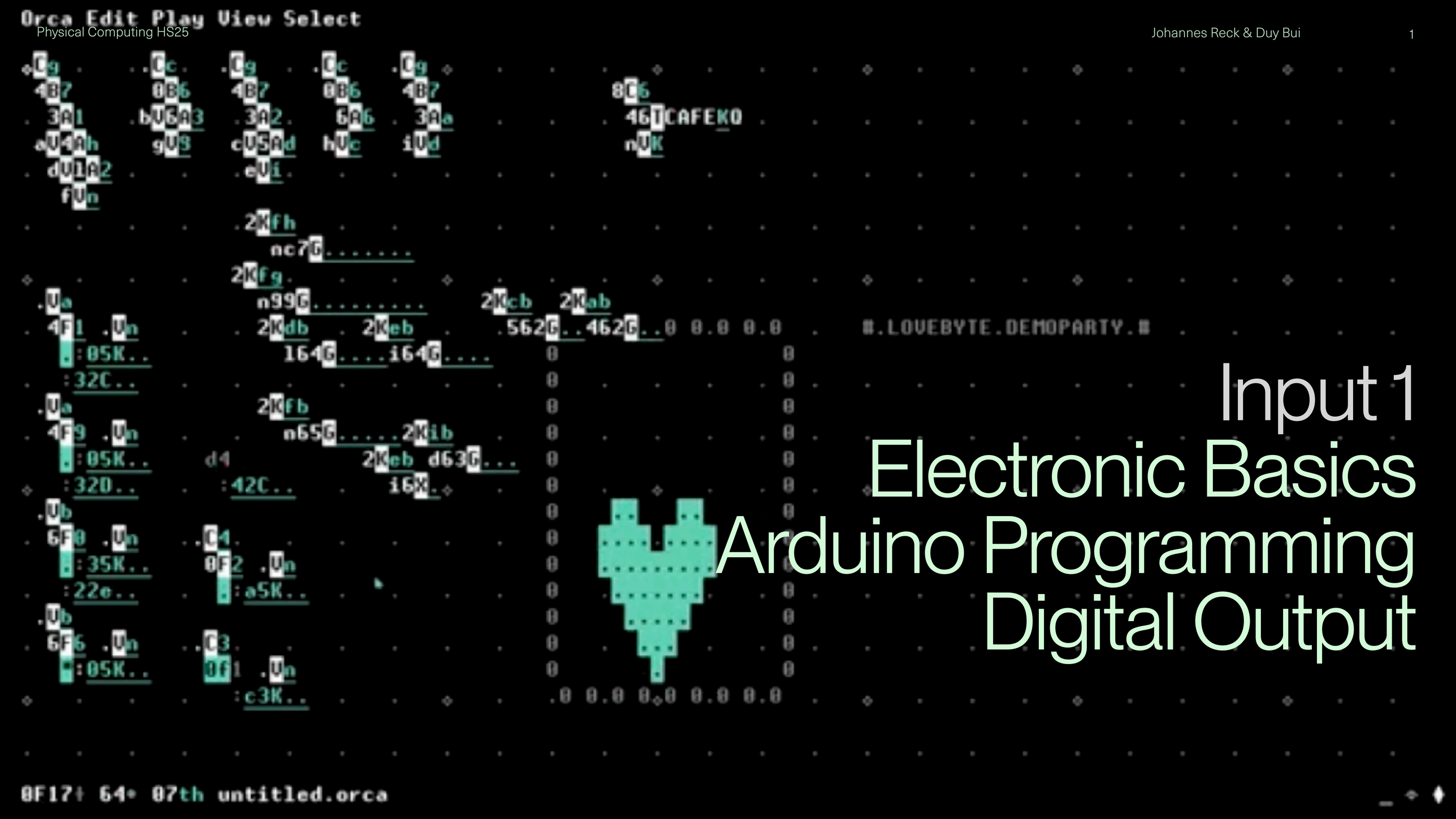
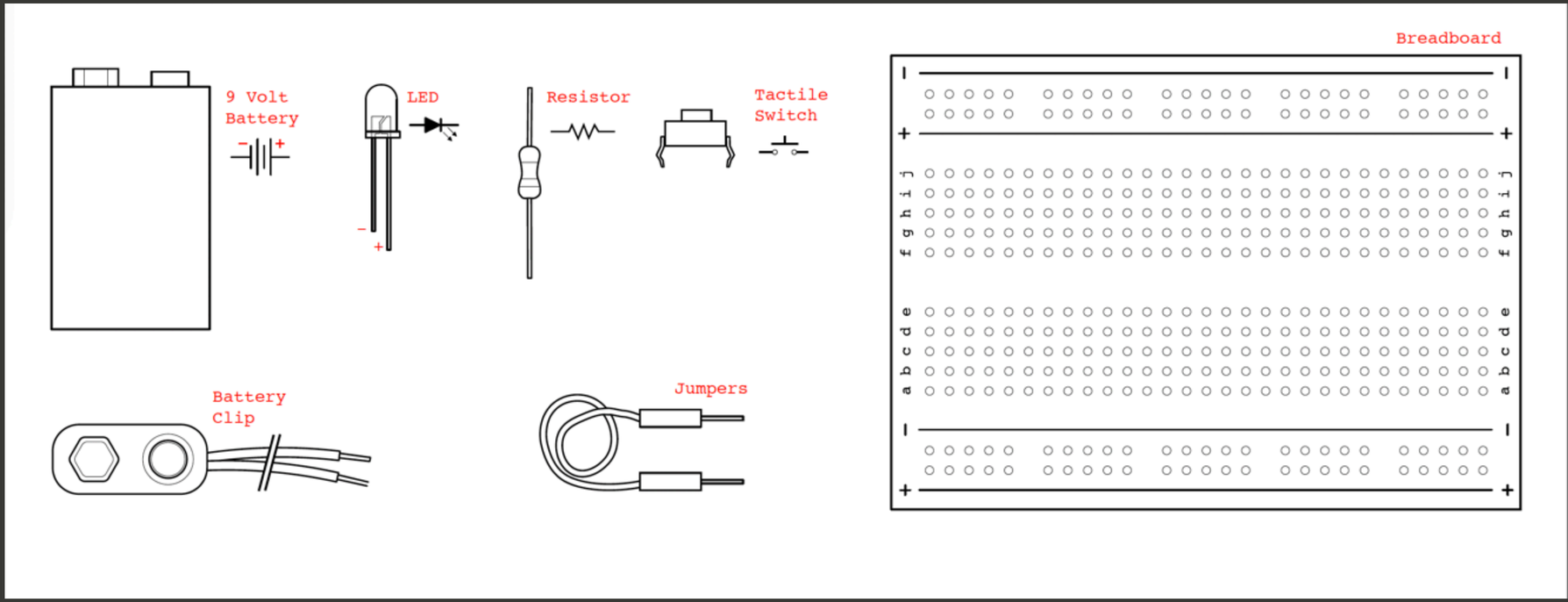



# Input 1
# Electronic Basics
# Arduino Programming
# Digital Output

# Electronic Basics

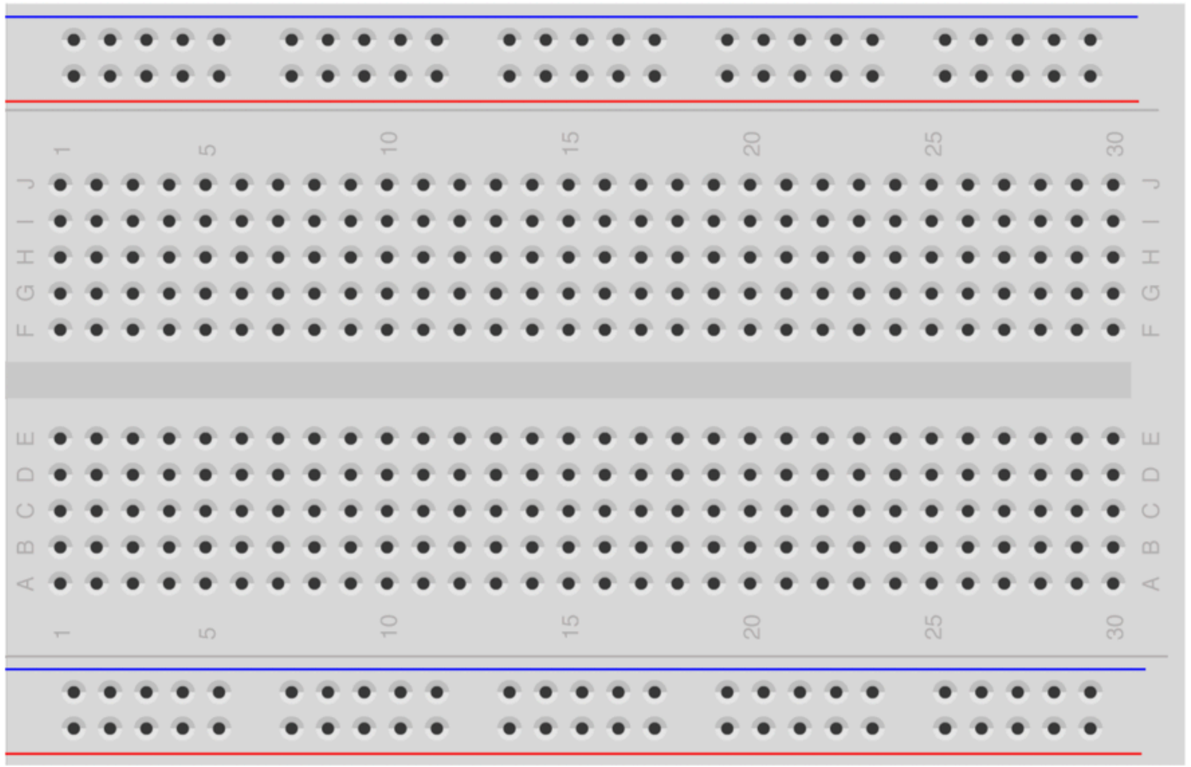
# Fundamentals of Electricity

# Exercise 1.1: Electricity

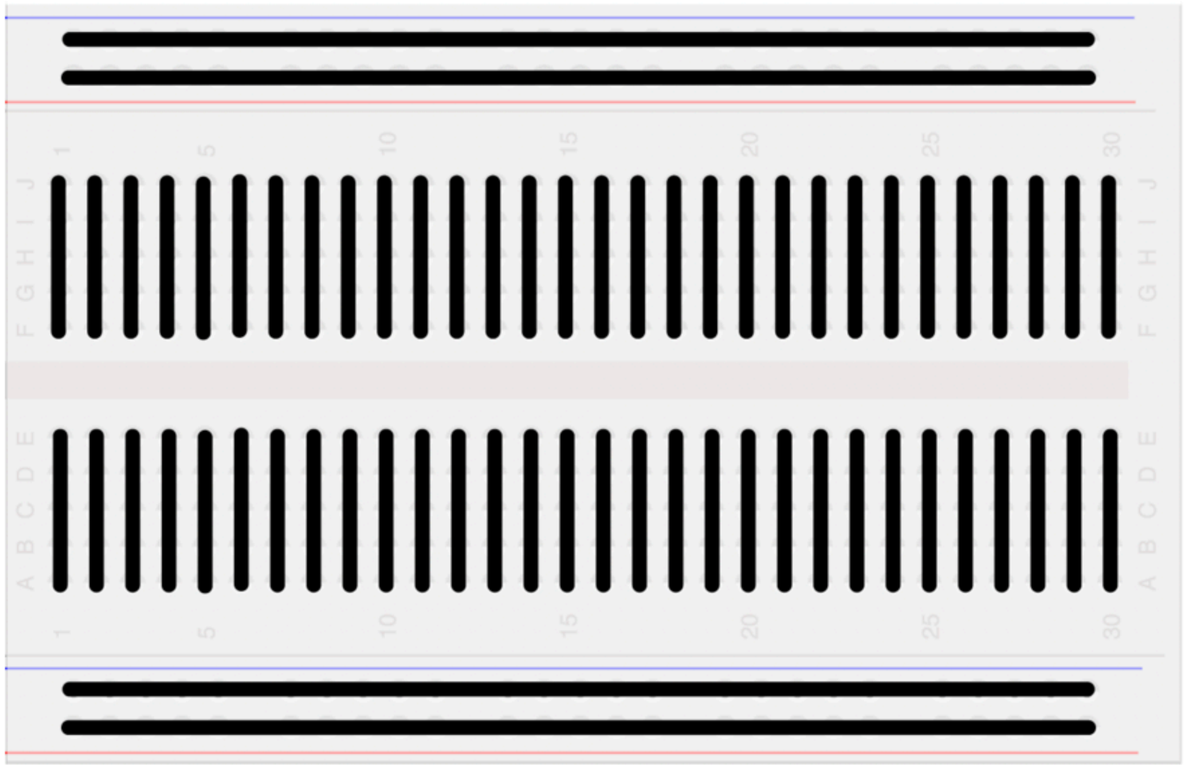



Using the materials shown, create a circuit with an LED that can be switched on and off.

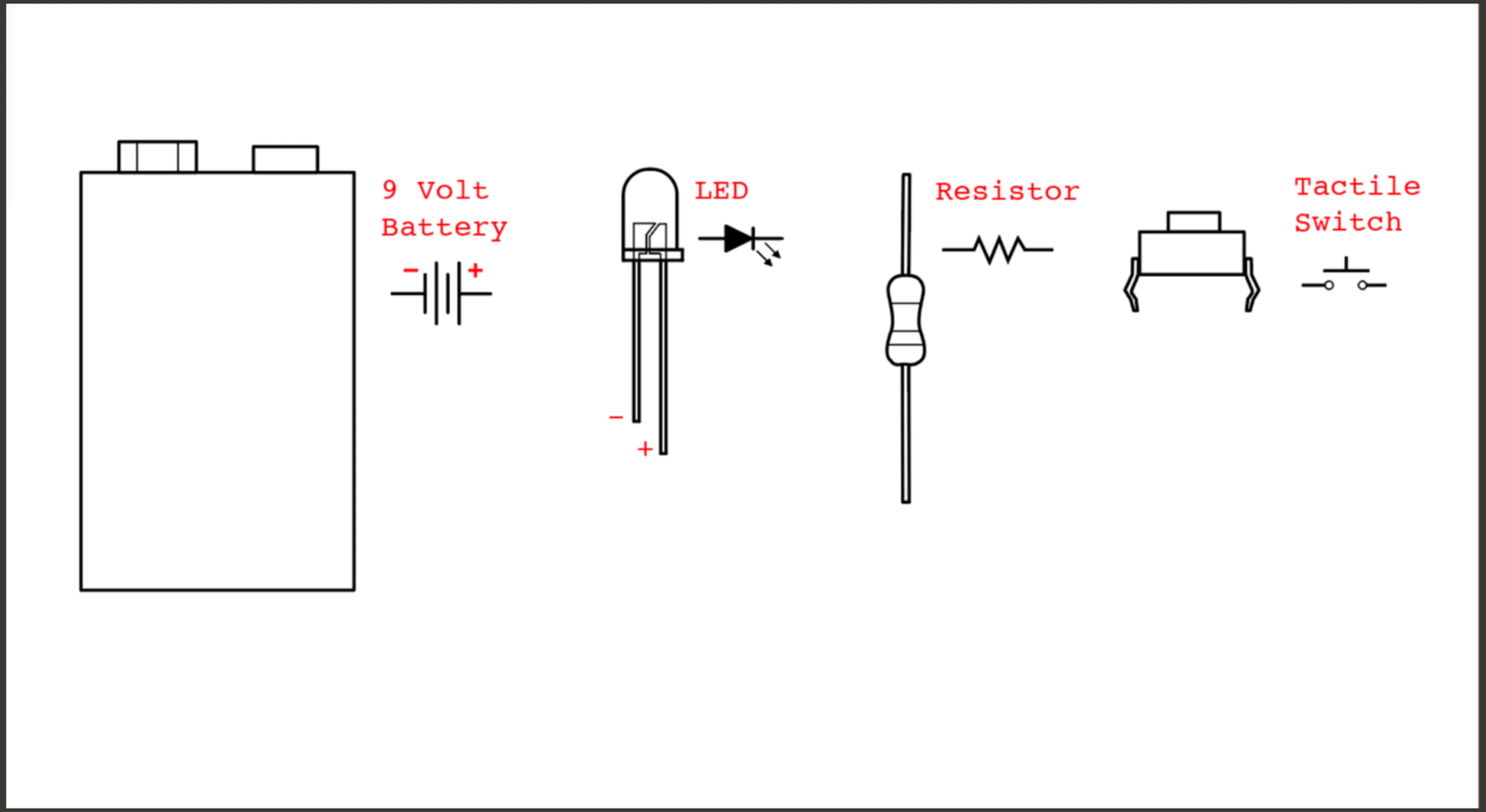
# Breadboard



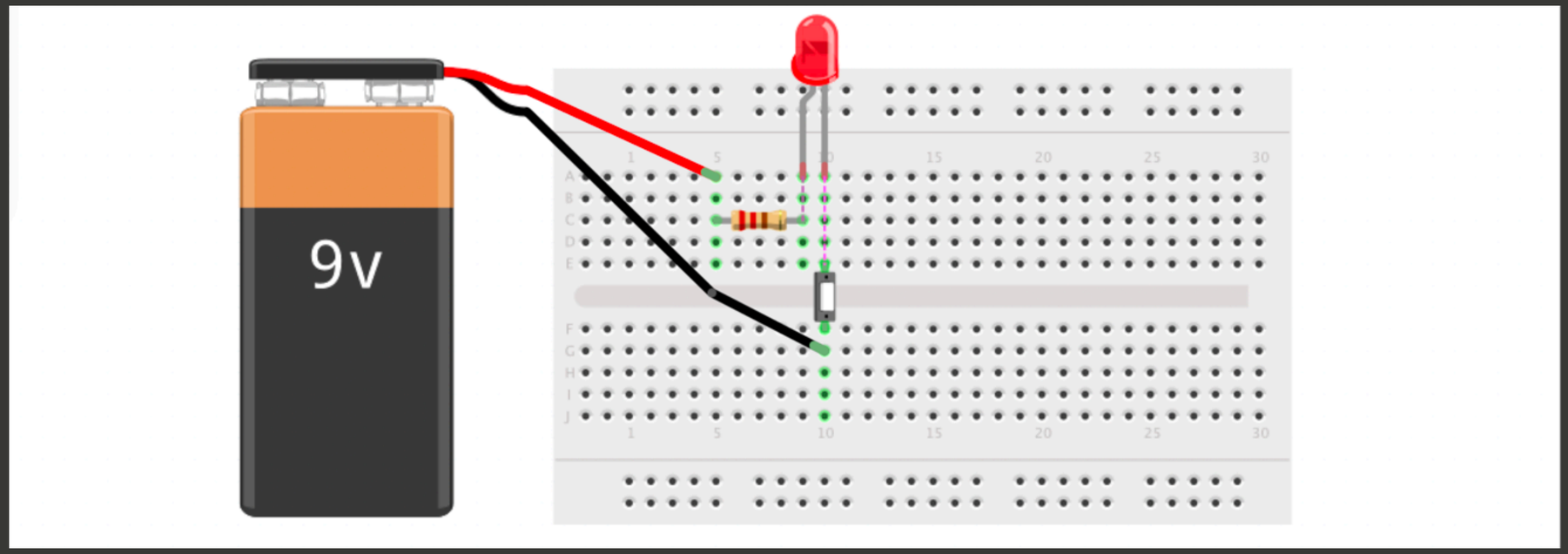
# Breadboard



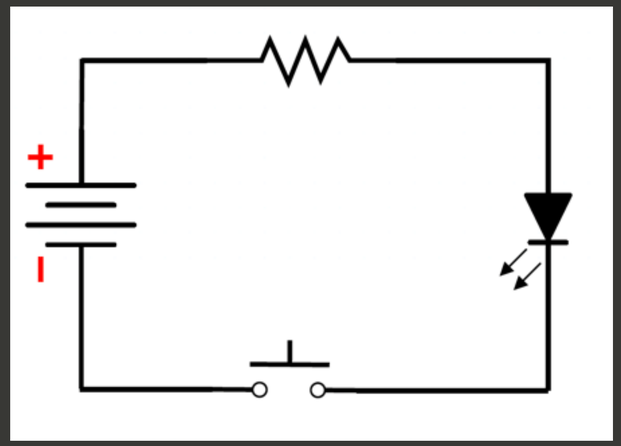
# Components



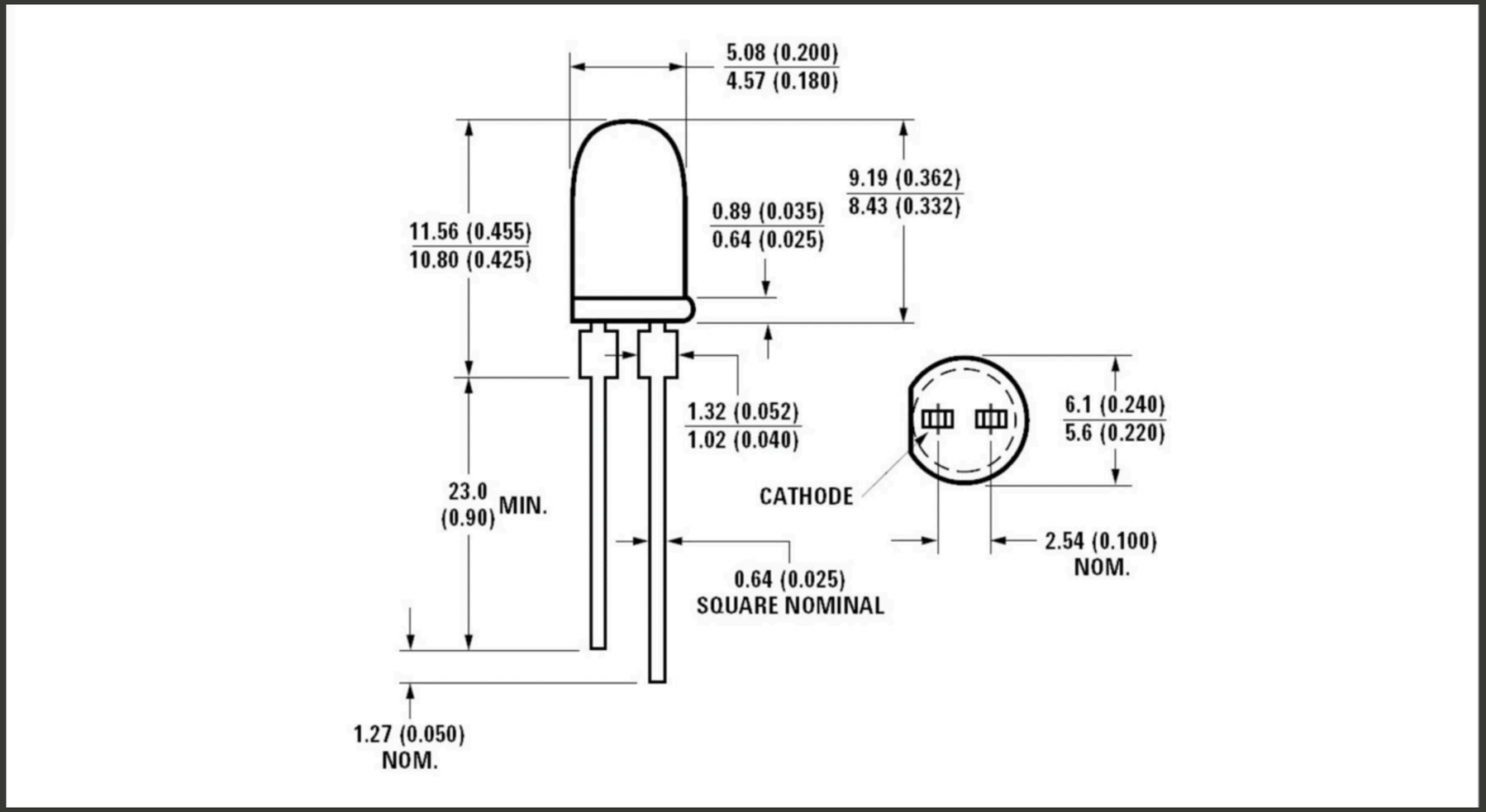
# Solution



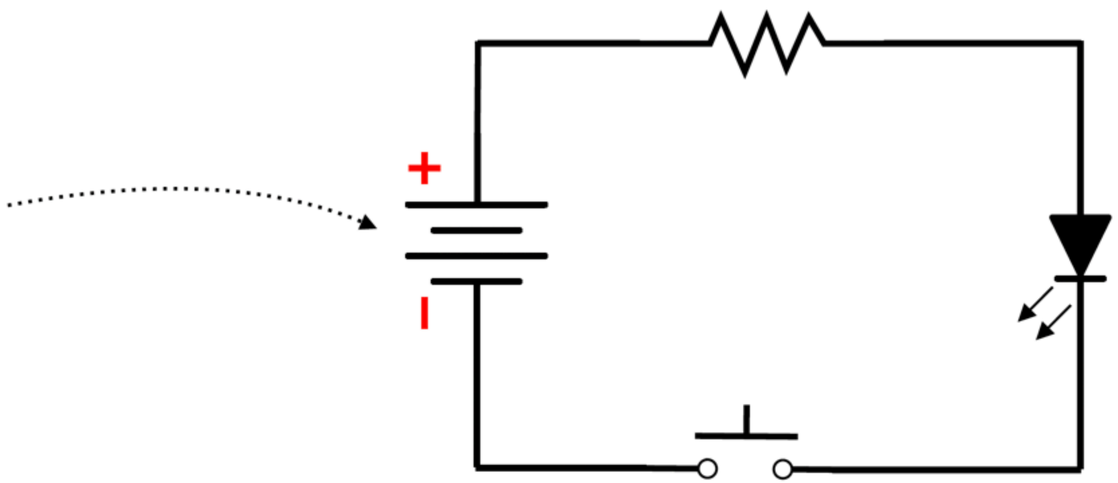

Note: 330 ohm is a suitable resistor, we will find out why latter.



# Led Polarity



# Schematics

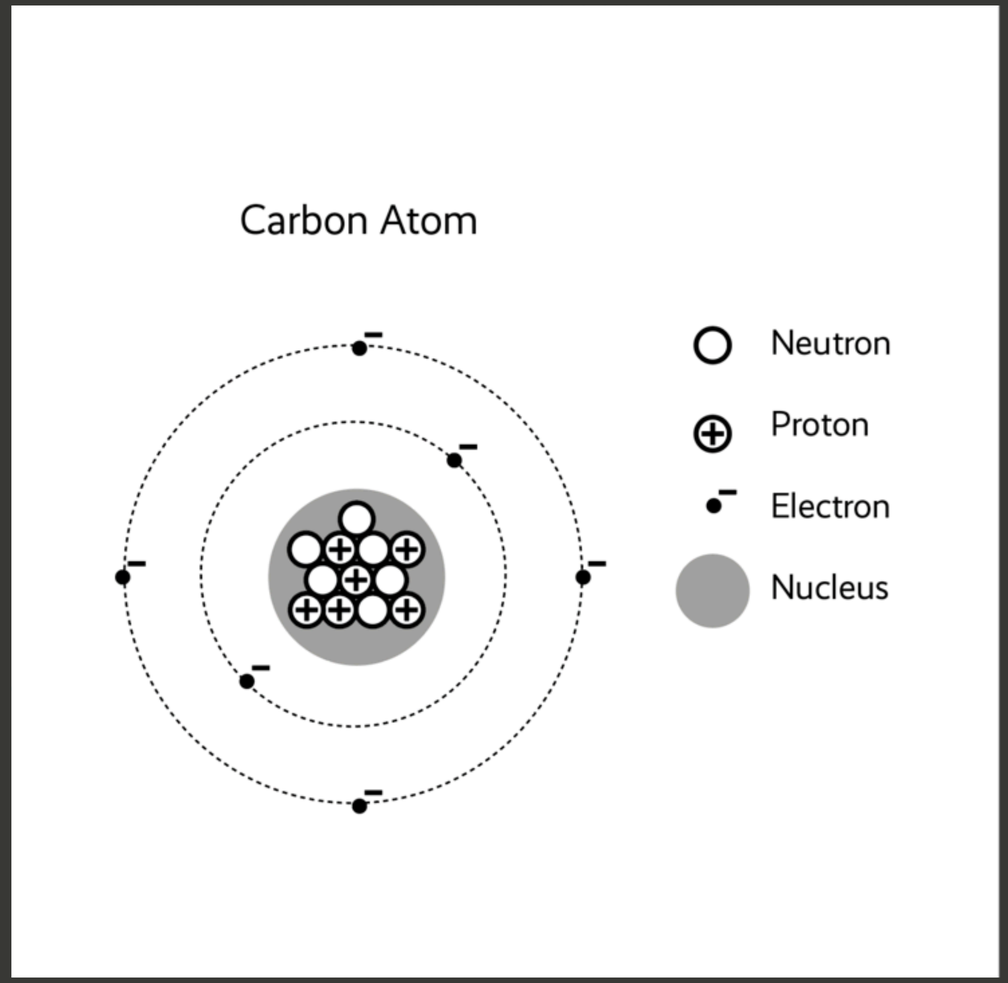



Many schematic symbols are pictorial in nature.

Using the materials shown, create a circuit with an LED that can be switched on and off.

# Atoms and Electromagnetic Force

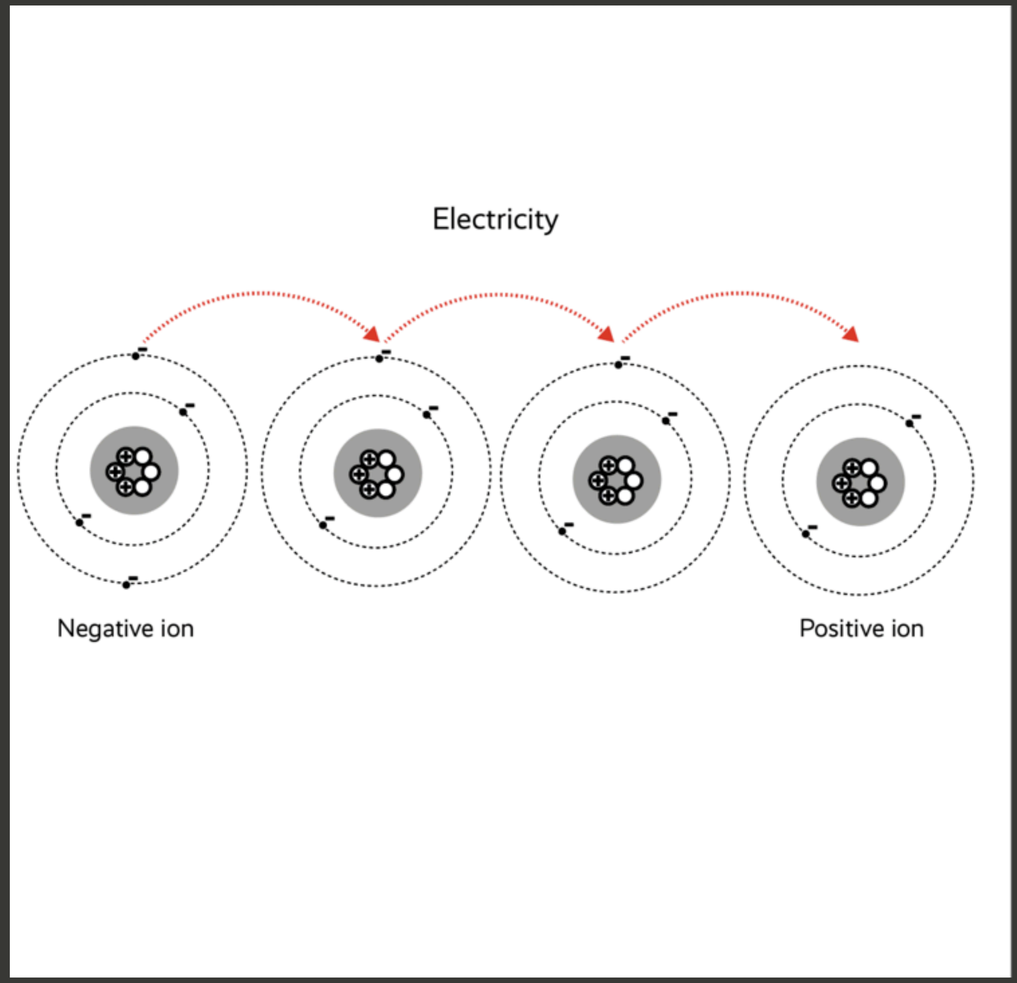
- Electricity is the interaction and movement of positive and negativity charged sub-atomic particles.
- Negatively charged electrons are attracted to positively charged protons (electromagnetic force)
- Protons are strongly held in the nucleus of an atom, but electrons are more mobile



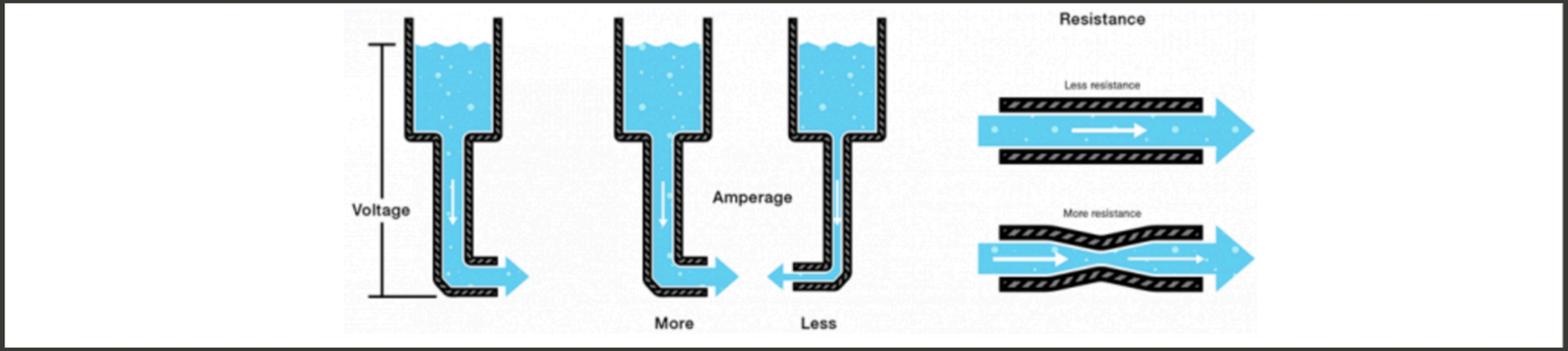
# Electricity

- The attraction (and repulsion) between subatomic particles can cause electrons to flow though conductive materials to reach positively charged atoms

- The difference in charge left to right in this diagram can be measured in volts.
  The amount of electrons flowing can be measured in amp and the resistance to flow from the atoms can be measured in ohms

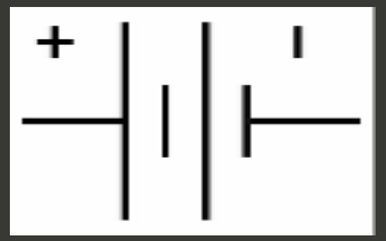


# Water Analogy



# Voltage [Volts]

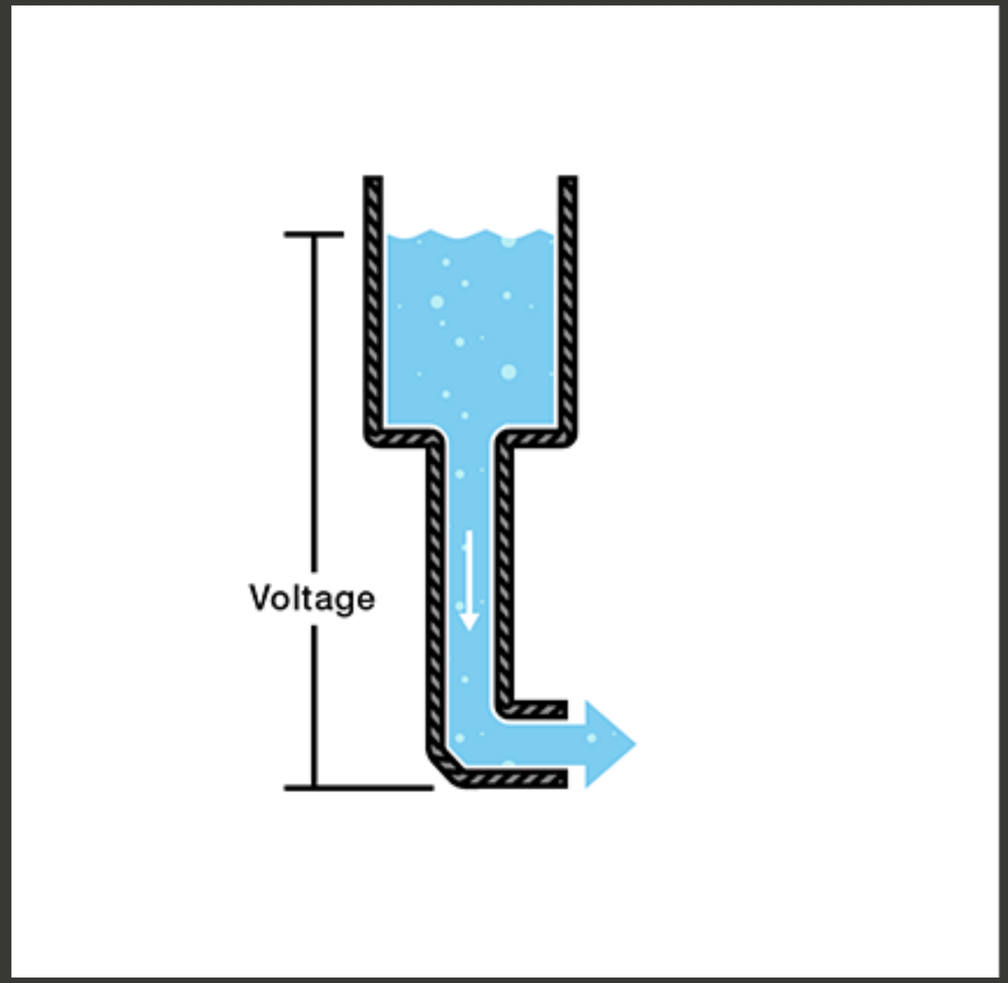
- Volts are measure of difference in electrical charge between two points.
  Voltage can exists in a system even if there is no circuit, as it refers to potential difference.




Power Supply Symbol

**UNITS: Volt**

| (mili) mV | V | (kilo) kV |
|---|---|---|
| 1000 | 1 | 0.001 |



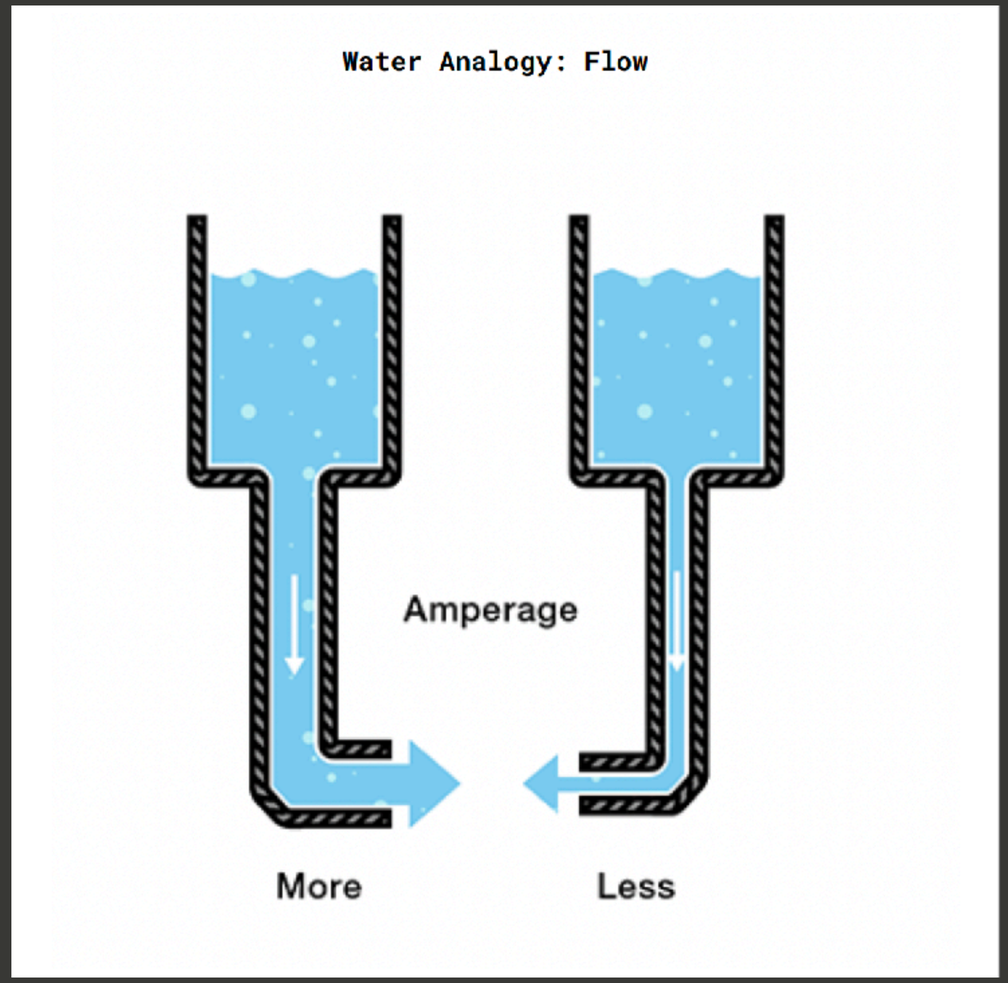
# Current [Ampère]

- Current is the amount of electrons moving through material per unit of time (flow).
  A circuit needs to be closed before electrons can flow, so we can only observe current in a working circuit.

- In a simple circuit, the same amount of current will be moving through every point (and every component).

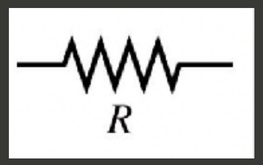
**UNITS: Amps**

| (micro) µA | (Mili) mA | A |
|---|---|---|
| 10000 | 1000 | 1 |



# Resistance [Ohm]

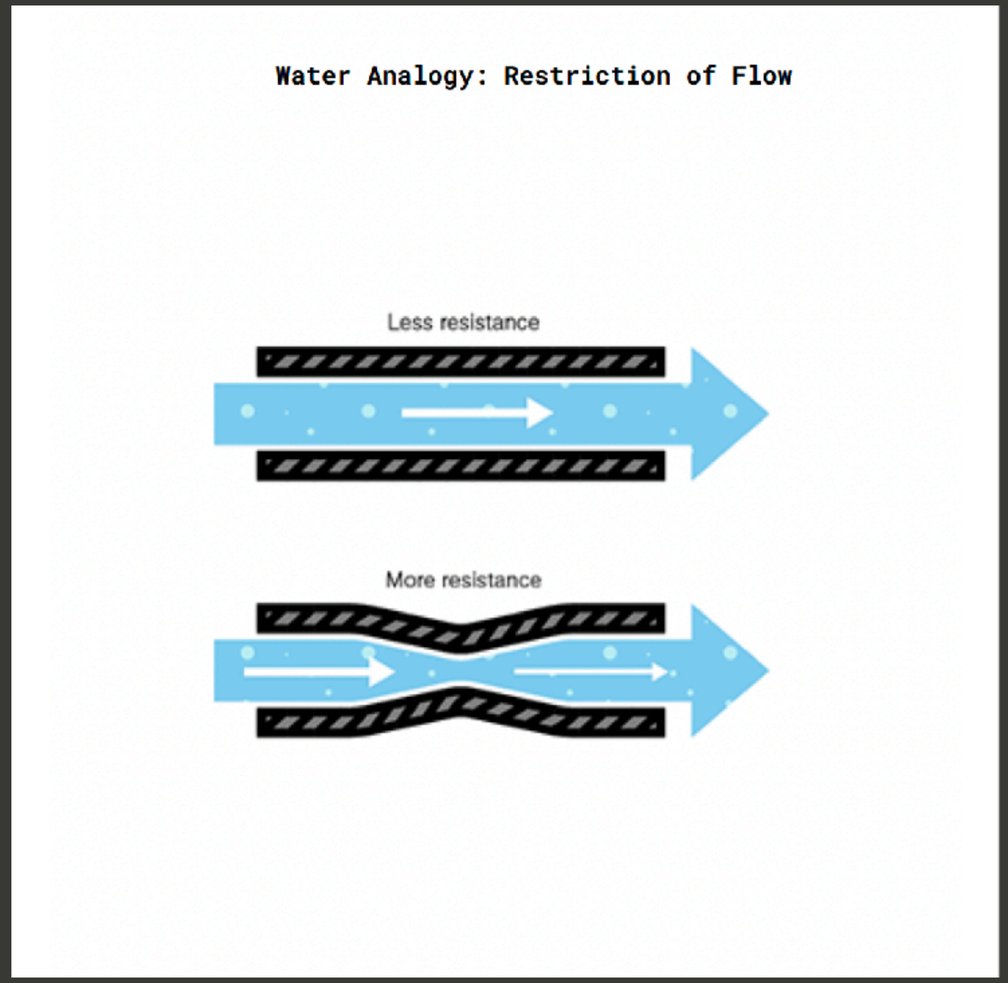
- Resistance is the measure of restriction in a material to the flow of electrons.
- All electronic components (including wires and batteries) have a resistance.
  However we mostly control this explicitly with a component called a resistor.



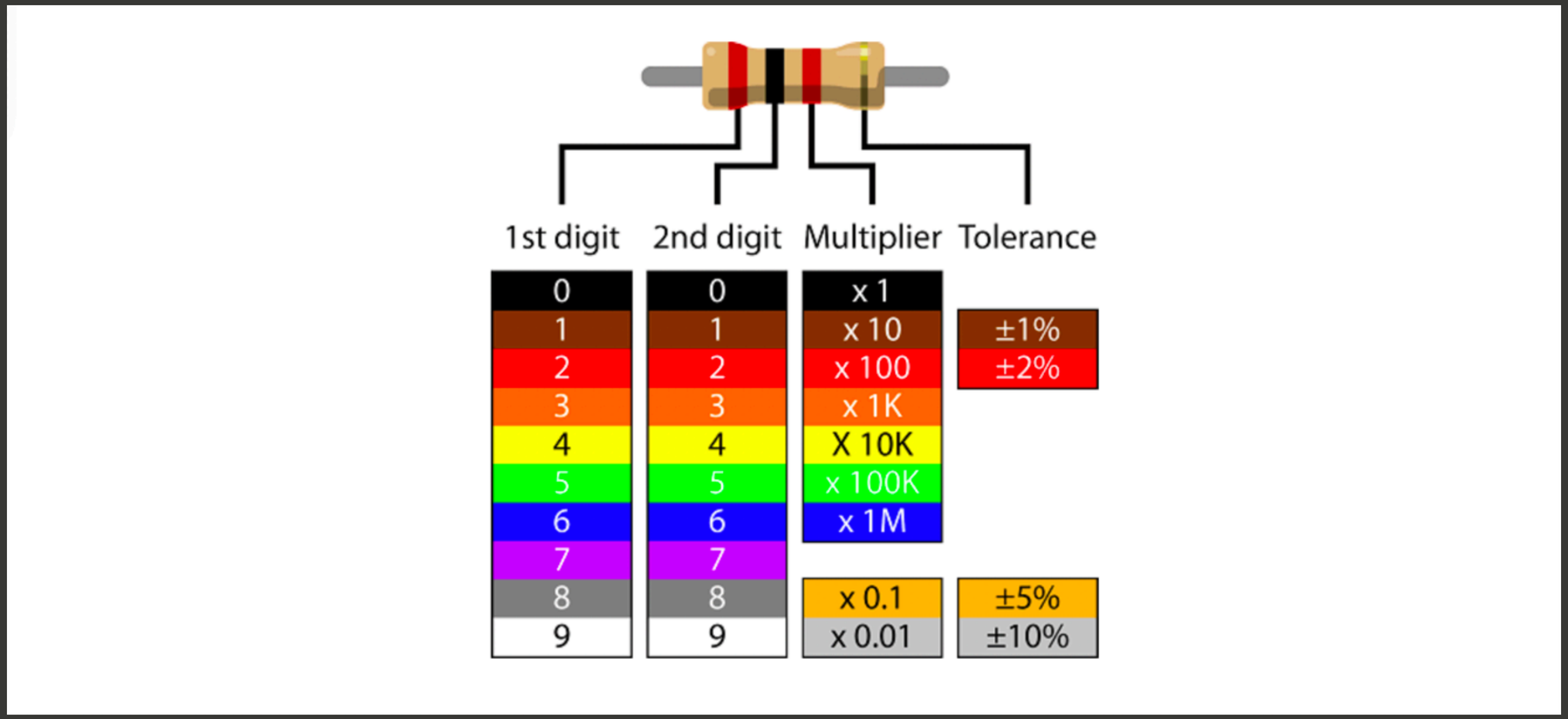

Resistor Symbol

**UNITS: ohms (Ω)**

| Ω | (kilo) kΩ | (mega) mΩ |
|---|---|---|
| 1 | 0.001 | 0.000001 |



# Resistors

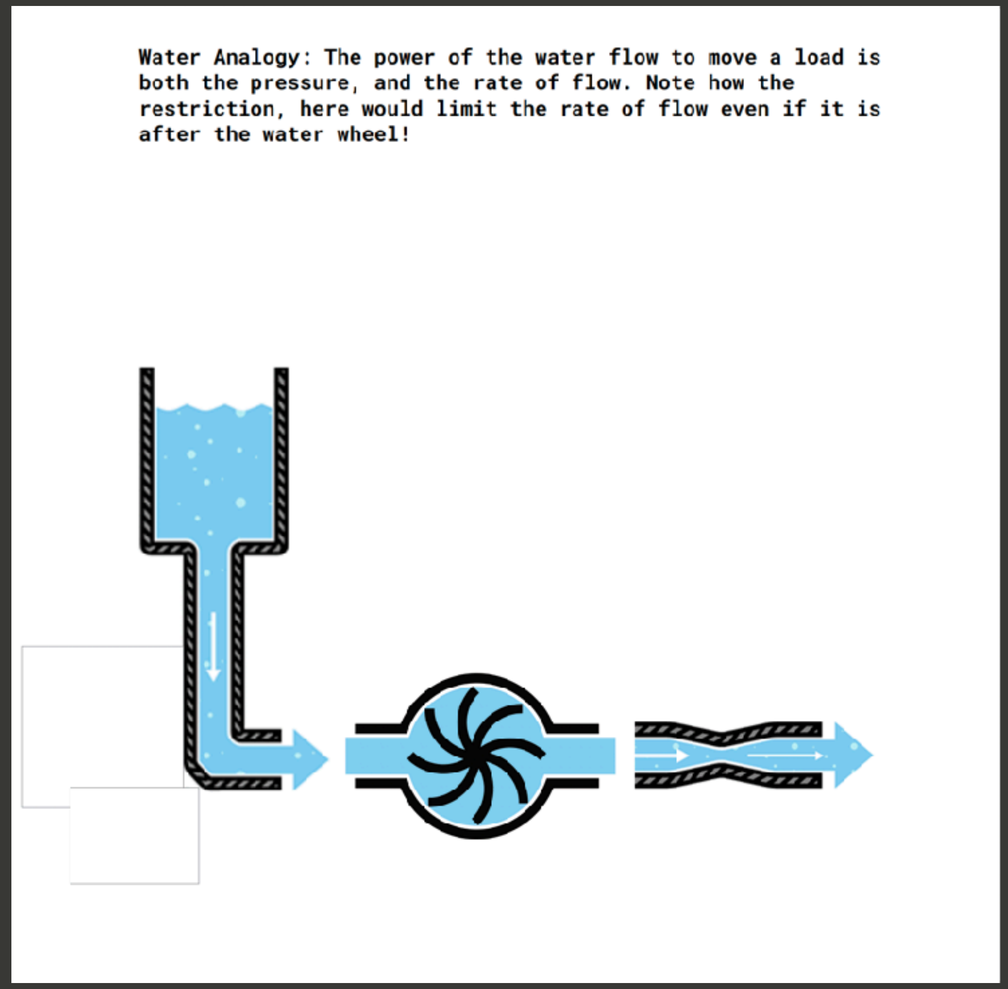

1st digit
2nd digit
Multiplier
Tolerance
0
1
2
3
4
5
6
7
8
9
x 1
x 10
x 100
x 1K
X 10K
x 100K
x 1M
x 0.1
x 0.01
±1%
±2%
±5%
±10%

# Power [Watt]

- Watts are measure of power (or energy transfer)
- Watts can be found by multiplying the current and the voltage in a circuit.
- When current passes through a component, there is a voltage drop.

UNITS: Watt

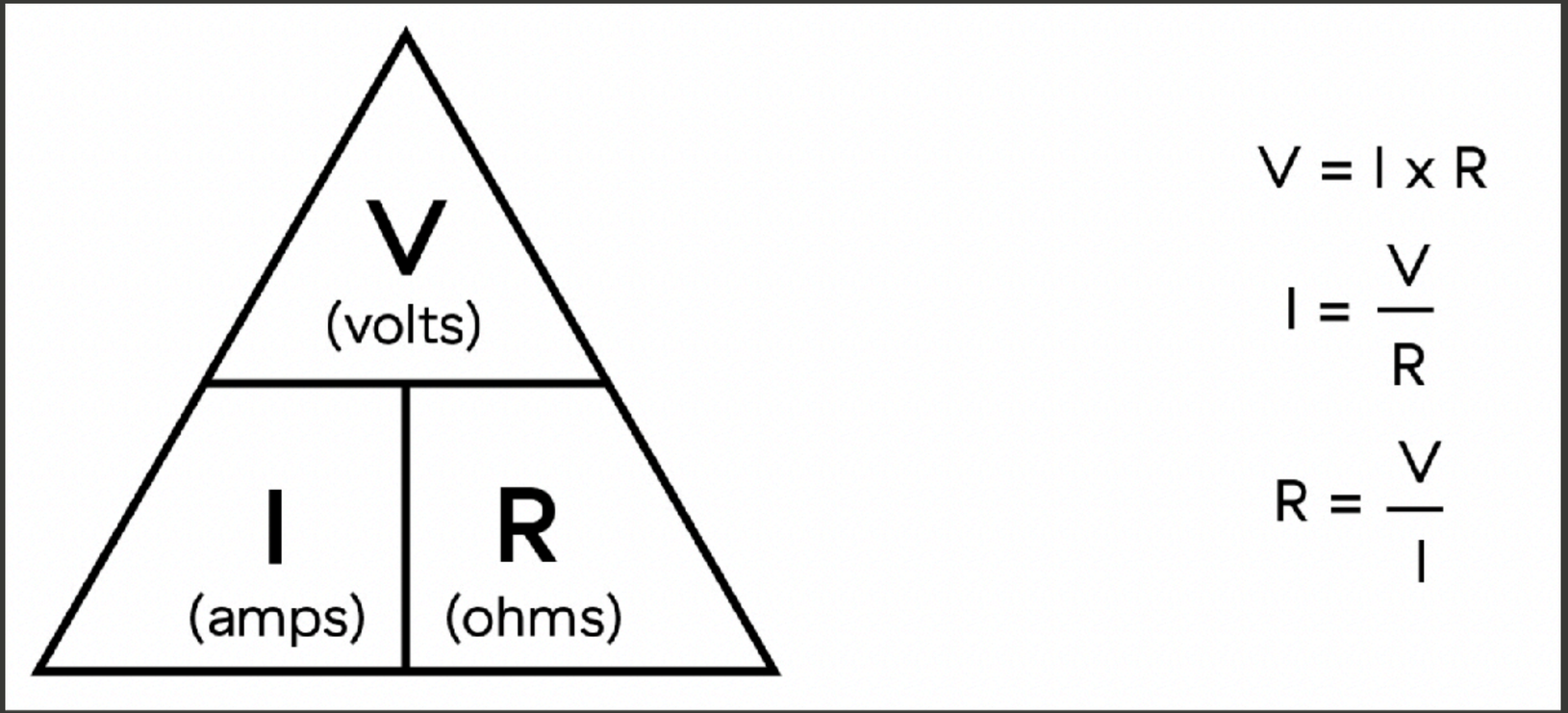
| (mili) mW | W | (Kilo) kW |
|---|---|---|
| 1000 | 1 | 0.001 |



# Power

**Watts = V [volts] x I [amps]**

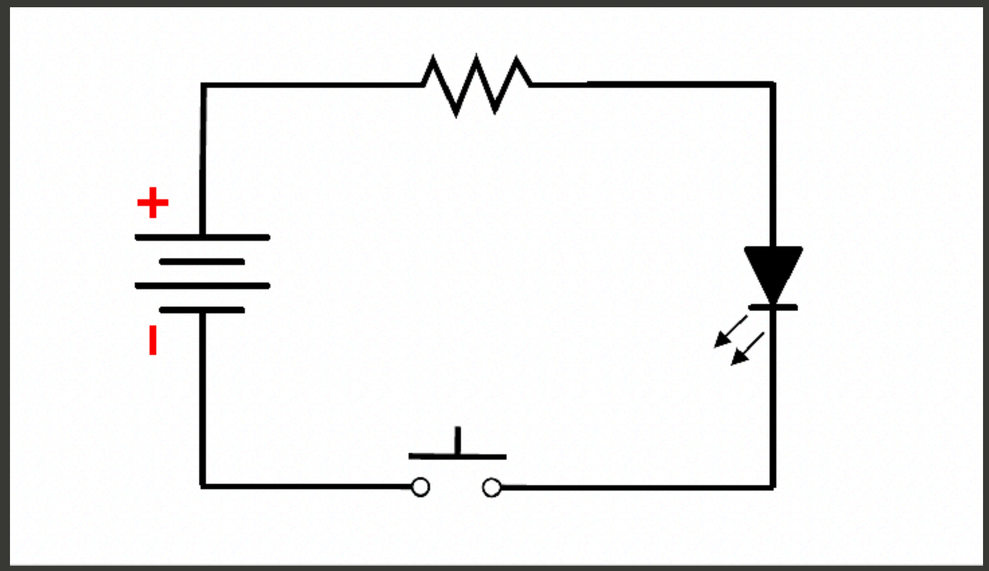
# Ohms Law




There is an intrinsic relationship between voltage, current and resistance, expressed in *Ohms Law*.
We can use this formula to deduct the values in many situations.

# Series Circuit

- In a series circuit, the same current runs through all wires and components.
- Voltage can vary, depending on where we measure it in the circuit, but will normally be constant between the terminals of the voltage source.



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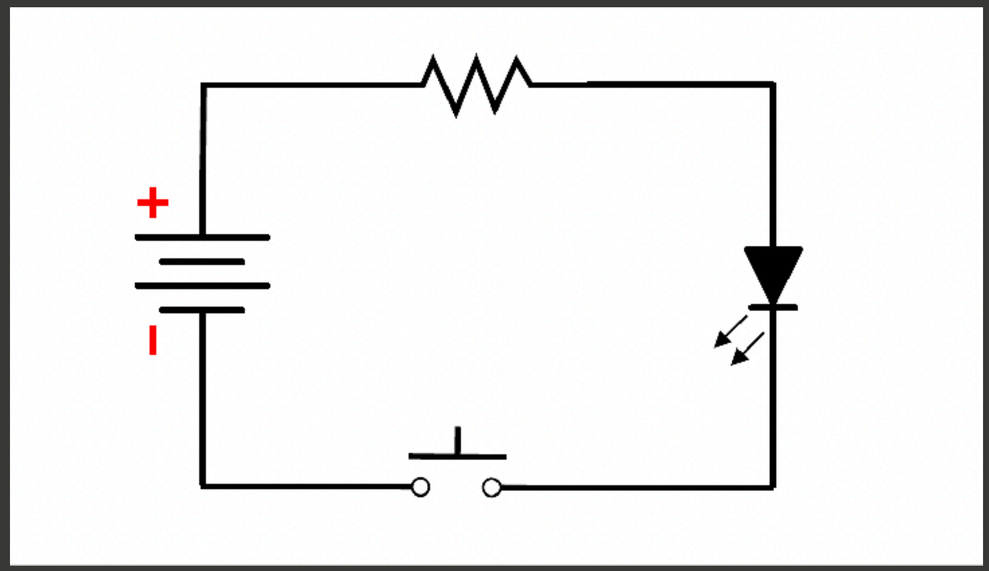
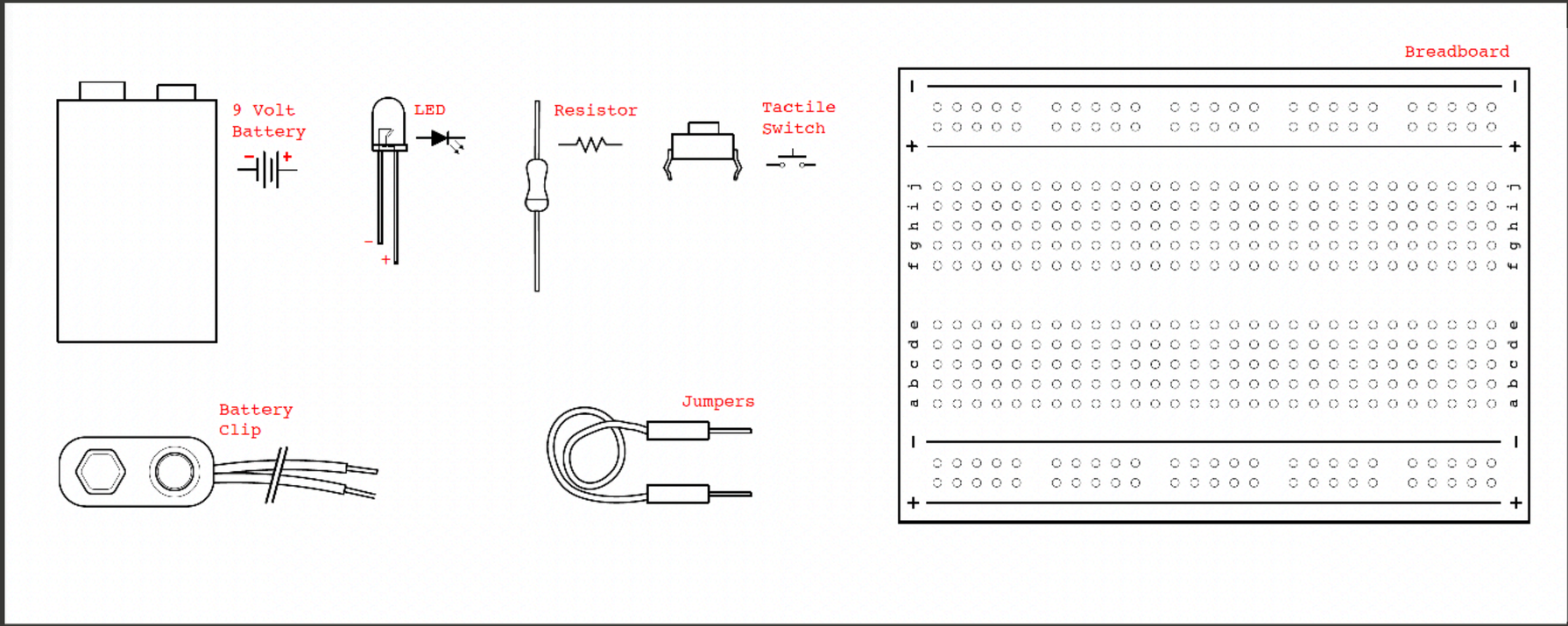


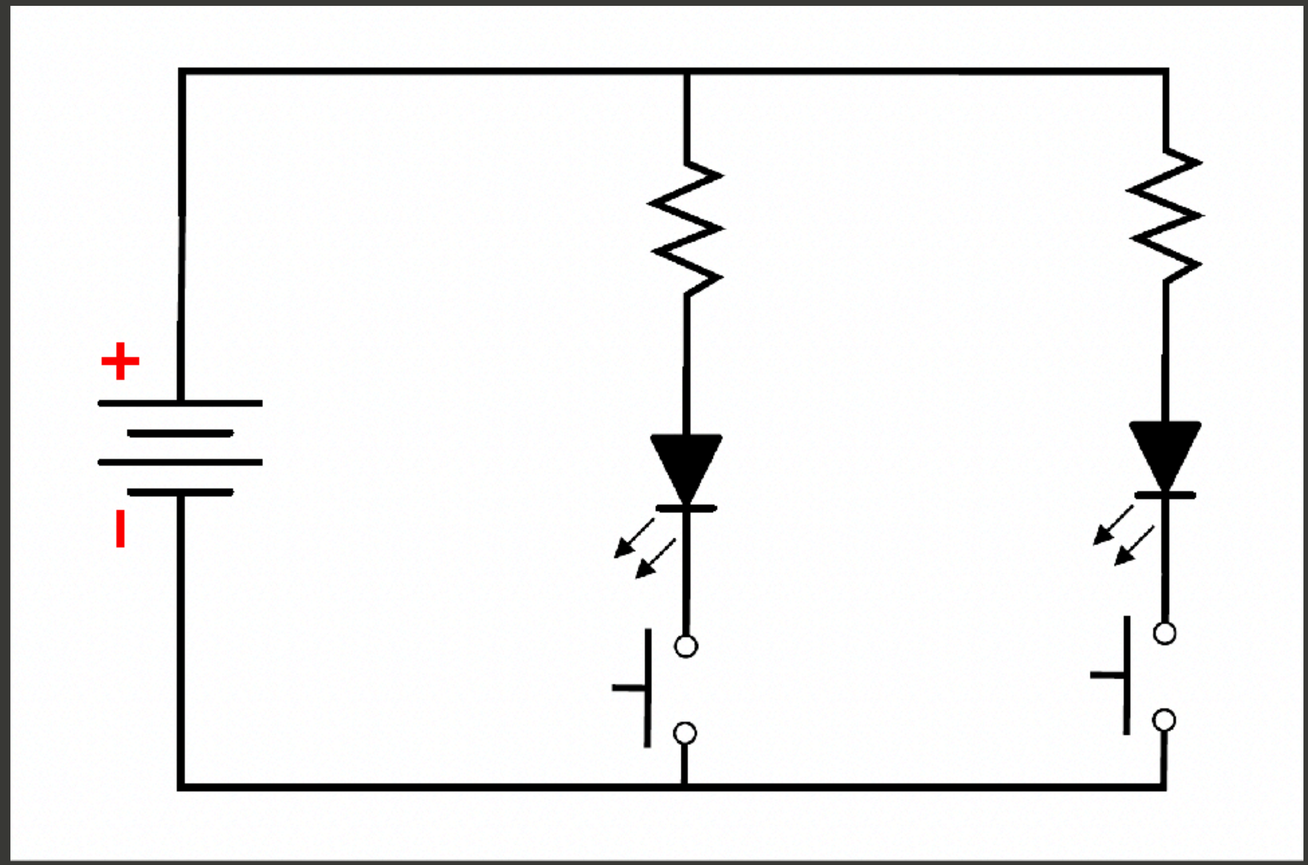
# Exercise 1.2: Parallel Circuits



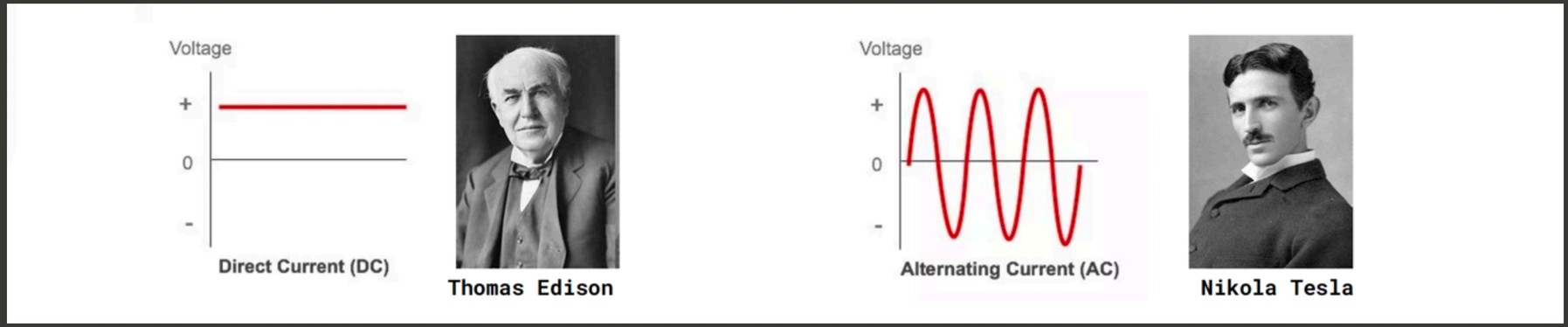

Add another LED to your circuit, that can be controlled by its own button

# Possible Solution

Note: In a parallel circuit, the total current is divided into each parallel pathway.
How this is divided will depend on the load, which in this case would be the same if both buttons are pressed.

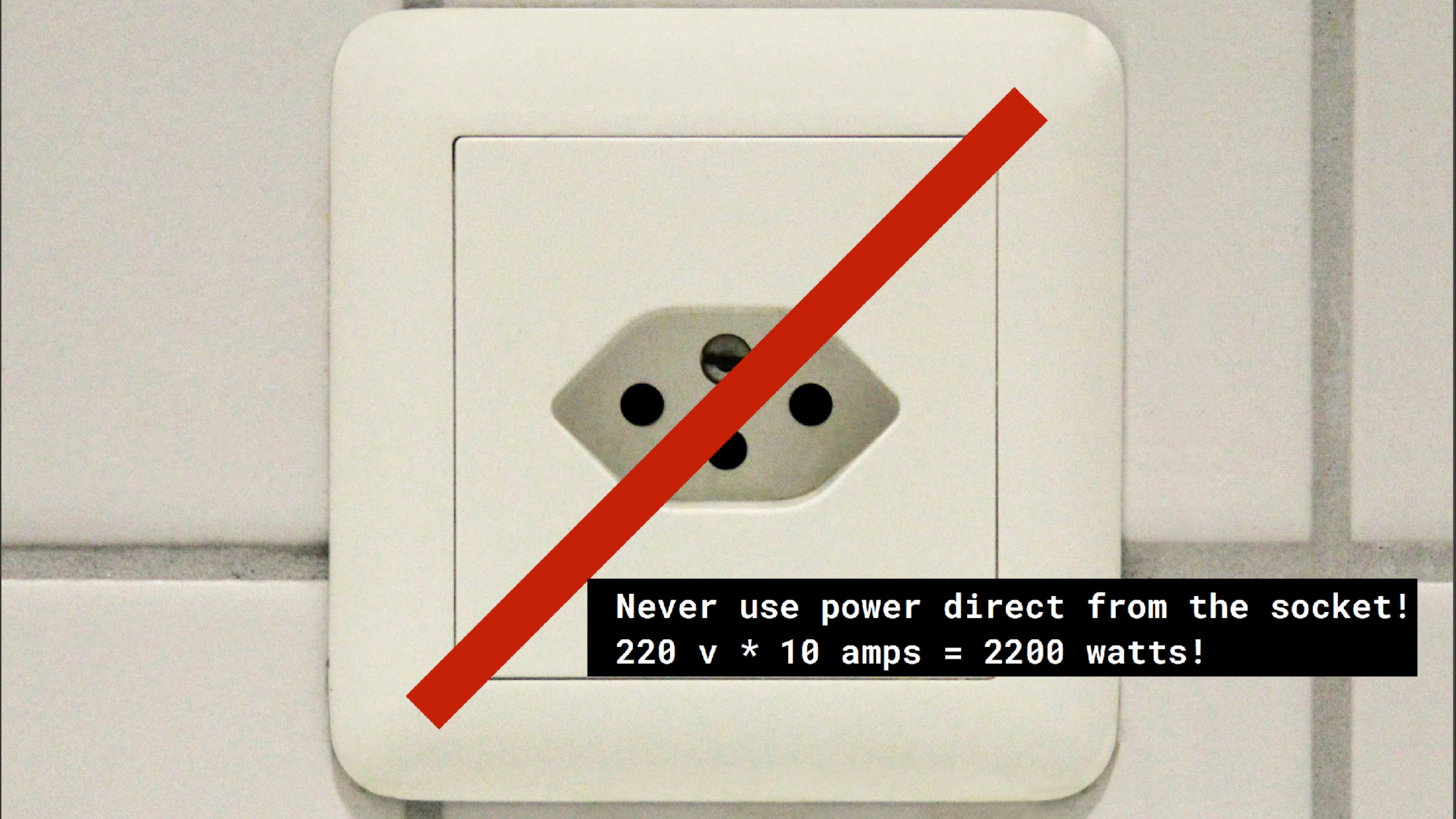


# AC vs DC




- Direct current is easier to store (batteries and capacitors)
- DC is required for many low power components and devices (LEDs, Computers, Sensors etc)
- DC is easy to work with in low voltage applications

- Alternating current can be easily converted up or down in voltage
- Higher voltages can be transmitted with less energy loss over long distances, and easily converted to other voltages
- Most electrical generators output AC
- Many high power devices can be driven directly by AC (motors, refrigerators, traditional light bulbs)


Never use power direct from the socket!
220 v * 10 amps = 2200 watts!

# Hazards: LIPO Batteries