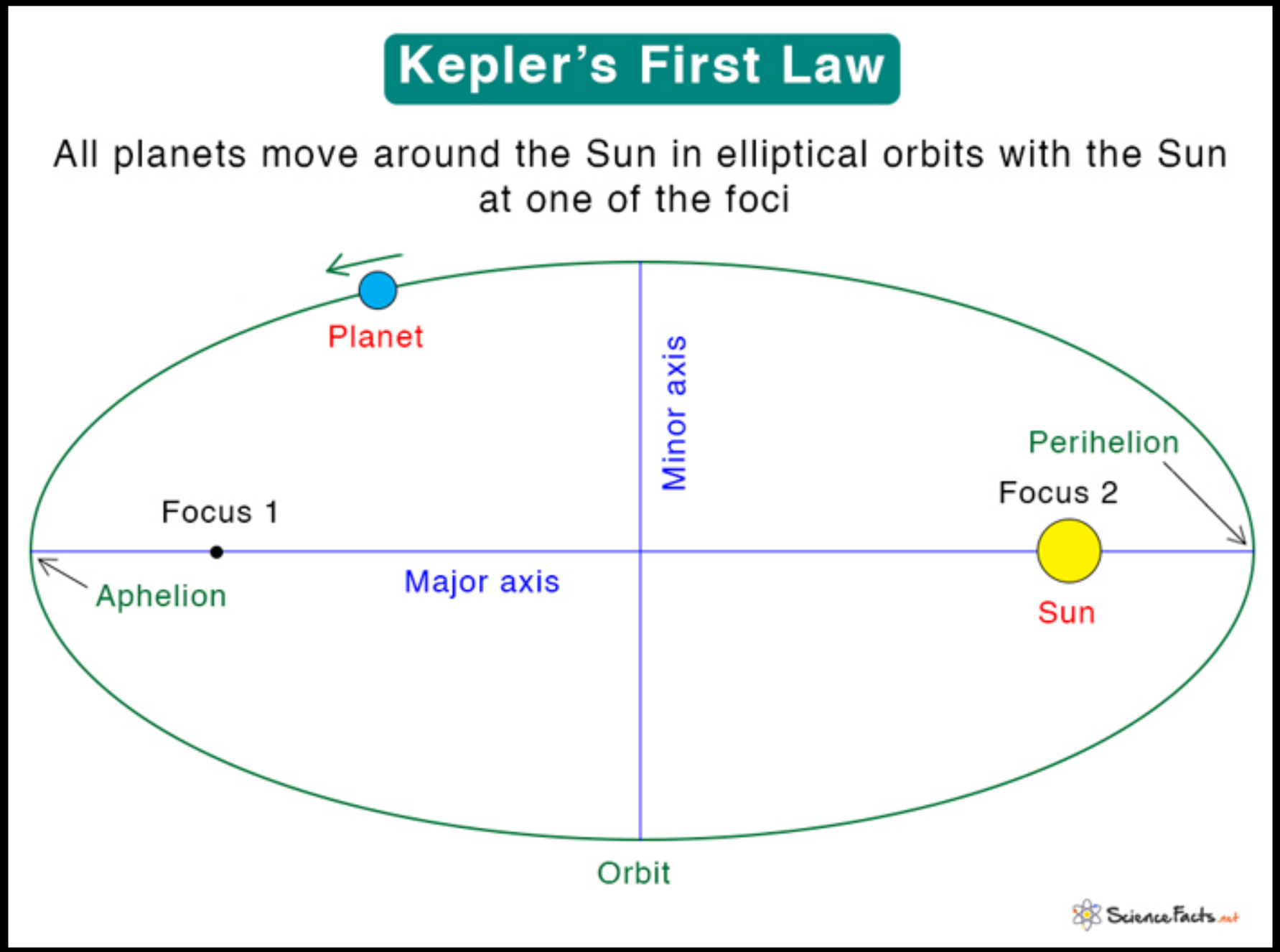
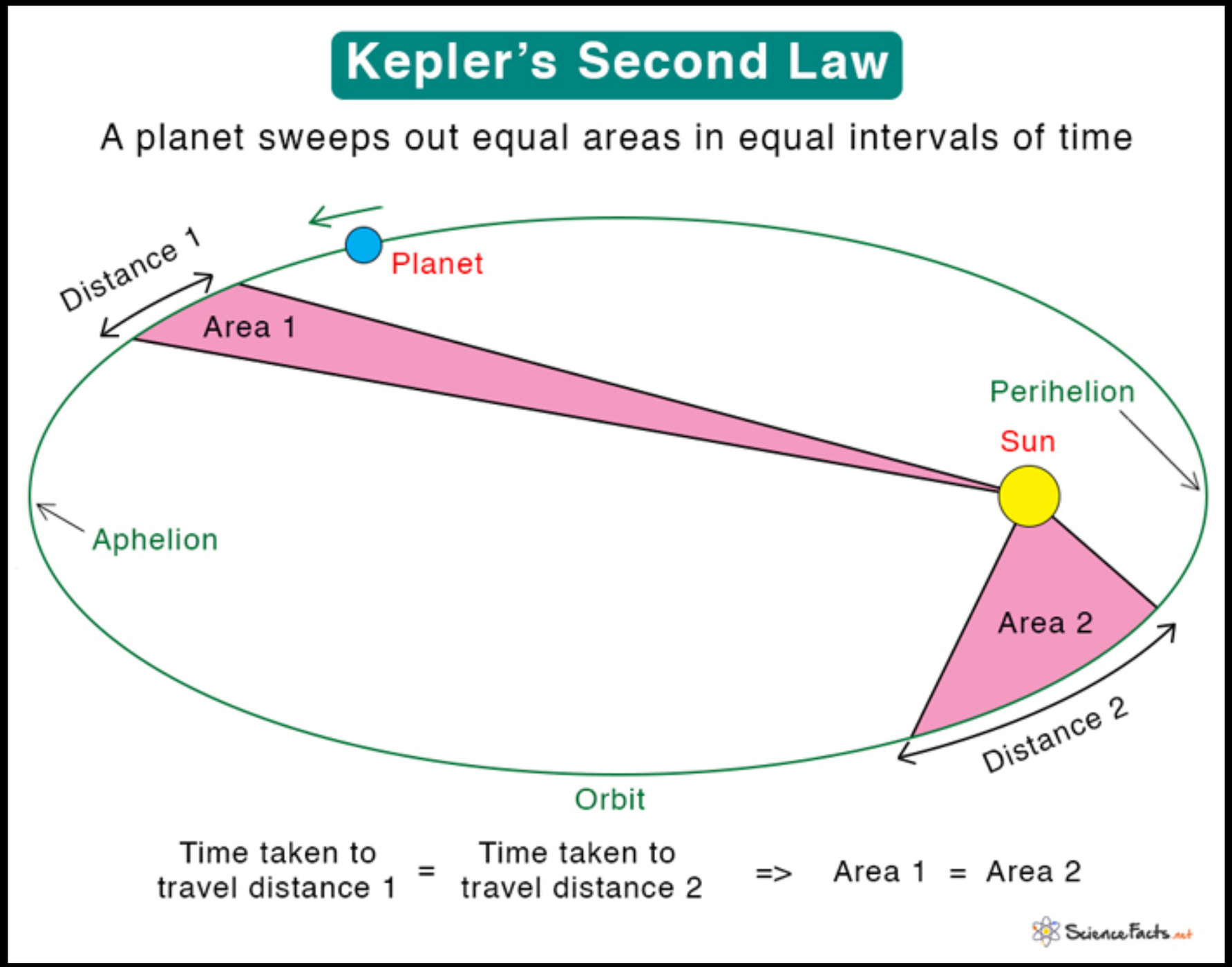
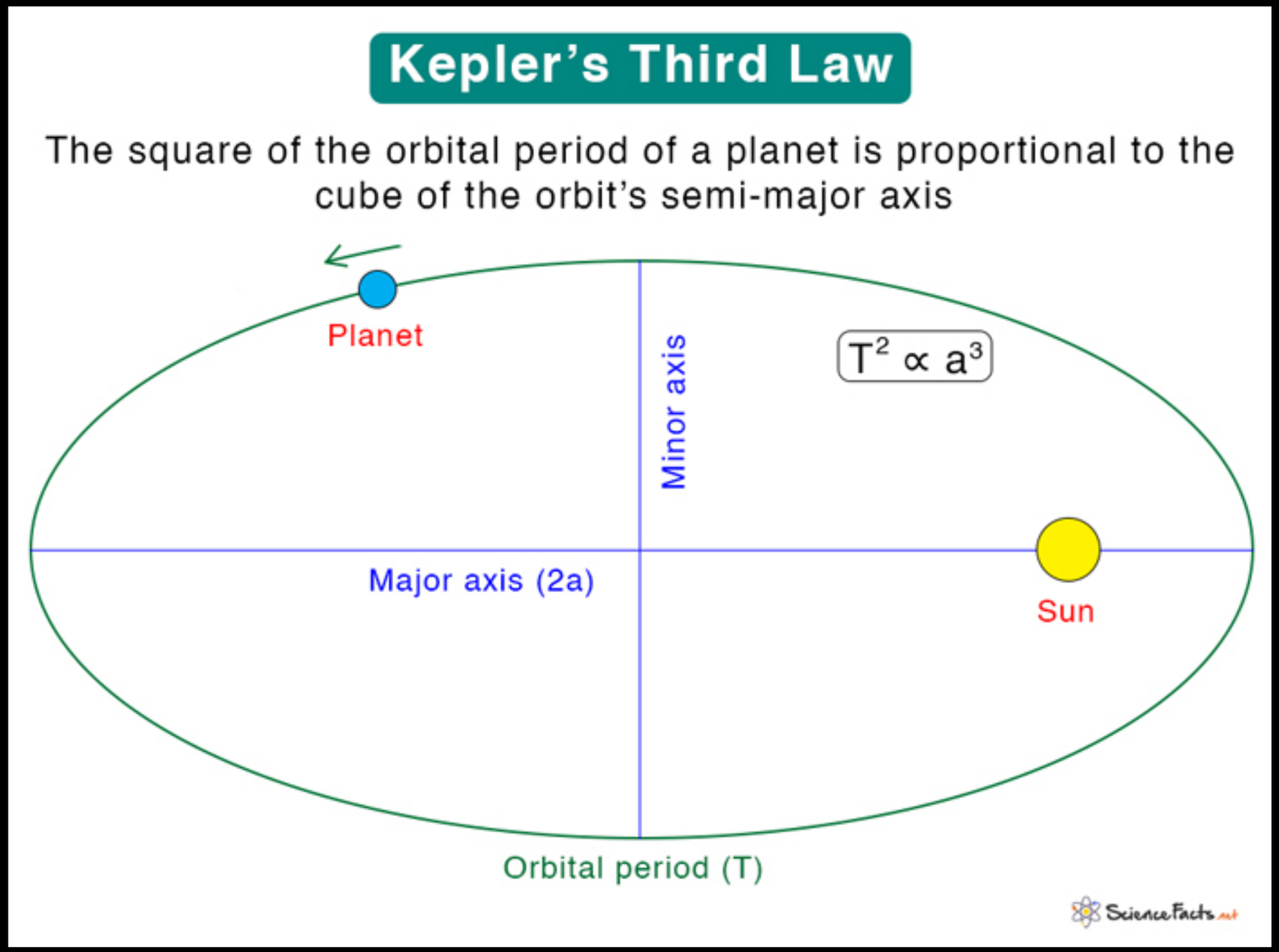
Planets orbit around the Sun, stars can orbit around each other (called binary stars). Both follow the same laws.



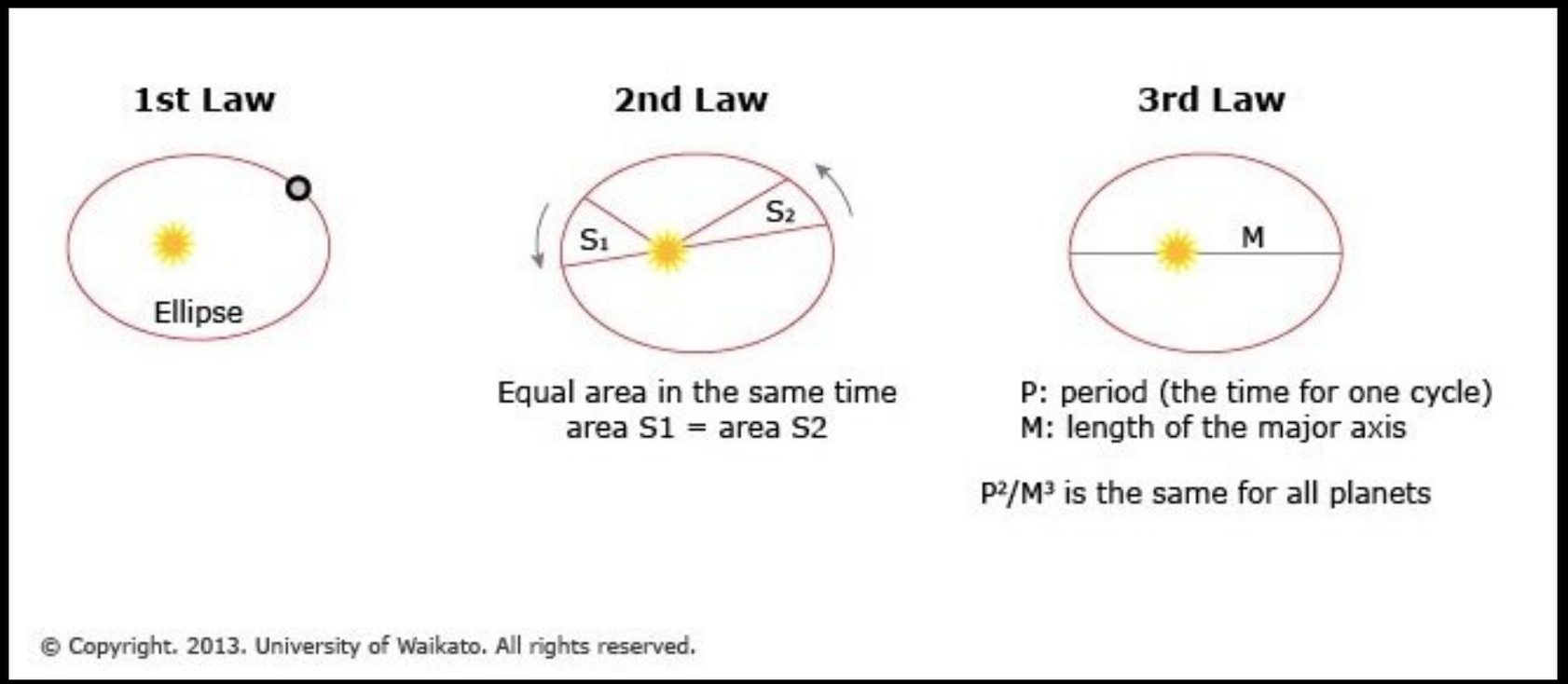
Kepler developed, using Tycho Brahe's observations, the first kinematic description of orbits, Newton will develop a dynamic description that involves the underlying influence (gravity)



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

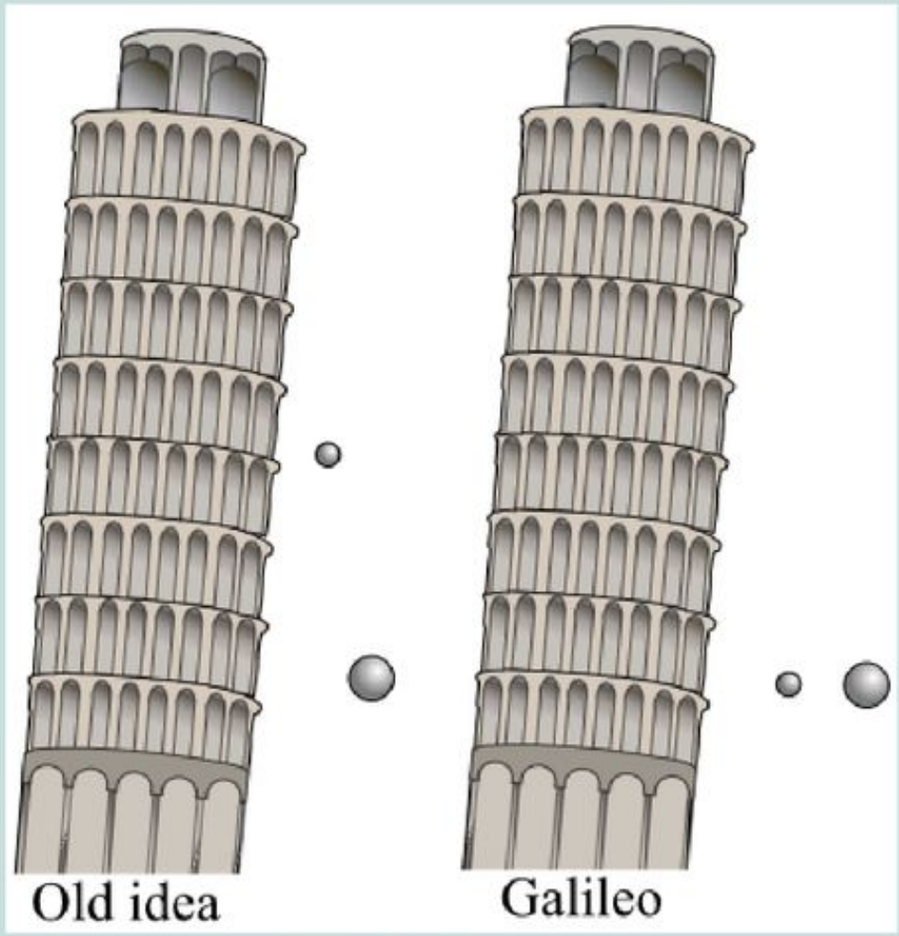


Kepler's 3rd law is the "yardstick" law, you know the distance of an object from the Sun if you know its orbital period



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



Pisa experiment by Galileo Galilei.
Drawn by Theresa Knott

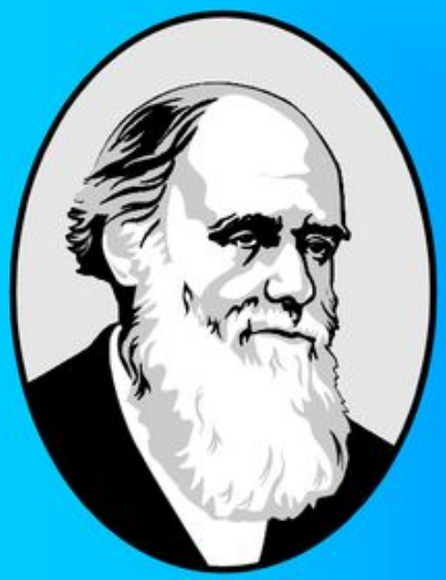
In 1589, so the story goes, the Italian scientist **Galileo Galilei** took **two cannon balls** of different weight to the top of the **Tower of Pisa** and dropped them off the side.

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**.

Galileo used incline planes to develop his laws of motion

1) developed the concept of motion in terms of velocity (spe
   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 v
   has a magnitude of zero = rest
4) objects resist change in motion, which is called inertia.

What is gravity?



Galileo

Sir Isaac Newton

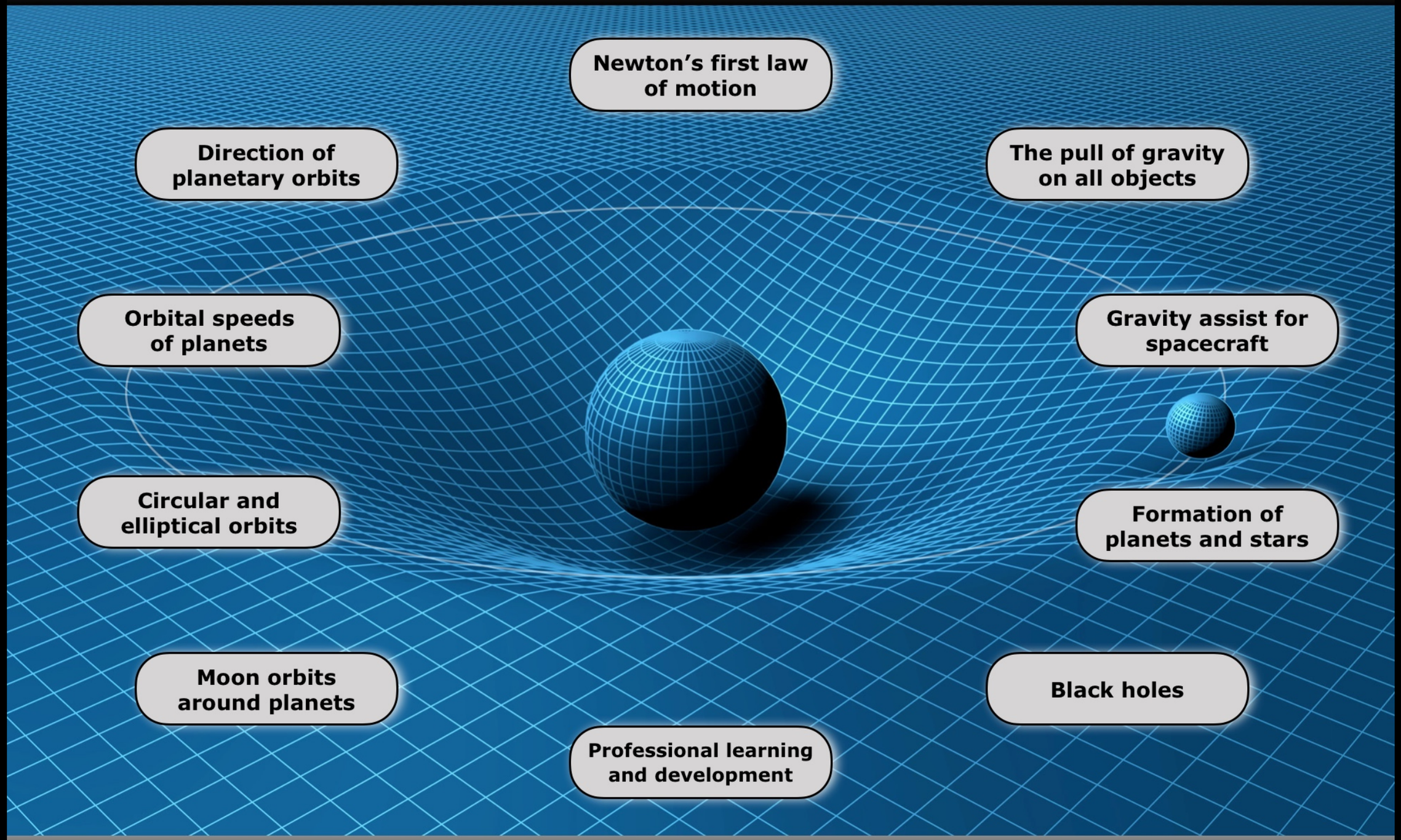
Galileo and Newton gave the name **gravity** to the force that exists between the Earth and objects.

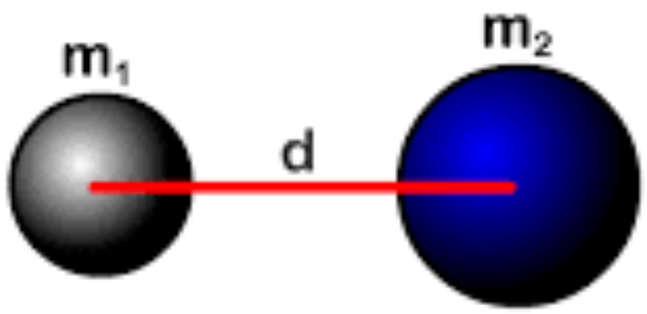
Newton showed that the same force exists between all objects.

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





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

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

Mass of object 1 times, Mass of object 2

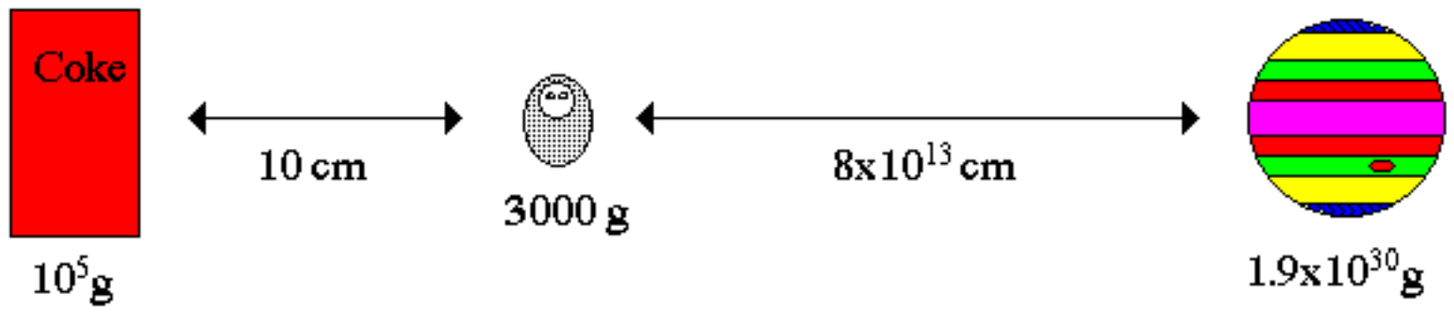
$$F = G\frac{m_1 m_2}{r^2}$$

Force, equals, Gravity times

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

Newton's Law of Gravity

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

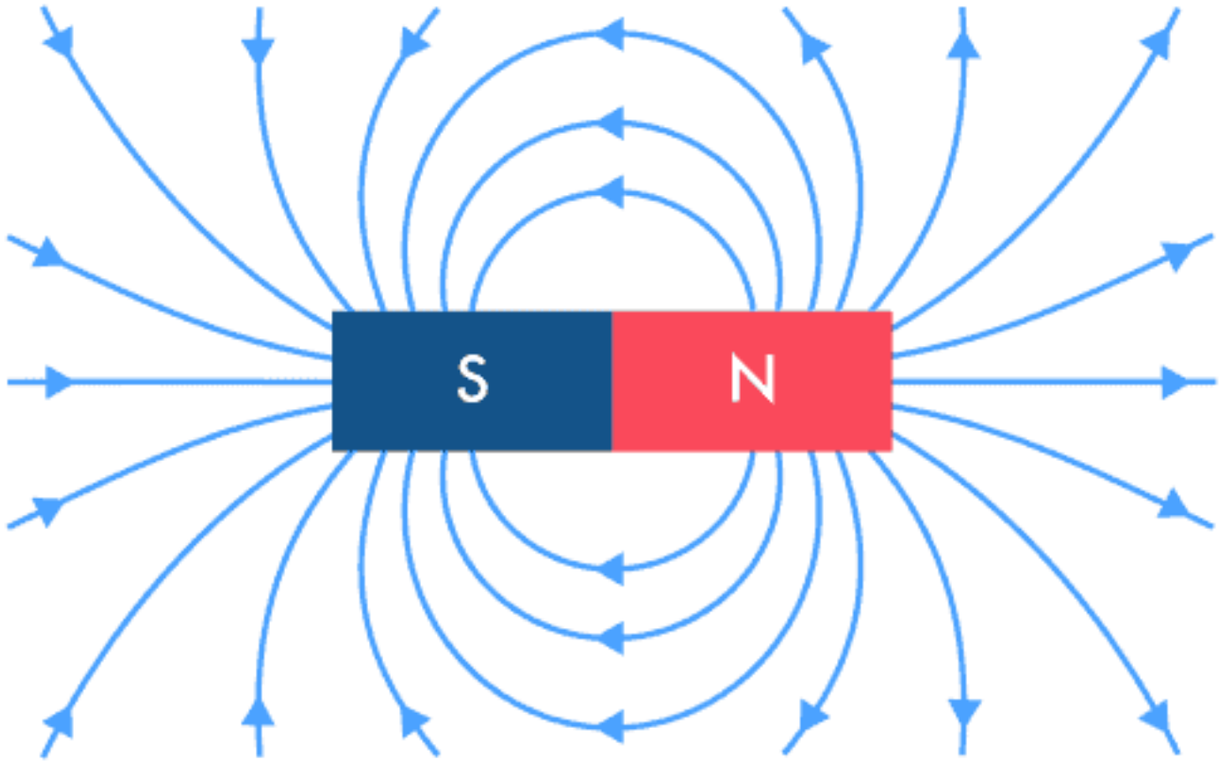


$$F_{Coke} = \frac{G(10^5 g)(3000 g)}{(10\,cm)^2} = 2x10^{-1}\ dynes$$

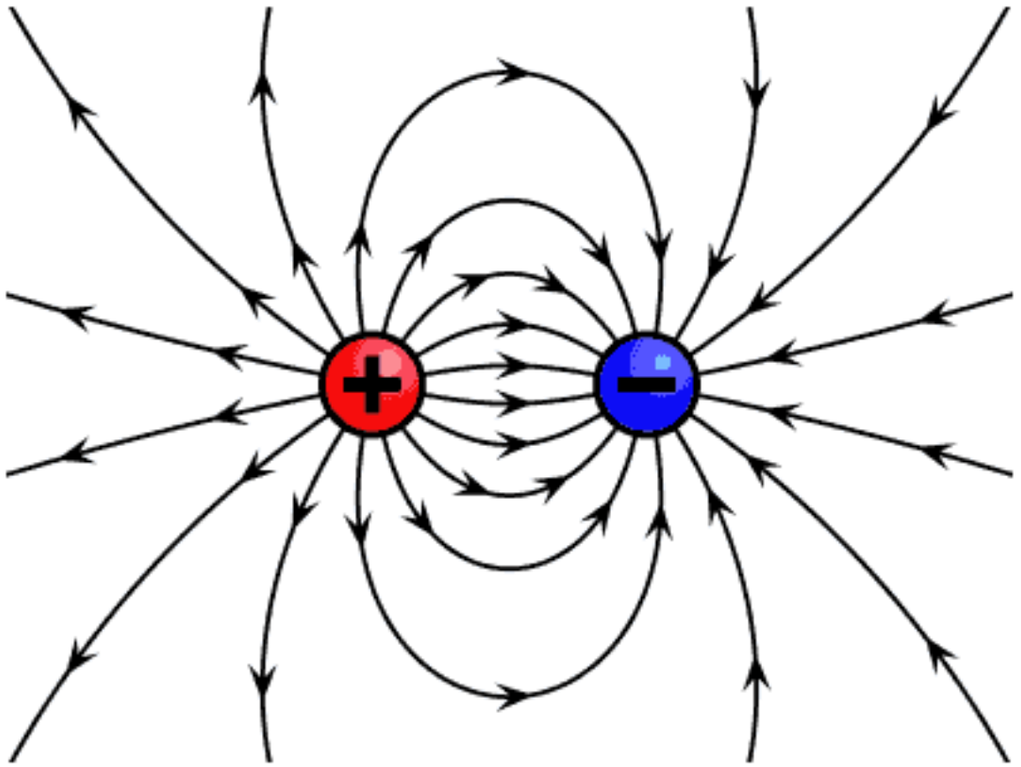
$$F_{Jupiter} = \frac{G(1.9x10^{30} g)(3000 g)}{(8x10^{13}\,cm)^2} = 5.9x10^{-2}\ dynes$$

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



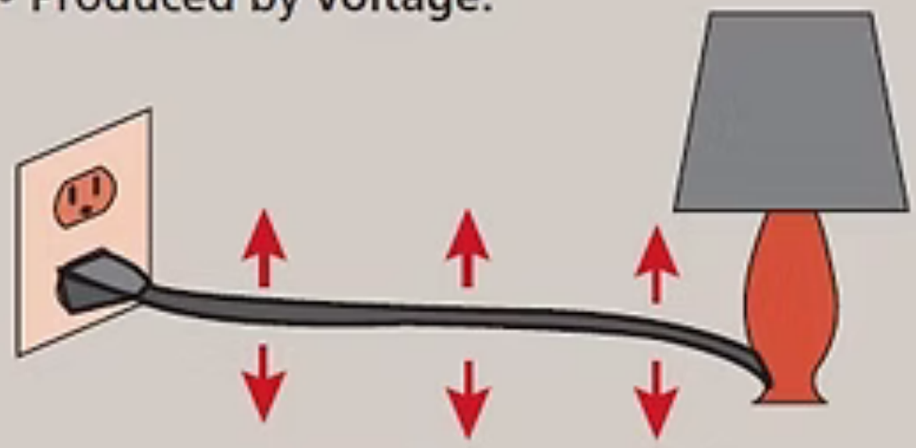
Electric Field

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.

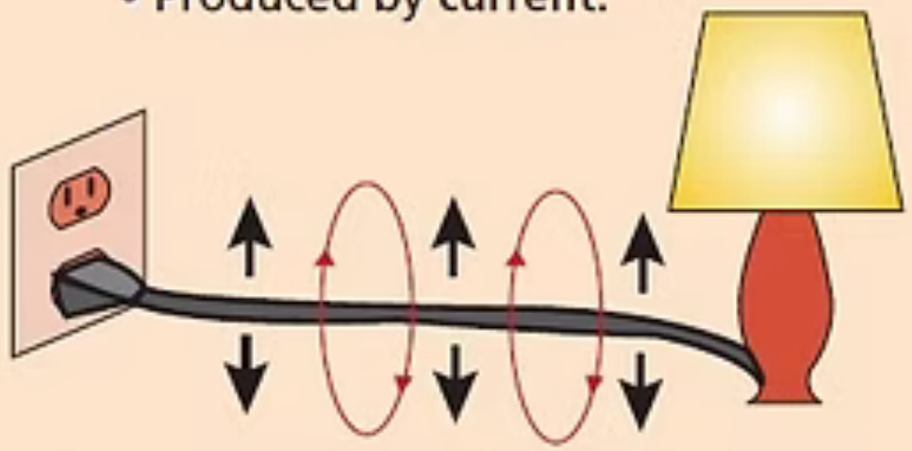


Lamp plugged in but turned off.
Voltage produces an electric field.

- Measured in volts per meter (V/m)

Magnetic Fields

- Produced by current.



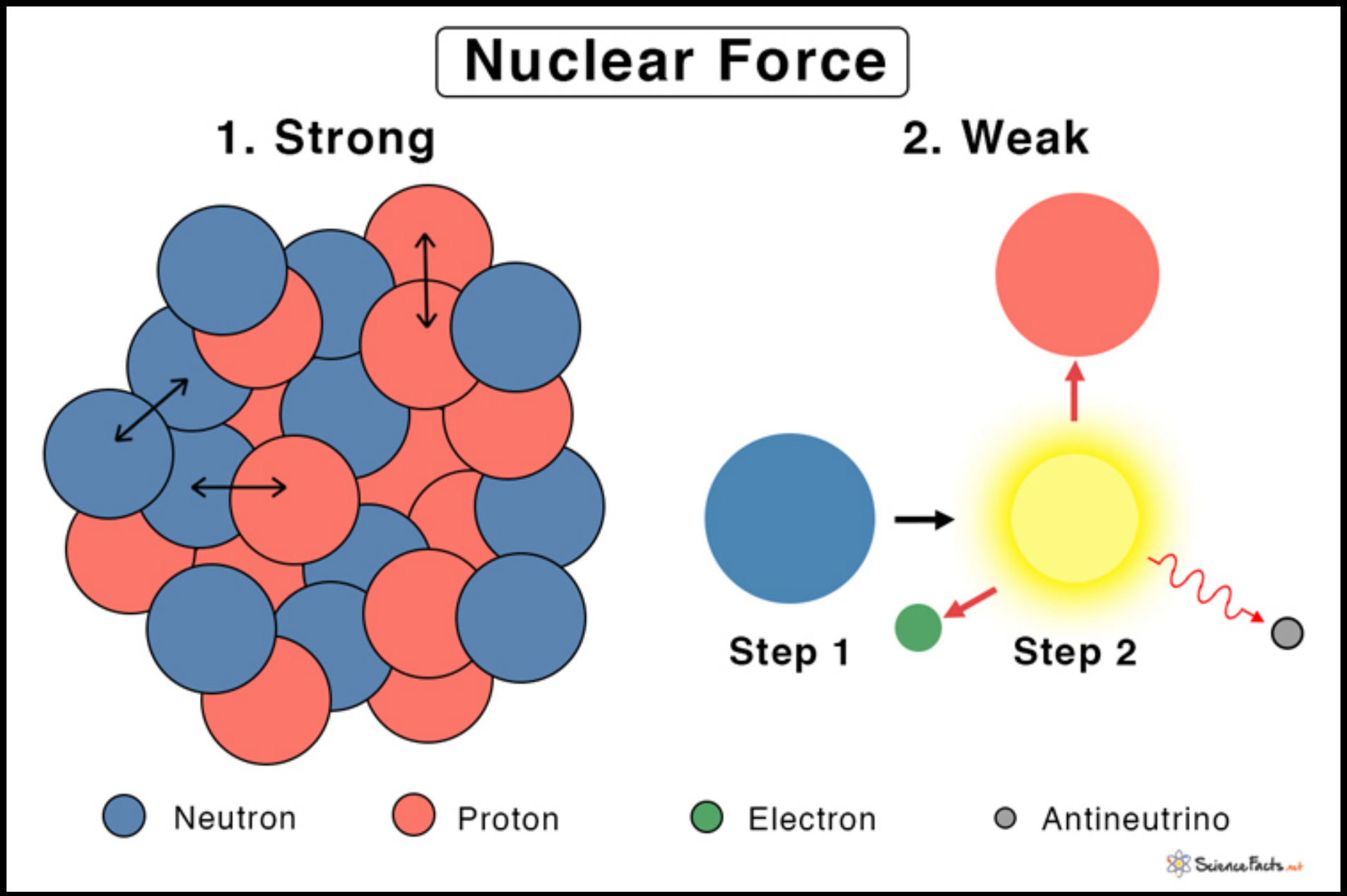
Lamp plugged in and turned on. Current now produces a magnetic field also.

- 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.



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