Magnetic Fields: Lab 2B

Names:
1.) _____
2.) _____
3.) _____

Learning objectives:

- Observe shape of a magnetic field around a bar magnet (Iron Filing and magnet)
- Observe how charged objects interact with magnetic fields
- Investigate the magnetic field around a coil of current carrying wire
- Explore the interaction of currents and permanent magnets
- Explore the path of a moving electron in a uniform magnetic field
- Observe that a changing magnetic field can produce a voltage (Magnet in and out of coil)

Activities:

- Map Field of Permanent Magnet
- Attraction of Paper Clips
- Charge Rods interaction with magnet
- Look at the forces involved with a magnet and current carrying wire
- Magnetic Field of a solenoid
- Moving magnet in a coil and moving coil near a magnet
- Build a speaker from the items on the table

WARNING: The small neodymium magnets are very strong and stick to surfaces and to each other very strongly. They can painfully pinch your fingers if you let them get in the way of the magnets. They are also very brittle and will shatter into small sharp fragments if allowed to slam onto a surface or dropped. Handle with care!

Warm-Up: Qualitative Magnetic Field Maps

1. Here a few applets to help visualize magnetic fields

a. http://phet.colorado.edu/en/simulation/faraday
b. http://www.surendranath.org/Applets/Electricity/MovChgMag/MCM.html

2. Place a magnet under a dish. Slowly sprinkle iron filings into the dish and observe the pattern that emerges. It may help to tap on the dish a little bit. Draw the pattern you observe below.

Use the small compasses provided to explore the field around the magnet as well.

2.) How does a compass work?

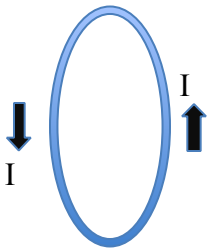
3.) Try picking up a chain of paper clips with a magnet. How does this work?

4.) Why does a magnet stick to a refrigerator door?

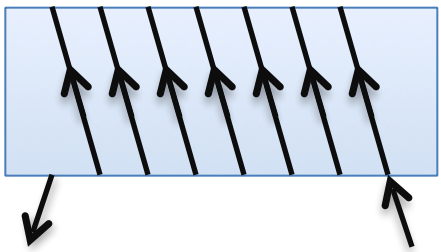
5.) Prediction: What will happen if you bring a charged rod towards a compass needle? Fill in your predictions below BEFORE you try the experiment.

Charge on Rod	Compass Needle reaction (Attracts North pole, Attracts South pole, Attracts both North and South Poles, No Attraction)
Neutral rod	
Charge Plastic (negative) by rubbing with fur	
Charge Glass (Positive) by rubbing with Silk	

6.) Extend the idea of a magnetic field around a single current carrying wire to a wire that is wound into a single loop. Draw what this field might look like.



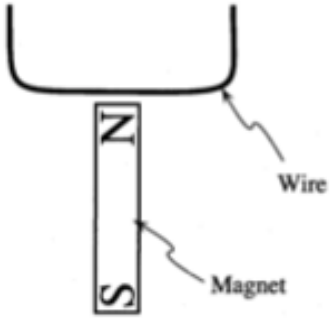
7.) The TA will demonstrate a current carrying solenoid. This consists of a DC power supply to pass a current through the wire shaped in coil. They will sprinkle some iron filings around the coil. Draw the resulting magnetic field below.



8.) On the figure below, sketch field lines representing the magnetic field of the bar magnet. Show the field both inside and outside the magnet.

Assume that positive current flows through the wire from left to right.

Predict the direction of the force exerted on the wire by the magnet when the circuit is complete. Explain.



Check your prediction. (**WARNING: Make sure the voltage is set to zero before you start. DO NOT leave the power supply on for more than 5 seconds at a stretch, and DO NOT go beyond 1 volt. The power supply and wires will become EXTREMELY HOT if the circuit is complete for too long, leading to FIRE and possible BURN INJURIES!**)

Make predictions for the following five situations based on what you observed in part A. Check your answers only after you have made all five predictions.

A.) The magnet is turned so that the south pole is near the wire while the battery is connected.

Prediction:

Observation:

B.) The leads to the battery are reversed (consider both orientations of the magnet).

Prediction:

Observation:

C.) The north pole of the magnet is held near the wire but the battery is not connected.

Prediction:

Observation:

D.) The north pole of the magnet is held: (a) closer to the wire and (b) farther from the wire.

Prediction:

Observation:

E.) The magnet is turned so that it is parallel to the wire while the battery is connected.

Prediction:

Observation:

Resolve any discrepancies between your predictions and your observations. *(Hint:* Consider the *vector equation* for the magnetic force on a current-carrying wire in a magnetic field: $\boldsymbol{F} = I^*\boldsymbol{L} \times \boldsymbol{B}$*.)*

9.) The TA will show a quick demonstration of an electron being shot into a uniform magnetic field. Explain what is happening using diagrams and words. X = into the page, O = out of the page.

10.) Attach the solenoid provided to the black galvanometer (sensitive ammeter). Can a magnet interact with the solenoid so that a current (deflection on the meter) is produced? Describe what you needed to do to produce a current.

11.) Try the same thing, but with the yellow coil. This time you can manipulate the solenoid and see how the current changes. Comment on the changes that occur.
Try:

A) Fewer turns

B) More turns

C) Coil changes size suddenly (Squish it!) in the presence of a magnetic field ("Flux compression": This technique is used to make EMP weapons, see http://en.wikipedia.org/wiki/Explosively_pumped_flux_compression_generator)

12.) Challenge problem:

A speaker takes an alternating electrical signal of recorded music and converts it to sound. Using the headphone output of the computer, and the provided amplifier to increase the signal strength, assemble a crude speaker with the materials available on the table [copper coil (you may need to sand the ends of the wires), neodymium magnets (the small ones stick 3-4 together), tape, paper cup]. For a free source of sound that is in an appropriate frequency range for your crude speaker, visit http://www.nyan.cat. Show your working speaker to the TA. (**WARNING: Do not operate the amplifier at more than 1/3rd volume or for more than 10 seconds at a stretch to avoid setting your crude speaker on fire! Also be careful with the neodymium magnets [see warning on page 1]**)

Hint: For better sound quality, turn the bass all the way down and the treble all the way up on the amplifier. The crude speaker is not capable of reproducing low frequency sounds.