

# Ohm's Law

## Introduction:

**Ohm's Law** describes the relationship between the **resistance** of a particular electrical component or circuit and the **current** which will flow through it for a given applied **voltage**. It is written mathematically as follows:

$$V = IR \quad (1)$$

or voltage equals current times resistance. If two of the above three quantities are known, the remaining one can be calculated.

Consider a certain component of unknown resistance  $R$ . If we apply a known voltage ( $V$ ) and measure the current ( $I$ ) through the circuit, we can compute the resistance from the following equation:

$$R = \frac{V}{I} \quad (2)$$

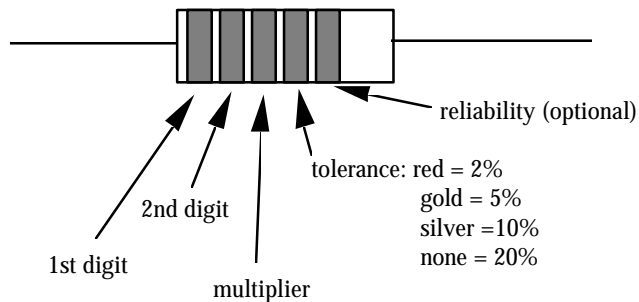
In addition, we can vary the voltage and take measurements of the current for several different voltages. Looking at equation (1), we see that a plot of  $V$  vs.  $I$  should yield a straight line with slope  $R$ .

Although resistors come in many forms, the most common form is that of the **carbon resistor**, which is a small cylindrical resistor made of carbon and some other elements yielding a fairly consistent resistance over a wide range of currents. The manufacturer's value for the resistance of a carbon resistor is given by the color code on the outside of the resistor. In this code system, each color corresponds to a digit. The first two stripes correspond to the two significant digits of the resistance. The third stripe corresponds to an exponential multiplier, and the fourth stripe corresponds to the "tolerance" of this value. The following table illustrates the color coding system and an example for how to compute the resistance from the color code.

## Resistance Color Code for Carbon Resistors

Color	Digit	Multiplier
Silver	-2	$10^{-2} = 0.01$
Gold	-1	$10^{-1} = 0.1$
Black	0	$10^0 = 1.0$
Brown	1	$10^1 = 10$
Red	2	$10^2 = 100$
Orange	3	$10^3 = 1000 = 1k$
Yellow	4	$10^4 = 10k$
Green	5	$10^5 = 100k$
Blue	6	$10^6 = 1000k = 1M$
Violet	7	$10^7 = 10M$
Gray	8	
White	9	

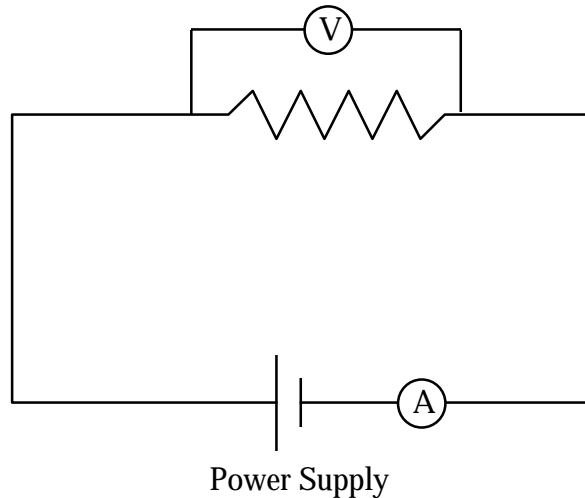
Example: red-green-blue-gold is a  
2, 5, times 1M, or 25M  $\pm$  5% Ohms resistor.



The objective of this laboratory is to test the resistance of three carbon resistors by plotting  $V$  vs.  $I$ , and compare this value with the value specified by the color code on the resistor.

### **Procedure:**

1. Choose one of the resistors from those provided and record its indicated resistance and tolerance.
2. Place the resistor in the terminals so that a connection is made at each end.
3. Make sure the power supply is turned off. Connect the power supply, the multimeter (set on volts), and an ammeter, in accordance with the following circuit diagram:



4. With the voltage on the power supply turned all the way down (counter-clockwise), turn on the power supply and the multimeter(s).
5. Slowly increasing the voltage, take readings of voltage and current for the voltages of 1,2,3,4, and 5 Volts. Record current and voltage in the table provided.
6. Repeat this procedure for two different resistors.

**Analysis:**

1. Use equation (2), Ohm's law, to find the resistance for each of the voltage/current data pairs. You should have five values for each resistor.
2. For each resistor, take the average of all five measured resistances and record it in the table. Compute the average deviation of the mean for each of the resistors. This is done through use of the following formulae:

$$S_n = \text{deviation from the mean} = |x_{\text{avg}} - x_n|$$

$$S_{\text{ave}} = \text{average deviation from the mean} = \frac{1}{N} \sum_{n=1}^N S_n$$

Where  $N$  is the number of measurements and  $n$  is the index of an individual measurement. This is a measure of the *precision* of your data collection.

On the graph paper provided, plot the voltage vs. current for all three resistors. voltage will be plotted along the y-axis, and current along the x-axis. You will wish to scale the graphs so that both axes reflect the entire range of data collected. Do the data points for each resistor form a straight line? If the line appears to curve at higher voltages, explain why.

**Conclusions:**

1. Write a summary of the experiment performed.
2. What did you find about the current and voltage for the different given resistors? Was the resistance you measured close to the indicated value? Which one do you think is more *accurate*?
3. Why do you think it is important to measure the current for several different voltages when testing Ohm's law?
4. For each of your graphs, how is the slope related to the resistance? Do the plotted data form straight lines? If the resistor were temperature sensitive, how would this affect the lines?

**Error Analysis:**

Explain probable sources of error and describe the significance of your  $S_{ave}$ .

# Ohm's Law

Name: \_\_\_\_\_ Section: \_\_\_\_\_

**Abstract:**

**Data:**

*Resistor One:*

$n$	$V$	$I$	$R$	$S$
1				
2				
3				
4				
5				
	Indicated Resistance		$R_{ave}$	$S_{ave}$

*Resistor Two:*

$n$	$V$	$I$	$R$	$S$
1				
2				
3				
4				
5				
	Indicated Resistance		$R_{ave}$	$S_{ave}$

**Resistor Three:**

$n$	$V$	$I$	$R$	$S$
1				
2				
3				
4				
5				
	Indicated Resistance		$R_{ave}$	$S_{ave}$

**Calculations:**

**Conclusions:**

**Error Analysis:**