Electronics 1

Electronics for Interactive Media Design

Emma Pareschi

About Me

Emma Pareschi

- 36, from Italy, in Amsterdam
- bachelor: Physics
- master: Electronics (Physics)

- I worked for Infineon
  - IC analog design engineer

- I work for Waag:
  - hardware developer
  - instructor and teacher

Waag Society

- Waag operates at the intersection of science, technology and the arts. Our work focuses on emergent technologies as instruments of social change, and is guided by the values of fairness, openness and inclusivity.
- Waag's dedicated team of sixty thinkers and makers empowers people to become active citizens through technology.
- Since 1994, based in Amsterdam

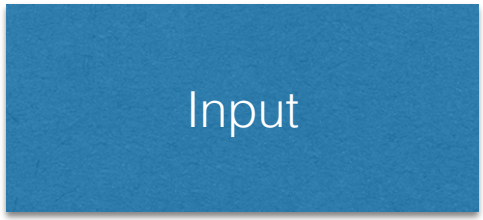
- Three labs:
- Fablab Amsterdam
- WetLab
- TextileLab Amsterdam

- I'm mainly busy in citizen science projects where we developed low cost sensor kits to measure the quality of our environments. The prototypes are made in the Fablab, part of an international network of digital fabrication laboratory where you can make almost anything.

Interactive System

Interactive Media Project

Three Elements

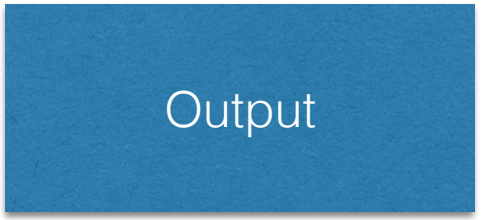


Sensors

Devices that detect and respond to some type of input from the physical environment.

Computer

A programmed system that manages input and output.



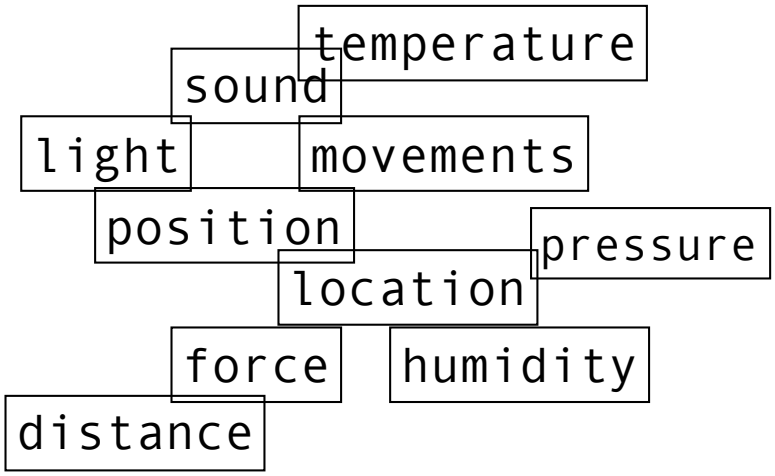
Actuators

Devices that are responsible for moving or controlling a mechanism or system.

Input Device

It is a device able to detect and measure physical or chemical magnitudes and transform it into electrical signal.

it collects information from the environment where it is included.

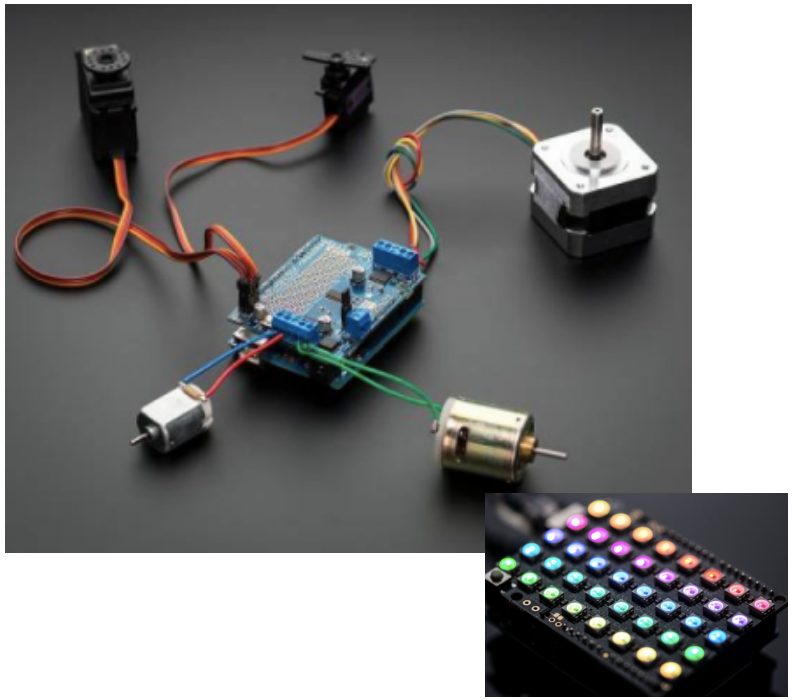


Output Device

It is a device able to convert electrical, hydraulic or mechanical energy to generate an effect, an action.

It changes physically the surrounding space.

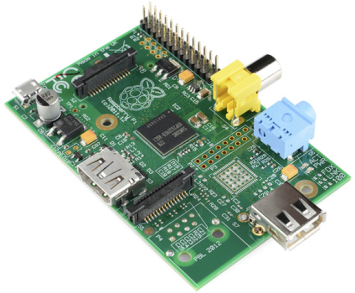
temperature
sound
light
movements
position
pressure
humidity
force



Electronic Brain

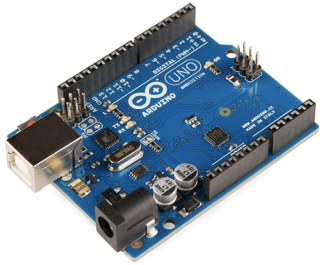
What it does:
- collect data from the input
- analyse data
- send the control command to the output

The most popular hardware platform are:



Microprocessor
(Raspberry Pi)

It’s a real computer, you can connect keyboard , screen, moused instal an operating system (Linux).

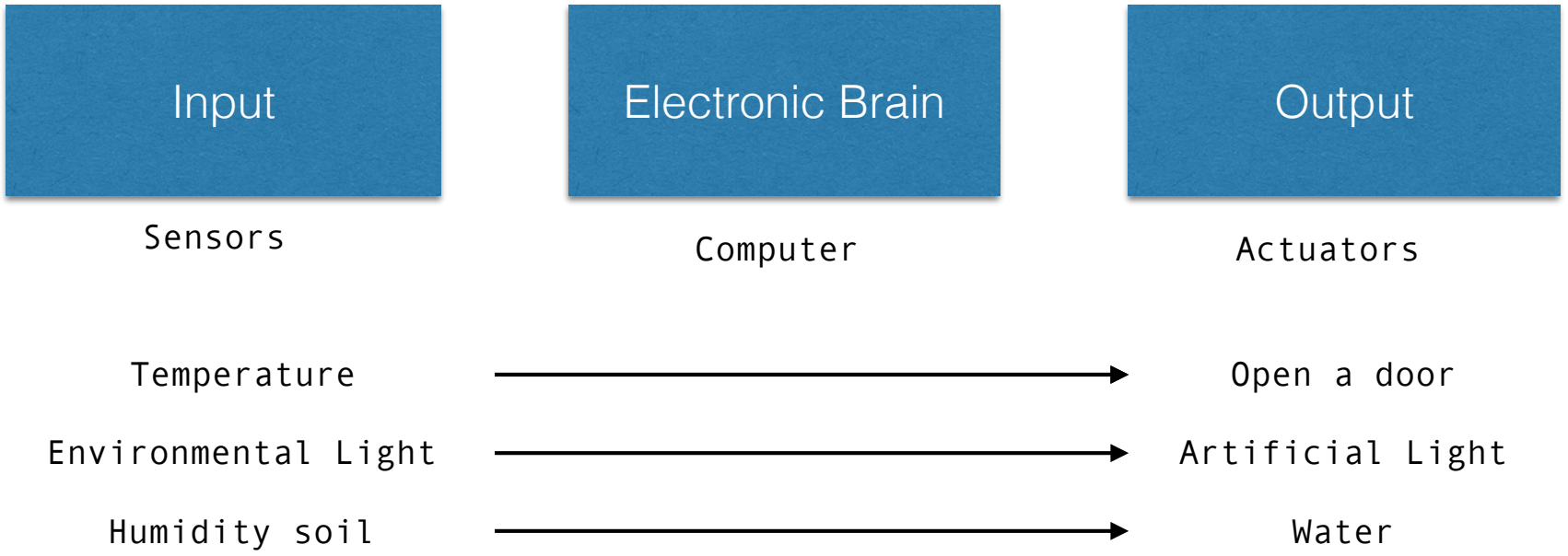


Microcontroller
(Arduino)

It is used to read sensors, analyse data and send command to an output device.

Interactive Media Project

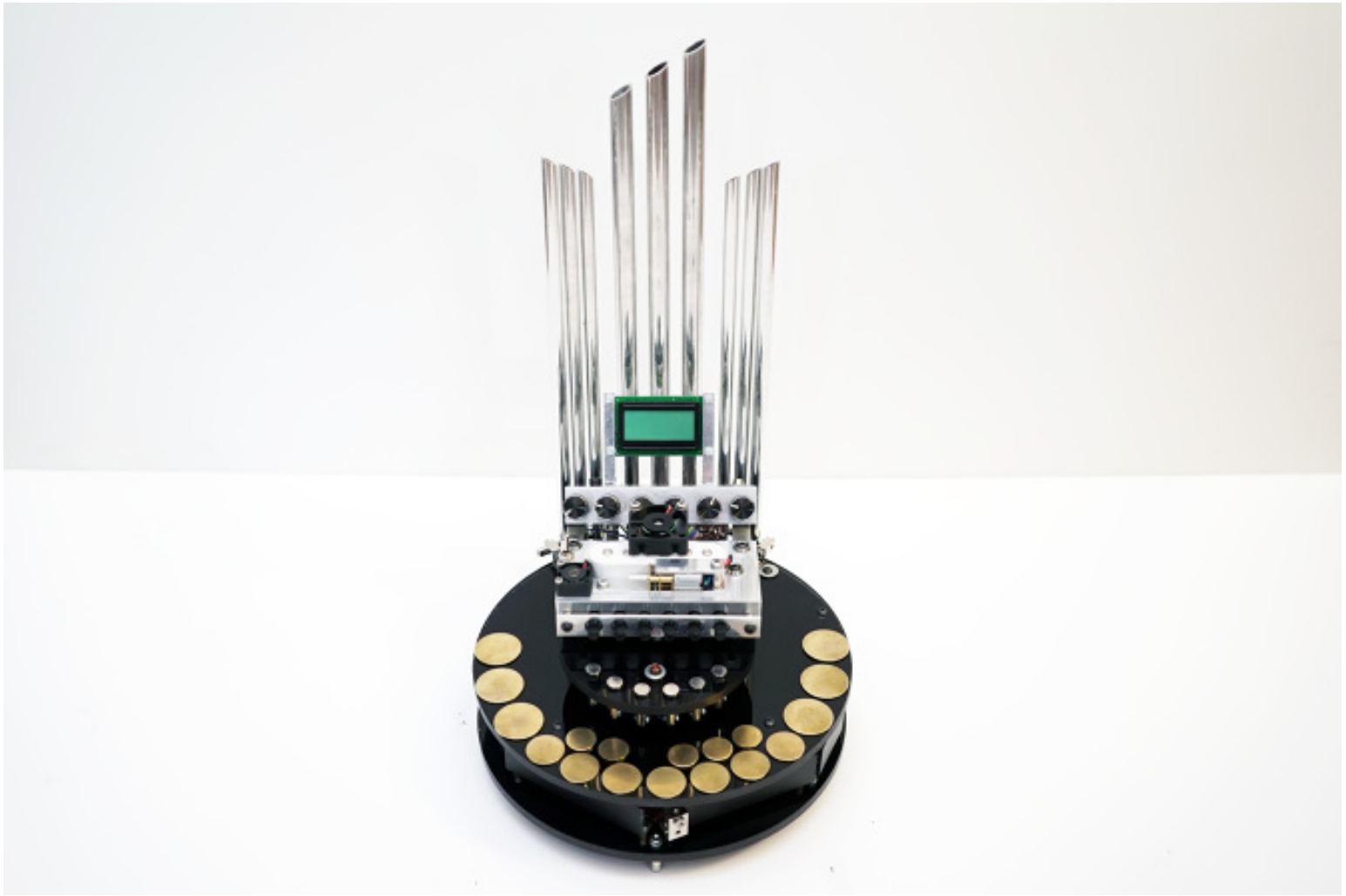
Three Elements



Interactive

The useless machine

Interactive



http://vtol.cc/filter/works/motorgan

Interactive

https://www.youtube.com/watch?v=3vAqv2la84w

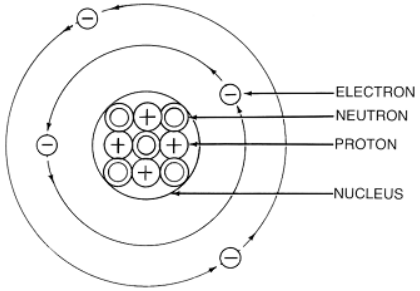
Interactive

http://treewifi.org/

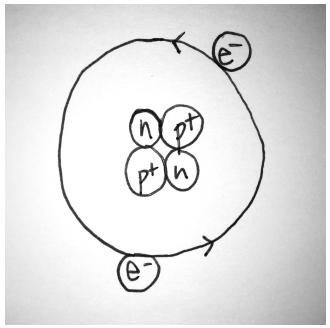
Electricity

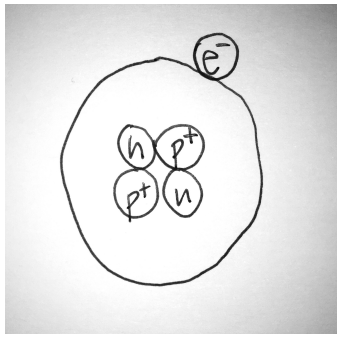
Kinds of energy:
- mechanical energy -> result of motion / motion
- thermal energy -> result of different heat / motion, heat
- sonic energy -> result of vibration / sound

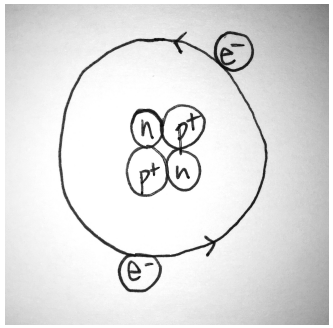
Electrical energy -> result of charged particles / motion, heat, sound, light.



Particles:
neutrons - no charge
protons - positive charge
electrons - negative charge



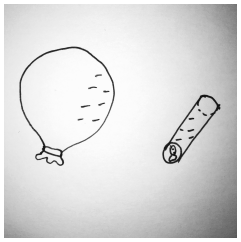


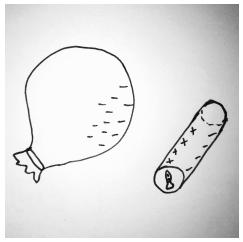


Electricity

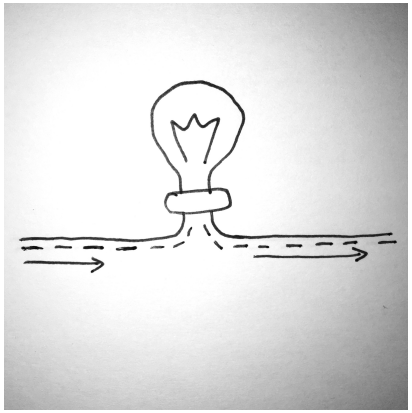
A form of energy resulting from the existence of charged particles (such as electrons or protons), either statically as an accumulation of charge or dynamically as a current.

Static electricity
Two objects with different electric charges due to the absence or presence of electrons.





Dynamic electricity
When the electrons moves continuously through matter.

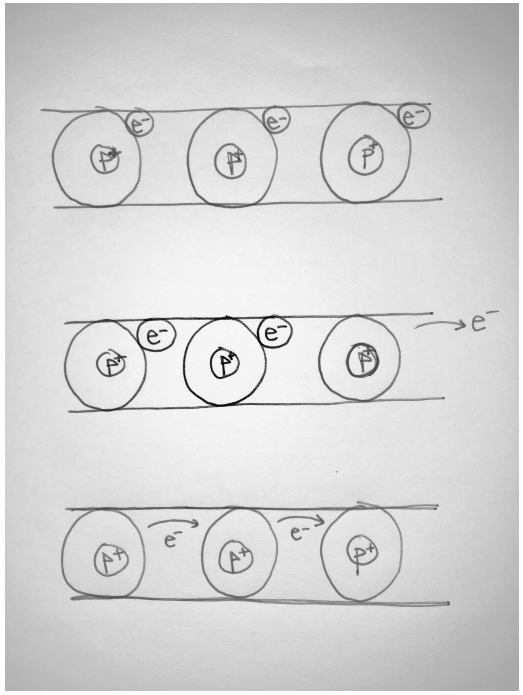


Dynamic Electricity - Current

Electrons flow = Current

Current is measured in Amperes (usually just referred to as “Amps”).
Symbol: A

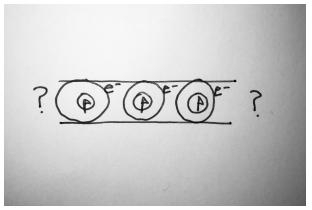
An ampere (1A) is defined as $6.241*10^{18}$ electrons (1 Coulomb) per second passing through a point in a circuit.

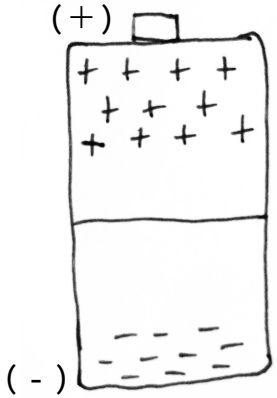


Engineering Notation	Prefix	Symbol
10^{9}	Giga	G
10^{6}	Mega	M
10^{3}	kilo	k
10^{-3}	milli	m
10^{-6}	micro	m
10^{-9}	nano	n
10^{-12}	pico	p

Power supply - Battery

The Power Supply is the device that gives the push to the electrons to move.
How?





Positively charged

Negatively charged

It always has two sides with orientation (positive-negative, plus-minus):
-> plus: VCC, V+, +V
-> minus: GND
The capability to move the charge is called Voltage.
Unit of measure: Volt (V).

Alkaline

9V

1.5V

3V

Lithium Ion Polymer (Rechargeable)

2.7V

2.7V

Power Supply

Low Voltage - Low Current

Alkaline

Lithium Ion Polymer (Rechargeable)

High Voltage - High Current

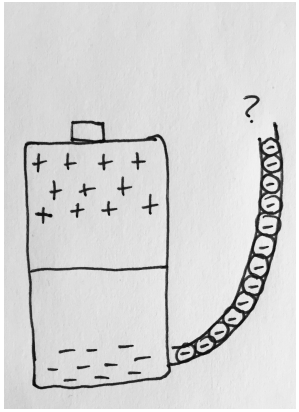
Adapter

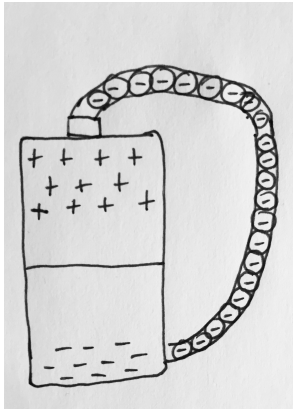
Switching Power Supply

Desktop Power Supply (laboratory)

Power supply - battery

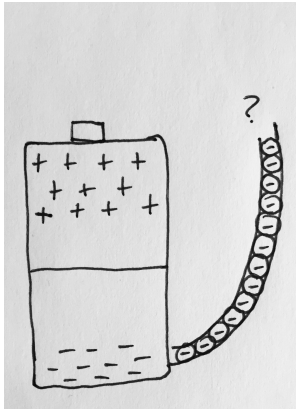
Close the loop. Physically connected

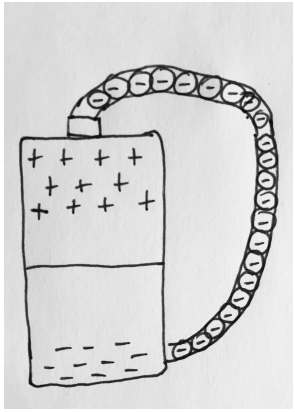


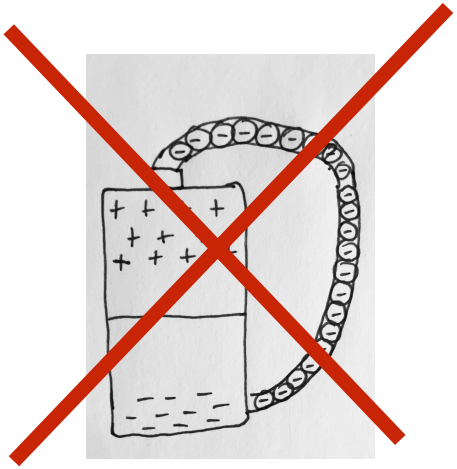


Power supply - battery

Close the loop. Physically connected







SHORT CIRCUIT!!!

DON’T DO IT

FIRE!!!!!

How to Measure Voltage

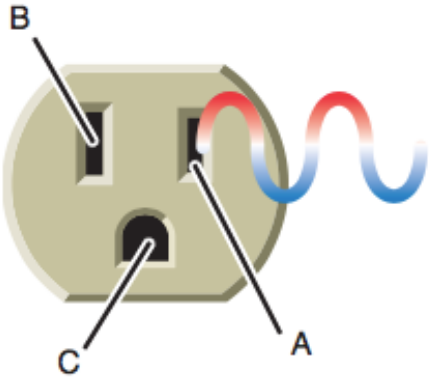
Your best friend in the electronic lab is **THE MULTIMETER**

Let measure the voltage of your battery.
- select the right mode and range
- check if the the lead are in the right position
- touch the terminals of the battery with the two leads

Power Supply - DC vs AC

Direct Current

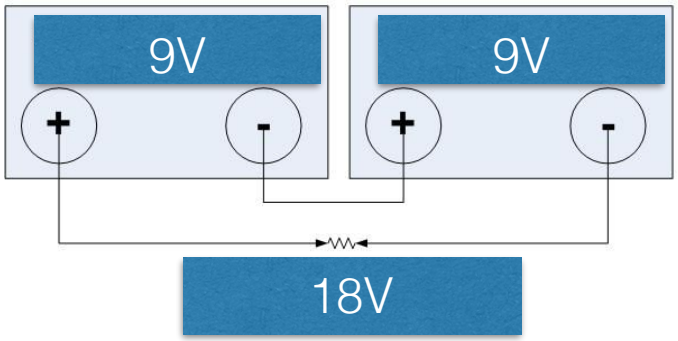
Alternating Current



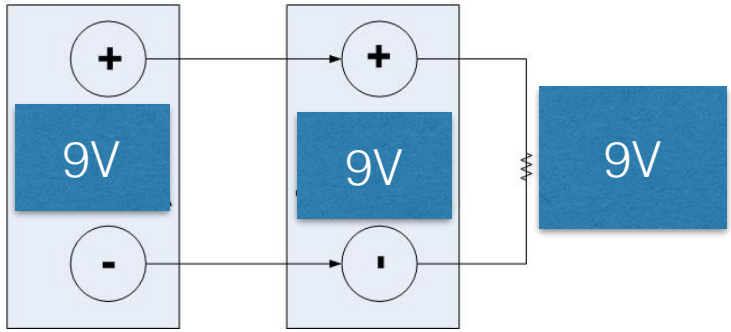
Series and Parallel

Simple Two Battery Examples

Series Wiring Example
Double Voltage



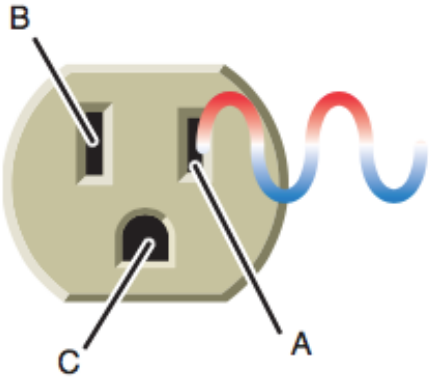
Parallel Wiring Example
Same Voltage



Power Supply - DC vs AC

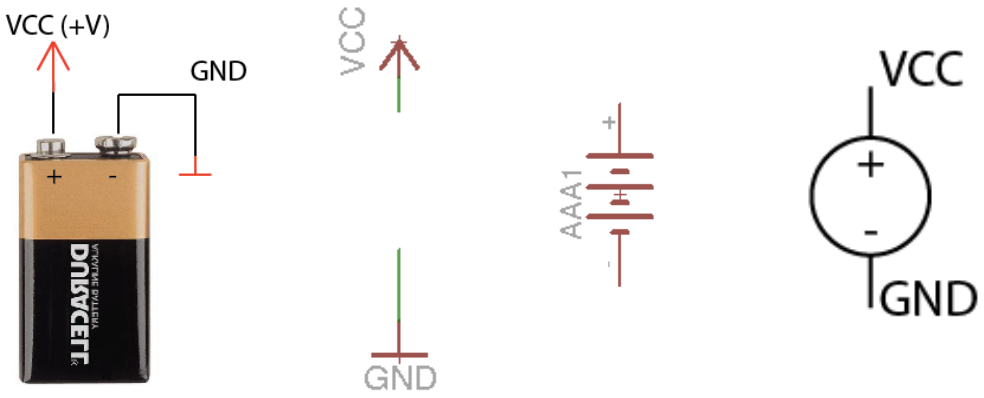
Direct Current

Alternating Current



Power Supply - Schematic

A schematic, or schematic diagram, is a representation of the elements of a system using abstract, graphic symbols rather than realistic pictures.



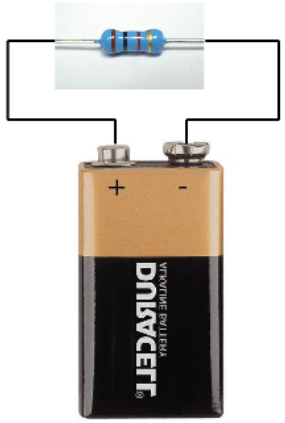
Schematic representation

The simplest circuit

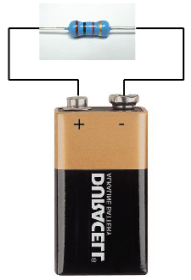
CIRCUIT: It's a CLOSE LOOP that electrons can travel in.

How can I generate a current?
Source of electrons - material to let them flow - a close loop

The simplest circuit is made of a battery, wire and a *resistor*

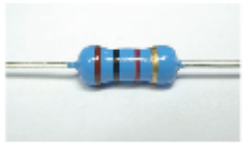


Resistor



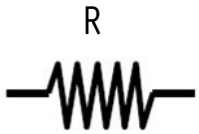
A resistor is one of the most fundamental components in electronics. Its purpose is to impede a flow of current and impose a voltage reduction.
Two wires or conductors attached at opposite ends or sides of a relatively poor electrical conductor.

It has two sides, it doesn't matter the orientation.

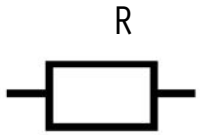


Through Hole Technology (THT)

Surface Mounted Technology (SMT or SMD)



US symbol



EU symbol

Voltage - RESISTOR - Current

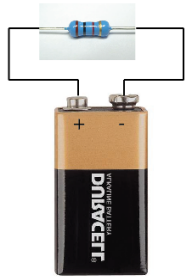
The resistance of resistor is measured in Ohms, universally represented by the Greek omega symbol, Ω.

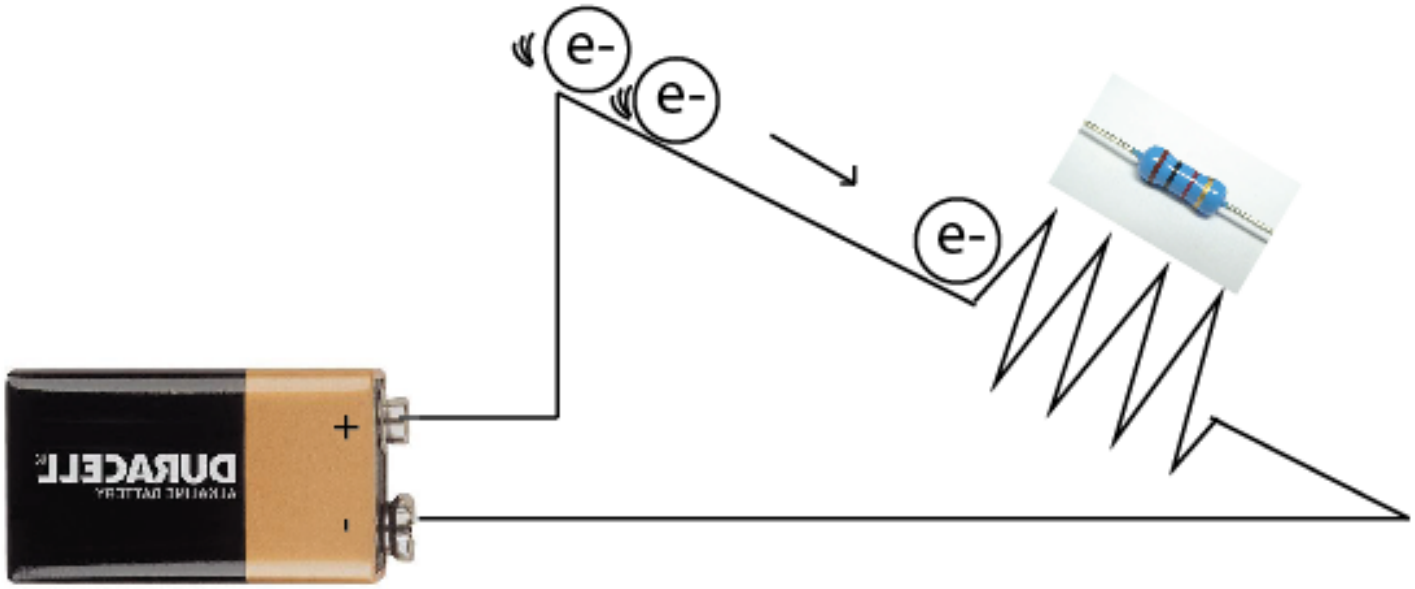
Ω	kΩ	MΩ
Ohms	Kilohms	Megohms
1	0.001	0.000001
10	0.01	0.00001
100	0.1	0.0001
1,000	1	0.001
10,000	10	0.01
100,000	100	0.1
1,000,000	1,000	1

How To measure the resistance? With the multimeter

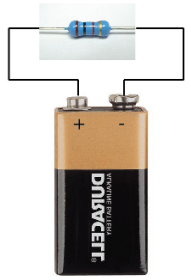
Use the multimeter to measure the value of the resistors in your bags.

The Simplest Circuit



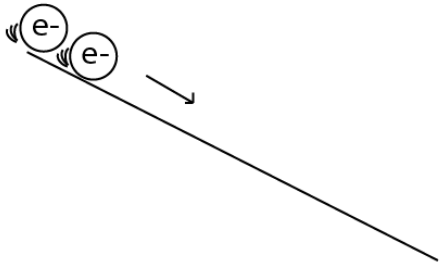


Current

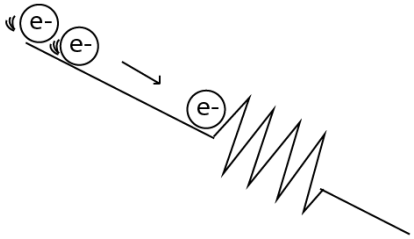


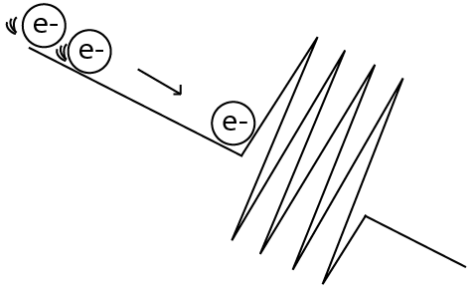
1) No Slope = No Motion

2) Slope = Motion without control



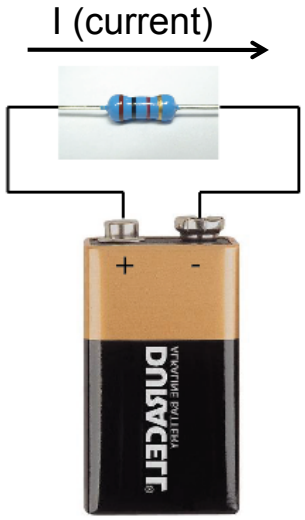
3) Slope + Obstacle = Motion with control

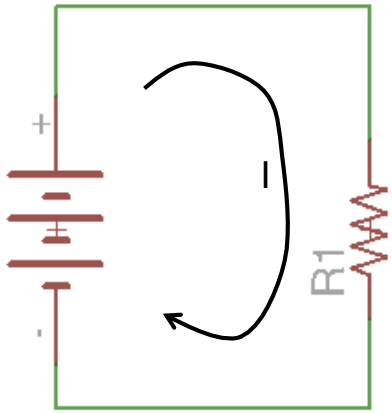




Higher is the Resistor => lower is the current
Lower is the Resistor => Higher is the current

The Simplest Circuit - Schematic





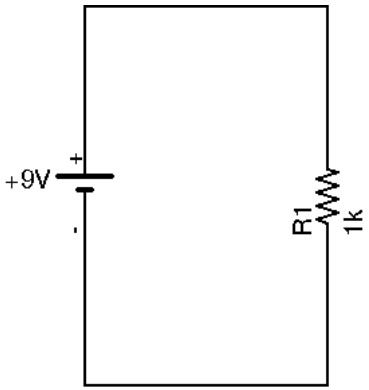
Conventional Current

Voltage: is the difference in charge between two points.
Current: is the rate at which charge is flowing.
Resistance: is a material's tendency to resist the flow of charge (current).

Ohm's Law

Ohm's Law defines the relation between voltage, current and resistor

$$V = I * R = IR$$



You know the Voltage and the Resistor =>
=> calculate the current you consume:

$$I = V / R$$

You know the Voltage and the Current =>
=> calculate the resistor you need:

$$R = V / I$$

Power

In physics: power is defined as the rate at which energy is transferred (or transformed). Unit of measure WATT (W).

TRANSFORMATION: energy can never be created or destroyed, only transferred to another form. A lot of what we're doing in electronics is converting different forms of energy to and from electric energy.

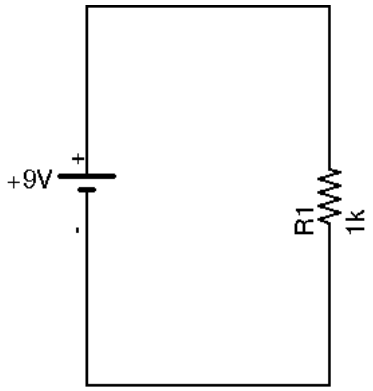
Electric Energy is transformed in:
- Light
- Heat
- Motion
- Sounds

Electric power is measured by combining both how much electric energy (Voltage) is transferred, and how fast that transfer (Current) happens.

$$P = V * I = VI$$

Unit of measure: Watt (W)

Simplest Circuit Analisys



$$I = V / R \text{ or } R = V / I$$

$$P = V * I$$

Exercise 1

- Use the multimeter to measure the voltage (Volt, V) of the batteries in the bags.

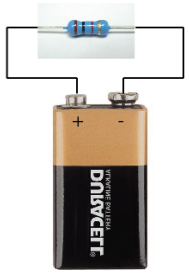
- Use the multimeter to measure the value of the resistors in your bags.

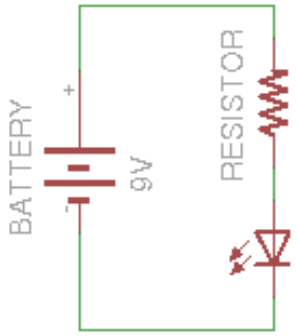
- calculate the current in the following case:
  - Voltage = 9V - Resistor = 220 Ohm => Current?, Power?
  - Voltage = 9V - Resistor = 1 KOhm => Current?, Power?
  - Voltage = 6V - Resistor = 220 Ohm => Current?, Power?
  - Voltage = 6V - Resistor = 1 KOhm => Current?, Power?

- calculate the right resistor in the following cases:
  - Voltage 9V - Current = 1 A => Resistor?, Power?
  - Voltage 9V - Current = 100 mA (0,1A) => Resistor?, Power?
  - Voltage 6V - Current = 20 mA => Resistor?, Power?

Turn On a Led

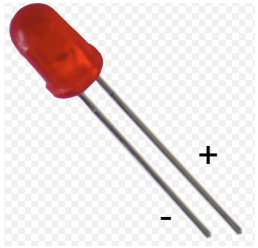
The simplest and useless circuit



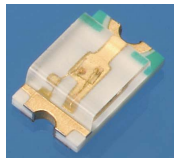


LED

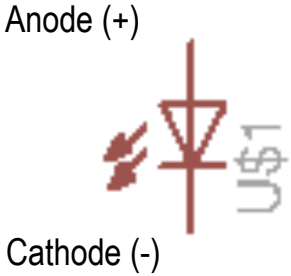
It is a light source. The LED is part of the family of DIODES.
Light Emitting Diode



Through Hole Technology (THT)



Surface Mounted Technology (SMT or SMD)



It has an orientation.
The current flows only from the Anode to Cathode.

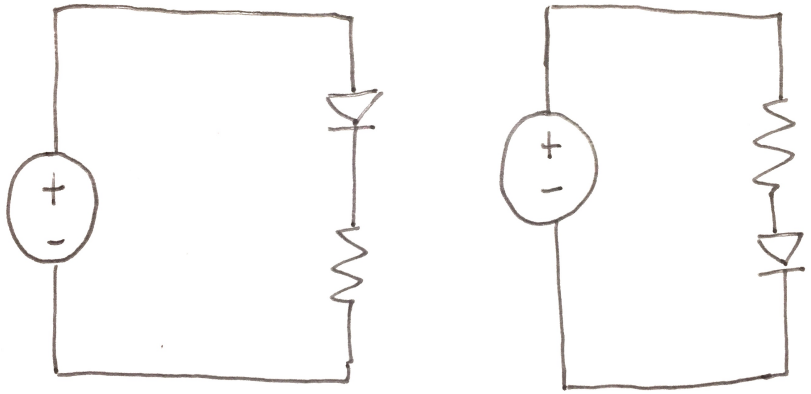
Forward Voltage (Vf)
It the optimal voltage at the sides of the LED when there is current through it.

Forward Current (If)
It's the maximum current that you fix.

Led circuit Analysis

Vbat = 9V

Green Led, Vf = 2V, If = 20mA
Red Led. Vf = 2V, If = 20mA
Blue Led. Vf = 2V, If = 30mA

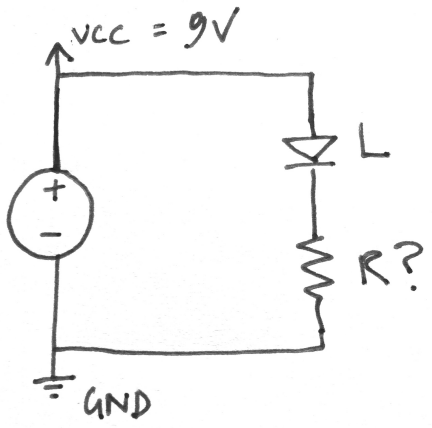


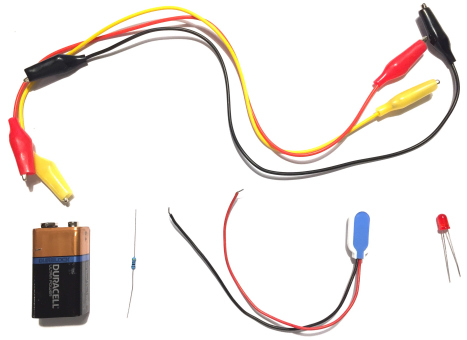
If you don't have the right resistor?

Turn On a Led - Exercise 2

You have:
- battery 9V
- Green or Red or Blue LED

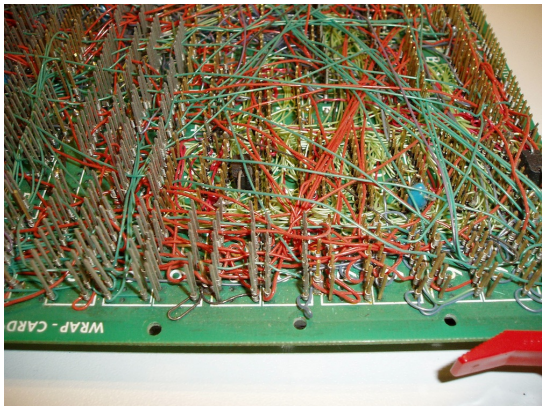
Make a circuit to turn on the Led following the steps:
- calculate the right resistor
- use alligator clips to make the connection

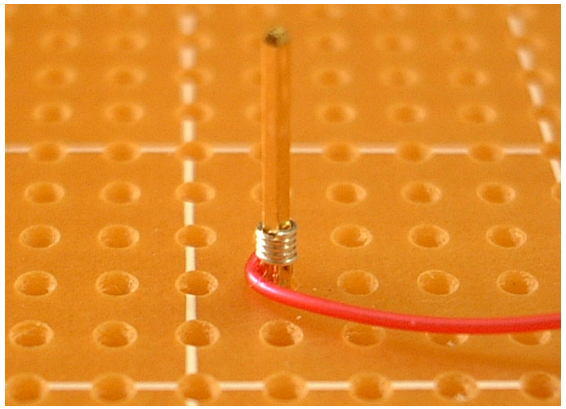




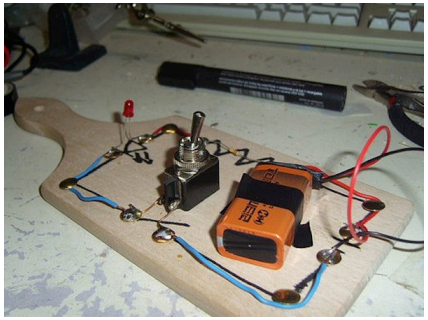
BreadBoard

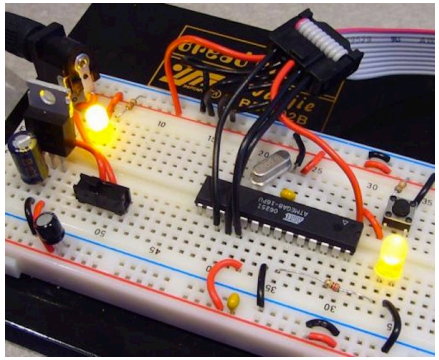
Wire - Wrap



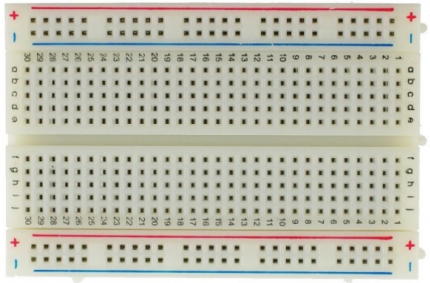


Breadboard

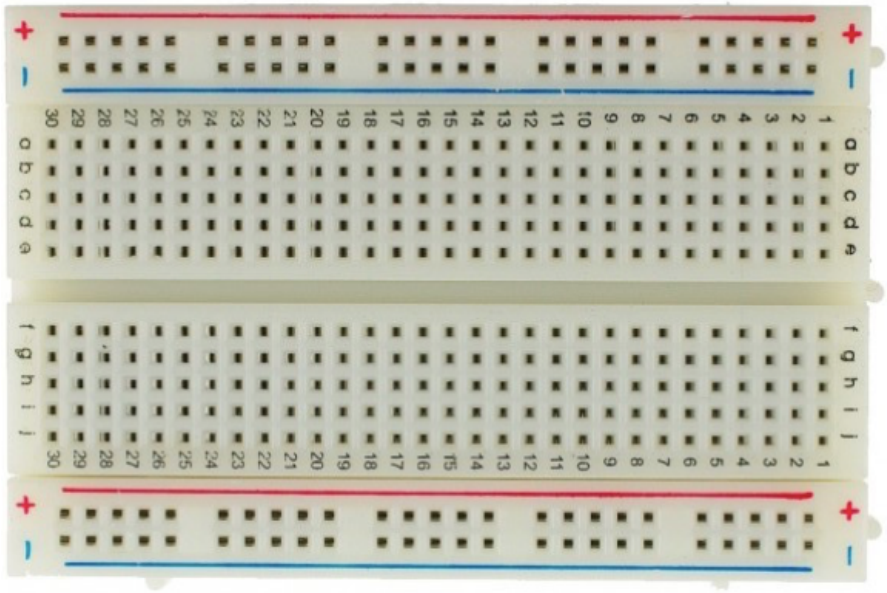


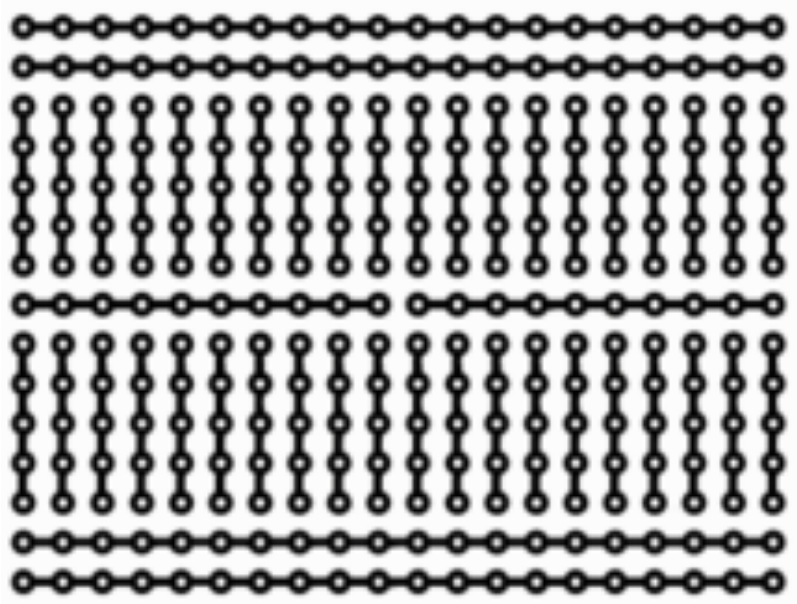


BreadBoard



It is a physical support for making temporary circuits and prototyping, and they require absolutely no soldering.

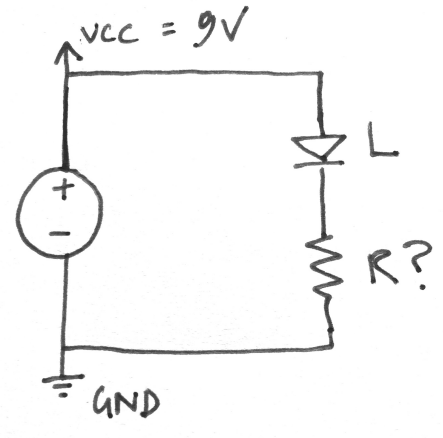




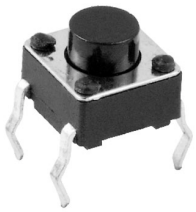
Turn On a Led - Exercise

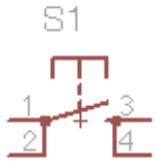
You have:
- battery 9V
- Green or Red or Blue LED

Make a circuit to turn on the Led following the steps:
- calculate the right resistor
- use the breadboard and jumper wires to make the circuit



Switch - push button

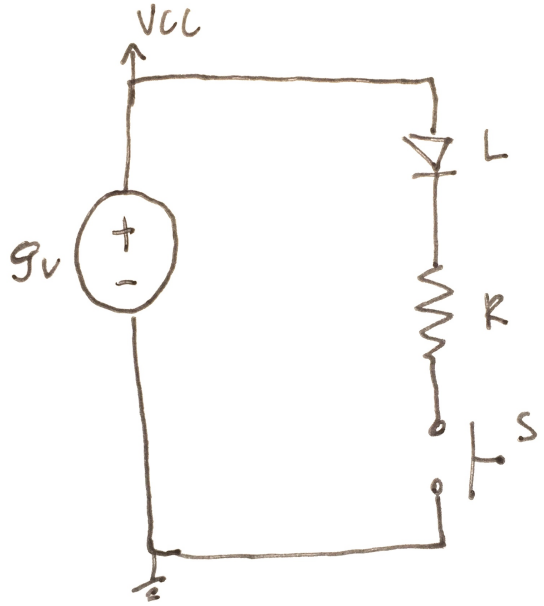




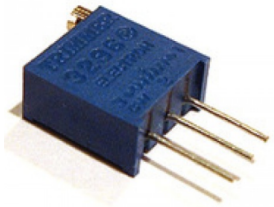
Turn On a Led - Exercise 3

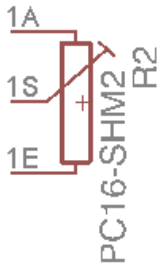
You have:
- battery 9V
- Green or Red or Blue LED
- Push button

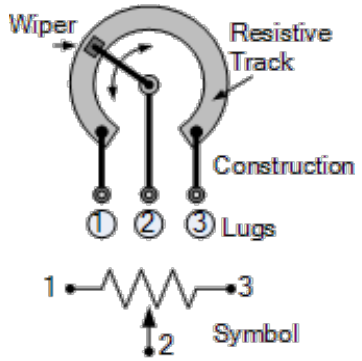
Make a circuit presented in the schematic below using the breadboard.



Potentiometer (Variable Resistor)



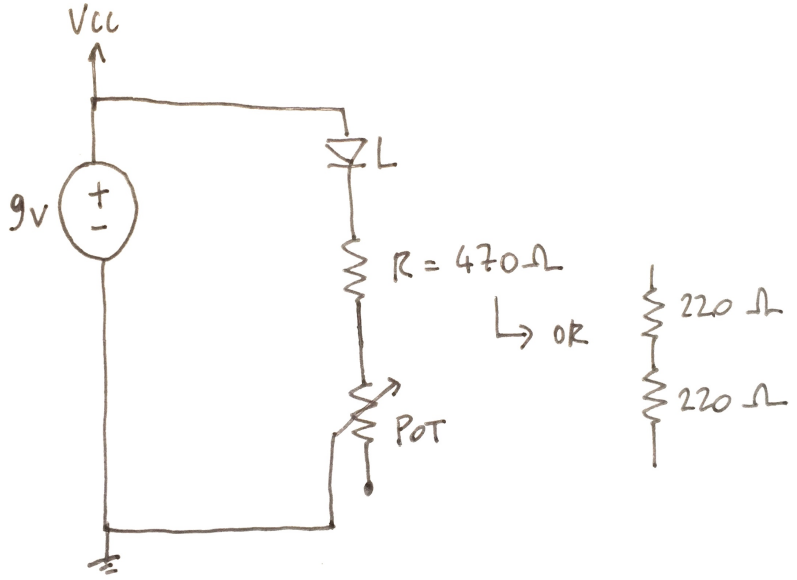




Turn On a Led - Exercise 4

You have:
- battery 9V
- Green or Red or Blue LED
- A potentiometer (10KOhm)

Make a circuit presented in the schematic below using the breadboard.



Weekly Assignments

- Open a blog (Tumblr)
  - A post where you introduce yourself:
    - name surname
    - picture
    - Introduction
  - Send to me (emma@waag.org) your blog address
  - Post a blog about an interactive project you saw at Art Electronica
  - Make exercise 1 and repeat exercise 2/3/4 and document(*) them in your blog.
  - Install Arduino IDE software

- Read the following pages:
  - https://learn.sparkfun.com/tutorials/voltage-current-resistance-and-ohms-law
  - https://learn.sparkfun.com/tutorials/electric-power
  - https://learn.sparkfun.com/tutorials/how-to-use-a-multimeter
  - https://learn.sparkfun.com/tutorials/resistors
  - https://learn.sparkfun.com/tutorials/how-to-use-a-breadboard

(*)Documentation:
- schematic, photo/video and description.

Outcome:
Get familiar with the concepts of Voltage, Current, Resistors.
Lear how to use a digital multimeter to measure Voltage and Resistance. Quickly prototype a circuit to turn on a Led with the selection of the right components.