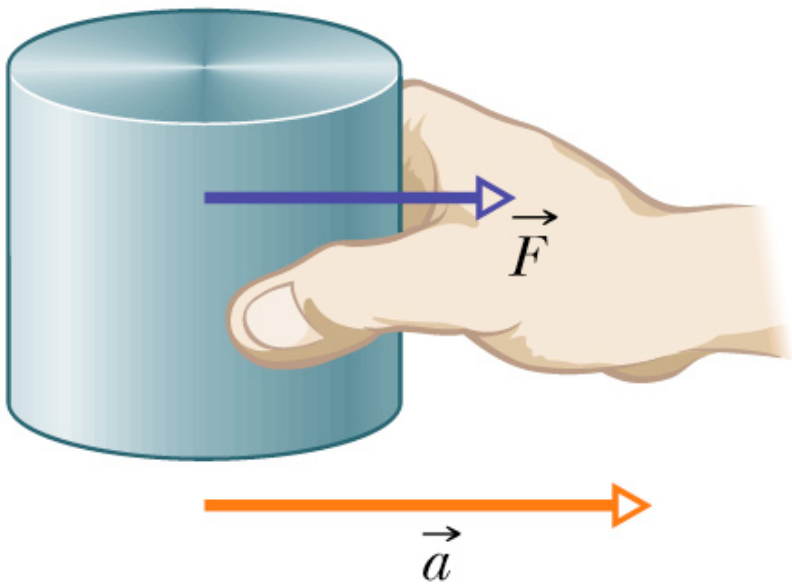
PHYS151
Lecture 05

Ch 05 Force and Motion - I

Eunil Won
Korea University

Force

What causes an acceleration? : An interaction that can cause an acceleration of a body is called a force



(We assume a horizontal frictionless plane here)

If a force moves an object of 1 kg with acceleration of 1 m/s^2, we define that amounts to 1 newton (N)

Force is a vector quantity (direction: same as the acceleration)

We represent a net force $\vec{F}_{net}$ as the vector sum of all the forces acting on a body:

Newton's First Law: if no net force acts on a body, ($\vec{F}_{net} = 0$) then the body's velocity cannot change

$$(\ \vec{a} = 0 \ )$$

Force

Inertial Reference Frame (관성기준틀): is the frame in which Newton's laws hold

ex) ground is an inertial frame if Earth's astronomical motions can be neglected

Newton's Second Law: The net force on a body is equal to the product of thee body's mass and the acceleration of the body

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

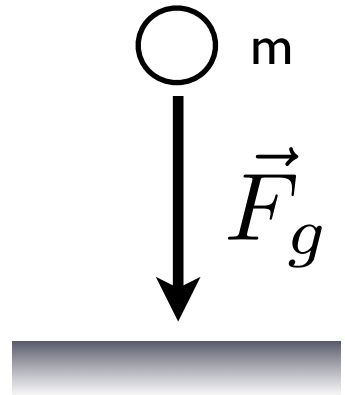
SI unit of the force: 1 N = (1 kg)(1 m/s^2) = 1 kg m/s^2

Some particular Forces

The gravitational force (중력) on a body: a pull that is directed toward a 2nd body

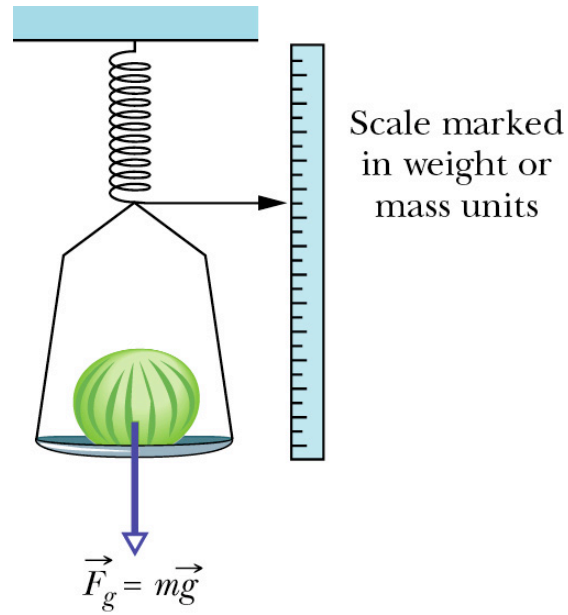
Note: This 2nd body is Earth in many cases

$$\vec{F}_g = -F_g\hat{j} = -mg\hat{j} = m\vec{g}$$



Weight (무게) : the magnitude of the net force required to prevent the body from falling freely

$$W = F_g = mg$$

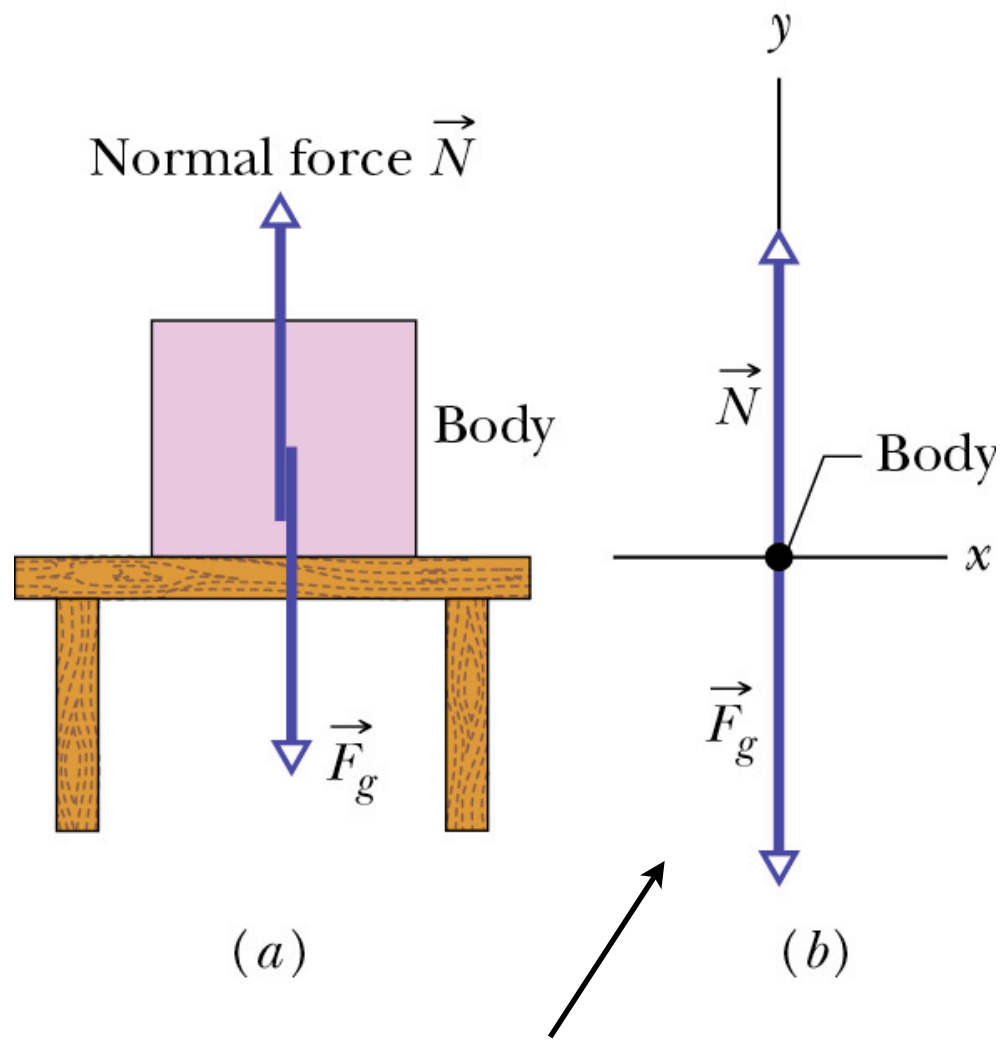


Some particular Forces

The normal force (수직힘) : when an object is stationary, there is a force that is normal to the surface that prevents the body from falling freely

If the table and block are not accelerating relative to the ground,

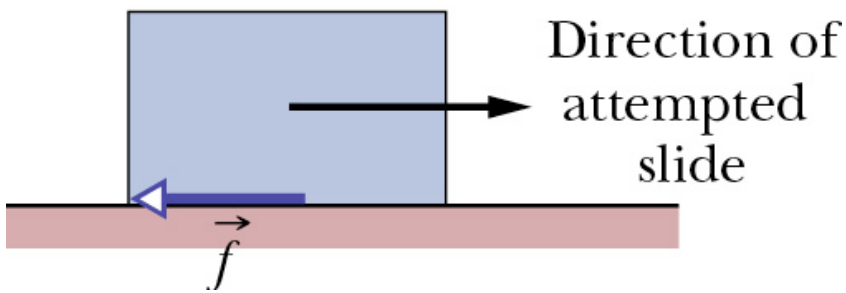
$$\vec{N} = -\vec{F}_g$$



By the way, this is called free-body diagram

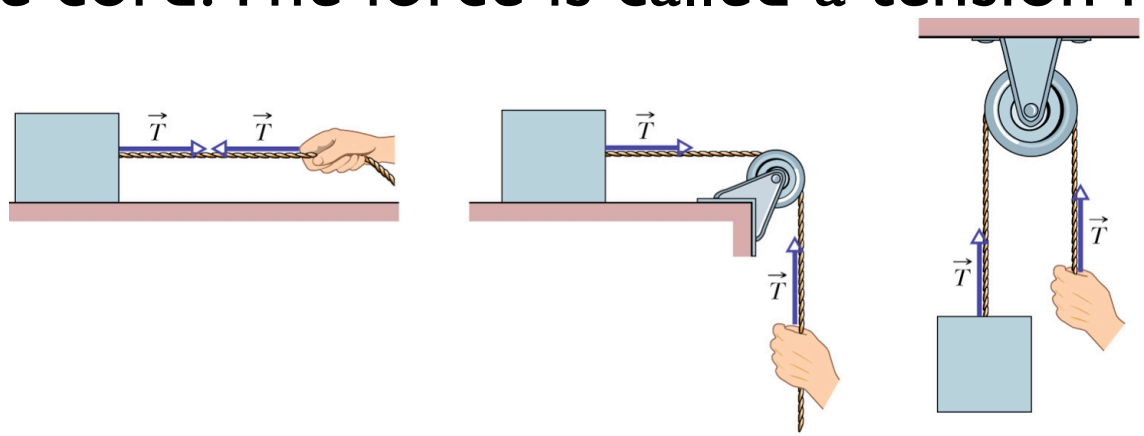
Some particular Forces

Friction : Even if a force $\vec{f}$ is applied to an object but can be stationary due to bonding between body and the surface. The resistance is called frictional force: $-\vec{f}$



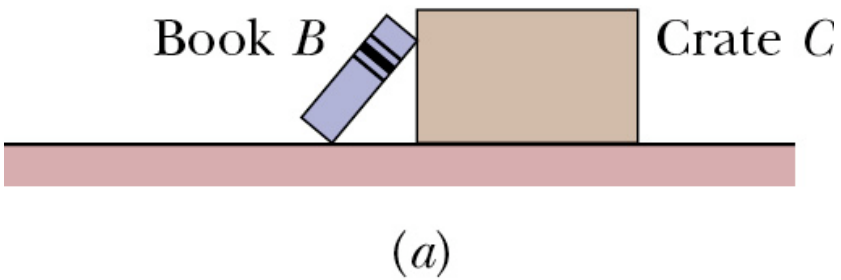
(A frictional force opposes the attempted slide of a body over a surface)

Tension : When a cord is attached to a body and pulled taut, the cord pulls on the body with a force $\vec{T}$ directed away from the body and along the cord. The force is called a tension force

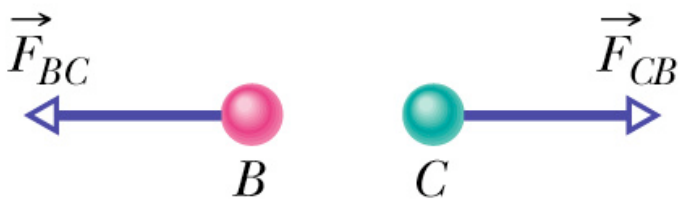


Newton's 3rd law

Newton's 3rd law : When two bodies interact, the forces on the bodies from each other are always equal in magnitude and opposite in direction



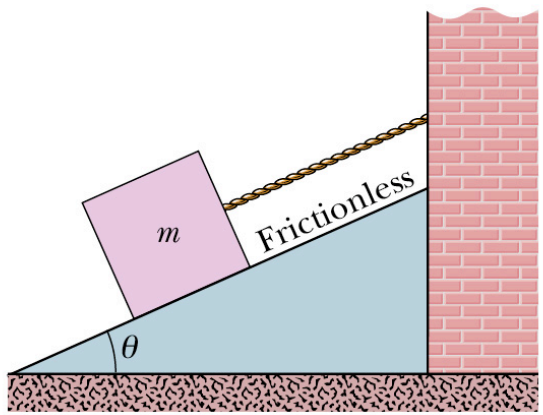
(a)



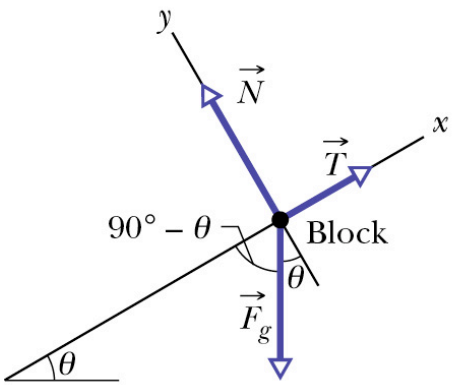
(b)

$$\vec{F}_{BC} = -\vec{F}_{CB}$$

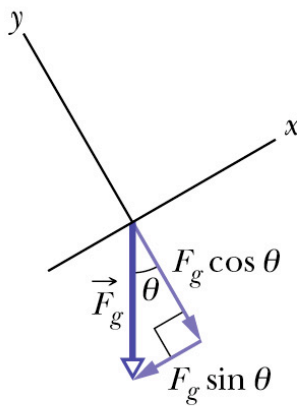
Applying Newton's Laws



(a)



(b)



(c)

m = 15 kg, angle = 27°

a) What are magnitude of the force $\vec{T}$ from the cord and the normal force $\vec{N}$ on the block from the plane?

$\vec{F}_{net} = m\vec{a}$ $\quad \vec{T} + \vec{N} + \vec{F}_g = 0$

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

$$\begin{aligned} T &= mg\sin\theta \\ &= (15kg)(9.8m/s^2)(\sin 27^0) \\ &= 67N. \end{aligned}$$

$$0 + N - mg\cos\theta = 0$$

$$\begin{aligned} N &= mg\cos\theta \\ &= (15kg)(9.8m/s^2)(\cos 27^0) \\ &= 131N. \end{aligned}$$

Summary

Newton's First Law: if no net force acts on a body, then the body's velocity cannot change

Newton's Second Law: The net force on a body is equal to the product of thee body's mass and the acceleration of the body

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

Newton's 3rd law : When two bodies interact, the forces on the bodies from each other are always equal in magnitude and opposite in direction