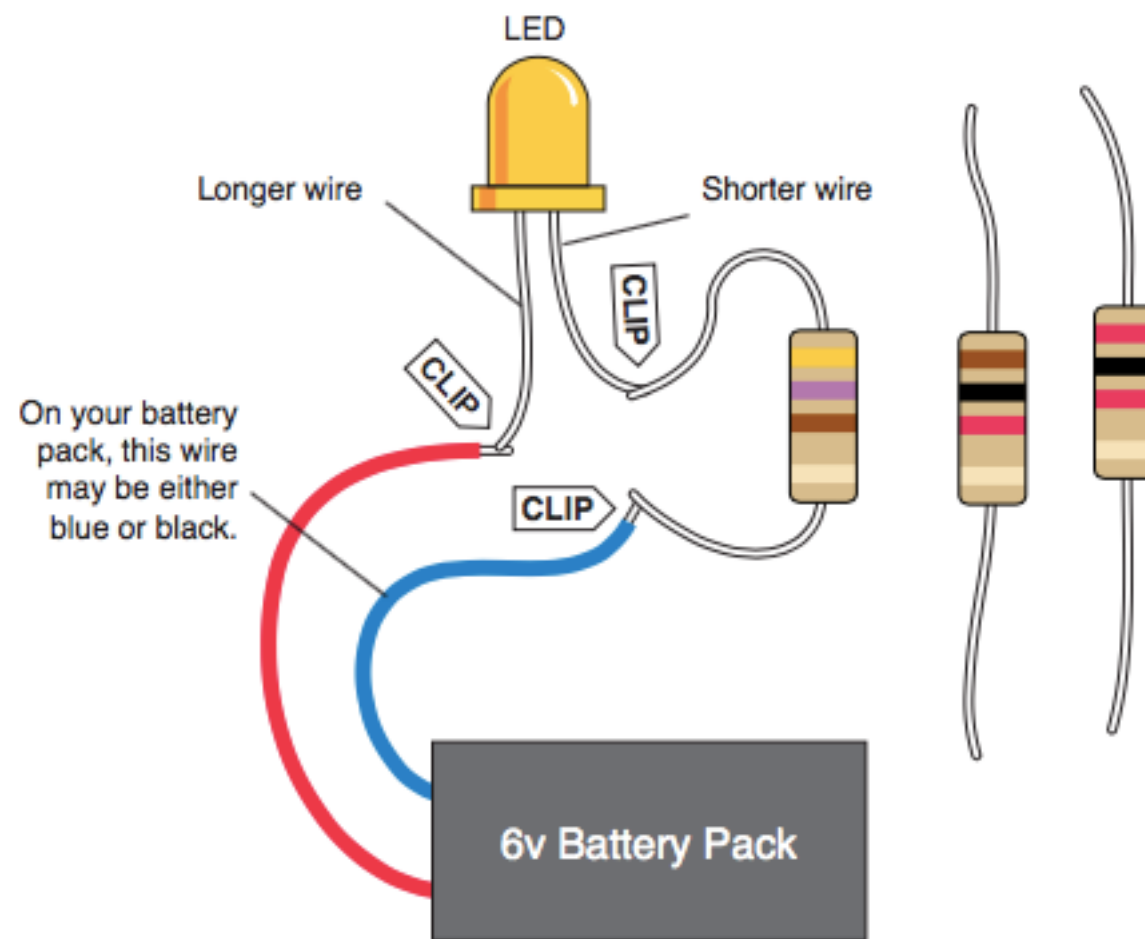# Electronics 1

Electronics for Interactive Media Design
Les 2

Emma Pareschi

Voltage - Resistor - Current

Voltage - RESISTOR - Current

A resistor is one of the most fundamental components in electronics. Its purpose is to <u>impede a flow of current</u> and <u>impose a voltage reduction</u>.

Two wires or conductors attached at opposite ends or sides of a relatively poor electrical conductor.

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

Ohm's Law

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

$$V = I * R = IR$$
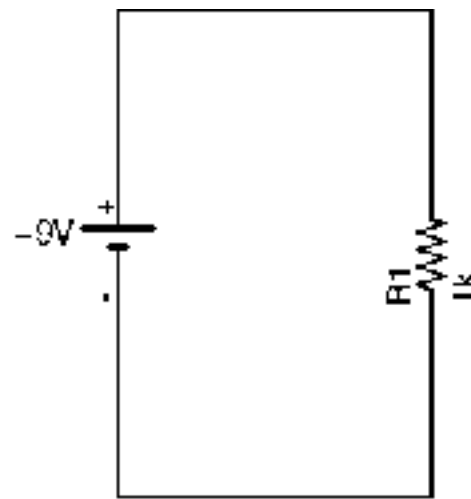
You know the Voltage and the Resistor =>
         => calculate the current you consume: $I = V / R$

You know the Voltage and the Current =>
         => calculate the resistor you will use: $R = V / I$

Electric Power

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

<u>ENERGY</u> is basically the ability of something to move something else. Forms of energy: mechanical, electrical, chemical, electromagnetic, thermal, and many others.

<u>TRANSFORMATION</u>: 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.

Energy type converted	Converted by
Mechanical	Electric Motor
Electromagnetic	LED
Heat	Resistor
Chemical	Battery
Wind	Windmill

Electric power is measured by combining both <u>how much electric energy</u> is transferred, and <u>how fast that transfer</u> happens.
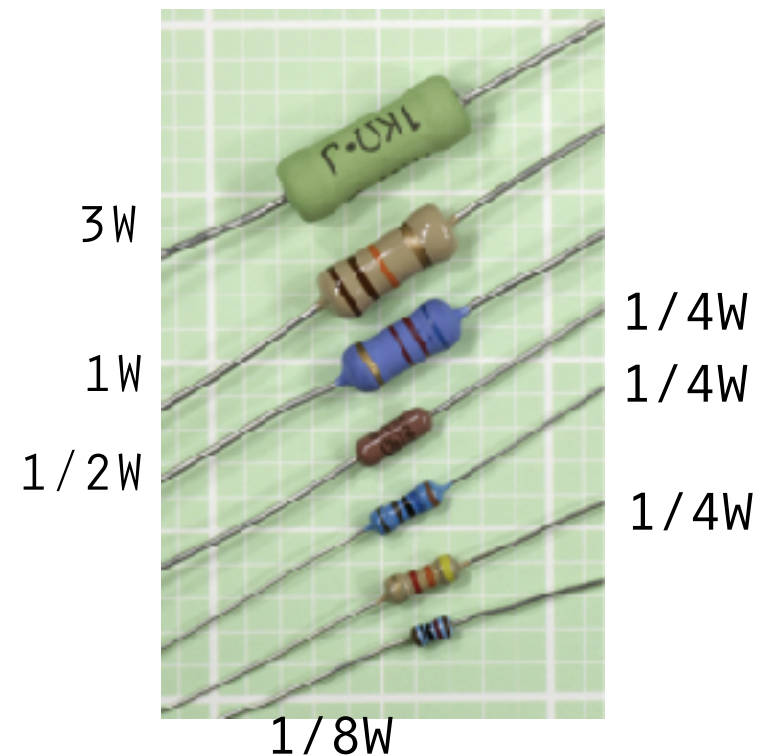
Electric Power

how much electric energy is transferred: Voltage
how fast that transfer happens: Current

Unit of measure: Watt (W)

P = V * I = VI

Electric Power for Resistors

3W

1W

1/2W
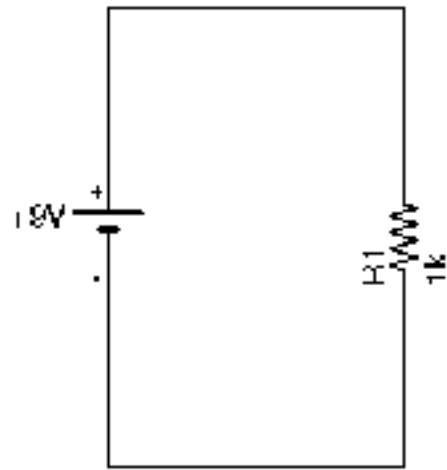
1/8W

1/4W

1/4W

1/4W

```
P = VI
or
P = RI *I = RI²
or
P = V * V/R = V²/R

The most common power rating
is 1/4W = 0.25W
```
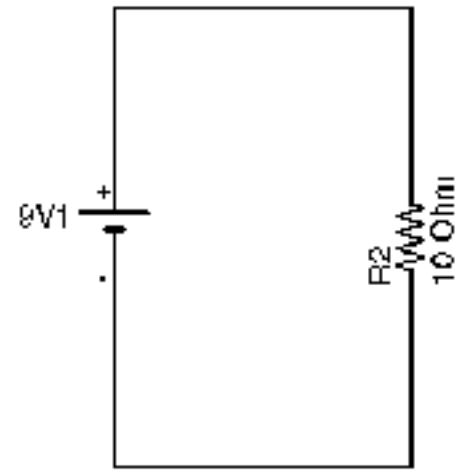
In case of resistors electric energy is converted to heat.

Power examples


```
V = 9 V          V = 9 V
R = 1K Ohм       R = 10 Ohм
I = 0.009 A      I = 0.9 A


P = 0.081W       P = 8.10W
```

Circuit LED

How to use Ohm's law in the design of my circuit?
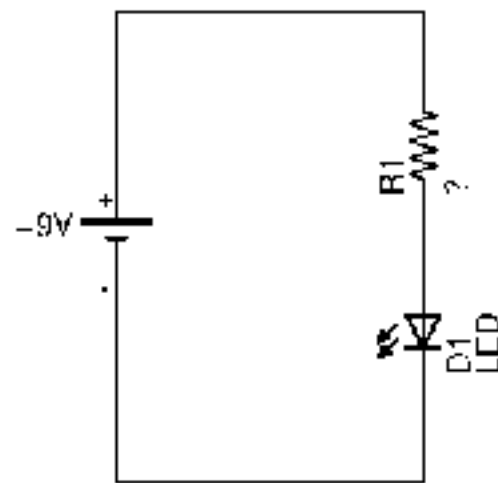
Specifications from Datasheet:
- wavelength of emitted light
- luminous intensity
- <u>maximum forward voltage and current</u>
- maximum reverse voltage and current,
- <u>working values for voltage and current</u>

Productgegevens

☐ **LED Colour:**	Red		☐ **Viewing Angle:**	68°
☐ **LED Mounting:**	Through Hole		☐ **Lens Shape:**	Round
☐ **Bulb Size:**	T-1 3/4 (5mm)		☐ **Packaging:**	Each
☐ **Forward Current If:**	25mA		☐ **Product Range:**	-
☐ **Forward Voltage:**	1.7V		☐ **Automotive Qualification Standard:**	-
☐ **Wavelength Typ:**	660nm		☐ **MSL:**	-
☐ **Luminous Intensity:**	32mcd			

Circuit LED
HOW TO CALCULATE THE RESISTOR
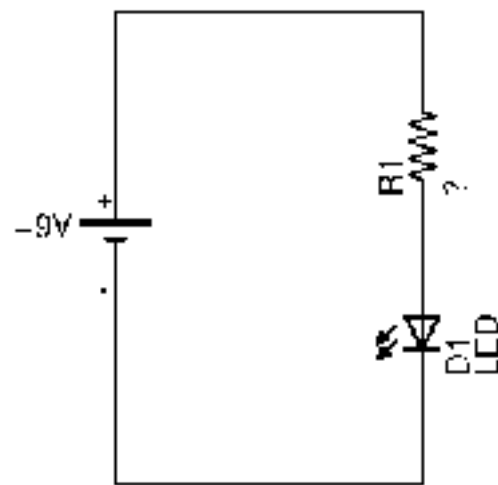
Specifications:
- working values for voltage and current
  - Vf = 1.7V
  - If = 25mA

$R = (V_{CC} - V_F) / I$

$R = (9 - 1.7)/0.025 = 292\ Ohm \sim 300\ Ohm$

Circuit LED

Typical forward voltages for various colours are, typical current 20mA:
- Infrared LED: 1.6V to 2V
- Red LED: 1.6V to 2.1V
- Orange LED: 1.9V to 2.1V
- Amber LED: 2V to 2.1V
- Yellow LED: 2V to 2.4V
- Green LED: 2.4V to 3.4V
- Blue LED: 3.2V to 3.4V
- Ultraviolet LED: 3.3V to 3.7V
- White LED: 3.2V to 3.6V

Circuit LED Analisys
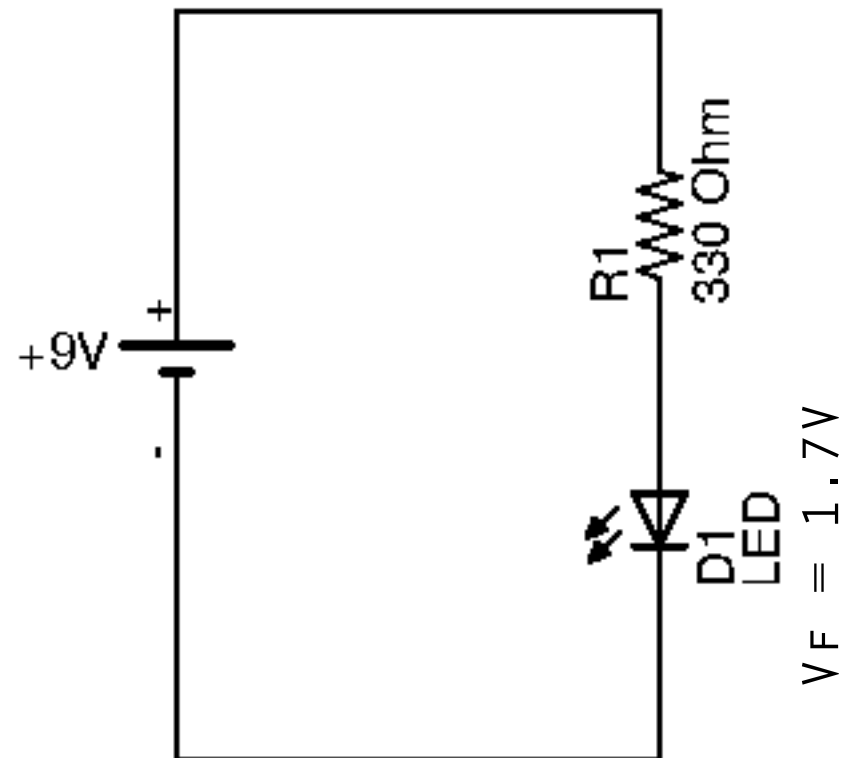
Vcc = 9V
R = 330 Ohm
Vf = 1.7V

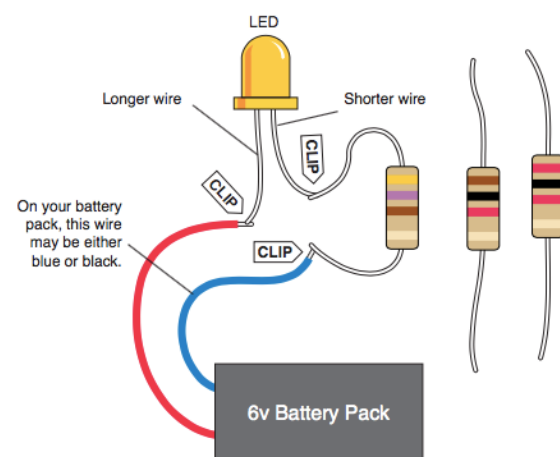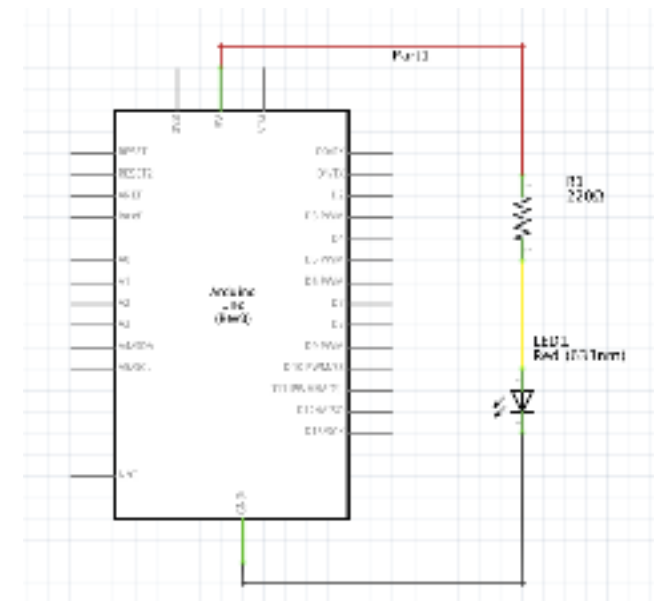$I = (Vcc - Vf) / R = 22mA$
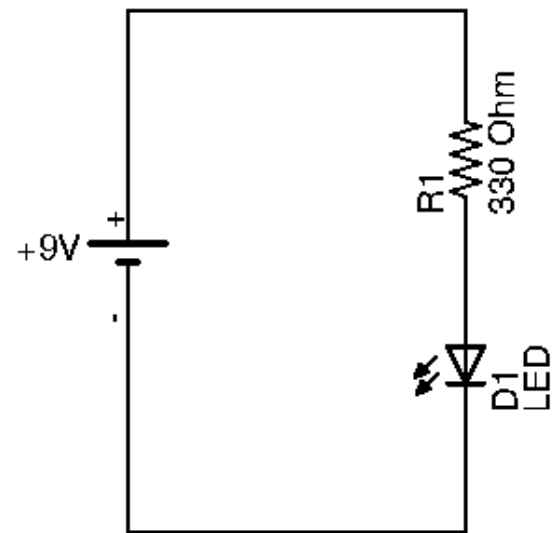
Power of the resistor:
$P_R = (Vcc - Vf)*I = 160mW$

Power of the LED:
$P_{LED} = Vf * I = 37mW$

Circuit LED
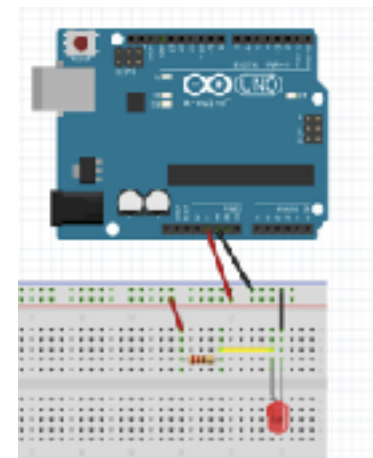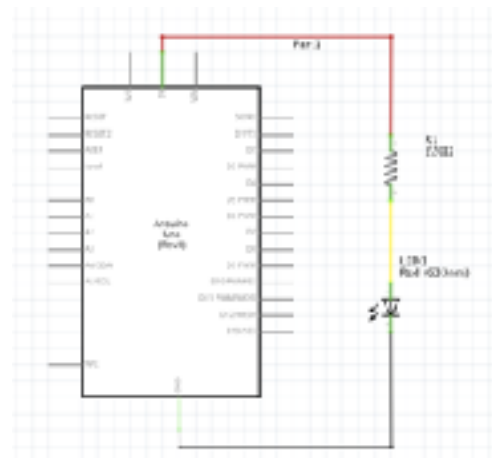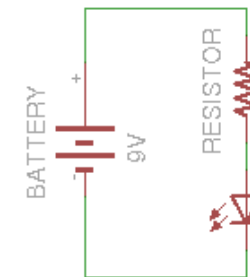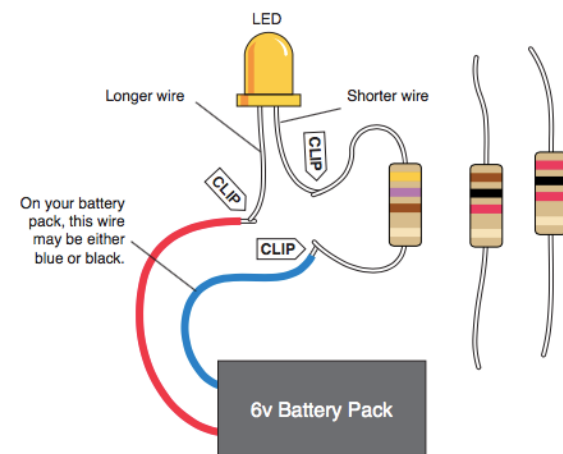
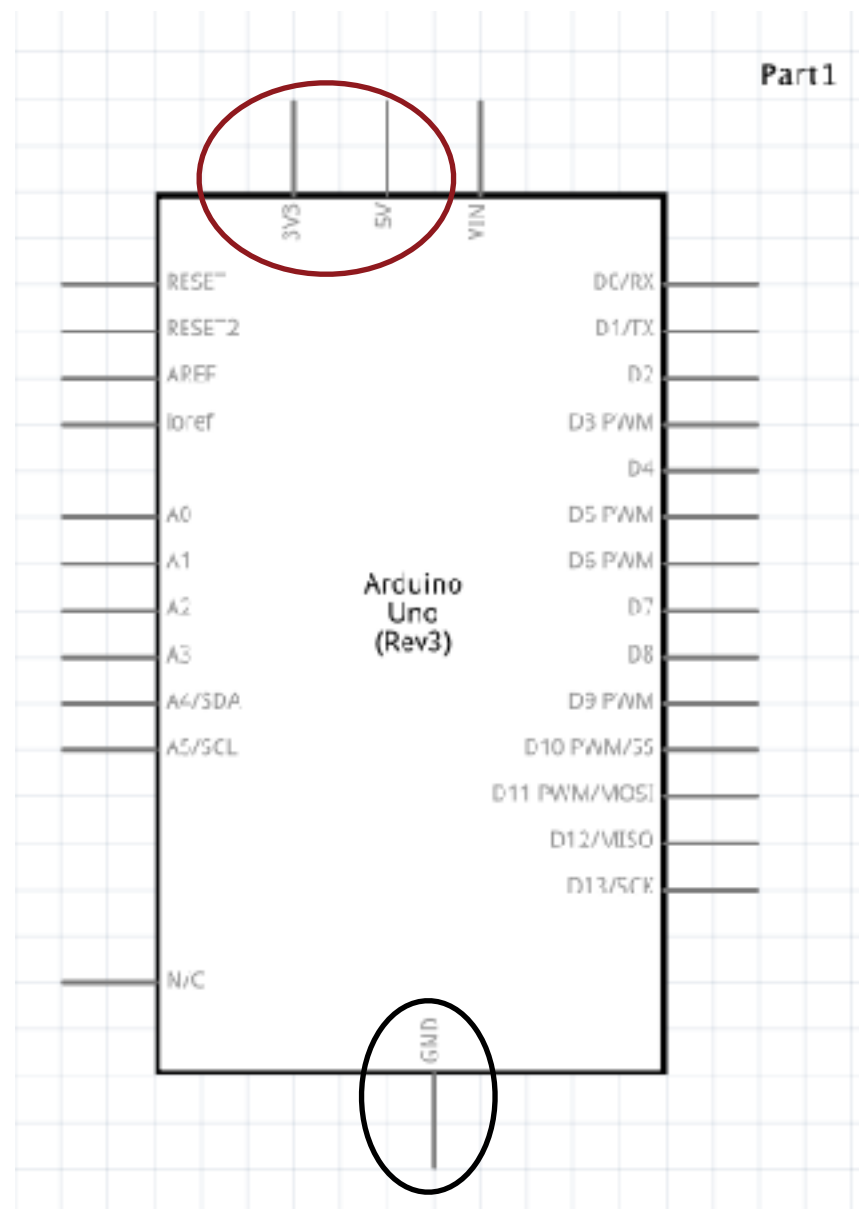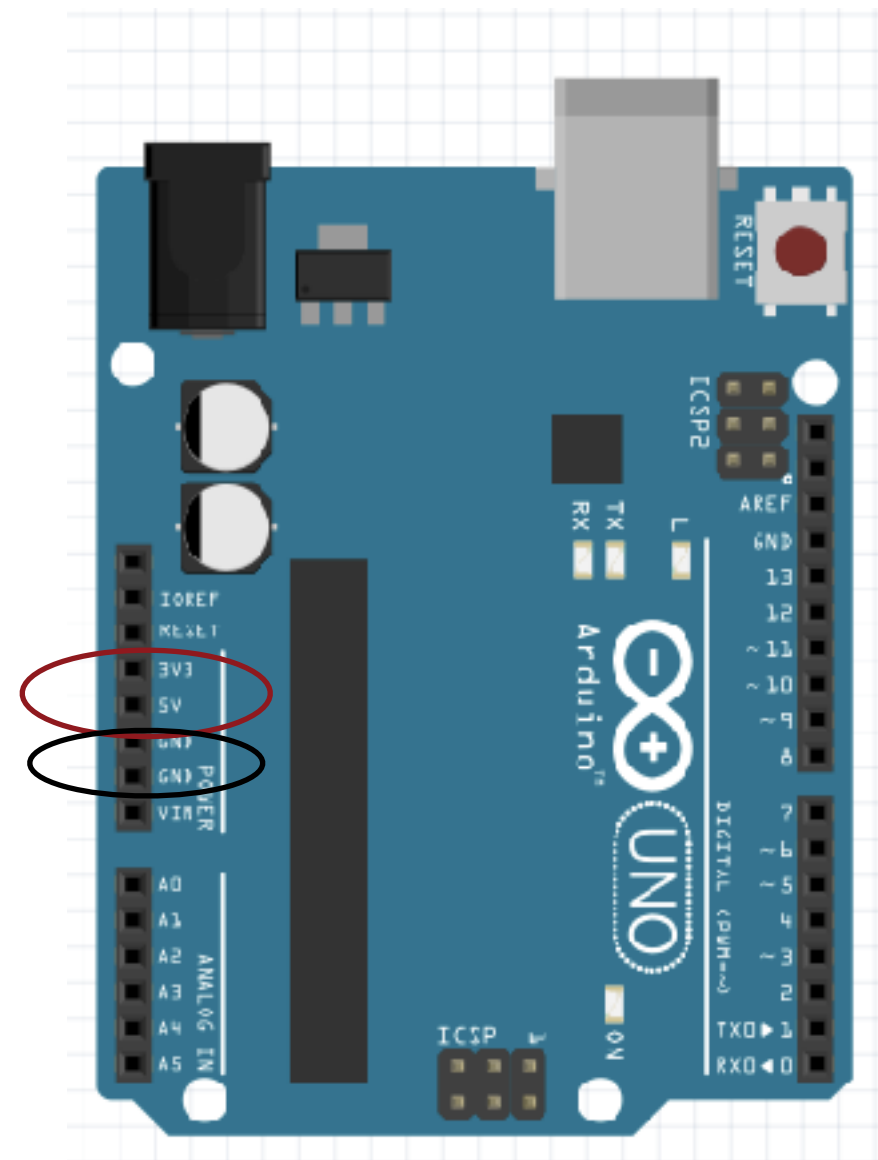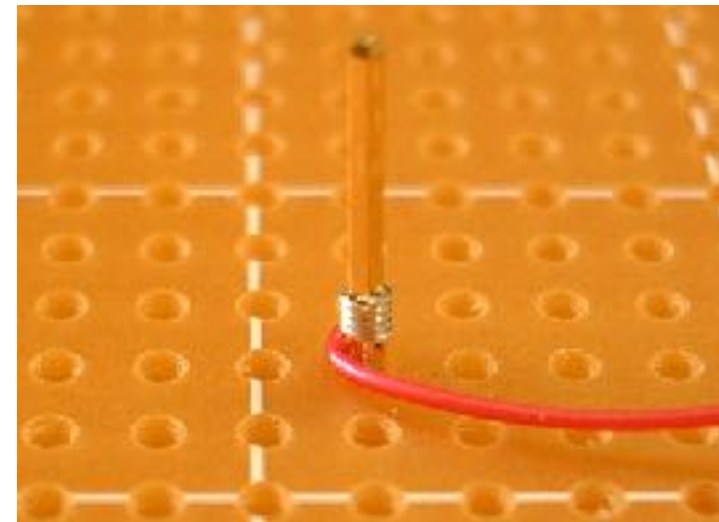# Circuit LED
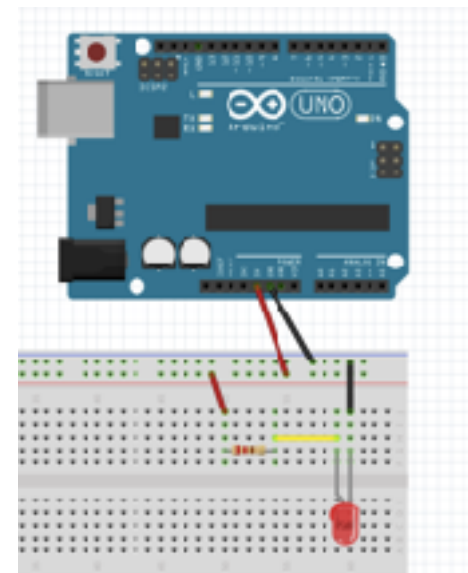
Arduino - Power Pins
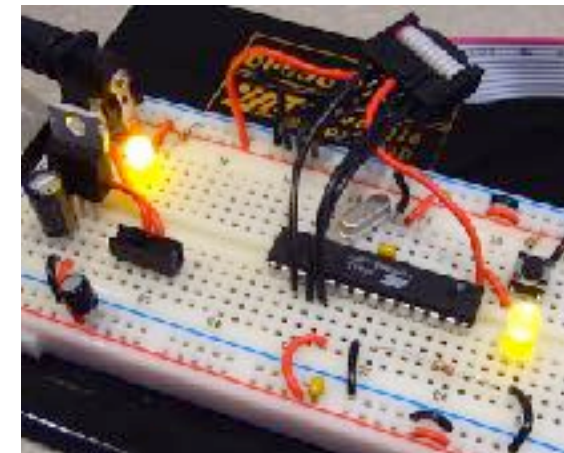
Power Pins

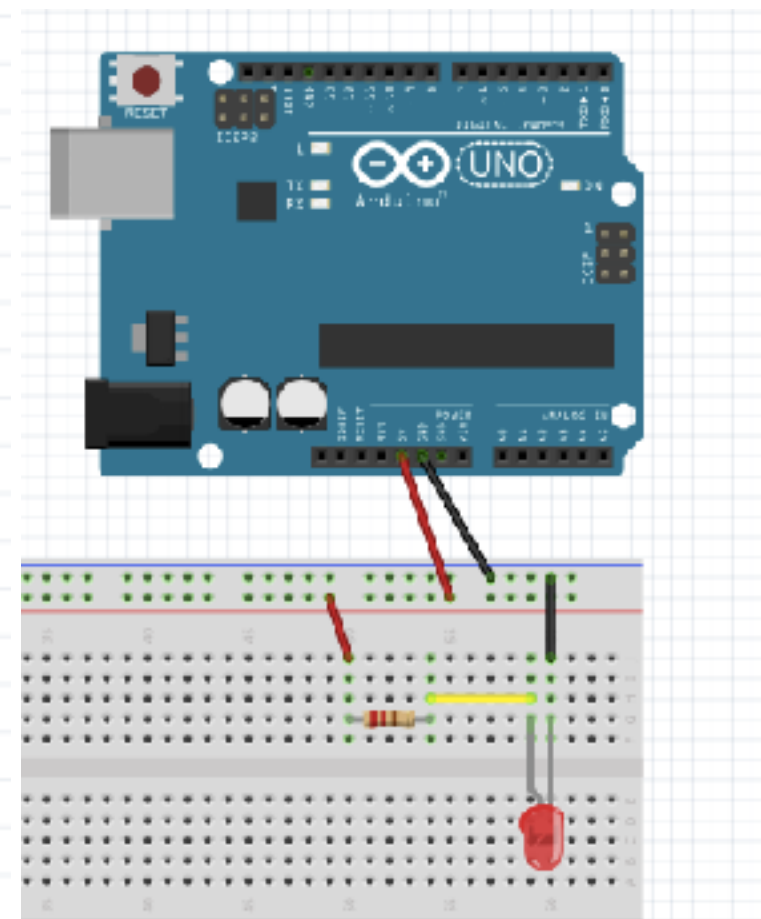

5V / 3.3V:
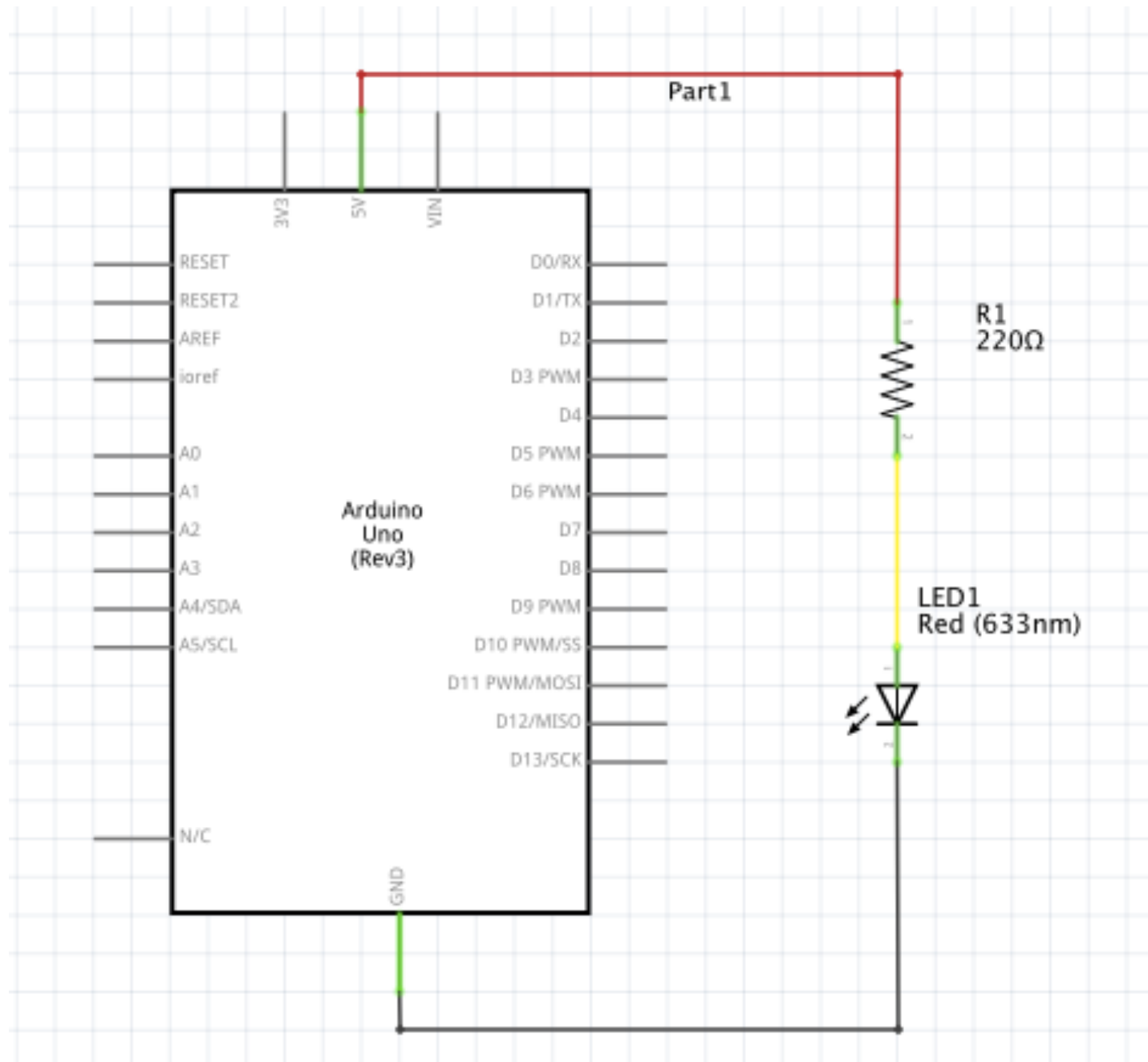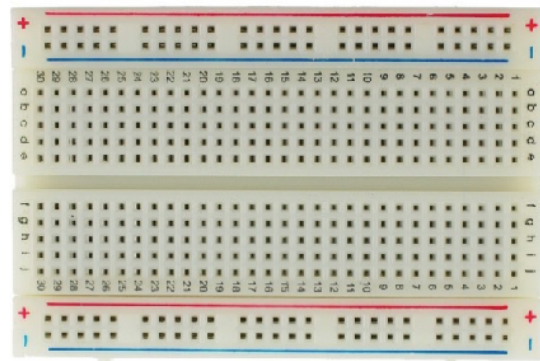Power

GND:
Ground Pin

BreadBoard

Wire - Wrap

Breadboard

Arduino

BreadBoard

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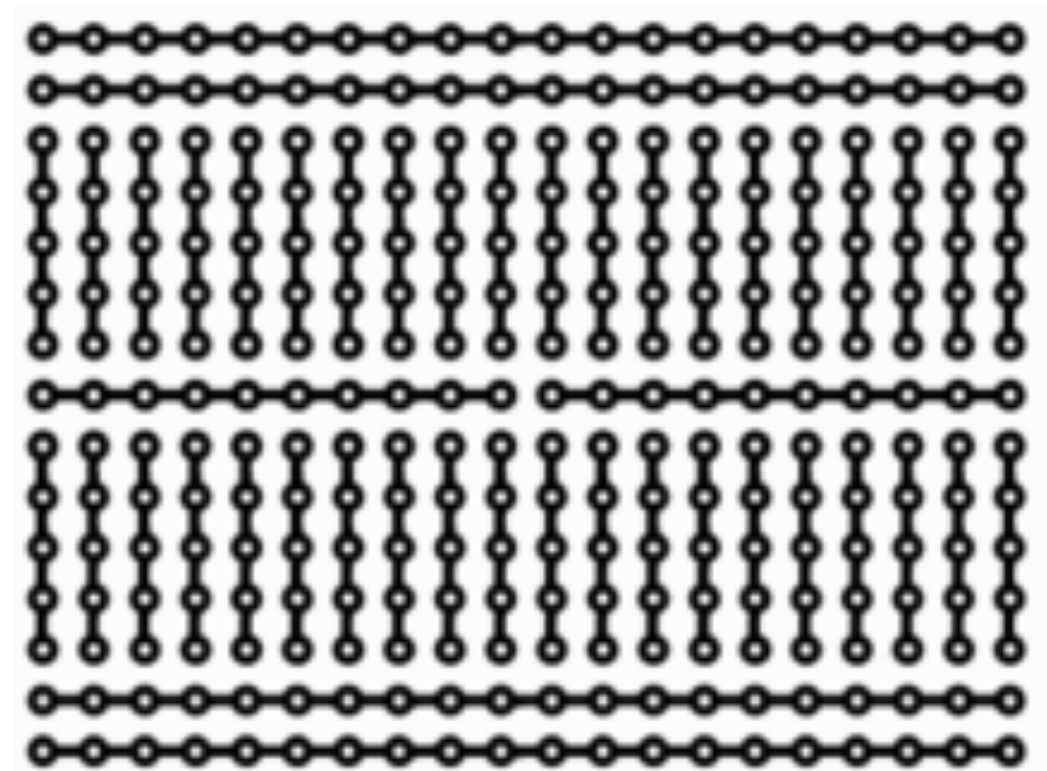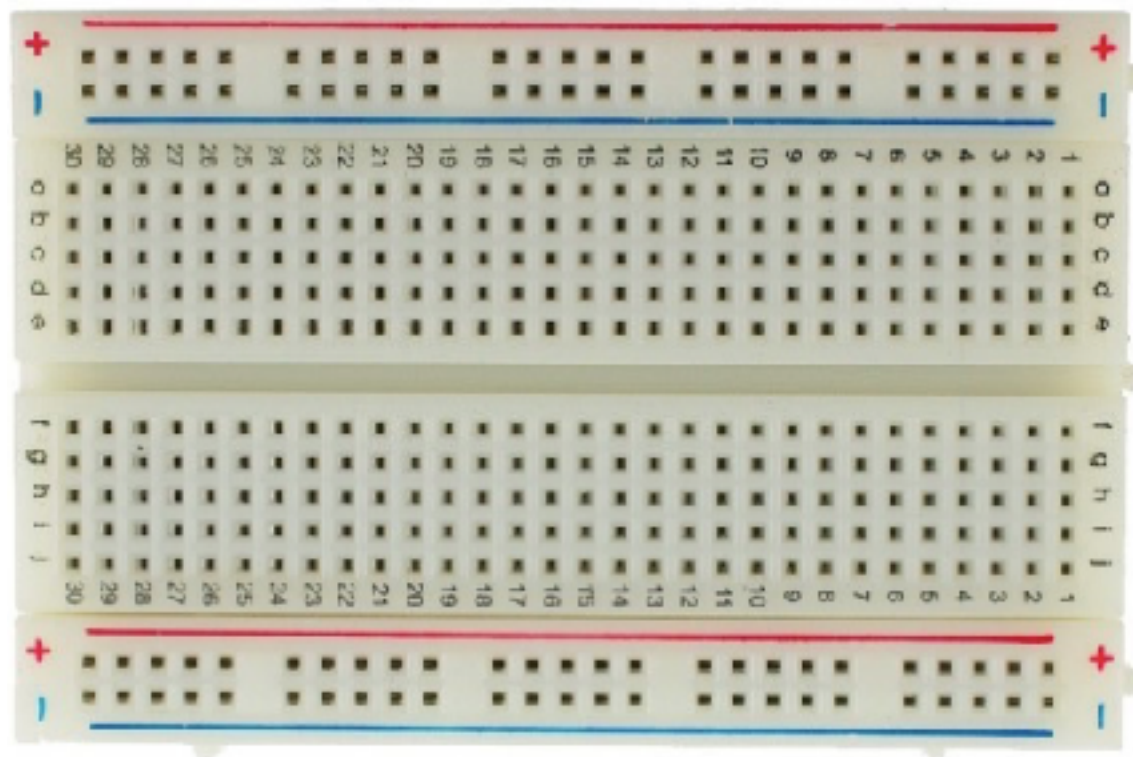
BreadBoard - best practice

Power Rails
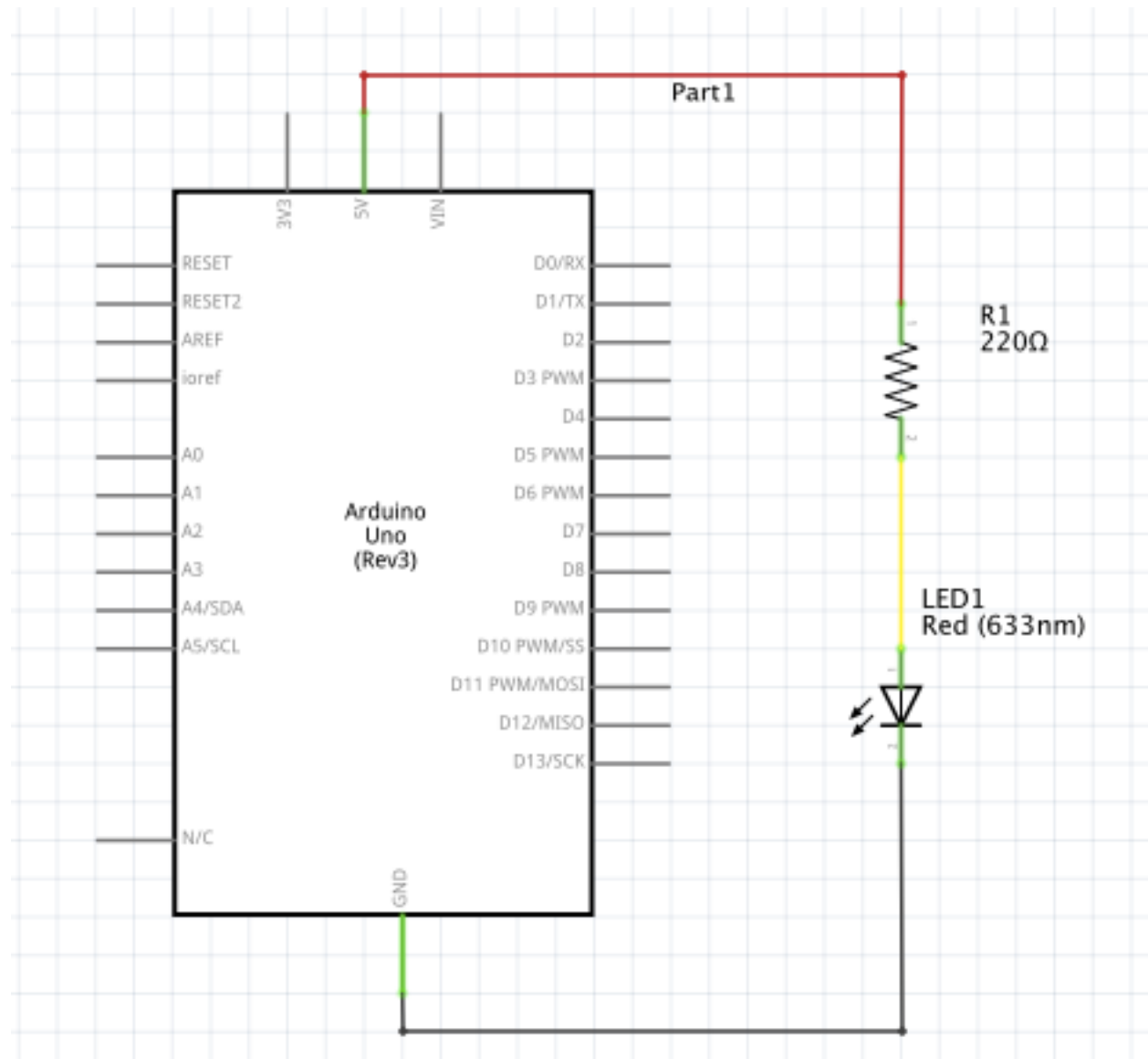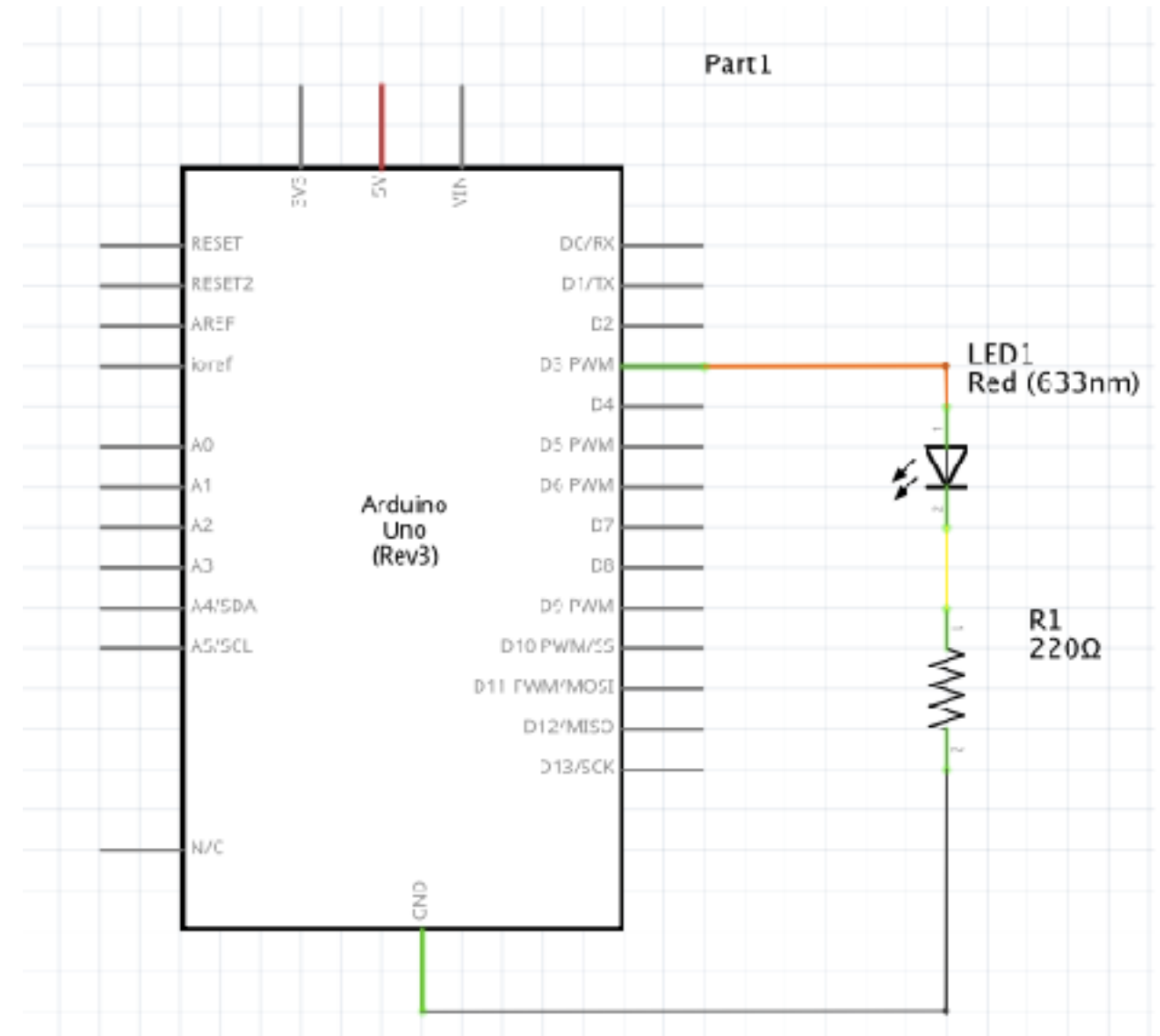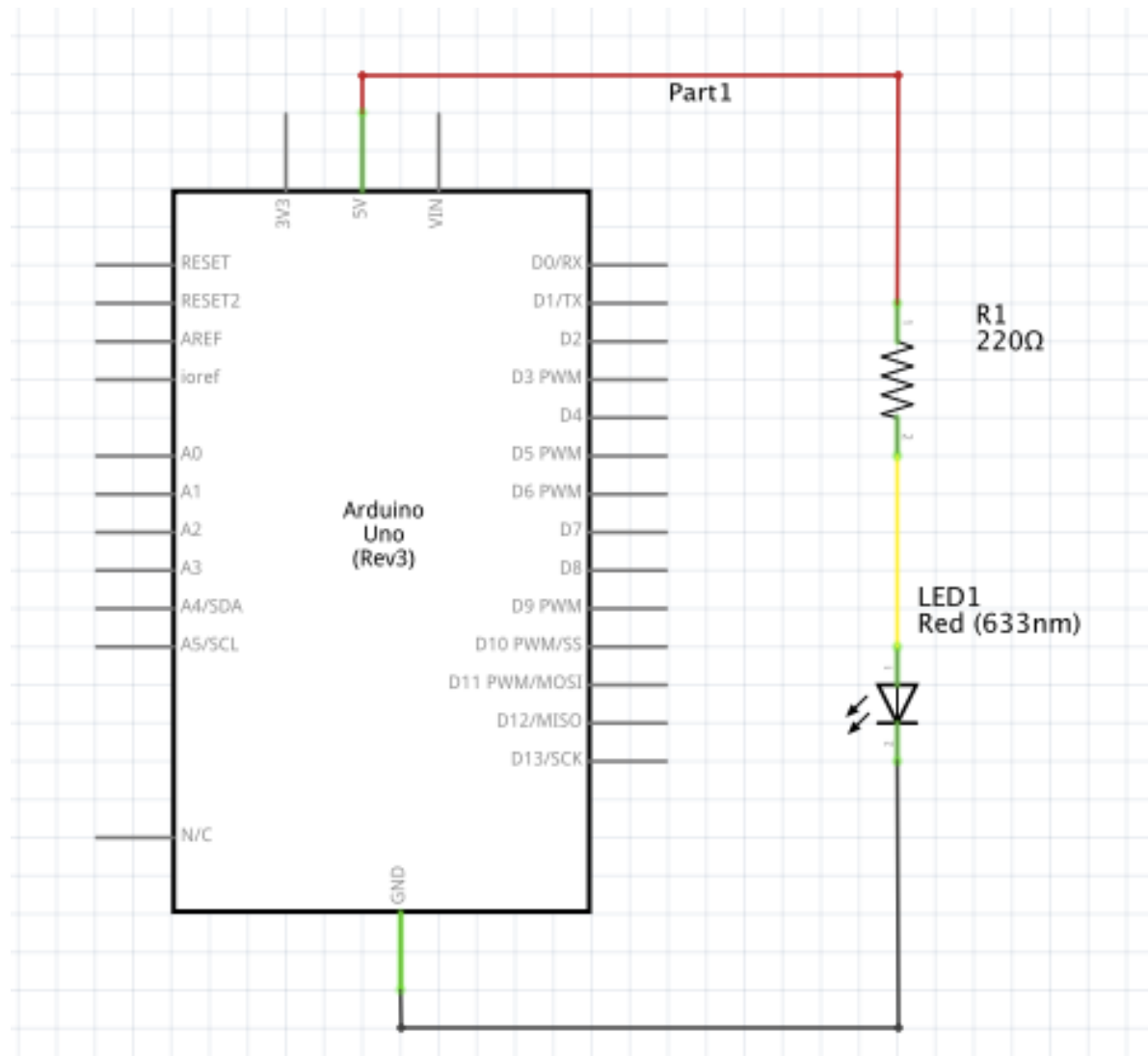
Arduino

Arduino

Arduino

"**Physical Computing** is about prototyping with electronics,
turning sensors, actuators and microcontrollers into materials for
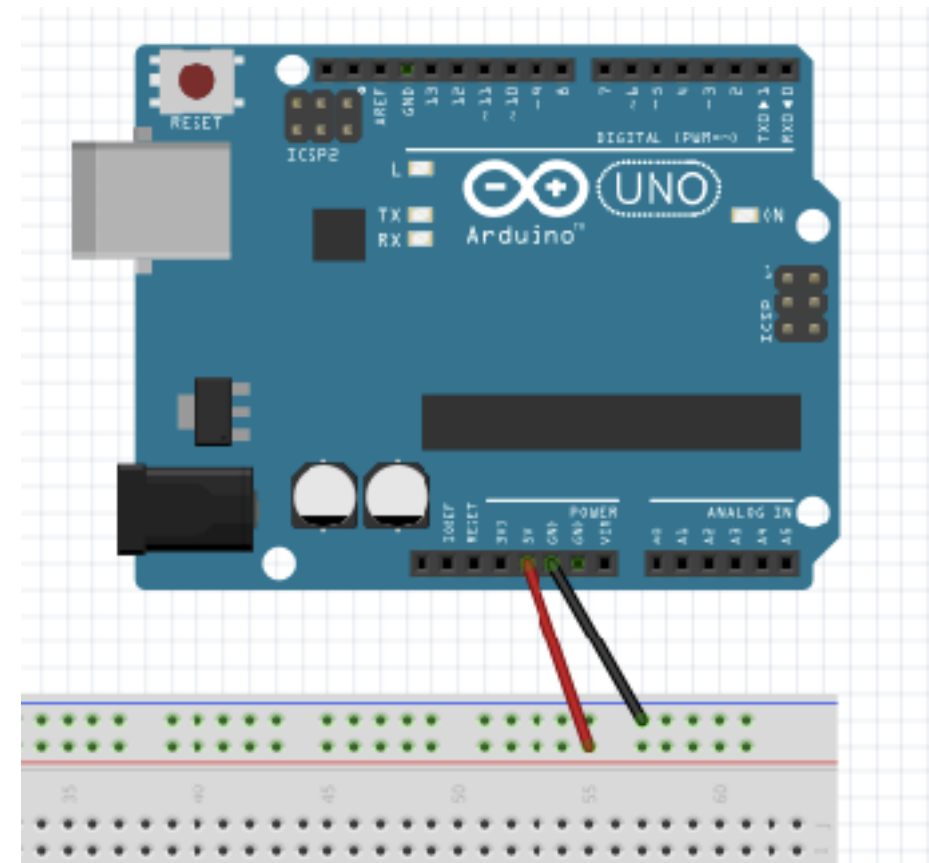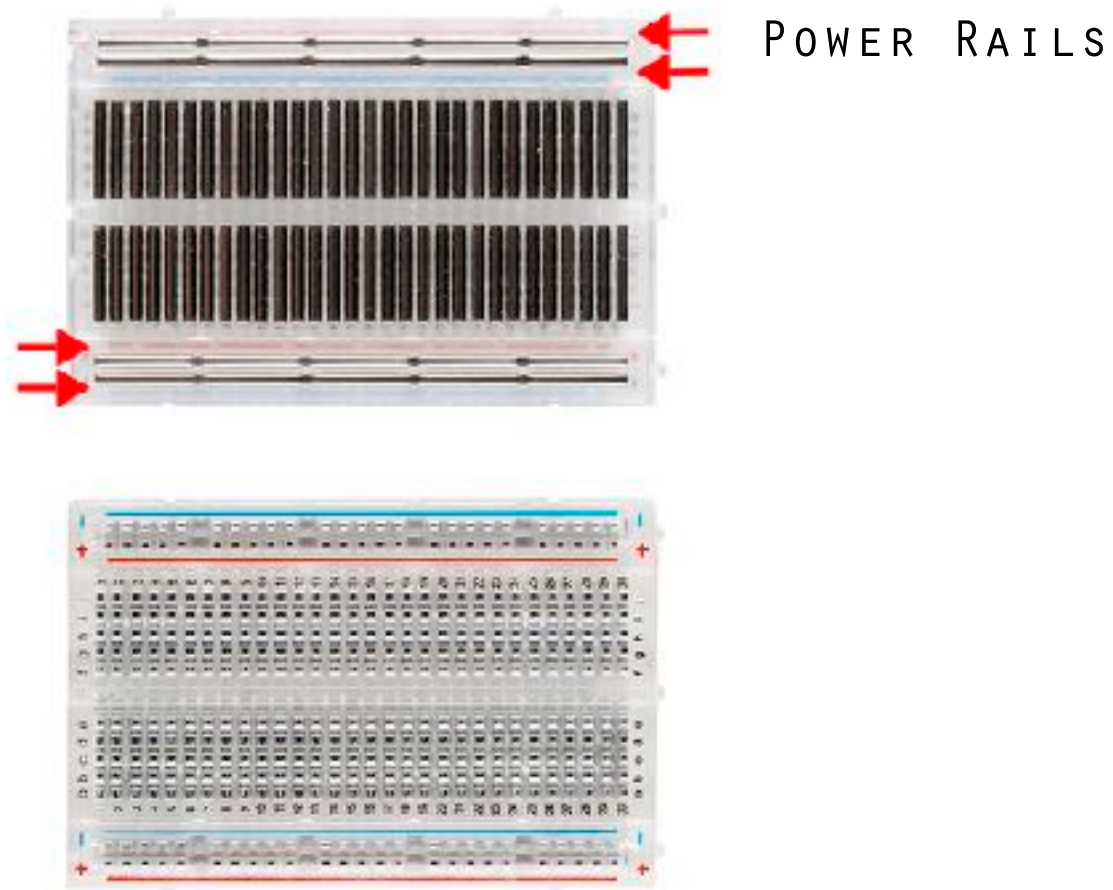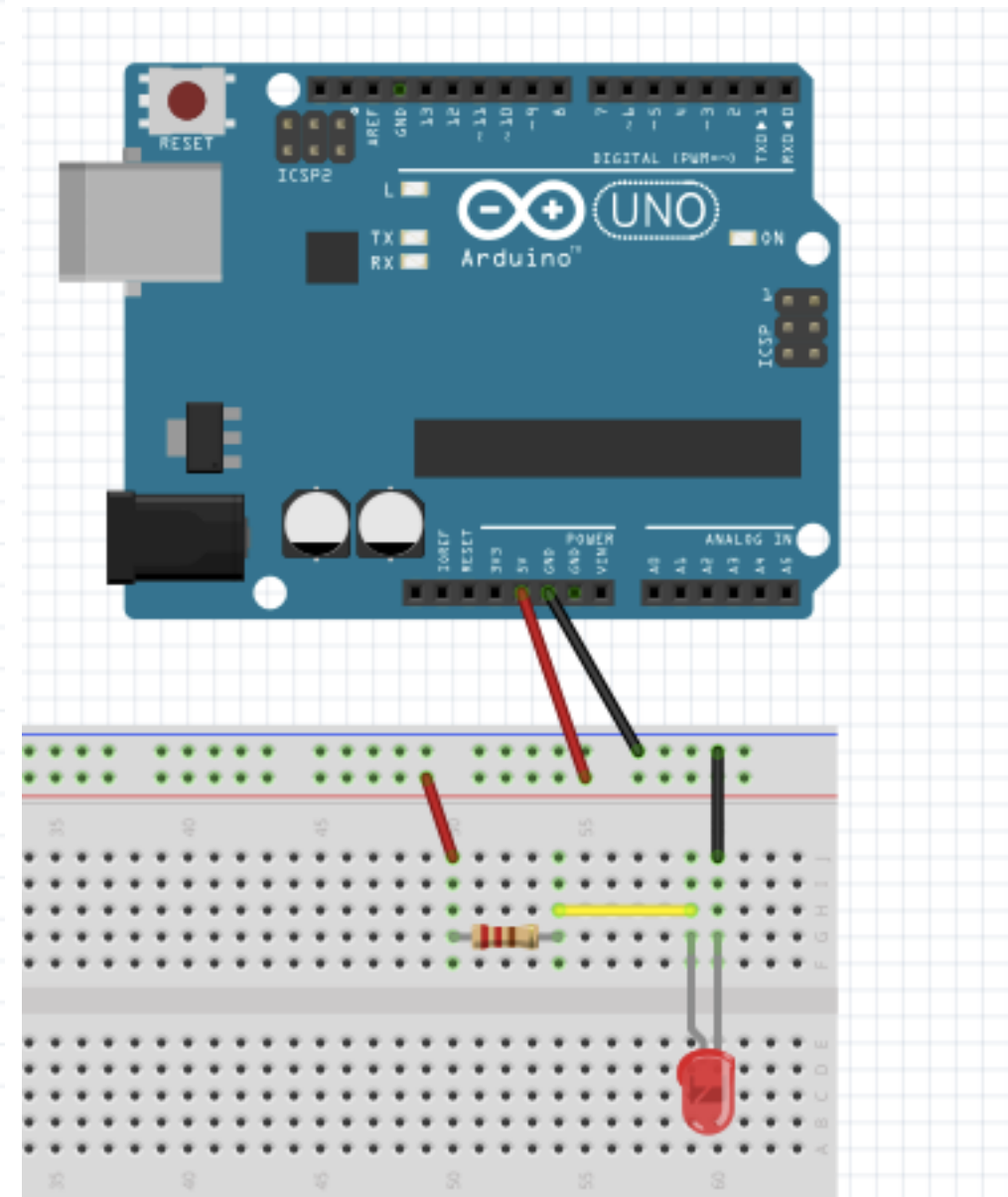designers and artists."

"It involves the design of interactive objects that can communicate
with humans using sensors and actuators controlled by a behaviour
implemented as software running inside a microcontroller."

Massimo Banzi, Tinker.it & Arduino Co-Founder

Hardware

Software

Community
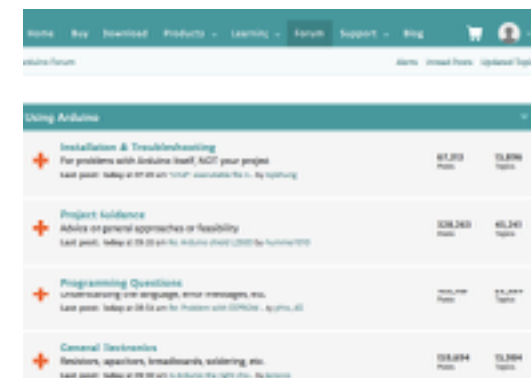
Input/Output Pin

Pin IO (Input/Output)
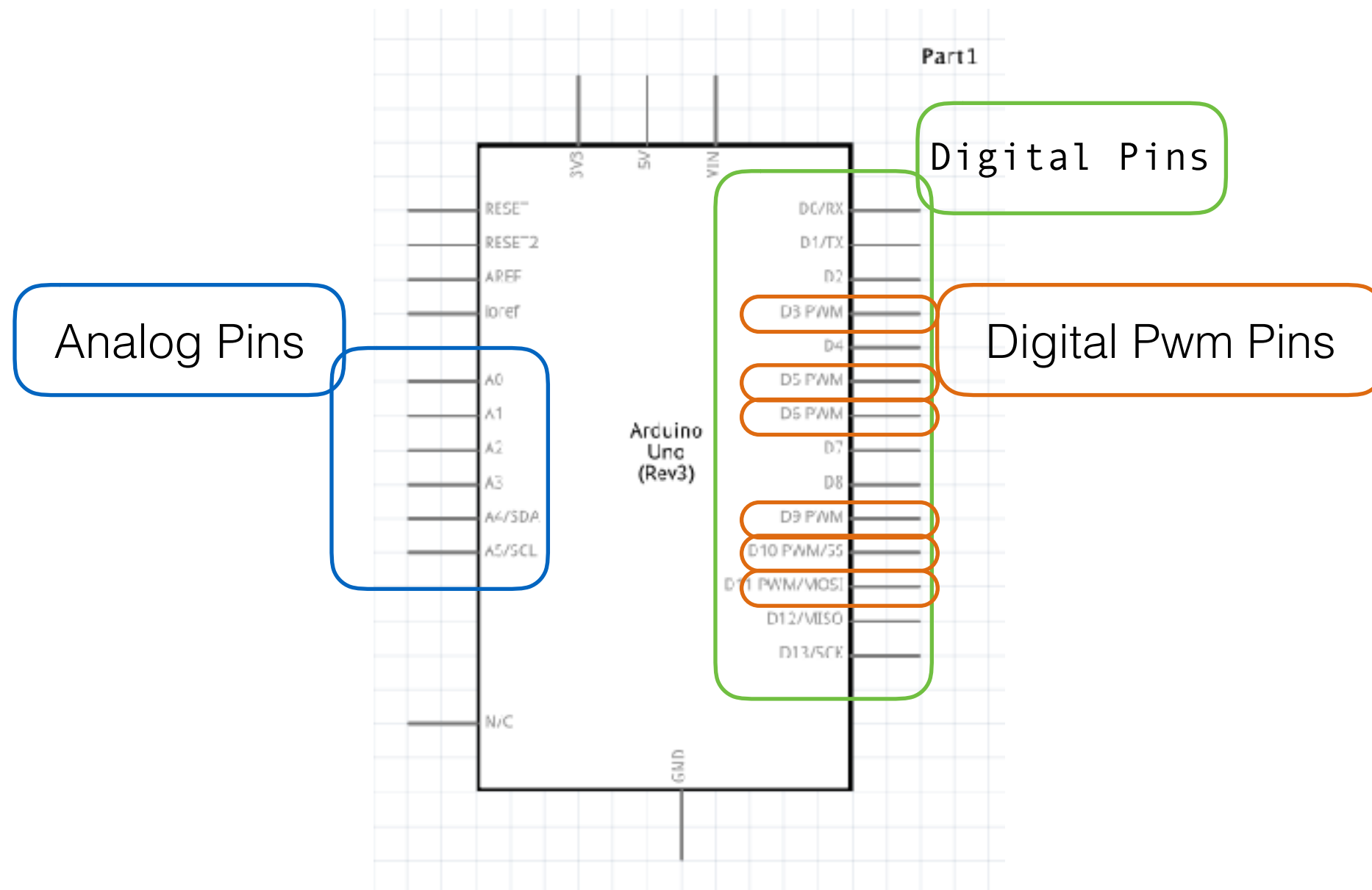
Control a Led with Arduino
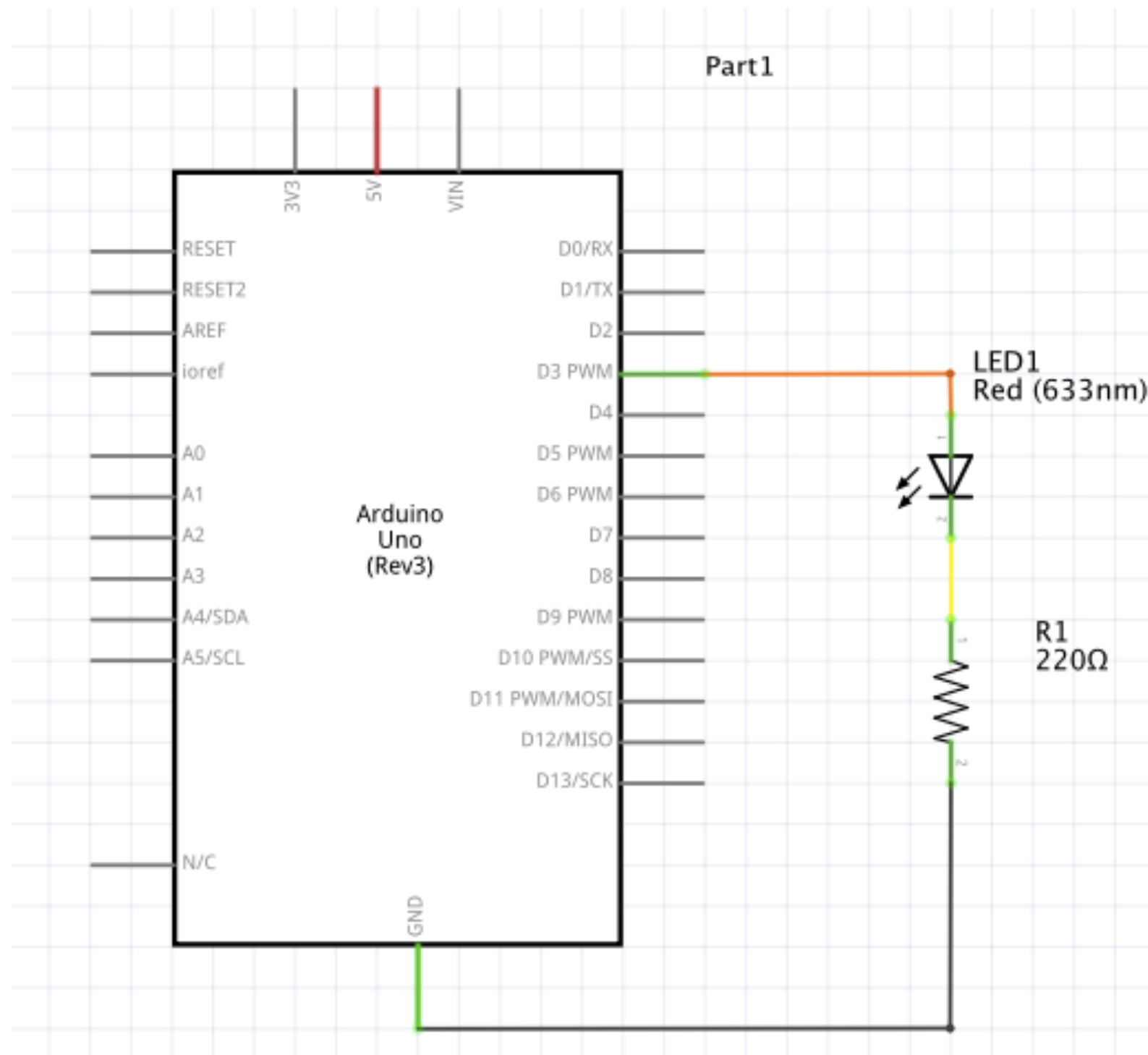
But…check if the environment works
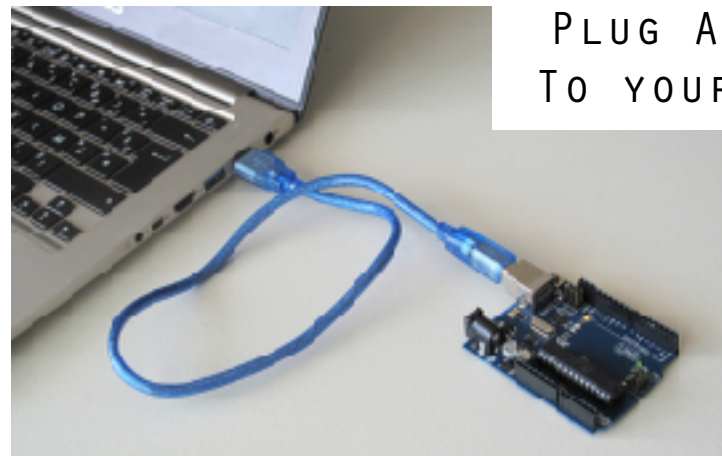
Plug Arduino
To your laptop
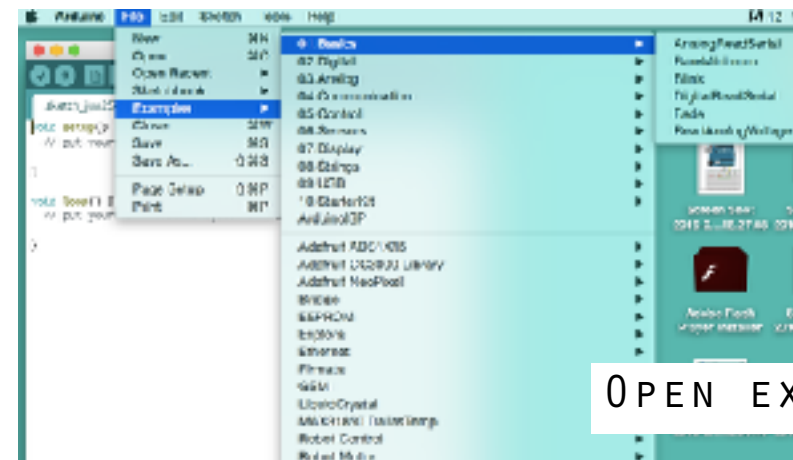
Open example Blink

Select the port
And the Board

Upload the code
To

If it works, the led embedded on the board blinks

SKETCH

Global Variables — Declare the variables

setup() — Initialise
Runs once, at the beginning
Define the pins
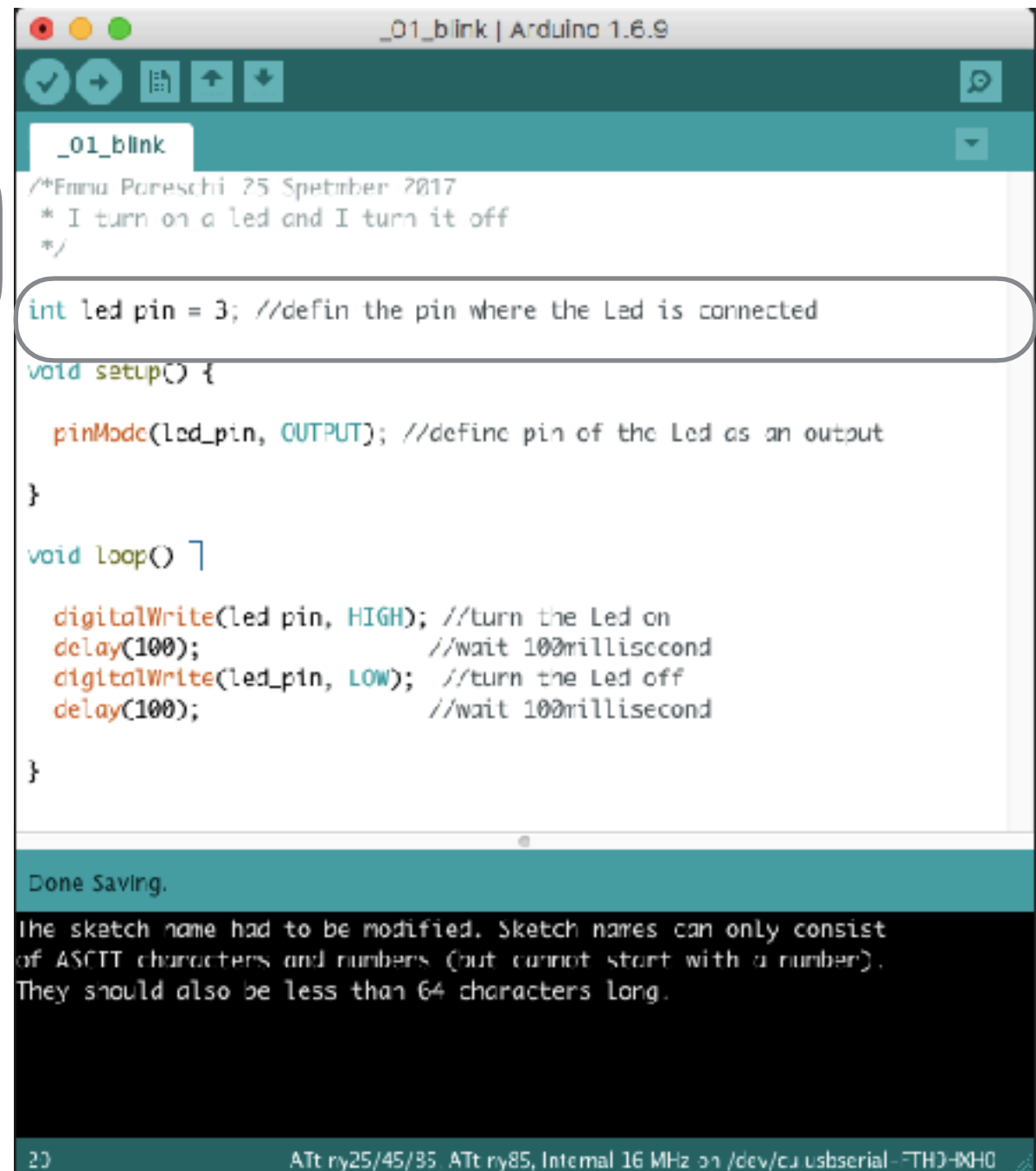
Loop() — Running
Run repeatedly, after setup
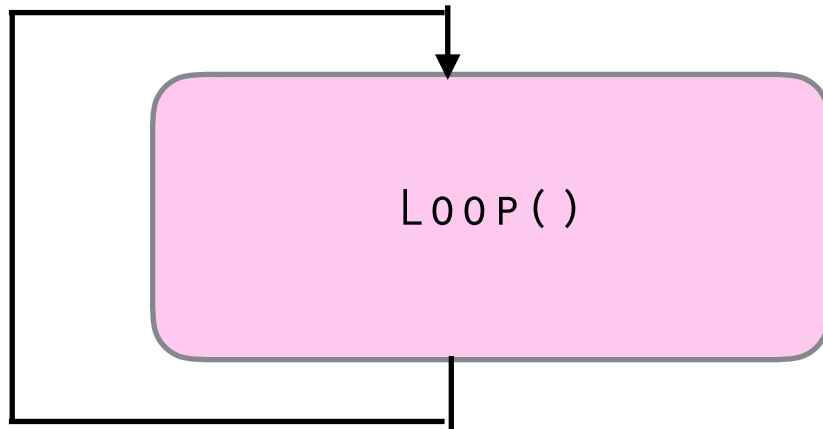
Blink Sketch

Global Variable 'led_pin'

Blink Sketch

setup()
DEFINE THE FUNCTION OF THE PIN
pinMode(pin, function);

THE PIN IS 'led_pin
THE FUNCTION IS Output

Blink Sketch

Loop()
The list of commands that arduino runs repeatedly.

DigitalWrite(pin, level);
we control the voltage on the pin
HIGH: high voltage (5V)
LOW: low voltage (ground)

Delay(time);
We add a delay in millisecond

Blink Sketch

Global variables

setup()

Loop()

```
/*Emma Pareschi 25 Spetmber 2017
 * I turn on a led and I turn it off
 */

int led_pin = 3; //defin the pin where the Led is connected

void setup() {

    pinMode(led_pin, OUTPUT); //define pin of the Led as an output

}

void loop() {

    digitalWrite(led_pin, HIGH); //turn the Led on
    delay(100);                  //wait 100millisecond
    digitalWrite(led_pin, LOW);  //turn the Led off
    delay(100);                  //wait 100millisecond

}
```

Done Saving.

The sketch name had to be modified. Sketch names can only consist of ASCII characters and numbers (but cannot start with a number). They should also be less than 64 characters long.

20   ATtiny25/45/85 ATtiny85, Internal 16 MHz on /dev/cu.usbserial-FTHJ-HXH0

Connect, Compile and Upload

1. Compile

2. Upload


```
/*Emma Pareschi 25 Spetmber 2017
 * I turn on a led and I turn it off
 */

int led_pin = 3; //defin the pin where the Led is connected

void setup() {

  pinMode(led_pin, OUTPUT); //define pin of the Led as an output

}

void loop() {

  digitalWrite(led_pin, HIGH); //turn the Led on
  delay(100);                  //wait 100millisecond
  digitalWrite(led_pin, LOW);  //turn the Led off
  delay(100);                  //wait 100millisecond

}
```

_01_blink | Arduino 1.6.9

_01_blink

Done Saving.

The sketch name had to be modified. Sketch names can only consist of ASCII characters and numbers (but cannot start with a number). They should also be less than 64 characters long.

20   ATt ny25/45/85, ATt ny85, Internal 16 MHz on /dev/cu.usbserial-FTH3-IXH0

CONTROL THE INTENSITY OF THE LED

analogWrite(pin, number 0/255);
We control the Voltage on the Pin
255: Max voltage (5V)
0: Min voltage (ground)

PWM Pins

PWM I/O (Input/Output)
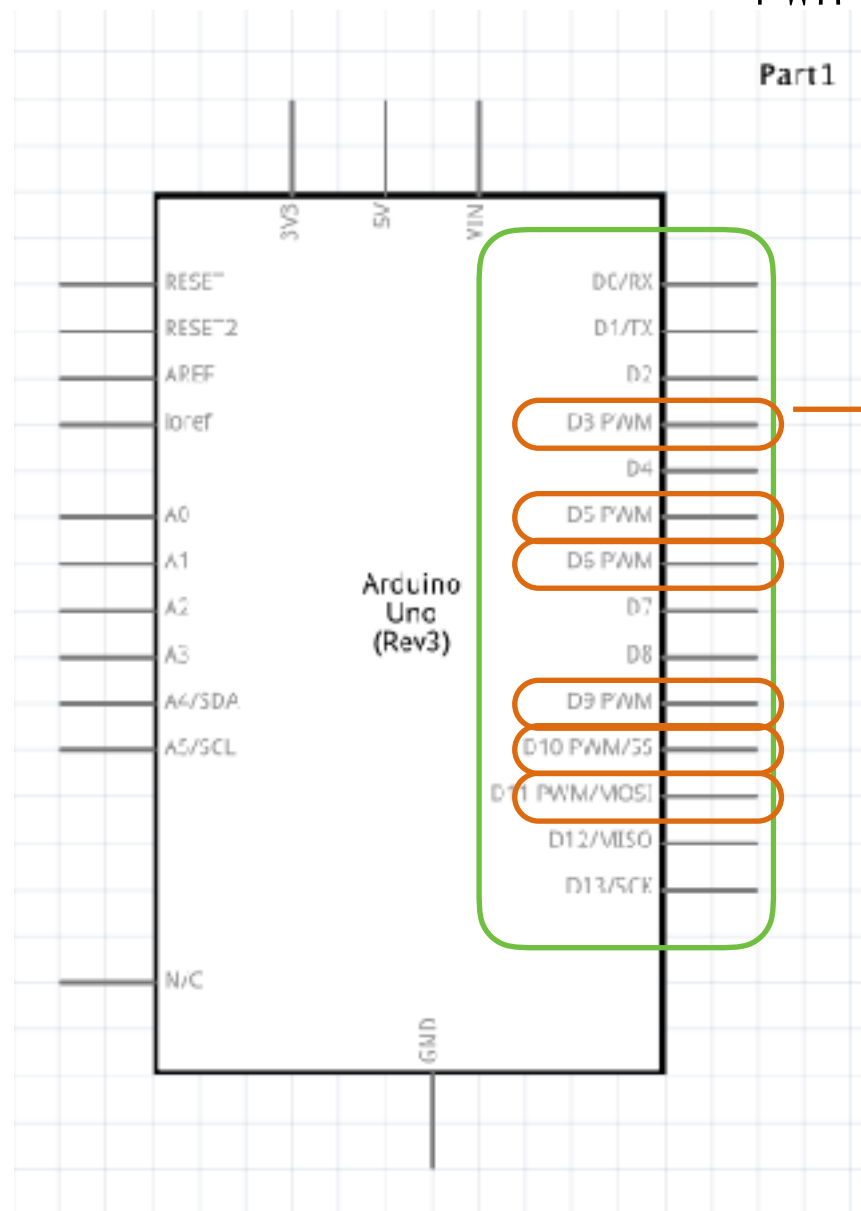
AnalogWrite() works only with some pins: PWM (~)

PWM

Pulse-width modulation

PWM
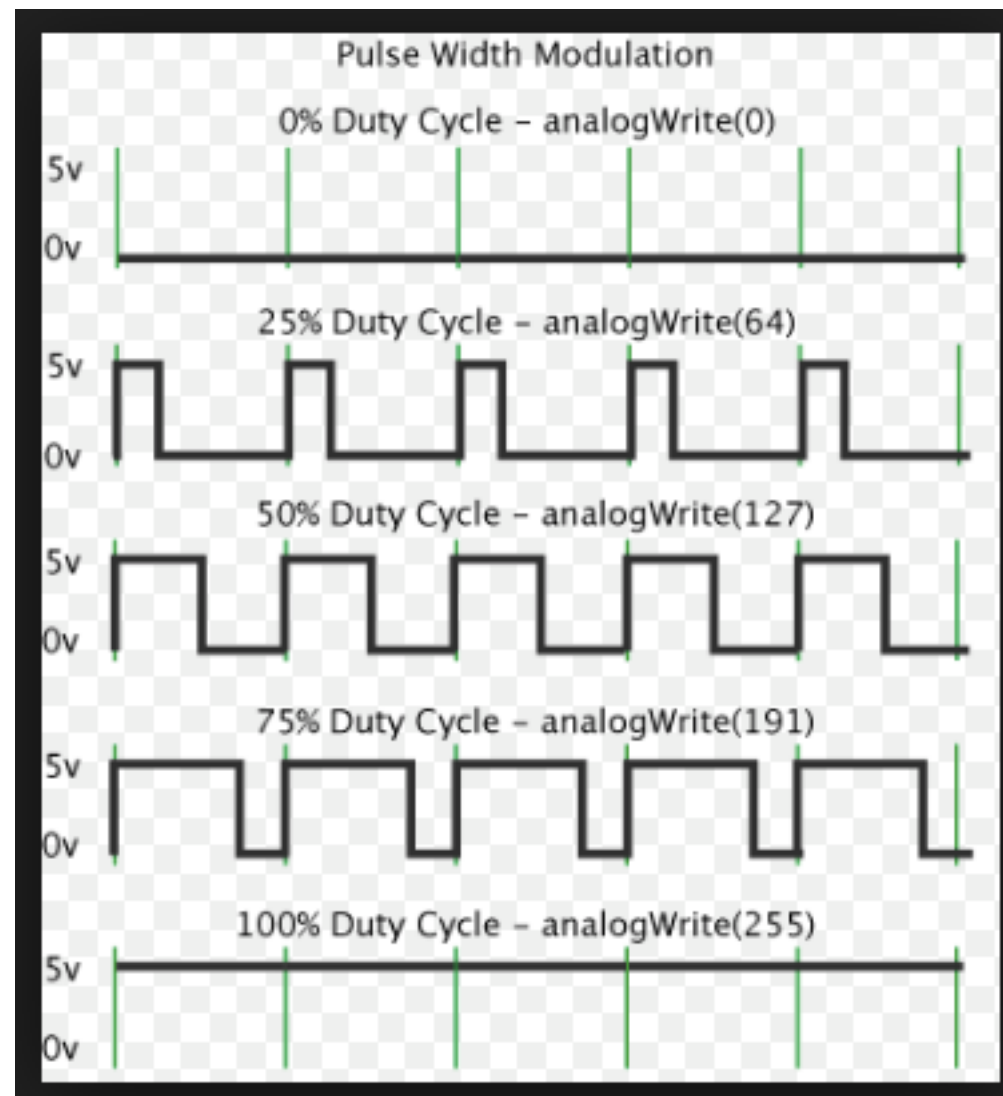
Pulse-width modulation

How to read a sensor (digital)

Part1

RESET
RESET2
AREF
IOREF

A0
A1
A2
A3
A4/SDA
A5/SCL

Arduino
Uno
(Rev3)
ICSP

N/C

D0/RX
D1/TX
D2
D3 PWM
D4
D5 PWM
D6 PWM
D7
D8
D9 PWM
D10 PWM/SS
D11 PWM/MOSI
D12/MISO
D13/SCK

ICSP2 MISO
ICSP2 SCK
ICSP2 MOSI

3V3   5V   VIN

GND

R1
1kΩ
±5%

Vsense

S1
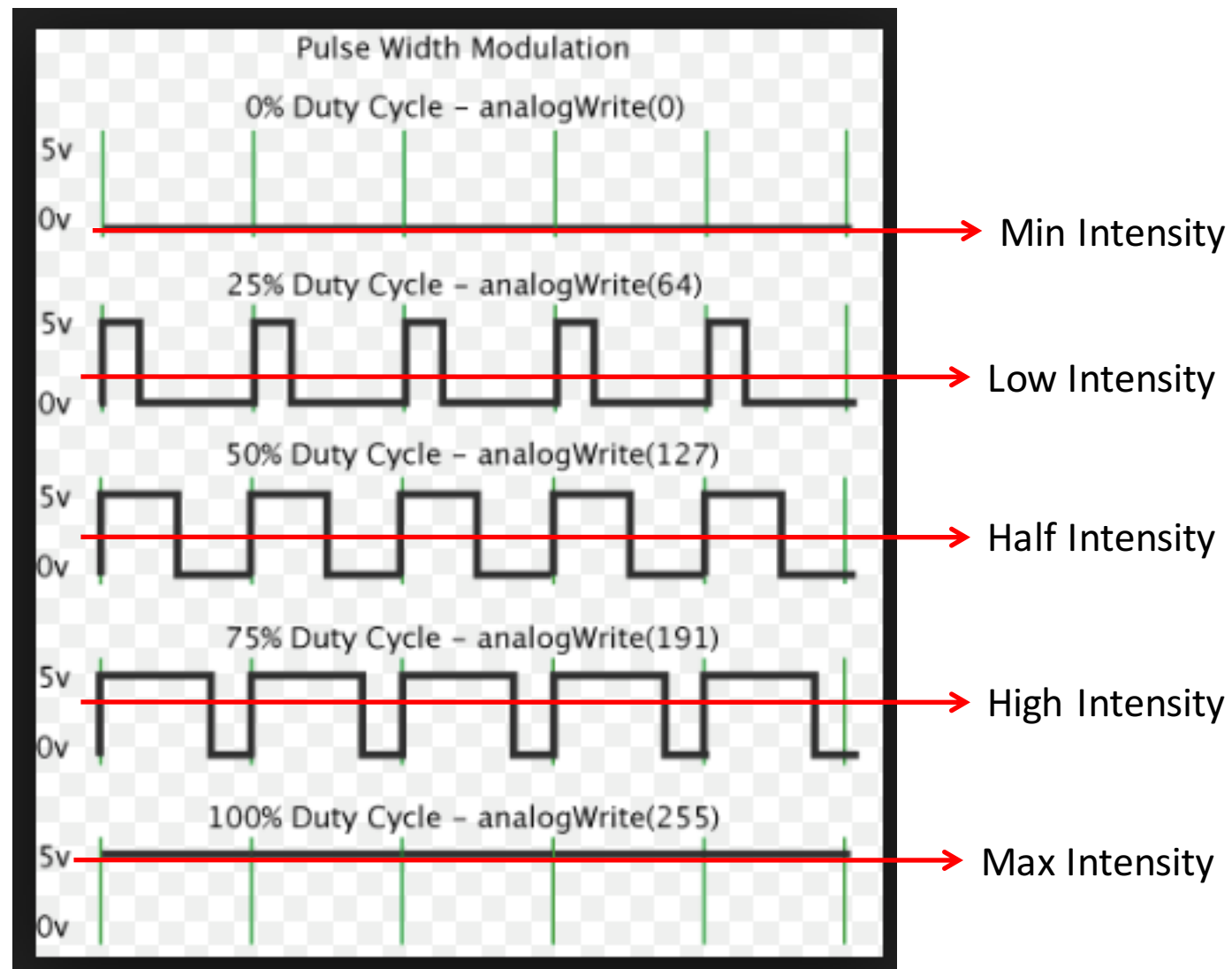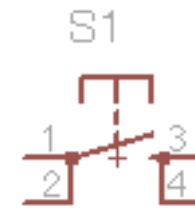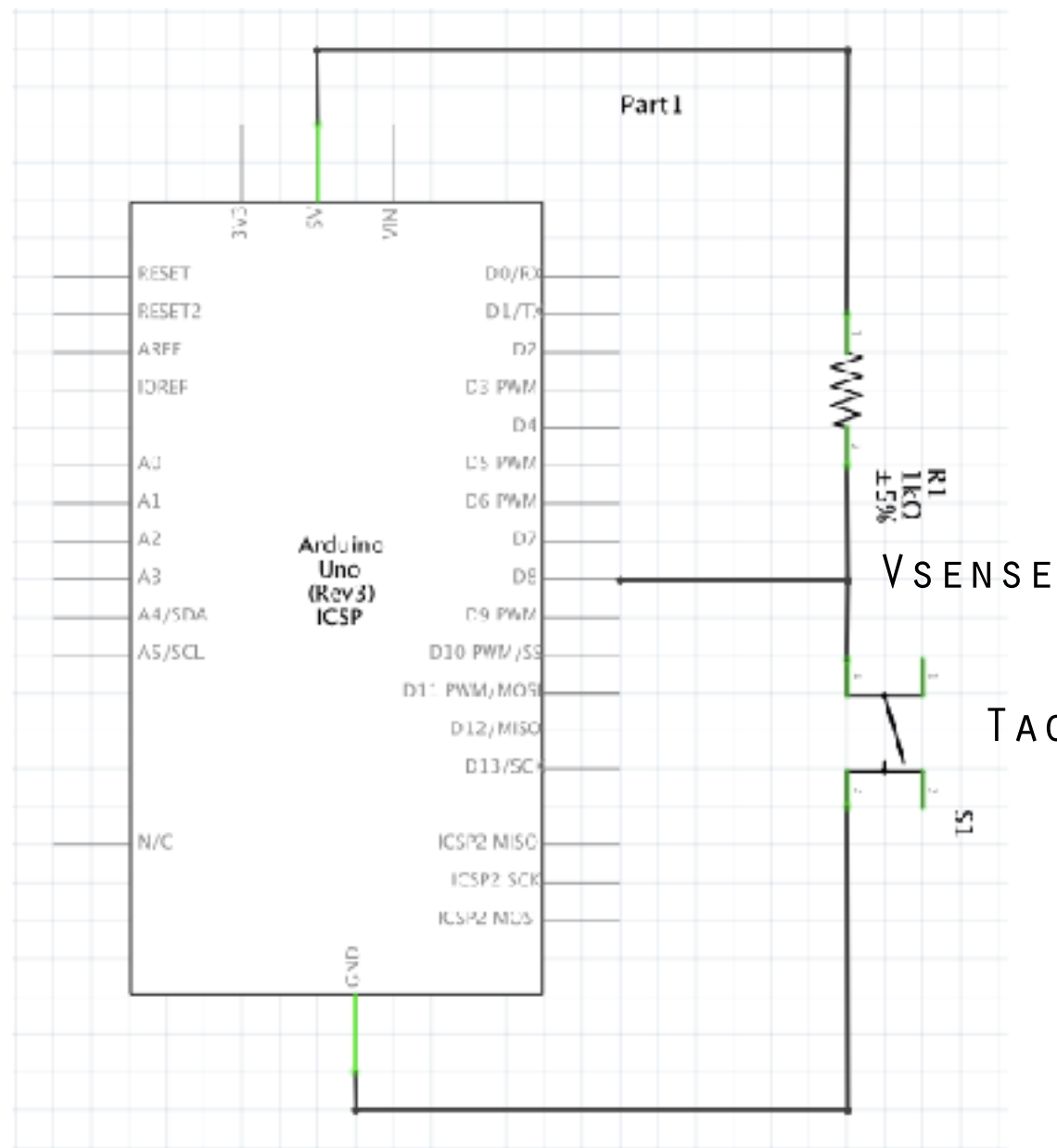
Tact Switch

How it works:
If the switch is NOT pushed
  Vsense = 5V

If the switch is pushed
  Vsense = 0

How to read a sensor (digital)
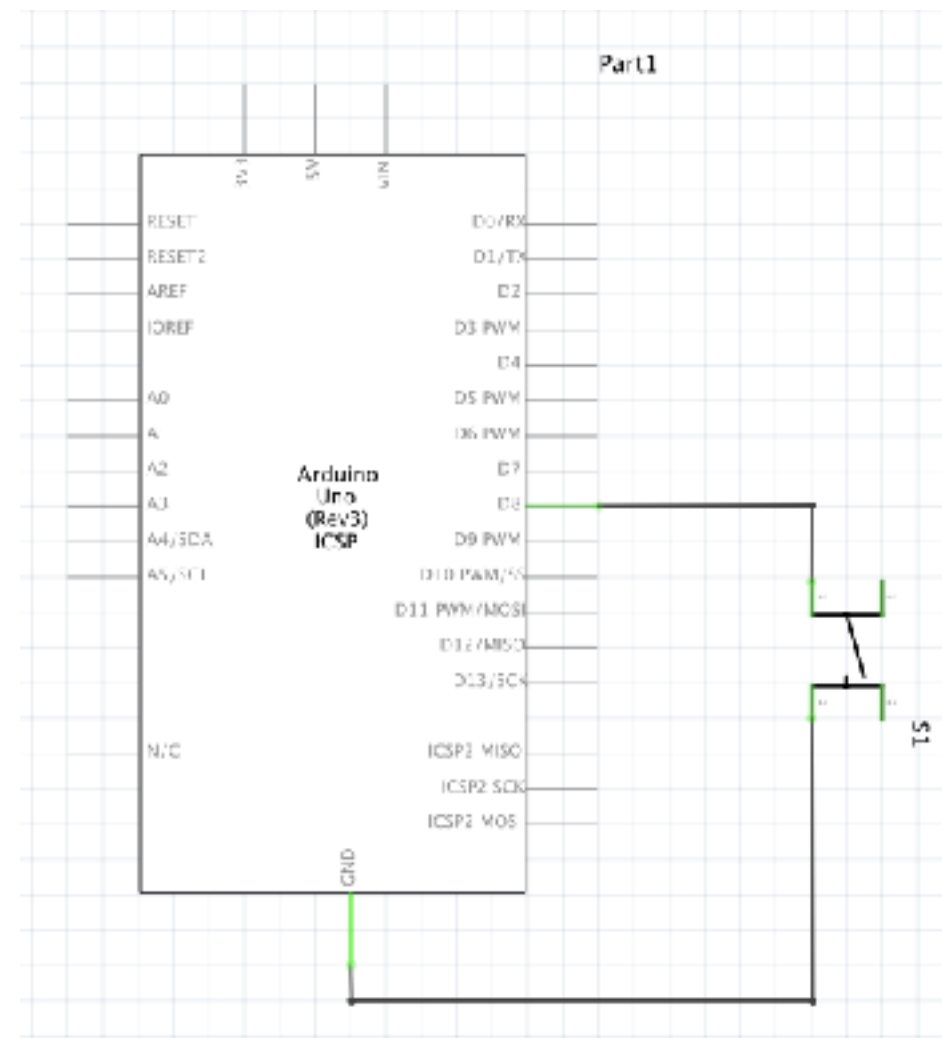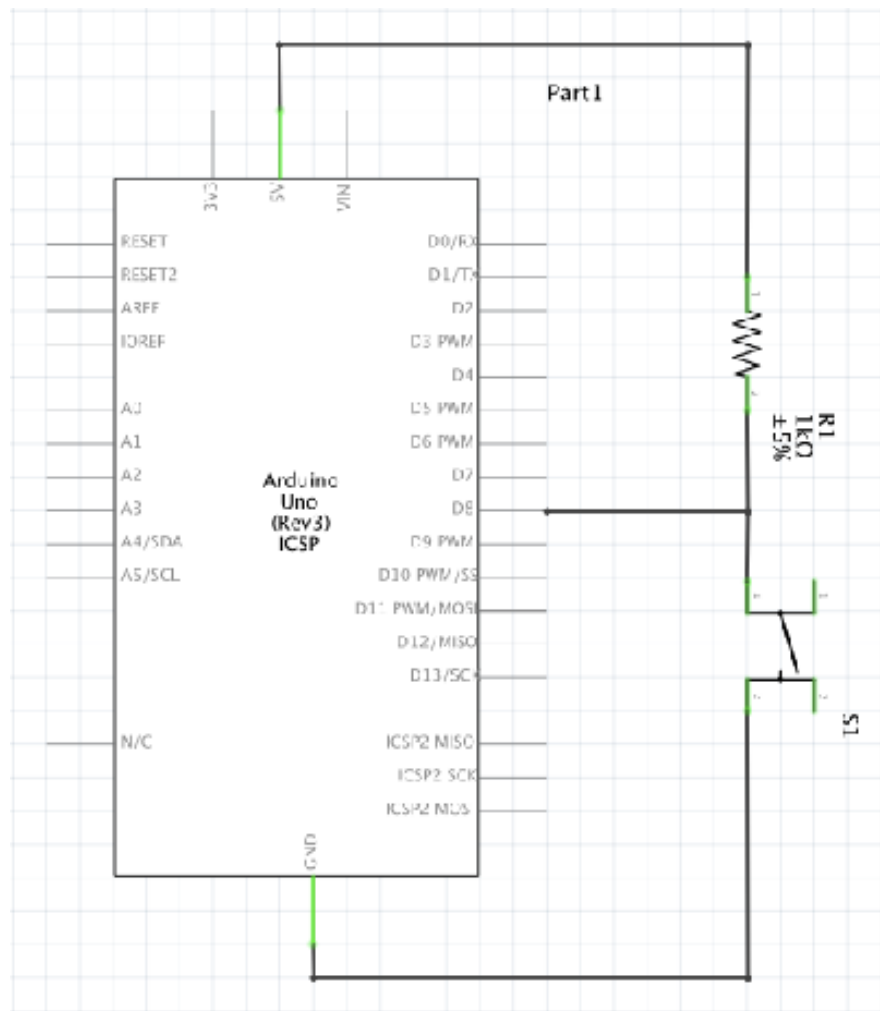
WRONG!!!
(for now it's wrong)

Sketch - read a sensor (digital)


```
_03_sw | Arduino 1.6.9

_03_sw §

/* Emma Pareschi
 *  September 2017
 *  I read  the value of a tact switch (or pushbutton)
 */

// constants won't change. They're used here to
// set pin numbers:
const int sw_pin = 8;       // the number of the pushbutton pin

// variables will change:
int sw_state = 0;           // variable for reading the pushbutton status

void setup() {
    // initialize the pushbutton pin as an input:
    pinMode(sw_pin, INPUT);


}

void loop() {
    // read the state of the pushbutton value:
    sw_state = digitalRead(sw_pin);



    delay(100);
}
```

sw_pin: to define the switch pin

sw_state: to save the data

pinMode INPUT

Function to read the value of the pin

Sketch - read a sensor (digital) and to print the values


```
_03_sw | Arduino 1.6.9

_03_sw

/* Emma Pareschi
 *  Septmber 2017
 *  I read and print on the computer
 *  the value of a tact switch (or pushbutton)
 */

// constants won't change. They're used here to
// set pin numbers:
const int sw_pin = 8;       // the number of the pushbutton pin

// variables will change:
int sw_state = 0;           // variable for reading the pushbutton status

void setup() {
    // initialize the pushbutton pin as an input:
    pinMode(sw_pin, INPUT);
    //open the serial communication with the laptop
    Serial.begin(9700);
}

void loop() {
    // read the state of the pushbutton value:
    sw_state = digitalRead(sw_pin);

    //print on the serial Monitor
    Serial.print("The value of the switch is: ");
    Serial.println(sw_state);
    //add a delay

    delay(100);
}
```

To open communication

To print on serial monitor

Turn on/off the Led based on the switch
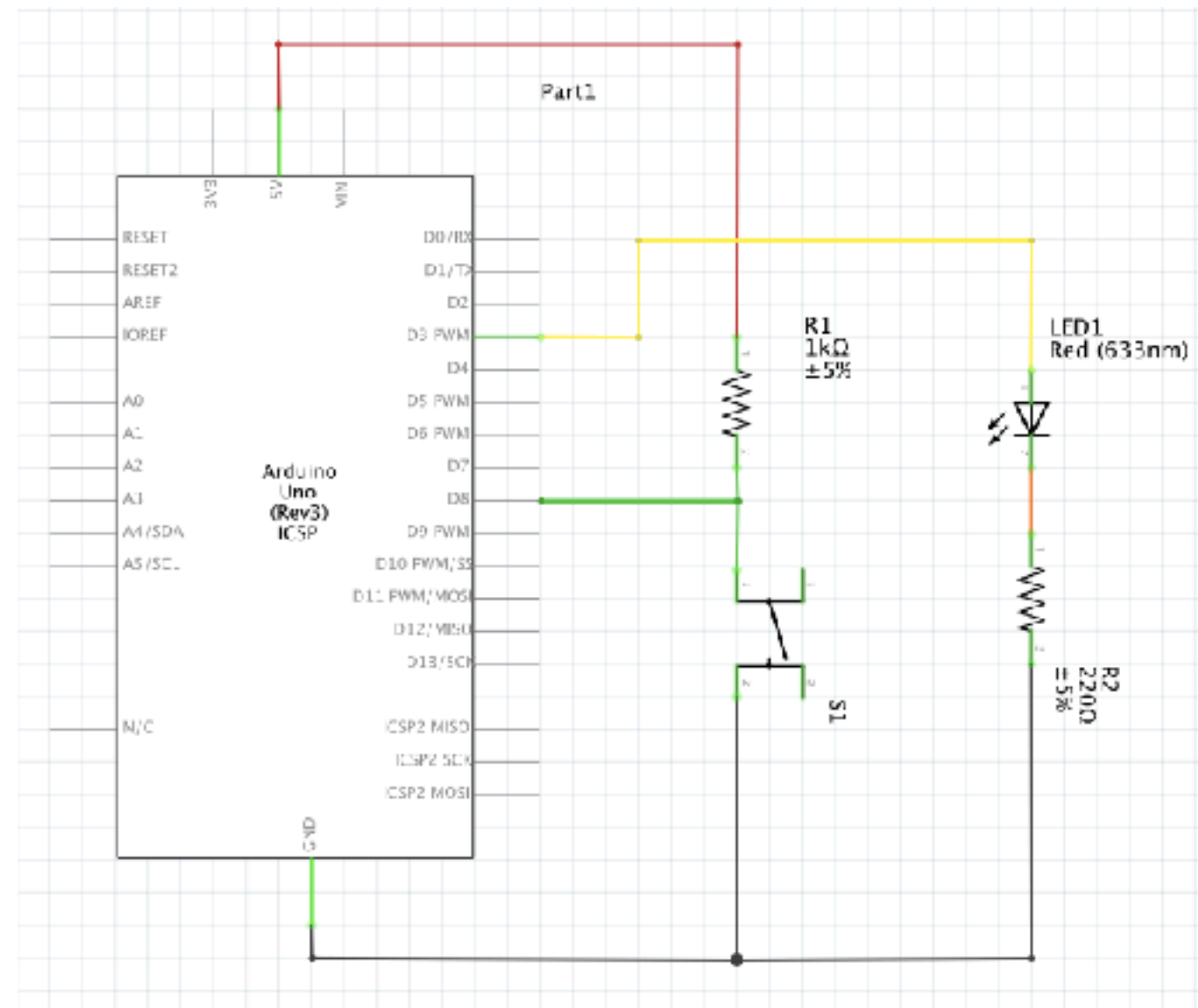
Sketch - Led and Switch

```
// constants won't change. They're used here to
// set pin numbers:
const int buttonPin = 2;      // the number of the pushbutton pin
const int ledPin =  13;       // the number of the LED pin

// variables will change:
int buttonState = 0;          // variable for reading the pushbutton sta

void setup() {
  // initialize the LED pin as an output:
  pinMode(ledPin, OUTPUT);
  // initialize the pushbutton pin as an input:
  pinMode(buttonPin, INPUT);
}

void loop() {
  // read the state of the pushbutton value:
  buttonState = digitalRead(buttonPin);

  // check if the pushbutton is pressed.
  // if it is, the buttonState is HIGH:
  if (buttonState == HIGH) {
    // turn LED on:
    digitalWrite(ledPin, HIGH);
  } else {
    // turn LED off:
    digitalWrite(ledPin, LOW);
  }
}
```
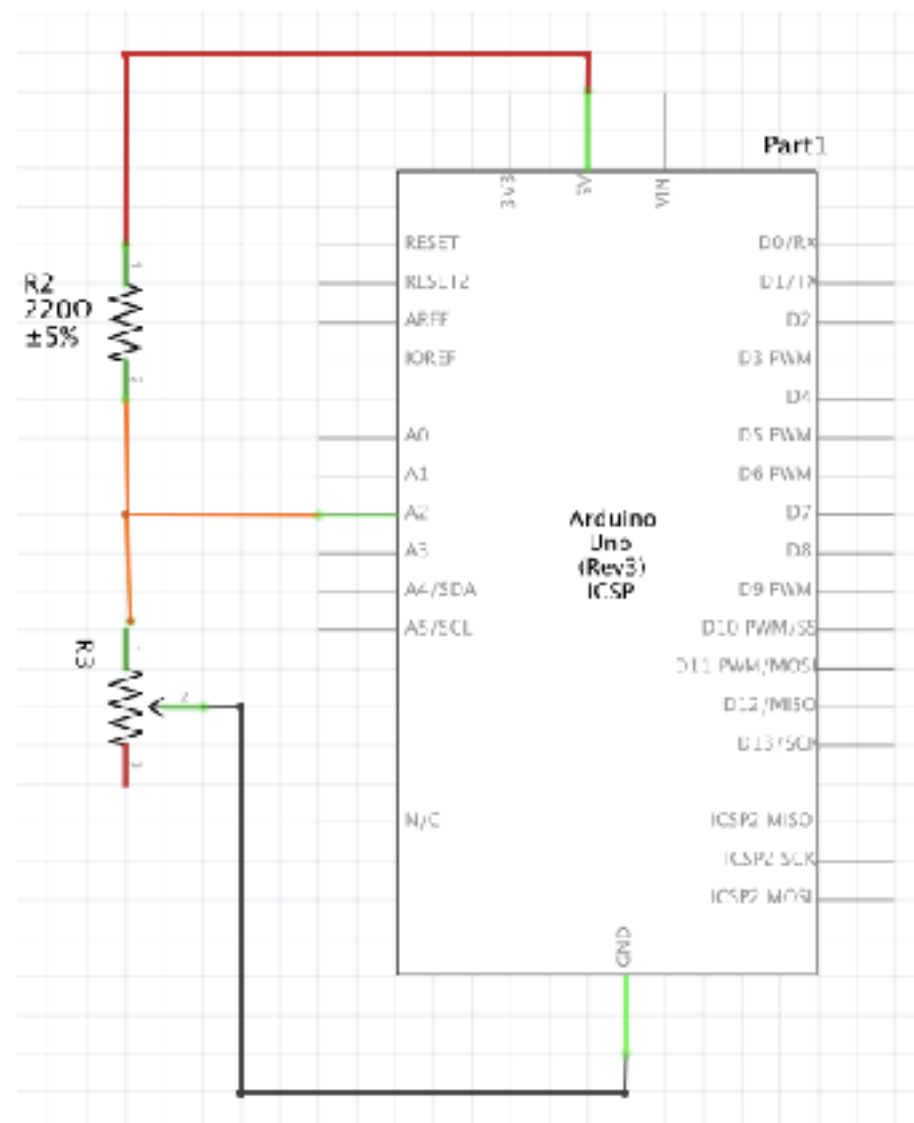
Control Structure 'if..else':

```
if (this condition happens)
{
   // action A
}
else
{
   // action B
}
```

How to read a sensor (Analog)

..next time..

ASSIGNMENTS

1) Design and program a circuit with the following specifications:
       - at least two LEDs
       - use the functions digitalWrite and analogWrite

2) Design and program a circuit with the following specifications:
       - at least one tact switch
       - use the functions digitalRead and the structure if…else

    More information about
    Serial.print: https://www.arduino.cc/en/Serial/Print
    Serial.println: https://www.arduino.cc/en/Serial/Println
    If…else: https://www.arduino.cc/en/Reference/Else

3) Document the two projects in your blog with two posts, the documentation
   includes:
       - a short description of the functionality of the circuit
       - schematic of the circuit
       - sketch (arduino code)
       - if it works: upload a video of the circuit that works
       - if it doesn't work: explain what you did to debug hardware and
         software

  Note: if you take inspiration or you reproduce a circuit/code done by someone
  else, you have to acknowledge the source in your post.

Assignments - Extra

4) Read a photcell, LDR. Make the circuit on the breadboard. Write the code using the function analogRead();

More information about
analogRead: https://www.arduino.cc/en/Reference/AnalogRead
LDR: https://learn.sparkfun.com/tutorials/photocell-hookup-guide
https://learn.adafruit.com/photocells/using-a-photocell
http://www.hobbytronics.co.uk/arduino-tutorial8-nightlight

OnLine Calculators

HTTP://WWW.OHMSLAWCALCULATOR.COM/OHMS-LAW-CALCULATOR

HTTP://WWW.OHMSLAWCALCULATOR.COM/LED-RESISTOR-CALCULATOR

HTTP://WWW.OHMSLAWCALCULATOR.COM/VOLTAGE-DIVIDER-CALCULATOR

Sources and Licence

Ohm's Law:
https://learn.sparkfun.com/tutorials/voltage-current-resistance-and-ohms-law

Electric Power:
https://learn.sparkfun.com/tutorials/electric-power

Resistors (pg.75)
Encyclopedia of Electronic Components Volume 1, 1st Edition,
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https://www.arduino.cc/en/Reference/HomePage