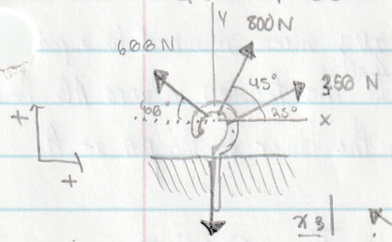
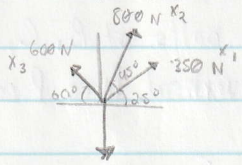
Quiz 1 solution

problem 2.32: Determine the resultant of the three forces of the problem

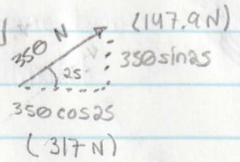
problem 2.33: Determine the x and y components of each of the forces shown



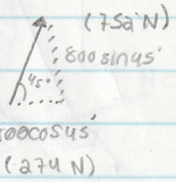
FBD:



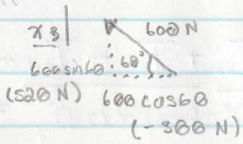
x_1



x_2



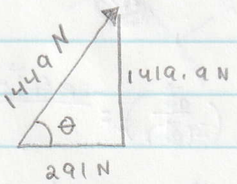
x_3



$T_x: (317\text{ N}) + (274\text{ N}) - (360\text{ N}) = 291\text{ N}$

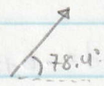
$T_y: (147.9\text{ N}) + (752\text{ N}) + (520\text{ N}) = 1419.9\text{ N}$

$$T = \sqrt{(291)^2 + (1419.9)^2} = 1449\text{ N}$$



$\theta = \tan\left(\frac{1419.9}{291}\right) \rightarrow \theta = 78.4°$

∴ Resultant is 1449 N



b) is it in equilibrium? Yes, it is in equilibrium!

Unrelated: cross product rule:

$$\begin{array}{ccc} i & j & k \end{array}$$
$$\begin{bmatrix} \# & \# & \# \\ 0 & 0 & 0 \end{bmatrix}$$

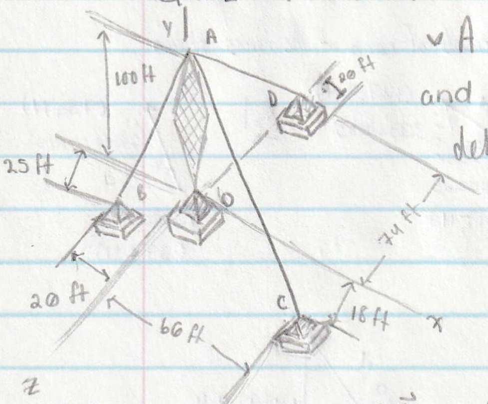
$\vec{k}\#\cdot\vec{i}0 - \vec{i}\#\cdot\vec{k}0 = \vec{j}$

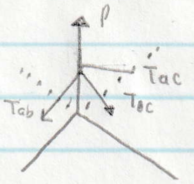
$\vec{j}\#\cdot\vec{k}0 - \vec{k}\#\cdot\vec{j}0 = \vec{i}$

$\vec{i}\#\cdot\vec{j}0 - \vec{j}\#\cdot\vec{i}0 = \vec{k}$

Quiz 2 solution problem 2.111

A transmission tower is held by three guy wires attached to a pin at A and anchored by bolts at B, C, and D. If the tension in wire AB is 840 lb determine the vertical force P exerted by the tower on the pin at A,





$\Sigma F = 0: T_{ab} + T_{ac} + T_{ad} + P j = 0$

$(\vec{ad}) = \sqrt{(20)^2 + (100)^2 + (74)^2} = 126\ ft$

$(\vec{ab}) = \sqrt{(20)^2 + (100)^2 (25)^2} = 105\ ft$

$(\vec{ac}) = \sqrt{(60)^2 + (100)^2 + (18)^2} = 118\ ft$

$T_{ab}\left(\frac{\vec{ab}}{(\vec{ab})}\right) = \frac{-20\ ft\ \vec{i} - 100\ ft\ \vec{j} + 25\ ft\ \vec{k}}{105\ ft} \longrightarrow T_{ab} = -0.190\vec{i} - 0.952\vec{j} + 0.238\vec{k}$

$T_{ab} = 840\ lb$

$T_{ac}\left(\frac{\vec{ac}}{|ac|}\right) = \frac{60\ ft\ \vec{i} - 100\ ft\ \vec{j} + 18\ \vec{k}}{118\ ft} \longrightarrow T_{ac} = 0.508\vec{i} - 0.847\vec{j} + 0.152\vec{k}$

$T_{ad}\left(\frac{\vec{ad}}{|\vec{ad}|}\right) = \frac{-20\ ft\ \vec{i} - 100\ ft\ \vec{j} - 74\ ft\ \vec{k}}{126\ ft} \longrightarrow T_{ad} = -0.158\vec{i} - 0.79\vec{j} - 0.587\vec{k}$

$\Sigma F_x = 0 = -0.190\,T_{ab} + 0.508\,T_{ac} - 0.158\,T_{ad}$

$\Sigma F_y = 0 = -0.952\,T_{ab} - 0.847\,T_{ac} - 0.79\,T_{ad} + P$

$\Sigma F_z = 0 = 0.238\,T_{ab} + 0.152\,T_{ac} - 0.587\,T_{ad}$

$\vec{i})\ -160\ lb + 0.508\,T_{ac} - 0.158\,T_{ad} = 0$

$\vec{j})\ -800\ lb - 0.847\,T_{ac} - 0.158\,T_{ad} + p = 0$

$\vec{k})\ 200\ lb + 0.152\,T_{ac} - 0.587\,T_{ad} = 0$

$\hookrightarrow T_{ad} = 340\ lb + 0.2589\,T_{ac}$

$-160\ lb + 0.508\,T_{ac} - 0.158(340\ lb + 0.2589\,T_{ac}) = 0 \rightarrow -160\ lb + 0.508\,T_{ac} - 53.72\ lb - 0.0409\,T_{ac}$

$0.467\,T_{ac} - 213.72\ lb = 0 \rightarrow \underline{T_{ac} = -458\ lb}$

$200\ lb + 0.152(-458\ lb) - 0.587\,T_{ad} \rightarrow -269.616\ lb = 0.587\,T_{ad} \rightarrow \underline{T_{ad} = 459\ lb}$

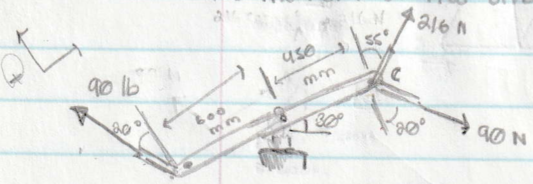
$-800\ lb - 0.847(-458\ lb) - 0.158(459\ lb) + p$

$\hookrightarrow -800\ lb + 387.926\ lb - 72.522$

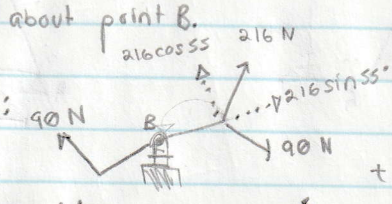
$p = 1553\ lb$

Quiz 3

a) Three control rods attached to a lever ABC exert on it forces shown in the figure on the right. Determine the moment of the 216 N force about point B.



FBD:



Sum of moments at B due to 216 N force only:

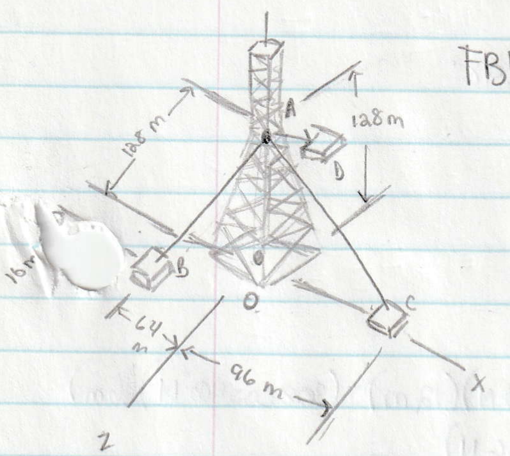
$$+\circlearrowleft M_B = (0.450\,m)(216\cos 55^\circ N)$$

$$\therefore M_B = 55.75\ Nm \circlearrowleft$$

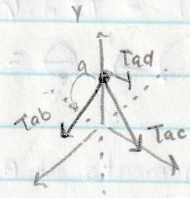
450 mm = 0.450 m

600 mm = 0.600 m

b) An antenna is guyed by three cables as shown in the figure on the left. Knowing that the tension in cable AB is 288 N, determine its moment about point O (origin.) (Tab = 288 N)



FBD:



$$\vec{T_{ab}} = T_{ab}\left(\frac{\vec{ab}}{|ab|}\right) = 288\,N\left(\frac{-64\,m\vec{i} - 128\,m\vec{j} + 16\,m\vec{k}}{\sqrt{(64m)^2 + (128m)^2 + (16m)^2}}\right)$$

$$\vec{T_{ab}} = -128\,N\vec{i} - 256\,N\vec{j} + 32\,N\vec{k}$$

$$M_o = r_{a/o} \cdot \vec{T_{ab}}$$

$$r_{a/o} = 128\,m\vec{j}$$

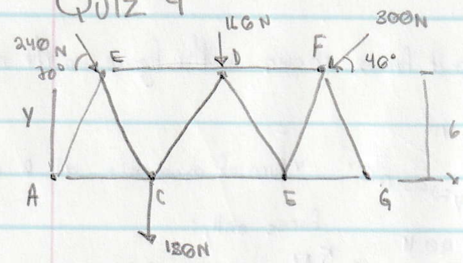
$$M_o = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 128\,m & 0 \\ -128\,N & -256\,N & 32\,N \end{vmatrix}$$

$$i(a_2b_3 - a_3b_2) + j(a_3b_1 - a_1b_3) + \vec{k}(a_1b_2 - a_2b_1)$$

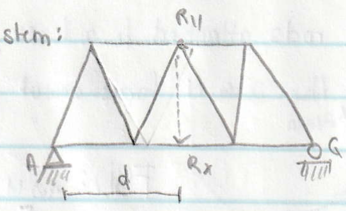
$$\vec{i}((128 \cdot 32) - \cancel{(0 \cdot -256)}) + \vec{j}((0 \cdot -128) \cancel{- (0 \cdot 32)}) + k((0 \cdot \cancel{-256}) - (128 \cdot -128))$$

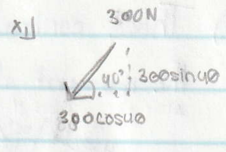
$$4096\ Nm\,\vec{i} + 16{,}384\ Nm\,\vec{k} \ \therefore$$

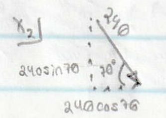
Quiz 4



equivalent system:





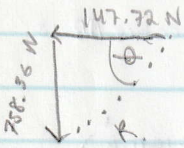


$\xrightarrow{+} \Sigma F_x = 240\cos 70° - 300\cos 40° = Rx \rightarrow Rx = -147.72\ N$

$\therefore Rx = 147.72\ N \leftarrow$

$+\uparrow \Sigma F_y = -240\sin 70 - 300\sin 40 - 180\ N - 160\ N = Ry \rightarrow Ry = -758.36\ N$

$\therefore Ry = 758.36\ N \downarrow$



$\sqrt{R^2} = \sqrt{Rx^2 + Ry^2} = \sqrt{(147.72)^2 + (758.36)^2} = 772.6\ N$

$\theta = \tan^{-1}\left(\frac{Ry}{Rx}\right) \rightarrow \theta = \tan^{-1}\left(\frac{758.36}{147.72}\right) \rightarrow \theta = 78.98°$

Now find distance from A; use a sum of moments at A.

$\Sigma M_a = d \cdot Ry$

$= (-240\cos 40° N)(6m) - (240\sin 40° N)(4m) - (160 N)(12m) + (300\cos 40° N)(6m)$
$- (300\sin 40° N)(20m) - (180\ N)(8m) = d(758.36N)$

$-7232.46N = d(758.36N)$

$d = 9.537\ m$