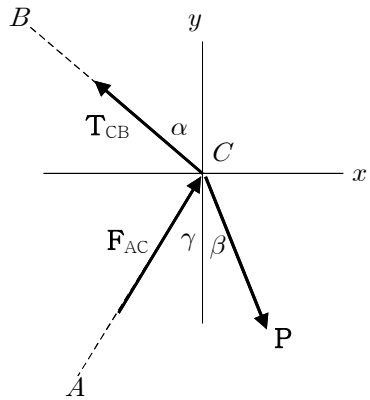
[2.9~11절]

2.48 [질점의 평형 문제]

P = 300 N, α = 55°, β = 20°, γ = 30°

F.B.D.



<방법 1 : 직각 성분>

$\Sigma F_x = 0$; $F_{AC}\sin\gamma - T_{CB}\sin\alpha + P\sin\beta = 0$

$\Rightarrow \quad F_{AC}\sin\gamma - T_{CB}\sin\alpha = -P\sin\beta \quad \cdots$ ①

$\Sigma F_y = 0$; $F_{AC}\cos\gamma + T_{CB}\cos\alpha - P\cos\beta = 0$

$\Rightarrow \quad F_{AC}\cos\gamma + T_{CB}\cos\alpha = P\cos\beta \quad \cdots$ ②

(a) ①×cosα + ②×sinα

$F_{AC}(\sin\gamma\cos\alpha + \cos\gamma\sin\alpha) = P(-\sin\beta\cos\alpha + \cos\beta\sin\alpha)$

$$\Rightarrow \quad F_{AC} = P\frac{\sin(\alpha-\beta)}{\sin(\alpha+\gamma)} = (300\text{ N})\frac{\sin(55^\circ-20^\circ)}{\sin(55^\circ+30^\circ)} = 172.73\text{ N}$$

$\Rightarrow \quad F_{AC} = 172.7$ N

(b) ① $\Rightarrow$ $$T_{CB} = \frac{F_{AC}\sin\gamma + P\sin\beta}{\sin\alpha} = \frac{(172.73\text{ N})\sin30^\circ + (300\text{ N})\sin20^\circ}{\sin55^\circ} = 230.7\text{ N}$$

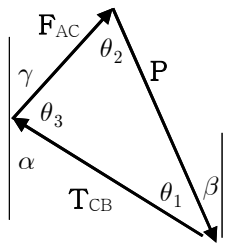
$\Rightarrow \quad T_{CB} = 231$ N

<방법 2 : 힘 삼각형>

$\theta_1 = \alpha - \beta = 55° - 20° = 35°$

$\theta_2 = \beta + \gamma = 20° + 30° = 50°$

$\theta_3 = 180° - (\alpha + \gamma) = 180° - (55° + 30°) = 95°$



(a) $$\frac{F_{AC}}{\sin\theta_1} = \frac{P}{\sin\theta_3}$$

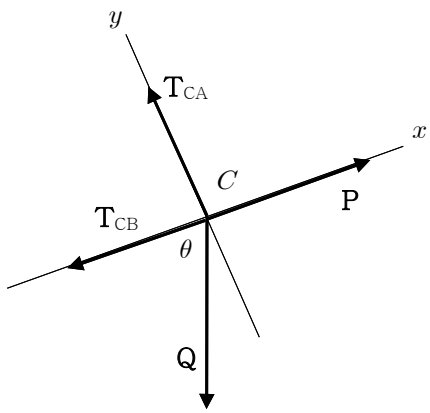
$$\Rightarrow \quad F_{AC} = P\frac{\sin\theta_1}{\sin\theta_3} = (300\text{ N})\frac{\sin35^\circ}{\sin95^\circ} = 172.73\text{ N} \quad \Rightarrow \quad F_{AC} = 172.7\text{ N}$$

(b) $$\frac{T_{CB}}{\sin\theta_2} = \frac{P}{\sin\theta_3}$$

$$\Rightarrow \quad T_{CB} = P\frac{\sin\theta_2}{\sin\theta_3} = (300\text{ N})\frac{\sin50^\circ}{\sin95^\circ} = 230.7\text{ N} \quad \Rightarrow \quad T_{CB} = 231\text{ N}$$

2.53 [질점의 평형 문제, 직각성분]

P = 75 N, Q = 60 N, θ = 60°



(a) $\Sigma F_y = 0$; $T_{CA} - Q\sin\theta = 0$

$\Rightarrow \quad T_{CA} = Q\sin\theta = (60\text{ N})\sin60° = 51.96\text{ N}$

$\Rightarrow \quad T_{CA} = 52.0$ N

(b) $\Sigma F_x = 0$; $-T_{CB} + P - Q\cos\theta = 0$

$\Rightarrow \quad T_{CB} = P - Q\cos\theta$

$= (75\text{ N}) - (60\text{ N})\cos60° = 45.00\text{ N}$

$\Rightarrow \quad T_{CB} = 45.0$ N

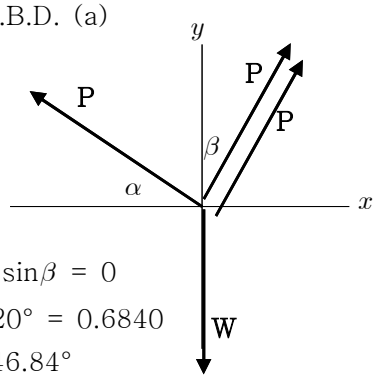
2.65 [질점의 평형 문제]

W = (160 kg)(9.81 m/s^2)

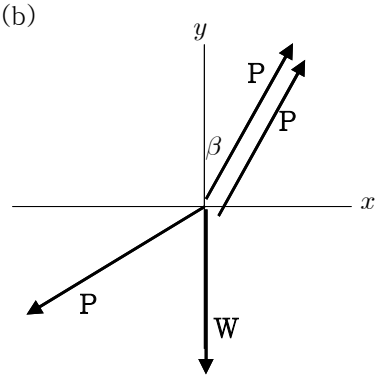
= 1569.6 N

β = 20°

F.B.D. (a)



(b)



<방법 1 : 직각 성분>

ΣF_x = 0 ; $-P\cos\alpha + 2P\sin\beta = 0$

⇒ $\cos\alpha = 2\sin\beta = 2\sin 20° = 0.6840$

$\alpha = \cos^{-1}(0.6840) = \pm 46.84°$

(a) $\alpha = +46.84°$

ΣF_y = 0 ; $P\sin\alpha + 2P\cos\beta - W = 0$

⇒ $P = \dfrac{W}{\sin\alpha + 2\cos\beta} = \dfrac{1569.6\text{ N}}{\sin 46.84° + 2\cos 20°} = 601.6\text{ N}$ ⇒ P = 602 N ↖46.8°

(b) $\alpha = -46.84°$

ΣF_y = 0 ; $P\sin\alpha + 2P\cos\beta - W = 0$

⇒ $P = \dfrac{W}{\sin\alpha + 2\cos\beta} = \dfrac{1569.6\text{ N}}{\sin(-46.84°) + 2\cos 20°} = 1364.9\text{ N}$

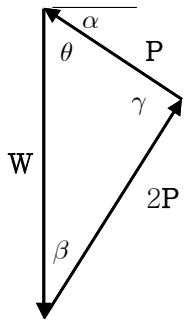
⇒ P = 1365 N ↙46.8°

<방법 2 : 힘 삼각형>

$\dfrac{2P}{\sin\theta} = \dfrac{P}{\sin\beta}$

⇒ $\sin\theta = 2\sin\beta = 2\sin 20° = 0.6840$

⇒ $\theta = \sin^{-1}(0.6840) = 43.16°,\ 136.84°$



(a) $\theta = 43.16°$

$\alpha = 90° - \theta = 90° - 43.16° = 46.84°$

$\gamma = 180° - (\beta + \theta) = 180° - (20° + 43.16°) = 116.84°$

$\dfrac{P}{\sin\beta} = \dfrac{W}{\sin\gamma}$

⇒ $P = W\dfrac{\sin\beta}{\sin\gamma} = (1569.6\text{ N})\dfrac{\sin 20°}{\sin 116.84°} = 601.7\text{ N}$

⇒ P = 602 N ↖46.8°

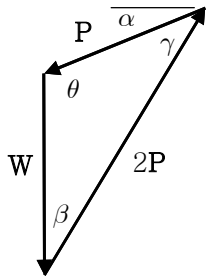
(b) $\theta = 136.84°$

$\alpha = \theta - 90° = 136.84° - 90° = 46.84°$

$\gamma = 180° - (\beta + \theta) = 180° - (20° + 136.84°) = 23.16°$

$\dfrac{P}{\sin\beta} = \dfrac{W}{\sin\gamma}$

⇒ $P = W\dfrac{\sin\beta}{\sin\gamma} = (1569.6\text{ N})\dfrac{\sin 20°}{\sin 23.16°} = 1364.9\text{ N}$



⇒ P = 1365 N ↙46.8°