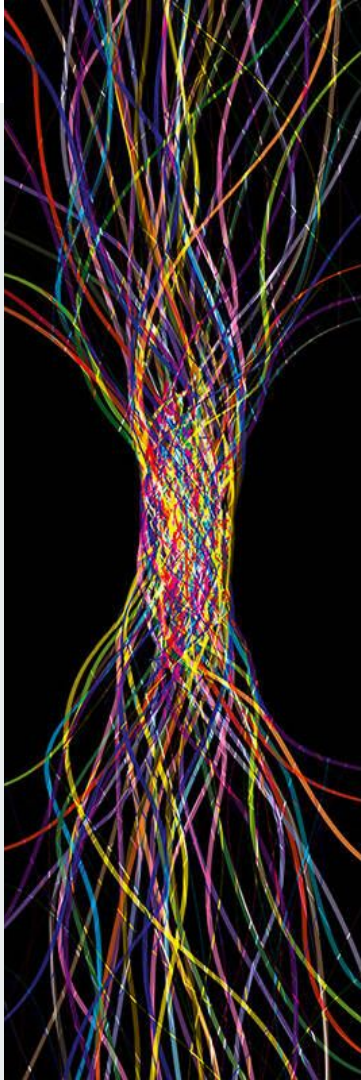
Arduino Series

Tim McCormack

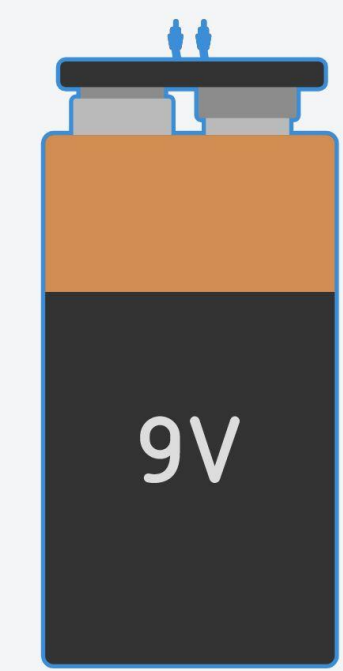


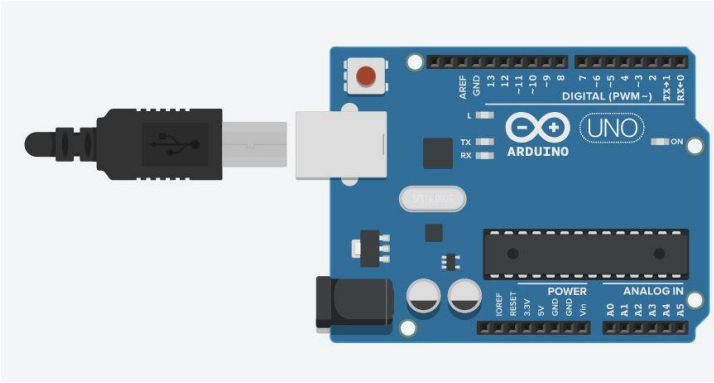
What is Arduino ?

A miniature computer used to create interactive electronic devices.

Arduinos used to prototype drones, fitbits, and smart watches.

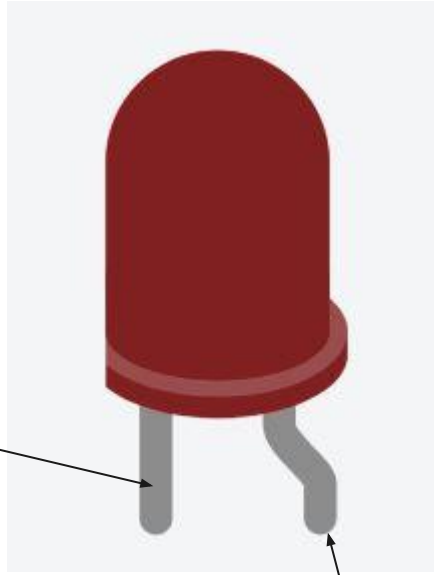
Sources of Power





LED

- Light-emitting diode
- Emits light when electricity flows through
- Comes in various colors (red, blue, green)



CHALLENGE 1: Light up an LED with Coin battery

1. Open up Tinkercad Circuits
2. Drag and drop an LED into the workspace
3. Drag and drop a coin battery in the workspace
4. Try to build a circuit that makes the led light up

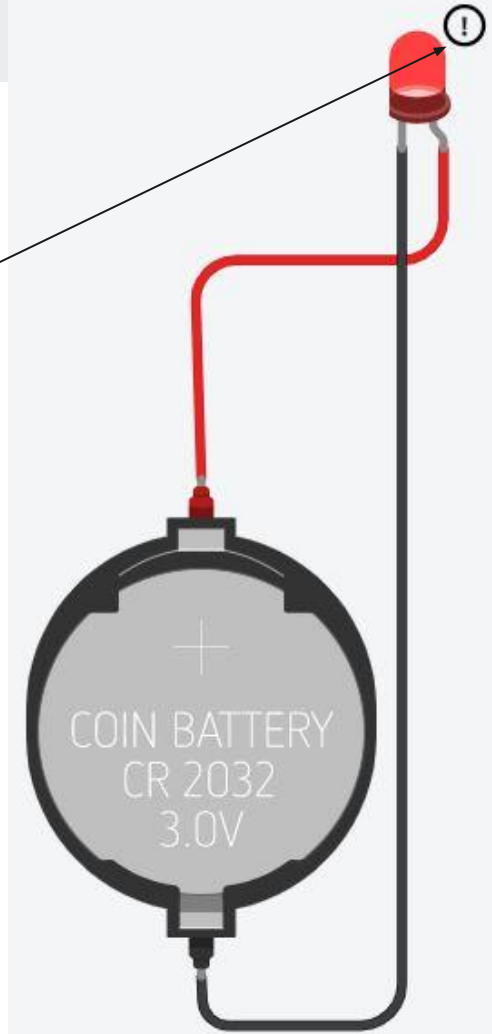
HINT: Keep in mind that the anode (longer leg) must connect to the positive side of the battery, and the cathode (shorter leg) must connect to the negative side of the battery.

Something to Note...

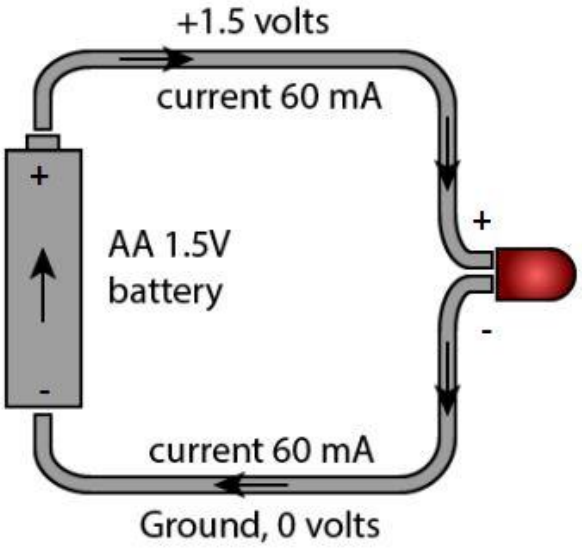
Error Message:
“Currently through the LED is 61.9 mA, while recommended maximum is 20.0 mA. The usable lifetime of may be reduced.”

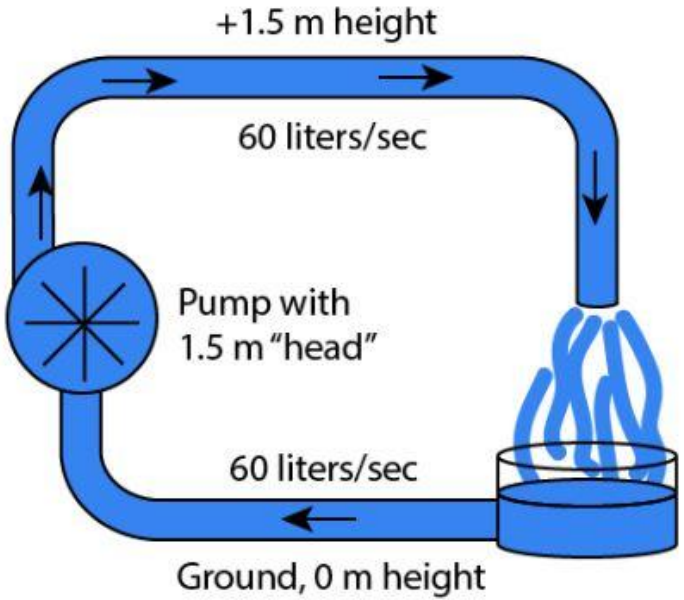
Why are we getting a warning??

mA: a unit for electric current



The Water Analogy



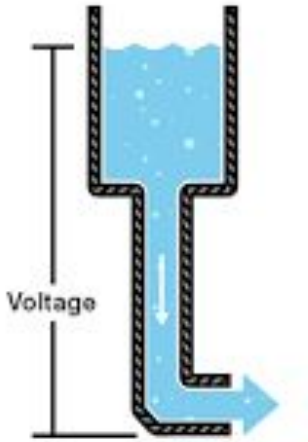


Voltage

Voltage is to height,
as
current is to flow rate

Voltage = height of the water

Varies throughout the circuit



Current

Like the water flow rate

Stays constant through entire circuit

Voltage is to height,
as
current is to flow rate

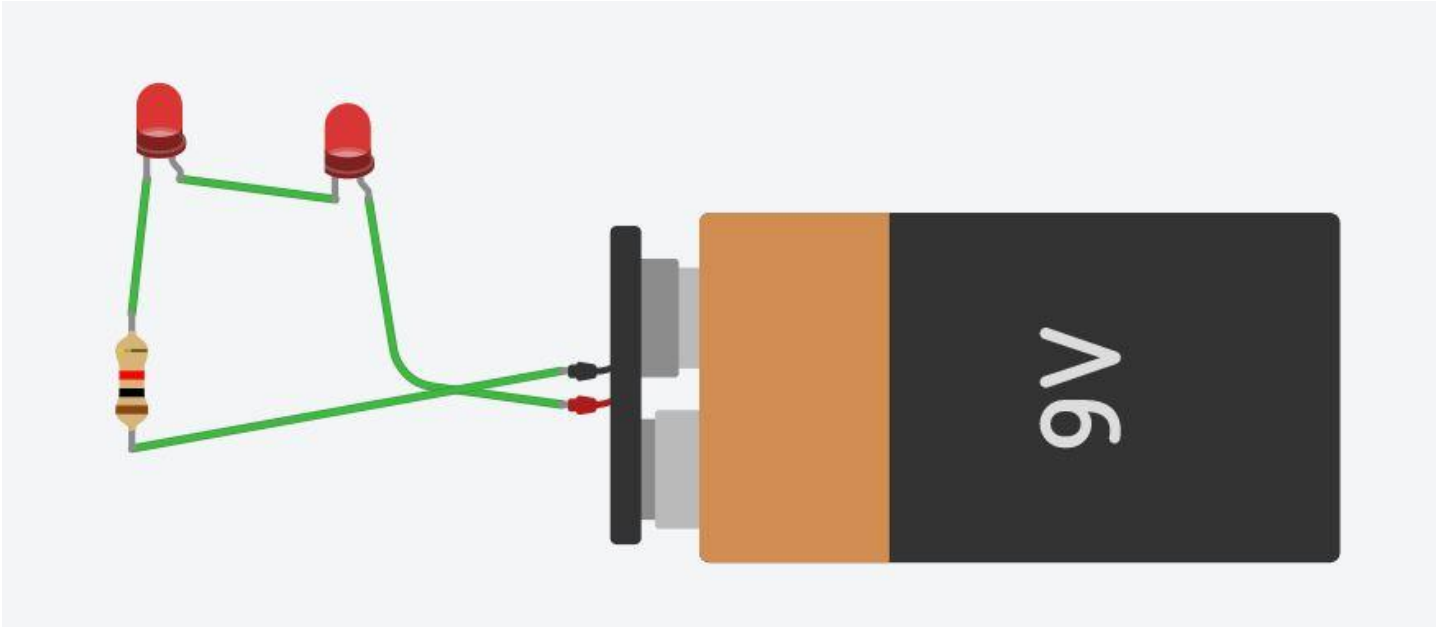
CHALLENGE 2: Light up two LED's with a 9 Volt battery

1. Open up Tinkercad Circuits
2. Drag and drop the 9V battery
3. Drag and drop two LEDs
4. Try to build a circuit that makes both LEDs light up

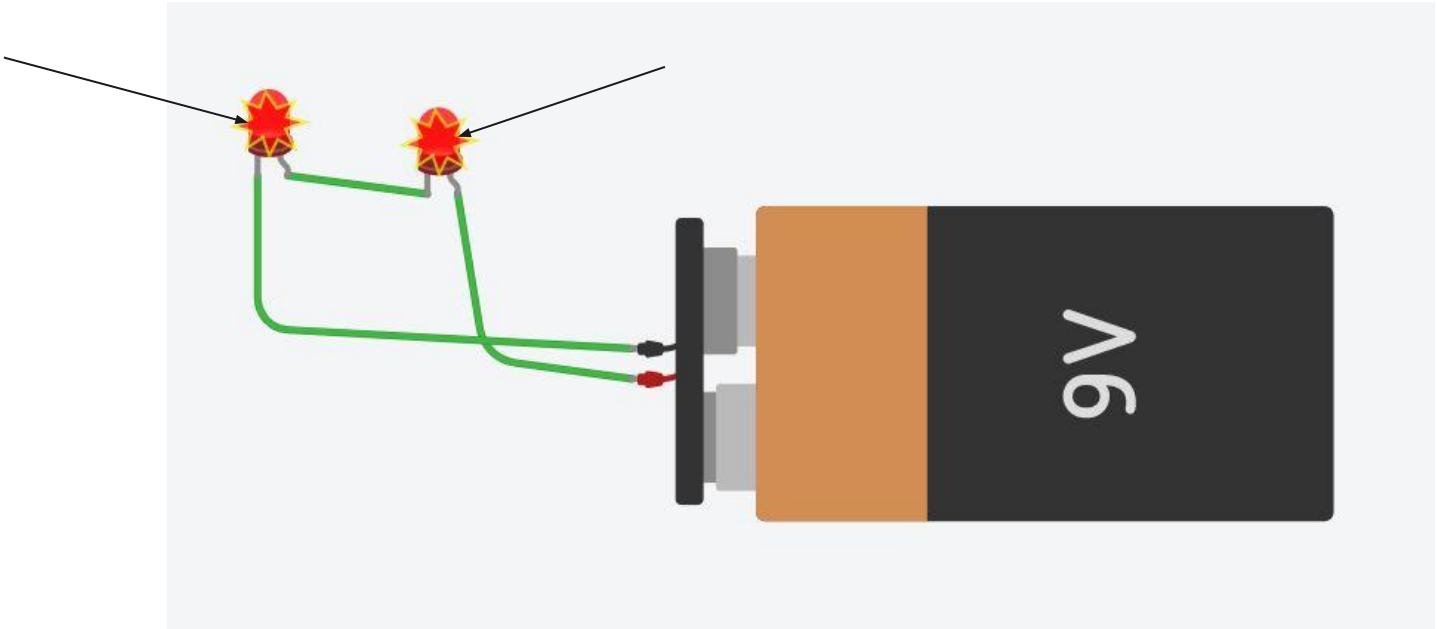
HINT: The cathode of one LED should be wired to the anode of another LED

HINT: You will need a resistor, it does not matter where in the circuit the resistor is located

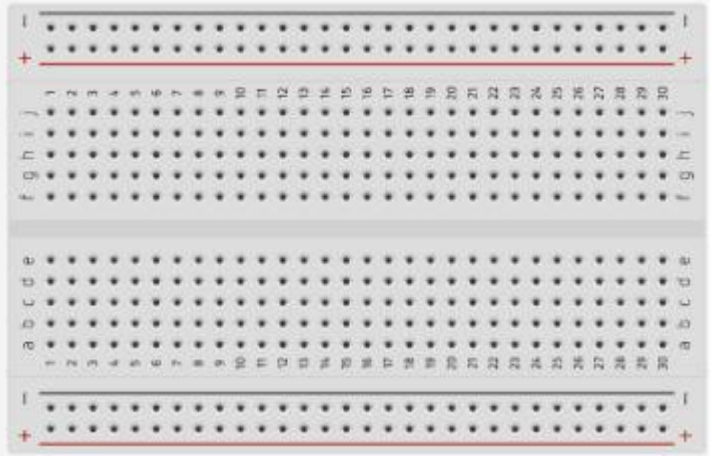
With Resistor

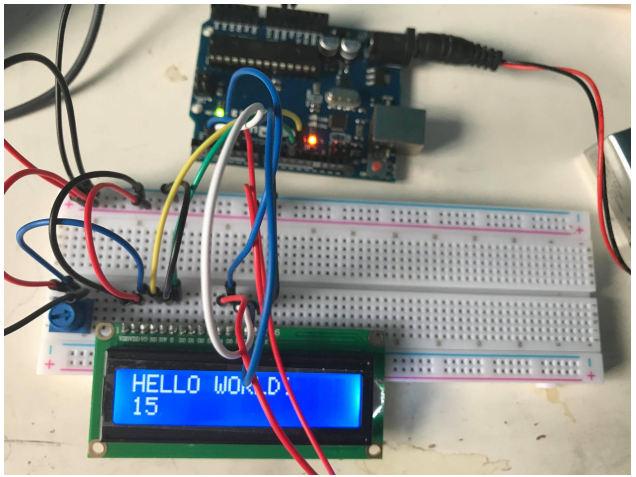


Without Resistor



How are we going to make circuits in real life?

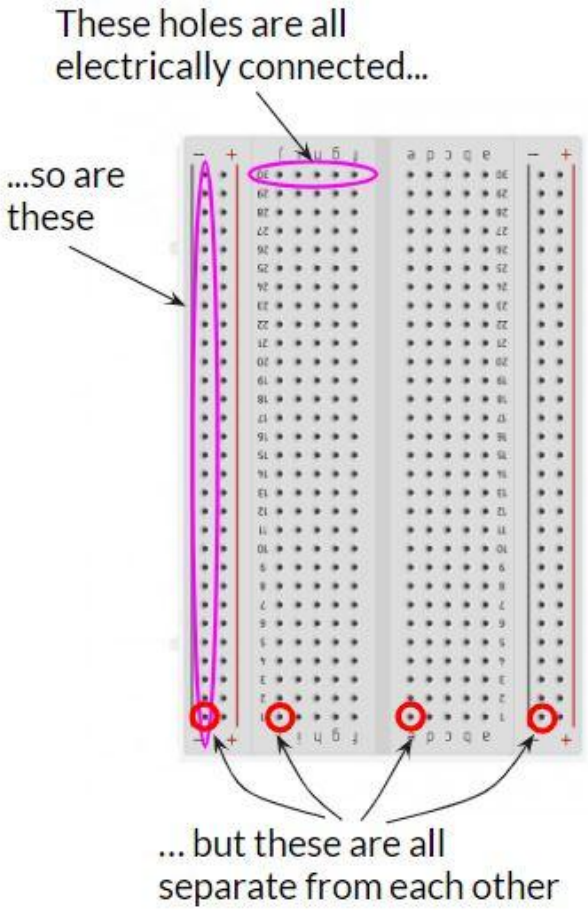




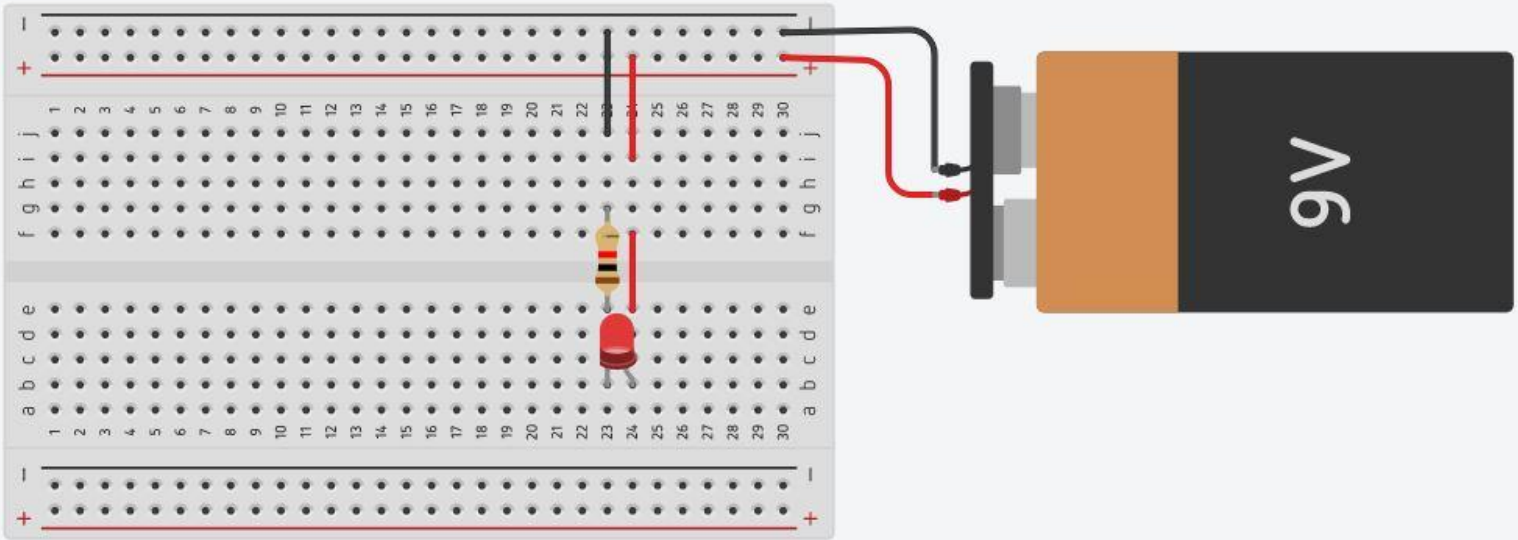
Breadboards

These boards are a way for us to connect wires to our LEDs.

Otherwise you would have to use a soldering gun to melt wires into electric components.



How can I connect my breadboard to power



CHALLENGE 3: Light up an LED with a 9 Volt battery and a breadboard

1. Open up Tinkercad Circuits
2. Drag and drop the 9V battery
3. Drag and drop one LED
4. Drag and drop a breadboard
5. Try to build a circuit that makes the LED light up

HINT: Refer to Slide 14 to see how parts of the breadboard are connected

HINT: You will still need a resistor, it does not matter where in the circuit the resistor is located

CHALLENGE 4: Light up an LED with our arduinos

1. Get your 9V battery and battery adapter
2. Get one LED
3. Get your breadboard
4. Try to build a circuit that makes the LED light up

HINT: Refer to Slide 14 to see how parts of the breadboard are connected

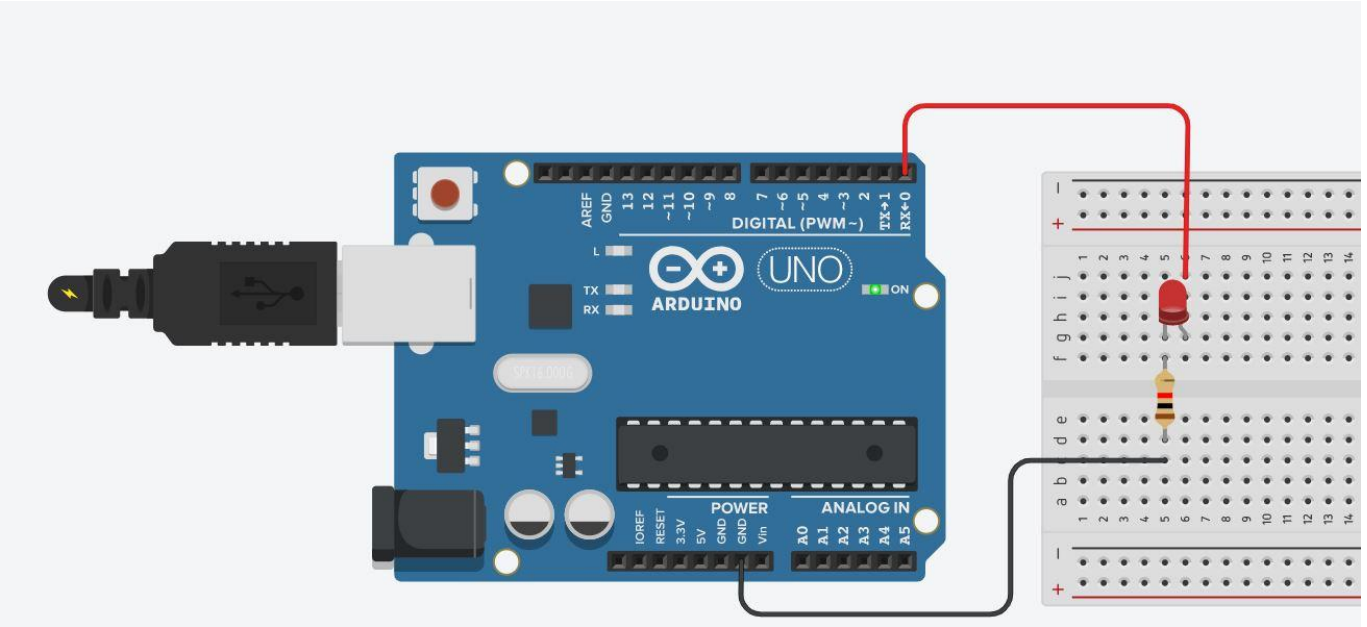
HINT: use your solution for challenge #3 as a guide

HINT: You will still need a resistor, it does not matter where in the circuit the resistor is located

Steps for Challenge 4

1. Connect Pin 0 to the anode (+) of the LED
2. Place a 220 ohm resistor in the column of the cathode (-) of the LED
3. Run a wire from the column of the resistor to GND (ground)
4. Plug in the 9 volt battery adapter to your arduino to check your circuit

Schema


AREF
GND
13
12
~11
~10
~9
8
7
~6
~5
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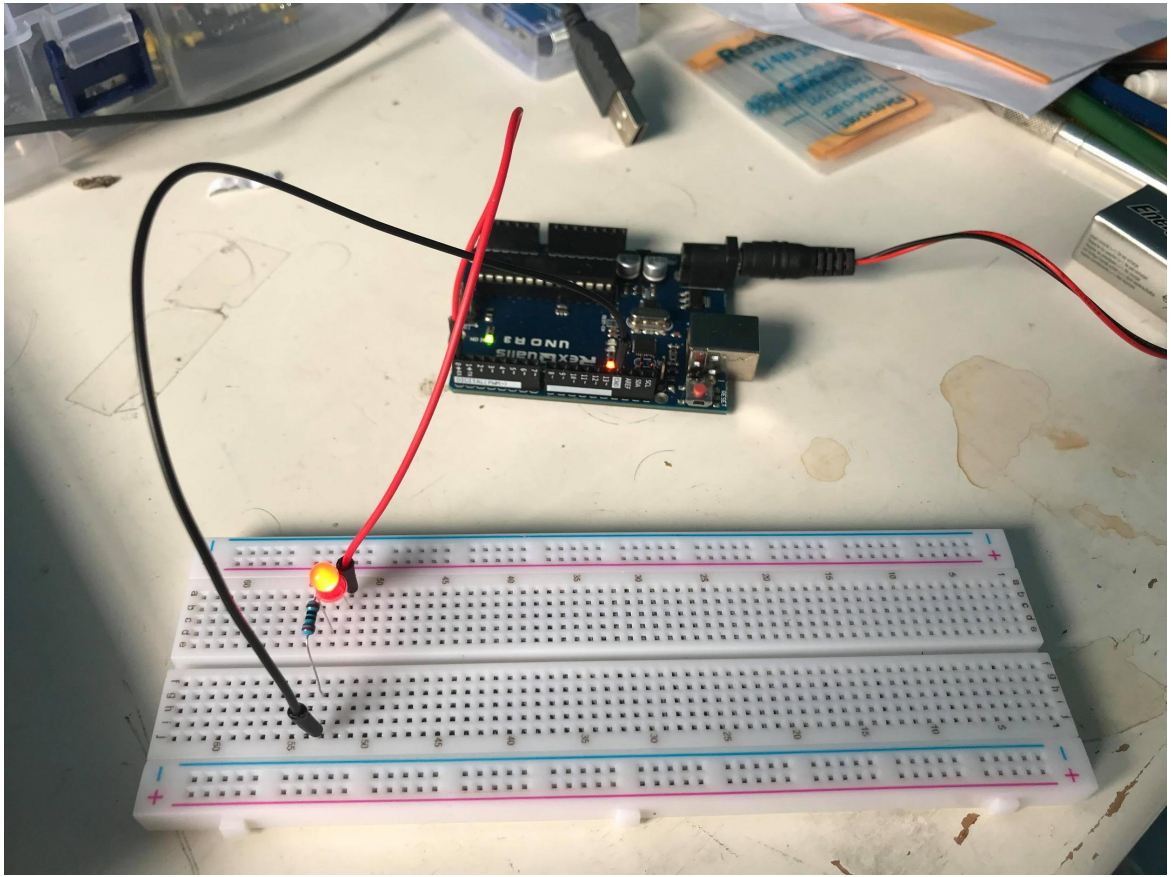
~3
2
TX→1
RX←0
DIGITAL (PWM~)
L
TX
RX
ARDUINO
UNO
ON
POWER
ANALOG IN
IOREF
RESET
3.3V
5V
GND
GND
Vin
A0
A1
A2
A3
A4
A5

In Real Life



CHALLENGE 5: Light up two LEDs with our arduinos

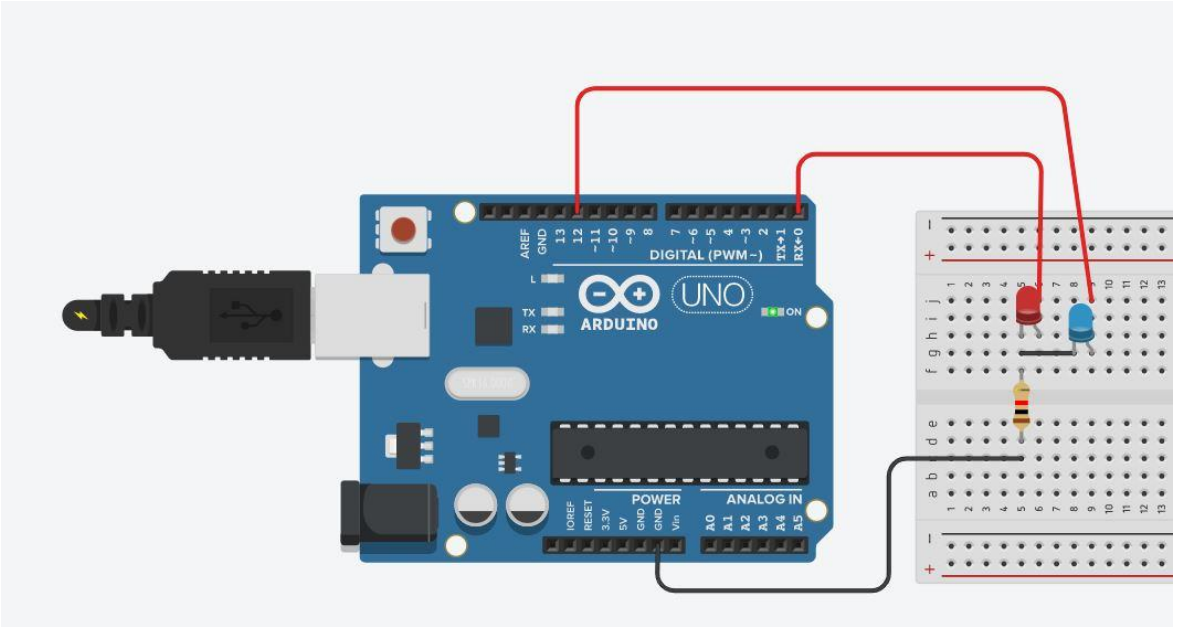
1. Get your 9V battery and battery adapter
2. Get arduino
3. Get two LEDs
4. Get your breadboard
5. Try to build a circuit that makes the LED light up

HINT: Refer to Slide 14 to see how parts of the breadboard are connected

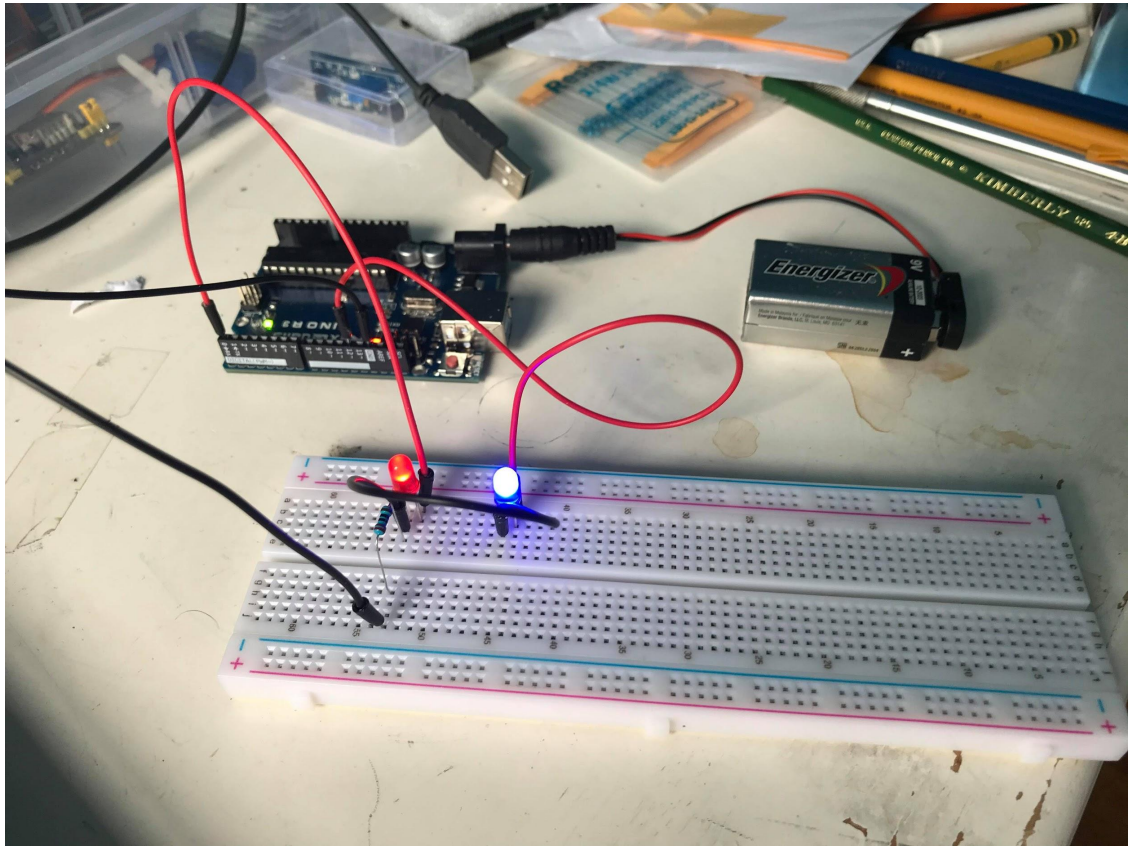
HINT: use your solution for challenge #4 as a guide

HINT: You will still need a resistor, it does not matter where in the circuit the resistor is located

Schema



In Real Life



CHALLENGE 6: Light up three LEDs with our arduinos

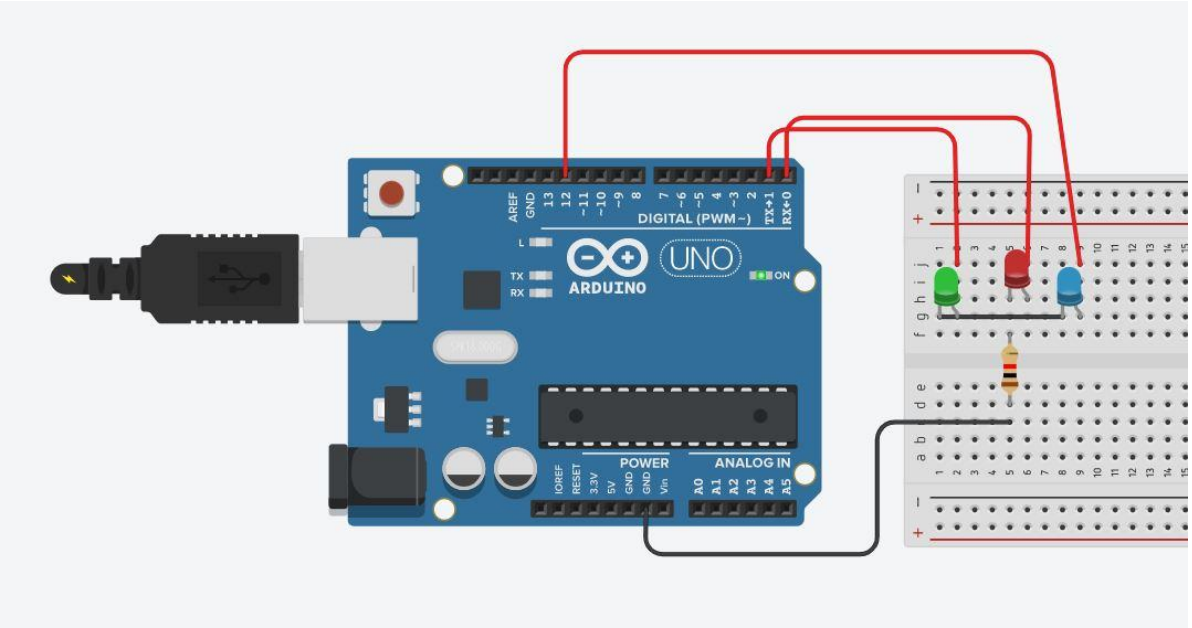
1. Get your 9V battery and battery adapter
2. Get arduino
3. Get three LEDs
4. Get your breadboard
5. Try to build a circuit that makes the LED light up

HINT: Refer to Slide 14 to see how parts of the breadboard are connected

HINT: use your solution for challenge #4 /5 as a guide

HINT: You will still need a resistor, it does not matter where in the circuit the resistor is located

Schema


AREF
GND
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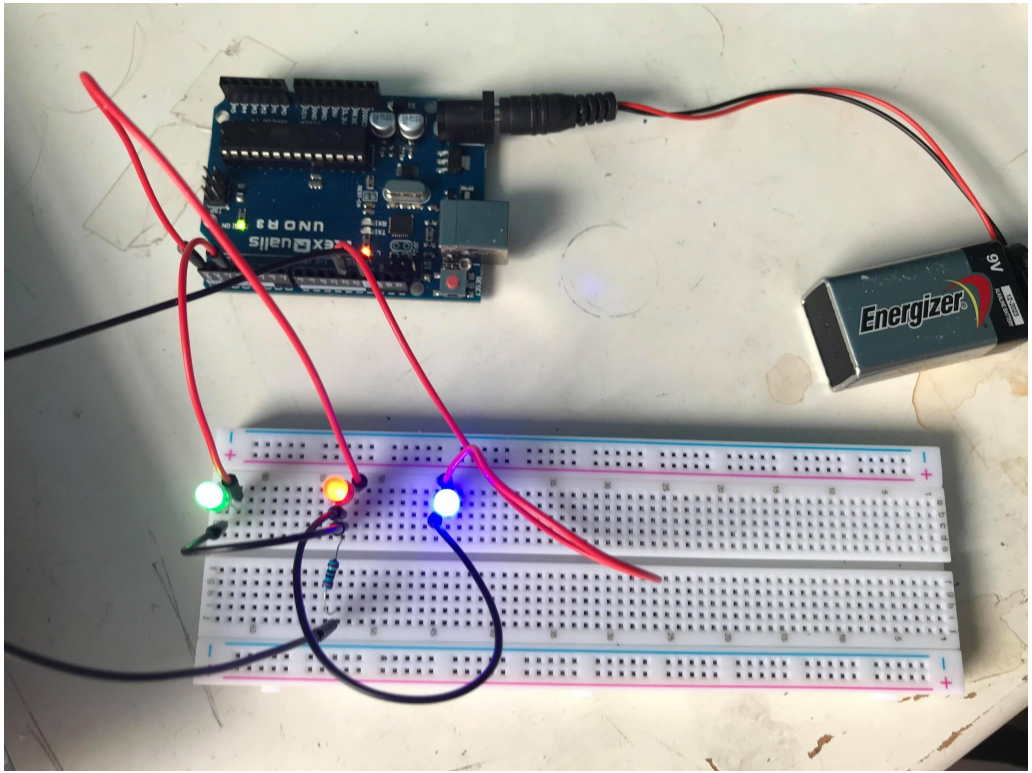
12
~11
~10
~9
8
7
~6
~5
4
~3
2
TX→1
RX←0
DIGITAL (PWM~)
L
TX
RX
ARDUINO
UNO
ON
POWER
ANALOG IN
IOREF
RESET
3.3V
5V
GND
GND
Vin
A0
A1
A2
A3
A4
A5

In Real Life



CHALLENGE 7: Blinking LED on pin 9

1. Get your 9V battery and battery adapter
2. Get arduino
3. Get one LEDs
4. Get your breadboard
5. Try to build a circuit that makes the LED light up

HINT: Refer to Slide 14 to see how parts of the breadboard are connected

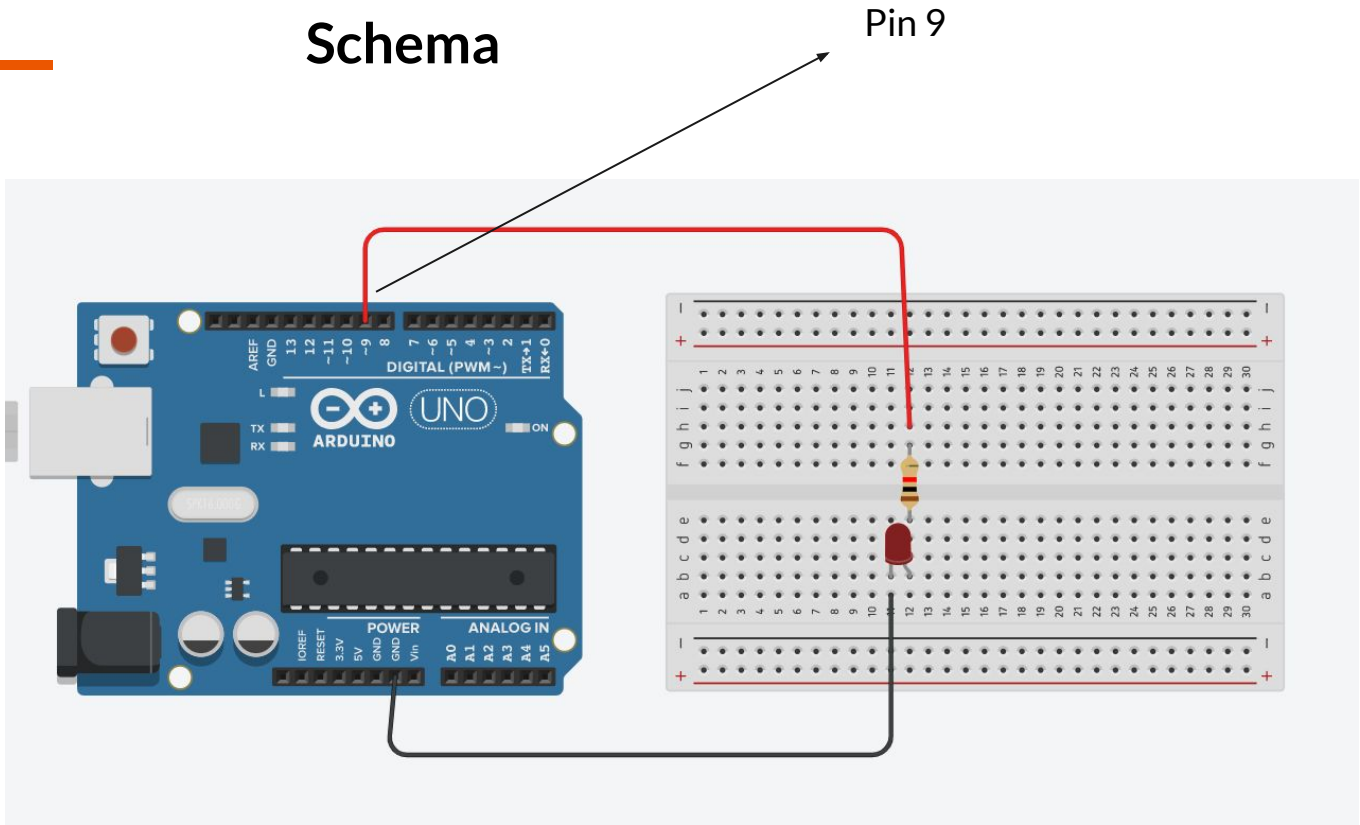
HINT: use your solution for challenge #4 as a guide

HINT: You will still need a resistor, it does not matter where in the circuit the resistor is located

Steps for Challenge 7

1. Open up TinkerCad
2. Connect PIN 9 of your arduino to the anode of a LED
3. Connect a resistor to the cathode of your LED
4. Connect the end of your resistor to GND
5. Notice that your LED light is blinking
    a. If it is not blinking, that is not a problem it is because your arduino has different default settings

Schema

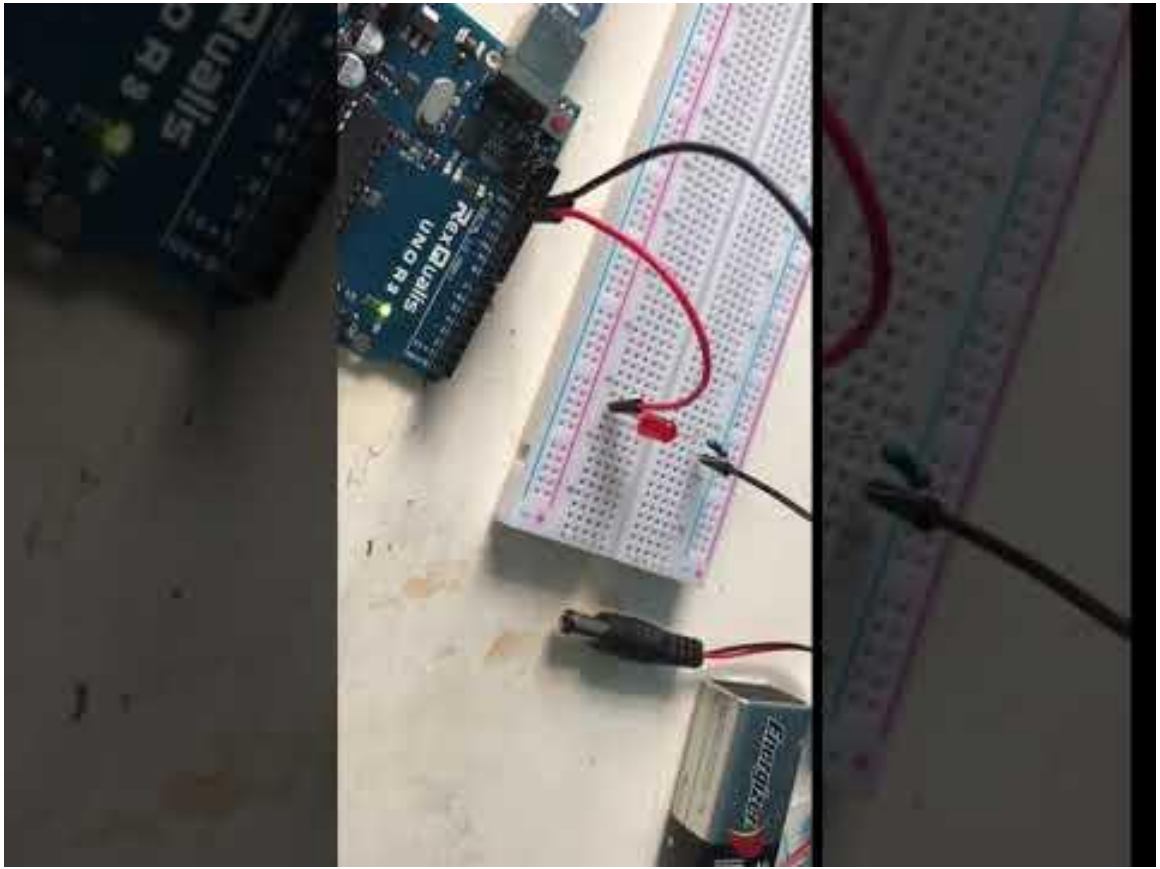


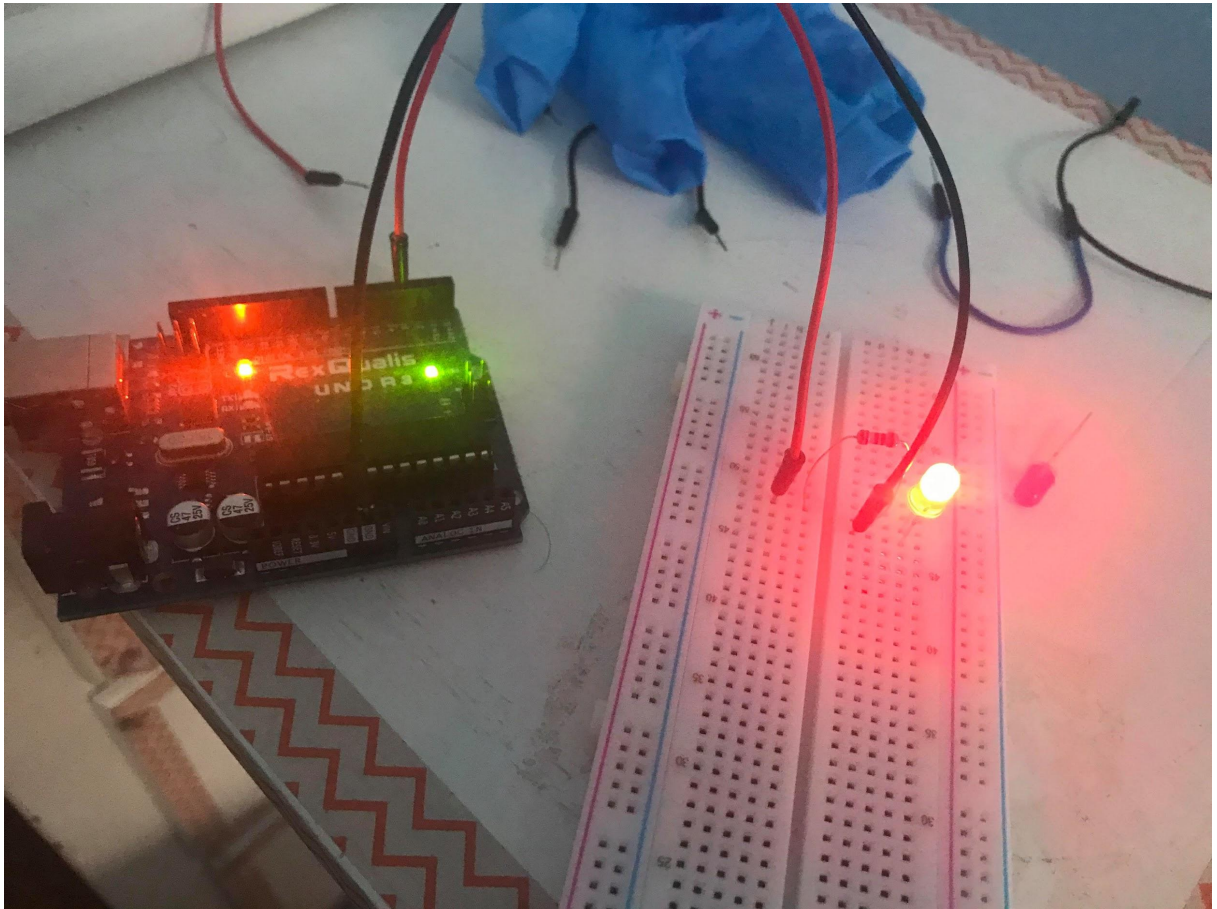
Code

```
void setup()
{
  pinMode(9, OUTPUT);
}

void loop()
{
  digitalWrite(9, HIGH);
  delay(100); millisecond(s)
  digitalWrite(9, LOW);
  delay(100); millisecond(s)
}
```

In Real Life





CHALLENGE 8: Flickering Light

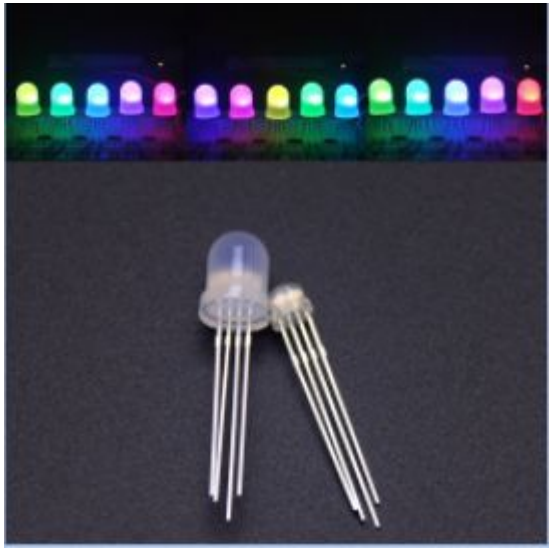
RGB LEDs

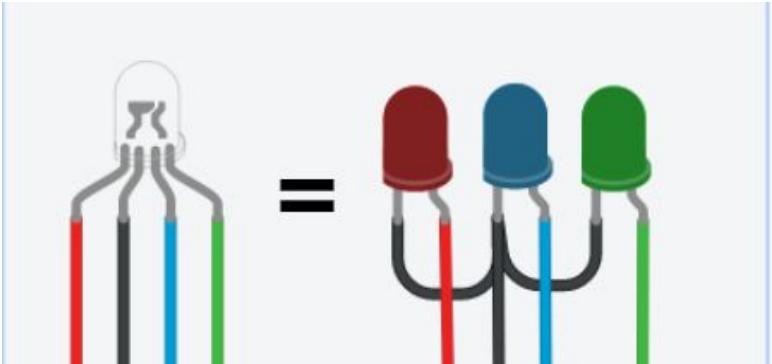
An RGB LED has three LEDs inside it! One red, one green, one blue.

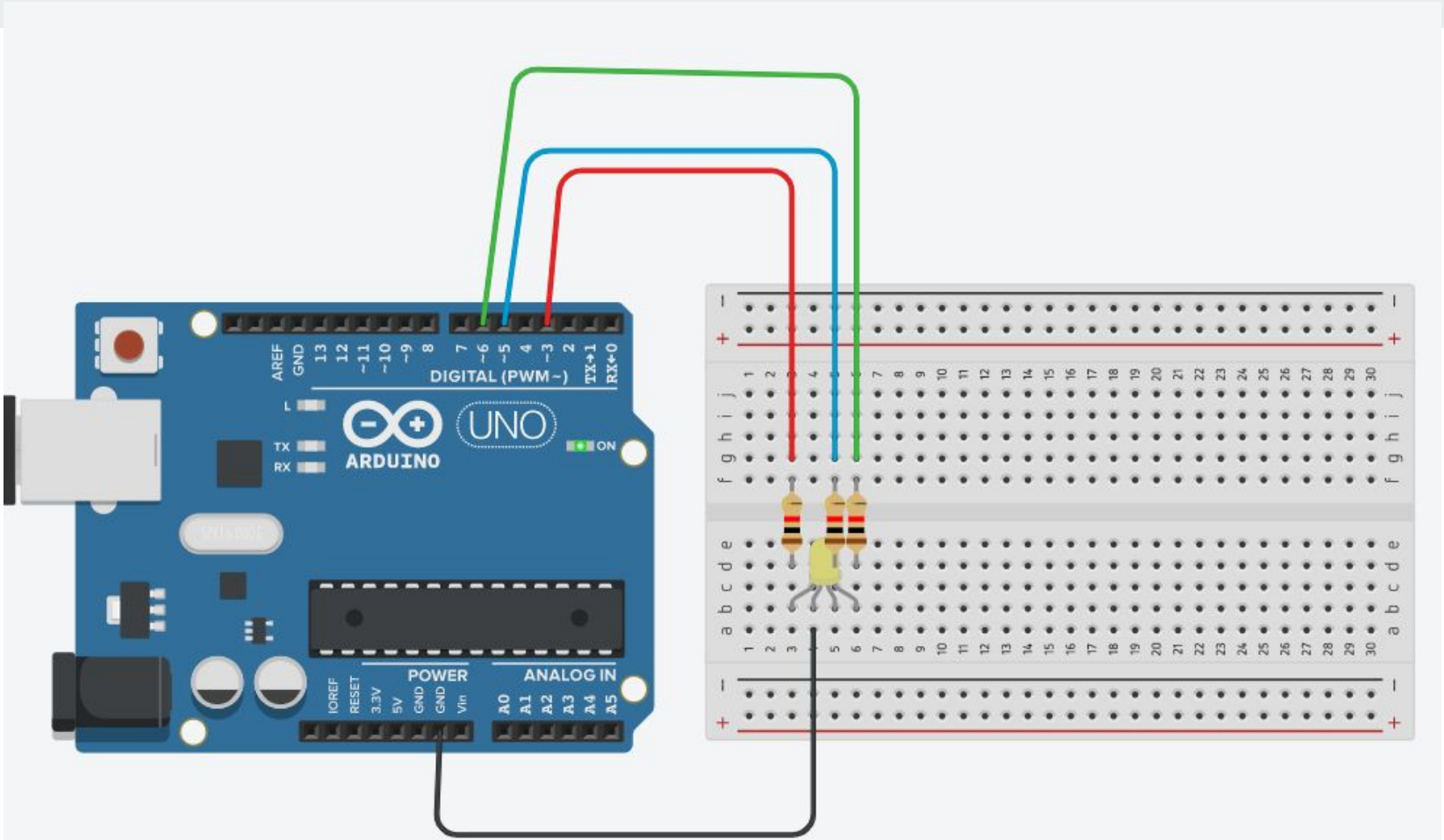
The cathodes (negative side) of the LEDs are all connected.

This LED can light up in any color!

red + blue = purple
blue + green = cyan
red + green = yellow (!)
red + green + blue = white






AREF
GND
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2
TX→1
RX←0
DIGITAL (PWM~)
L
TX
RX
ARDUINO
UNO
ON
POWER
ANALOG IN
IOREF
RESET
3.3V
5V
GND
GND
Vin
A0
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A3
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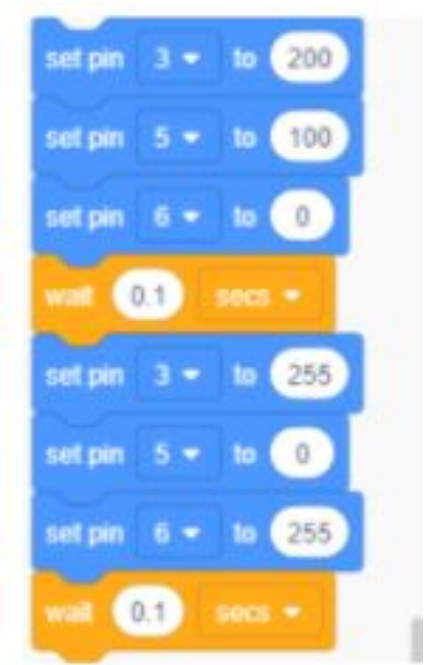
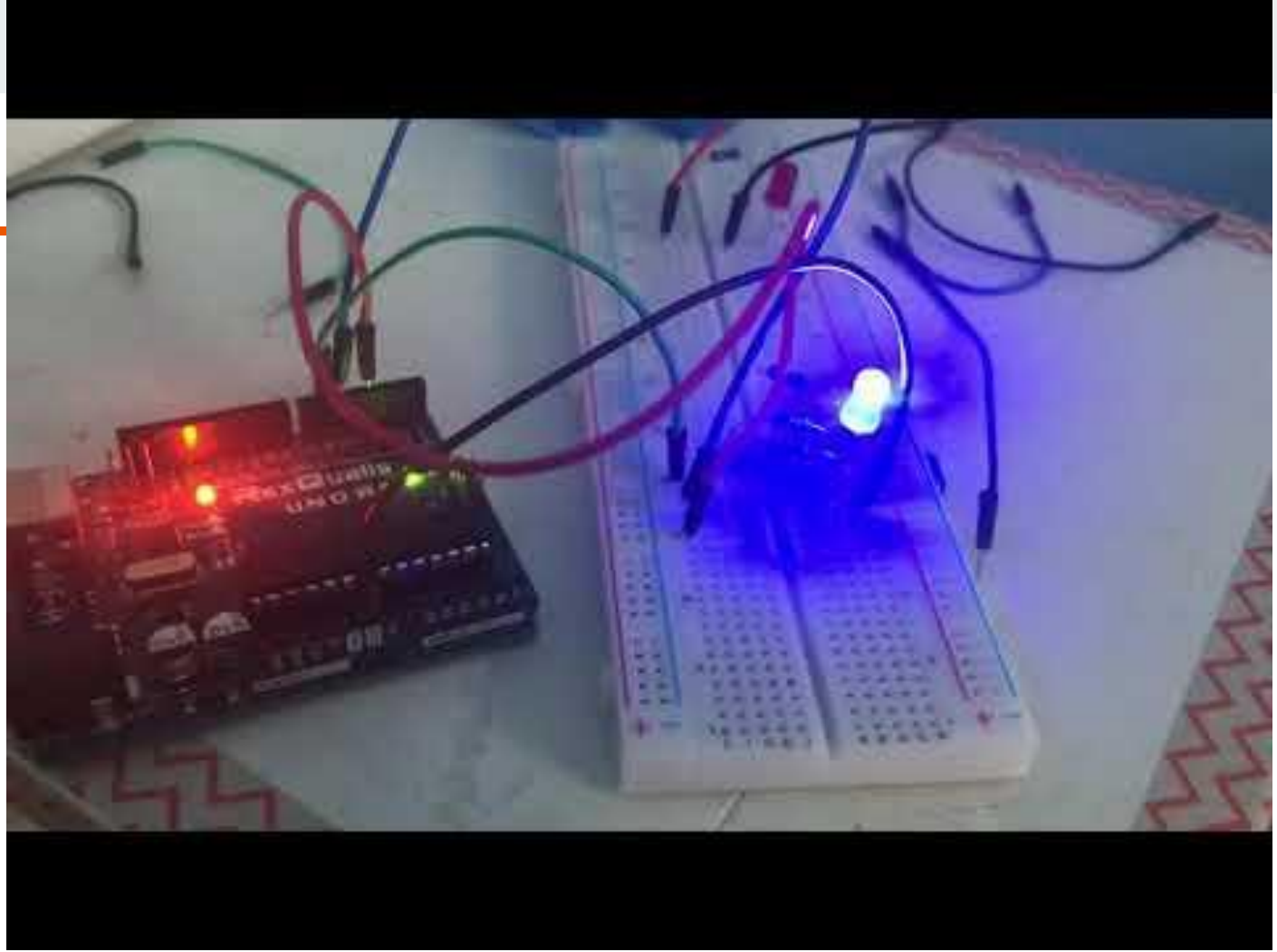


Code

```
void setup()
{
  pinMode(3, OUTPUT);
  pinMode(5, OUTPUT);
  pinMode(6, OUTPUT);
}

void loop()
{
  analogWrite(3, 200);
  analogWrite(5, 100);
  analogWrite(6, 0);
  delay(100); // Wait for 100 millisecond(s)
  analogWrite(3, 255);
  analogWrite(5, 0);
  analogWrite(6, 255);
  delay(100); // Wait for 100 millisecond(s)
}
```

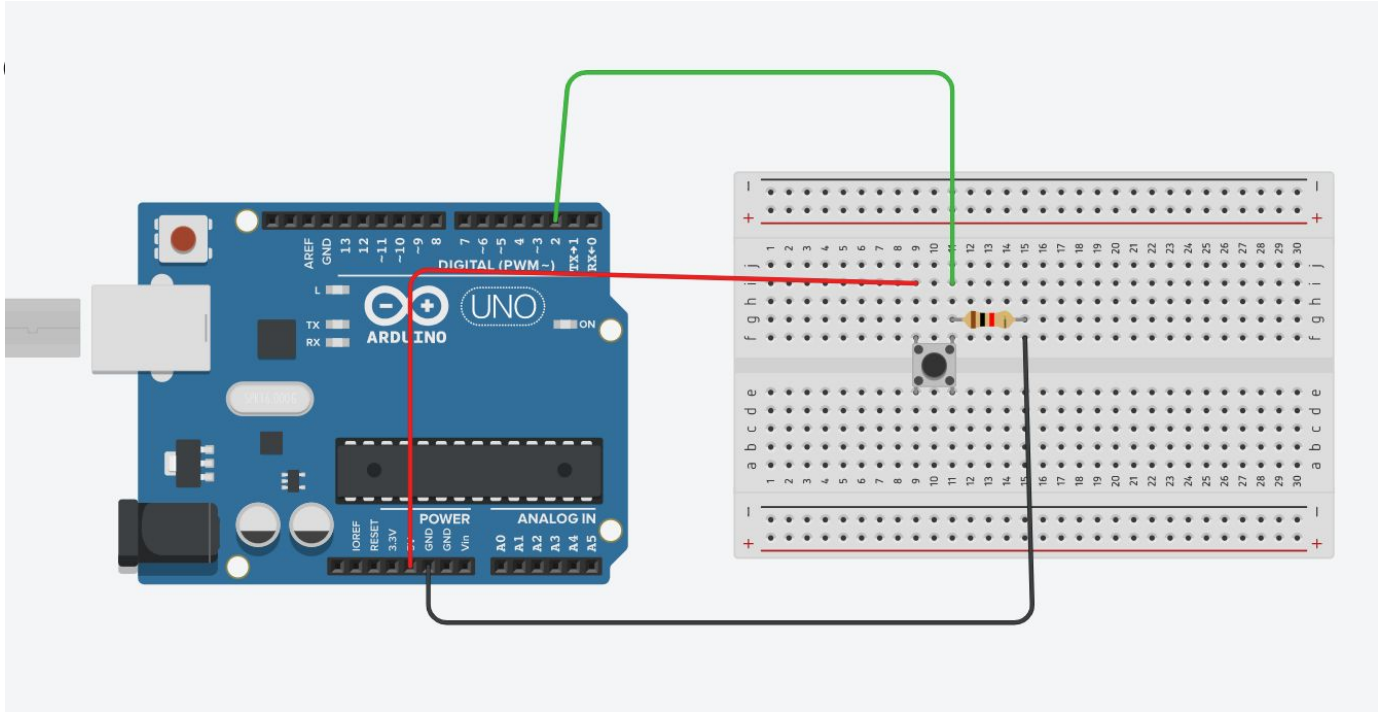
RGB Color Codes

https://www.rapidtables.com/web/color/RGB_Color.html



CHALLENGE 9: Add a button to turn built in LED on and off

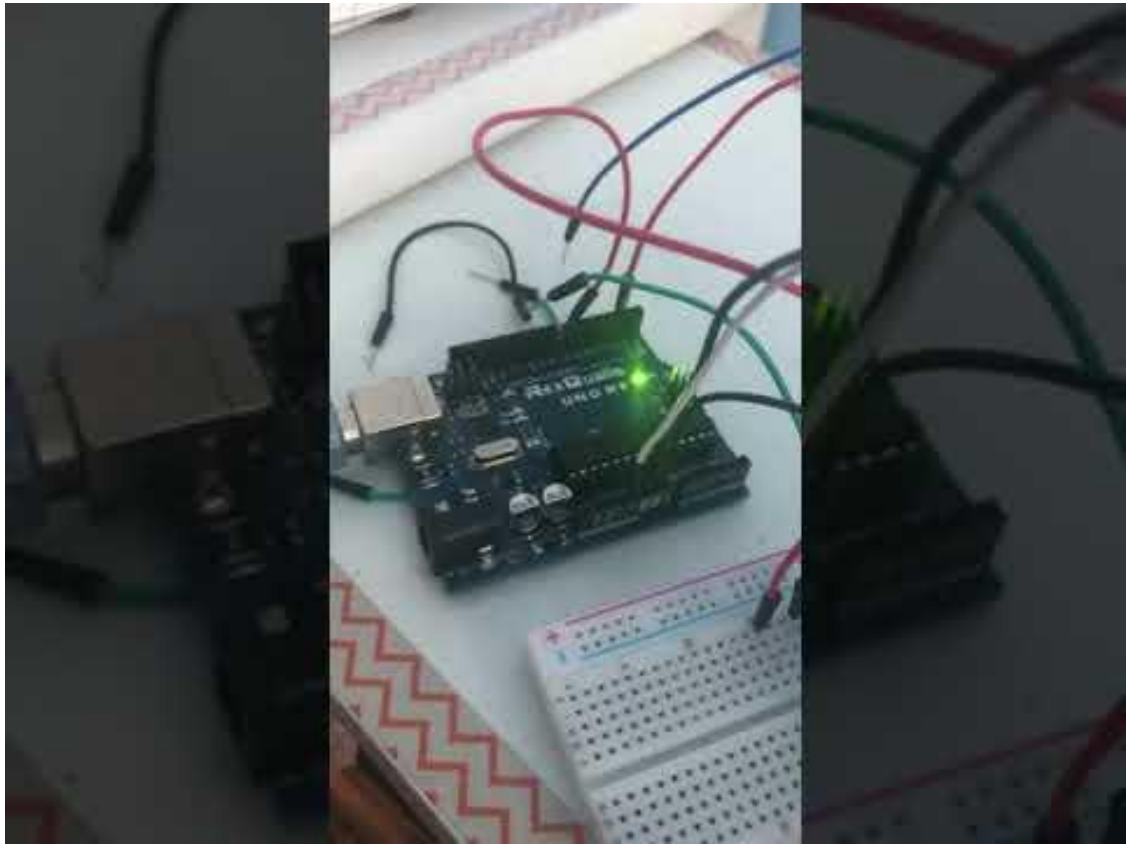
Button D
Circuit



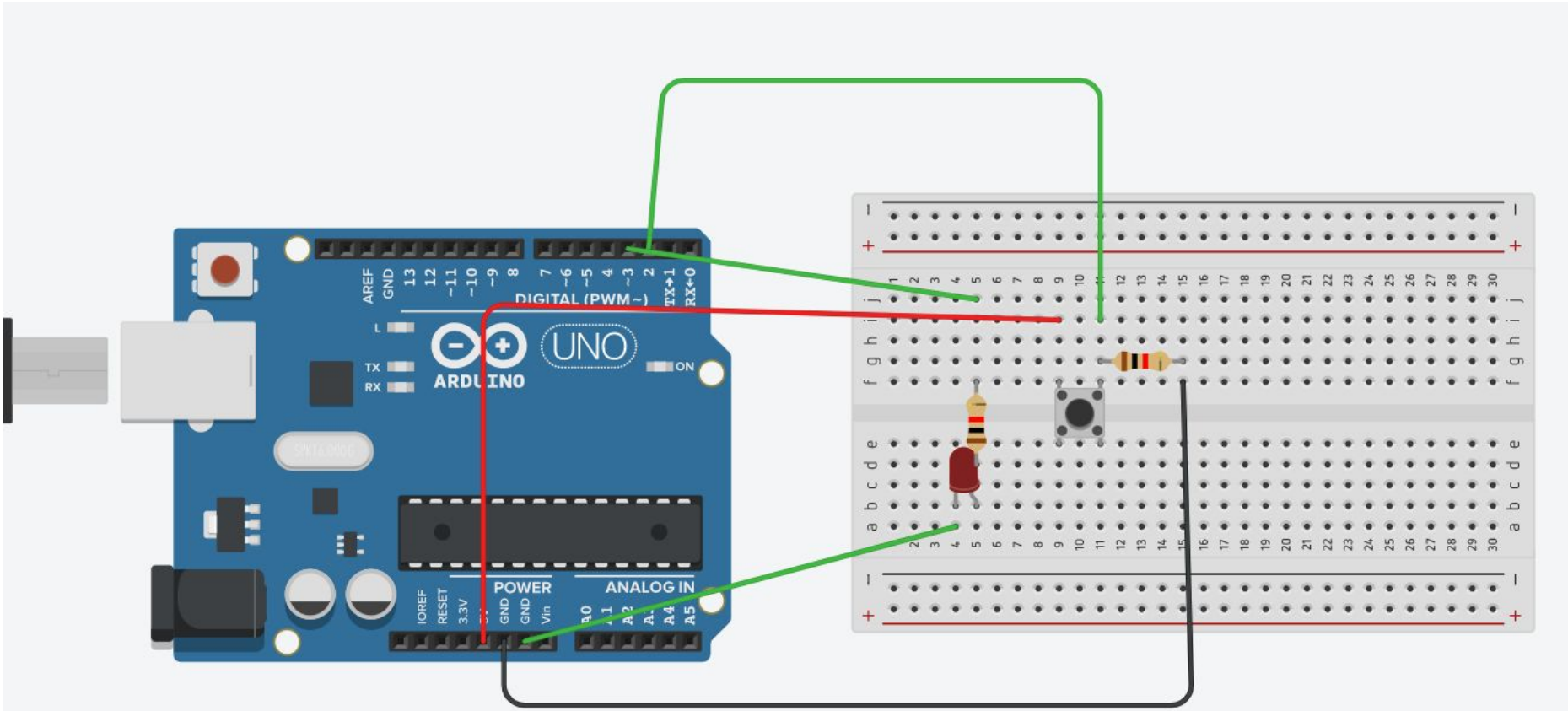
Code


```
int buttonState = 0;

void setup()
{
  pinMode(2, INPUT);
  pinMode(13, OUTPUT);
}

void loop()
{
  buttonState = digitalRead(2);
  if (buttonState == HIGH) {
    digitalWrite(13, HIGH);
  } else {
    digitalWrite(13, LOW);
  }
  delay(10); // Delay a little bit to
improve simulation performance
}
```

Button Detection Circuit



CHALLENGE 10: Add a button to a LED on and off


AREF
GND
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TX→1
RX←0
DIGITAL (PWM~)
L
TX
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UNO
ON
POWER
ANALOG IN
IOREF
RESET
3.3V
GND
GND
Vin
A0
A1
A2
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A4
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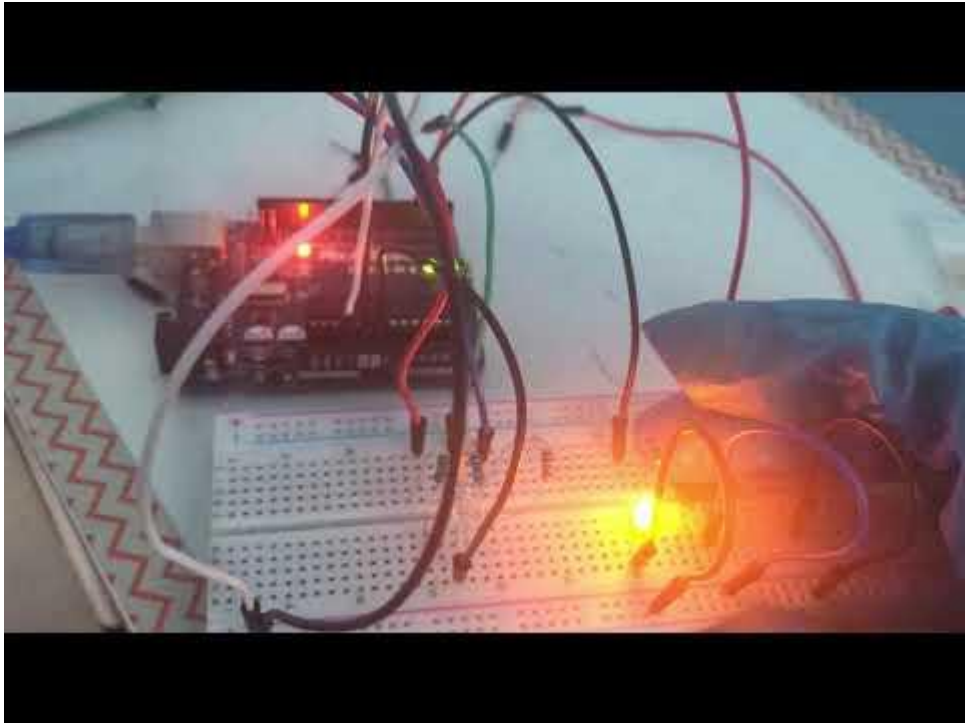
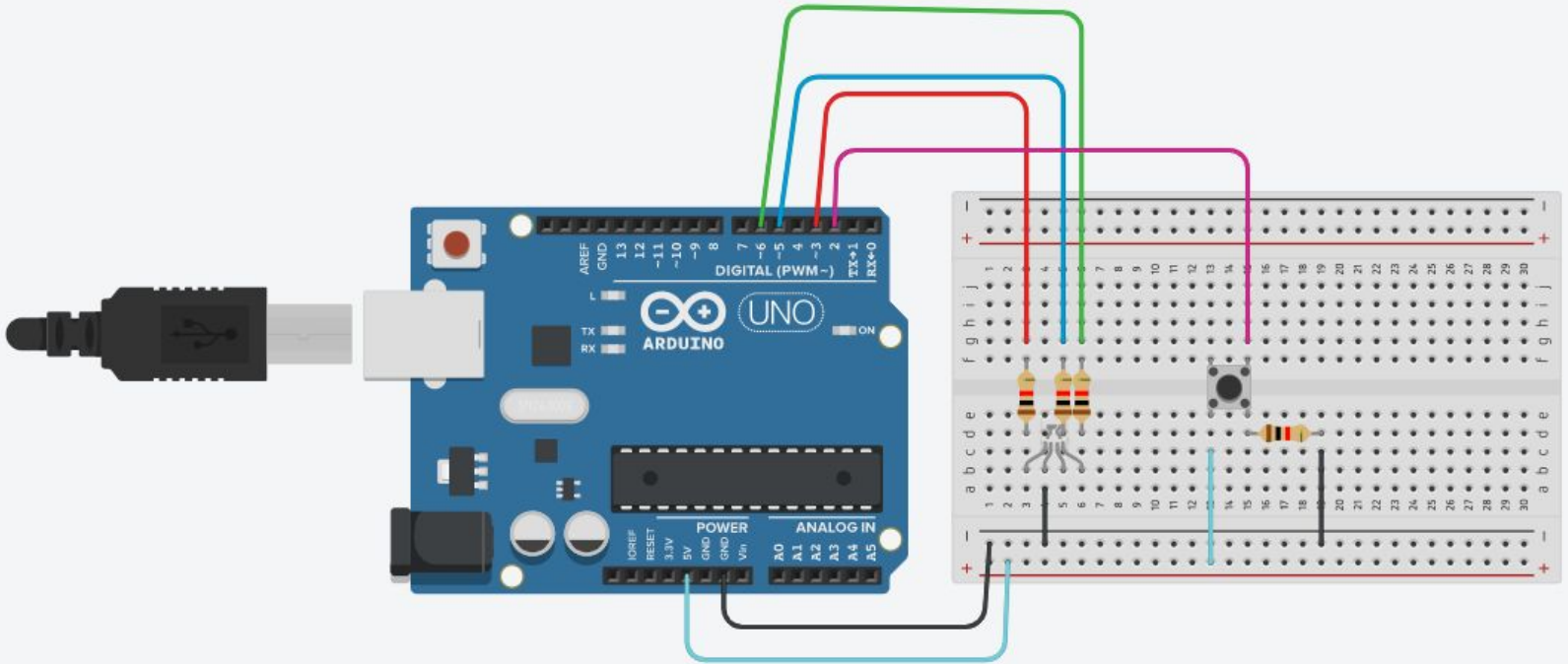
Video

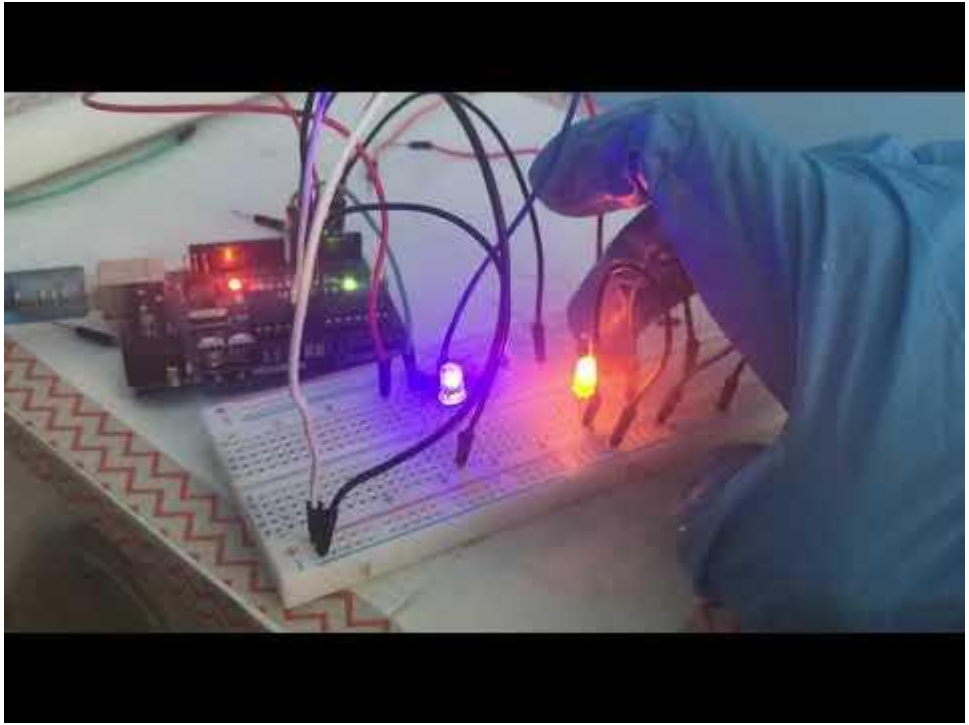


Challenge 11: Merge the RGB LED with the button circuit


DIGITAL (PWM~)
UNO
ARDUINO
POWER
ANALOG IN

Code: See Challenge 11 Code in Shared Folder

Video



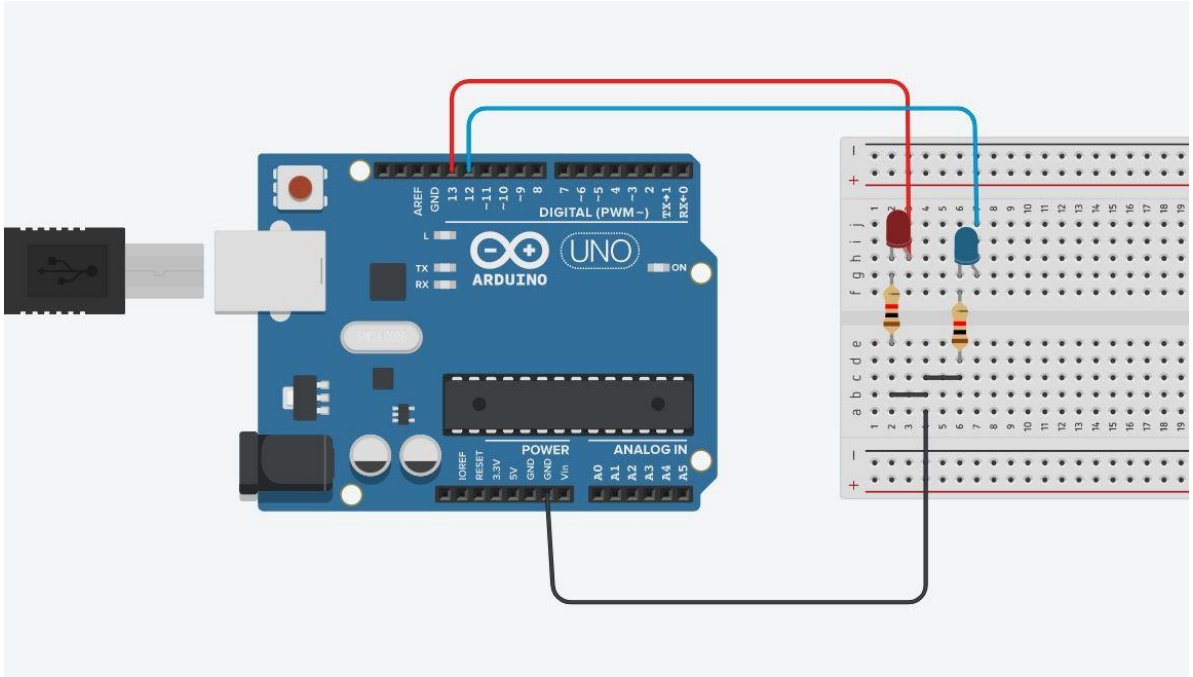
CHALLENGE 12: Interleaving Lights

1. Take solution from challenge 9
2. Modify the code so that the LED's are on at different times
3. The hardware does not need to change

HINT: You will need two different code blocks each with a HIGH and LOW light output

HINT: You will need four wait blocks

Schema Challenge 10 (identical to 9)



Code Challenge 10:

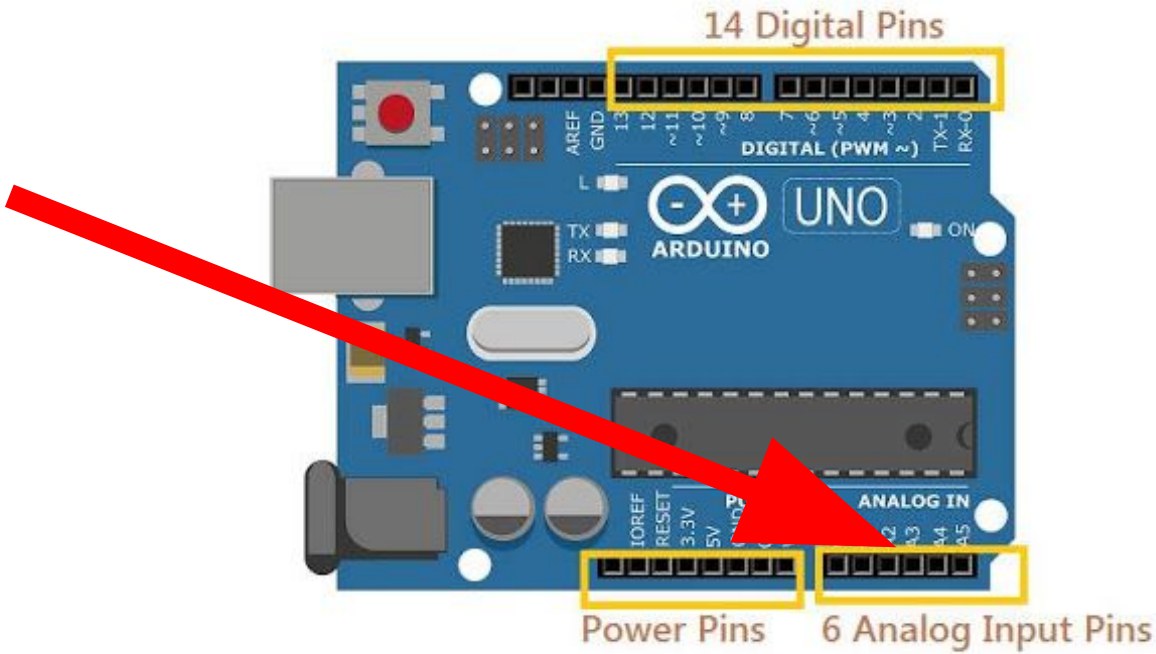
Photoresistors

A resistor, but its value depends on how much light it receives!

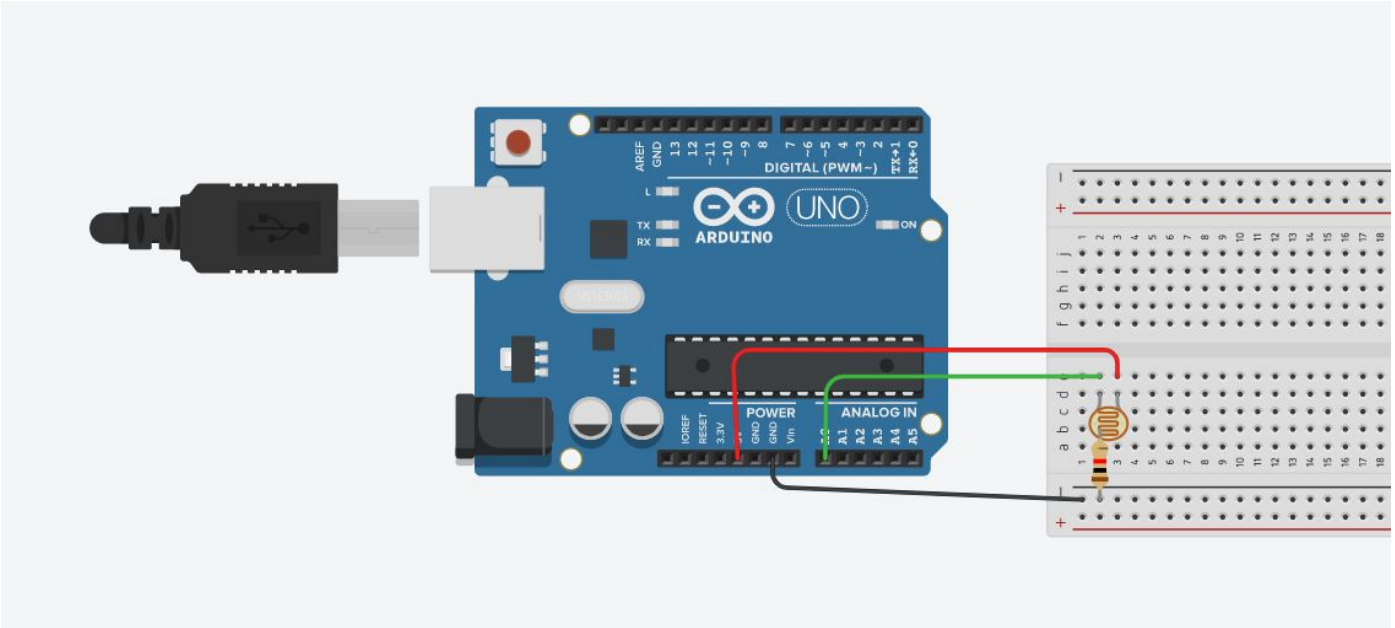
Resistance is usually a few thousand ohms.

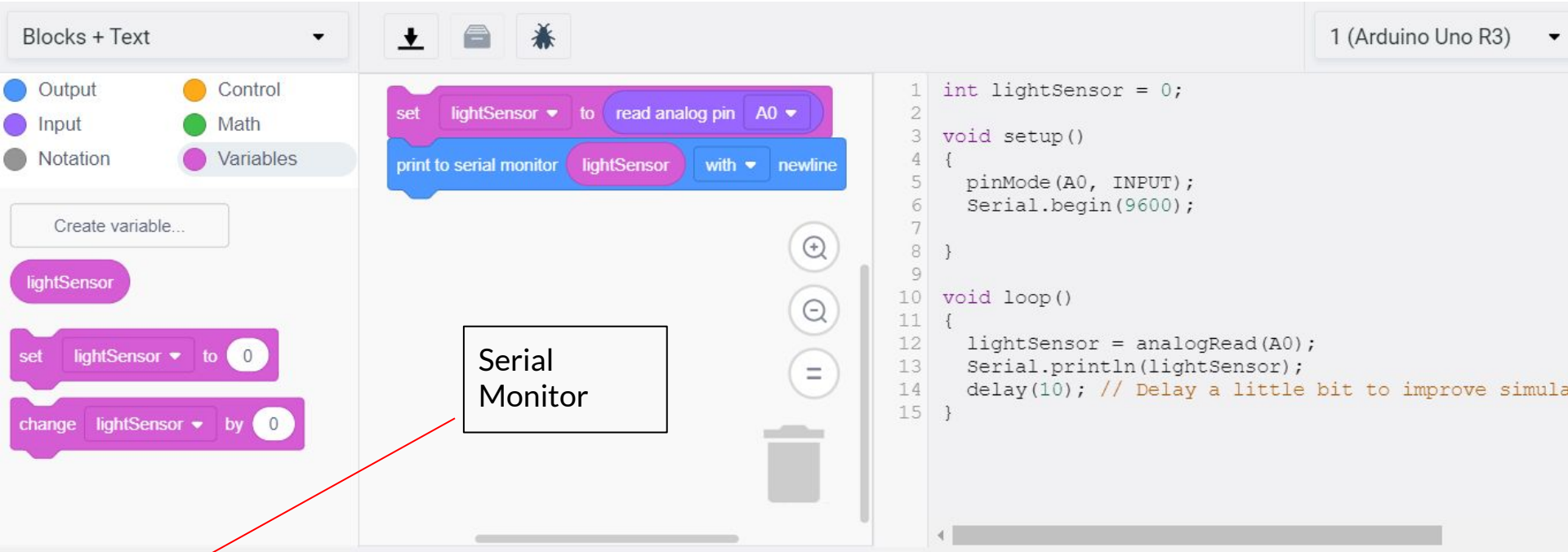
Analog Pins

Analog Pins are used for reading voltage, from values 0 to 1023



Building a Photoresistor Circuit




Blocks + Text
1 (Arduino Uno R3)
Output
Control
Input
Math
Notation
Variables
Create variable...
lightSensor
set lightSensor to 0
change lightSensor by 0
set lightSensor to read analog pin A0
print to serial monitor lightSensor with newline
Serial Monitor
1 int lightSensor = 0;
2
3 void setup()
4 {
5 pinMode(A0, INPUT);
6 Serial.begin(9600);
7
8 }
9
10 void loop()
11 {
12 lightSensor = analogRead(A0);
13 Serial.println(lightSensor);
14 delay(10); // Delay a little bit to improve simula
15 }
Serial Monitor
6
6
6
6
6
6
6
6

What is the Serial Monitor

It is a way for the arduino to talk to the computer.

In our code we wrote “`Serial.println(lightSensor);`”

TinkerCAD has a practice serial monitor, but the one on our computers will give us better data

The C++ Code

```
int lightSensor = 0;

void setup()
{
  pinMode(A0, INPUT);
  Serial.begin(9600);

}

void loop()
{
  lightSensor = analogRead(A0);
  Serial.println(lightSensor);
  delay(10);
}
```

Initiatie communication

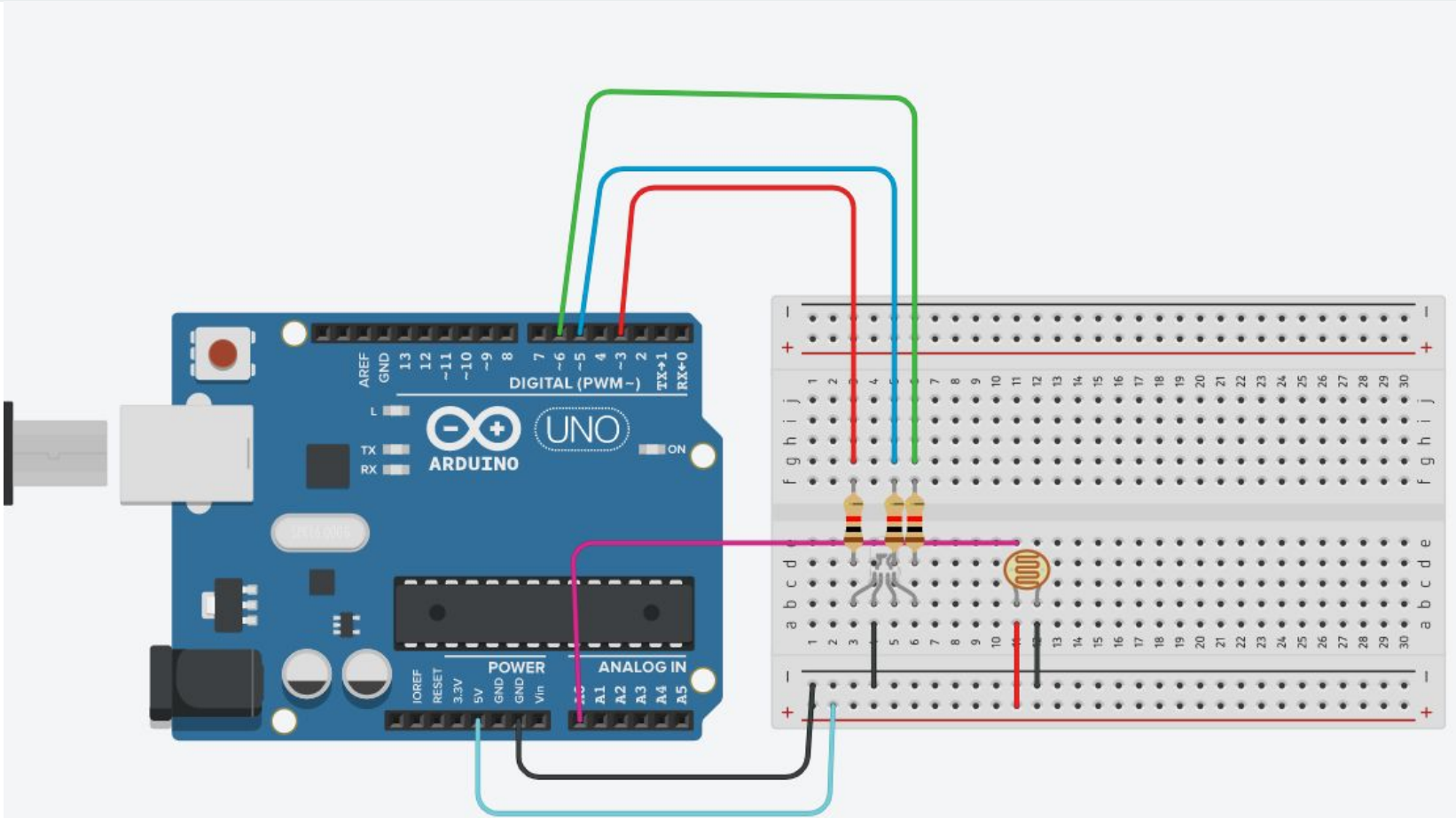
Declare a variable called lightSensor

Get a reading for the light sensor and print it to the serial monitor

Challenge 12: Night Light

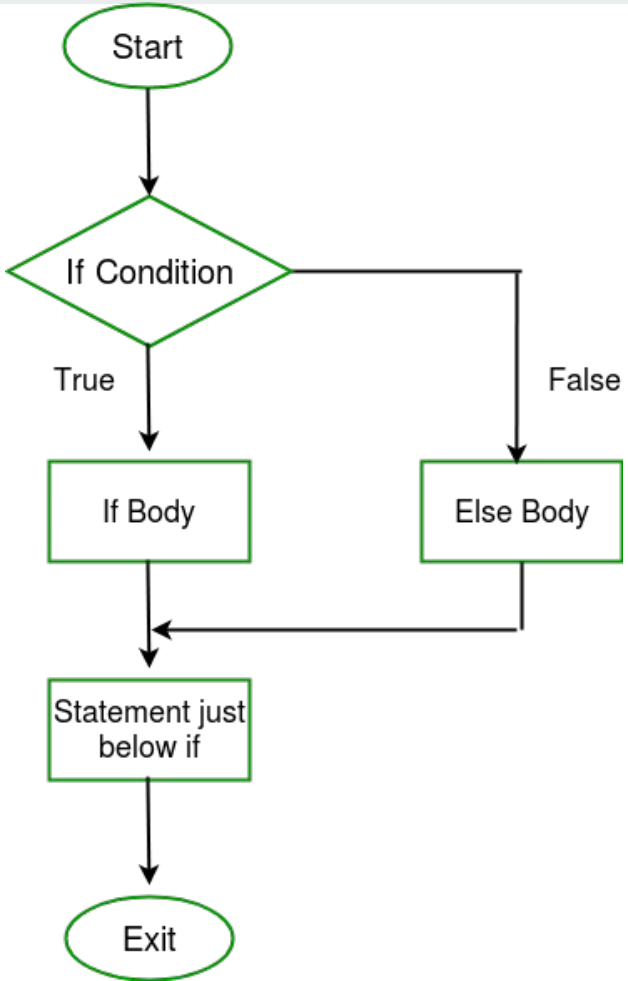
Using the code and circuit from the flickering light challenge, add a component that shuts the light of when the light sensor detects light. If the sensor detects no light, then turn on the RGB LED.

Check out the schema on the next slide and try to build that before you think about the code


AREF
GND
13
12
~11
~10
~9
8
7
~6
~5
4
~3
2
TX→1
RX←0
DIGITAL (PWM~)
L
TX
RX
ARDUINO
UNO
ON
POWER
ANALOG IN
IOREF
RESET
3.3V
5V
GND
GND
Vin
A1
A2
A3
A4
A5

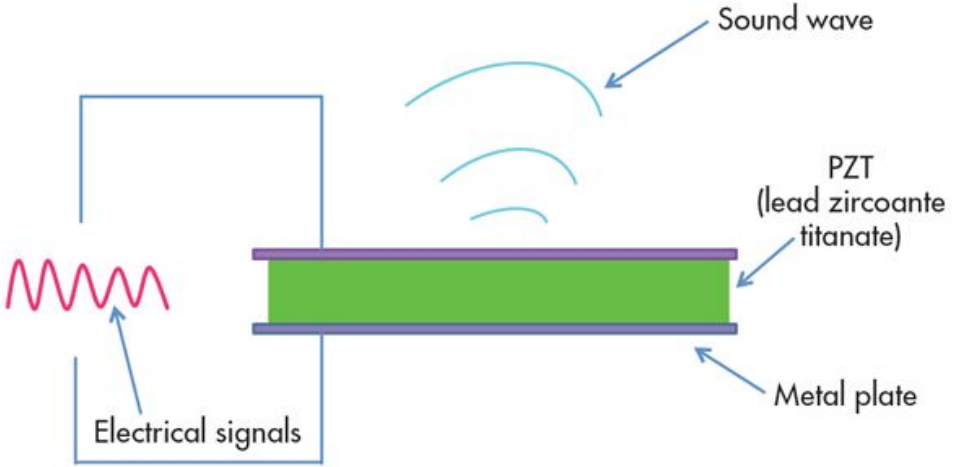
Our circuit will not work in TinkerCAD, but it will in Real Life

Decision Making



Piezo Buzzer

A thin sheet of crystal that moves when a voltage is applied, creating sound (or vice versa!)

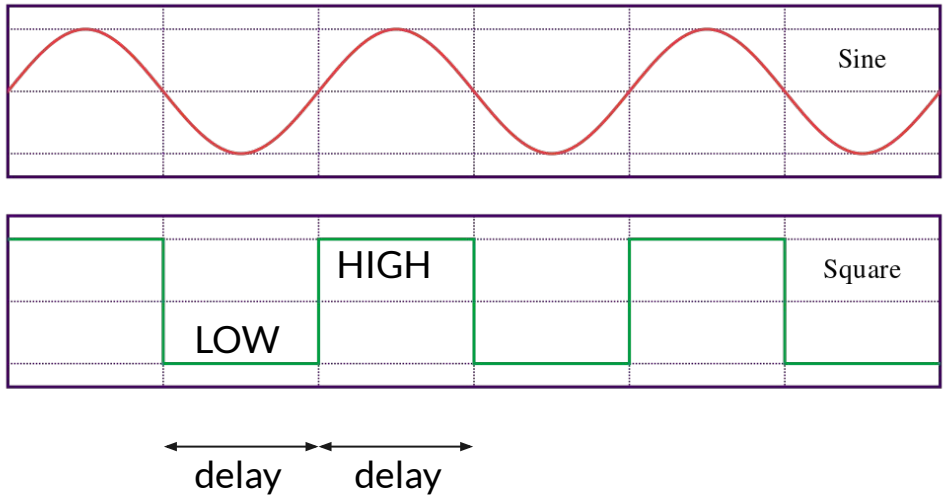


Sound: Square Waves

Frequency = pulses per second

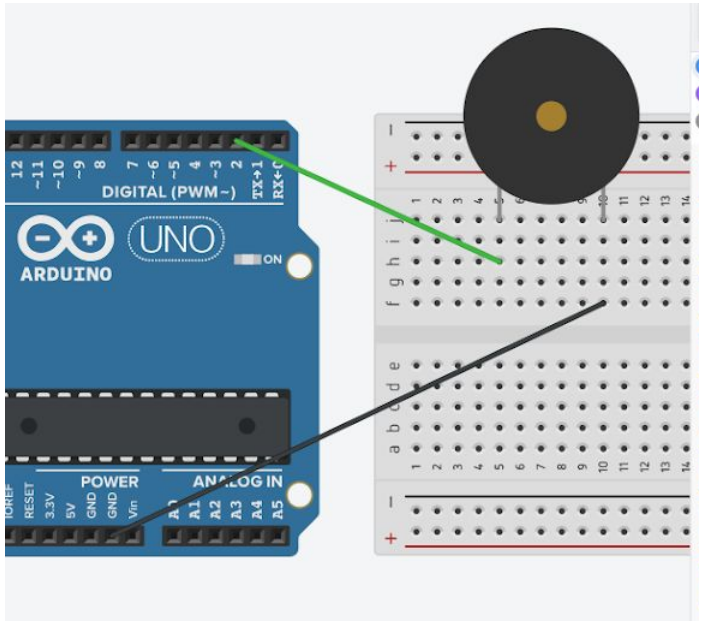
Two delays per pulse

delay = 1/(2*frequency)

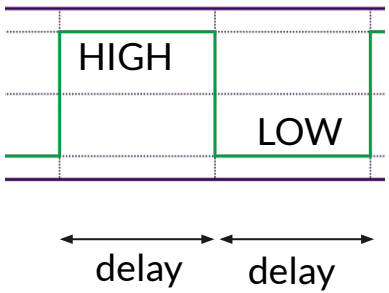


The wiring is easy....

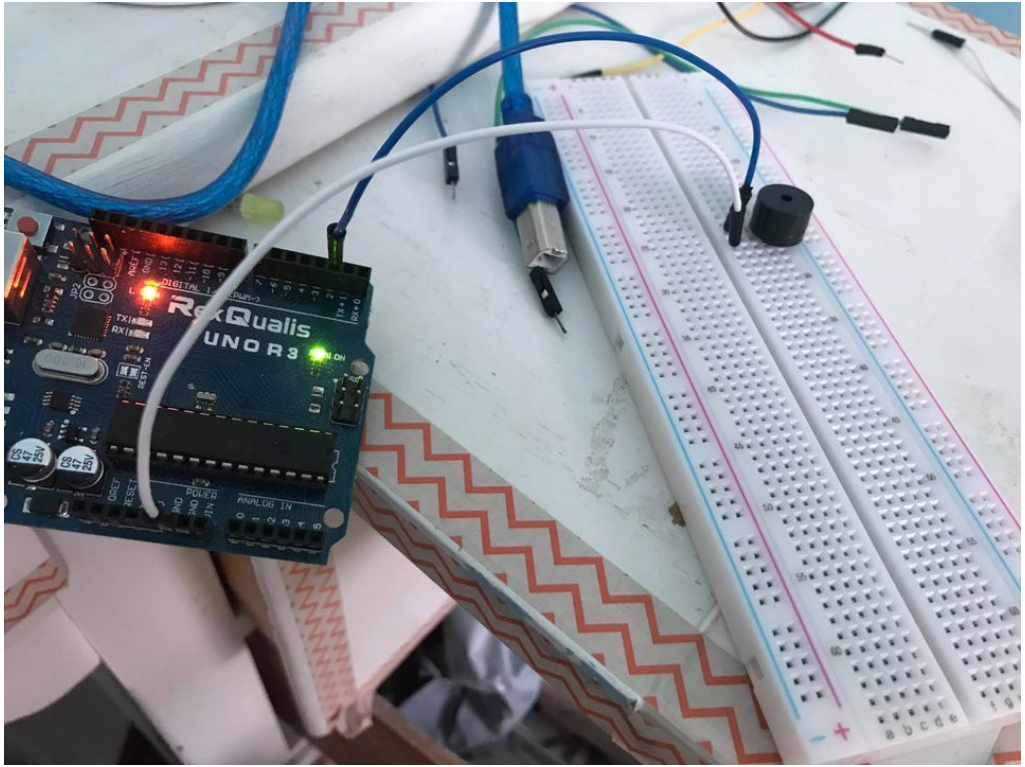
Aka “passive buzzer”



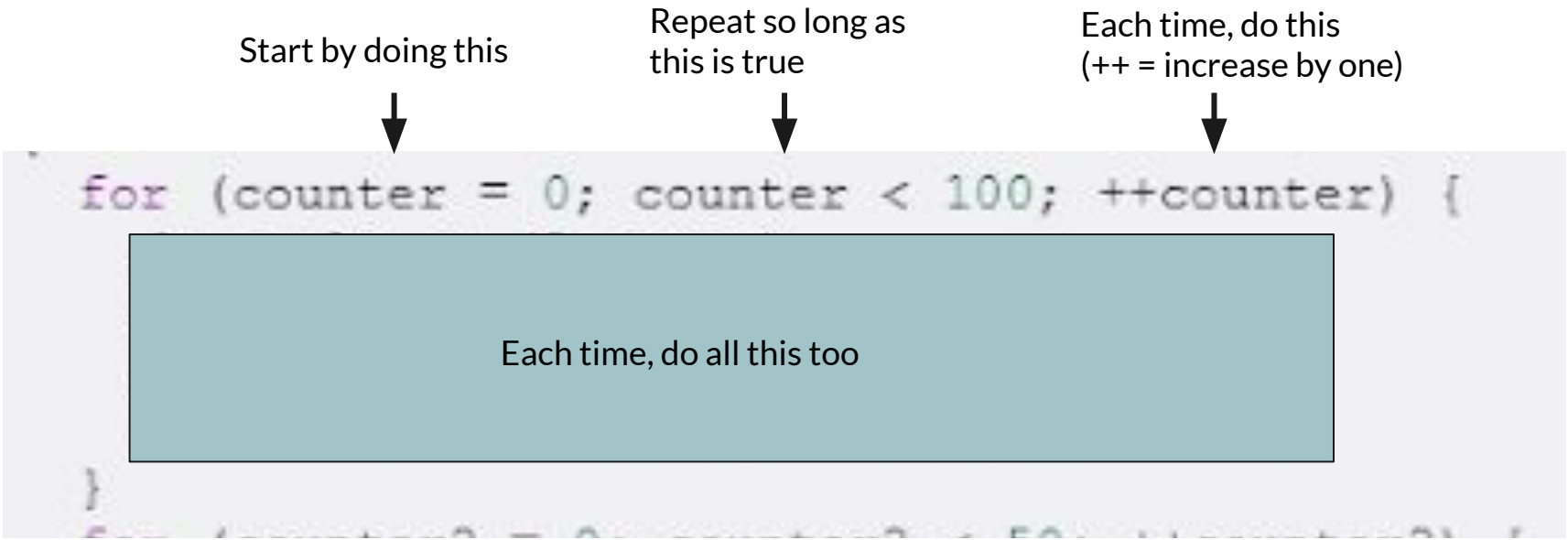
Doing things repeatedly



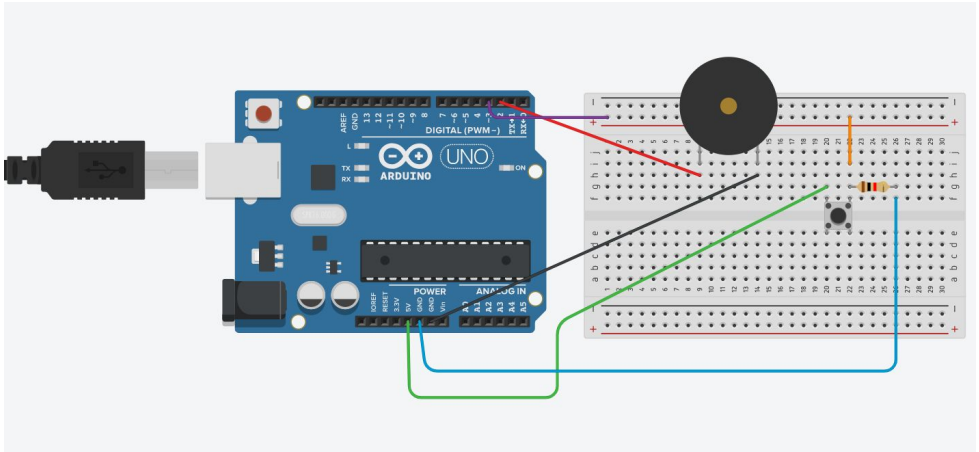

```
void setup()
{
  pinMode(2, OUTPUT);
}

void loop()
{
  digitalWrite(2, HIGH);
  delay(0.1);
  digitalWrite(2, LOW);
  delay(0.2);
}
```

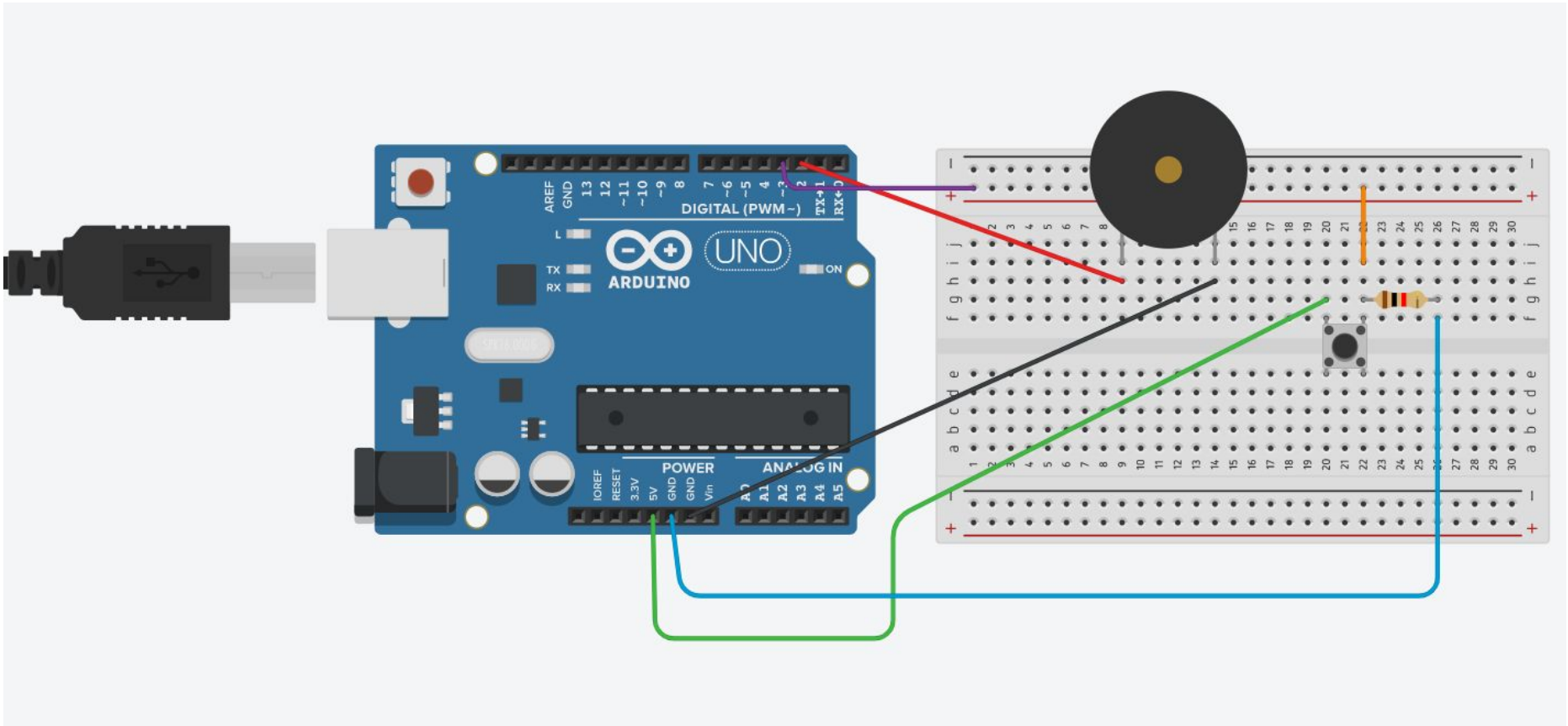

RobQualis
UNO R3
ANALOG IN
POWER

FOR Loops in C++



Challenge 14 (Alarm System)



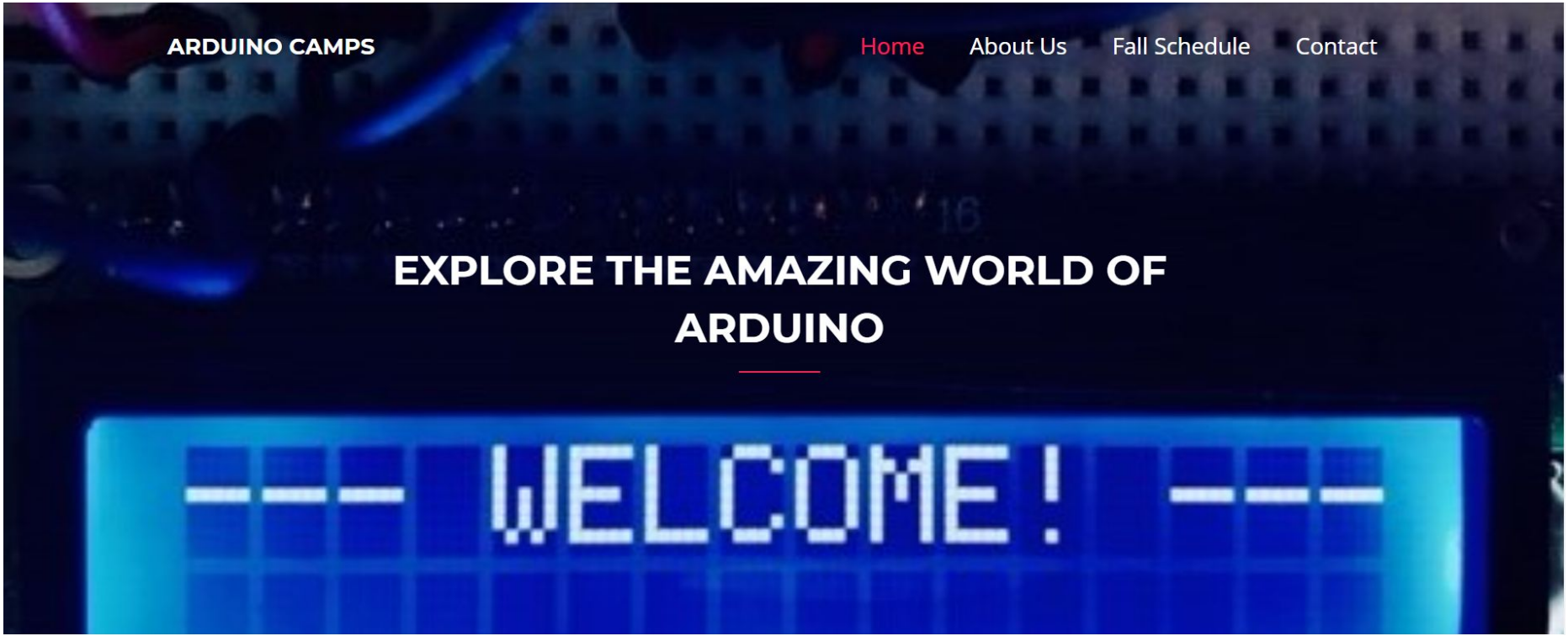

DIGITAL (PWM~)
UNO
ARDUINO
POWER
ANALOG IN

```
int buttonState;

void setup()
{
  pinMode(2, OUTPUT);
}

void loop()
{
  buttonState =
digitalRead(3);
  if(buttonState == HIGH){
    digitalWrite(2, HIGH);
    delay(0.1);
    digitalWrite(2, LOW);
    delay(0.2);
  }
}
```

```
int buttonState;

void setup()
{
  pinMode(2, OUTPUT);
}

void loop()
{
  buttonState = digitalRead(3);
  if(buttonState == HIGH){
    digitalWrite(2, HIGH);
    delay(0.1);
    digitalWrite(2, LOW);
    delay(0.2);
  }
}
```

Now try to change the delay values … What happens to the sound?

LCD Display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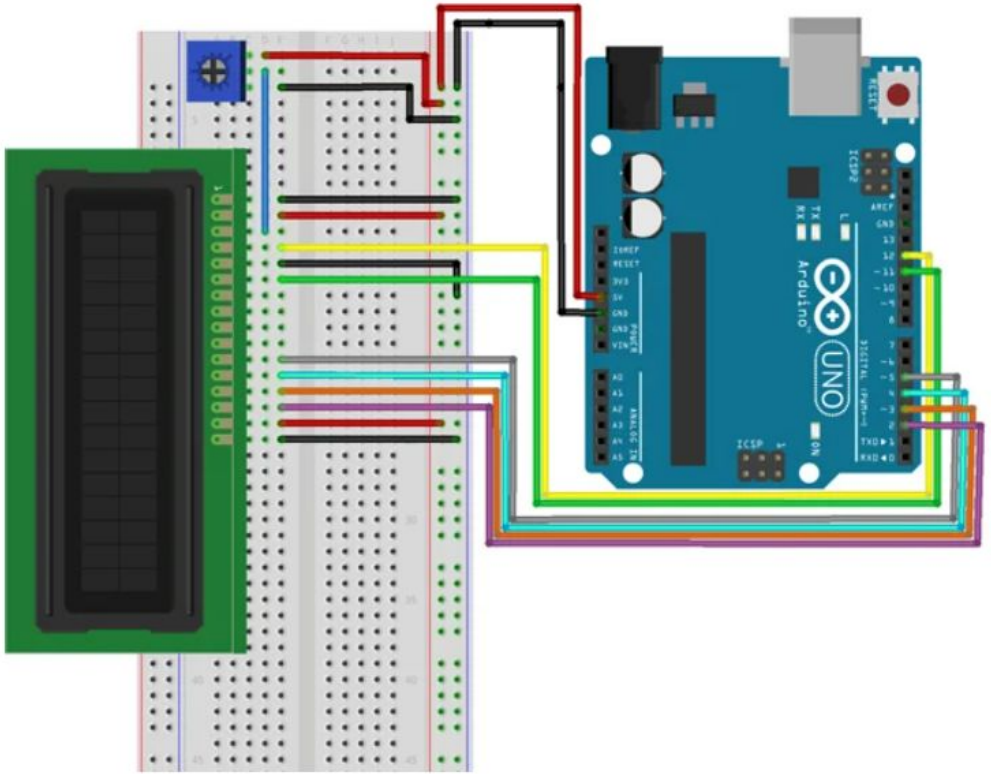
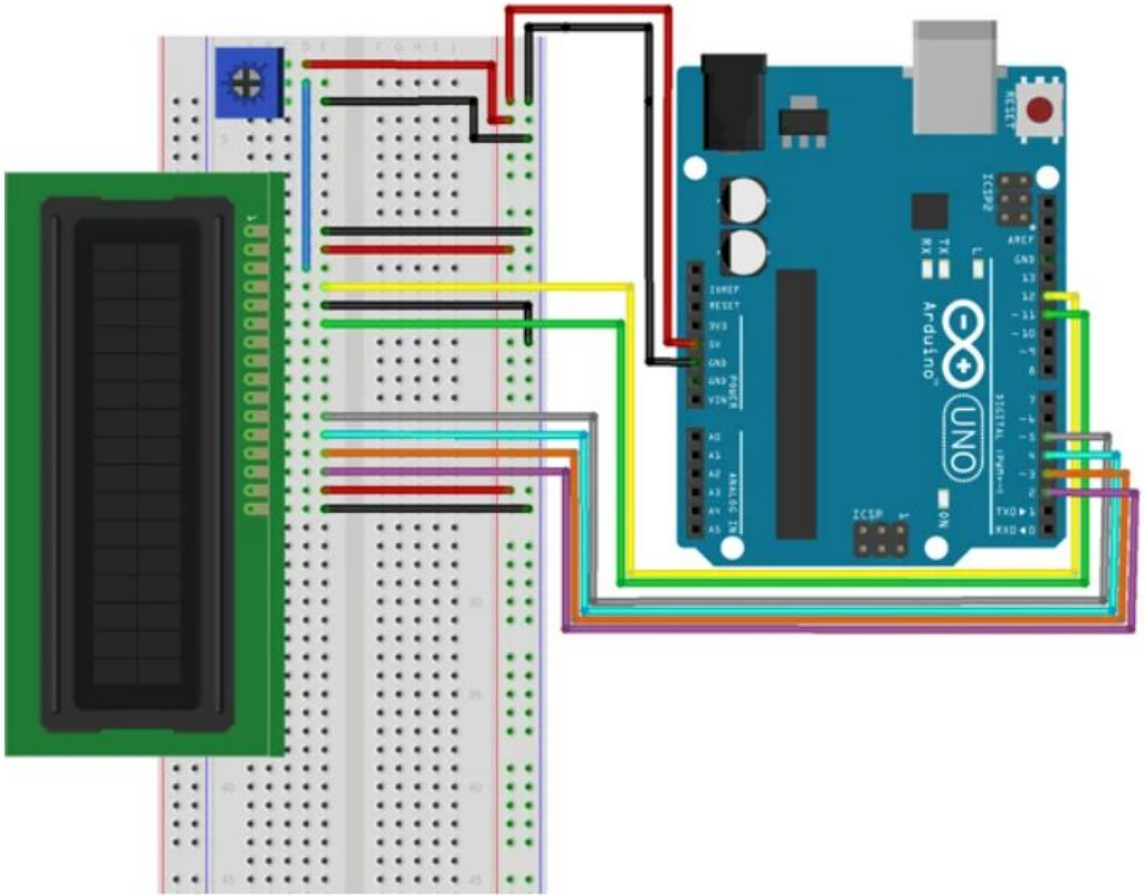
--- WELCOME! ---

Website with LCD Display Instructions

https://core-electronics.com.au/tutorials/use-lcd-arduino-uno.html



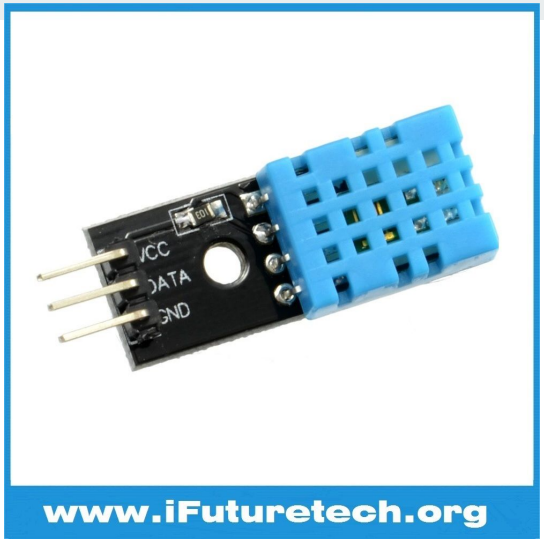

Arduino
UNO

THE SETUP

1. Insert your LCD screen into your breadboard vertically such that each pin has its own separate line on the board.
2. Insert your potentiometer in the same way.
3. Connect 5v and GND from Arduino to the + / - rails on your breadboard. This will ground your Backlight and LCD.
4. Connect Pins 1 and 16 from the LCD screen to the negative power rail. This will power your Backlight and LCD.
5. Connect Pins 2 and 15 from the LCD to the positive power rail. This will power your Backlight and LCD.
6. Connect Pin 3 to the center pin of your potentiometer, this will control the contrast.
7. Connect the top and bottom pins on your potentiometer to GND and 5v rails. As you twist this potentiometer you will control contrast.
8. Connect Pin 4 of the LCD to pin 12 on your Arduino. This will be the register select pin we output to from the Arduino later.
9. Connect Pin 5 of the LCD to ground.
10. Connect Pin 6 of the LCD to pin 10 on your Arduino. This is the data enable pin that we will use later.
11. We will be using data pins 4,5,6,7 for our LCD screen. This represents 4 bits of data, known as a nibble. The LCD screen has the capability for 8-bit parallel communication but 4 bit will be adequate for our project.
12. Connect those pins to 4 pins on your Arduino, we use 5,4,3,2 respectively.
13. Connect your Arduino to the PC and move on!

DHT-11 Sensor

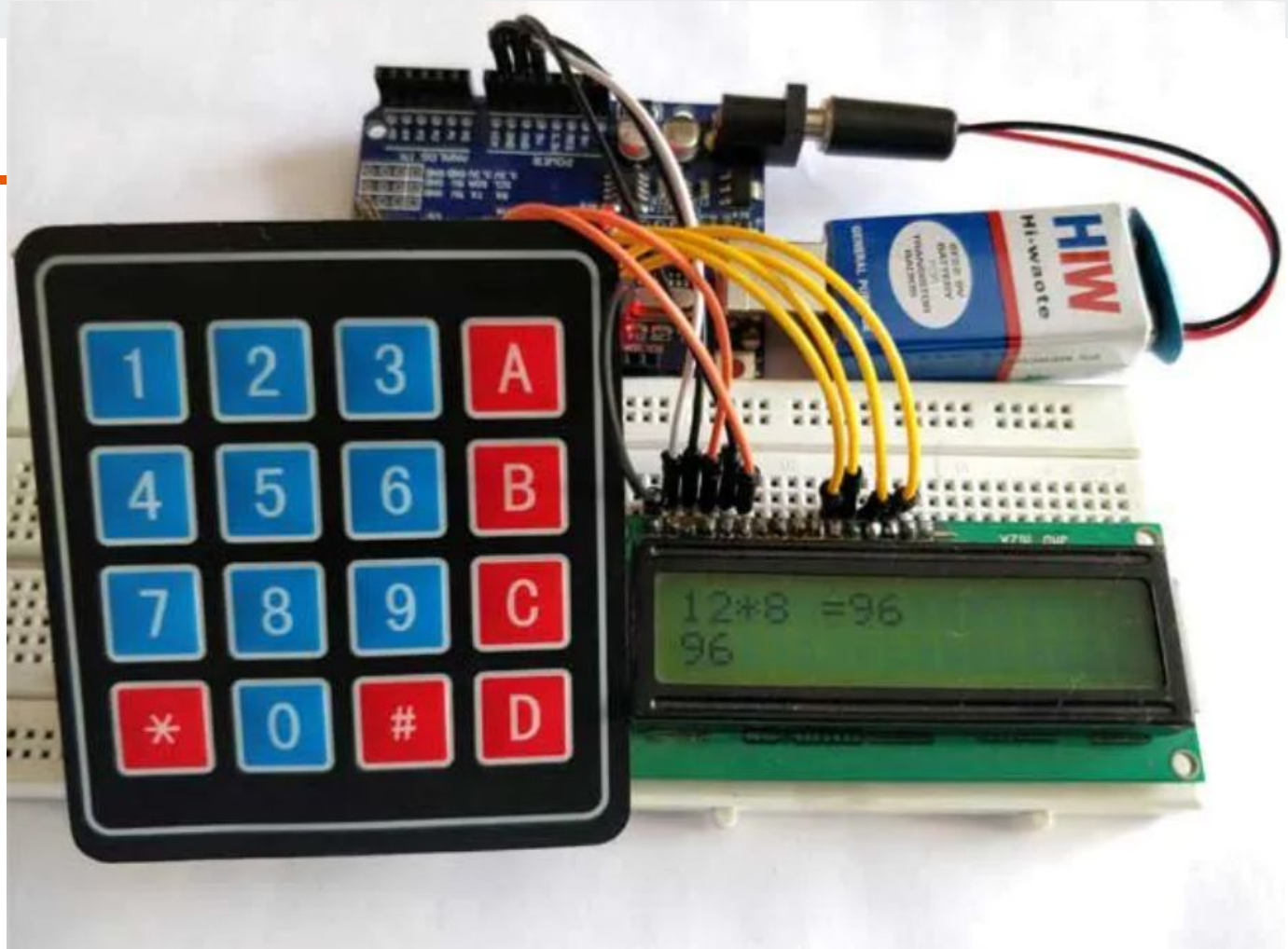
The first external chip we have used



S → 2

\- → GND

\+ → 5V


1 2 3 A
4 5 6 B
7 8 9 C
* 0 # D
12*8 =96
96
HW
Hi-Watt

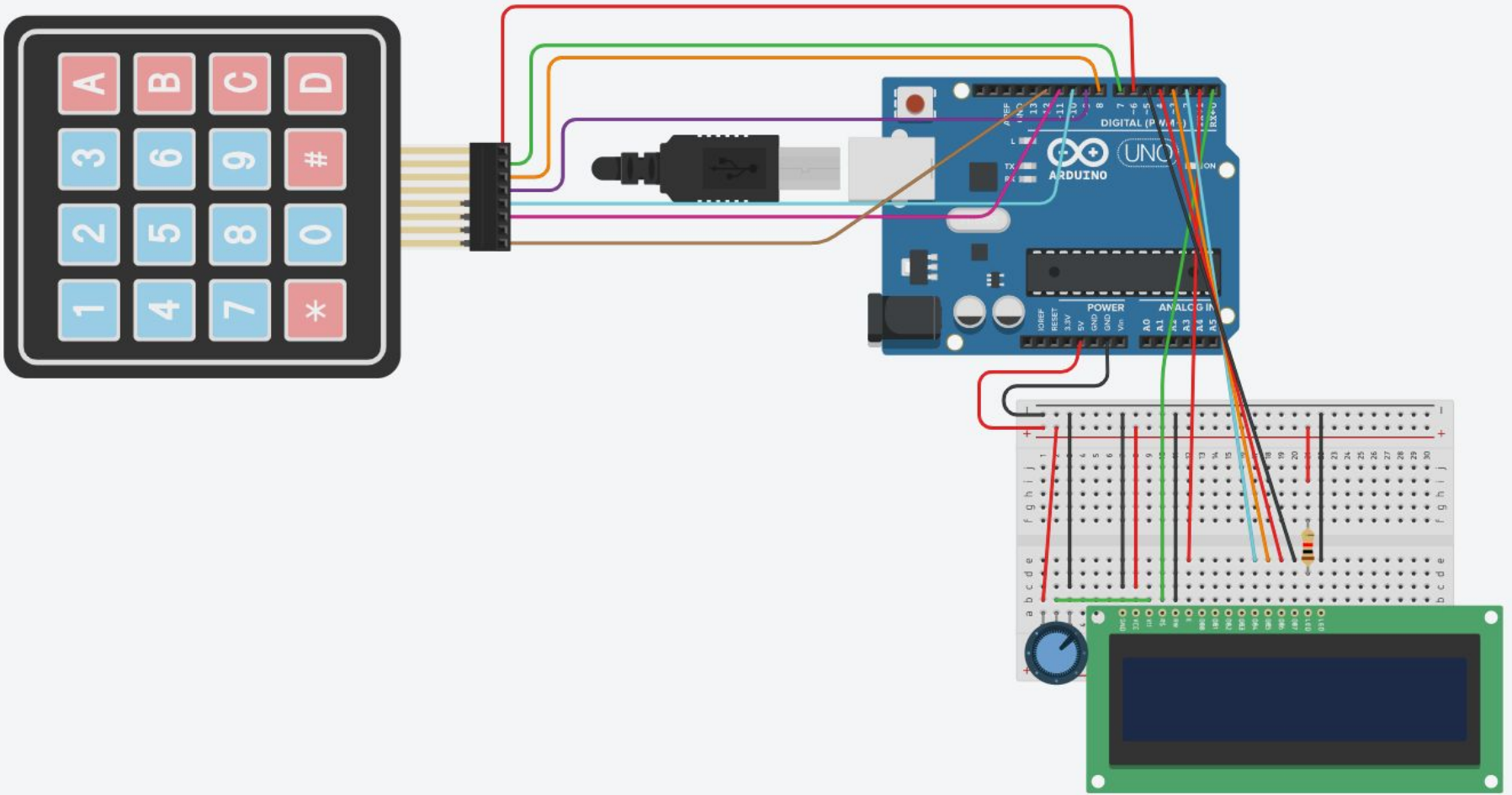
New Game Plan for Calculator Project

https://www.instructables.com/Arduino-Calculator-Using-4X4-Keypad/

We need Keypad.h

Manage Libraries -> Adrafruit Keypad -> Install

Sketch -> Include Library -> Adrafruit Keypad


A
B
C
D
3
6
9
#
2
5
8
0
1
4
7
*
ARDUINO
UNO
DIGITAL (PWM~)
POWER
ANALOG IN

A -> + * -> Clear Screen

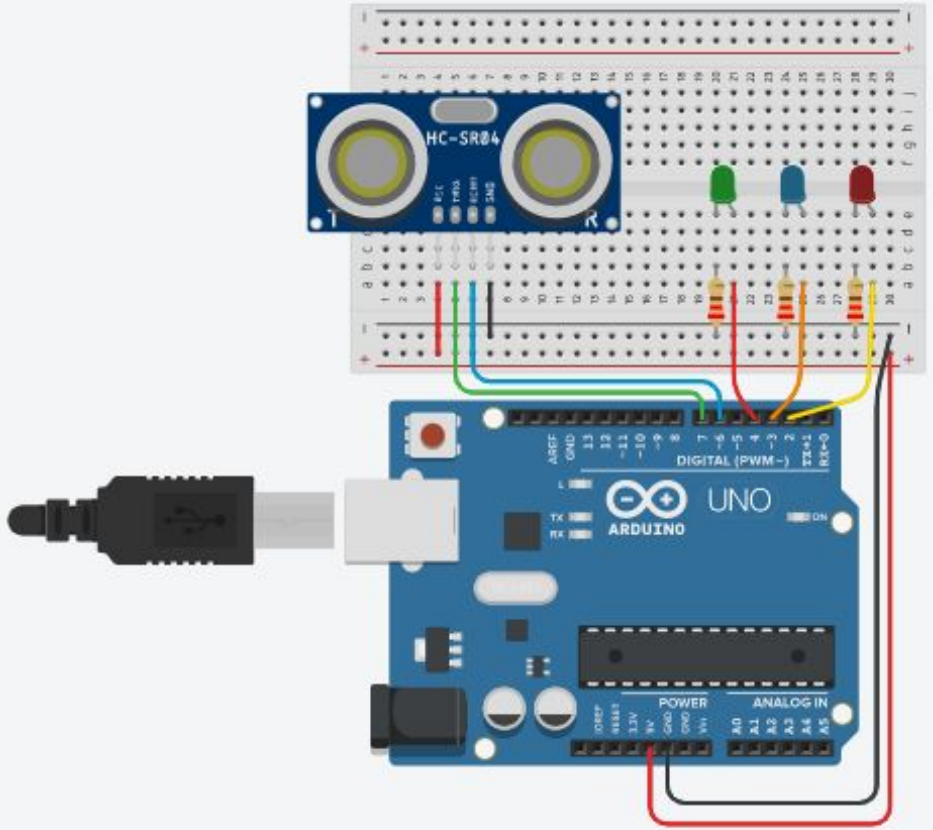
B -> -

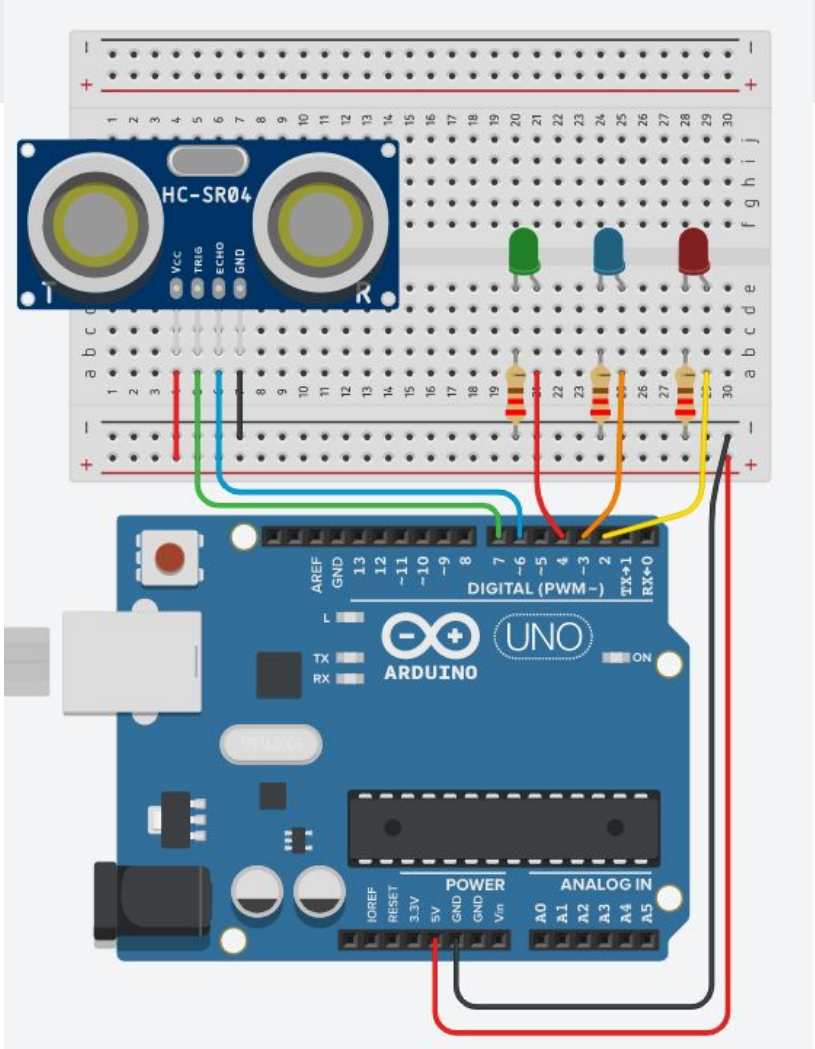
C -> *

D -> /

-> =

Radar Machine


HC-SR04
DIGITAL (PWM~)
UNO
ARDUINO
POWER
ANALOG IN


HC-SR04
Vcc
TRIG
ECHO
GND
DIGITAL (PWM~)
UNO
ARDUINO
POWER
ANALOG IN

Ultra-Sonic Sensing Article: https://www.instructables.com/Ultrasonic-Distance-Sensor-Arduino-Tinkercad/

https://www.tinkercad.com/things/5kUwvfaIrtW-copy-of-ultrasonic-distance-sensor-led-bar-graph-blocks/editel?tenant=circuits

Best Way to Start Learning C++

https://www.hackerrank.com/domains/cpp

Project Hunting

Trip-Wire:
https://create.arduino.cc/projecthub/ammaratef45/detecting-obstacles-and-warning-arduino-and-ultrasonic-13e5ea?ref=platform&ref_id=424_trending__beginner_&offset=32

Robot Arm:
https://create.arduino.cc/projecthub/ryanchan/simple-programmable-robotic-arm-bd28a0?ref=platform&ref_id=424_trending__beginner_&offset=24