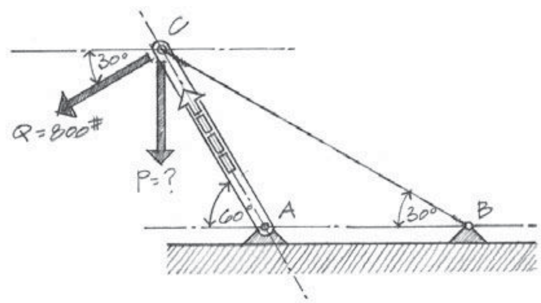
2.25 The tension in the cable CB must be of a specific magnitude necessary to provide equilibrium at the concurrent point of C. If the force in the boom AC is 4,000# and Q is 800#, determine the load P (vertical) that can be supported. In addition, find the tension developed in cable CB. Solve this problem analytically as well as graphically using a scale of 1″ = 800#.



Analytical Solution:

Force	F_x	F_y
Q	$-Q\cos 30° = -800\#(0.866) = -693\#$	$-Q\sin 30° = -800\#(0.5) = -400\#$
AC	$-AC\cos 60° = -4{,}000\#(0.5) = -2{,}000\#$	$+AC\sin 60° = +4{,}000\#(0.866) = +3{,}464\#$
P	0	$-P$
CB	$+CB\cos 30° = +0.866\,CB$	$-CB\sin 30° = -0.5\,CB$

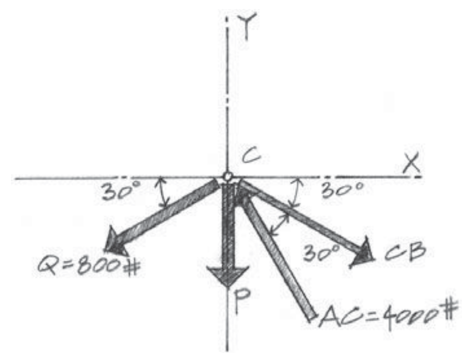
$$\underbrace{R_x = \Sigma F_x = 0 \quad R_y = \Sigma F_y = 0}_{\text{For equilibrium to exist}}$$

$$\therefore R_x = [\Sigma F_x = 0] - 693\# - 2{,}000\# + 0.866CB = 0$$

$$CB = \frac{+693\# + 2{,}000\#}{0.866} = 3{,}110\#$$

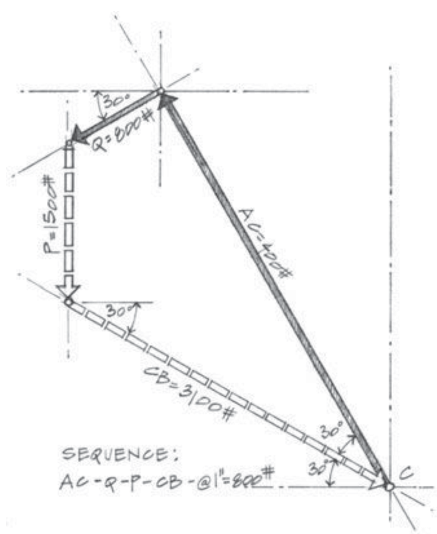
$$R_y = [\Sigma F_y = 0] - 400\# + 3{,}464\# \\ -P - 0.5(3{,}110\#) = 0$$

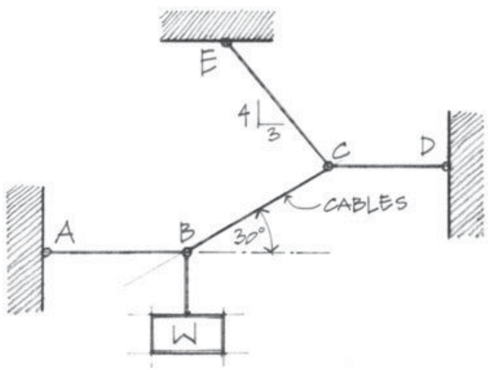
$$P = 3{,}464\# - 400\# - 0.5(3{,}110\#); \quad P = 1{,}509\#$$



Graphical Solution:

Begin the graphical solution by drawing the known force AC = 4,000# (a 5″ line at 60° from the horizontal axis). Then, to the tip of AC, draw force Q (1″ long and 30° from the horizontal). Force P has a known direction (vertical) but an unknown magnitude. Construct a vertical line from the tip of Q to represent the line of action of force P. For equilibrium to be established, the last force CB must close at the origin point C. Draw CB with a 30° inclination passing through C. The intersection of the lines P and CB defines the limits of the forces. Magnitudes of P and CB are obtained by scaling the respective force lines.





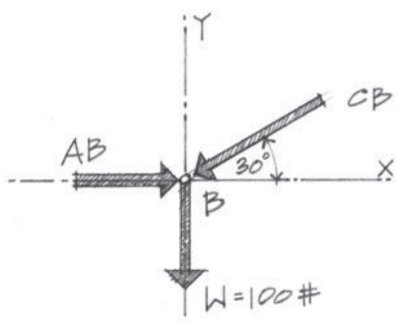
2.26 Determine the tensile forces in the cables *BA*, *BC*, *CD*, and *CE* assuming $W = 100\#$.

Analytical Solution:

Because this problem involves solving four unknown cable forces, a single FBD of the entire system would be inappropriate, because only two equations of equilibrium can be written. This problem is best solved by isolating the two concurrent points *B* and *C* and writing two distinct sets of equilibrium equations to solve for the four unknowns.

Note: *The FBD of particle* B *shows that only two unknowns,* AB *and* CB, *are present.*

In the FBD of *B*, the directions of cable forces *BA* and *BC* have been *purposely* reversed to illustrate how forces assumed in the wrong direction are handled.



Force	F_x	F_y
AB	$+AB$	0
CB	$-CB \cos 30°$	$-CB \sin 30°$
W	0	$-100\#$

$$[\Sigma F_x = 0] + AB - CB \cos 30° = 0 \quad (1)$$

$$AB = +0.866(CB)$$

$$[\Sigma F_y = 0] - CB \sin 30° - 100\# = 0 \quad (2)$$

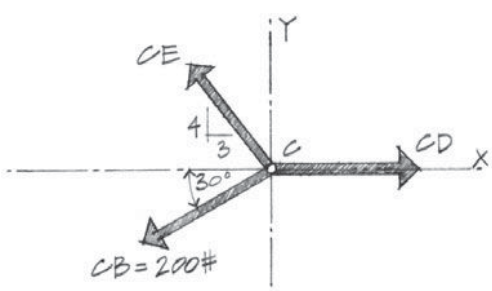
$$+0.5CB = -100\#$$

$$\therefore CB = -200\#$$

The negative sign indicates that the assumed direction for *CB* is incorrect; *CB* is actually a tension force. The magnitude of 200# is correct even though the direction was assumed incorrectly. Substituting the value of *CB* (including the negative sign) into equation (1),

$$AB = +0.866(-200\#)$$

$$AB = -173.2\#$$



AB was also assumed initially as a compressive force, but the negative sign in the result indicates that it should be tensile.

Note: *In the FBD above, the direction of force* CB *(tension) has been changed to reflect its correct direction.*

Force	F_x	F_y
CB	$-(200\#)\cos 30° = -173.2\#$	$-(200\#)\sin 30° = -100\#$
CD	$+CD$	0
CE	$-\frac{3}{5}CE$	$+\frac{4}{5}CE$

$$[\Sigma F_y = 0] - 100\# + \frac{4}{5}CE = 0$$

$$CE = \frac{5}{4}(+100\#) = +125\#$$

$$[\Sigma F_x = 0] - 173.2\# + CD - \frac{3}{5}CE = 0$$

$$CD = +173.2\# + \frac{3}{5}(+125\#)$$

$$CD = +248\#$$