

The Nature of Force

(Chapter 10 – Section 1)

Key Terms:

force

unbalanced forces

newton (N)

balanced forces

net force

Standard 8.2.a: Students know a force has both direction and magnitude.

Standard 8.2.c: Students know when the forces on an object are balanced, the motion of the object does not change.

Objective 10.1.1 – After this lesson, you should be able to describe what a force is.

Objective 10.1.2 – After this lesson, you should be able to explain how balanced and unbalanced forces affect an object's velocity.

What causes an object to start moving, stop moving, or change direction? The answer is force.

What is a Force?:

In science, force has a simple and specific meaning. **A force is a push or pull.** You use force to open a door, to stretch a rubber band, and to carry your backpack. When one object pushes or pulls another object, you say that the first object exerts a force on the second object.

Like velocity and acceleration, force is a vector quantity. A force is described by its magnitude and by the direction in which it acts. If you push on a door, you exert a force in a different direction than if you pull on the door.

You can use an arrow (\rightarrow) to represent the direction and strength of a force. The arrow points in the direction of the force. The length of the arrow tells you the strength of a force. The longer the arrow, the greater the force.

The SI unit for the magnitude, or strength, of a force is the newton (N). This unit is named after the English scientist and mathematician Isaac Newton. You exert about one newton of force when you lift an apple.

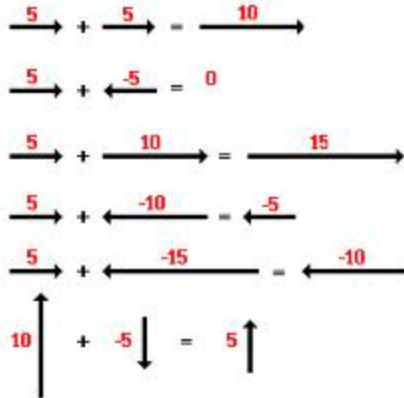
Combining Forces:

Often, more than a single force acts on an object at one time. When an object is subject to two or more forces at once, the result is the combination, or cumulative effect, of all the forces. **The combination of all the forces acting on an object is called the net force. The net force determines whether an object moves and also in what direction it moves.**

When two or more forces act in the same direction, the net force is found by adding the strengths of the individual forces. In the illustration at left, notice the first example: The lengths of the two arrows are the same size (magnitude) and are going in the same direction. They are added together to find the net force (**10 N**). The net force acts in the same direction as the individual forces.

When two or more forces act in opposite directions, the net force is also found by adding the strengths of the forces. However, you must note the direction of each force. Adding a force acting in one direction to a force acting in the opposite direction is the same as adding positive numbers to a negative number. The net force always acts in the direction of the greater force. The fourth example in the illustration shows this principle. Notice that you have a positive arrow with a magnitude of **5 N** added to a arrow going in the opposite direction (negative) with a magnitude of **10 N**. When combined, you get a net force of **-5 N** indicated by the arrow going in the opposite direction.

If the opposing forces are of equal strength, there is no net force – look at the second example and you'll see the net force is **0 N**.



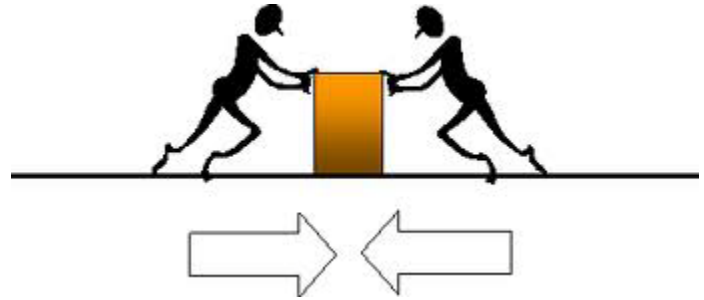
- Unbalanced Forces** – Whenever there are two forces acting in opposition to each other and one has a greater magnitude, the net force is said to be unbalanced. **Unbalanced forces can cause the velocity of an object to change. The object can speed up, slow down, or change direction. Unbalanced forces acting on an object result in a net force and cause a change in the object's velocity.** The illustration at right shows two forces being exerted on the box in opposite directions. This produces a net force on the box that is the difference between the two forces. As a result of the force on the left being greater than the force on the right, the box moves to the left.



What is the direction and net force when two people are exerting forces in the same direction as the two are doing here? When one pushes and the other pulls the piano to the right, their individual forces add together to produce a net force in that direction. Since unbalanced forces are acting on the piano, there is a net force of 45 N and the piano moves to the right.



- **Balanced Forces** – In a tug-of-war contest between two people, each person pulls on opposite ends of the rope. If each person pulls with equal force, neither the rope nor the people will move. **Equal forces acting on one object in opposite directions are called balanced forces.**



When equal forces are exerted in opposite directions, there is no net force. Balanced forces acting on an object do not change the object's velocity. In the figure above, when two people push on the box with equal force in the opposite directions, the forces are balanced. The box does not move.