

Forces

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What is a force? A **force** is a push or a pull. Forces are acting all around you. Forces are even acting on you! Objects (and you) are being pushed and pulled in different directions. Sometimes the force can be seen, like when you push a toy car or throw a ball. Sometimes you don't see forces at all. Even objects that are not moving have forces acting on them. Forces have the ability to cause change.

Forces always come in pairs. Objects exert forces on each other. When you run into something, let's say another person, you exert a force on that person. He may fall down if the force is strong enough. But that other person also exerts a force on you. You might also fall down. You can see movement caused by the force. If you run into a wall, you might not see any movement. The wall doesn't move. You probably wouldn't fall down. But it might hurt. You pushed on the wall, or exerted a force on the wall. The wall exerted a force back on you. It hurts the part of your body that hit the wall because the wall exerted a force on your body.

The strength of the force is called the **magnitude** of the force. Forces also have a certain direction. For example, when you are standing, you exert a force on the ground that is equal to your weight. Your body is exerting a force on the ground in a downward direction.

Forces are measured in units called **newtons**. Newtons were named for the English scientist Isaac Newton who came up with the set of laws that describes forces and motion. It takes about forty newtons to lift a small dog.

Forces can affect objects in several ways. Forces that act on an object that is not moving can cause the object to move. Forces can act on an object that is already moving to cause a change in the object's speed or direction of movement. A force can act on an object and not make it move. Forces acting on a still object can change the object's shape. For example, if you sit on a bean bag chair, you can see how the force of your body pushing down on the chair changes the shape of the chair.

Acceleration means a change in the speed or direction of an object. When something speeds up, we say that is a positive acceleration. When it slows down, we say that is a negative acceleration. But remember that acceleration can also be a change in the direction of an object that is moving. An object that is moving along a curved path is always accelerating. That is to say, its line of motion is always changing.

The force you are probably most familiar with is the force of gravity. **Gravity** is the force of attraction between objects that have mass. Two objects that have mass are attracted toward each other. They exert force on each other. They pull on each other. Hold a book out from your side and let go. What happens to the book? It falls until it hits the floor. What force pulled on the book? The force of gravity. The book and the earth are attracted to each other. Earth pulled the book toward its center.



Mass is a measure of the amount of "stuff" in an object. Since all objects have mass, gravity acts on all objects. You know that the earth pulls all objects toward its center. But what you might not know is that all objects, including you, pull the earth toward their centers. Since the earth is a lot bigger than you, it pulls a lot harder on you than you pull on it.

The greater the mass of either of two objects, the stronger the force of gravity is between them. The force of gravity between the earth and the book you let go of is stronger than the force of gravity between your hand and the book. The earth, because it has so much more mass, pulls more on the book than your hand does. That explains why the book falls when you let go of it, and it doesn't stick to your hand.

The strength of the force of gravity depends on two things. One is the mass of the two objects. The other is the distance between the two things. The closer the two objects are, the stronger the force. The farther apart the objects, the weaker the force exerted by the objects on each other.

For example, the sun and the moon both exert gravity on the earth's oceans. This is what causes ocean tides to rise and fall. The sun is about 400 times bigger than the moon. But the moon is much closer to the earth. So the moon exerts more force on tides than the sun does.

Forces are all around you. Understanding forces helps us understand how many things happen. Physics is the branch of science that studies forces, energy, and motion. Every motion you make and every job you do uses forces.