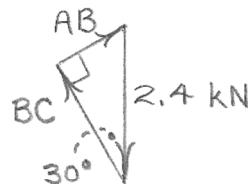
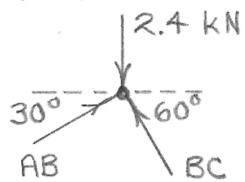


4/1

Joint B:



$$AB = 2.4 \left(\frac{1}{2}\right)$$

$$= \frac{1.2 \text{ kN}}{C}$$

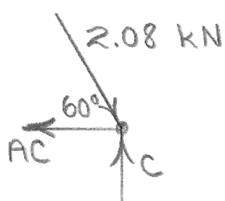
$$BC = \frac{2.4 (\sqrt{3}/2)}{C}$$

$$= \underline{\underline{2.08 \text{ kN } C}}$$

Joint C:

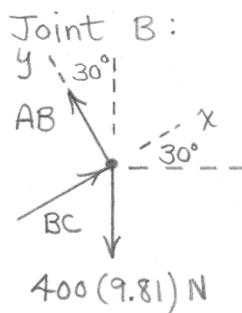
$$\rightarrow \sum F_x = 0 : -AC + 2.08 \cos 60^\circ = 0$$

$$\underline{\underline{AC = 1.039 \text{ kN T}}}$$



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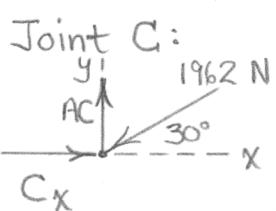


$$\sum F_x = 0 : BC - 400(9.81) \cos 60^\circ = 0$$

$$BC = 1962 \text{ N C}$$

$$\sum F_y = 0 : AB - 400(9.81) \sin 60^\circ = 0$$

$$AB = 3400 \text{ N T}$$



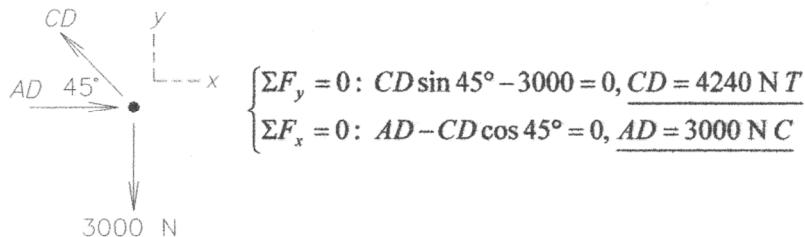
$$\sum F_y = 0 : AC - 1962 \sin 30^\circ = 0$$

$$AC = 981 \text{ N T}$$

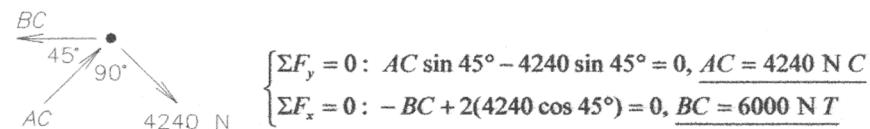
4/3

We can begin at joint D without finding the external reactions.

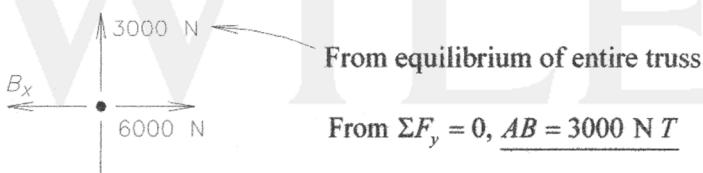
Joint D:



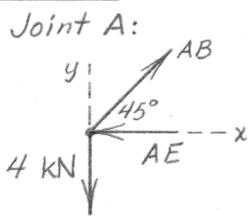
Joint C:



Joint B:



4/4



$$\sum F_y = 0: AB \sin 45^\circ - 4 = 0$$

$$AB = 5.66 \text{ kN T}$$

$$\sum F_x = 0: 5.66 \cos 45^\circ - AE = 0$$

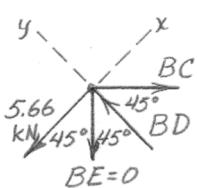
$$AE = 4 \text{ kN C}$$

Joint E:



$$\sum F_y = 0: BE = 0$$

Joint B:



$$\sum F_x = 0: BC \cos 45^\circ - 5.66 = 0$$

$$BC = 8 \text{ kN T}$$

$$\sum F_y = 0: BD - 8 \cos 45^\circ = 0$$

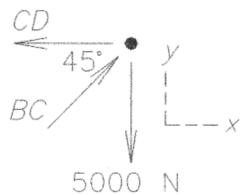
$$BD = 5.66 \text{ kN C}$$

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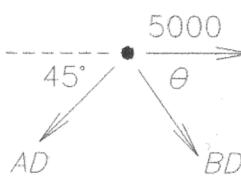
We can begin at joint C without finding the external reactions.

Joint C:



$$\begin{cases} \sum F_y = 0: BC \sin 45^\circ - 5000 = 0, BC = 7070 \text{ N C} \\ \sum F_x = 0: 7070 \cos 45^\circ - CD = 0, CD = 5000 \text{ N T} \end{cases}$$

Joint D:

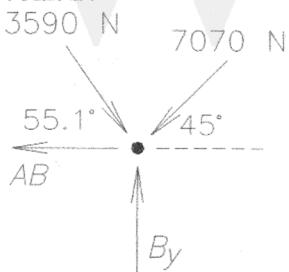


$$\begin{aligned} DB^2 &= 5^2 + 6^2 - 2(5)(6) \cos 45^\circ, DB = 4.31 \text{ m} \\ \frac{\sin \theta}{5} &= \frac{\sin 45^\circ}{4.31} \Rightarrow \theta = 55.1^\circ \end{aligned}$$

$$\begin{cases} \sum F_x = 0: 5000 + BD \cos 55.1^\circ - AD \cos 45^\circ = 0 \\ \sum F_y = 0: -AD \sin 45^\circ - BD \sin 55.1^\circ = 0 \end{cases}$$

Solve simultaneously to obtain: $\frac{BD = -3590 \text{ N or } 3590 \text{ N C}}{AD = 4170 \text{ N T}}$

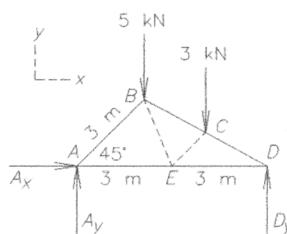
Joint B:



$$\sum F_x = 0: 3590 \cos 55.1^\circ - 7070 \cos 45^\circ - AB = 0$$

$$\underline{AB = -2950 \text{ N or } 2950 \text{ N C}}$$

4/6



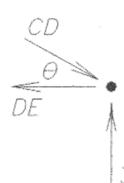
As a whole:

Note: $\overline{CE} = 1.5 \text{ m}$ by similar triangles

$$\sum M_A = 0: 5(3 \cos 45^\circ) + 3(3 + 1.5 \cos 45^\circ) - 6D_y = 0$$

$$D_y = 3.80 \text{ kN}$$

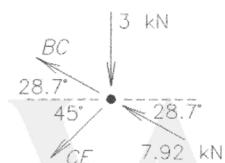
Joint D:



$$\theta = \tan^{-1} \frac{3 \sin 45^\circ}{6 - 3 \cos 45^\circ} = 28.7^\circ$$

$$\begin{cases} \sum F_y = 0: 3.80 - CD \sin 28.7^\circ = 0, CD = 7.92 \text{ kN} \\ \sum F_x = 0: 7.92 \cos 28.7^\circ - DE = 0, DE = 6.94 \text{ kN T} \end{cases}$$

Joint C:

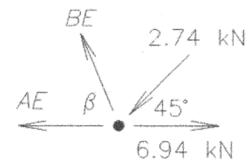


$$\begin{cases} \sum F_x = 0: -BC \cos 28.7^\circ - CE \cos 45^\circ - 7.92 \cos 28.7^\circ = 0 \\ \sum F_y = 0: BC \sin 28.7^\circ - CE \sin 45^\circ + 7.92 \sin 28.7^\circ - 3 = 0 \end{cases}$$

Solve simultaneously to obtain:

$$\begin{aligned} BC &= -5.70 \text{ kN (C)} \\ CE &= -2.74 \text{ kN (C)} \end{aligned}$$

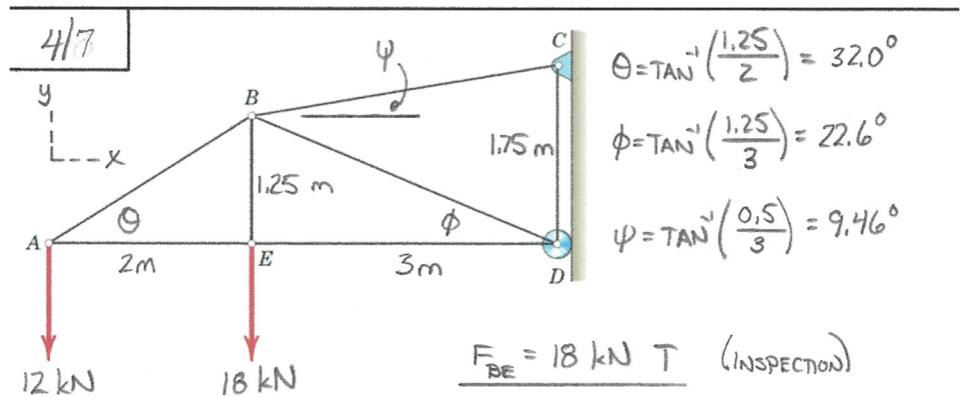
Joint E:



$$\beta = \frac{180^\circ - 45^\circ}{2} = 67.5^\circ$$

$$\sum F_y = 0: BE \sin 67.5^\circ - 2.74 \sin 45^\circ = 0$$

$$BE = 2.10 \text{ kN T}$$



JOINT A:

$$\begin{cases} \sum F_y = 0: F_{AB} \sin \theta - 12 = 0 \\ \sum F_x = 0: F_{AB} \cos \theta - F_{AE} = 0 \end{cases} \rightarrow \begin{cases} F_{AB} = 22.6 \text{ kN T} \\ F_{AE} = 19.20 \text{ kN C} \end{cases}$$

$F_{DE} = 19.20 \text{ kN C}$ (INSPECTION)

JOINT B:

$$\begin{cases} \sum F_x = 0: F_{BC} \cos \psi - F_{BD} \cos \phi - F_{AB} \cos \theta = 0 \\ \sum F_y = 0: F_{BC} \sin \psi + F_{BD} \sin \phi - F_{BE} - F_{AB} \sin \theta = 0 \end{cases}$$

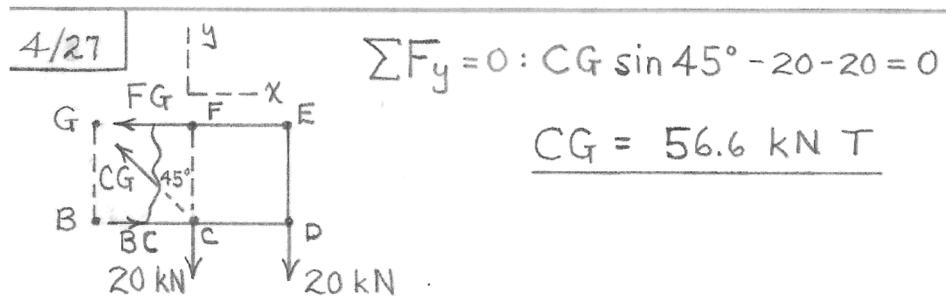
$F_{BC} = 66.0 \text{ kN T}$ & $F_{BD} = 49.8 \text{ kN C}$

JOINT D:

$$\sum F_y = 0: F_{CD} - F_{BD} \sin \phi = 0$$

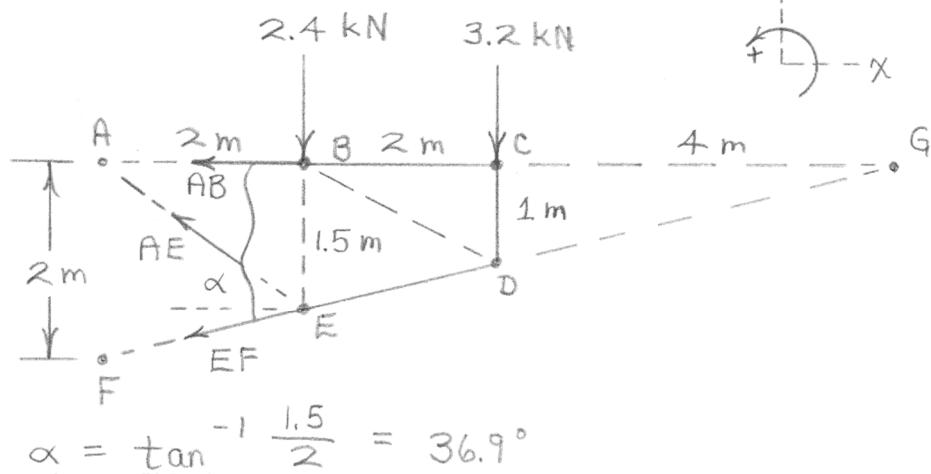
$F_{CD} = 19.14 \text{ kN T}$

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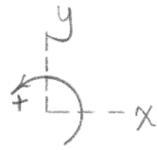
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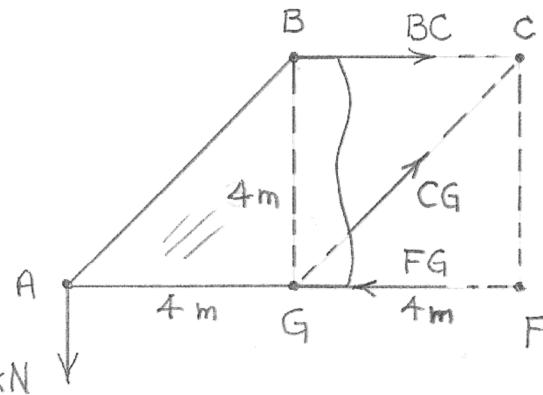
$$\alpha = \tan^{-1} \frac{1.5}{2} = 36.9^\circ$$

$$\begin{aligned}\sum M_G = 0 : & 3.2(4) + 2.4(6) - AE \cos \alpha (1.5) \\ & - AE \sin \alpha (6) = 0 \\ AE &= 5.67 \text{ kN T}\end{aligned}$$



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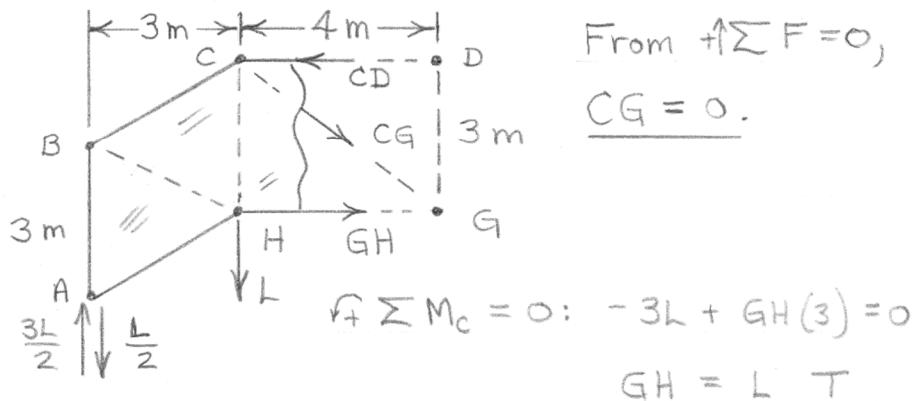


$$+\uparrow \sum F = 0 : CG \frac{\sqrt{2}}{2} - 60 = 0, \quad CG = 84.9 \text{ kN T}$$

$$+\leftarrow \sum M_G = 0 : 60(4) - BC(4) = 0, \quad BC = 60 \text{ kN T}$$

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4/30 By symmetry, the reaction at A
is $\frac{3L}{2}$ up.



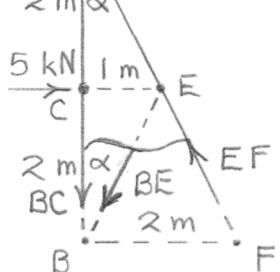
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4/31 $\alpha = \tan^{-1} \frac{1}{2} = 26.6^\circ$

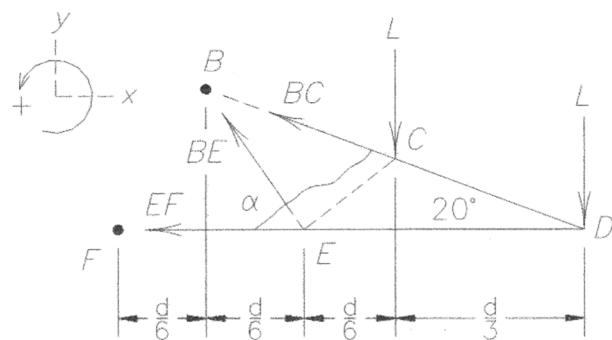
$$\text{At } \sum M_D = 0 : 5(2) - BE \sin 26.6^\circ (4) = 0$$

$$BE = 5.59 \text{ kN T}$$



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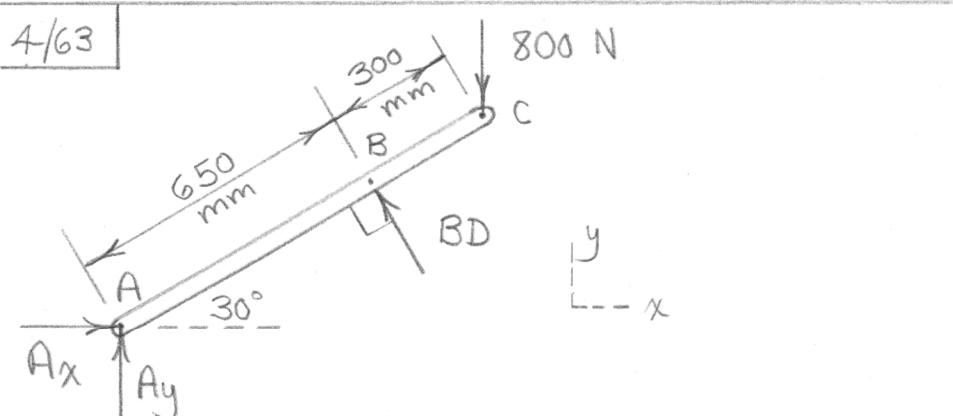
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$$\alpha = \tan^{-1} \frac{\frac{4}{6}d \tan 20^\circ}{\frac{d}{6}} = 55.5^\circ$$

$$\sum M_D = 0 : L\left(\frac{d}{3}\right) - BE\left(\frac{d}{2}\right)(\sin 55.5^\circ) = 0$$

$$\underline{BE = 0.809L T}$$



$$\text{At } \sum M_A = 0 : BD(650) - 800(950 \cos 30^\circ) = 0 \\ BD = 1013 \text{ N}$$

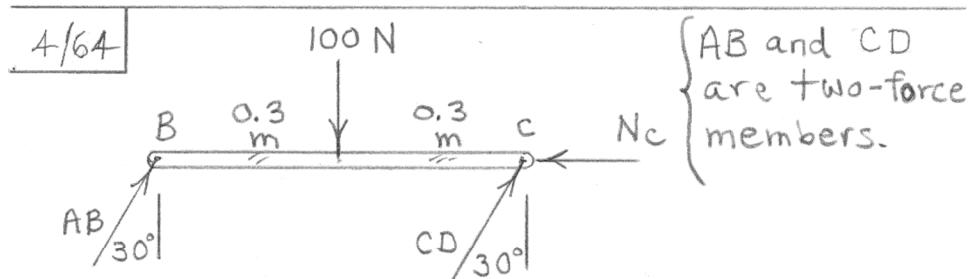
So pin-reaction magnitudes at B and D
are $B = D = 1013 \text{ N}$.

$$\sum F_x = 0 : A_x - 1013 \sin 30^\circ = 0, A_x = 506 \text{ N}$$

$$\sum F_y = 0 : A_y + 1013 \cos 30^\circ - 800 = 0$$

$$A_y = -76.9 \text{ N}$$

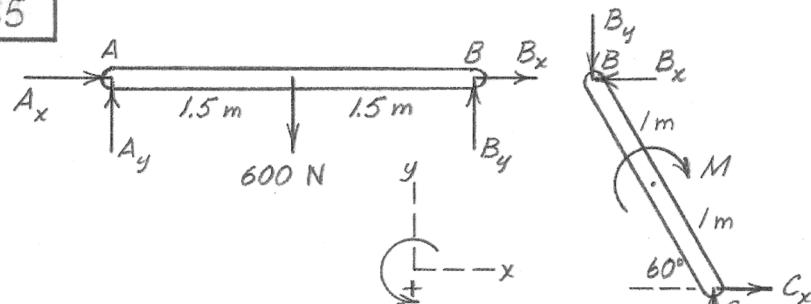
$$A = \sqrt{A_x^2 + A_y^2} = \underline{512 \text{ N}}$$



$$\text{At } \sum M_B = 0 : -100(0.3) + CD \frac{\sqrt{3}}{2} (0.6) = 0$$
$$CD = 57.7 \text{ N}$$

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(AB) For $A_x = 0, B_x = 0; A_y = B_y = 300 \text{ N}$
by inspection

For $M + (CW)$,

$$(BC) \sum M_C = 0: B_y (2 \cos 60^\circ) - M = 0, \underline{M = 300 \text{ N}\cdot\text{m}}$$

For $M - (CCW)$,

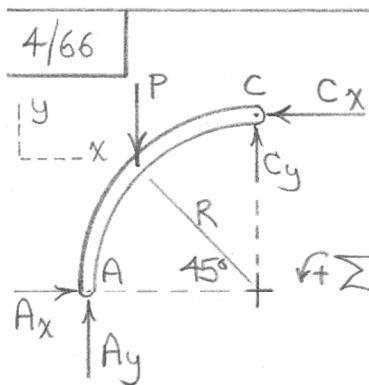
$A_x \neq B_x \neq 0$, but $A_y = B_y = 300 \text{ N}$

$$(BC) \sum M_C = 0: B_y (2 \cos 60^\circ) + B_x (2 \sin 60^\circ) + 300 = 0$$

$$\Rightarrow B_x = -346 \text{ N}$$

$$(AB) \sum F_x = 0: A_x + B_x = 0, A_x = -B_x = -(-346)$$

$$\text{or } \underline{A_x = 346 \text{ N}}$$



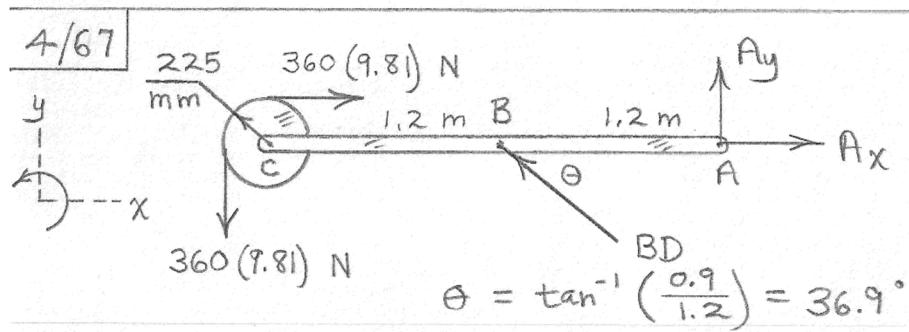
$C_y = 0$ due to symmetry
of overall structure.

Then $\sum F_y = 0$ yields $A_y = P$
 $\sum M_A = 0: -PR(1-\cos 45^\circ) + C_x(R) = 0$
 $C_x = 0.293P$

Finally, $\sum F_x = 0$ yields $A_x = 0.293P$

(Forces on member BC are symmetric)

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$$\sum M_A = 0 : 360(9.81)(2.4 + 0.225) - BD(1.2)(0.6) = 0, \quad BD = 11,770 \text{ N}$$

$$\sum F_x = 0 : 360(9.81) - 11,770(0.8) + A_x = 0$$

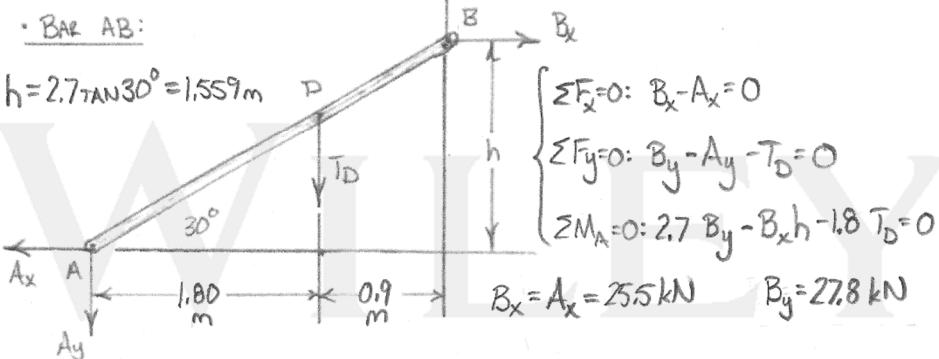
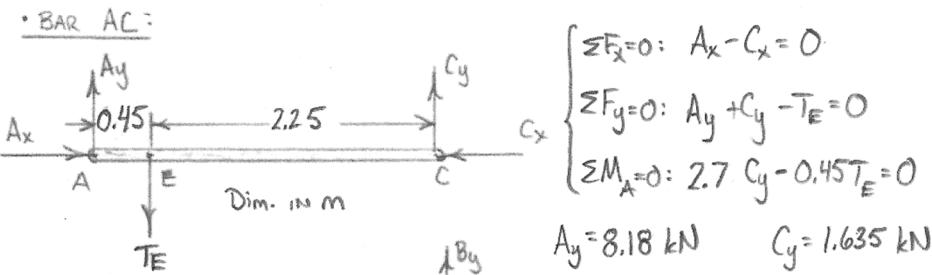
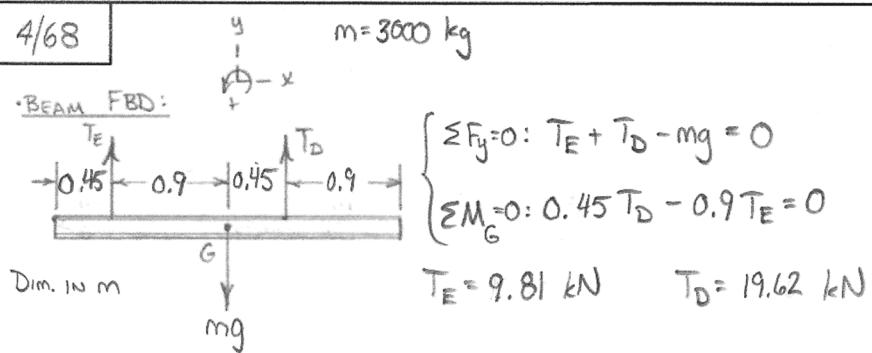
$$A_x = 5890 \text{ N}$$

$$\sum F_y = 0 : -360(9.81) + 11,770(0.6) + A_y = 0$$

$$A_y = -3530 \text{ N}$$

$$A = \sqrt{A_x^2 + A_y^2} = \sqrt{5890^2 + 3530^2}$$

$$= 6860 \text{ N}$$



$$A = \sqrt{A_x^2 + A_y^2} \rightarrow A = 26.8 \text{ kN} \quad B = \sqrt{B_x^2 + B_y^2} \rightarrow B = 37.7 \text{ kN}$$

$$C = \sqrt{C_x^2 + C_y^2} \rightarrow C = 25.5 \text{ kN}$$