



The Earth as A Magnet

Middle School Grades

Lesson Summary

Students sprinkle iron filings onto a sheet of paper (or shoe-box lid) that rests upon a bar magnet to observe and explore a magnetic field. They use a second magnet to distort the pattern created by the iron filings surrounding magnet on the table and. They record their observations of the iron filings for several trials. Following their investigation, students share their findings with peers. Next, students apply their experience with the magnets to predict the magnetic field around Earth. The scientist explains and models the effects of the solar wind upon the Earth's magnetic field.

Prior Knowledge & Skills

Understanding of:

- Forces and motion

Ability to:

- Make and record observations

AAAS Science Benchmarks

The Nature of Science

Scientific Inquiry

The Physical Setting

The Universe

Forces of Nature

NSES Science Standards

Science as Inquiry

Abilities to do Scientific Inquiry

Understandings of Scientific Inquiry

Physical Science

Motions and Forces

History and Nature of Science

Nature of Science

Teaching Time: One 45-minute period

Materials for the Facilitator

- Overhead projector
- Several overhead transparencies
- Overhead transparency of student recording sheet
- Overhead markers
- (2) Bar magnets 100 mm x 7 mm
- (1) Salt shaker containing iron filings
- Role of masking tape
- PowerPoint presentation and associated computer equipment (*optional*)
- Chalkboard and chalk or Dry erase board and markers
- Additional magnets of various sizes and shapes

Editor's note

Materials for Student Teams

- Funnel (1 per table)
- Collection container (1 per table)
- Sheet white paper (1)
- Sheet acetate (1)
- Bar magnets 100 mm x 7 mm (2)
- Salt shaker of iron filings (1)
- 3" x 1" piece of masking tape (1)
- Student activity page:
Earth as a Magnet (1)
- Recording sheet:
Earth as a Magnet (1)

Advanced Planning

Preparation Time: 20-30 minutes

1. Review lesson plan.
2. Gather materials
3. Create teams of 2-3 students and let you know the total number of teams to expect.
4. Arrange supplies so that students will have easy and organized access to them.
5. Set-up and check audiovisual equipment.

The Earth as a Magnet: Exploring Interactions in Geospace

Grades: 5-8
Earth Systems Science

Materials for the Facilitator

- Overhead projector
- Several overhead transparencies
- Overhead transparency of student recording sheet
- Overhead markers
- (2) Bar magnets 100 mm x 7 mm
- (1) Salt shaker containing iron filings
- Role of masking tape
- PowerPoint presentation and associated computer equipment
- Chalkboard and chalk or Dry erase board and markers
- Additional magnets of various sizes and shapes

Materials for Student Teams

- (1 per two teams) funnel
- (1 per two teams) collection container
- (1) shoe box lid
- (1) Sheet acetate
- (2) Bar magnets 100 mm x 7 mm
- (1) Salt shaker containing iron filings
- (1) 3" x 1" piece of masking tape
- (1) Student activity page: *Earth as a Magnet*
- (1 per student) Recording sheet: *Earth as a Magnet*



Materials for Student Teams

Two magnets, longer sits under shoe box lid during activity

Transparency Film



Colorado State Standards

Science: 1, 2.1, 2.3, 4.1, 4.4, 5, 6

Learning Goals

Students will:

- Make and record observations
- Communicate scientific work and observations to peers
- Observe and describe the magnetic field around a magnet
- Observe changes to the patterns of the magnetic field surrounding a magnet
- Begin to understand the magnetosphere
- Begin to understand the concepts and terms associated with magnetism and space weather
- Be introduced to and begin to understand the existence of the solar wind and its impact on Earth and Earth's magnetosphere.

What Students Do in this Activity

Students sprinkle iron filings into a shoe-box lid that rests upon a bar magnet to observe and explore a magnetic field. They use a second magnet to distort the pattern created by the iron filings surrounding magnet on the table and. They record their observations of the iron filings for several trials. Following their investigation, students share their findings with peers. Next, students apply their experience with the magnets to predict the magnetic field around Earth. The scientist explains and models the effects of the solar wind upon the Earth's magnetic field.

What the Scientist Does in this Activity

- Demonstrates the activity to the students and models the skills and techniques particularly useful to problem solving and inquiry
- Circulates around the room to support student investigations

- Helps students to clarify and extend their ideas by posing questions, suggesting additional work, and summarizing student findings
- Shares her/his work and responds to student interests and questions

Advanced Preparation

1. Prior to your classroom visit, meet or speak with the teacher. Review the [checklist](#) with your host teacher and make any specific arrangements with respect to classroom materials, management, and audiovisual equipment.
2. Ask the teacher to create teams of 2-3 students and let you know the total number of teams to expect.
3. Review the activity described below.
4. Check that the kit contains all necessary items.
5. Practice your presentation.
6. Review the document on [K-12 Instruction for Scientists as Educators](#)
7. Upon arrival in the classroom, arrange your supplies so that students will have easy and organized access to them. Set-up and check your audiovisual equipment.

Classroom Activity

Introduction

- Briefly introduce yourself to the students
- Write your name on the board and give students instructions for its pronunciation.
- Provide students with nametags to complete and wear.
- If the teacher has not done so, ask students to
 - a. Respect each other and the materials
 - b. Follow directions
 - c. (optional) Request that students raise their hands to speak or request your assistance.

Introduce the Activity

- On the chalk or white board write: *Earth as a Magnet*
- Explain to students that they will make and record observations of magnets and magnetic fields and use their observations to consider how the Earth behaves like a magnet.
- Ask students to share what they already know about magnets. ***Keep this brief.***

In trials of this activity student responses included:

- attracts metal
- attracts other magnets
- is made of a metal
- has two ends
- has a north and south (pole)
- pulls things to it

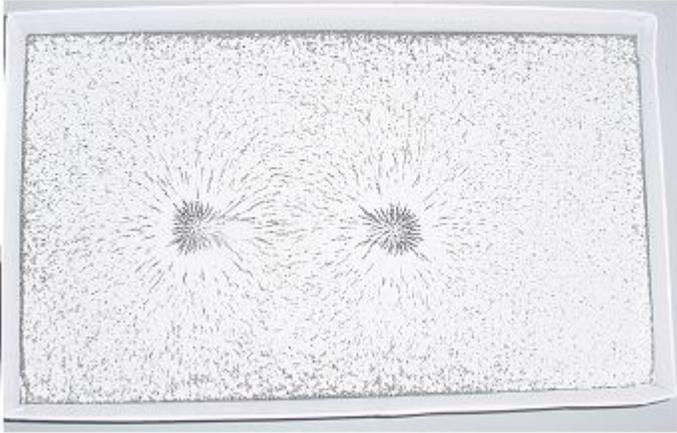
Model the Activity

Step I

- Ask the entire class to gather around one central table and observe as you arrange the equipment.
- Tape a single bar magnet to the table top.
- Place the shoe box lid over the magnet taped to the table.

- Show students the salt-shaker containing iron filings and demonstrate gently sprinkling the filings liberally and uniformly over the shoe box lid.

Iron Filings Display Magnetic Field in 2-D on Shoe Box Lid

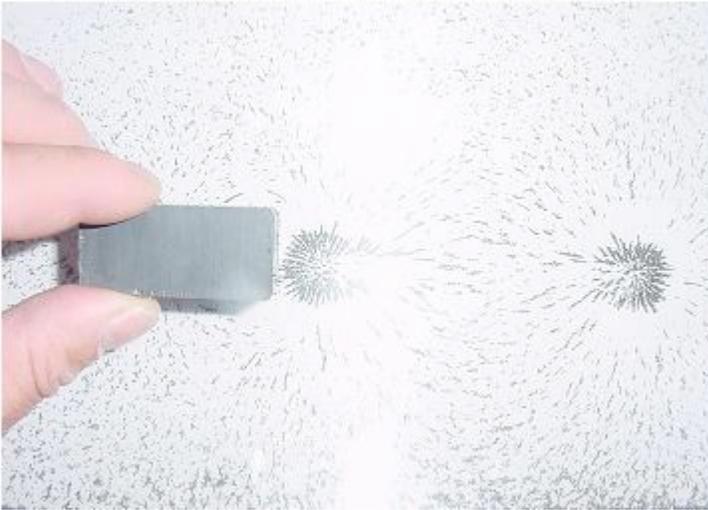


- Explain to students that you would like them to look at and describe the position of the iron filings.
- Explain that students should note places where the iron filings are concentrated and where there are few or no filings.
- Explain that students should draw a detailed diagram of what they see on the shoe box lid.
- On the student recording sheet, indicate the space where students should draw the pattern of iron filings that appears with only one magnet in use, the “BEFORE” square.

Step II

- Next, gently lay a sheet of acetate over the shoe box lid and the iron filings.
- Use the second magnet to distort the existing iron filing pattern.
- Slowly, “fly” the second magnet over the iron filings and ask students to observe if there appears to be any change in the existing pattern.

Distorting the Pattern with a Second Magnet



- Show students the “AFTER” section of the recording sheet where they should make the drawing of the position of the iron filings following the “fly-by” of the second magnet.
- Ask students if there are any questions regarding the activity procedures.
- Explain that they will now repeat the activity in pairs, keeping a detailed record of their observations.

Enlist students as assistants, provide them with responsibilities such as distributing and collecting the materials, keeping class notes on the board or overhead, and keeping track of the time.

Create Student Teams

- If the teacher has not already done so, ask students to find a partner with whom to work.
- Ask students to sit with their partners at a desk where they will work.
- Tell students that they will have approximately 10-15 minutes to make and record their observations.
- Ask students to have one member of their team collect the materials.
- Ask if they have any questions.
- Remind students to follow the directions on the **student activity sheet** if you are unavailable to answer their questions immediately.

Facilitate Student Inquiry

- As students work, circulate throughout the class to observe and speak with each student or team. Ask them to show you their work, explain their observations.
- Remind them to work carefully and add the iron filings a little at a time.
- Remind students when 5 minutes remain before the activity ends.
- One minute before work ends, warn students that they need to bring their work to a close and clean up.
- Ask reporters to reproduce one “before and after” drawing from the team recording sheet on the board or on a transparency while the remainder of the team cleans up the materials.
- Have the material managers return the equipment to the original location.



Figure 1 Recycling the Iron Filings

Summarize Student Inquiry:

Project the “BEFORE” image on a wall or movie screen. Use the projected image to summarize student observations.

- Tape a magnet to the overhead projector.
- Place a sheet of acetate over the magnet.
- Sprinkle iron filings on to the acetate sheet

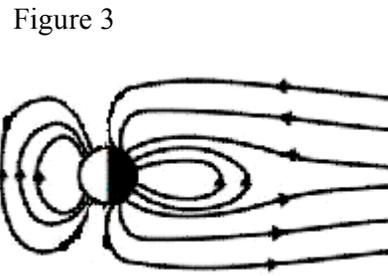
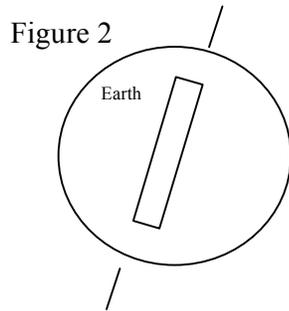
Ask students open-ended questions about the observations they made of the position of the iron filings. Some sample questions include:

- What observations can you make about the position of the iron filings?
- How would you describe the position of the iron filings?
- Does anyone see a pattern made by the iron filings?
- What is happening in this area (indicate one or more areas of the projection)?

Next, ask students to explain what happened when they used the second magnet to distort the field around the existing magnet and the position of the iron filings. Student responses may vary depending upon how they manipulated the second magnet.

Applying Knowledge: The Earth as a Magnet

- Draw Figure 2 on the board or overhead.
- Ask students to imagine that the Earth behaves like a magnet.
- Have students copy your version of figure 2 on a sheet of paper.
- Remind them of their results of working with the magnet
- ask them to draw the pattern that iron filings might make if they were sprinkled all around the Earth
- Walk around the room and look at student work.
- Ask for volunteers to hold up their drawings and explain their ideas to the class.



- Next, draw Figure 3 on the board or overhead. Explain to students that this is the actual shape of the magnetic field that surrounds Earth. Ask students to hypothesize what might account for the distortion of the Earth's magnetic field. List their ideas on the board.

Review student suggestions and concluded that:

- The Earth has a magnetic field that is distorted by the solar wind
- The magnetic field is constantly changing in response to activity of the Sun.

Share Your Work

Personalize your visit by sharing your work with the students.

- Encourage students to ask questions.
- Show images of your work such as instruments and data that you have collected
- Discuss the roles and responsibilities of various members of your research team
- Introduce the importance of specific education goals students need to set to prepare for a career in mathematics, science, and engineering.

Extend Student Inquiry

If students work quickly or a teacher requests ideas for follow-up activities, consider the options below:

- Have students repeat their observations using magnets of various shapes and strengths.
- Have students collect their own iron filings by dragging a magnet through sand. Students may do this with a box of sand or outside in places such as dunes, the seashore, or a desert.
- Identify, describe, and explain the existence, or lack of, a magnetic field around the other planets in our solar system.

Figures 2 and 3 for Transparency

Figure 2

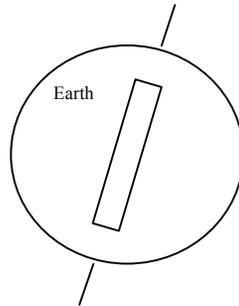
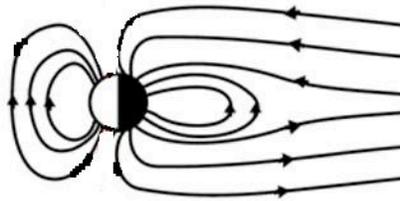


Figure 3



Earth as a Magnet

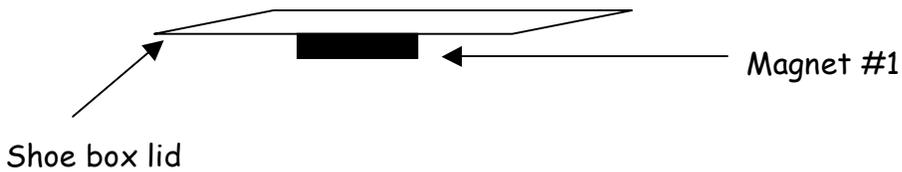
Student Activity Sheet

Purpose

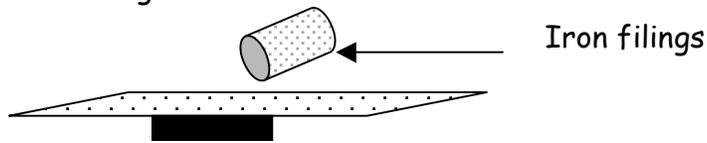
- * To observe and describe the pattern made by iron filings when sprinkled near a magnet.
- * To apply your experience with a magnet when thinking about the Earth as a magnet.

Directions

1. Tape the magnet to the table top. Place a shoe box lid over it.

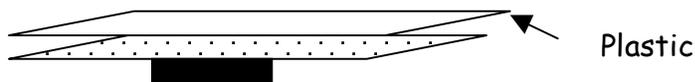


2. Sprinkle Iron Filings over the Shoe box lid

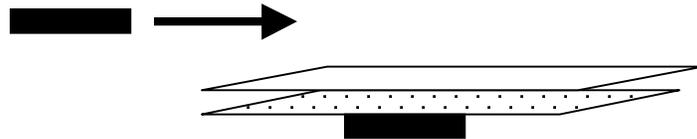


3. On the recording sheet, draw the pattern formed by the iron filings on the "before" side of the chart.

4. Without disturbing the iron filings, cover them with the sheet of plastic.



5. Take a second magnet and slowly move it from one side to the other about $\frac{1}{2}$ an inch (1 cm) above the sheet of plastic.

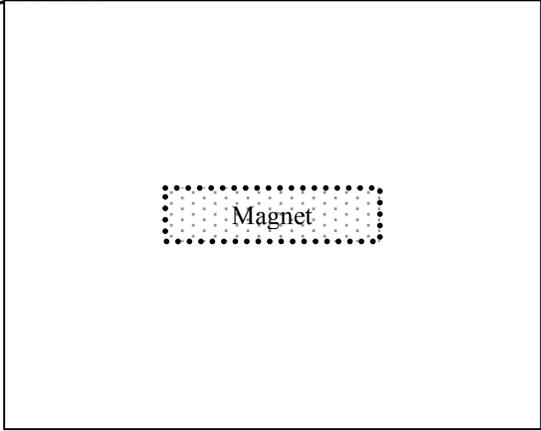
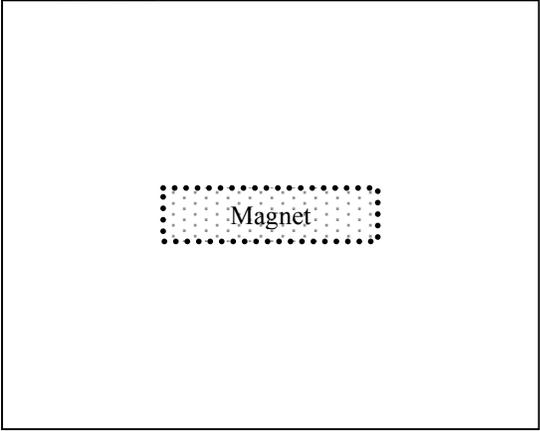
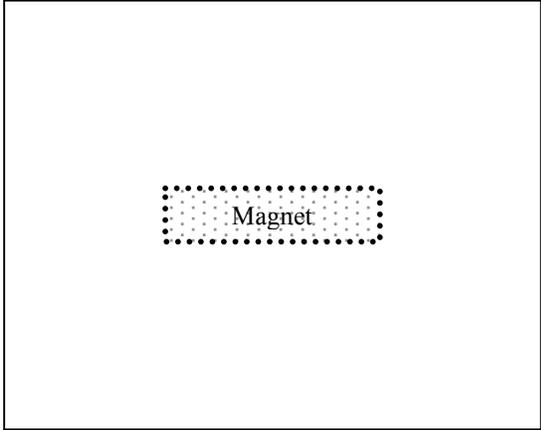
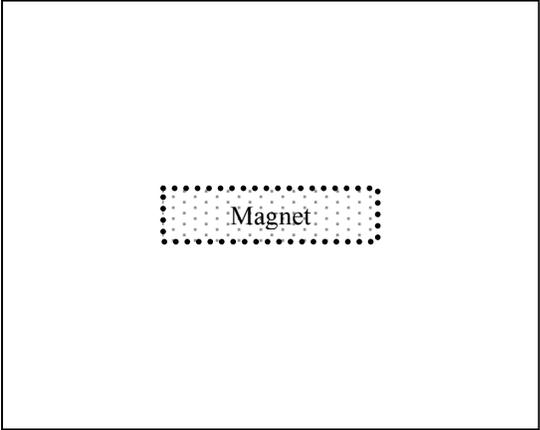


6. On the recording sheet, re-draw the position of the iron filings showing if and how the pattern has changed.

7. Repeat steps 2-6.

Directions

Record your observations. In the diagrams below, draw the pattern(s) made by the iron filings.

	Pattern with 1 Magnet	Pattern with 2
	Magnets	Magnets
	BEFORE	AFTER
Trail 1		
Trial 2		

Questions:

1. Did the iron filings appear to make a pattern? If so, describe the pattern as best as you can.
2. Were the patterns the same or different for each trial?
3. Did the position the iron filings change when you passed the second magnet over them? If so, describe what you observed.