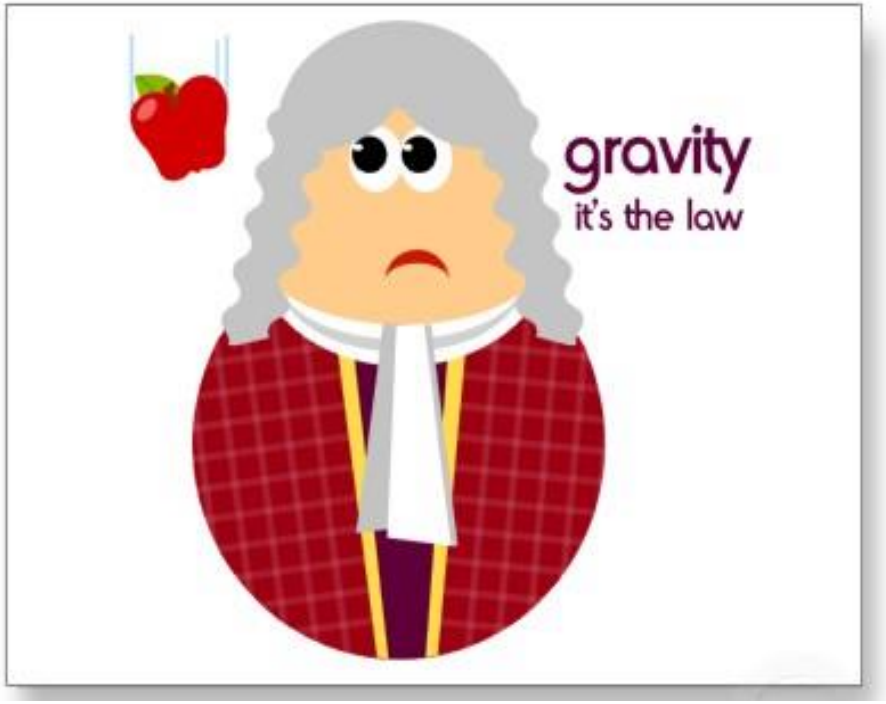
Studying the Force of Gravity

The Motion of Falling Objects



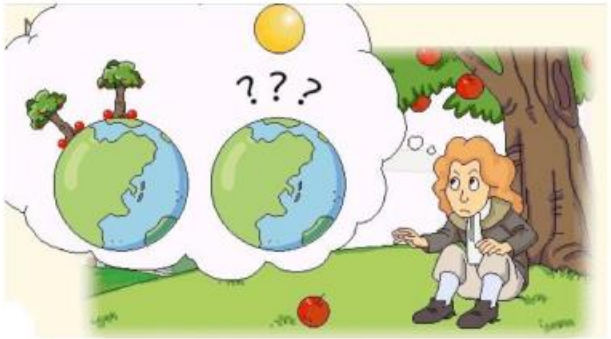
Sir Isaac Newton and the Study of Gravity

• Observed: an apple falling from a tree

•Conclusion 1: unbalanced force on the apple made the apple fall

•Conclusion 2: unbalanced force on the moon keeps the moon moving around the Earth.

• 1665: proposed that these two forces are actually the same force– ***gravity***.



Sir Isaac Newton & Gravity

- **Gravity:** a force of attraction between objects that is due to their masses.

- I**saac Newton:** Scientist who studied gravity & forces

Law of Universal Gravitation

Law of Universal Gravitation states that every object in the universe attracts ever other object.

It depends upon:

- **Mass**
- **Distance**

- **As mass increases, gravitational force increases**
- **As distance decreases, gravitational force increases**

Gravitational Force Depends on Mass

The gravitational force between objects increases as the masses of the objects increase. The arrows indicate the gravitational force between two objects. The length of the arrows indicates the strength of the force.

a Gravitational force is small between objects that have small masses.

b Gravitational force is large when the mass of one or both objects is large.

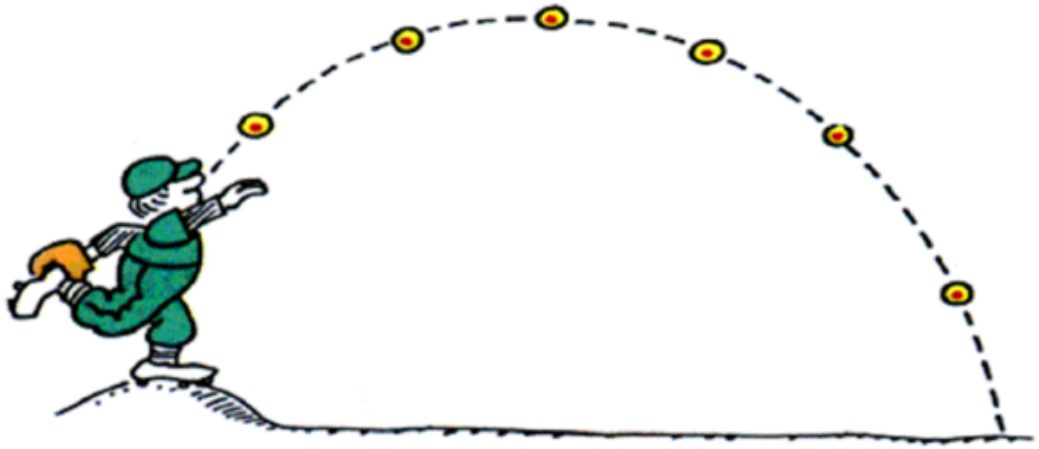
Gravitational Force Depends on Distance

The gravitational force between objects decreases as the distance between the objects increases. The length of the arrows indicates the strength of the gravitational force between two objects.

a Gravitational force is strong when the distance between two objects is small.

b If the distance between two objects increases, the gravitational force pulling them together decreases rapidly.

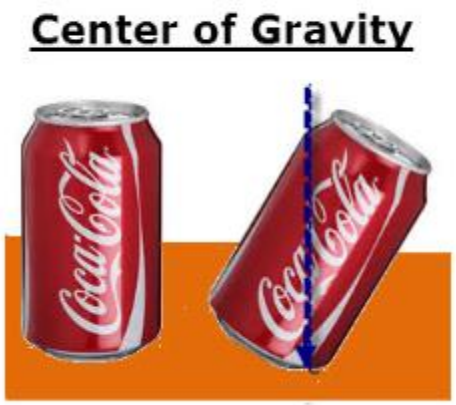
Projectile Motion

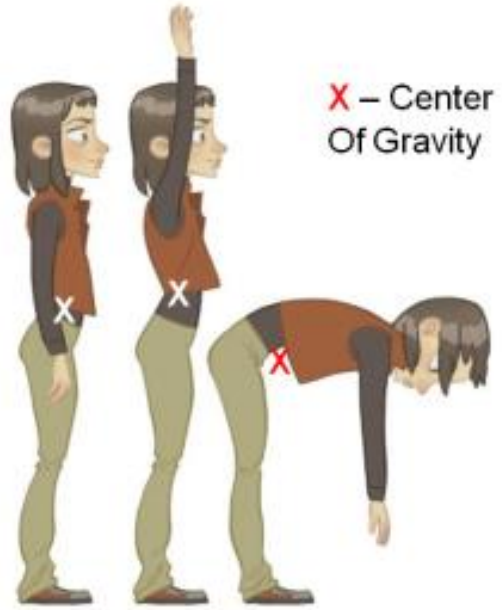


- Curved path an object follows when it is thrown or propelled near the surface of the earth

- Two Components: Horizontal Force & Vertical Force

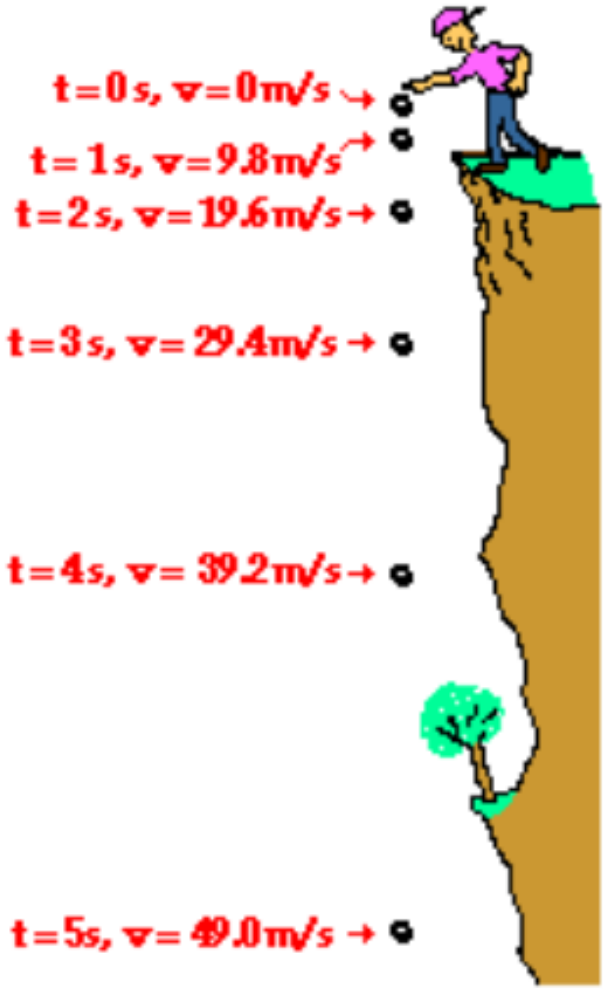
Center of Gravity





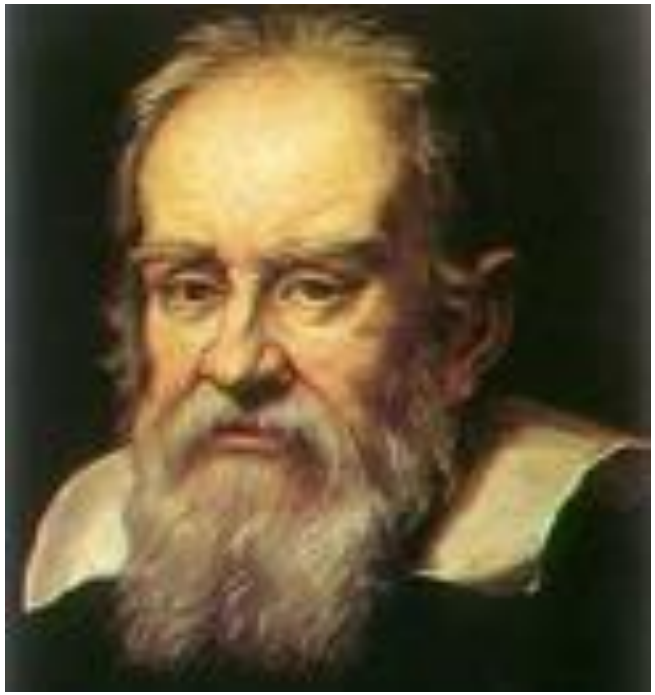
- Regardless of an object's size and shape, its weight seems to be concentrated at one point

Falling Objects



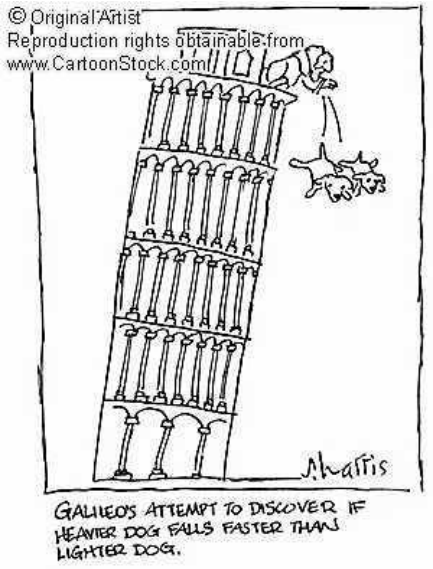
- Gravity causes objects to accelerate downward, whereas air resistance acts in the direction opposite to the motion and reduces acceleration.

Galileo



- 1564 – 1642
- Famous for invention of the telescope
- Discovered the moons of Jupiter and the rings of Saturn

Galileo's work on the motion of objects and their acceleration due to gravity paved the way for Isaac Newton's theories.



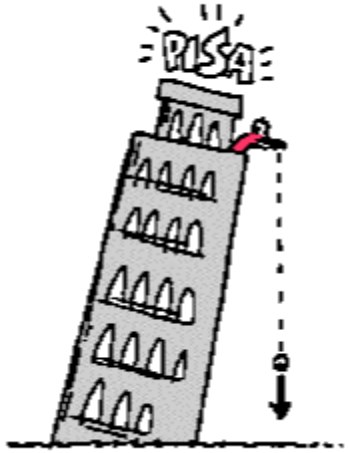
Galileo proved his theory by rolling balls of different masses down an inclined plane.

Galileo's Experiments proved that gravity causes objects to…

Accelerate

Galileo

• Scientist who invented the telescope & studied gravity

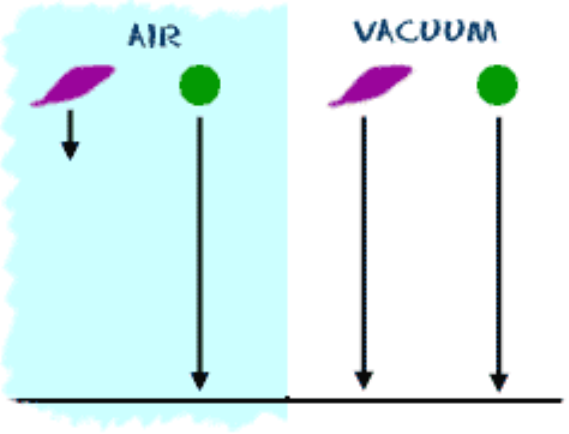


• Acceleration : $A = Vf - Vi / t$

•Galileo's Theory: Gravity causes objects to accelerate

• On earth, falling objects accelerate at a rate of 9.8 m/s2

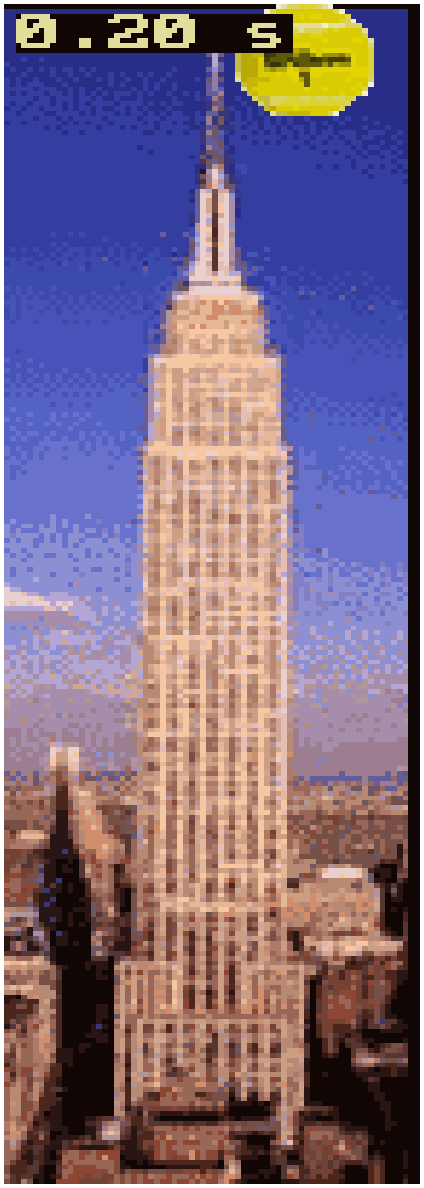
All falling objects accelerate at the same rate regardless of their mass.



Acceleration due to gravity: $9.8\ m/s^2$

This means each second it falls, it will be traveling 9.8 meters per second faster :

If something is dropped from The Empire State Building (443.00 meters up) it will hit the ground in 9.51 seconds.
It will be traveling at 93.18 meters per second when it hits the ground.
93.18 meters per second is <u>208.44 miles per hour</u> (mph).



9.8 m/s x 9.51 s = 93.18 m/s/s

So… the speed of a falling object depends on….

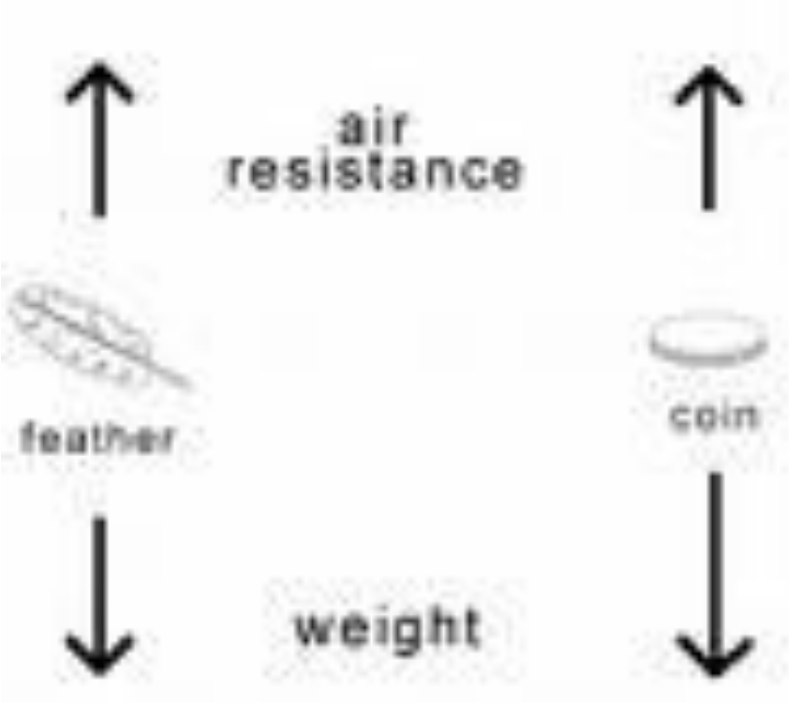
How Long it Falls!

Free Fall

- The movement of an object towards the earth only because of gravity.
- Free falling objects do NOT encounter air resistance

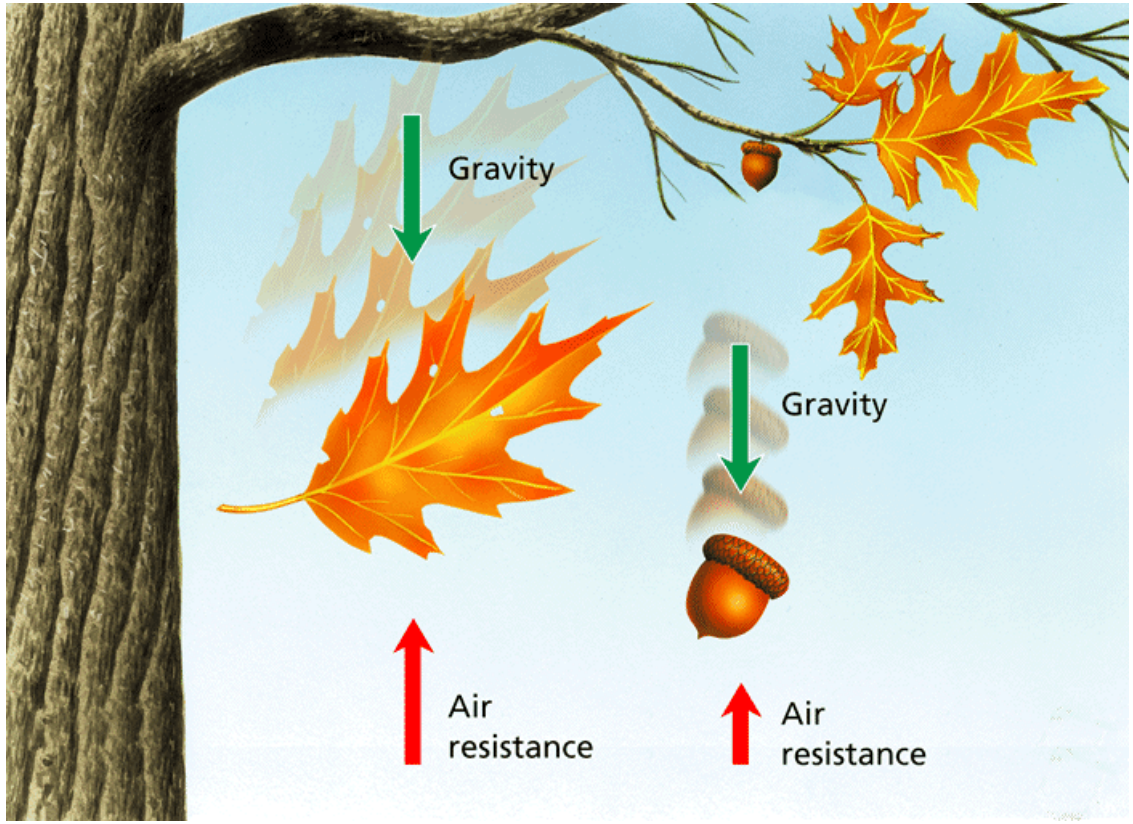
On Earth, falling objects are affected by air resistance.

This opposes downward motion.



Air Resistance

- Falling objects with a greater surface area experience more air resistance.



A point is reached where acceleration stops. The highest speed reached by a falling object is called….

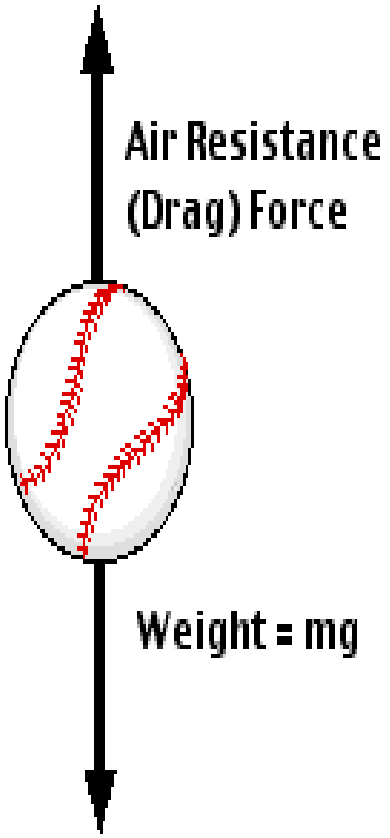
Terminal Velocity

Once terminal velocity is reached the object continues to fall at that constant speed.

Height	5m	10m	15m	20m	25m
Speed	7m/s	8m/s	9m/s	9m/s	9m/s

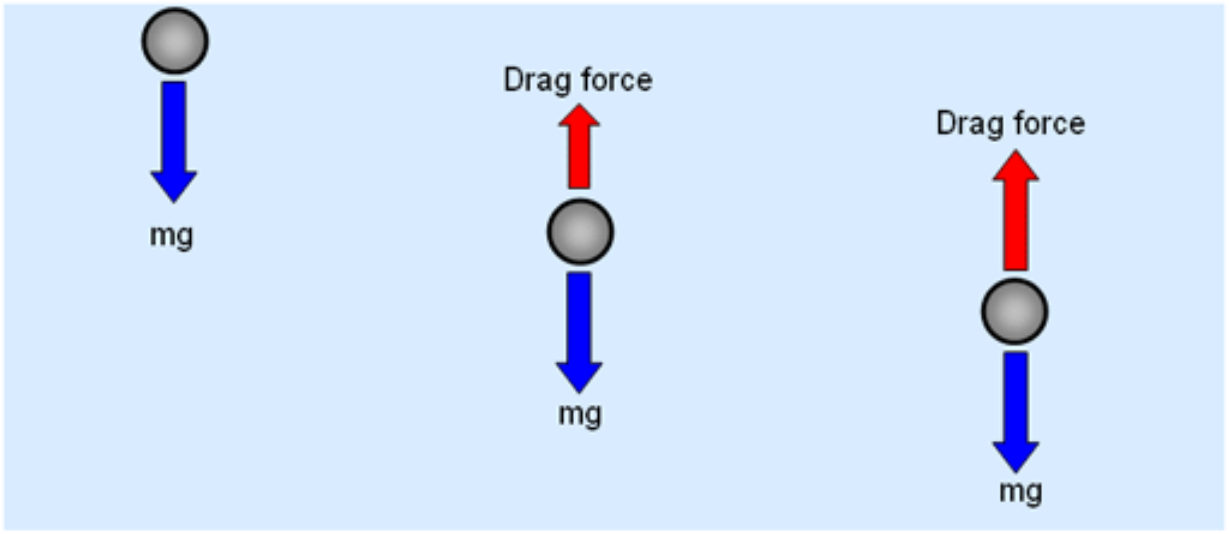
Terminal Velocity

The top speed reached by a falling object. At terminal velocity air resistance is equal to gravitational pull or weight .



Terminal Velocity

- Net force = 0
- A falling object reaches its highest speed and acceleration stops



- Let's compare and contrast friction and gravity by completing this table

	Friction	**Gravity**
Effect on motion	Opposes motion	Pulls objects toward one another
Depends on	Types of surfaces involved, how hard the surfaces push together	Mass and distance
Measured in	Newtons	Newtons