Problem 1   (3.65)

a) write components of forces

$\vec{T}$ $\vec{F}$

$\vec{T_{AB}} = |\vec{T}| \vec{e_{AB}}$

$\vec{e_{AB}} = \dfrac{\vec{V_{AB}}}{|\vec{V_{AB}}|}^{B-A} = \dfrac{(6-12)\vec{i} + (0-4)\vec{j} + (0-2)\vec{k}}{\sqrt{(-6)^2 + (-4)^2 + (-2)^2}}$

$= -0.802\,\vec{i} - 0.535\,\vec{j} - 0.267\,\vec{k}$

$\vec{e_{AC}} = \dfrac{\vec{V_{AC}}}{|\vec{V_{AC}}|}^{C-A} = \dfrac{-12\vec{i} + 4\vec{k}}{\sqrt{(-12)^2 + 4^2}} =$
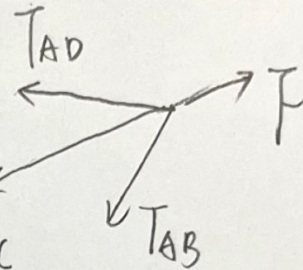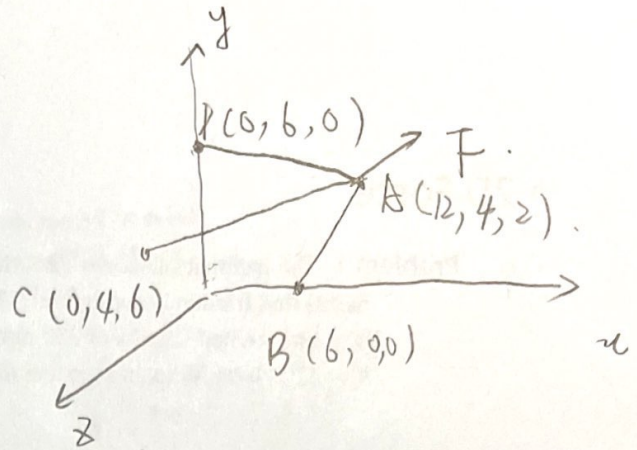
$= -0.949\,\vec{i} + 0.316\,\vec{k}$

$\vec{e_{AD}} = \dfrac{\vec{V_{AD}}}{|\vec{V_{AD}}|}^{D-A} = \dfrac{(-12)\vec{i} + 2\vec{j} - 2\vec{k}}{\sqrt{12^2 + 2^2 + (-2)^2}} = -0.975\,\vec{i} + 0.162\,\vec{j} - 0.162\,\vec{k}$

$\vec{T_{AB}} = |\vec{T}|\,\vec{e_{AB}} = T\,(-0.802\,i \cdots)$

$\vec{T_{AC}} = |\vec{T}|\,\vec{e_{AC}} = T\,(-0.949\,i + 0.3.6\,\vec{k})$

$\vec{T_{AD}} = |\vec{T}|\,\vec{e_{AD}} = T\,(-0.97\,3\,i \cdots)$

$\vec{F} = F_x\,\vec{i} + F_y\,\vec{j} + F_z\,\vec{k}$

$|\vec{T_{AD}}| = |\vec{T_{AC}}| = |\vec{T_{AB}}| = |\vec{T}|$

$$\Sigma F = 0$$

$$\Sigma F_x = 0 \quad ; \quad \Sigma F_y = 0 \quad ; \quad \Sigma F_z = 0$$

$$\Sigma F_x = 0 \qquad -0.802T - 0.949T - 0.973T + F_x = 0$$

$$\Rightarrow F_x = 2.72T$$

$$\Sigma F_y = 0 \qquad -0.535T + 0.162T + F_y = 0 \qquad \Rightarrow F_y = 0.373T$$

$$\Sigma F_z = 0 \quad -0.261T + 0.316T - 0.162T + F_z = 0 \quad \Rightarrow F_z = 0.113T$$

$$|F| = 1000\, lb = \sqrt{F_x^2 + F_y^2 + F_z^2}$$

$$\sqrt{(2.72T)^2 \pm (0.373T)^2 + (0.113T)^2} = 1000.$$

$$T = 363\, lb$$

$$F_x = 2.72T = 987\, lb$$

$$F_y = 0.373T = 135\, lb$$

$$F_z = 0.113T = 41.2\, lb$$

Pb2

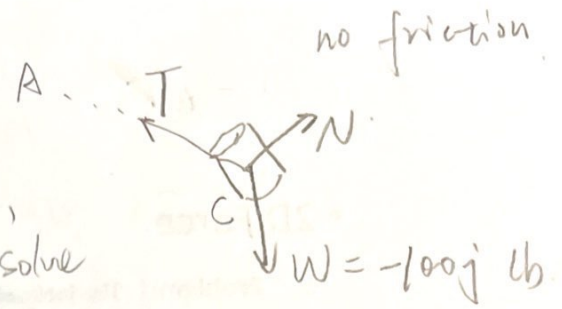B $(0,7,0)$ A $(0,7,4)$ D $(4,0,4)$

$BC = 6$

two unknowns, cannot solve

$W = -100\,\vec{j}$ lb

$\vec{e}_{BD}$ | $\Sigma \vec{F} = \vec{T} + \vec{N} + \vec{W} = \vec{T} + \vec{N} - 100\,\vec{j} = 0$

$\vec{N}$ is perpendicular to the bar BD.

$\vec{r_1} \cdot \vec{r_2} = 0$

$\boxed{\vec{e}_{BD} \cdot \vec{N} = 0}$

$\star$ | $\vec{e}_{BD} \cdot \Sigma \vec{F} = \vec{e}_{BD} \cdot \vec{T} + \vec{e}_{BD} \cdot \overset{0}{\cancel{\vec{N}}} - \vec{e}_{BD} \cdot 100\,\vec{j} = 0$

$\vec{e}_{BD} = \dfrac{\vec{r}_{BD}}{|\vec{r}_{BD}|}\; \overset{D-B}{} = \dfrac{4\vec{i} - 7\vec{j} + 4\vec{k}}{\sqrt{4^2 + (-7)^2 + 4^2}} = \dfrac{4}{9}\vec{i} - \dfrac{7}{9}\vec{j} + \dfrac{4}{9}\vec{k}$

$\vec{T} = |\vec{T}|\,\widehat{e_{CA}}$
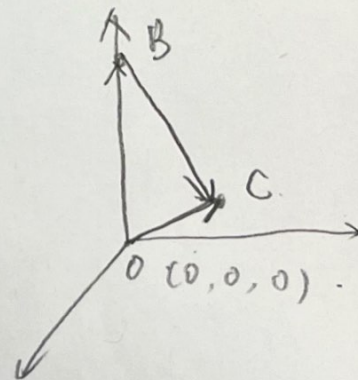
$C\,(\quad\quad)$
$A\,(\quad\quad)$

$\vec{r}_{OC} = \vec{r}_{OB} + \vec{r}_{BC}$

(position of C)
$= 7\vec{j} + 6 \cdot \widehat{e}_{BC}$

$= 7\vec{j} + 6 \cdot \widehat{e}_{BD}$

$= 7\vec{j} + 6 \cdot \dfrac{\vec{r}_{BD}}{|\vec{r}_{BD}|} = 7\vec{j} + (2.67\vec{i} - 4.67\vec{j} + 2.67\vec{k})$

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$$\vec{r}_{OC} = 2.67\vec{i} + 2.33\vec{j} + 2.67\vec{k}$$

$$c \; (2.67, \; 2.33, \; 2.67)$$

$$\vec{e}_{CA} = \frac{\vec{r}_{CA}}{|\vec{r}_{CA}|} \overset{A-C}{=} \frac{(0-2.67)\vec{i} + (7-2.33)\vec{j} + (4-2.67)\vec{k}}{\sqrt{(2.67)^2 + 4.67^2 + 1.33^2}}$$

$$= -0.482\vec{i} + 0.843\vec{j} + 0.241\vec{k}$$

⭐

$$\vec{e}_{BD} \cdot \vec{T} - \vec{e}_{BD} \cdot 100\vec{j} = 0.$$

$$\vec{e}_{BD} \, (\vec{T} - 100\vec{j}) = 0.$$

$$\left(\frac{4}{8}\vec{i} - \frac{7}{8}\vec{j} + \frac{4}{8}\vec{k}\right) \cdot \left(|\vec{T}| \, \vec{e}_{CA} - 100\vec{j}\right) = 0.$$

$$-0.762\,T + 77.8 = 0$$

$$T = 102 \; lb.$$

4.