4.2: Activities

Equipment

- metal board with conducting paper strips
- magnetic electrode plates
- component board
- 15V & 9V DC power supplies
- multimeters
- wires
- ruler

The General Idea

This lab consists of two very distinct parts. In Part 1, you will be measuring the resistivity of some conducting paper, confirming your answer with two separate sets of data. In Part 2, you will set up a DC network (subject to certain requirements) and use it to test/confirm Kirchhoff's rules.

Some Things to Think About

Part 1

- The formula that relates the resistance to the resistivity includes the dimensions of the resistor (see Figure 4.1.1 in the Background Material). In our case, the "rectangular prisms" are strips of paper. It's difficult to measure their thicknesses, so it is provided for you: $\tau \approx 0.1mm$.
- Note that the magnetic electrodes have holes into which the banana leads of the wires fit nicely. They also stick to the board and make it easy to define endpoints of the strip "resistor." The electrodes and wires are also very good conductors, so since they are in series with the strips, they contribute a negligible amount to the resistance measurement.
- We are able to vary the length of the strip resistor by simply moving the electrodes, and we can vary the width of the resistor by using different paper strips.
- You are expected to treat each of the dimension variables separately (i.e. hold one fixed while varying the other), generating for your lab report a data table and a best-fit linear graph *for each one*. (Use the usual desmos online graphing calculator.)
- The resistivity can then be extracted from the two best-fit lines, and compared.
- Comment on what conditions might affect the outcome. This can be speculation or actual weird fluctuations in results whose cause you were able to deduce. You should feel free to do ancillary quick tests to check your ideas.

Part 2

- Here are the required elements of your network:
  - It must include at least four resistors and two batteries.
  - It must include at least two loops (i.e. there must be branch points).
  - The batteries must appear in different branches.
  - Each branch with a battery in it must also include at least one resistor (this is to avoid any nasty short-circuiting).
- Your lab report needs to include a *large* circuit diagram that matches the network that you wired in the real world. It needs to be large enough that you can label everything that you measure, including:
  - the resistances (use the ohmmeter, as you did in Part 1, and don't do these measurements while they are connected to anything else!)
  - the emfs of the batteries
  - the currents through each branch
  - the voltage drops across the resistors (you need to indicate a loop direction to do this)
- When measuring the battery emfs and voltage drops around loops, you need to be especially careful to record the proper *signs*, which means you have to remain consistent with the direction of the voltmeter.
- *Before* you measure the currents, check with your TA to make sure you are doing it right, because connecting an ammeter incorrectly can result in a nuclear detonation and the extinction of all life within a 5-mile radius. Okay, it isn't that bad, but we don't want to damage/disable the multimeters. When you get the green light from the TA, be sure to make a note of the *directions* of the currents you measure.

- With all the data gathered in one place on the schematic, do the arithmetic to show that the loop rule holds for at least two loops, and that the junction rule holds for at least one junction.

Lab Report

Craft a lab report for these activities and analysis, making sure to include every contributing group member's name on the front page. You are ***strongly encouraged*** to refer back to the Read Me as you do this, to make sure that you are not leaving out anything important. You should also feel free to get feedback from your lab TA whenever you find that your group is at an impasse.

Every member of the group must upload a separate digital copy of the report to their lab assignment in Canvas *prior to leaving the lab classroom*. These reports are not to be written outside the lab setting.
