Reflect

Imagine that you had two "superpowers." Both powers allow you to move things without touching them. You can even move things located on the other side of a wall!

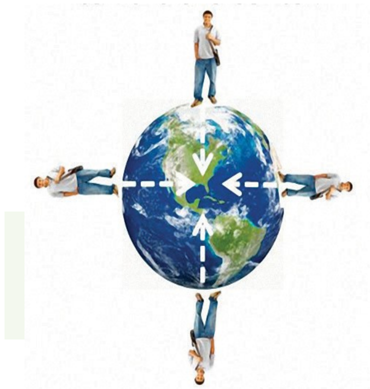
One power is the ability to pull something toward you without touching it. This **force** acts on objects both near and far, but it pulls harder on nearby objects. The other power allows you to pull **and** push objects. However, this force acts only on things made of certain materials like iron.

force: a push or a pull

Do these powers seem familiar? If so, it is because you have seen both forces in action. You can feel one of them right now. Do you know what these forces are?

What is gravity?

You are probably sitting in a chair as you read this. What keeps you there? Why do you not float away into space?



Why do people not float away into space? It is the force of gravity that pulls them toward Earth's center.

The answer is the force of gravity. This is one of the "superpowers" mentioned above. Gravity is a force that pulls objects toward other objects. That means we all have our own gravity! However, the force of attraction is very weak unless one of the objects is very large. Because Earth is very large, you can feel it pulling on you. This pull is called your *weight*. You cannot feel the pull between yourself and smaller things, like other people, because the force is too weak. Gravity is always a pull. It never pushes.

Instead of saying Earth is large, we should say it has a lot of mass. **Mass** is the stuff that makes up all things in the universe. The more mass an object has, the harder it is to move. Gravity is the attraction between any two masses. The force of gravity is stronger when the masses are greater. The farther apart the masses are from each other, the weaker the force is between them.

predict: tell me what will happen in the future based on how things are now

Scientists understand enough about gravity to **predict** how it will affect different objects, but why do you think the force exists? Scientists have different theories about this. Gravity is both familiar and strange, but altogether amazing.

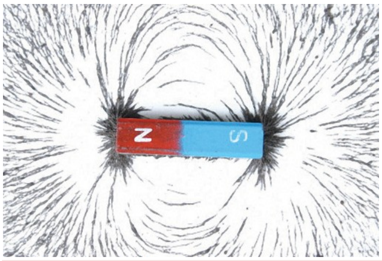
Reflect

What is magnetism?
Magnetism is a force between certain kinds of objects. This force can be either a push or pull. (Remember, gravity only pulls.) Magnetism is a force that can act between two magnets or between a magnet and something magnetic (like something made of iron). Magnets can be made of iron.

Magnets come in many shapes.

The two ends of a magnet are different. One end is called the north pole. The other end is called the south pole. Any part of a magnet pulls on things made of iron and a few other metals. Poles that are the same push each other away, while different poles pull toward each other.

North poles of magnets only pull on south poles. Two north poles push each other away. Two south poles also push each other away.



Iron filings arrange themselves along magnetic lines of force.

Magnetic force is caused by certain particles that make up an object. When these particles are all arranged in the same way, the object becomes a magnet. The size of the force between two magnets depends on their orientation relative to each other.

The magnetic force of a magnet forms a pattern called a magnetic field. A magnetic field is made up of magnetic lines of force. The lines of force are invisible, but there is a way to see their shape.

Put a magnet under a piece of paper and sprinkle small bits of iron on the paper. The iron bits will line up with the lines of force. You can see this in the picture to the right.

When a piece of iron is put into the field of a magnet, it will become a magnet, too.

A compass needle always points north.

When the iron object is taken out of the field, it will still be a magnet although the new magnet may not be very strong. It helps to heat and tap on the iron object while it is in the field. Earth is a large magnet with a magnetic field. A compass has a needle that is a small magnet. The needle always points toward Earth's magnetic North Pole.

Reflect

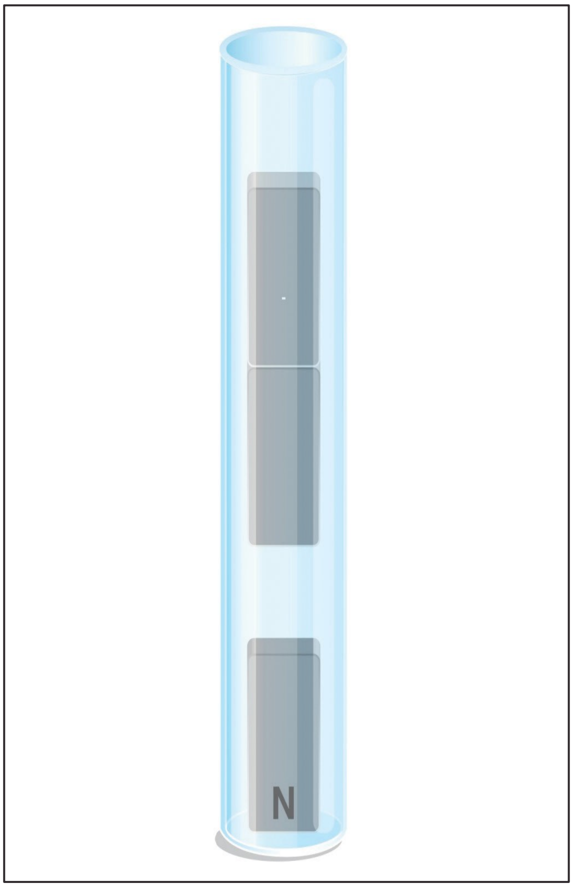
You can use Earth's magnetic field to make a magnet. You will need a compass, a hammer, and an iron rod. The iron rod should be about a foot long. (The vertical rod in a ring stand works well.) With an adult's help, use the compass to find the north direction. Point one end of the rod toward the north. Hit one end of the rod with the hammer several times. This will help rearrange the iron atoms to create a magnetic field.

Now you can see if you made the rod into a magnet. With an adult's help, tie a string to the middle of the rod. The rod should spin freely while hanging from the string in a level position. Tie the string to something overhead. Give the rod a gentle spin. If one end is pointing north when it stops spinning, the rod has become a magnet.

What Do You Think?

Imagine dropping three magnets into a glass tube. The picture below shows how the magnets lined up in the tube.

The north pole of the bottom magnets is marked with an N. Mark the remaining poles of all three magnets. Write the letter N on each north pole. Write the letter S on each south pole. Remember, if poles are the same, they push away from each other.

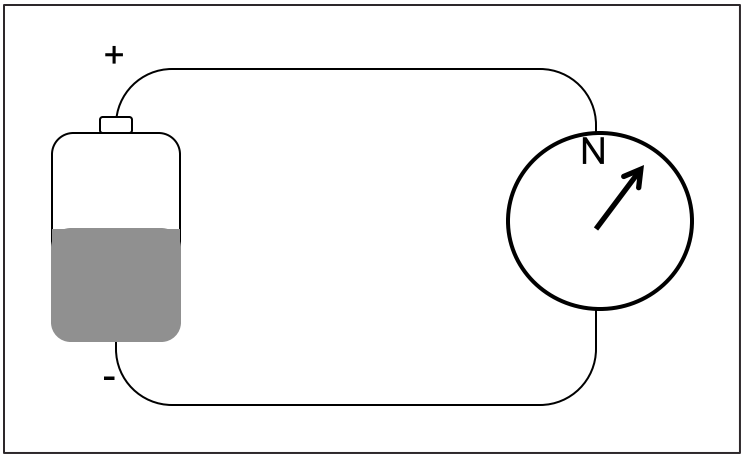


What Do You Think?

A compass needle always points north because the magnetic needle in the compass lines up with Earth's magnetic field. However, Earth's magnetic field is weak. Almost any other magnetic field will make the needle swing away from Earth's magnetic north pole. Think about moving a magnet near a compass—the needle will move! That means the little magnet you have in your hand is affecting the compass more than Earth's magnetic field.

Electric currents create magnetic fields. We can see this using a compass and something that produces an electric current. You can create an electric current with something as simple as a battery and a wire, as shown in the figure below. Separated wires will work better than a double wire. Place the magnet over the wire, and connect each end of the wire to the positive and negative terminals on the battery. Observe any movement of the compass needle when the circuit is completed.

Remember: Electric and magnetic forces between objects or particles do not require that the objects be in contact. Keep this in mind as you use electric currents to create magnetic fields.



What happens to the direction of the compass needle when current is flowing through this simple battery circuit?

Connecting With Your Child

Magnetism and Gravity at Home

This activity will help you explore the forces of gravity and magnetism with your child. The only materials you will need are two bar magnets, duct tape, and a transparent tube. You may use any size tube; however, the longer the tube, the easier it will be to see the results. The magnets must fit lengthwise into the tube. Stronger magnets work better than weaker magnets. (Very strong bar magnets might be available from a veterinarian who treats large animals. Vets put strong magnets in cows' stomachs to prevent iron scraps from traveling farther down the digestive tract.) The tube can be large-diameter, clear plastic tubing available from a hardware store.

1. Attach one end of the tubing to the floor with tape, and support the other end so that the tube is nearly vertical.
2. Drop one bar magnet into the tube. Observe its acceleration as it falls. Note whether the north pole or the south pole is facing up.
3. Drop the other magnet into the tube. Observe its acceleration as it falls. Note whether the north pole or the south pole is facing up.
4. Remove the second magnet, reverse it end-over-end, and drop it again. Observe its acceleration as it falls.

How did the alignment of each magnet's poles affect how the second magnet fell? (When like poles for each magnet are facing each other, the upper magnet should hover above the lower magnet. When opposite poles are facing each other, the upper magnet should collide with the lower magnet.)

Here are some questions to discuss with your child:

- Which forces are acting on the falling magnets?
- What is acceleration?
- Why did the top magnet hang in the air above the bottom magnet in one trial? Explain by comparing the forces acting on the magnet.
- You watched magnets fall in three different trials. Explain the differences in the motion of the magnets in terms of forces acting on them.