VIEWING A MAGNETIC FIELD

PLANNING YOUR EXPEDITION

Prepare your Magnetic Field Viewers (MFVs) ahead of time (see Appendix B) or have iron filings and plastic trays available.

Use this activity with half the class; the other half will complete Expedition 4, "Visualizing Magnetic Field Lines." Students will compare four magnets and the shape of the field that each one generates.

The observations and drawings that the students produce as well as the questions they will be asked to address are designed to be exploratory and to help students formulate and clarify their ideas about magnetic fields. Conceptualizing magnetic fields not only as "real," but as forces that can be manipulated, prepares students for dealing with the idea of magnetic fields so large that they *cannot* be seen. Since the next activity in the series introduces students to the Earth's magnetic field, the connection needs to be made either in this activity or the next. Look for this when assessing student work.

Before students complete this activity, it would be interesting to have them go back to their very first exploration about magnetism and review what they wrote in their Alpha Logs. This would be a good time for some reflective writing in their Logs. How have their ideas about magnetism changed? How would they draw a magnet now? Would the drawing be different or the same?

Using reflective writing activities to guide students' conceptualization of the "big ideas" can help both the teacher and students. From a teacher's standpoint reading students' journals, Alpha Logs, or reactions to statements helps identify misconceptions that students continue to hold even after activities are completed. It can be a tool you use to evaluate where students are in relation to your expectations. Weekly reflections that clarify what was accomplished by the group, identify what was important to the individual, and state questions yet to be answered could be looked at on a weekly or biweekly basis. Or, depending upon the level of the class, it might never be looked at. A truly reflective piece of writing is of use only to the person writing it. Reflective discussion might be more appropriate if you are looking for answers to *your* questions. (See also Reflective Writing in "Today's Science Classroom.")

1. Students will place four magnets on the magnetic field viewer to determine if the shape of the magnet has any bearing on the pattern of the magnetic field. We have come a long way from the conception of a horseshoe-shaped magnet (which was probably what most of the students drew in "What Is A Magnet?"). Your students have discovered that magnets come in many shapes and sizes; what they have yet to discover is how the magnetic fields are related to their shapes.
2. Throughout this activity there are a number of questions that students will address in their Logs. Answers should be supported by diagrams. Whether you evaluate these or not is a matter of personal preference.

BACKGROUND

Some discussion of magnetic field lines is appropriate at this point. Detailed information beyond what is defined here can be found in the accompanying CD-ROM. The magnet generates a magnetic field which extends to the area around the magnet. The magnetic field is visible by using iron filings to illustrate the shape of the field, the field lines, and the fact that fields are strongest near the poles. Field lines spread out from the north pole and circle back around to the south pole.

Magnets can be shielded so that magnetic fields go around the object blocking the field. Magnetic fields can also pass through materials which can be easily demonstrated by placing two magnets on either side of a piece of paper or a student's hand; or a magnet on the underside of the desk and a paper clip or other magnet on the top. The degree to which this is observable depends upon the strength of the magnet, the material between an object and the magnet, or the distance between the magnet and the object. This will be observed in the Expedition "Blocking the Field."

The unit of measure of a magnetic field is gauss or Tesla. A refrigerator magnet typically equals 1 Tesla; the Earth's magnetic field, 5×10^{-5} Tesla. The nucleus of a hydrogen atom equals 14 Tesla. Ten thousand gauss equals 1 Tesla which is 20000 times as strong as the Earth's magnetic field. An analogy that could be used here is ounces and pounds or miles and light years.

EXCURSIONS

If you have chosen to read The Secret Life of Dilly McBean as recommended in "What Objects Do Magnets Attract?" students could draw what they think the magnetic field lines would look like emanating from Dilly's hands. Successful completion of this assignment will further extend students' thinking on the shape of magnetic fields being related to the shape of the magnet. The poles should be indicated on the drawing as the basis for the field lines.

LA.A.1.3.3, LA.C.1.3.1, 2, 4, LA.E.2.3.8

SC.C.2.3.1-3

Using the K-12 Educational Programs homepage at the National High Magnetic Field Laboratory in Tallahassee, students could begin research on what high magnetic fields are and how they are used in research. How much further you wish to go with this information depends upon the level of sophistication of the group as well as the time available to devote to this subject. Some practical applications of high magnetic fields will be dealt with in later activities.

SC.C.2.3.1-3, SC.H.1.3.1-7, 3.3.4-7

LA.A.1.3.3-4, LA.B.2.3.4

Research the work of Pieter Zeeman as it relates to the study of astronomy. His work solidified the relationship between light and magnetism; and the existence of magnetic fields in space. The discoveries that have been made since Zeeman's initial work in 1896 can be related to the Big Bang Theory, stars, galaxies, and planets. This assignment provides yet another link between magnetism and other scientific disciplines.

SC.C.1.3.1-2, 2.3.1-3, SC.E.2.3.1, SC.H.1.3.1-7, 2.3.1, 3.3.5-6

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

FOR YOUR PLANBOOK: Viewing a Magnetic Field

Suggested Time: 1 hour

Gear: magnetic field viewers, wand magnets, bar magnets, round magnets, square magnets, rulers

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

Sunshine State Standards Benchmarks: SC.A.2.3.1, SC.B.1.3.2, SC.B.1.3.3, SC.B.2.3.1, SC.C.2.3.1, SC.C.2.3.3, SC.E.1.3.1, SC.E.1.3.4, SC.E.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.2.3.1, SC.H.3.3.5, SC.H.3.3.6, SC.H.3.3.7

Sunshine State Standards Benchmarks -- Language Arts: LA.A.1.3.1-3, LA.B.2.3.1-4, LA.C.1.3.1-2, 1.3.4, 3.3.2-3

Homework: Have students design their own homework assignment relative to magnetism. For example, a wordsearch using vocabulary words, a crossword puzzle, an art piece based on the patterns of magnetic fields, a collage of things in nature and things human-made that are affected by magnetism, a research paper on a scientist or scientific discovery, a creative story with magnetism as a theme, etc. Allow at least one week for this assignment based on the class schedule.

Homework Assessment: Integrating magnetism with another theme will result in a positive evaluation. For example, if students use definitions in a crossword that indicate they not only know what the word means but know how the word is commonly used, that would demonstrate successful mastery of the words. A research paper on a scientist or scientific discovery that includes a piece on how far science has come since that discovery or because of that discovery demonstrates that the student understands how scientific work leads to more questions and

further experimentation.

Assessment: Check Alpha Logs for answers to activity questions. Answers should reflect that the shape of a magnet determines the pattern of field lines. Students at this point will predict the shape of the field based on the shape of the magnet to successfully complete the assignment.

Drawings should mirror written answers to in-text questions. To successfully complete this assignment, students will demonstrate their knowledge of the names of types of magnets by labeling the drawing; show that they know that a bar magnet, for example, creates a certain pattern every time; and distinguish between each type of magnet.

Student paragraphs will summarize the activity and must include some information about field lines, their length and density, that the magnetic field exists within the field lines and on the lines themselves, and that fields are strongest at the poles (and/or where lines are closest together).

In sharing paragraphs, students demonstrate to you that they can articulate an explanation of magnetic fields and magnetic field lines. This particular manner of assessment requires no grading. If you wish to assign a grade, it would be appropriate to look at the paragraphs as clarification of each student's theory. For example, "If a magnet is round, then the shape of the magnetic field will. . . ." "Bar magnets will always cause iron filings to appear in the shape of . . . ."

VIEWING A MAGNETIC FIELD

Itinerary

A magnet generates a magnetic field which extends to the area around the magnet. The magnetic field is visible by using iron filings to illustrate the shape of the field, the field lines, and the fact that different regions on the magnet may have different strengths. Field lines spread out from the north pole and circle back around to the south pole. Using your magnetic field viewer and differently shaped magnets, you will be observing these things.

Magnetic fields can be shielded so that magnetic fields go around the object blocking the field. Magnetic fields can also pass through materials, which can be easily demonstrated by placing two magnets on either side of a piece of paper or your hand; or, a magnet on the underside of the desk and a paper clip or other magnet on the top. The degree to which this is observable depends upon the strength of the magnet, the material between an object and the magnet, or the distance between the magnet and the object.

The unit of measure of a magnetic field is gauss or Tesla. A refrigerator magnet equals 10000 gauss; the Earth's magnetic field, 1/2 gauss. Ten thousand gauss equals 1 Tesla which is 20000 times as strong as the Earth's magnetic field.

1. The Materials Manager will collect the materials necessary to complete this task: a magnetic field viewer, a wand magnet, a bar magnet, a square magnet, a round magnet, and a ruler.

2. Place the bar magnet on top of the magnetic field viewer so that the magnet is in the middle. Tap the viewer until you get a clear view of the magnetic field. Draw and label a diagram of what you see and then answer the following in your science Alpha Log:
   1. How far does the field extend out from the magnet?
   2. How far apart are the field lines?
   3. Are they the same distance apart everywhere in the field?

4. If not, where are they closer together?
5. Do the field lines run in the same direction?
6. If not, what pattern do they form?
7. Are all the field lines the same length?

3. Repeat Step 2 for each of the remaining three magnets, recording diagrams and answers in your Alpha Log.
4. When you have finished your investigation, write several paragraphs summarizing what you have learned. Be sure to include information about the distance between field lines.
5. Share your paragraph with another student. If there are any findings in conflict, retest them together and record your observations in your Log.