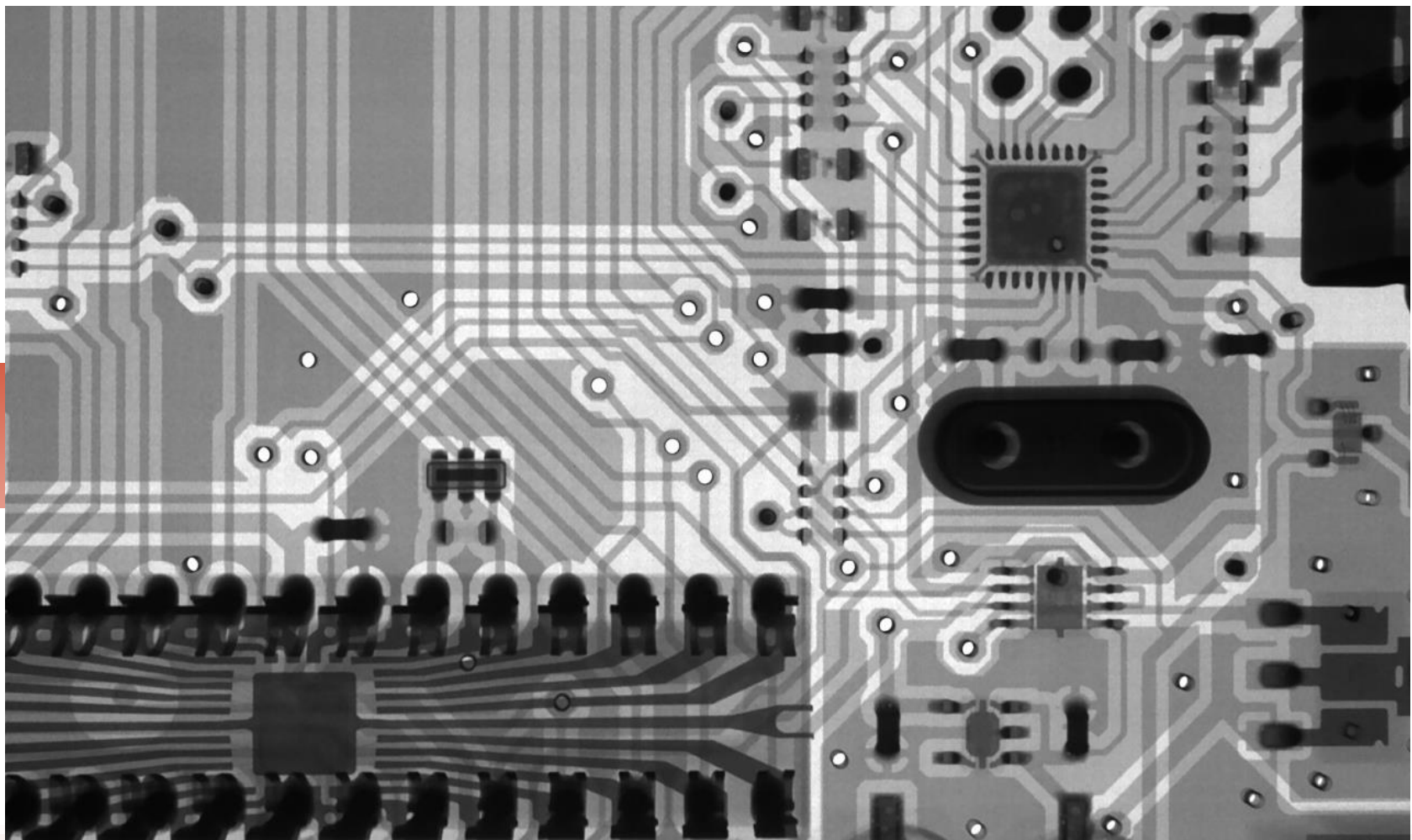# Arduino SYS-STEM for Schools

Training Methodology
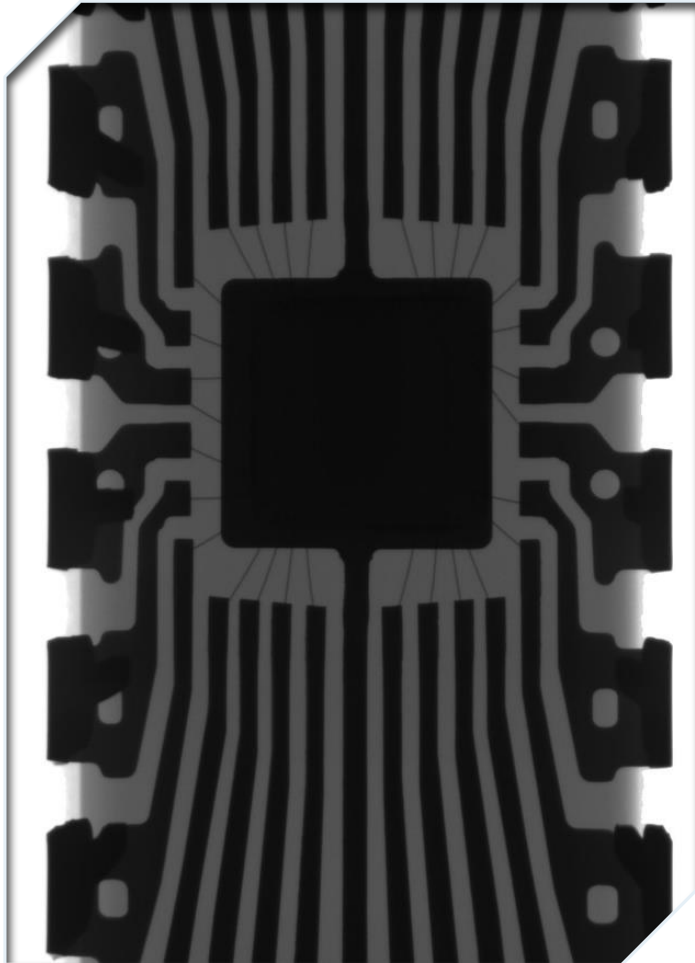
MODULE 1

INTRODUCING ARDUINO

▶ Objective

▶ Learning Outcomes

▶ Unit 1 – Arduino basics

▶ Unit 2 – Basic devices and components

▶ Additional reading materials

▶ Tests and exercises

OBJECTIVE

This module will show the learner an approach to Arduino, the main features of it and tools that will help along the learning process.

Aditionally, the learner will learn the name and function of basic electronic components used along with Arduino.

As the course goes ahead more devices will be introduced but this module will show common general purpose components that can appear as complements in the designs.

Knowledge

▶ Recognize the different parts of an Arduino board

▶ Know the basic features of Arduino and their function

▶ Know the function of electronic components and basic properties

Competences and Skills

▶ Application of basic electronic components and functionality

▶ Use of protoboard to assemble electronic circuits

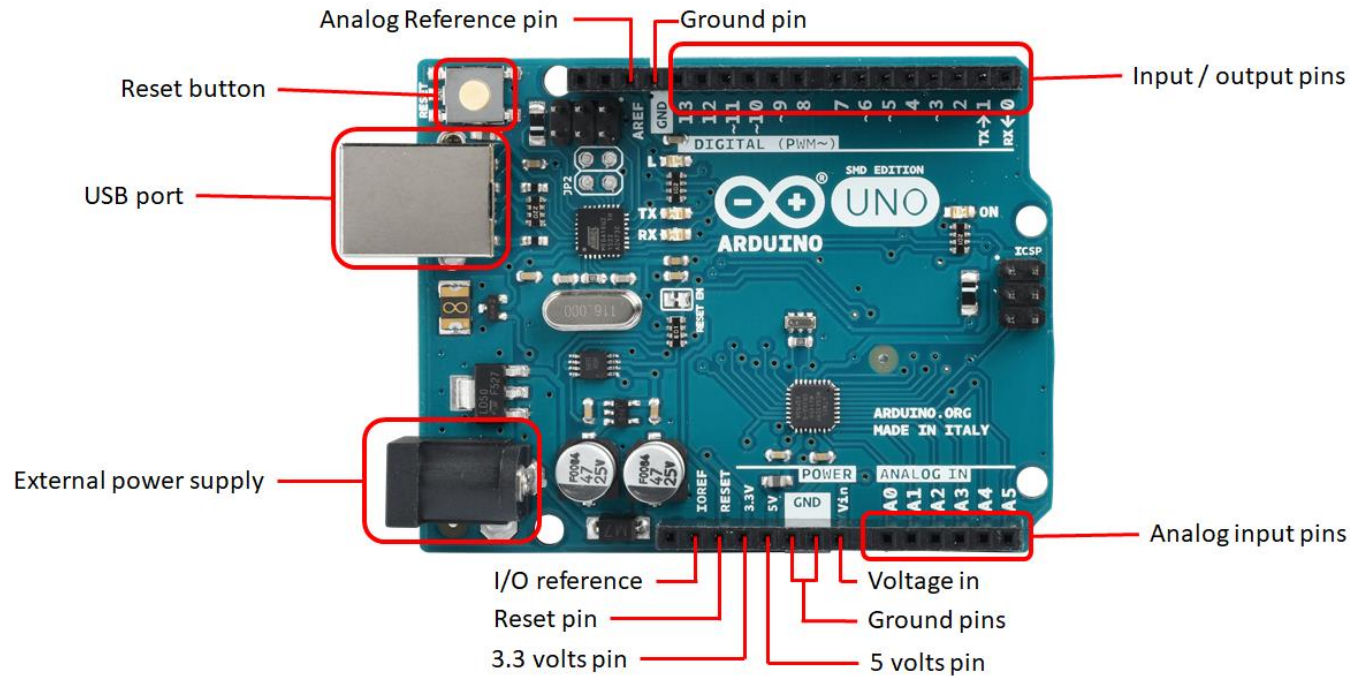# EXPECTED LEARNING OUTCOMES

UNIT 1

INTRODUCTION

▶ Arduino is an electronically programable board that can be useful to develop programming skills and electronic knowledge

▶ It is a versatile tool that can be applied to learn from the very basic up to a quite advanced level, according to what the learner is aimed for.

▶ In this unit the objective will be to get familiar with the board, get to know the composition of it and some other basic things that concern Arduino.

▶ This documentation will use Arduino Uno board as standard, even though other kind of Arduino boards can be found in the market.

Analog Reference pin — Ground pin
Reset button
Input / output pins
USB port
External power supply
Analog input pins
I/O reference
Voltage in
Reset pin
Ground pins
3.3 volts pin
5 volts pin

ARDUINO BOARD PARTS

The image shows an Arduino UNO board in which the main parts have been highlighted.

Most interesting parts are connection pins, that will allow the connection of components, sensors etc.

USB port to connect the cable to program Arduino.

Reset button to start over the program.

DEVICE PARTS DESCRIPTION

▸ Analog reference pin (AREF)

  ▸ Rarely used pin, for advanced users. It sets an analog voltaje reference

▸ Ground pin (GND)

  ▸ Can be found either at the top part (one pin) and at the bottom part of the board (two ground pins). It sets the 0 voltaje reference, needed to complete the circuits of a large amount of devices

▸ Input / output reference (IOREF)

  ▸ This pin supplies a voltage corresponding to the I/O voltaje of the board, in Arduino UNO case the value of this voltage will be 5 volts.

▸ Reset pin (RESET)

  ▸ This pin will allow to recreate the original reset switch button on the board, in order to be able to reset Arduino if the original reset is not at hand.

DEVICE PARTS DESCRIPTION: PINS

▶ 3.3 and 5 volts pins (3.3V and 5V)

  ▶ These pins provide electric Direct Current (DC) to feed devices connected to Arduino

▶ Voltage in (Vin)

  ▶ This pin allows an external power supply to run Arduino instead of using the more popular way (USB cable). In case a Jack conector is used to supply power to Arduino this pin will supply as much voltaje as the Jack does.

▶ Input / Output pins

  ▶ These pins are used when devices need to be conected to Arduino, each pin is linked to a number, those numbers will be used in the sketch to reference the connected device whenever an action needs to be carried out afecting the latter. Digital devices are conected to these pins but those with a Little wave next to the number of the pin (such as ~) can generate, let's say, analog signals.

▶ Analog input pins

  ▶ Analog input devices can be connected to these pins.

DEVICE PARTS DESCRIPTION: OTHERS

▶ Reset button

  ▶ This hardware button performs a reset to Arduino, in case it is programmed, the runing program will start over again from the top.

▶ USB port

  ▶ The aim of this port is, on one hand, provide power supply to Arduino and on the other hand, load sketches into it. When powering Arduino through this port it will get 5 volt supply.

▶ External power supply

  ▶ This entry can be used to power Arduino, in case of using this port to power Arduino it will get 6-12 volt supply.
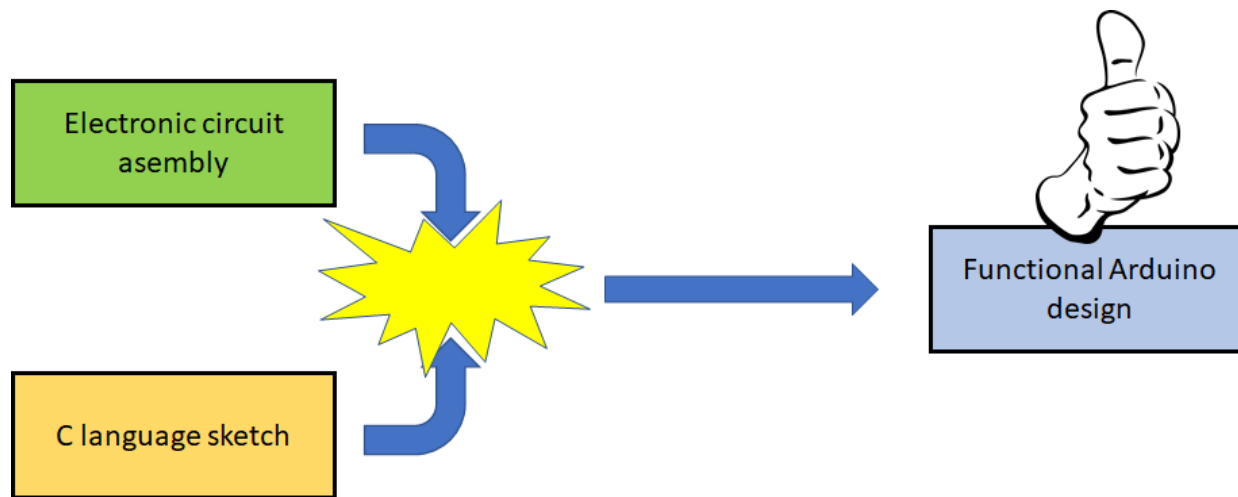
DESIGNING WITH ARDUINO

Arduino is based in the electronic circuit assembly and the loading of sketches that will describe what the devices of the electronic circuit should do, how they would behave.

The assembly consists on the phisycal unión of electronic components to créate a circuit.

Sketches are a range of code lines written in C languaje that will describe the function of the components of the assembly.

```
Electronic circuit
asembly

C language sketch

Functional Arduino
design
```

ARDUINO IDE

Arduino IDE is, as its own name indicates, an Integrated Developement Environment, a software that will enable the learner to:

▶ Write sketches in C language

▶ Transfer the sketches to Arduino through the USB cable

It is avaliable for platforms such as Windows, Linux and Mac OS at the link under the logo to the right.
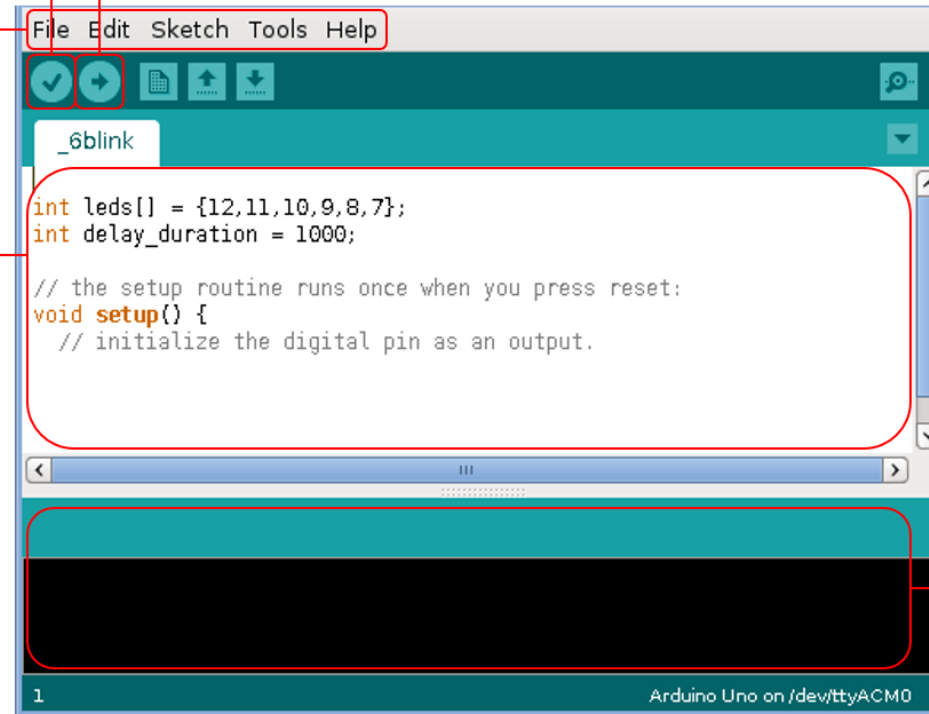
Click to get Arduino IDE

ARDUINO IDE INTERFACE

Compile: this option will check the sketch and tell us if any error was found in it

Program: this option will send the sketch to Arduino board providing there isn't any error in it. This sketch will remain in the Arduino board until another sketch is programed over it

```
File  Edit  Sketch  Tools  Help

_6blink

int leds[] = {12,11,10,9,8,7};
int delay_duration = 1000;

// the setup routine runs once when you press reset:
void setup() {
  // initialize the digital pin as an output.

1                                    Arduino Uno on /dev/ttyACM0
```

Sketch: in this área the sketch that will later be transferred to the will be written, some of the reserved words will be highlighted in different colours

Error report: once the sketch is written, when the program or compile button are pushed, the error(s), if any, will be reported in this área. It will be useful to make the corrections

Menu: tolos for the Arduino IDE software hndling are provided here

Tinkercad

Fritzing

DESIGNING AND SIMULATING TOOLS

Images link to software websites

TINKERCAD

Tinkercad is an online Arduino simulation tool. You can sign up in several ways, such as a Google account.

This tool lets you assemble electronical circuits and bind them with a written sketch. Along this course you will find exercises that link to Tinkercad examples.

Tinkercad saves "on the cloud" all the Arduino designs you do with the tool and allows you to share them and visit examples of other creators
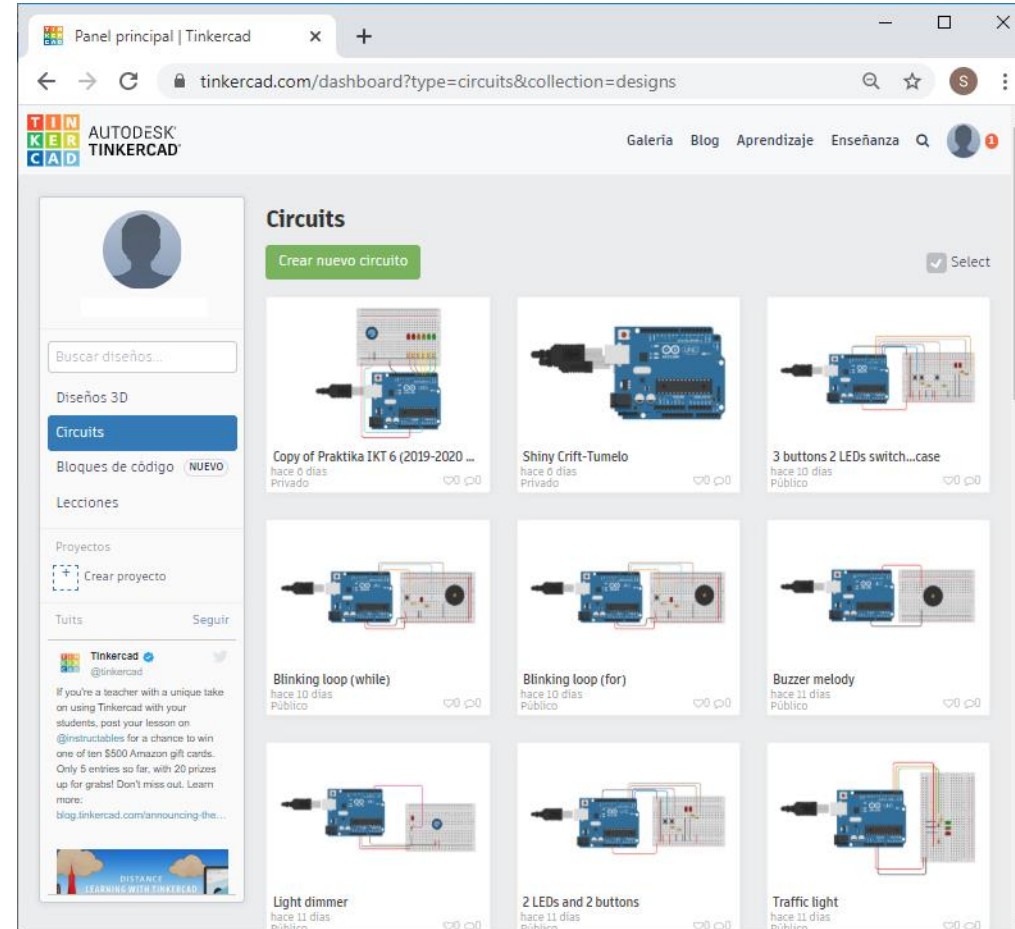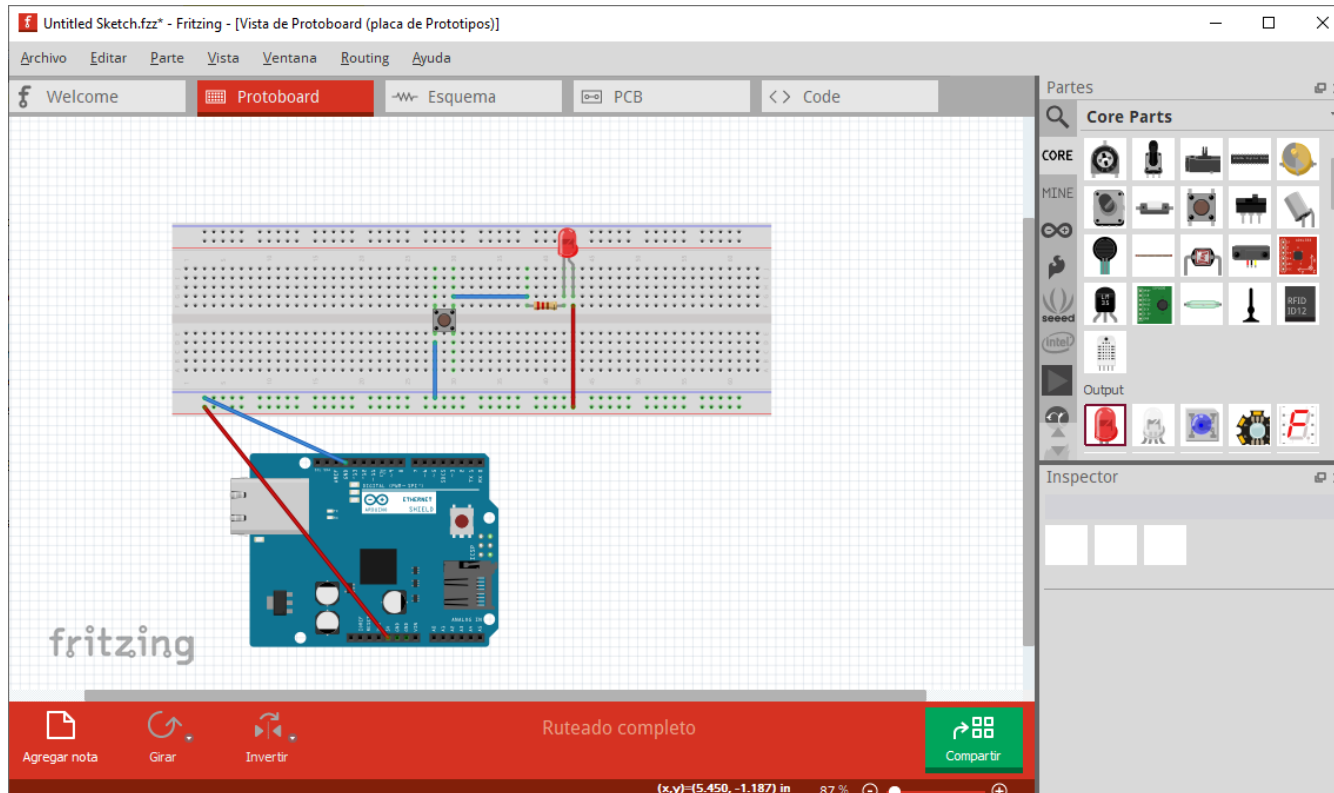
FRITZING

Fritzing is a designing tool for Arduino. This software provides a large amount of Arduino components to assemble.

It will not allow you to simulate but you will be able to make visual circuits with all the components you need.

This tool, unlike Tinkercad, requires the downloading of source files

UNIT 2

INTRODUCTION

▶ Arduino is relatively complex electronic board that will let the learner to program it

▶ By itself the board can carry out just a few actions, that is why other components and devices are used along with it

▶ This unit will explain the aim and functionality of basic components that will turn out usefulto develop proyects with Arduino
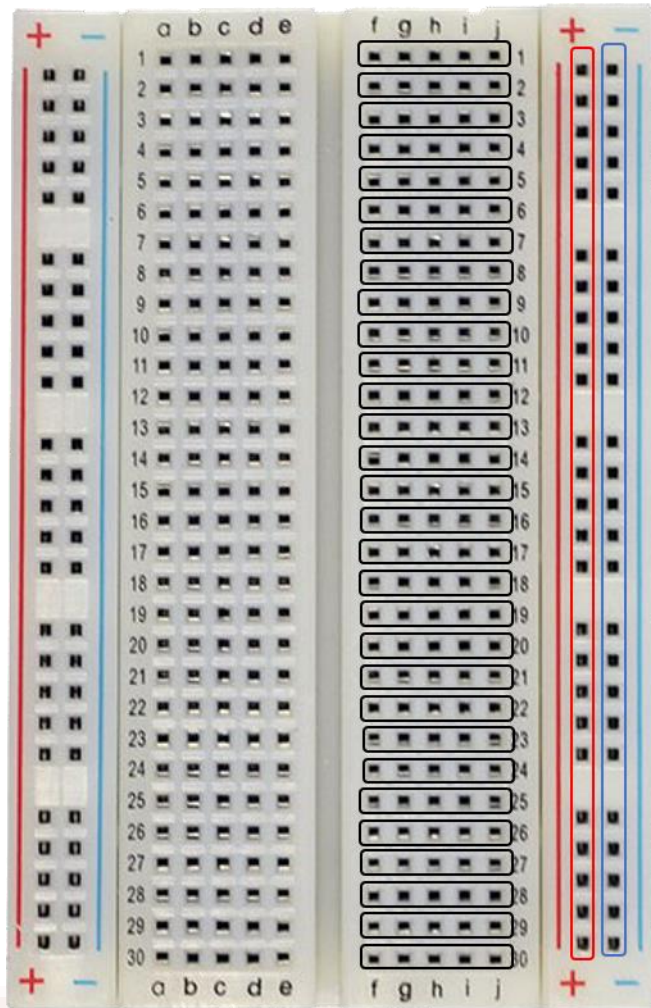
PROTOBOARD

This item will provide a way to connect devices among them. It is formed by a large amount of little holes where electronic devices will be placed.

These boards are found in different sises but the way of use does not change from one to another.

The holes on it are grouped, horizontaly or verticaly and each of those groups represent the same electrical point so that different electrical circuits can be designed on them.
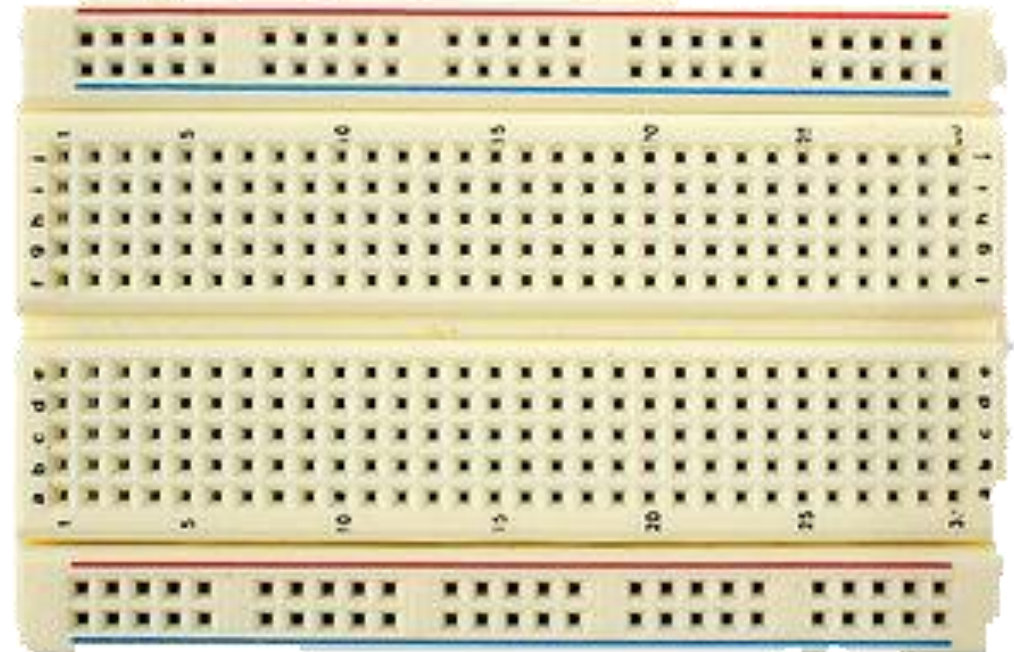
PROTOBOARD: CONTACTS

As you see to the side, on the image, different groups of holes have been highlighted. It is common to have symmetrical structures for these boards, that is why the contacts on the left part of the protoboard have not been highlighted, beacuse they behave just the same way that the highlighted ones.

To the righ part two rows arranged verticaly highlighted one in red and the other one in blue can be found, usually with + and – symbols, and will usually be used to supply DC power to devices placed on the board.

In the middle of the board the holes are grouped horizontaly.

All the groups highlighted in the same rectangle will behave like the same electrical spot.

Appearence and symbol

RESISTOR

- ▶ Basic electronical component which function is to control the current flow.

- ▶ When it comes to Arduino projects they will always be used along with other components with practical functions (LEDs, switches, sensors…)

- ▶ Resistors have a big range of different values that can be measured with a device called polymeter or it can be calculated thanks to the coloured stripes printed on them.
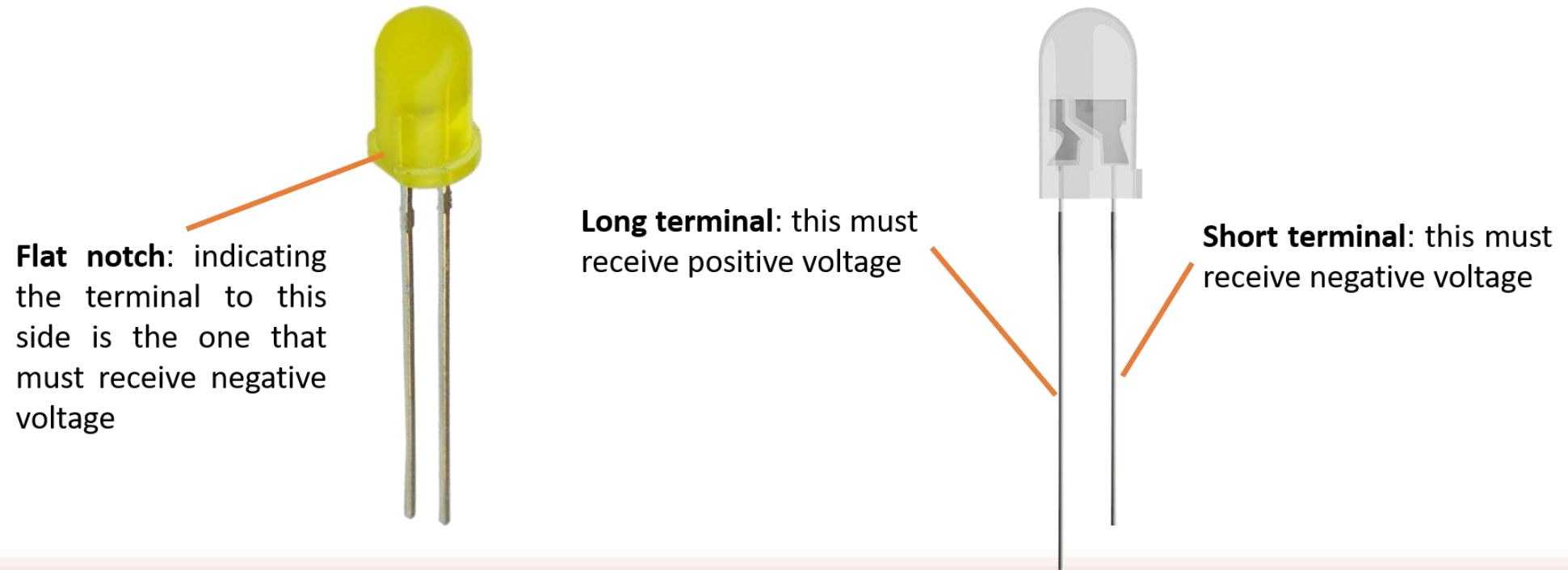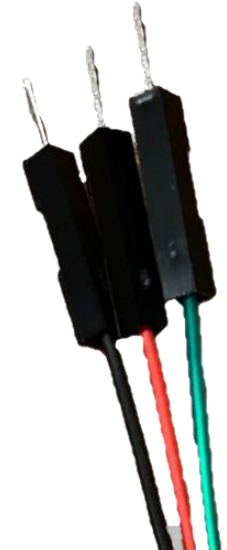
Appearence and symbol

▶ Usually called LED diode, this component can be described as a small light bulb. Small component that emits light when current goes through it.

▶ It is manufactured in several colours and it takes very little amount of current and voltage to make them work.

▶ It is **important to acompany these LEDs by resistors** so that they do not break over too large current going through them.

▶ This components **have polarization**, which means that you must pay close atenttion to the way they are placed into the electronical circuit because it makes a difference to place it one way or the other way around.

▶ To make it easier to guess the correct way to place them one of the terminals of the LED will be longer (+ or positive voltaje) than the other (- or negative voltage). This can be recongised as well because the – terminal has a flat notch.

LIGHT EMITTING DIODE

LED TERMINAL RECOGNITION

Flat notch: indicating the terminal to this side is the one that must receive negative voltage

Long terminal: this must receive positive voltage

**Short terminal**: this must receive negative voltage

Appearence

- Metalic thread covered by a non-conducting material.

- Basic item that will help in circuit assembling tasks.

- Wire will turn out useful when trying to make electric contact between components or among several pins of Arduino or when linking holes in the protoboard is necesary.

- To the right examples of wires are shown, they can be found with pins to make the conection easier (upper pictures) or without (the example beneath)

WIRE

Appearence and symbol

Anode   Katode

+   -
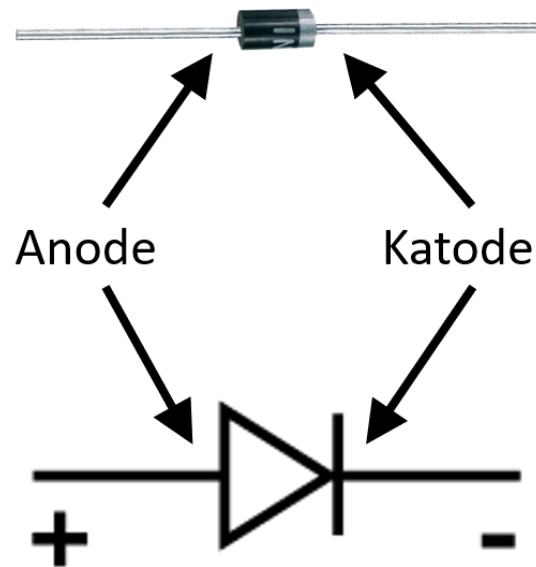
DIODE

A diode is an electronic gate, so to speak, it allows the current flow in just one direction but not the other way around.

It is formed by 2 parts:

▶ Anode: it is the part that must be connected to the positive (+) side to allow the current flow

▶ Katode: it is the part that must be connected to the negative (-) side to allow the current flow
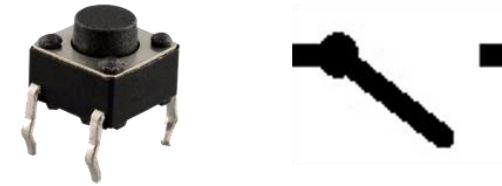
Appearence and symbol

POTENCIOMETER

Potenciometer is a resistor that can change its value, to this aim it usually has coupled a small rod that swirls in both directions, each of which will make the value go up or down.

To the right the looks of a potenciometer can be observed and beneath, the electronic symbol of it.

A button is a device that change the status of an electronic circuit depending on whether it is pushed or not.
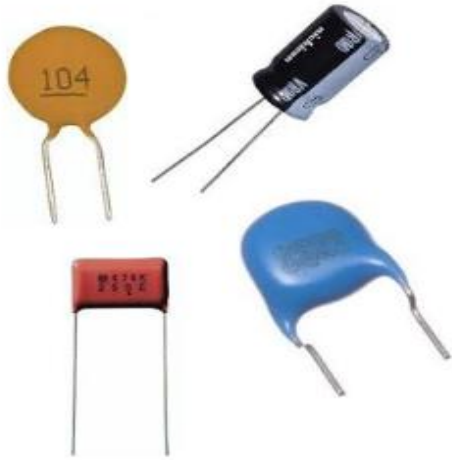
Pushing it will allow the electric current through it and releasing it will stop the flow. Electronic buttons have a special structure, they have just two terminals but 4 pins, as you can see in the picture to the right the pins that are opposite from one another are the same electric spot.

Appearence and symbol
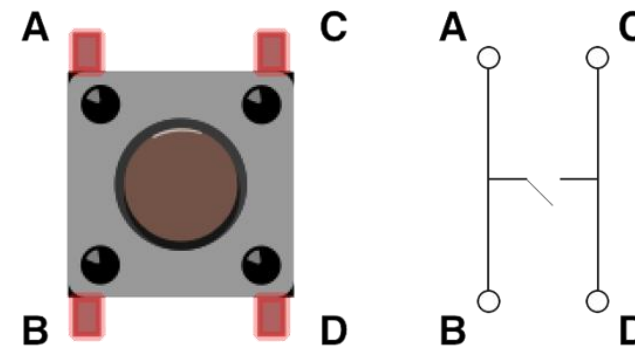
BUTTON

Appearence and symbol

CAPACITOR

This component is able to store and release electrical energy according to the neccesity of the circuit.

When the circuit's voltaje is higher tan that stored in the capacitor, this will charge and when the voltaje of the circuit is lower tan the capacitor's it will release energy.

It is usualy placed in circuits to smooth voltaje changes.

BUZZER

This component makes sound when current is flowing through it. It can emit different sounds depending on the frequency you want to use, this frequency is determined by the user in the sketch.

The higher the frequency the higher the pitch of the sound made by the buzzer will be.

To the right you can see the looks of this device.

EXTRA READING MATERIALS

Infographics

Website, links, etc.

- Openin Project

- Tinkercad

- Fritzing

EXTRA READING MATERIALS

Studies, e-books

Videos

▶ Arduino IDE download and instalation

▶ Fritzing, an overview

▶ Tinkercad sample

EXTRA READING MATERIALS

EXERCISES / TESTS / QUIZZES

TESTS

Question tests to self asses the adquired knowledge

[TEST FROM UNIT 1](#)

[TEST FROM UNIT 2](#)

Some electronic schemes will be provided to be assembled on a protoboard along with Arduino. The solution will be given, but take into account that more than one solution is possible.

This simple exercises will help you understand the assembling method with protoboard and how to connect Arduino's power supply. You will need to connect all the circuits to the Arduino, which will provide the power supply to the LED, which will be the indicator of the correct assembling.

Just make clear one more explanation, the power supply has the symbol shown to the right.
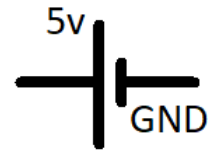
The longer segment represents the side where you will have to connect 5 volts pin, the shorter one, you will connect to the pin named GND
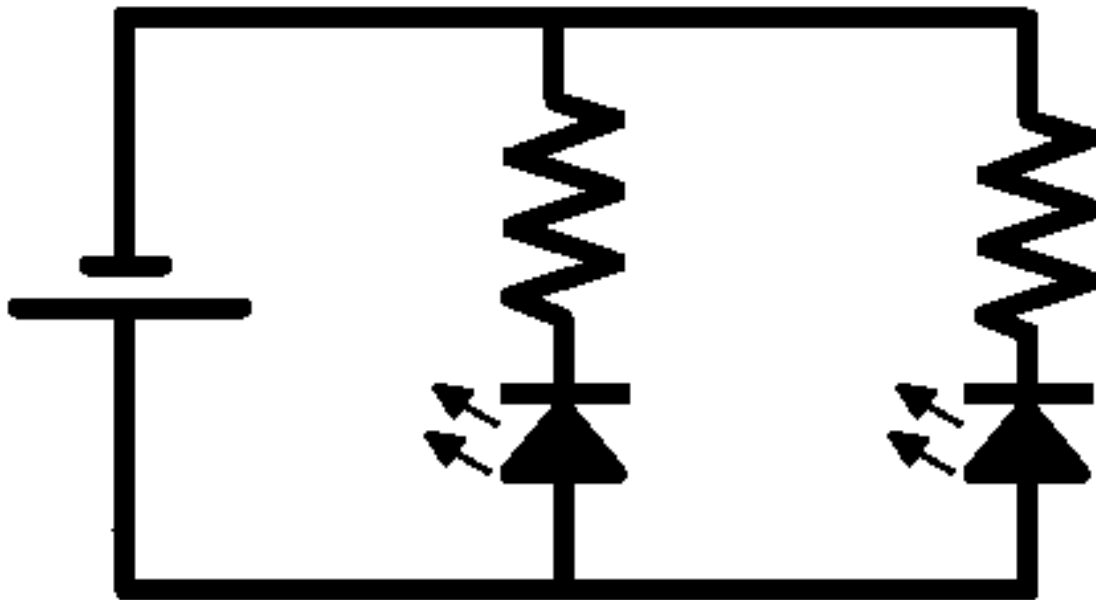
EXERCISE 1
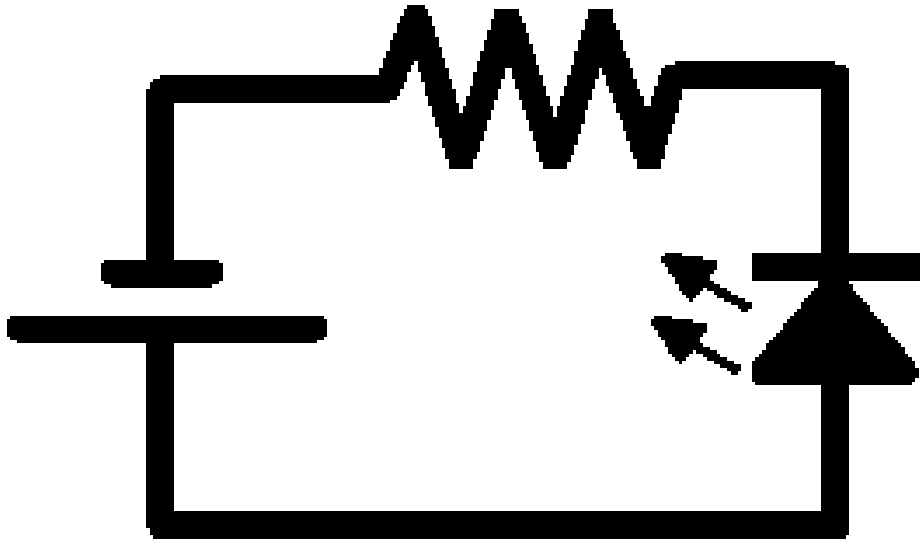
In this exercise you will have to turn on the LED, which will be assembled along with a resistor

Solution

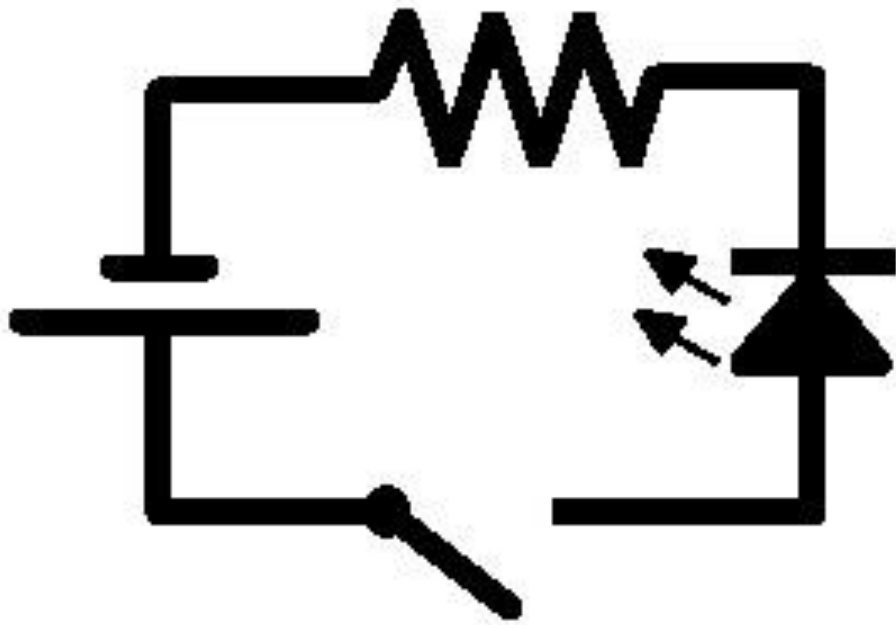In this circuit you will have two LEDs, and one resistor apiece, the objective is to make them work together at the same time
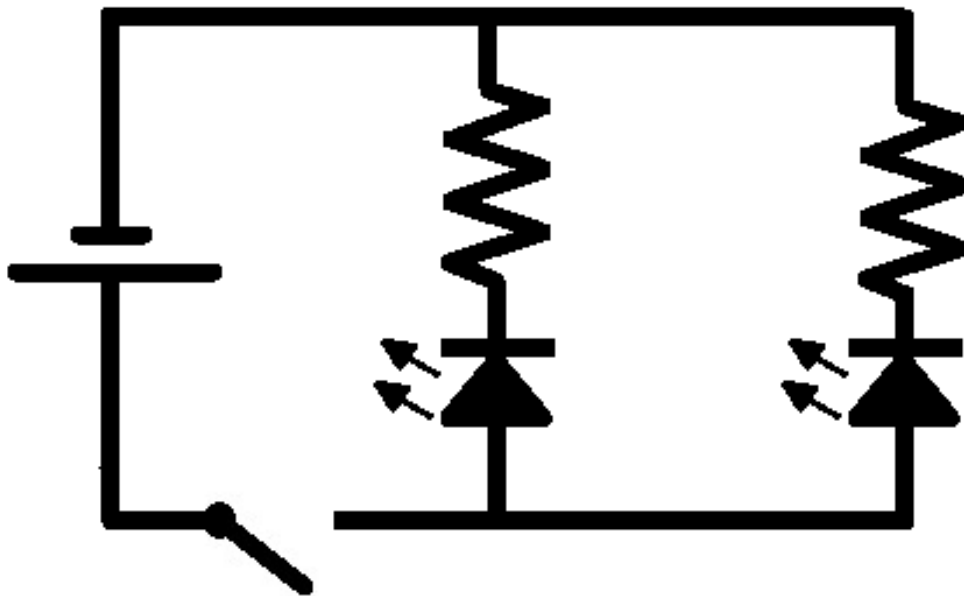
Solution

This exercise adds a button, so the LED will switch on only when the switch is being pushed
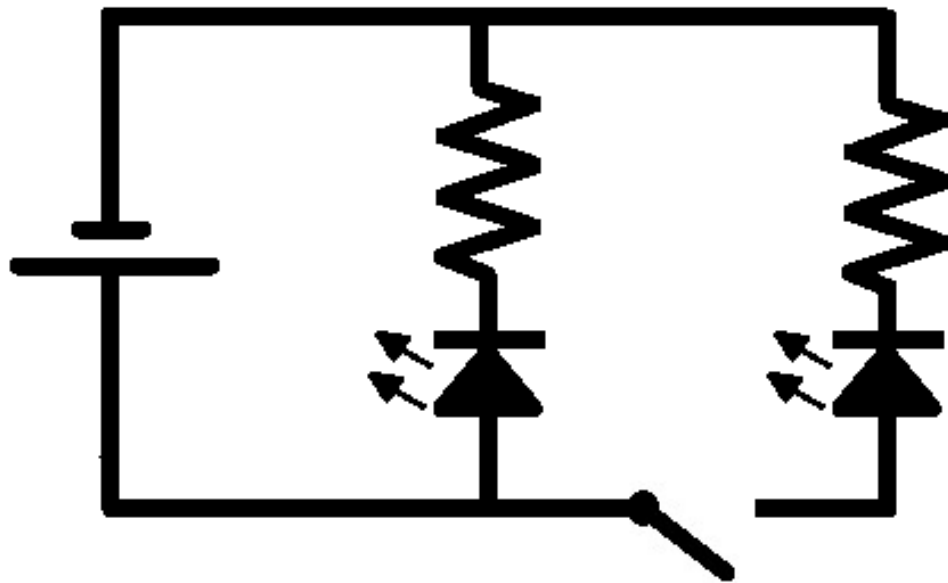
Solution

EXERCISE 4

This exercise has a button that has an effect on both LEDs in the circuit, the switch will turn both LEDs on (if pushed) or off (if released)
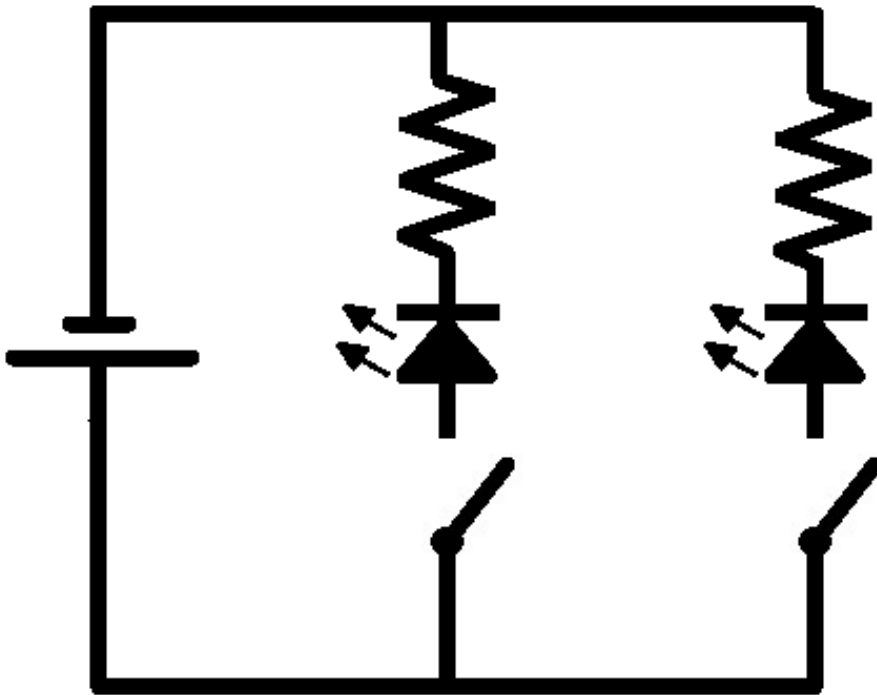
Solution

In this exercise the button will have an effect only on the LED placed to the right part, the other one will be on all the time
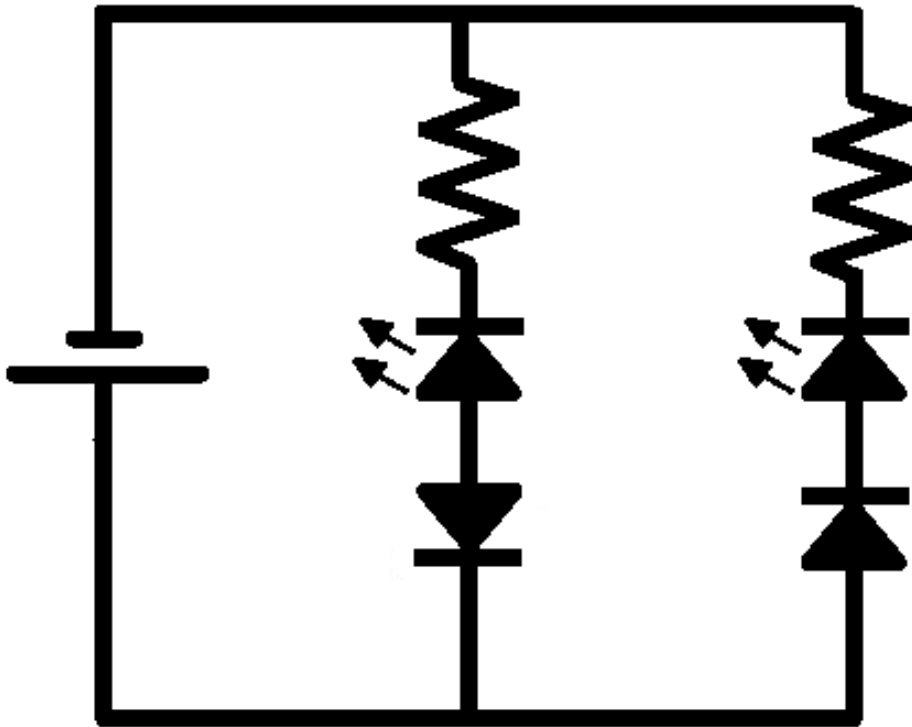
Solution

In this exercise you will have to assemble two LEDs, two resistors to keep the current through the LEDs under control and two buttons, each of them will manage one of the LEDs

Solution

In this exercise you will assemble two LEDs and their resistors and a diode along with them but the diodes must be in opposite positions. This will prevent one of them to turn on.

Solution

CONGRATULATIONS

You have completed SYS-STEM Module 1