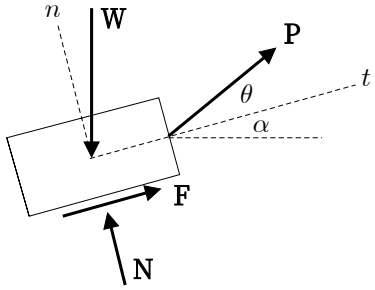
정 역 학　　연습문제 풀이　　제8장

<8.1~8.2절>

8.5　$\theta = 25°$,　$\alpha = 20°$,　$m = 9$ kg

$\mu_s = 0.30$,　$\mu_k = 0.25$

$W = mg = (9\text{ kg})(9.81\text{ m/s}^2) = 88.29$ N



$\nwarrow \Sigma F_n = 0$; $N - W\cos\alpha + P\sin\theta = 0$

$\Rightarrow \quad N = W\cos\alpha - P\sin\theta$

아래로 움직이기 시작할 때

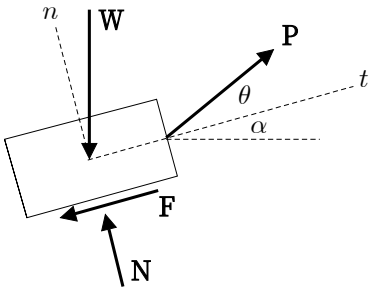
$\nearrow \Sigma F_t = 0$; $F_m - W\sin\alpha + P\cos\theta = 0$

$\Rightarrow \quad F_m = W\sin\alpha - P\cos\theta$

$F_m = \mu_s N$; $\quad W\sin\alpha - P\cos\theta = \mu_s (W\cos\alpha - P\sin\theta)$

$$\Rightarrow \quad P = W\frac{\sin\alpha - \mu_s\cos\alpha}{\cos\theta - \mu_s\sin\theta} = (88.29\text{ N})\ \frac{\sin 20^\circ - (0.30)\cos 20^\circ}{\cos 25^\circ - (0.30)\sin 25^\circ} = 6.81\text{ N}$$

위로 움직이기 시작할 때



$\nearrow \Sigma F_t = 0$; $-F_m - W\sin\alpha + P\cos\theta = 0$

$\Rightarrow \quad F_m = -W\sin\alpha + P\cos\theta$

$F_m = \mu_s N$;

$-W\sin\alpha + P\cos\theta = \mu_s (W\cos\alpha - P\sin\theta)$

$$\Rightarrow \quad P = W\frac{\sin\alpha + \mu_s\cos\alpha}{\cos\theta + \mu_s\sin\theta}$$

$$= (88.29\text{ N})\ \frac{\sin 20^\circ + (0.30)\cos 20^\circ}{\cos 25^\circ + (0.30)\sin 25^\circ} = 53.32\text{ N}$$

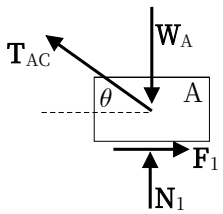
$\Rightarrow \quad 6.81\text{ N} \le P \le 53.32\text{ N}$

8.13　$m_A = 8$ kg,　$m_B = 12$ kg

$W_A = m_A g = (8\text{ kg})(9.81\text{ m/s}^2) = 78.48$ N

$W_B = m_B g = (12\text{ kg})(9.81\text{ m/s}^2) = 117.72$ N

$\mu_s = 0.20$,　$P = 50$ N



블록 A

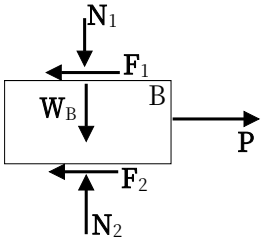
$\uparrow \Sigma F_y = 0$; $N_1 - W_A + T_{AC}\sin\theta = 0$

$\Rightarrow \quad N_1 = W_A - T_{AC}\sin\theta$

$\rightarrow \Sigma F_x = 0$; $\mu_s N_1 - T_{AC}\cos\theta = 0$

$\Rightarrow \quad \mu_s(W_A - T_{AC}\sin\theta) - T_{AC}\cos\theta = 0$

$\Rightarrow \quad T_{AC}\cos\theta + \mu_s T_{AC}\sin\theta = \mu_s W_A \qquad \cdots ①$



블록 B

$\uparrow \Sigma F_y = 0$; $N_2 - N_1 - W_B = 0 \quad \Rightarrow \quad N_2 = W_B + W_A - T_{AC}\sin\theta$

$\rightarrow \Sigma F_x = 0$; $-\mu_s N_1 - \mu_s N_2 + P = 0$

$\Rightarrow \quad -\mu_s[(W_A - T_{AC}\sin\theta) + (W_B + W_A - T_{AC}\sin\theta)] + P = 0$

$\Rightarrow \quad T_{AC}\sin\theta = W_A + \frac{1}{2}W_B - \frac{P}{2\mu_s} \qquad \cdots ②$

②를 ①에 대입 ; $T_{AC}\cos\theta + \mu_s\left(W_A + \frac{1}{2}W_B - \frac{P}{2\mu_s}\right) = \mu_s W_A$

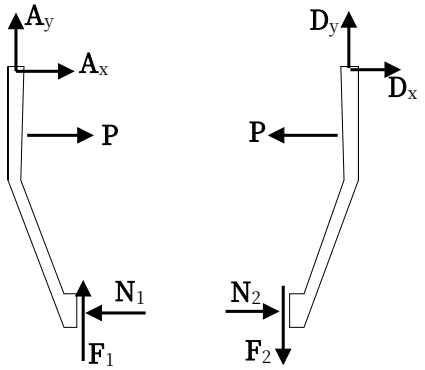
$\Rightarrow \quad T_{AC}\cos\theta = -\frac{1}{2}\mu_s W_B + \frac{1}{2}P \qquad \cdots ③$

$② \div ③ \quad \Rightarrow \quad \tan\theta = \dfrac{2W_A + W_B - \dfrac{P}{\mu_s}}{-\mu_s W_B + P} = \dfrac{2(78.48\text{ N}) + (117.72\text{ N}) - \dfrac{50\text{ N}}{0.20}}{-(0.20)(117.72\text{ N}) + (50\text{ N})} = 0.9329$

$\Rightarrow \quad \theta = \tan^{-1}(0.9329) = 43.0°$

8.19 $\mu_s = 0.40, \quad \mu_k = 0.30, \quad P = 3000$ N

$F_1 = \mu_k N_1, \quad F_2 = \mu_k N_2$



AB에서 $\Sigma M_A = 0$;

$(0.150\text{ m})\,P + (0.150\text{ m})\,\mu_k N_1 - (0.450\text{ m})\,N_1 = 0$

$\Rightarrow \quad N_1 = P\dfrac{1}{3-\mu_k} = (3000\text{ N})\dfrac{1}{3-0.30} = 1111.11\text{ N}$

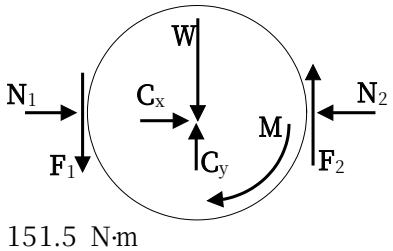
$\Rightarrow \quad F_1 = (0.30)(1111.11\text{ N}) = 333.33\text{ N}$

DE에서 $\Sigma M_D = 0$;

$-(0.150\text{ m})\,P + (0.150\text{ m})\,\mu_k N_2 + (0.450\text{ m})\,N_2 = 0$

$\Rightarrow \quad N_2 = P\dfrac{1}{3+\mu_k} = (3000\text{ N})\dfrac{1}{3+0.30} = 909.09\text{ N}$

$\Rightarrow \quad F_2 = (0.30)(909.09\text{ N}) = 272.727\text{ N}$



드럼에서 $\Sigma M_C = 0$;

$(0.250\text{ m})\,(F_1 + F_2) - M = 0$

$\Rightarrow \quad M = (0.250\text{ m})\,[(333.33\text{ N}) + (272.73\text{ N})] = 151.5\text{ N·m}$