Exploring the Relationship between Magnetism and Electricity

*A magnetic field is an invisible entity that pervades space in the neighborhood of certain sources: for instance, a permanent magnet is a source of magnetic field. The "Magnaprobe" device acts as a small arrow**: tail at the blue end, tip at the red end**. In the presence of a magnetic field, this arrow points in the same direction as the magnetic field that exists at the location of the Magnaprobe needle.*

As the Magnaprobe is moved around in a region containing a magnetic field, its direction continually changes to show the direction of the field at any given point. An ordinary magnetic compass also serves to indicate the direction of a magnetic field; the compass tip (colored end) points in the direction of the magnetic field.

1. Using the Magnaprobe or the smallest compasses, make a map of the magnetic field in the neighborhood around the bar magnet. First, place the bar magnet on a piece of notebook paper, trace its outline, and label north and south poles. Then, keeping the magnet in place, place the Magnaprobe at many different locations around the bar magnet – at least 10 different locations. At each location, draw an arrow that represents the direction in which the needle points. Draw the length of the arrow to be approximately proportional to the ***magnitude*** of the magnetic field at that point.

   a) How can you estimate the magnitude of the field?

   b) Is the magnitude of the field ***near*** the magnet *larger than, smaller than,* or *the same as* the magnitude of the field ***far away from*** the magnet?

A galvanometer is a device the indicates the flow of electric current. Larger deviations from the zero point indicates larger amounts of current flow. When the galvanometer needle indicates a negative value, the direction of current flow through the galvanometer is **opposite** *to the direction of flow corresponding to a positive value.*

You have been given a galvanometer connected to a solenoid, which is a very long piece of wire wrapped around in a cylindrical spiral.

2. ***Without*** using the battery, but using any of the other equipment you have, try to make the galvanometer needle deflect either to the right or to the left. Do this ***without*** shaking or touching the galvanometer itself. Describe your method:

3. Once you have figured out how to make the galvanometer meter needle deflect, explain:

a) how to make a *large* deflection, and how to make a *small* deflection.

b) how to make a deflection to the left, and how to make a deflection to the right. Describe ***two methods*** for each.

i) Deflection to the left:

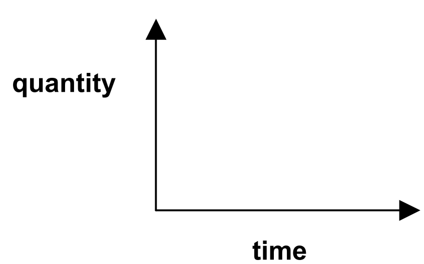
ii) Deflection to the right:

4. Now, figure out how to keep the galvanometer needle *steady* at a reading of +50 for *two consecutive seconds*. Then, do the same for a reading of –50. (If you can't manage a reading of 50, keep it at 30.)

a) Describe what you had to do to carry this out.

b) During the period the needle is steady at 50 (or 30), what quantity is changing?

c) Sketch an approximate graph of this quantity as a function of time. (Vertical axis represents the unknown quantity, horizontal axis represents time, increasing toward the right:



d) Although you would have to make detailed measurements to be sure, can you guess at a quantity related to your graph that might be *constant* during the time the needle is steady?

5.

a) Disconnect all wires from the solenoid. Use the Magnaprobe to examine the space around the solenoid. Is there any clear indication of a sizeable magnetic field?

b) Now, connect the solenoid to the battery and explore the space around it with the Magnaprobe.

i) Can you label the "north" and the "south" pole of the coil? Explain.

ii) What happens to these poles when you reverse the leads to the battery? Explain ***why*** you think this happens.

6. Connect the galvanometer directly to the small coil mounted on the metal rod. Try to make the needle deflect; you can move the coil, but not the galvanometer. Describe what you had to do to make the needle deflect.

7. Try to find *one more method* for causing a galvanometer needle deflection, *different* from the methods you have been using up till now. This method should work ***without moving <u>either</u> the solenoid, or the small coil.*** Wires may be moved and/or connected or disconnected.

a) Describe the method.

b) Why do you think it works?