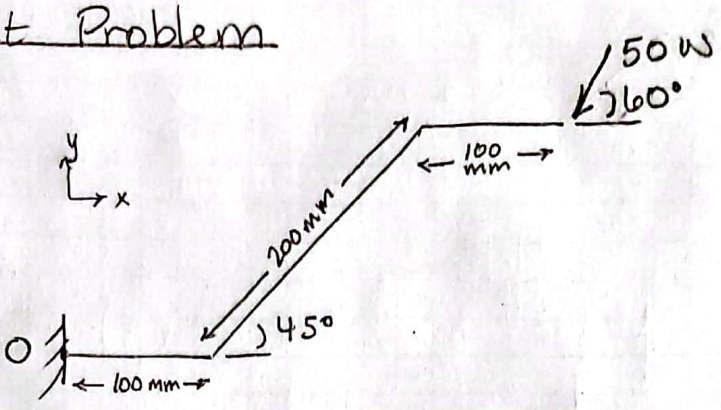
10/7/21 | SI Statics Worksheet #5 | Solution

First Problem



Find moment about point O:

First, divide applied 50 N force into x- & y-components

$F_x = -50\,N \cos 60° = -25\,N$

$F_y = -50\,N \sin 60° = -43.3\,N$

Next, find x- and y-direction distances from O to the point where the force is applied

$x = 100mm + 200\,mm \cos 45° + 100mm$

$= 341.4\,mm = .3414\,m$

$y = 200\,mm \sin 45° = 141.4mm = .1414\,m$

Finally, find moment. (it is best to deal with signs by inspection rather than the sign of the force causing the moment — in this case, the x-component of the force causes counterclockwise rotation about O, and the y-component causes clockwise)

$\circlearrowleft \Sigma M_O = y F_x - x F_y$

$= (.1414m)(25\,N) - (.3414m)(43.3\,N)$

$= -11.2\,N\cdot m$ CCW

or $11.2\,N\cdot m$ CW

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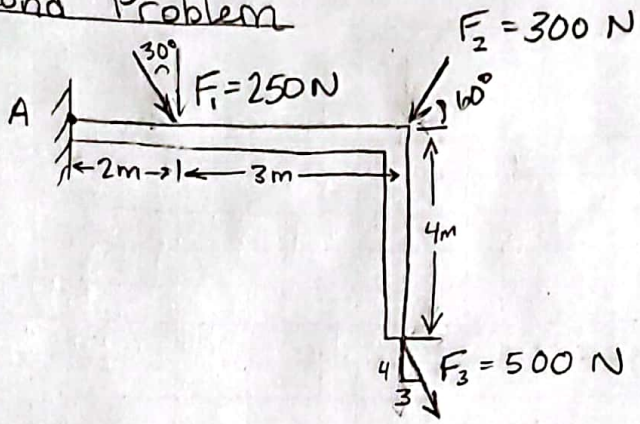
Second Problem



Find moment about point A

Divide forces into components:

$F_1 \Rightarrow$ $250\,N \sin 30° = 125\,N$
$250\,N \cos 30° = 216.51\,N$

$F_2 \Rightarrow$ $300\,N \cos 60° = 150\,N$
$300\,N \sin 60° = 259.81\,N$

$F_3 \Rightarrow$ $\frac{3}{5}(500\,N) = 300\,N$
$\frac{4}{5}(500\,N) = 400\,N$

Sum moments about A, observing which cause CW vs. CCW rotation

$$\overset{+}{\circlearrowleft}_A \Sigma M = \cancel{(F_1 \sin 30°)(0\,m)} - (F_1 \cos 30°)(2\,m)$$
$$+ \cancel{(F_2 \cos 60°)(0\,m)} - (F_2 \sin 60°)(5\,m)$$
$$+ \left(\tfrac{3}{5}F_3\right)(4\,m) - \left(\tfrac{4}{5}F_3\right)(5\,m)$$
$$= -(216.51\,N)(2\,m) - (259.81\,N)(5\,m)$$
$$+ (300\,N)(4\,m) - (400\,N)(5\,m)$$
$$= -2.53\ kN\cdot m\ CCW$$
$$= 2.53\ kN\cdot m\ CW$$

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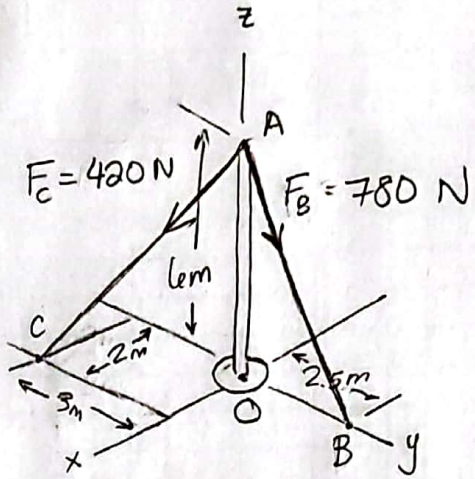
Third Problem

Find resultant moment about point O in Cartesian form



Put forces in Cartesian form:

$$\bar{F}_B = 780\,N \frac{\langle 0, 2.5\,m, -6m\rangle}{\sqrt{2.5^2+6^2}\,m} = \langle 0, 300, -720\rangle\,N$$

$$\bar{F}_C = 420\,N \frac{\langle 2m, -3m, -6m\rangle}{\sqrt{2^2+3^2+6^2}\,m} = \langle 120, -180, -360\rangle\,N$$

Find directional vectors from point O to points B & C:

$$\bar{r}_{O\to B} = \langle 0, 2.5\,m, 0\rangle$$

$$\bar{r}_{O\to C} = \langle 2m, -3m, 0\rangle$$

Take cross products to find moments:

$$\bar{M}_B = \bar{r}_{O\to B} \times \bar{F}_B = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 2.5m & 0 \\ 0 & 300\,N & -720\,N \end{vmatrix} = -1800 \uparrow\ N\cdot m$$

$$\bar{M}_C = \bar{r}_{O\to C} \times \bar{F}_C = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2m & -3m & 0 \\ 120\,N & -180\,N & -360\,N \end{vmatrix}$$

$$= 1080 \uparrow + 720 \hat{j}\ N\cdot m$$

Find resultant moment

$$\bar{M} = \bar{M}_B + \bar{M}_C = -1800 \uparrow + 1080 \uparrow + 720 \hat{j}\ N\cdot m$$

$$= -720 \uparrow + 720 \hat{j}\ N\cdot m$$