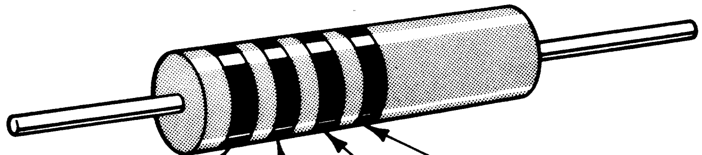
Resistors

Fixed resistors are usually made of carbon encased in either a phenolic or plastic cylinder with a connecting wire extending from each end of the cylinder. The magnitude of the resistor is color coded in bands around the cylinder. Upon examination, you'll notice that the bands are closer to one end of the cylinder. Orient this end so that it is on your left. Or, you may find that one band is a metallic color. Orient the resistor so that this band is on your right. Then use the following code to translate the colors:



	Digit 1	Digit 2	Exponent
Black	0	0	10^0
Brown	1	1	10^1
Red	2	2	10^2
Orange	3	3	10^3
Yellow	4	4	10^4
Green	5	5	10^5
Blue	6	6	10^6
Violet	7	7	10^7
Grey	8	8	10^8
White	9	9	10^9

The fourth band (if there is one) denotes the precision or tolerance of the resistor:

Gold = ±5%

Silver = ±10%

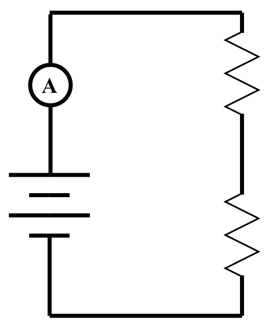
No Band = ±15%

This color code is used extensively in electronics for marking the values or the serial numbers of electronic devices.

The physical size of a resistor does not usually reflect its resistance but does reflect the power it can handle. The power size depends upon the voltage, current and resistance as is calculated by

$$P = IV \quad \text{or} \quad P = V^2/R \quad \text{or} \quad P = I^2R$$

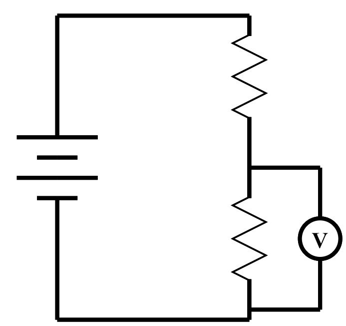
Carbon resistors come in power sizes ranging from 1/8 watt to 10 watt. Higher powers are achieved by switching to other materials.



An ammeter is used in a circuit as if it was a conductor. For all practical purposes, it is. *An ammeter must be wired in series* with the device being measured so that the current flows throught the ammeter as well as the device. This means that an ammeter must have an extremely low resistance so that its presence will not significantly alter the current it is intended to measure. Because of this low resistance, an ammeter can be used to conduct current with as much success as a wire; and, if mistakenly wired in parallel with a current carrying device, it can short-circuit the device.

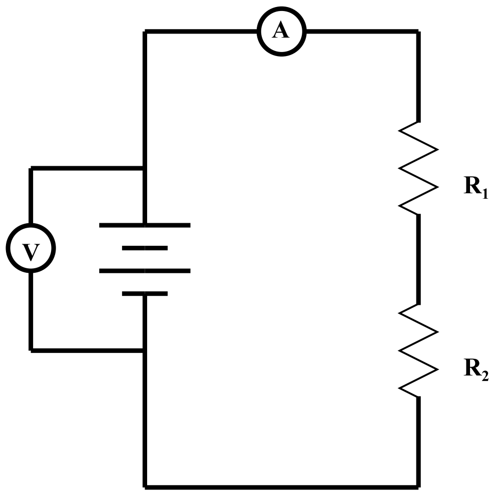
Remember that!

Voltmeters and ammeters have opposite electrical characteristics. *A voltmeter must be wired in parallel* with an electrical device in order to measure the electrical potential across the device. Because it is connected in parallel, a voltmeter must have extremely high resistance so as not to provide an alternate path for the current flowing through the device.



To determine the polarity of a meter in a circuit, ask yourself; “which end of the meter will be closest to the positive (or negative) source of electricity?”

Experiment:



1. Set up the circuit shown using a 1k (i.e. a 1000 ohm) resistor for R_1 and a regulated power supply in place of the cell. (A 1k resistor would have bands of brown-black-red.)

2. Use a 10k resistor initially for R_2.

3. Adjust the power supply for a voltage of 10 volts and periodically readjust it if necessary to maintain 10 volts.

4. Measure the current flowing through the circuit using the ammeter. This is also the current I_1 and I_2 that flows through R_1 and R_2. Why? Enter this current in the chart below.

5. Using V = IR, calculate the voltage drops V_1 and V_2 that should theoretically develop across R_1 and R_2 and then measure them with a voltmeter. Enter the values that you actually measure for V_1 and V_2 in the chart along with their sum, $V_1 + V_2$.

6. Repeat steps 3, 4 and 5 for the values of R_2 given in the chart. For $R_2 = \infty$, simply remove R_2 from the circuit. For $R_2 = 0$, replace R_2 with a wire.

7. What conclusions can you draw about $V_1 + V_2$?

8. For what value of R_2 is the current a minimum? a maximum? Using Ohm's law, show how this maximum could have been predicted. What would the current have been (theoretically) if both R_1 and R_2 had been 0 ohms? Can you see why R_1 is referred to as a "current limiting resistor?"

9. With R_1 = 1k, for what value of R_2 was the power it encountered (P_2) a maximum?

R_2	I	V_1	V_2	V_1+V_2	P_2
∞					
10k					
4.7k					
1k					
470Ω					
100Ω					
0Ω					

Theoretical values:

R_2	I	V_1	V_2	V_1+V_2	P_2
∞	0 mA	0 V	10 V	10 V	0 mW
10k	0.909 mA	0.909 V	9.091 V	10 V	8.26 mW
4.7k	1.754 mA	1.754 V	8.246 V	10 V	14.47 mW
1k	5.000 mA	5.000 V	5.000 V	10 V	25.00 mW
470Ω	6.803 mA	6.803 V	3.197 V	10 V	21.75 mW
100Ω	9.091 mA	9.091 V	0.909 V	10 V	8.26 mW
0Ω	10.000 mA	10.000 V	0 V	10 V	0 mW