Physics

Magnetic Force Field Mapping Lab

Purpose

This lab carefully investigates the strange, invisible force fields surrounding magnets. **Record** what you already know about magnets, the fields they produce, and the effects of these fields **before** beginning the lab.

Warning!

The compasses are sensitive instruments that can easily get re-magnetized in the opposite direction, **destroying all subsequent experimental results**. One group member, the **Compass Holder**, is responsible for holding the compass well to the side of your experimental setup whenever it is not being used. When mapping, always be extremely careful to **avoid touching the compass to the magnet** or **even holding one above the other**. Instead, hold the magnet in position as you slide the compass carefully around **without making contact** or lifting either off the desk.

Procedure

1. Open the box containing the two bar magnets. **Before** removing the magnets, **sketch** the arrangement of the 5 parts inside the box, including the location of the white dots on the red bar magnets. Remove all 5 parts and then place the 2 silver magnet keepers and the black buffer back into the box.
2. Play around with the two red bar magnets for a while. **Record** which parts of the magnets attract one another and which parts repel, **using the white dots** to carefully specify the parts of the magnets you're referring to. For example, if you write "the left side of one magnet is attracted to the right side of the other magnet," then nobody will have any idea what you're talking about. If instead you describe what happens when you bring the ends with the white dots together, then everyone will understand what you mean. Make sure you try at least four completely different arrangements (including side by side). Are there any arrangements that the magnets themselves seem to prefer?
3. Remove one of the silver magnet keepers from the bag, **record** how it is affected by various parts of the bar magnets, and then replace it.
4. The Compass Holder should check the compass calibration by placing it on the table at least one meter from any other magnets. Make sure that its red indicator points north (roughly toward the San Juan Ridge). The Compass Holder should check the calibration of the compass each time it is handed to them. Raise your hand if you feel that your compass has become defective.

5. Lay one bar magnet flat within the rectangle in **Figure 1** with the white dot in the position shown. Without moving the magnet or the paper, use the compass to explore the field surrounding the magnet. The compass's red indicator will show the direction in which the arrows on the magnetic field lines should point.

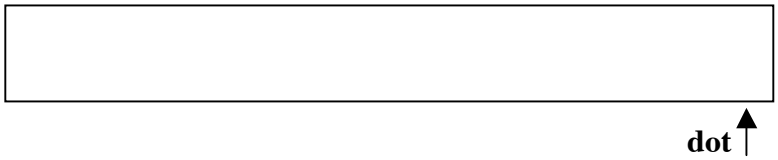

Figure 1

6. **Sketch** the magnetic field lines within **Figure 1**, checking to make sure that your field lines always point in the same direction as the red indicator. Give the compass to the Compass Holder.
7. Lay both bar magnets flat within the rectangles in **Figure 2** with the white dots in the position shown.

Figure 2

8. Use your compass to map out the field lines in the area between the two magnets and nearby. The region exactly between them is hard to map, so concentrate on what happens just to the left and right of center. **Sketch** the magnetic field lines within **Figure 2**. Give the compass to the Compass Holder.

9. Lay both bar magnets flat within the rectangles in **Figure 3** with the white dots in the position shown.

Figure 3

10. Again, map out and then **sketch** the field lines in the area between the two magnets and nearby. Give the compass to the Compass Holder.
11. Lay both bar magnets flat within the rectangles in **Figure 4** with the white dots in the position shown.

Figure 4

12. Again, map out and then **sketch** the field lines in the area between the two magnets and nearby. Give the compass to the Compass Holder.
13. Place your magnets as in **Figure 4**, but this time let the ends touch. Use your imagination instead of the compass. Think of this combination as a longer version of the single magnet you explored in **Figure 1**. Referring to the field lines you sketched in **Figure 4**, make a guess at the direction of the field lines **inside** the magnet in **Figure 1**.
14. **Sketch** the field inside the magnets using dotted lines (with arrows) inside each magnet rectangle in **Figures 1-4**.
15. Replace the magnets, buffer and keepers back into the bag and the bag into the box **exactly as you recorded in step 1**.

Analysis and Conclusions

Physicists call the dotted side of these bar magnets "north", and the non-dotted side "south", so write "**N**" on the dotted side and "**S**" on the other side of each magnet in **Figures 1-4**. A compass is actually a small magnet balanced on a pinhead, and its red side is its north side. Analyze your observations (repulsions, attractions, field lines in your diagrams, etc.) Try to come up with a few general rules that seem to be true for all magnets, using the physicists' "north" and "south" terminology. Compare the magnetic field lines in **Figure 4** with the electric field lines that would surround two charged objects, one positive and one negative, placed the same distance apart. Discuss the similarities and differences between electric field lines and magnetic field lines.