2.103 [공간에서 질점의 평형]
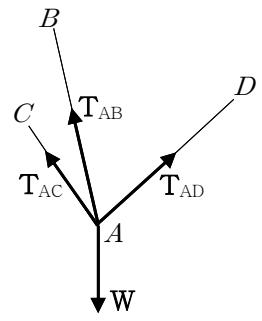
T_{AB} = 750 N,

$\mathbf{W}$ = $-$ $W\,\mathbf{j}$

$$d_{AB} = \sqrt{(-36\text{ cm})^2 + (60\text{ cm})^2 + (-27\text{ cm})^2} = 75\text{ cm}$$

$$\boldsymbol{\lambda}_{AB} = \frac{1}{75}(-36\ \mathbf{i} + 60\ \mathbf{j} - 27\ \mathbf{k})$$

$$= -0.48\ \mathbf{i} + 0.80\ \mathbf{j} - 0.36\ \mathbf{k}$$

$\mathbf{T}_{AB}$ = $T_{AB}\,\boldsymbol{\lambda}_{AB}$ = (750 N) ($-0.48\ \mathbf{i}$ + $0.80\ \mathbf{j}$ $-$ $0.36\ \mathbf{k}$)

$$= (-360\text{ N})\ \mathbf{i} + (600\text{ N})\ \mathbf{j} + (-270\text{ N})\ \mathbf{k}$$

$$d_{AC} = \sqrt{0 + (60\text{ cm})^2 + (32\text{ cm})^2} = 68\text{ cm}$$

$$\boldsymbol{\lambda}_{AC} = \frac{1}{68}(60\ \mathbf{j} + 32\ \mathbf{k}) = 0.8824\ \mathbf{j} + 0.4706\ \mathbf{k}$$

$\mathbf{T}_{AC}$ = $T_{AC}\,\boldsymbol{\lambda}_{AC}$ = T_{AC} (0.8824 $\mathbf{j}$ + 0.4706 $\mathbf{k}$)

$$d_{AD} = \sqrt{(40\text{ cm})^2 + (60\text{ cm})^2 + (-27\text{ cm})^2} = 77\text{ cm}$$

$$\boldsymbol{\lambda}_{AD} = \frac{1}{77}(40\ \mathbf{i} + 60\ \mathbf{j} - 27\ \mathbf{k}) = 0.5195\ \mathbf{i} + 0.7792\ \mathbf{j} - 0.3506\ \mathbf{k}$$

$\mathbf{T}_{AD}$ = $T_{AD}\,\boldsymbol{\lambda}_{AD}$ = T_{AD} (0.5195 $\mathbf{i}$ + 0.7792 $\mathbf{j}$ $-$ 0.3506 $\mathbf{k}$)

$\Sigma\mathbf{F}$ = 0 $\Rightarrow$ $\mathbf{T}_{AB}$ + $\mathbf{T}_{AC}$ + $\mathbf{T}_{AD}$ + $\mathbf{W}$ = 0

ΣF_x = 0 ; (-360 N) + 0.5195 T_{AD} = 0 $\cdots$ ①

ΣF_y = 0 ; (600 N) + 0.8824 T_{AC} + 0.7792 T_{AD} $-$ W = 0 $\cdots$ ②

ΣF_z = 0 ; (-270 N) + 0.4706 T_{AC} $-$ 0.3506 T_{AD} = 0 $\cdots$ ③

① $\Rightarrow$ $T_{AD} = \dfrac{360\text{ N}}{0.5195} = 693.0\text{ N}$

③ $\Rightarrow$ $T_{AC} = \dfrac{1}{0.4706}[(270\text{ N}) + 0.3506\,(693.0\text{ N})] = 1090.0\text{ N}$

② $\Rightarrow$ W = (600 N) + 0.8824 (1090.0 N) + 0.7792 (693.0 N) = 2102 N

$\Rightarrow$ W = 2100 N

2.120 [공간에서 질점의 평형]

$W = 60$ N, $\theta = 30°$
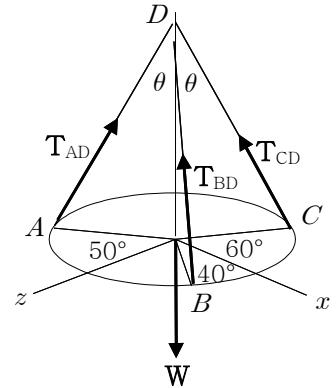
$(T_{AD})_y = T_{AD} \cos\theta, \quad (T_{AD})_h = T_{AD} \sin\theta$

$(T_{AD})_x = (T_{AD})_h \sin50° = T_{AD} \sin\theta \sin50°$

$(T_{AD})_z = -(T_{AD})_h \cos50° = -T_{AD} \sin\theta \cos50°$

$(T_{BD})_y = T_{BD} \cos\theta, \quad (T_{BD})_h = T_{BD} \sin\theta$

$(T_{BD})_x = -(T_{BD})_h \cos40° = -T_{BD} \sin\theta \cos40°$

$(T_{BD})_z = -(T_{BD})_h \sin40° = -T_{BD} \sin\theta \sin40°$

$(T_{CD})_y = T_{CD} \cos\theta, \quad (T_{CD})_h = T_{CD} \sin\theta$

$(T_{CD})_x = -(T_{CD})_h \cos60° = -T_{CD} \sin\theta \cos60°$

$(T_{CD})_z = (T_{CD})_h \sin60° = T_{CD} \sin\theta \sin60°$

$\Sigma F_x = 0 \; ; \; (T_{AD})_x + (T_{BD})_x + (T_{CD})_x = 0$

$\Rightarrow \quad T_{AD} \sin\theta \sin50° - T_{BD} \sin\theta \cos40° - T_{CD} \sin\theta \cos60° = 0$

$\Rightarrow \quad T_{AD} \sin50° - T_{BD} \cos40° - T_{CD} \cos60° = 0$

$\Rightarrow \quad 0.7660 \; T_{AD} - 0.7660 \; T_{BD} - 0.5 \; T_{CD} = 0 \qquad \cdots \; ①$

$\Sigma F_y = 0 \; ; \; (T_{AD})_y + (T_{BD})_y + (T_{CD})_y = 0$

$\Rightarrow \quad T_{AD} \cos\theta + T_{BD} \cos\theta + T_{CD} \cos\theta - W = 0$

$\Rightarrow \quad T_{AD} + T_{BD} + T_{CD} = \dfrac{W}{\cos\theta} = \dfrac{60 \text{ N}}{\cos30°} = 69.28 \qquad \cdots \; ②$

$\Sigma F_z = 0 \; ; \; (T_{AD})_z + (T_{BD})_z + (T_{CD})_z = 0$

$\Rightarrow \quad -T_{AD} \sin\theta \cos50° - T_{BD} \sin\theta \sin40° + T_{CD} \sin\theta \sin60° = 0$

$\Rightarrow \quad -T_{AD} \cos50° - T_{BD} \sin40° + T_{CD} \sin60° = 0$

$\Rightarrow \quad -0.6428 \; T_{AD} - 0.6428 \; T_{BD} + 0.8660 \; T_{CD} = 0 \qquad \cdots \; ③$

$D = \begin{vmatrix} 0.7660 & -0.7660 & -0.5 \\ 1 & 1 & 1 \\ -0.6428 & -0.6428 & 0.8660 \end{vmatrix} = 2.3115$

$T_{AD} = \dfrac{1}{D} \begin{vmatrix} 0 & -0.7660 & -0.5 \\ 69.28 & 1 & 1 \\ 0 & -0.6428 & 0.8660 \end{vmatrix} = \dfrac{68.2245}{2.3115} = 29.5153$

$T_{BD} = \dfrac{1}{D} \begin{vmatrix} 0.7660 & 0 & -0.5 \\ 1 & 69.28 & 1 \\ -0.6428 & 0 & 0.8660 \end{vmatrix} = \dfrac{23.6909}{2.3115} = 10.2491$

$T_{CD} = \dfrac{1}{D} \begin{vmatrix} 0.7660 & -0.7660 & 0 \\ 1 & 1 & 69.28 \\ -0.6428 & -0.6428 & 0 \end{vmatrix} = \dfrac{68.2255}{2.3115} = 29.5157$

$\Rightarrow \quad T_{AD} = 29.5$ N, $T_{BD} = 10.25$ N, $T_{CD} = 29.5$ N