Basic Electronics, Circuits, Switches, & Resistors

Your New Media Arts Kit

- Breadboard (Large and Small)
- LEDs
- Resistors
- 3V Button Battery Containers
- And much more (RexQualis Arduino, jumper wires, servos, motors, photoresistors, etc…)
- RexQualis Super Starter Kit + Extras: http://www.rexqualis.com/product/uno-project-super-starter-kit-for-arduino-w-uno-r3-development-board-detailed-tutorial/

Theory

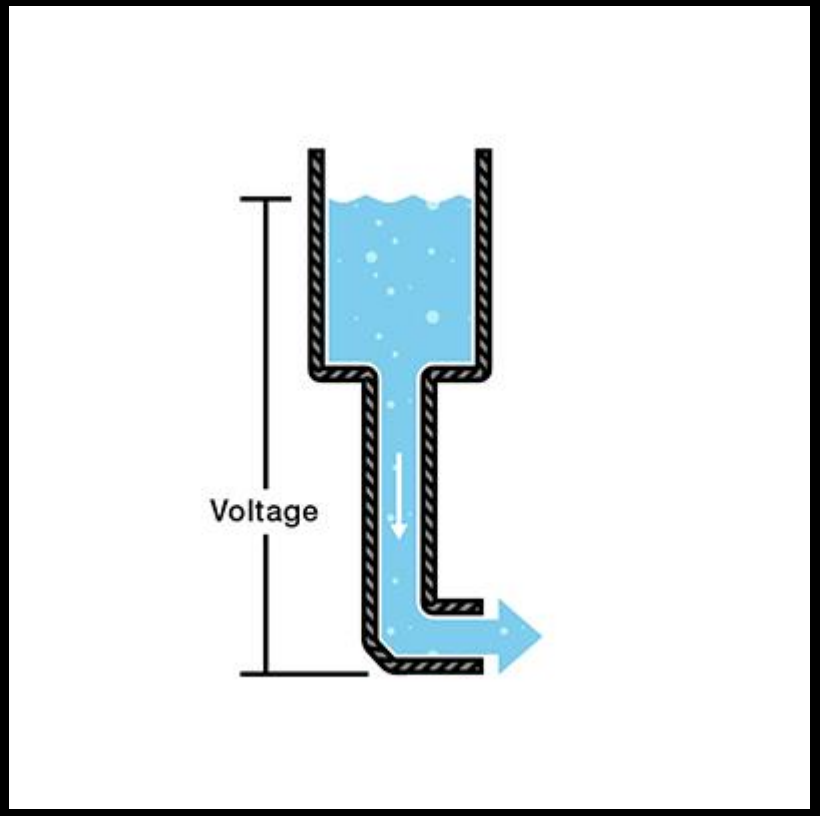
Electricity

Electricity is essentially the flow of electrons between two points through a conductive material, like copper or wire.

The 3 Main, Interrelated Ingredients:

- Voltage: The difference in charge between two points, which creates electrical pressure. Measured in Volts.
- Current: The rate at which electricity flows. Measured in Amps, this tells us how much electricity is moving through the circuit per second.
- Resistance: The amount of resistance against the flow of electrons.

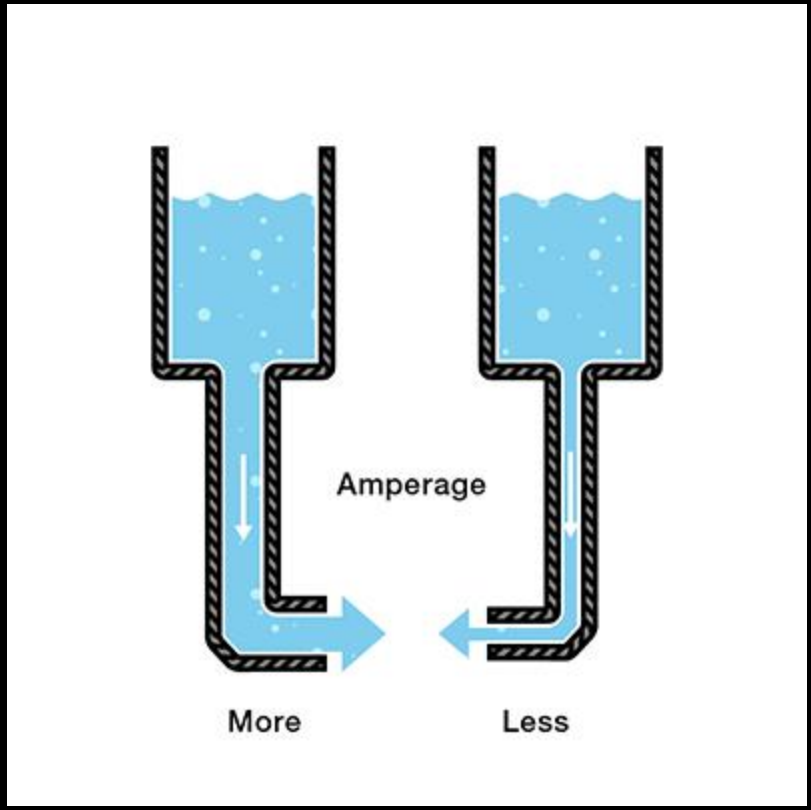
Voltage



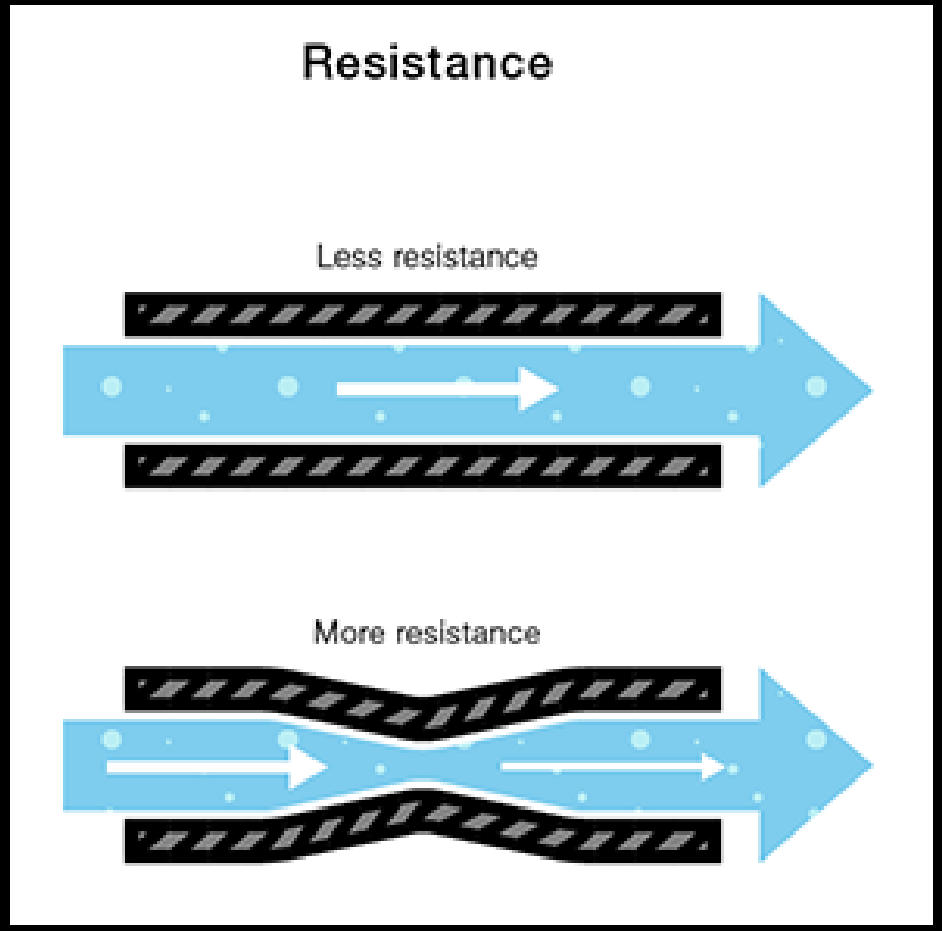
- Voltage measures the potential energy (pressure) between two points on a circuit, usually travelling between the positive and negative terminals of a battery.
- Voltage is represented in equations and schematics by the letter “V”, as in “9V Battery”

Current & Amperage

- Current is measured in Amperes, which tells us how much electricity is flowing through our circuit per second.
- Answers the question, “how quickly is electricity flowing?”
- Represented in equations and schematics by the letter “I”.



Resistance



- Resistance limits the current (rate of flow of electrons) through the circuit.
- Higher resistance = less current
- Measured in Ohms (Ω)
- Referenced in equations, datasheets, and schematics as “Ω” or “R”

Ohm’s Law

V = I * R - Voltage equals Current times Resistance

Where

V = Voltage

I = Current (Amps)

R = Resistance (Ohms)

Also:

R = V / I – Resistance equals Voltage divided by Current
I = V / R – Current equals Voltage divided by Resistance

Applying Ohm's Law

Understanding that a Red LED can handle .02 amps (or 20mA, 20 milli-amps) maximum before burning out, we can find what kind of resistor we need to use to create a circuit with an LED and a 3V battery

- V = I * R (Voltage = Current * Resistance)
- R = V / I (Resistance = Voltage / Current)
- R = 3 / .02
- R = 150 Ohms

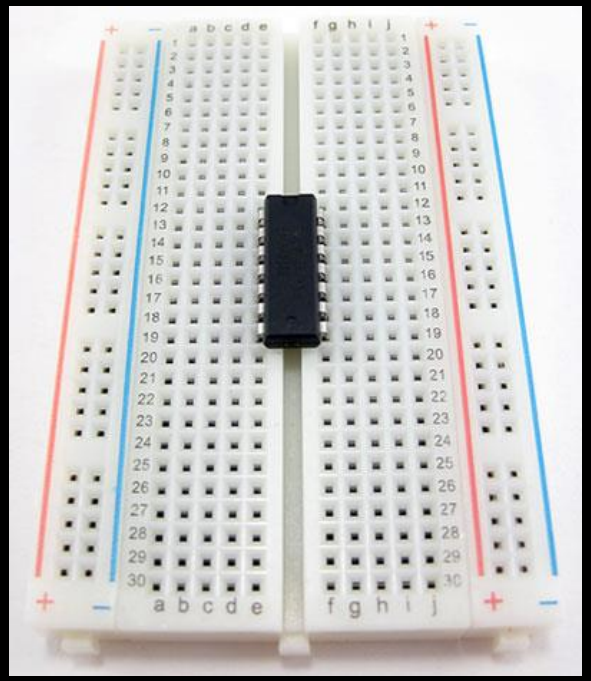
Therefore we will want to use a resistor that is at least 150 Ohm, always rounding up (more resistance is safer than less!)

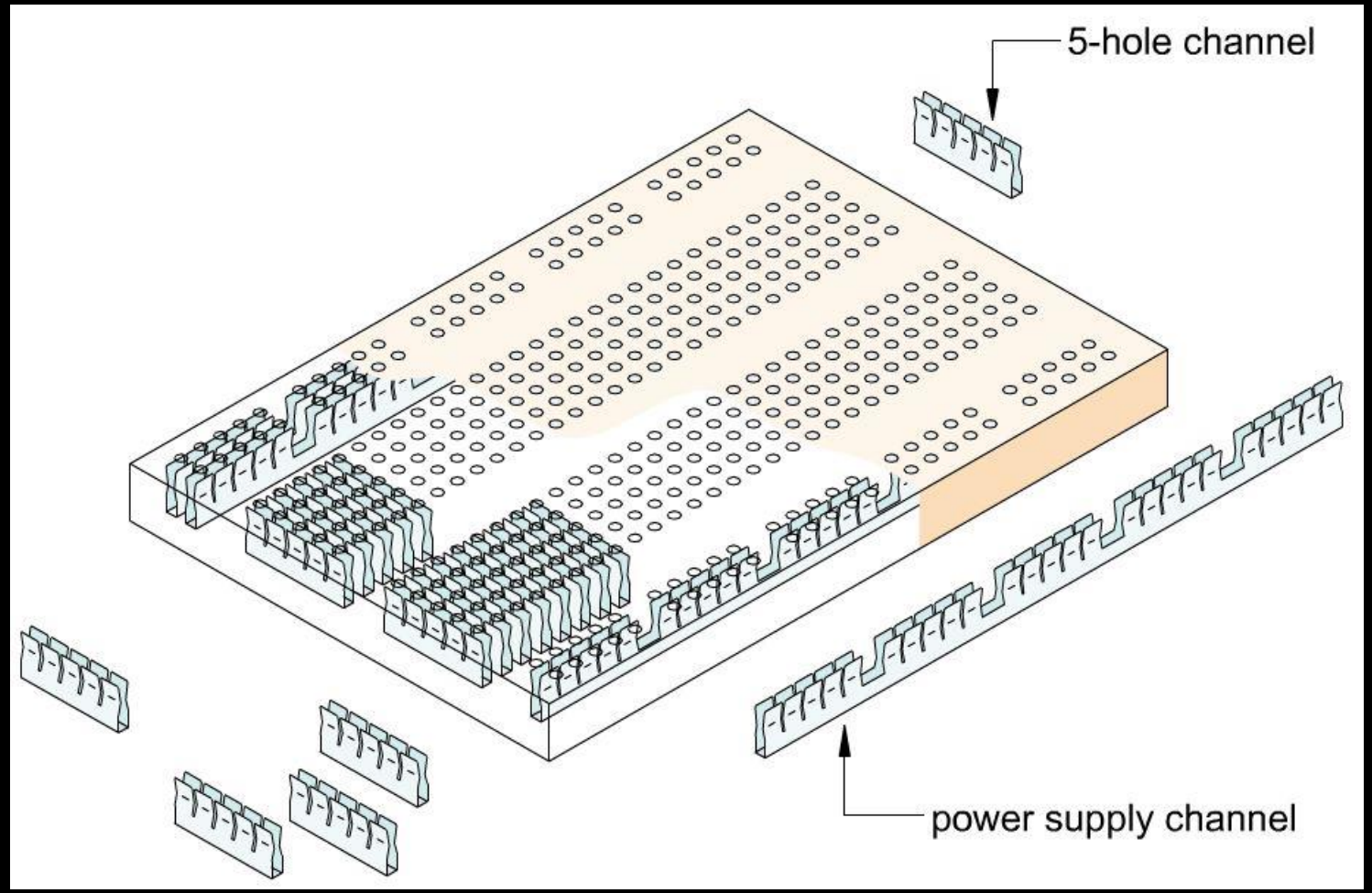
- Electrical Theory: https://learn.sparkfun.com/tutorials/voltage-current-resistance-and-ohms-law/electricity-basics

Practice

The Breadboard

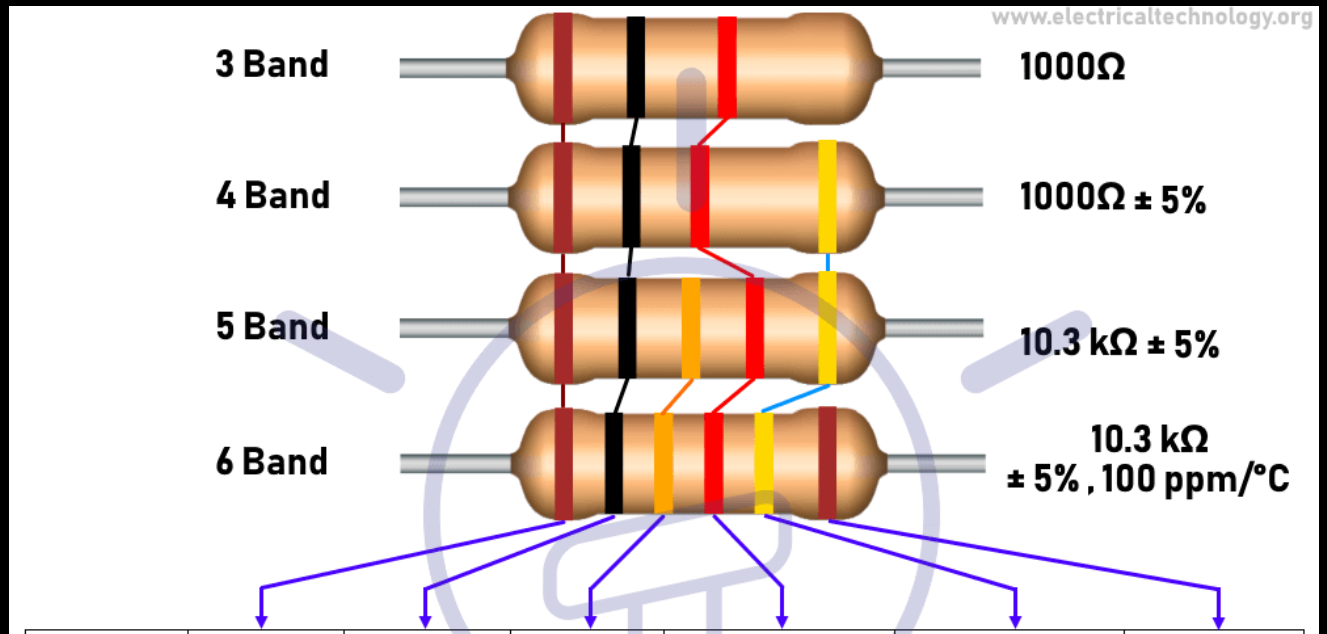
- Construction base for prototyping electrical circuits.





Resistors

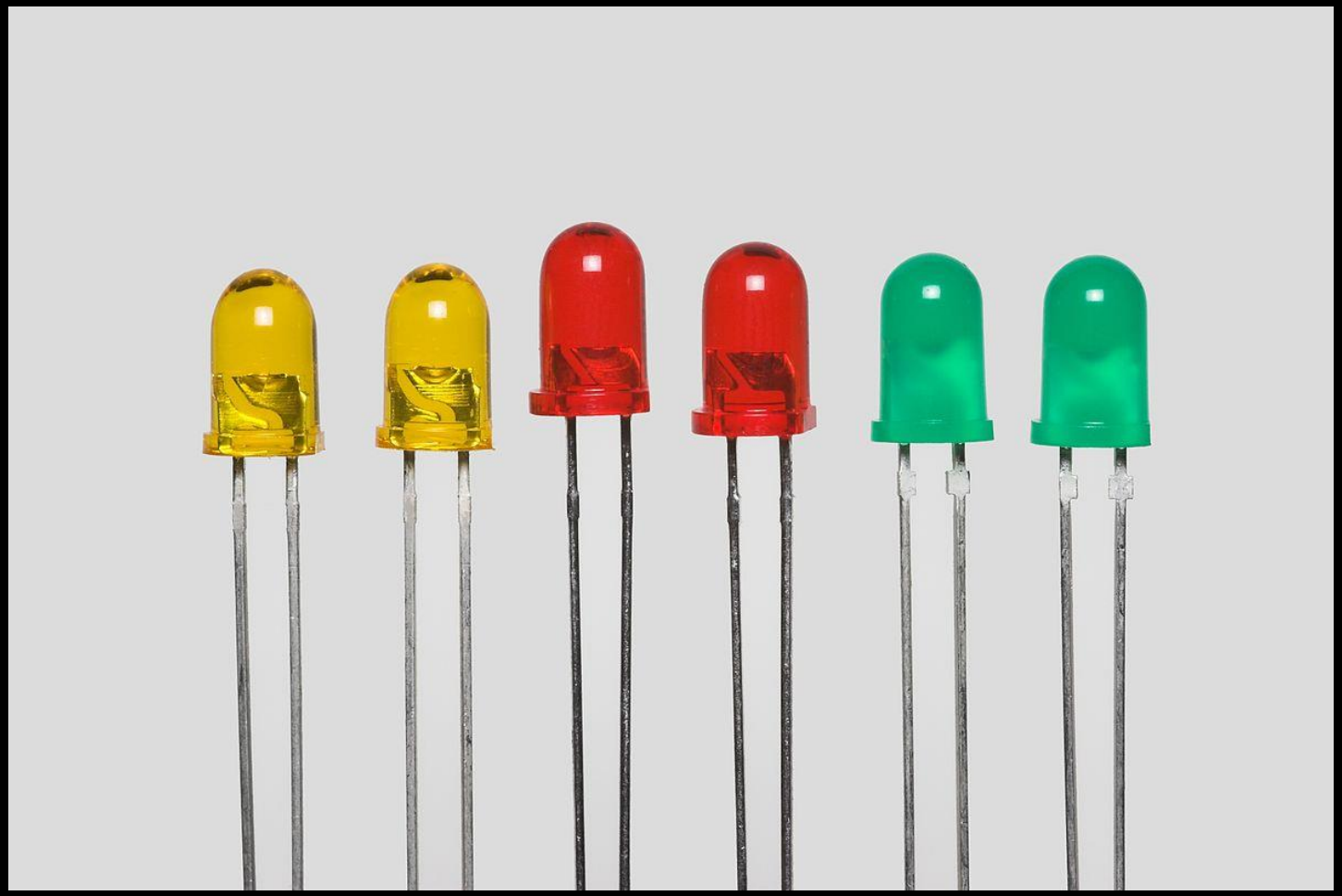
- Resistors are used to control the flow of the current within a circuit, by adding resistance



COLOR	1st DIGIT	2nd DIGIT	3rd DIGIT	MULTIPLIER	TOLERANCE	TEMP .Co
BLACK	0	0	0	1Ω		
BROWN	1	1	1	10Ω	± 1% (F)	100
RED	2	2	2	100Ω	± 2% (G)	50
ORANGE	3	3	3	1kΩ	± 3%	15
YELLOW	4	4	4	10kΩ	± 4%	25
GREEN	5	5	5	100kΩ	± 0.5% (D)	
BLUE	6	6	6	1MΩ	± 0.25% (C)	10
VIOLET	7	7	7	10MΩ	± 0.10% (B)	5
GREY	8	8	8	100MΩ	± 0.05% (A)	
WHITE	9	9	9	1GΩ		
GOLD				0.1Ω	± 5% (J)	
SILVER				0.01Ω	± 10% (K)	

LEDs

- Light Emitting Diode
- A Diode is a semiconductor that allows electricity to flow in only one direction



Switches

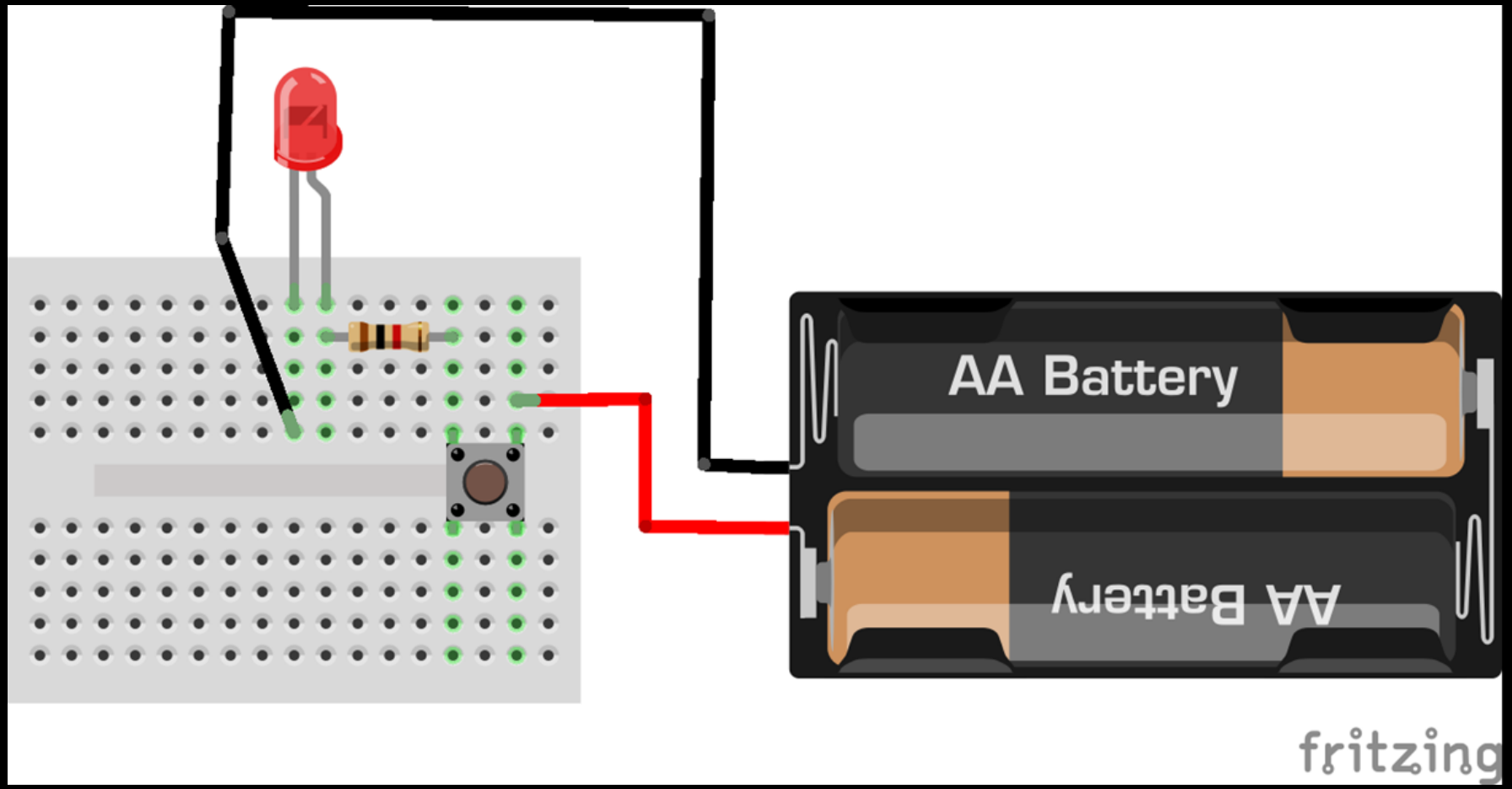
- Can take many forms, but all switches make an electrical connection between two parts of a circuit

Basic Circuits

Open and Closed Circuits

- **Open circuits** are circuits that are not complete, where the electrons cannot find a path to the negative “pressure” or negative battery/power terminal
- **Closed circuits** are the opposite – the electrons can find a way and the electricity will flow through the circuit!
- Keep in mind that the electrons will find the “flow path” with the least resistance. This creates a “**short circuit**” and could cause damage to your equipment.

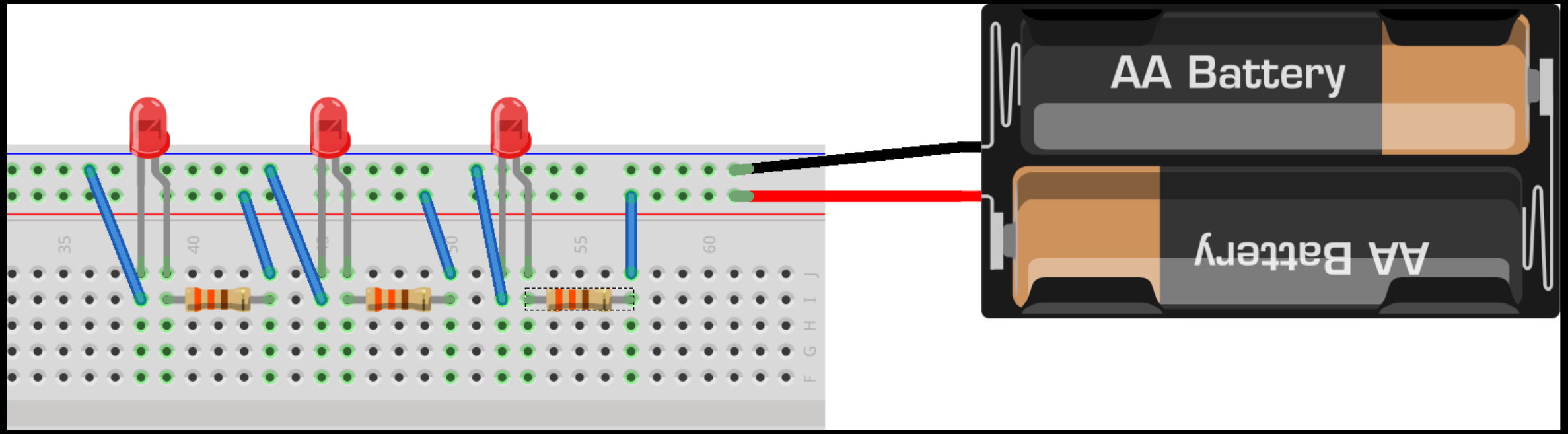
Basic LED Switch Circuit



Parallel Circuit

- Circuit resistance is the sum of all the resistors for each pathway

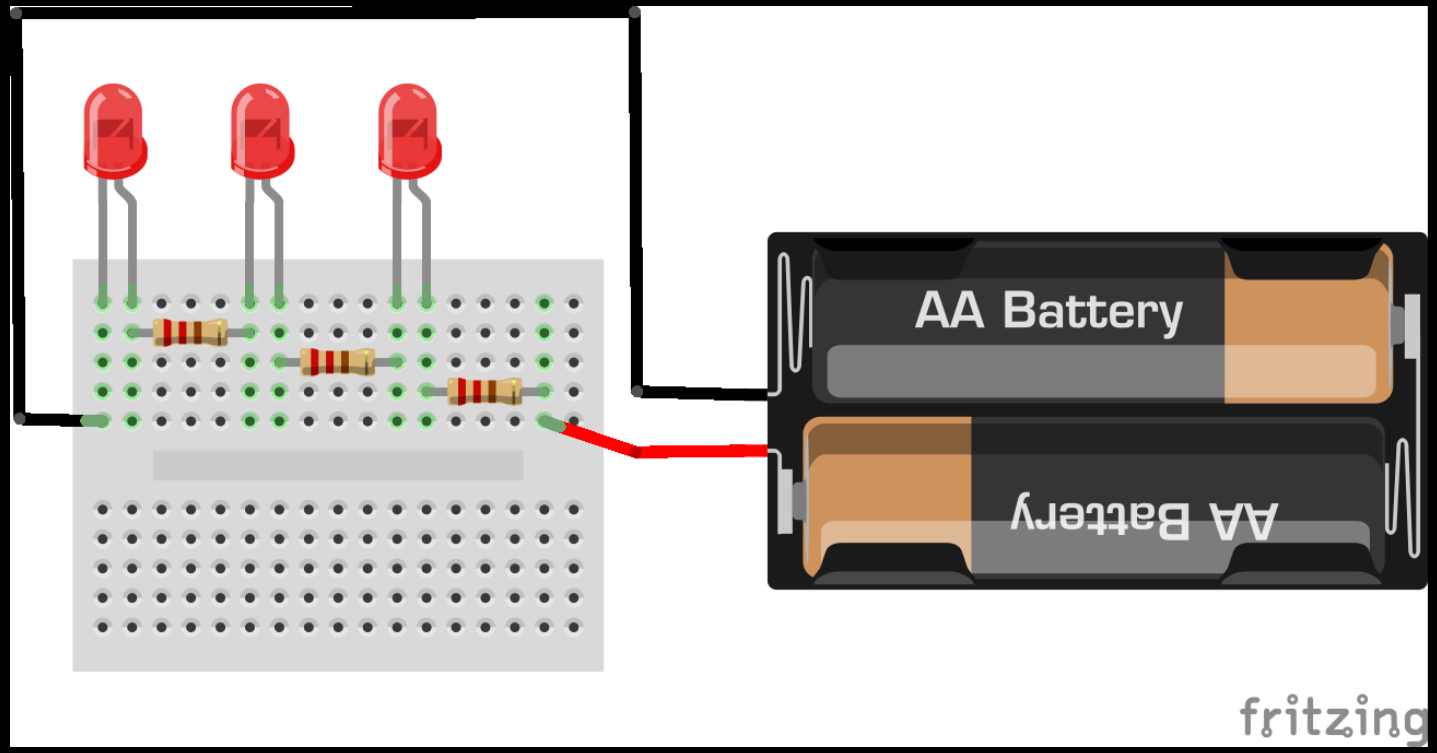
Total Resistance: R = R1, R = R2, R = R3, etc.



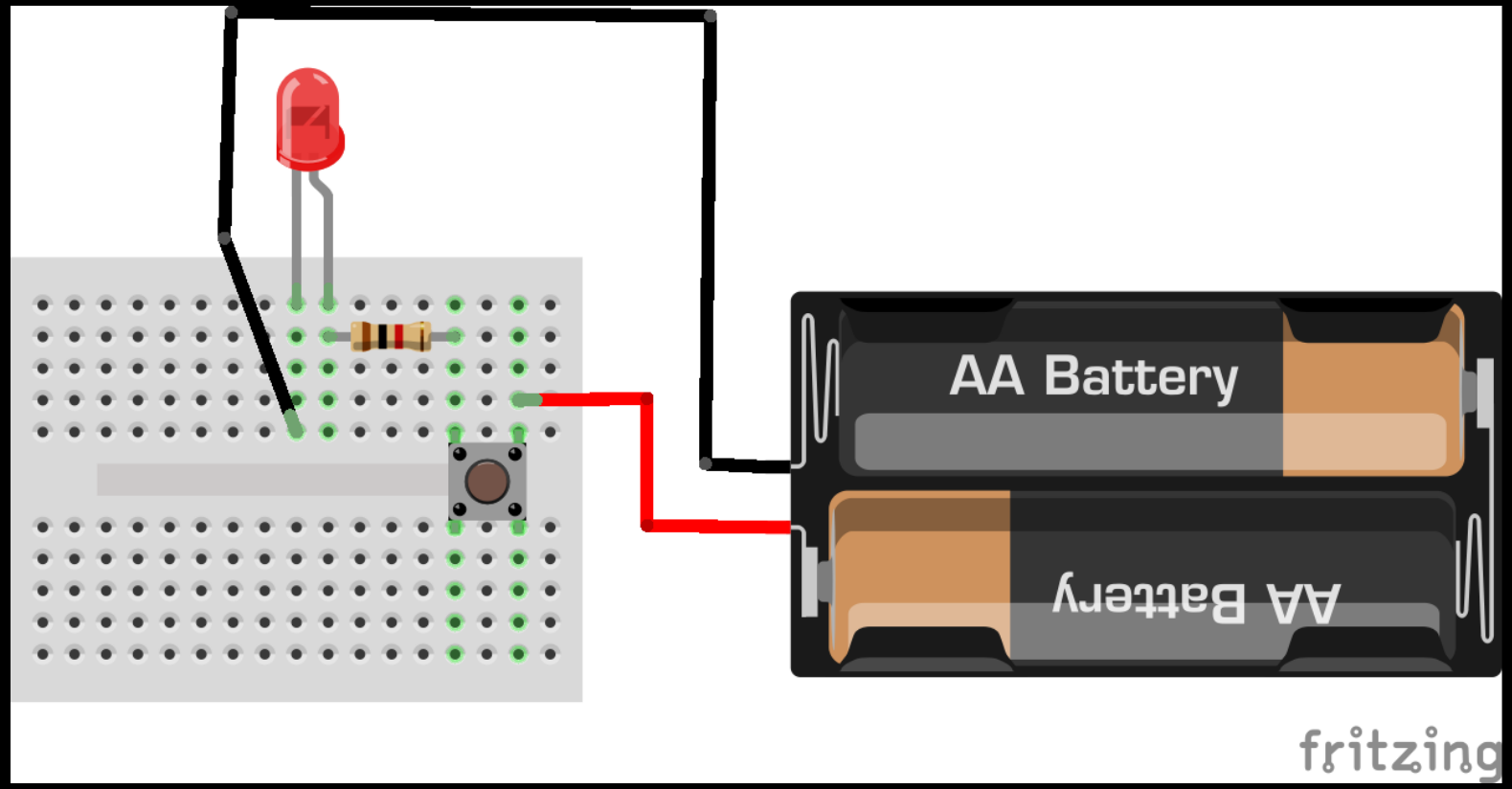
Series Circuit

- Circuit resistance is added together for all resistors in the series

Total Resistance = R1 + R2 + R3 +R4, etc.



Making Your Own LED Switch Circuit



Parts List (All in your Kit):

1. LED
2. Resistor (330 to 1k Ohm)
3. Button Switch
4. 2 Lithium Ion Watch Batteries
5. Watch Battery Case

Further Reading

- Circuits: https://learn.sparkfun.com/tutorials/what-is-a-circuit?_ga=2.255182408.1340962001.1569177210-1386735272.1560196141

Creative Switch Assignment

Assignment #2 /// CREATIVE SWITCH
10% of final grade /// due October 7th

This assignment explores your ability to use your newfound electronic knowledge to create a custom switch. This can be a soft circuit button, out of materials found at home, etc. Use your switch to turn on at least 2 LED's (you may use more LEDs if desired). Or, you can make two switch circuits that each light one LED. This assignment may be turned in as "bare bones", a.k.a. on a circuit board with exposed wires.

The emphasis here is on creating small sculptures or design objects, which incorporate an original or unique switch method that you design.

You should spend a good amount of time on brain storming and on construction. The components of the circuit may be relatively simple – it's really the mechanics of the switch (how it opens and closes) that will be your "ingenious" solution.

The switch should be functional!

Assignment #2 /// CREATIVE SWITCH
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Requirements & Deliverables

- Completion of assignment for in class critique
- Turn on at least 2 LED's OR use at least 2 switches to turn on at least 1 LED
- Documentation: 5 detailed high-resolution images of your piece to be emailed to the instructor before class on the due date of the project. Your email should also contain:
  1) a list of parts used
  2) a description/elaboration of what the images show
  3) a description of how the switch circuit is constructed and works
- Someone should be able to construct and understand the switch by using your email as a guide.

Examples from Prior Students

- https://intronma.wordpress.com/2017/02/07/trapped-light-ben-mckenna/
- https://intronma.wordpress.com/2017/02/07/creative-switch-alexis-clodfelter/
- https://intronma.wordpress.com/2017/02/07/creative-switch-by-kyle-lindenman/
- https://intronma.wordpress.com/2017/09/24/creative-switch-project-2/
- https://intronma.wordpress.com/2018/02/12/creative-switch-brains/