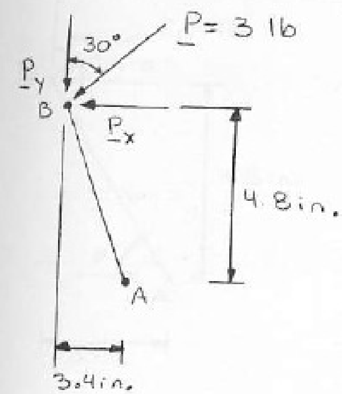
Home Work # 4

Solution: 3.3



$$P_x = (3 \text{ lb})\sin 30°$$

$$= 1.5 \text{ lb}$$

$$P_y = (3 \text{ lb})\cos 30°$$

$$= 2.5981 \text{ lb}$$

$$M_A = x_{B/A} P_y + y_{B/A} P_x$$

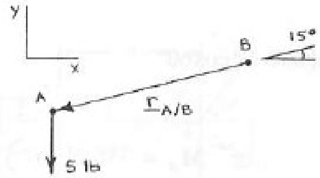
$$= (3.4 \text{ in.})(2.5981 \text{ lb}) + (4.8 \text{ in.})(1.5 \text{ lb})$$

$$= 16.0335 \text{ lb} \cdot \text{in.}$$

$$\mathbf{M}_A = 16.03 \text{ lb} \cdot \text{in.} \circlearrowright$$

Solution: 3.8

(*a*)



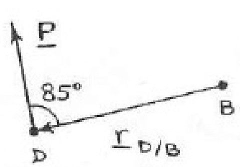
$$M_B = (r_{A/B} \cos 15°) W$$

$$= (14 \text{ in.})(\cos 15°)(5 \text{ lb})$$

$$= 67.615 \text{ lb} \cdot \text{in.}$$

or $\quad \mathbf{M}_B = 67.6 \text{ lb} \cdot \text{in.} \circlearrowright$

(*b*)

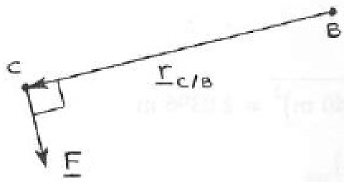


$$M_B = r_{D/B} P \sin 85°$$

$$67.615 \text{ lb} \cdot \text{in.} = (3.2 \text{ in.}) P \sin 85°$$

or $\quad P = 21.2 \text{ lb}$

(c)



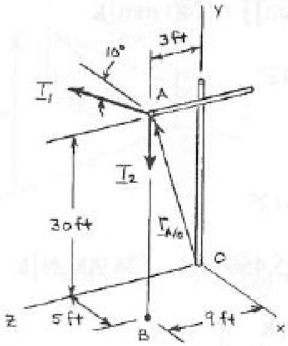
For $(\mathbf{F})_{min}$, $\mathbf{F}$ must be perpendicular to BC.

Then, $$M_B = r_{C/B}F$$

$$67.615 \text{ lb}\cdot\text{in.} = (18 \text{ in.})F$$

or $\mathbf{F} = 3.76 \text{ lb} \measuredangle 75.0^\circ$

Solution: 3.23



Have $$\mathbf{M}_O = \mathbf{r}_{A/O} \times \mathbf{R}$$

where $$\mathbf{r}_{A/D} = (30 \text{ ft})\mathbf{j} + (3 \text{ ft})\mathbf{k}$$

$$\mathbf{T}_1 = -[(62 \text{ lb})\cos 10^\circ]\mathbf{i} - [(62 \text{ lb})\sin 10^\circ]\mathbf{j}$$

$$= -(61.058 \text{ lb})\mathbf{i} - (10.766 \text{ lb})\mathbf{j}$$

$$\mathbf{T}_2 = T_2 \frac{\overline{AB}}{AB}$$

$$= (62 \text{ lb}) \frac{(5 \text{ ft})\mathbf{i} - (30 \text{ ft})\mathbf{j} + (6 \text{ ft})\mathbf{k}}{\sqrt{(5 \text{ ft})^2 + (-30 \text{ ft})^2 + (6 \text{ ft})^2}}$$

$$= (10 \text{ lb})\mathbf{i} - (60 \text{ lb})\mathbf{j} + (12 \text{ lb})\mathbf{k}$$

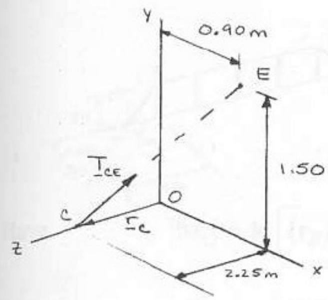
$$\therefore \mathbf{R} = -(51.058 \text{ lb})\mathbf{i} - (70.766 \text{ lb})\mathbf{j} + (12 \text{ lb})\mathbf{k}$$

$$\mathbf{M}_O = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 0 & 30 & 3 \\ -51.058 & -70.766 & 12 \end{vmatrix} \text{lb}\cdot\text{ft}$$

$$= (572.30 \text{ lb}\cdot\text{ft})\mathbf{i} - (153.17 \text{ lb}\cdot\text{ft})\mathbf{j} + (1531.74 \text{ lb}\cdot\text{ft})\mathbf{k}$$

$$\mathbf{M}_O = (572 \text{ lb}\cdot\text{ft})\mathbf{i} - (153.2 \text{ lb}\cdot\text{ft})\mathbf{j} + (1532 \text{ lb}\cdot\text{ft})\mathbf{k} \blacktriangleleft$$

Solution: 3.45



Have $\mathbf{r}_C = (2.25\text{ m})\mathbf{k}$

$$\mathbf{T}_{CE} = T_{CE}\frac{\overrightarrow{CE}}{CE}$$

$$\mathbf{T}_{CE} = (1349\text{ N})\frac{\left[(0.90\text{ m})\mathbf{i} + (1.50\text{ m})\mathbf{j} - (2.25\text{ m})\mathbf{k}\right]}{\sqrt{(0.90)^2 + (1.50)^2 + (-2.25)^2}\text{ m}}$$

$$= (426\text{ N})\mathbf{i} + (710\text{ N})\mathbf{j} - (1065\text{ N})\mathbf{k}$$

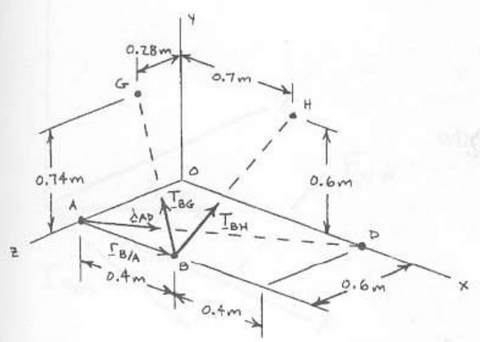
Now $\mathbf{M}_O = \mathbf{r}_C \times \mathbf{T}_{CE}$

$$= \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 0 & 0 & 2.25 \\ 426 & 710 & -1065 \end{vmatrix}\text{ N}\cdot\text{m}$$

$$= -(1597.5\text{ N}\cdot\text{m})\mathbf{i} + (958.5\text{ N}\cdot\text{m})\mathbf{j}$$

$$\therefore\ M_x = -1598\text{ N}\cdot\text{m},\ M_y = 959\text{ N}\cdot\text{m},\ M_z = 0$$

Solution: 3.53



Have $M_{AD} = \boldsymbol{\lambda}_{AD}\cdot\left(\mathbf{r}_{B/A} \times \mathbf{T}_{BH}\right)$

where $\boldsymbol{\lambda}_{AD} = \dfrac{(0.8\text{ m})\mathbf{i} - (0.6\text{ m})\mathbf{k}}{\sqrt{(0.8\text{ m})^2 + (-0.6\text{ m})^2}} = 0.8\mathbf{i} - 0.6\mathbf{k}$

$$\mathbf{r}_{B/A} = (0.4\text{ m})\mathbf{i}$$

$$\mathbf{T}_{BH} = T_{BH}\frac{\overrightarrow{BH}}{BH} = (1125\text{ N})\frac{\left[(0.3\text{ m})\mathbf{i} + (0.6\text{ m})\mathbf{j} - (0.6\text{ m})\mathbf{k}\right]}{\sqrt{(0.3)^2 + (0.6)^2 + (-0.6)^2}\text{ m}}$$

Then

$$M_{AD} = \begin{vmatrix} 0.8 & 0 & -0.6 \\ 0.4 & 0 & 0 \\ 375 & 750 & -750 \end{vmatrix} = -180 \text{ N}\cdot\text{m}$$

or $M_{AD} = -180.0 \text{ N}\cdot\text{m}$

Solution: 3.71

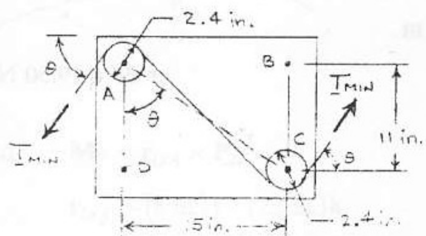
(*a*) Have $M = \Sigma F_d (+\circlearrowleft)$

$$= (9 \text{ lb})(13.8 \text{ in.}) - (2.5 \text{ lb})(15.2 \text{ in.})$$

$$= (86.2 \text{ lb}\cdot\text{in.})$$

$\mathbf{M} = 86.2 \text{ lb}\cdot\text{in.} \circlearrowleft$

(*b*)



Have $M = Td = 86.2 \text{ lb}\cdot\text{in.}$

For T to be a minimum, d must be maximum.

$\therefore T_{\min}$ must be perpendicular to line AC.

$$\tan\theta = \frac{15.2 \text{ in.}}{11.4 \text{ in.}}$$

$$\theta = 53.130°$$

or $\theta = 53.1°$ ∠

(*c*) Have $M = T_{\min} d_{\max}$ Where $M = 86.2 \text{ lb}\cdot\text{in.}$

$$d_{\max} = \sqrt{(15.2 \text{ in.})^2 + (11.4 \text{ in.})^2} + 2(1.2 \text{ in.})$$

$$= 21.4 \text{ in.}$$

$$\therefore 86.2 \text{ lb}\cdot\text{in.} = T_{\min}(21.4 \text{ in.})$$

$$T_{\min} = 4.0280 \text{ lb}$$

or $T_{\min} = 4.03 \text{ lb}$