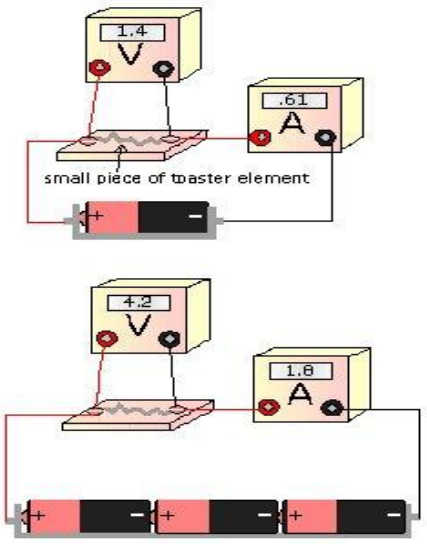
Section 6: Introduction to Resistance

Recall:

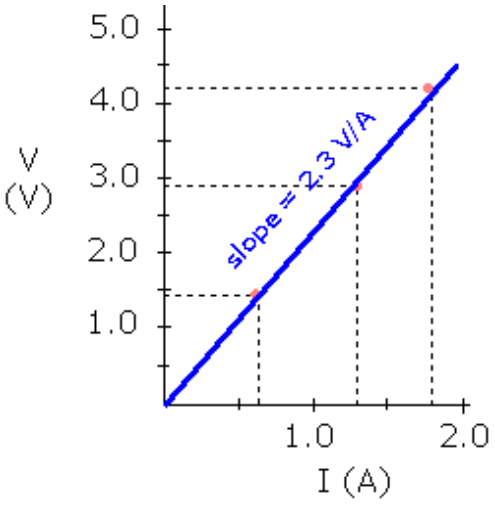
Voltage or potential difference (*V*) may be thought of as the force behind the current (*I*). Thinking of voltage as a force suggests that the larger the voltage of a source, the more current will be pushed through the circuit. Large *V* means large *I*. **To make that last statement it is assumed that the resistance of the path doesn't change.**

To investigate the relation between the Voltage (or Potential Difference) and the rate of current flow, we can apply different potentials across a toaster element, a resistor, and monitor the corresponding currents that result.

The picture below shows 3 circuits. One, two and three 1.5 V cells are connected in series with a small piece of toaster element mounted on a piece of wood. An ammeter and a voltmeter give the current and voltage readings for each set-up. These measurements are also tabulated in the accompanying table.



V (V)	I (A)	V/I (V/A)
1.4	0.61	2.3
2.9	1.3	2.2
4.2	1.8	2.3



Note that *V* vs. *I* is a straight line which means that for this particular circuit element the ratio of potential difference to the current is constant. This **ratio** (which can be found by calculating the slope) is referred to as the **resistance**. The **slope** or **resistance of this element is** 2.3 V/A or 2.3 Ω.

The SI unit of resistance is the ohm and uses the Greek symbol omega, "Ω".

A resistance of 1 Ω means that a potential difference of 1 V applied across the ends of the device will sustain a current of 1 ampere. 10 Ω of resistance means that a potential difference of 10 V is necessary to sustain a current of 1A.

This is Ohm's Law, $R = \frac{V}{I}$ where: **R** is called the resistance in ohms (Ω) and it depends on the particular conductor. 1 Ω = 1V /1A

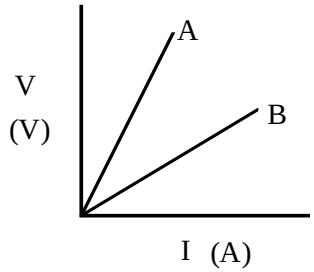
V is the potential difference in volts (**V**)

I is the current in amperes (**A**)

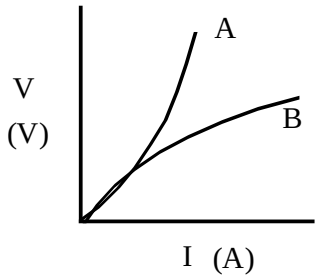
Ohm's Law:

The current in a circuit is directly proportional to the voltage applied as long a the resistance in the circuit does not change

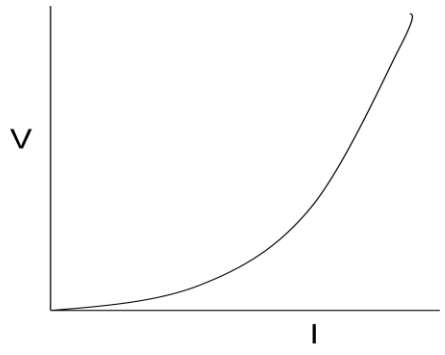
A **linear** or **ohmic resistor** is one for which the graph of Voltage (V) versus Current (I) is a straight line. The slope of the line is the resistance;
the greater the slope, the greater the resistance.



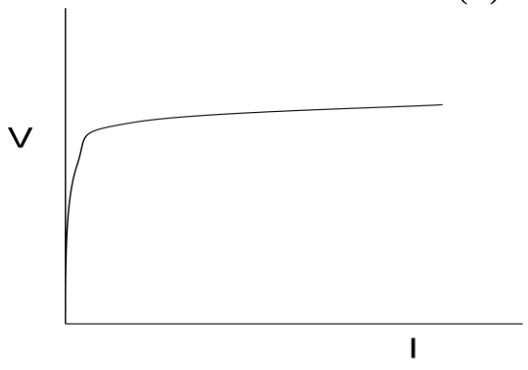
A **non-linear** or **non-ohmic** resistor is one for which the graph of Voltage (V) versus Current (I) is a curve.



Non-ohmic Circuit Elements



This graph is typical of a light bulb. Resistance increases as the filament heats up.



This graph is typical of a diode, a semi-conductor. Under lower voltages it behaves very much like an insulator. Then, when the voltage is right it "cuts in" and acts like a conductor!

Rearrangements of the Formula: $R = \frac{V}{I}$

Examples:

1. A 30 V battery maintains current through a 10 □ resistor. What is the current?

2. A 12 V battery is connected to a device and 24 mA of current flows through it. If the device obeys Ohm's Law, how much current will flow when a 24 V battery is used?

3. An FRS radio is operated by 4 AA cells. If the device has a resistance of 26.8 Ω, what current does the device draw?