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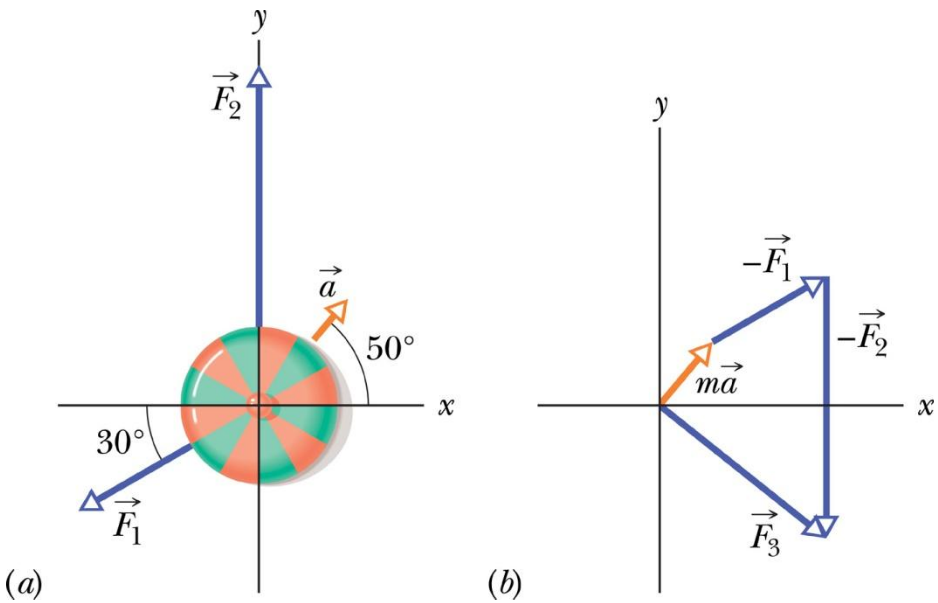
  1. University Physics, Bauer and Westfall, McGraw-Hill, 2011.
  2. Principles of Physics, Halliday, Resnick, and Walker, Wiley, 8th and 9th Ed.
- The rest is made by me.

Force in 2D



$$m = 2.0\ \text{kg},\ \ a = 3.0\ \text{m/s}^2$$

$$F_1 = 10\ \text{N},\ \ F_2 = 20\ \text{N}$$

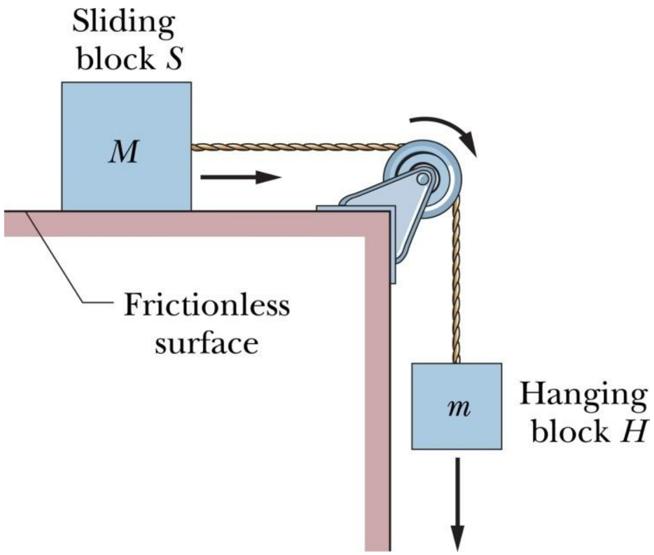
$$\vec{F}_1 + \vec{F}_2 + \vec{F}_3 = m\vec{a}$$

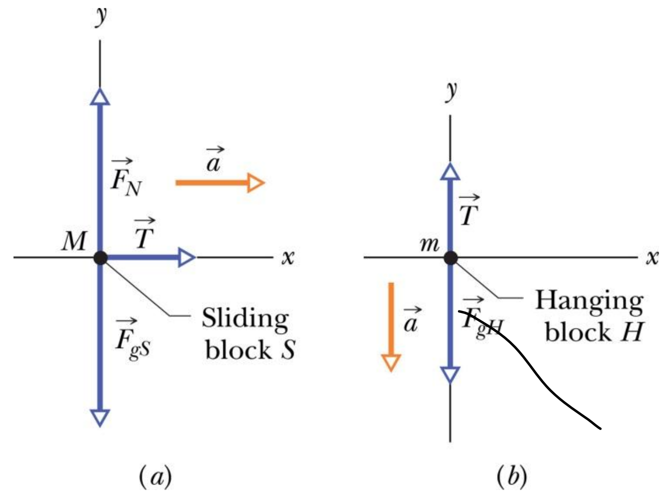
$$\boxed{\vec{F}_3 = m\vec{a} - \vec{F}_1 - \vec{F}_2}$$

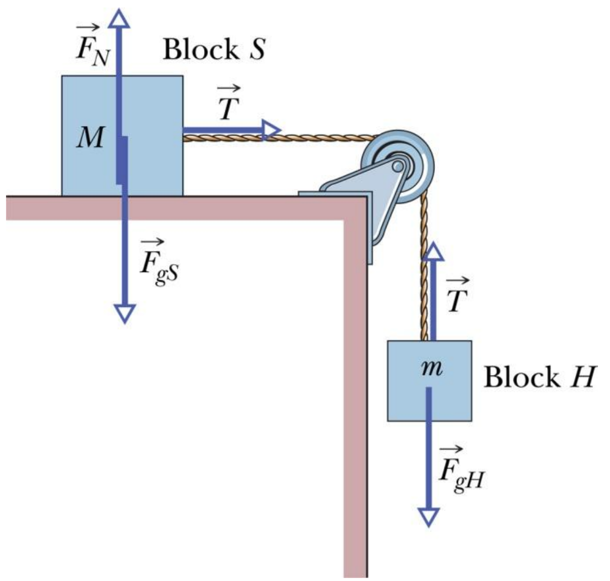
$$F_{3,x} = ma_x - F_{1,x} - F_{2,x}$$
$$= ma\cos 50^\circ - F_1\cos(-150^\circ) - F_2\cos 90^\circ = 12.5\ \text{N}$$
$$F_{3,y} = ma_y - F_{1,y} - F_{2,y}$$
$$= ma\sin 50^\circ - F_1\sin(-150^\circ) - F_2\sin 90^\circ = -10.4\ \text{N}$$

$$\boxed{F_3 = \sqrt{F_{3,x}^2 + F_{3,y}^2} = 16\ \text{N}, \quad \theta = \tan^{-1}\frac{F_{3,y}}{F_{3,x}} = -40^\circ.}$$

Pulley problem







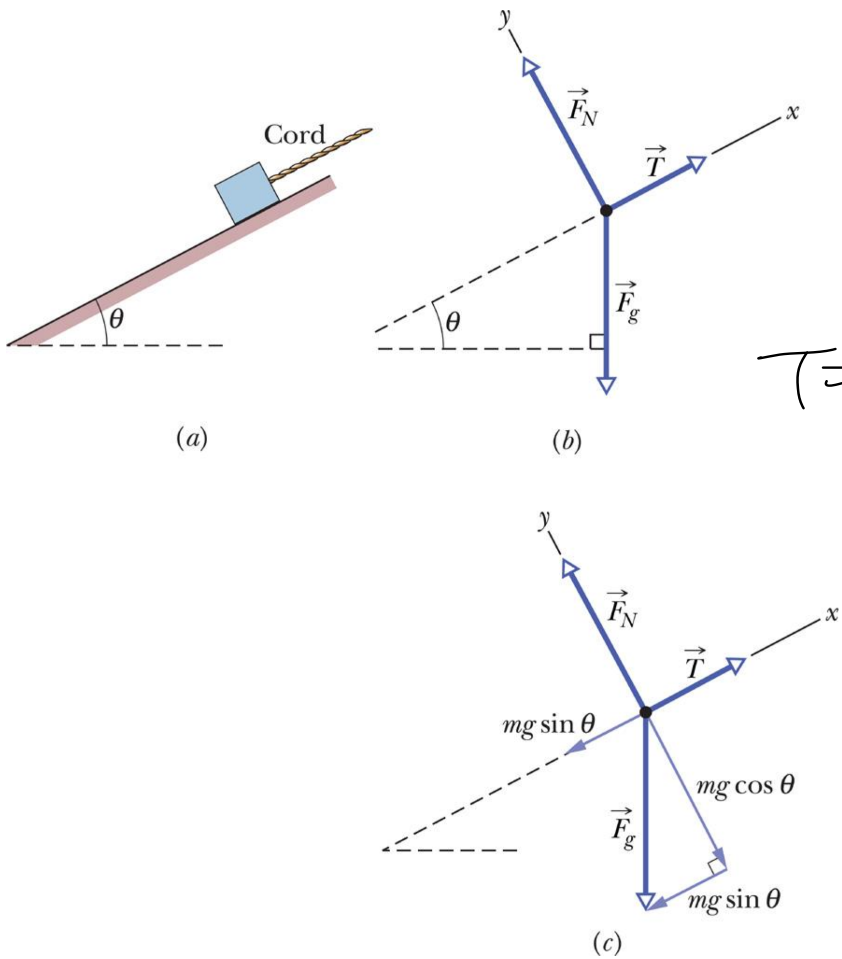
$$T = Ma$$

$$mg - T = ma$$

$$mg = (M+m)a$$

$$a = \frac{m}{M+m} g, \quad T = \frac{mM}{M+m} g$$

Body on a slope



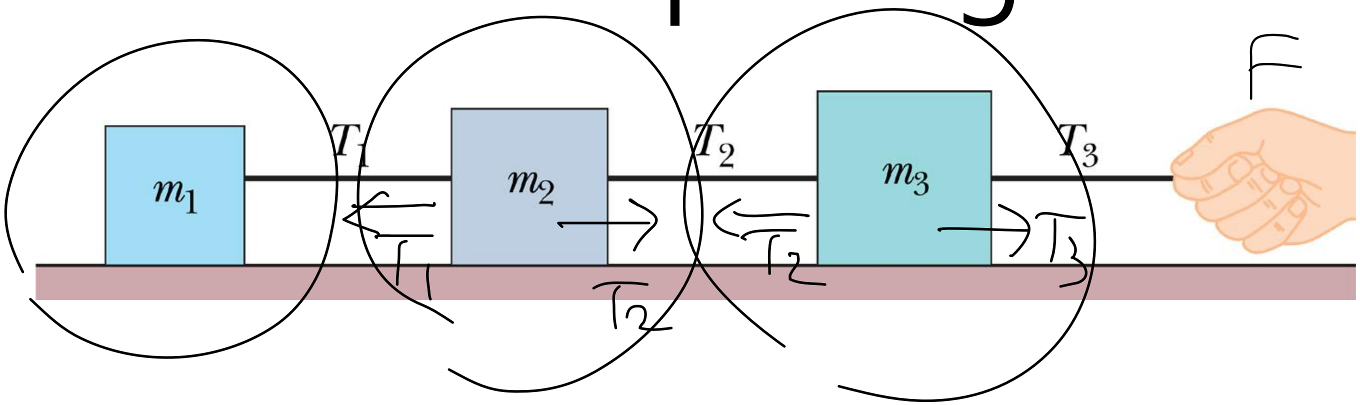
$$F_x = T - mg\sin\theta = 0$$

$$F_y = F_N - mg\cos\theta = 0$$

$$T = 0 \rightarrow -mg\sin\theta = ma$$

$$a = -g\sin\theta$$

Cart pulling



$T_1 = m_1 a$

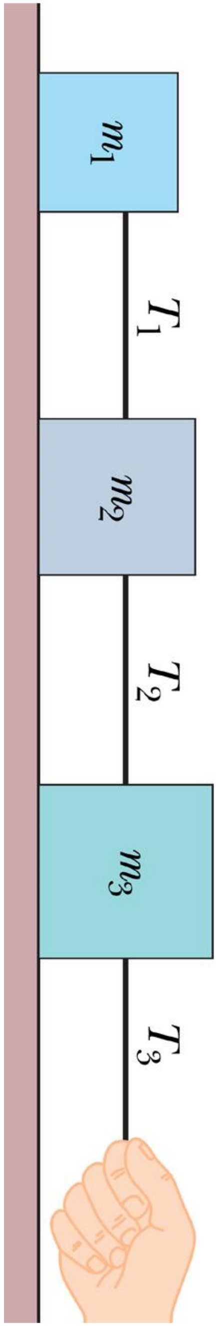
$T_2 - T_1 = m_2 a$

$T_3 - T_2 = m_3 a$

$T_3 = (m_1 + m_2 + m_3) a$

$T_2 = (m_1 + m_2) a$

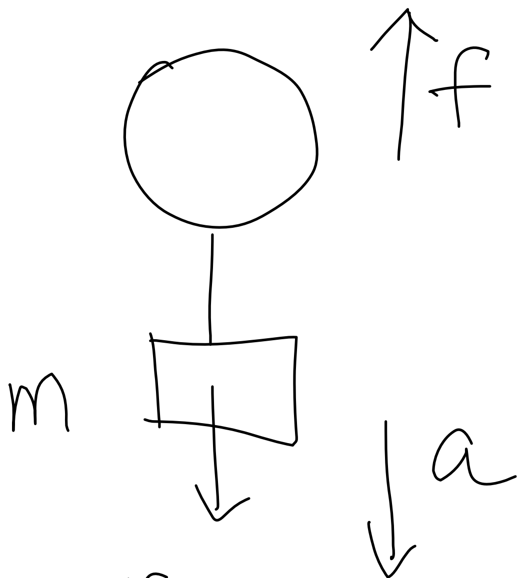
화장지 한 손으로 자르기

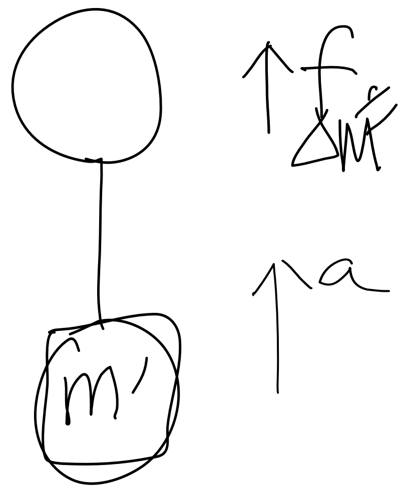


T

$T_2 -$

열기구가 아래로 a의 가속도로 내려오면 얼마나 자루를
내던지면 a의 가속도로 위로 올라갈까?





$$mg - f = ma$$

$$f - m'g = m'a$$

$$(m - m')g = (m + m')a$$

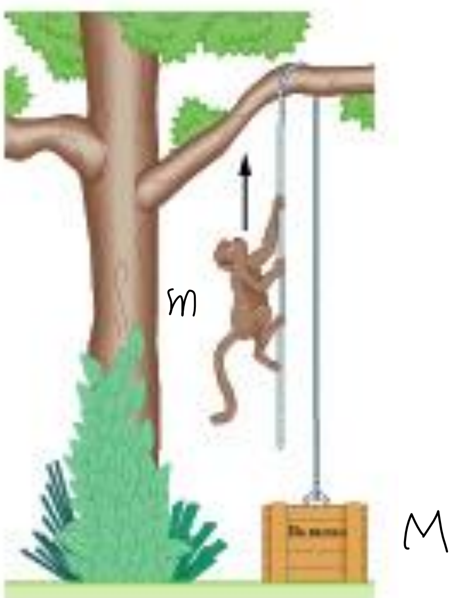
$$m'(g+a) = m(g-a)$$

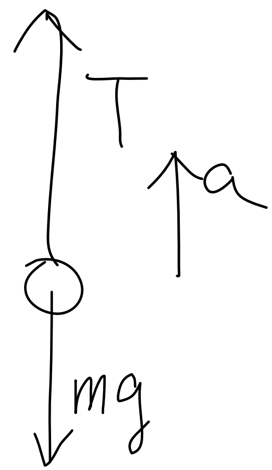
$$m' = m\frac{g-a}{g+a}$$

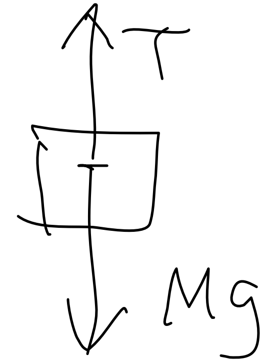
$$m - m' = m\left[\frac{\cancel{g}+a-\cancel{g}+a}{g+a}\right]$$

$$= \frac{2ma}{g+a}$$

원숭이가 상자 끌어올리기







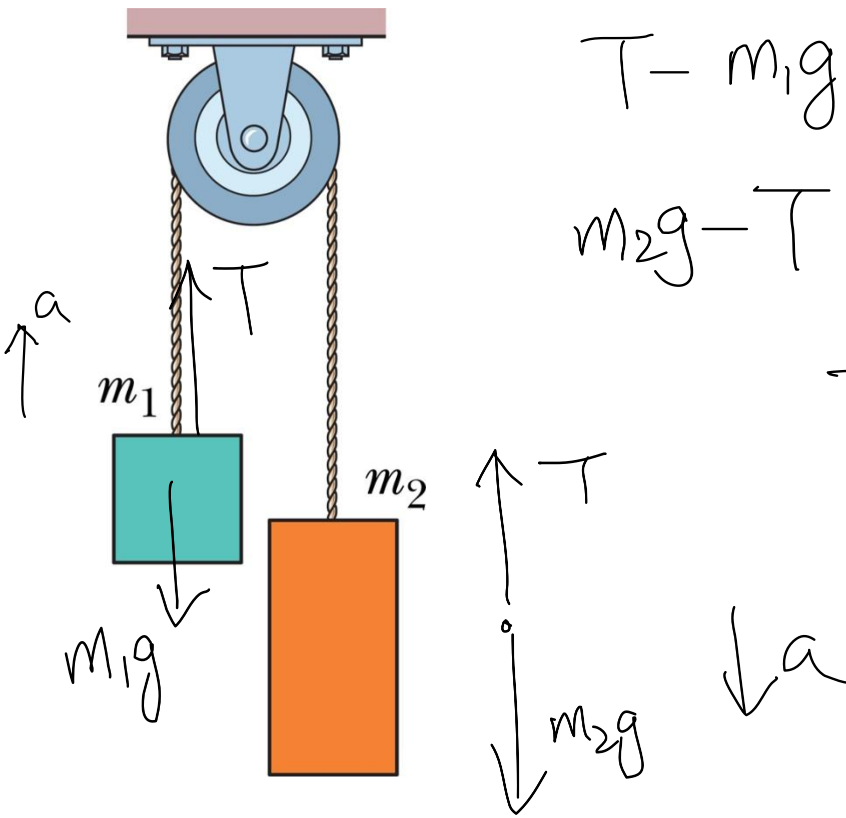
$$T = Mg$$

$$T - mg = ma$$

$$(M-m)g = ma$$

$$a = \frac{M-m}{m} g$$

pulley 1



$$(m_1+m_2)a = (m_2-m_1)g$$

$$T - m_1 g = m_1 a$$

$$a = \frac{m_2 - m_1}{m_1 + m_2} g$$

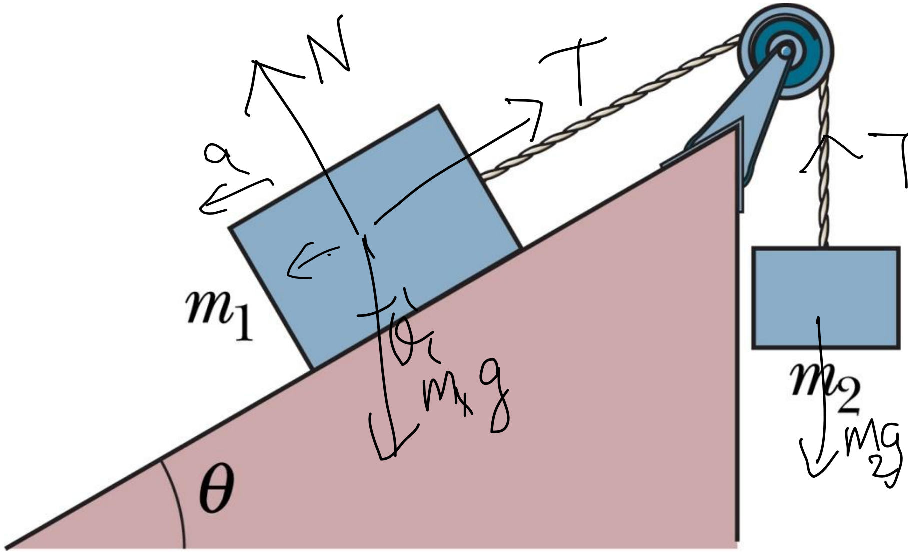
$$m_2 g - T = m_2 a$$

$$T = m_1(g+a)$$

$$= m_1 g\left[1 + \frac{m_2 - m_1}{m_1 + m_2}\right]$$

$$= g\,\frac{2 m_1 m_2}{m_1 + m_2}$$

pulley 2



$$T - m_2 g = m_2 a$$

$$\boxed{N = m_1 g\cos\theta}$$

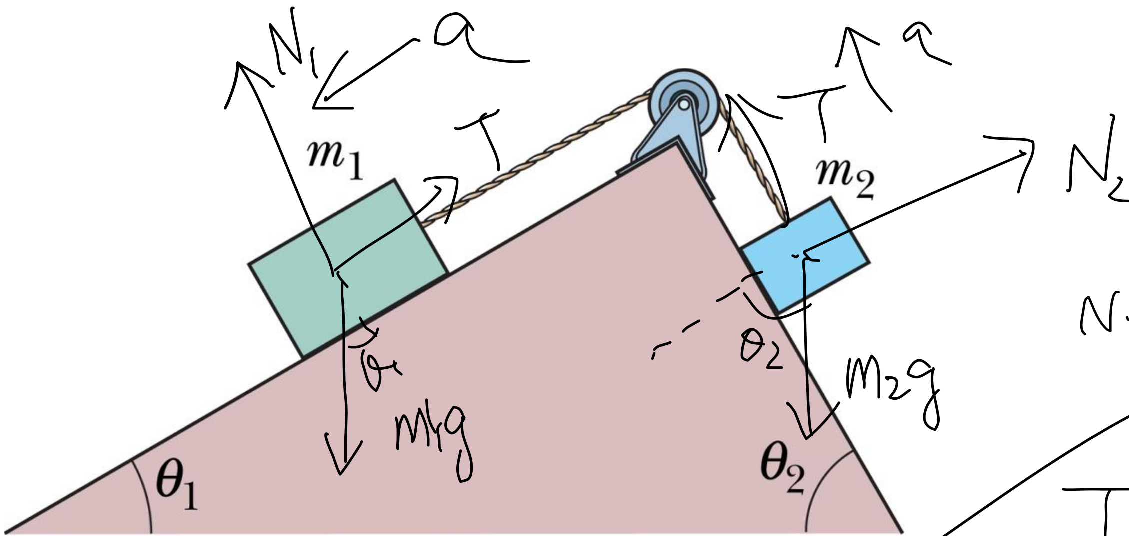
$$m_1 g\sin\theta - T = m_1 a$$

$$g(m_1\sin\theta - m_2) = (m_1+m_2)a$$

$$a = \frac{m_1\sin\theta - m_2}{m_1+m_2}$$

$$T = m_2 g m_1 \frac{1+\sin\theta}{m_1+m_2}$$

pulley 3



$N_2 = m_2 g \cos\theta_2$

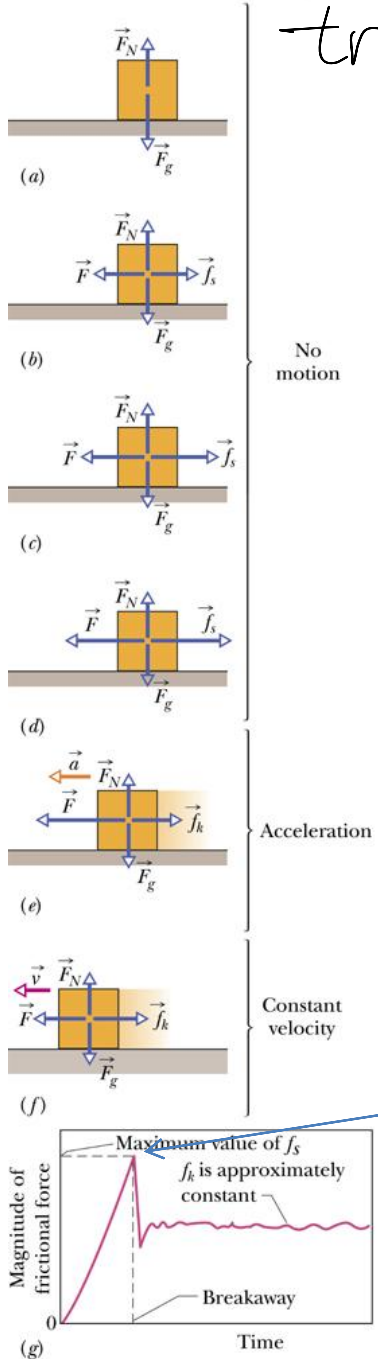
$T - m_2 g \sin\theta_2 = m_2 a$

$N_1 = m_1 g \cos\theta_1$

$m_1 g \sin\theta_1 - T = m_1 a$

tribology

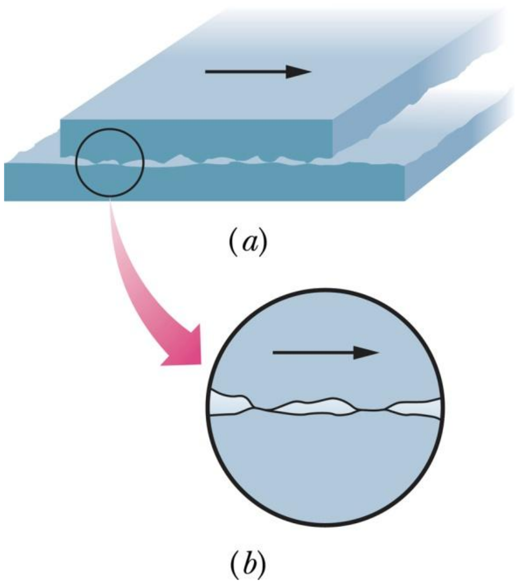
Friction



Static friction

Kinetic friction $f_k = \mu_k N$

Cold welding



Max. static friction

$$(f_s)_{\max} = \mu_s N$$

Example 4.4 2 blocks

μ_s, μ_k

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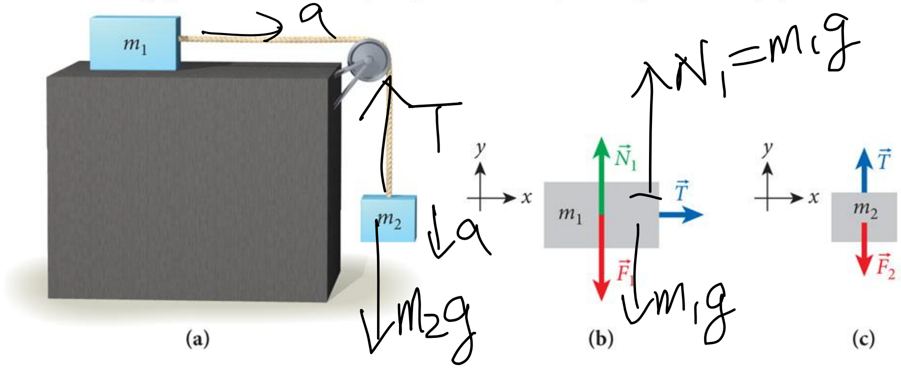

$(f_s)_{max} = \mu_s m_1 g$ $\quad T$

i) $T < \mu_s m_1 g$

즉 $m_2 < \mu_s m_1$ 일 경우

$a = 0$, $T = m_2 g$

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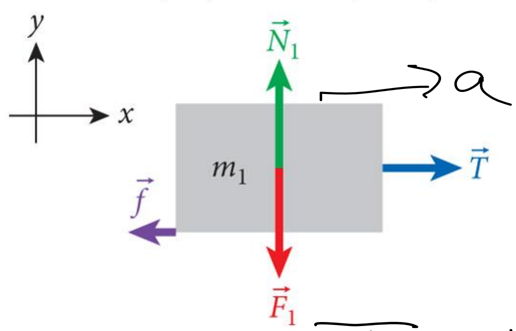


ii) $m_2 > \mu_s m_1$

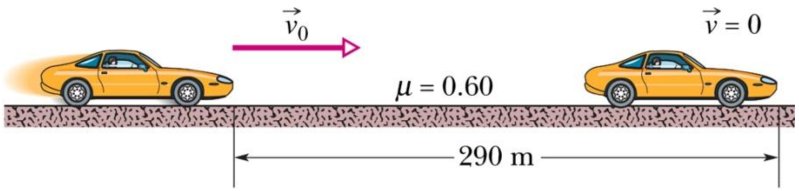
$m_2 g - T = m_2 a$

$T - \mu_k m_1 g = m_1 a$

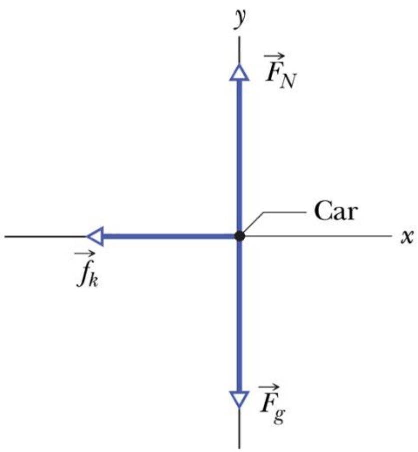
$(m_2 - \mu_k m_1) g = (m_1 + m_2) a$

$$a = \frac{m_2 - \mu_k m_1}{m_1 + m_2} g$$

Sample Problem



(a)



(b)

$v = 0,\ x = 290\text{m},\ \mu_k = 0.60,\ v_0 = ?$

$$
\begin{aligned}
-f_k &= ma, \\
a &= -\frac{f_k}{m} = -\frac{\mu_k mg}{m} = -\mu_k g.
\end{aligned}
$$

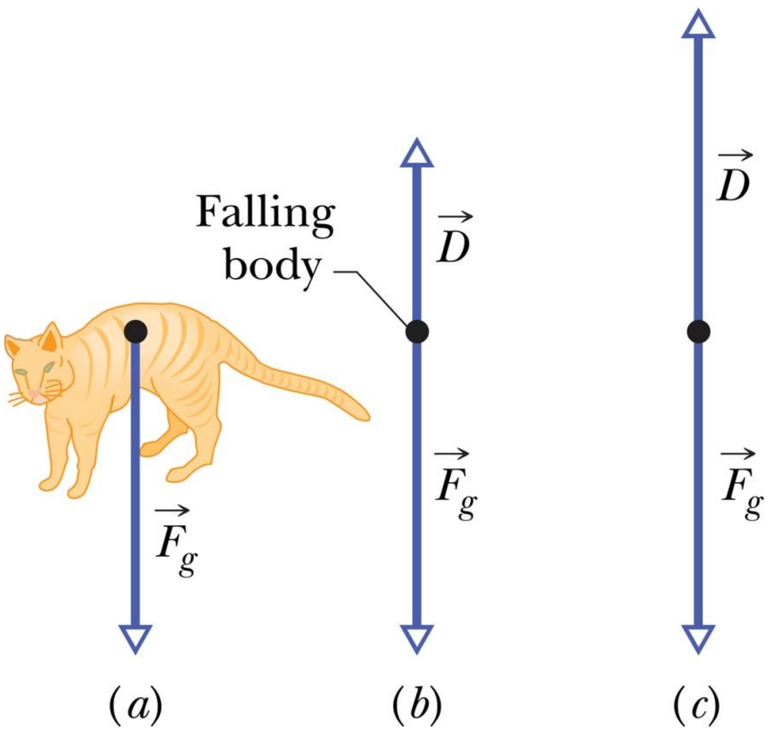
$$
\begin{aligned}
v^2 &= v_0^2 + 2a(x - x_0), \\
v_0 &= \sqrt{2\mu_k g x} = 210\ (\text{km/h}).
\end{aligned}
$$

$v^2 - \cancel{v_0^2} = +2gh$

$= 20 \cdot 4000$

$= 80000 = 10^4 \times 8$

drag force



$$D \propto v^2$$

$$D = \frac{1}{2} C \rho A v^2$$

$$D_t = \frac{1}{2} C \rho A v_t^2 = mg \longrightarrow v_t = \sqrt{\frac{2mg}{C \rho A}}$$

Dimensional analysis

$$[D] = MLT^{-2} \qquad \rho A v^2$$

$$\rho,\ A,\ v$$

$$\rho^x A^y v^z = (ML^{-3})^x (L^2)^y (LT^{-1})^z$$

$$= M^x L^{-3x+2y+z} T^{-z}$$

$$x = 1, \quad -3+2y+2 = 1$$

$$z = 2 \qquad y = 1$$