Getting to Know: Interaction of Force and Mass

When a parent pushes a child in a swing, it is clear that the parent is exerting a force on the child. However, there are other forces acting on the child in the swing as well. Earth's gravitational force is pulling the child toward Earth, and friction between the child and the swing helps keep the child from slipping out of the swing as it goes up and down. Forces are part of everyday life.

A force is a push or pull, and unbalanced forces result in motion.

What exactly is a force?

You probably know that a force is a push or pull that acts on an object. These forces can act between objects that are touching or at a distance. Friction, for example, only occurs when two objects are in contact with one another. Magnetic force and gravity, however, can act at great distances. The force of gravity is an interaction between the Earth and the Sun that acts at a very large distance. The force between a magnet and a piece of iron buried underground can trigger the signal in a metal detector.

Friction keeps a skater on his board during tricks.

I've heard of friction, but I did not know it was a force. What is friction?

Friction is a *force* that occurs when two materials rub against each other and which works against motion. For example, friction between a soccer ball and the grass helps to slow the ball as it is rolling.

The force of friction also produces heat; when you rub your hands together, you can feel the warmth produced by friction. The oil you put in a car's engine makes the moving parts inside more slippery, so they experience less friction and the engine does not become too hot.

Misconception 1: ***Force is a property of an object. An object has force, and when it runs out of force, it stops moving.***

That is not true. A force is a push or pull on an object resulting from the object's interaction with another object. Forces act on an object, but they are not a property of an object.

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How are force and motion related?

Think for a minute about what happens when you exert a force on an object. Maybe you push a chair along the floor so that your push is the force that causes the chair to move. Other forces are working against the motion of the chair such as friction between the chair and the floor and the force of Earth's gravity pulling downward on the chair. Would it be harder to push a chair along a smooth floor or along a rough or carpeted floor? When friction is greater, you need to use greater force to move the chair. Would it be harder to push an iron chair or a plastic one? The force of gravity pulls downward on an iron chair with greater force than it does on a plastic chair.

When both teams in a tug-of-war pull with the same force, the rope does not move, but when the forces are unbalanced, the rope moves.

A change in motion will not result if the forces acting on an object are balanced. For example, forces are balanced when two teams in a tug-of-war pull on a rope with the same amount of force. The rope does not move because the forces are balanced. In general, when forces are unbalanced—for example, when you push a chair and the chair does not exert enough force to oppose the push—motion will result.

Misconception 2: ***A second force pushing in the same direction on an object will stop the object from moving.***

A second force pushing in the same direction on an object will add to the first force. If the force is applied in the opposite direction as the first force, and the forces are equal, then the object will stop moving.

A seesaw shows us the relationship among force, mass, and motion

Is there a relationship between force and mass?

There is a direct relationship between mass and force, which you can easily see when you observe a seesaw. When one person on the seesaw has a greater mass, the force of Earth's gravity acting on the person is greater than the force of gravity acting on the other person. This results in the person with greater mass being pulled downward while the person with less mass goes up. However, if the two people on either end of the seesaw are the same mass, the seesaw balances and does not move.

From this illustration, you may easily see that mass and gravitational force are related, but as you learn more about force and mass, you will be able to understand how force, mass, and motion are related in many other ways as well.

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