

Lesson 1: Magnetic Fields and the Earth

Materials:

| <u>For Part 1</u> | <u>For Parts 2 & 3</u> |
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| <ul style="list-style-type: none">• 1 bar magnet (with North & South poles marked)• A compass• A sheet of paper• A pencil | <ul style="list-style-type: none">• 2 bar magnets (with North & South poles marked)• Iron filings• A sheet of paper • Plastic or glass bottle• A sheet of construction paper• Cow magnet (optional)• Transparent tape |

Procedure and Questions:

Part 1 —Magnet and Compass

1. Question: What is a magnet? What does it do? How do you know? When are they used?
2. Question: What is a compass? What does it do? How do you know? When are they used?
3. Question: Do you think the Earth is a magnet? Why or why not?
4. Play with magnets for a few minutes, along with the compass. Write down your observations in your notebook.
5. You are now going to use a magnet and a compass to trace the magnetic field lines of a magnet. To do this, follow these instructions:

- a. Tape one bar magnet in the center of a large sheet of paper so that it will not move.
- b. Draw a dot near one of the poles of the magnet (as shown below).



- c. Place the center of the compass over the dot (as shown below).
- d. Then, draw two dots—one at each arrow (head & tail) of the compass. Draw a line to connect the two dots.



- e. Move the center of the compass over the second dot. Again, draw two dots—at the head and tail of the compass needle.

f. Repeat these steps, marking the direction of the needle with dots and connecting them until the line meets the other end of the magnet or the edge of the paper.

g. When finished with the first line, pick another spot near the magnet and repeat the process to trace more magnetic field lines.

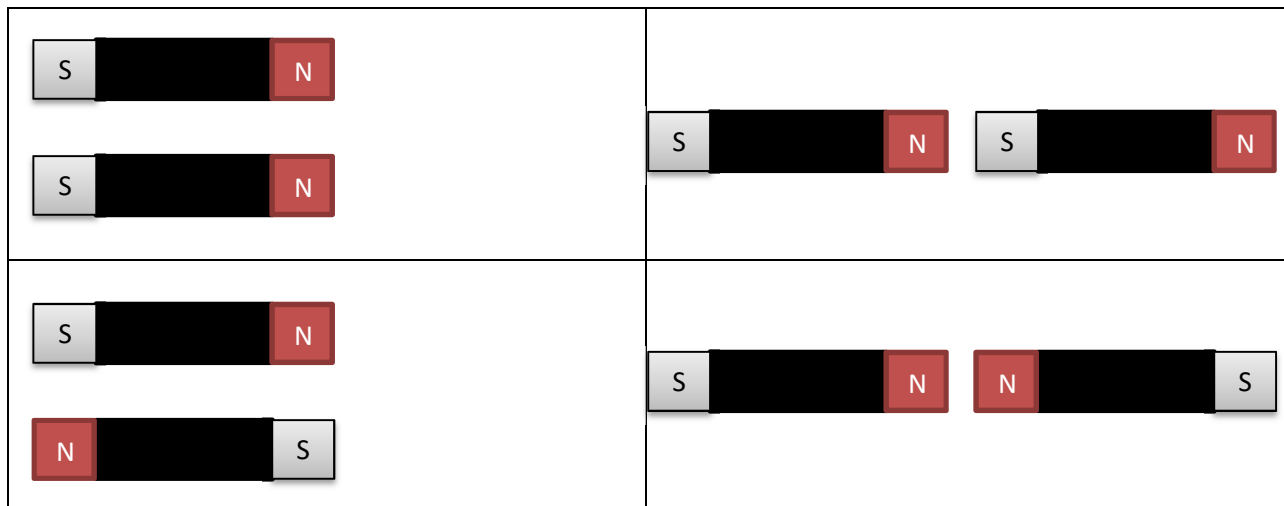
Part 2 —Magnetic Field lines (in 2-D)

NOTE: Iron filings can be messy and are difficult to remove from magnets. It is a good idea to keep paper/plastic between the filings and the magnets.

1. You are now going to use a magnet and iron filings to trace the magnetic field lines of a magnet. To do this, follow these instructions:
 - a. Place a sheet of paper on top of one bar magnet. Trace the outline of the magnet with a pencil and label the N and S poles.
 - b. Lightly sprinkle some iron filings evenly over the paper and then gently tap the paper to make the filings line up with the magnetic field lines of the magnet.
 - c. Draw what you see in your notebook.

- d. Now, place a sheet of paper on top of two bar magnets (see below for ideas to try). Trace the outlines of the magnets with a pencil and label the N and S poles.
- e. Lightly sprinkle some iron filings evenly over the paper and then gently tap the paper to make the filings line up with the magnetic field lines of the magnets.
- f. Draw what you see in your notebook for each of the setups you try.

[Ideas you can try. Also, come up with your own ideas!]



Part 3 —Magnetic Field lines (in 3-D)

1. You are now going to use a magnet, iron filings, and other materials to model the magnetic field lines of a magnet in 3D. This shows what the magnetic field of the Earth looks like. To do this, follow these instructions:
 - a. First, you must construct a 3-D “visualizer”, using a bottle, construction paper, and tape (see image below).
 - i. Remove the label from the bottle.
 - ii. Roll the construction paper into a tube (about the diameter of a bar magnet/cow magnet). Use tape to keep the tube rolled up.
 - iii. Seal one end of the roll with tape and stuff some paper/tissue so that when you put the magnet into the tube it won't go all the way to the bottom of the tube.
 - iv. Pour some iron filings into the bottle—enough to coat the bottom with a layer $\frac{1}{4}$ inch thick.
 - v. Insert the tube into the bottle and use paper/tissue and tape to seal up the bottle opening around the tube.
2. Now, drop your magnet into the tube. Use a pencil to hold the magnet in place and shake the bottle. The iron filings will take the form of the magnetic field surrounding the magnet.
3. Question: How do you think this model compares to the Earth?
4. When finished, you can “fish out” the magnet using a string and large paper clip. TRY IT!!!

These activities are adapted, in part, from Exploring Magnetic Field Lines

(http://sunearthday.nasa.gov/2007/materials/magnetic_field_lines.pdf) and Iron Filings and Magnetic Field Lines

(http://lasp.colorado.edu/home/wp-content/uploads/2011/08/P1-2_3D_field.pdf)