PH262

Ohm's Law

Lab # _____ Name ____ Date _________

Lab Partner(s) Name ____

I. EQUIPMENT LIST

- Component Box
- Bread board
- 10k Potentiometer*
- DC Milliammeter (1 mA – 100 mA)
- Adjustable DC Power supply (1 – 35v)
- Digital Multi Meter (DMM)
- Resistors
- Assorted Batteries

II. BACKGROUND INFORMATION

Objectives:

When you have completed this lab exercise you should be able to:

(a) recognize resistors and distinguish them from other electronic components.

(b) read the resistor color code.

(c) use analog voltmeters and ammeters.

(d) use a breadboard to set up circuits

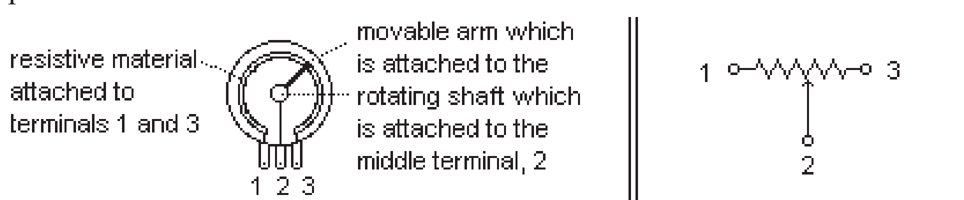
(e) use a digital multimeter (DMM).

(f) calculate power for a resistor.

(g) calculate equivalent R's for resistors in series, parallel, and series/parallel.

(h) construct a circuit using a DC power supply and a potentiometer to make a simple voltage divider.

*The 10 kΩ potentiometer.



sketch of potentiometer with cover removed | **schematic diagram of potentiometer**

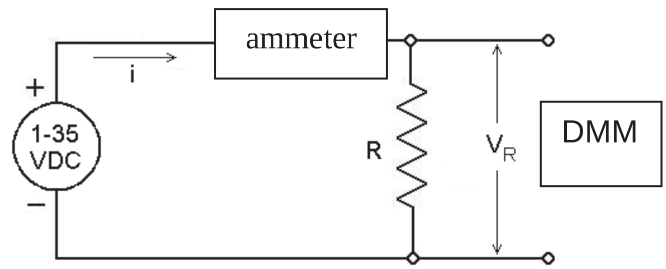
A potentiometer is a resistor with a sliding arm which may be moved from one end of the resistance to the other. Notice that it has 3 terminals.

III. EXPERIMENTAL PROCEDURE

1. Resistor Color Code, Voltage, and the DMM

Find 4 or 5 resistors with different values. Read the resistance values from the color code. Use the resistor color-code sheet (from your component box), you don't need to memorize the colors. Use the DMM to measure the actual resistance for these resistors. Compare your measured values with the color code values. Were the measured resistances within the rated tolerance for each resistor? Use your digital multi-meter (DMM) to measure some DC voltages. Use the VDC power supply and a battery. When using the DMM, always start on the <u>highest</u> scale and work down to avoid damage to the DMM.

2. <u>Ohm's Law Graph and Power Calculations</u>



Set up the circuit on the right.

Let R = 1.5 kΩ. Choose the voltage of the power supply so that the power dissipated by the 1.5 kΩ resistor does not exceed 1/2 watt. Remember that power = VI and that power also is equal to $I^2R = V^2/R$ for <u>Ohmic</u> resistors. Ohmic means that Ohm's law holds, ie., V = IR, the graph of V vs. I passes through (0,0).

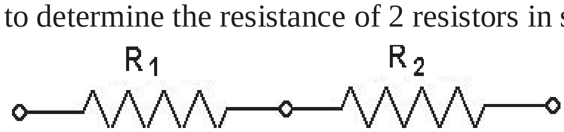
Measure the current **I** flowing through the resistor **R** for at least five different settings of the power supply voltage. Also measure **V** across the resistor for each setting. Graph V_R vs. I for the resistor. Compare the value of R found from the slope of the graph with the color code value. How do these values of R compare to the value measured with the digital multimeter? (You must take R out of the circuit to measure its resistance with the DMM. Why?) Find out (somehow) how the DMM measures resistance. Explain in your lab report. Do not exceed the power rating of the resistors. (The small color coded resistors are good for about 1/2 watt at most.) Calculate P = VI for each voltage-current combination. Show V, I, and Power in a neat table with 3 columns. Use Excel for the V-I graph!

3. <u>Resistors in Series, Parallel, and Series/Parallel</u>

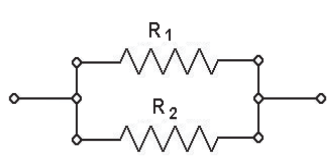
Note: For parts (A) through (E) you should use sets of resistors whose largest and smallest values do not differ from each other by more than a factor of 5.

(A) Use the DMM to measure the actual R for each of the resistors.

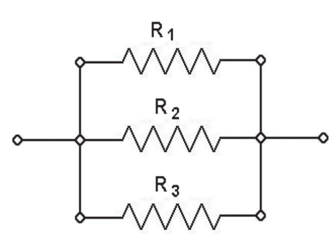
(B) Use your DMM to determine the resistance of 2 resistors in series.



Compare your measured value of equivalent R with the value you can compute from your measured values of R_1 and R_2.
Show how you computed the equivalent resistance, R.



Two resistors in parallel.



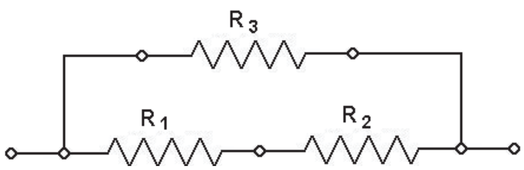
Three resistors in parallel.

(C) Repeat part (B) using 3 resistors in series.

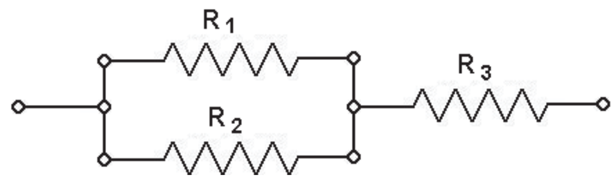
(D) Repeat part (B) using 2 resistors in parallel.

(E) Repeat part (B) using 3 resistors in parallel.

(F) Repeat part (A) using the two simple series/parallel circuits shown below.



(1)



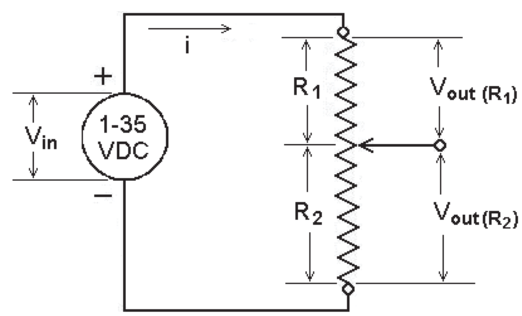
(2)

4. <u>A Voltage Divider using a Potentiometer</u>

Use Ohm's Law to solve for V_{out} (R_1) (voltage measured across R_1) as a function of V_{in} and R_1 in the circuit below. If you don't understand how the 10 kΩ potentiometer works, try measuring $R_1 + R_2 \approx 10$ kΩ, and then measure R_1 or R_2 as a function of the shaft position. **You really do need to understand this device!**

Note: In order to measure R_1 with the DMM, you must disconnect the potentiometer from the power supply. Why?

Connect the 10 kΩ potentiometer to the power supply as in this diagram. Set the power supply for some reasonable value of V_{in} such as 10 volts, and measure V_{out} as a function of R_1. NOTE: This requires that you use your DMM to measure R_1 and R_2 for each setting of the potentiometer.
R_2 = 10 kΩ - R_1!



Graph V_{out} as a function of R_1. Show how the graph agrees both <u>qualitatively</u> and <u>quantitatively</u> with your formula for V_{out} as a function of R_1, R_2 and V_{in}. In other words, compare your theoretical equation to the trend line equation from Excel.

The circuit is called a voltage divider. Why? Does it represent a practical method of getting low voltages from very high voltages? Why or why not? Answer this, don't ignore it. (Hint: Think about power being lost or wasted by R_1 or R_2.)

The DMM has an input impedance (resistance) of 10 mega-ohms, so it does not draw an appreciable amount of current from this circuit. What would happen if the input resistance of the volt meter were about 25 kilo-ohms? How would this affect your measurement of V?