45^o + .7071\mathbf{F}_{BE} = 0$$

$$\sum \mathbf{F}_y = -4 + \mathbf{R}_B \sin 45^o = 0$$

$$\sum \mathbf{F}_z = 2 + \mathbf{F}_{BD} - +.7071\mathbf{F}_{BE} = 0$$

$$\mathbf{F}_{BE} = \mathbf{R}_B = 5.66\,\text{kN}$$

$$\mathbf{F}_{BD} = 2\,\text{kN}$$