LAB 3: MEASURING RESISTANCE & OHM'S LAW

Equipment List:

Simpson VOM
hand-held DMM
HP-DMM
DC power supply
Three carbon-type resistors: from about 50 to 100,000 ohms
Assorted banana cables

Purpose: In this lab you will learn to construct a circuit and measure voltage, current, and resistance using a volt-ohm meter (VOM) and a digital multimeter (DMM). When using meters to measure values, you want to learn to use the meter with confidence. You will study the relation called Ohm's Law and you will draw a graph and interpret it.

Introduction: Typical carbon type resistors have a color code on their body that you must learn to interpret. Learn how to read the resistor's value and its "tolerance" from the code below.

Resistor Value		**Tolerance (i.e. nominal uncertainty)**	
0	Black	Nothing	± 20%
1	Brown	Silver	± 10%
2	Red	Gold	± 5%
3	Orange	Red	± 2%
4	Yellow		
5	Green		
6	Blue		
7	Violet		
8	Grey		
9	White		

Procedure:

Part I - Reading and measuring resistors. Hold the resistor so the bands of color are located on the left side of the resistor; the first and second colors give the two significant figures of the resistor's value (no decimal point between them). The third color from the left gives the power of ten. The fourth color (if it exists) is the tolerance value (+ or - nominal value).

1. Determining resistance by direct measurement: **There are no voltages from power supplies and no currents to be measured in this part.** Measure the resistance of

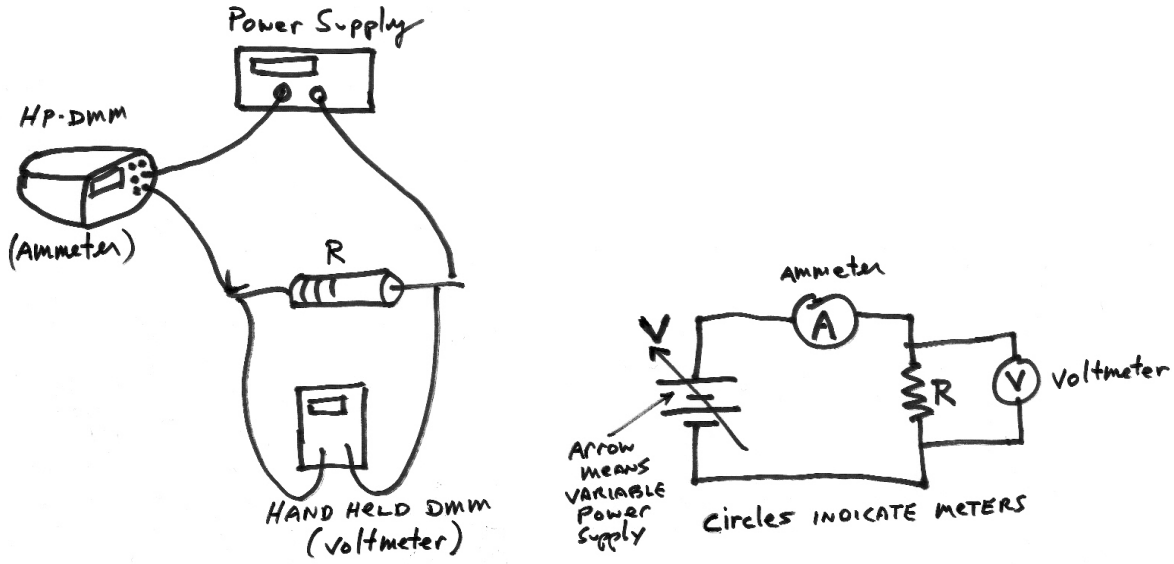
all three resistors with each of the VOM, hand-held DMM, and HP-DMM (use 2 wire mode) and record the three values for each resistor, being sure to note the device used for each measurement. Does the measured value lie within the most probable range determined from the tolerance stamped on the resistor? Comment on the accuracy of the three measuring instruments used. What range setting on your instrument gives the most precise reading?

2. Just for curiosity, measure your own resistance, from one hand to the other using one of the 3 devices (your choice); examine how your resistance can change as you change the tightness of your grip or as your hands become moist. Record a few representative values of your body's resistance in your lab book.

Part II - Determining resistance by calculating a slope from measured data.

1. Take one of your resistors and circle the the nominal resistance (value marked on the side) and the measured value for that resistor that you recorded in your lab book in Part I.

2. Now construct a circuit based on the schematic and pictorial diagram below. Construct the circuit first and then connect your meters. Use the HP DMM for the current readings and the hand-held DMM for the voltage. Prepare your lab book so that you can record your data and draw your graph at the same time, point by point.



3. Take your data by starting at a low voltage value (e.g. less than five volts) and record the voltage across the resistor and the current through the resistor. Increasing the voltage each time, repeat your measurements four more times for a total of five different pairs of voltage and current readings. Each successive data point will represent an increase in voltage and current readings. Plot voltage on the horizontal and current on the vertical axis; this graph is called a "characteristic curve" of the resistor.

4. Draw the best straight line you can using your ruler that best represents the line formed by the data points. Do not use the origin as a data point. Do not connect one point to the next point, draw one straight line. Do not "force" the line to intersect as many points as possible; the best fit line may not intersect any data points.

Analysis: Use the data points to determine the line, then use the line, not the data points, to determine the slope. Choose two points on your drawn line (not data points and outside the range of the data points) that span a large part of your graph. Calculate the resistor's value by applying Ohm's law and understanding how the slope of the graph is related to the resistance.

Also, use a computer graph the data and calculate a least squares best slope value to yield a more accurate value for the resistor. Compare the mathematical best slope from the computer (using linear regression) to your eyeball best slope from the hand drawn graph in your lab book. Compare your resistor's value from the computer graph to the resistor's value from the three measurements of the same resistor as performed in part 1. Neatly tape the computer graph in your lab book.

Conclusion: For Part I, discuss the agreement of all your resistor's values with one another. How closely do the agree? Do any measurements disagree? If so, why do you think that has happened? What sources of variation in the measurements might there be?

For Part II, does your direct measurement of your resistor's value agree with your calculation from Ohm's law and your current and potential difference measurements? If not, why not? Does your plot of voltage against current look like a straight line or a curve? Why do you think it looks as it does?