D9 Investigation of Current as a Source of Magnetic Fields

name ___________________ block _______

2/19/01

review......

As we know, there is a ____________ _________ in and around a bar magnet. We also know that every normal bar magnet has at least two regions where the field lines are very close together. We call these regions the ___________ of the magnet, one being _________ and the other being ________.

In particular, we recall that the field in and around a simple bar magnet looks like:

with the field lines running __ to __ outside the magnet material and __ to __ inside, and the lines closer together at the ________ where the field is ___________.

Another <u>very</u> large "magnet" with a field like that of a bar magnet is the ________. Its field looks like:

A (usually small) useful bar magnet balanced so it is free to rotate in an external magnetic field is called a _____________. This device is useful in mapping magnetic fields because__________________________
____.

We all know that some metals cannot be made into a magnet. For instance _____________ and _______________. However, we have seen an aluminum foil "wire" pushed up in a preexisting magnetic field when electrons were made to flow through the aluminum -- remember the foil in a U-magnet tunnel demo.

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new observations...

The wire you have is copper with a plastic coating on the outside. You will use your compass to determine if and when the wire behaves at all magnetically.

With the wire just sitting there (nothing special happening) check your wire for magnetism. What is your result? _______________________ Is there a magnetic field being caused by the wire? ____________

I. MAGNETIC FIELD OF A STRAIGHT CURRENT-CARRYING WIRE / EARTH'S MAGNETIC FIELD

A. With the current off, orient a portion (about 40cm) of the wire horizontally north/south. Hold a compass just under the wire and note how the needle is pointing. When the switch is thrown, __________ ___________ will flow in the wire because it is attached to a _________ _________. Now record the behavior of your compass both above and below the horizontal current when the switch is closed:

Notice how distance from the wire affects the compass needle-- As the compass is moved further away from the wire, the compass _____________________________ because _________________________.

Turn off the current and observe the compass needle behavior as the current goes to zero. Explain this behavior.

Summarize your findings.

Why didn't we orient the wire east/west for our observations?

B. With the current off, orient a portion (about 40cm) of the wire vertically. Hold a compass right beside the wire just north (or just south) of the wire and note how the needle is pointing. Why is it pointing that way?

Turn on the power source and observe the behavior of the compass needle. Move the compass around the wire while observing the needle. Notice how distance from the wire affects the compass needle. Sketch the shape, direction, and density of the magnetic field lines in the vicinity of the straight current-carrying wire, making sure you denote the current direction in the wire. Sketch both a side view and an end view.

Turn off the current and observe the compass needle behavior.
Summarize your findings.

C. Again use the vertically oriented wire with the current on. Hold your compass north of the wire and record the distance from the wire when the compass needle points at an angle of 45 degrees with the north/south direction. Repeat your measurement with the compass held directly south of the wire. Finally, use an ammeter (that can handle several amps) to measure the current flowing in the wire. Use your measurements to determine the horizontal component of the earth's magnetic field at this location. Compare to the "known" value--be sure to cite your source properly. Completely explain your reasoning and all calculations.

Distance north of wire= ______________ Distance south of wire= _______________

Calculated strength of horizontal component of Earth's field = __________________

Book value = ___________________

Percent error = ________________

II. MAGNETIC FIELD OF A CURRENT LOOP

With the current off, make a single loop of wire (about 5cm diameter) and hold it such that the plane of the loop is oriented vertically and perpendicular to east/west. Hold your compass in the middle of the loop, noticing the needle orientation. Turn on the current and observe the compass needle. Observe and record the needle behavior as you move the compass around the wire and into and out of the loop.

Sketch the shape, direction, and density of the magnetic field lines in the vicinity of the single loop of current, making sure you denote the current direction in the wire. (Also, turn off the current and observe the compass needle behavior. Does it behave as expected? Predict first!)

Summarize your findings.

Is the shape, direction, and density of these field lines consistent with your findings for a straight current-carrying wire? Explain completely.

Did your loop of current exhibit any magnetic polar regions? Explain carefully.

III. CURRENT-CARRYING COIL/ELECTROMAGNET

A. With the current off, make several loops around a clear plastic cylinder or cup. Pack the loops close together, but do not overlap the loops. Hold the coil so that its long axis is oriented horizontally east/west. Hold your compass in the middle of the coil, noticing the needle orientation. Turn on the current and observe the compass needle. Observe and record the needle behavior as you move the compass around and into and out of the coil.

Sketch the shape, direction, and density of the magnetic field lines inside and near the current-carrying coil, making sure you denote the current direction in the wire. (Turn off the current and observe the compass needle behavior.)

Is the shape, direction, and density of these field lines consistent with your findings for a single loop of current? Explain completely.

Did your coil exhibit any magnetic polar regions? Explain. Does the shape and distribution of the field lines look familiar? Explain.

B. With the current off, make several tightly packed loops around a nail or bolt. Do not overlap the loops and make them loose enough to slide the nail out. Slide out the nail. Hold the coil so that its long axis is oriented horizontally east/west. Hold your compass near one end of the coil, noticing the needle orientation. Turn on the current and observe the compass needle. Observe the needle behavior as you move the compass around and near the ends of the coil. Sketch the shape, direction, and density of the magnetic field lines near the tight current-carrying coil, making sure you denote the current direction in the wire. Turn off the current and observe the compass needle behavior.

Summarize your findings. Have you seen this field shape before in a no-current situation? Are their any obvious magnetic poles? Explain.

Try picking up some paper clips or a key ring with the current-carrying loop. Record your results.

Try picking up some paper clips or a key ring with the current turned off. Record your results.

Also try picking up some paper clips or a key ring with the nail alone to see if it is magnetized. Record your results.

C. With the current off, replace the nail in the tight coil. Turn on the current and try picking up the paper clips, key-rings, etc. with the current wrapped nail. Record your results, comparing to your previous observations. Try picking up some paper clips or a key ring with the current turned off. Record your results. Explain what caused these effects--be specific.

This device is called an _____________. It has two very strong magnetic _________. Its field looks just like that of a strong _____ magnet. Neat!

The advantages of electromagnets as compared to permanent magnets are:

Examples of electromagnets in use in our daily use are:

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