Lab 3

Magnetic Field of a Solenoid

Introduction

In class, we learned the expression for the magnetic field of a loop of current:

$$|\vec{B}| = \frac{\mu_0}{2}\frac{R^2 I}{(z^2+R^2)^{3/2}}$$

Today we will investigate the magnetic field inside a structure of several stacked current loops: a solenoid. The magnetic field of a solenoid can be expressed as:

$$|\vec{B}| = \frac{\mu_0 N I}{L} \tag{1}$$

Where I is the current, N is the number of loops, or "turns" of the solenoid, and L is the length of the solenoid. In this lap, we will measure B as I is varied in order to determine N.

Procedure

The procedure for this lab is fairly straightforward:

- Use the voltage knob on the power supply to vary the current
- Measure the magnetic field for at least 10 different values of current. Try to keep these values evenly spaced.
- You will need to measure the length L of your solenoid.

Analysis Questions

1. You now have a table of current and field values. Using graphing software such as Excel, Google Sheets, Python, etc: make a plot of B vs I. What does the slope of this line represent?
2. Use this same software to fit your data to a linear curve. What is the slope? What is the intercept? What *should* the intercept be?
3. Use your value for m to calculate the number of turns N in the solenoid. Is your result reasonable?