Copyright statement

- The images and the pictures in this lecture are provided by the CDs accompanied by the books
  1. University Physics, Bauer and Westfall, McGraw-Hill, 2011.
  2. Principles of Physics, Halliday, Resnick, and Walker, Wiley, 8^{th} and 9^{th} Ed.
- The rest is made by me.

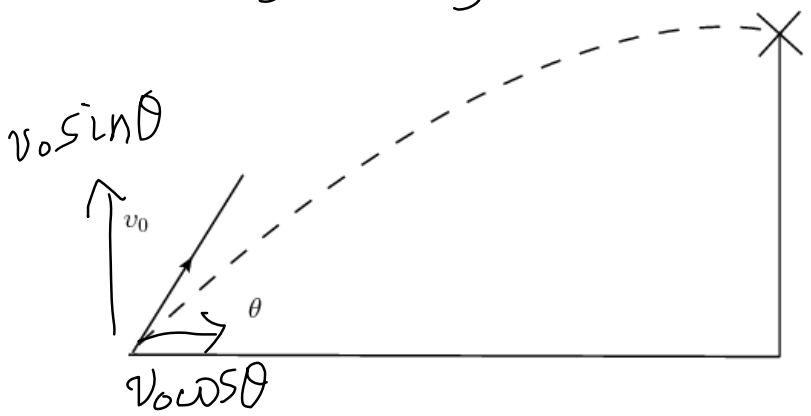
$$x^2 - \frac{2v_0^2}{gL}x + 1 + \frac{2hv_0^2}{gL^2} = 0$$

보충

Free Throw

$$\tan\theta = \frac{v_0^2}{gL} \pm \sqrt{\left(\frac{v_0^2}{gL}\right)^2 - 1 - \frac{2hv_0^2}{gL^2}}$$

3/26 목 8PM 화



$$v_0\cos\theta \cdot t = L$$

$$h = v_0\sin\theta\, t - \frac{1}{2}gt^2$$

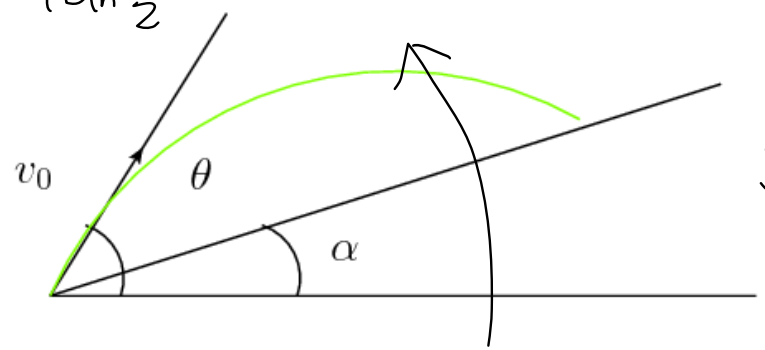
$$h = v_0\sin\theta\frac{L}{v_0\cos\theta} - \frac{1}{2}g\frac{L^2}{v_0^2\cos^2\theta}$$

$$= L\tan\theta - \frac{1}{2}\frac{gL^2}{v_0^2}(1+\tan^2\theta)$$

$$1+\tan^2\theta - \frac{2v_0^2}{gL}\tan\theta + \frac{2hv_0^2}{gL^2} = 0$$

Throwing on a slope

$\frac{1+\tan\frac{\alpha}{2}}{1-\tan\frac{\alpha}{2}}$



$$x = v_0 \cos\theta\, t$$

$$y = v_0 \sin\theta\, t - \frac{1}{2} g t^2$$

$$y = \tan\theta \cdot x - \frac{1}{2} g \frac{x^2}{v_0^2 \cos^2\theta}$$

$$y = x \tan\alpha$$

$$\tan\alpha = \tan\theta - \frac{1}{2} \frac{g x}{v_0^2 \cos^2\theta}$$

$$x = \frac{2 v_0^2 \cos^2\theta}{g} (\tan\theta - \tan\alpha)$$

$$\frac{dx}{d\theta} = 0 = \frac{2 v_0^2}{g} \left[\cos^2\theta - \sin^2\theta + 2 \sin\theta \cos\theta \tan\alpha \right]$$

$$\cos 2\theta + \tan\alpha \sin 2\theta = 0$$

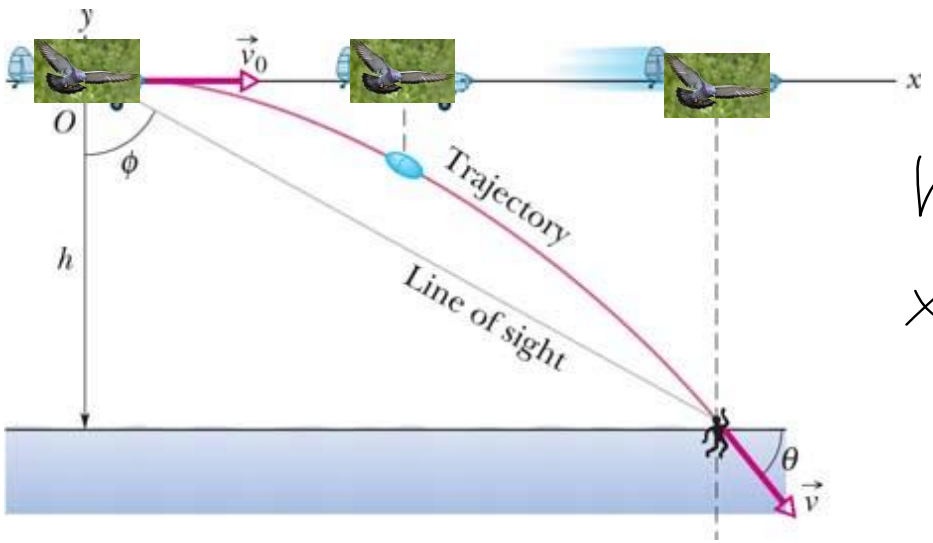
$$\cos\alpha \cos 2\theta + \sin\alpha \sin 2\theta = 0$$

$$\cos(2\theta - \alpha) = 0 \qquad 2\theta - \alpha = \frac{\pi}{2}$$

$$\theta = \frac{\pi}{4} + \frac{\alpha}{2}$$

Sample problem: Bird's eye

$h = 500 \text{ m}, \; v_x = 198 \text{ km/h} = 55.0 \text{ m/s}$



$$y - y_0 = v_{0y}t - \frac{1}{2}gt^2$$

$$h = \frac{1}{2}gt^2 = \frac{1}{2}g\frac{x^2}{v_0^2}$$

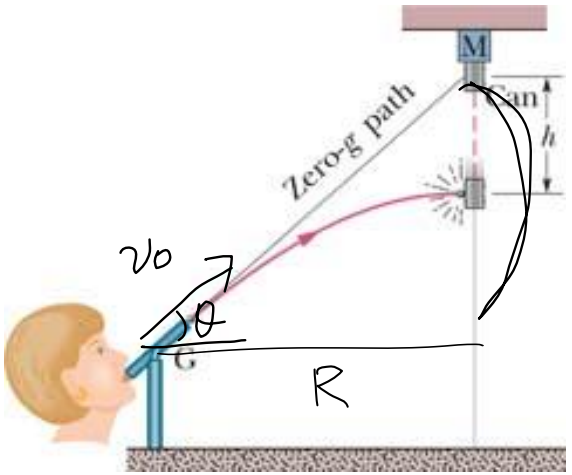
$$x = v_0 t \qquad t = 10.1 \text{ s}$$

$$x = v_x t \qquad x = 555.5 \text{ m}$$

$$\phi = \tan^{-1}\frac{x}{h} = \tan^{-1}\frac{555.5}{500} = 48.0°$$

$$\tan\phi = \frac{x}{h} = \frac{x}{\frac{1}{2}gx^2/v_0^2} = \frac{2v_0^2}{gx}$$

Monkey with a banana



$$y = x\tan\theta - \frac{gx^2}{2v_0^2\cos^2\theta}$$

$$t\,v_0\cos\theta = R$$

$$t = \frac{R}{v_0\cos\theta}.$$

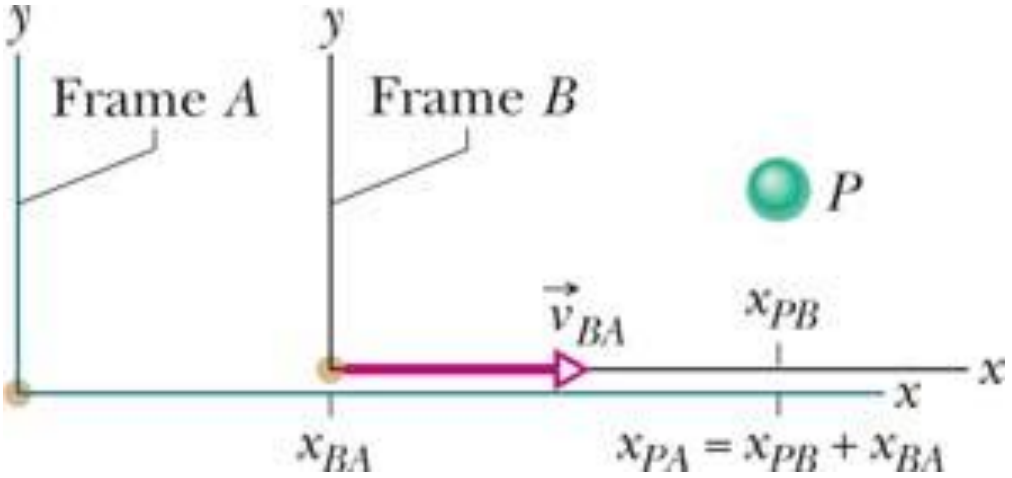
$$y_b = v_0\sin\theta\frac{R}{v_0\cos\theta} - \frac{1}{2}g\frac{R^2}{v_0^2\cos^2\theta}$$

$$= R\tan\theta - \frac{1}{2}\frac{gR^2}{v_0^2\cos^2\theta}$$

$$y_M = \cancel{h} - \frac{1}{2}g\,R\tan\theta - \frac{1}{2}g\frac{R^2}{v_0^2\cos^2\theta}$$

Relative velocity

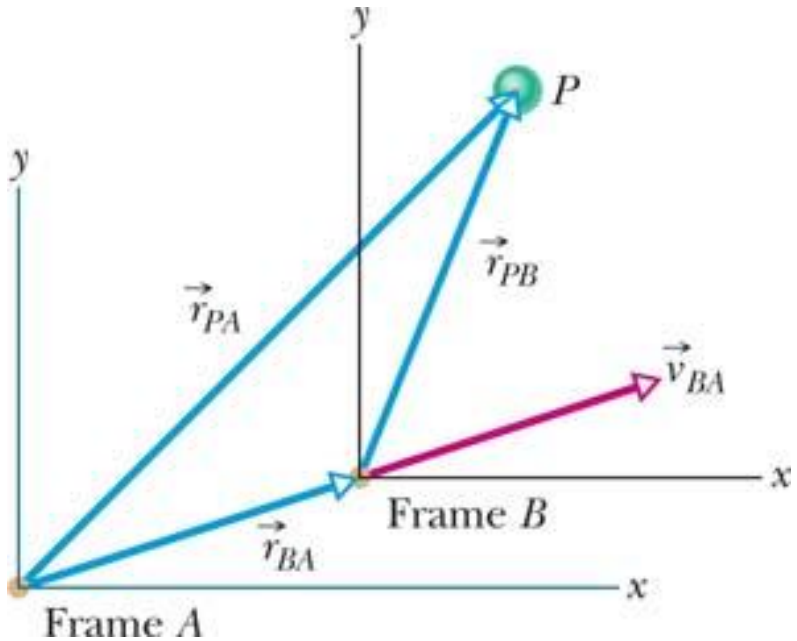
- 1D



$$
\begin{aligned}
x_{PA} &= x_{PB} + x_{BA} \\
\frac{d}{dt}(x_{PA}) &= \frac{d}{dt}(x_{PB}) + \frac{d}{dt}(x_{BA}) \\
\frac{d^2}{dt^2}(x_{PA}) &= \frac{d^2}{dt^2}(x_{PB}) + \frac{d^2}{dt^2}(x_{BA})
\end{aligned}
$$

상대속도

- 2D

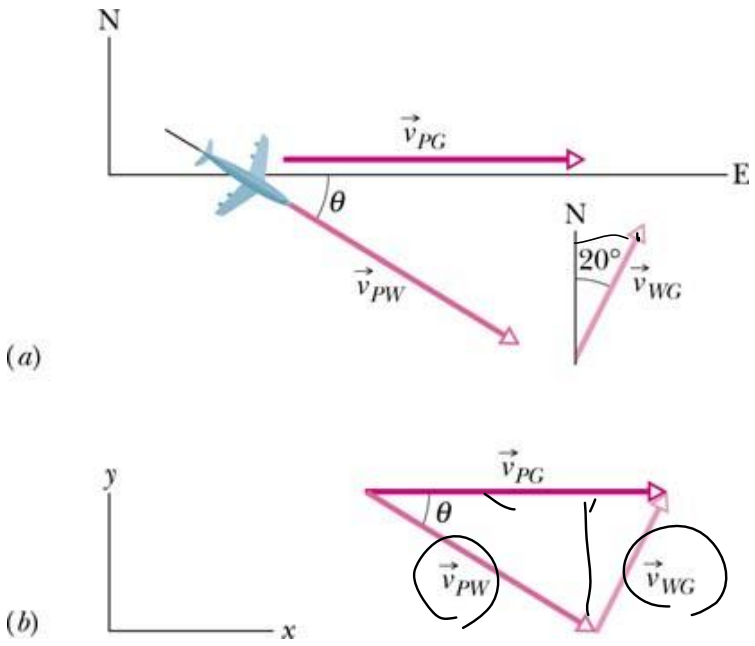


$$\vec{r}_{PA} = \vec{r}_{PB} + \vec{r}_{BA}$$

$$\frac{d}{dt}(\vec{r}_{PA}) = \frac{d}{dt}(\vec{r}_{PB}) + \frac{d}{dt}(\vec{r}_{BA})$$

$$\frac{d^2}{dt^2}(\vec{r}_{PA}) = \frac{d^2}{dt^2}(\vec{r}_{PB}) + \frac{d^2}{dt^2}(\vec{r}_{BA})$$

Sample problem



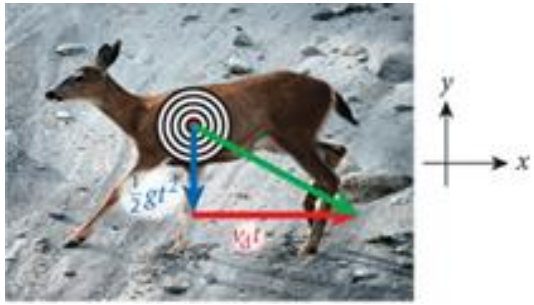
$$v_{PW}\sin\theta + v_{WG}\cos 20^\circ = 0$$

$$v_{PG} = v_{PW}\cos\theta + v_{WG}\sin 20^\circ$$

$$\vec{v}_{PG} = \vec{v}_{PW} + \vec{v}_{WG}. \qquad (4\text{-}46)$$

Problem 3.4 Moving deer

v_b | L



$$t = \frac{L}{v_b}$$

$$\Delta x = v_d t = \frac{L v_d}{v_b}$$

$$\Delta y = \frac{1}{2} g \frac{L^2}{v_b^2}$$

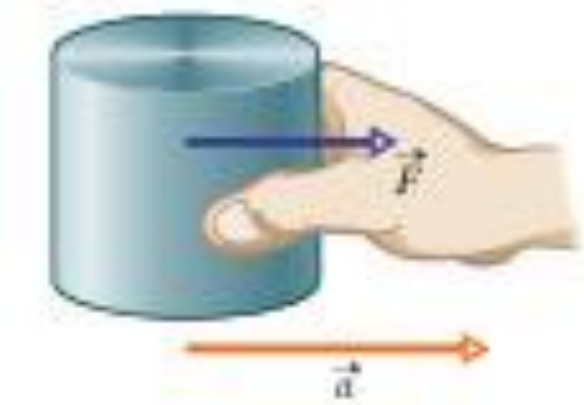
Chapter 4 Force

Motion of a particle

Force

velocity, acceleration

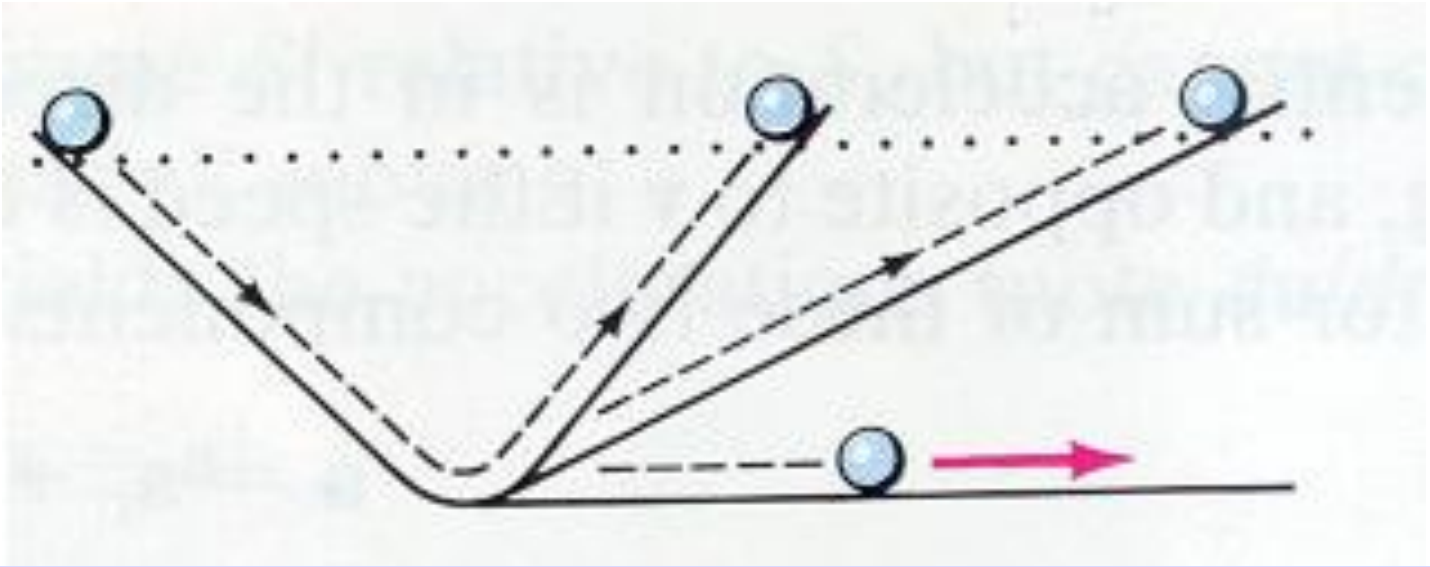
Force and acceleration



Cause for acceleration is Force.

→ Newton's law

Newton's 1st law



Law of inertia

If no force is acting on a body, the velocity of the body does not change.

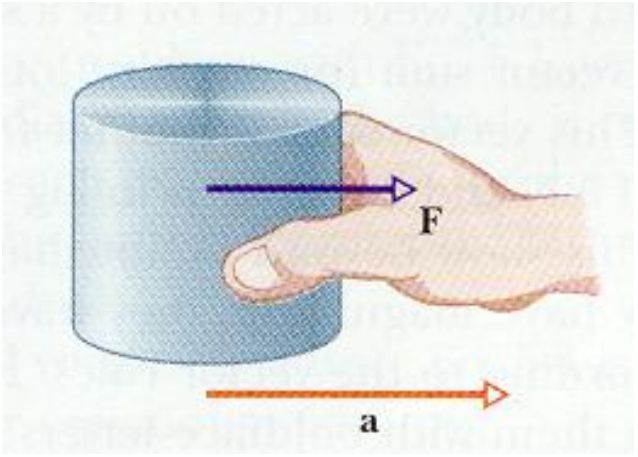
If the net force is 0, there exists a inertial reference frame with no acceleration.

Newton's 2nd law

$\vec{F} = m\vec{a}$

inertial mass

$F \propto a$



$[F] = LMT^{-2}$

Law of motion

If a force is acting on a body, the state of motion changes.

$$\mathbf{F} = \left[\frac{d\mathbf{p}}{dt} = \frac{d}{dt}(m\mathbf{v}) = m\frac{d\mathbf{v}}{dt} \right] = m\mathbf{a}$$

newton

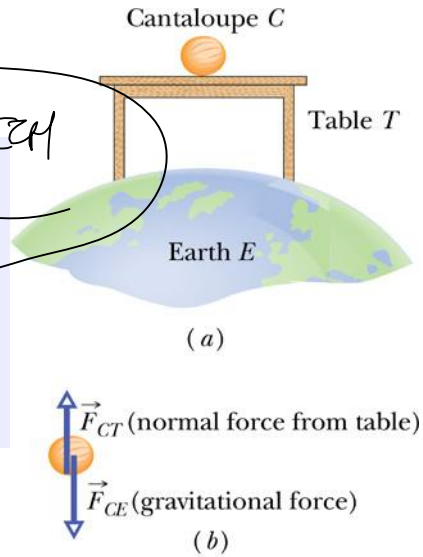
$$1\ \mathrm{N} = (1\ \mathrm{kg})(1\ \mathrm{m/s^2}) = 1\ \mathrm{kg \cdot m/s^2}.$$

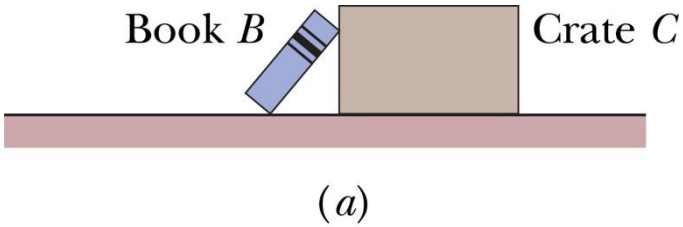
Newton's 3rd law

Law of action-reaction

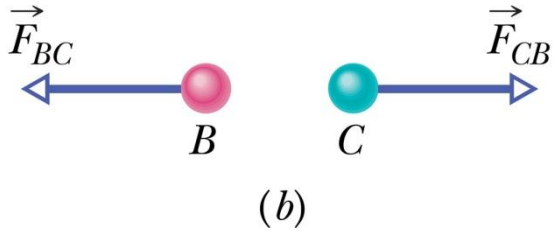
물체 A가 물체 B에 힘을 작용하면

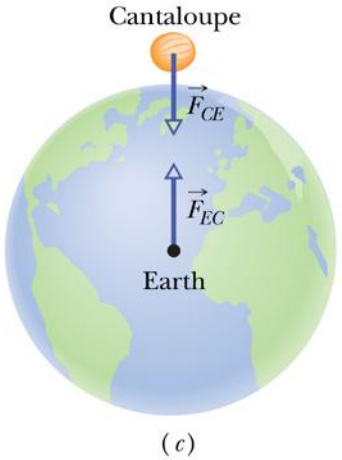
물체 B 도 물체 A 에 같은 크기의 힘을 작용한다.

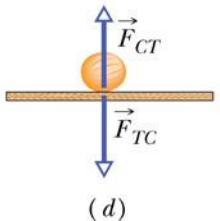




$$\mathbf{F}_{AB} = -\mathbf{F}_{BA}$$



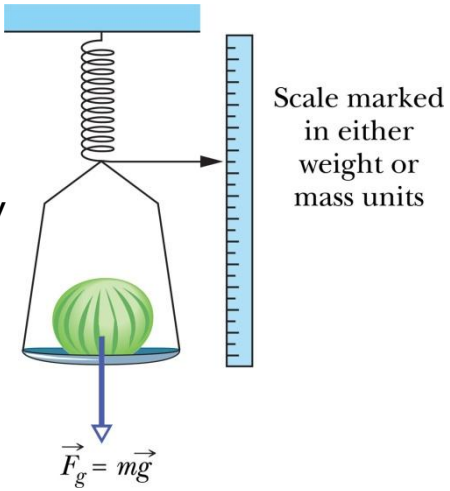


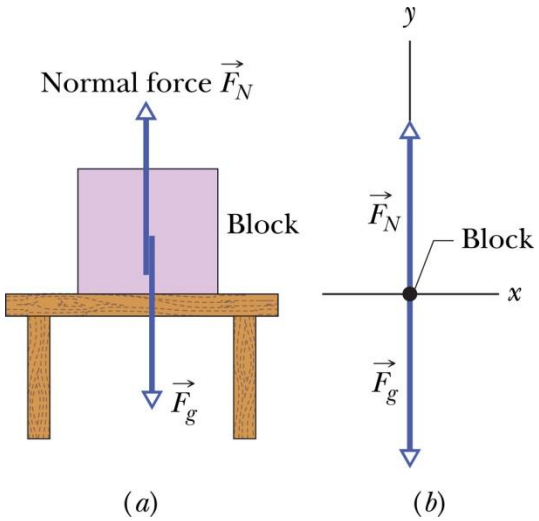


강의에서 많이 나타나는 힘들

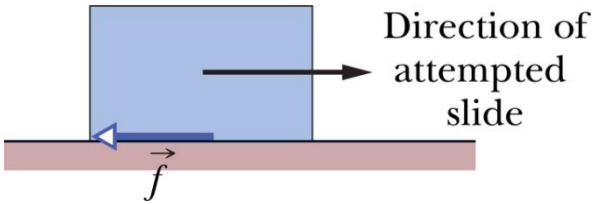
Normal force

gravity





Frictional force



tension