Name: ______________________
Date: ______________________
Course ______________________
Instructor: ______________________

DC EXPERIMENT 1

Ohm’s Law

OBJECTIVES

1. Become familiar with the DC power supply and setting the output voltage
2. Become familiar with building circuits on a breadboard
3. Measure the voltage and the current in a dc circuit by using a digital multi-meter (DMM)
4. Apply and plot Ohm’s law
5. Determine the slop of an I-V curve

EQUIPMENT REQUIRED

Instruments	Components	Tools
Power Supply Digital Multimeter	1 kΩ resistor (1/4W) × 1	Breadboard Conducting wires

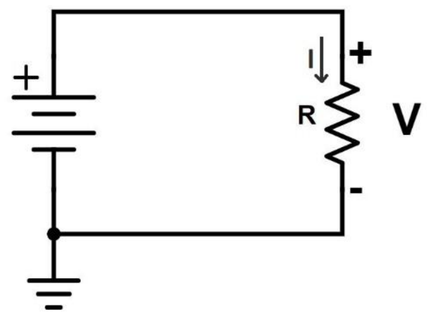
EQUIPMENT ISSUED

Check if your group has been issued with the instruments listed above. Note down the manufacturer model number for the instrument you used (if you don’t know where to find it, ask your instructor). Also, note down your lab group number.

Item	Manufacturer Model #	Lab Group #
Power Supply [MEGO] Digital Multimeter [ZOYI]		

THEORY

The relationship between Voltage, Current, and Resistance in any DC electrical circuit can be described by Ohm's law in the following form:



$$\text{Resistance: } R = \frac{V}{I}$$

$$\text{Voltage: } V = IR$$

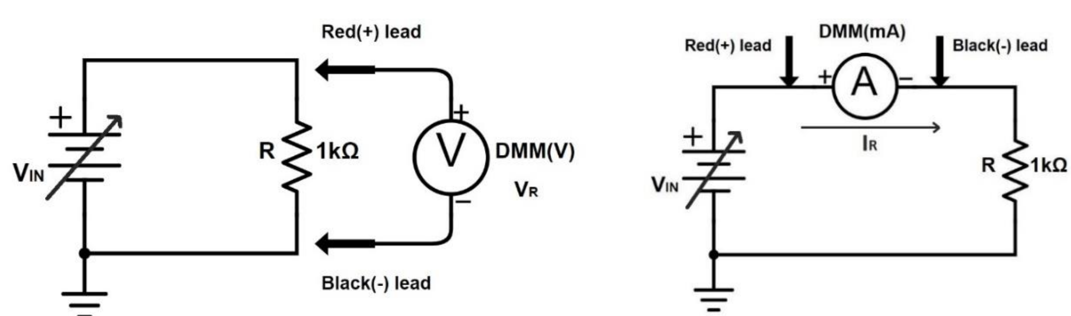
$$\text{Current: } I = \frac{V}{R}$$

where R is the resistance of the resistor in units of ohms (Ω), V is the voltage across the resistor in units of volts (V), and I is the current through the resistor in units of amperes (A).

By knowing any two values of the Voltage, Current, or Resistance quantities we can use Ohm's law to find the third missing value. For example, the voltage across and the current through a conductor can be used to determine its resistance. Ohm's law is used extensively in electronics formulas and calculations, so it is very important to understand and accurately remember these formulas.

OVERVIEW

In this experiment, you will follow the procedures to build simple circuits to verify Ohm's Law. The two circuit diagrams in Figure 1 showed the approaches to practically measure the voltage and current of the resistor, using these measured values to verify Ohm's Law experimentally.



(a) Voltage Measurement (b) Current Measurement

Figure 1

PROCEDURE

Part I: Voltage Measurement

1. Construct the circuit of Figure 2 on the breadboard using your 1kΩ resistor. Be sure the connectors are plugged into the holes so that the circuit is well conducted.

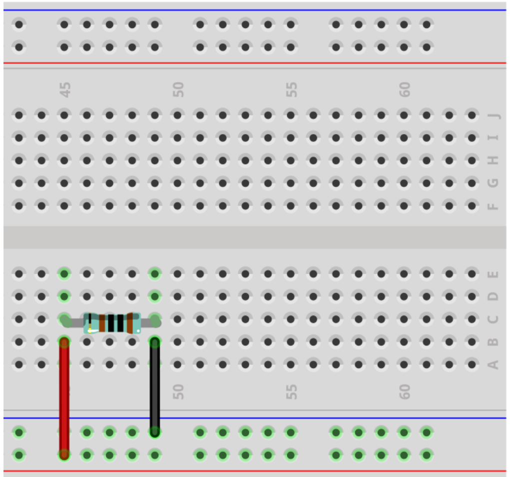


Figure 2

2. Turn on the power supply and adjust its output voltage to 5V using the mini screwdriver.
3. Plug the Power Supply onto the breadboard, make sure the "+" polarity on the Power Supply is matching to the "+" rail of the breadboard.
4. Now your setup should look like Figure 3.

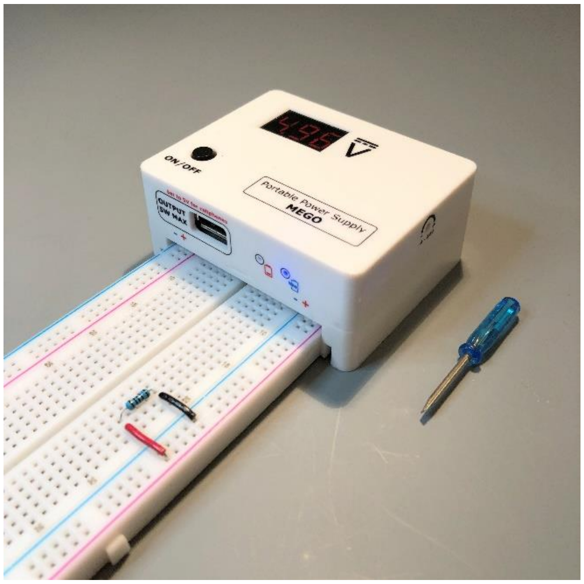
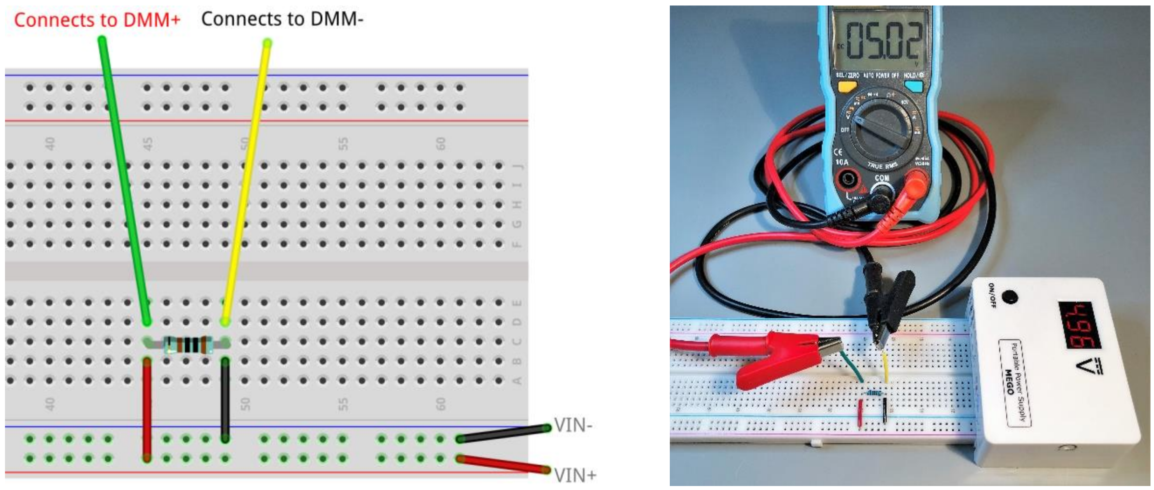


Figure 3

5. At this stage, you have built the basic circuit for Ohm's Law. To take measurements, you will need the digital multimeter, or DMM. We start off by measuring voltages.

6. To measure voltage, turn DMM's knob to position [V] (right above position [OFF]), then use two wires to measure the voltage across the 1kΩ resistor as shown in Figure 4.



(a) Breadboard Connection (b) DMM Setting for voltage

Figure 4

7. If your DMM gives a reasonable voltage readout, e.g. around 5V, it means your setup is correct. Then you can continue onwards.
8. In Table 1, fill column 2 by recording the measured value of V_R from DMM. You will need to set power supply output voltage to 5V, 6V, 7V, 8V and 9V respectively, and meanwhile record the precise voltage reading from DMM. Note that DMM is more precise than power supply, so you will use this measured value to do calculations.
9. You will also need to measure the actual resistance of the resistor. To do so, simply turn DMM's knob to position "Ω", then DMM should display the actual resistance. Record this value for $R_{meas.}$ in Table 1. Now you can complete column 3 of Table 1 using the given equation.
10. Once you have the Table 1's column 2 and 3 filled, Part I is completed. Turn off the DMM by switching the knob to position "OFF". Turn off the power supply and disconnect it from the breadboard.

Part II: Current Measurement

1. To measure the current, use the same 1kΩ resistor to build the circuit on breadboard as shown in Figure 5. Note that you need to leave some space which allows DMM to be connected in series with your resistor.

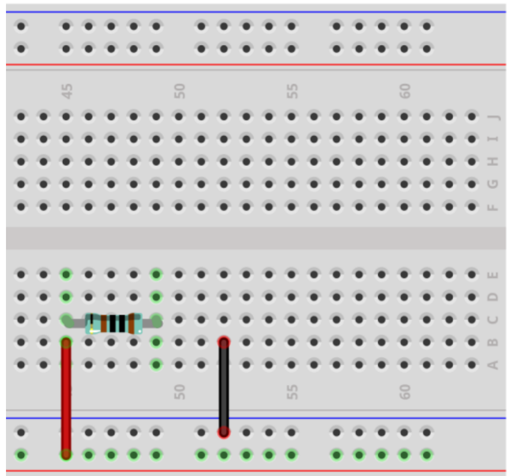
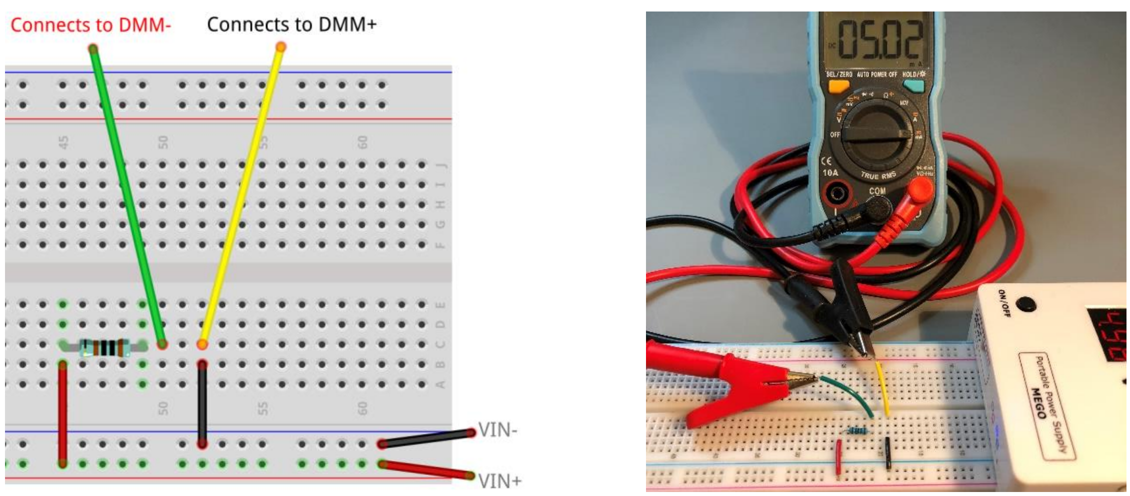


Figure 5

2. Turn on the power supply and adjust its output voltage to 5V using the mini screwdriver, then plug the power supply onto breadboard. Always make sure the "+" and "-" polarities are consistent.
3. To measure current, turn DMM's knob to position [mA] (the last position), then use red and black cables to connect your DMM in series of the 1kΩ resistor. See Figure 6.



(a) Breadboard connection

(b) DMM Setting for current

Figure 6

4. If your DMM gives a reasonable current readout, e.g. around 5mA, it means your setup is correct. Then you can continue onwards.
5. In Table 1, fill the last column by recording the measured value of I_R from DMM. Similar to Part

I, you need to set the power supply output voltage to 5V, 6V, 7V, 8V and 9V respectively, and for each power supply voltage, record the measured values of I_R from the DMM.

6. Once you have the Table 1 column 4 completed, Part II is completed. Turn off the DMM by switching the knob to position "OFF". Turn off the power supply and disconnect it from the breadboard.

TABLE 1 R = 1kΩ $R_{measured}$ =

	Part I		**Part II**
Power Supply Voltage	V_R	$I_R = V_R/R_{meas}$	I_R [DMM (mA)]
5 V			
6 V			
7 V			
8 V			
9 V			

EXERCISES

1. For Table 1, comment on the difference of calculated current (column 3) and measured current (column 4). Are the differences sufficiently small to establish firmly the fact that the current determined by Ohm's law will be very close (if not equal) to that measured directly?

2. Plotting Ohm's law

a) Using the data of Table 1, plot an I-V function on the provided graph paper. Use column 2 values for voltage and column 4 values for current.

Plot on your graph paper with pencil and ruler. Use solid line while drawing.

Once the curve of part (a) is drawn, the level of resistance can be determined at any level of voltage or current. For instance, at I = 5.6 mA, draw a horizontal line from the vertical axis to the curve. Then draw a line down from the intersection to the horizontal voltage axis. Record the level of V in Table 2.

TABLE 2

I_R(mA)	V_R	R(Ω)
5.6		
1.2		
	8.3	

b) The slope of I-V curve is related to the resistance by

$$\text{slope} = \text{m} = \frac{\Delta y}{\Delta x} = \frac{\Delta I_R}{\Delta V_R} = \frac{1}{R}$$

Determine the slope for the 1kΩ resistor using any two measured data points. Then calculate the resistance value.

Calculations:

3. According to the equation above, if the resistance increases, does the slope of the I-V function defined as m increase or decrease? Suppose you have an element with a nearly flat I-V curve, is it a conductor or an insulator?