Magnetic Fields: The Earth Acts as a Giant Magnet

Lesson Concept All magnets have a magnetic field. A compass is a device that detects the magnetic field around a magnet and the Earth. Earth's magnetic field is caused by the circulating electric fields that surround the molten core.

Link Magnets may be natural or manmade. Lodestones are natural magnets made of magnetite. Magnets are found throughout the world and have many uses.

Time 70 minutes

Materials

Whole class

5-6 small directional compasses

Bar magnet

Document camera

Per Group (groups of 2)

Iron Filings in a shaker (a salt shaker with small holes can be utilized)

Glue stick

1 bar magnet

1- 8 ½ x 11" white piece of unlined paper

Individual

Pencil

Science Notebook

Advance Preparation

1. Copy *Iron Filings Lab* (1 per group of 2 students).
2. Have a projector available to display Teacher Resource 1and 2.
3. Practice all parts of the Engage and Explore ahead of time. Be sure to practice removing the blank piece of paper with the iron filings on it from the magnet. Use your most accurate compasses.
4. Post *Finger Rubric.*
5. Copy the worksheet: *Why might scientists say that the Earth is like a giant magnet?* (1 per student)

Procedure:

Engage ***(15 minutes) A compass detects the invisible magnetic force that exists around a magnet. We know this because the compass moves in the proximity of the magnet.***

1. Use a document camera to conduct the following demonstration the following investigation. Place the set of compasses in a circle formation with a 4 inch diameter. Turn the compasses so that the north (N) end points towards the outer circumference of the circle. Ask students to describe the position of the compass needles to their partner.
2. Explain to students that you are going to place a bar magnet in the center of the circle of compasses. Ask students to predict what they think will happen.
3. Place a bar magnet on its south end in the center of the circle of compasses. Ask students to describe the position of the compass needles to their partner. What changes did you notice? [Expected Student Response (ESR): The compass needled pointed toward the magnet.] Was this what you predicted would happen? Compare your prediction to what actually happened.
4. State and write the following on the board, "When the magnet was placed in the center of the compasses, I observed that the compass needles pointed/moved _____ (needles pointed/moved inward toward the magnet)."
5. Flip the magnet over so that the north end is in the middle of the compasses. The compass needles should turn 180°. Ask students to describe the position of the compass needles to their partner. What changes did you notice?
6. Have students pair-share their responses. [ESR: When the magnet was placed in the center of the compasses, I observed that the needles pointed/moved _____ (needles pointed inward toward the magnet)].
7. Exchange the magnet for a piece of magnetite. Place the magnetite in the center of the compasses. The compass needles should move. Have students pair-share a response to the following question, "Why do the compass' needles move?" [ESR: When the magnetite was placed in the center of the compasses, I observed that the needles pointed/moved_____(needles pointed inward toward the magnet) because the compass needles are attracted to the magnetite.]
8. Ask students, "Did the magnetite or magnet have to touch the compasses in order to move the needle?" (ESR: No) Point out that this is an invisible force that does not need the objects to touch.

Teacher Note: ***Try this ahead of time.*** *If the compass needles do not move, you may have to move the compasses closer to the magnet or turn the magnetite in different directions.*

Explore ***(20 minutes) Iron filings and a magnet show magnetic lines of force that exist around a magnet.***

9. Ask students, "Since we can't see the magnetic field, what evidence do Earth scientists use to prove that it exists?" (ESR: Compass needles move because of the Earth's magnetic field.) Explain that in the next part of the investigation students will learn another way to detect a magnetic field.

10. Distribute the *Iron Filings Lab* to each pair. Distribute a white piece of paper, 1 bar magnet, and an iron filings shaker to each pair. Have students follow the procedure on the *Iron Filings Lab.* Have students glue the *Iron Filings Lab* into their science notebooks.

Teacher note: 1) ***Caution: Iron filings can be somewhat splintery and difficult to remove from the magnet.*** *To remove the magnet from under the paper, have students pull the magnet down and away from the paper rather than sliding the magnet out form under the paper. This will prevent iron filings from sticking to the magnet. 2) The magnetic lines will look like arcs. 3) Have students sprinkle additional filings near the poles so that the iron filings will attract and build up.*

Explain (25 minutes) Lines of force are a characteristic of a magnetic field.

11. Have students revisit their diagram on the *Iron Filings Lab* to add lines of force if necessary.
12. Ask students what they see on their paper. (ESR: The shape looks somewhat like an apple with the core in the middle. There were more filings on the ends/poles of the magnet.)
13. Display Teacher Resource 1. Ask students to compare their drawings of the magnetic field to the photographs of magnetic fields on Teacher Resource 1. Model a think aloud to share your thinking with your students, "I can see where the iron filings accumulate and stand on end on the actual poles. The magnetic field is strongest at the north and south poles. There are more iron filings closer to the magnet. A magnetic field can be thought of as consisting of lines of force. The forces of magnetic attraction and repulsion move along the lines of force."

Extend (5 minutes) Lines of force are a characteristic of a magnetic field.

14. Display Teacher Resource 2. Explain that, "This is a drawing of the earth with its invisible magnetic field. Compare your drawing of the magnetic field you observed to Earth's magnetic field." Allow time for students to compare their drawings to that of the Earth's magnetic field. Have students share their comparisons with a partner as a think aloud. Ask, "What do you notice about the Earth's magnetic field that is similar to your drawings?" (ESR: The Earth has a north and a south pole. Lines of magnetic forces come from the poles. There are more lines of force at the poles. The magnetic field must be stronger at the poles."

Teacher Note: The Earth's magnetic field is a result of the spinning Earth's iron inner and outer core.

Evaluate (5 minutes) All magnets have a magnetic field and poles.

15. Display and distribute the following worksheet: *Why might scientists say that the Earth is like a giant magnet?* Ask students to read the following question and the frame to

themselves, Why might scientists say that the Earth is like a giant magnet? Scientists consider the Earth to be _____(comparable/similar) to a magnet because they both have a (magnetic) (field) and (poles).

16. Ask students to complete the frame with what they have learned today. Then have students restate the completed frame to themselves.

17. Have students pair-share their responses to the sentence frame.

18. Have students glue the worksheet, *Why might scientists say that the Earth is like a giant magnet?* in their science notebooks.

19. Display the *Finger Rubric*. Have students use the *Finger Rubric* to self-evaluate their understanding of why scientists think the Earth is a giant magnet.

“Iron Filings Lab”

Materials:
1 shaker with iron filings
1 bar magnet
1 unlined piece of paper

Procedure:

1. Place the magnet under the paper.
2. Sprinkle a small amount of iron filings onto the paper.
3. Slowly continue until you see patterns emerge.
4. Diagram and label your observation on this lab sheet.
5. Explain the diagram. What patterns do you see in the arrangement of the filings? Be sure to notice where there are the most filings, the least filings, or none at all.

Diagram

Explain the diagram.

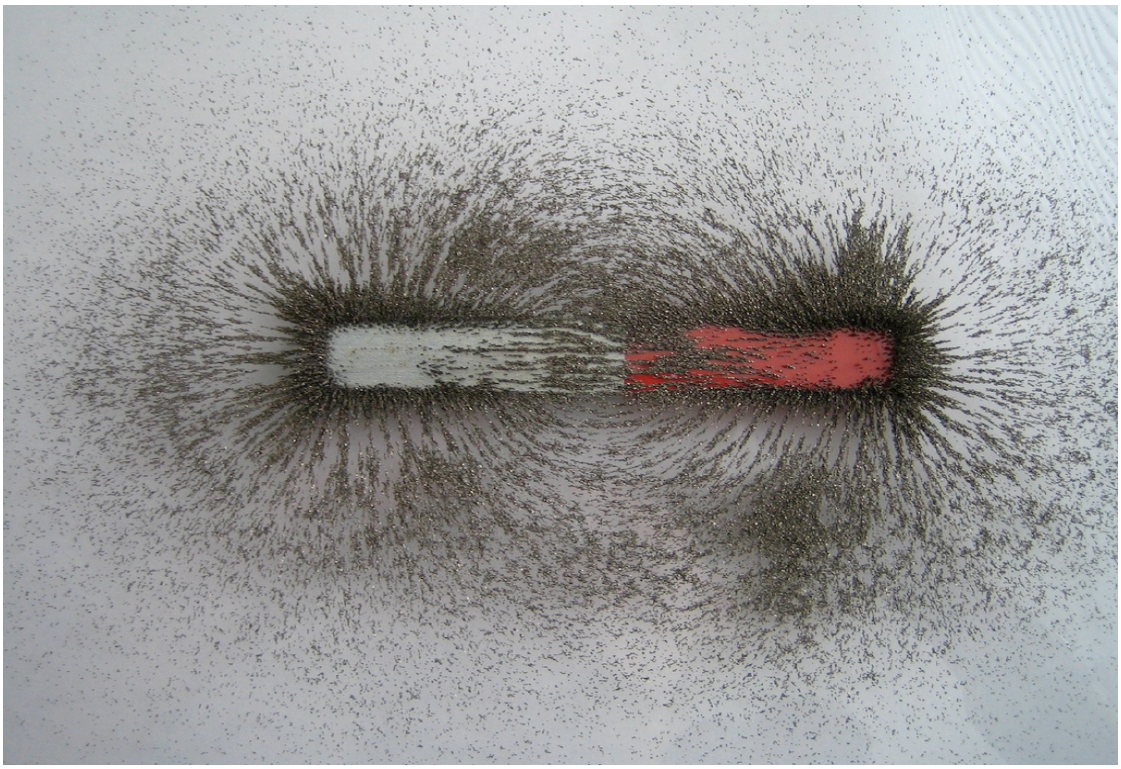
_____

_____

_____

_____

Teacher Resource 1



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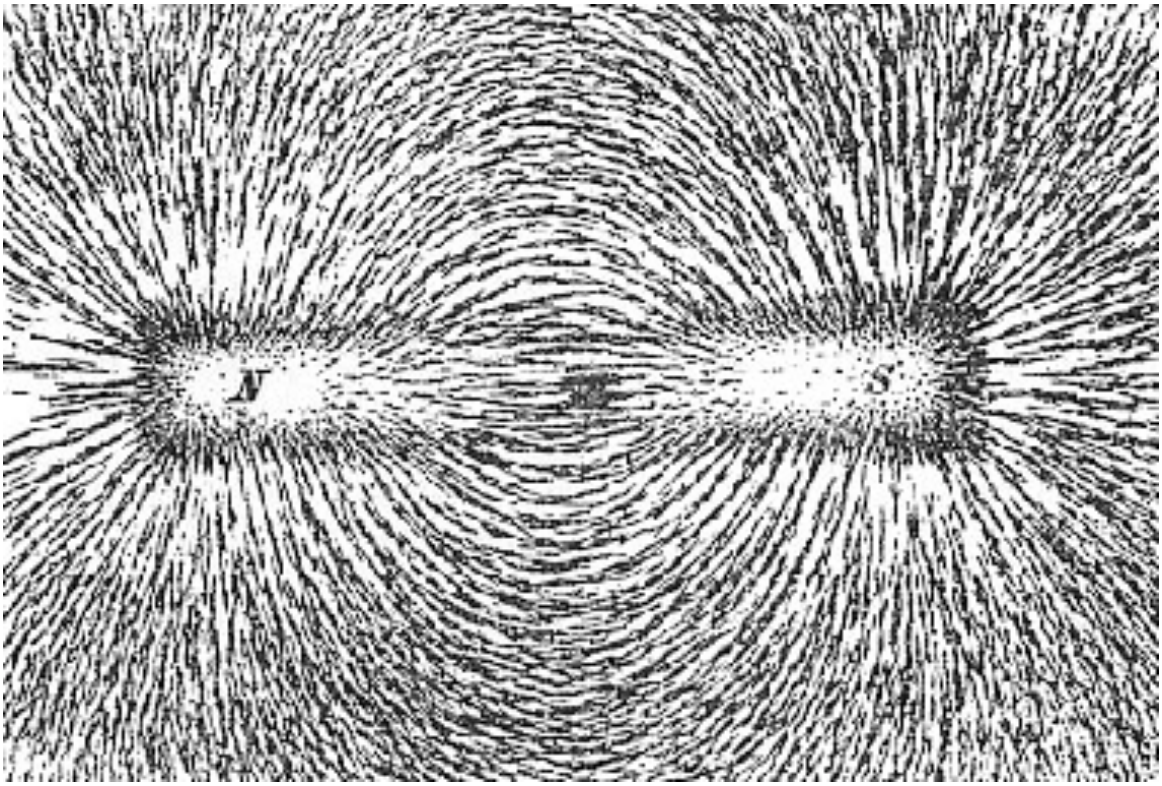
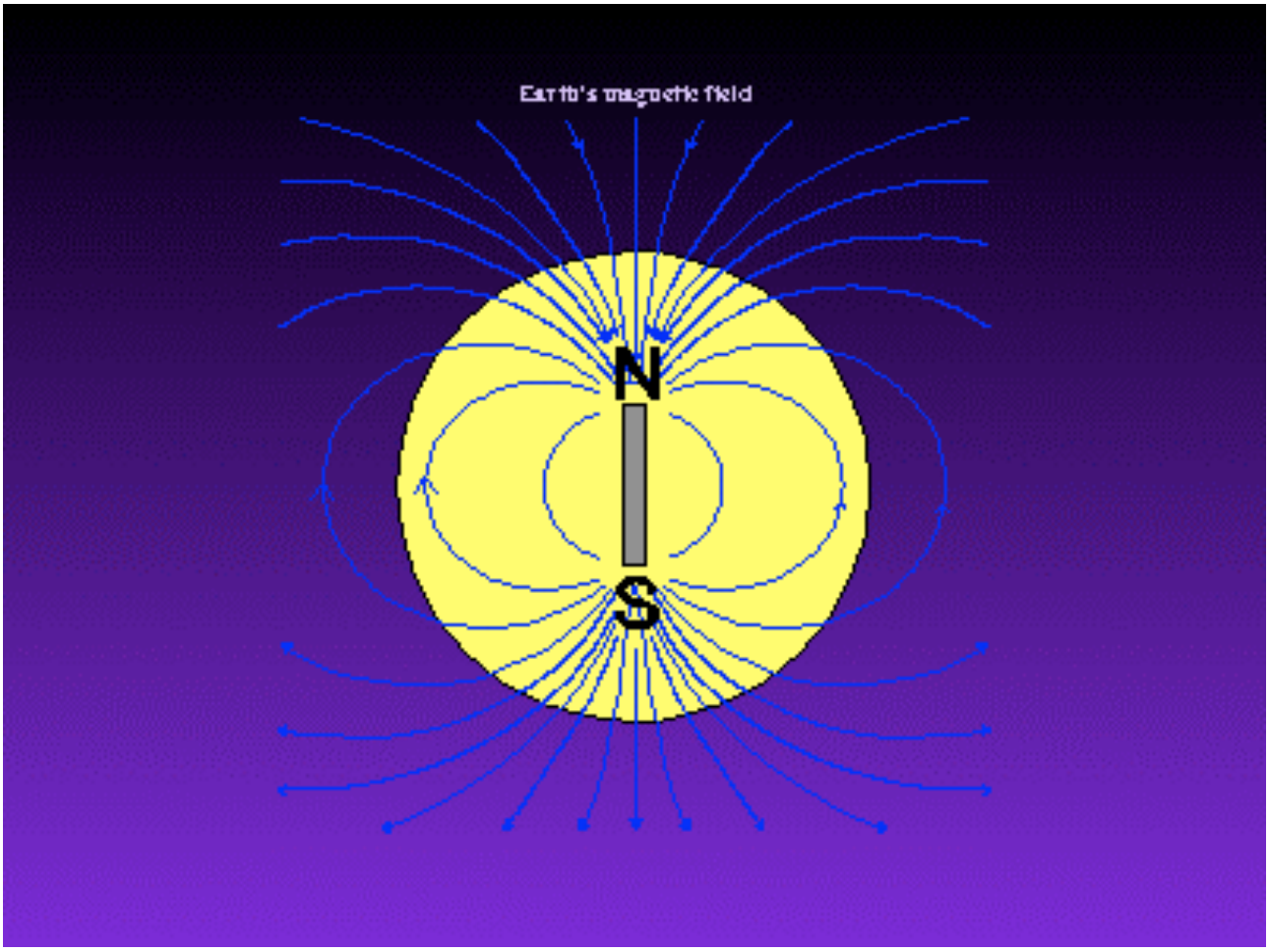


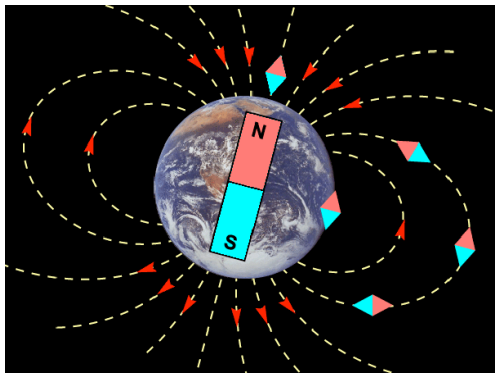
http://mitocw.udsm.ac.tz/OcwWeb/Physics/8-022Fall-2006/CourseHome/index.htm

Teacher Resource 2



Why might scientists say that the Earth is like a giant magnet?

"Scientists consider the Earth to be _____(comparable or similar) to a magnet because they both have a _____ _____, and _____."



Finger Rubric

 3. I understand the answer and can explain my answer to the class.

 2. I am slightly confused about part of the answer.

 1. I would like to answer but I am unclear about all parts of the answer.

Adapted from Kate Kinsella: ***Instructional Tools to Bolster Cognitive and Linguistic Engagement for All Students Workshop***