PHYSICS 122.1

LAB 1: ELECTRICAL MEASUREMENTS

INTRODUCTION

One part of this lab is an introduction to lab procedures and to **Blackboard**. The experiment is designed so you can become familiar with the use of a multimeter, and also learn something about Ohm's law. In each procedure:

- There are three trials: one of the light bulbs is connected to first one, then two and finally three batteries.
- In each trial, you will measure the potential difference across the batteries and the current in the circuit.
- Then, you will graph *V* vs. *I* for the three trials.

BASIC CONCEPTS

ELECTRIC CHARGES AND CURRENT

There are two types of electric charges: positive and negative. The symbol for charge is q, and the unit of charge is the Coulomb. (An electron or proton has charge $e = \pm 1.60 \times 10^{-19}\ C$.)

When charges move through a wire it is called ***current*** (I). The value of I is the rate at which charge passes through a wire per second: $I = \Delta q / \Delta t$. Current is measured in Coulombs per second, or Amperes (A). If $1\ C$ passes through a wire per second, the current in the wire is $1\ A$.

ELECTRIC POTENTIAL

A battery is a device that keeps one terminal positive and the other terminal negative; this is done with a chemical reaction.

The "strength" of the battery is given by its ***electric potential difference*** ΔV, usually referred to as potential difference or just potential. Potential difference is defined as the work done by the battery to move charge q through the circuit connecting one terminal to the other. Mathematically: $\Delta V = W / q$

Potential difference is measured in Joules/Coulombs, or Volts. If a battery does $1\ J$ of work to move each $1\ C$ of charge, the potential difference between the terminals is $1\ V$.

Electrons in a wire will not flow unless they are pushed. Therefore, a potential difference is required for current to flow.

When the batteries are clipped together, they must be connected positive to negative. In this way, both batteries are pushing in the same direction, and the net difference in potential across both batteries is the sum $V_1 + V_2$.

CURRENT VS. VOLTAGE

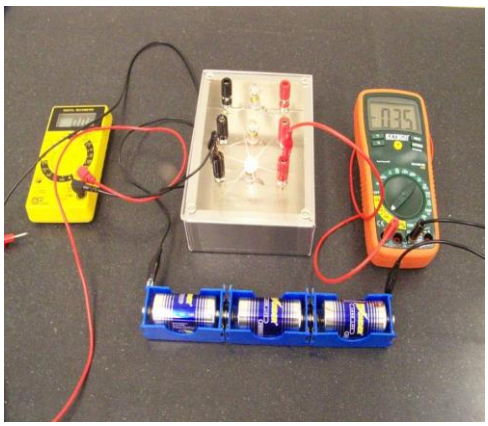
For many materials, if the potential difference across a given circuit is increased, the current increases. This is the relationship you will verify today.

Be sure every measurement and calculation has the correct number of decimal places!

EQUIPMENT

APPARATUS

- ☐ Bulb box with three different light bulbs
- ☐ 2 multimeters[1]
- ☐ 2 Banana jacks with alligator clip on the other end
- ☐ 2 Banana jacks with probe on the other end
- ☐ Three batteries and holders that clip together
- ☐ Wires with alligator clips on both ends
- ☐ Computer (with **Excel**)



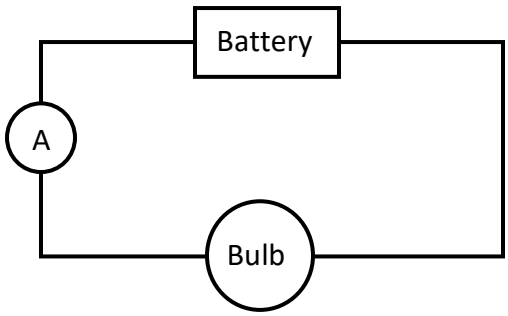
The photograph shows the equipment you will use for this experiment. The orange multimeter is used as an ammeter, and the yellow multimeter has probes attached and is used as a voltmeter. (Of course, with the right settings they can be interchanged.) Notice that only the bottom bulb is lit- this is the only bulbs actually attached to the batteries (in the blue holders).

PROCEDURES

PROCEDURE 1: THE TOP BULB ON THE BULB BOX.

MEASUREMENTS

Connect one battery, the top bulb in the box, and the multimeter to be used as an ammeter. The connections should be in series- one after the other- as shown.



Use the voltmeter to measure the potential difference across the battery, and read the value of the current on the ammeter. Record these values on your data sheet.

Now, replace the battery in the circuit with two batteries clipped together. Measure the potential difference and current, and record these values on your data sheet.

Now, replace the battery in the circuit with three batteries clipped together. Measure the potential difference and current, and record these values on your data sheet.

[1] Further details on the use of the multimeter can be found in Appendix H.

GRAPH

On Excel, use a scatter graph to plot potential difference V (on the y-axis) vs. current I (on the x-axis) for 4 points (including when $V = 0, I = 0$).

PROCEDURE 2: THE MIDDLE BULB ON THE BULB BOX.

Repeat all the steps from procedure 1, using the middle bulb on the bulb box. Graph V vs. I ***on the same axes*** as for procedure 1.

PROCEDURE 3: THE BOTTOM BULB ON THE BULB BOX.

Repeat all the steps from procedure 1, using the bottom bulb on the bulb box. Graph V vs. I ***on the same axes*** as for procedure 1. Be sure to:

- Label the axes with the appropriate units.
- Adjust the axes so the data just fits.
- Give the graph the title "**Electrical Measurements by…** " followed by your full name.
- Add a best-fit quadratic line for each graph.
- On the side is a legend. Each line should be labeled: BULB 1, BULB 2 AND BULB 3
- Print the graph.

WHEN YOU ARE FINISHED:

- Close all open computer files. NEVER SAVE YOUR WORK ON THE LAB COMPUTER.
- Staple the graph and data sheets. Be sure your name is on each page.
- Sign the attendance sheet.

DON'T FORGET TO PRINT THE SPREADSHEET WITH YOUR DATA AND GRAPHS!