USE ELECTRICITY TO MAKE A MAGNET

PLANNING YOUR EXPEDITION

This activity can be used alone or can be the first in a series of activities in which your students attempt to build stronger electromagnets by manipulating a number of variables: material around which the wire is wound, number of winds of wire, and style of wrapping. If you are choosing to use this as a first activity in a series, refer to the activity entitled "Can You Build a Stronger Electromagnet?" Using a directional compass as a measurement tool models the creative, innovative way that scientists use equipment in the real world. When there is a need, a scientist finds a way to use what is available to satisfy that need.

Batteries will need to be charged for this activity. This is a task for which you might want to train lab assistants. Before you begin each unit it is a good idea to train 2-3 students from each class as helpers. Once these students are familiar with your purpose for the unit, the basic concepts you will be covering, and how the activities will work, they can be given a number of responsibilities: charging the batteries, helping other students, explaining procedures to groups, conveying in "kid words" your expectations, consulting on homework, etc. The limit of responsibility is, of course, your choice and depends upon the time you have to set this up. However, it is well worth your time and the students' since ultimately this will be of great help to you. It is particularly helpful with large classes. See "Today's Science Classroom" for ways to implement this.

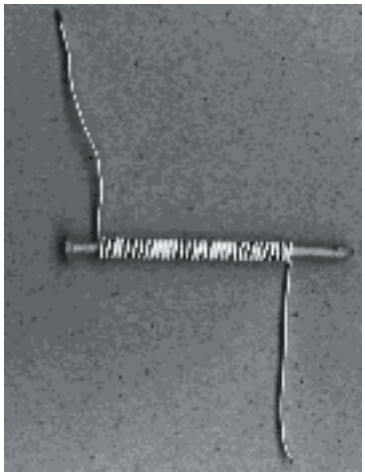
It is important for students to keep a detailed record of observations and results of trials in their Alpha Logs. The Log can be a way for you to assess students' progress, grasp of concepts, and organizational skills. The individual pieces of work that are produced can either be kept in the Log or can be treated separately. You can pre-establish categories of work done in the classroom so that students will know ahead of time which types of work are expected to be in their Logs. Use of the Alpha Log can vary depending upon the activity.

Questions that you will expect students to answer at the conclusion of this activity include, but are not limited to, the following: How can electricity be used to make a magnet? Why do the winds with an iron rod inside of them pick up paper clips when the iron rod alone or the winds alone will not? Winds is a term used by magnet scientists to describe wire being wrapped around a core material.

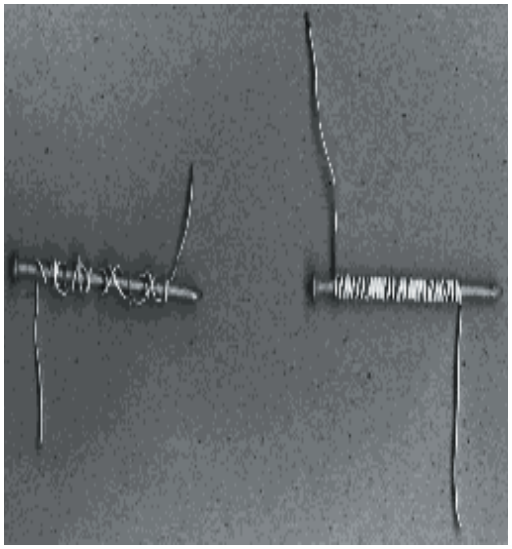
Have on hand copies of the story of how Hans Christian Oersted made the connection between magnetism and electricity (see Background). Students could read this as a homework assignment before the activity.

As in all activities dealing with electricity and magnetism, warn your students that heat is generated. The iron rod, the battery holder, and the wire will become warm as they work.

1. In groups, students will gather their equipment and, using the Itinerary, will begin to construct an electromagnet. It is important for their data collection that they be encouraged to read through all the steps of the activity before beginning so students will know what is expected of them.



2. Before groups begin their task, there should be some discussion of any areas that are unclear or any questions or problems that resulted from their last group activity. Since students are working in groups a great deal there should be some mechanism in place through which they can address their concerns to the teacher, either in private or in group discussion. A general discussion with each group as to what worked well and what needs improvement helps clear the air and clarify what is expected of the group by the teacher.
3. Students will be using a compass as a measuring device. The deflection of the compass needle indicates the presence of a magnetic field. Using a compass in this manner will demonstrate to students how scientists are creative in their use of tools.
4. First, students will substantiate that there is a magnetic field created by a connection of the insulated wire to the battery. Second, they will intensify this field by wrapping an iron rod with the wire and will again substantiate that the strength of the magnetic field has increased by observing the action of the compass needle.
5. Students will also notice that the battery holder gets warm as does the iron rod. Although the activity does not have a component for measuring change in temperature, this is an extension that you may choose to include.



BACKGROUND INFORMATION

Until 1820 scientists believed that the relationship between electricity and magnetism was purely coincidental. One scientist, Hans Christian Oersted, thought that there was a connection that he hoped to demonstrate, but until he could actually substantiate it to his colleagues, he kept silent. Even after he decided to present his ideas he was still unsure as to whether or not his simple experiment would work. Not until he was in front of a group of scientists to whom he was lecturing did he demonstrate his findings. It is this demonstration that your students will be recreating. Oersted connected a platinum wire to a source of electricity and noticed that it caused a compass needle to deflect. This would only happen if a magnetic field were being created by the electricity running through the wire.

Magnetism is the result of electrons moving in very particular ways within the atoms that make up a magnetic substance. Since it is the movement of electrons that can cause a material to generate magnetic forces, a weak magnetic field can be generated when electrons flow through a wire. If the wire is wound, the movement of electrons will be enhanced (concentrated) so that the tighter the wire is wound, the stronger the magnetic field will be.

EXCURSIONS

There are some people who believe that high voltage wires create a magnetic field that is dangerous to the health of those who live near them. **Although the medical establishment has said that this is NOT true,** these beliefs persist. Students could research this issue using print media, the CD-ROM, websites, or personal interviews. Students then find a way to present this information to the class or you can evaluate each one individually. A concise, straightforward article on this subject can be found in The New York Times Book of Science Literacy, Richard Flaste, editor, 1991, ISBN 0-06-097455-9.

SC.A.2.3.3, SC.B.1.3.4, SC.D.2.3.1-2, SC.G.2.3.4, 3.3.5-7, SC.H.1.3.1-7, 3.3.4

LA.A.1.3.1-4, 2.3.5-7, LA.B.1.3.1-3, 2.3.3-4, LA.D.1.3.3, 2.3.3-7

SS.A.1.3.2, SS.C.2.3.1-4, 2.3.5-7

Either read aloud or have students read "The Mysterious Rays" by Angela Bull, in Heroic Stories, Anthony Masters, editor, 1994, ISBN 1-85697-983-0. Discuss why Pierre and Marie Curie did not connect Pierre's illness with their research. Encourage students to read more on Marie Curie, particularly about her own illness. Did the Curies not realize that their illnesses were caused by the use of radium in their research; or, was there a reason why they could not publicly make the connection?

SC.H.1.3.1-7, SC.H.3.3.1-4, SC.H.3.3.5-7

LA.A.1.3.1-4, LA.E.2.3.1-8

Numerous misconceptions about magnetism exist that could be explored individually or in groups. One possibility is to assign a misconception to each group and then have the students report back to the larger group. Students may come into the classroom with their

own **misconceptions** about magnetism (or science in general) -- a good place to start an investigation. Some common misconceptions are: north and south poles are the same as plus (+) and minus (-); field lines start at one pole and end at the other pole; magnetic fields and electric fields are the same; magnetic field lines hold you on Earth; iron and steel are the only magnetic materials; geographic North Pole and magnetic north pole are the same.

SC.C.2.3.1-3, SC.G.3.3.5-7, SC.H.1.3.1-7

LA.B.2.3.3-4

Research Hans Christian Oersted using various media. Students can either write a research report, create a poster describing his life and work, role-play the original presentation of his results, or write a paper describing the impact that Oersted's work had on the study of magnetism. Students plan a debate of Oersted's work with one side of the argument representing that his demonstration *did* show the relationship between electricity and magnetism and the other side providing evidence that it was not sufficient to demonstrate such a relationship. Any of these activities show the relationship between past scientists and present discoveries demonstrating that science is not done in isolation.

SC.C.2.3.1-3,2.3.4,6, SC.G.3.3.5-7,

SC.H.1.3.1-7, 3.3.4

LA.A.1.3.1-4, 2.3.1-8, LA.B.2.3.3-4

SS.A.1.3.1-3, 2.3.2-3

Read The Time Machine by H. G. Wells. Use the premise of the novel as a start for a creative writing assignment going back in time to visit with an early scientist to whom magnetism was an important concept (for example, Luigi Galvani, William Gilbert, Hans Christian Oersted, or Alessandro Volta). An interesting connection to time travel (among other ideas) is made in The Physics of Star Trek by Lawrence M. Krauss (1995), ISBN 0-465-00559-4.

SC.G.2.3.4, 3.3.5-6

LA.D.1.3.2-4, LA.E.1.3.1-5, 2.3.5-8

SS.A.2.3.2-3

Assign a biography (student's choice) of a scientist or other professional whose life was in some way affected by magnets, the discovery of magnetism as it relates to electricity, the use of magnetism in his or her work, etc. Students could then design their own culminating project that is well- suited to their own learning style. For instance, dioramas, posters, book talks, book report/synopsis, or role playing the character in the book. Students should be encouraged to choose a scientist to read about. This is an opportunity to demonstrate the great diversity in the scientific community: minorities and women in science or contemporary scientists, for example.

SC.D.2.3.1, SC.H.1.3.1-7, 3.3.5-7

LA.A.1.3.1-4, 2.3.1-8, LA.B.1.3.1-3, 2.3.1-4, LA.D.1.3.4, 2.3.1-2

SS.A.1.3.1-3, 2.3.2-3

FOR YOUR PLANBOOK: Use Electricity to Make a Magnet

Suggested time: 1 hour

Gear: 1 D-cell battery, 1 battery holder, 200 cm insulated wire, compass, iron rod, wooden dowel, aluminum rod, paper clips

National Science Content Standards: A, B, E, F, G

Sunshine State Standards Benchmarks: SC.A.1.3.3, SC.A.2.3.2, SC.A.2.3.3, SC.B.1.3.5, SC.C.2.3.1, SC.H.1.3.1, SC.H.1.3.2, SC.H.1.3.3., SC.H.1.3.4., SC.H.1.3.5, SC.H.1.3.6, SC.H.1.3.7, SC.H.3.3.1, SC.H.3.3.4, SC.H.3.3.5, SC.H.3.3.6, SC.H.3.3.7

Sunshine State Standards Benchmarks -- Language Arts: LA.A.1.3.1-4, 2.3.1-8, LA.B.1.3.1-3, 2.3.1, 3, LA.C.1.3.1, LA.D.2.3.1-6, LA.E.1.3.5, 2.3.5-8

Homework: Allow one week for students to find an article in a newspaper or magazine that deals with magnetism. Encourage them to find articles about magnetic fields and/or electricity as it relates to magnetism. Students can approach this task from a variety of angles: for instance, article on Earth's magnetic field, magnetic fields in medical research (MRIs), magnetism and health concerns. Remind students that there are many kinds of print media, some of which can be accessed through the worldwide web: for instance, the The New York Times or newspapers from around the world. Have students either bring the articles to class to write the assessment or assign it to be done at home (see below).

Homework Assessment: Students hand in the article with their written assignment, each paragraph answering one of the following questions: What is the source of the article and why did you choose this source? What

is the article about (a brief summary)? How does the article relate to our study of magnetism? Who would be most interested in reading this article (other students, scientists, teachers, or parents)?

Students present the information to the class as a whole with a statement explaining the connection between the article and magnetism.

Assessment: Students construct an electromagnet that influences a compass needle. They also create a way to test their electromagnet by picking up paper clips or some other item. This provides evidence that students have linked electricity to magnetism.

Alpha Logs reflect a plan, include question(s) to be answered, observations, conclusions, and a short summary of what was learned. Accurate record keeping is directly linked to how others view a person's work. Students demonstrate that their work can be replicated by others who might question their results.

Students write a science fiction story about a sailor whose voyage is affected by the presence of a magnetic field. Science fiction should have the following characteristics: tells a good story, uses science fact, presents strange and unusual events, and includes some facet of human nature.

USE ELECTRICITY TO MAKE A MAGNET

Itinerary

Magnetism is the result of electrons moving in very particular ways within the atoms that make up a magnetic substance. Since it is the movement of electrons that can cause a material to generate magnetic forces, a weak magnetic field can be generated when electrons flow through a wire. It is possible to use this idea to build a magnet. In this activity, you will use electricity to create magnetic fields.

In fact, by completing this investigation, you will be duplicating the work of Hans Christian Oersted. He was not the first scientist to notice a connection between electricity and magnetism, but Oersted was the first to believe it was more than just coincidence. Proving his theory, however, turned out to be more difficult than he thought. In 1820 Oersted brought his theory to his colleagues in a public lecture during which he showed the attending scientists the same demonstration that you will recreate today.

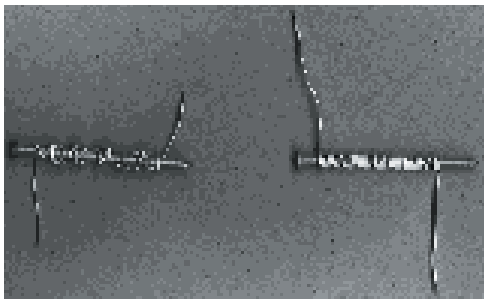
All observations should be recorded and all questions answered in your Alpha Log. You will use these observations to help you figure out how to construct your electromagnet. The conclusions that you draw from completing this activity will also help you in later activities about electromagnets.

1. Collect all materials that you will need to complete this activity: 1 D-cell battery, 1 battery holder, 200 cm insulated wire, a compass, iron rod, wooden dowel, aluminum rod, and paper clips.
2. Before you begin to build your electromagnet, check to see if the iron rod is a magnet. Describe the procedure that you use to determine if the iron rod is a magnet in your Alpha Log. Answer the questions: Is the iron rod by itself a magnet? Is the iron rod by itself magnetic? What is the difference between being a magnet and being magnetic?

3. Construct your electromagnet. Begin by connecting the insulated wire to the battery. (Leave enough wire at each end to connect the magnet to the battery.) Place the compass underneath the wire. Is there any reaction?
4. Now wrap the wire around the iron rod 15 times before connecting the wire to the battery. Record your observations. Answer the following questions in your Alpha Log: Can you pick up paper clips with the iron rod? Are there any unexpected results? Place your compass under the wound wire and record your results. Is this reaction different from what you saw when you placed the compass underneath the straight wire?
5. Remove the iron rod from the wire without unwinding it. Will the wire pick up any paper clips?

Will the rod alone pick up any paper clips? How can you explain your observations?

6. Use the wooden dowel and then the aluminum rod as a core around which you will again wrap the insulated wire 15 times. Do either of these pick up paper clips? Explain your results.
7. Place your compass under the wound wire. Do you get the same reaction as you did when you observed the compass in Step 4? How can you explain this?



8. Write an explanation of what you have learned from this activity. This can be a summary of what happened and why. When your group has reached agreement on this issue (if you **do** agree), compare your results with those of at least two other groups. Note in your Log how your results were different and how they were alike. Scientists often confirm the results of their work with others before going on to further investigation, research, or study. This communication can save time, energy, and money in the real world.