

1.  $V_1 = \frac{72 \times 10^3 \text{ m}}{3600 \text{ s}} = 20 \text{ (m/s)}, V_2 = 0, 10 \text{ s}.$

$a = \frac{\Delta V}{\Delta t} = \frac{V_2 - V_1}{10 \text{ s}} = \frac{0 - 20 \text{ m/s}}{10 \text{ s}} = -2 \text{ m/s}^2.$

$V = \int a dt = -2t + 20 \quad S = \int v dt = -t^2 + 20t$

$S_{10} = -10^2 + 20 \cdot 10 = 100 \text{ (m)},$

2.  $\omega_1 = 0, \omega_2 = \frac{1200 \times 2\pi \text{ (rad)}}{60 \text{ s}} = 40\pi \text{ (rad/s)}, 4 \text{ s}.$

$\alpha = \frac{\Delta \omega}{\Delta t} = \frac{40\pi \text{ (rad/s)}}{4 \text{ s}} = 10\pi \text{ (rad/s}^2\text{)}$

$\omega = \int \alpha dt = 10\pi t \quad \theta = \int \omega dt = 5\pi t^2$

$\theta_4 = 5\pi \cdot 4^2 = 80\pi \text{ (rad)} = 40 \text{ (바퀴)}$

3.

X: 등속운동  $V_x = 10 \cos 45^\circ = 5\sqrt{2}$   
 $x = 5\sqrt{2}t$   
 $\frac{\sqrt{3}}{2}R = 5\sqrt{2}t \quad \text{①}$   
 $y: \text{등가속운동}$   
 $a_y = -10$   
 $V_y = -10t + 10 \sin 45^\circ = -10t + 5\sqrt{2}$   
 $y = -5t^2 + 5\sqrt{2}t \quad \text{②}$   
 $-\frac{R}{2} = -5t^2 + 5\sqrt{2}t \quad \text{②}$   
 ①과 ② 연립으로 풀면  
 $-\frac{R}{2} = -5\left(\frac{\sqrt{3}}{10\sqrt{2}}R\right)^2 + \frac{\sqrt{3}}{2}R$   
 $\frac{1}{2} + \frac{\sqrt{3}}{2} = 5 \frac{3}{100 \times 2} R \quad \therefore R = \frac{40}{3} \left(\frac{1}{2} + \frac{\sqrt{3}}{2}\right) = 18.21 \text{ (m)}$

4-1.

A:  $\sum F_x = F_T - F_f - m_A g \sin 30^\circ = m_A a_x \quad m_A = 1 \text{ kg} \rightarrow \text{①}$   
 $\sum F_y = N_1 - m_A g \cos 30^\circ = 0 \quad F_f = \mu \cdot N_1 = 0.2 \cdot 10 \frac{\sqrt{3}}{2} = \sqrt{3} \text{ (N)}$   
 B:  $\sum F_x = m_B g \sin 30^\circ - F_T - F_f = m_B a_x \quad \text{②}$   
 $\sum F_y = N_2 - N_1 - m_B g \cos 30^\circ = 0$   
 $a_{Ax} = a_{Bx}$   
 ①과 ② 2 연립으로 풀면  
 $m_B g \sin 30^\circ - m_A g \sin 30^\circ - 2F_f = (m_A + m_B) a_x$   
 $15 - 5 - 2\sqrt{3} = (1 + 3) a_x \quad \therefore a_x = 1.634 \text{ (m/s}^2\text{)}$   
 $F_T = F_f + m_A g \sin 30^\circ + m_A a_x = 8.366 \text{ (N)}$   
 $F_T = m_B g \sin 30^\circ - F_f - m_B a_x = 8.366 \text{ (N)}$

4-2.  $V_x = \int a \cdot dt = \int 1.634 \cdot dt = 1.634 t$ .  $V_x = 1.634 \text{ (m/s)}$   
 $x = \int 1.634 t \cdot dt = 0.817 t^2 \quad \therefore \underline{x = 0.817 \text{ (m)}}$

4-3. 에너지 보존 법칙 응용

$$(\sum \text{역학적 Energy (처음상태)}) - \text{바뀐 에너지} = (\sum \text{역학적 Energy (결과)})$$

처음상태  $\sum \text{역학적 Energy}$  A, B 의 상대적 위치 에너지 모두 '0'

결과 역학적 Energy : A는 처음보다 상승 (+ 위치 E), B는 처음보다 하강 (- 위치 E)

A, B 의 Energy

$$0 - (F_f \cdot 0.817) \cdot 2 = m_A g (0.817 \sin 30^\circ) - m_B g (0.817 \sin 30^\circ) + \frac{1}{2} (m_A + m_B) V^2$$

$$\frac{1}{2} (1+3) V^2 = (30-10) \frac{0.817}{2} - 2 \cdot \sqrt{3} \cdot 0.817$$

$$\therefore \underline{V = 1.634 \text{ (m/s)}}$$

4-4. 운동량 충격량 관계  $A: \int_0^1 (F_T - F_f) dt = m_A (V_{A2} - \overset{\circ}{V}_{A1})$   
 $\int \Sigma \vec{F} \cdot dt = m (\vec{V}_2 - \vec{V}_1)$   $\overset{\circ}{V}_{A1} = m_A g \sin 30^\circ$

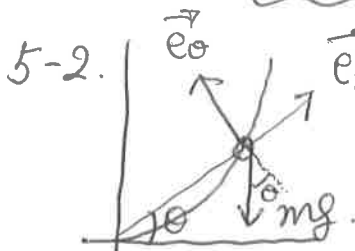
$$\underline{V_{A2} = 1.634 \text{ (m/s)}}$$

$B: \int_0^1 (m_B g \sin 30^\circ - F_T - F_f) dt = m_B (V_{B2} - \overset{\circ}{V}_{B1})$   $\underline{V_{B2} = 1.634 \text{ (m/s)}}$

5-1.  $r = 0.4\theta$ ,  $\theta = t^2$ ,  $t = 1 \text{ sec}$ .  $\ddot{r} = 0.4\ddot{\theta}$   
 위치:  $r = 0.4 \frac{\text{m}}{\text{rad}}$ ,  $\theta = 1^2 = 1 \text{ (rad)}$   $\dot{r} = 0.4\dot{\theta}$ ,  $\dot{\theta} = 2t$   $\ddot{\theta} = 2$

속도:  $\vec{V} = \dot{r} \vec{e}_r + r \dot{\theta} \vec{e}_\theta = 0.8t \vec{e}_r + 0.4 \cdot 2t \vec{e}_\theta = 0.8 \vec{e}_r + 0.8 \vec{e}_\theta \text{ (m/s)}$

가속도:  $\vec{a} = (\ddot{r} - r\dot{\theta}^2) \vec{e}_r + (2\dot{r}\dot{\theta} + r\ddot{\theta}) \vec{e}_\theta = (0.4 \cdot 2 - 0.4 \cdot 4) \vec{e}_r + (2 \cdot 0.8 \cdot 2 + 0.4 \cdot 2) \vec{e}_\theta$   
 $= -0.8 \vec{e}_r + 4 \vec{e}_\theta \text{ (m/s}^2\text{)}$



5-2.  $\Sigma F_r = \Sigma N_r - mg \sin \theta = m \cdot a_r$

$$\therefore \Sigma N_r = m a_r + mg \sin \theta = 0.5(-0.8) + 0.5 \times 10 \sin 1$$

$$= \underline{3.807 \text{ (N)}}$$

$$\Sigma F_\theta = \Sigma N_\theta - mg \cos \theta = m \cdot a_\theta$$

$$\therefore \Sigma N_\theta = m a_\theta + mg \cos \theta = 0.5(4) + 0.5 \times 10 \cdot \cos 1$$

$$= \underline{4.402 \text{ (N)}}$$



9-3.  $\vec{\omega}_1 = \vec{\omega}_{0A} = 2\vec{k}$   $\vec{V}_P = \vec{V}_A + \vec{V}_{P/A} = \vec{\omega}_1 \times \vec{r}_A + \vec{\omega}_2 \times \vec{r}_{P/A}$   
 $\vec{\omega}_2 = \vec{\omega}_{AP} = \omega_2 \vec{k}$   $= 2\vec{k} \times (0.1\vec{i} + 0.1\sqrt{3}\vec{j}) + \omega_2 \vec{k} \times (0.361\vec{i} - 0.173\vec{j})$   
 $\vec{r}_{P/A} = 0.361\vec{i} - 0.173\vec{j}$   $= (0.173\omega_2 - 0.2\sqrt{3})\vec{i} + (0.361\omega_2 + 0.2)\vec{j} = V_P \vec{i}$   
 $\therefore \omega_2 = -\frac{0.2}{0.361} = -0.554$   $\vec{V}_P = -0.442\vec{i} \text{ (m/s)}, \vec{\omega}_2 = \frac{-0.554\vec{k}}{\text{시계방향}}$

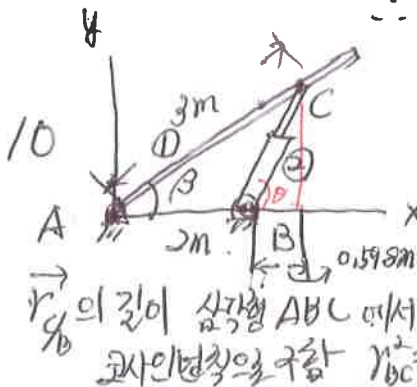
9-4.  $V_A = r_A \cdot \omega_1 = 0.2 \cdot 2 = 0.4 \text{ (m/s)}$

$\therefore \omega_2 = \omega_{AP} = \frac{0.4}{0.922 - 0.2 (= r_{O'A})} = 0.554 \text{ (rad/s)} \curvearrowright \text{시계방향}$   
 $(\approx 0.555)$

$V_P = r_{O'P} \cdot \omega_{AP} = 0.798 \times 0.554 = 0.442 \text{ (m/s)} \leftarrow$   
 $\text{"} \times (\approx 0.555) = 0.443 \text{ (m/s)}$

9-5.  $\vec{a}_P = \vec{a}_1 \times \vec{r}_A + \vec{\omega}_1 \times \vec{V}_A + \vec{a}_2 \times \vec{r}_{P/A} + \vec{\omega}_2 \times \vec{V}_{P/A}$   $\vec{a}_2 = \alpha_2 \vec{k}$   
 $= -\omega_1^2 \vec{r}_A + \vec{a}_2 \times \vec{r}_{P/A} - \omega_2^2 \cdot \vec{r}_{P/A} = -2^2(0.1\vec{i} + 0.1\sqrt{3}\vec{j}) - 0.554^2(0.361\vec{i} - 0.173\vec{j})$   
 $- \alpha_2 \vec{k} \times (0.361\vec{i} - 0.173\vec{j}) - 0.173\vec{j}$   
 $= (-0.4 - 0.111 - 0.173\alpha_2)\vec{i} + (-0.693 + 0.053 - 0.361\alpha_2)\vec{j} = a_P \vec{i}$

$\therefore \alpha_2 = -1.773 \text{ (rad/s}^2\text{)} \curvearrowright \text{시계방향}$   $\vec{a}_P = -0.204\vec{i} \text{ (m/s}^2\text{)}$



$\beta = 30^\circ$   $\vec{V}_C = \vec{\omega}_{AC} \times \vec{r}_{C/A} = \omega_1 \vec{k} \times (3\cos 30^\circ \vec{i} + 3\sin 30^\circ \vec{j})$   
 $\vec{\omega}_{AC} = \vec{\omega}_1 = \omega_1 \vec{k}$   $= -1.5\omega_1 \vec{i} + 1.5\sqrt{3}\omega_1 \vec{j}$

$\vec{V}_B = \vec{\omega}_{BC} \times \vec{r}_{B/C} + (\vec{V}_B)_{rel} = \omega_2 \vec{k} \times \vec{r}_{B/C} + 3(\cos 30^\circ \vec{i} + \sin 30^\circ \vec{j})$   
 $\vec{\omega}_{BC} = \vec{\omega}_2 = \omega_2 \vec{k}$   $\vec{r}_{B/C} = 3^2 + 2^2 - 2 \cdot 3 \cdot 2 \cos 30^\circ \therefore r_{BC} = 1.615 \text{ (m)}$

$\vec{V}_{C/A} = \vec{V}_C$   $\vec{V}_C = \omega_2 \vec{k} \times (0.598\vec{i} + 1.5\vec{j}) + 3(\frac{0.498}{1.615}\vec{i} + \frac{1.5}{1.615}\vec{j})$   
 $= (-1.5\omega_2 + 1.111)\vec{i} + (0.598\omega_2 + 2.786)\vec{j}$

$-1.5\omega_1 = -1.5\omega_2 + 1.111$  — ①

$1.5\sqrt{3}\omega_1 = 0.598\omega_2 + 2.786$  — ②

$\omega_1 = 1.614 \text{ (rad/s)}$   $\omega_2 = 2.355 \text{ (rad/s)}$   $\curvearrowright \text{시계방향}$