Experiment 16
Magnetism, Magnetic Force, and Electromagnets

Introduction

In this lab, you will explore magnetism with several different activities. The first two are about magnetic poles and the magnetic field of the Earth; the second two are more detailed activities about how the magnetic field varies from point to point.

In this lab, you will also explore ways to make magnets and electromagnets using iron nails and rods. The fifth activity is a qualitative experiment on how to make a "permanent" magnet; the sixth one a more detailed, quantitative investigation on how to make an electromagnet and what variables the strength of a magnet of this type depends on.

Part A: The magnetic poles of the earth

You should find on each of your lab table both a bar magnet and a compass. The bar magnet been magnetized so that the end marked with the "N" is the north pole of the magnet.

A properly working compass needle should point to the north. The north end of the needle can be either the north or south end of a magnet depending on the polarity of the earth's magnetic north pole.

1. Take the north end of your bar magnet and use it to determine whether the north end of the compass needle is either a south pole or a north pole.

2. Based upon what you observe you should be able to determine whether the earth's magnetic north pole is really a north pole or a south pole.

Part B: Plotting a magnetic field lines?

Materials:
Bar Magnet
Magnaprobe 3D compass
(2 axis compass)

3. Place bar magnet vertically in clamp and tighten in place.

4. Take magnaprobe (see figure below) and place about 2 inches from pole of magnet. Move magnet in an elliptical path starting at top and circling to bottom pole of magnet. Compass needle should rotate to trace out path of magnetic field lines.

5. Move magnet to approximately 4 inches from pole and repeat elliptical path. Try another distance.

6. Based upon what you have observed plot the magnetic field lines on the on page 5. Field lines run from north pole to south pole. Draw field lines on both sides of magnet.

Part C: Exploring the strength of a magnetic field as a function of distance

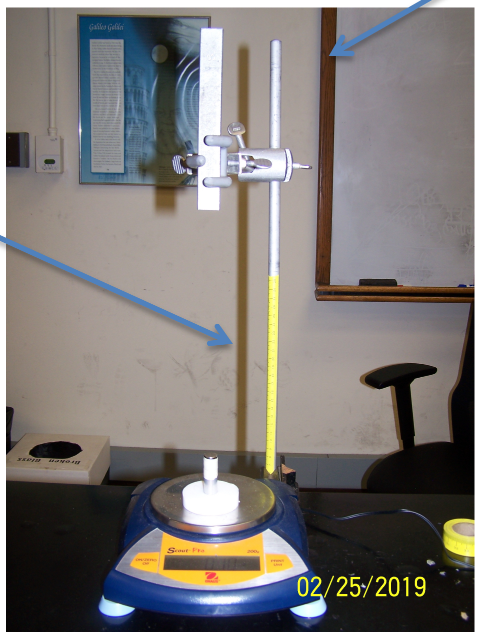

Figure 2

7. Place small silver magnet and holder on top of digital balance and zero it. The balance should now read zero

8. ~~Using the **screw on the table clamp**, raise or lower the **vertical rod** until the **ruler taped to the rod** reads 25 cm *as indicated by some convenient part of the table clamp*.~~

9. ~~Make sure bar magnet is directly above small magnet sitting on the balance.~~

10. ~~Next, using the screw on the top clamp, raise or lower **the top clamp (holding magnet)** until the bottom of the bar magnet is 25 cm from the top of the small silver magnet. **Verify with a ruler.**~~

11. ~~This step calibrates the tape ruler to the plastic ruler. **You will no longer need a ruler.**~~

12. ~~Using the **table clamp screw**, lower the vertical rod until the magnet is 20 cm. Your balance might then show some small mass (probably not).~~

13. Using a ruler to measure the distances, lower the bar magnet in one (1) cm increments until the distance (to the bottom magnet is 2 cm. Complete table 2 and plot mass vs. distance using Graphical Analysis program. **Be careful not to let magnets touch!**

Part D: Exploring the strength of a magnetic field as a function of current

14. Remove bar magnet and replace it with the solenoid. See figure below. Connect to power supply as shown.

15. Lower solenoid until it is around 5 cm from the top of the magnet. Zero balance and turn on power supply. Balance shown them read a positive mass. *Turn power supply off and switch red and black wires (leads) on the power supply if mass is negative*.

16. Adjust current to one (1) amp and record mass. Adjust current to 5 amps in one (1) amp increments and record data in table 2 below.

17. Plot data and copy graph below the data table 2.

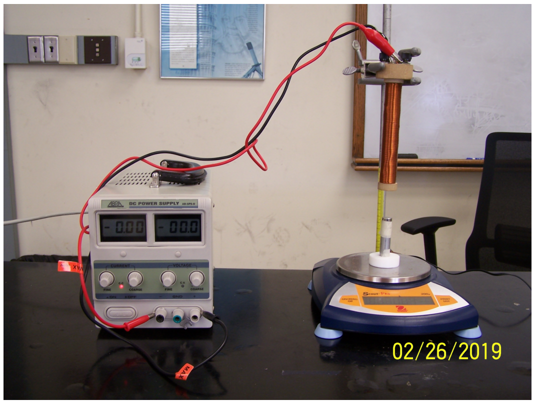

Figure 2

~~Part E: How can you make an electromagnet?~~

~~If you wrap wire around an iron rod and supply a current you will make an electromagnet. The iron rod is not necessary to make an electromagnet it serves the purpose of strengthening the field.~~

18. ~~Take the iron rod and see if it is magnetic. If it is magnetized, tap it firmly on the heavy piece of metal in the front of the lab.~~

19. ~~Wrap all of the wire around the iron bar. Connect the wire to the power supply and turn to around one (1) amp. The rod should then be magnetized. Increase current to around 5 amps. What do you notice about the strength of the magnet?~~

20. ~~Turn off the current. The rod should still be magnetized. Check that it is. Get rid of magnetization by firmly tapping it on the heavy metal block.~~

Part F: The effect of the number of loops on the strength of a magnet?

21. Your TA show you how to do this part.

22. Complete table on page 5 below.

23. Plot data and copy plot on page 5 below.

Name:____________________
Table ________ Section _____

Sketch your results from mapping the magnetic field lines. Be sure to put in arrows for direction.

Figure 1

Question: **Describe any patterns you see as you answer these questions**: Where are the lines closer together? Which pole do they leave from/enter? What do you think the lines are doing inside the magnet?

The effect of the number of loops on the strength of a magnet

Number of turns	Mass (grams)
0	0
50	
100	
150	

Table 1
Mass (magnetic force) vs. distance)

Distance (cm)	Mass (g)

Copy plot below (be sure and label axes)

Table 2
Mass (magnetic force) vs. current

Current (Amps)	Mass (g)
0	0
1	
2	
3	
4	
5	

Copy plot below (be sure and label axes)

Questions:

1. *Which half (typically the red half) of your Compass needle pointed North? This end of the needle is attracted to the Earth's "Geographic North Pole". Which end of the bar magnet was this side of the needle attracted to, and what does this tell you about what most people normally call the north pole?*

2. *Explain your observations of the strength of a magnet as a function of distance.*

3. *After you tapped the metal rod, were you able to pick up any paper clips? What do you think happened? Use "magnetic domain" in your answer.*

4. *How are current and magnetic fields related? What type of relationship do your graphs reveal?*

5. *Explain why the rod with the wire wrapped around it becomes a magnet.*

6. *Why would the deflection angle of the needle increase when the number of turns in the wire increases, and when the current increases?*