## Newton's first and second laws (5.1)

1. If no force acts on a body, the body's velocity cannot change; that is; the body cannot accelerate. Basically if a body or object is at rest then it will remain at rest unless another force acts upon the object. Similarly if an object is moving with a constant velocity it will remain travelling with the same velocity unless acted upon by another force.

note: Newton's first law only holds true in an inertial frame of reference, that is a viewpoint that is stationary with reference to the object that is moving.

2. The net force on a body is equal to product of the body's mass and acceleration.

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

## Some particular forces (5.2)

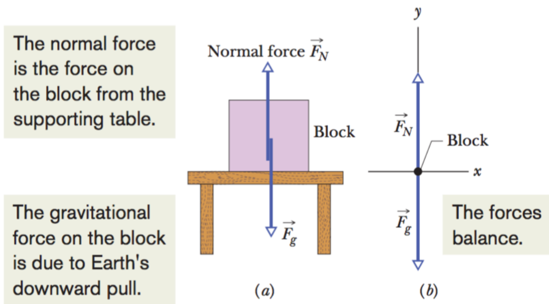
*Gravitational force*
Gravitational force is a certain type of pull that is directed towards second body (eg Earth). Free-fall is when the only force acting on a body is Earth's gravitational force (g), which can be represented by equation:

$$F_g = mg,$$

*Weight*
Weight (W) of a body is the magnitude of the net force required to prevent the body from free falling, as measured by someone on the ground. The weight of a body is equal to the the magnitude of the gravitational force on the body.

$$W = mg.$$

*The normal force*
When a body presses against a surface, the surface (even a seemingly rigid one) deforms and pushes on the body with a normal force that is perpendicular to the surface.




*Friction*
If a body is slid over a surface, the motion is resisted by a bonding between the body and the surface. The resistance is considered to be a single force called friction.

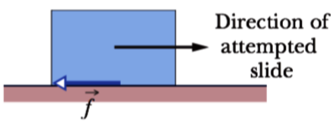
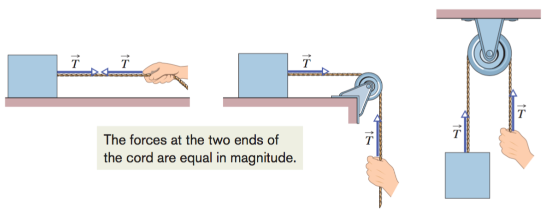



**Figure 5-8** A frictional force $\vec{f}$ opposes the attempted slide of a body over a surface.

*Tension*
When a cord is attached to a body and pulled taut, the cord pulls on the body with a force directed away from the body along the cord.




## Applying Newton's Laws (5.3)

3. When two bodies interact, the forces on the bodies from each other are always equal in magnitude and opposite in direction

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

## Friction (6.1)

- $f_{s;max}$ (maximum value of magnitude)
- $u_s$ (coefficient of static function)
- $F_N$ (Magnitude of the normal force)

$$f_{s,\max} = \mu_s F_N,$$

- $f_k$ (Magnitude of the frictional force)
- $u_k$ (coefficient f kinetic friction)
- $F_N$ (Magnitude of normal force)

$$f_k = \mu_k F_N,$$

## Kinetic Energy (7.1)

- K (kinetic energy, joules)
- m (mass)
- v (speed)

$$K = \tfrac{1}{2}mv^2$$

## Work and Kinetic Energy (7.2)

Work (W) is energy transferred to or from an object by means of a force acting on the object. Energy transferred to the object is positive work, and energy transferred from the object is negative work.

*Work done on a particle by a constant force.*

- *d is a force*
- *f is a force*
- $\phi$ is the angle between these two forces

$$W = Fd\cos\phi = \vec{F}\cdot\vec{d}$$

- $\triangle K$ (equal to the net work done)
- $K_f$ (final kinetic energy)
- $K_i$ (initial kinetic energy)

$$\Delta K = K_f - K_i = W$$

Therefore this equation can be deduced: $K_f = K_i + W.$

*Units for work*

$$1\ \text{J} = 1\ \text{kg}\cdot\text{m}^2/\text{s}^2 = 1\ \text{N}\cdot\text{m} = 0.738\ \text{ft}\cdot\text{lb}.$$

## Work done by the gravitational force (7.3)

- $W_g$ (work done by gravitational force)
- m (mass of object)
- g (gravitational constant, Earth: 9.8m/s$^2$)
- d (displacement)
- $\phi$ (angle between the two forces)

$$W_g = mgd\cos\phi,$$

Equations similar to above can then be deduce:

$$\Delta K = K_f - K_i = W_a + W_g.$$

If $K_f = K_i$, then the equation reduces to

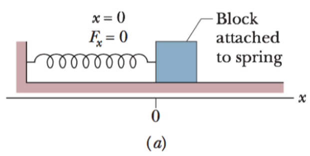
$$W_a = -W_g,$$

## Work done by a spring force (7.4)

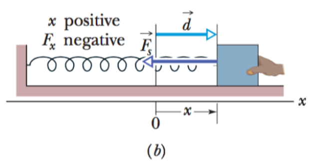
$$\vec{F}_s = -k\vec{d} \qquad \text{(Hooke's law)},$$

- $F_s$ (Force from the spring)
- k (Spring constant, a measure of the spring stiffness)
- d (displacement of spring from its relaxed position)

Relaxed Spring -




Extended Spring -




Compressed Spring -