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

When we make PROGRAM for Regular Computers, we do not need to know much about electricity because we do not connect "raw" electrical components to the Regular Computers

When we work with micro-controllers, we will have many **"raw" electrical components** connected to the micro-controller. Many of those "raw" electrical components can only be manipulated with raw electrical properties. 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 Start, we only need to know a few basic things in electricty

1.VOLTAGE (measured in Volt)
2.RESISTANCE (measured in Ohm)
3.CURRENT(measured in Ampere) - we often see mA, mA is milli-Ampere
4.CURRENT FLOW DIRECTION

Here are examples of a few "raw" electrical components,

LED bulb - The operation of this component depends on electrical properites **"VOLTAGE"**, **"CURRENT"**, and **"CURRENT FLOW DIRECTION"**.

Tactile Switch - The is a mechanical device that can prevent or allow **"VOLTAGE"**, **"CURRENT"** to parts of our system

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 paired with another Resistor to be used as "Voltage divider" so that we can have a different **"VOLTAGE"** at different parts of our circuit

BASIC ELECTRICAL FORMULA

Ohm's Law, VOLTAGE, RESISTANCE and **CURRENT** are related to each other, by changing any one of them will effect the others

VOLTAGE(Volt) = CURRENT(Ampere) x RESISTANCE(Ohm)

This formula can be interchanged like mathematic equations (make sure the correct unit measurement is used)

Krichoff's Voltage Law, in a Closed Electrical Circuit,

TOTAL SUPPLY VOLTAGE(Volt) = TOTAL VOLTAGE DROP(Volt)

VOLTAGE DROP is specific to each individual Device on an electrical circuit

Power, In some product specifications, Power rating in "Watt" is sometimes mentioned

POWER(Watt) = VOLTAGE(Volt) X CURRENT(Ampere)

As example: A "0.25W Resistor" means the VOLTAGE x CURRENT on the Resistor must not exceed 0.25W, otherwise the Resistor risk being damaged

There are other electrical formulas, the few formula above are the ones that we will be using the most when working with micro-controllers

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

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

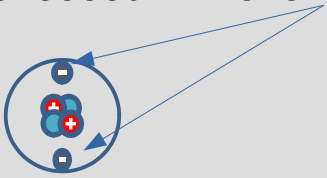
Atom is very small, each is measured in picometers. It will take more than "billions" of atoms combined, in order to become something visible

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.

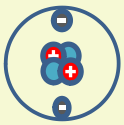
For the sake of simplicity in this tutorial, we use a "fictatious Atom" with 2 electrons (which happens to be a Helium in the real-world).

This is just and example for easy visualization

We are only interested in the Electrons



In normal situation

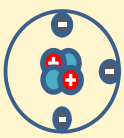


the **Number of Electrons** are **EQUAL** to the **Number of Protons**
The Atom is in "NEUTRAL" state (Electrically Neutral)

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

An interference took place to the two Atoms below

Electron is taken away from Atom



Electron is added to Atom

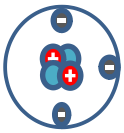
the **Number of Electrons** are **NOT EQUAL** to the **Number of Protons**
These Atoms are now in "CHARGED" state

LESS Electron than Proton
POSITIVE CHARGED Atom

MORE Electron than Proton
NEGATIVE CHARGED Atom

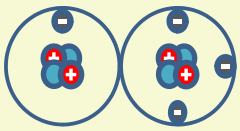
LESS Electron than Proton
POSITIVE CHARGED Atom

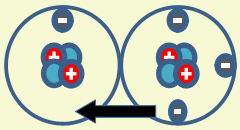
MORE Electron than Proton
NEGATIVE CHARGED Atom



Atoms always want to return to their "NEUTRAL" State

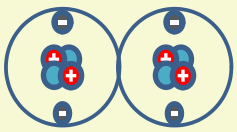
What happen if we put POSITIVE and NEGATIVE CHARGED Atoms together ?





The extra Electron from NEGATIVE CHARGED Atom will move over to the POSITIVE CHARGED Atom

both CHARGED Atoms now becomes NEUTRAL again ("DISCHARGED")



Movement of Electrons across the Atoms generates "Energy" and this "Energy" can do work for us

We make alot of POSITIVE and NEGATIVE CHARGED Atoms
Keep them separated
When we need the Electron to move, we just connect them together

This is our "POWER SOURCE"

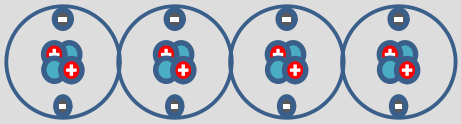
+Ve 

POWER SOURCE

 -Ve

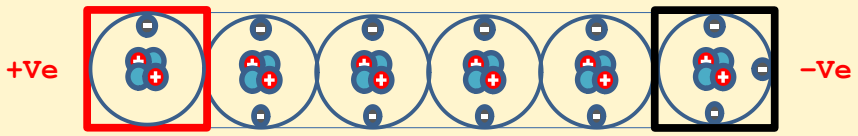
ELECTRIC CONDUCTOR

ELECTRIC CONDUCTOR is made from material where its Electrons can be easily removed its Atom
(they are 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 connecting the POSITIVE and the NEGATIVE ?



A "PATH" is created between the +ve and -ve of the Power Source

VOLTAGE in CLOSED CIRCUIT

1. From the picture above, we can see a **"PATH"** where Electron can move from the **-Ve** to the **+Ve** , to make charged Atoms neutral, this is called a **"CLOSED CIRCUIT"**

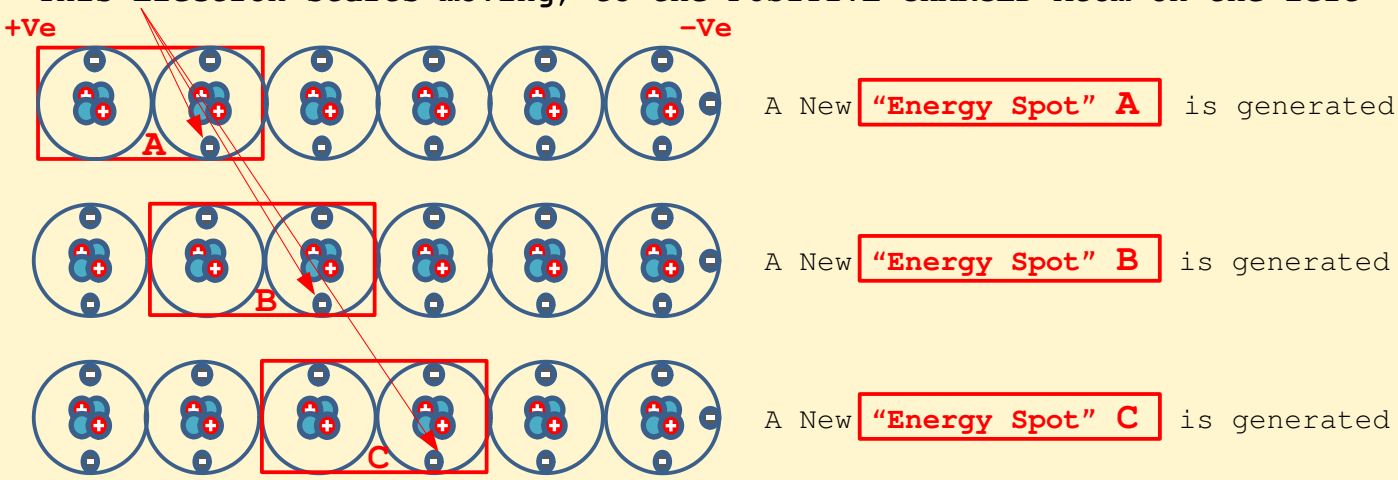
2. From the picture above, we can also see **"imbalance"** at the both ends of this **"CLOSED CIRCUIT"**
- The Atoms at **one end** is charged and have **MORE Electron(-ve)**
- The Atoms at **the other end** is also charged but with **LESS Electron(+ve)**

The **"imbalance"** of electrons between the both ends of the POWER SOURCE is also known as called **"VOLTAGE"**

More **"imbalance"** also means more **"VOLTAGE"**, more strength to move the Electrons and it will also influence the direction of the Electron Movement

Electron will move from the side with more electrons will move to the side with less electrons

Starting from position A
This Electron starts moving, to the POSITIVE CHARGED Atom on the left



CURRENT

Movement starts from **position A.** When done, it does the same at **position B**, and then **position C**, and so on,... **Each Electron Movement creates an "Energy Spot"**

When there is a continued movement of a large number of electrons for a long period of time at high speed, the entire Closed Circuit will be filled with this moving **"Energy Spot"**, also known as the **"ELECTRIC CURRENT"**

CURRENT FLOW DIRECTION

The SEQUENCE of "Energy Spot" appearing at **position A**, then at **position B**, then at **position C**, and so on,... is the **"CURRENT FLOW DIRECTION".**

From the picture above, we can visually see the **"Energy Spot"** moving from the **+ve side to -ve side**.

- **CURRENT FLOW** from from Positive towards Negative

- **PHYSICAL ELECTRON** movement is the opposite, from Negative to Positive

RESISTANCE

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

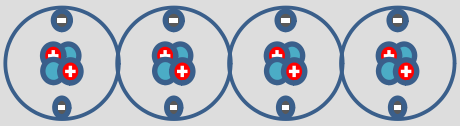
The more RESISTANCE, the less intense CURRENT will be.
The less RESISTANCE, the more intense CURRENT will be.

By having different resistance, we can control the intensity of CURRENT at a device which will change the behaviour of the device or prevent the device from damage. The amount of **RESISTANCE** can be "artificially introduced" into a closed circuit, by using a specialized conductor material (often in the form or component known as "Resistors")

Electric Conductor/Devices

Often we associate conductors with wires.

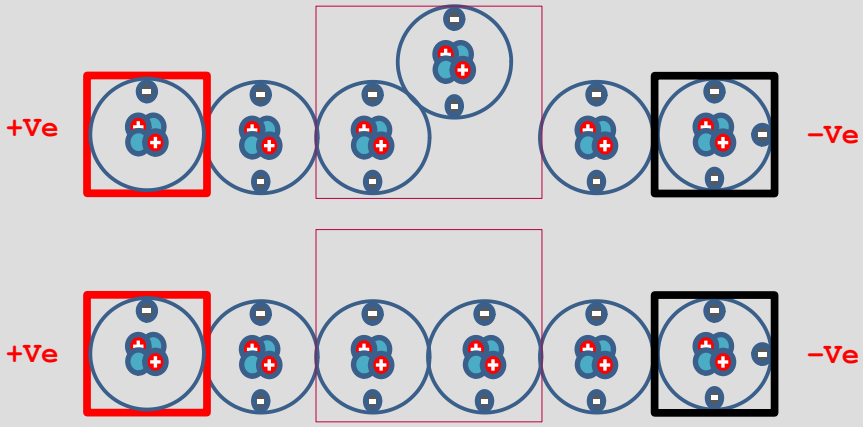
Electrical Devices are also a type Electric Conductor
Unlike the wires, the Electrical Device have some parts that will re-act differently connected between the Power Source in a Closed Circuit



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

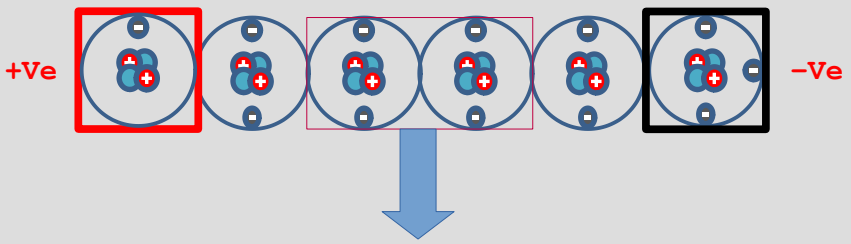
Switch is TURNED OFF
- electron cannot move
(path is broken)

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

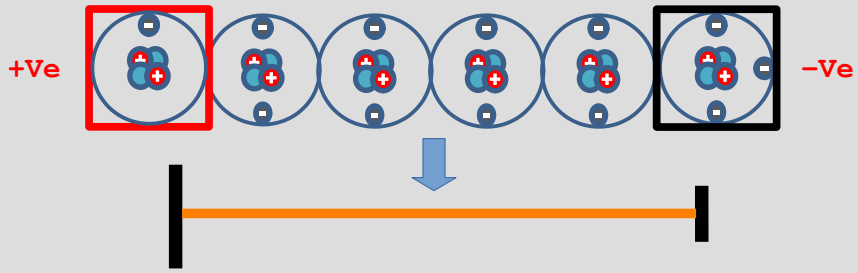


This part of the Light Bulb “Conductor” is made from thin tungstun wire. When alot of electron flow past non-stop on this thin tungstun wire, it becomes very hot until it burns, fortunately tungstun wire will not melt, it just glow in burning hot, emitting lights.

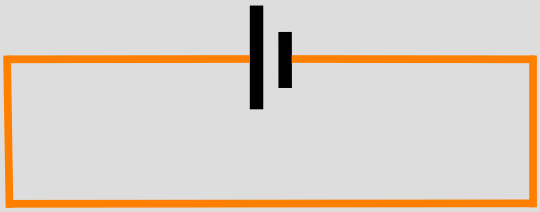
The other parts of this bulb is made from different “Electric Conductor” material, so they behave differently from the thin tungstun wire part.

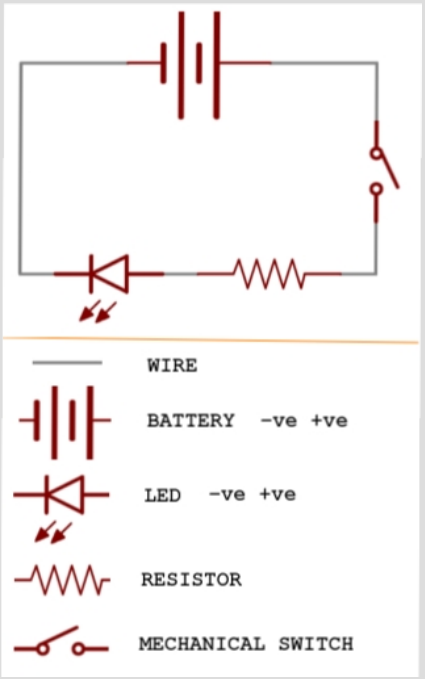
Basic Electric Circuit Diagram

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



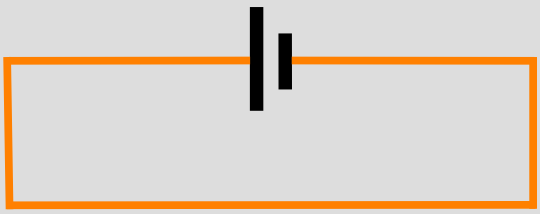
Although the above is what really happening. Electric Circuit diagram are not drawn that way. It is normally in a "loop shape", like the one below. Both are actually the same, if we we stretch out the one below, it will look exactly like the one on top.





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
Electric Current will flow for a long period of time

It is our duty to make sure that all the components in the circuit can cope with the amount CURRENT/ENERGY flowing in it, otherwise those parts that are unable to cope may end up burnt

Every Electrical Component, even a single wire has a manufacturer specification, telling us how much CURRENT that it can cope

Do not exceed the specified limits

ALSO

DO NOT CONNECT +ve and -ve Terminal of a POWER SOURCE directly without any device or "LOAD" in-between (like the picture above with just wire and POWER SUPPLY). CURRENT will be moving too intense, something in the Circuit will surely not be able to cope