Introduction

This activity is designed to get students familiar with the basic operation of a Digital Multimeter and take basic voltage and current measurements. Students should work in groups of two to share their multimeter

Materials List

1. 2 Digital Multimeters capable
2. 12 V adjustable power supply
3. Small Lamp Bulb
4. Lamp Socket
5. 5000 Ohm Resistor
6. Leads/Wires as needed to connect power supplies and meteres

Familiarize Yourself with the Multimeter

1. Look at your multimeter's knob. Locate the settings for Voltage, Current, and Resistance. Does your meter have separate positions for different ranges, or is it auto-ranging? Note if there are separate positions for AC (indicated by sine wave) and DC Voltage and Current. Look to see if your meter has any other settings/positions.
   Examples might include diode polarity (with diode symbol), capacitance, and Temperature (requires a particular sensor to be plugged in).
2. Now look at the plugs for the probes. For each setting, determine where the probes need to be. If you cannot determine a probe position from the meter's markings, ask your instructor.
3. Now set one meter to the lowest current setting and plug the probes in. Using a second meter set to the lowest resistance setting, measure the resistance between current leads by touching the red lead of the second meter to the first and the black lead of the second meter to the first. You should get a number close

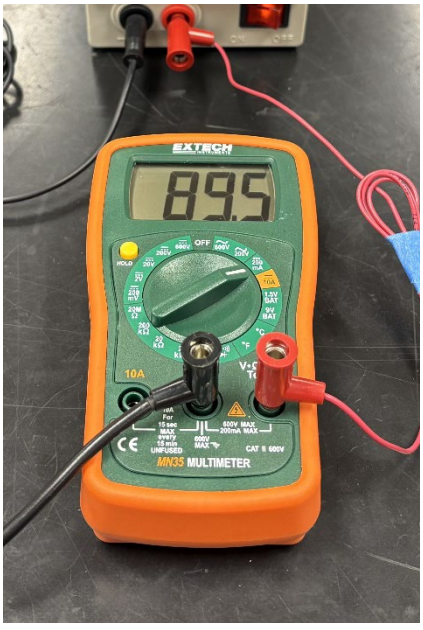

Figure 1: Example multimeter. This meter is not auto-ranging. It is currently set to 200 mA DC Current. On this meter, all settings use this plug except the 10A DC

to 0 Ohms. If you do not first make sure your probes are plugged in correctly and making good contact. If you still do not get ~0 Ohms, contact your instructor because you may have a blown fuse.

4. Repeat this for all the current settings.
5. Now switch the first meter to Voltage and set the 2nd meter to the highest resistance setting, and repeat the measurement. You should get a very large number or possibly an indication of overrange (meaning the value is bigger than the max value of the current setting).
6. Decrease the resistance setting of the second meter so you can see what an overrange setting looks like on your meter.
7. Screw the light bulb into the socket.
8. Measure the resistance of the light bulb and the 5K Resistor. For the lightbulb, this is done by touching your probes to the screws. You should get a number <100 Ohms. Do the same for the 5K resistor. Write these values down in your lab notebook.

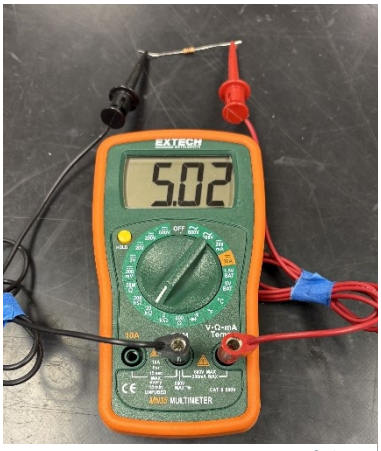

Figure 2: Measuring resistance of the 5KOhm resistor.

Measuring Voltage

1. Now connect your power supply to your light bulb to your power supply and turn it on.
2. First, set it to 2V and then use your meter to measure the voltage across the light bulb by touching your probes to the screws of the socket, as shown in Figure 3. This sets up the circuit shown in Figure 4.
   Notice how the meter is in parallel with the bulb. Remember, components are in parallel; they have the same voltage.
3. Now switch your red and black probes. What happens to your voltage.
4. Now set your meter to resistance and try to measure the light bulb's resistance while powered. You will not get the correct value.
5. Move your probes of the meter directly to the power supply

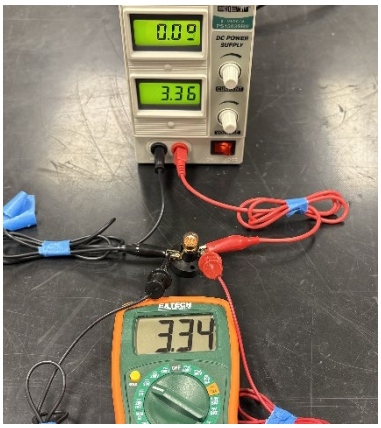

Figure 3: Power supply and voltmeter connected to the bulb for voltage measurement.

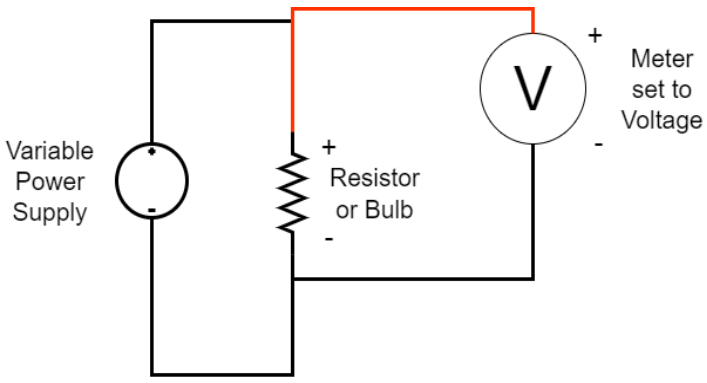

Figure 4: Circuit for Voltage measurement.

terminals. You should get the same voltage across the bulb. Look at your voltage reading on the multimeter compared to the power supply setting. Often, power supply meters can be slightly off depending on the age and quality of the supply.

6. Repeat the voltage measurements with the power supply set to 4V and 6V.

Measuring Current

1. Now we want to measure current. **USE CAUTION: Placing a low-resistance Ammeter in parallel will create a short circuit. When measuring current, the meter should always be in series. Make sure the meter leads are plugged into the correct location.**
2. To connect in series, the power supply should connect to the positive lead of the meter. The negative lead should connect to one of the light bulb screws. The other screw terminal should connect back to the negative terminal of the power supply. It is recommended that you use some clips so you do not have to hold the multimeter leads in place to complete the circuit. When done, it should look like Figure 5. The circuit is given by Figure 6.
3. Turn the power supply on to 2V and measure the current. Because the meter is in series, we know the current through the meter is the same as the current through the resistor.
4. Again, compare the current measured by the multimeter with the reading on the power supply.
5. Switch the positive and negative leads of the meter. What happens?
6. Repeat your current measurements at 4V and 6V

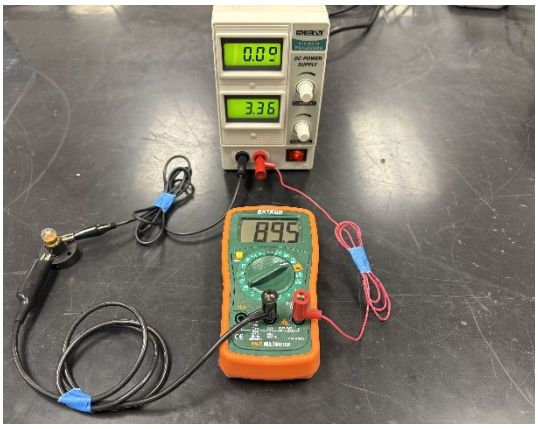

Figure 5: Power supply and Ammeter connected to the bulb for current measurement.

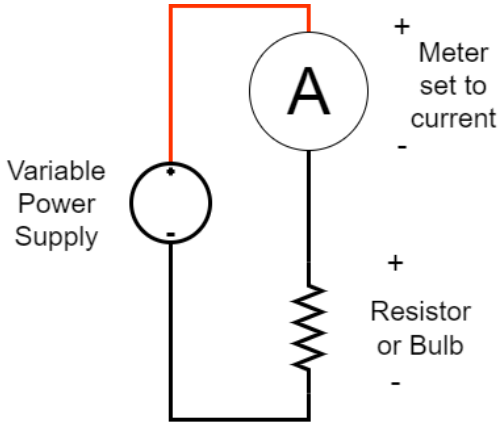

Figure 6: Circuit for current measurement.

Ohm's Law Measurements

1. Now build the circuit shown in Figure 6 with two meters, one for current and one for voltage, and the light bulb. Be careful to check you have meters and leads all set up correctly before applying power to avoid a short circuit.
2. Now use this setup to measure the voltage and current simultaneously at 2, 4, 6, and 8V. Record these values in your lab notebook.
3. Replace the lightbulb with the 5K resistor and repeat the measurements, again recording the values in your lab notebook.
4. Plot your data with Current on the X axis and Voltage on the Y axis.
5. Fit a line to your data. How does the slope of the line compare to the resistance you measured in Part 1?

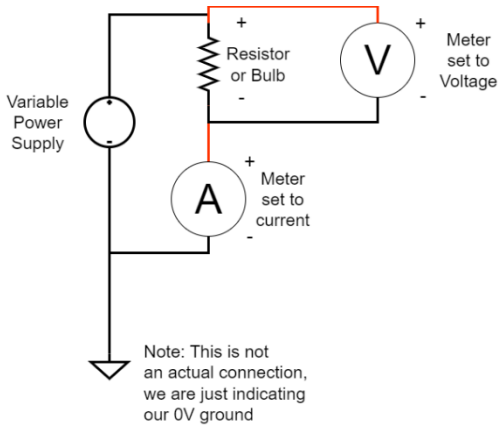

Figure 7: Circuit for simultaneous voltage and current measurement.

Table 1: Voltage and Current measurements for bulb and 5K Resistor

Power Supply Voltage	Bulb Voltage	Bulb Current	Resistor Voltage	Resistor Current
2 V				
4 V				
6 V				
8 V				

Recall that Ohm's Law is: $V = I * R$.

If you notice the bulb showing some nonlinear behavior, do not assume something went wrong. The filament in the bulb heats up to a very high temperature, which is how it makes the light it emits. An object's resistance usually has a temperature dependence. So the resistance of the bulb was not actually constant during the measurements.

The resistor did not heat up as much so should have a much more linear plot.