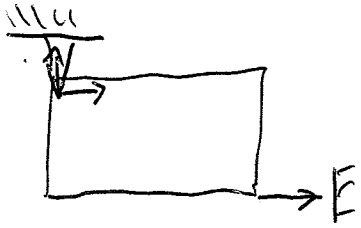
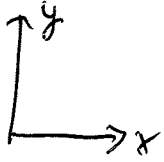
Part II

① .1



3 constraints

A) Static determinancy



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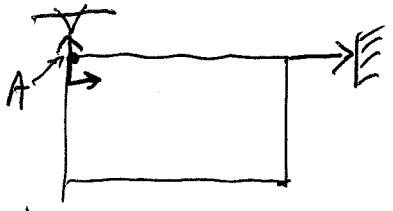
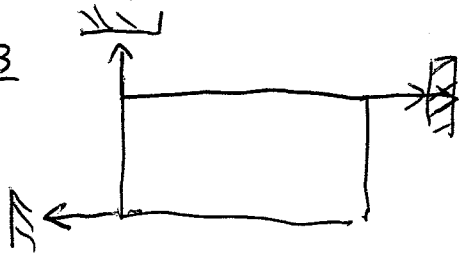


3 constraints

D) over constrained in x
underconstrained in moment about pt A

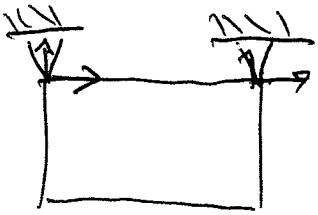
3



3 constraints

A) Static determinancy

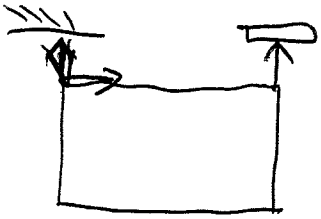
4



4 constraints

B) over constrained in x or y

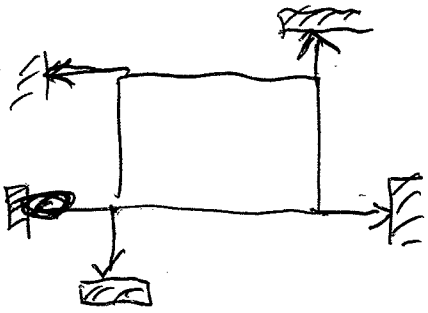
5



3 constraints

A) Static determinancy

6



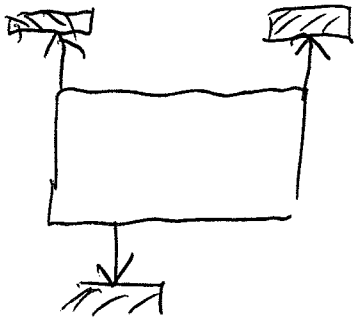
4 constraints

B) over constraint in x or y

Part II

① continued

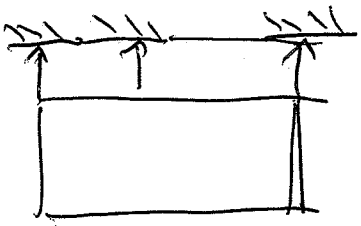
7.



3 constraints

D) over constrained in y
under constrained in x

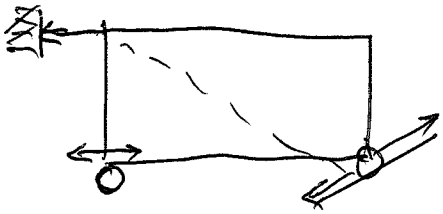
8



3 constraints

D) over constrained in y
underconstrained in y

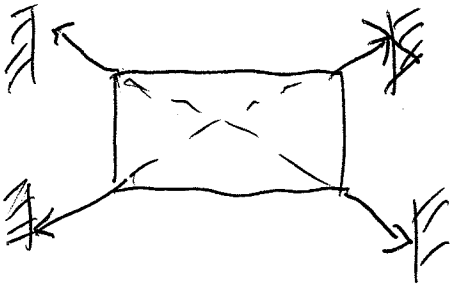
9



3 constraints

D) over constrained in x or y
under constraint in M_z

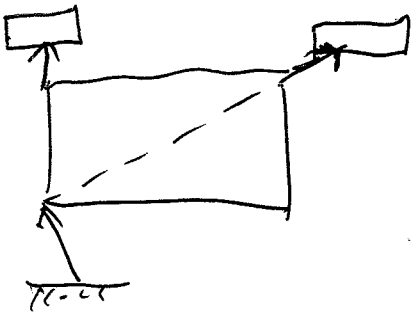
10



4 constraints

D) over constrained in x and y
under constrained in M_z

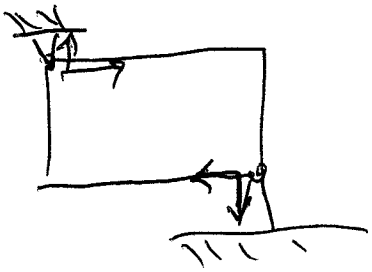
11



3 constraints

D) over constrained in x or y
under constrained in M_z

12

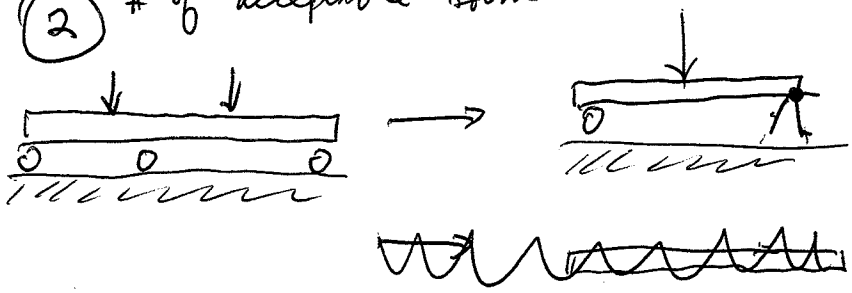


4 constraints

B) over constrained in x or y

Part II (2) # of acceptable solns

1.



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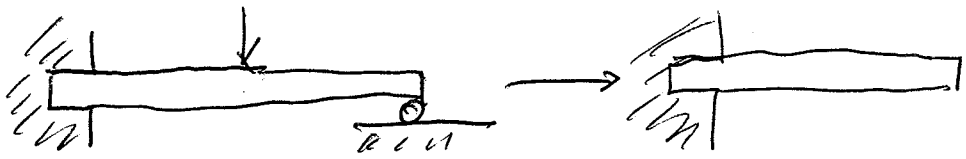
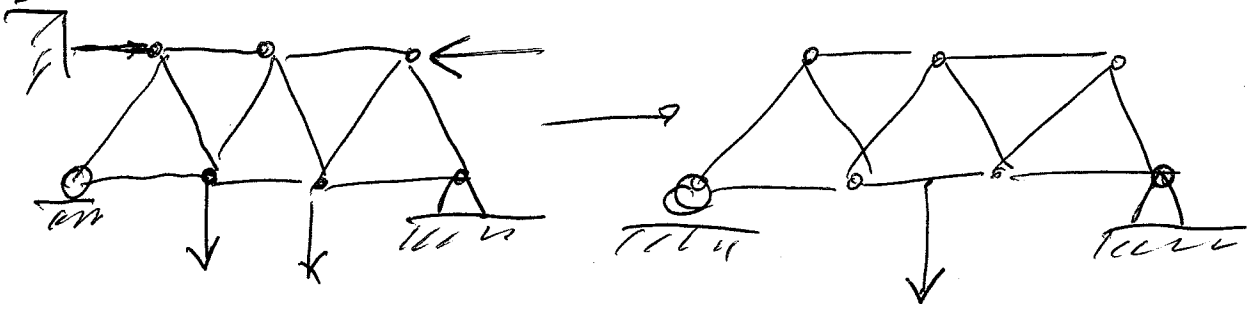


3



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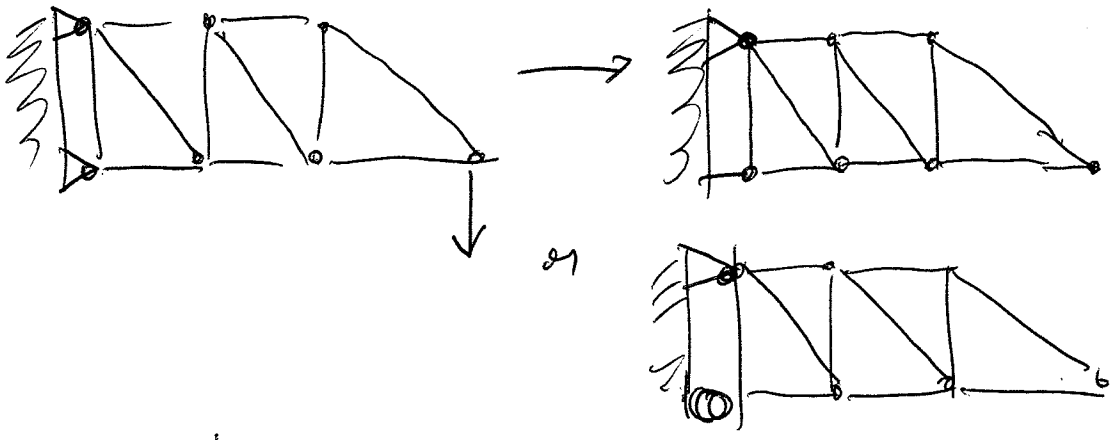

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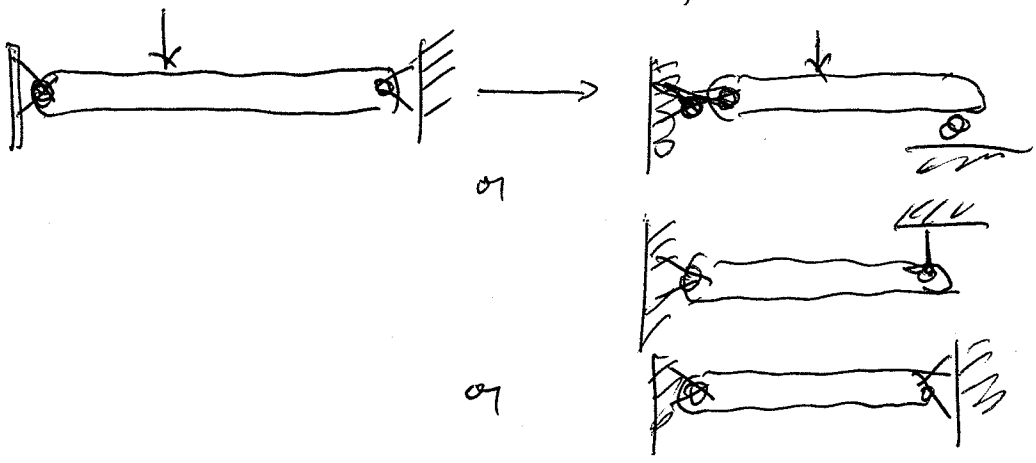
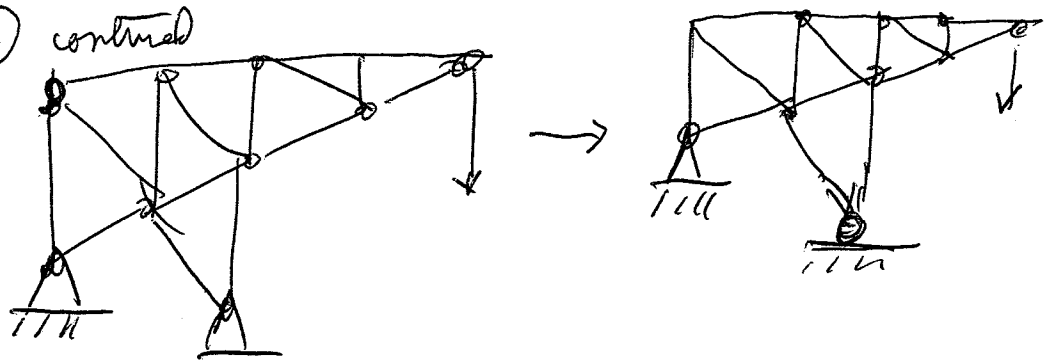


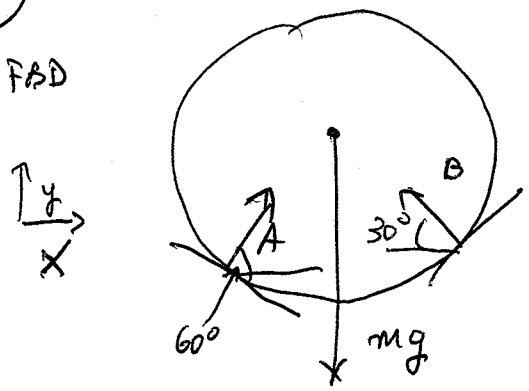
Part II

(2) continued



(3)

FBD



$m = 40\,kg$

$mg = 392\,N$

solve for forces A, B

$$\sum F_x = 0 = A_x - B_x = A\cos 60^\circ - B\cos 60^\circ \quad (1)$$

$$\sum F_y = 0 = A_y + B_y - mg = A\sin 60^\circ + B\sin 30^\circ - 392N \quad (2)$$

we have 2 eqns for 2 unknowns A, B as geometry is known!

from (2) $\quad \frac{A}{2} - \frac{\sqrt{3}}{2}B = 0 \Rightarrow A = \sqrt{3}B$

(1) $\quad \frac{\sqrt{3}}{2}A + \frac{B}{2} = 392N$

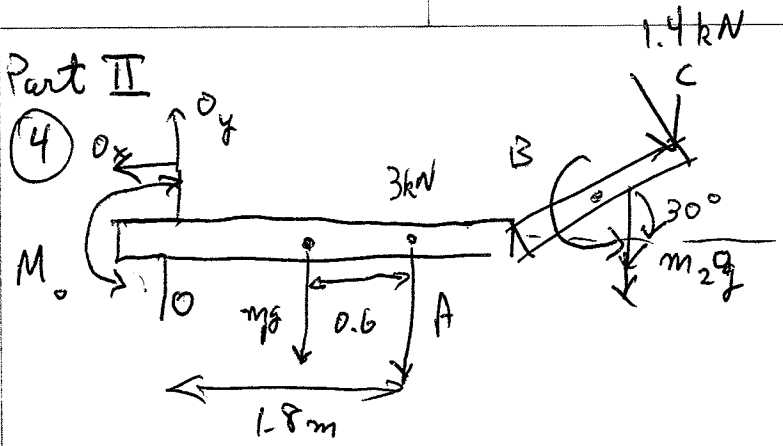
$\Rightarrow \quad \frac{3B}{2} + \frac{B}{2} = 2B = 392N$

$\therefore \quad \boxed{B = 196\,N}$

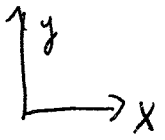
$\boxed{A = 339\,N}$

Part II

(4)



mass $\frac{50\,kg}{m}$



$\sum F_x = 0 = C \sin 30 - O_x \Rightarrow$ **$O_x = 1.4\,kN \cdot \frac{1}{2} = 0.7\,kN$**

$\sum F_y = 0 = -m_1 g + m_2 g - A - C \cos 30° + O_y$

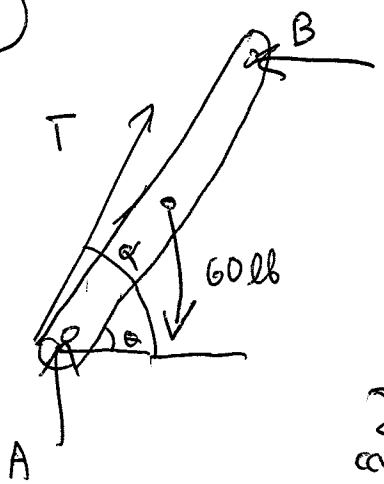
$= 50 \times (1.8 + 0.6 + 0.6 + 0.6) \times 9.8 \frac{kg}{m^2} + 3\,kN + 1.212\,kN$

$O_y = 5.98\,kN$ $\Rightarrow$ **$O = \sqrt{O_x^2 + O_y^2} = 5.98\,kN$**

$\overset{\text{ccw+}}{\underset{\text{at O}}{\sum M_z = 0}} = -B + M_o + m_1 g \cdot 1.2\,m + A \cdot 1.8 + m_2 g \left(2.4\,m + 0.6\,m \cdot \frac{\sqrt{3}}{2}\right) - C\left(2.4\,m \frac{\sqrt{3}}{2} + 1.2\,m\right)$

$M_o = 9.12\,kN\,m$

(5)



$\theta = \arctan \frac{3'}{4'} = 36.87°$

$\alpha = \arctan \frac{4.5'}{4'} = 48.37°$

$\sum F_x = 0 = T \cos\alpha - B$ (1)

$\sum F_y = 0 = A + T \sin\alpha - mg$ (2)

$\overset{\text{ccw+}}{\sum M_A = 0} = B \cdot 3' - mg \cdot 2' = 0$ (3)

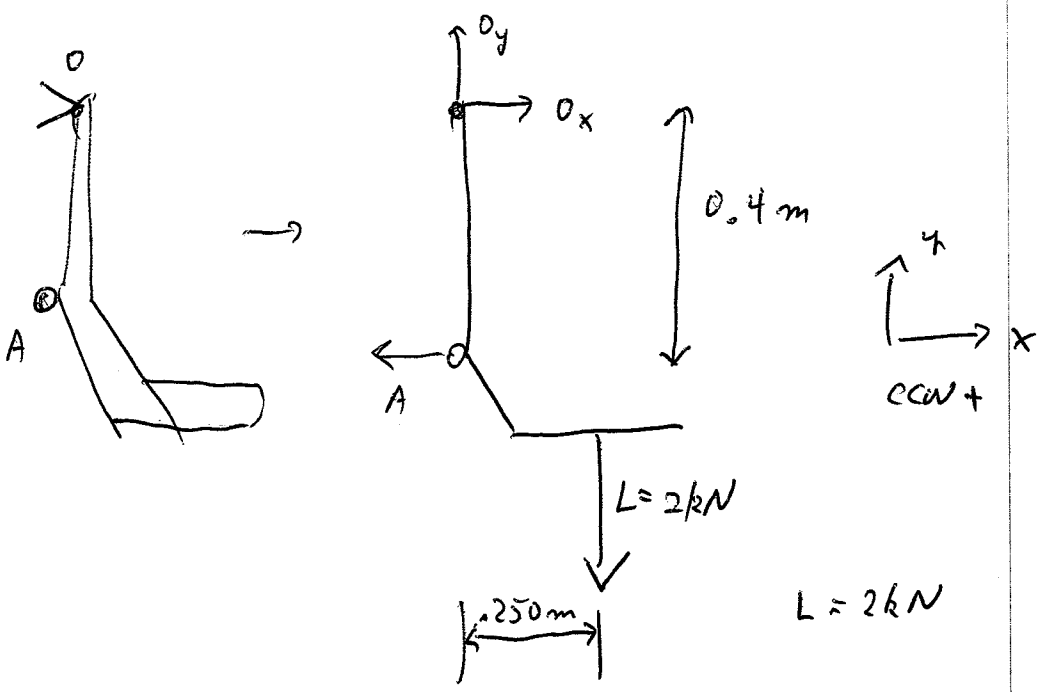
$B = \frac{2' \cdot 60\,lb}{3'} \Rightarrow$ **$B = 40\,lb$** from (3)

$T = \frac{B}{\cos\alpha} \Rightarrow$ **$T = 60.2\,lb$** from (1)

$A = mg - T \sin A \Rightarrow$ **$A = 15.0\,lb$** from 2

Part II

(6)



forces, moments

$$\sum F_x = 0 = -A + O_x \quad (1)$$

$$\sum F_y = 0 = O_y - L \quad (2)$$

$$\sum_{\text{at pt O}} M_z = 0 = L \cdot 0.25\,m - A \cdot 0.4\,m \quad (3)$$

from (3)

$$2\,kN \cdot 0.25\,m = A\,kN \cdot 0.4\,m$$

$$A = \frac{0.5\,kN\,m}{0.4\,m}$$

$$\boxed{A = 1.25\,kN}$$

from (1)

$$O_x = A = 1.25\,kN$$

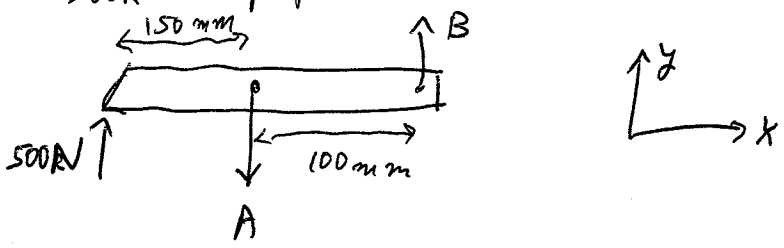
$$O_y = L = 2\,kN$$

$$O = \sqrt{O_x^2 + O_y^2}$$

$$\boxed{O = 2.36\ kN}$$

Part II

(7) free body diagram - look at top piece



$\sum F_x = 0$ (1)

$\sum F_y = 0 = 500N - A + B$ (2)

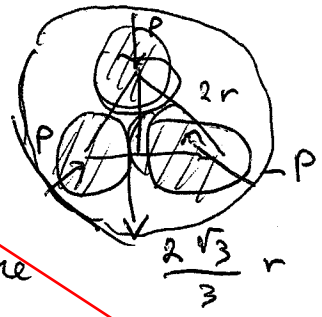
$\sum M_z = 0 = 500N \cdot 0.15m - B \cdot 0.1m$ (3)

CCW+ at A $\Rightarrow$ $B = \frac{500N \cdot 0.15m}{0.1m} \Rightarrow$ $\boxed{B = 750N}$

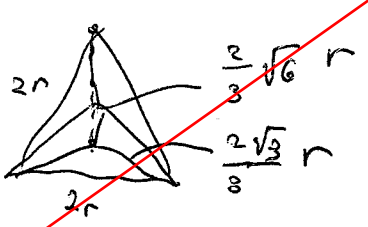
plugging (2) $A = 500 + B$

$\therefore \boxed{A = 1250N}$

(8) top view

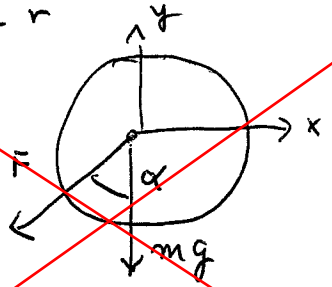


side View



F is reaction force of top ball on the lower balls

P is normal to ring



$\alpha = \sin^{-1}\frac{2\sqrt{3}}{6}$

$= 35.264°$

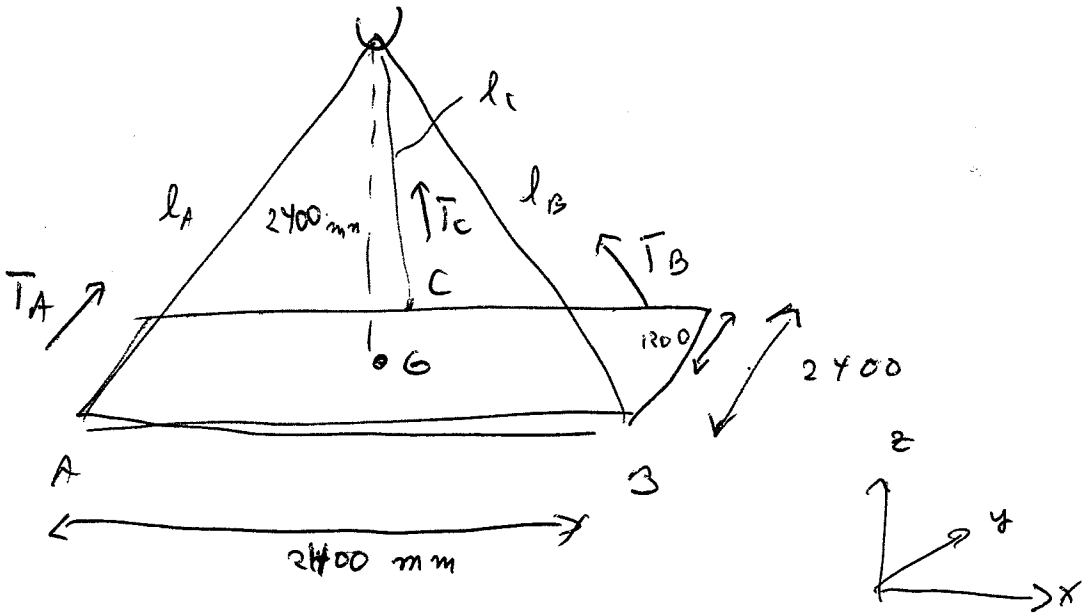
$\Rightarrow mg = 3F\cos\alpha \Rightarrow F = 0.41\,mg$

but by geometry $P = F\sin\alpha = 0.41\,mg \cdot 0.577$

$\therefore \boxed{P = 0.24\,mg}$

Part II

8



wt of plate = 18×9.8 kN
= 17.64 kN

by symmetry $T_A = T_B$, $l_A = l_B$

in z direction use direction cosines

$$\sum F_z = T_A \cdot \frac{2.4\,m}{l_A} + T_B \frac{2.4}{l_B} + T_c \frac{2.4}{l_c} - mg = 0$$

$$= 2T_A \frac{2.4\,m}{l_A} - mg + T_c \frac{2.4\,m}{l_c} \qquad (1)$$

in x direction by observation $T_{Bx} = T_{Ax}$ not useful

y direct (by direct cosines)

$$\sum F_y = -\frac{1.2\,m}{l_c} T_c + 2\frac{1.2}{l_A} T_A = 0 \qquad (2)$$

we can find l_c, $l_B = l_B$

$$l_A^2 = l_B^2 = (2.4\,m)^2 + (1.2\,m)^2 + (1.2\,m)^2 = (3.64\,m)^2$$

$$l_A^2 = (2.4\,m)^2 + (1.2\,m)^2 = (2.3\,m)^2$$

$$\therefore \boxed{l_A = l_B = 2.94\,m,\ l_c = 2.68\,m}$$

Part II

8 continued

we have 2 eqns 2 unknowns by the symmetry;

so from eqn(2)

$$T_c = \frac{2 \cdot 2.68}{2.94} T_A$$

$$= 1.823\, T_A$$

we plug this into eqn (1)

$$2T_A \cdot \frac{2.4\,m}{2.94\,m} + 1.823\, T_A \frac{2.4\,m}{2.68\,m} = 17.64\ kN$$

$$\Rightarrow \quad (1.63 + 1.63)\, T_A = 17.64\ kN$$

$$\Rightarrow \quad T_A = \frac{17.64\ kN}{3.26}$$

$$\therefore \quad \boxed{T_A = T_B = 5.41\ kN \uparrow}$$

$$T_c = 1.823\, T_A \Rightarrow \boxed{T_c = 9.87\ kN}$$