

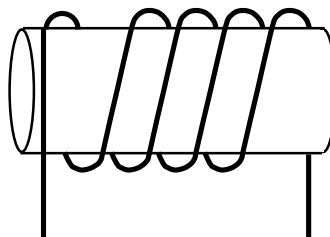
Magnetic Fields Spring 2009

Introduction

The purpose of this experiment is to observe the magnetic fields of a bar magnet, a *coil* of current-carrying wire, and a *straight* current-carrying wire.

Experiment

1. *The \vec{B} field of a permanent magnet.*
 - a. Use the large horseshoe magnet to find the north pole of your compass, *taking care* not to get the compass too close to the magnet. Then use your compass to mark the north and south poles of your permanent magnet – note that they may not be the same as the poles stamped on the magnet!
 - b. Measure the \vec{B} field *at each end* of your bar magnet with the gaussmeter. Also measure \vec{B} for the large horseshoe magnet.
 - c. Tape a sheet of graph paper to the table (to keep it from moving) and place the bar magnet near the center. Trace the outline of the magnet on the paper. Pick a starting point near the *north* end of the magnet, and place your compass with its *south* end over the point. Make a dot on the paper at the north and south ends of the compass. Remove the compass, and draw a small arrow that goes from the south to the north points you've drawn; this represents a portion of a magnetic field line.
 - d. Now place the compass so that its south end is on top of the arrow head you just drew, and draw another arrow. Repeat this procedure until the magnetic field line returns to the magnet, or leaves the page.
 - e. Fill up the page with enough magnetic field lines so that you can clearly see the pattern.
2. *The \vec{B} field of current carrying coils.*
 - a. Place your coil *vertically* on the lab bench. Plug your coil in to the *DC* (red and black) connectors on your lab table; these will supply 6 volts of direct current through the coil. Move your compass through and around the coil to get a sense of the direction of the field lines due to this current. Summarize your observations, comparing the magnetic field around the coil to your sketch of the field around the bar magnet (*parts 1c – e*).
 - b. Go to the solenoid (the large, long coil) in the lab. Use the gaussmeter to measure the maximum strength of the \vec{B} field at one end of this coil. Make a three-dimensional sketch of the solenoid (below – note the direction the wire wraps around the core), and sketch the direction of the current flow in the coil, and the magnetic field and its direction (recall that current leaves the + terminal of the power supply). Be sure to record the current passing through the solenoid, and the number of turns of wire (*this solenoid has $N = 4319$ turns*).



- c. The \bar{B} field at the *end* of a solenoid is:

$$B = \frac{\mu_0 NI}{2\ell}$$

where μ_0 is $12.57 \times 10^{-7} \text{ N/A}^2$, N is the number of turns in the solenoid, I is the current (indicated on the ammeter), and ℓ is the length of the coil. Calculate \bar{B} (units: *Tesla*), and compare it with the value you just measured in step (2b).

- d. Calculate the amount of current you would have to pass through the solenoid in order to produce the *same* magnetic field strength as: *i*) the strongest pole of your bar magnet; *ii*) the horseshoe magnet as measured in step (1b).

Something to consider: The circuit breakers in your house will trip when the current exceeds 15 to 20 A. How does the current you just calculated compare to these values?

3. The \bar{B} field of a current carrying straight wire. {Summarize your observations with a simple sketch and a few words}
- Turn the knob on the power supply down to zero. Several compasses are arranged on the platform of the apparatus around the vertical wire. Observe their direction when no current flows through the wire.
 - Note the direction the current will be traveling through the wire, and use the right hand rule to predict the direction of the magnetic field when current passes through the wire.
 - Turn up the knob on the power supply, and use a known compass to see if your prediction is correct. Note the pattern indicated by the compass needle directions.
 - When finished with your observations set the power supply to zero so that the wires won't heat up!
4. *Fun with magnetism!*

Here are a few other pieces of equipment for you to experiment with:

- There is a clear container with iron filings suspended in a clear gelatinous substance. Hold this container in various positions near the horseshoe magnet, carefully noting the direction of the field lines.
- You'll want assistance from your instructor with this one!*** Place a wire between the poles of the horseshoe magnet. Use the right-hand rule to predict the direction the wire will "jump" when current passes through it. *Briefly* short out the power supply with the wire, and see if your prediction was correct! Create a sketch showing the correct orientation of the magnet, the \bar{B} field, the current and the force exerted on the wire.
- Your instructor will show you an old computer monitor. Take your bar magnet, wave it around in front of the monitor, and observe the effect. ***Don't try this with the other lab computers, or your own computer!***

Discussion

- Briefly summarize your results and observations from experiments 1 through 3.