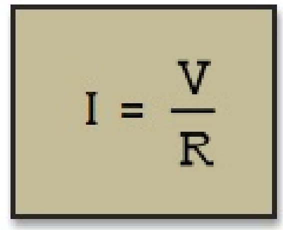
Name: ____ Section: ___________ Date: _________________

Worksheet - Exp 15: Ohm's Law

Objective: This experiment applies Ohm's Law to varying voltages, currents, and resistances in order to study the relationship. Students will become familiar with reading resistor color codes.

Theory:

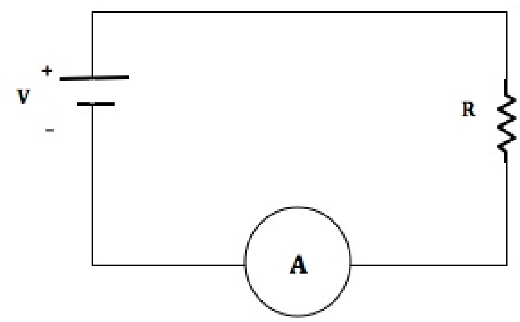
Ohm's Law states that the current I that flows in a circuit is directly proportional to the voltage V across the circuit and inversely proportional to the resistance R of the circuit.



Knowing the value of any two of these variables in a circuit, one can solve for the third. In this lab, voltage and current will be manipulated in order to determine the equivalent resistance of a circuit.

1. A simple series circuit, like the one used in this experiment, is shown at the right. If the resistance of the circuit is 11 kΩ, what voltage must be applied to achieve a current of 16 mA? (3 pts)

   $V =$ _________________



2. Consider the behavior of the above circuit when altered in the following manner. Voltage and resistance are both increased; the current in the circuit will be: (3 pts)
   a) Increased
   b) Decreased
   c) Unchanged
   d) (not enough information)

3. Currents as low as 0.07 amps can be fatal when they pass through the human heart, but this semester's experiment will involve currents of several amps. To see why the experiment is safe, calculate the voltage required to produce such a current, assuming the human body has a resistance of about 10,000 Ω. (2 pts)

Procedure

Part 1: Measures of Resistance

4. Determine the nominal resistance for the three resistors: interpret the color codes according to the color code chart provided at the bottom of the page.
5. Measure the actual resistance of the three resistors using the ohmmeter and record them in the Table.
6. Do the measured resistances fall within the tolerance of the nominal resistance for each resistor? If not, what might cause their measured values to differ from those listed? (3 pts)

7. An ideal ammeter has no resistance; this ammeter does have a small resistance. Measure the resistance of the ammeter. (2 pts)

$R_A =$ ____________________

Color	**Number**	**Multiplier**
Black	0	10^0
Brown	1	10^1
Red	2	10^2
Orange	3	10^3
Yellow	4	10^4
Green	5	10^5
Blue	6	10^6
Violet	7	10^7
Grey	8	10^8
White	9	10^9

Tolerance	
Gold	5%
Silver	10%
(No Band)	20%

Table 1

R_1

Color Code				
Code Value			10^—— ±	%
Nominal Resistance	________________ ± ________ Ω			
Measured Resistance				

(5 pts)

R_2

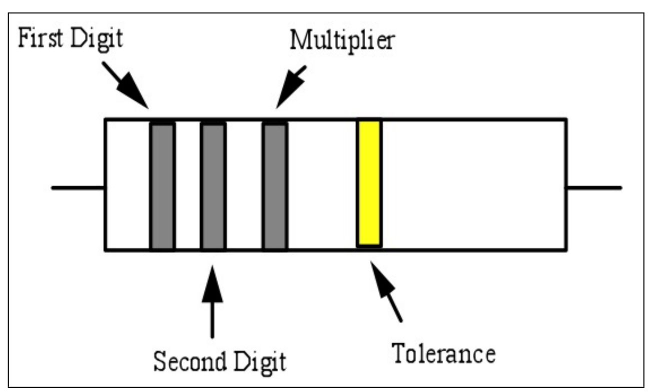
Color Code				
Code Value			10^—— ±	%
Nominal Resistance	________________ ± ________ Ω			
Measured Resistance				

(5 pts)

R_3

Color Code				
Code Value			10^—— ±	%
Nominal Resistance	________________ ± ________ Ω			
Measured Resistance				

(5 pts)



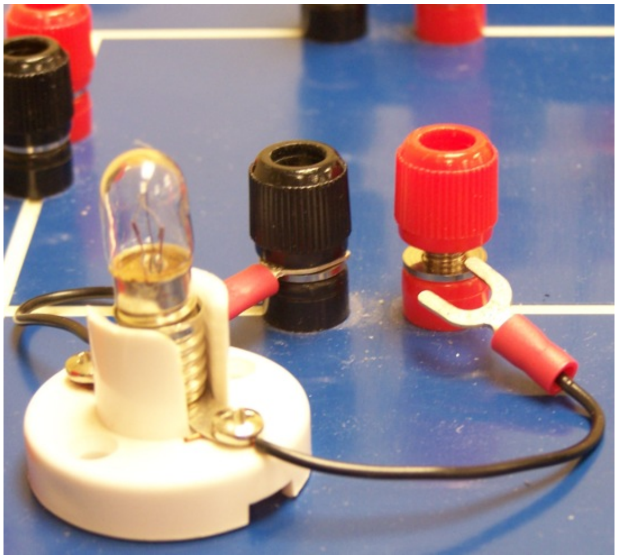
Part 2: Ohm's Law Applied

8. Build a simple series circuit using R_1, an ohmmeter, an ammeter, and a jumper.
9. Measure the equivalent resistance of the circuit using the ohmmeter and record this value in the table. Include units and uncertainty.
10. Is the equivalent resistance what we expect it to be – is it equal to the resistance of R_1 plus the resistance of the ammeter? What would cause R_{eq} to be different than $R_1 + R_A$? (4 pts)
11. Remove the ohmmeter and connect the unplugged power supply to the circuit. Connect a voltmeter to the circuit, across the power supply leads (in parallel).
12. Have your TA check your circuit. Plug in the power supply and turn it on.
13. Test Ohm's Law ($V = IR$) by verifying that current increases linearly with applied voltage. Apply 1V, 2V, 3V, and 4V to the circuit. Measure current and voltage and record them in the table. Include units and uncertainty.
14. Repeat the *Ohm's Law Applied* procedure for R_2 and R_3.

Table 2

R_1 circuit	
Equivalent Resistance: R_{eq}= ________	
Voltage	Current
R_2 circuit	
Equivalent Resistance: R_{eq}= ________	
Voltage	Current
R_3 circuit	
Equivalent Resistance: R_{eq}= ________	
Voltage	Current

(18 pts)



Part 3: Non-Ohmic Device

15. Build a series circuit using R_4, the light bulb.
16. Measure the current and voltage as you increase the applied voltage in 0.2V increments up to 2.0V, the continue in 1.0V increments up to 4.0V. Adjust the voltmeter scale to obtain the most significant figures possible.
17. Turn off and unplug the power supply; turn off the DMM's.
18. If necessary, Tables 2 and 3 may be copied to the back of the extended worksheet.

Table 3

R_4 circuit	
Voltage	Current

(12 pts)

Part 4: Graphing

19. Open your graphing software. Enter all of your voltage and current data from Tables 2 and 3 as four separate data sets (one for each resistor). Include the point (0,0) in each set.

20. Plot I $vs.$ V for the three Ohmic resistors. Apply a linear fit to each one. (18 pts)

21. What does the slope of this graph represent? Consider Ohm's law and how it is represented on the graph by $y = mx$. (6 pts)

22. Calculate the resistance of each circuit using the slope of your I $vs.$ V graphs. Compare these R_{graph} values to the measured R_{eq} values using the percent difference formula. (6 pts)

R_1 circuit: R_{graph} = ________________ % Diff. = ____________

R_2 circuit: R_{graph} = ________________ % Diff. = ____________

R_3 circuit: R_{graph} = ________________ % Diff. = ____________

23. Plot a separate I $vs.$ V graph for the light bulb. (5 pts)

24. Does the slope of this graph change at different voltages, or does it remain constant? What does this tell you about the resistance of the light bulb? (5 pts)

25. Print a copy of both graphs and submit them with your worksheet.