Lesson Topic: Electric and Magnetic Forces

Objective:
Students will be able to:

1. Identify and describe electric and magnetic forces.
2. Create an electromagnet.
3. Explain how an electromagnet utilizes electric and magnetic forces.

Time Required: 75 minutes

Materials Needed:

- Battery (a 1.5 volt, D cell is preferred) (1 per group)
- Copper wire (4-6 feet of 18 gauge)
- Iron nail - at least 3 inches (1 per group)
- paper clips (approx. 10 per group)
- Teacher computer with internet access
- Projector/Smartboard
- 1 computer/laptop/iPad per student with internet access
- Electric and Magnetic Forces handout (attached)
- 1 Balloon
- Ring magnets (at least 2)
- Iron nail (longer iron rod works better)

Teacher Preparation:

- Assign a Legends of Learning Instructional Quick Play playlist for the day(s) you will be teaching the lesson.
    - Instructional - Middle School - Electric and Magnetic Forces
- Assign a Legends of Learning Content Review Quick Play playlist for the day(s) you will be teaching the lesson.
    - Content Review - Middle School - Electric and Magnetic Forces
- Make copies of Electric and Magnetic Forces Worksheet (1 per student)

Engage (10 minutes):

1. Pass out the Electric and Magnetic Forces handout.
2. Tell students “In a minute, I will demonstrate two different scientific principles.
    a. First, I want you to observe what happens.
    b. Then, I want you to give your best guess as to why it happened.
    c. Leave the third column blank for now.”
3. Show the students the balloon.
4. Ask for a volunteer who doesn’t mind getting their hair a little messed up.
    a. It is more easily observed with a student with longer hair, but could certainly work for any student.
5. Take the balloon and rub the balloon on their head.
    a. Give students time to write their answers, but do not discuss the actual answers until later in the lesson.
    b. The student’s hair should stick up and be connected to the balloon.

6. Next, show students the long iron nail.
7. Then, show them the ring magnets.
8. Last, secure the iron nail vertically and put the nail through the center of both ring magnets and see what happens (Be sure that the north pole of both magnets are facing each other or it will not work).
    i. (This activity can be completed with more than 4 magnets making an even cooler effect, however not necessary).
    b. Give students time to write their answers, but do not discuss the actual answers until later in the lesson.
    c. The magnet will repel one another, making it appear as if the top magnet is levitating in thin air.
9. Tell students “Keep these two demonstrations in your mind as we work through the lesson.”

Explore (20 minutes):

1. Have your students sign in to Legends of Learning. Instruct students to complete the Instructional playlist.
2. Assist students as needed during game play, pause playlist if you need to address content or questions to the entire class.

Explain (10 minutes):

1. Have students get out their handout to write down some important definitions (Write them on the board);
    a. Electric Force - a force that occurs between any two charged objects
        i. Opposite charges = attract; Same charges = repel
    b. Magnetic Forces - the attraction or repulsion between electrically charged particles.
2. Tell students “As you can see from the definitions, electric and magnetic forces work together much of the time.”
3. Ask students “Let’s first talk about the balloon and hair demonstration.
    a. Who can summarize what happened? (The student’s hair stood on end and was connected to the balloon).
    b. Why do you think it happened? (Answers will vary)
4. Tell students “This process is actually called static electricity. It is an example of an electrical force. When the balloon was rubbed on the hair, electrons are transferred from the hair to the balloon. The balloon now has a negative charge while the hair has a positive charge, having lost an electron to the balloon.
    a. These opposite charges are attracted to one another and is the reason why her hair stuck to the balloon and nearly stood straight up.
    b. There might be time, especially in the winter when the air is dry, that your hair gets “staticy.” It is because of electric forces gaining and losing electrons.
    c. The same static electricity can occur when shuffling along the carpet with socks on. This creates electron transfer between your socks and the carpet. In fact, if you try it and then touch a person’s skin with your finger you can actually give them a small electric shock!
    d. Lightning is another example of an electric force.
    e. Things like batteries and electricity use electric forces in order to work.They all

have to do with the flow of electrons."

5. Give students time to fill in the last column in their handout.
6. Ask students "Now let's switch gears and discuss the second demonstration with the ring magnets.
    a. Can someone summarize what happened? (The magnets repelled one another, making it appear as if the top magnet was levitating in thin air).
    b. Why do you think it happened? (Answers will vary).
7. Tell students "Just like electric forces, when charges are the same they repel, and when charges are opposite they attract one another. On a magnet, there are north and south poles. The north pole of one magnet is attracted to the south pole of another magnet and vice versa.
    a. When I placed the ring magnets around the iron nail, they were placed with both north poles facing each other causing them to repel, or push away. This created the illusion that the top magnet was floating in air."
8. Give students time to fill in the last column of their handout.

Elaborate (20 minutes):

1. Tell students "Today we are going to build an electromagnet."
2. Ask students "What do you think an electromagnet is?" (a magnet that runs on electricity).
3. Tell students "On its own, a nail would not be able to pick up paper clips using magnetism, however with some electricity, the nail will have no problem picking up paper clips."
4. Model for students how they are going to make it.
    a. Wrap the wire around the iron nail many times, leaving enough wire on each end to connect it to the battery.
5. Tell students "In your groups, follow the directions on the hand out. You will be using your electromagnet to see how many paperclips you can pick up."
6. Tell students "When you are finished building your electromagnet and working with the paperclips, answer the questions on your handout."
7. After everyone is finished with the handout, bring the class together to discuss their answers (Key is attached).

Evaluate (15 minutes):

1. Have your students sign in to Legends of Learning. Instruct students to complete the Content Review playlist.
2. Analyze student results to determine what concepts need to be a focus for reteaching.

Additional Lesson Strategies:

- To use Legends for additional instruction, create a custom playlist with an instructional game and pre and post assessment.
- To use Legends for a quick formative assessment, create a 5-question assessment in a playlist.
- To use Legends for a student-directed experience, create a targeted freeplay playlist.

- Encourage students to play on their own at home in Legends of Learning: Awakening for a student-driven experience including avatars, battling, and quests all centered around topics they are covering in class.

Name:_____

Electric and Magnetic Forces

	What did you observe?	Why do you think it happened?	What ACTUALLY happened?
Demo #1			
Demo #2			

Electric Forces -

Magnetic Forces -

Building an Electromagnet

1. Take the wire and wrap it around the iron nail many times. Be sure to leave enough wire on each end to attach it to the battery.
2. One end of the wire should attach to the positive side of the battery, and the other end of the wire should attach to the negative side of the battery.
3. Spread out some paper clips on the table.
4. Using the electromagnet you created, try and pick up as many paper clips as you can. Be sure all students in your group get a chance to try it out.

Answer the following questions:

A. Explain in detail what you observed when using the electromagnet.

B. How is the electromagnet able to pick up paper clips?

C. How are electric and magnetic forces used in an electromagnet?

Name:**KEY**

Electric and Magnetic Forces

	What did you observe?	Why do you think it happened?	What ACTUALLY happened?
Demo #1	**When the balloon was rubbed on the student's head, the hair stood on end!**	**Answers will vary.**	**Static Electricity. It is an example of an electrical force. When the balloon was rubbed on the hair, electrons were transferred from the hair to the balloon. The balloon now has a negative charge while the hair has a positive charge, having lost an electron to the balloon. These opposite charges are attracted to one another and is the reason why her hair stuck to the balloon and nearly stood straight up.**
Demo #2	**The teacher held an iron nail and put two ring magnets around it. The first magnet fell to the bottom, but the second magnet floated in air.**	**Answers will vary.**	**On a magnet, there are north and south poles. The north pole of one magnet is attracted to the south pole of another magnet and vice versa. When I placed the ring magnets around the iron nail, they were placed with both north poles facing each other causing them to repel, or push away. This**

			created the illusion that the top magnet was floating in air.

Electric Forces - **a force that occurs between any two charged objects; Opposite charges = attract; Same charges = repel**

Magnetic Forces - **the attraction or repulsion between electrically charged particles.**

Building an Electromagnet

5. Take the wire and wrap it around the iron nail many times. Be sure to leave enough wire on each end to attach it to the battery.
6. One end of the wire should attach to the positive side of the battery, and the other end of the wire should attach to the negative side of the battery.
7. Spread out some paper clips on the table.
8. Using the electromagnet you created, try and pick up as many paper clips as you can. Be sure all students in your group get a chance to try it out.

Answer the following questions:

D. Explain in detail what you observed when using the electromagnet.
After the wire was wrapped and attached to the battery, the nail turned into a large magnet. This allowed it to pick up paper clips very easily.

E. How is the electromagnet able to pick up paper clips?
When the wire is plugged into the battery an electric current flows through the wire. Because the wire is wrapped around a metal (the iron nail) those electric forces cause a magnetic field around the nail. This allows it to pick up the paper clips.

F. How are electric and magnetic forces used in an electromagnet?
The battery is a flow of electrons that creates an electric current. It acts on the iron nail through the wire creating a magnetic force.