We think of force as ***a push, or pull or lift***. There are other words we commonly use to describe forces such as: hitting, kicking, pounding, and catching. The sports we enjoy such as baseball, basketball, tennis, volleyball, and football are really about applying forces.

Force is one of the big ideas (concepts) in science. Sometimes force applications are easy to see, such as when a gardener pushes a wheelbarrow and it moves. It is perhaps less obvious in the case where no movement results. Try pushing against a wall. Nothing moves but there are certainly forces at work. It is even less evident when no visible agent **exerts** (applies or puts on) the force. For example, we cannot see gravity. We can only see or feel its effects such as when something falls. We also feel its effects when we try to pedal up a hill on a bicycle. In the case of gravity the force is exerted invisibly and over great distances.

In those cases where *we can see something or someone* exerting a force we refer to it as a **mechanical force.** The gardener pushing the wheelbarrow is an example of a mechanical force. The gardener is the **agent** causing the wheelbarrow to move.

Field forces are those exerted without any such visible agent. These forces are invisible. Two magnets that repel each other without touching is an example of a field force. Gravity is also an invisible force. You cannot see it reach out and grab things. Gravity is the most familiar force that is created by a field.

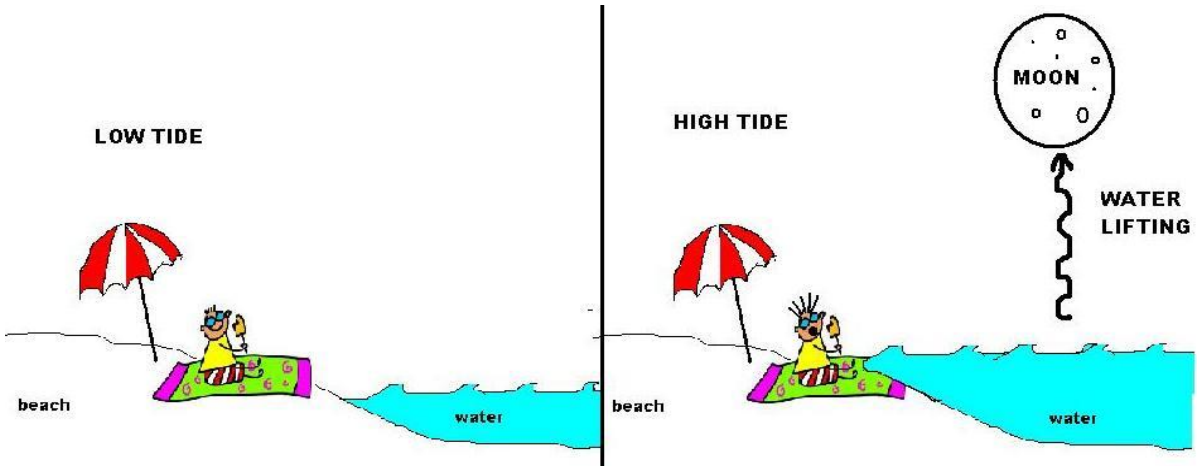
Scientists know of four basic forces. Those four forces are **gravitational, electromagnetic, weak nuclear and strong nuclear.** Gravity was the first of the four to be discovered, and it is the one that we will be studying in this unit. In all the systems we will be investigating, **gravitational force will** play a part.

A force can **cause:**

1) an object to **start moving** or to **move faster.**
2) a moving object to **change direction.**
3) an object to **slow down or stop moving.**
4) **prevent the motion** of an object
5) **change the shape** of an object.
6) changes in a system.

A **system** is a *group of objects or materials that are related in some way* and are being considered as a whole. A bicycle is a system because there are many objects working together. (wheel, gears, chain, metal bars, etc.) We say that the **parts of a system interact.** This means they have something to do with each other**. Interaction** is the *relation among the forces, objects or materials*. The wheels of a bike interact with the spokes which interact with the axle which interacts with the frame of the bike. **Evidence of interaction** would be something that is observable. For example, if you interact with the bike, the pedal turns the gear, which applies force to the chain, which interacts with the rear wheel. If you sit on a couch you will see the couch cushion dent in because of the force of your body.

Sometimes we speak of **interaction at a distance**. For example, ocean tides on the earth are evidence of **gravitational interaction** between the moon and ocean water. The moon literally pulls up the water and causes the tide to rise. Some of the beach then gets covered in water.

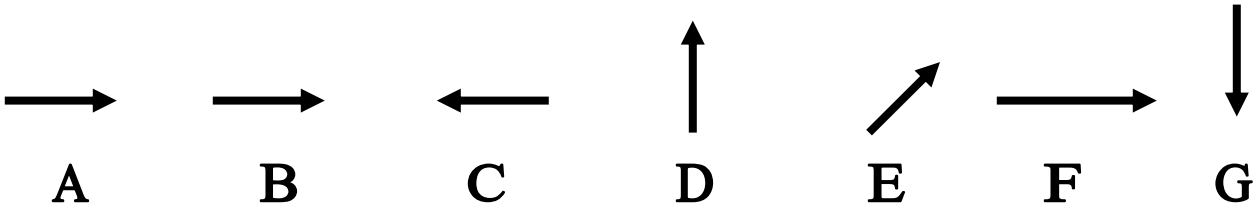


These tidal events are evidence of interaction at a distance. This interaction is among objects that are not in **physical contact**. In other words, they don't touch. The tides are caused by gravitational field forces. The earth, the moon, and gravity can be considered as an interacting system.

When we are defining forces we need to be concerned with the direction as well as the **amount (magnitude**) of the force. Quantities defined by magnitude and direction are called **vector** quantities. The **length** of the vector shows its *magnitude*. An arrow points in the direction of the vector.

The units of force are the **Newton (N)** in the System International (SI). The **pound (lb**) is the unit of force in the English (foot, pound, second) FPS system. In scientific studies the SI system is used.

In the activities which follow, we will help you understand the concept of force as it acts in various systems. You will need to also understand the meaning of balanced forces and unbalanced forces. A **net force** is the *sum of all forces* acting on an object. If the sum of the forces is balanced, the net force is zero. If the net force is greater than zero, the forces are unbalanced. Consider the examples of vectors below:



_____1. Which two vectors are equal in magnitude and in direction?
_____2. Which vector is equal in magnitude but opposite in direction to A?
_____3. Which vector has **the** same direction as A but a larger magnitude?
_____4. Which vector acts upward?
_____5. Which vector acts downward?
_____6. Which vector has the largest magnitude?
_____7. Which vector can be said to act West?
_____8. Which vector can be said to act North?

9. If you put B opposite from C would the forces be balanced or unbalanced?

10. If you put F opposite from C would the forces be balanced or unbalanced?

11. Draw the NET force of A and B below.

FORCES GLOSSARY

[Use these words when you write your answers during the lab "Forces A to Z"]

Bouyancy- (noun) **The ability to float**. A body's apparent loss of weight when suspended in a fluid (liquid or gas) caused by the lifting force of the displaced fluid. If the density of the fluid displaced is greater than the density of the fluid in the object, the object will rise. If the density of the fluid in the object is greater the object will sink.

Bouyant – (adjective) a type of force applied by a fluid on an object that is suspended in it. **A fluid's push up forces**.

Distort- (verb) **to change the size, shape, or form of an object** (to deform).

Distortion – (noun) **the condition of having been changed in size, shape, or form**.

Elasticity - (noun) The tendency of a body to come back to its original size or form after having been distorted or changed in form by a force. **The ability to go back to normal after a distortion.**

Elastic Limit – (noun) The point to which a force may be applied to an elastic body causing it to change size or form, without destroying its ability to come back to its first form, when the force is taken away. **How far you can go before breaking**.

Fracture – (verb and noun) **The act of getting or becoming broken**, or the condition of already being broken. The forces of molecular attraction are not strong enough to hold the material together under a distorting force.

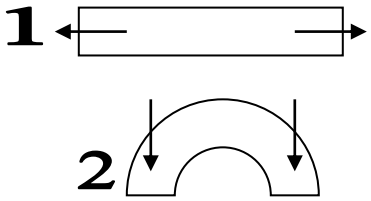
Gravitational force – (noun) **A pulling force that attracts all objects on the planet toward the center of the planet.** All matter is considered to be influenced by the gravitational system. Gravity interacts with matter causing an object to have weight. Gravity is a field force meaning it is exerted without any visible agent, and it is exerted at a distance.

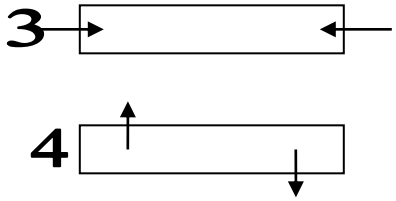
Strain – (noun) the ratio of the **change in length** (L) to the original length (Lo) caused by a stress. Force $_{strain}$ = L/Lo

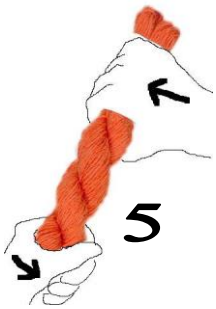
Stress – (noun) **the effect of a distorting force** being applied to an object or force per unit area. There are five types of stress: tension, compression, flexion, twisting, and shear.

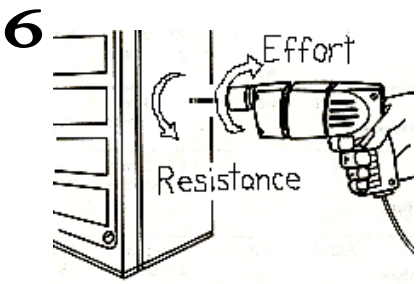
Tension -- (noun) the condition of being pulled apart.
Compression – (noun) the condition of being pushed or squeezed together.
Flexing (flexion) – (noun) the state of being bent or curved.
Twisting – (verb) turning about an axis.
Shearing - (verb) opposite forces that can pass each other.

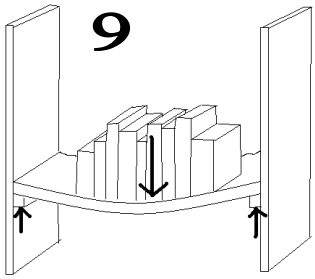
Match the picture with the vocabulary word:

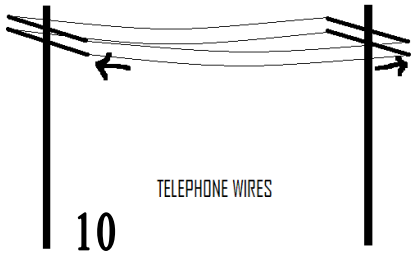




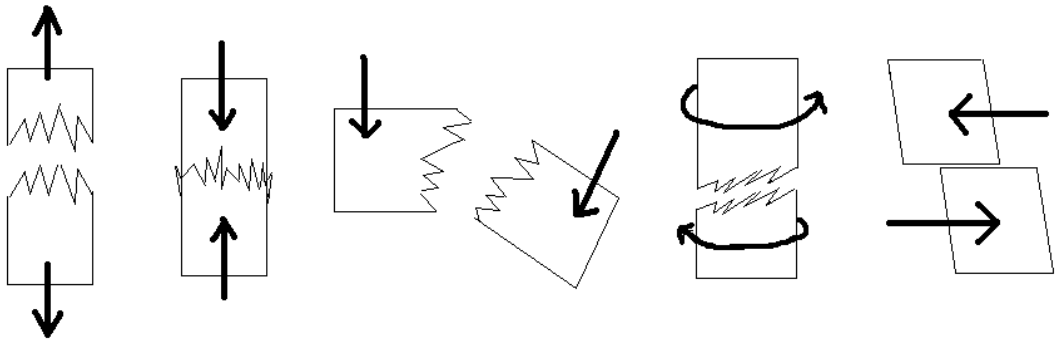








If the stress on an object is too great, the object **fractures** (breaks).



TENSION COMPRESSION FLEXION TWISTING SHEAR