

Basic Electricity

<https://github.com/teaksoon/lmaewapm>

When we do programming work with our Regular Computers, we do not need to know much about electricity because we do not connect “raw” electrical components to the Regular Computers

For **micro-controller** programming, we have “raw” electrical components connected to the micro-controllers most of the time. Programming micro-controller are mostly about dealing with various electrical properties on those components. **Because of that, we will need to know at least the basics of electricity, otherwise it will be very difficult for us to write our Program effectively for our micro-controller**

For beginners, we only need to know a few basic things. They are mainly,

1. **VOLTAGE** (measured in Volt)

2. **RESISTANCE** (measured in Ohm)

3. **CURRENT** (measured in Ampere) - we often see mA, mA is mili-Ampere

4. **CURRENT FLOW DIRECTION**

Here are examples of some raw electrical components and how they generally relates to the electrical properties above



LED bulb - Will light-up when there is enough “**VOLTAGE**”, “**CURRENT**” with the correct “**CURRENT FLOW DIRECTION**” at the “pin” that it is connected to. If the LED terminal connection are reversed, the LED will not light-up. It will cut off the “**CURRENT**” from flowing through it and becomes an “OFF switch” instead. The LED also have a very small maximum “**CURRENT**” limits before it “blows-up”



Tactile Switch - Will allow or disallow “**CURRENT**” flowing through the Switch. This is a physical connection/disconnection. By doing that the connected device will either have or do not have “**CURRENT**” and “**VOLTAGE**”. The device and our micro-controller can re-act accordingly



RESISTOR - This device have a fixed “**RESISTANCE**” value. When we put it in series with another device, it gives additional resistance to reduce the **intensity of “CURRENT” flow** to the device preventing the device from damage. It can be arrange in a way that it can also influence the “**VOLTAGE**” on certain part of our circuit

VOLTAGE, **RESISTANCE** and **CURRENT** are related to each other, by changing any one of them will effect the others. They are predictable and can be calculated by using the following formula, from the **Ohm's Law**,

$$\text{VOLTAGE (Volt)} = \text{CURRENT (Ampere)} \times \text{RESISTANCE (Ohm)}$$

This formula can be interchanged like mathematic equations (the correct unit measurement must be used)

When working with a Closed Circuit Electrical Circuit. There is another formula that we will use alot, from the **Krichoff's Voltage Law**,

$$\text{TOTAL SUPPLY VOLTAGE} = \text{TOTAL VOLTAGE DROP}$$

VOLTAGE DROP is specific to each individual Device on the Closed Circuit

In some product specifications, “watt” is sometimes mentioned. “watt” is the unit measurement for “Power”

$$\text{POWER (WATT)} = \text{VOLTAGE} \times \text{CURRENT}$$

How exactly does **VOLTAGE**, **RESISTANCE**, **CURRENT** and **CURRENT FLOW DIRECTION** come into existence ?

You can skip this tutorial if you already know about them

Please take note that this tutorial is not meant to be very accurate or with complete details. This tutorial is kept as simple as possible, so that beginners get started as quickly as possible.

We will get into the details as we go along working with our micro-controller

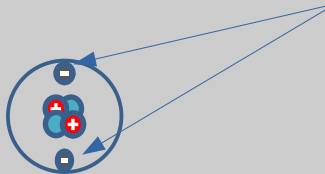
All physical things in our world (including our physical body) is made from a combination of the smallest unit called "Atom"

Atom is very small, each is measured in picometers. So, it will take more than billions of atoms combined, to become something visible with some specific attributes, for example: a metal copper wire



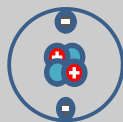
Each Atom is consist of 3 components, Neutron, Proton and Electron. The Neutron and Proton are bind together in the middle, while the smaller Electrons moves freely on the outside.

We are only interested in the Electrons



For the sake of simplicity in this tutorial, we use a "fictitious Atom" with 2 electrons (which happens to be a helium in the real-world).

This is just an example for easy visualization



In normal situation,
the **Number of Electrons** is **EQUAL** to the **Number of Protons**
The Atom is now in **"NEUTRAL"** state (**Electrically Neutral**)

The Proton and Neutron are bind together in the middle of the Atom in a very strong binding. However, the Electrons on the outside can be removed or added when external interference took place

In the two Atoms below,
the **Number of Electrons** is **NOT EQUAL** to the **Number of Protons**
These Atoms are now in **"CHARGED"** state

Electron is taken
away from Atom



Less Electron than Proton
Positive Charged Atom

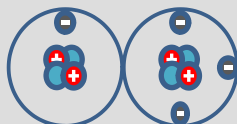


Electron is added to
Atom

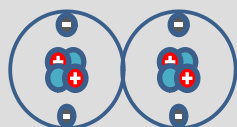
More Electron than Proton
Negative Charged Atom

Atoms always want to return to their Neutral State

What happen if we put Positive and Negative Charged Atoms together ?



The extra Electron from Negative Charged Atom will jump over to the Positive Charged Atom, both Charged Atoms now becomes Neutral again (discharge).



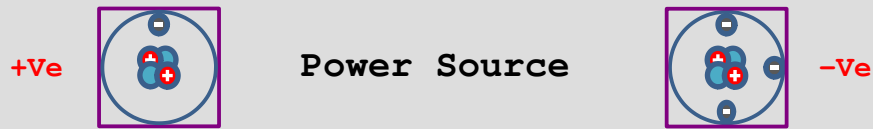
So, what is the big deal of electron moving across atom ?

In this example, we only see one atom with one electron moving across. In real-life, there will be more than one atoms, with billions of electrons moving across for a long period of time, and that becomes a big deal. The continuous movement of electrons for a long period of time creates lot of energy, **"Electric Energy"**

Now we know that if **Negative Charged Atoms** is connected to **Positive Charged Atoms**, the electron move across and we get **"Electric Energy"**

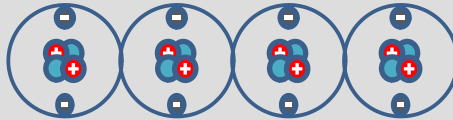
So, we simply keep alot of them seperated OR kept-on making them





Electric Conductor

Electric Conductor is made from material with Electrons that can be easily removed from its Atom
(mostly metals. **Example: copper wires**)



Not all Electric Conductor are the same, in some material the Electrons are easily removed from its atom (**Low RESISTANCE**), in some material the Electrons are harder to be removed from its atom (**High RESISTANCE**).

What will happen when we place the Electric Conductor between the Power Source ?



A Path is created between the +ve and -ve of our Power Source
(known as **Closed Circuit**)

1. We see a path where electron can move to make charged Atoms neutral
2. Then we will also see **"imbalance"** at both ends of this **Closed Circuit**.
 - The Atoms at one end is charged and have MORE Electron(-ve)
 - The Atoms at the other end is charged and have LESS Electron(+ve)

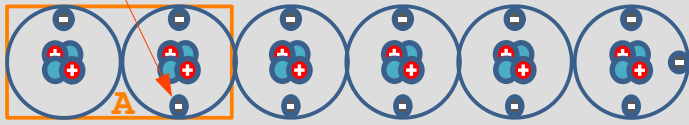
The **"imbalance"** between the both ends is also known as called **VOLTAGE**.

more **"imbalance"** means more **VOLTAGE**

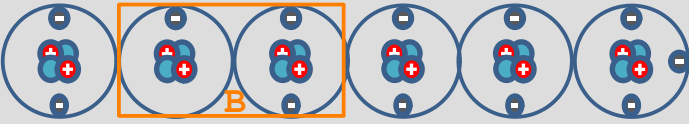
The **"imbalance" / VOLTAGE** in this Closed Circuit will "kick-start" the electron to move and influence the direction of electron movement to discharge the all the charged atoms

Starting from position **A**

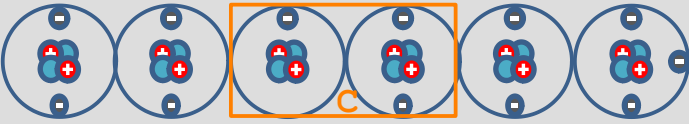
This Electron starts moving, to the positive charged atom.



A New **"Energy Spot" A** is generated



A New **"Energy Spot" B** is generated



A New **"Energy Spot" C** is generated

Movement starts from position **A**. When done, it does the same at position **B**, and then **C**, and so on... **Electron movement at each spot creates "energy spot"**

In our example: it is for just one atom and one electron at a time. In real-life, our Power Source will have more than billions of charged atoms (each with many electrons), some Power Source even have continued generation of charged atoms.

It will take a long time for the electron to complete the movement (to fully discharge all the charged atoms, sometimes the atoms will never be fully discharged). Because of that, the entire Closed Circuit will have this continued moving **"energy spot"**, known as the **ELECTRIC CURRENT**

The sequence of "energy spot" appearing at A, then at B, then at C,... is the **ELECTRIC CURRENT FLOW DIRECTION** (the current flow direction will have effects on some devices, that is why we need to know about current flow direction)

- **Electron** move from negative side (more electron) to positive side (less electron)
- **Electric Current** does the opposite, it moves from positive towards negative

While moving across atoms, the Electrons will also face movement **RESISTANCE** in our Electric Conductor.

The more RESISTANCE, the less intense the CURRENT will be.
The less RESISTANCE, the more intense the CURRENT will be.

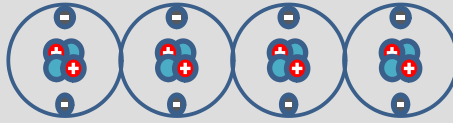
By having different resistance, we can control the intensity of Electric Current at a device which will change the behaviour of the device.

The amount of **RESISTANCE** can be "artificially introduced" into a closed circuit, by using different material as Electric Conductor (often in the form or device called "Resistors").

Electric Conductor/Devices

Often we associate conductors with wires.

Electrical Devices are also a type Electric Conductor. Unlike the wires, the Electrical Device have some parts that will re-act differently connected between the Power Source in a Closed Circuit



Electric Device Example: An **Electric Switch** when placed between the Power Source

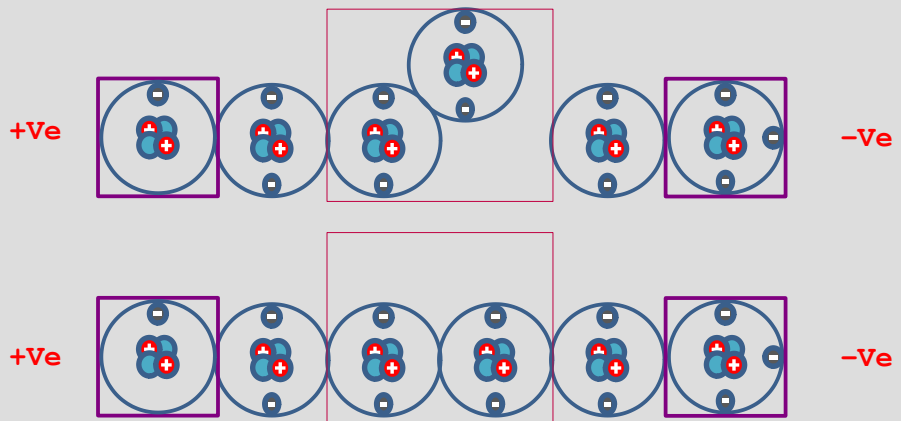
Switch is TURNED OFF

- electron cannot move (path is broken)



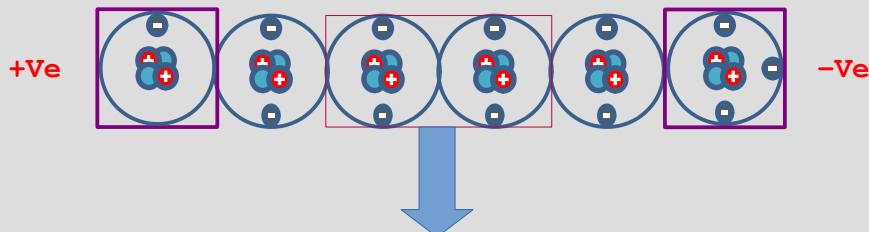
Switch is TURNED ON

- electron can move



This “Electric Conductor” has the ability to be connect and disconnect the link between its atoms by mechanical means

Electric Device Example: A tungsten **Light Bulb** when placed between the Power Source



This part of the Light Bulb “Conductor” is made from thin tungsten wire. When a lot of electron flow past non-stop on this thin tungsten wire, it becomes very hot until it burns, fortunately tungsten wire will not melt, it just glow in burning hot, emitting lights.

The other parts of this bulb is made from different “Electric Conductor” material, so they behave differently from the thin tungsten wire part.