

Voltage, Current, Resistance and Ohm's Law (R1)

Goals of Experiment:

To gain familiarity with the ideas of voltage, current and resistance and to become familiar with the tools and equipment used in simple electrical measurements.

Necessary Equipment

1. Resistors of various magnitudes
2. Digital Multimeter (DMM)
3. Protoboard
4. Voltage Supply
5. Potentiometer

Procedure

1. Use a DMM to read the voltage of a power supply. Record the maximum possible voltage. [3 p]. *Note: If you blow a fuse in the DMM, on this occasion or another, you should replace the fuse inside on your own.*
2. Use the resistor color code to find a 12 k Ω and a 3 k Ω axial lead resistors. Check these values with a DMM. Are the DMM readings consistent with the tolerance rating marked on the resistor? [4 p]

Color	A	B	C	Multiplier	Tolerance
Black	0	0	0	x 1 Ω	
Brown	1	1	1	x 10 Ω	+/- 1%
Red	2	2	2	x 100 Ω	+/- 2%
Orange	3	3	3	x 1K Ω	
Yellow	4	4	4	x 10K Ω	
Green	5	5	5	x 100K Ω	+/- .5%
Blue	6	6	6	x 1M Ω	+/- .25%
Violet	7	7	7	x 10M Ω	+/- .1%
Grey	8	8	8		+/- .05%
White	9	9	9		
Gold				x .1 Ω	+/- 5%
Silver				x .01 Ω	+/- 10%

Note: Every time you pick a component, such as a resistor, from a component bin, you should verify whether the value markings on that component agree with your expectation. Unfortunately, it is common for the components to be returned to incorrect bins.

3. The power rating of a resistor depends on its size. Using the vernier calipers measure the length and diameter of the 12 k Ω miniature carbon film resistor. Compare your measurements with the data on the page from a component catalog at http://www.pa.msu.edu/courses/2011fall/PHY440/Exp_pdf/DigiRes.pdf. What are the power ratings for your resistors? [4 p]
4. Use a DMM to measure the resistance of a 1 M Ω resistor, while holding one resistor lead in the fingers of your left hand and the other resistor lead in the fingers of your right hand. Repeat the measurement in a way that gets your body out of the circuit. Do you find a difference? Would you expect to find a difference if the resistance to be measured was 12 k Ω ? Try it. [4 p]
5. Predict and measure the combined resistance of:
 - A) 12 k Ω and 3 k Ω in series. [3 p]
 - B) 12 k Ω and 3 k Ω in parallel. [3 p]
6. The circuit in Figure 1 is known as a voltage divider. You can build it on your protoboard.
 - A) Predict and measure the voltages V_1 and V_2 . Compare with the supply voltage. [3 p]
 - B) Predict the battery current. Use the DMM to measure it. [3 p]
 - C) Suppose the 3 k Ω resistor is shorted. Predict the battery current and the current through the 12 k Ω resistor. Use the DMM to measure these. [3 p]
7. Figure 2 shows an open circuit. What is the current through the ammeter? What is the voltage at point P? [3 p]

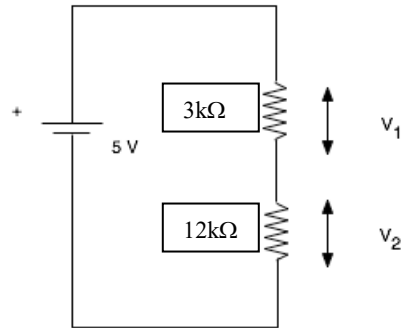


Figure 1: Resistors in Series.

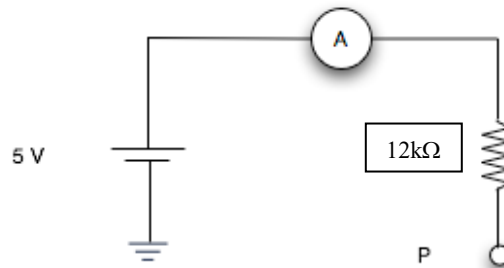


Figure 2: Open Circuit.

8. Figure 3 shows a voltage divider that is loaded by a load resistor R_L . Predict how the voltage V_2 changes if $R_L = 1 \text{ M}\Omega$. Measure it. Predict how the voltage V_2 changes if $R_L = 20 \text{ k}\Omega$ and measure it. [4 p]

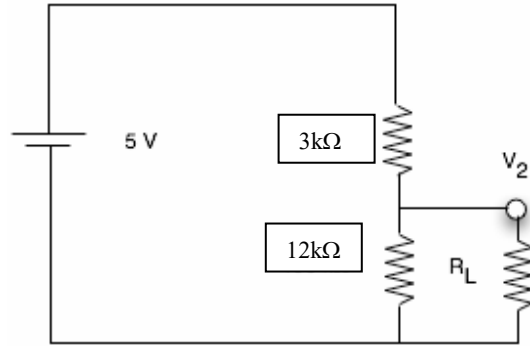


Figure 3: Voltage Divider.

9. A potentiometer (pot) has three terminals. Use a DMM to identify the terminal for the moveable tap on a standard rotary trimmer pot. Which terminals get connected together for maximum clockwise rotation? For maximum CCW rotation? Make a drawing to indicate your answers [4 p]
10. Adjust the pot so that the resistances of the two sides are equal. Show by measurements that this pot is now a voltage divider that divides the voltage by two. Does it matter what the net resistance of the pot is? How does the net pot resistance affect the behavior of this divider under loading? [4p]