Student Worksheet

Ohm's Law with Light Bulbs and LEDs

Objective: Through experimentation, observe the behavior of ohmic and non-ohmic materials in a series circuit.

Materials:

- Power Supply
- Resistors
- Holiday Light Bulb
- Holiday LED or Circuit Board LED
- Breadboard
- Jumper wires
- Digital multimeter or Vernier current probe
- LabPro and LoggerPro (if using the Vernier current probe)
- Computer with Excel

Procedure:

Part A: Reading Resistors

1. Use a multimeter on the ohmmeter (Ω setting to measure the value of resistance for each of the resistors. Look at Figure 1 for help.
2. Find the value of each resistor using Figure 2 (below). The last color band is the tolerance.
3. Enter all the values in Table 1.

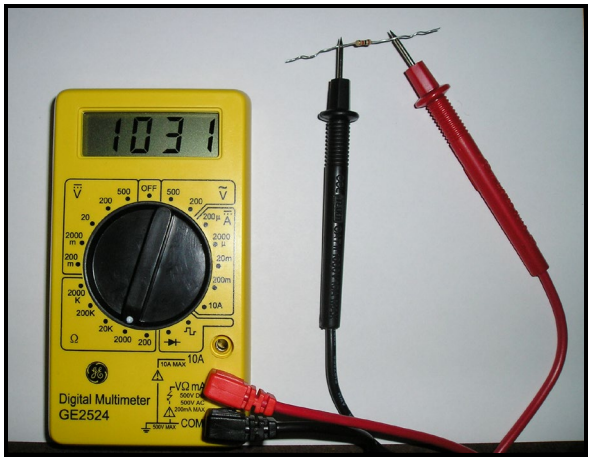

Figure 1. Measuring Resistance.

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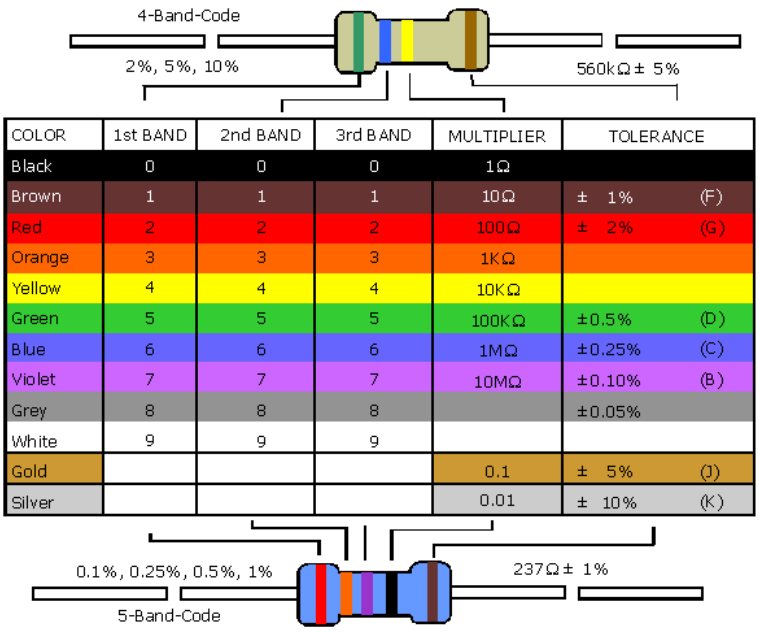

COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE	
Black	0	0	0	1Ω		
Brown	1	1	1	10Ω	± 1%	(F)
Red	2	2	2	100Ω	± 2%	(G)
Orange	3	3	3	1KΩ		
Yellow	4	4	4	10KΩ		
Green	5	5	5	100KΩ	±0.5%	(D)
Blue	6	6	6	1MΩ	±0.25%	(C)
Violet	7	7	7	10MΩ	±0.10%	(B)
Grey	8	8	8		±0.05%	
White	9	9	9			
Gold				0.1	± 5%	(J)
Silver				0.01	± 10%	(K)

Figure 2. Resistor color code chart.
(www.elexp.com/tips/clr_code.gif)

Table 1. Data for the resistors.

Resistor Colors	Measured Resistance (Ω)	Calculated Resistance (Ω)

Part B: Resistor in a Circuit

1. Using the breadboard, build a simple circuit consisting of a 1 kΩ resistor connected to a power supply. In your circuit, include a digital multimeter to measure the voltage across and the current through the 1 kΩ resistor.
2. Adjust the power supply until the voltage across the resistor is about 1.0 V. Record both the voltage across and the current through the resistor.
3. Increase the voltage across the resistor to about 2.0 V and record the voltage and current. Continue to increase the voltage in 1.0 V increments until you reach 10.0 V. Record all your data on Table 2.

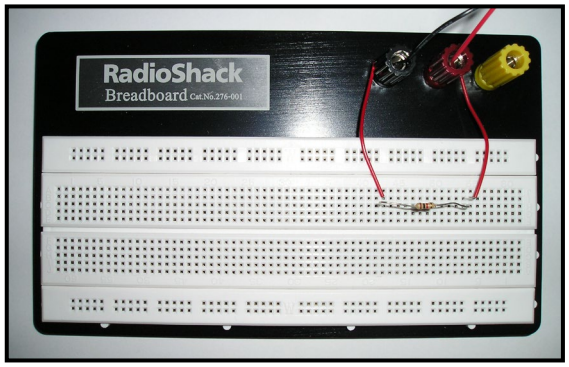

Figure 3. Resistor circuit setup.

4. When the voltage across the resistor is 10 V, watch the current through the resistor for about 30 s. Does the current through the resistor change during the 30 s? What does this tell you about the temperature of the resistor?
5. Turn the power supply off.
6. Switch the leads from the resistor. Check on the current for two or three different values of the voltage and compare with your previous results. Does the polarity of the voltage across the resistor make any difference in the current through the resistor?
7. Use Excel to fit the data to a straight line or curve. From the slope of your line, calculate the resistance.

Table 2. Data for the resistor circuit.

Voltage (V)	Current (A)
1.0	
2.0	
3.0	
4.0	
5.0	
6.0	
7.0	
8.0	
9.0	
10	

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Part C: Light Bulb in a Circuit

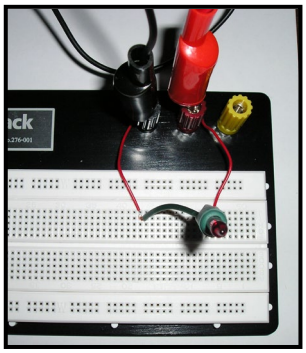

Figure 4. Light Bulb Circuit Setup.

1. Build a simple circuit consisting of a light bulb connected to a power supply. In your circuit, include a digital multimeter to measure the voltage across and the current through the light bulb.
2. Adjust the power supply until the voltage across the light bulb is about 0.5 V. Record both the voltage across and the current through the light bulb.
3. Increase the voltage across the light bulb to about 1.0 and record the voltage and current. Continue to increase the voltage in 0.5 V increments until you reach 3.0 V. Record all of your data in Table 3.
4. Use Excel to make a plot of current vs. voltage. Is the light bulb ohmic or non-ohmic? How do you know? Does the light bulb filament have a constant resistance? Why or why not?

Table 3. Data for the light circuit.

Voltage (V)	Current (A)
0.5	
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	
4.5	
5.0	

Part D: Light Emitting Diode (LED) in a Circuit

1. Using the breadboard, build a simple circuit consisting of a 1 k resistor and an LED connected in series with a power supply. In your circuit, include a digital multimeter to measure the voltage across and the current through the LED.
2. Adjust the power supply until the voltage across the LED is about 1.75 V. Is there any current flowing through the LED?

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3. Reverse the polarity of the voltage across the LED by switching the leads of the LED. Does the polarity of the voltage across the LED make any difference in the current through the LED?
4. Adjust the polarity of the voltage across the LED so current flows through the LED.
5. Adjust the voltage across the LED to 0.5 V and record the current through the LED. Increase the voltage to 1.0 V and then 1.5 V and record the current through the LED.
6. Record the current through the voltage across the LED for values between 1.5 V and 2.0 V. Record all of your data into Table 4. What is the turn-on voltage of the LED?
7. Use Excel to plot current vs. voltage for the LED. Is the LED ohmic or non-ohmic? How do you know?

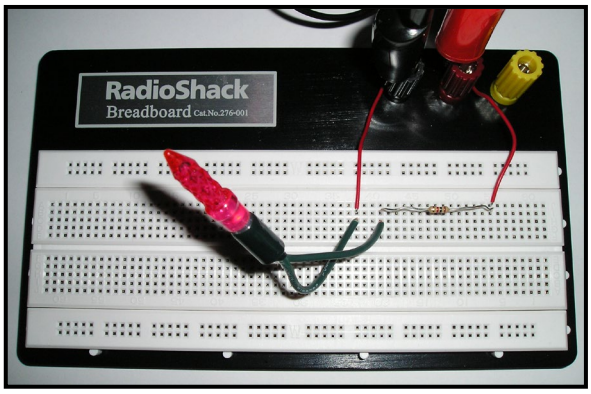

Figure 5. Resistor-LED combination circuit setup.

Table 4. Data for the LED.

Voltage (V)	Current (A)
0.5	
1.0	
1.5	
1.6	
1.7	
1.8	
1.9	
2.0	

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Analysis:

1. Create Excel ® plots of I (current) vs. V (voltage) or each part (B-D).

2. Calculate the slopes or plot regression fits for each part (B-D).

3. Which parts are ohmic and which are non-ohmic?

4. What is the point of placing a resistor in series with the LED?

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