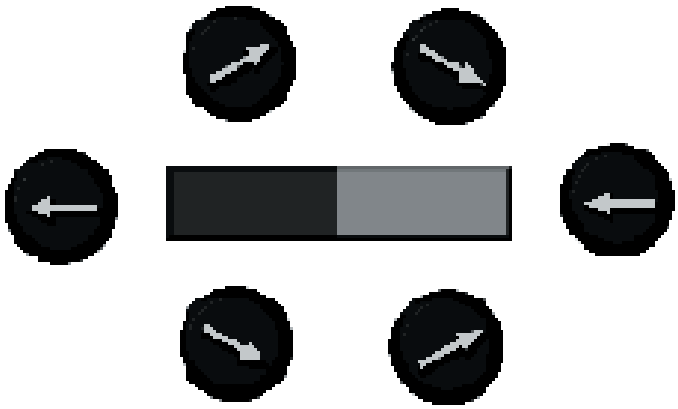
VISUALIZING MAGNETIC FIELD LINES

PLANNING YOUR EXPEDITION

Students will be looking at magnetic field lines in this activity by observing the effect that the lines have on compasses. The other activity that deals with this subject is Expedition 3, "Viewing a Magnetic Field." You can use one in place of the other, or both at the same time, depending upon your group and the time you have.

This is another activity designed to help students visualize a magnetic field. It could be used before "Making a Map Using a Compass" but can stand alone and be used at any time. This is the type of activity that can be revisited from time to time, and Excursions from any of the activities would be appropriate.

1. Students predict how they think compasses will respond to the magnetic field. The rest of the activity will either confirm or refute their prediction.
2. Students place a bar magnet on the desk with the north pole pointing away from them. They will place 6 compasses randomly around the magnet.
3. Placing the magnetic field viewer on top of the magnet *and* compasses, students begin gently tapping the side of the MFV to get a clear picture of the field.
4. Compass needles will point in the direction of the nearest field line and student drawings should reflect this. Some students may have difficulty recognizing this. If, after a few trials, they still do not see the connection, it may be helpful to suggest that students arrange all of the compasses in an arc along one side of the magnet.
5. Encourage students to move the compasses around as many times as they wish; also encourage them to use more than one magnet (2 bar magnets pushed together).



BACKGROUND INFORMATION

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. 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 the object blocking the field. Magnetic fields can also pass through materials; this 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, 3×10^{-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.

EXCURSIONS

Conduct a class discussion or debate about health concerns of people living near high power lines. Some people believe that the magnetic fields created by these high power electrical lines are harmful. **Recent research done by the medical community indicates that this is not true.** A worldwide web search or print media search could turn up many articles on this subject. Choose four class members for each side and the rest of the class becomes the audience at a town meeting called by concerned citizens. At the end of the debate, the audience decides whether or not to pay to evacuate citizens that live in the affected area. This exercise takes a real-world concern/current issue and allows students to use their knowledge of magnetic fields. They will be modeling a process that is widely used by communities to discuss issues of concern. The New York Times Book of Science Literacy (ISBN 0-06-097455-9) has a short article on this subject.

SC.C.2.3.1-3,

SC.H.1.3.1-7, 3.3.1-4

LA.A.1.3.1-4, 2.3.1-8, LA.C.3.3.1-3

SS.C.2.3.6-7, SS.D.1.3.1-3, 2.3.1-2

A search of worldwide web sites about magnetism will reveal a large number of products for sale that claim to have medical benefits.. Have students research these -- let each group choose one -- and then report back to the class. Becoming educated, responsible consumers is important, especially when students realize that they control a large percentage of dollars spent on consumer goods.

SC.H. 1.3.1-7, 3.3.1-4

LA.A.1.3.1-4, 2.3.1-8

SS.C.2.3.1-3, SS.D.1.3.1-3, 2.3.1-2

FOR YOUR PLANBOOK: Visualizing Magnetic Field Lines

Suggested time: 1 hour

Gear: compasses, bar magnets, magnetic field viewers

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

Sunshine State Standards Benchmarks: SC.C.1.3.1, SC.C.2.3.1, SC.C.2.3.2, SC.C.2.3.3, SC.D.2.3.1, SC.D.2.3.2, SC.E.1.3.1, SC.H.1.3.1, SC.H.1.3.2, SC.H.1.3.4, SC.H.1.3.5, SC.H.2.3.1, SC.H.3.3.1, SC.H.3.3.4

Sunshine State Standards Benchmarks -- Language Arts: LA.A.1.3.1-4, 2.3.1-8

Homework: Allow students about a week to complete this assignment. That will ensure that everyone has an opportunity to get a newspaper. Students find a newspaper article that describes an instrument used to look at or understand something else. For example, a microscope, telescope, binoculars, eyeglasses, camera, contact lenses, computer, magnifying glass, watch, television, mirror, etc. Make sure students know that they will be expected to read, summarize, and report on their choice.

Homework Assessment: If students bring in an article that they have summarized, they will have met the requirements of this assignment. When presenting the summary, if students make some analogy to the magnetic field viewer, or any other model that is used to understand magnetic fields, they will have articulated the relationship that you are looking for. Students should realize at this point that technology does not always mean computers but can be anything that enhances what a person does.

Assessment: Alpha Logs will contain answers to the questions asked on the Student Itinerary. Answers should reflect the fact that magnetic fields affect a compass and, without a magnetic field, a compass would be useless. Answers to questions will explain why magnetic fields vary in intensity.

Have students draw their diagrams in the Alpha Log. Drawings should indicate that compass needles line up along magnetic field lines. An explanation with the drawing will predict that adding another magnet will change the field lines, and compasses will still line up with those lines. Combining a drawing with verbal explanation requires that students identify the basic concepts that this activity addresses.

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The magnet generates a magnetic field which extends around the magnet. Iron filings help to illustrate the shape of the field, the field lines, and the fact that the fields are strongest near the poles. The field lines spread out from the north pole and circle back around to the south pole. In this activity you will be observing how these field lines affect a compass needle in order to understand the limitations and advantages of this instrument.

1. You will be placing a number of compasses around a magnet. In your Alpha Log and in consultation with group members, predict how the compasses will react. Draw a picture of what you think the compasses and magnet will look like, paying particular attention to the direction in which the compass needle will point.
2. Have your Materials Manager collect the items you will need to complete this activity: 6 compasses, 1 bar magnet, 1 magnetic field viewer.

   After each trial of this experiment, remove the magnets and let the compasses realign so that you control the starting configuration each time.

   Be careful not to work too close to another group's magnet.
3. Place the magnet on your desk with the north pole pointing away from you. Put the compasses randomly around the magnet.
4. Put the MFV on top of the magnet and compasses and tap the sides or top of the MFV in order to get the clearest view of the magnetic field lines.

5. Observe how the compasses respond to the magnet and record your observations in your Alpha Log. Draw a picture of what you see.
6. Remove the MFV and rearrange the compasses. Place the box on top of the magnet and compasses again and reconstruct the field. Observe again how the compasses respond and record your observations in your Log drawing the new picture.
7. Based on your two observations, what do you think is happening? Is it what you predicted? Does this confirm what you thought about magnetic fields?