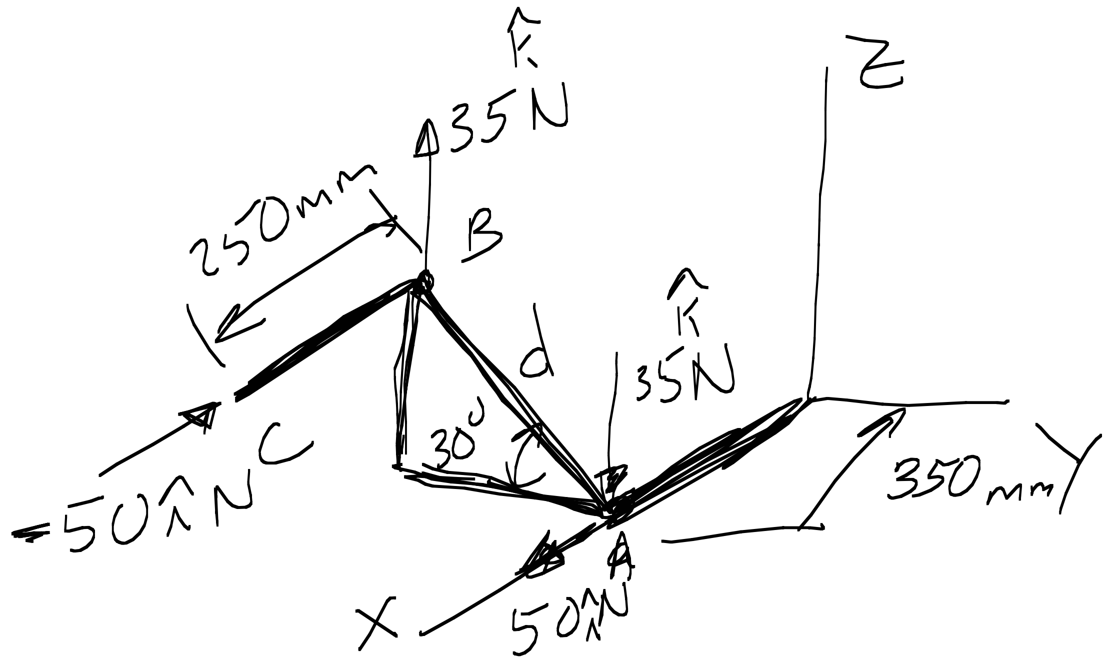
4.99

$M_R = 20 N\cdot m$

Find: d



$$\sum \vec{M}_A = (\vec{r}_{AB} \times 35\hat{k} N) + (\vec{r}_{AC} \times -50\hat{i})$$

$$\vec{r}_{AB} = \{0\hat{i} - d\cos 30^\circ \hat{j} + d\sin 30^\circ \hat{k}\}$$

$$\vec{r}_{AC} = \{0.25m\hat{i} - d\cos 30^\circ \hat{j} + d\sin 30^\circ \hat{k}\}$$

$\underline{r_{AB} \times 35\hat{k}}$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & -0.866d & 0.5d \\ 0 & 0 & 35 \end{vmatrix} = (-0.866d)(35)\hat{i} = -30.31d\,\hat{i}$$

$\underline{\vec{r}_{AC} \times -50\hat{i}}$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \cancel{0.25} & -0.866d & 0.5d \\ -50 & 0 & 0 \end{vmatrix} = -\left(0-(0.5d)(-50)\right)\hat{j}$$

$$+\left(0-(-0.866d)(-50)\right)\hat{k}$$

$$= \underline{-25d\hat{j} - 43.3d\hat{k}}$$

$$\vec{M}_R = \{-30.31d\hat{i} - 25d\hat{j} - 43.3d\hat{k}\}\ N\cdot m$$

$$M_R = \sqrt{(-30.31d)^2 + (-25d)^2 + (43.3d)^2} = 20 \text{ N}\cdot\text{m}$$

$$\boxed{d = 0.342 \text{ m}}$$

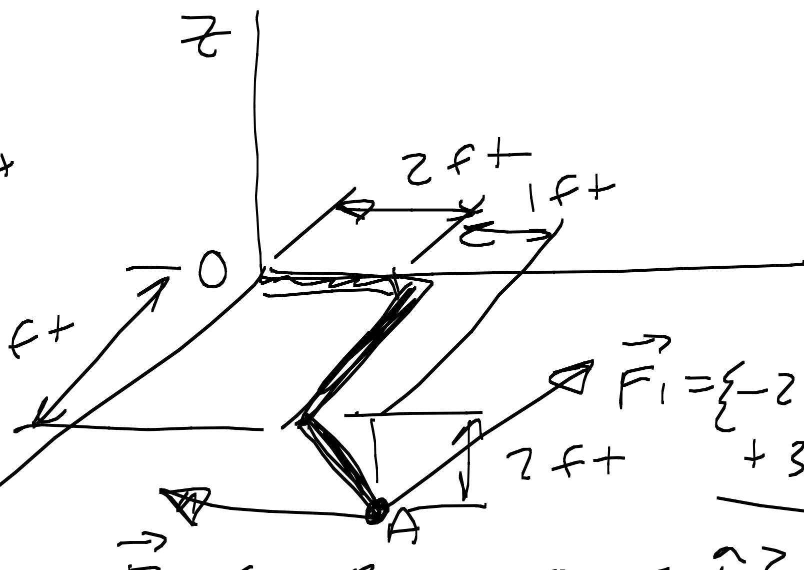
4.39

Find $\vec{M}_O$

$O(0,0,0)$ ft

$A(3,3,-2)$ ft

$\vec{r}_{OA} = \{3\hat{\imath} + 3\hat{\jmath} - 2\hat{k}\}$ ft



$\vec{F}_1 = \{-20\hat{\imath} + 10\hat{\jmath} + 30\hat{k}\}$ lb

$\vec{F}_2 = \{-10\hat{\imath} - 30\hat{\jmath} + 50\hat{k}\}$ lb

$$\vec{M}_O = (\vec{r}_{OA} \times \vec{F}_1) + (\vec{r}_{OA} \times \vec{F}_2)$$

$\vec{r}_{OA} \times \vec{F}_1$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 3 & -2 \\ -20 & 10 & 30 \end{vmatrix} = [(3)(30)-(-2)(10)]\hat{i} - [(3)(30)-(-2)(-20)]\hat{j} + [(3)(10)-(3)(-20)]\hat{k}$$

$$= \underline{\{110\hat{i} - 50\hat{j} + 90\hat{k}\}\ \text{lb}\cdot\text{ft}}$$

$\underline{\vec{r}_{OA} \times \vec{F}_2}$

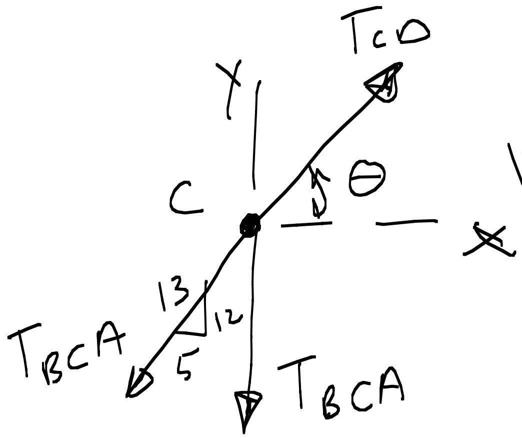
$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 3 & -2 \\ -10 & -30 & 50 \end{vmatrix} = [(3)(50)-(-2)(-30)]\hat{i} - [(3)(50)-(-2)(-10)]\hat{j} + [(3)(-30)-(3)(-10)]\hat{k}$$

$$= \underline{\{90\hat{i} - 130\hat{j} - 60\hat{k}\}\ \text{lb}\cdot\text{ft}}$$

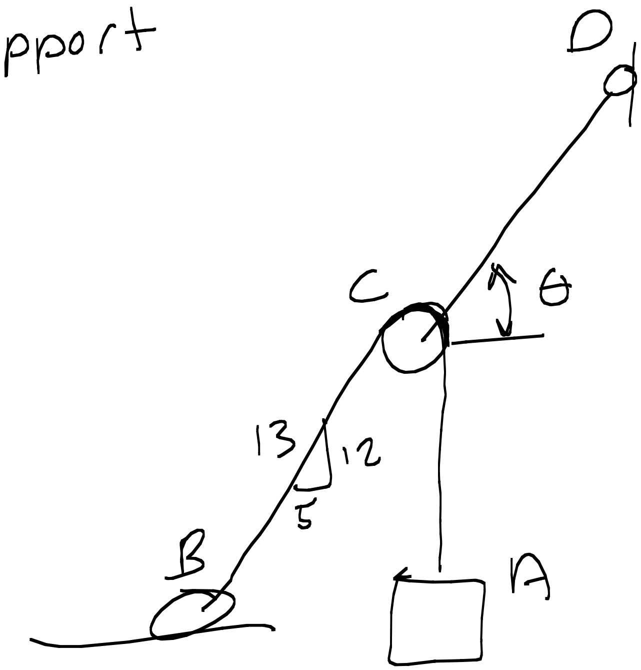
$$\boxed{\vec{M}_O = \{200\hat{i} - 180\hat{j} + 30\hat{k}\}\ \text{lb}\cdot\text{ft}}$$

3-29 BCA & CD can each support up to 100 lb

Find the max weight



$W = T_{BCA}$



$$\xrightarrow{+} \sum F_x = 0 \Rightarrow \boxed{T_{CD}\cos\theta - T_{BCA}\left(\frac{5}{13}\right) = 0}$$

$$+\uparrow \sum F_y = 0 \Rightarrow T_{CD}\sin\theta - T_{BCA}\left(\frac{12}{13}\right) - T_{BCA} = 0$$

$$\boxed{T_{CD}\sin\theta - T_{BCA}\left(\frac{25}{13}\right) = 0}$$

Try $T_{CD} = 100\,lb$

$$100\cos\theta - \frac{5}{13} T_{BCA} = 0$$

$$100\sin\theta - \frac{25}{13} T_{BCA} = 0$$

$$\boxed{\begin{array}{l}\theta = 78.7^\circ \\ T_{BCA} = 51\,lb\end{array}}$$

Try $T_{BCA} = 100\,lb$

$$T_{CD}\cos\theta - \frac{5}{13}(100) = 0$$

$$T_{CD}\sin\theta - \frac{25}{13}(100) = 0$$

$$\frac{T_{CD}\sin\theta = 192.3}{T_{CD}\cos\theta = 38.5}$$

$$\tan\theta = \frac{192.3}{38.5}$$

$$\theta = 78.7^\circ$$

$$T_{CD} = \frac{192.3}{\sin(78.7^\circ)}$$

$$T_{CD} = 196.1\ lb$$ Not OK