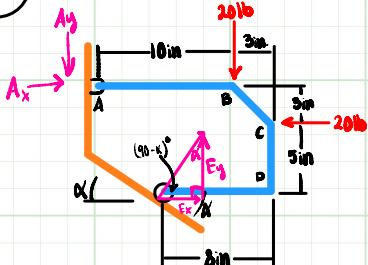


4.11



$$a) \alpha = 30^\circ$$

$$E = \frac{260}{5\cos(30^\circ) + 8\sin(30^\circ)} \\ = 31.2120$$

$$E = 31.2 \text{ lb } \angle 60^\circ$$

$$\sum F_x = 0 \Rightarrow A_x - 20 + E_x = 0$$

$$A_x = 20 - E_x$$

$$A_x = 20 - 31.2 \sin 30^\circ$$

$$A_x = 4.39 \text{ lb} \rightarrow$$

$$\sum F_y = 0 \Rightarrow A_y - 20 + E_y = 0$$

$$A_y = 20 - 31.2 \cos(30^\circ)$$

$$A_y = -7.03 = 7.03 \text{ lb} \downarrow$$

$$A = \sqrt{(4.39)^2 + (7.03)^2} = 8.29 \text{ lb } \angle 58^\circ$$

$$\sum M_A = 0$$

$$E_y = E \cos \alpha$$

$$E_x = E \sin \alpha$$

$$-(20lb)(10in) - (20lb)(3in) + (E_y)(5) + (E_x)(6)$$

$$-200 - 60 + E \cos \alpha (5) + E \sin \alpha (6) = 0$$

$$-280 + E (5 \cos \alpha + 8 \sin \alpha) = 0$$

$$E (5 \cos \alpha + 8 \sin \alpha) = 280$$

$$E = \frac{280}{5 \cos \alpha + 8 \sin \alpha}$$

$$b) \alpha = 45^\circ$$

$$E = \frac{260}{5 \cos(45^\circ) + 8 \sin(45^\circ)}$$

$$E = 28.28 \text{ lb } 45^\circ \angle$$

$$\sum F_x = A_x - 20 + 28.28 \sin 45^\circ = 0$$

$$A_x - 0 = 0$$

$$A_x = 0$$

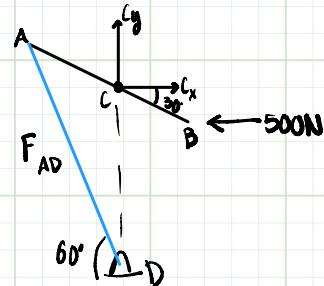
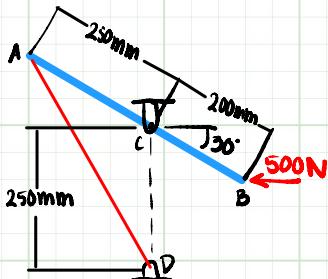
$$\sum F_y = A_y - 20 + 28.28 \cos 45^\circ = 0$$

$$A_y - 0 = 0$$

$$A_y = 0$$

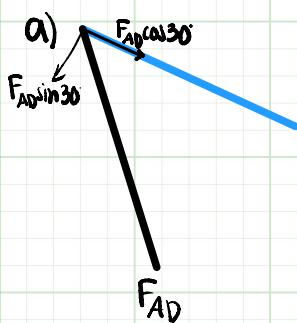
$$A = 0 \text{ lb}$$

4.12



$$\Delta ACD \text{ when } \angle C = 90 + 30 = 120^\circ$$

$$\angle A - \angle D = \frac{1}{2} (180 - 120) = 30^\circ$$



$$\sum M_C = 0$$

$$(F_{AD} \sin 30^\circ) (250 \text{ mm}) - (500 \text{ N})(100 \text{ mm}) = 0$$

$$F_{AD} \sin 30^\circ = 200 \text{ N}$$

$$F_{AD} = 400 \text{ N}$$

$$b) \sum F_x = 0 \Rightarrow 400 \text{ N} \cos 60^\circ + C_x - 500 \text{ N} = 0$$

$$C_x = 300 \text{ N}$$

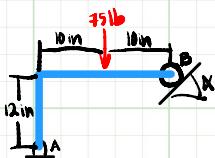
$$\sum F_y = 0 \Rightarrow -400 \text{ N} \sin 60^\circ + C_y = 0$$

$$C_y = 346.4 \text{ N}$$

$$C = \sqrt{300^2 + 346.4^2}$$

$$C = 458 \text{ N} \approx 49.1^\circ$$

(4.13)

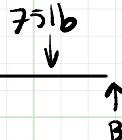


a) $\alpha = 0$

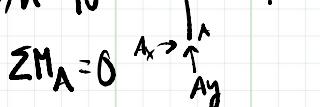
$\sum M_A = 0$

$B(20) - 75(10) = 0$

$B = 37.5 \text{ lb}$



b) $\alpha = 90^\circ$



$B(12 \text{ in}) - 75(10 \text{ in}) = 0$

$B = \frac{750}{12} = 62.5 \text{ lb}$

$B = 62.5 \text{ lb } \leftarrow$

$\sum F_x = -62.5 + A_x$

$A_x = 62.5 \text{ lb}$

$\sum F_y = -75 + A_y$

$A_y = 75 \text{ lb}$

$A = \sqrt{62.5^2 + 75^2}$

$A = 97.6 \text{ lb } \angle 50.2^\circ$

$\theta = \arctan\left(\frac{75}{62.5}\right)$

$\theta = 50.2^\circ$

$A = \sqrt{(F_x)^2 + (F_y)^2}$

$A = 49.81 \text{ lb}$

$\theta = \arctan\left(\frac{47.148}{16.0805}\right)$

$\theta = 71.2^\circ$

$\sum F_x = 0 \quad A_x = 0$

$\sum F_y = 0 \quad A_y - 75 \text{ lb} + 37.5 = 0$

$A_y = 37.5 \text{ lb}$

$A = 37.5 \text{ lb } \uparrow$



$\sum M_A = 0 - 75(10) + (B \cos 30^\circ)(20) + (B \sin 30^\circ)(12)$

$B\left(\frac{\sqrt{3}}{2}(20) + \frac{1}{2}(12)\right) = 750$

$B(10 + 6) = 750$

$B = 32.16 \text{ lb } \angle 60^\circ$

$\sum F_x = A_x - 32.16 \sin 30^\circ$

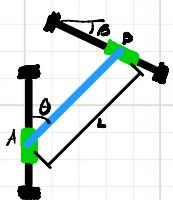
$A_x = 16.0805 \text{ lb}$

$\sum F_y = A_y - 75 + 32.16 \cos 30^\circ$

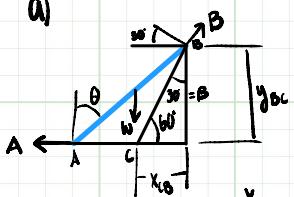
$A_y = -47.148 \text{ lb}$

$A = 49.81 \text{ lb } \angle 71.2^\circ$

(4.43)



a)



$$\tan \beta = \frac{x_{AB}}{y_{AB}}$$

$$x_{AB} = \frac{1}{2} L \sin \theta \quad y_{AB} = L \cos \theta$$

$$\tan \beta = \frac{\frac{1}{2} L \sin \theta}{L \cos \theta}$$

$$\tan \beta = \frac{1}{2} \tan \theta \quad \beta = 30^\circ$$

$$\theta = \arctan(2 \tan 30^\circ)$$

$$\theta = 49.1^\circ$$

b) $W = mg = (8\text{kg})(9.81 \text{m/s}^2) = 78.48 \text{N}$

$$A = W \tan \beta$$

$$= (78.48)(\tan 30^\circ)$$

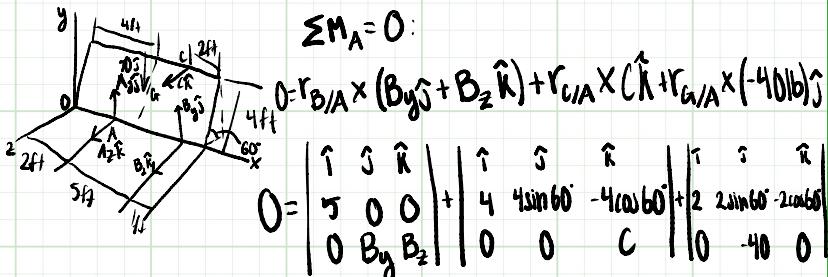
$$= 45.3$$

$$A = 45.3 \leftarrow$$

$$B = \frac{W}{\cos \beta} = \frac{78.48}{\cos 30^\circ} = 90.6 \text{N}$$

$$B = 90.6 \text{N} \not\propto 60^\circ$$

4.53



$$0 = (4C \sin 60^\circ - 80 \cos 60^\circ) \hat{i} + (-5B_z - 4C) \hat{j} + (5B_y - 80) \hat{k}$$

$$4C \sin 60^\circ - 80 \cos 60^\circ = 0$$

$$C = 11.547 \text{ lb}$$

$$-5B_z - 4C = 0$$

$$-5B_z - 4(11.547) = 0$$

$$B_z = 9.2376 \text{ lb}$$

$$5B_y - 80 = 0$$

$$B_y = 16 \text{ lb}$$

$$\sum F_y = 0 \Rightarrow A_y + B_y - 40 = 0 \quad A_y = 40 - 16 = 24 \text{ lb}$$

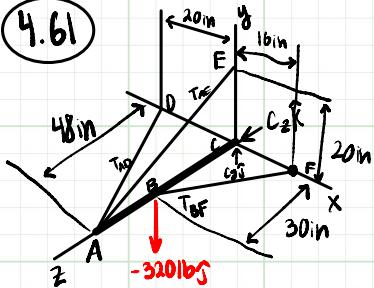
$$\sum F_z = 0 \Rightarrow A_z + B_z + C = 0 \quad A_z = -2.3094 \text{ lb}$$

$$A = (24.0 \text{ lb}) \hat{j} - (2.31 \text{ lb}) \hat{k}$$

$$B = (16.00 \text{ lb}) \hat{j} - (9.24 \text{ lb}) \hat{k}$$

$$C = (11.55 \text{ lb}) \hat{i}$$

4.61



$$T_{AD} = \frac{T}{52}(-20\hat{i} - 48\hat{k})$$

$$= \frac{T}{13}(-5\hat{j} - 12\hat{k})$$

$$T_{AE} = \frac{T}{52}(20\hat{j} - 48\hat{k})$$

$$= \frac{T}{13}(5\hat{j} - 12\hat{k})$$

$$T_{BF} = \frac{T_{BF}}{34}(16\hat{i} - 30\hat{k})$$

$$= \frac{T_{BF}}{17}(8\hat{i} - 15\hat{k})$$

$$\uparrow: -\frac{240}{13}T + 9600 = 0 \quad T = 520 \text{ lb}$$

$$\hat{j}: -\frac{240}{13}T + \frac{240}{17}T_{BF} = 0$$

$$T_{BD} = 680 \text{ lb}$$

$$C = -(120)16\hat{i} + 120\hat{j} + 1560\hat{k}$$

$$r_B = 30\hat{k}$$

$$r_A = 48\hat{k}$$

$$\begin{aligned}\overline{AD} &= -20\hat{i} - 48\hat{k} \\ \overline{AE} &= 20\hat{j} - 48\hat{k} \\ \overline{BF} &= 16\hat{i} - 30\hat{k}\end{aligned}$$

$$AD = 52 \text{ in.}$$

$$AE = 52 \text{ in.}$$

$$BF = 34 \text{ in.}$$

$$\sum M_C = 0$$

$$r_A \times T_{AD} + r_A \times T_{AE} + r_B \times T_{BF} + r_B \times (-320 \text{ lb}) \hat{j} = 0$$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 48 \\ 0 & 0 & \frac{T}{13} \\ -5 & 0 & -12 \end{vmatrix} + \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 48 \\ 0 & 0 & \frac{T}{13} \\ 0 & 5 & -12 \end{vmatrix} = 0$$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 30 \\ 0 & 0 & -15 \end{vmatrix} \frac{T_{BF}}{17} + (30\hat{k}) \times (320\hat{j}) = 0$$

$$\sum F = 0$$

$$\begin{aligned}T_{AD} + T_{AE} + T_{BF} - 320\hat{j} + C &= 0 \\ T_{DAE} &= 520 \text{ lb}\end{aligned}$$

$$\uparrow: -\frac{20}{52}(520) + \frac{8}{17}(680) + C_x = 0$$

$$-200 + 320 + C_x = 0 \quad C_x = -120 \text{ lb}$$

$$\hat{j}: \frac{20}{52}(520) - 320 + C_y = 0 \quad C_y = 120 \text{ lb}$$

$$\hat{k}: -\frac{48}{52}(520) - \frac{48}{52}(520) - \frac{30}{34}(680) + C_z = 0$$

$$C_z = 1560 \text{ lb}$$

4.66

$$r_{B/A}(960 - 180)\hat{j} = 780\hat{j}$$

$$\begin{aligned} r_{G/A} &= \left(\frac{960}{2} - 90\right)\hat{i} + \frac{450}{2}\hat{k} \\ &= 390\hat{i} + 225\hat{k} \end{aligned}$$

$$T = T_{DCE}$$

$$\overline{CD} = -690\hat{i} + 675\hat{j} - 450\hat{k} \quad |CD| = 1065\text{mm}$$

$$\overline{CE} = 270\hat{i} + 675\hat{j} - 450\hat{k} \quad |CE| = 855\text{mm}$$

$$T_{CD} = \frac{T}{1065} (-690\hat{i} + 675\hat{j} - 450\hat{k})$$

$$T_{CE} = \frac{T}{855} (270\hat{i} + 675\hat{j} - 450\hat{k})$$

$$W = -mg\hat{j} = -(100\text{kg})(9.81\text{m/s}^2)\hat{j} = -(981\text{N})\hat{j}$$

$$\sum M_A = 0 : r_{C/A} \times T_{CD} + r_{C/A} \times T_{CE} + r_{G/A} \times (-W\hat{j}) + r_{B/A} \times B = 0$$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 600 & 0 & 450 \\ -690 & 675 & -450 \end{vmatrix} \frac{T}{1065} + \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 600 & 0 & 450 \\ 270 & 675 & -450 \end{vmatrix} \frac{T}{855} + \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 390 & 0 & 225 \\ 0 & -981 & 0 \end{vmatrix} + \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 780 & 0 & 0 \\ 0 & B_y & B_z \end{vmatrix} = 0$$

$$\hat{i} : -(450)(675) \frac{T}{1065} - (450)(675) \frac{T}{855} + 220.73 \times 10^3 = 0$$

$$T \left(-\frac{303750}{1065} - \frac{303750}{855} \right) + 220.73 \times 10^3 = 0$$

$$T = 345\text{N}$$

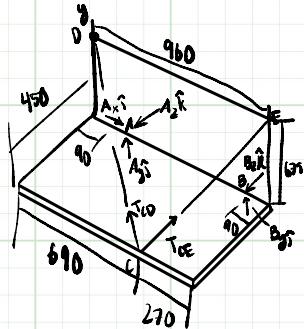
$$\hat{j} : 0 = (-690 \times 450 + 600 \times 450) \frac{344.64}{1065} + (270 \times 450 + 600 \times 450) \frac{344.64}{855} - 780B_z$$

$$B_z = 185.516\text{ N}$$

$$\hat{k} : (600)(675) \frac{344.64}{1065} + (600)(675) \frac{344.64}{855} - 382.59 \times 10^3 + 780B_y = 0$$

$$B_y = 113.178\text{ N}$$

$$B = (113.2\text{ N})\hat{j} + (185.5\text{ N})\hat{k}$$



4.66 cont.

$$\sum F = 0 : A + B + T_{CD} + T_{CF} + W = 0$$

$$\hat{i} : A_x - \frac{690}{1065} (344.64) + \frac{270}{855} (344.64) = 0 \quad A_x = 114.5 \text{ N}$$

$$\hat{j} : A_y + 113.178 + \frac{675}{1065} (344.64) + \frac{675}{855} (344.64) - 981 = 0 \quad A_y = 377 \text{ N}$$

$$\hat{k} : A_z + 189.516 - \frac{450}{1065} (344.64) + \frac{450}{855} (344.64) = 0 \quad A_z = 141.5 \text{ N}$$

$$A = (114.5 \text{ N})\hat{i} + (377 \text{ N})\hat{j} + (141.5 \text{ N})\hat{k}$$