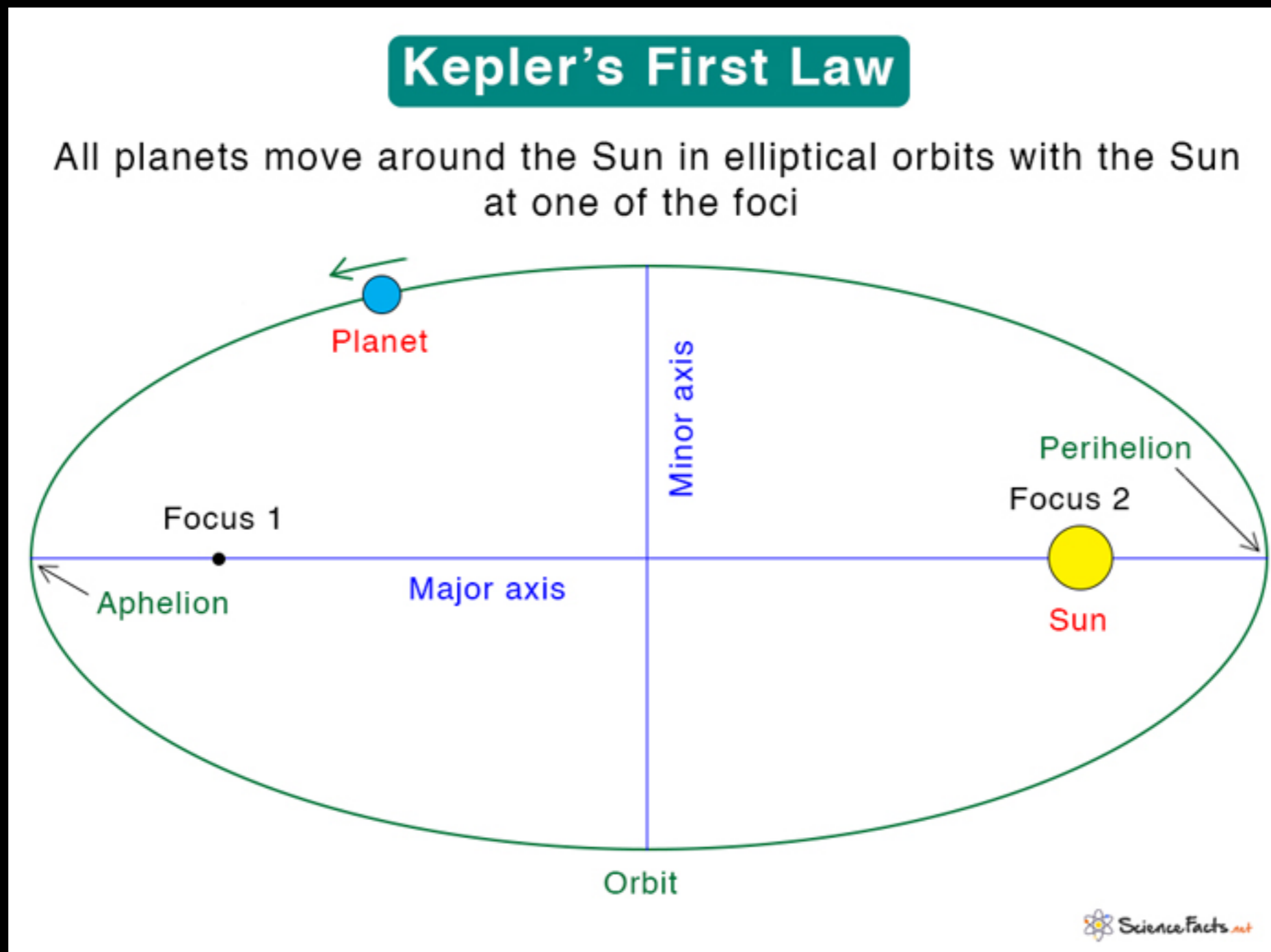


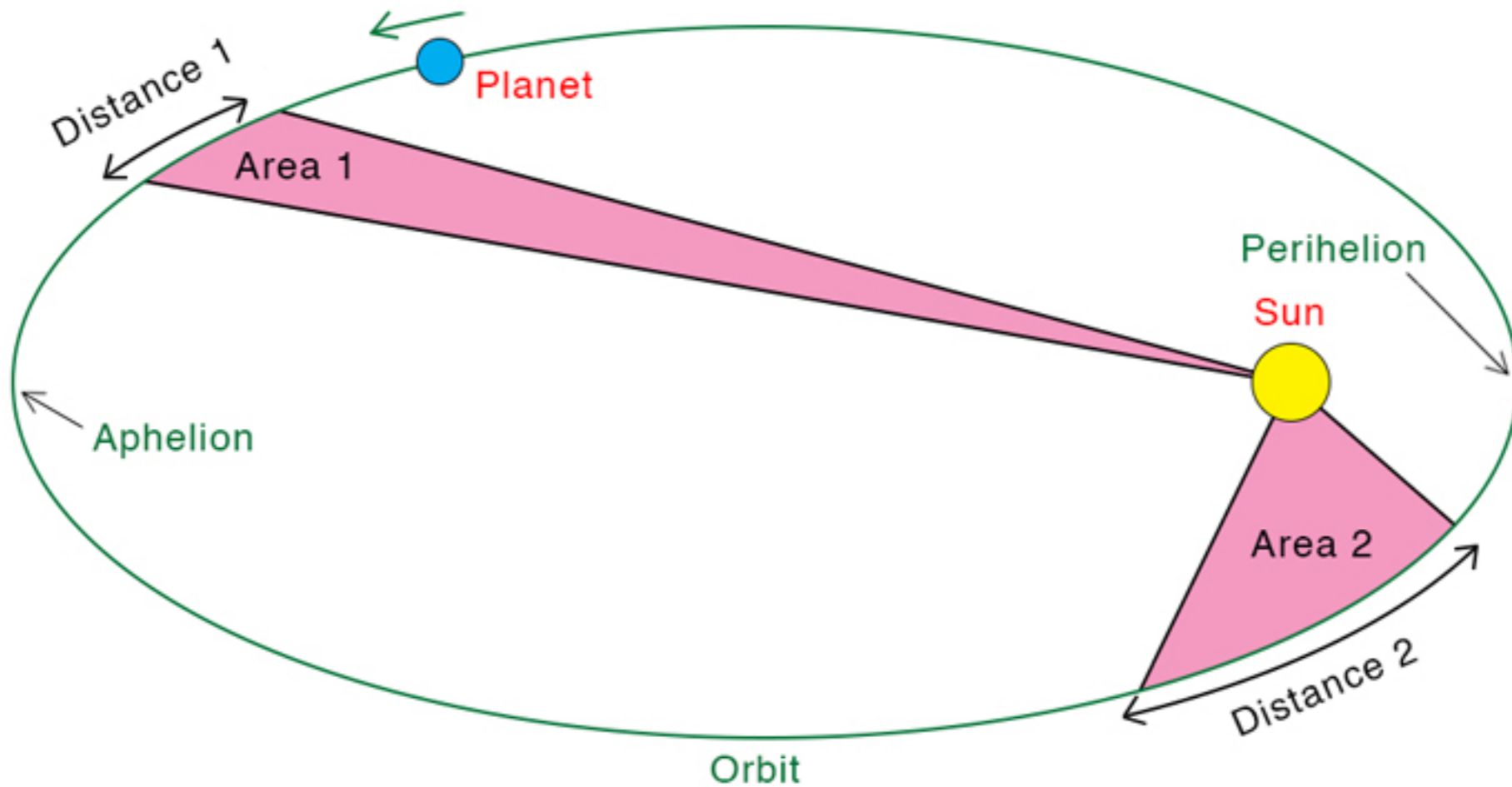
Planets orbit around the Sun, stars can orbit around each other (called binary stars). Both follow the same laws.



Kepler developed, using Tycho Brahe's observations, the first kinematic description of orbits, Newton will develop a dynamic description that involves the underlying influence (gravity)

Kepler's Second Law

A planet sweeps out equal areas in equal intervals of time

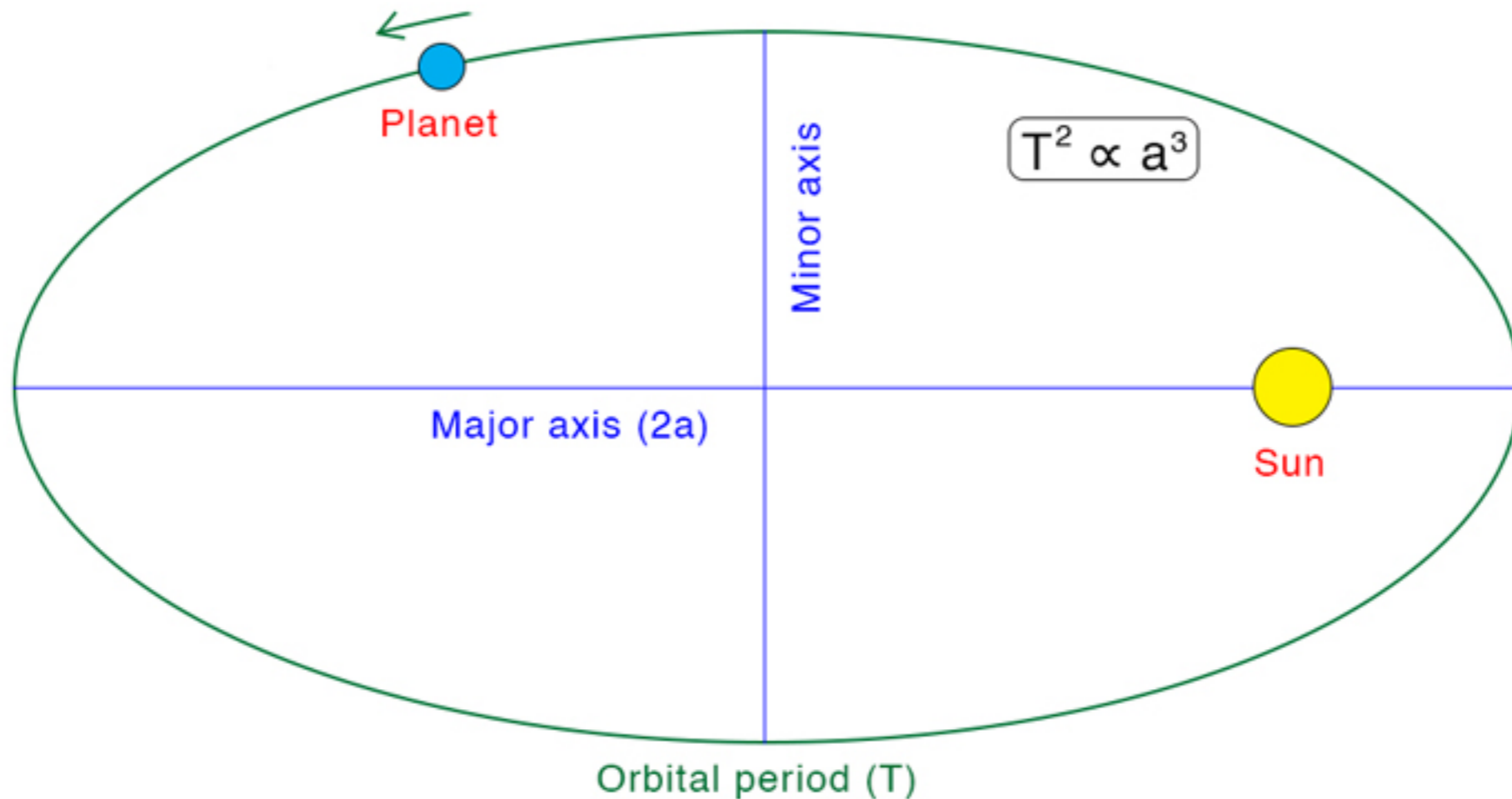


$$\text{Time taken to travel distance 1} = \text{Time taken to travel distance 2} \Rightarrow \text{Area 1} = \text{Area 2}$$

Notice that Kepler's 2nd law also states that objects move the fastest when closest to the Sun


Kepler's Third Law

The square of the orbital period of a planet is proportional to the cube of the orbit's semi-major axis




Kepler's 3rd law is the "yardstick" law, you know the distance of an object from the Sun if you know its orbital period

1st Law



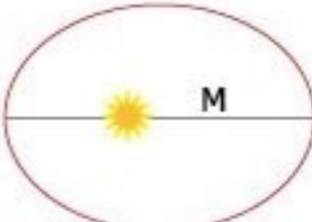
Ellipse

2nd Law



Equal area in the same time
area $S_1 = \text{area } S_2$

3rd Law



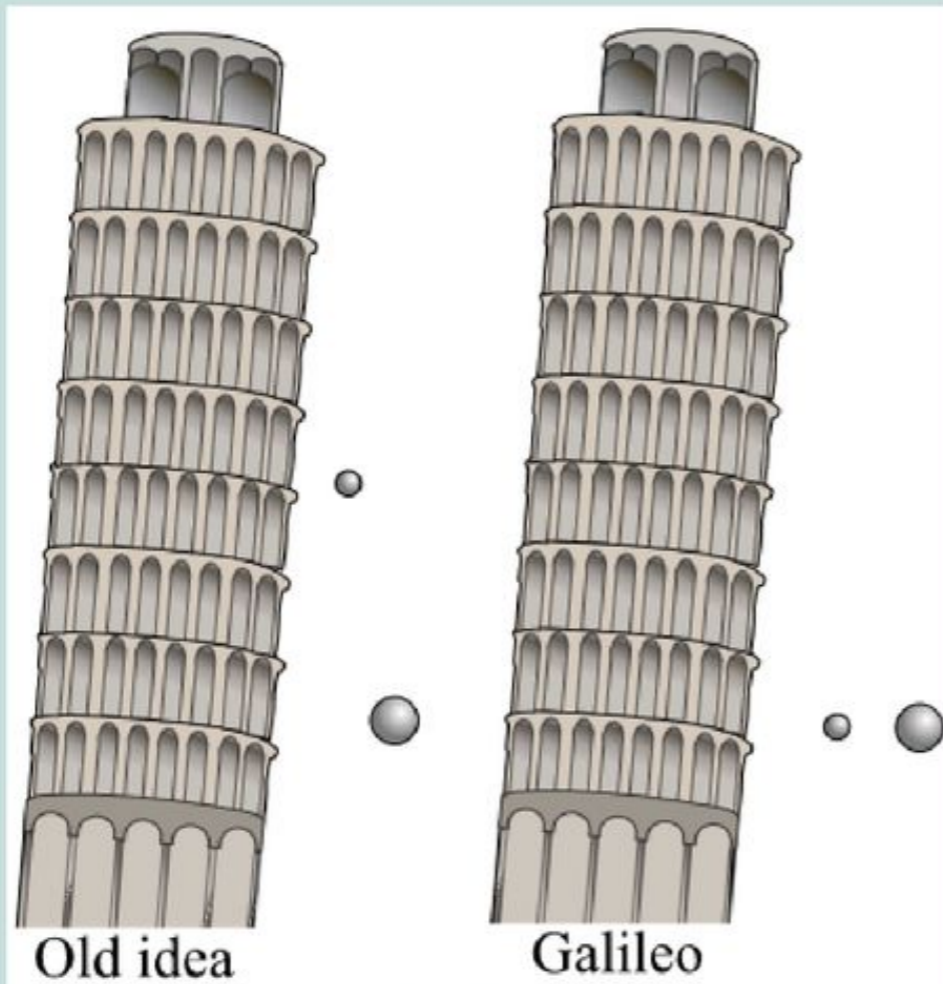
P: period (the time for one cycle)
M: length of the major axis

P^2/M^3 is the same for all planets

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Newton will add mass to the 3rd law, so that if you know an objects distance and period, you can calculate its mass

Galileo's cannon balls



In 1589, so the story goes, the Italian scientist **Galileo Galilei** took **two cannon balls** of different weight to the top of the **Tower of Pisa** and dropped them off the side.

Both balls **landed at the same time**. This showed that the weight of an object does not change how fast it falls - **heavy objects do not fall faster than light ones**.

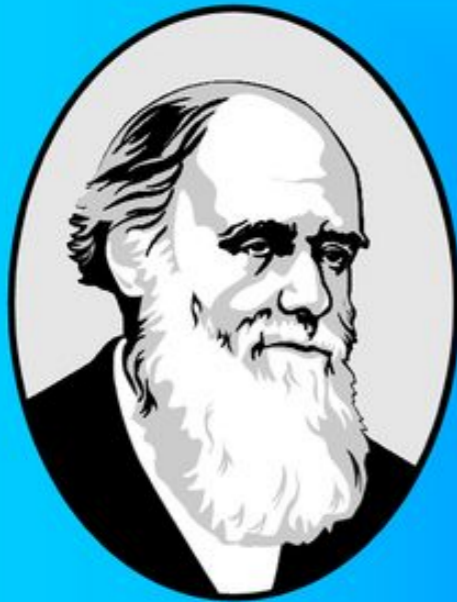
Pisa experiment by Galileo Galilei.
Drawn by Theresa Knott



Galileo used incline planes to develop his laws of motion

- 1) developed the concept of motion in terms of velocity (speed and direction) through the use of inclined planes
- 2) developed the idea of force, as a cause for motion
- 3) determined that the natural state of an object is rest or motion, i.e. objects always have a velocity, sometimes that velocity has a magnitude of zero = rest
- 4) objects resist change in motion, which is called inertia.

What is gravity?



Galileo

Galileo and Newton gave the name **gravity** to the force that exists between the Earth and objects.



Sir Isaac Newton

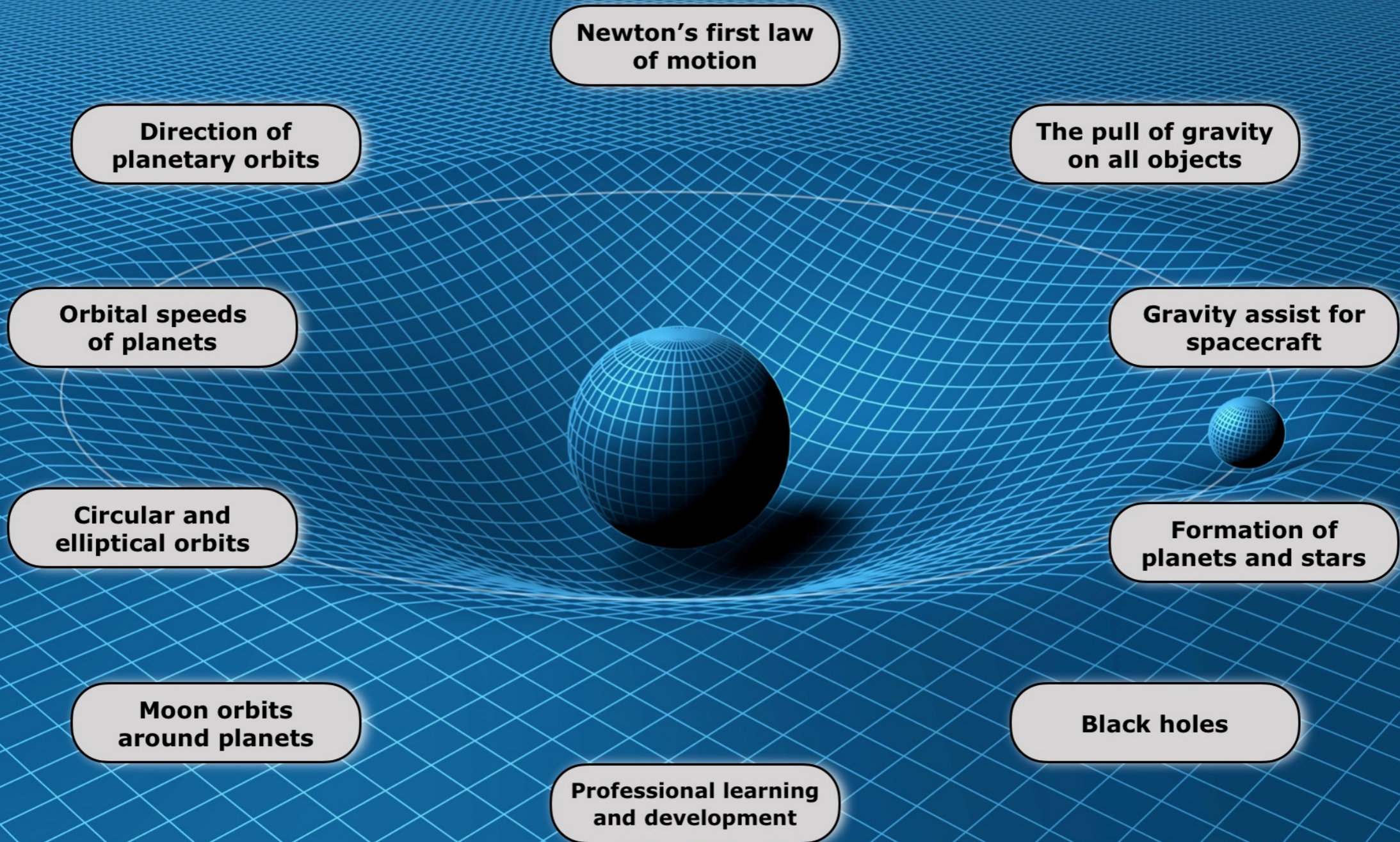
Newton showed that the **same force** exists between **all** objects.

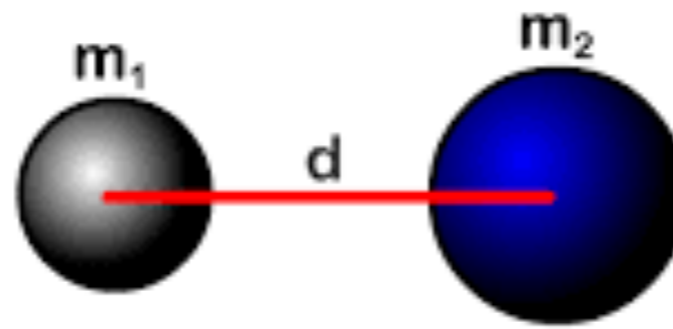
Even today, **no one knows** exactly why objects attract each other.



The fact that the same force that makes an apple fall off a tree is the same force that makes the planets and stars move is called the insight of Newton's apple

EXPLORING PHYSICS CONCEPTS WITH A GRAVITY WELL





$$F_g = \frac{G m_1 m_2}{d^2}$$

$$G = 6.67 \times 10^{-11} \frac{\text{Nm}}{\text{kg}^2}$$

Mass of object 1 times, Mass of object 2

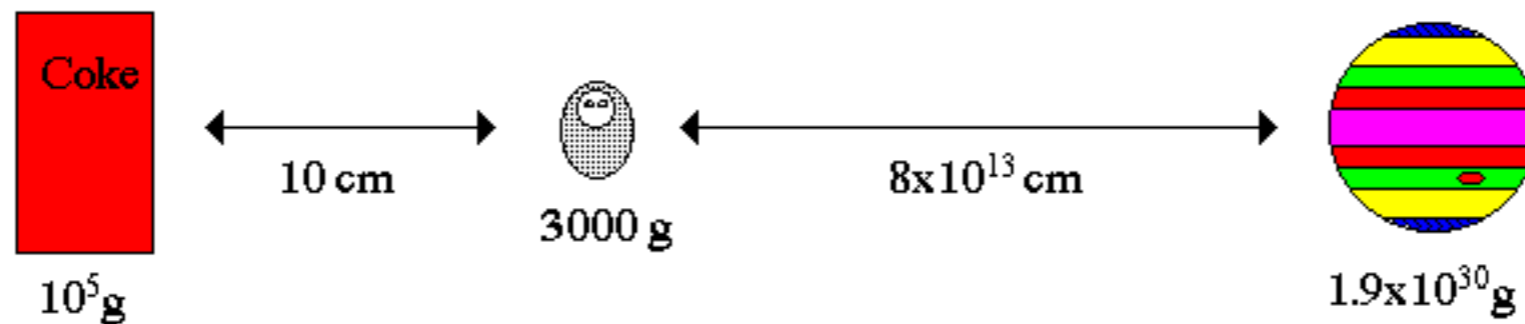
$$F = G \frac{m_1 m_2}{r^2}$$

Force, equals, Gravity times

Newton's Law of Gravity

Divided by, distance between the center of those two objects, squared

Example: what is the force of gravity from Jupiter on you at birth compared to the force of gravity from a nearby Coke machine?

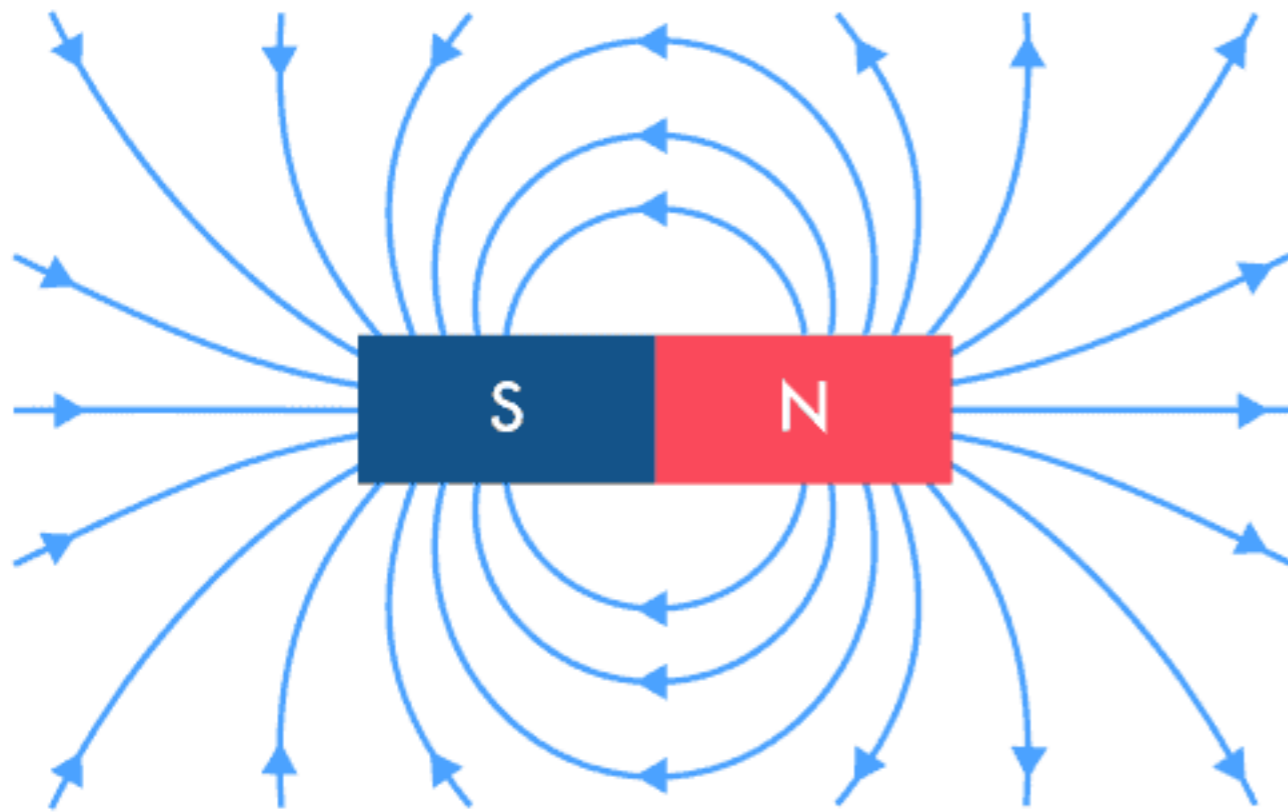


$$F_{\text{Coke}} = \frac{G(10^5 \text{ g})(3000 \text{ g})}{(10 \text{ cm})^2}$$
$$= 2 \times 10^{-1} \text{ dynes}$$

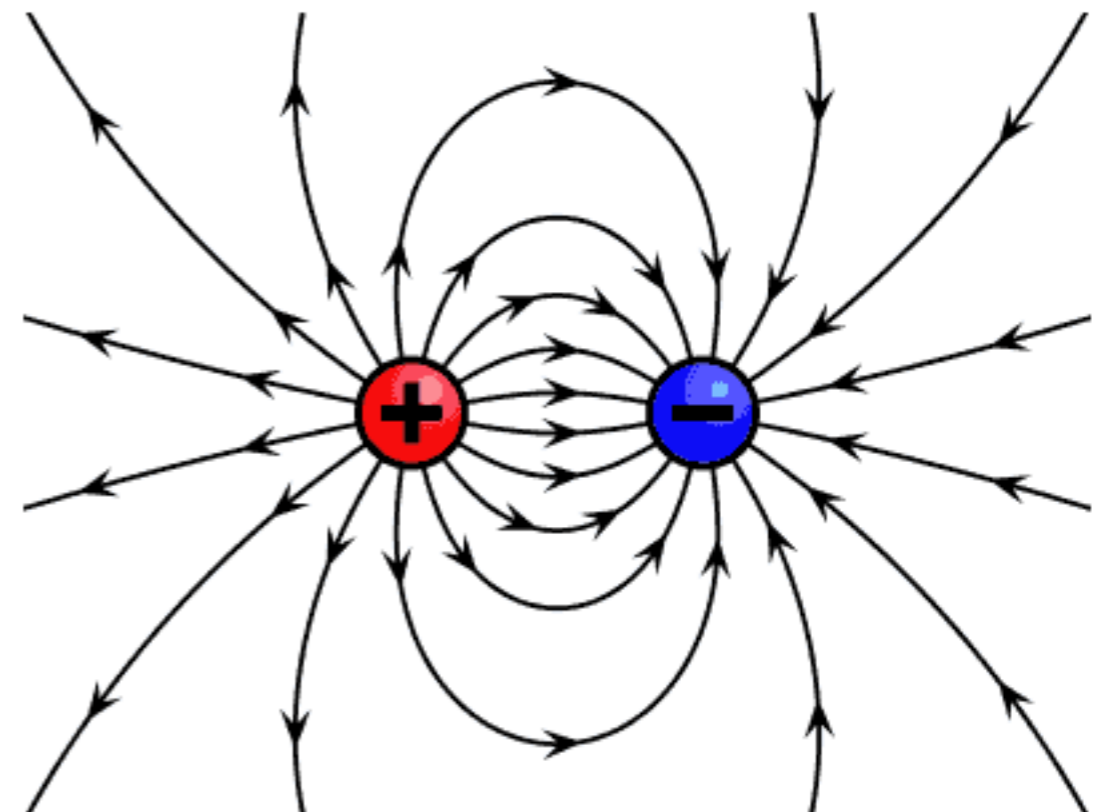
$$F_{\text{Jupiter}} = \frac{G(1.9 \times 10^{30} \text{ g})(3000 \text{ g})}{(8 \times 10^{13} \text{ cm})^2}$$
$$= 5.9 \times 10^{-2} \text{ dynes}$$

therefore, the force of gravity from the Coke machine is about 3 times more than the force of gravity from Jupiter.

Magnetic Field vs. Electric Field



Magnetic Field



Electric Field

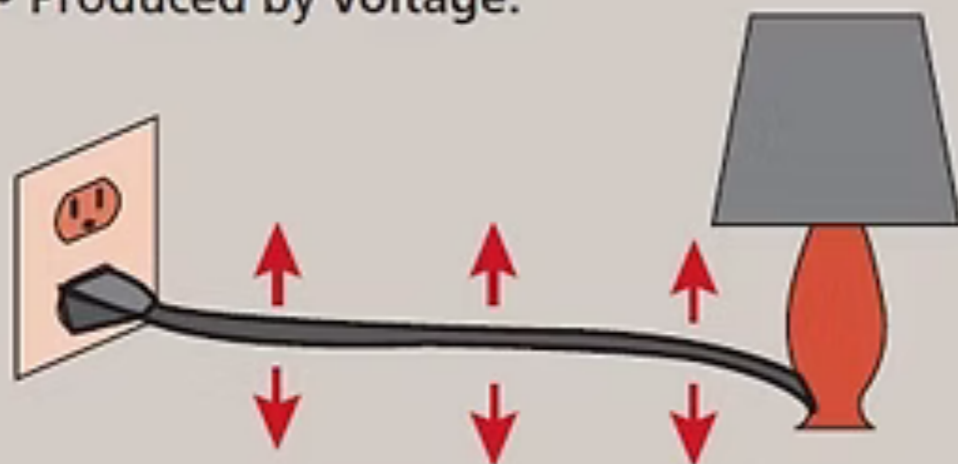
WWW.ELECTRICALTECHNOLOGY.ORG

Although conceived of as distinct phenomena until the 19th century, electricity and magnetism are now known to be components of the unified theory of electromagnetism.

The objects effected by electric and magnetic forces are charged particles (positive and negative) and magnetic poles (north and south).

Electric Fields

- Produced by voltage.

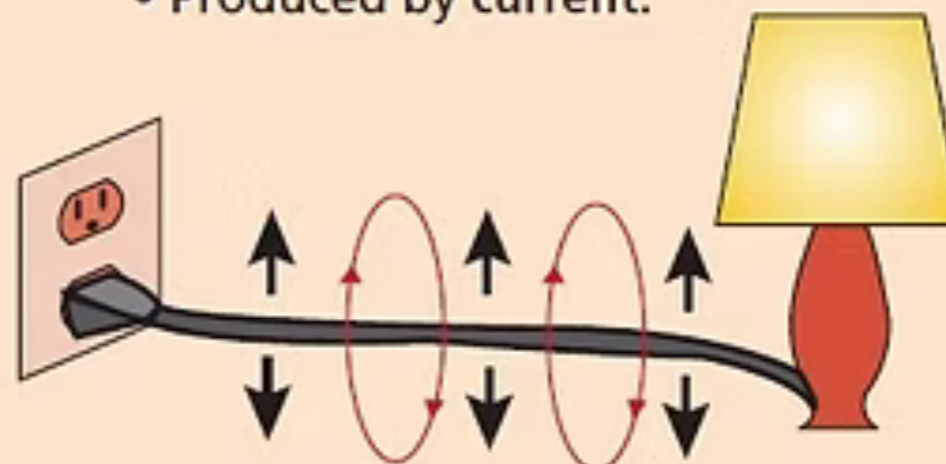


Lamp plugged in but turned off.
Voltage produces an electric field.

- Measured in volts per meter (V/m)

Magnetic Fields

- Produced by current.



Lamp plugged in and turned on. Current
now produces a magnetic field also.

- Measured in gauss (G) or tesla (T).

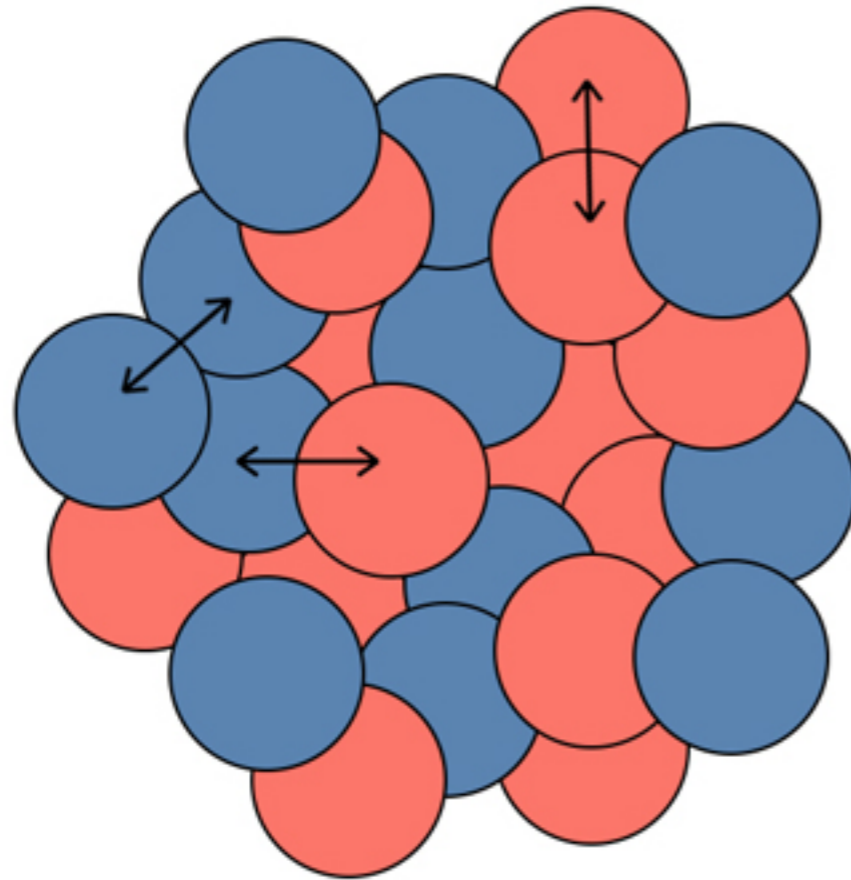
Magnetism vs Electricity

Comparison Chart

Electricity	Magnetism
The movement of electrons or electric charge is called electricity.	Magnetism is an interaction between moving charges.
It is an invisible force, a phenomenon that occurs due to electric charges.	It is a byproduct of electricity which occurs when electric charges begin to move or change.
Electric monopoles exist in the form of particles with positive or negative electric charges.	Magnetic monopoles do not exist because magnetic charges are produced in opposite pairs.
Electricity is present where there is a static charge or presence of moving charges.	Magnetism is caused by the motion of electric charges so it is present where there are moving charges.
Electricity is used everywhere from lighting, heating, and cooling to computers, machinery and electronics appliances and more.	Magnets are used on the doors of refrigerators and freezers or to store data on computers, or in compass needles, etc.

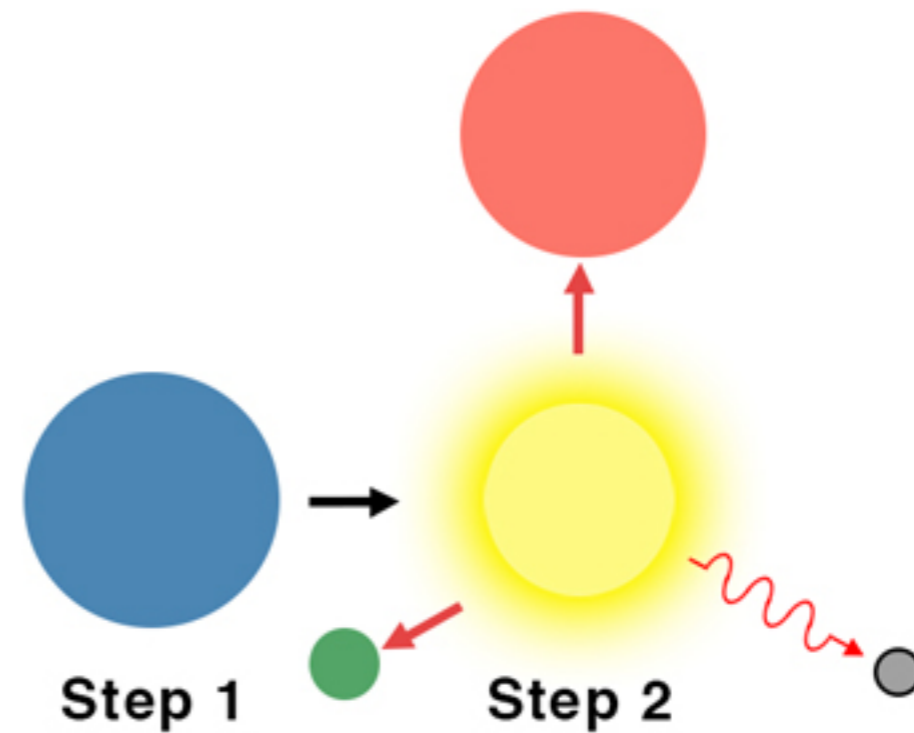
Nuclear Force

1. Strong



● Neutron ● Proton

2. Weak



● Electron ● Antineutrino

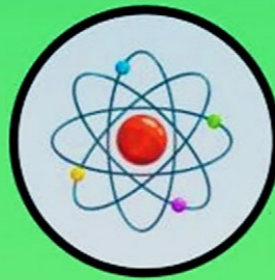
ScienceFacts.net

The strong and weak force only occur inside the nucleus of atoms. The strong force binds quarks into protons, neutrons and mesons, and holds the nucleus of the atom together despite the repulsive electromagnetic force between protons. The weak force controls the radioactive decay of atomic nuclei and the reactions between leptons (electrons and neutrinos).

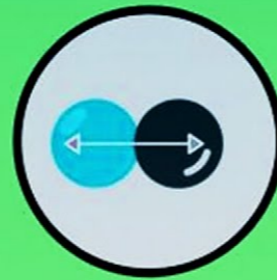
4 FUNDAMENTAL FORCES



Gravitation



Electro-magnetism



Strong Force



Weak Force

Leptons	Strong	Electromagnetic
<p>Electric Charge</p> <p>Tau -1 0 Tau Neutrino</p> <p>Muon -1 0 Muon Neutrino</p> <p>Electron -1 0 Electron Neutrino</p>	<p>Gluons (8)</p> <p>Quarks</p> <p>Mesons Baryons</p> <p>Nuclei</p>	<p>Photon</p> <p>Atoms Light Chemistry Electronics</p>
<p>Quarks</p> <p>Electric Charge</p> <p>Bottom $-1/3$ $2/3$ Top</p> <p>Strange $-1/3$ $2/3$ Charm</p> <p>Down $-1/3$ $2/3$ Up</p> <p>each quark: R, B, G 3 colours</p>	<p>Gravitational</p> <p>Graviton ?</p> <p>Solar system Galaxies Black holes</p>	<p>Weak</p> <p>Bosons (W,Z)</p> <p>Neutron decay Beta radioactivity Neutrino interactions Burning of the sun</p>