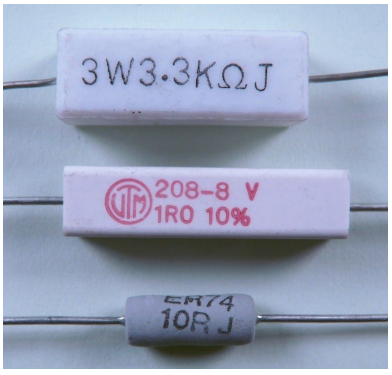
Resistance

Introduction



A resistor is a component that opposes the flow of current. In a simple circuit containing a battery and a bulb the battery causes current to flow through the bulb and the bulb has resistance that limits the current that can flow. In the bulb electrical energy is transferred to light and heat. In any resistor electrical energy is transferred to heat.

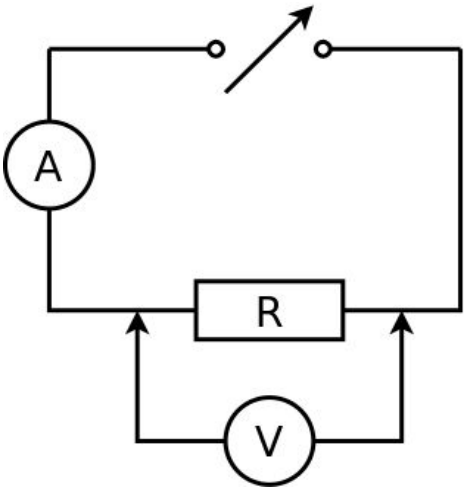
Resistance is measured in ohms (Ω)

The resistance of a resistor is a property of the material that the resistor is made from. An example of a resistor is a piece of wire. The resistance of the wire depends on its length, diameter, the material the wire is made from and the temperature of the wire - all physical properties of the wire.

When current flows through a resistor, it dissipates energy and gets hot - this may or may not be useful! For example, the filament in a light bulb is a resistor and the current flowing allows the filament to get hot enough to glow. On the other hand, if too much current flows in domestic wiring, the wire will get hot and melt or catch fire - definitely not a useful result. Domestic wiring is protected by a thermal fuse - a small piece of wire that is designed to melt when it gets hot due to excess current.

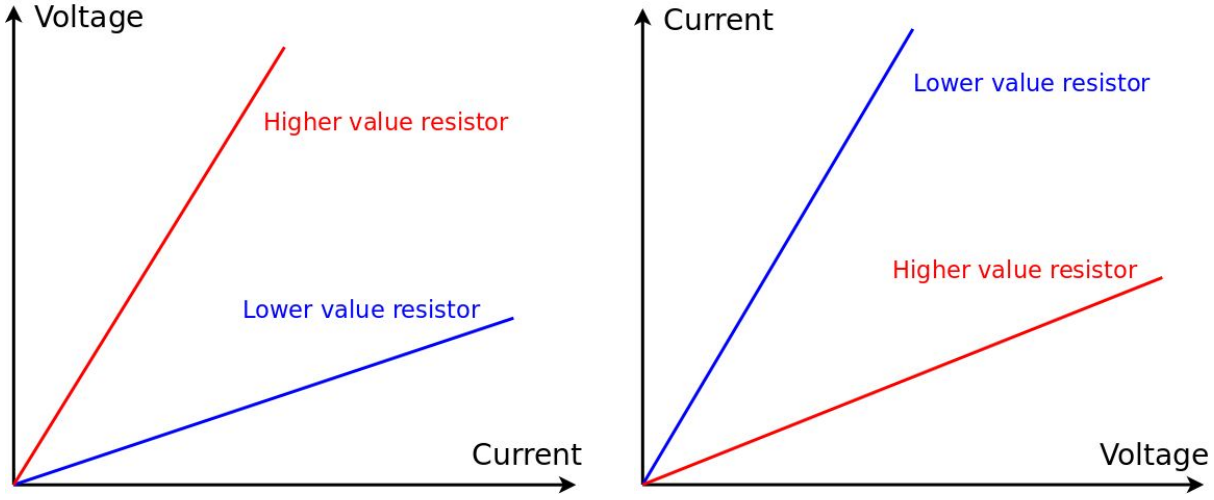
Resistance, Voltage and Current

In a simple circuit containing a battery and a bulb, increasing the battery voltage (EMF) causes more current to flow and there is a greater potential difference (Pd) across the bulb. Generally, a larger current flowing through a resistor means there must be a greater voltage (Pd) across the resistor



For any resistor, the relationship between voltage and current can be investigated and the nature of the resistor determined by measuring values of potential difference and current using the test circuit shown.

These values can be plotted on a graph of current (x-axis) and voltage (y-axis). Alternatively a graph of voltage (x-axis) against current (y-axis) is equally valid - you need to recognise both.



A fixed resistor is a resistor that has a constant resistance. The graph of potential difference against current for a fixed resistor is a straight line.

Other resistors, such as bulbs and thermistors, do not have a linear graph but in all cases the graph will go through the origin - when the current is zero, the potential difference is zero.

On the graphs shown, the red line is for a higher value resistor and the blue line is a lower value resistor. At any given voltage, more current flows through the lower value resistor and less current through the higher value resistor.

The resistor equation

The actual resistance of a component is determined by how it is constructed i.e. what it is made from.

However, in an electrical circuit, resistance is DEFINED as:

Resistance = Voltage ÷ Current

or, using standard symbols

$R = V \div I$

R = Resistance measured in ohms (Ω)
V = Potential difference across the resistor, measured in volts (V)
I = Current flowing through the resistor, measured in Amps (A)

This is known as the resistor equation. Note, this is not Ohm's Law, Ohm's Law is a special case that only applies to fixed value resistors. Always refer to the resistor equation when talking about resistor values.

The resistor equation can be rearranged to give:

$$V = I \times R$$

or

$$I = V \div R$$

Examples of the Resistor Equation

A potential difference of 5 V causes a current of 200 mA to flow through a resistor. What is the resistance?
Recall 200 mA = 0.2 A R = V ÷ I R = 5 ÷ 0.2 R = 25 Ω

A current of 12 A flows through a 4 Ω resistor, what potential difference is causing the current to flow?
V = I × R V = 12 × 4 V = 48 V

A potential difference of 120 V is applied across a 47 kΩ resistor. What current flows in the resistor?
I = V ÷ R I = 120 ÷ 47×103 = 0.0026 A I = 2.6 mA

Note: In question 3, the answer is only given to 2 significant figures as the data in the question is only given to 2 sig. fig. Don't put too many digits!

Website

http://www.pfnicholls.com/Electronics/resistance.html

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