Public Outreach
- Make and Take Activities

Exploring Magnetic Field Lines

About this Activity

When discussing space weather or how Earth's magnetosphere protects us, we often see diagrams with lines wrapping around the globe. What are these lines? Can we see these lines if we were in space looking back at Earth? This activity lets us explore the magnetic field of a bar magnet and serves as a good introduction to understanding Earth's magnetic field. It is also a good way to demonstrate why prominences are always "loops".

Left: Two participants tracing magnetic field lines.
Below: Magnetic field line tracings of a bar magnet, made using compasses.

Preparation

This activity doesn't need much preparation ahead of time besides gathering the necessary materials. If you wish, you can tape the paper and magnets together ahead to save some time during the activity. We normally tape 2 pieces of 8.5"x11" paper together lengthwise with the magnet taped down in the middle, as in the picture above. You might also want to make a large tracing with many field lines as an example that you can show to participants during discussions or questions. The example in the picture below was made with 4 pieces of 8.5"x11" taped together.

What You'll Need

- Alnico bar magnets
  1 for each setup or group
  (We find that Alnico and cow magnets are most durable and easy to work with. Other bar magnets would work too, but we find that those made of chrome tend to lose their magnetic fields quickly while ceramic ones are usually brittle and hard to work with.

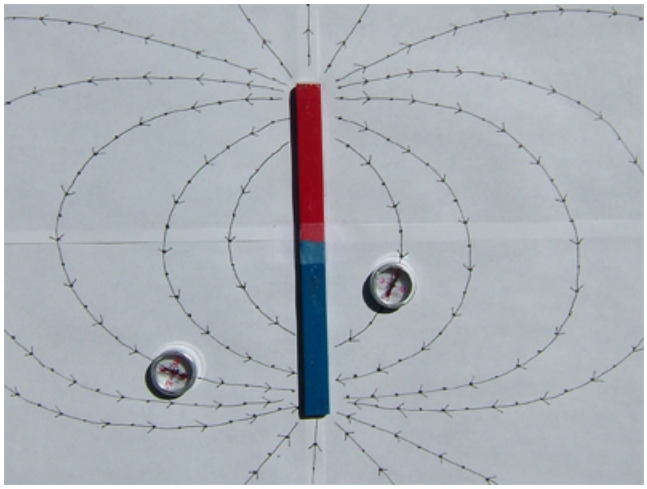
  You can find Alnico bar magnets online at: http://www.arborsci.com/

  Cow magnets can be found at pet/farm supply stores such as: http://petvetsupply.com/)
- compasses
  2 for each setup or group
  (We find that smaller compasses with transparent faces work best for this activity. The ones shown in the pictures are bought from http://www.arborsci.com/ although others would work.)
- sheets of blank paper
- pens / pencils
- tape

To Do and Notice

1) One good way to begin this activity is with a discussion of compasses. What do they do? How does it work? You may also begin with talking about magnets. What do we know about magnets? Is Earth magnetic? How do we know?

2) Divide up the magnets and compasses between the participants. Give them a little time to play with the materials in groups. What happens when you put a compass next to a magnet? What happens when you take the compass further away? What happens when you put it close to a different part of the magnet?



3) If you have not done this already, give participants a large piece of paper or ask them to tape 2 pieces of paper together. Tape down a bar magnet in the center.

4) To make the tracings, have participants do the following:

- Draw a dot somewhere near the magnet and place the center of a compass over the dot.
- Draw a dot at the location of the arrow head (or tail) of the compass needle.
- Draw a line to connect the 2 dots.
- Move the compass center directly over the second dot, and again draw a dot at the location of the compass needle head or tail.
- Continue these steps, marking the direction of the needle with dots and connecting them until the line meets the magnet or the edge of the paper. Go back to the first dot and repeat these steps until the other end of the line also meets the magnet or the paper edge.
- When finished with the first line, pick another spot near the magnet and repeat the process to trace more field lines.

Exploring Magnetic Field Lines (continued)

Activity Notes

When you put two magnets close together, you will notice that the opposite poles attract while the ends with the same polarity repel each other. A typical magnetic compass is actually made with a tiny magnet suspended on a pivot. When it is placed near another magnet, the tiny magnet on the compass needle will be attracted or repelled, thus turning the point of the needle to a specific direction. Now imagine the Earth as a big bar magnet, with the poles at where but the north and south poles. The pointed needle tips of our compasses are attracted to the north pole and help us find our way no matter where we are on Earth.

When we place our compasses close to a bar magnet as we did in this activity, the tiny magnets on the needles get attracted to the nearby bar magnet instead of Earth's north. By looking at how the needles point and tracing their directions, we can see the invisible magnetic field of the bar magnet.

When tracing the magnetic field lines, did you notice that no matter where you place the compass, you can always find a "line"? That's because the magnetic field isn't consisted of lines, but is continuous all around the magnets. The lines are just there to help us see what the magnetic field is like at different locations around the magnet. If we were to keep tracing more and more lines and if we could draw lines in midair, we would see that we'll fill the space around the magnet completely with lines.

However, magnetic fields get weaker as you move further away from the source. What happens if you try to trace a line a few feet away from the bar magnet? If you keep tracing lines further and further away from the magnet, you might notice that the lines no longer wrap around the magnet and connect neatly to the poles. Where are the lines going instead? Are they pointing to a particular direction? Without a bar magnet nearby to attract and repel the magnet on needle, the compass goes back to doing what it is meant to do, pointing north!

This activity is adapted from session 1, activity 1 of Exploring Magnetism: A Teacher's Magnetism Activity Guide.

Related Websites

Exploring Magnetism: classroom version of this activity plus related content and lessons
http://cse.ssl.berkeley.edu/SegwayEd/lessons/exploring_magnetism/

A guide to Earth's magnetosphere
http://www.agu.org/sci_soc/cowley.html

Space Weather: the latest updates and images
http://www.spaceweather.com