Experiment No. 3: Drawing Magnetic Curves

1. Objective

The objective of this experiment is to examine the magnetic field associated with a bar magnet and construct the magnetic field lines.

2. Apparatus

- Magnetic Bar
- Compass needle

3. Theory

Magnetism is a class of physical phenomena that is mediated by magnetic fields. Electric currents and the magnetic moments of elementary particles give rise to a magnetic field, which acts on other currents and magnetic moments. The most familiar effects occur in ferromagnetic materials, which are strongly attracted by magnetic fields and can be magnetized to become permanent magnets, producing magnetic fields themselves. Only a few substances are ferromagnetic; the most common ones are iron, cobalt and nickel and their alloys. The prefix ferro- refers to iron, because permanent magnetism was first observed in lodestone, a form of natural iron ore called magnetite, Fe_3O_4.

The direction of the magnetic field at any point in space can be measured by placing a small compass at that point; the N pole of the compass will point in the direction of the magnetic field. Pictorial representations of magnetic fields are usually produced by drawing magnetic field lines. The field line passing through any point in space must be parallel to the magnetic field at that point. Small arrowheads are usually drawn on the field lines to indicate the field direction. Since the field can only point in one direction at one point in space, field lines can never cross. Magnetic field lines always make complete loops, and field lines are closest together where the magnetic field strength is largest.

Magnetic field strength is measured in units of (N/C)/ (m/s). This combination of units is called a tesla (T). The Earth's magnetic field at the location of Tempe points roughly towards geographic North with a strength of about 20-50 μT. The field strength near the end of a common bar magnet is typically hundreds of times larger than the field of the Earth. Following are the properties of magnet,

1. **Attractive Property**: Magnet attracts ferromagnetic materials like iron, cobalt, and nickel.
2. **Repulsive Property:** Like magnetic poles repel each other and unlike magnetic poles attract each other.
3. **Directive Property:** A freely suspended magnet always points in a north-south direction.

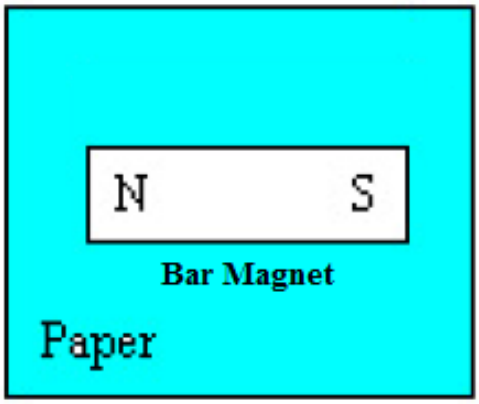

Figure 3.1: Setup for Constructing Magnetic Field Lines of a Bar Magnet

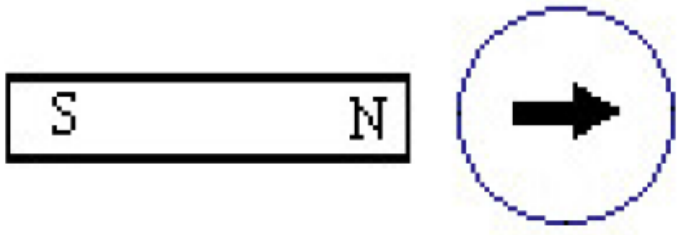

Figure 3.2: Direction of Compass Placed Near Bar Magnet

4. Procedure

1. Tape a sheet of paper to your lab table with the long edge of the paper as shown in the Figure 3.1, and stay far away from any iron objects.
2. The arrow on the compass is magnetic and will experience a torque so that the North pole of the compass will point in the direction of the Earth's magnetic field if no other magnetic fields are present.
3. Determine which ends of your magnet are north or south magnetic poles. Place the compass near the bar magnet, the North pole of your compass will point toward the South pole of the bar magnet or away from the North pole when placed as shown in Figure 3.2.
4. Trace the bar magnet on the paper, then remove the magnet so that you can indicate on the paper the S and N pole locations of the magnet, and finally replace the magnet.
5. Place a compass near one end of the magnet. Make two dots on the paper, one at the end of the compass needle next to the magnet and the second at the other end of the compass needle.
6. Move the compass so that the end of the needle that was next to the magnet is directly over the second dot, and make a new dot at the other end of the needle.
7. Continue this process until the compass comes back to the magnet or leaves the edge of the paper.

8. Draw a line through the dots and indicate with an arrowhead the direction in which the North end of the needle pointed, as shown below in Figure 3.3.

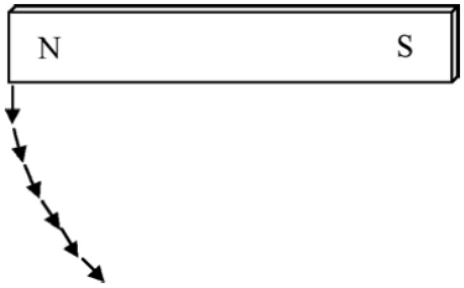

Figure 3.3: Constructing Magnetic Field Lines

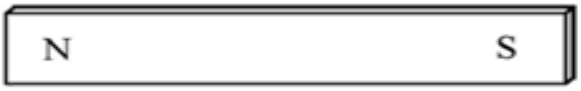

Figure 3.4: Magnetic Field Lines

5. Lab Tasks:

1. Repeat the process described above, when the compass touching the magnet approximately 1 cm in from the same end of the magnet that you used above and draw the field lines of bar magnet in Figure 3.4.
2. Using a clean portion of the paper (or turn the paper over, or get a new piece of paper), arrange compasses and two magnets as shown in Figure 3.5 below. Allow enough room between the magnet poles to place three compasses roughly as shown below. Sketch the compass needles' directions in the diagram. Based on these compass directions

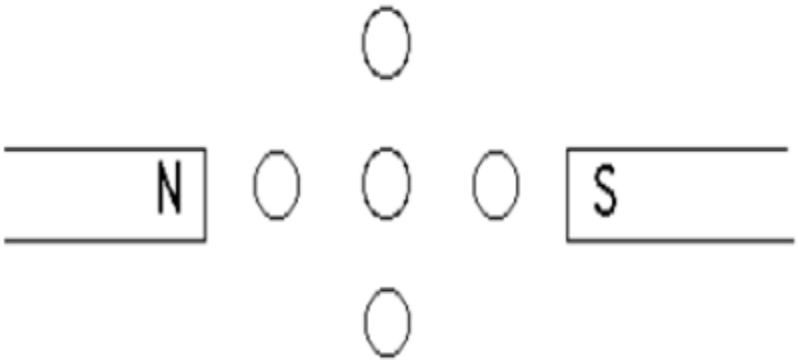

Figure 3.5: Two Magnets With Opposite Poles Facing Each Other

6. Conclusions