



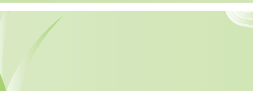
Sample Grade 3 Teacher's Guide and Student Literacy



Forces and Interactions

A New Generation





Materials List

Needed from the kit

16 bar magnets
8 beam boards
8 diecast cars
8 fulcrums
8 large resealable plastic bags
8 large styrene balls
8 large washers
8 levels
1 Literacy Series Reader: <i>Forces and Interactions</i>
16 ring magnets
16 rods
1 roll of string
8 slotted mass sets with hanger
8 small resealable plastic bags
16 small styrene balls
80 small washers
8 spools
8 spring scales
8 stopwatches
8 tape measures, 60 in
Bubble wrap (small bubbles)
Felt
Iron filings
Sandpaper

Provided by the teacher

Access to a long, smooth surface such as a linoleum floor
Assorted metallic magnetic and nonmagnetic objects (for example, soda cans, coins [each domination has a different metal composition], aluminum foil, metal barrettes or clips, brads, paper clips, nails, metal washers, screws, bottle caps, etc.)
Rolls of masking tape
8 elevated work stations at least 5 feet long
30 glue sticks
56 large paper clips
1 measuring spoon, 1/8 tsp
30 pairs of scissors
1 quarter
8 rulers, 12 in
8 sheets of white paper, 8.5 x 11 in
32 small paper clips
8 textbooks
24 various small lightweight objects that will fit at the end of a balance, such as blocks, cards, paper clips, pen caps, spoons, erasers, plastic toys, etc.

Provided by the student

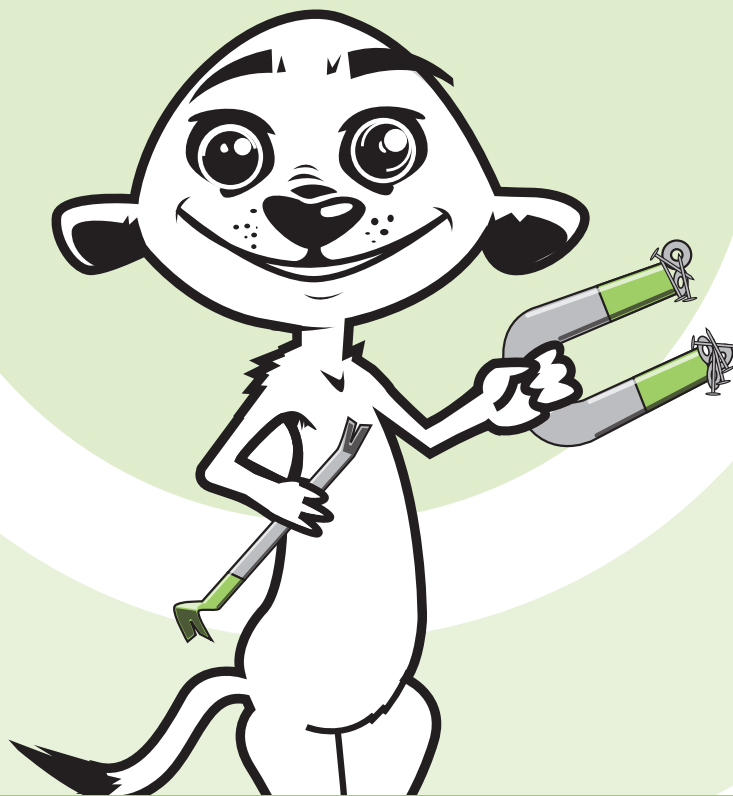
1 science notebook
1 pencil



Forces and Interactions

A New Generation

Teacher's Guide



 BuildingBlocks
of Science®

Unit and Lesson Summaries

Unit Overview

The concepts of forces and interactions naturally lend themselves to scientific investigation. The activities in this unit give students inquiry-based experiences that build on one another, providing a solid foundation of these physical science concepts.

Students build and use simple equipment to observe that a force is a push or a pull, and that forces can be applied to objects without them being touched.

Students investigate the effects of balanced and unbalanced forces on the motion of objects. They use evidence from their investigations to predict changes in motion. Students develop an understanding of the cause and effect relationship between forces and objects based on their observations of the movement and reactions of objects when forces are applied to them.

Assessment

This unit offers several ways to assess students, including a pre- and a post-unit assessment opportunity. Teachers can also use class discussions and charts to assess each lesson. Student activity sheets and science notebook entries—including drawings, writings, and dictated statements—can be used to gauge individual understanding of objectives and key vocabulary throughout the unit. A general rubric is provided to help teachers evaluate individual students at any point in the unit. The rubric provides a progression of skills and understanding that covers exploration, vocabulary, concept building, and notebook entries. Finally, a summative assessment gives students the opportunity to demonstrate unit-specific content knowledge by responding to questions in a variety of formats.

Lesson 1: Balanced Forces

Students begin their study with an inquiry-based pre-unit assessment in which they balance objects on a scale. They learn that all objects on earth have the force of gravity being applied to them at all times, and based on Newton's third law of motion, whatever surface an object is resting on has an equal but opposite force to gravity pushing on it. Students make a scale from a beam board and masses and use it to investigate different forces that can be applied to keep objects at rest.

Lesson 2: Unbalanced Forces

Building on the law of inertia, students investigate the unbalanced forces that set objects in motion. They determine forces that are applied to a moving object to make it stop moving by setting a toy car in motion, and conclude that friction is a force that causes a resistance in movement. By testing the movement of the car against different surfaces, students learn that different textures of surfaces have different coefficients of friction that cause different changes in the motion of the car.

Lesson 3: Changes in Motion

In this lesson, students apply the concept of unbalanced forces to an object. They secure small masses to the end of a string attached to a car to observe how fast the car will go as the force being applied increases with the amount of mass. They learn that adding a load to the car will slow down the movement and will require more force to be applied to make the car move.

Lesson 4: Magnetism and Electricity

Students investigate how magnets create a force field that can either attract (pull) or repel (push) objects toward or away from them. They examine the movement of magnets to determine that opposite poles attract and same poles repel each other.

Once students have a firm grasp on magnetism, they apply this concept to understand that positive and negative electric charges create the same attraction or repulsion based on the type of charge. Opposite charges attract each other, while same charges repel. A Take-Home Science Activity gives students the opportunity to test the negative and positive charges of simple household items at home by investigating which items attract each other and which repel.

Lesson 5: Magnetic Solutions

This final lesson provides students with the opportunity to assess their knowledge of forces and the interactions between forces. First, they reinforce what they have learned about forces, including gravity and magnetism, and how various forces interact.

Then, in a culminating engineering challenge, groups design a model using magnetism as the solution to a problem. Groups select a problem to tackle, and then design two models that solve the problem using magnetism. They then compare their models, selected the best solution to the problem, and present this model to their classmates.





LESSON NOTES

Lined area for writing lesson notes.

Lesson Overview Charts

Lesson 4: Magnetism and Electricity

Lesson Essentials	Next Generation Science Standards	Language Arts and Math Standards
<p>Objectives:</p> <ul style="list-style-type: none"> Determine that the direction of the force of a magnet on materials made of iron is a pull. Observe and investigate the relationship between the pushes or pulls of magnets on other magnets and the direction of their poles. Demonstrate how opposite electric charges attract and like charges repel each other. Explain the similarities and differences between electric and magnetic forces. <p>Time Requirements:</p> <p>Teacher Preparation</p> <p>Part A: 20 minutes Part B: 20 minutes Part C: 10 minutes Part D: 5 minutes</p> <p>Lesson</p> <p>Part A: 1 class session Part B: 1 class session Part C: 2 class sessions Part D: 1 class session</p> <p>Essential Questions:</p> <ul style="list-style-type: none"> What is the connection between magnetism and electricity? <p>Vocabulary:</p> <ul style="list-style-type: none"> Attract Charge Magnet Magnetic field Magnetism Repel Static electricity 	<p>Performance Expectations</p> <ul style="list-style-type: none"> 3-PS2-3: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. <p>Disciplinary Core Ideas</p> <ul style="list-style-type: none"> PS2.A: Forces and Motion PS2.B: Types of Interactions <p>Science and Engineering Practices</p> <ul style="list-style-type: none"> Asking Questions and Defining Problems <p>Crosscutting Concepts</p> <ul style="list-style-type: none"> Cause and Effect 	<p>Language Arts</p> <ul style="list-style-type: none"> L.3.6: Vocabulary Acquisition and Use RI.3.3: Key Ideas and Details RI.3.9: Integration of Knowledge and Ideas. SL.3.1: Comprehension and Collaboration W.3.2: Text Type and Purpose W.3.8: Research to Build and Present Knowledge <p>Math</p> <ul style="list-style-type: none"> 3.NBT.A.1: Use place value understanding and properties of operations to perform multi-digit arithmetic. 3.MD.B.3: Represent and interpret data.



Cross-Curricular Connections	Literacy	Assessment Strategies
<div data-bbox="120 426 168 474"></div> Science Notebooks <div data-bbox="120 516 168 564"></div> Language Arts <div data-bbox="120 606 168 655"></div> Math <div data-bbox="120 697 168 745"></div> Science <div data-bbox="120 787 168 835"></div> Technology <div data-bbox="120 877 168 926"></div> Music <div data-bbox="120 968 168 1016"></div> Geography <div data-bbox="120 1058 168 1106"></div> Movement Education <div data-bbox="120 1184 168 1232"></div> Engineering and Design <div data-bbox="120 1310 168 1358"></div> Take-Home Science	<p>Forces and Interactions Literacy Reader*:</p> <ul style="list-style-type: none"> • “Noncontact Forces—Magnetic Forces,” pgs. 10–11 • “Noncontact Forces—Electric Forces,” pg. 9 <p><i>* See Appendix E for Literacy Connections for before, during, and after reading.</i></p> <p>Additional Reading Suggestions: TG pg. 72</p> <ul style="list-style-type: none"> • <i>What Magnets Can Do (Rookie Read- About Science)</i> by Allan Fowler (Children’s Press, 1995) • <i>Magnets: Pulling Together, Pushing Apart (Amazing Science)</i> by Natalie M. Rosinsky (Picture Window Books, 2002) • <i>Magnets (All Aboard Science Reader)</i> by Anne Schreiber (Grosset & Dunlap, 2003) 	<p>Student Activity Sheets:</p> <ul style="list-style-type: none"> • Student Activity Sheet 4A: <i>Magnetic Field</i> • Student Activity Sheet 4B: <i>Opposites Attract</i> • Student Activity Sheet 4C: <i>Ring Magnets by Design</i> • Student Activity Sheet 4D: <i>Static Spiral</i> • Student Activity Sheet 4E: <i>Attracting or Repelling Charges?</i> <p>Science Notebook Opportunity:</p> <ul style="list-style-type: none"> • Students explain why metal washers likely contain iron. (TG pg. 64) • Students explain why the poles of a bar magnet have stronger magnetic forces than the middle of the bar. (TG pg. 66) • Students explain the relationship between positive and negative charges and attracting and repelling. (TG pg. 71) <p>Formative Assessment:</p> <ol style="list-style-type: none"> 1. Notebook Prompt: Use evidence from your investigation to explain how magnets are similar to electric charges. 2. Use Student Activity Sheet 4A: <i>Magnetic Field</i> and/or Student Activity Sheet 4B: <i>Opposites Attract</i> to assess student understanding of North and South magnetic poles and magnetic fields. 3. Use Student Activity Sheet 4C: <i>Ring Magnets by Design</i> to assess student understanding of engineering practices, magnetism, and magnetic fields. 4. Use Student Activity Sheet 4E: <i>Attracting or Repelling Charges?</i> to assess student understanding negatively and positively charged objects. 5. Use Science Notebook Opportunities to formatively assess the class and adjust instruction as needed. 6. Evaluate student understanding through class discussions. <p>General Rubric:</p> <ul style="list-style-type: none"> • Refer to the General Rubric included in Appendix D to assess individual progress. <p>Science Notebooks</p>



Lesson 4

MAGNETISM AND ELECTRICITY

MATERIALS

Student

- 1 science notebook*
- 1 Student Activity Sheet 4A: *Magnetic Field*
- 1 Student Activity Sheet 4B: *Opposites Attract*
- 1 Student Activity Sheet 4C: *Ring Magnets by Design*
- 1 Student Activity Sheet 4D: *Static Spiral*
- 1 Student Activity Sheet 4E: *Attracting or Repelling Charges?*
- 1 Take-Home Science Activity: *What's the Charge?*
- 1 Take-Home Science General Letter

Team of four students

- 2 bar magnets
- 2 ring magnets
- 1 ruler, 12 in*
- 1 small washer
- 1 bag of iron filings*
- 4 pieces of masking tape*
- 2 small styrene balls
- 1 large styrene ball
- 1 rod
- 1 fulcrum
- 1 pair of scissors*

Class

- 8 assorted metallic magnetic and non-magnetic objects (for example, a soda can, coins, aluminum foil, metal barrettes or clips, brads, paper clips, nails, metal washers, screws, bottle caps, etc.)*

Teacher

- 1 Student Activity Sheet 4B: *Opposites Attract* (Teacher's Version)
- 1 pair of scissors*
- 1 roll masking tape*
- 8 sheets of white paper, 8.5 x 11 in*
- 8 small resealable plastic bags
- 1 measuring spoon, 1/8 tsp*
- 8 large resealable plastic bags
- Iron filings
- General Rubric (Appendix D)

LESSON OVERVIEW

Students investigate how magnets create force fields that can either attract (pull) objects toward or repel (push) objects away from them. They examine the movement of magnets to determine that opposite poles attract and that same poles repel each other.

Once students have a firm grasp on magnetism, they apply this concept to understand that positive and negative electric charges create the same attraction or repulsion based on the type of charge. Opposite charges attract each other, while same charges repel. A Take-Home Science Activity gives students the opportunity to test the negative and positive charges of simple household items by investigating whether common items stick to each other or repel one another.

OBJECTIVES

- ☉ Determine that the direction of the force of a magnet on materials made of iron is a pull.
- ☉ Observe and investigate the relationship between the pushes or pulls of magnets on other magnets and the direction of their poles.
- ☉ Demonstrate how opposite electric charges attract and like charges repel each other.
- ☉ Explain the similarities and differences between electric and magnetic forces.

VOCABULARY

Science Words

- Attract
- Charge
- Magnet
- Magnetic field
- Magnetism
- Repel
- Static electricity

TIME CONSIDERATIONS

Teacher Preparation

- Part A 20 minutes
- Part B 20 minutes
- Part C 10 minutes
- Part D 5 minutes

Lesson

- Part A 1 class session
- Part B 1 class session
- Part C 2 class sessions
- Part D 1 class session

TEACHER PREPARATION

Part A

1. Have available from the kit one bar magnet and one small washer for each group of four students.
2. Collect at least eight items that are metallic, such as soda cans, coins (each denomination has a different metal composition), aluminum foil, metal barrettes or clips, brads, paper clips, nails, metal washers, screws, or bottle caps. Be sure to include both magnetic and non-magnetic objects. Randomly divide these objects among four stations around the classroom.

Part B

1. Make one copy of Student Activity Sheet 4A: *Magnetic Field* for each student.

*These materials are needed but not supplied.

2. Prepare a bag of iron filings for each group of four students by doing the following:

- A.** Cut a small piece of white paper to match the size of a small resealable plastic bag provided in the kit.
- B.** Place the paper inside the bag.
- C.** Scoop 1/8 teaspoon of iron filings into the bag and seal it securely.

3. Place two bar magnets and a prepared bag of iron filings into a large resealable plastic bag for each group of four students.

Part C

1. Make one copy of Student Activity Sheet 4B: *Opposites Attract* and one copy of Student Activity Sheet 4C: *Ring Magnets by Design* for each student. Make one copy of the Teacher's Version of the Student Activity Sheet 4B for yourself.

2. Each group of four students will need two bar magnets and two ring magnets from the kit and a prepared bag of iron filings from Part B. Place these in a large resealable plastic bag for each group.

3. For each group, obtain one ruler. To the ruler, attach four small pieces of masking tape. Add these items to each group's bag.

Part D

1. Make one copy of the Take Home Science Activity: *What's the Charge?* and one copy of the Take-Home Science General Letter (Appendix C) for each student.

2. Make one copy of Student Activity Sheet 4D: *Static Spiral* for each group and one copy of Student Activity Sheet 4E: *Attracting or Repelling Charges?* for each student.

3. Each group of four students will need two small styrene balls, one large styrene ball, one rod, and one fulcrum from the kit, as well as one pair of scissors. Place these items in a large plastic resealable bag for each group.

BACKGROUND INFORMATION

Magnetism

Magnetism is an example of a non-contact force, or a force that occurs when objects are not touching. Many materials are **magnets** or are attracted to magnets, such as nickel, cobalt, or the rare-earth magnets like neodymium and samarium. The materials students will work with in this lesson will demonstrate that iron is one type of material attracted to magnets.

When you hold a magnet near a steel paper clip, the magnet does not have to be touching the paper clip in order to apply force and pull the paper clip toward it. The area around a magnet that applies a force is called the **magnetic field**. Magnetic materials such as a paper clips or iron filings must be close enough to the magnet to feel a significant force, as the strength of the magnetic field falls off rapidly with increasing distance from the magnet.

Electricity

Electricity is the flow of charged particles. Electrical forces are caused by the interaction of positive and negative **charges**. These charges can be due to ions (positively or negatively charged atoms) or free electrons. Positive charges push away from positive charges, and negative charges push away from negative charges, but a negative charge and a positive charge will pull toward each other.

Static electricity is the buildup of electric charges on a surface. Opposite charges are attracted to each other, which causes some objects to stick together. Electric shock can be caused by an excessive buildup of static charge.

ACTIVITY INSTRUCTIONS

Part A

Magnetic Metals

1

Discuss the different ways forces can be applied to an object. Have students provide examples of pushes and pulls.

2

Distribute one washer and one bar magnet to each group of four students. Instruct them to hold the north (N) end of the magnet close to, but not touching, the washer, and to observe what happens. (*The washer will move toward the magnet.*) Ask,

- What type of force is being applied? (*A pull*)
- Which object is applying the force? How do you know? (*The magnet is applying the force [a pull] because the washer is moving toward it.*)

3

Explain that the washer is magnetic because it is attracted to the magnet. Have students think about other magnetic objects. (*Students should make a connection that magnets “stick” to some metals.*)

4

Make a T-chart on the board. Title one side of the chart “Object” and the other side “Magnetic?” See Figure 4.1 for an example. Direct students to copy the chart into their science notebooks, and to write *washer* on the first line.

OBJECT	MAGNETIC?
WASHER	YES
NAIL	
NICKEL COIN	
PAPER CLIP	

Figure 4.1 Object/Magnetism Chart

5

Have students use the magnet to attract the washer again. Ask students whether the washer is magnetic (yes), and to record this result on the chart.



6

Point out the four stations you have set up around the room. Explain that groups will travel to each station with their magnets and test the objects at each station to see if they are magnetic. They should list each item they test and whether it is magnetic on the T-chart in their science notebooks.

7

After ample time for groups to test the objects, call students back to their seats and discuss their findings as a class. Ask,

- What materials did you find that were magnetic?
- Were there any metal objects that were not attracted to the magnet?

8

Explain that only certain metals are attracted to magnets. Iron is one metal that students will work with in this unit. Many objects have a mixture of iron and other metals, which makes them magnetic.

9

Collect the washers and the magnets for later use.

Science Notebook Opportunity

Notebook Prompt:

Explain why it is possible for a metal washer to contain iron, based on your observations and evidence from the activity.

A metal washer likely contains iron because _____.

Part B

Magnetic Field

1

Review types of objects that are attracted to magnets. Have students recall that iron is one type of metal that is attracted to magnets.

2

Distribute a bag of materials to each group of four students. Have them remove the two bar magnets and the small bag of iron filings. Instruct students to shake the bag to arrange the iron filings in a thin layer on top of the white paper when the bag is laid flat on the desk.

3

Allow students to drag a magnet across the bag on top of the iron filings and observe them move.

4

Distribute a copy of Student Activity Sheet 4A: *Magnetic Field* to each student. Read the directions aloud, and answer any questions students may have about the activity.

5

Ask students to predict whether the magnetic forces are the same on either end of the magnet. They should record this under Part A of the activity sheet.

6

Allow time for groups to conduct the investigation as described in Part B of the activity sheet. By exploring the way the filings interact with the magnets in different orientations, students will observe that the magnet has a different magnetic force at each end. As they work, make sure students draw to record what they observe for each arrangement of magnets and iron filings.

7

Once all groups have completed Part B of Student Activity Sheet 4A, discuss findings as a class. Clear up any misconceptions that students may have. Explicitly explain that the magnetic force of magnets can be strong enough to attract magnetic objects without touching them. Ask,

- What happened to the iron filings when they came close to or in contact with the magnets? (*They gathered around the poles of the magnets.*)
- What were the differences in the patterns made by the iron filings when you changed the position of the magnets? (*Figure 4.2 shows the different patterns students should have observed with different orientations of the magnets.*)
- Which parts of the magnets attracted the most iron filings? (*The poles*)
- Did the iron filings need to be touching the magnets in order to move? (*No*)
- What caused the iron filings to move toward the magnets? (*The magnetic force*)

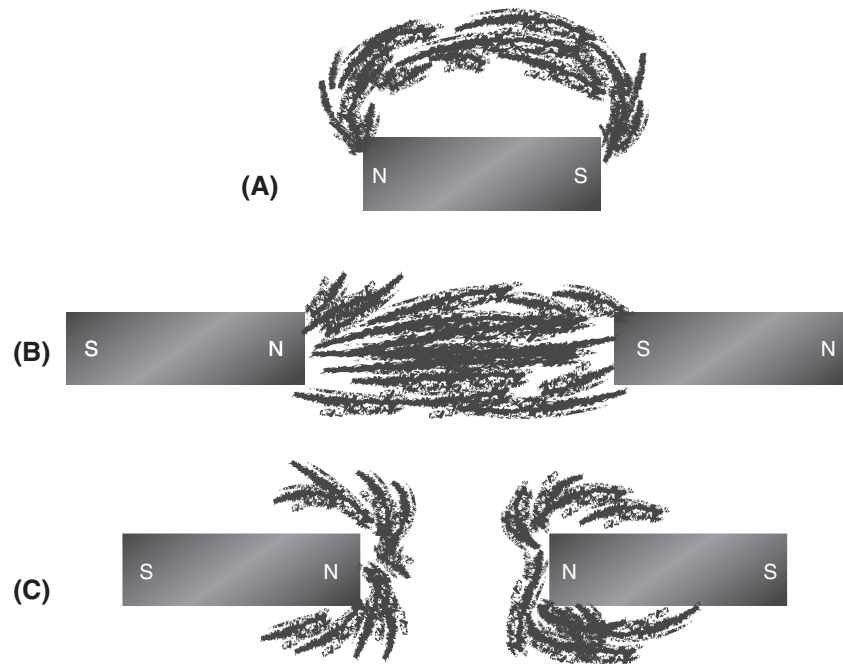


Figure 4.2
How students will observe the magnetic filings behaving as they follow the directions in Part B of Student Activity Sheet 4A. (A) shows results for Step 2, (B) for Step 5, and (C) for Step 7.



Allow time for students to answer the question in Part C of the activity sheet to formulate their conclusions.

Ask groups to place all their materials in the resealable plastic bags, and collect them.

Science Notebook Opportunity

Notebook Prompt:

Use evidence from your investigation to explain how you know that the poles of the bar magnet have a stronger magnetic force than the middle of the bar magnet.

I know that the poles of the bar magnet have a stronger magnetic force than the middle of the bar magnet because _____.



Part C

Opposites Attract

1

Review what happened to the iron filings when the opposite poles of the magnets were facing each other. (*The filings were pushed to the center of the space between the magnets.*) Explain that when magnets push away from each other, they repel each other. Review what happened to the filings when similar poles of two magnets were facing each other. (*The filings were pulled to each of the magnets.*) Explain that when magnets pull toward each other, they are attracted to each other.

2

Distribute a bag of materials to each group of four students, and direct them to remove the two bar magnets. Allow students time to manipulate the magnets to observe them attracting and repelling each other.

3

Distribute a copy of Student Activity Sheet 4B: *Opposites Attract* to each student. Read the directions aloud. Answer any questions students may have about what is expected in the activity.

4

Ask students to fill out Part A of the activity sheet by recording a prediction about how they think two different magnets will interact with each other.

5

Allow ample time for groups to complete Part B of the activity sheet by placing the bar magnets as described under the centimeter rulers provided and making observations as they slide the magnets toward each other.

6

After students have completed Part B of the activity sheet, ask for volunteers to share their predictions and results. Based on their observations, were the predictions correct or incorrect? Discuss several different predictions and the outcomes.

7

Ask each student to write a concluding summary in Part C of the activity sheet explaining the relationship between the positions of two different magnets and the strength of the magnetic force. Ask a volunteer to share his or her summary. (*Students should conclude that two opposite poles of two different magnets are attracted to each other with a strong magnetic force.*) Clear up any misconceptions that students may have.

Teacher Tip

Student Activity Sheet 3B: *Opposites Attract* (Teacher's Version) includes anticipated outcomes and responses to the prompts and questions on the student version of activity sheet. Refer to this as needed as you discuss outcomes of the investigation during Steps 6 and 7.

Teacher Tip

This activity will take two class sessions. A good time to break the activity is after completing Step 7. Students can explore the ring magnets in the next class session using Student Activity Sheet 3C.





8

Distribute a copy of Student Activity Sheet 4C: *Ring Magnets by Design* to each student. Explain that groups will design their own investigations to determine the poles of two unmarked ring magnets. Point out that they can use any of the materials in the bag as they investigate, but it is up to each group to decide how to determine the poles.

9

Read the directions on the activity sheet aloud to the class. Be sure all groups understand the task, the materials available, and how to proceed. Reiterate the task and the goal as defined in Parts A and B of the activity sheet.

10

Allow ample time for groups to plan an investigation to identify the poles of each ring magnet. Point out that they should fill in Part C of the activity sheet as they complete each substep. As groups devise their plans, circulate the room, coach groups, and redirect any misconceived ideas that groups may have.

11

Once groups have a concrete idea of the design for their investigation, allow them time to carry out their plans, completing Parts D and E of the activity sheet. Students should work together to test, observe, and sketch/write to describe their investigation and the results they obtain, and draw conclusions based on their results.

You may need to help groups evaluate and refine their designs in Part D, Step 6, of the activity sheet. If so, ask,

- Was your team successful in identifying the north and south poles of both ring magnets?
- How did you determine the north pole from the south pole on your magnets?

12

Allow time for each group to share its plan, results, and conclusions with the class. Facilitate a rich discussion about the scientific process and using evidence to support ideas.

Part D

Electricity Attracts and Repels

1

Review how opposite poles of two magnets attract each other and the same poles of two magnets repel each other. Have students recall that magnets do not need to be touching to move toward or away from each other. Discuss the meanings of the words *attract* and *repel*. Make the connection that one is a pull and one is a push.



2

Explain to students that they have observed magnetic forces, and now they will explore electric forces. Distribute a bag of materials and a copy of Student Activity Sheet 4D: *Static Spiral* to each group of four students. Ask them to remove one large styrene ball and one pair of scissors from the bag.

3

Explain to students that they have observed magnetic forces, and now they will explore electric forces. Guide groups to cut out the spiral from the activity sheet and then to lay it flat on the desktop, coiled.

4

One student in each group should rub the styrene ball on his/her shirt vigorously for at least 30 seconds, then hold the styrene ball approximately 1–2 inches above the center of the cut-out spiral and observe what happens. *(The center of the spiral will be attracted to the ball and rise up from the desk.)* Ask,

- Did the styrene ball attract or repel the paper spiral? How do you know? *(The styrene ball attracted the spiral because the paper was pulled toward it.)*

5

Distribute one copy of Student Activity Sheet 4E: *Attracting or Repelling Charges?* to each student, and direct groups to remove two small styrene balls, one rod, and one fulcrum from their bag of materials.

6

Read the directions on the activity sheet aloud, and use one group's materials to model how to assemble the styrene ball balance by inserting each end of the rod into one small styrene ball, and then balancing the rod on the fulcrum, as directed in Part A of the activity sheet.

7

Have students record under Part B of the activity sheet a prediction about what will happen if two negatively charged styrene balls are placed near each other.

8

Lead groups through the investigation described in Part C of the activity sheet. Direct one student in each group to negatively charge the large styrene ball by rubbing it on his/her shirt.

9

Meanwhile, direct a second student in each group to negatively charge one small styrene ball on the rod of the balance by rubbing the ball on his/her shirt and then balancing the rod on the fulcrum.

10

Instruct the student with the large styrene ball to slowly bring it close to the side of the negatively charged small styrene ball. The whole group should observe what happens.

Teacher Tip

Not all materials will produce a charge. Silk or wool work much better than cotton. If it's humid outside, it can be tough to get things to charge up. Human hair is a great material for producing a charge. See Figure 4.3 for a list of materials that can create a charge.





11

Have students record their observations and conclusions in Parts D and E of the activity sheet, then discuss students' outcomes as a class. *(The small styrene ball [with a negative charge] repelled and moved away from the large styrene ball [with a negative charge] when it came close to it.)*

12

Ask students to return their materials to the plastic bags and collect them for later use.

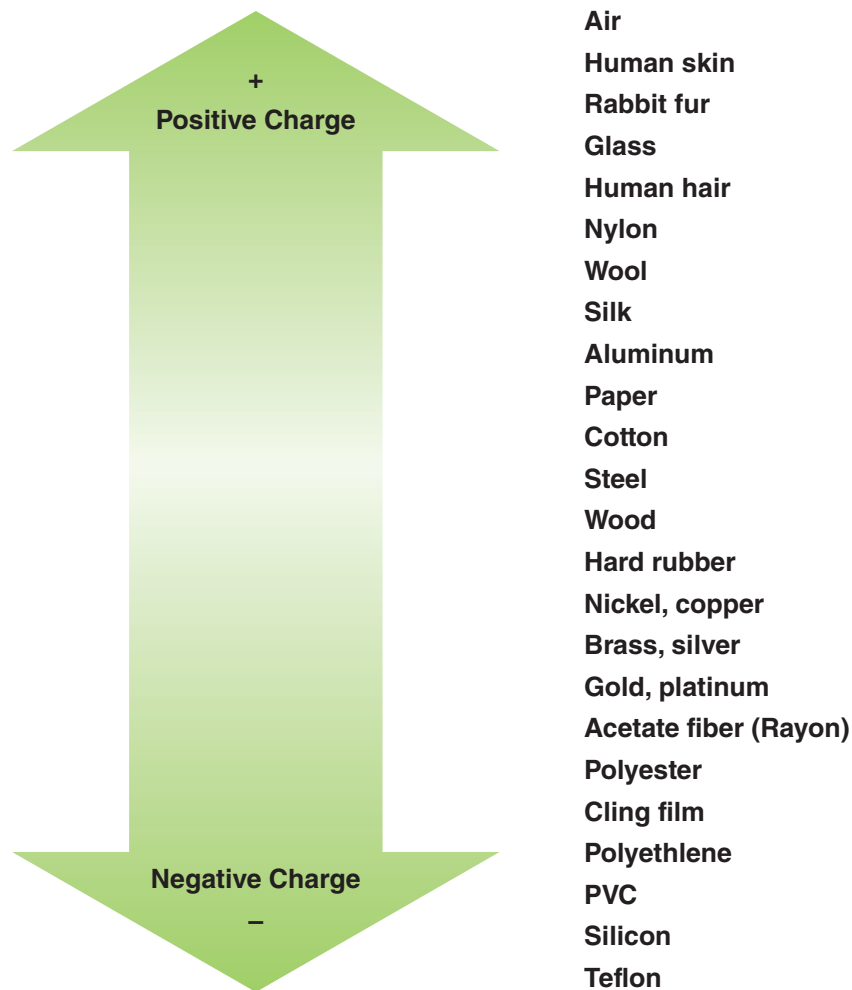


Figure 4.3
Materials to Produce Positive and Negative Charges on Objects



Science Notebook Opportunity

Notebook Prompt:

Using evidence from the investigation, explain the relationship between positive and negative charges and attracting and repelling.

Negative charges will repel _____. I know this because I observed _____.

Positive charges will attract _____. I know this because I observed _____.

Take-Home Science

What's the Charge?

Students will negatively charge a plastic pen and test different household objects to see how they react when they come near the negative charge of the pen. Send home a copy of the Take-Home Science General Letter (Appendix C) with the activity sheet.

LESSON NOTES



EXTENSIONS



Find Your Way with Magnets



Show this short video of two men making a compass by magnetizing a paper clip to survive in the wild.



- www.discovery.com/tv-shows/dual-survival/videos/diy-survival-make-a-compass.htm

Provide pairs of students a ring magnet, a paper clip, a 3-inch piece of string or thread, a pair of scissors, a straw, and a large paper cup.

Guide students to assemble a compass similar to the one in the video by following the steps below:

1. Straighten the paper clip and stroke each end on the ring magnet approximately 40–50 times until it is magnetized (acts like a magnet on its own).
2. Remove the bottom from the paper cup.
3. Poke a hole on each side of the paper cup about one-quarter of the way from the top of the cup.
4. Slide the straw through the holes in the cup.
5. Tie the string to the center of the straw.
6. Tie one end of the string to the paper clip. The paper clip should be able to move and spin freely below the cup.

As a class, use the completed compasses to determine the direction of true North, or all four directions relative to your location. Explain that the magnetized paper clip will naturally align with the Earth's magnetic field, providing a North–South reading.



Paper Clip Collection



Have students collect data from testing the strength of two different types of magnets to determine which magnet is stronger. Challenge them to use each magnet to attract as many paper clips at once as possible. Students should count the number of paper clips attracted to each magnet and draw a scaled picture graph to show the data. Ask them to write and solve an addition equation to determine how many more paper clips were attracted by the stronger of the two magnets.



Comparing Books about Magnets



Obtain at least one copy of each of the following books:

- *What Magnets Can Do (Rookie Read-About Science)* by Allan Fowler
- *Magnets: Pulling Together, Pushing Apart (Amazing Science)* by Natalie M. Rosinsky
- *Magnets (All Aboard Science Reader)* by Anne Schreiber

Divide the class into three groups, and allow each group to read its assigned text. (Note: These texts are listed from low to high reading level. You may want to organize students into three groups by ability, or you may want to pair high ability and low ability students in each group for peer teaching.)

After each group has explored its text, bring the class together for a discussion. Create a three-column chart on the board. Title one column with a book title. Ask each group to share how its book presented the poles, magnetic fields, and attracting and repelling. (*Students may give an example from the book, read a definition, or tell how diagrams or other graphics showed the concept.*) Record student responses on the chart. When the chart is complete, compare the information presented in each of the books.



All Our Magnets Have Two Poles







Write the following lyrics on the board or project them as your classroom technology allows. Have students sing the song to the melody, *Row, Row, Row Your Boat*.

Magnets have two poles,
North and South Poles true.
Opposite poles pull or attract, similar poles
push or repel—Whew!

Once the class is familiar with the lyrics, challenge students to create movements to the song. You might also sing the song in rounds.

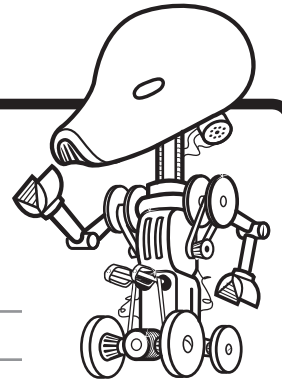




EXTENSIONS	EVALUATION/ASSESSMENT
<p> Negative and Positive Charge Challenge</p> <p> Make the materials from Part D of this lesson available for students to use to design an investigation to determine what would happen if the large, negatively charged styrene ball came close to a small, positively charged styrene ball on the balance. Have students test and then explain the results of their investigation.</p> <p> Literacy Series Reader: Forces and Interactions</p> <p> As a class, in small groups, or in pairs, have students explore the informational text in the literacy reader for this unit. Refer to Appendix E for strategies for before, during, and after reading the lesson-specific chapters or for exploring the literacy reader as a whole after the unit.</p>	<ol style="list-style-type: none">1. Notebook Prompt: Use evidence from your investigation to explain how magnets are similar to electric charges.2. Use Student Activity Sheet 4A: <i>Magnetic Field</i> and/or Student Activity Sheet 4B: <i>Opposites Attract</i> to assess student understanding of North and South magnetic poles and magnetic fields.3. Use Student Activity Sheet 4C: <i>Ring Magnets by Design</i> to assess student understanding of engineering practices, magnetism, and magnetic fields.4. Use Student Activity Sheet 4E: <i>Attracting or Repelling Charges?</i> to assess student understanding negatively and positively charged objects.5. Use Science Notebook Opportunities to formatively assess the class and adjust instruction as needed.6. Evaluate student understanding through class discussions7. Use the General Rubric in Appendix D to assess individual progress as needed.

Student Activity Sheet 4A Name _____

Magnetic Field



Date: _____

Team of Scientists: _____

A) _____ **B)** _____

C) _____ **D)** _____

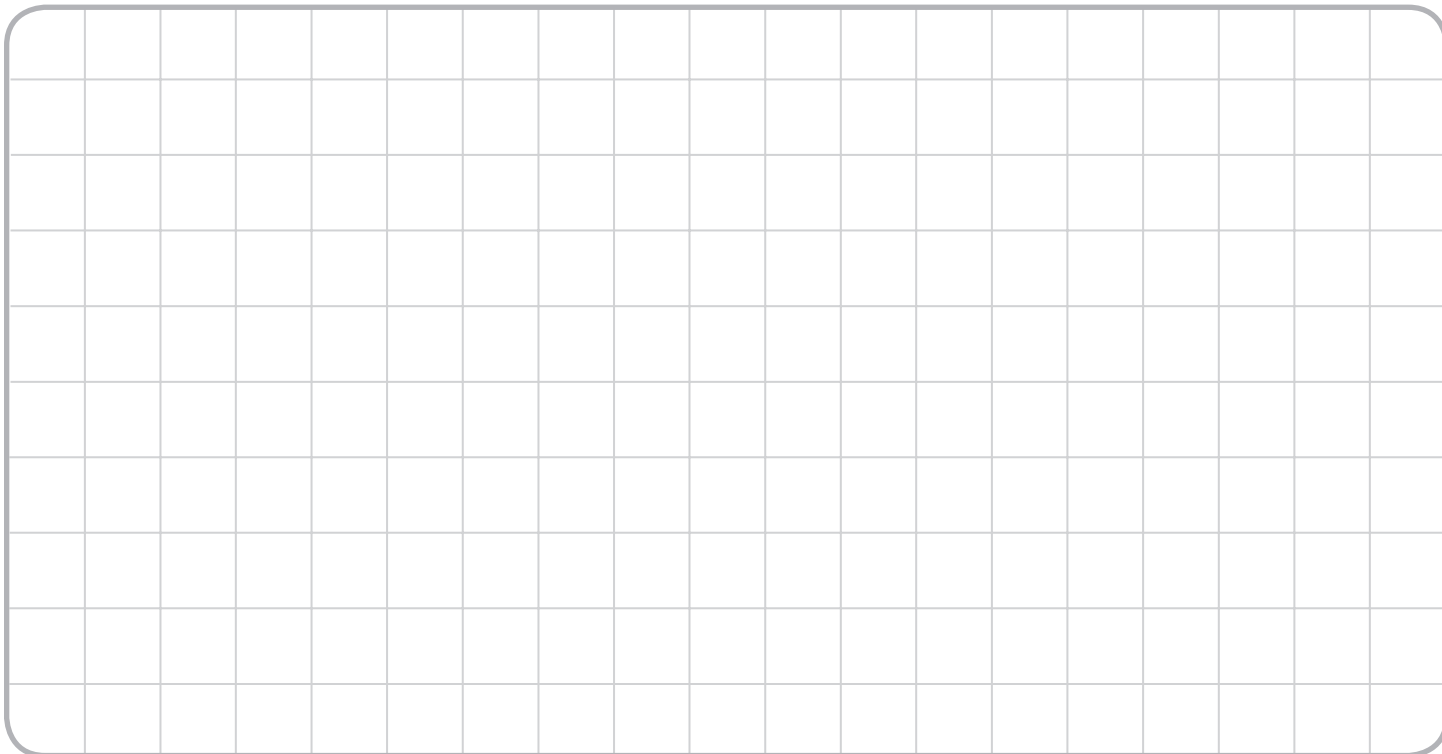
Equipment: 1 bag of iron filings 2 bar magnets

A. Predict

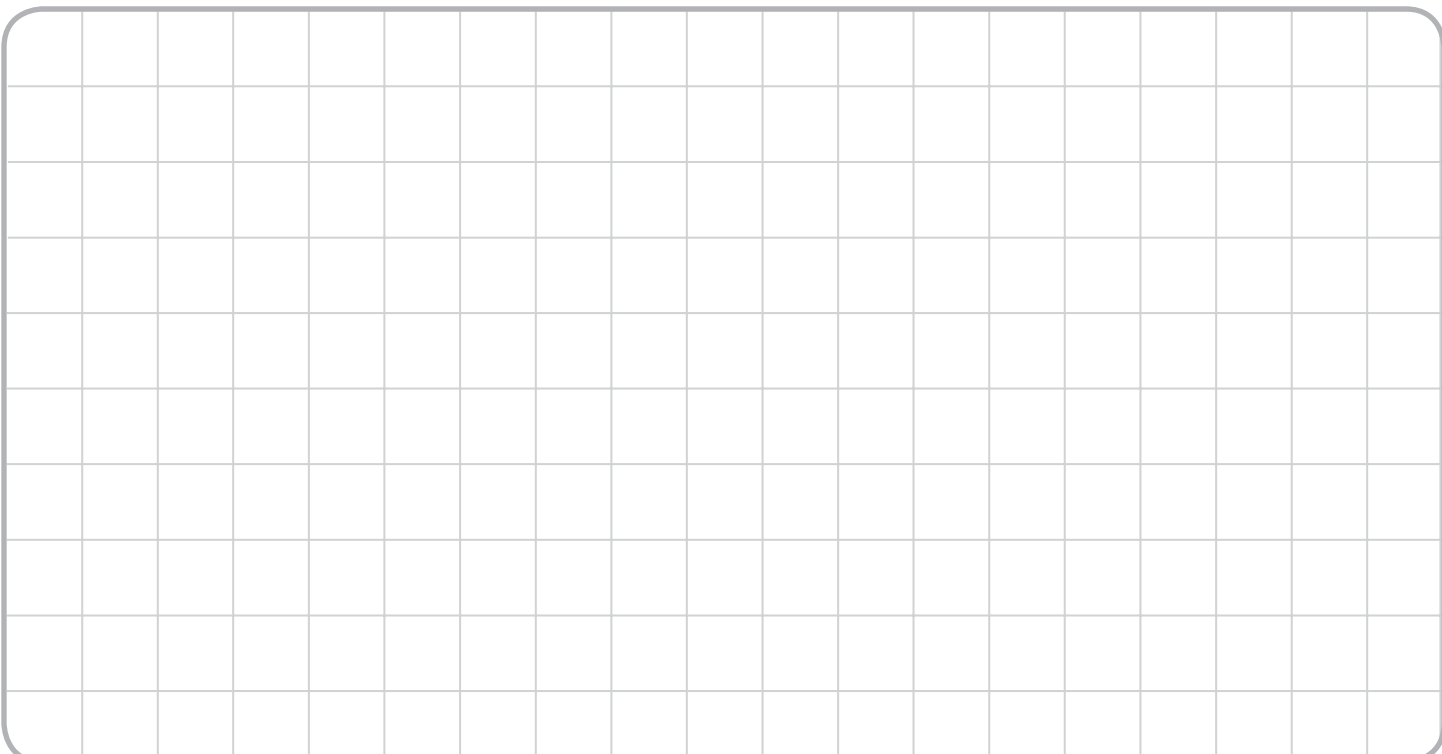
Do you think the magnetic forces are the same on both ends of the same magnet? _____

B. Observe and Record

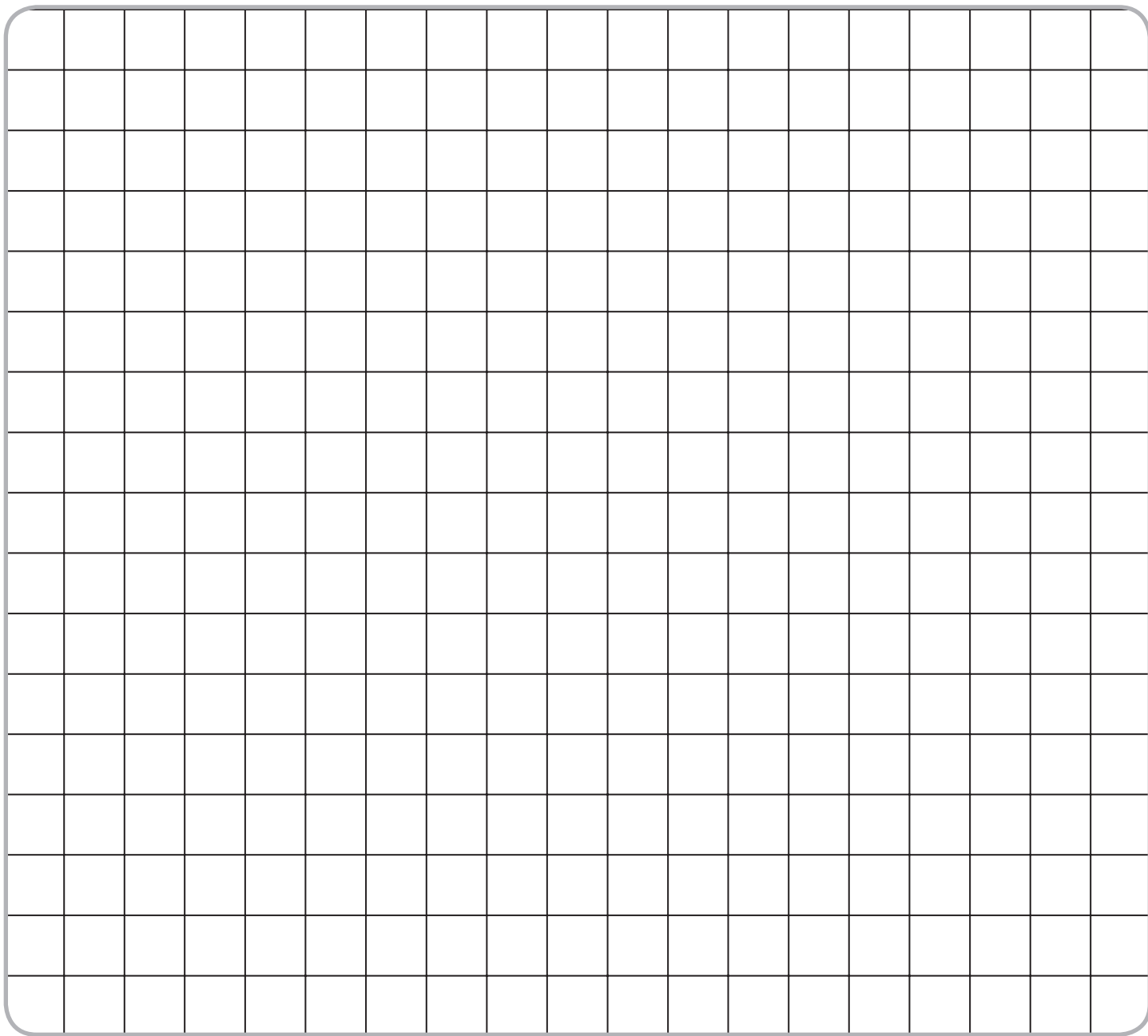
1. Shake the bag of iron filings so that they are in a thin layer in the middle of the white paper.
2. Drag one bar magnet over the pile of filings.
3. Draw what the iron filings in the bag look like after you drag the magnet over them.



4. Shake the bag of iron filings so that they are in a thin layer in the middle of the white paper.
5. Point the north (N) end of one bar magnet toward the south (S) end of the other bar magnet with the iron filings between them. Draw what the iron filings between the magnets look like.



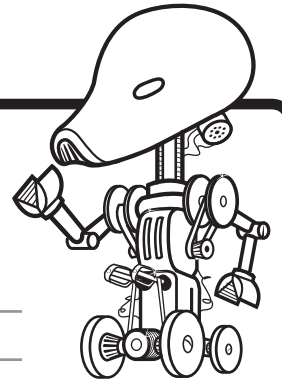
- 6.** Shake the bag of iron filings so that they are in a thin layer in the middle of the white paper.
- 7.** Point the north (N) end of one bar magnet toward the north (N) end of the other bar magnet with the iron filings between them. Draw what the iron filings between the magnets look like.



C. Conclude

What do the patterns in the iron filings help you determine about the magnetic force of a magnet?

Opposites Attract



Date: _____

Team of Scientists: _____

A) _____ **B)** _____

C) _____ **D)** _____

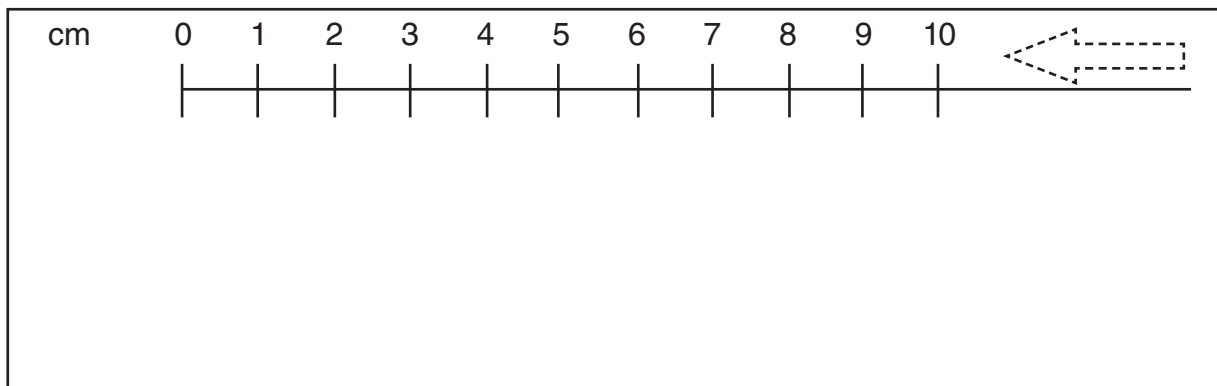
Equipment: 2 bar magnets

A. Predict

How will the magnetic fields of two different magnets interact with each other? _____

B. Observe and Record

1. Place one bar magnet on the 0-cm mark on the ruler below. Make sure the north pole (N) of the magnet is facing to the right.
2. Place a second bar magnet on the 10-cm mark on the ruler below. Make sure the south pole (S) of the magnet is facing to the left.

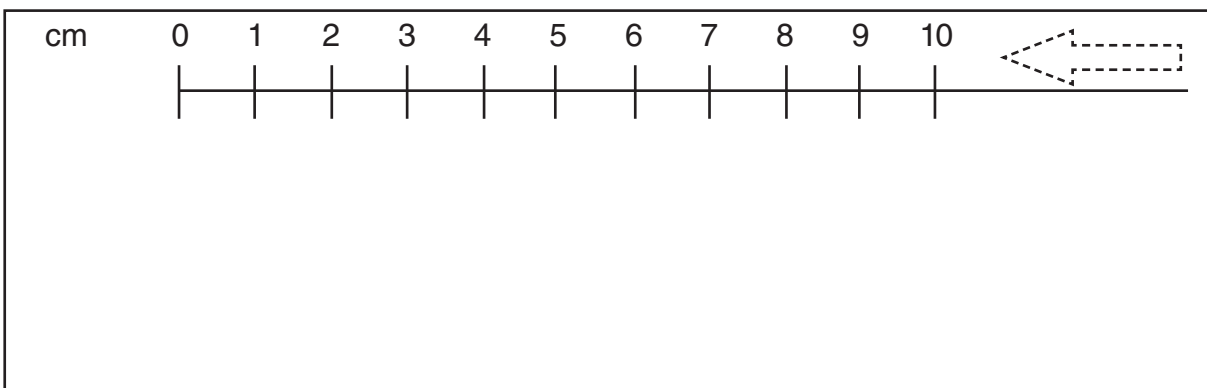


3. Move the magnet at the 10-cm mark toward the magnet at the 0-cm mark one centimeter at a time. How far apart are the magnets when the magnetic force becomes strong enough to push or pull one magnet to the other? ____ cm

4. Explain what happens to the magnets that helps you conclude that they attract each other or repel each other. _____

5. Place one bar magnet with the 0-cm mark on the ruler below. Make sure that the north pole (N) of the magnet is facing to the right.

6. Place a second bar magnet with 10-cm mark on the ruler below. Make sure the north pole (N) of the magnet is facing to the left.



7. Move the magnet at the 10-cm mark toward the magnet at the 0-cm mark one centimeter at a time. How far apart are the magnets when the magnetic fields of the magnets interact with each other? ____cm

8. Explain what happens to the magnets that helps you conclude that they attract each other or repel each other. _____

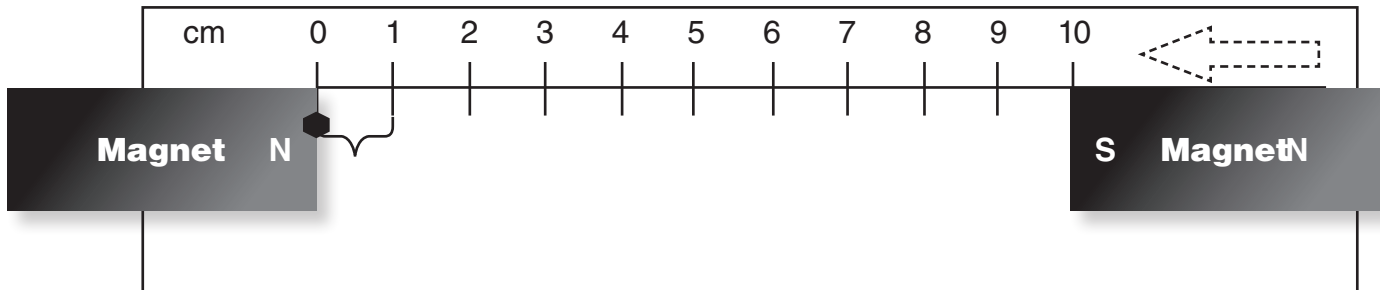
E. Conclude

Explain the relationship between the positions of two different magnets and the strength of the magnetic force. _____

Student Activity Sheet 4B: (Teacher's Version)

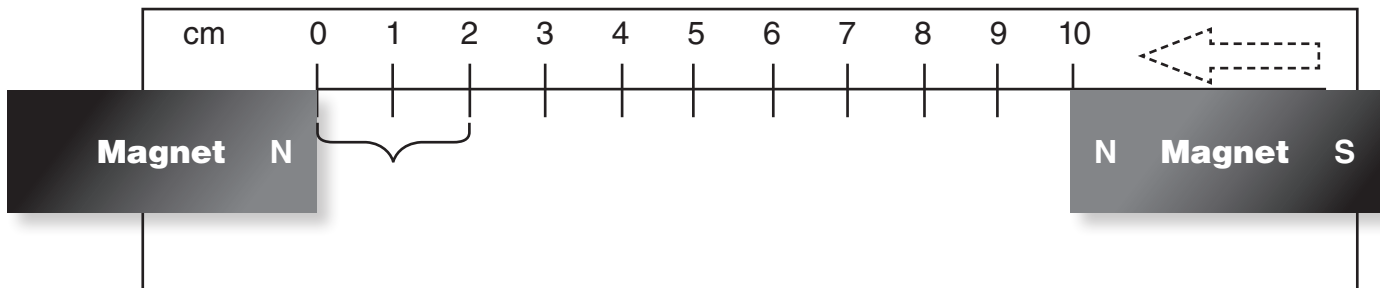
Opposites Attract

B. Observe and Record



3. Move the magnet at the 10-cm mark toward the magnet at the 0-cm mark one centimeter at a time. How far apart are the magnets when the magnetic force becomes strong enough to push or pull one magnet to the other? (*1 cm*)

4. Explain what happens to the magnets that helps you conclude that they attract each other or repel each other. (*The magnets attract each other because when the magnets are about 1 cm apart they move towards each other and stick to each other.*)



7. Move the magnet at the 10-cm mark toward the magnet at the 0-cm mark one centimeter at a time. How far apart are the magnets when the magnetic fields of the magnets interact with each other? (*2 cm*)

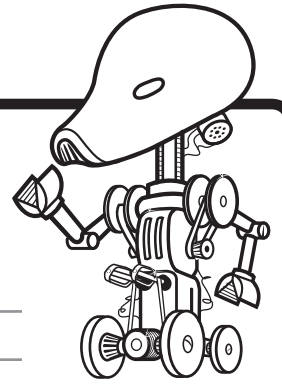
8. Explain what happens to the magnets that helps you conclude that they attract each other or repel each other? (*The magnets repel each other because when the magnets are 1–2 cm apart, they move away from each other.*)

B. Conclude

Explain the relationship between the position of two different magnets and the way the magnetic fields interact. (*Opposite [north and south] poles move toward each other because their magnetic poles are attracted to each other. Like poles move away from [repel] each other, as these magnetic fields are not attracted to each other.*)

Student Activity Sheet 4C Name _____

Ring Magnets by Design



Date: _____

Team of Scientists: _____

A) _____ **B)** _____

C) _____ **D)** _____

Equipment: 2 ring magnets 2 bar magnets 4 pieces of masking tape
1 ruler, 12 in 1 bag of iron filings

A. Task

Use the engineering design process and what you have learned about magnetism and magnetic fields to complete the following challenge.

B. Define the Goal

The ring magnets do not have a letter to identify the north and south poles. Design an investigation to identify the north and south poles of the ring magnets.

C. Plan

1. Identify the steps to reach the goal.

a. You can use bar magnets, the bag of iron filings, and the ruler to help determine the poles on each of the ring magnets.

b. Once you have determined which pole is north and which pole is south, label the poles on each magnet using the masking tape provided. Use “N” and “S” as abbreviations.

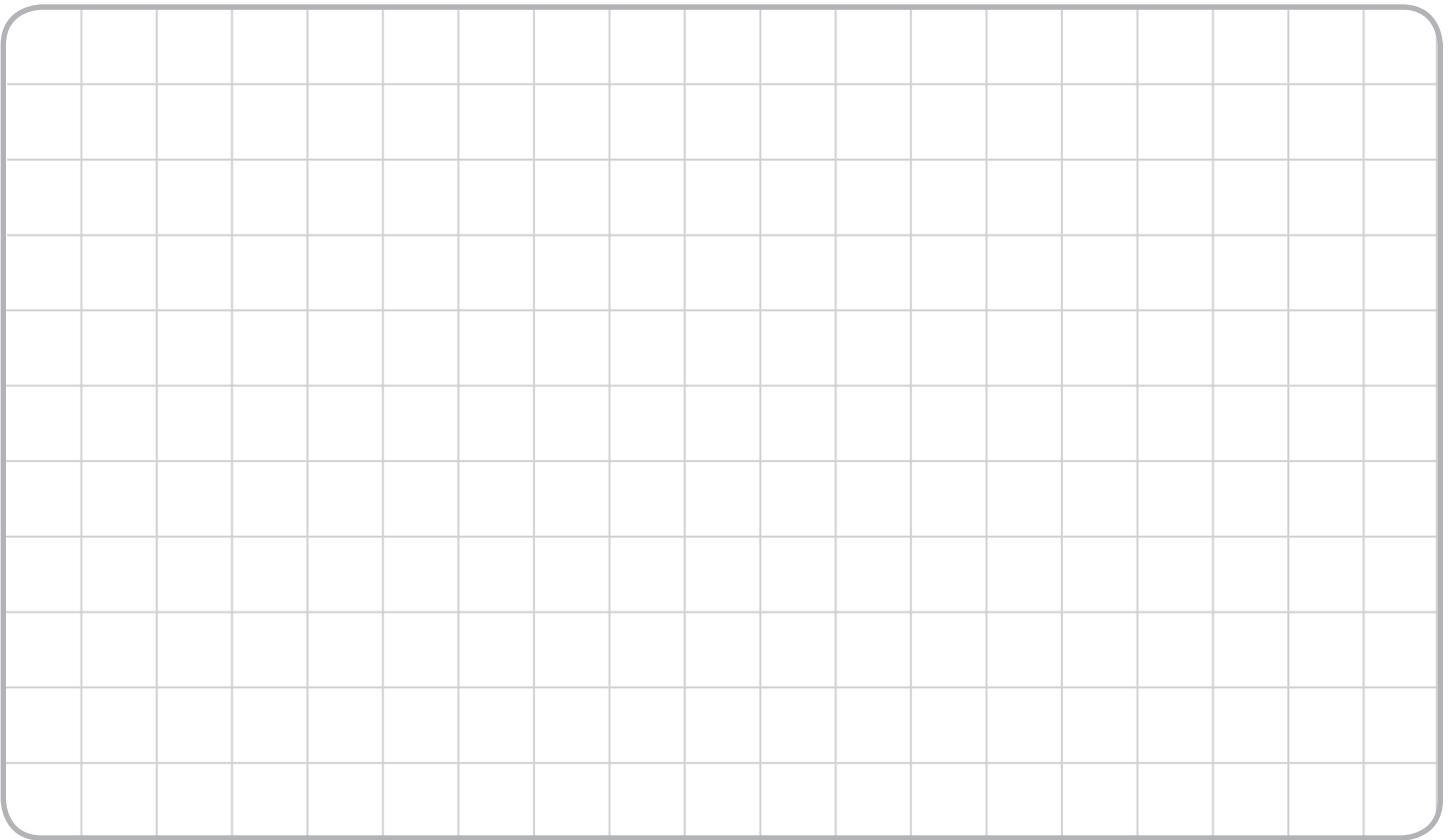
2. Identify the design requirements.

a. How can you determine the poles of a magnet? _____

b. What can you observe about magnets that lets you know the poles are the same or opposite? _____

3. Brainstorm possible solutions.

a. Make a list of all the ideas your team can think of that will help you accomplish your goal.



b. Which idea will work best? Draw and label a sketch of the most promising design.



D. Test, Observe, and Record

1. Execute the plan you devised to identify the poles of the ring magnets.
2. What did you do to determine the poles of the ring magnets?

- 3.** Make a list of the steps you took to find the north and south poles of the ring magnets.

4. Did the plan you devised obtain the desired results and accomplish the goal? _____

5. How do you know it worked or didn't work? _____

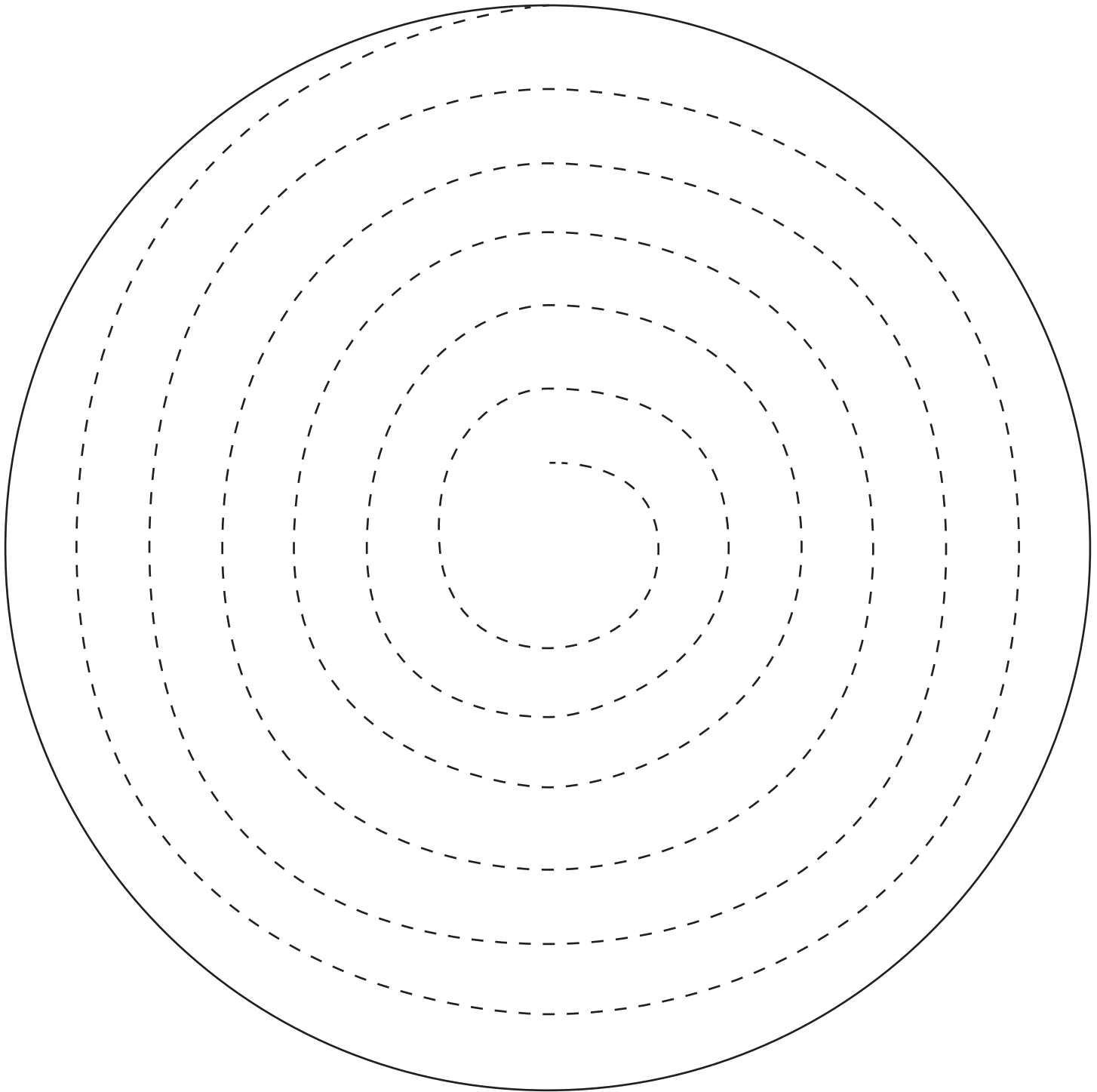
6. What can you do to improve your design and reach your goal? _____

E. Conclude

I was challenged to engineer, design, and test an investigation to identify the north and south poles of two ring magnets. I used the following knowledge of magnets and magnetic fields to complete my goal by _____

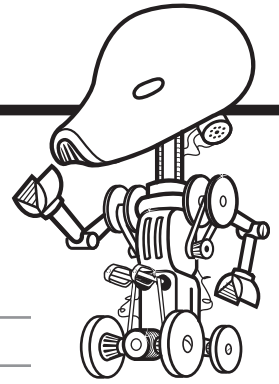
Static Spiral

Directions: Cut out the circle, then cut along the dotted line to create a spiral.



Student Activity Sheet 4E Name _____

Attracting or Repelling Charges?



Date: _____

Team of Scientists:

A) _____ **B)** _____

C) _____ **D)** _____

Equipment: 2 small styrene balls 1 large styrene ball 1 rod 1 fulcrum

A. Set Up

1. Place one small styrene ball on each end of the rod.
2. Use the fulcrum to balance the rod.

B. Predict

What will happen to two objects that are near each other that are both negatively charged? _____

C. Investigate

1. Have one group member negatively charge the large styrene ball by rubbing it on his or her shirt.
2. Meanwhile, have a second group member negatively charge one small styrene ball from the rod of the balance by rubbing the ball on his or her shirt, and then return the rod to the fulcrum.
3. Slowly bring the large styrene ball close to the side of the negatively charged small styrene ball. Observe what happens, and complete Parts D and E of this activity sheet.

NOTE: If you don't observe a reaction between the two balls after rubbing them to create charges, you may need to ask your teacher for another material to create a better charge.

D. Observe and Record

Describe what happened to the small ball with the negative charge when the large ball with the negative charge came close to it. _____

E. Conclude

1. Was your prediction correct? Why or why not? _____

2. What happened when two negatively charged objects were near each other? Use evidence from your investigation to explain your answer. _____

Take-Home Science

In class you learned that opposites attract. Investigate items in your house to find out if they attract each other. Rub a plastic pen or balloon on your shirt or hair to negatively charge it, and then touch it to different items in your house to see what it attracts!

What's the Charge?

Location: Your house

Challenge: Determine whether items around your house are attracted to a negatively charged plastic pen or balloon.

Who: You and any person who will help (like brothers, sisters, parents, or friends).

What to look for: Items that are attracted to the negative charge will move forward (or pull toward) the balloon or pen.

What to record: On the chart on the back of this sheet, list the items you test and the outcome of your test.

What to report: Bring your completed chart to class. Be prepared to share what you have found.

Equipment:

- 1 plastic pen or an inflated balloon
- 1 small piece of plastic wrap
- 1 small piece of aluminum foil
- A sheet of paper
- 5 grains of rice
- 5 pieces of cereal
- Your hair
- Bed sheets

Science Words

attract: When a force causes something to pull toward it.

electric charge: When particles cause an electromagnetic field that either attracts or repels other particles.

observe: To use your senses in a special way to get a better understanding of something.

repel: When a force causes something to push away from it.

static electricity: The buildup of electric charges on a surface.



Name: _____ **Date:** _____

Take-Home Science

What to Do:

1. Create a negative electrostatic charge on a plastic pen or an inflated balloon by vigorously rubbing it on your shirt for at least 30 seconds.
2. Slowly bring the pen or balloon close to the different materials to see if it attracts them. Record the result of your test in the chart below by adding a check mark in the correct column.
3. Use the blank rows at the bottom of the chart to add other objects you would like to test.

Object	Attracted	Repelled	No movement
Piece of plastic wrap			
Sheet of paper			
Piece of aluminum foil			
5 grains of rice			
5 pieces of cereal			
Your hair			
Bed sheets			





Forces and Interactions

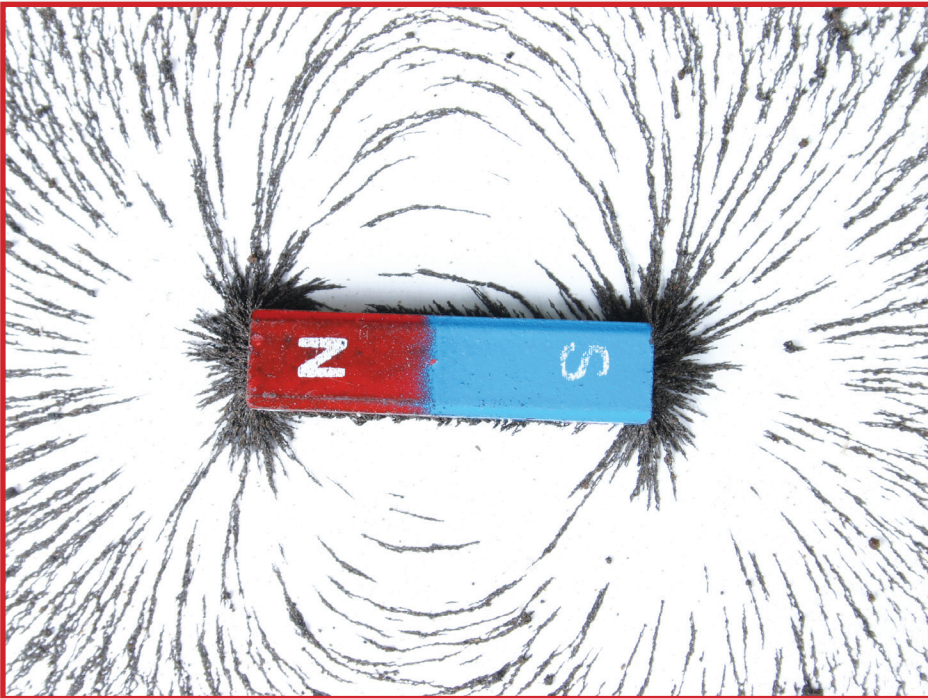
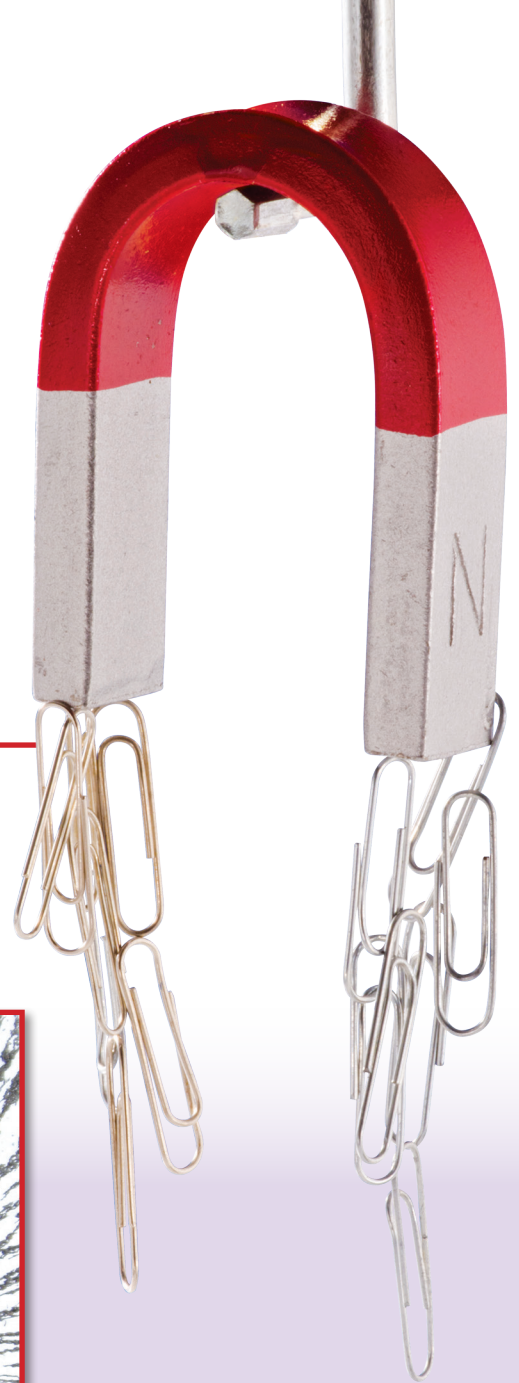


Magnetic Forces

A magnet has a force that attracts some metals, such as iron and steel. The pull of a magnet is called **magnetic force**. Magnetic force is a noncontact force. A magnet does not have to touch an iron object to attract it.

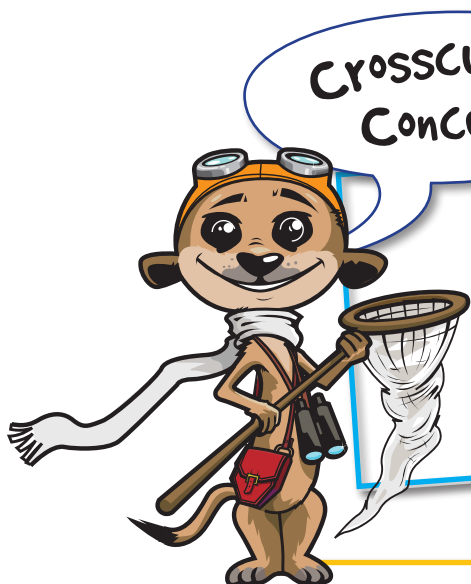
The magnetic force acts in an area that surrounds a magnet. The places on a magnet where magnetic force is strongest are called **poles**. There are two kinds of poles—north poles and south poles.

A magnetic force attracts and holds steel paper clips to this magnet.



The picture shows the area of magnetic force around a magnet. The force is strongest where there are a lot of iron pieces grouped together.

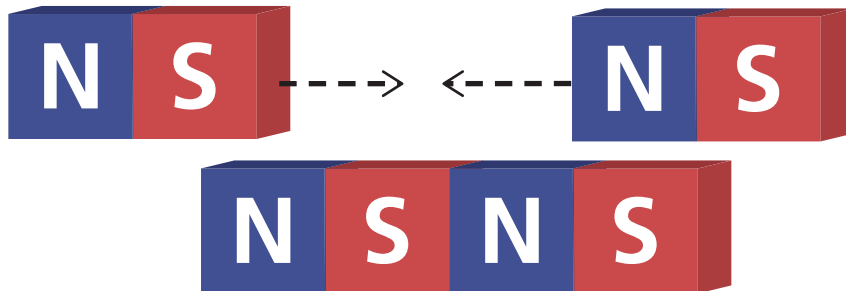
Magnets can attract and repel one another. The north pole of one magnet attracts the south pole of another magnet. Two north poles repel each other. So do two south poles.



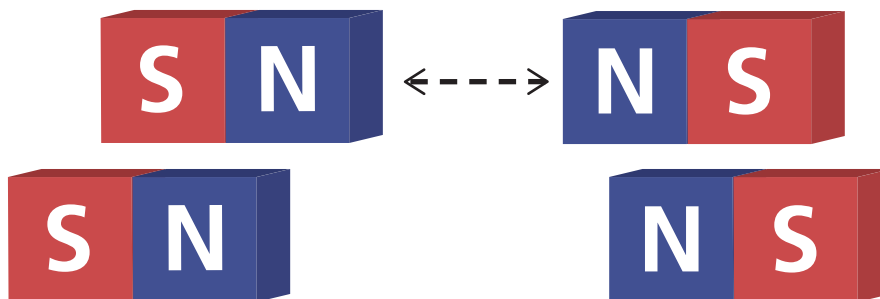
Crosscutting
Concept

The doors on refrigerators have magnets around them. They help the doors stay closed. What do you think causes them to stay closed?

Opposite poles of magnets attract. Like poles repel.



attracting



repelling

	B Physical	B Life	S Earth & Space
Kindergarten	Push, Pull, Go <i>K-PS2-1; K-PS2-2</i>	Living Things and Their Needs <i>K-LS1-1; K-ESS2-2; K-ESS3-1; K-ESS3-3</i>	Weather and Sky <i>K-PS3-1; K-PS3-2; K-ESS2-1; K-ESS3-2</i>
1st Grade	Light and Sound Waves <i>1-PS4-1; 1-PS4-2; 1-PS4-3; 1-PS4-4</i>	Exploring Organisms <i>1-LS1-1; 1-LS1-2; 1-LS3-1</i>	Sky Watchers <i>1-ESS1-1; 1-ESS1-2</i>
2nd Grade	Matter <i>2-PS1-1; 2-PS1-2; 2-PS1-3; 2-PS1-4</i>	Ecosystem Diversity <i>2-LS2-1; 2-LS2-2; 2-LS4-1</i>	Earth Materials <i>2-ESS1-1; 2-ESS2-1; 2-ESS2-2; 2-ESS2-3</i>
3rd Grade	Forces and Interactions <i>3-PS2-1; 3-PS2-2; 3-PS2-3; 3-PS2-4</i>	Life in Ecosystems <i>3-LS1-1; 3-LS2-1; 3-LS3-1; 3-LS3-2; 3-LS4-1; 3-LS4-2; 3-LS4-3; 3-LS4-4</i>	Weather and Climate Patterns <i>3-ESS2-1; 3-ESS2-2; 3-ESS3-1</i>
4th Grade	Energy Works! <i>4-PS3-1; 4-PS3-2; 4-PS3-3; 4-PS3-4; 4-PS4-1; 4-PS4-3; 4-ESS3-1</i>	Plant and Animal Structures <i>4-LS1-1; 4-LS1-2; 4-PS4-2</i>	Changing Earth <i>4-ESS1-1; 4-ESS2-1; 4-ESS2-2; 4-ESS3-2</i>
5th Grade	Structure and Properties of Matter <i>5-PS1-1; 5-PS1-2; 5-PS1-3; 5-PS1-4</i>	Matter and Energy in Ecosystems <i>5-PS3-1; 5-LS1-1; 5-LS2-1; 5-ESS2-1; 5-ESS2-2; 5-ESS3-1</i>	Earth and Space Systems <i>5-PS2-1; 5-ESS1-1; 5-ESS1-2</i>
	Science	Science	Science