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Title: Lab Equipment

Name _

Objective

For this lab we will perform simple measurements in order for you to become familiar with the equipment and software we will be using for the rest of the semester.

Data and Calculations

Part A: The resistor

- Use the color code to determine the resistance values of the 5 resistors provided to you. Include the uncertainty.
- Record the color pattern and the numeric value (so that your instructor knows if you are right).

Resistor #	Color Code	Printed Value (Ω)	Uncertainty (%)	Uncertainty (Ω)
ex	Blue-Black-Brown-Gold	600 Ω	$\pm 5\%$	$\pm 30 \Omega$
1	<u>Brown – Black – Brown – Silver</u>	<u>100 Ω</u>	<u>$\pm 10\%$</u>	<u>$\pm 10 \Omega$</u>
2	<u>Blue-Green-Brown-Silver</u>	<u>670 Ω</u>	<u>$\pm 10\%$</u>	<u>$\pm 67 \Omega$</u>
3	<u>Brown-Black-Red-Gold</u>	<u>1,000 Ω</u>	<u>$\pm 5\%$</u>	<u>$\pm 50 \Omega$</u>
4	<u>Red-Red-Orange-Silver</u>	<u>22,000 Ω</u>	<u>$\pm 10\%$</u>	<u>$\pm 2,200 \Omega$</u>
5	<u>N/A (Special Purple Resistor)</u>	<u>10 Ω</u>	<u>N/A</u>	<u>N/A</u>

Part B: DMM (Digital Multi Meter)

- Set the DMM to measure resistance (Ω key).
- Take one of the resistors provided and measure the resistance at every range on the DMM. Include the uncertainty of each range position (use the rule-of-thumb: uncertainty = $\frac{1}{2}$ the smallest unit of measure).

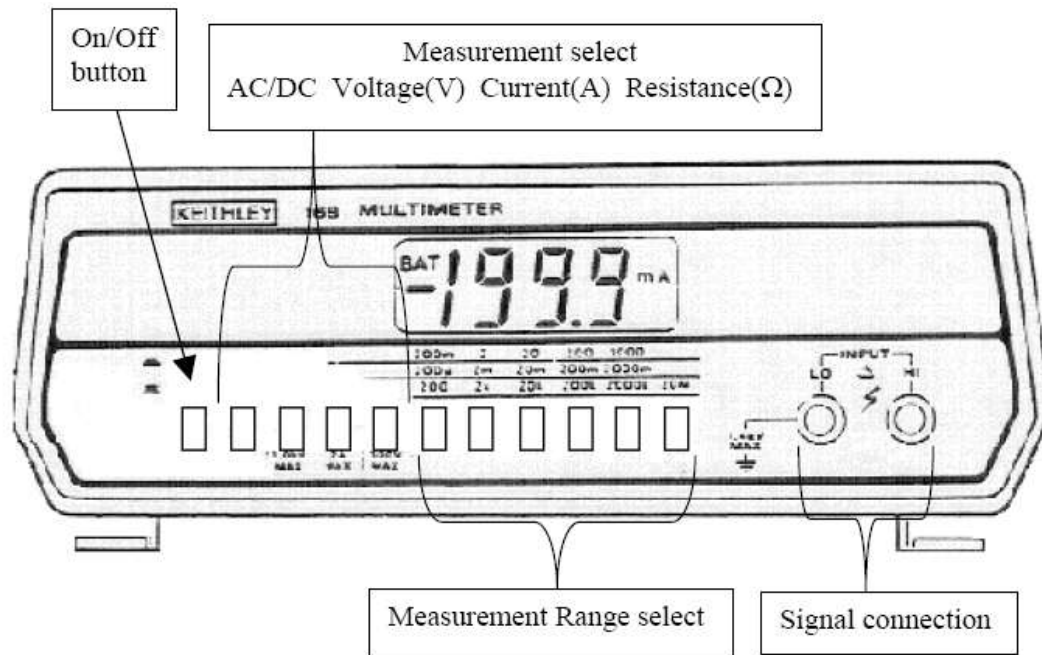


Figure 1: Digital Multimeter Used in Class to Measure Resistance, Current and Voltage

Printed value of selected resistor 1000 $\pm$ 5% Ω

Range (Ω)	Meter Reading (Ω)	Uncertainty (Ω)
200	<u>1. (Overload)</u>	<u>N/A</u>
2k	<u>0.991 kΩ</u>	<u>$\pm 0.0005 \text{ k}\Omega = \pm 0.5 \Omega$</u>
20k	<u>0.99 kΩ</u>	<u>$\pm 0.005 \text{ k}\Omega = \pm 5 \Omega$</u>
200k	<u>01.0 kΩ</u>	<u>$\pm 0.05 \text{ k}\Omega = \pm 50 \Omega$</u>
2000k	<u>001 kΩ</u>	<u>$\pm 0.5 \text{ k}\Omega = \pm 500 \Omega$</u>
20M	<u>0.0 MΩ (Out of Range)</u>	<u>N/A</u>

Example 1: For the “20 k Ω ” range, my meter reading was 0.99 k Ω . If the resistor was just a little more resistive, the meter would have read 1.00 k Ω . If the resistor was just a little less resistive, the meter would have read 0.98 k Ω . Thusly, this means my tool is measuring in the smallest increments of 0.01 k Ω . Half of the smallest increment of the tool in this configuration is: $0.5 * 0.01 \text{ k}\Omega = 0.005 \text{ k}\Omega = 5 \Omega$.

Example 2: For the “200 k Ω ” range, my meter reading was 01.0 k Ω . If the resistor was just a little more resistive, the meter would have read 01.1 k Ω . If the resistor was just a little less resistive, the meter would have read 00.9 k Ω . Thusly, this means that my tool is measuring in the smallest increments of 0.1 k Ω . Half of the smallest increment of the tool in this configuration is: $0.5 * 0.1 \text{ k}\Omega = 0.05 \text{ k}\Omega = 50 \Omega$.

- Which range gave you the greatest accuracy (Notice that the uncertainty at some of the ranges is larger than the value of the resistor)?

For the 1 k Ω resistor the “2K” setting gave the best accuracy. This was the smallest measurable range which did not cause an overload on the DMM.

- Measure the remaining resistors. Use the range that will give you the greatest accuracy.

Printed Value (Ω)	Printed Uncertainty (%)	DMM Value (Ω)
<u>670 Ω</u>	<u>$\pm 10\%$</u>	<u>670 Ω</u>
<u>100 Ω</u>	<u>$\pm 10\%$</u>	<u>98.9 Ω</u>
<u>22,000 Ω</u>	<u>$\pm 10\%$</u>	<u>21.7 kΩ = 21,700 Ω</u>
<u>10 Ω</u>	<u>N/A</u>	<u>10.4 Ω</u>

- Compare the DMM results to the color code values gathered earlier. Which one of these do you feel is a better measurement and why?

The range of “2k” was the most accurate for my resistor. The uncertainty was only 0.5 Ω . Coincidentally this was the lowest setting on the DMM which was measurable (i.e., it didn’t cause an overload). If I had used a lower measurement setting range, would have gotten an overload reading. If I had used a higher measurement setting range, the error exceeds the uncertainty I found for the “2k” range.

- Do the DMM measurements match the value given by the color code, taking into account the uncertainty color code?

The printed value on my selected resistor was: 1000 $\Omega \pm 5\%$. That means that the acceptable range of resistance for my selected resistor would be 950 Ω to 1050 Ω . The DMM measured the resistance to be: 991 Ω . This value falls within the range printed on my selected resistor, so it looks like it was labeled correctly. So, yes, the DMM measurement does match the value given by the color code on the resistor.

Part C: Protoboard and a simple circuit

- Close-up of the UCCS circuit board.

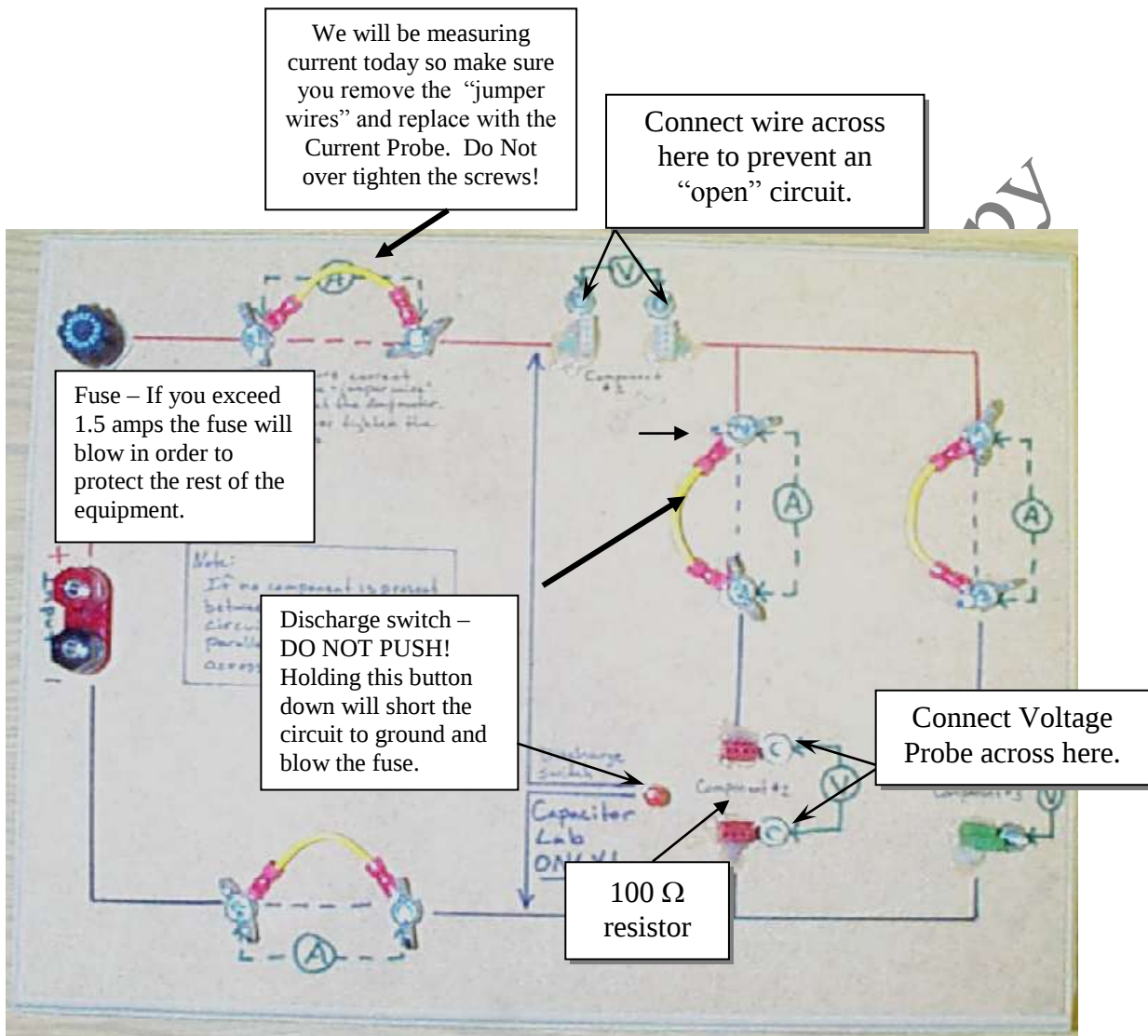
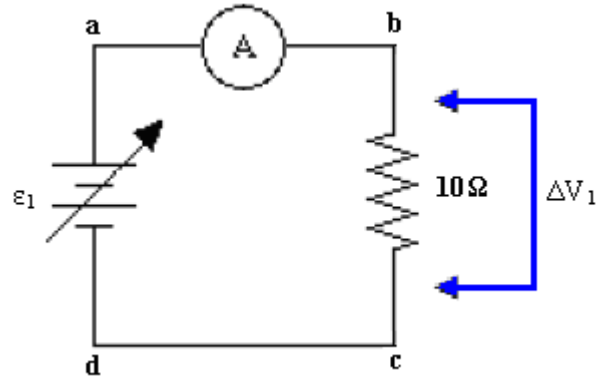


Figure 2: Simple circuit (layout) used to determine the purpose and mechanics of the resistor

Figure 3: Circuit diagram of circuit built during the class

- Set the power supply voltage control to zero, and then turn on the power supply. **Always set the voltage to zero when you are turning the power supply on or off!**

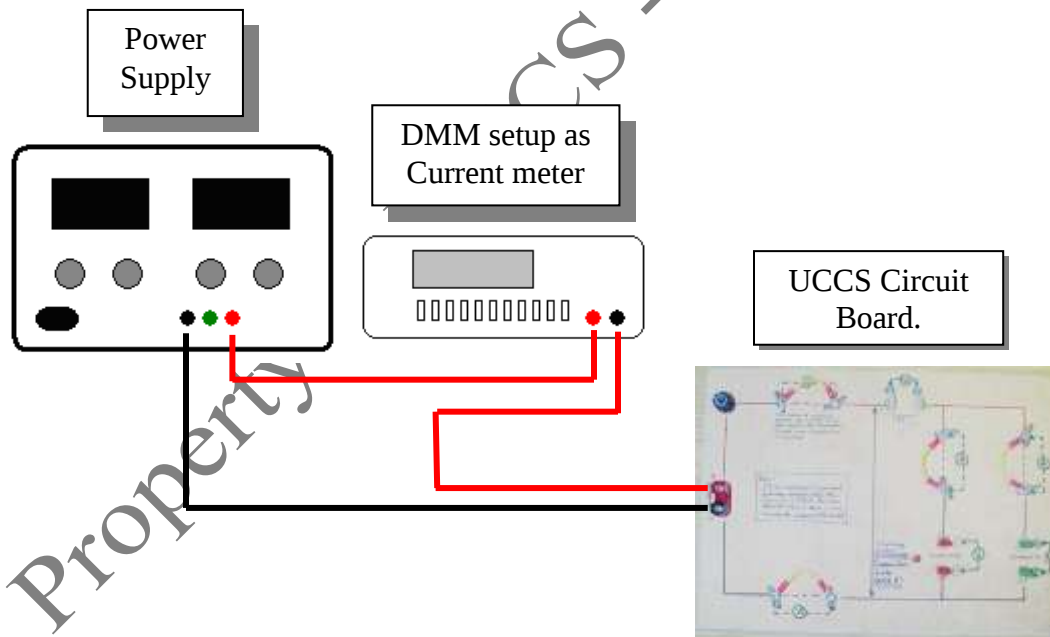
- Connect-up the circuit as shown below.



- Set the power supply to deliver 4V.
- Record the value of the 100Ω resistor you measured with the DMM earlier.

98.9 Ω

(From above – see the second table in part B)



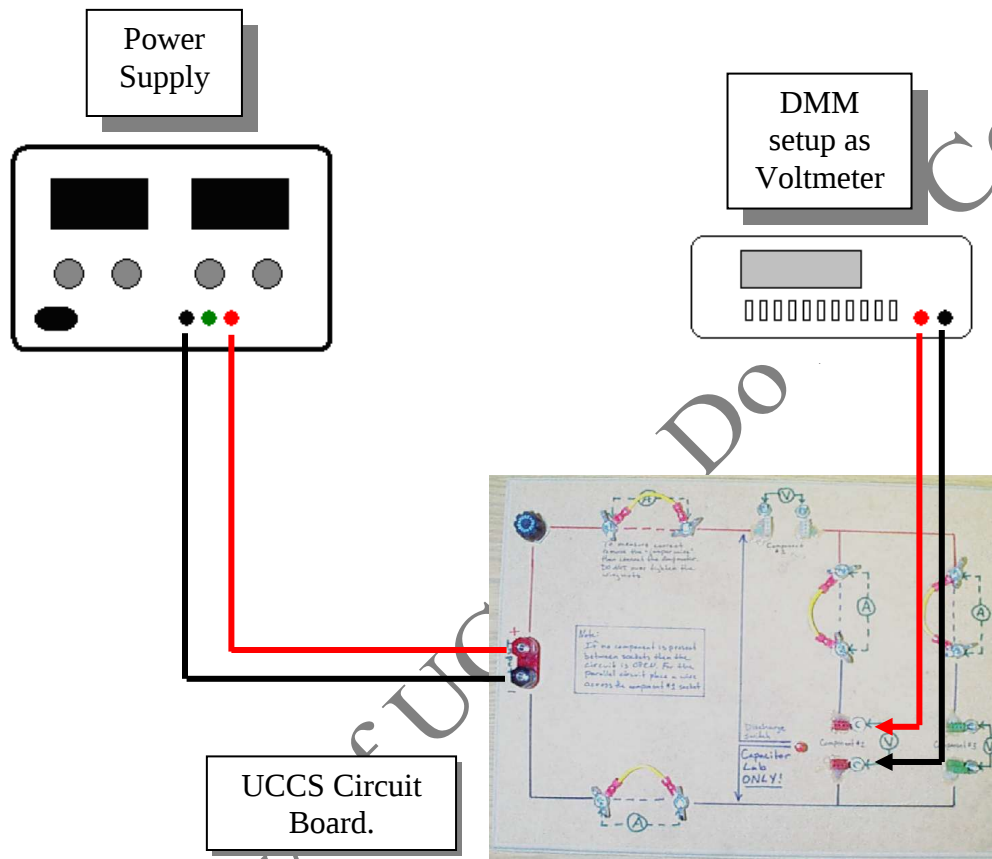
- Measure the current through the resistor. Adjust the DMM accordingly.

39.2 mA = 0.0392 A

(Measured on the “200 mA” button – all buttons below that gave a value of “1.”)

[It should be noted that this value is a little low, just due to the resistivity of the wires in the circuit board we were using.]

- Connect-up the circuit as shown below.



- Measure the voltage across the resistor. Adjust the DMM as needed to give the highest accuracy.

3.87 V

(Measured on the "200V" button – all buttons below that gave a value of "1.")

Part D: A Look ahead at some physics

- You will learn about *Ohm's Law* later in the semester, but here is a sneak peak. The resistive value of a component is determined by its physical parameters (eq: materials and dimensions). The resistance can be found

another way by how it reacts within an electrical circuit. Given a know value of voltage applied and measuring the corresponding current allowed to pass through a resistor, the value of the resistance can be calculated using Ohm's Law.

- Calculate the resistance of the simple circuit in Part C

$$\text{Resistance} = \frac{\text{Voltage}}{\text{Current}} = \left(\frac{\quad}{\quad} \right) = \quad \Omega$$

$$\text{Resistance} = \frac{\text{Voltage}}{\text{Current}} = \left(\frac{3.87 \text{ V}}{0.0392 \text{ A}} \right) = 98.72 \Omega$$

$$\boxed{\text{Resistance}_{\text{calculated}} = 98.72 \Omega}$$

- How well does this calculated value of the resistance compare to the one measured by the DMM earlier? Explain any discrepancy.

The values were very close! They were only off by a discrepancy of 0.08 Ohms. The loss is probably just due to the resistivity of the wires in the circuit board we were using.

Conclusion (later in life this is what your boss will look at first!)

- This closing paragraph is where it is appropriate to conclude and express your opinions about the results of the experiment and all its parts. Only the final result(s) needs to be restated.
- Comment on all the measurement methods used to find resistance. Include a discussion of accuracy of each method and the situation when each would be appropriate.

- Color Code

<Add description here about your opinion on this method of labeling. My personal opinion is that it is not very accurate, but is easy to get a "general" idea of the value. Plus it doesn't rub off like numbers would.>

- DMM

<Same thing here add your opinion on this method of measurement. I consider this to be a lot more accurate, but sometimes it is hard to set it up and remember how the stupid thing works.>

- Simple Circuit Calculation

<Same thing. Notice that this required using math in addition to making two measurements with the DMM, once measuring current and once measuring potential. This was 2x as hard as just using the DMM as an Ohmmeter alone, because we had to build a circuit AND make measurements AND do math to find the resistance.>

** NOTE: There are several components of error which could significantly modify the results of this experiment. Some of these are listed below:

- Heat
- Age
- Humidity
- Short circuit
- Fuse
- Bad power supply
- Bad connections (in protoboard)
- Insulation

It is recommended that you take these and explain the “why” part of each for your results and conclusions sections – and possibly what could have been done (if anything) to minimize the effects of these errors.