Tangent Galvanometer
Investigating the Relationship Between Current and Magnetic Field

The tangent galvanometer is a device that allows you to measure the strength of the magnetic field at the center of a coil of wire as a function of the number of loops of wire in that coil. The tangent galvanometer consists of a platform that is in the middle of coil of wire. Before beginning, review the basic concepts of connecting electrical components in series.

Remember that Earth is producing a magnetic field in addition to the magnetic field you will create with the galvanometer. The vector for the coil's magnetic field is added to that of Earth and the compass responds to the vector sum of these two fields.

PURPOSE
In this activity you will use a tangent galvanometer to study the quantitative relationship between the number of loops on wire in a coil and the strength of the magnetic field at the center of the coil.

MATERIALS
- tangent galvanometer
- power supply
- ammeter
- 50Ω resistor
- connecting wires (4)
- compass
- protractor
- ruler
- small pieces of paper
- long piece of wire

> **Safety Alert**
> Obey the standard safety procedures for using an electric circuit and working with power supplies.

PROCEDURE

1. Locate the power supply away from the apparatus as far as the cord will allow.

2. Construct the following circuit as shown in Figure 1.

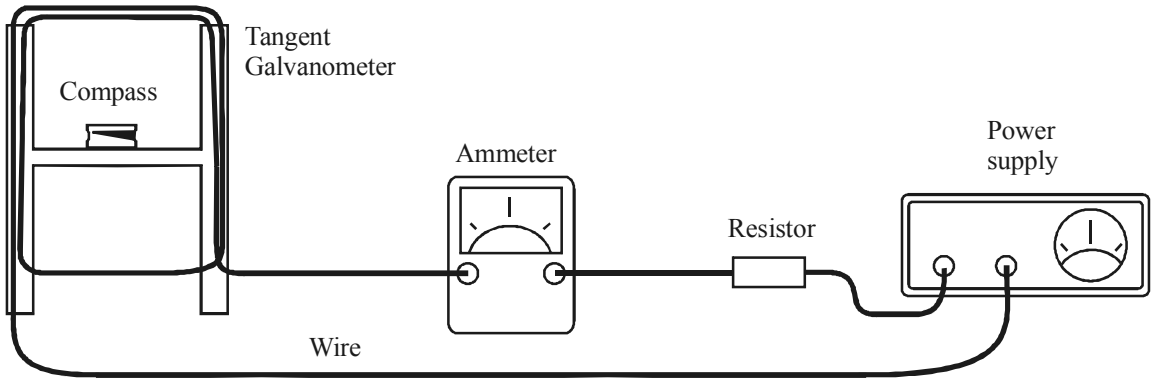

Figure 1

3. Recording your data will take place on a small sheet of paper placed under the compass on the platform of the galvanometer. Obtain a small piece of paper that has been cut to fit the device platform. Divide the paper into quadrants by drawing two perpendicular lines with the intersection point at the center of the paper. Label the quadrants as shown in Figure 2. Position the paper on the platform and make sure the paper is lying flat.

4. Put one loop of wire on the galvanometer's frame. Make sure that the wire is pressed as far back onto the frame as possible and is as taut as possible.

5. Position the compass in the middle of the paper and directly below the wire on the frame. Align the entire apparatus so that the compass needle is directly under the first loop of wire, as shown in Figure 2. In other words, the apparatus must be arranged so that the wire on the frame and the needle of the compass are pointing in the north-south direction.

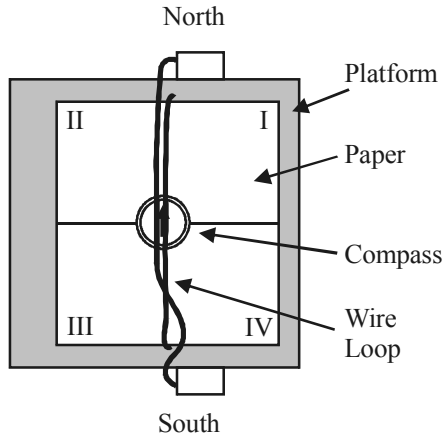

Figure 2

6. Before you turn on the power supply, use the right-hand rule to determine the direction that the compass needle should swing when you turn on the power supply and the current flows from the positive to the negative terminals of the power supply. If your teacher instructs, call them over to verify your hypothesis.

7. Turn on the power supply and set the current to 0.5 amperes. The setting of 0.5 amperes will remain constant throughout this exercise.

8. When you turned on the power supply the compass needle moved very slightly. Very carefully and without disturbing the apparatus or the compass, use a pencil to mark the position of the compass needle. Since the movement is so slight you may want to come back to this one loop arrangement after you have done more loops and re-measure this first value.

9. Turn off the power supply. Carefully add a second loop of wire to the apparatus. Make sure that the second wire is pushed as far back on the frame as possible. Check the north-south alignment and the position of the compass.

10. Turn on the power supply and record the position of the needle.

11. Repeat steps 9 and 10, adding one additional loop for each trial. Record the resulting needle position for each trial. Continue the procedure until you run out of useable wire length. There should be at least five loops. Check the alignment of the apparatus frequently to ensure that the wires and needle are properly aligned in the off position.

12. After you have recorded the positions of the north pole for each additional loop of wire remove the paper from the platform.

Name _____

Period _____

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DATA AND OBSERVATIONS

Tape your marking paper into this section.

ANALYSIS

1. On your marking paper above, carefully draw a line from the center of the compass (the intersecting point of the two perpendicular lines) through each of the points representing a needle position.

2. Draw a vector to represent Earth's magnetic field. The length will be approximately 4 cm. We will use this relative value of 4 cm for Earth's field.

3. From the tip of this vector, draw a perpendicular dashed line that will intersect all of the lines of the compass readings, as shown in Figure 3.

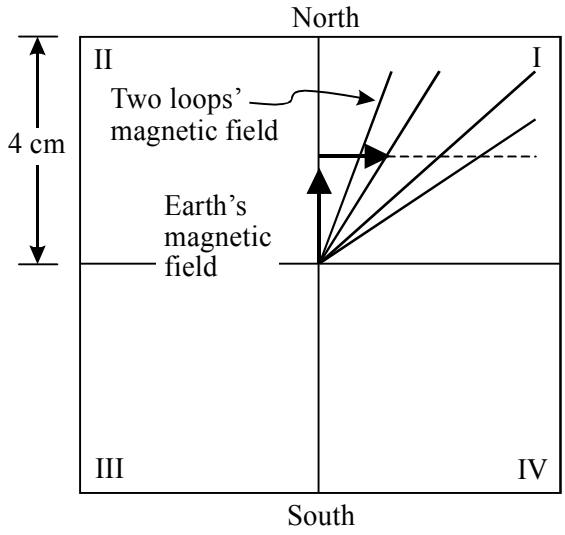


Figure 3

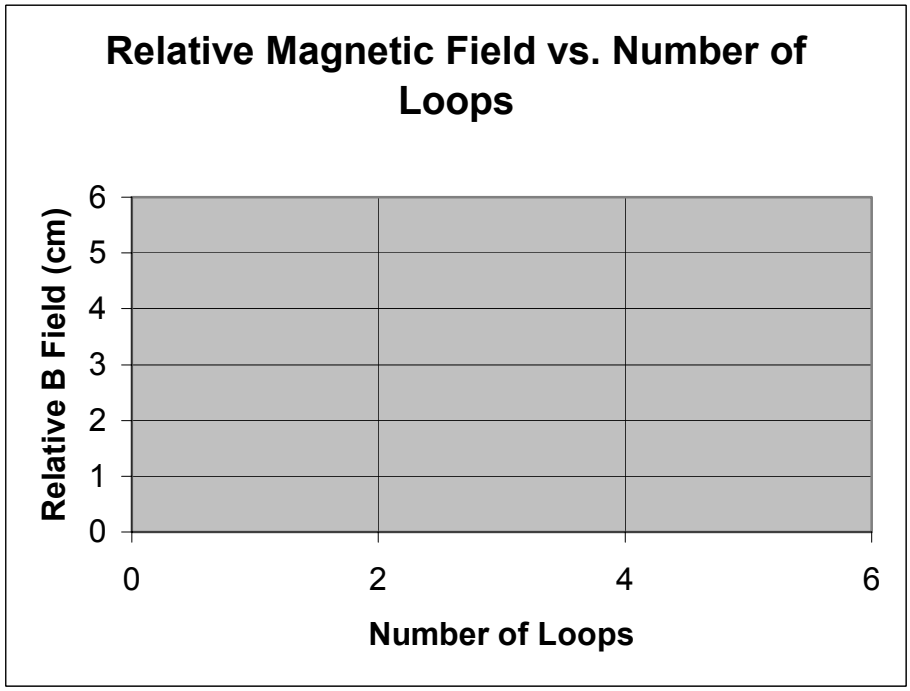
4. Measure the distance, in centimeters of each of the compass lines. The length of these lines will be the strength of the magnetic field of the coil relative to Earth's magnetic field.

5. Record the values in the data table below.

Number of Loops	Length of Loop's Magnetic Field (cm)
1	
2	
3	
4	
5	

CONCLUSION QUESTIONS

1. Use the axes below to plot the magnitude of the magnetic field of the loops versus the number of loops of wire.

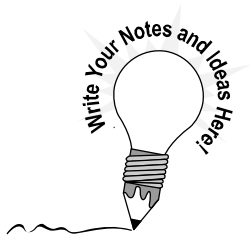


2. Does the magnetic field of the coil ever exceed the magnetic field of Earth? Explain your answer and, if applicable, state the number of loops needed.

3. What additional information would you need to have if you wanted to know the actual magnetic field of the loops in Teslas as opposed to just a relative measure?

4. Why was it desirable to locate the power supply as far away from the galvanometer as possible?

5. Why is the galvanometer made of wood and aluminum?


Write Your Notes and Ideas Here!