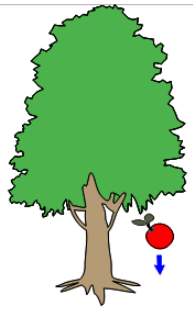
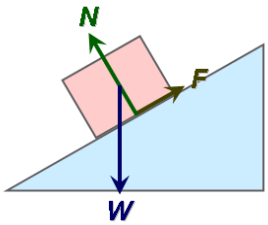
Forces and Motion

Kinematics



Describes the motion of an object without considering the cause.

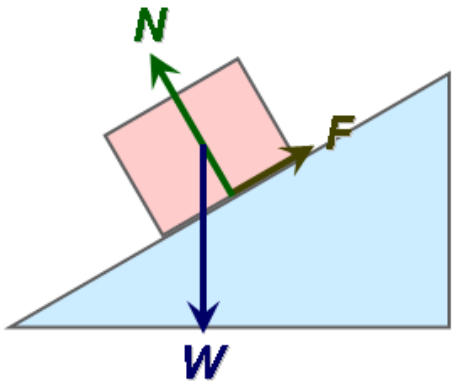
Dynamics



Study of the effects of forces on matter.

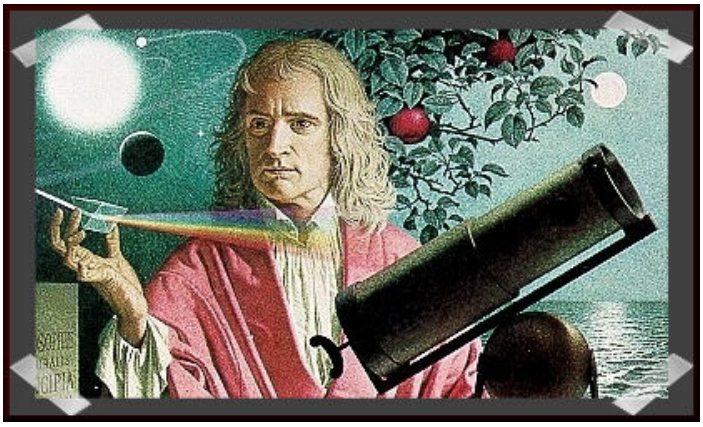
Dynamics

Forces cause or tend to cause motion. The relationships between force and matter are the most basic of all scientific concepts. Anytime two or more objects interact, forces are the cause.
There are no exceptions.
All changes in motion are the result of forces.



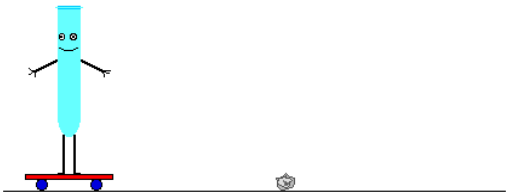
Isaac Newton

In 1665, Newton stated three laws that are now known as Newton's three laws of motion. The three laws are basic to the science of physics and anytime forces act on matter, these laws are followed.



Law of Inertia (Newtons 1st Law)
Law of Acceleration (Newton's 2nd Law)
Law of Interaction (Newton's 3rd Law)

Law of Inertia



Every object will continue in a state of rest or with uniform motion unless acted upon by an unbalanced external or net force.

Examples
- stopping a car quickly
- table cloth
- sharp turn

http://teachertech.rice.edu/Participants/louviere/Newton/law1.html

So... 4 key points

a) Objects at rest tend to remain at rest

b) Objects in motion tend to remain in motion

c) If the velocity of an object is constant, the net external force acting on it must be zero. (acceleration is zero!)

d) If the velocity of an object is changing in either magnitude or direction or both, the change must be caused by a net external force acting on the object.

Law of Acceleration

When a net force acts on an object, the object accelerates in the direction of the net force. The acceleration is directly proportional to the net force and inversely proportional to the mass. Newton's 2nd Law can be defined mathematically as:

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

Examples:

- hitting a golf ball
- shooting a puck
- pushing a car
- shooting a bullet / canon

Examples:

1. A 1.5 Kg box accelerates across a smooth table top at 16 m/s^2. What unbalanced force was applied to the mass?

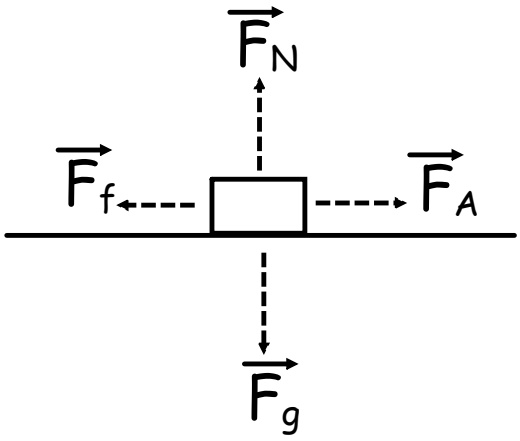
2. An object moving at a constant velocity has an unbalanced force of 20.0 N, and a mass of 37.5 Kg act on it.
What is the acceleration while the force is acting upon it?

3. A race car undergoes a uniform acceleration of 8.00 m/s^2. If the unbalanced force causing this acceleration is 6.0×10^3 N, What would the mass of the race car be?

4. A car having a mass of 710 Kg starts from rest and goes 120 m in 3.0 s. The car undergoes uniform acceleration during that 3.0 s. What unbalanced force is being applied to the car?

5. An artillery shell has a mass of 55 Kg. The shell is fired from the muzzle of the gun at 77.0 m/s. The length of the barrel is 1.50 m. Assuming the force and acceleration is constant while the shell is in the gun barrel, what is the force that acts on the shell while it is in the barrel?

Newton's 2nd law applies to his first law by stating that in a given situation the mass multiplied by the acceleration will give the ***net*** force applied. This is applied in any direction.



$\vec{F}_{NET} = \vec{F}_A + \vec{F}_f$ (horizontally)

$\vec{F}_{NET} = \vec{F}_g + \vec{F}_N$ (vertically)

and

$F_{NET} = ma$ (Newtons 2nd Law)

What would happen to the net force if the force applied were causing the box to move at a constant speed?

Example:

A person pushes a crate weighing 5.0 kg with a force of 10.0 N. If the frictional force between the crate and ground is 2.0 N, with what acceleration is the crate moving?

Remember that all forces behave the same under Newtons second law.

What if an object is in free-fall?

$F_{NET} = \vec{F}_g = m\vec{a}$ (but what is acceleration here?)

$\vec{F}_{NET} = m\vec{g}$ (in free fall)

The **force of gravity** is also known as the **weight**

Handout on Newton's 2nd Law