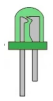
Basic Electricity
https://github.com/teaksoon/lmaewapm

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 eletricity, 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 occordingly

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,**

VOLTAGE(Volt) = CURRENT(Ampere) x 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,**

TOTAL SUPPLY VOLTAGE = 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"

POWER (WATT) = VOLTAGE X CURRENT

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

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.

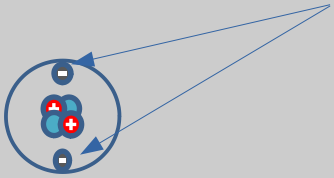
We will get into the details as we go along working with our micro-controller

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 and example for easy visualization

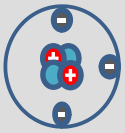
In normal situation,
the **Number of Electrons** is **EQUAL** to the **Number of Protons**
The Atom is now in "NEUTRAL" state (Electrically Neutral)

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

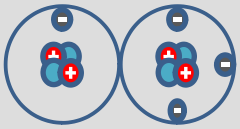


Electron is added to Atom

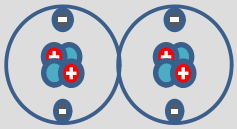
More Electron than Proton
Negative Charged Atom

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 continueus 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

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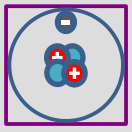
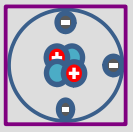


Power Source



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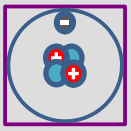
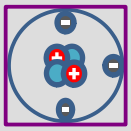
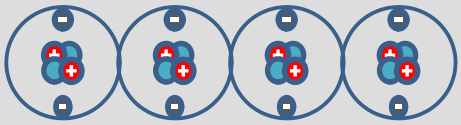
+Ve  **Power Source**  -Ve

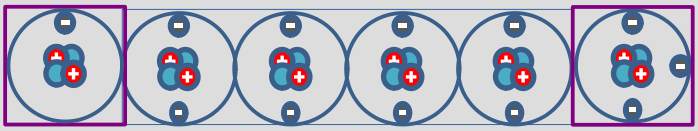
Electric Conductor

Electric Conductor is made from material with Electrons that can be easily removed 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 ?

+Ve  -Ve

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**.

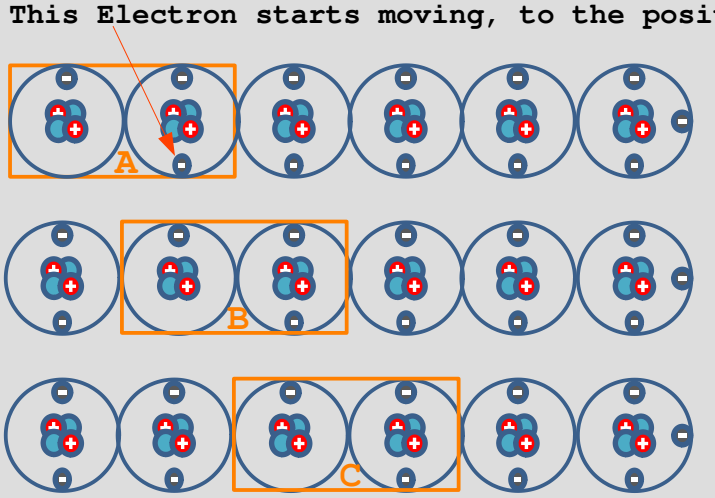
- The Atoms at one end is charged and have MORE Electron(-ve)
- The Atoms at the other end is charged and have LESS Electron(+ve)

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.

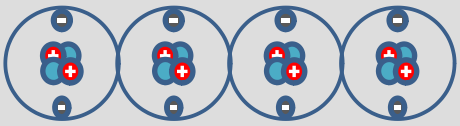
By having different resistance, we can control the intensity of Electric Current at a device which will change the behaviour of the device.

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

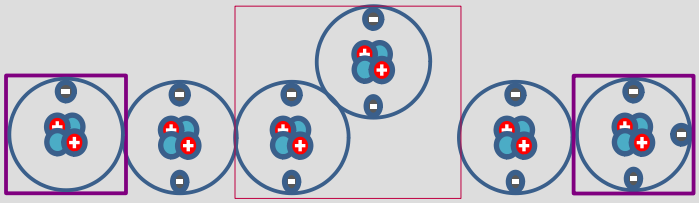
Often we associate conductors with wires.

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

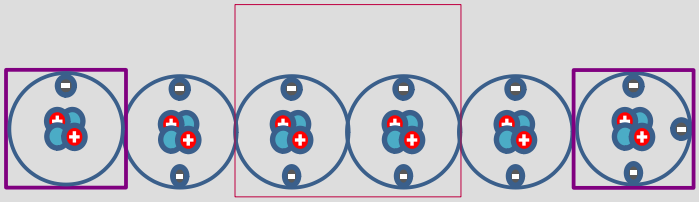


Electric Device Example: An **Electric Switch** when placed between the Power Source

Switch is TURNED OFF
- electron cannot move
(path is broken)

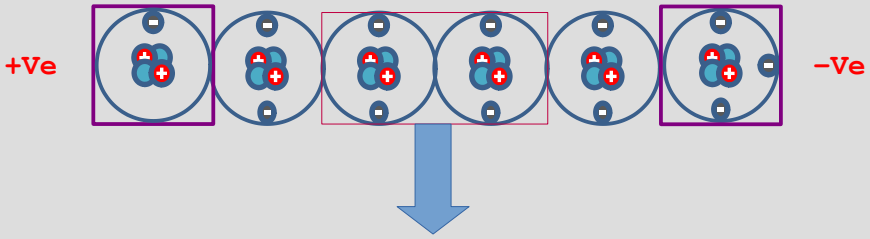


Switch is TURNED ON
- electron can move



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

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

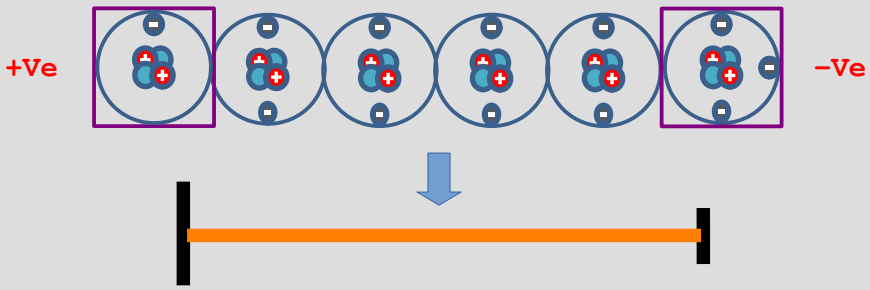


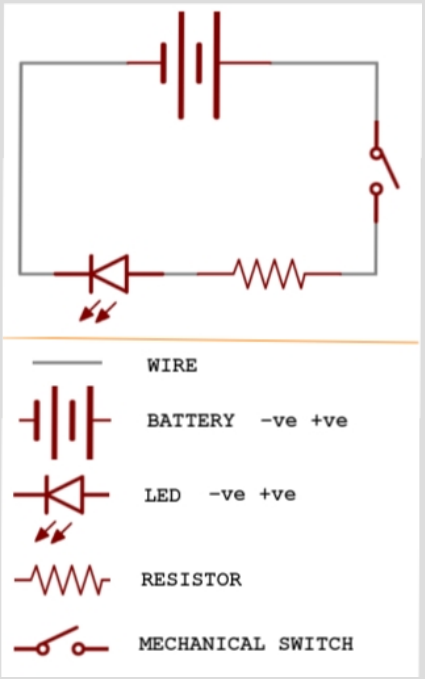
This part of the Light Bulb “Conductor” is made from thin tungstun wire. When alot of electron flow past non-stop on this thin tungstun wire, it becomes very hot until it burns, fortunately tungstun wire will not melt, it just glow in burning hot, emitting lights.

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

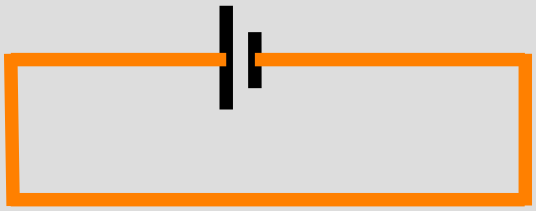
Simple Basic Electric Circuit Diagram

Electrical Circuit is a situation where Electric Conductors are placed between the Power Source. We can place many devices on the Electrical Circuit, for the sake of keeping records or sharing the design with others. We need to draw them in a standard form so that everyone can understand.



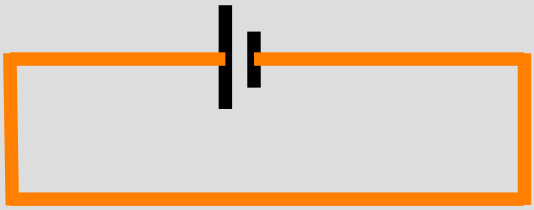


Although the above is what really happening. Electric Circuit diagram are not drawn that way. It is normally in a “loop shape”, like the one below. Both are actually the same, if we we stretch out the one below, it will look exactly like the one on top.



Everyone will draw things differently, that is why an universal standard symbols are used in circuit diagrams, the picture on the right is what we normally see on circuit diagrams. (Different symbols are used for different devices)

DANGER IN A CLOSED CIRCUIT



In a Closed Circuit, the Electric Current will flow for a long period of time. Alot of “Electric Energy” will be flowing in the the entire circuit.

It is our duty to make sure that all the things in the circuit can cope with the amount Electric Current flowing in it, otherwise those unable to cope may end up burnt.

On every Electrical Device, even a single wire, there is always a manufacturer specification, telling us how much Electric Current that it can cope.

Do not exceed the specified limits.