Lesson Topic: Force Fields

Objective:
Students will be able to:

1. Recognize that forces exist between objects, even when not in contact.
2. Differentiate between magnetic, electric, and gravitational force fields.
3. Understand that when a second object is removed, the force exerted by the first object disappears.

Time Required: 75 minutes

Materials Needed:

- 6 donut ring magnets (large enough to fit a pencil through)
- Cardboard (approximate sizing: 1- 6”x8” rectangle, 1-1”X2” rectangle)
- Tape or hot glue
- Wood pencil
- Balloon (Be careful of students with allergies)
- Teacher computer with internet access
- Projector/interactive whiteboard
- 1 computer/laptop/iPad per student with internet access
- Force Fields Worksheet (attached)
- Diagram of Magnetic Pencil Levitation Device (attached)

Teacher Preparation:

- Assign a Legends of Learning Instructional Quick Play playlist for the day(s) you will be teaching the lesson.
    - Instructional - Middle School - Force Fields
- Assign a Legends of Learning Content Review Quick Play playlist for the day(s) you will be teaching the lesson.
    - Content Review - Middle School - Force Fields
- Make copies of Force Fields Worksheet (1 per student)
- Construct Magnetic Pencil Levitation Device (see attached)
    - Glue or tape the 1”x 2” cardboard rectangle to the center-left 6” side of the 6”x8” cardboard rectangle.
    - Orient four (4) magnets so that two (2) are north-facing, and two (2) are south-facing. You will be able to determine the poles by checking if the magnets repel each other.
    - Place the two north-facing magnets on the left side of the 6”X8” cardboard. One should be above the other, but not touching.
    - Place the two south-facing magnets on the right side of the 6”X8” cardboard. One should be above the other, but not touching. They should not touch the north-facing magnets.
    - Place the pencil through the remaining two magnets.
    - Practice “levitating” the pencil. You may need to adjust the position of the magnets on the pencil. One magnet should be over each set on the cardboard.

Engage (10 minutes):

1. Explain to students that they will be learning about the interaction of three different types of forces: gravitational, electrical, and magnetic.
2. Ask for a student volunteer to demonstrate the gravitational force.
3. Have the student jump up and down two or three times.
4. Explain to the class that the student has demonstrated the gravitational force. Highlight that the mass of the student interacts with the mass of the Earth in this demonstration, but the greater mass of the Earth exerts a larger force, pulling the student back to the Earth's center of gravity.
5. Blow up the balloon and rub it through your hair. (You may have a student volunteer for this demonstration, but be sure to check for latex allergies before beginning.)
6. Ask students why the hair and balloon are attracted.
   Answer: A possible response might include static electricity.
7. Explain to students that they have just observed an electrical force field, which resulted from opposing charges generated on the balloon and hair.
8. Explain to students that opposite charges attract, and same charges repel. Demonstrate by holding up two magnets.
9. Show students the Magnetic Pencil Levitation Device.
10. Explain to students that the base is constructed with two north-facing poles and two south-facing poles. Use the two free magnets to demonstrate that magnets have two poles that will attract or repel each other depending on orientation.
11. Place the two free magnets over the pencil.
12. Allow the pencil to "levitate" over the cardboard set-up.
13. Ask students what they think is holding the pencil up.
    Answer: Possible responses should relate to magnets and forces.
14. Explain to students that they have observed a magnetic force field, which resulted in the magnets on the pencil repelling the magnets on the cardboard.
15. Explain to students that the three force fields they observed today are all invisible, and all are acting at a distance without contact, and they will learn more about each type during the lesson.

Explore (30 minute):

1. Have your students sign in to Legends of Learning. Instruct students to complete the Instructional playlist.
2. As students complete the assigned games, students will complete the Force Fields Worksheet.
3. Circulate as students work through the playlist and complete the handout. Listen for evidence of understanding and use this opportunity to correct any misconceptions.

Explain (20 minutes):

1. Review the answers to Force Fields Worksheet by drawing a labeled three-column chart on the whiteboard or using Smartboard. Ask for student volunteers to complete the chart.
2. Relate student knowledge to the demonstration at the beginning of class.
   a. At the start of the lesson, you observe a pencil levitate. What force field allowed the pencil to levitate? (magnetic)
   b. What caused the magnetic force field to form? (the repulsion of the magnets

creates the force field.)

c. What would happen if the magnets on the cardboard were all oriented in the same direction? For example, what if they were all south facing? (the pencil would not be held up because there would be no force field.)
d. Is it possible for a force field to exist with only one object? Why or why not? (No, because the force disappears when one object is removed. All fields resulted from the interaction between two objects.)
e. What caused the electrical force field between the balloon and the hair to form? (the rubbing of the balloon in the hair caused charged particles to form)
f. What is the attraction in an electrical force field? (oppositely charged particles are attracted to one another)
g. Why is it not possible to completely escape Earth's gravitational force by jumping? (the mass of the Earth is greater, so it has a stronger pull)
h. What might be different if you were jumping on the moon where the gravity is much less than on Earth? (you would jump high, stay up longer)

Elaborate (5 minutes):

1. Explain to students that force fields exist in nature, but also have applications in science and technology.
2. Show this video of a computer-controlled magnetic force field: Magnetic levitation
3. Ask students what is allowing the sphere to levitate and move in the video.
    a. Answer: A magnetic force field allows the sphere to levitate, while a computer is moving the sphere.

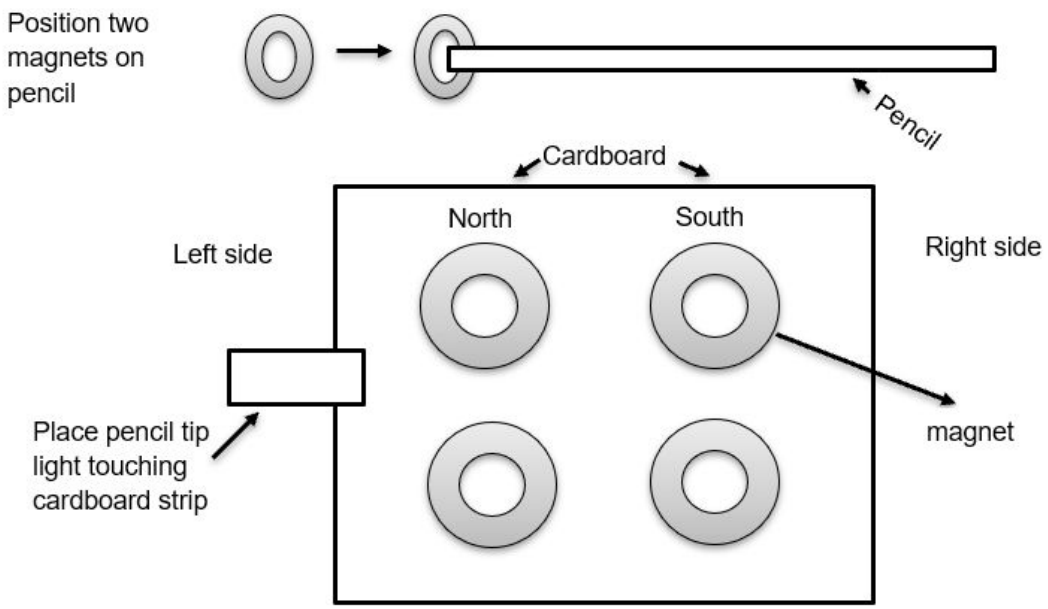
Evaluate (10 minutes):

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.

Diagram of Magnetic Pencil Levitation Device



Force Fields

Name:_____

Directions: While playing the games in Legends of Learning, use what you learn to sort the information into the correct boxes. Some phrases may be used in more than one box.

Electric

Magnetic

Gravitational

helps compasses work

causes paper airplanes to fall to Earth

occurs between charged particles

occurs without contact

makes hair and balloon attract

causes apples to fall

field can be mapped

has a N and S pole

causes tides

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