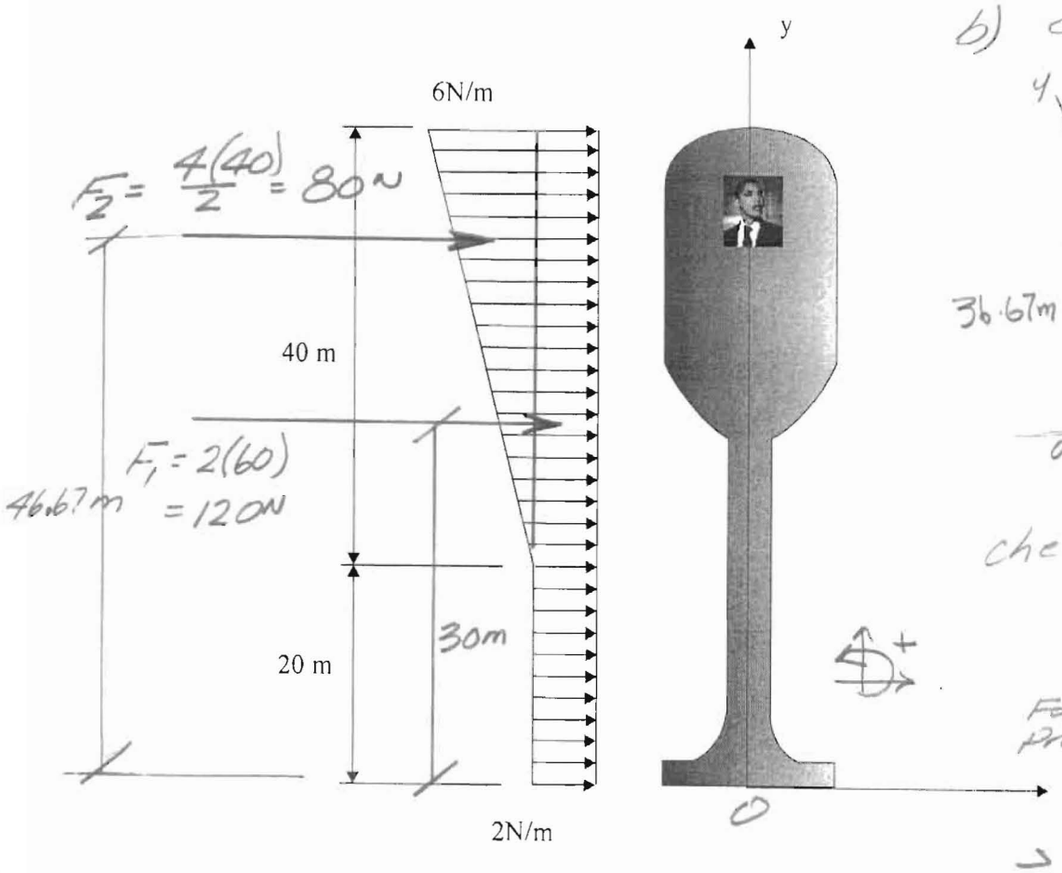
QUESTION 1

The wind load on a water tank outside Winnipeg is shown in the figure below. The total weight of the water and the tower is *1000 N* (acting vertically downward on the *y* axis).

a) Find the equivalent force-couple at the intersection of the *x* and *y* axis.

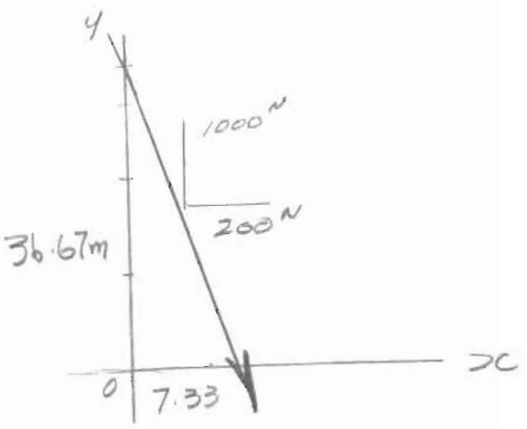
b) Replace the force system by a single force and determine where the line of action of this force crosses the *x* and *y* axis.



$F_2 = \frac{4(40)}{2} = 80\,N$

$F_1 = 2(60) = 120\,N$

b) continued



check $\frac{36.67}{7.33} = 5$ ✓

$\frac{1000}{200} = 5$ ✓

Force components proportional to Slope of Line of Action

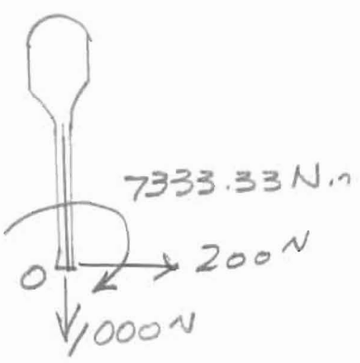
$R_x = \Sigma F_x = +120+80 = +200\,N \quad \vec{R}_x = 200\,N \rightarrow$

$R_y = \Sigma F_y = -1000\,N \quad \vec{R}_y = 1000\,N \downarrow$

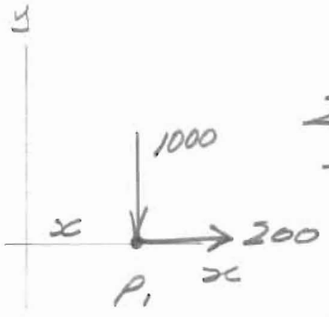
$M_{OR} = -80(46.67) - 120(30) = -7333.33\,N.m$

$\vec{M}_{OR} = 7333.33\,N.m \circlearrowleft$

a) Equivalent Force-Couple at O



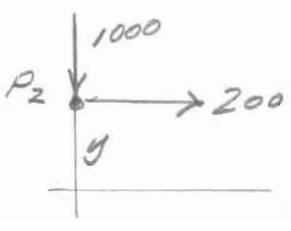
b)



$\Sigma M_{P_1} = 0$

$-7333.33 + 1000x = 0$

$x = +7.33\,m$



$\Sigma M_{P_2} = 0$

$-7333.33 + 200y = 0$

$y = \frac{7333.33}{200} = 36.67\,m$

QUESTION 2

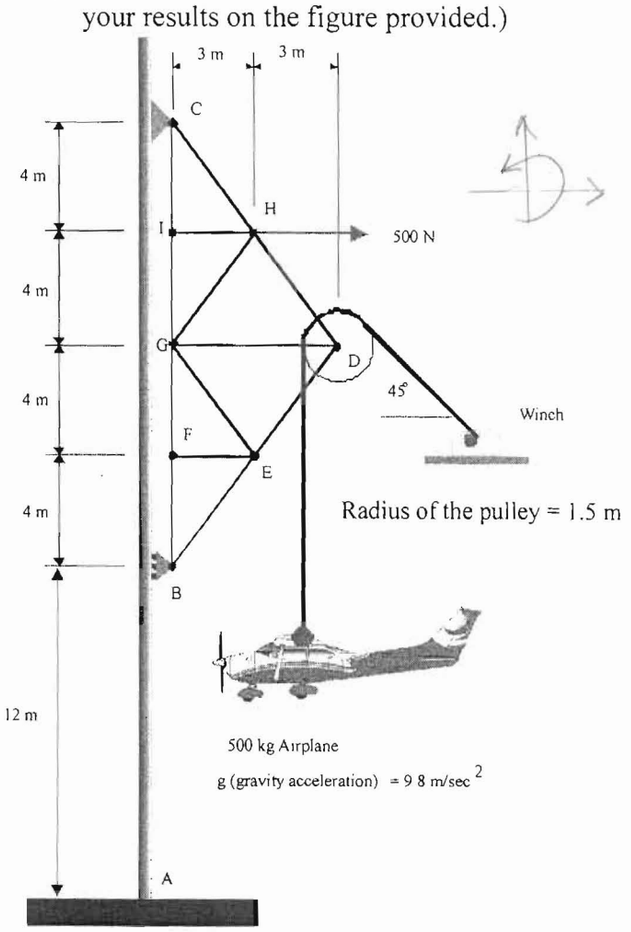
The pole has a fixed support at *A*. A truss is supported by the pole by a pin support at *C* and a roller support at *B*. A winch is used to lift a small airplane that has a mass of *500 kg* (use $g = 9.8\ m/sec^2$). The cable attached to the winch goes over a pulley that is attached to the truss at *D*. A *500 N* load is also applied to the truss at *H*.

Determine:

a) The reactions of the pulley on the truss at *D*,

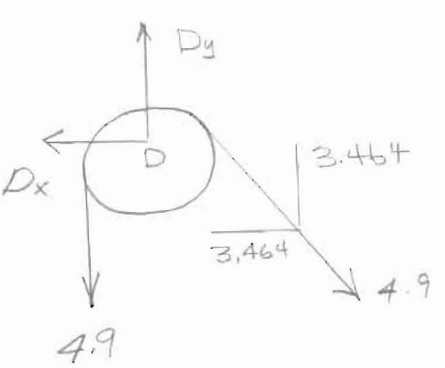
b) The reactions at the fixed support at A, and

c) The force in each member of the truss and state whether it is in tension or compression. (Show all of your results on the figure provided.)



Radius of the pulley = 1.5 m

a)



$\Sigma F_x = 0 \rightarrow$

$-D_x + 3.464 = 0$

$D_x = +3.464\ kN$; $\vec{D_x} = 3.464\ kN \leftarrow$ on the pulley

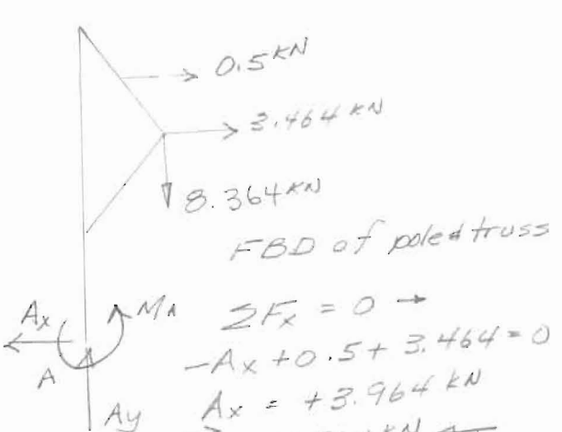
$\Sigma F_y = 0 \uparrow$

$D_y - 4.9 - 3.464 = 0$

$D_y = +8.364\ kN$

$\vec{D_y} = 8.364\ kN \uparrow$ on the pulley

b)



$\Sigma F_x = 0 \rightarrow$

$-A_x + 0.5 + 3.464 = 0$

$A_x = +3.964\ kN$

$\vec{A_x} = 3.964\ kN \leftarrow$

$\Sigma F_y = 0 \uparrow \quad A_y - 8.364 = 0$

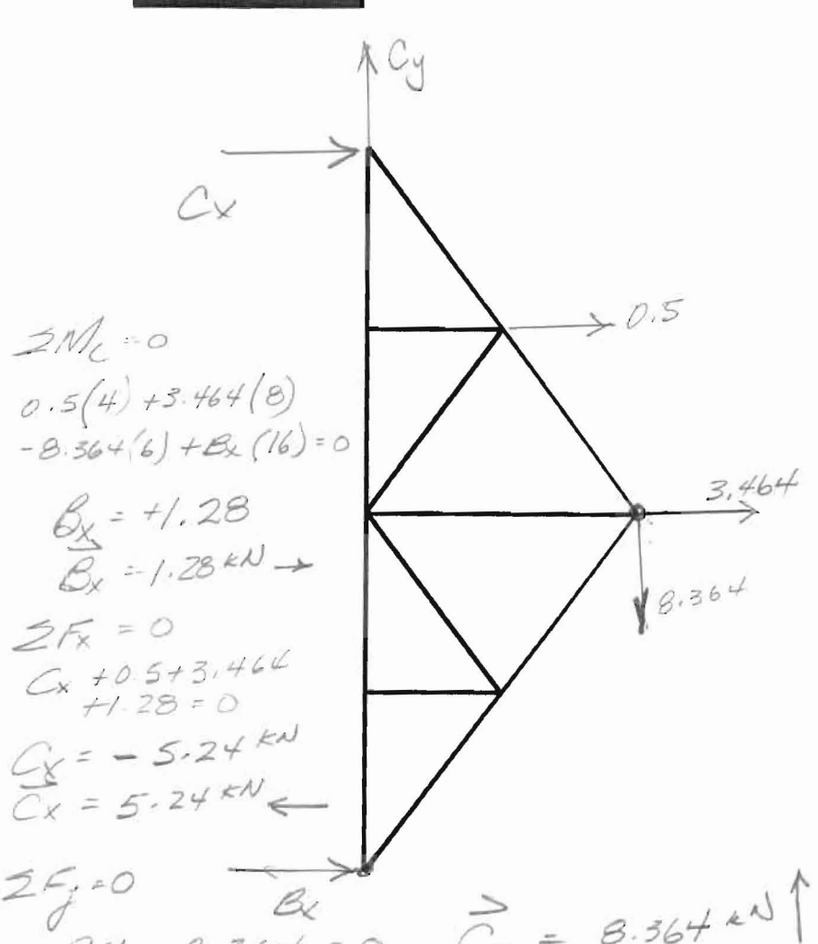
$A_y = +8.364\ kN \quad \vec{A_y} = 8.364\ kN \uparrow$

$\Sigma M_A = 0 \circlearrowleft$

$M_A - 0.5(24) - 3.464(20) - 8.364(6) = 0$

$M_A = 131.5\ kN.m$

$\vec{M_A} = 131.5\ kN.m \circlearrowleft$



$\Sigma M_C = 0$

$0.5(4) + 3.464(8) - 8.364(6) + B_x(16) = 0$

$B_x = +1.28$

$\vec{B_x} = 1.28\ kN \rightarrow$

$\Sigma F_x = 0$

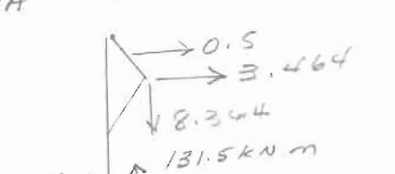
$C_x + 0.5 + 3.464 + 1.28 = 0$

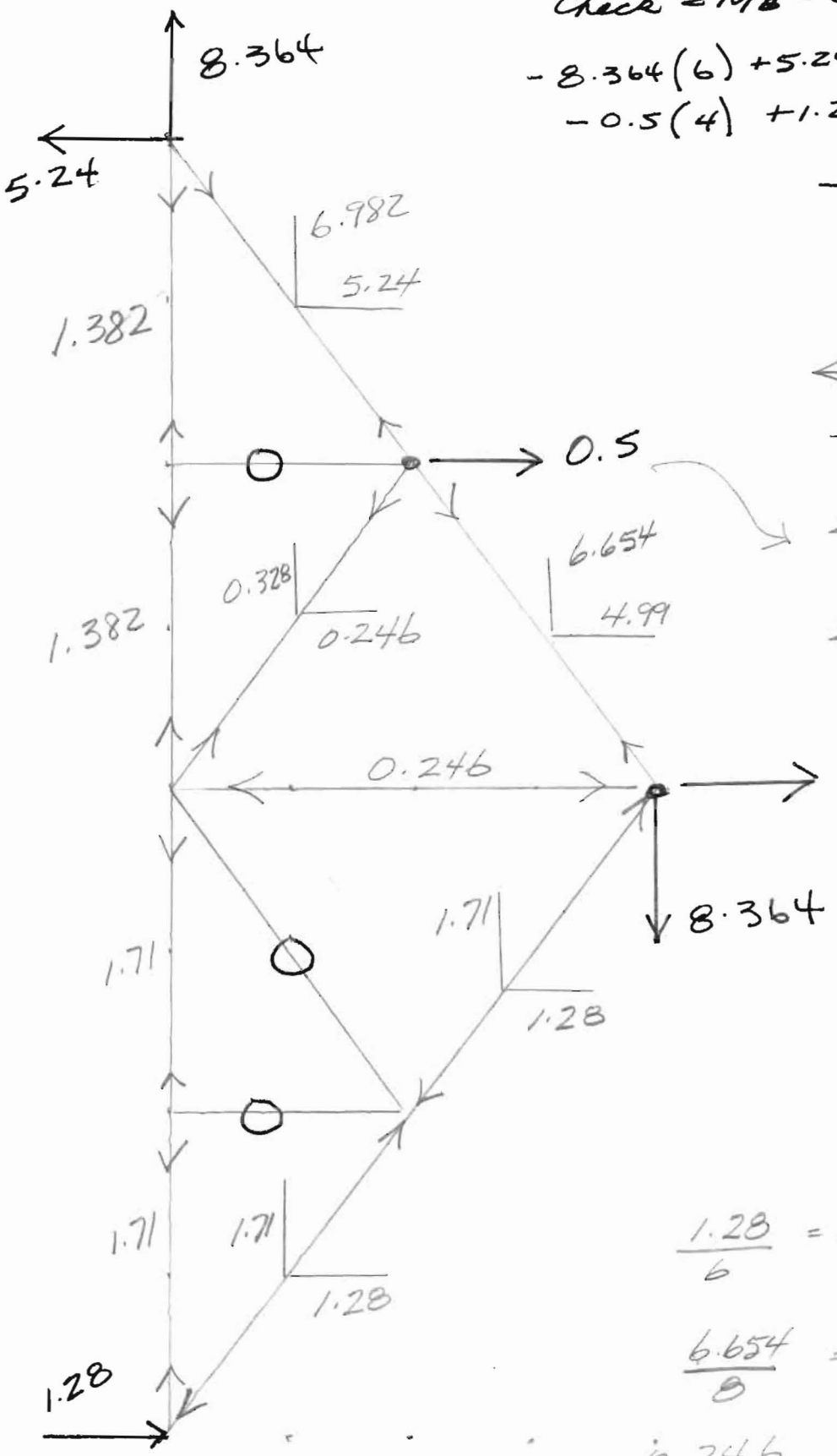
$C_x = -5.24\ kN$

$\vec{C_x} = 5.24\ kN \leftarrow$

$\Sigma F_y = 0$

$C_y - 8.364 = 0 \quad \vec{C_y} = 8.364\ kN \uparrow$





Check $\Sigma M_B = 0$

$-8.364(6) + 5.24(8)$
$-0.5(4) + 1.28(8) = 0$

$-0.024 = 0$
close enough

comp

tens

ΣF_x $0.5 + 4.99$
$-0.246 - 5.24$
$0.004 = 0$ ✓

ΣF_y $6.987 - 0.328$
$- 6.654 = 0$
$0 = 0$

$\frac{1.28}{6} = \frac{y}{8}$ $y = 1.71$

$\frac{6.654}{8} = \frac{x}{6}$ $x = 4.99$

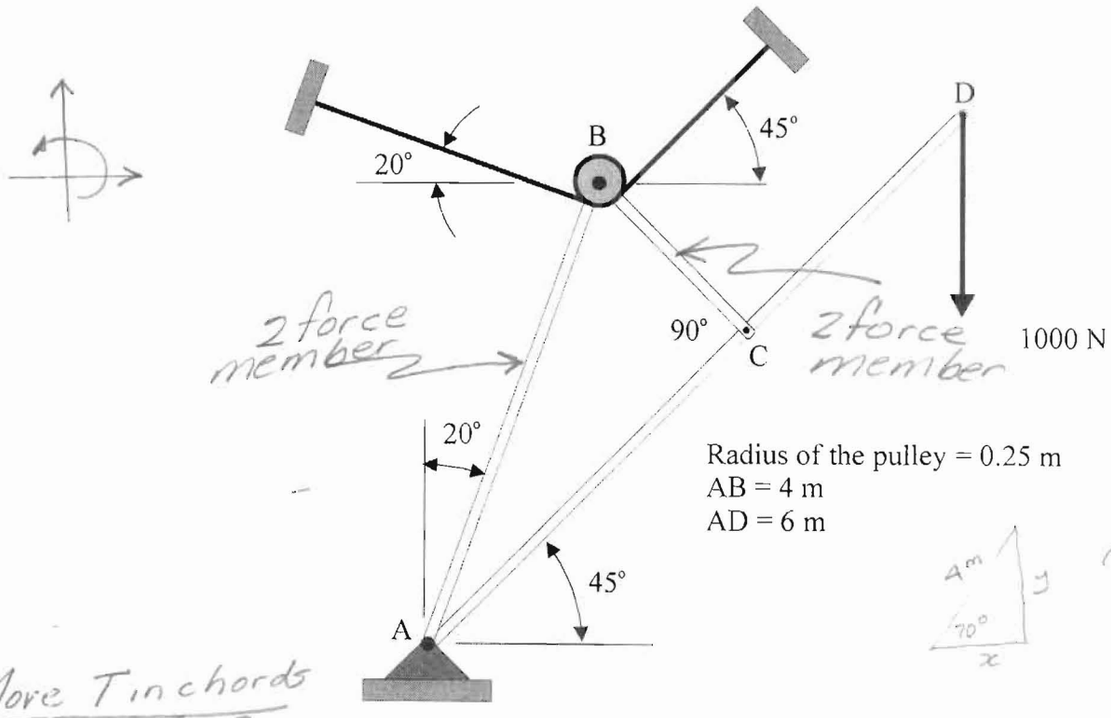
$\frac{0.246}{3} = \frac{y}{4}$ $y = 0.328$

QUESTION 3

For the frame shown in the figure, determine:

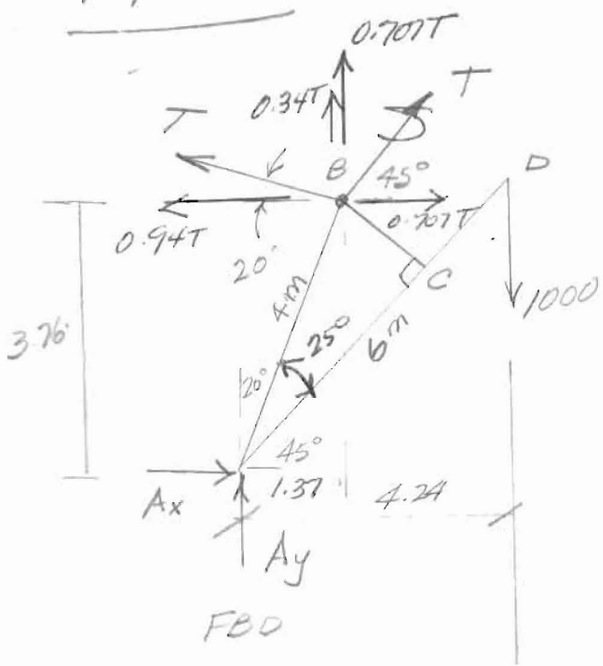
a) The tension in the support cable and the reaction at the pin support at *A*, and

b) The force in members *ACD* and *AB*.



Radius of the pulley = 0.25 m
AB = 4 m
AD = 6 m

More T in chords to pin at B



$\Sigma M_A = 0$

$0.94T(3.76) + 0.34T(1.37) + 0.707T(1.37) - 0.707T(3.76) - 1000(4.24) = 0$

$2.31T = 4240$ $\quad T = 1835.1\ N$

$\Sigma F_x = 0$

$A_x - 0.94(1835.1) + 0.707(1835.1) = 0$

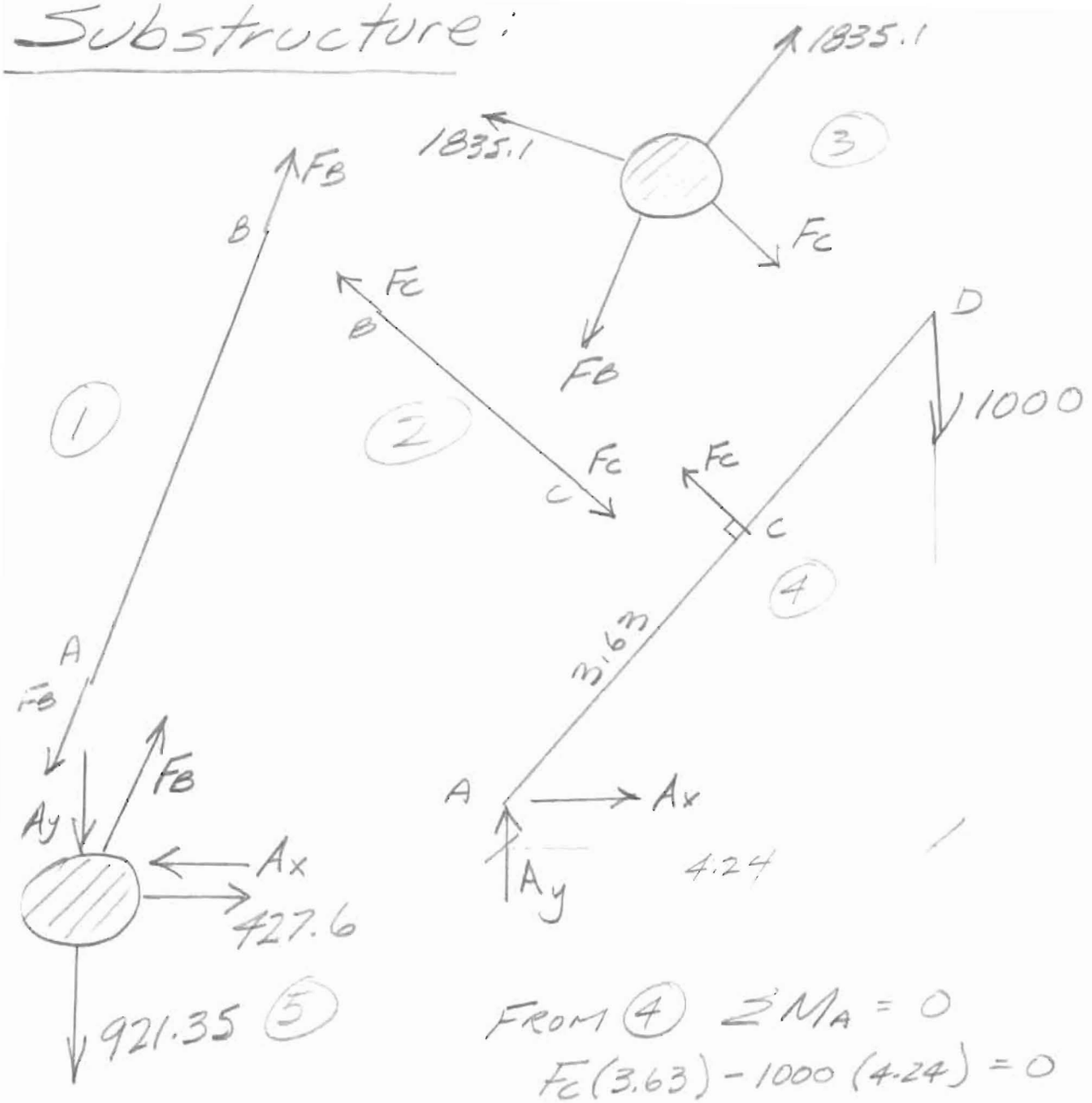
$A_x = +427.6 \rightarrow$ $\quad \vec{A}_x = 427.6\ N \rightarrow$

$\Sigma F_y = 0$ $\quad A_y + 0.34(1835.1) + 0.707(1835.1) - 1000 = 0$

$A_y = -921.35\ N$

$\vec{A}_y = 921.35\ N \downarrow$

Substructure:



FROM ④ $\Sigma M_A = 0$

$F_C(3.63) - 1000(4.24) = 0$

$F_C = +1168\ N$

$\vec{F_C} = 1168\ N$ ↗ 45° on ACD

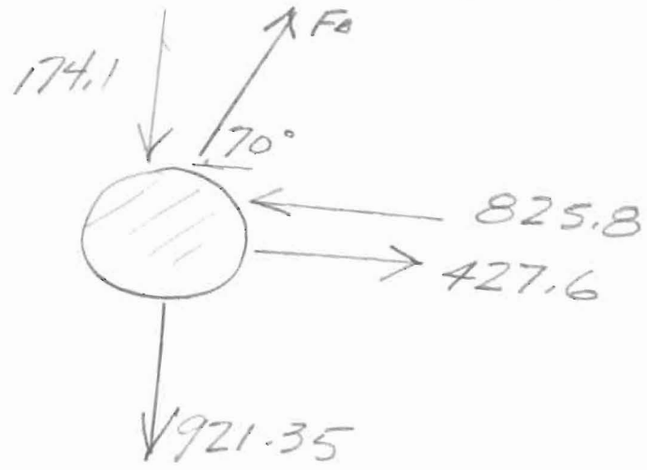
$\Sigma F_x = 0 \quad A_x - \frac{1}{\sqrt{2}}(1168) = 0$

$A_x = +825.8\ N$ $\quad \vec{A_x} = 825.8\ N \rightarrow$ on ACD

$\Sigma F_y = 0 \quad A_y + \frac{1}{\sqrt{2}}(1168) - 1000 = 0 \quad A_y = +174.1\ N$

$\vec{A_y} = 174.1\ N \uparrow$ on ACD

FROM (5) Re-draw pin

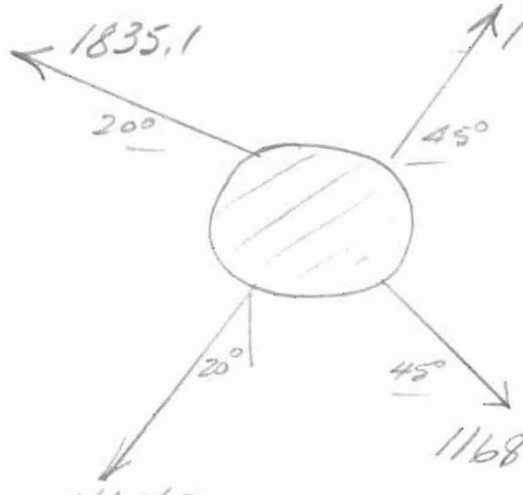


$$\Sigma F_x = -825.8 + 427.6 + F_B \cos 70° = 0$$

$$F_B = +1164.3\ N$$

$$\vec{F}_B = 1164.3\ N \angle 70°$$ on pin at A

Check Pin at B check.



$\Sigma F_x = 0$

$-1835.1 \cos 20°$
$+1835.1 \cos 45°$
$+1168 \cos 45°$
$- 1164.3 \sin 20° = 0$

$0.54 = 0$ ✓

$\Sigma F_y = 0$

$1835.1 \sin 20 + 1835.1 \sin 45°$
$- 1164.3 \cos 20° - 1168 \sin 45° = 0$

$5.26 \neq 0$ OR