Introduction

Magnets are everywhere in our day-to-day lives. From the refrigerator to the engine of our car, most electrical equipment utilizes the magnetic field in some fashion. Magnetic fields always go from "north" to "south". Here, north and south do not mean the cardinal directions, but are the binary names for magnetic fields. This is quite similar to how the electric field has positive and negative charges—both are binary opposites.

Since there is no such thing as a magnetic monopole, magnetic fields always "curl". This means that the field lines loop around to form arcs. This is the concept that will be studied in today's lab.

Experiment

Part 1: Acquiring a Sense

This setup will help you get a feel of the magnetic field strength. Once you have this sense, the rest of the lab will be much more beneficial.

1. Set a magnet at one end of your lab bench.
2. With another magnet in your hand, try to push it to the other end of your lab bench. Note the special rules:
   - **Do not let the magnets touch!** The only force should be the magnetic force. If your magnet touches anything but the bench, start over.
   - It is recommended that you only use repulsive forces. Attractive forces are a little harder to work with.

Part 2: Visualizing the Magnetic Field

In this part of the lab, you will get a hands-on picture of the magnetic field from a bar magnet.

1. Place the bar magnet in the middle of a blank sheet of paper. Make sure that your iron powder is on a separate sheet of paper (see Figure 1).
2. Sketch the outline of the magnet on the paper, then cover the magnet with the paper
3. On your own sheet of paper, sketch a prediction of the 2D magnetic field lines.
4. Take a small pinch of iron powder and sprinkle it on the paper around the magnet. You may have to do this a couple of times to get an accurate picture of the field lines. **Keep the iron powder on the paper at all times!** This ensures that there is no messy cleanup and the powder may be used again in the next lab section.
5. Based on the iron filings, make a sketch of the magnetic field lines around the magnet. You will turn in this sketch along with your prediction in your lab report.
6. Repeat this procedure for an attractive dipole, a repulsive dipole, and an attractive quadrupole (Figures 2, 3, and 4, respectively).
7. Create three configurations of your own and repeat the procedure.

Figure 1: The setup for the single bar magnet.

Figure 2: Diagram of an attractive dipole.

Figure 3: Diagram of a repulsive dipole.

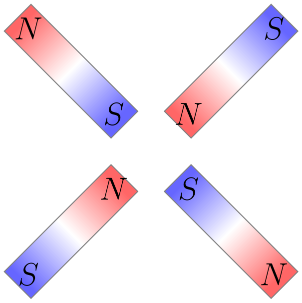

Figure 4: Diagram of an attractive quadrupole.

Analysis Questions

1. How different were your predictions from observation? Be specific! For example, were there differences in size of the field loops?
2. Magnetic fields are created by moving charges (current). How is it then that a bar magnet produces a magnetic field?
3. How do magnetic fields differ from electric fields?