ΓΥΜΝΑΣΙΟ
ΖΗΠΑΡΙΟΥ

Gymnasio Zipariou Kos

School 3.0

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Erasmus KA 229
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LTTA C5 Open Source Coding: Scratch and mBlock Programming Languages

Draft Edition 1.0

18 to 22 July 2022,
Gymnasio Zipariou, Kos island, Greece

The activities included in this booklet are an introduction to STEAM. They are activities with electrical/electronic circuits and sensors. For the implementation of these activities, elementary programming knowledge in block-based programming (scratch) is needed.
With these activities

- Programming/Computational Thinking is taught in an experiential way (experiential learning)
- Science concepts are taught (math, physics, chemistry) with an experiential and playful mode
- Concepts from Technology and Engineering are taught and implemented

The activities are compatible with the new Informatics Curriculum for Primary and High School in Greece as well as in other countries
These activities have many advantages for students

- They help students understand concepts from science
- They help students develop critical thinking and exercise their imagination
- They help students become familiar with teamwork
- They help students engage in activities that are relevant to everyday life and that are meaningful to them
- They help students understand aspects of modern technology, since sensors and circuits are integrated in almost all devices
- They help students learn in a multimodal, differentiated, embodied, hands-on way
- They help students improve their communication skills, since at the end of each activity it is recommended to present them to the whole class

Lesson 1

This Lesson can also be used for teaching about Electricity in primary schools

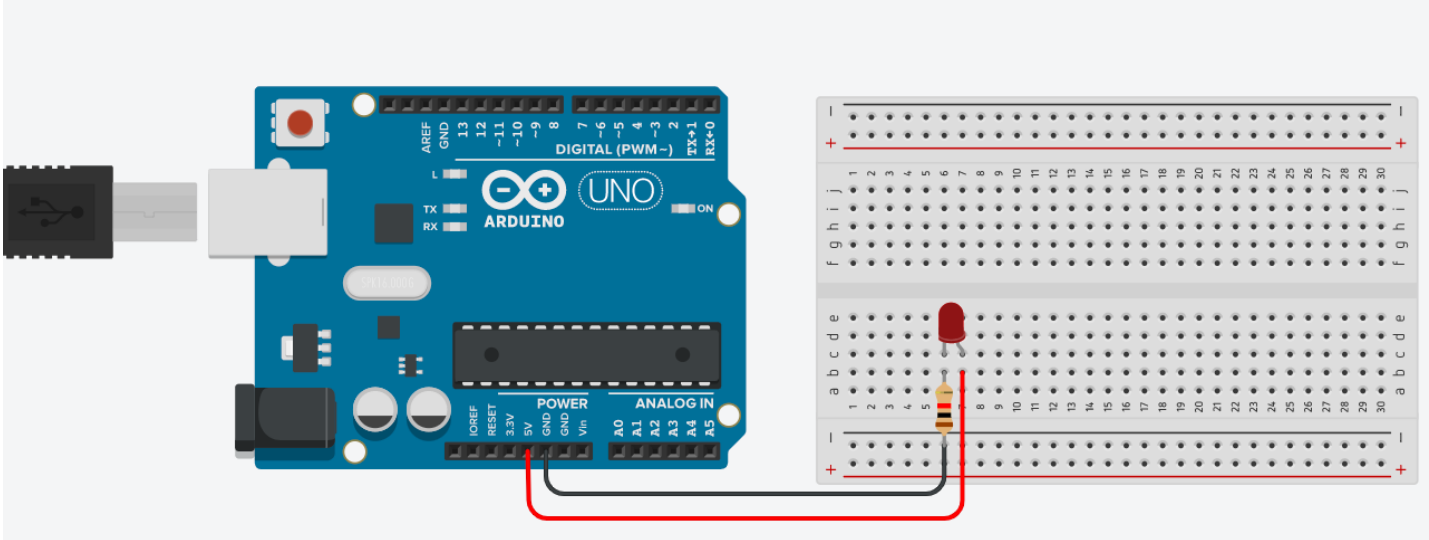
Objectives

Students should be able to

- understand the concepts “electric current” and “circuit”
- design and implement an electrical circuit
- detect errors in an electrical circuit
- publicly present their creations after implementation of each activity (whole class presentation is recommended)
- write code that implements complex electrical circuits

What is an electrical circuit?

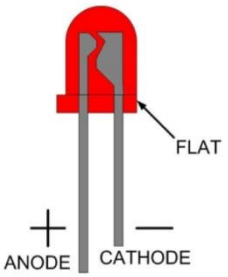
An electrical circuit is a closed path through which electricity passes.
The image below depicts a circuit.



Electricity is the directed movement of electrical charges along an electrically conductive conductor (wire). Electricity is created when there is a voltage difference.
The Arduino board is powered from the computer or from a battery that we connect it to.
The electricity in our circuit is created when we apply +5Volt to pin 7 of the board.

The circuit ends with grounding GND. Grounding is the connection of an electrical circuit terminal to the ground or another object with a voltage of 0 Volts.
This difference between +5Volt and 0 Volt creates electricity.
Electricity flows from the positive pole to ground.
Between pin 7 and ground GND there are

1. A resistor: The resistor "brakes" the electricity so that the LED does not burn out. If we do not connect a resistor the LED will burn. Because the current moves from +5 Volt to ground the resistor goes before the lamp (LED).
2. The LED, depending on whether electricity is passing through, lights up, if no electricity is passing through, it is off.



Electricity flows through the LED from the positive (Anode) to the negative (Cathode) terminal. Note that the positive pole is longer!

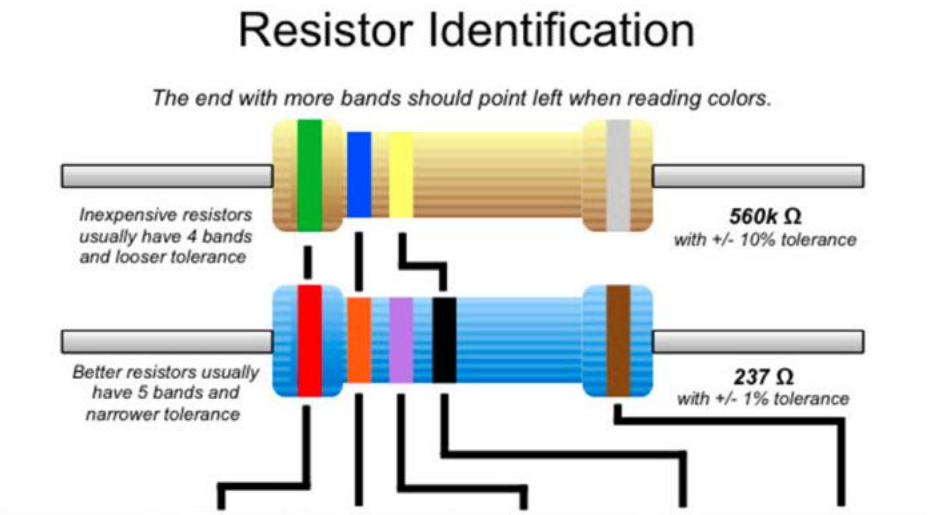
Resistor

A resistor is an electronic component that limits the flow of electrons. In doing so, it dissipates energy in the form of heat. Put into plain English, electricity has to struggle to flow through something which has a high resistance. In doing so, it works up a lot of energy and this is converted into heat.

Resistors with four stripes are the most common. These will likely be the type you will work with the most.

It makes no difference whether the resistor is connected to the anode or cathode.

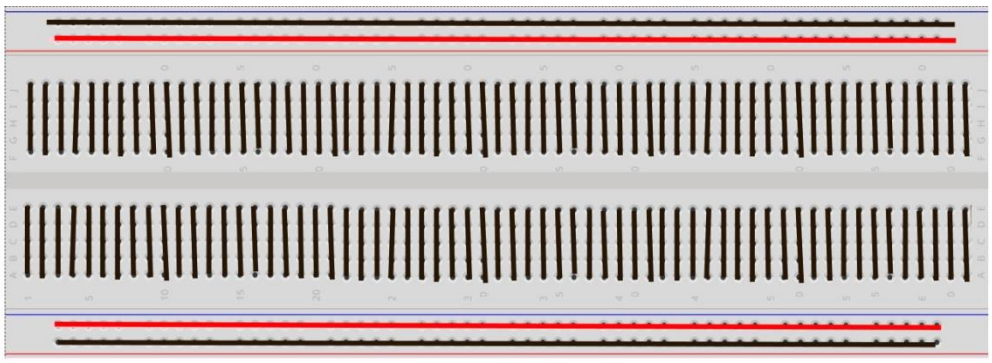
When reading a resistor with four stripes, the first two stripes are combined together to form a number between 1 and 99. The third marking is the multiplier. The last marking determines the tolerance.



Color	1st Band	2nd Band	3rd Band	Multiplier	Tolerance
Black	0	0	0	x 1 Ω	
Brown	1	1	1	x 10 Ω	+/- 1%
Red	2	2	2	x 100 Ω	+/- 2%
Orange	3	3	3	x 1K Ω	
Yellow	4	4	4	x 10K Ω	
Green	5	5	5	x 100K Ω	+/- .5%
Blue	6	6	6	x 1M Ω	+/- .25%
Violet	7	7	7	x 10M Ω	+/- .1%
Grey	8	8	8		+/- .05%
White	9	9	9		
Gold				x .1 Ω	+/- 5%
Silver				x .01 Ω	+/- 10%

Breadbord

Under the breadboard there are connections as shown in the figure:

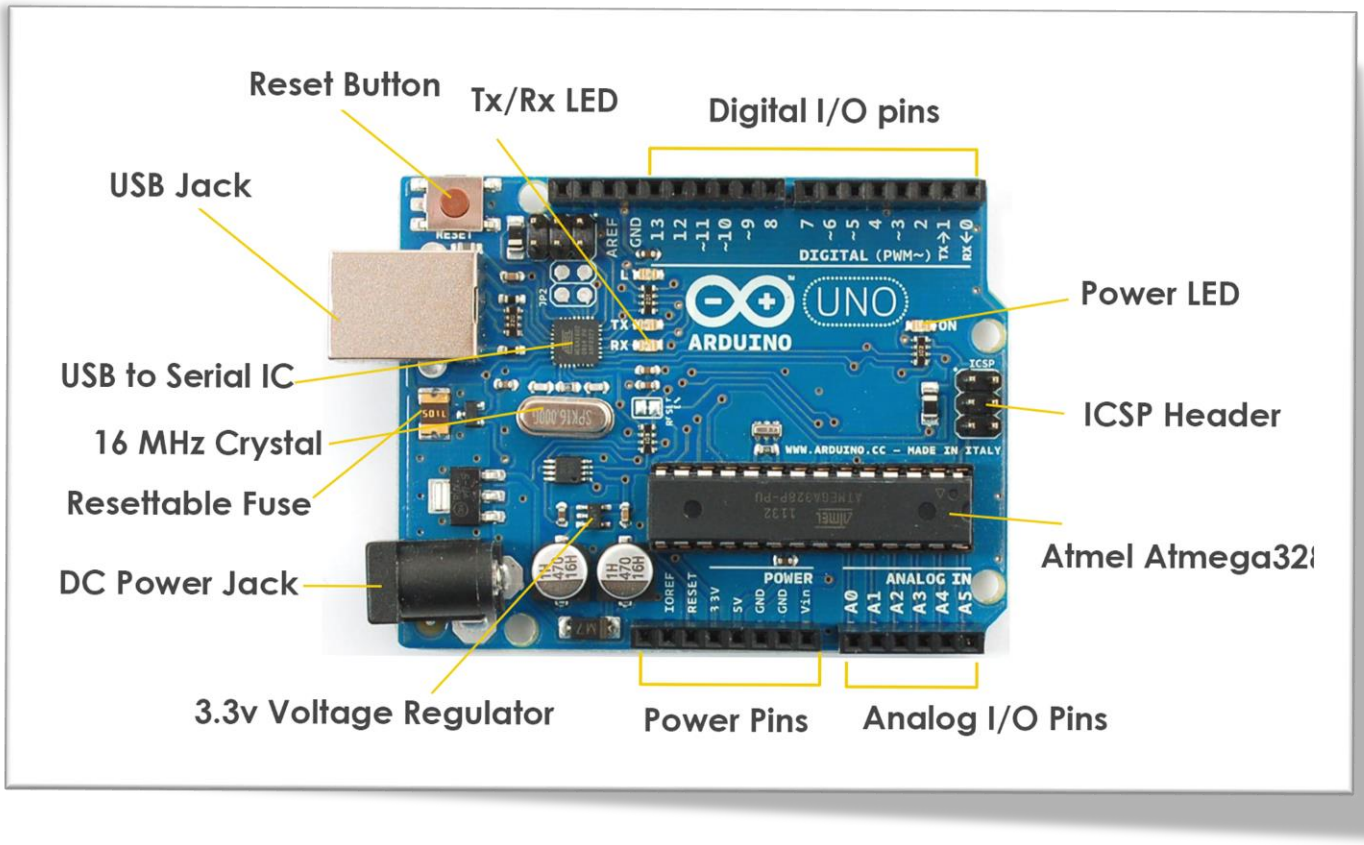


Breaboard

We bear these connections in mind in order to know how to design our circuit and how to connect our various components

Arduino Hardware

Arduino's analog inputs (pins marked A0-A6) can detect a gradually changing electrical signal, and translate that signal into a number between 0 and 1023.



The Arduino project began in 2005 as a tool for students at the Interaction Design Institute Ivrea, Italy, aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats and motion detectors.

The name *Arduino* comes from a bar in Ivrea, Italy, where some of the founders of the project used to meet. The bar was named after Arduin of Ivrea, who was the margrave of the March of Ivrea and King of Italy from 1002 to 1014 (Wikipedia.org).

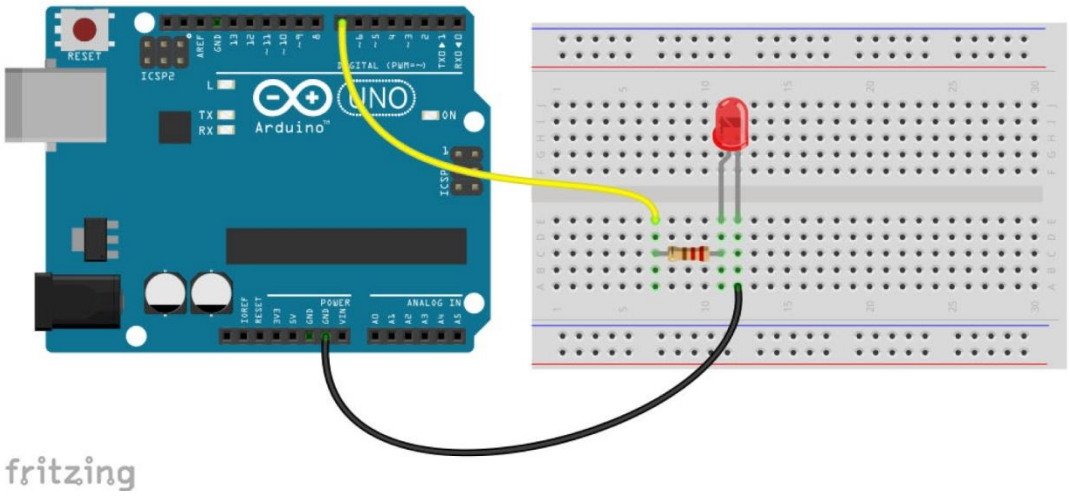
What Is mBlock 5?

mBlock 5 is designed for the Science, Technology, Engineering, Arts and Mathematics (STEAM) education. Inspired by Scratch 3.0, it supports both graphical and textual programming languages. Currently, more than 10 million people are using it to learn programming, create their own projects, and share their creations. With mBlock 5, you can design engaging stories, games, and animations, and program devices such as Makeblock robots and microbit. On mBlock 5, you can switch to the Python mode simply with one-click. In addition, mBlock 5 integrates cutting-edge technologies including Artificial Intelligence (AI) and Internet of Things (IoT).

mBlock - One-Stop Coding Platform for Teaching and Learning (makeblock.com)

Activity 1

Draw the circuit in the figure below with a red marker



Activity 2

Read the text below:

A huge circuit

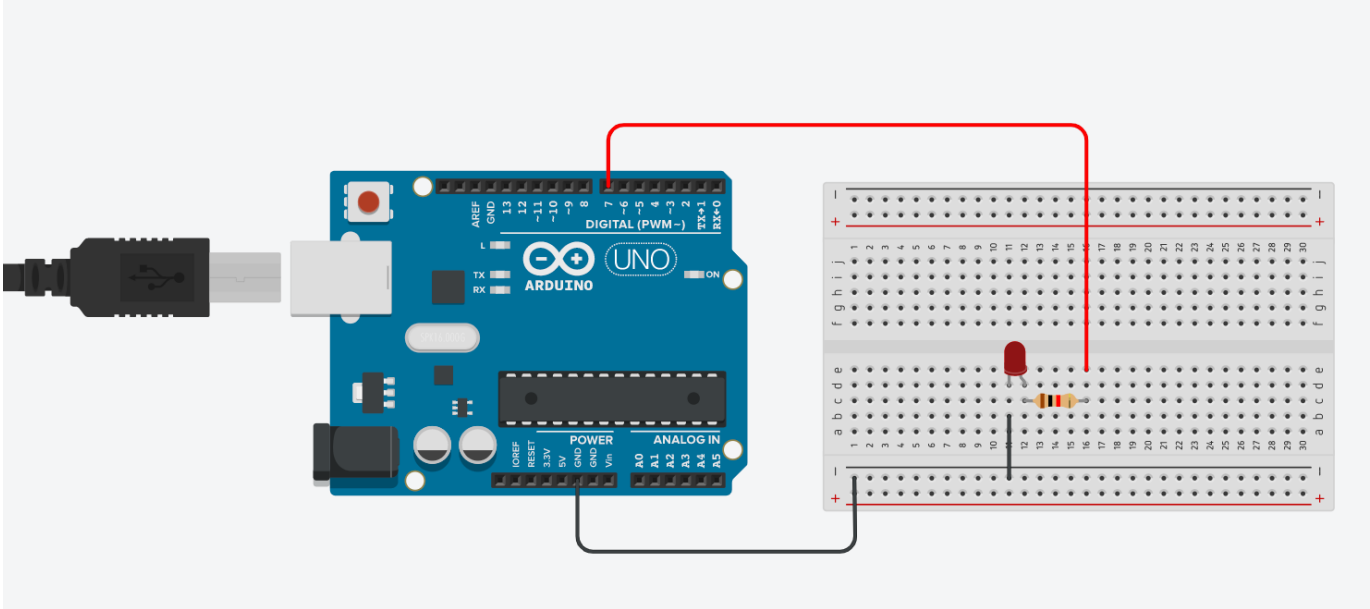
The whole of Greece is a huge, complex electrical circuit. Most of the electricity factories of the Greek Electricity Company are located in northern Greece. Electricity is transported across the country by overhead, underground and even submarine cables. If you observe the country's topography, with its high mountains and remote islands, you will understand how difficult it is to supply the entire country with electricity. The Greek electricity factories transmit electricity to the large urban centers and industries through a company network of lines whose total length exceeds 10,000 kilometers. The total length of the distribution network lines exceeds 170,000 kilometers.

Does anyone know how electricity is supplied to Kos island?

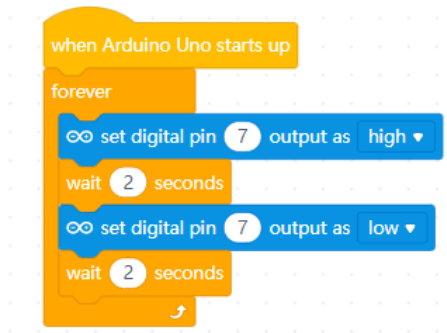
Activity 3

Add one more blue LED without changing the code to the circuit of Activity 1.

Activity 4- Make LED flash



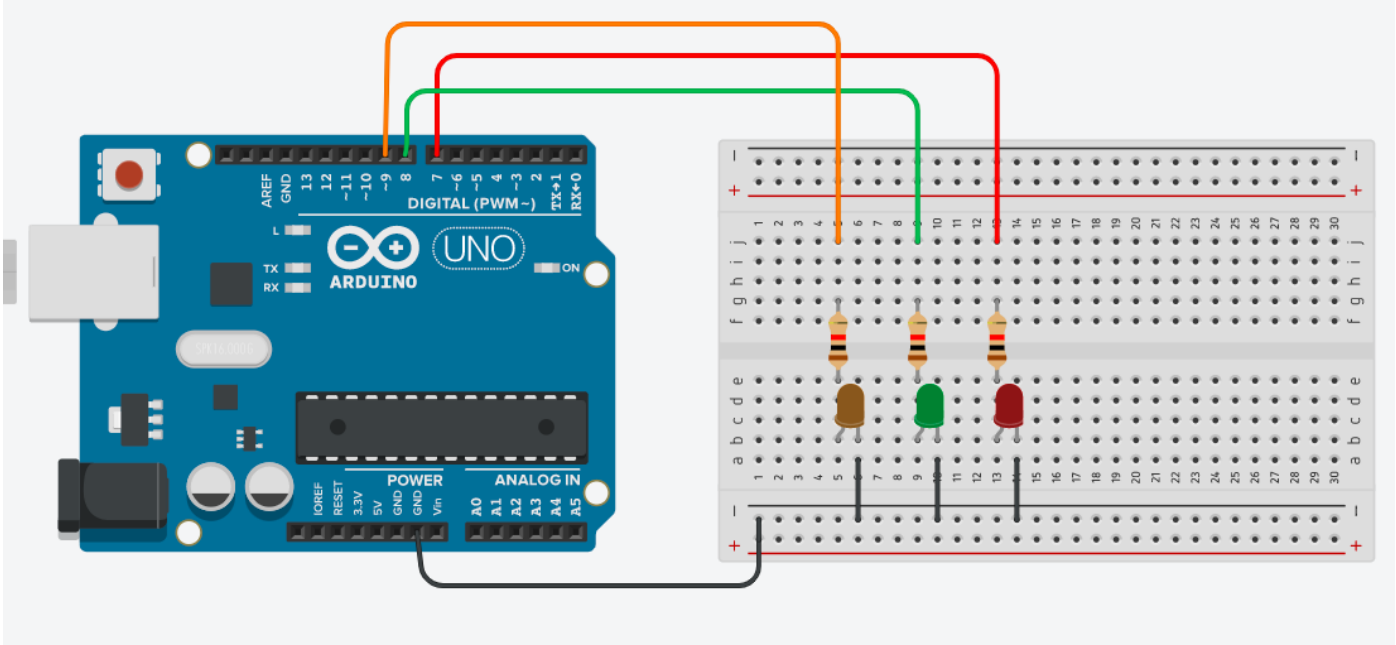
Code for mBlock

	Forever Set digital pin 7→ 5 Volt Wait 2 seconds Set digital pin 7→ 0 Volt Wait 2 seconds

Activity 5

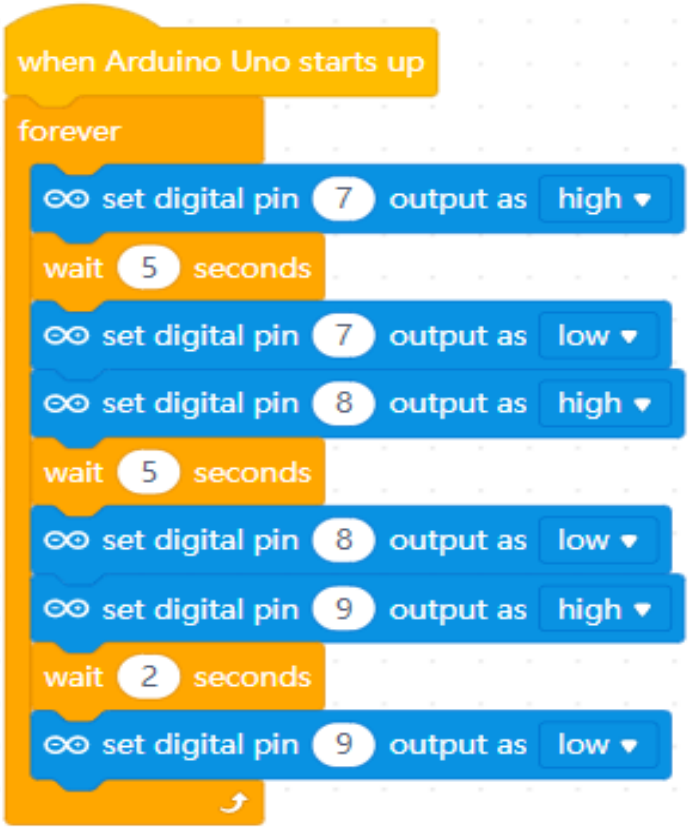
- Add one more LED to the circuit of activity 2.
- Write the program so that the LEDS light up in sequence, one at a time.
- Create the code

Solution



Designed by Tinkercad

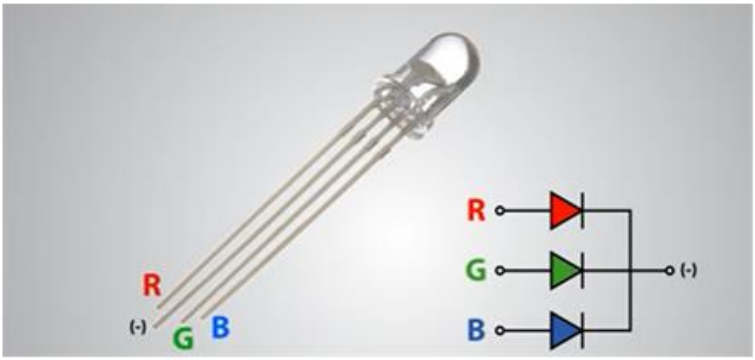
code for mBlock

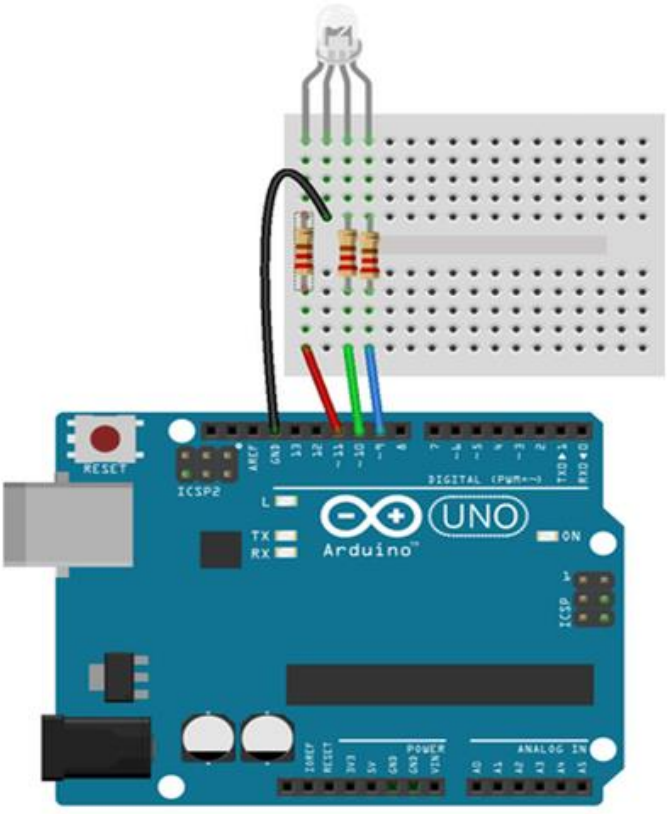


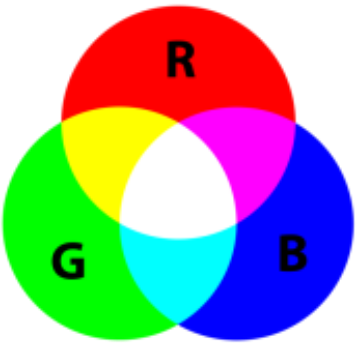
Lesson 2

Circuit RGB Led

This Lesson can be also be used to teach students about screen color production and mixing color for Art Lessons.

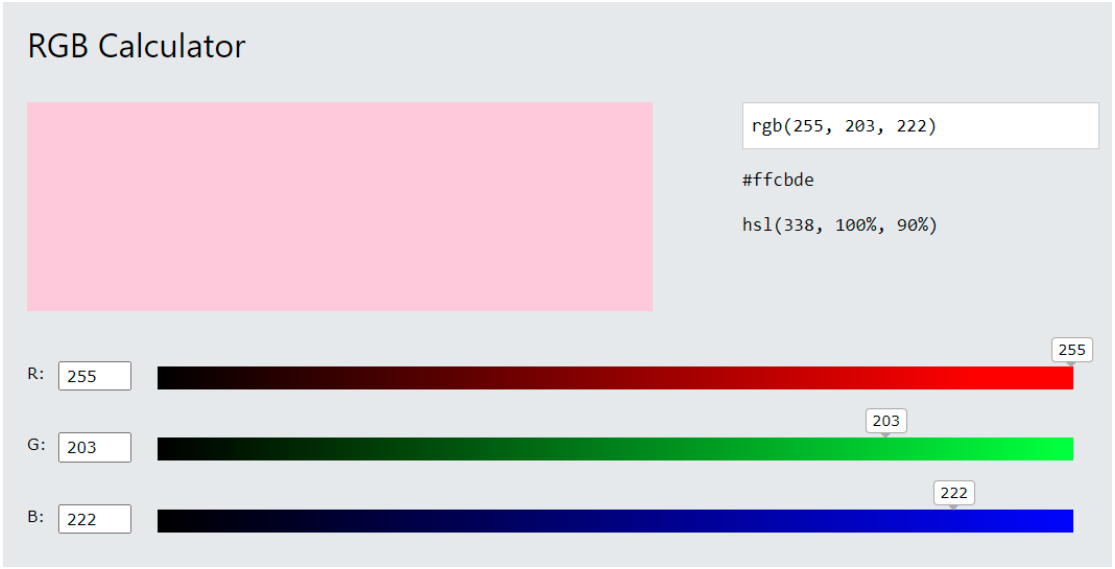






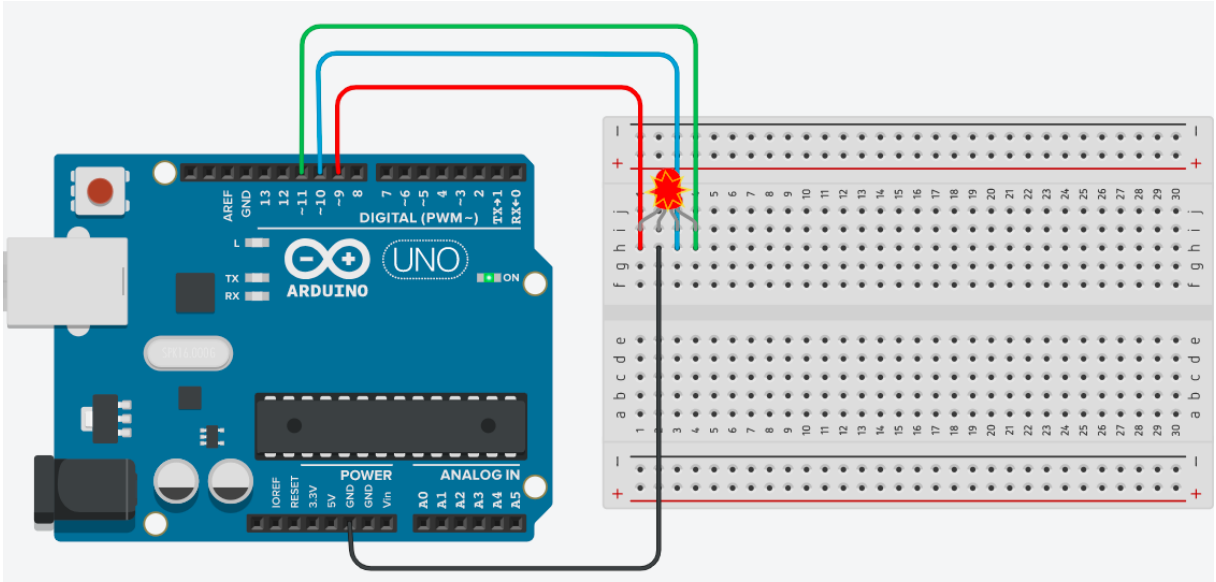
https://www.w3schools.com/colors/colors_picker.asp

Example of a specific color

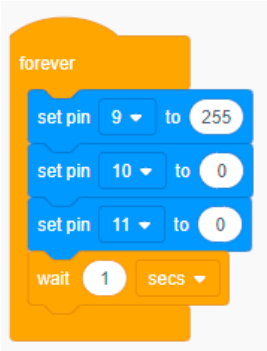


https://www.w3schools.com/colors/colors_rgb.asp

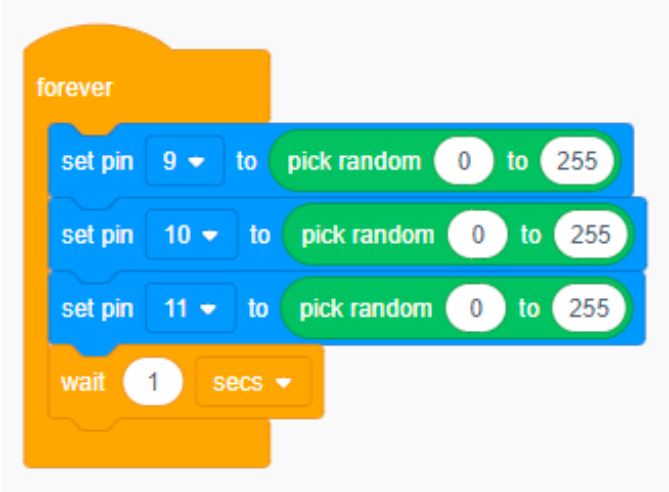
Activity 1
Specific color Production



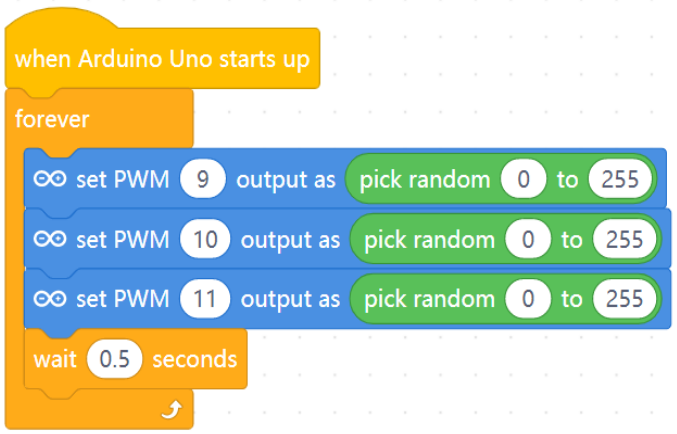
Code in tinkercad to produce pure RED



Activity 2
random color production



Code in tinkercad

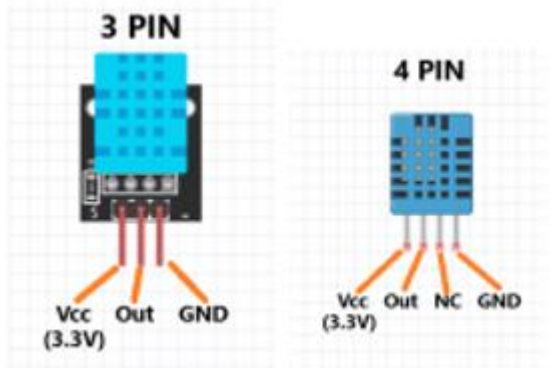


Code in mBlock

Lesson 3
Activity 1
Connecting a 3-pin DHT11 Temperature/Humidity sensor to Arduino

Characteristics :

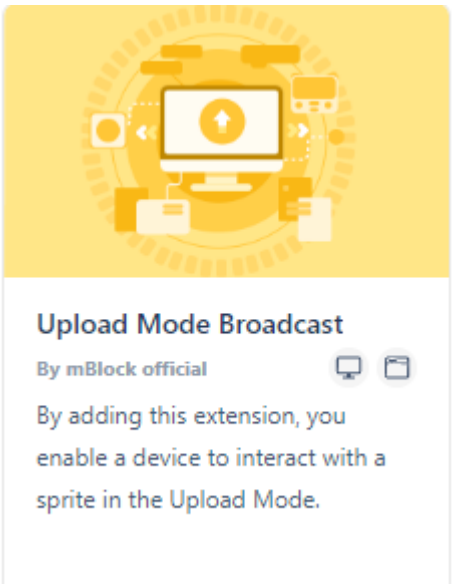
Temperature ranging from 0°C to 50°C can be measured with an accuracy of ± 2%°C
Humidity can be measured from 20% to 90% with an accuracy of ± 5%
Data is transmitted digitally.
The sensor itself is analog, it does however include a system for converting an analog value to a digital one, so it can be directly connected to an Arduino digital input (e.g. pin4) or to an analog input (e.g. A0)
There are two different versions of the DHT11 that you may come across. One type has 4 pins and the other type has 3 pins.



The connection of the 3-pin humidity and temperature sensor is quite simple, since the sensor has only 3 pins and is implemented as follows:
Out : Connect to arduino digital pin
GND (Ground) : Connection to ground
Out (Signal) : Connection to digital or analog input
Vcc Connection to 3.3v or 5v power supply (*)
(*) if you use 3.3 Volt instead of 5 Volt, then the cable should not exceed 20cm, due to voltage drop. **Use 3.3 Volt**

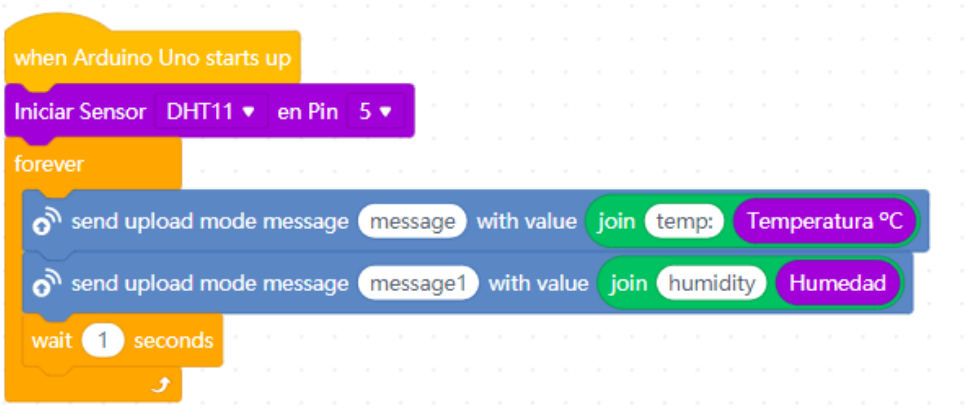
Program for temperature monitoring on computer screens, using messaging

1. Install the Upload Mode Broadcast extension **twice**, **once for the Devices tab and once for the Sprites tab.**

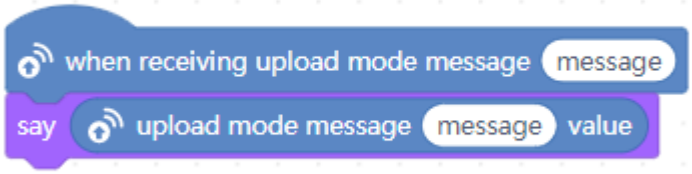


2. Install the extension DHT11-DHT22

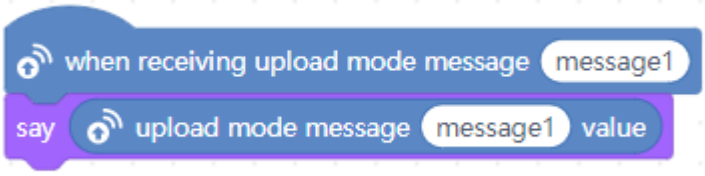
Code for device



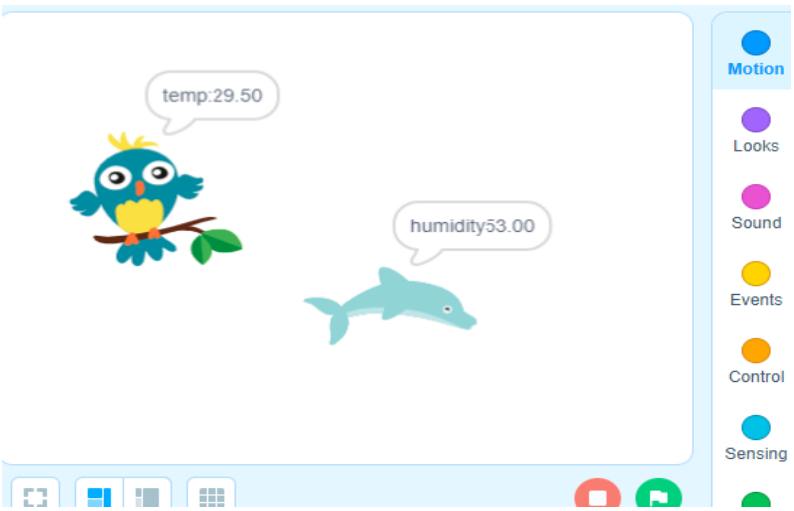
Code for sprite1 (Temperature)



Code for sprite 2 (Humidity)



Sensor DHT11 measures two values, **Temperatura** and **Humedad**
These values transmitted to variables **message** and **message1**
The variable **message** has the final value temp: (text) *join* Temperatura (value), for example *temp: 29.50*
The variable **message1** has the final value humidity(text) *join* Humedad (value), for example humidity *53.00*
The values sent by the sensor connected to the Arduino are displayed on the screen with the **say** command, as a statement of the corresponding sprites



Activity 2

Temperature/Humidity monitoring in LCD screen

LCD (i2c) connections

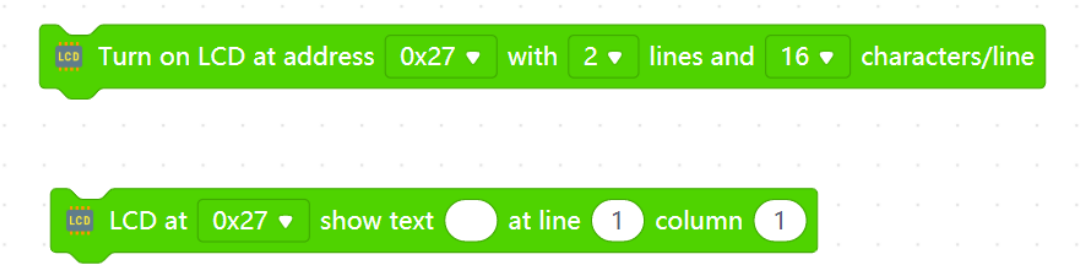
LCD	Arduino
GND	GND
VCC	5 Volt
SDA	A4
SCL	A5

Install extension LCD i2c

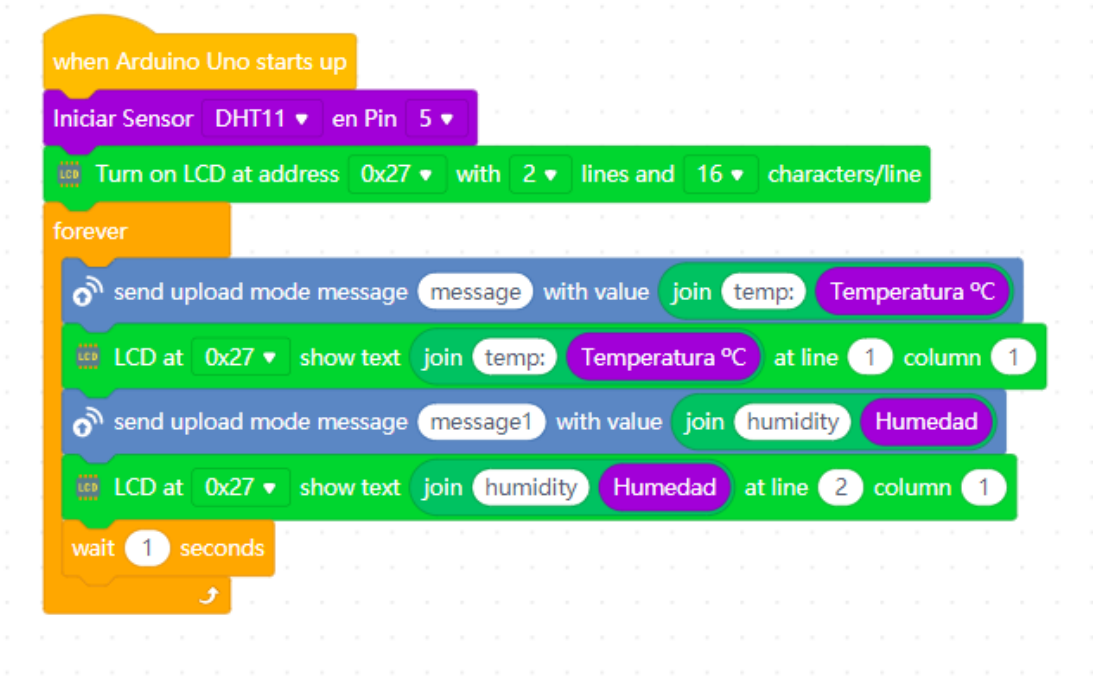
What is SDA and SCL pins?

The I2C protocol involves using two lines to send and receive data: a serial clock pin (SCL) that the Arduino Master board pulses at a regular interval, and a serial data pin (SDA) over which data is sent between the two devices

The extra commands you need are:



So the final code is as follow:

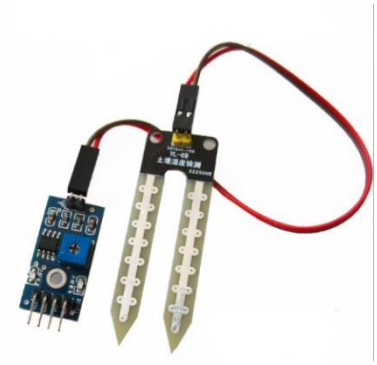


Lesson 4

Activity 1

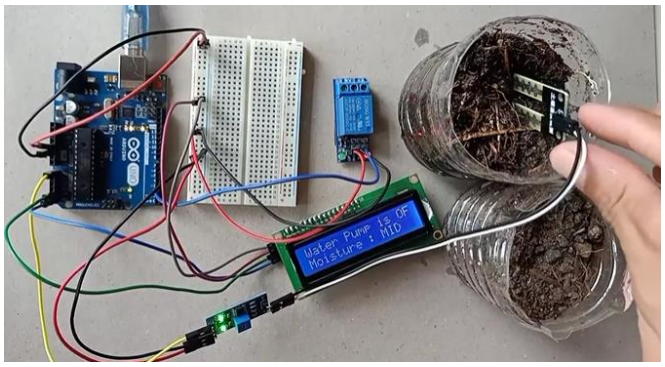
Soil-moisture sensor

To measure soil moisture we will use a soil-moisture sensor.
A soil moisture sensor is a device that measures current soil moisture**.** Sensors integrated into the irrigation system aid in scheduling water supply and distribution much more efficiently. Such gauges help to reduce or enhance irrigation for optimum plant growth.



The soil humidity sensor has 4 pins

Soil humidity sensor	Arduino
VCC	5 Volt
GND	GND
DO (digital output)	-
AO (analog output)	A0

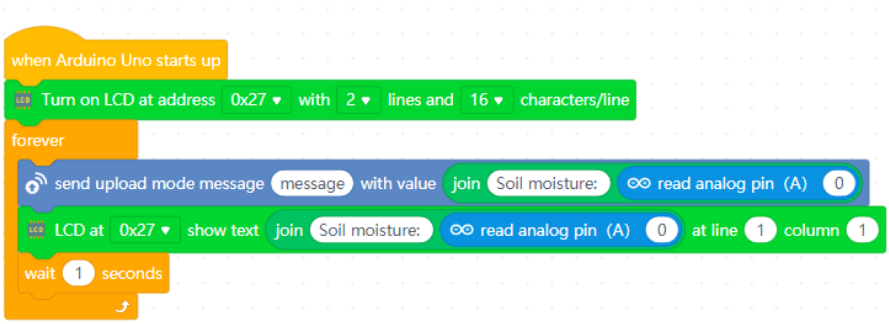


You can also watch the following videos

video1

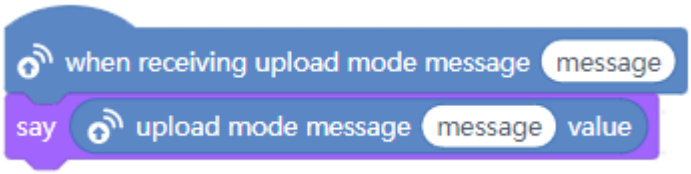
video2

The code:

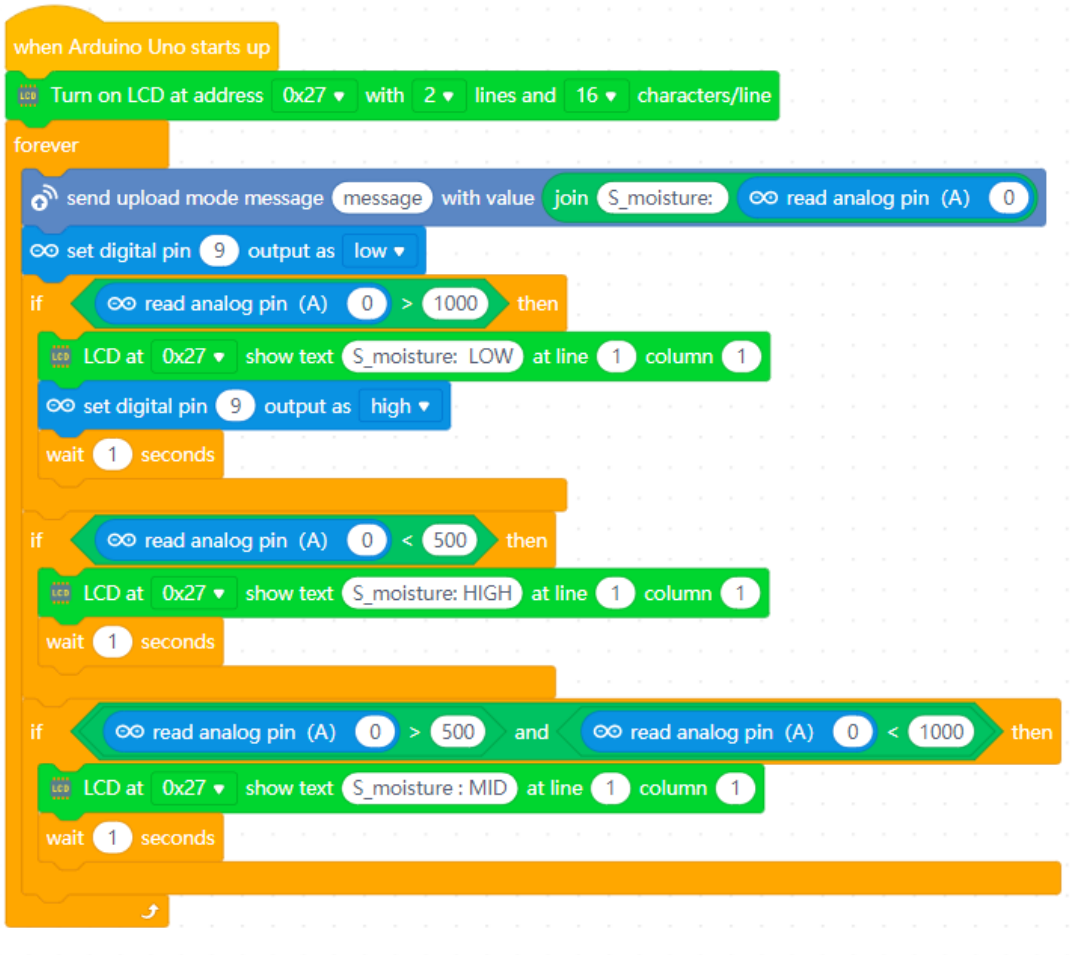


The display shows the moisture values from 1 to 4.
1 for very dry soil
4 for very wet soil

The corresponding sprite has this code



In the sprite soil moisture values are seen in analog values (>1000 for dry soil). So the code is modified as follows:



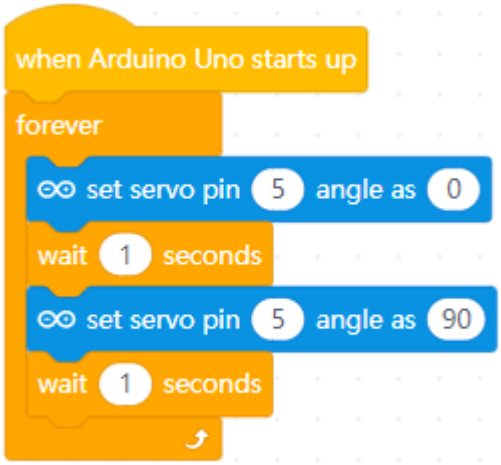
Additionally a RED LED is added, in digital pin 9, that turns on if the soil moisture is LOW.
Instead of lighting the LED, the signal could have been used to open a watering valve, activating a water pump etc. (application in GreenHouses)

Lesson 5

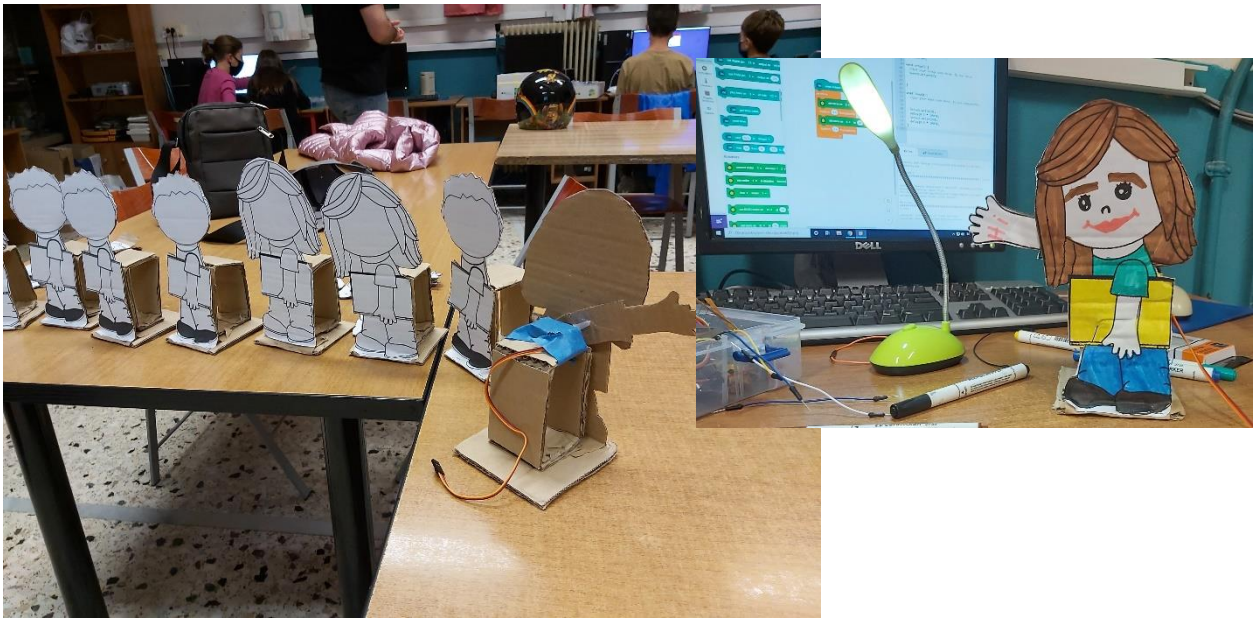
Servo motor

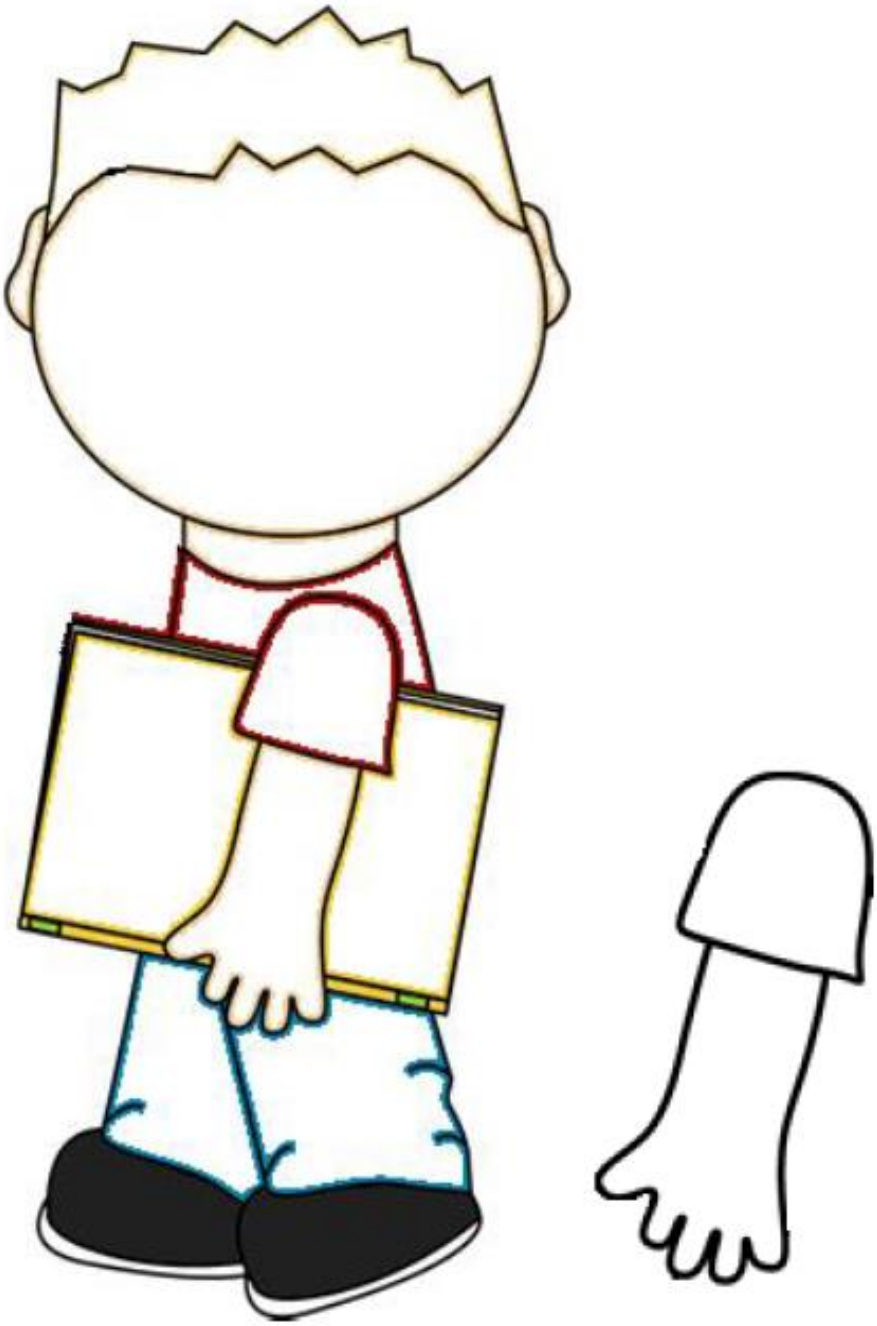
A servo motor is a motor that can rotate a shaft from zero degrees to 180 degrees. It has 3 wires, black or brown, red and orange.
The red wire connects to the 5V (VCC) pin,
the black/brown to the ground (GND) and
the orange to a digital pin (pin) so we can check it

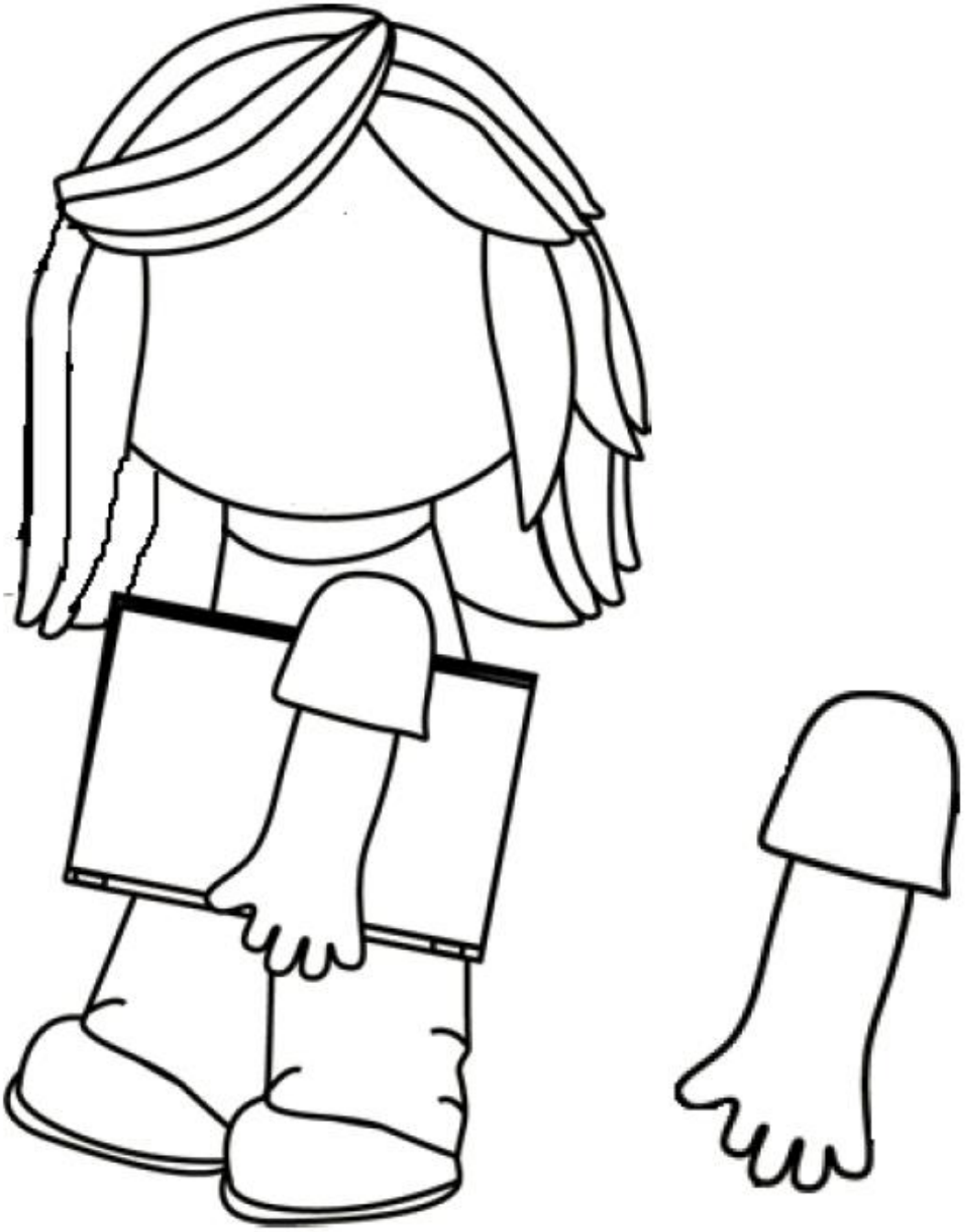
the code



Activity 1-Greeting





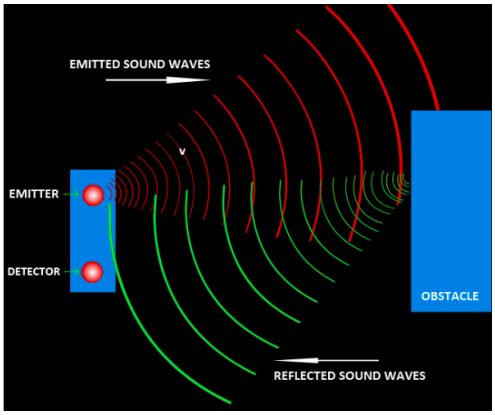


Lesson 6

Activity 1

Ultrasonic sensor

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after it has travelled to and from the target).



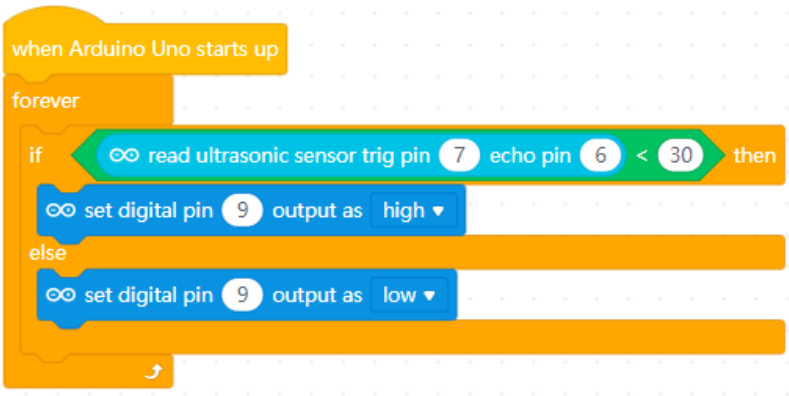
Ultrasonic sensors are used primarily as proximity sensors. They can be found in automobile self-parking technology and anti-collision safety systems. Ultrasonic sensors are also used in robotic obstacle detection systems, as well as manufacturing technology

Connections

Ultrasonic sensor	Arduino
VCC	5 Volt
Trig	Pin7
echo	Pin6
Gnd	GND

We will implement a mechanism for distance detection. A led is connected to pin 9. The LED turns on when an object approaches the sensor at a distance of less than 30 cm.

The code



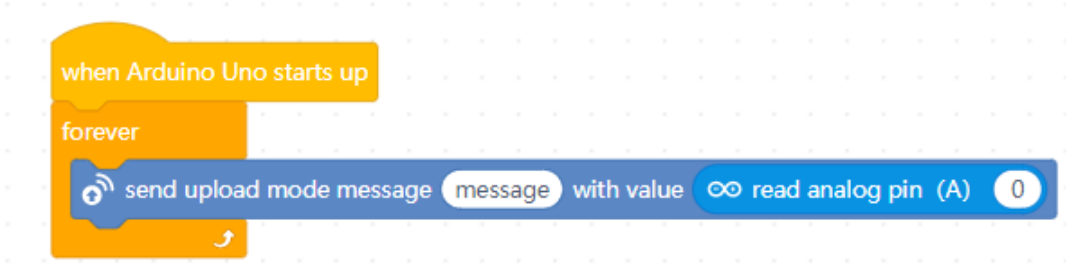
Lesson 7

Activity 1

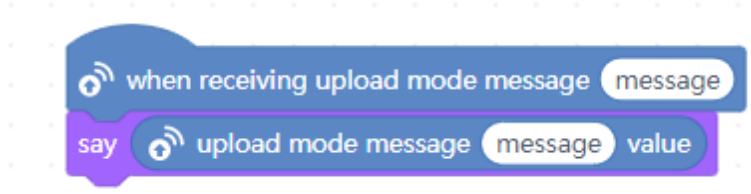
Photoresistor Light Sensor LDR

The Photoresistor Light Sensor LDR is connected to the analog port of the Arduino. Low values correspond to light (light is detected) while large values correspond to darkness.

Code for device

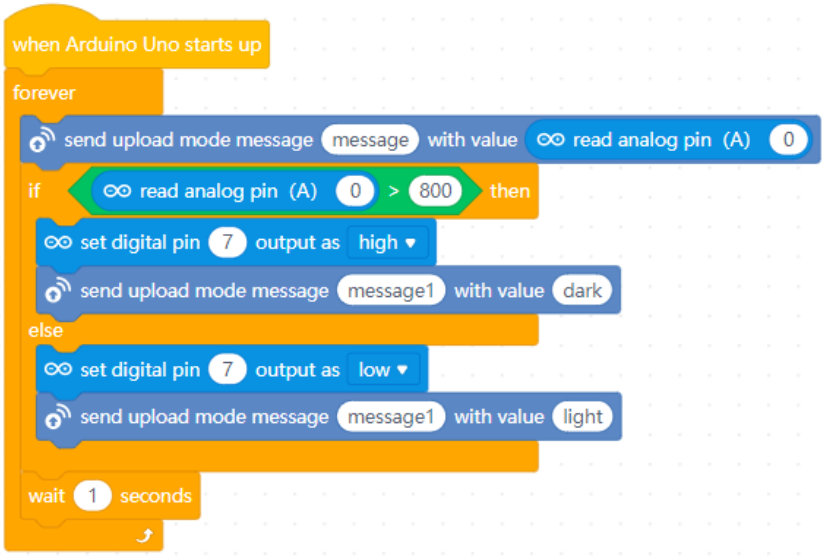


Code for Sprite

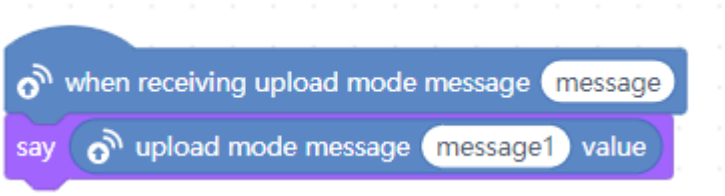


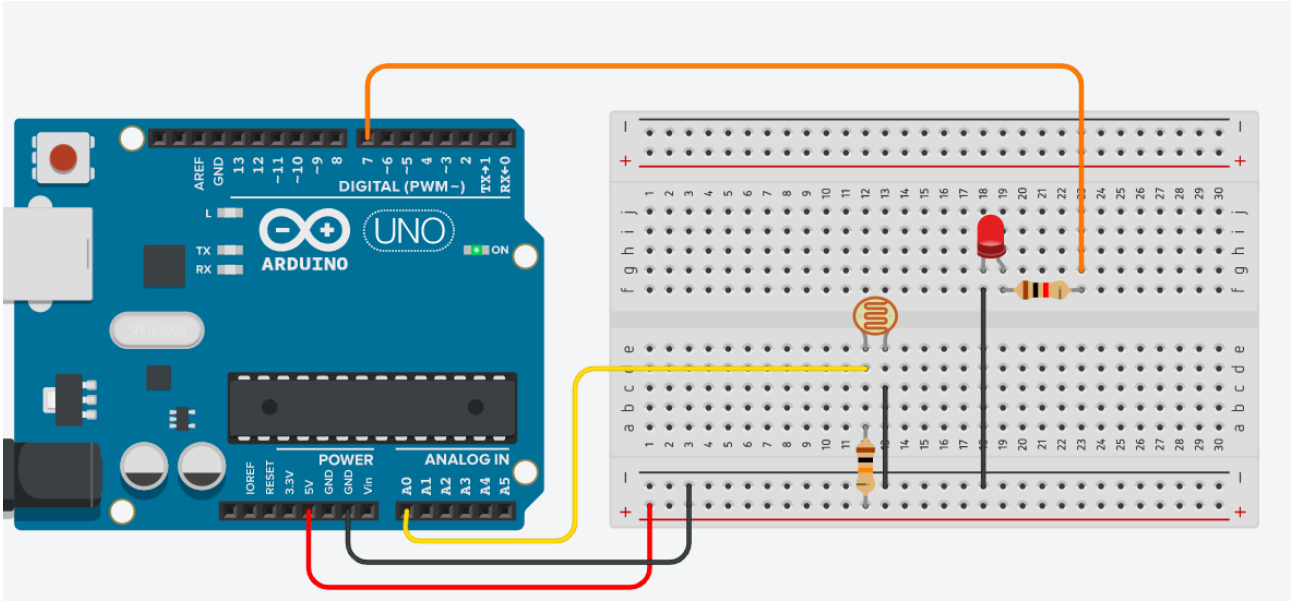
We will add to the circuit a LED which will light up when the sensor detects darkness (values>800)

The code for device



The code for sprite





Designed by Tinkercad

https://www.tinkercad.com/things/cx14v2CEKA1-grand-bojo-tumelo/editel?share-code=io0345rhC2LIQpYEKMeyPzhSXZyUdwBz0gEU24KaLnc

Activity 2

In the previous circuit we will add a new sprite, which is a baby. When darkness is detected, the baby changes its costume and starts screaming!!!