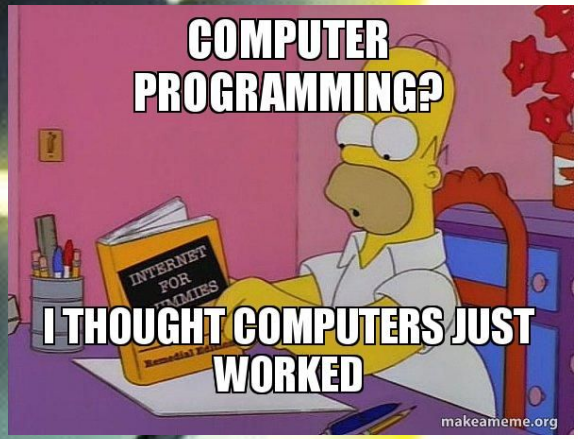
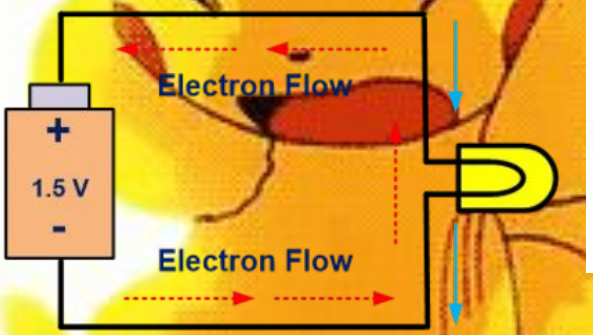
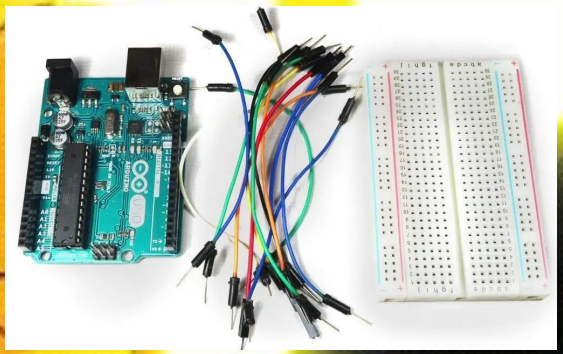
JAMCODERS

Circuits!!!!

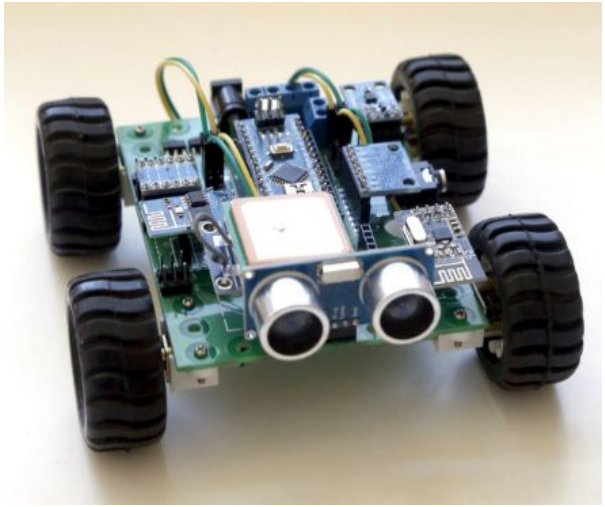






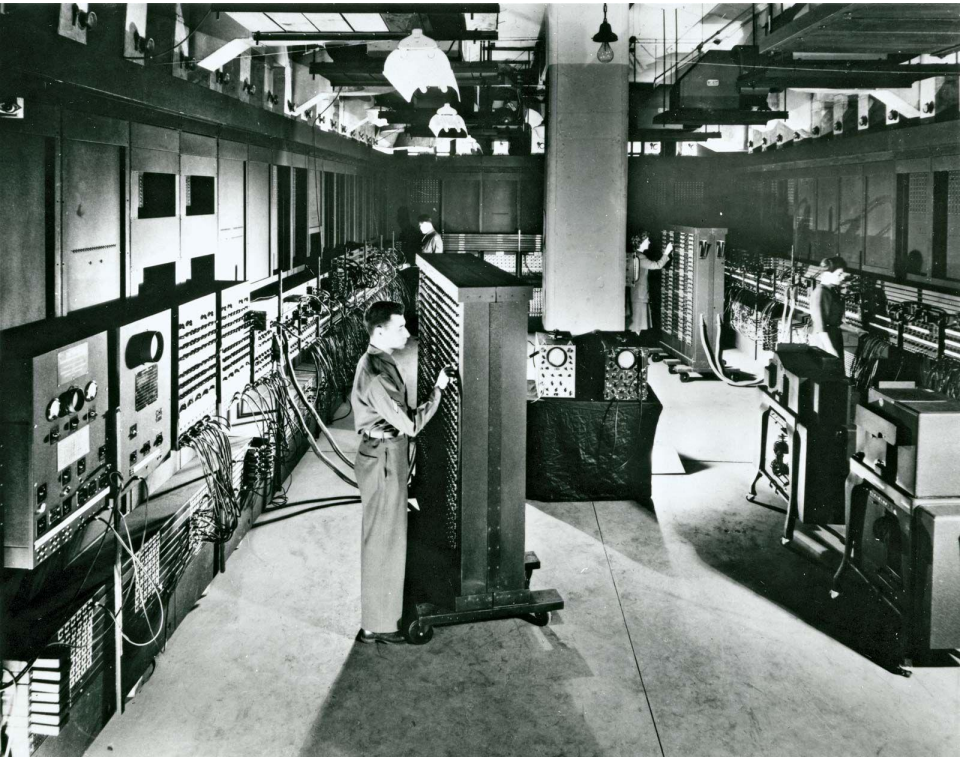
In JamCoders, so far: Software

Today: Hardware!



About Safety: Arduinos can’t hurt you.

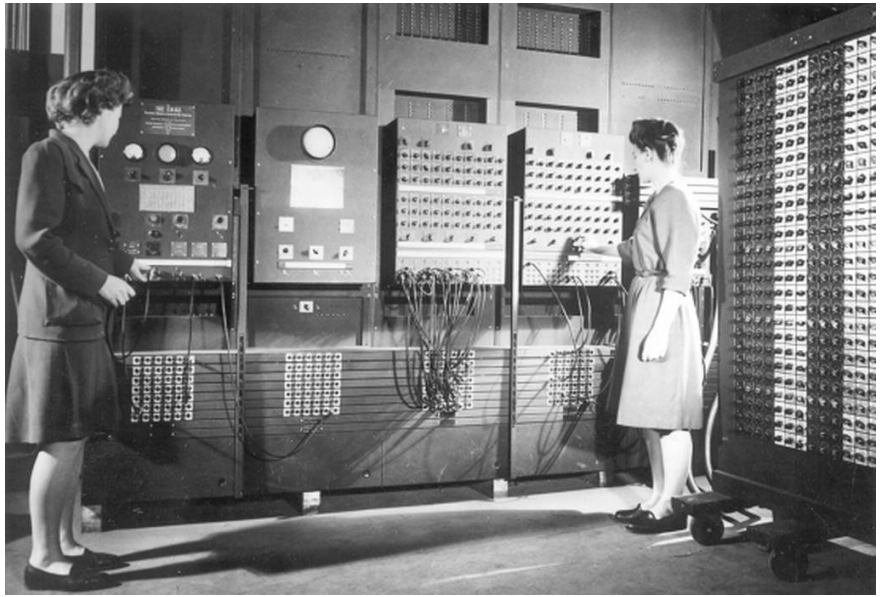
Electronic Numerical Integrator and Computer (ENIAC)



- Invented 1946
- University of Pennsylvania (U Penn)

Penn
University of Pennsylvania

Electronic Numerical Integrator and Computer (ENIAC): 5000 calculations per second



M3Ultra: 36 trillion operations per second

Who is Grace Hopper?

Grace Hopper: Born 1906

Early computer scientist

Navy admiral

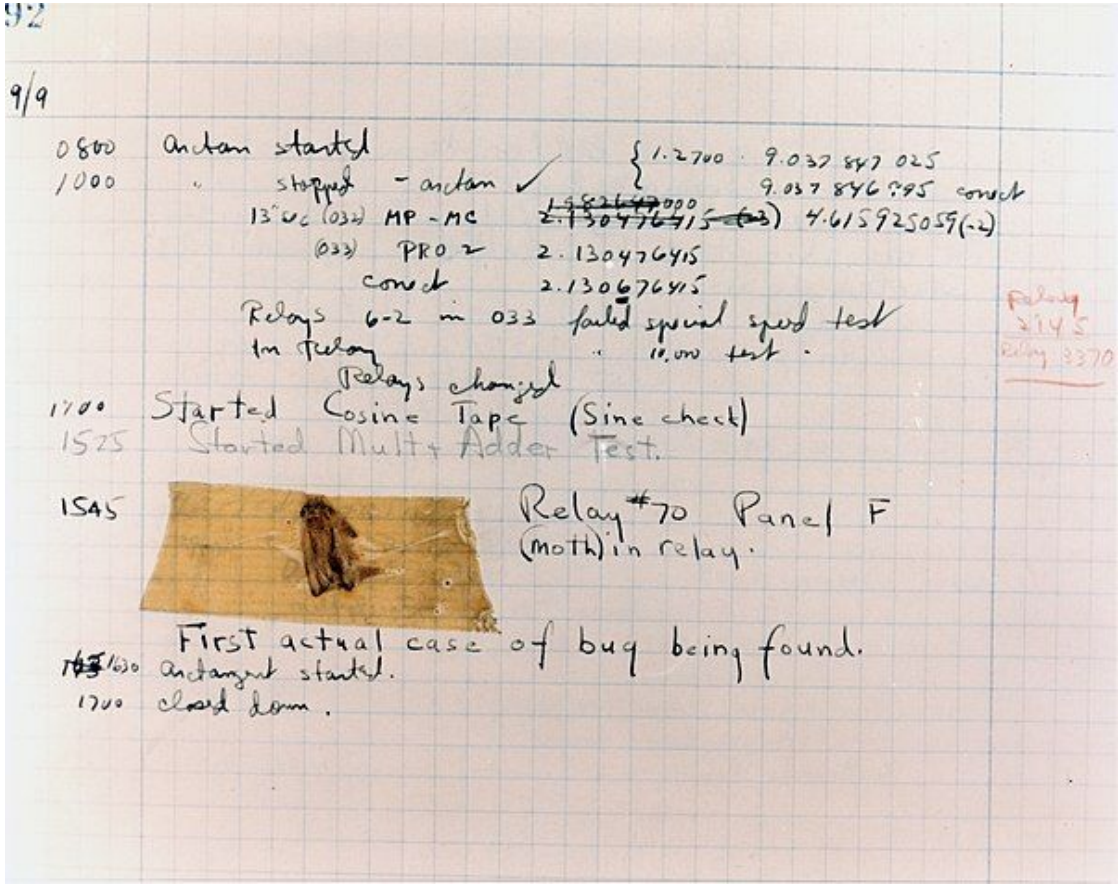
Known for:

- Inventing one of the first linkers
- Theory of machine-independent programming languages

What is debugging?

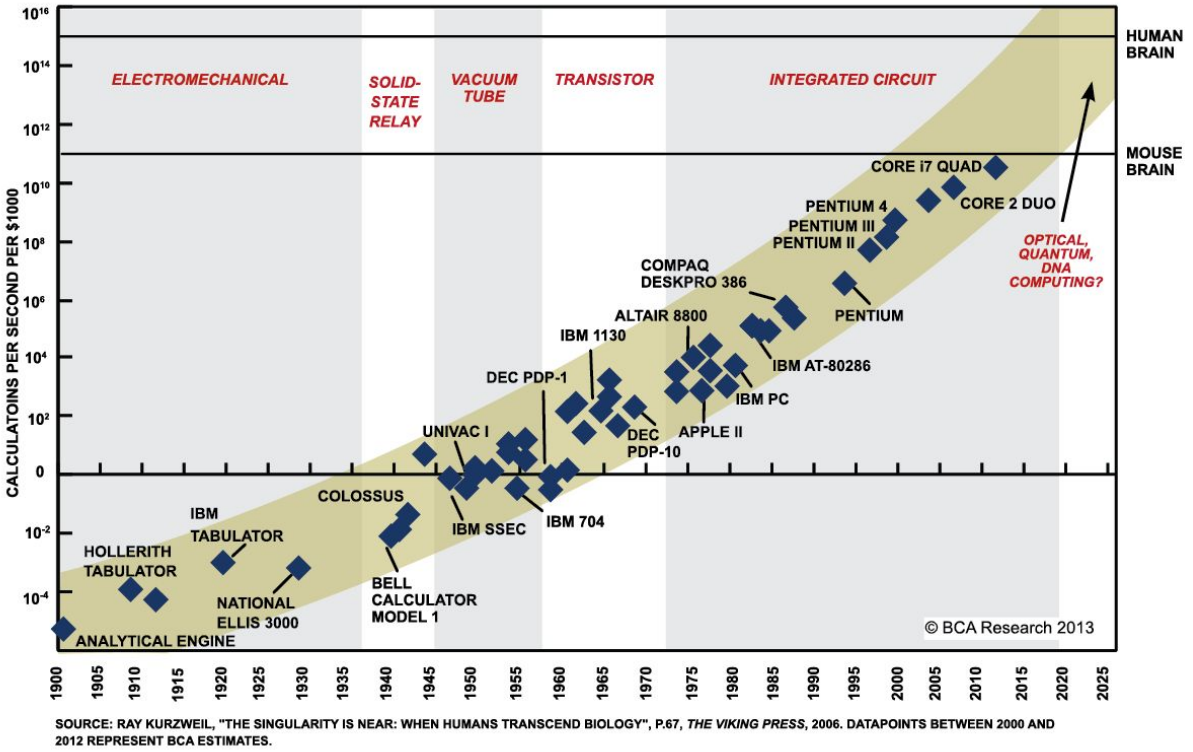
A bug died inside Grace Hopper's computer and impeded the relay operations

The term "debugging" was born

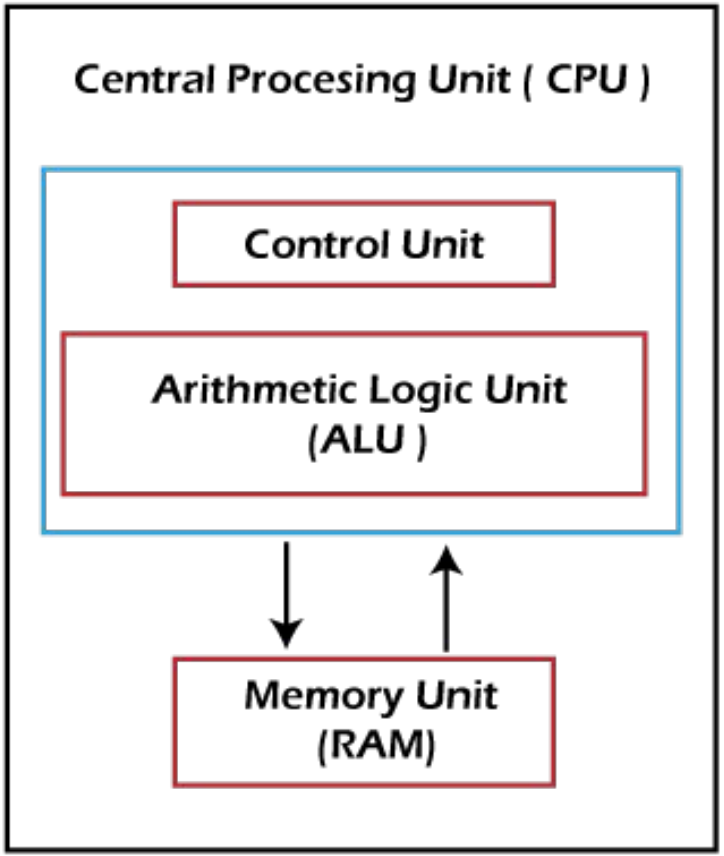


Debugging is still difficult, but luckily doesn't involve real bugs

Today, computers are faster, store more data, and take up less space.



SOURCE: RAY KURZWEIL, "THE SINGULARITY IS NEAR: WHEN HUMANS TRANSCEND BIOLOGY", P.67, *THE VIKING PRESS*, 2006. DATAPOINTS BETWEEN 2000 AND 2012 REPRESENT BCA ESTIMATES.



vim hello.asm

```
0  section        .text                _   ; declare the .text section
1  global         _start                   ; has to be declared for the linker (ld)
2  _start:                                 ; entry point for _start
3      mov edx, len                        ; "invoke" the len of the message
4      mov ecx, msg                        ; "invoke" the message itself
5
6      mov ebx, 1                          ; set the file descriptor (fd) to stdout
7
8      mov eax, 4                          ; system call for "write"
9      int 0x80                            ; call the kernel
10
11     mov eax, 1                          ; system call for "exit"
12     int 0x80                            ; call the kernel
13
14 section        .data                   ; here you declare the data
15     msg        db "Hello world!", 0xa   ; the actual message to use
16     len        equ $ -msg               ; get the size of the message
```

How to make computers faster?

- Get data faster.
  - Access to data is limited by distance (speed of light).
  - Multiple tiers of cache on a chip.

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Computer	**Human Analogy**

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Computer	**Human Analogy**
L1 Cache: 1ns	

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Computer	**Human Analogy**
L1 Cache: 1ns	0.25 seconds

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Computer	**Human Analogy**
L1 Cache: 1ns	0.25 seconds (fact just learned)

How to make computers faster?

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  - Access to data is limited by distance (speed of light).
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Computer	**Human Analogy**
L1 Cache: 1ns	0.25 seconds (fact just learned)
L3 Cache: 16ns	

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Computer	**Human Analogy**
L1 Cache: 1ns	0.25 seconds (fact just learned)
L3 Cache: 16ns	4 seconds (fact from a month ago)

How to make computers faster?

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Computer	**Human Analogy**
L1 Cache: 1ns	0.25 seconds (fact just learned)
L3 Cache: 16ns	4 seconds (fact from a month ago)
RAM: 100ns	

How to make computers faster?

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Computer	**Human Analogy**
L1 Cache: 1ns	0.25 seconds (fact just learned)
L3 Cache: 16ns	4 seconds (fact from a month ago)
RAM: 100ns	25 seconds (look in a book on your desk)

How to make computers faster?

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  - Multiple tiers of cache on a chip.

Computer	**Human Analogy**
L1 Cache: 1ns	0.25 seconds (fact just learned)
L3 Cache: 16ns	4 seconds (fact from a month ago)
RAM: 100ns	25 seconds (look in a book on your desk)
SSD: 100,000ns (100us)	

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L1 Cache: 1ns	0.25 seconds (fact just learned)
L3 Cache: 16ns	4 seconds (fact from a month ago)
RAM: 100ns	25 seconds (look in a book on your desk)
SSD: 100,000ns (100us)	~7 hours (go to the library today)

How to make computers faster?

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L3 Cache: 16ns	4 seconds (fact from a month ago)
RAM: 100ns	25 seconds (look in a book on your desk)
SSD: 100,000ns (100us)	~7 hours (go to the library today)
Disk: 10,000,000ns (10,000us, 10ms)	

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Network (JAM ↔ NYC): 70,000,000ns (70,000us, 70ms)	

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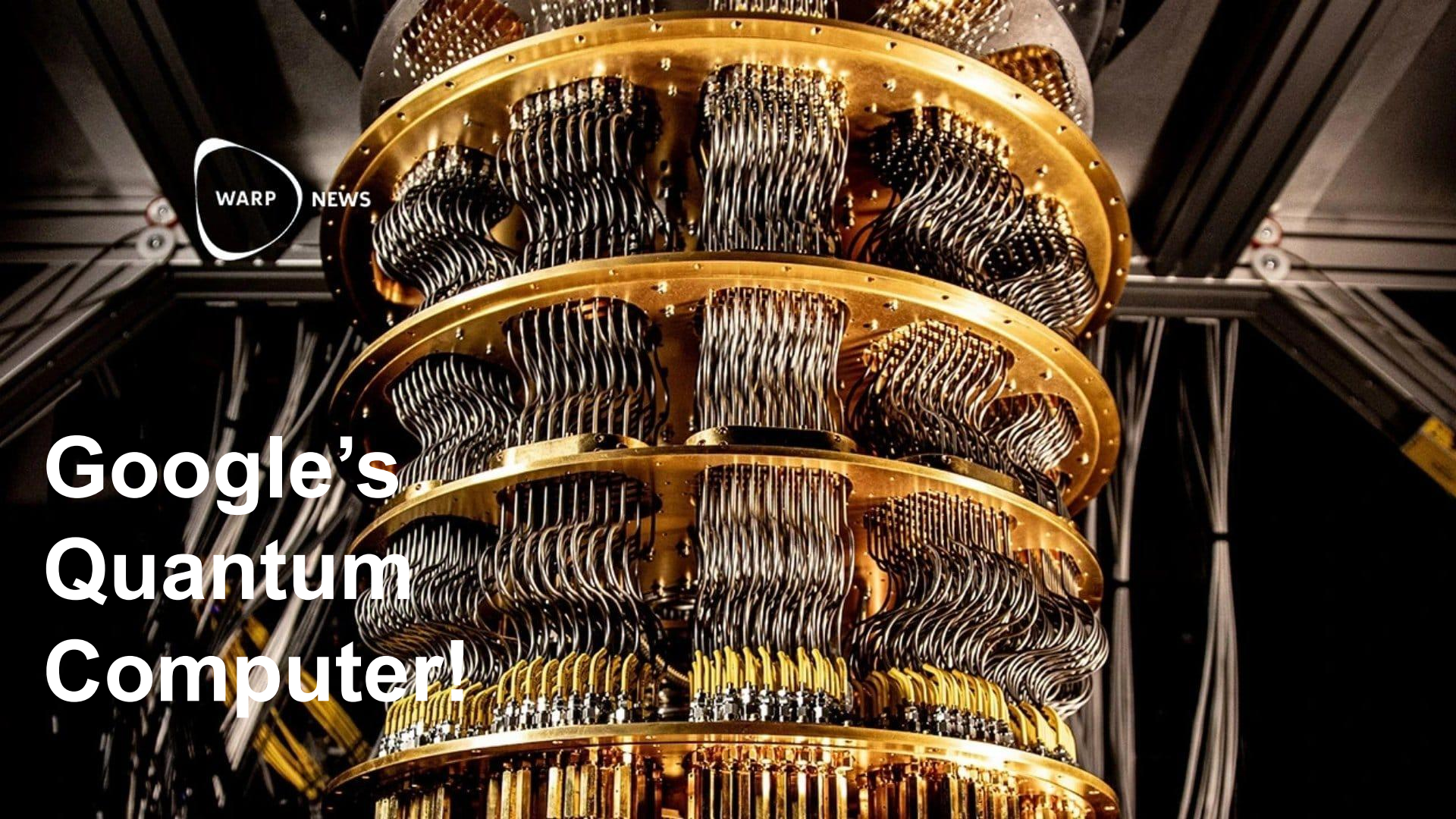
SSD: 100,000ns (100us)	~7 hours (go to the library today)
Disk: 10,000,000ns (10,000us, 10ms)	~29 days (Jamcoders!)
Network (JAM ↔ NYC): 70,000,000ns (70,000us, 70ms)	~202 days (a year of school)

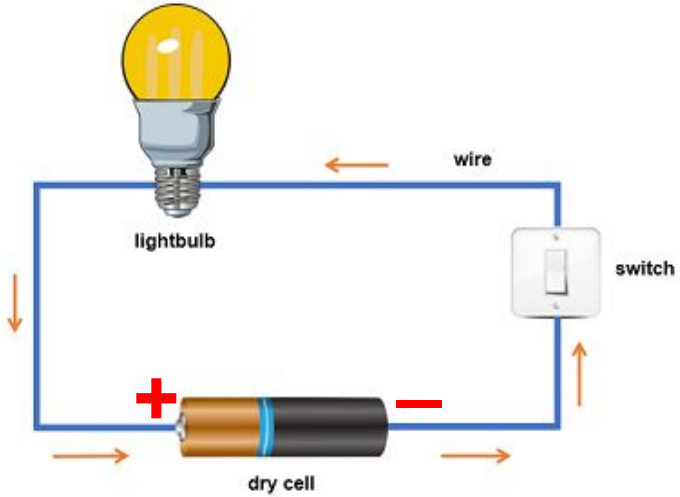
Why make them faster?

EVERYTHING IN THIS PHOTO IS NOW IN YOUR POCKET


WARP
NEWS
Google’s Quantum Computer!

What is voltage?

Electric potential difference per unit charge between two points in a circuit's electric field.

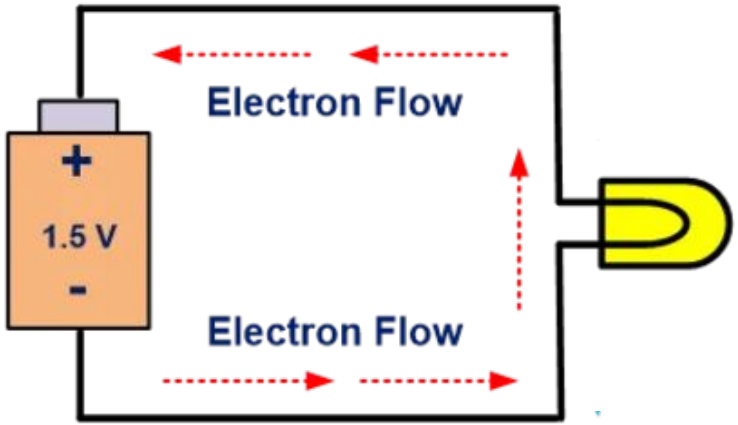


- The battery supplies voltage, causing an energy imbalance to exist between the + and -
- This causes current (electrons or ions) to flow

What is current? Resistance?

Electrical current is a stream of charged particles, such as electrons or ions, moving through an electrical conductor.

Resistance restricts the flow of current.

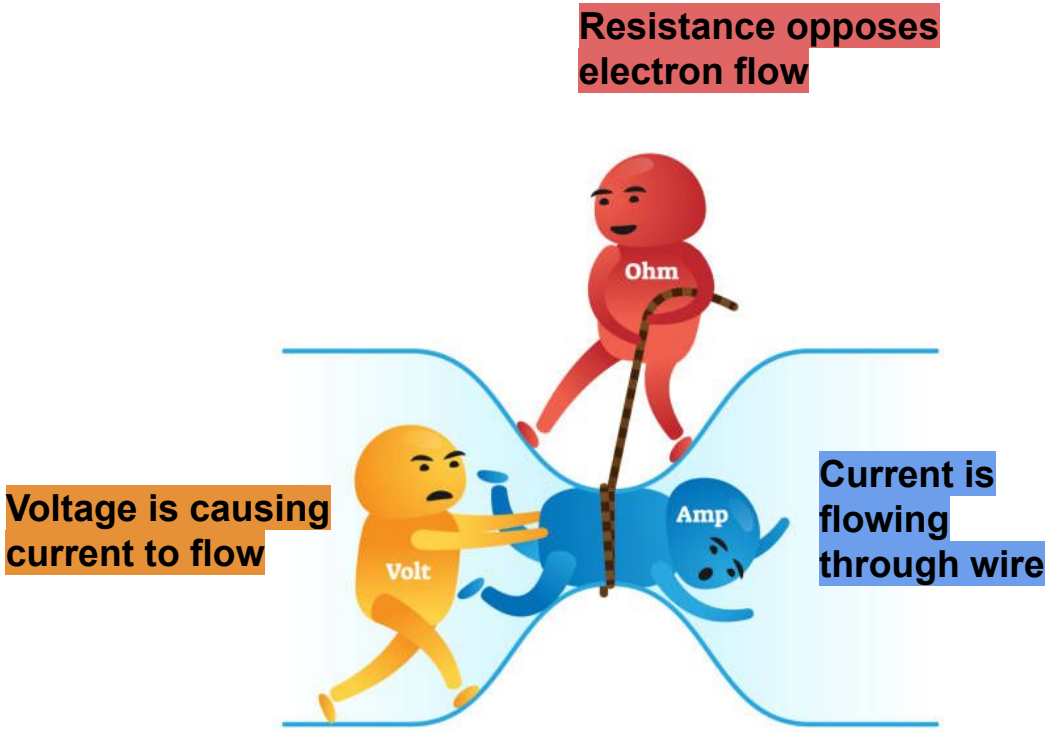


Ohm’s Law

Ohm’s Law captures the relationship between:

- Current (I)
- Voltage (V)
- Resistance (R)

V = IR

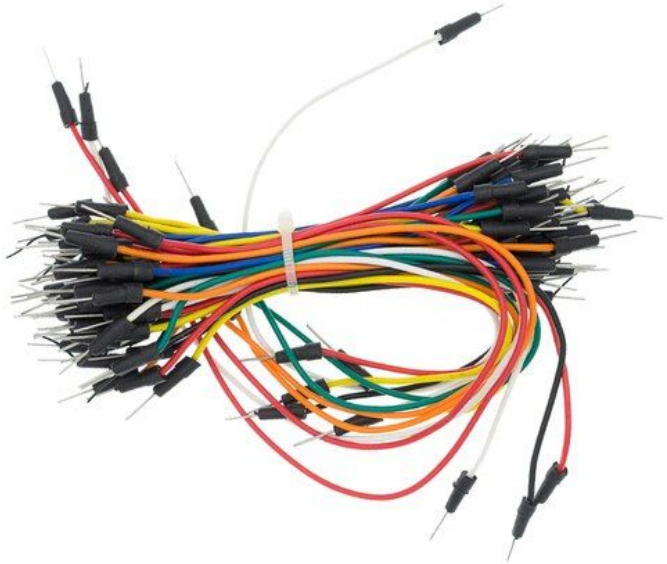


Circuit Components

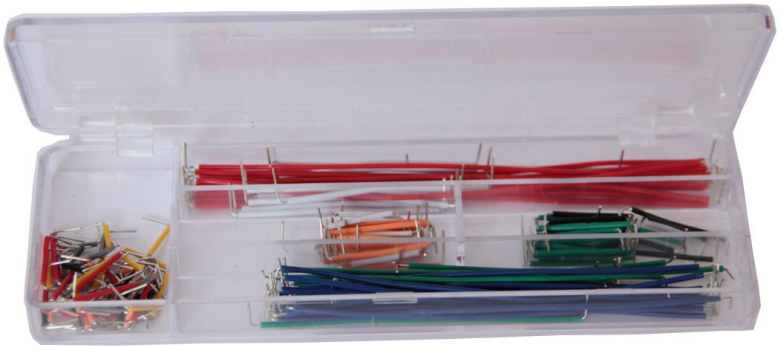
- Wires
- Resistors
- Capacitors
- TransistorsSwitches
- OR, AND, NOR, and NOT gates
- The list goes on…

Wires

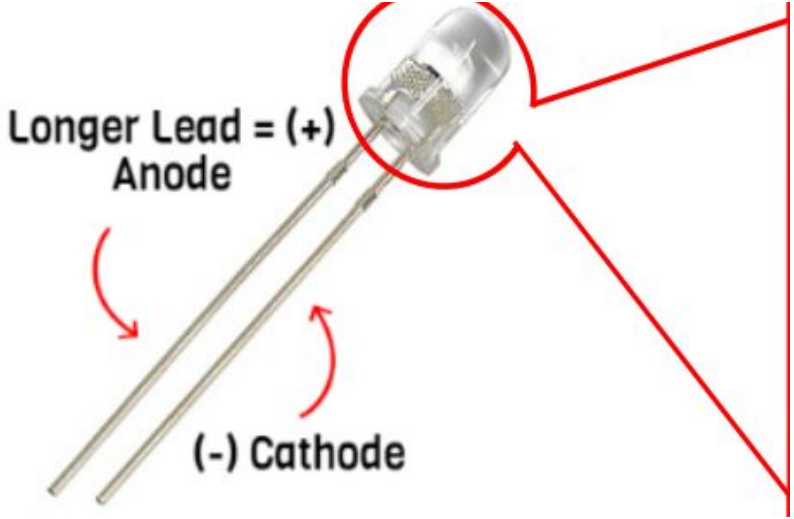
I know you know what wires are, here are some photos of the ones we're using:



The metal ends enter the breadboard and Arduino pin holes



LED Lightbulbs

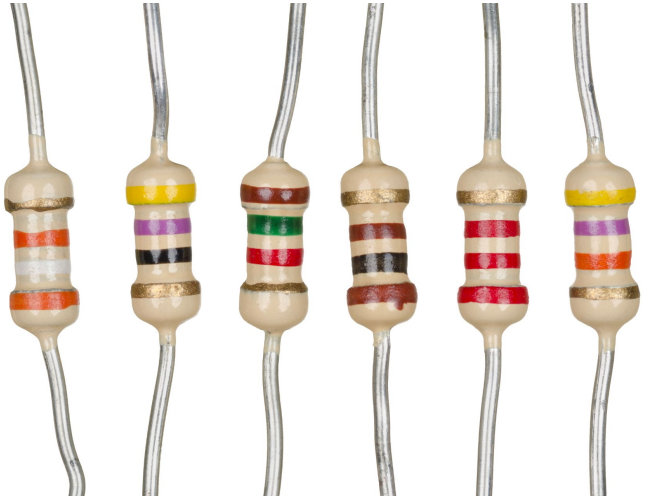


Resistors

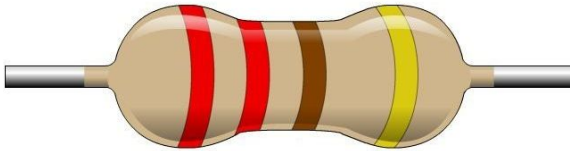
Resistors provide resistance to electrical current.

They are often needed to regulate the current and voltage in a circuit.

(You'll be using ~220 Ohms)



Resistors



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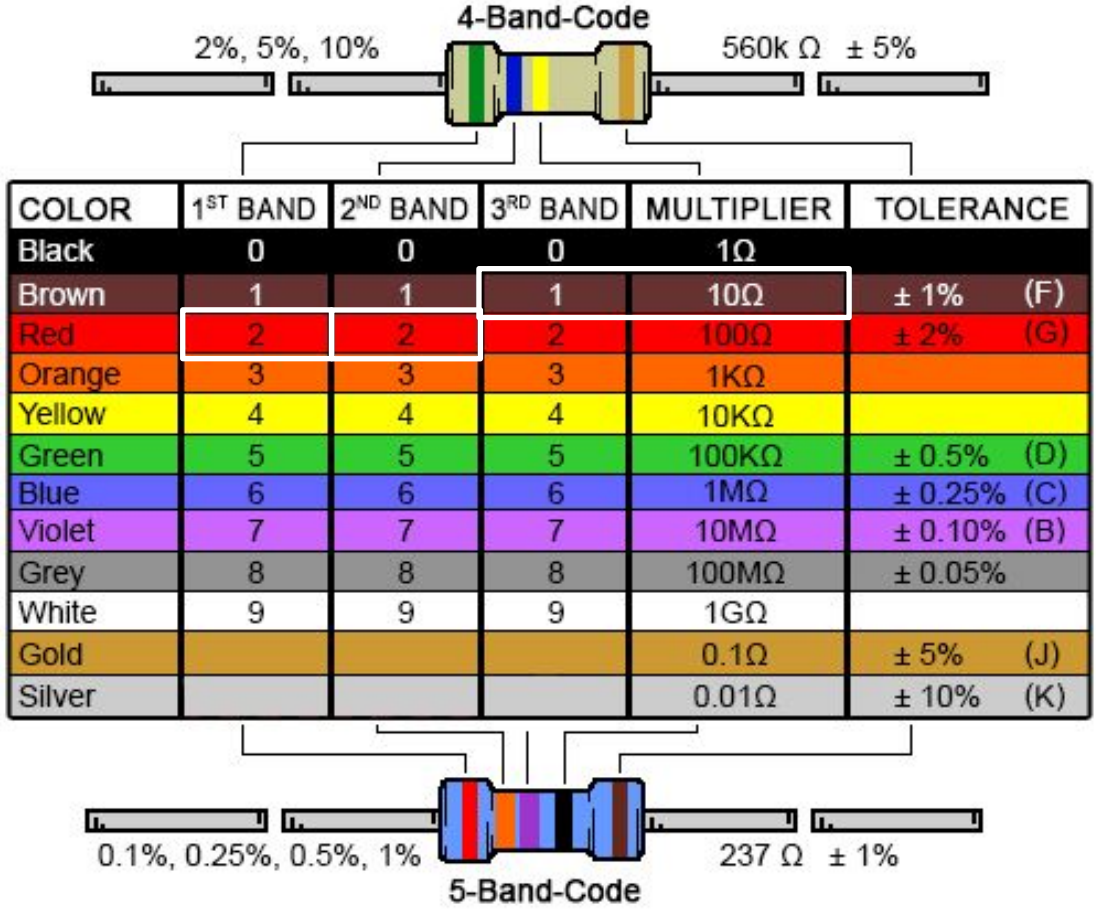
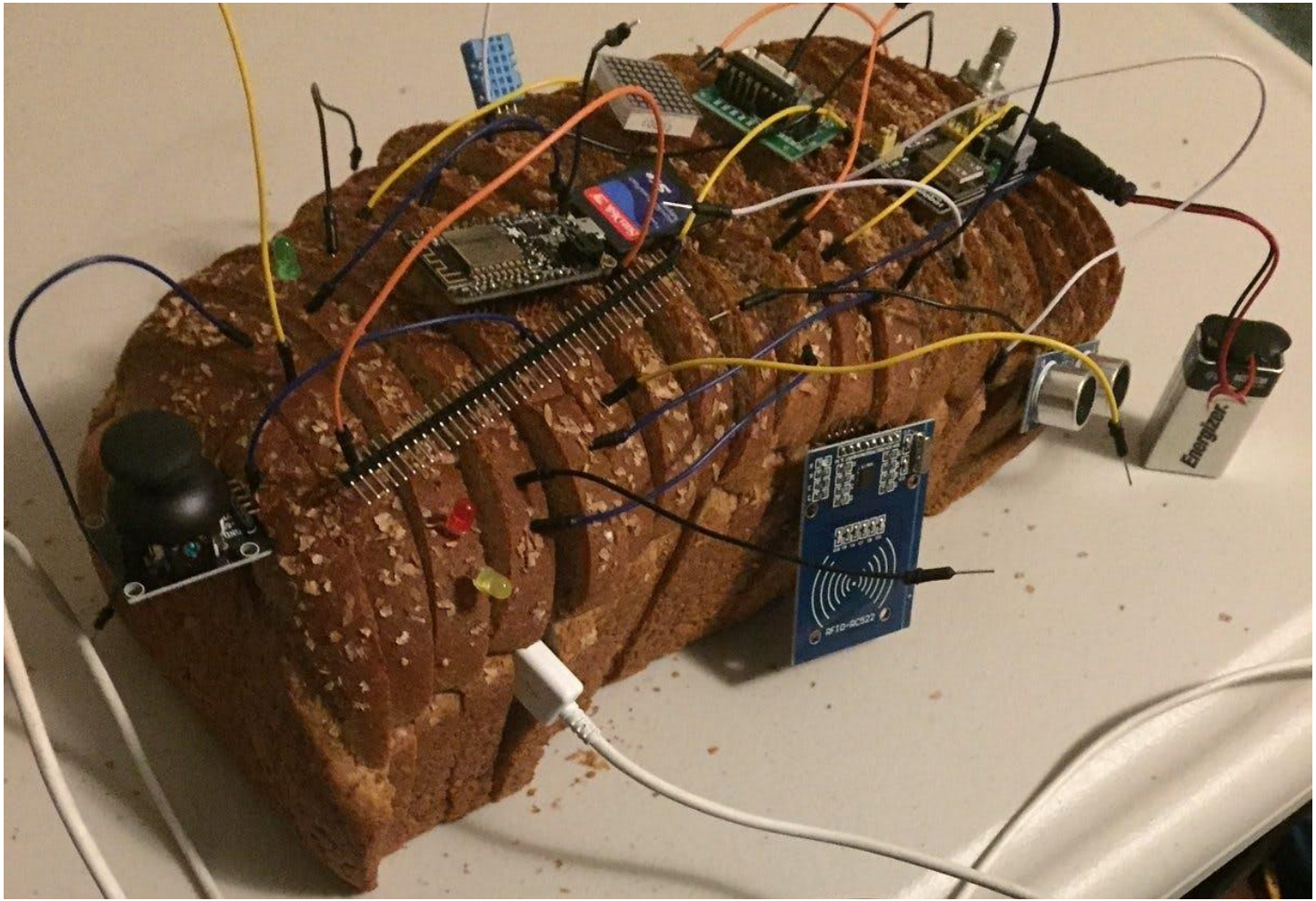
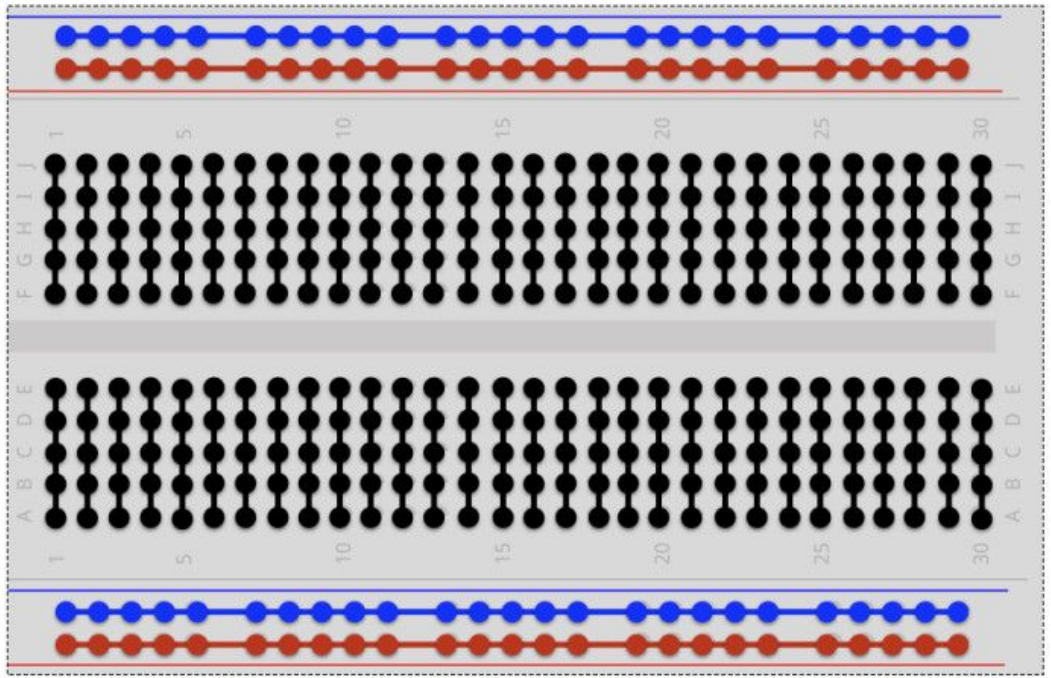


COLOR	1ST BAND	2ND BAND	3RD BAND	MULTIPLIER	TOLERANCE
Black	0	0	0	1Ω	
Brown	1	1	1	10Ω	± 1% (F)
Red	2	2	2	100Ω	± 2% (G)
Orange	3	3	3	1KΩ	
Yellow	4	4	4	10KΩ	
Green	5	5	5	100KΩ	± 0.5% (D)
Blue	6	6	6	1MΩ	± 0.25% (C)
Violet	7	7	7	10MΩ	± 0.10% (B)
Grey	8	8	8	100MΩ	± 0.05%
White	9	9	9	1GΩ	
Gold				0.1Ω	± 5% (J)
Silver				0.01Ω	± 10% (K)

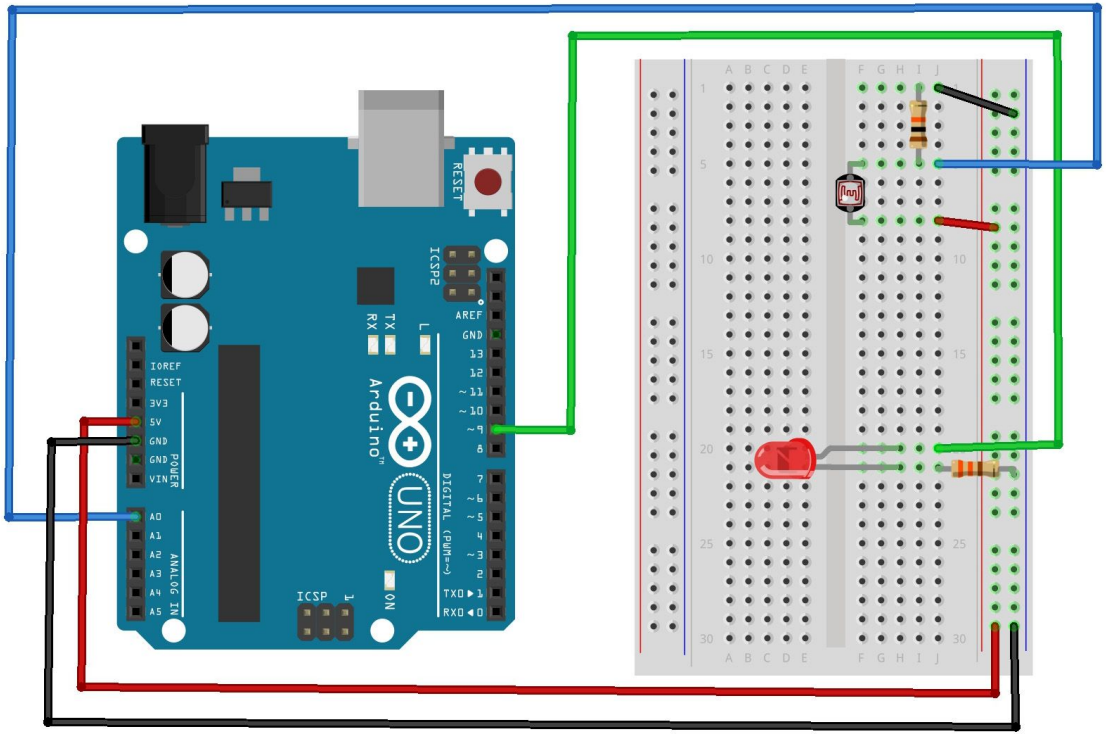

Energizer
RFID-RC522

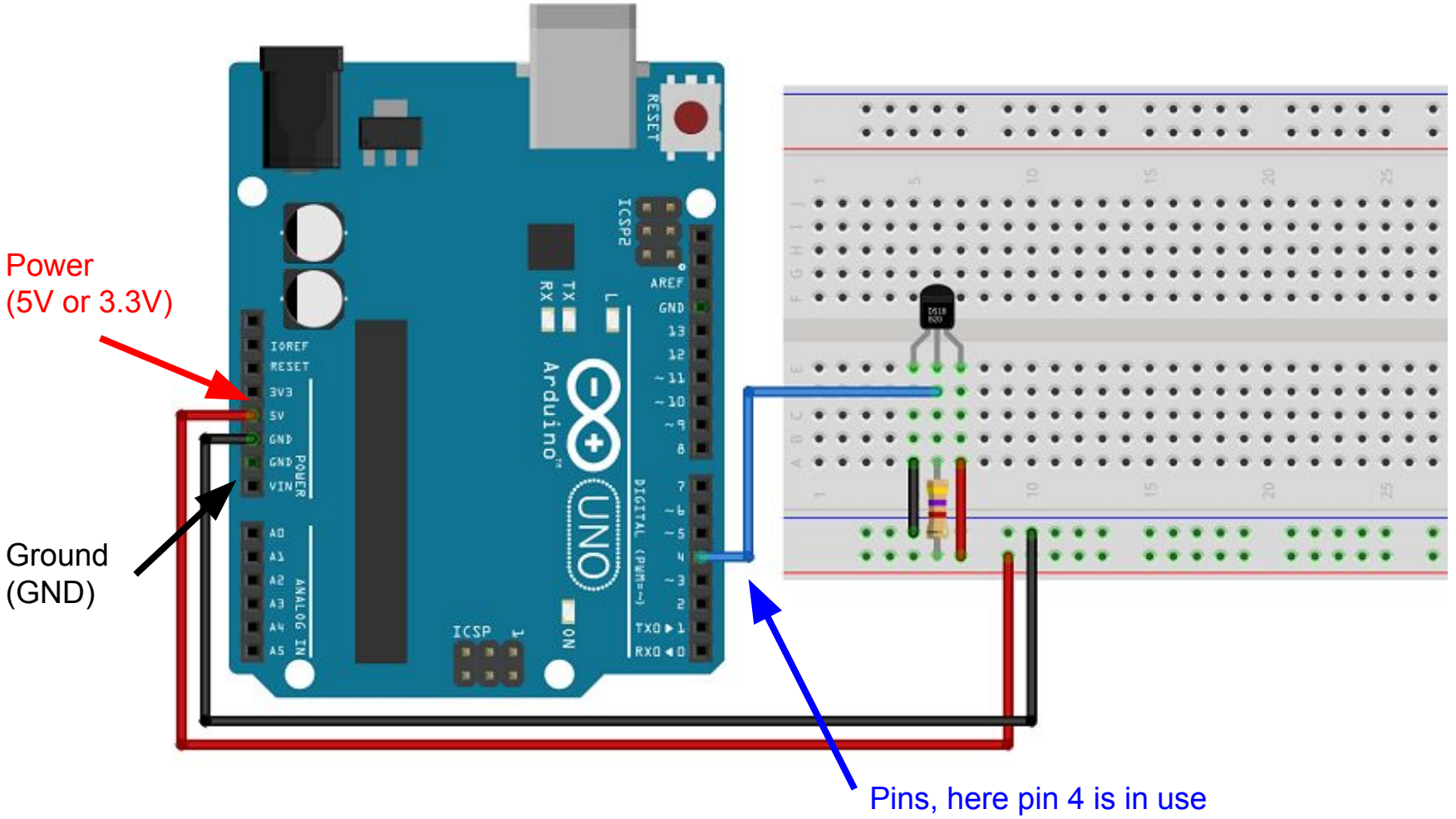
Breadboard

Breadboards are used to organize and connect circuit elements.

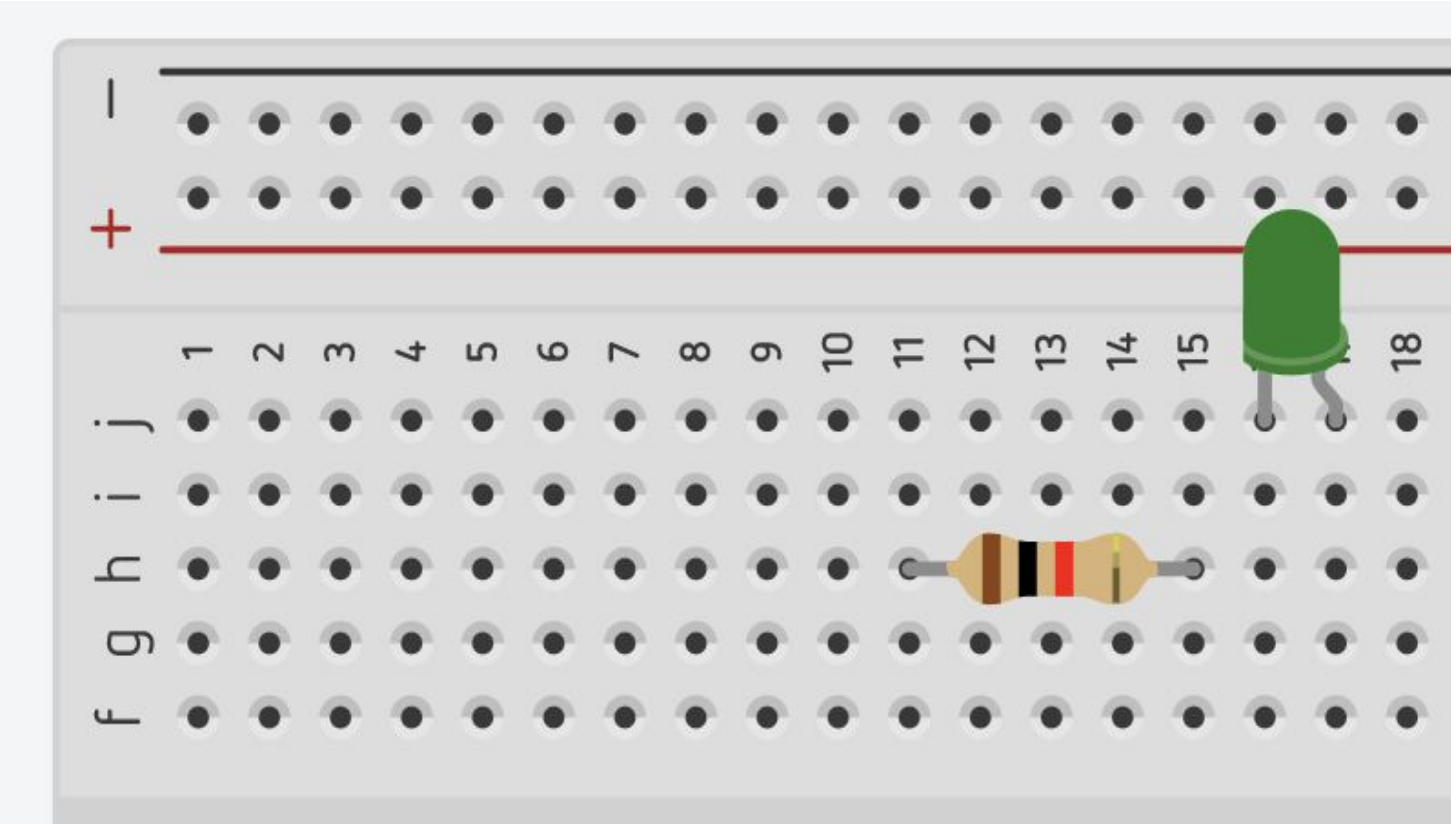


Arduino Chip Breadboard

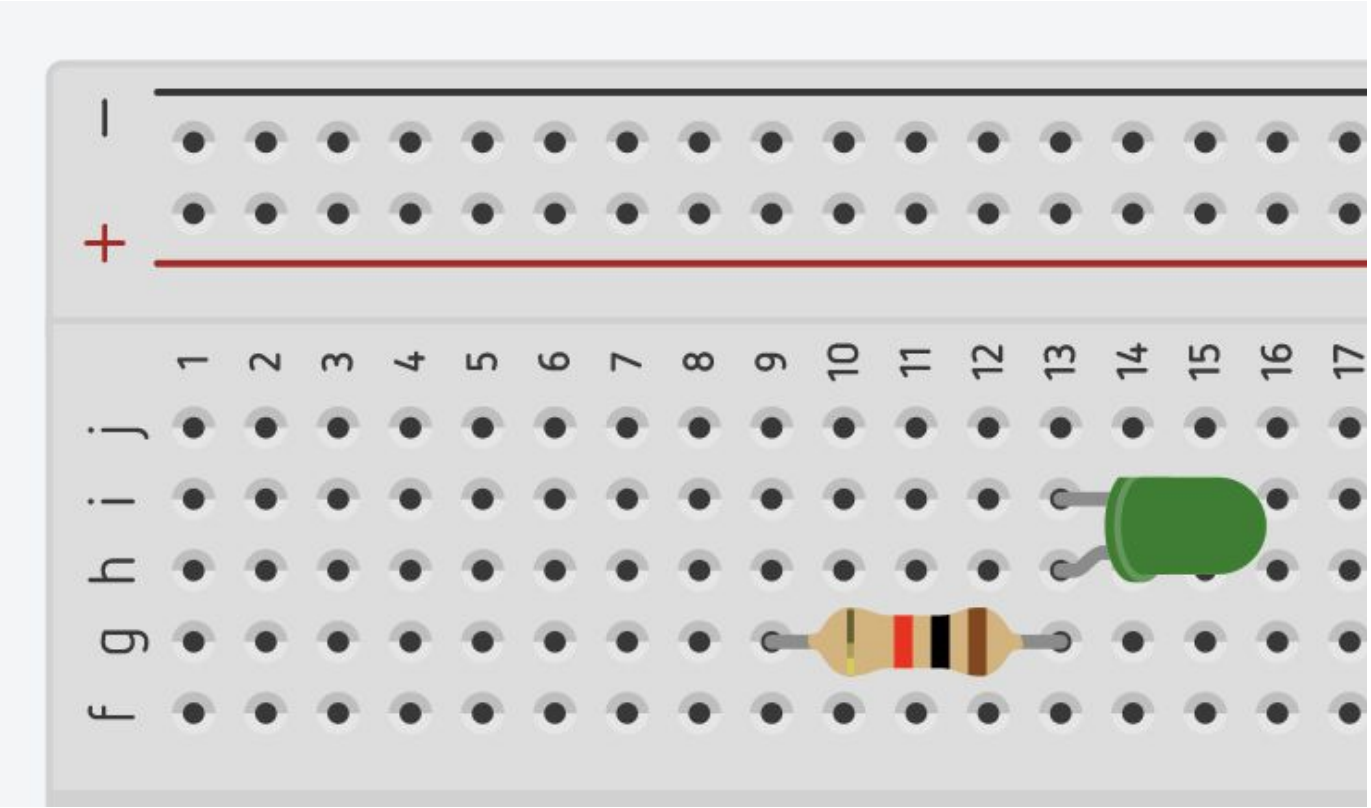



Power
(5V or 3.3V)
Ground
(GND)
Pins, here pin 4 is in use
RESET
ICSP2
AREF
GND
13
12
~11
~10
~9
8
7
~6
~5
4
~3
2
TX→1
RX←0
DIGITAL (PWM=~)
TX
RX
L
ON
ICSP
IOREF
RESET
3V3
5V
GND
GND
VIN
POWER
A0
A1
A2
A3
A4
A5
ANALOG IN
Arduino
UNO

Are the resistor and the lightbulb connected?



What about now? Is there anything wrong with this connection?



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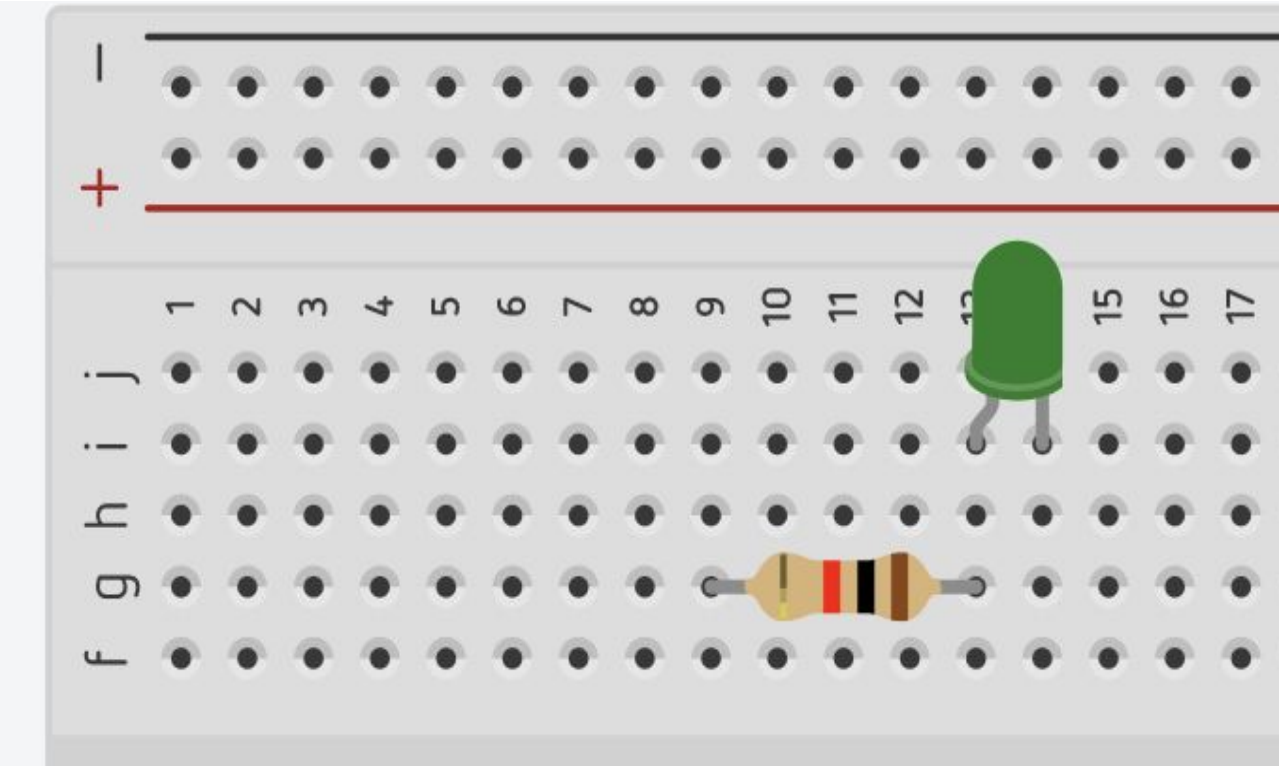


Now it’s your turn to make some circuits!

Group 1: Shechanyah, Kalani, Joelle, Ayeisha, Zyeka

Group 2: Nyla, Kayleigh, Austin, Sean, Rebekah, Oksana

Group 3: Aiden, Naandi, Jozanne, Yemesi, Gisele

Group 4: Antwaun, Alyssa, Rishi, Kairo-Alexis, Tariq

Group 5: Robert, Chenelle, Daniel, Tessanne, Brianna

Group 6: Aprille, Oscar, Kamali, Kara-Lee, Kayla

Group 7: Jadon, Aneika, Kejaaun, Jemila, Tiandra, Damir

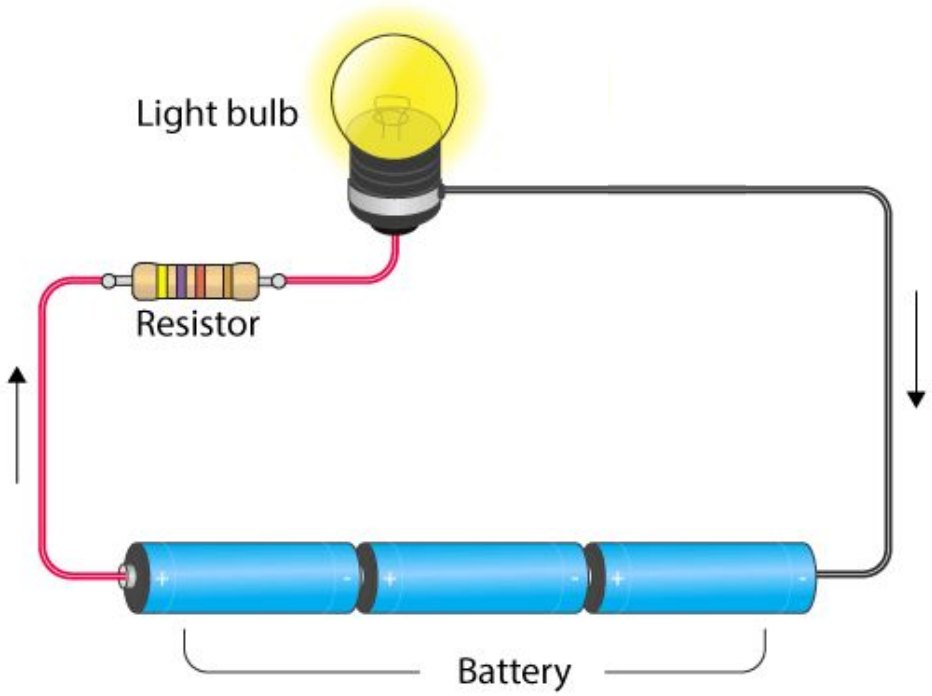
Group 8: Kiana, Zephan, Janic, Orett, Larissa, Cavier

Group 9: Neveno, Malique, Daniela, Gabrielle, Richaiya, Raheem

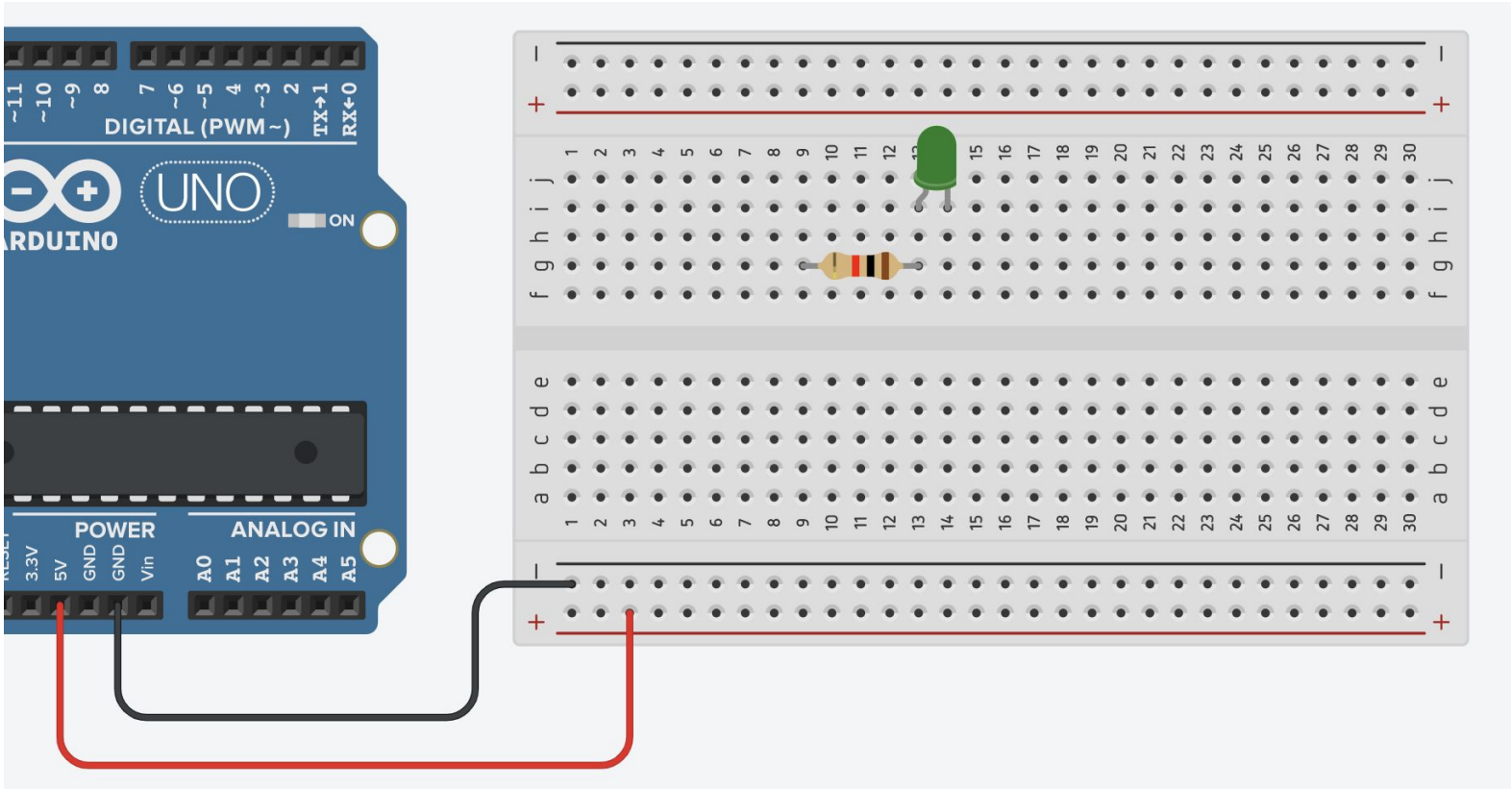
What’s in Your Kit? → Call a TA if you’re missing things

- 1 Arduino Uno
- 1 Single-Colour LED 💡
- 1 RGB LED 🌈
- 3 Resistors (100-330 Ohms)
- 1 Breadboard 🍞
- Wiressss

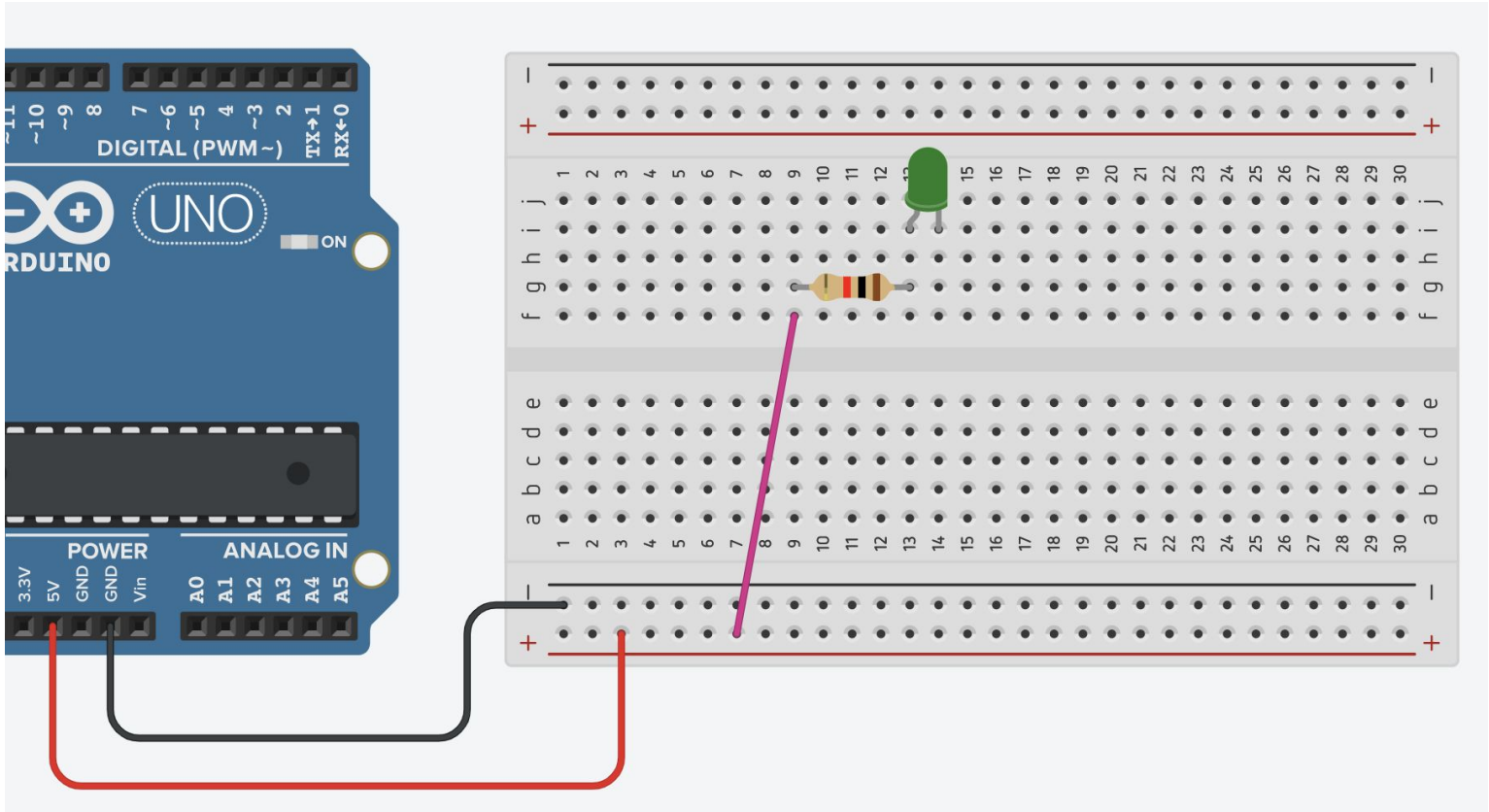
Let’s Make a Simple Light Circuit!



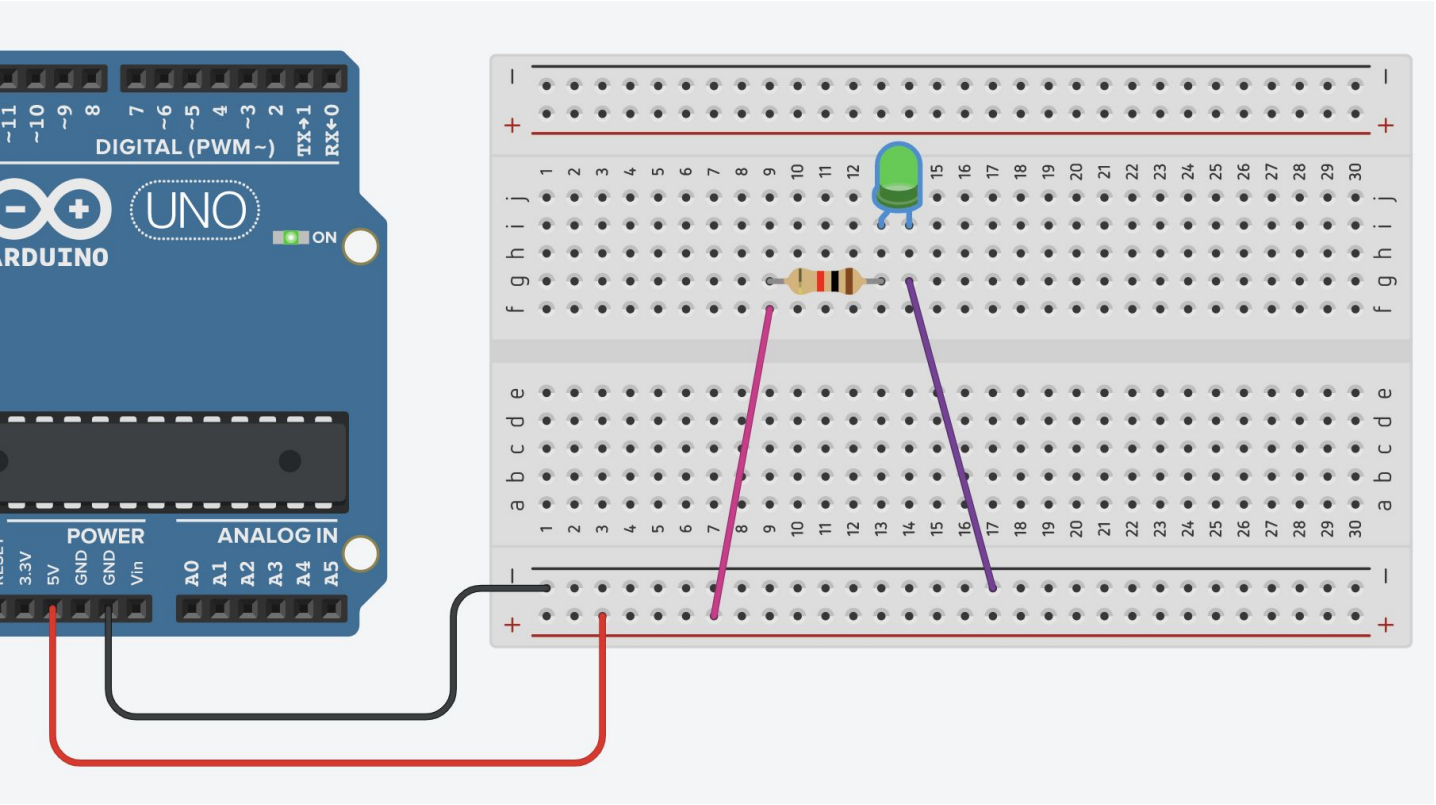
Let’s connect our circuit board to +/- voltage:



Now let’s connect the positive voltage to the resistor:



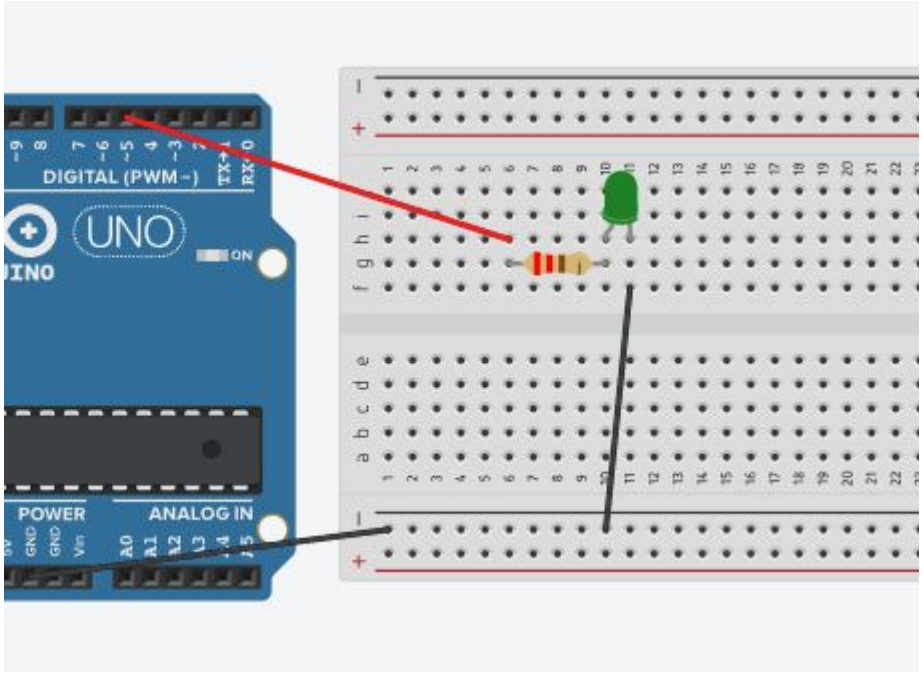
Now let's connect the negative voltage to the lightbulb:



Now, raise your hand and I will plug in the Arduino microcontroller!

But what if I want it to blink?

Giving our Circuit Personality



Move your positive voltage to pin 5 on the Arduino and open the following file and run it:

blink_led.ino

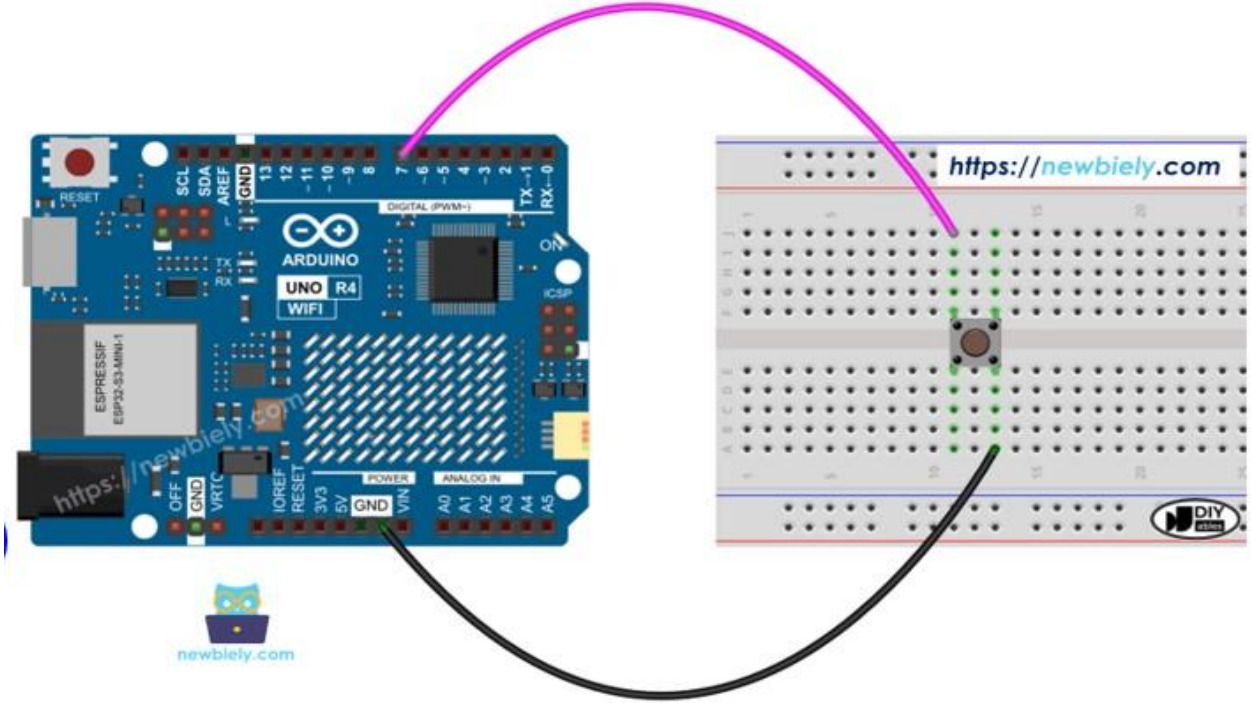
Image of Arduino ui
- connect to board

Arduino chips run code which controls the voltage and current applied via wires into our circuit

But what if I want to make a light switch?

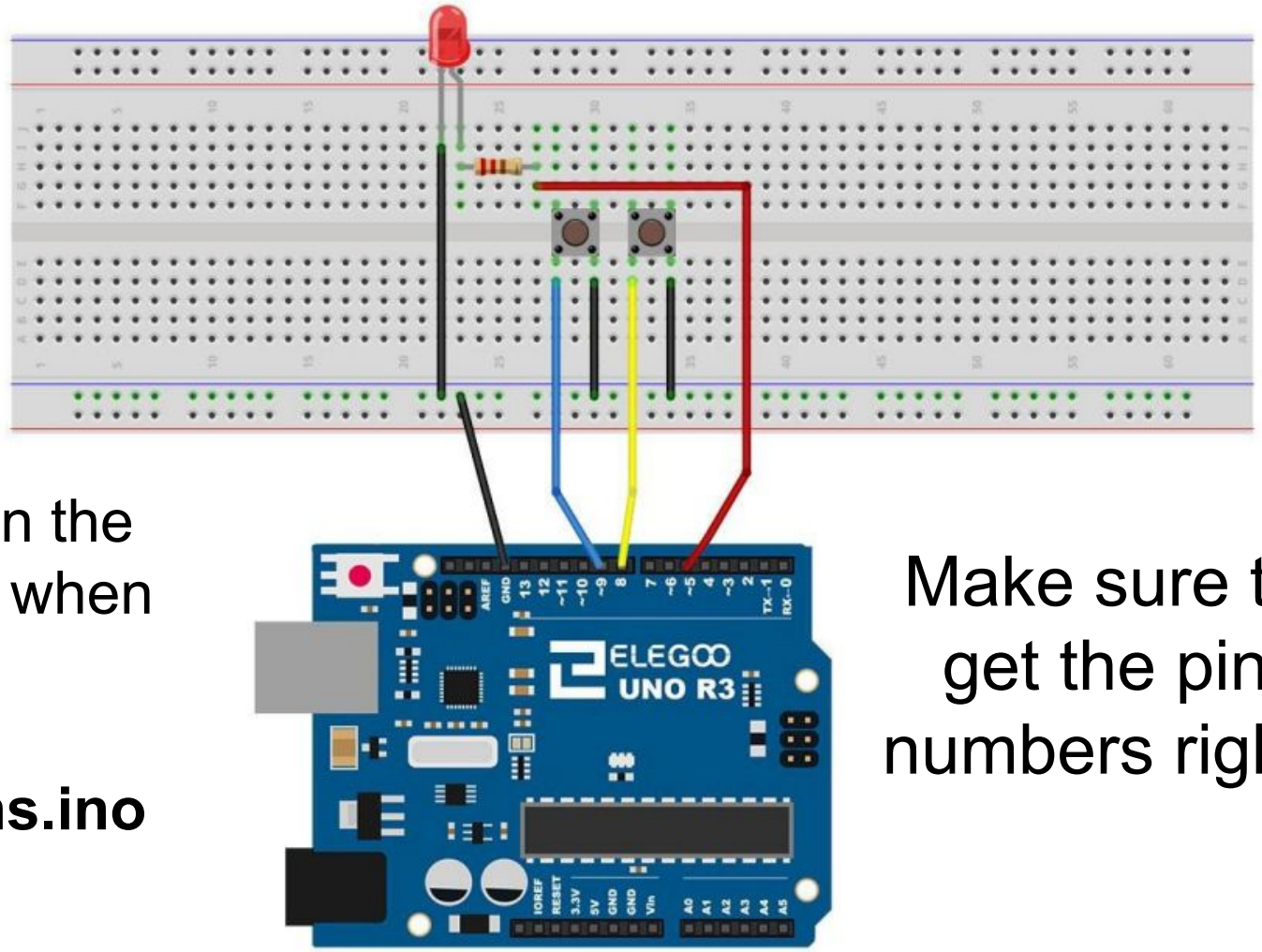
Not Pressed

Pressed



Try to make a circuit that turns an LED on and off with a button.

Try it on your own first, but don’t be afraid to ask for help!

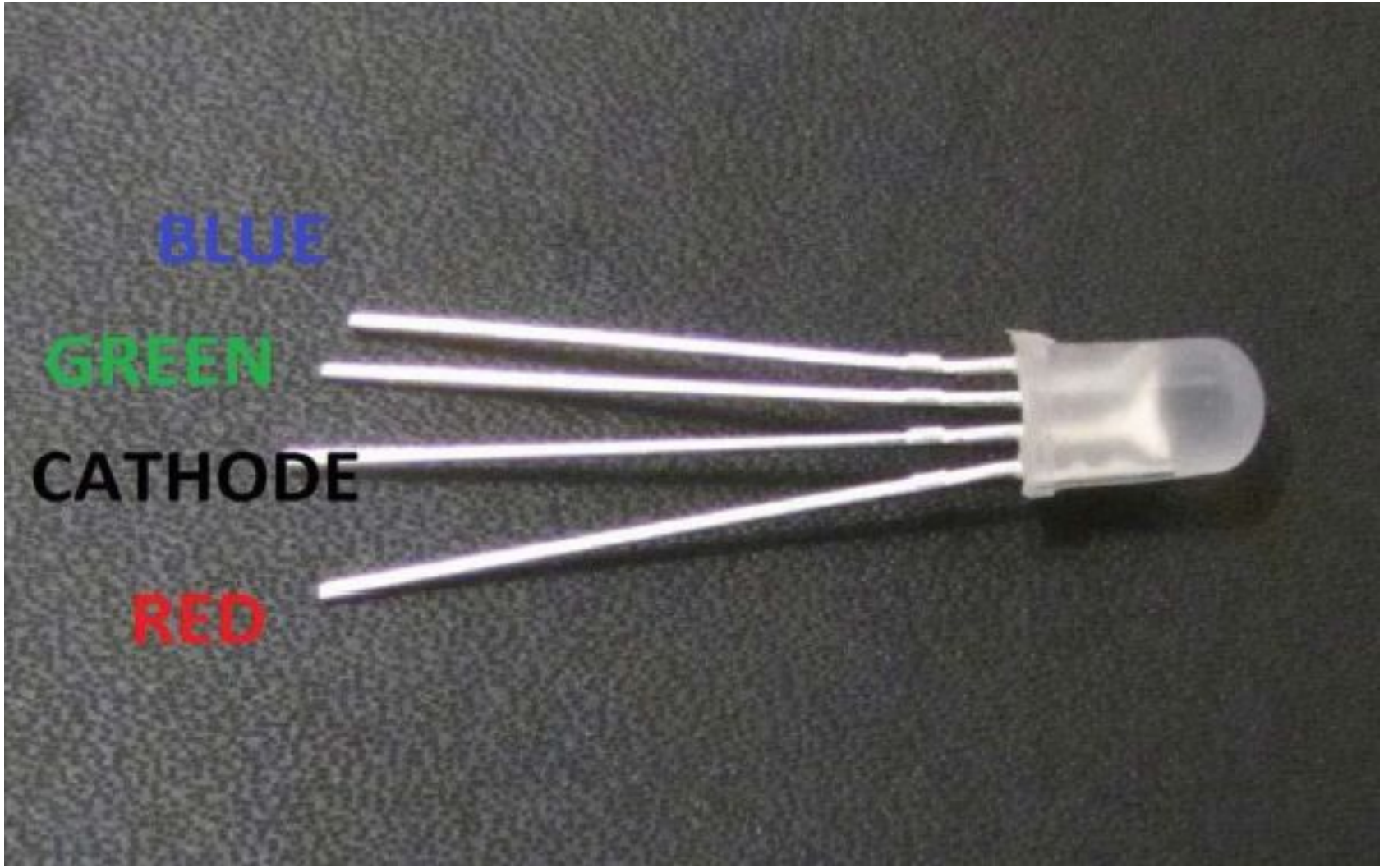


Open and run the following file when finished:

LED_buttons.ino

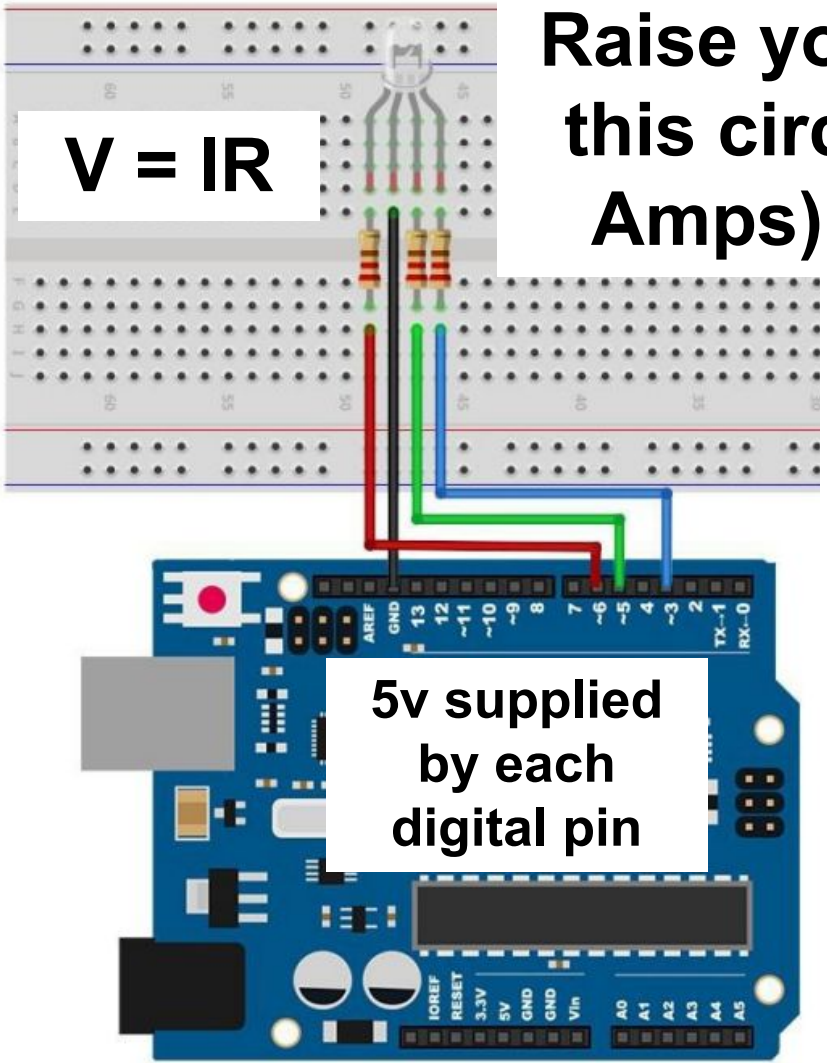
Make sure to get the pin numbers right!

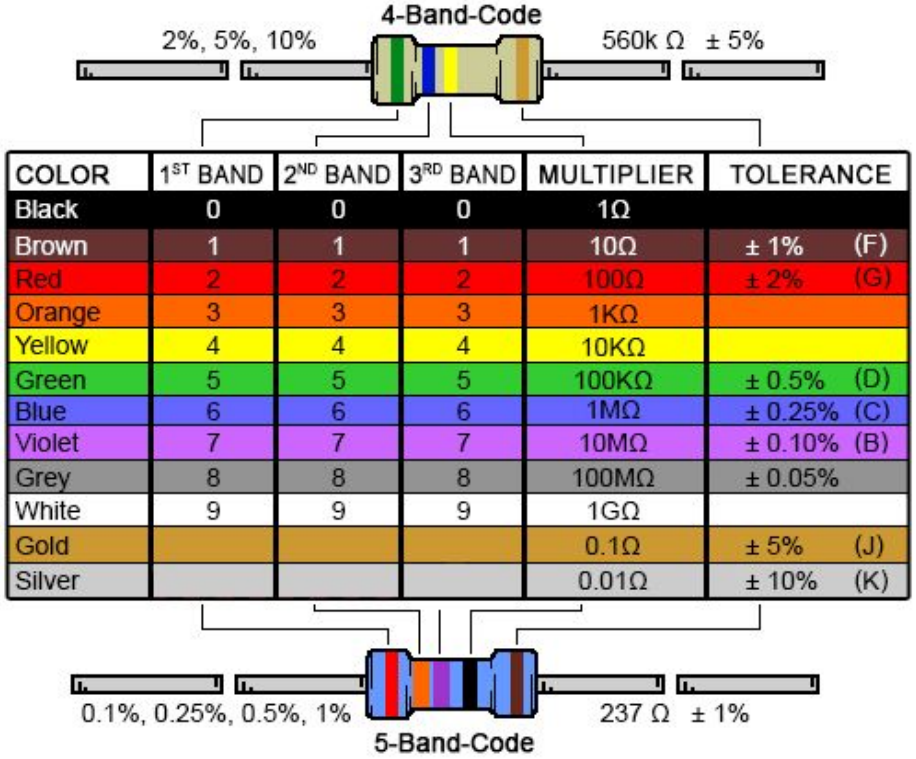
But what if I want to have a colorful light?


BLUE
GREEN
CATHODE
RED

Raise your hand when you have built this circuit and know the current (in Amps) supplied to each RGB pin!!

V = IR





COLOR	1ST BAND	2ND BAND	3RD BAND	MULTIPLIER	TOLERANCE
Black	0	0	0	1Ω	
Brown	1	1	1	10Ω	± 1% (F)
Red	2	2	2	100Ω	± 2% (G)
Orange	3	3	3	1KΩ	
Yellow	4	4	4	10KΩ	
Green	5	5	5	100KΩ	± 0.5% (D)
Blue	6	6	6	1MΩ	± 0.25% (C)
Violet	7	7	7	10MΩ	± 0.10% (B)
Grey	8	8	8	100MΩ	± 0.05%
White	9	9	9	1GΩ	
Gold				0.1Ω	± 5% (J)
Silver				0.01Ω	± 10% (K)

Now put it together!

Make a circuit that uses TWO buttons to control the colour of an RGB LED.

Use pins 8 and 9 for the buttons
RED -> 3, BLUE -> 6, GREEN -> 5
Remember your resistors!!!!

Call a TA when you're done!

Open rbg_buttons.ino

Challenge Problem! Diming light with potentiometer (analog input)

Open led_dim.ino