Focus on the NYS Learning Standards

Lesson 19 Magnetic Force

PS 4.4f Without touching them, material that has been electrically charged attracts uncharged material, and may either attract or repel other charged material.

PS 4.4g Without direct contact, a magnet attracts certain materials and either attracts or repels other magnets. The attractive force of a magnet is greatest at its poles.

PS 5.2b Electric currents and magnets can exert a force on each other.

Demonstrate an understanding of magnetism, electromagnets, and electromagnetic induction.

A **magnet** is a material that attracts iron or materials containing iron.

An **electromagnet** is a magnet that is made by an electric current.

Electromagnetic induction is the process of using a changing magnetic field to generate an electric current in a circuit.

Guided Instruction

DIRECTIONS Read the following information.

Guided Questions

A **magnet** is a material that attracts iron or materials containing iron. All magnets have certain properties. For example, all magnets exert *magnetic forces* on other magnets and on objects containing certain metals such as iron, steel, cobalt, and nickel. Even without touching, the magnetic force of a magnet can attract or repel other magnets. Magnetic forces are found in the area that surrounds each magnet called the *magnetic field*. Magnetic field lines show the shape of the magnetic field and can be used to predict the strength and direction of the magnetic force on an object in the field. The magnetic forces of a magnet are strongest at its two ends, or *magnetic poles*. All magnets have two poles, a north pole and a south pole. The opposite poles of magnets will attract each other but the same poles will repel each other.

What is a **magnet**?

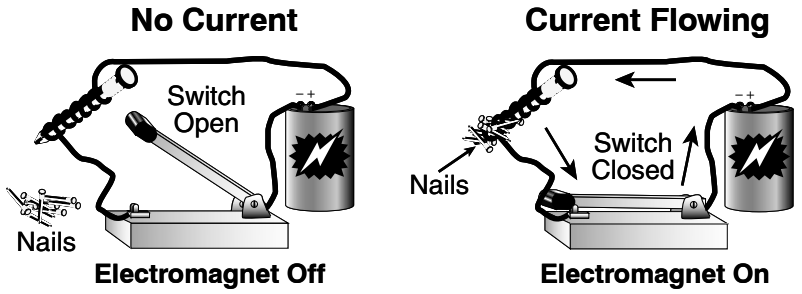
The kind of magnet you are probably most familiar with is a ferromagnet. Ferromagnets contain iron, nickel, or cobalt and are usually found in toys, tools, and closures on refrigerators.

What is a ferromagnet?

Another kind of magnet is called an electromagnet. **Electromagnets** are magnets that are made by an electric current. An electric current in a wire creates a magnetic field around the wire. If a wire that is carrying a current is coiled around an iron core, an electromagnet is formed. In fact, you can make a simple electromagnet by wrapping a wire around an iron nail and connecting the ends of the wire to the terminals of a battery. Electromagnets are very useful because they can be very strong—some are even strong enough to lift a car. Electromagnets are also useful because they can be turned on and off simply by turning the electric current on and off, as shown in the drawings on the next page.

What is an **electromagnet**?

Guided Questions



How are electricity and magnetism related?

Just as electricity can create magnetism, magnetism can also create electricity. The process of using a magnetic field to generate an electric current in a circuit is called **electromagnetic induction.** In order to create a current in a circuit, the magnetic field surrounding the circuit must be changing. For example, placing a bar magnet inside a coil of wire will not create a current in the wire. But if you move the magnet through the coil, the magnetic field around the wire will change, and a current will be induced. A current will also be induced if you move the coil of wire while holding the magnet in place.

Because of their lack of resistance, superconductors have been used to make electromagnets that generate large magnetic fields with no energy loss. These kinds of electromagnets are used in diagnostic medical equipment and in construction of powerful particle accelerators.

DIRECTIONS For each question, write your answer in the space provided.

1. Name and describe two kinds of magnets.

2. A wire has been wrapped around a magnet. Explain why no current is induced in the wire and explain what must be done to induce a current.

3. Describe how you would build an electromagnet.

Apply the NYS Learning Standards

DIRECTIONS Read the information below and answer the questions.

If you hang a bar magnet from a string, you will notice that the magnet will spin until its north pole points north. The north poles of magnets will point to the north because a magnetic field exists around the Earth. You can think of Earth as one giant magnet because Earth has a magnetic field that is created by the movement of electrically charged particles in its iron core.

The magnetic poles of Earth are close to but are not the same as the geographic poles of the planet. The geographic poles are located on the axis on which Earth rotates, and the magnetic poles are the points on Earth's surface where the magnetic forces are the strongest. Therefore, the poles of a freely spinning magnet will point to Earth's magnetic poles rather than to Earth's geographic poles. Also, Earth's magnetic poles do not stay in one place, but can move up to 15 km each year. Earth's magnetic poles have flipped many times throughout Earth's history so that the magnetic south pole becomes the magnetic north pole and vice versa.

1. The north pole of a bar magnet will point in a northern direction if allowed to rotate. Apply your knowledge of magnets to determine whether the magnetic pole near Earth's geographic North Pole is a magnetic north pole or a magnetic south pole. Explain your answer.

2. A compass is a device that contains a needle that points to the north. Explain how a compass works.

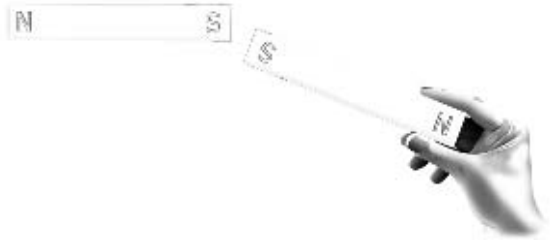
3. Describe how the behavior of magnets would change if Earth's magnetic poles flipped.

4. Compass needles do not point to Earth's geographic North Pole. Could this fact be a problem for people who use compasses to navigate?

NYS Test Practice

DIRECTIONS Choose the best answer for each question. Then circle the number of the answer you have chosen.

1 The diagram below shows two magnets.



A student moves a magnet close to another magnet that is lying on a table as shown above. Predict what will happen to the magnet on the table.

(1) The magnet will move closer to the magnet in the student's hand and will stick to it.

(2) The magnet will move closer to the magnet in the student's hand but will not touch it.

(3) The magnet will move away from the magnet in the student's hand.

(4) The magnet will move neither closer to nor away from the magnet in the student's hand.

2 An electric current will be induced in which of the following coils of wire?

(1) a coil of wire wrapped around an iron nail

(2) a coil of wire wrapped around a magnet

(3) a coil of wire with an iron nail moving through it

(4) a coil of wire with a magnet moving through it

3 Which of the following statements about magnetic poles is true?

(1) The attractive force of a magnet is greatest at its north pole and south pole.

(2) The attractive force of a magnet's north and south pole counteract each other.

(3) Magnetic poles switch directions so that the magnetic field is strongest at the center of a bar magnet.

(4) The magnetic poles produce the weakest magnetic field.

4 What property of electromagnets is not a property of ferromagnets?

(1) Electromagnets contain iron.

(2) Electromagnets can be turned on and off.

(3) Electromagnets attract iron or materials contain iron.

(4) Electromagnets have a north pole that points to the north.

5 The magnetic forces of a magnet are the strongest

(1) at the geographic poles

(2) at the magnetic poles

(3) in the magnetic field

(4) in the magnetic field lines

