Resistance

What is electrical resistance?

- What is current?
  - The flow of charged particles, the main form of which is electrons
- What do they flow in?
  - 'Conductors', objects that allow the movement of electrons
- Can they freely flow?
  - 'Yeah, nah', they have mass and charge and must move past other things that are charged and …
  - They were 'initially' attached to an atom (or molecule)

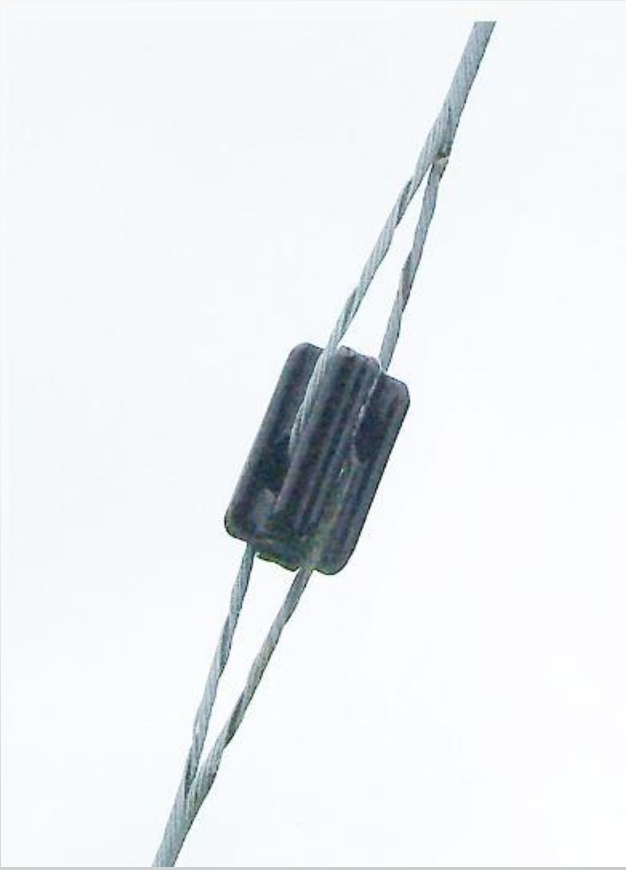
Thus

- In conductors electrons are able to move, however, a number of factors resist that movement. These factors change depending on the material and its temperature.
- This difference in the ability to move is what we call resistance.
  - Low resistance – easy for electrons to move
  - High resistance – hard for electrons to move
  - Non-conductor (or insulator) – very very hard for electrons to move

NOTE: Conductors and insulators run on a continuum and if you put enough voltage “across” any insulator, current will flow and conversely, if you only have a tiny voltage across a conductor, it may not flow.

Quick exploration

We just said: "*Conductors and insulators run on a continuum and if you put enough voltage "across" any insulator, current will flow and conversely, if you only have a tiny voltage across a conductor, it may not flow.*"



- In the case of porcelain insulators on high tension cables, air around the insulator is a better conductor than the insulator, thus any "leakage" is seen as sparks going around the insulator, rather than through it.

Resistance?

- The resistance of a conductor depends on its
  - Length
  - Area of cross-section
  - Temperature
  - Type of the material of which it is composed

Thus, no memory required, we just look it up in a book (or google)

Ohm

- Georg Ohm was a German physicist, mathematician and school teacher.
- Ohm researched Volta's electrochemical cell
- He found that there is a direct proportionality between the potential difference (voltage (V)) applied across a conductor and the resultant electric current (I). This relation is called Ohm's law, and the ohm (Ω), the unit of electrical resistance (R), is named after him

$$\boldsymbol{V = IR}$$

However, its not quite that simple …

- Some conductors are ohmic, that is the resistance does not change with changes in voltage.
  - In other words, a change in V produces a proportional change in I
- Some are non-ohmic, resistance changes with voltage change
  - A change in V does not produce a proportional change in I, which implies that the resistance has changed
- And … generally resistance changes with temperature but “weirdly”

Temperature change in resistors

- First, lets be brutal
  - Electrical current (the flow of electrons), involves friction, which produces heat.
  - Heat is the energy of moving atoms and molecules.
  - Increasing heat makes it more likely that electrons will be "freed", simply because they are moving more vigorously
  - Thus reducing one part of the "resisting"
- But …
  - Superconductors use cooling …
  - Because they are really cool (-100s of degrees generally), the atoms and molecules aren't moving and thus there is less in the way of electrons that are "just travelling through"

But for now ….

An ohmic conductor will follow ohm's law

$$V = IR$$

For the normal temperature range of its use

A change in voltage will cause a proportional change in current and the materials resistance will not change

And …

A non-ohmic conductor’s resistance will change with a change in the voltage across the resistor.

Lets go back over the key facts

Video suggestions

- Resistors, FuseSchool
- Ohm's Law, SparkFun

$$V = IR$$