Magnetic Induction Activity

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 30 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?

2. ***Without*** using the battery, but using any of the other equipment you have, try to make the galvanometer needle deflect (move) 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) why your method in part (a) works. Use Faraday's law as applied to a circuit with a resistor, i.e. $I = (1/R)\ \Delta\Phi / \Delta t$, where $\Phi = BA \cos\theta$.

c) 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 +10 for *two consecutive seconds*. Then, do the same for a reading of –10. (If you can't manage a reading of 10, keep it at 5.)

   a) What did you have to do to carry this out?

b) During the period the needle is steady at 10 (or 5), is the value of $\Delta\Phi / \Delta t$ *constant* or *changing?*

c) During the period the needle is steady at 10 (or 5), is the value of Φ *constant* or *changing?* Explain.

5.

a) Use the Magnaprobe to examine the space around the large-diameter solenoid. (At this point, this solenoid should not be connected to anything.) Is there any sign of a magnetic field?

b) Now, connect the large-diameter solenoid to the battery and explore the space around it with the Magnaprobe. Sketch out an approximate map of the magnetic field in the neighborhood of the solenoid when it is connected to the battery.

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*** this happens.

iii) ***Inside*** the solenoid, near the center, the magnetic field is very nearly uniform. (Probe the field at the center of the very large, flat coil; it's similar to that in the solenoid.) How about at the ***ends*** of the solenoid: is the field uniform, or not?

6. Find a way to cause the galvanometer needle to deflect using the two coils, but ***without*** connecting the battery itself in the circuit containing the galvanometer. Connect the galvanometer directly to the narrow coil, ***without*** connecting either of them to the battery. Then try to make the needle deflect.

a) How can you make the galvanometer needle deflect:

i) by using the magnet, but not the battery.

ii) without using the magnet. Use the battery, but ***without*** connecting it to the circuit that includes the galvanometer.

b) For method (ii) in part (a), describe very carefully where and how you have to move the narrow coil to make the galvanometer needle deflect.

i) Which locations ***do*** cause the needle to deflect?

ii) Which locations do ***not*** cause the needle to deflect?

iii) Try to explain why there is no deflection in case (ii). *Hint: Refer to 5b(iii). Consider what happens to the magnetic flux Φ as you move the narrow coil at different locations. Where will Φ be changing, and where will it be nearly constant?*

7. Find *one more method* for causing a galvanometer needle deflection, *different* from the method you have been using up till now. This method should work ***without moving <u>either</u> coil.***

a) Describe it:

b) Why does it work?

8. Describe what you have found about how to cause a galvanometer needle deflection:

a) Which methods worked?

b) Which did not?

c) Try to come up with some kind of general rule about the methods that worked:

i) What conditions could be kept unchanging?

ii) What conditions had to be changed?