Enter group members' names: [ ]
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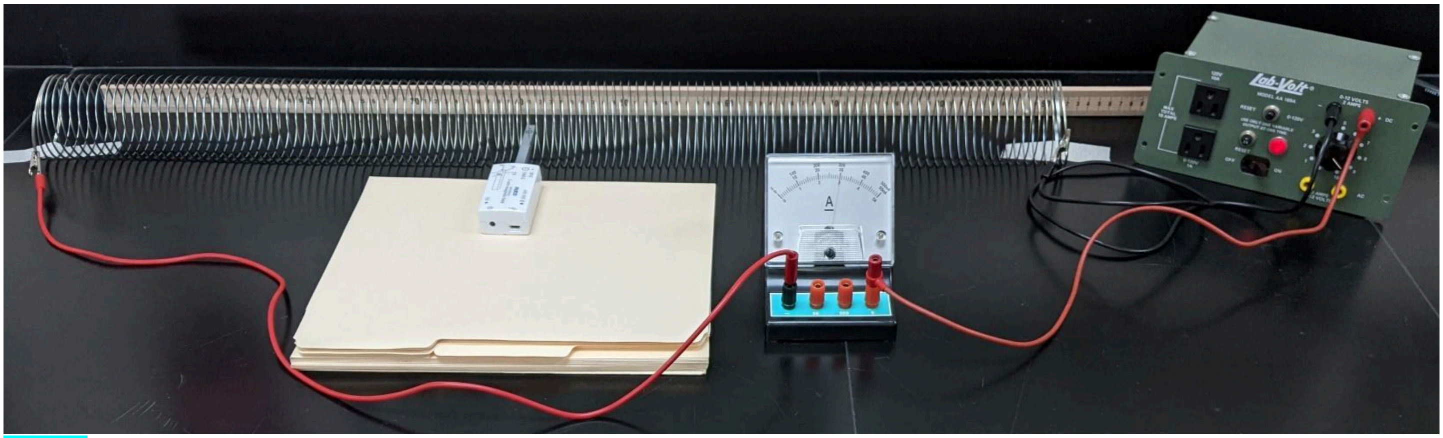
AP Physics C: Slinky Solenoid

Purpose: Use the derived equation for the magnitude of the magnetic field produced by a current carrying solenoid to experimentally determine the vacuum permeability μ_0.

Materials:

1. A metal slinky solenoid
2. For circuit building: a DC power supply, wires with connectors, and an ammeter.
3. A magnetic field sensor and data collection and analysis software (SPARKvue)



PART I:

Procedures:

1. Stretch the slinky on lab table until the rings are spread out evenly and the distance between adjacent rings is about the width of the magnetic field sensor tip. Tape the ends of the slinky down securely. Count the number of evenly spaced rings and the length of that part of the slinky. Record both numbers.
2. Keep the power supply off until you are ready to take data. Use wires to connect the slinky, the power supply, and the ammeter in series to form a circuit loop.
3. Insert the magnetic field sensor in the middle of the slinky solenoid. The circle with a center dot marking should face upward.
4. Open SPARKvue, select sensor data. Turn on your sensor, so you can select the correct wireless sensor to connect. Select Z Magnetic Field Strength and the Resultant Magnetic Field Strength. Then click the Graph button under Templates. You should see 2 graphs.
5. With the power supply being off, **click the  button to zero the sensor at the position and orientation you have set up.** This means the sensor has been calibrated to not include the Earth's and any other magnetic fields at the sensor's location and for the sensor's orientation. If you move the sensor or change its orientation, you will need to zero the sensor again.
6. You will collect at least one set of data for each of the following current values: 0.5 A, 1.0 A, 1.5 A, 2.0 A, 2.5 A, and 3.0 A. For each data collection run:
   i. Turn on the power supply, adjust the voltage to produce the desired current in the solenoid, click "Start" and then, after a couple seconds, click "Stop".
   ii. Once you click stop, turn down the power supply voltage and turn off the power supply.
7. For each valid data collection run, click Σ to find the mean magnetic field strength during the run. Record and convert the magnetic field strength reading from gauss to tesla.

Data:

The number of evenly spaced slinky rings is [ ]. The length of that part of the slinky is [m]. n = [ ]

Run #	Name of member who collected and analyzed the data for the run	I (A)	B (Gauss)	B (Teslas)
		0.5		
		1.0		
		1.5		

		2.0		
		2.5		
		3.0		

Graph: Plot a linear graph to relate the current I and the magnetic field B so the slope of the graph can be used to determine an experimental value for the vacuum permeability μ_0. Use a software or graph paper to plot the graph. Your graph should include all data points and the line of best-fit. Include the graph here:

Find the linear regression equation (equation of the line of best-fit) for your graph. Write the equation here: [ ].
What is the slope of your linear regression line? [ ] Using the slope of the linear regression, calculate an experimental value for the vacuum permeability μ_0. Show your work here:

Compare this experimental vacuum permeability μ_0 = [T•m/A] you find using the slope of your graph to the known vacuum permeability $\mu_0 = 4\pi \times 10^{-7}$ T•m/A. The % error between the two is [ ]. Show your work here:

PART II:
Increase the number of rings per unit length to about 3/2 of the value in PART I. Record:
The number of evenly spaced slinky rings is [ ]. The length of that part of the slinky is [m]. n = [ ]
The magnetic field B = [ ]
Compare the B for I = 2A in PART I to see if $B \propto n$. E.g. compare whether $B_1/B_2 = n_1/n_2$. Show your work here:

Do error analysis and discuss sources of error here: