DRAWING MAGNETIC FIELD LINES

PLANNING YOUR EXPEDITION

Using a navigational compass your students will be studying magnetic field lines produced by a permanent bar magnet. One advantage to doing this activity is that it can be used as a model for Earth's magnetic field. Some textbooks describe our magnetic field by comparing the Earth to a "big bar magnet." The connections that you make with this activity will depend how far you wish to take it.

By using a compass, students will see that measuring devices can be used in a variety of ways and not always for the purpose for which they were intended. Perhaps you can introduce this activity by brainstorming common items that we use in a variety of ways; for example, using a knife as a screwdriver.

Students will reexamine their drawings from any of the activities for which they drew magnetic field lines, or they could place their bar magnet under the plastic box and pour iron filings in the box to test their drawings, or use the magnetic field viewer if it is already assembled (see Appendix B). Whether you choose to extend the activity this far will be up to you as you determine students' levels of understanding.

This activity is best done individually or in pairs. Groups will be too large for all group members to get the full benefit of drawing the magnetic field lines.

This activity is more prescriptive than some of the others in that students must follow the directions carefully in order to draw the magnetic field lines. They will be answering the question, "Can I draw the lines of magnetic force by using only a compass? Will that be an accurate representation of magnetic field lines?" There may be other questions that students will answer based upon their own preconceptions of magnetic field lines.

1. Students place the bar magnet in the middle of a large piece of paper. They will be moving a compass around the magnet, so depending upon the level of your students, you may want students to tape the magnet to the paper.
2. Place the compass at one end of the magnet and make a dot at both ends of the arrow.
3. Then put the compass down again so that the tail of the arrow is over the dot where the point of the arrow was. Students will keep moving the compass in this manner until they reach the other end of the magnet, or until they lose the magnetic field.
4. By connecting the points marked on the paper students will be drawing the magnetic field lines.

BACKGROUND INFORMATION

The magnet generates a magnetic field which extends into the area around the magnet. Iron filings show the shape, strength, and extent of the magnetic field. The field lines spread out from the north pole and circle back around to the south pole.

Magnetic fields can be shielded so that they go around an 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 activity "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, 3 X 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

Use any excursions that apply to magnetic field lines, in particular those that deal with health issues (see Expeditions 4 and 9).

Science and nature have inspired artwork for centuries. Have groups of students (or, if you wish, pairs or individuals) find one example of science influencing art. Encourage them to use various resources, for example, the worldwide web (they can check out the National High Magnetic Field Laboratory for Mike Davidson's work in photo-microscopy: http://micro.magnet.fsu.edu), print media, videos, films, music (audiotapes or scores of shows, operas, etc.), museums, and poster shops. Students will realize that science is not something done in isolation but that it influences the culture in which it is an enterprise. Have students compare what they have found.

SC.D.2.3.1, SC.H.1.3.6, 3.3.4-5, 7

LA.A.2.3.6

SS.A.2.3.3, 7, 3.3.1

FOR YOUR PLANBOOK: Drawing Magnetic Field Lines

Suggested time: 1 hour

Gear: bar magnets, large drawing paper (18" x 24"), compasses (enough of each for students to complete this activity individually or in pairs), masking tape

National Science Content Standards: A, B, D

Sunshine State Standards Benchmarks: SC.C.2.3.1, SC.C.2.3.2, SC.C.2.3.3, SC.C.2.3.1, SC.C.2.3.2, SC.C.2.3.3, SC.D.2.3.1, SC.H.1.3.4, 6, SC.H.2.3.1, 3.3.4-5,7

Sunshine State Standards Benchmarks -- Language Arts: LA.A. 2.3.6

Sunshine State Standards Benchmarks -- Social Studies: SS.A. 2.3.3, 2.3.7, 3.3.1

Homework: This assignment is intended for use after the activity has been completed. In view of what you have learned about magnetic field lines, imagine that you are a farmer and the power company in your area will be putting high voltage power lines on your property. You object because you believe that the electromagnetic fields surrounding these lines might affect the health of your livestock as well as your family. Can you visit another site of high voltage power lines and figure out how far the electromagnetic fields extend? Devise a plan that you will use to figure this out and that you could use as evidence to support your opinion.

Homework Assessment: Student plans should include some way of measuring the field lines. If students attempt to do this using a compass, although this would be unreliable at best, it is a natural extension of the activity and should be accepted as their attempt to find a relationship between the classroom and the outside world; between real life problem solving and classroom theorizing. If students propose writing a letter of inquiry to the power company and/or calling to get already published information, this should be acceptable as well. Any attempt at measuring how far the field lines extend is a successful completion of the assignment.

Assessment: Alpha Logs will contain a drawing of magnetic fields. By completing this diagram, students will have modeled magnetic field lines in a way that is transferable to other applications. Students will then be able to predict field lines for differently shaped magnets.

Often science and nature are the inspiration for artwork (see Extensions). Have students develop an art project that incorporates magnetic field lines. This could be a collage, a 3-dimensional model, a drawing, a sketch, sculpture, poster, or any artwork that they can defend as having something to do with magnetism. In doing this assignment, students become aware that science, technology, art, and culture are interwoven.

By walking around the room looking at what the students are accomplishing and talking with them, you can determine whether the students are identifying the relationship between the magnetic field lines and their affect on a compass. By doing so, students will be demonstrating that they recognize the relationship between evidence (the drawing of the lines) and explanation (why does the compass allow you to do this?).

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Itinerary

You will be using a compass to draw the magnetic field lines of a small bar magnet in order to look at their direction and magnitude. This will be a good model for supporting what you already know about magnets. You will clearly see how the magnetic field is concentrated at the poles and field lines are more spread out the further you get from the poles of the magnet.

The magnet generates a magnetic field which extends to the area around the magnet. The field lines spread out from the north pole and circle back around to the south pole.

The unit of measure of a magnetic field is gauss or Tesla. A refrigerator magnet typically equals 1 Tesla; the Earth's magnetic field, 3 X 10^{-5} Tesla. The nucleus of a hydrogen atom equals 14 Tesla. Ten thousand gauss equals one 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.

1. Gather the materials you will need to complete this activity: a small bar magnet, a large piece of paper, and a compass.
2. Place the bar magnet in the middle of the paper. Trace the outline of the magnet. That way if it gets bumped or moved you can put it back in exactly the same position. If you do not complete this activity in one sitting, you will know where to start tomorrow.

3. Place the compass at the end of the magnet (near the edge) and make a dot where the compass arrow points (see picture).
4. Move the compass so that the bottom of the arrow is at the dot and make a new mark where the tip of the arrow is pointing. Keep doing this until you reach the other end of the magnet.

5. Connect the dots as you move around the magnet.
6. Go back and begin again placing the compass about 1/4 inch along the edge of the magnet.

Repeat the steps connecting the dots as you go along.

7. Repeat the process until you have drawn as many lines as you can for both ends of the magnet. You will now have a representation of magnetic field lines.