**EXPERIMENT: CURRENT AND RESISTANCE**

Experiment list: Laptop Computer, Computer Interface, Voltage Probes (2), Current Probes (2), Circuit Board (various resistors on board), Light Bulbs (3), AA-cell Batteries (4)]

**Overview:**

When a wire is attached to the positive terminal of a power source, such as a battery, and to the negative terminal of the battery a potential difference is set across that wire and a current is generated through that wire. Depending on how much resistance there is in the wire will affect the amount of current through that wire. Adding more resistance will further affect the amount of current. In this experiment you will measure both the current through different resistive elements (such as light bulbs and resistors) and the voltages across these elements.

**Light Bulbs**

Start the investigation of the amount of current, which flows through a circuit element (such as a light bulb, or a resistor), by placing 4 AA-Cell batteries into the battery holder on the circuit board. Adjust the Battery Switch SW4 so that two batteries are used. Screw in a round light bulb into the receptacle marked “LAMP 1”. Connect wires that have alligator clips attached to both ends from the positive terminal (located near the battery holder) to one of the connectors of the single-pole single-throw (SPST) switch (SW3) marked with the number 22. Connect another wire from the other connector to this switch (23) to one of the connectors on one side of LAMP 1. Connect a third wire from the other side of LAMP 1 to the ground terminal located near the bottom edge of the circuit board (35). By pressing down on the red button of SW3, you close the circuit and allow the light bulb to glow.

**All Questions are to be answered in the Results section of your Lab Report. Make sure to number the answers to coincide with the question numbers.**

**Question 1**: Does the round light bulb glow brightly, or dimly? Brightly

**Change the round light bulb for a long light bulb and close the circuit by pressing the switch**.

**Question 2**: Does this light bulb glow brighter, or dimmer, compared to the round light bulb? Brighter

Add another long light bulb into the socket marked LAMP 2. Detach the end of the wire that is connected to the negative terminal (35) and attach it to one side of LAMP 2. Take another wire and connect the other side of LAMP 2 to the negative terminal. By doing this you have connected a second light bulb “in series” with the first light bulb. Now, press the red button on SW3 to close the circuit.

**Question 3**: How does the brightness of each of these two bulbs compare to each other (one is brighter than the other is; they are of the same brightness). How does the brightness of these two light bulbs compare to the brightness of having just one long light bulb in the circuit? Same brightness. Dimmer

**Remove the two long light bulbs and place a short bulb back into Lamp 1.**

Current is the amount of charge (measured in Coulombs) that passes a point in a circuit each second. The unit for current is the Ampere which is equal to one Coulomb per second. Located in the box on your table are two Current Probes. Connect these two probes to the Lab Pro computer interface, one into Ch 1, and the other into Ch 2, located on the side of the interface. On the desktop of the laptop computer double-click on the Logger Pro icon. Logger Pro will load and automatically recognize that there are two current probes connected to the interface. To investigate how much current is flowing into one light bulb a current probe (the one connected to Ch 1) will need to be connected “in series” prior to the light bulb in the circuit (see figure 1).

LAMP 1

LAMP 2

LAMP 3

SW3

SW2

+

-

+

-

Current Probe

SW4

L1

5mH

Figure 1

Before you collect data, zero the current probes by selecting the “zero” icon at the top of the screen. Then, to collect data, select the “collect” icon. It will take a few seconds to collect the data. While this is occurring press down on the red button (SW3) for a portion of the data collection, then release the button.

Record the current (Ch 1, nothing is connected to Ch 2, yet) before the button is pushed, during the time that it is pushed (only the constant current part), and after the button is released. To determine the average current during each of these occurrences, click and drag the cursor across the region you wish to check. A gray area should appear over the region you are selecting. Then, select the STAT button icon near the top of the screen. **Record the average value onto the Excel worksheet for this experiment**.

A.

Current before button is pushed: \_\_\_\_\_\_\_\_\_\_\_\_\_ amps

Current while button is pushed: \_\_\_\_\_\_\_\_\_\_\_\_\_\_amps

Current after button is released: \_\_\_\_\_\_\_\_\_\_\_\_\_\_amps

Did you notice anything peculiar about the current at the moment you closed the circuit? **Take a screen shot of the current and include it in your report**.

**Question 4**: (**Prediction**) How would the amount of current going into the light bulb compare to the amount of current leaving it? Does some of the current get used up in lighting the light bulb? There would be less current leaving than entering. Yes.

Test this and compare to what you have written in Question 4 by connecting a second current probe (Ch 2) just after the light bulb in series with it. Again, collect data by starting the program and press and release the SW3 button during collection time. Don’t forget to zero the current probes before taking data. **Record the data on the Excel worksheet**.

B.

Current probe 1 before button is pushed: \_\_\_\_\_\_\_\_\_\_\_\_\_ amps

Current probe 2 before button is pushed: \_\_\_\_\_\_\_\_\_\_\_\_\_ amps

Current probe 1 while button is pushed: \_\_\_\_\_\_\_\_\_\_\_\_\_\_amps

Current probe 2 while button is pushed: \_\_\_\_\_\_\_\_\_\_\_\_\_\_amps

Current probe 1 after button is released: \_\_\_\_\_\_\_\_\_\_\_\_\_\_amps

Current probe 2 after button is released: \_\_\_\_\_\_\_\_\_\_\_\_\_\_amps

**Question 5**: How do the currents through current probe 1 and current probe 2 compare throughout the data taking? Basically identical

**Question 6**: By comparing these two current values, what can be said about the amount of current passing through the positive terminal of the battery to the amount of current passing through the negative terminal of the battery while the circuit is connected? It’s equal

**Resistors (use all 4 batteries)**

Disconnect the wires attached to the light bulb and replace it with a 10 Ω resistor. Again, take data, holding SW3 down for a portion of the data taking collection. **Record the values onto the Excel worksheet and take a screen shot of the current graph to include in your report**.

C.

Current probe 1 before button is pushed: \_\_\_\_\_\_\_\_\_\_\_\_\_ amps

Current probe 2 before button is pushed: \_\_\_\_\_\_\_\_\_\_\_\_\_ amps

Current probe 1 while button is pushed: \_\_\_\_\_\_\_\_\_\_\_\_\_\_amps

Current probe 2 while button is pushed: \_\_\_\_\_\_\_\_\_\_\_\_\_\_amps

Current probe 1 after button is released: \_\_\_\_\_\_\_\_\_\_\_\_\_\_amps

Current probe 2 after button is released: \_\_\_\_\_\_\_\_\_\_\_\_\_\_amps

**Question 7**: Is the graph of the current through a resistor different than for a light bulb? What is happening to the resistance of the filament of the light bulb as it warms up from the current passing through it? Yes and no. As it warms up, the resistance increases.

**Question 8**: (**Prediction**) What would happen to the current from the battery if another resistor of equal resistance is connected in series with the first resistor? It would decrease.

Test this to see what would happen. Use both current probes having one current probe testing how much current is going into the first resistor (which is also the amount of current from the battery) and the second current probe testing how much current is leaving the second resistor (which is the amount of current going back to the battery). **Only record the current (on the Excel worksheet) while the circuit is closed this time.**

D.

Current probe 1: \_\_\_\_\_\_\_\_\_\_\_ amps

Current probe 2: \_\_\_\_\_\_\_\_\_\_\_ amps

**Question 9**: How do these currents compare to each other? Virtually identical

**Question 10**: How do these currents compare to the current with only one 10 Ω resistor in the circuit (circuit closed, of course)? They are significantly smaller.

**Question 11**: (**Prediction**) If you adjust SW4 to only use 2 AA-cell batteries you would approximately half the available potential difference across the two resistors. What would happen to the current if you reduced the voltage across them by this amount? You would half the current.

Test this. Adjust the amount of voltage supplied to your circuit so that only 2 AA-cell batteries are being used. **Take data and record it on the Excel worksheet**.

E.

Current probe 1: \_\_\_\_\_\_\_\_\_\_\_ amps

Current probe 2: \_\_\_\_\_\_\_\_\_\_\_ amps

**Question 12**: How do these currents compare to the currents in the circuit that had four batteries and two 10 Ω resistors? Almost exactly half

**How much voltage?**

**Adjust the Battery Switch SW4 back to include all four AA-cell batteries.**

**Question 13**: (**Prediction**) How much voltage would be across one 10 Ω resistor connected to the battery? How does this voltage compare to the voltage of the battery? 6 V, 6 V

Replace the current probes with voltage probes. These probes need to be connected with the red connector on the leading (higher voltage) side of the resistor and the black probe on the other (lower voltage) side of the resistor. Still include switch SW3 in your circuit. Before connecting voltage probe 1 across the “+” and “-" terminals on the circuit board to measure the voltage across the battery, zero both voltage probes. Connect voltage probe 1 across the battery terminals and voltage probe 2 across the 10 Ω resistor to measure the voltage across each. **Record these voltages on the Excel worksheet**.

F.

Voltage across the battery terminals: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across the 10 Ω resistor: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Question 14**: How do these two voltages compare? The 10 ohm resistor voltage is twice the battery terminal’s voltage.

**Question 15**: (**Prediction**) How much voltage would be across each of two 10 Ω resistors connected in series with each other? How do these voltages compare to the voltage across the battery terminals? The first resistor would be the same as before. The second would be linearly increased.

Disconnect the voltage probe 1 from across the battery terminals and attach it to the second 10 Ω resistor. Connect this second 10 Ω resistor in series with the first 10 Ω resistor. **Measure the voltages and record them on the Excel worksheet.**

G.

Voltage across first 10 Ω resistor: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across second 10 Ω resistor: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Question 16**: How do these two voltages compare to each other? How do they compare with the voltage of the battery?i

Ohm’s Law states that there is a **linear relationship** between the voltage across an Ohmic device (a resistor, for example) and the current through this resistor. To show this only use one 10 Ω resistor, with one voltage probe connected across it and one current probe connected in series before it. You will initially need to adjust your battery supply to use one battery. However, to start, you will need to disconnect the wire from the “+” terminal so that a zero voltage is applied to your circuit. Open the “Ohm’s Law” file to take the data. When you are ready to take data select the “collect” button near the top of the screen. When you do so you should notice that a “keep” button becomes available to select. You will take several data points using this “keep” button. Zero both the voltage probe and the current probe before taking data. Select the “keep” button to take the first data point of zero volts and zero amps. Attach the wire back to the “+” terminal and take the next data point (1 battery). Adjust SW4 to 2 batteries and take this data point. Repeat for 3 batteries and for 4 batteries. Once you have completed taking the data, select the “stop” button to stop taking data.

Select the Linear Fit button at the top of the screen and record the slope of the line onto the worksheet. **Take a screen shot of the graph showing the equation for the linear fit and include it in your report**.

H.

Slope: \_\_\_\_\_\_\_\_\_\_\_

The slope of the line should represent the resistance of the circuit. The equation for Ohm’s Law written in this manner is:

Where the potential difference V is graphed along the y-axis and the current I is graphed along the x-axis in the program.

**Question 17**: Does the slope of the line equal the 10 Ω value that the manufacturer states it is? Is it nearly equal to it?

**Question 18**: How well do the data points fit the line? Would you say that as the voltage changes across the resistor that the current through the resistor follows well with Ohm’s Law?

Look at the resistor and you will see a set of colored bands. These represent a code stating approximately the resistance of the resistor. The gold band at the end of the sequence is a tolerance band representing a tolerance of ± 5% of the resistor value. The range of values for this 10Ω resistor is from 9.5 Ω to 10.5 Ω.

**Question 19**: Does the value of the slope (which represents the resistance) fall within this range?