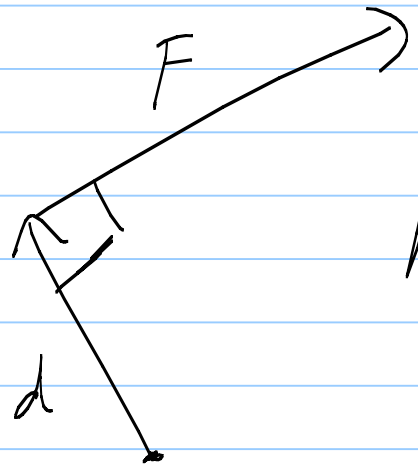
EGR 180 6/8

Note Title 6/8/2009

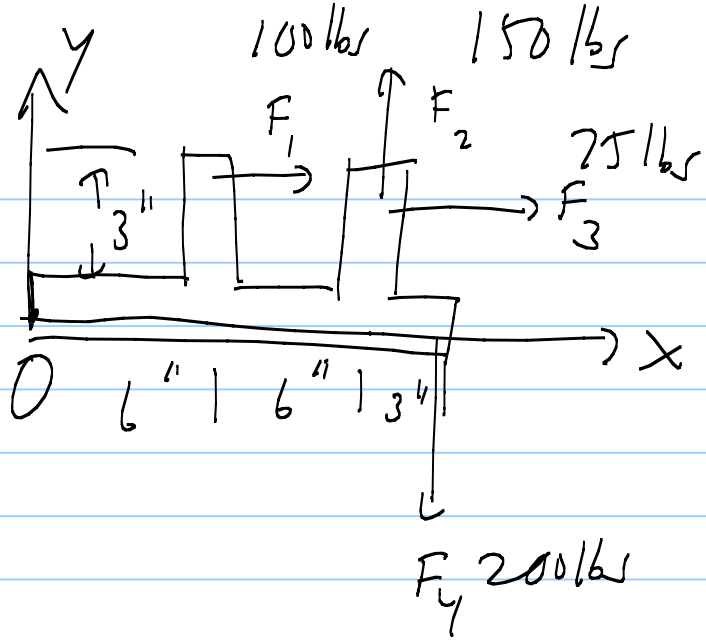
Moments

Force times a distance

Force & distance are perpendicular



$M = Fd$

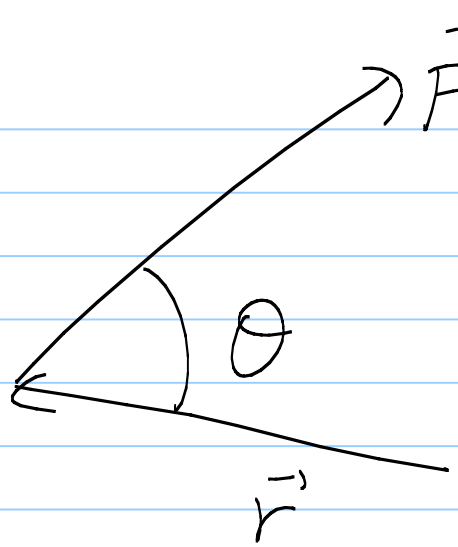


$M_1 = 3 \cdot 100 = 300$ in-lbs

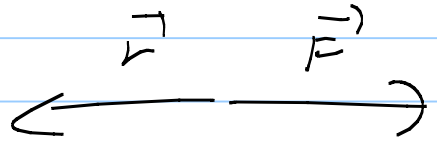
$M_2 = 12 \cdot 150 = 1800$ in-lbs

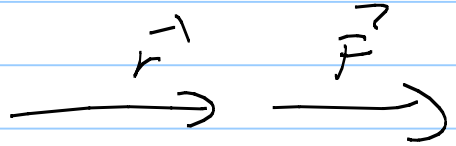
$M_3 = 3 \cdot 75 = 225$ in-lbs

$M_4 = 15 \cdot 200 = 3000$ in-lbs

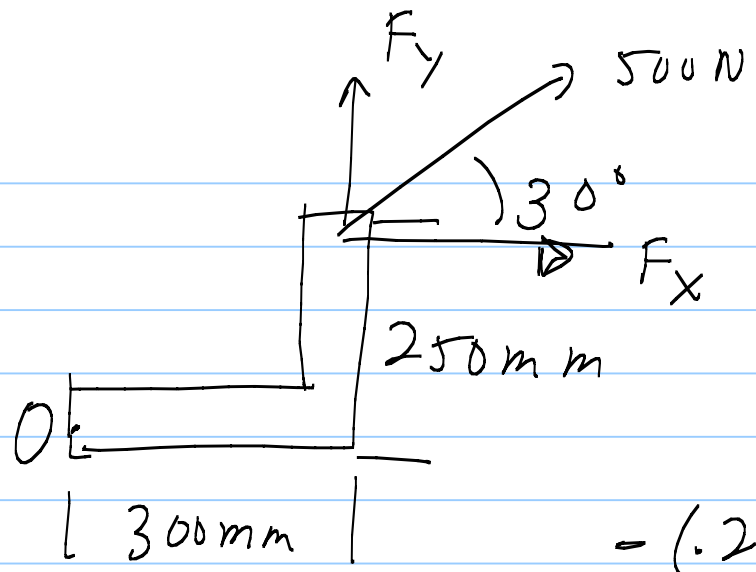


$$M = |\vec{F}||\vec{r}| \sin\theta$$





$M = 0$



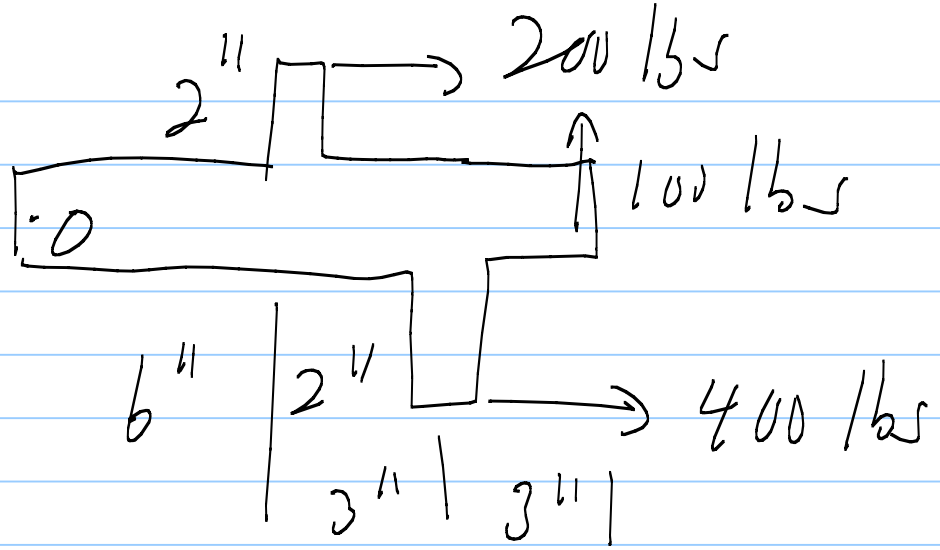
$M = \sum M_i$

$-(.25)\,500\cos(30) = -108.3\ N\cdot m$

$(.3)(500\sin(30) = \ \ 75.0\ N\cdot m$

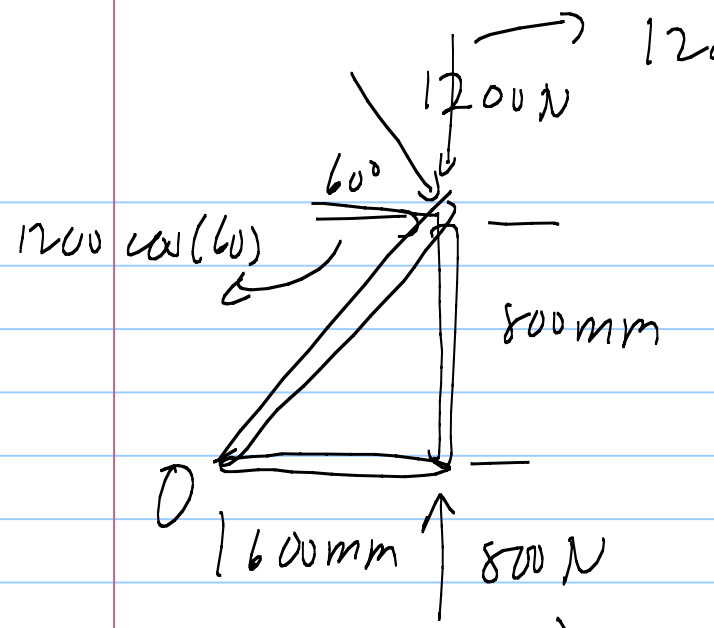
$= -33.3\ N\cdot m$

Moments are free Vectors

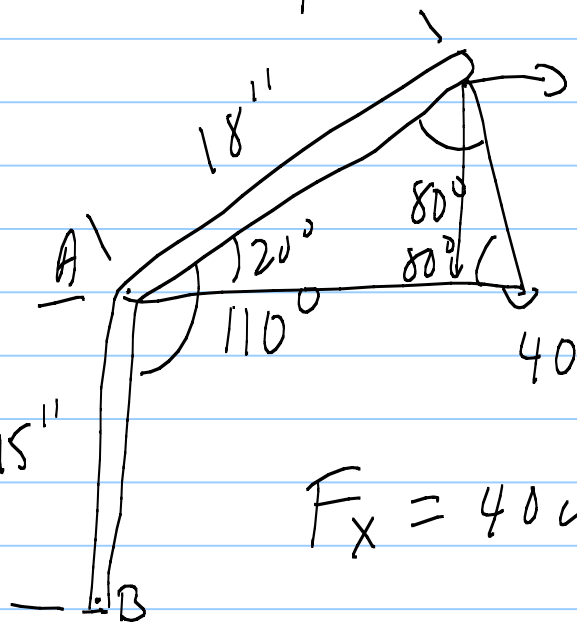


$$M_O = -2.200 + 2.400 + 12.100$$

$$= -400 + 800 + 1200 = 1600 \text{ in. lbs}$$



$$M_O = (.6)(800) - (.6)(1039.2) - (.8)(600) = -623.5 \text{ N·m}$$



$$M_A = -18 \cdot 40 \cdot \sin(80°) = -709.1 \text{ in·lbs}$$

$$M_B = -18\cos(20) \cdot 40\sin(80) = (15 + 18\sin(20)) \cdot 40\cos(80)$$

$$F_x = 40\cos 80 \quad F_y = 40\sin(80) \quad = -813.3 \text{ in·lbs}$$

Vector Moments

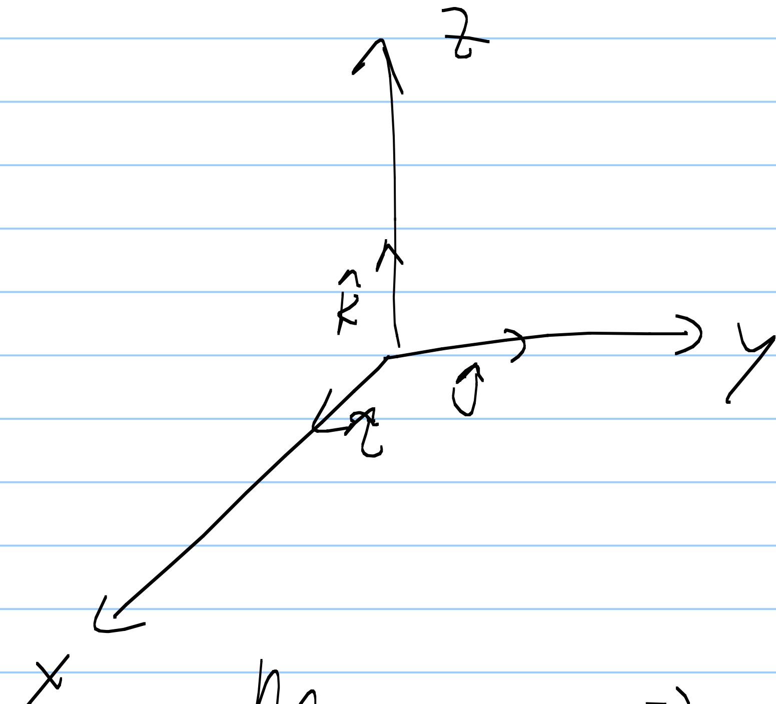
$$\vec{M} = \vec{r} \times \vec{F}$$

$\hat{i} \times \hat{j} = \hat{k}$ $\quad$ $\hat{j} \times \hat{i} = -\hat{k}$

$\hat{j} \times \hat{k} = \hat{i}$ $\quad$ $\hat{k} \times \hat{j} = -\hat{i}$

$\hat{k} \times \hat{i} = \hat{j}$ $\quad$ $\hat{i} \times \hat{k} = -\hat{j}$

$\vec{u} \times \vec{v} = -\vec{v} \times \vec{u}$



$$M = |\vec{r}||\vec{F}|\sin(\theta)$$

$$\vec{u} = u_x \hat{i} + u_y \hat{j} + u_z \hat{k}$$

$$\vec{v} = v_x \hat{i} + v_y \hat{j} + v_z \hat{k}$$

$$\vec{u} \times \vec{v} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ u_x & u_y & u_z \\ v_x & v_y & v_z \end{vmatrix}$$

$$= \hat{i}\left(u_y v_z - v_y u_z\right)$$

$$-\hat{j}\left(u_x v_z - v_x u_z\right)$$

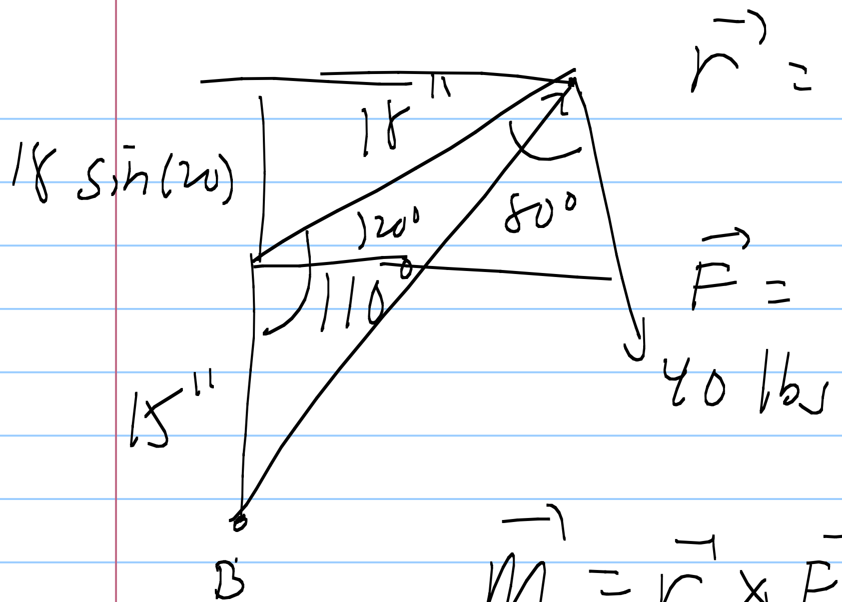
$$+\hat{k}\left(u_x v_y - v_x u_y\right)$$

$$\vec{u} = 2\hat{i} + 3\hat{j} - 4\hat{k}$$

$$\vec{v} = 4\hat{i} - 2\hat{j} + 2\hat{k}$$

$$\vec{u} \times \vec{v} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 3 & -4 \\ 4 & -2 & 2 \end{vmatrix} \begin{matrix} \hat{i}(6-8) \\ -\hat{j}(4+16) \\ +\hat{k}(-4-12) \end{matrix}$$

$$= -2\hat{i} - 20\hat{j} - 16\hat{k}$$



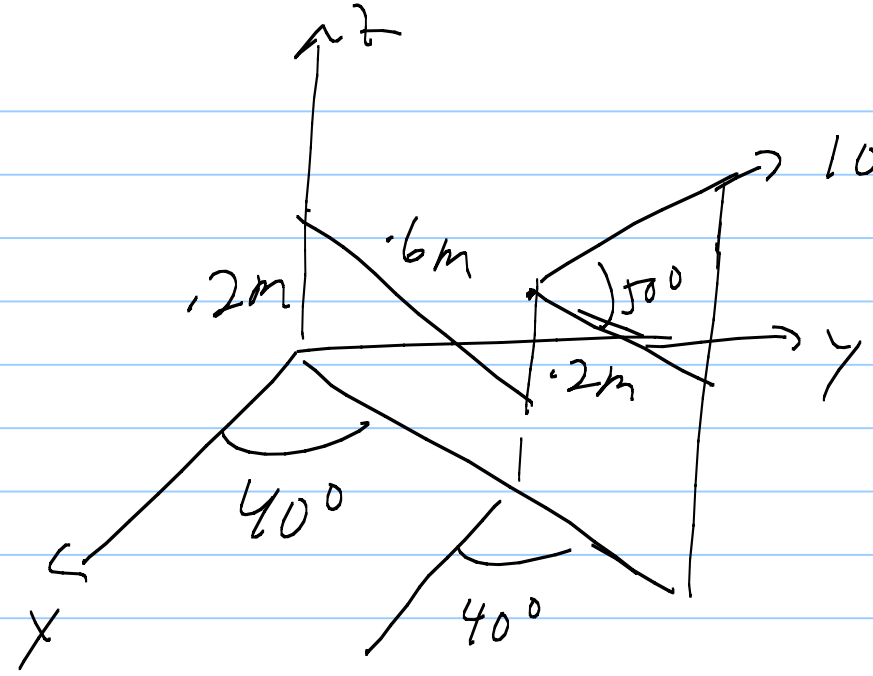
$$\vec{r} = 18\cos 20\,\hat{i} + 15+18\sin(20)\,\hat{j}$$

$$\vec{F} = 40\cos 80\,\hat{i} - 40\sin 80\,\hat{j}$$

$$\vec{M} = \vec{r} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 18\cos 20 & 15+18\sin(20) & 0 \\ 40\cos(80) & -40\sin(80) & 0 \end{vmatrix}$$

$$= \hat{k}\left(-40\cdot 18\cos 20\sin 80) - 40\cos(80)\cdot(15+18\sin(20)\right)$$

$$= -813.3\,\hat{k} \text{ in}\cdot\text{lbs}$$



$$\vec{r} = .6\cos(40)\,\hat{i} + .6\sin(40)\,\hat{j} + .4\,\hat{k}$$

$$\vec{F} = 1000\cos(50)\cos(40)\,\hat{i} + 1000\cos(50)\sin(40)\,\hat{j} + 1000\sin(50)\,\hat{k}$$

$$\vec{M} = \vec{r} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ .46 & .386 & .4 \\ 492.4 & 413.2 & 766.0 \end{vmatrix} = \hat{i}\,130.2 - \hat{j}\,155.1 + \hat{k}\,0 \quad N\cdot m$$