2

$$x_f = x_i + v_i \Delta t + \frac{1}{2} a (\Delta t)^2$$

$$6.0\,\mathrm{m} = 0 + 0 \times 1.0\,\mathrm{s} + \frac{1}{2} a (1.0\,\mathrm{s})^2$$

$$\Longrightarrow \quad a = 12\,\mathrm{m/s^2}$$

$$x_f = 0 + 0 \times 1.0\,\mathrm{s} + \frac{1}{2} (12\,\mathrm{m/s^2})(5.0\,\mathrm{s})^2$$

$$= 150\,\mathrm{m}$$

(2.11) $(v_x)_f = (v_x)_i + a_x \mathit{\Delta} t \quad \Longrightarrow \quad \mathit{\Delta} t = \dfrac{(v_x)_f - (v_x)_i}{a_x}$

(2.12) $x_f = x_i + (v_x)_i \mathit{\Delta} t + \dfrac{1}{2} a_x (\mathit{\Delta} t)^2$

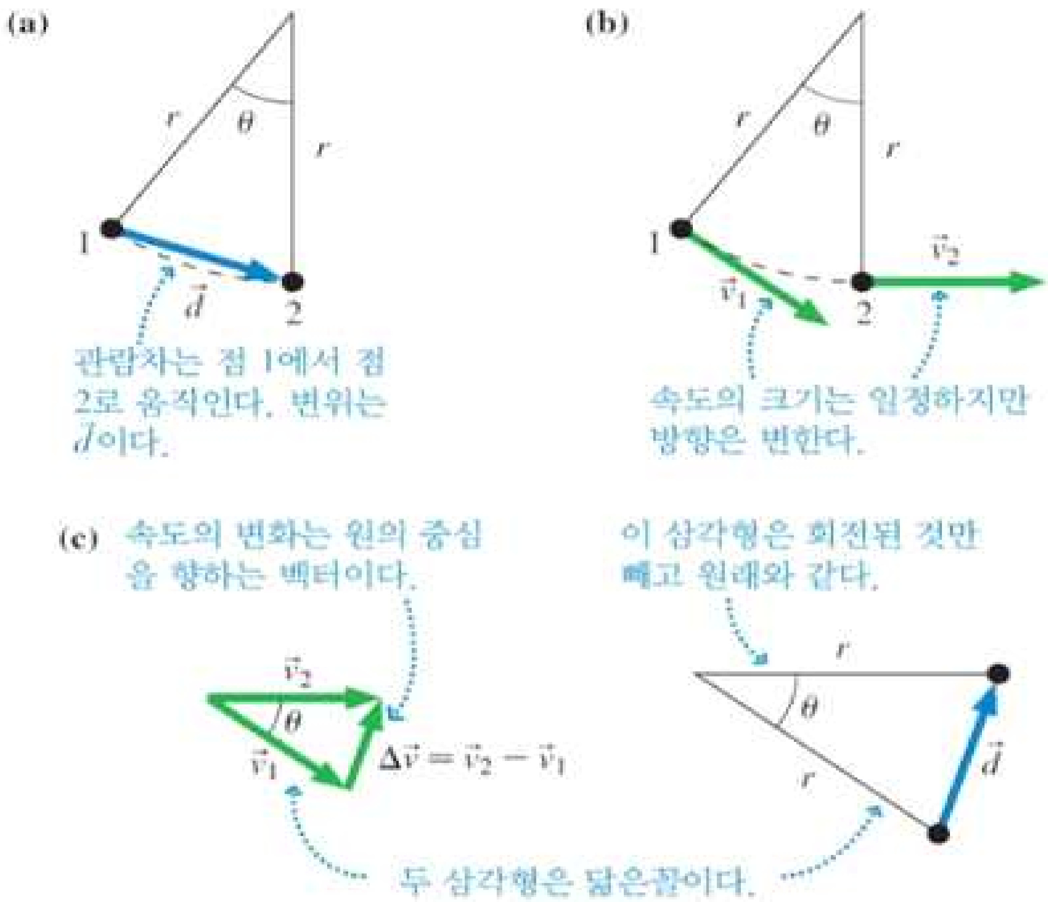
$$\Longrightarrow \; x_f = x_i + (v_x)_i \frac{(v_x)_f - (v_x)_i}{a_x} + \frac{1}{2} a_x \left(\frac{(v_x)_f - (v_x)_i}{a_x} \right)^2$$

$$\Longrightarrow \; x_f - x_i = (v_x)_i \frac{(v_x)_f - (v_x)_i}{a_x} + \frac{1}{2} a_x \left(\frac{(v_x)_f^2 - 2(v_x)_f (v_x)_i + (v_x)_i^2}{a_x^2} \right)$$

$$\Longrightarrow 2a_x (x_f - x_i) = 2(v_x)_i (v_x)_f - 2(v_x)_i^2 + \left[\, (v_x)_f^2 - 2(v_x)_f (v_x)_i + (v_x)_i^2 \right]$$

$$\Longrightarrow \; 2a_x \mathit{\Delta} x = \; (v_x)_f^2 - (v_x)_i^2$$

$$\Longrightarrow \; (v_x)_f^2 = (v_x)_i^2 + 2a_x \mathit{\Delta} x$$



등속원운동의 가속력

$$\frac{\Delta v}{v} = \frac{d}{r} \Longrightarrow \frac{\Delta v}{v} = \frac{v \Delta t}{r} \Longrightarrow \frac{\Delta v}{\Delta t} = \frac{v^2}{r} \Longrightarrow a = \frac{v^2}{r}$$

[예제6.8]

$$\sum F_x = n\sin\theta = \frac{m\nu^2}{r}$$

$$\sum F_y = n\cos\theta - w = 0$$

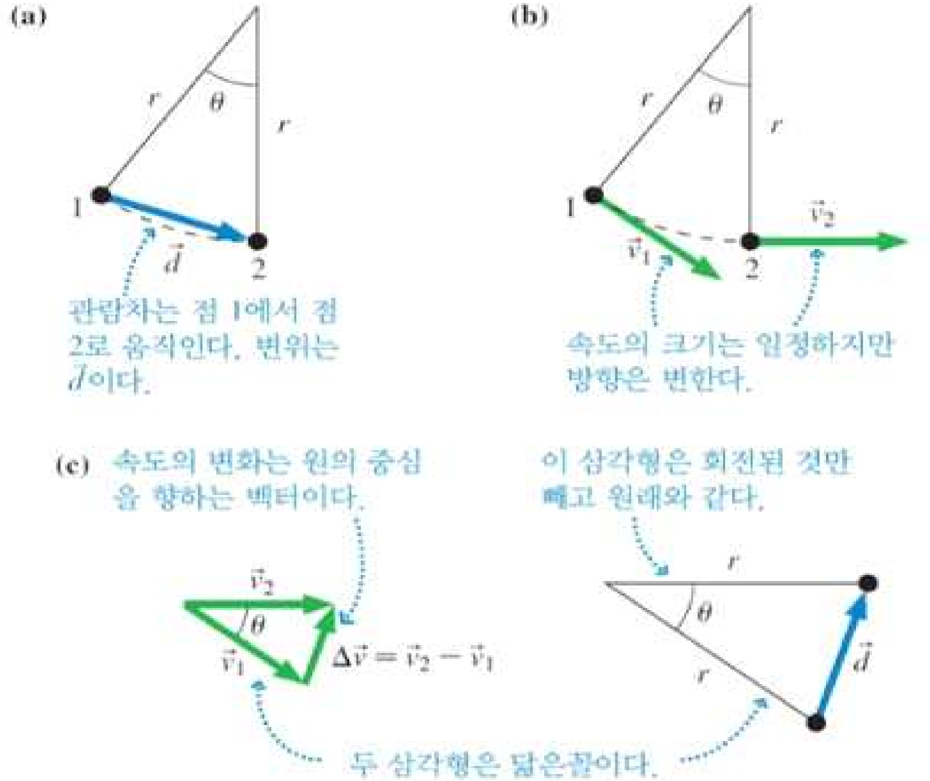
$$\Longrightarrow \quad n = \frac{m\nu^2}{r\sin\theta} \;, \quad n = \frac{w}{\cos\theta}$$

$$\Longrightarrow \quad \frac{m\nu^2}{r\sin\theta} = \frac{w}{\cos\theta}$$

$$\Longrightarrow \quad \nu = \sqrt{\frac{rw}{m}\frac{\sin\theta}{\cos\theta}} = \sqrt{\frac{r\,mg}{m}\tan\theta} = \sqrt{rg\tan\theta} = 14\,m/s$$

등속원운동의 가속력

$$\frac{\Delta v}{v} = \frac{d}{r} \Rightarrow \frac{\Delta v}{v} = \frac{v \Delta t}{r} \Rightarrow \frac{\Delta v}{\Delta t} = \frac{v^2}{r} \Rightarrow a = \frac{v^2}{r}$$



선속도와 각속도의 관계

$$d = r\theta \Rightarrow \frac{d}{t} = r\frac{\theta}{t} \Rightarrow v = r\omega$$

$$\omega = 2\pi f = \frac{2\pi}{T}$$

선가속도와 각가속도의 관계

$$v = r\omega \Rightarrow \frac{v}{t} = r\frac{\omega}{t} \Rightarrow a = r\alpha$$

돌림힘

$$\tau = F \cdot r = (ma)r = (m r\alpha)r = (mr^2)\alpha = I\alpha$$

$\tau = I\alpha$:돌림힘 , $I = mr^2$:관성모멘트(관성능률,회전관성)

운동량 : $p = mv$, 각운동량 : $L = I\omega$

힘과 일(에너지)

$$W=\int F\,dx=\int ma\,dx=m\int\frac{dv}{dx}\,dx=m\frac{1}{2}v^2=\frac{1}{2}mv^2$$

회전운동에너지

$$W=\frac{1}{2}mv^2=\frac{1}{2}m(r\omega)^2=\frac{1}{2}(mr^2)\omega^2=\frac{1}{2}I\omega^2$$

용수철운동에너지

$$W=\int F\,dx=\int kx\,dx=\frac{1}{2}kx^2$$

충격량 = $F\Delta t$ = 운동량의 변화 = mv_1-mv_0

단위 : $kg(m/s^2)s=kg\,m/s$

두레박과 도르래

회전운동

$$a = \alpha R,\ \alpha = \frac{\tau}{I},\ \tau = TR,\ I = \frac{1}{2}MR^2$$

$$\Rightarrow a = \frac{2T}{M} \ \Rightarrow \ T = \frac{1}{2}Ma$$

힘 = 중력 – 장력 : $F = mg - \frac{1}{2}Ma$

운동방정식

$$F = ma \ \Rightarrow \ mg - \frac{1}{2}Ma = ma$$

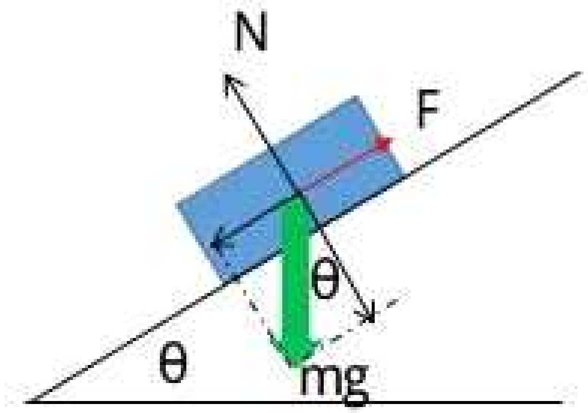
$$\Rightarrow a = \frac{g}{1 + M/2m} = \frac{9.8\,m/s^2}{1 + 3kg/2(2.5kg)} = 6.125m/s^2$$

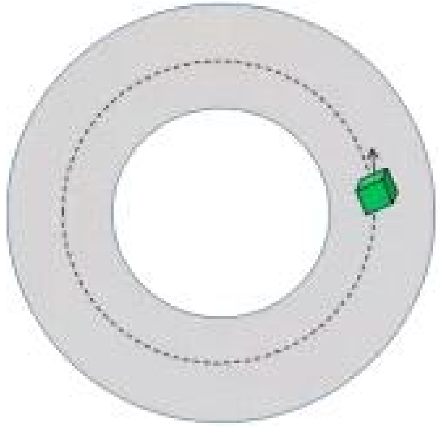
운동법칙

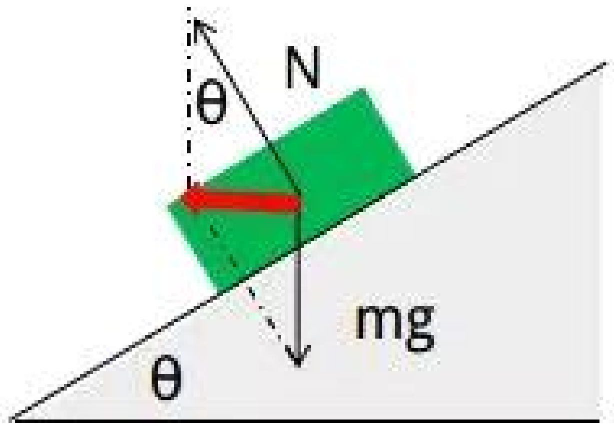
$$S = \frac{1}{2}at^2 \Rightarrow t = \sqrt{\frac{2S}{a}} = \sqrt{\frac{2 \times 4\,m}{6.125m/s^2}} = 1.14\,s$$

경사면 물체역학 비교

1. **정지 상태** (마찰력가정): $F = mg\sin\theta,\ N = mg\cos\theta$







2. **운동 상태**(마찰력없다고가정) : 구심력(빨간화살표)은 무게 mg와 수직항력 N의 합력이어야 한다. 그런데 합력은 수평이 되어야 하므로 사각형은 평행사변형이 되어야 한다. 따라서 빗면이 물체를 미는 수직항력 N은 (평행사변형 조건 : $N\cos\theta = mg$) 만큼만 발휘될 수 있다.

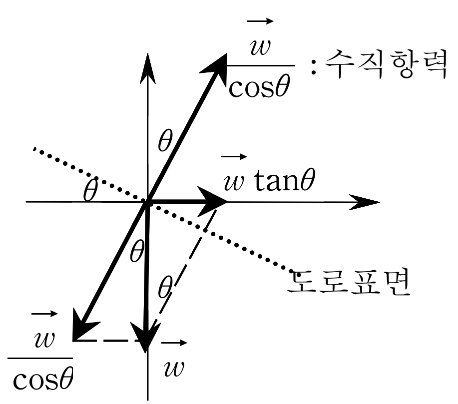
$$\vec{w}\ \tan\theta = ma$$

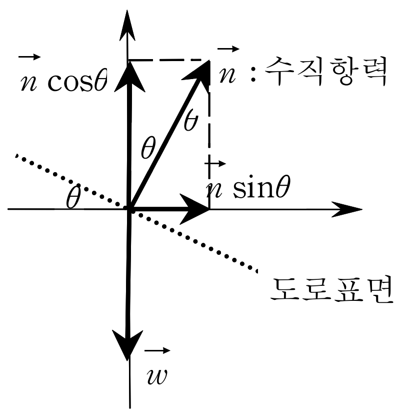
$$\Rightarrow mg\tan\theta = m\frac{v^2}{r}$$

$$\Rightarrow v = \sqrt{rg\tan\theta}$$

$$= \sqrt{70\,m \times 9.8\,m/s^2 \times \tan 15^\circ}$$

$$\approx 14\ m/s$$





$$a = \frac{v^2}{r} \Rightarrow v = \sqrt{ar} = \sqrt{20\,m/s^2 \times 5.0\,m} = 10\,m/s$$

$$v = 2\pi r f = \frac{2\pi r}{T} \Rightarrow T = \frac{2\pi r}{v} = \frac{2\pi \times 5.0\,m/s}{10\,m/s} = \pi$$

중력(mg)은 가속도(a_y)와 같은 방향이고
장력(T)은 가속도(a_y)와 반대 방향이다.

$a_y(+)$를 하방향 $\Rightarrow a_y > 0 \Rightarrow m a_y = mg - \frac{1}{2} a_y M$

$a_y(+)$를 상방향 $\Rightarrow a_y < 0 \Rightarrow m a_y = -mg - \frac{1}{2} a_y M$

(A+B)의 가속도

$$F = ma$$

$$\Rightarrow 3\ kg\ m/s^2 = (5kg + 10kg)\,a$$

$$\Rightarrow a = 0.2\ m/s^2$$

B가 A로부터 받은 힘

$$\begin{aligned} F &= ma \\ &= 10\,kg \times 0.2\,m/s^2 \\ &= 2.0\,kg\ m/s^2 \\ &= 2.0\,N \end{aligned}$$

요약풀이:

$$\begin{cases} F = g\,m_S - g\,m_M \\ F = (m_S + m_M)a \end{cases}$$

$$\begin{aligned} \Rightarrow a &= \frac{g(m_S - m_M)}{m_S + m_M} \\ &= \frac{9.8\,m/s^2\,(200\,kg - 100\,kg)}{(200\,kg + 100\,kg)} \\ &\approx 3.3\,m/s^2 \end{aligned}$$

시간 $\varDelta t$ <-- 가속도 a_y <-- 각가속도 α <-- 장력 T

$$h=\frac{1}{2}a_y\varDelta t^2,\quad a_y=-\alpha R,\quad \alpha=\frac{\tau}{I}=\frac{TR}{\frac{1}{2}MR^2}=\frac{2T}{MR}$$

T를 a_y로 표시하여 a_y에 관하여 푼다.

$$a_y=-\left(\frac{2T}{MR}\right)R=\frac{2T}{M}\quad\Rightarrow\quad T=-\frac{M}{2}a_y$$

뉴톤제2법칙 $ma_y=T-mg$

a_y를 α로 표시한다.

$$\Rightarrow ma_y=-\frac{M}{2}a_y-mg$$

$$\Rightarrow a_y=-\frac{g}{1+\frac{M}{2m}}=\frac{9.8}{1+\frac{3}{2\times 2.5}}=-6.13\ \mathrm{m/s^2}$$

$$\Rightarrow \varDelta t=\sqrt{\frac{2h}{a_y}}=\sqrt{\frac{2(-4.0\,\mathrm{m})}{-6.13\ \mathrm{m/s^2}}}=1.1\ \mathrm{s}$$