

Holy Cow Magnet!

Mapping the magnetic field of a cow magnet can be a "moo-ving" experience.

Materials Needed

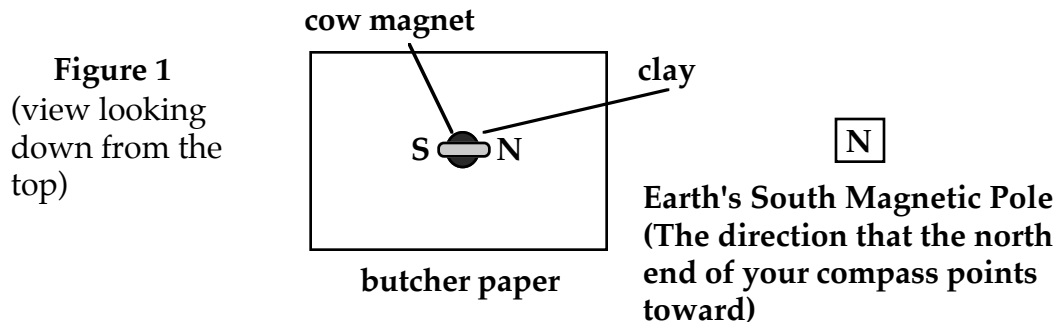
- One cow magnet
- Enough sheets of paper to cover a 4 ft² area
- scotch tape
- 5 magnetic compasses
- Pen, pencils, or crayons
- modeling clay

What To Do

- (1) Using your compass, locate the direction of the earth's "magnetic north pole." Make a note of this. You'll need this information for the rest of this activity.*

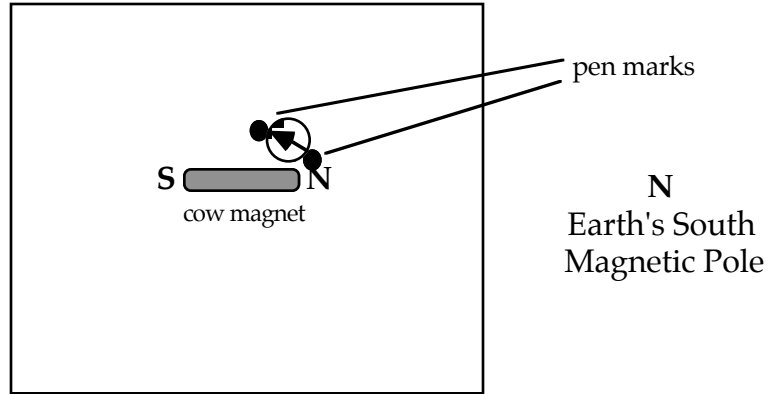
*** The north end of your compass needle will point toward the "magnetic north pole" of the earth. Actually, what we call the "magnetic north pole" is actually the *south pole* of the earth's magnetic field.**

- (2) Lay enough sheets of paper on a tabletop or hard floor** to cover a 4 ft² area. Use tape to attach the sheets together. (**Make sure that the surface is not made of metal and does not have metal supports.)
- (3) Using your magnetic compass, determine which end of the cow magnet is a north pole and which is south pole. (*The north end of the compass needle will be attracted to the south end of the cow magnet.*)
- (4) Place a small lump of clay in the center of the butcher paper. Press the cow magnet into the clay so that the north magnetic pole of the cow magnet is pointing toward the north magnetic pole of the room. The clay will prevent the cow magnet from rolling around. (see **Figure 1**).



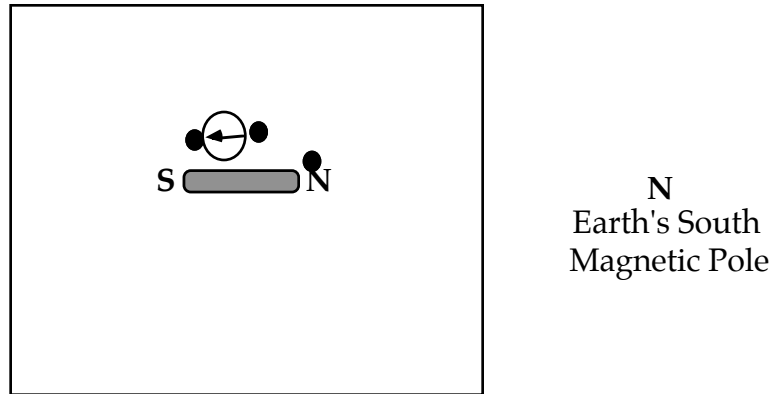
- (5) Now you're ready to map the field lines of the cow magnet. Place the compass near the north pole of the cow magnet. Using a pen or pencil, mark the position of the north and south ends of the compass needle (see **Figure 2**).

Figure 2



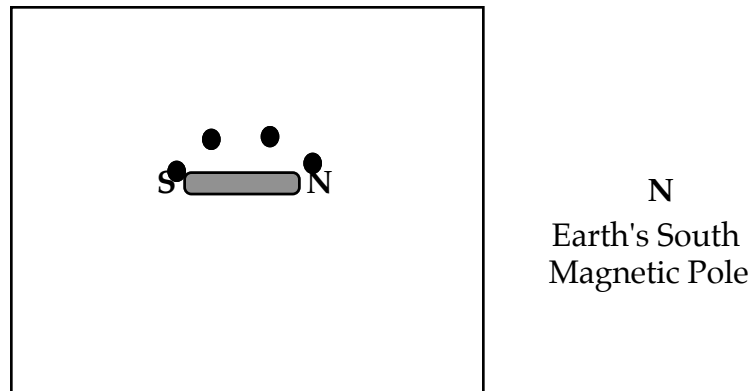
- (6) Move the compass so that the south end of the needle is where you had marked the position of the north end of the needle. Using a pen or pencil, mark the position of the ends of the compass needle as you did in step (5). (See **Figure 3**)

Figure 3



- (7) Repeat step (6) until the north end of the compass needle reaches the south pole of the cow magnet. Using a pen or pencil, connect all the dots with a smooth line. You have just mapped a magnetic field line. (see **Figure 4**).

Figure 4



- (8) Try many different parts of the butcher paper and continue to trace out magnetic field lines. A field line ends when your compass either leaves the paper or reaches one of the two poles of the magnet. Try to trace out at least 10 different field lines in ten different parts of the paper. When you are through, you might notice that the magnetic field you

traced looks something like **Figure 5**, except that there will be regions where the earth's magnetic field is influencing the compass needle as much or more than the cow magnet.

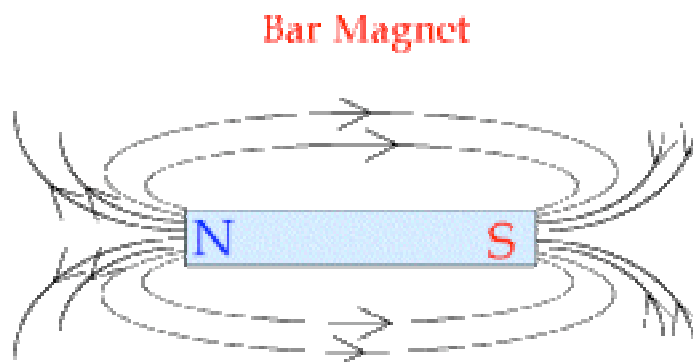


Figure 5

What's Going On?

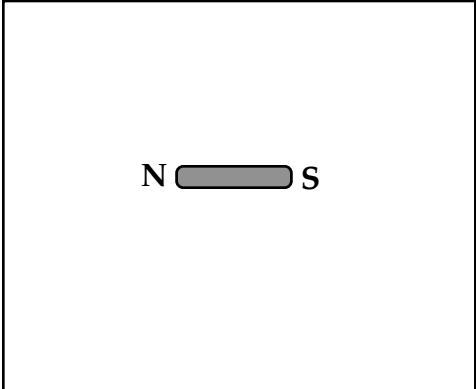
If you have ever sprinkled iron filings over a magnet, you've probably noticed that the filings seem to arrange themselves in a pattern of lines that loop from one pole of the magnet to the other. That's because each tiny iron shaving was temporarily magnetized by the magnet. Iron is a material that becomes magnetized in the presence of strong magnets which is why magnets attract iron. One end of the shaving temporarily became a north pole and the other end became a south pole—causing the tiny piece of iron to align itself along the lines of magnetic force created by the magnet. You can think of iron filings as thousands of tiny compasses, each under the influence of the strength and direction of the magnetic force.

In this activity, instead of using iron filings to visualize magnetic lines of force, you used a single compass needle to trace out the magnetic field lines along a sheet of paper. As you moved your compass around different parts of the paper, the needle changed its orientation depending on the strength and direction of the forces acting on it.

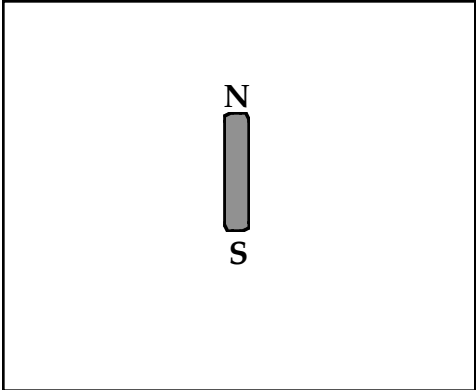
However, you may have noticed that the compass needle was being influenced by two magnetic fields at the same time. One was the field of the cow magnet; the other was the earth's magnetic field. When you probed the region close to the cow magnet, you probably noticed that the field lines looped from its north to the south poles. But at the edges of the paper, far from the cow magnet, you probably noticed that the lines were straight, and were pointing toward the "north" end of the room. These straight lines are forces created by the earth's magnetic field. In between these two parts of the paper, the lines of force were a combination of the influence of the earth's magnetism and your cow magnet. In fact, you may have found places on the paper where the two magnetic fields opposed each other in strength and direction so that the compass felt no forces acting on it at all.

What Else Can I Do?

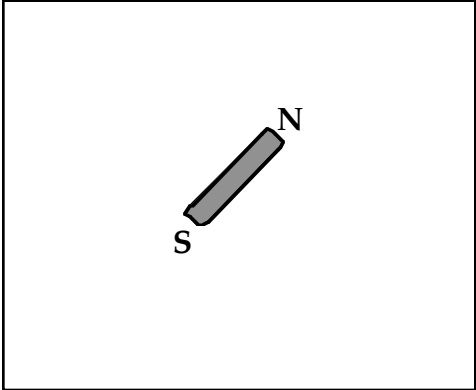
Try mapping the magnetic lines of force on your compass needle with these orientations of the cow magnet:



N
Earth's South
Magnetic Pole



N
Earth's South
Magnetic Pole



N
Earth's South
Magnetic Pole