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Benchmark 4 The Physical Setting

4G Forces of Nature #3

Electric currents and magnets can exert a force on each other....

Resources

- The Exploration of the Earth's Magnetosphere

Exploring Magnetic Fields

Purpose

To reinforce the concept that magnets attract and repel items and exert a magnetic field that can vary in strength.

Context

By exploring magnets, students are indirectly introduced to the idea that there are forces that occur on earth which cannot be seen. This idea can then be developed into an understanding that objects, such as the earth or electrically charged objects, can pull on other objects. It is important that students get a sense of electric and magnetic force fields (as well as of gravity) and of some simple relations between magnetic and electric currents (Benchmarks for Science Literacy, p. 93.) In grades 3-5, students should have had opportunities to observe and explore the lines of force, the attraction and the repelling forces that all magnets exhibit in activities such as those found in Magnets 1: Magnetic Pick-ups and Magnets 2: How Strong is Your Magnet.

They also should have become familiar with the poles of each magnet and observe for themselves the differences between the north and south sides of the magnet.

In this lesson, students will see evidence of the magnetic field of a small magnet.

Planning Ahead

Materials for Activity 1:

- Exploring Magnetic Fields: Activity 1 student sheet
- Ziploc® bags
- 3 x 5-inch index cards
- Iron filings
- Paper clips
- Bar magnets

Materials for Activity 2:

- Exploring Magnetic Fields: Activity 2 student sheet
- Bar magnets
- Doughnut or horseshoe magnets
- Paper clips
- Pens or pencils for drawing pictures
- Ziploc® bags with a 3 x 5-inch index card and iron filings inside

Gather the materials for both parts of the activity and perform the experiments

yourself before you do them with the students. If you are using loose filings, clean them up very carefully. To pick up the filings easily, slip your magnet inside a plastic bag. Run it over the loose filings and it will pick them up easily. To remove them from the magnet, simply remove the bag. Store iron filings separately from the magnets so they won't become demagnetized.

Motivation

Begin by asking students to discuss their experiences with magnets. More than likely, students have conducted simple activities with magnets in earlier grades. Ask students to describe what magnets are and how they work. This discussion will help you assess students' naïve explanations of magnetism, which will be helpful as you guide them to more scientific explanations.

Development

The first part of this lesson is a hands-on exploration of magnetic fields using the Exploring Magnetic Fields: Activity 1 student sheet.

Allow students to work in pairs or small groups to carry out the activity. Each student, however, should fill out the student sheet. When students have finished, ask students to describe what happened. Ask one or more students to share their drawings of the patterns made by the iron fillings with the class.

Then discuss these questions:

- Were the patterns and shapes formed by the iron filings the same no matter how many times you did the experiment?
- What do you think caused this pattern?

After students have shared their ideas, explain that the pattern they saw was the outline of the magnetic field around the magnet. Around every magnet there is an invisible field called a magnetic field. This field is what attracts items such as paper clips and nails to the magnet. Although the magnetic field is invisible, the iron filings indicate where it is because they line up with the field.

Have students continue with their exploration of magnetic fields, using Exploring Magnetic Fields: Activity 2 student sheet.

Please note that students will repeat part of the first activity so that they can compare the magnetic field created by one bar magnet to that of other combinations and types of magnets.

After students have completed the activity, have them discuss their findings by reviewing the questions on the Student Sheet and sharing their drawings of what they observed.

To reinforce the concepts in the lesson, ask the following questions:

- Could you see the magnetic field? (No, the magnetic field is invisible. What was observed was the pattern made by the field.)
- Were the field lines the same for each type of magnet? (The field lines you see will be different when you use different magnets.)
- Where does the field seem to be the strongest? (Magnets have two poles; the field lines spread out from the north pole and circle back around to the south pole. Iron filings line up along the lines of magnetic force. The field is strongest at the poles; this is where the iron filings tend to be the most concentrated.)
- How was this activity similar to that in Part 1? How was it different? What

more did you learn?

Although the thin layer of iron filings we use in this activity only shows the magnetic field in two dimensions, it really is three-dimensional. The lines of force in the field extend upward and downward as well as from side to side. In fact, you can see some of these lines near the pole of the magnet where some of the filings seem to stand up straight in the air. If we had a way to see it, these lines would curve upward and then back down toward the other pole of the magnet, just like those we can see in the filings. The earth's magnetic field looks very much the same, although it is much larger.

Assessment

After students have thoroughly discussed the activities in the student sheet, refer students to Magnetic Fields. Instruct students to read this article and use what they have read to explain what happened in the activity. This will help them to refine their ideas about magnetism and to express their explanations in a more scientific way.

Extensions

Magnetic Fields: History discusses the history of magnetism and includes directions for conducting the experiment done by Hans Christian Oersted in which he discovered that an electrical current creates a magnetic field.

Magnets Part 1 and Magnets Part 2, from the Fermi Lab's High Energy Physics Made Painless Website, further extends the ideas in this lesson and discusses the use of magnets in particle accelerators.

Magnetic Shielding, from the Exploratorium, is an activity that extends the ideas in this lesson.

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