STATE LIBRARY QUEENSLAND

STATE LIBRARY QUEENSLAND

Electronics Bench Induction

Acknowledgement of Country

We acknowledge Aboriginal and Torres Strait Islander peoples and their continuing connection to land and as custodians of stories for millennia. We respectfully acknowledge the land on which we all meet today, and pay our respects to elders past, present and emerging.

INDUCTION SUMMARY

The Edge at State Library of Queensland offers the public use of an electronics workbench.

In this induction you will learn;

- Health and safety information
- Basic understand of circuits and common components
- Safe and efficient use of equipment
- Soldering practice
- Booking procedures

Once you've completed the induction you can book and use the Electronics Bench at The Edge during Open lab.

Open lab sessions are a chance to meet up with like-minded makers and tinkerers at The Edge with facilitators to support your creative needs in the space.

Bookings are required to use the equipment and you will be able to book with your SLQ account once you have completed the relevant induction.

Wednesdays & Saturdays 12:00pm – 5:00pm
Thursdays 1.30pm – 8:00pm

For more info and to book, head
https://www.slq.qld.gov.au/visit/spaces/edge

INDUCTION RUN THROUGH

1. **Safety**
2. **Equipment overview**
3. **How a circuit works**
   - Flow
   - Ohm's law
   - Components
   - Activity with breadboards
   - Activity with multimeter
4. **Soldering / Desoldering**
   - Types; Surface mount, through hole soldering, good solder joint, bad solder joint
5. **Practical demonstration of soldering**
   - populate board
   - good solder joints
   - diagnose fault
6. **Diagnostic tools**
7. **Hand tools**
8. **Hands on activities**

SAFETY

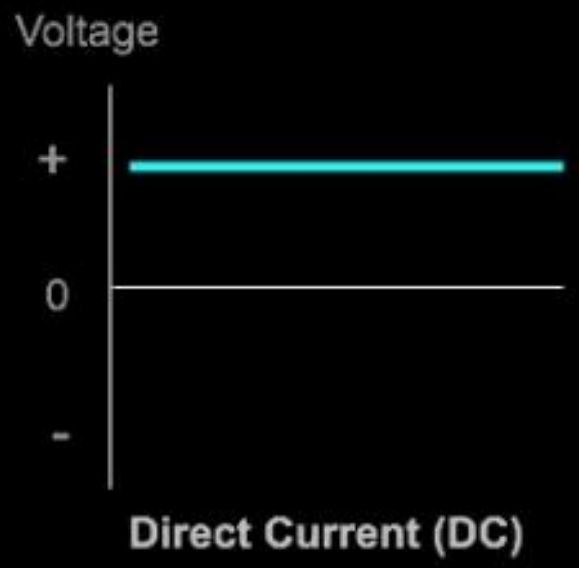
Be confident in your Electrical Safety

In Queensland, it's illegal for anyone to undertake unlicenced work on any electrical equipment over the ELV threshold.

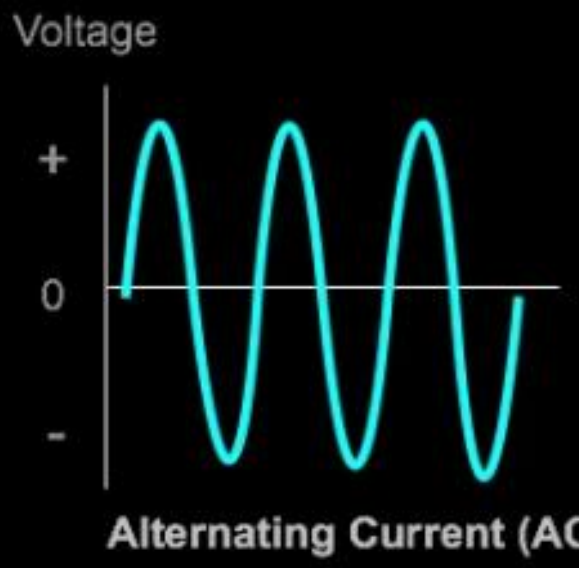
Voltage range	AC voltage (V)	DC voltage (V)
High voltage (HV)	> 1000	> 1500
Low voltage (LV)	≤ 1000	≤ 1500
Extra Low voltage (ELV)	≤ 50	≤ 120

AC? DC?

These terms refer to characteristics of the current.



Direct Current (DC)

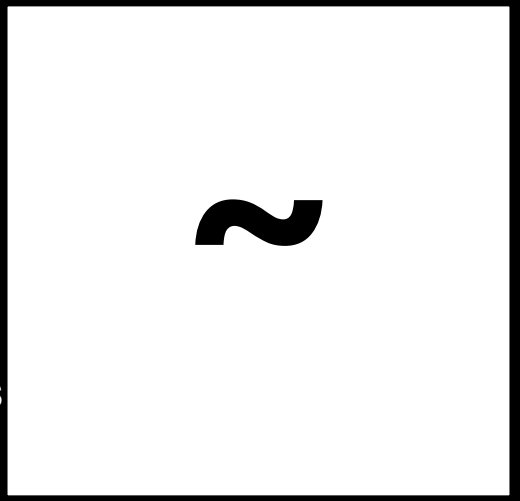


Alternating Current (AC)

WHAT'S AC-DC ?

- **AC** stands for Alternating Current
- It's the type of electricity that we have in our houses and office environments.

The symbol for AC is



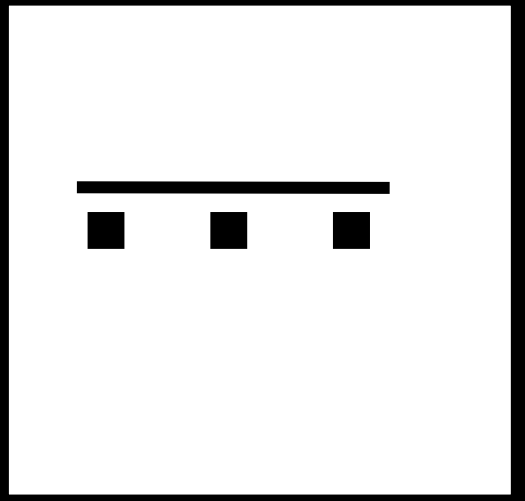
How does it work? Instead of just ramping up to 240 V the current reverses 50 time a second from 240 V+ to 240V- and back again.

If in doubt check before you disassemble any electrical appliance or equipment.

WHAT'S AC-DC ?

- **DC** stands for Direct Current
- It's the type of energy used in cars and electronics.

The symbol for DC is



DC gets used in battery operated devices and Consumer Electronics

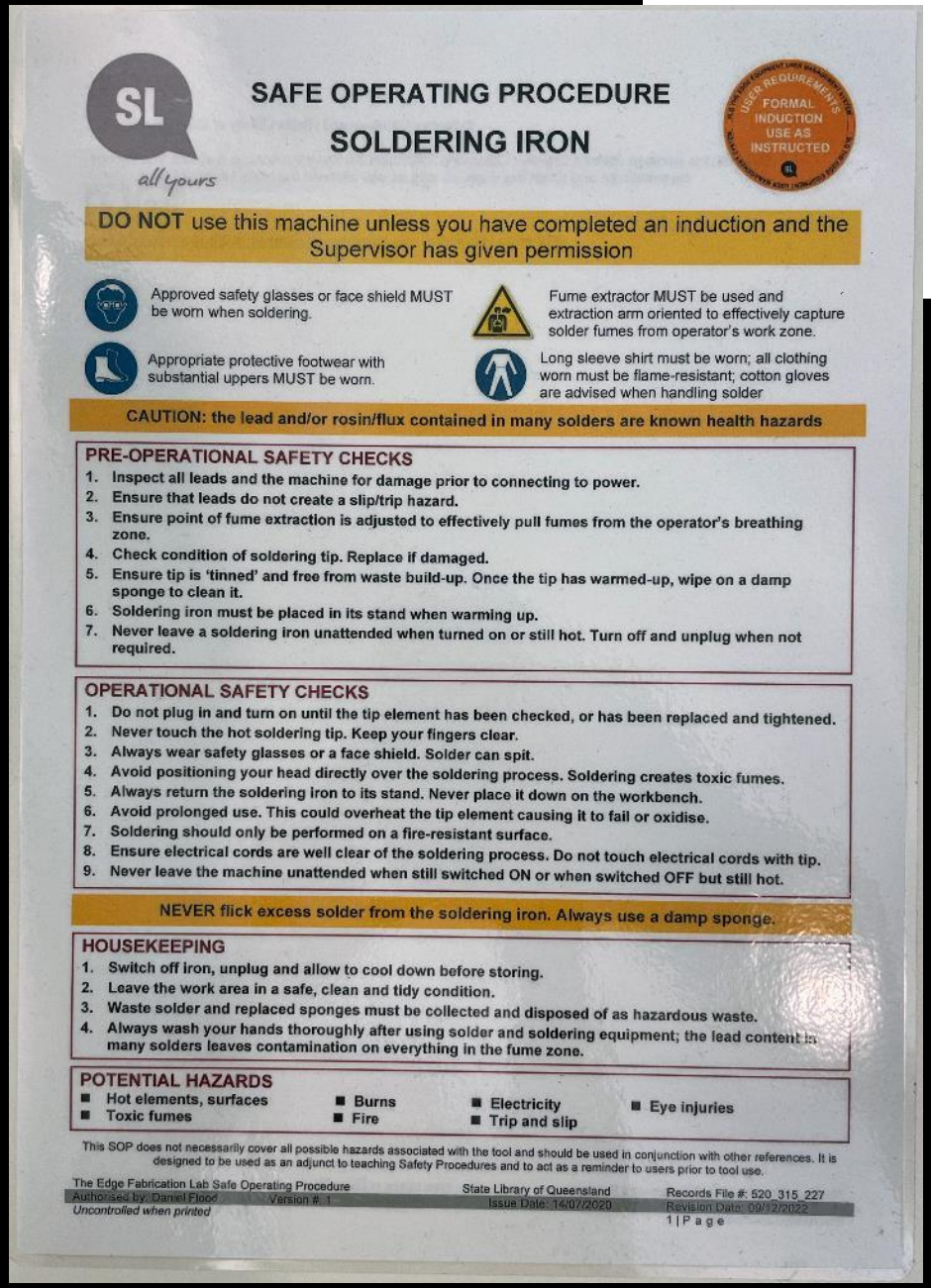
But lots of consumer electronics plug into the wall..? How are they different. The power pack that that you power these with generally steps this voltage down and flattens it out. That's why in Australia these don't have an earth.

If in doubt check before you disassemble any electrical appliance or equipment.

SAFETY CONT.

- Only use the Electronics Bench tools under direct staff supervision.
- Read and understand SOPs for the tools.
- Understand the risks;
  - Electric shock
  - Burns and fire
  - Hazardous materials (Lead solder, flux, isopropyl, fumes)
  - Eyes (eye strain and flying foreign objects)
  - Cuts and abrasions
  - Brain explosions

Check the safe operating procedures regularly and ask a staff member for help if you have any problems or concerns.



SL all yours

SAFE OPERATING PROCEDURE

SOLDERING IRON

USER REQUIREMENTS FORMAL INDUCTION USE AS INSTRUCTED

DO NOT use this machine unless you have completed an induction and the Supervisor has given permission

Approved safety glasses or face shield MUST be worn when soldering.

Fume extractor MUST be used and extraction arm oriented to effectively capture solder fumes from operator's work zone.

Appropriate protective footwear with substantial uppers MUST be worn.

Long sleeve shirt must be worn; all clothing worn must be flame-resistant; cotton gloves are advised when handling solder

CAUTION: the lead and/or rosin/flux contained in many solders are known health hazards

PRE-OPERATIONAL SAFETY CHECKS

1. Inspect all leads and the machine for damage prior to connecting to power.
2. Ensure that leads do not create a slip/trip hazard.
3. Ensure point of fume extraction is adjusted to effectively pull fumes from the operator's breathing zone.
4. Check condition of soldering tip. Replace if damaged.
5. Ensure tip is 'tinned' and free from waste build-up. Once the tip has warmed-up, wipe on a damp sponge to clean it.
6. Soldering iron must be placed in its stand when warming up.
7. Never leave a soldering iron unattended when turned on or still hot. Turn off and unplug when not required.

OPERATIONAL SAFETY CHECKS

1. Do not plug in and turn on until the tip element has been checked, or has been replaced and tightened.
2. Never touch the hot soldering tip. Keep your fingers clear.
3. Always wear safety glasses or a face shield. Solder can spit.
4. Avoid positioning your head directly over the soldering process. Soldering creates toxic fumes.
5. Always return the soldering iron to its stand. Never place it down on the workbench.
6. Avoid prolonged use. This could overheat the tip element causing it to fail or oxidise.
7. Soldering should only be performed on a fire-resistant surface.
8. Ensure electrical cords are well clear of the soldering process. Do not touch electrical cords with tip.
9. Never leave the machine unattended when still switched ON or when switched OFF but still hot.

NEVER flick excess solder from the soldering iron. Always use a damp sponge.

HOUSEKEEPING

1. Switch off iron, unplug and allow to cool down before storing.
2. Leave the work area in a safe, clean and tidy condition.
3. Waste solder and replaced sponges must be collected and disposed of as hazardous waste.
4. Always wash your hands thoroughly after using solder and soldering equipment; the lead content in many solders leaves contamination on everything in the fume zone.

POTENTIAL HAZARDS

- Hot elements, surfaces
- Toxic fumes
- Burns
- Fire
- Electricity
- Trip and slip
- Eye injuries

This SOP does not necessarily cover all possible hazards associated with the tool and should be used in conjunction with other references. It is designed to be used as an adjunct to teaching Safety Procedures and to act as a reminder to users prior to tool use.

The Edge Fabrication Lab Safe Operating Procedure | State Library of Queensland | Records File #: 520_315_227
Authorised by: Daniel Flood | Version #: 1 | Issue Date: 14/07/2020 | Revision Date: 09/12/2022
Uncontrolled when printed
1 | P a g e

SAFETY CONT.

- Read and understand SOPs for each piece of equipment and component you are using
- Understand the voltage limits of components and the equipment
- Don’t overload!

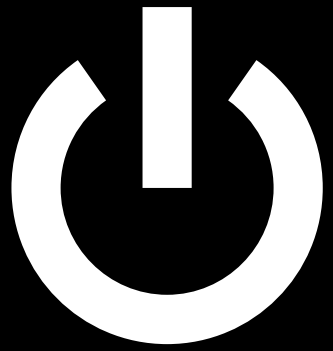
PLEASE REMEMBER!

- Don't blow stuff up! If you are not sure, just ask.
- Turn things off when you're finished, reset instruments to the lowest default setting when finished.
- Clean up after yourself.

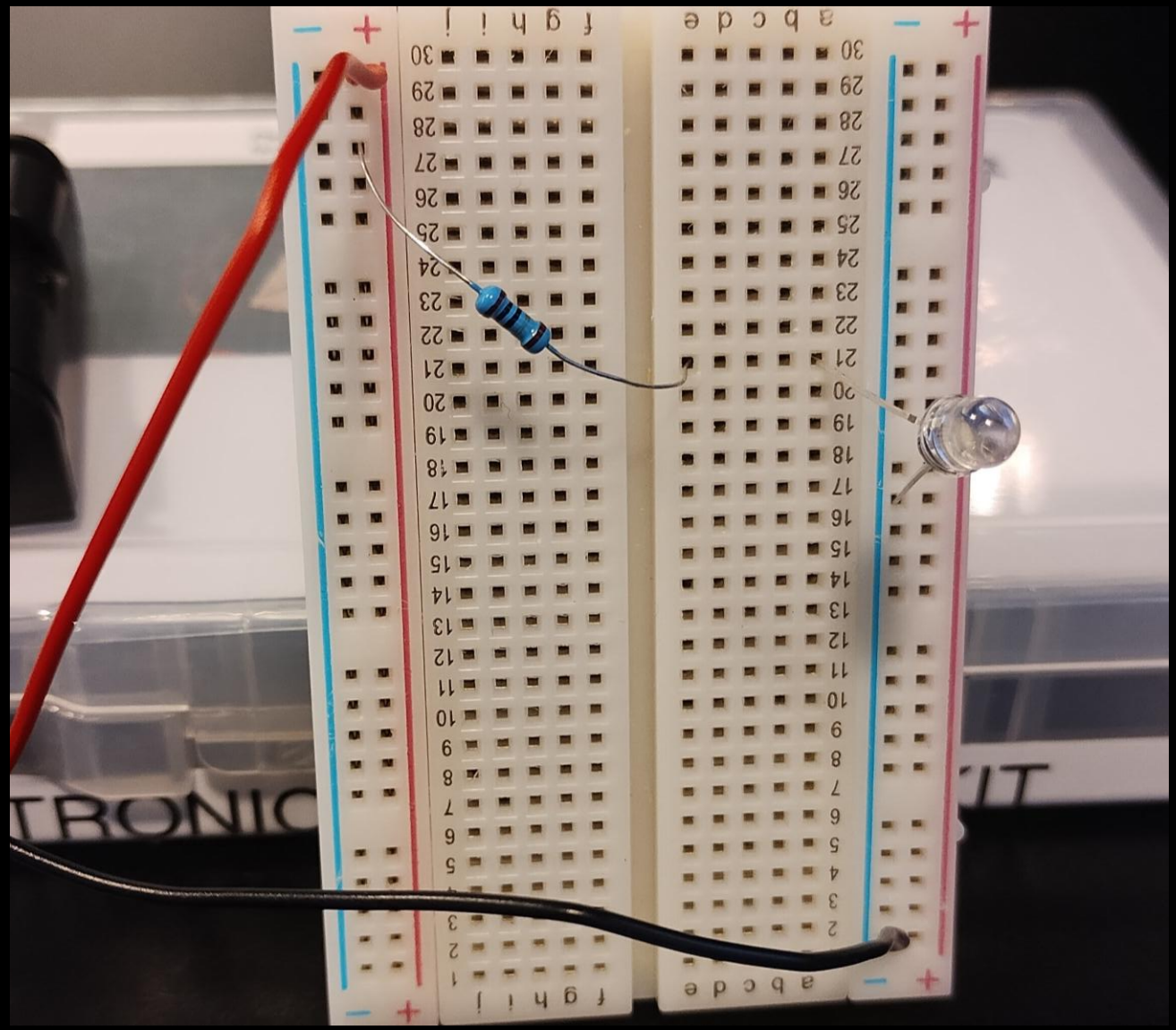
Check the safe operating procedures regularly and ask a staff member for help if you have any problems or concerns.

MITIGATION STRATEGIES

- Wear the appropriate clothing and PPE
- Use the fume extraction properly
- Use good hand hygiene practices (wash your hands; NO eating)
- Always turn off hot tools before walking away
- Don’t force it or rush – ask for assistance
- If you’re getting stressed grab 5 min of fresh air



Let’s make a circuit.



ACTIVITY 1

Red wire from the battery: Top hole in the + rail

Resistor leg #1: Anywhere in the + rail

Resistor leg #2: Anywhere across the ditch

LED long leg: In line the resistor leg #2

LED short leg: Anywhere in the – rail

Black wire from the battery: Bottom hole in the – rail

Important idea here: Everything must touch – either physically or *electrically.*

What questions did you find yourself asking?

Which hole connects to which hole?

Why is the LED not turning on when the circuit looks right?

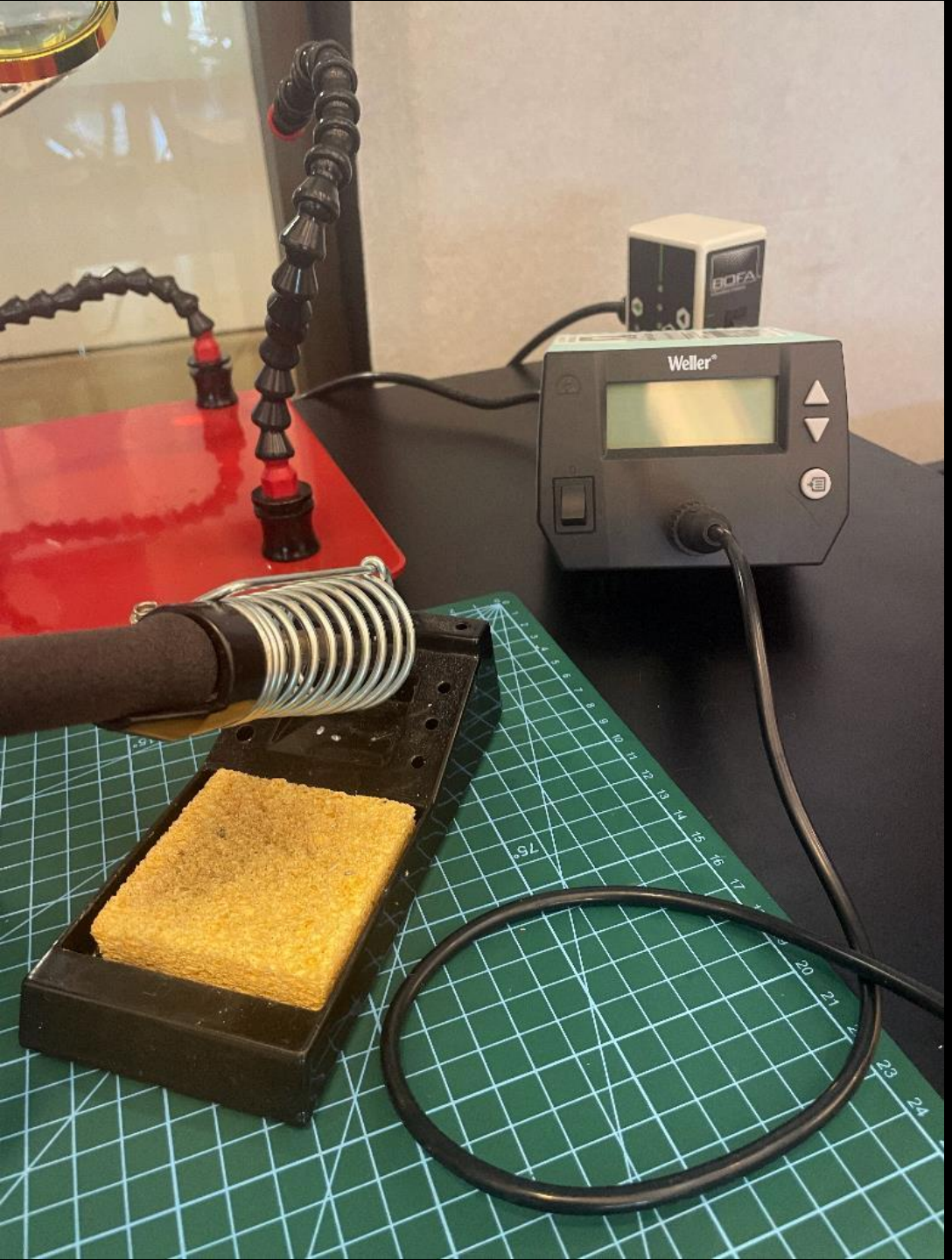
What happens if I forget the resistor?

Why does the wire colour matter?

What is happening?

Let's get some answers.

In the process, let’s set up our stations and talk about the tools available on the bench.



EQUIPMENT OVERVIEW

Weller Soldering irons

- Adjustable temperature
- Replaceable tips
- High wattage for rapid heating

Set up your irons!

Plug in the power, plug the iron into the soldering unit.

EQUIPMENT OVERVIEW

Helping hands

- Because you're not an octopus
- Holds components for you
- Magnify glass

EQUIPMENT OVERVIEW

Bofa Soldering Fumes Extractor

- HEPA and Activate Charcoal filtered
- Extracts the fumes safely

Set up your extractors!

Plug them in and place them close to your soldering area.

EQUIPMENT OVERVIEW

EEVBlog Brymen BM235 Digital Multimeter

- can measure multiple electrical properties
- accuracy of 0.3%
- Fulfills CATII – CAT IV safety class requirements

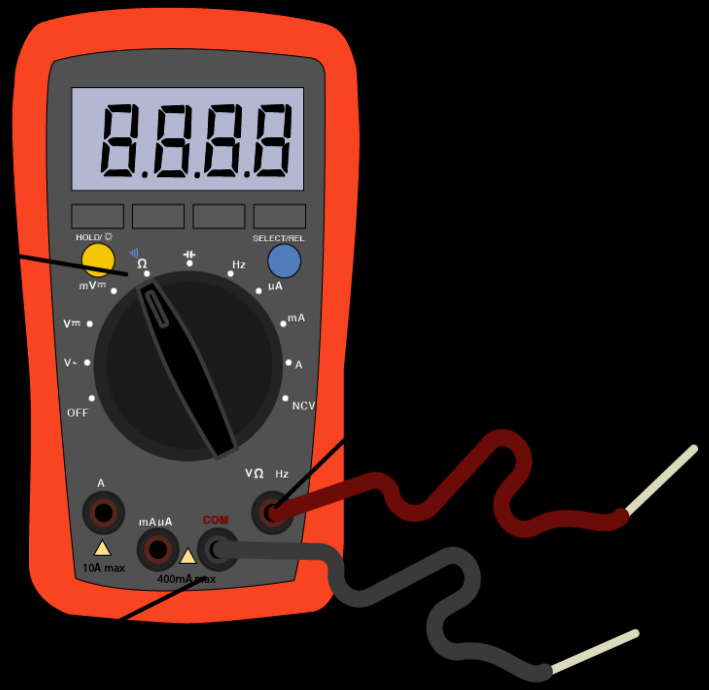
MULTIMETER

Multimeters are tools used for fault finding and checking things are working as you go.

There are 2 main types, digital and analogue, and there are a variety of digital options.

The main thing to know is whether it's manual or auto ranging, the Edge multimeters are auto ranging .

Although they measure all sort of things, the three we will focus on are Voltage, Resistance and Current.



Before you can measure anything, the first thing to work out is whether you're dealing with a Direct Current (DC) or Alternating Current (AC).

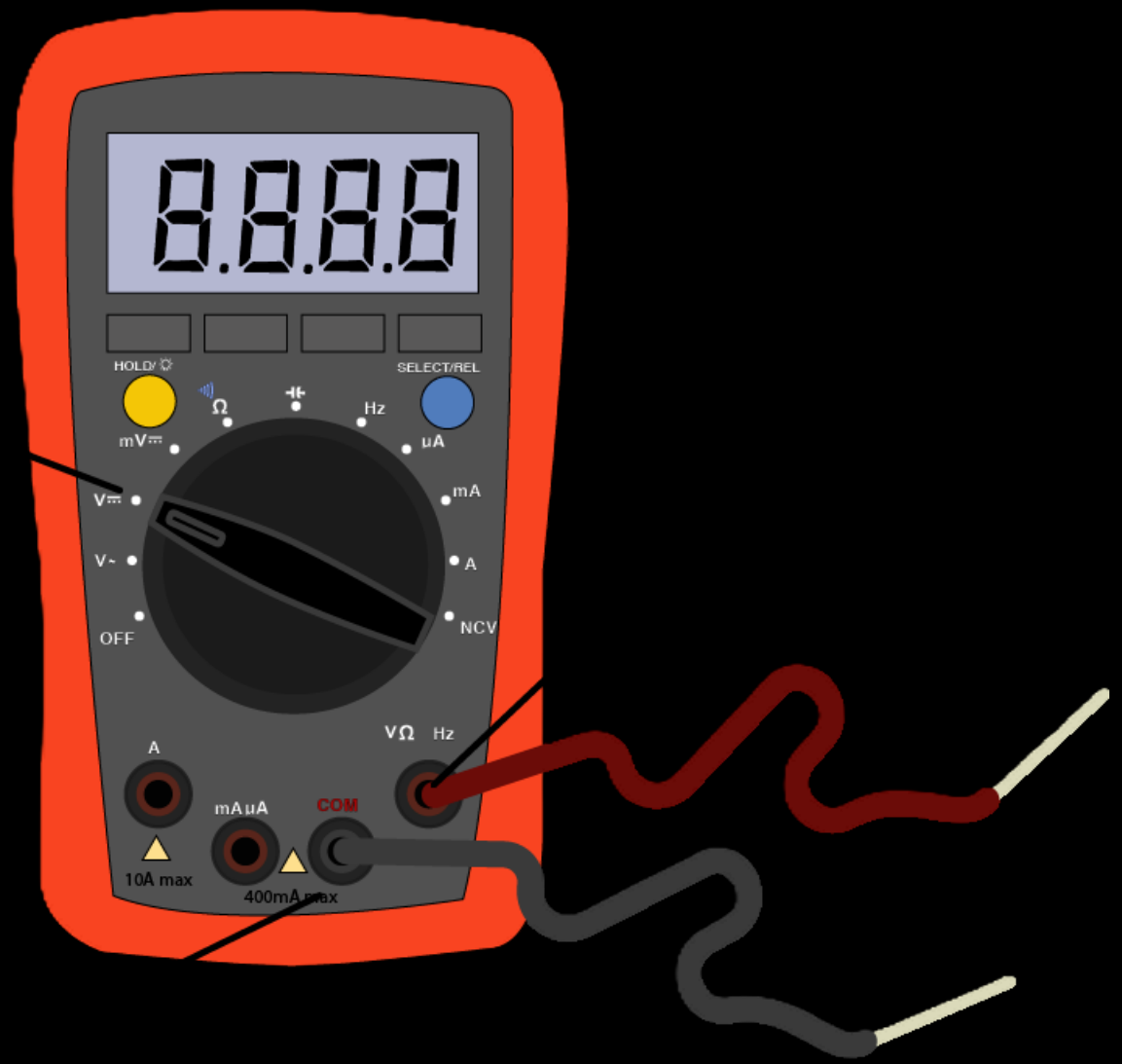
It should be DC because we generally **should not** be playing with AC.

We're luck cause these meters default to DC.

1. Place red cable in the V Ω -|)- Hz terminal and the black in the common.
2. Select V--- for DC Voltage.
3. Connect the red lead to the positive (+) and back lead to the negative (-) component or section of circuit you would like to measure.

Note

- Remember you are measuring the difference in voltage (potential, pressure) so measuring at the same point you get zero (no difference in voltage).
- If you get a negative Voltage – you have the leads around the wrong way.



CURRENT CAN DAMAGE YOUR METER!!

The mA (milliAmp) µA (microamp) terminal is only designed to measure up to a maximum value of 400mA. Try to measure anything over this and you'll blow the fuse.

If you don't know what amperage reading you are likely to get, select the "**A" setting** and work your way back if need be.

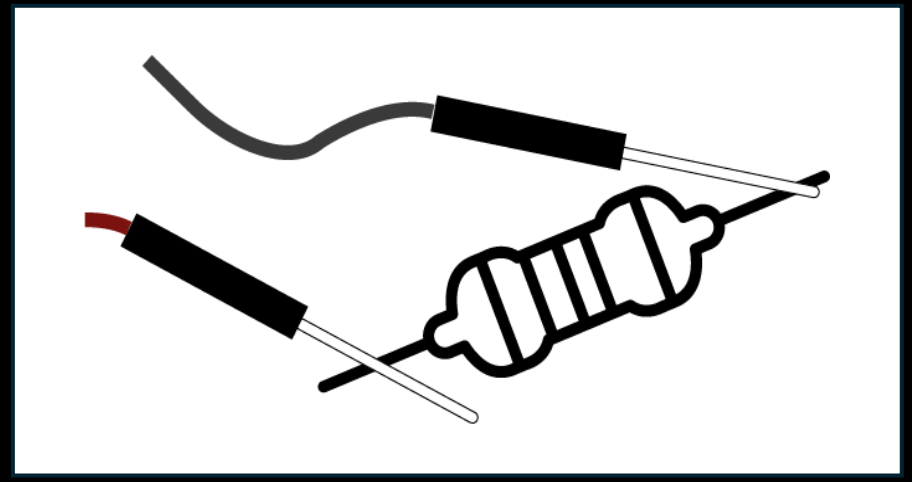
If you don't know the Amperage range

1. Place the black in the common and the red cable in the **A** or **mA µA** terminal.
2. Select for A---, mA---, or µA---
3. **Amperage readings need to always taken in series. Taking a reading in parallel to the load provides a shorter path for the current to to flow and will give you a false reading and could damage your meter.**
1. Remember you are measuring the difference in voltage (potential, pressure) so measuring at the same point you get zero (no difference in voltage) .

Let’s use the multimeter.

ACTIVITY 2

Let's try the multimeter out on a couple of resistors.

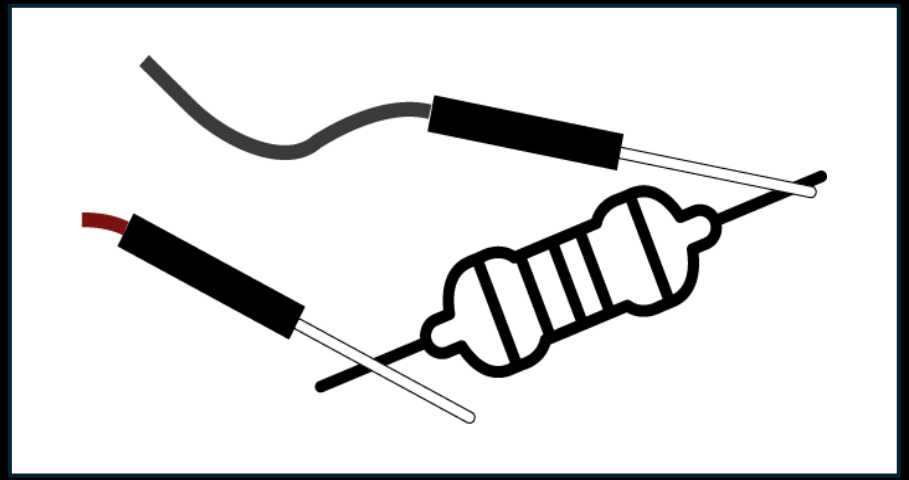


You need to find the ohm setting on the dial.

V	Volts
A	Amperes
mA	milliamps
Ω	Ohms
~	AC
⎓	DC
→|	Diode test
•))	Continuity test
Hz	Hertz
⊣⊢	Capacitance

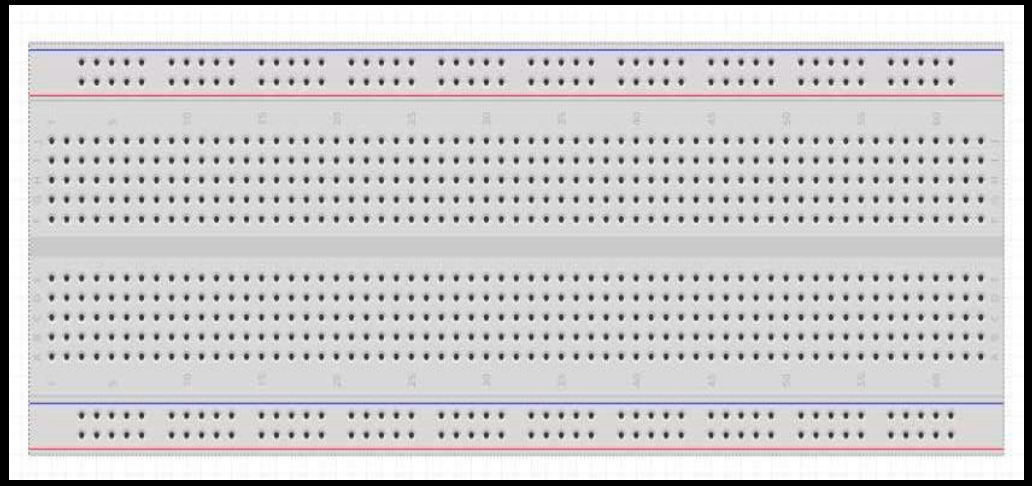
ACTIVITY 2

Let's try the multimeter out on a couple of resistors.



ACTIVITY 3

Let’s see which holes are connected on the breadboard and stripboard.

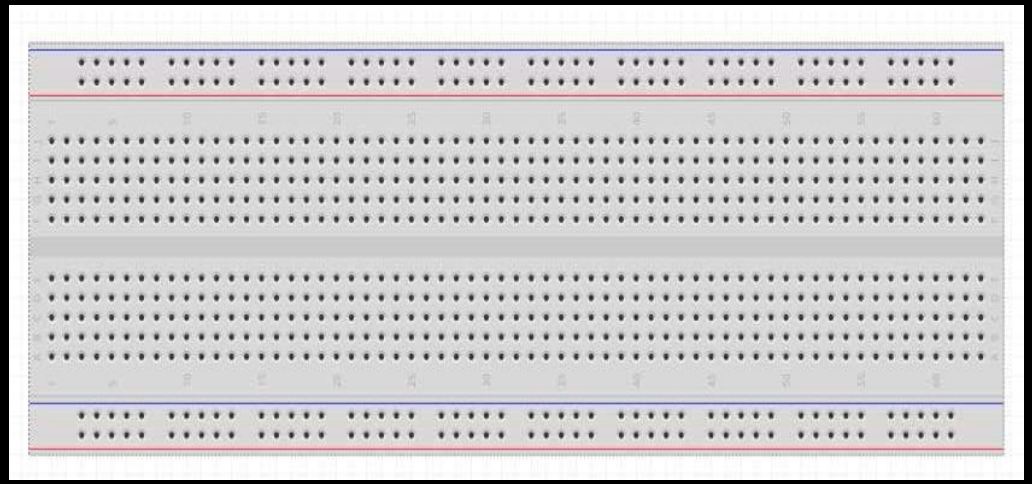


You need to find the continuity test setting on the dial.

V	Volts
A	Amperes
mA	milliamps
Ω	Ohms
~	AC
⎓	DC
⟶	Diode test
•)))	Continuity test
Hz	Hertz
⊣⊢	Capacitance

ACTIVITY 3

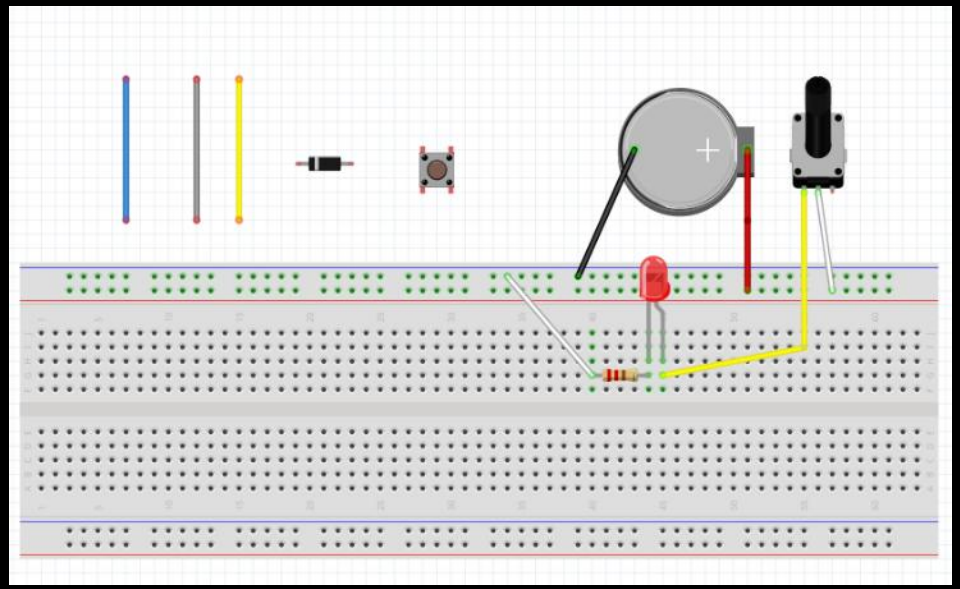
Let’s see which holes are connected on the breadboard and stripboard.

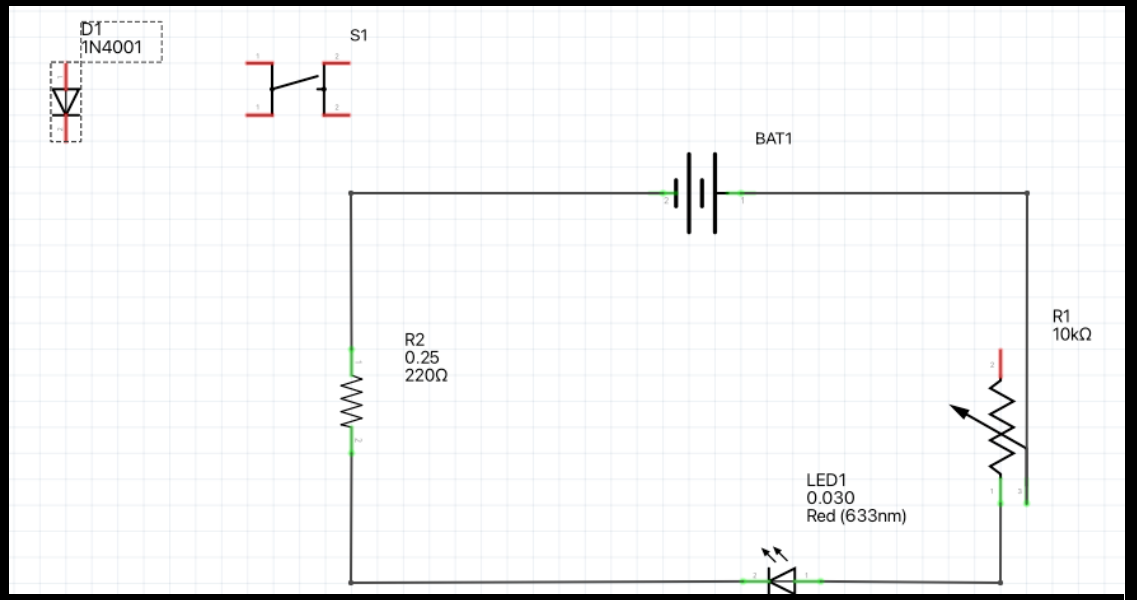


SIMPLE CIRCUITS

How a circuit works

- Current Flow, Voltage & Resistance
- Basic components
- Use a multimeter
- Make a circuit with a breadboard





Switch

Mechanical break in a circuit that stops the flow of curre

Resistors

Inhibits the flow of current

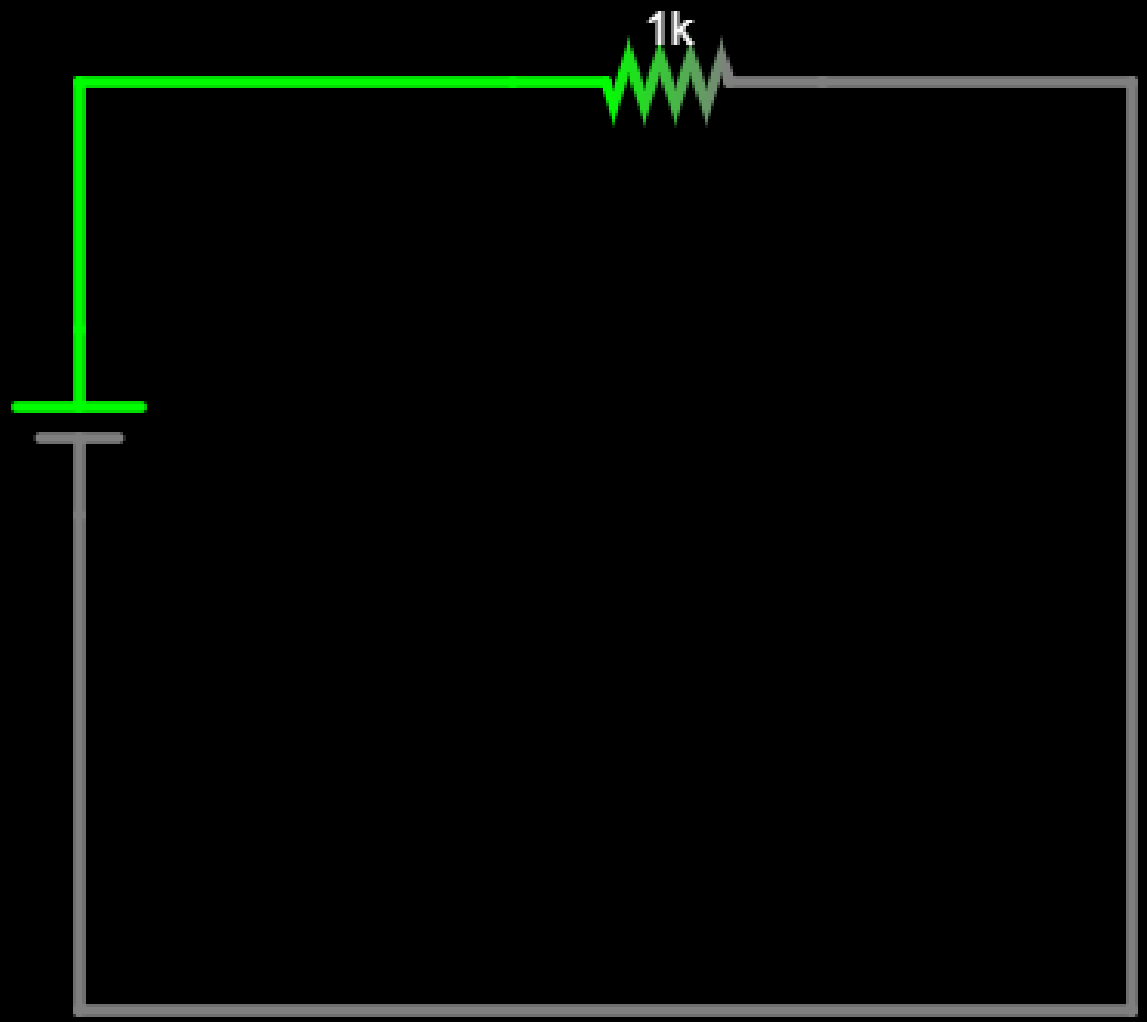
Diodes (LED)

One-way gate

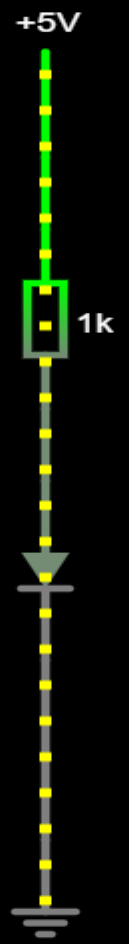
Common components

Let’s start with a simulation and end with some theories.

FALSTAD.COM/CIRCUIT

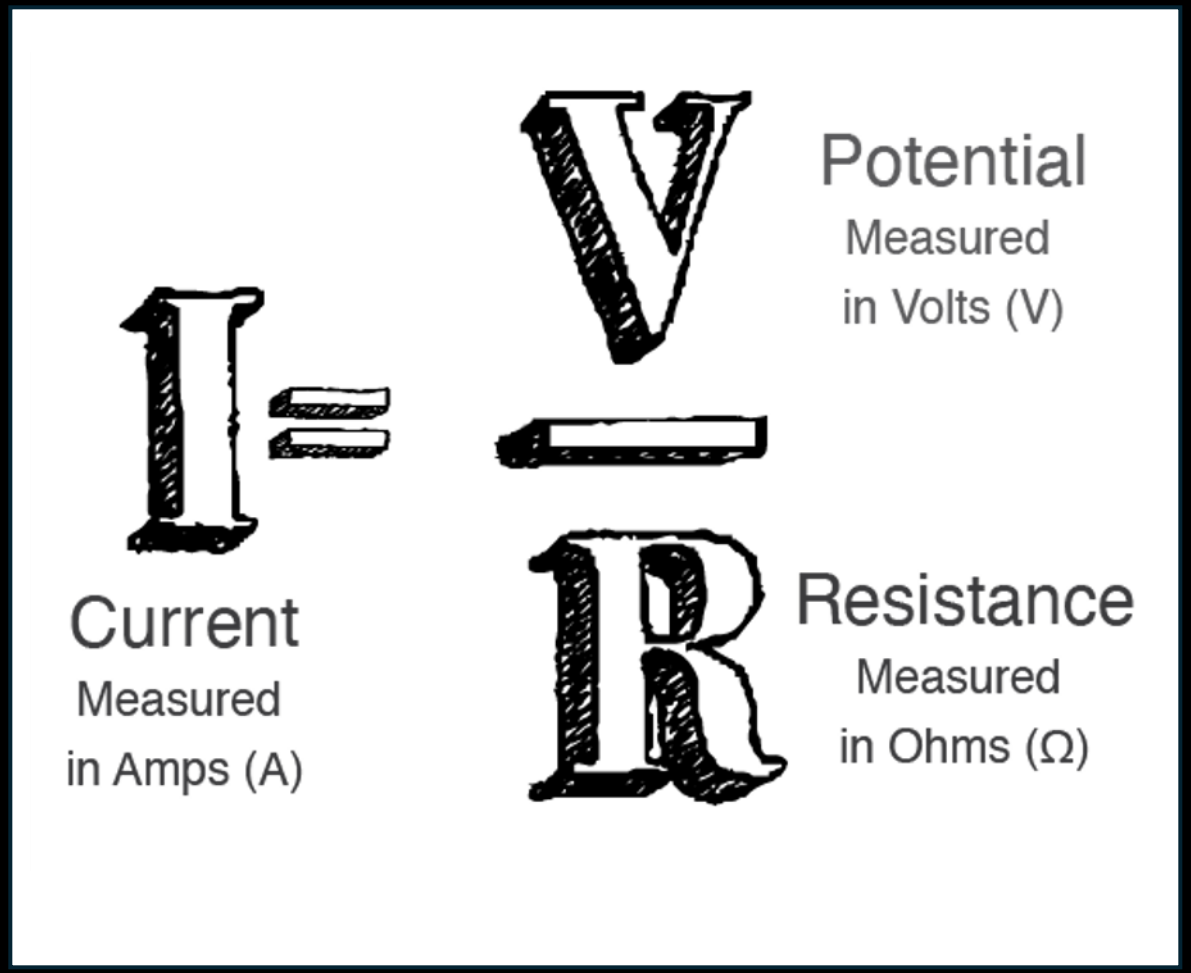


FALSTAD.COM/CIRCUIT




R
I
V is the tap we cannot see

OHM'S LAW



EFFECT

CAUSE

Ohm's Law Calculator. Below are three calculators used for Ohm's law to calculate the Current, Voltage and Resistance. There are basic examples below this for how to use the calculator.

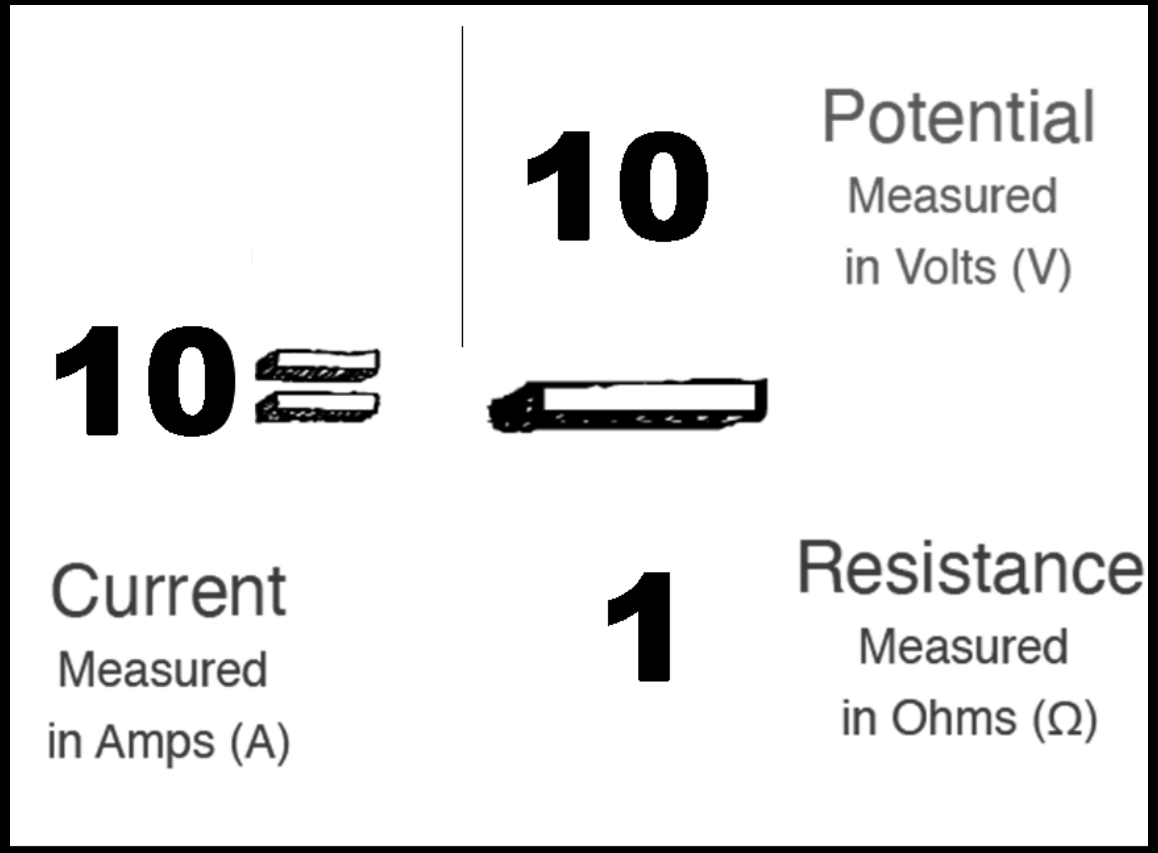
Voltage	120
Resistance	5
	Calculate
Current	24

Resistance	5
Current	24
	Calculate
Voltage	120

Voltage	120
Current	24
	Calculate
Resistance	5

theengineeringmindset.com/ohms-law-calculator

OHM'S LAW



Ohm's Law Calculator. Below are three calculators used for Ohm's law to calculate the Current, Voltage and Resistance. There are basic examples below this for how to use the calculator.

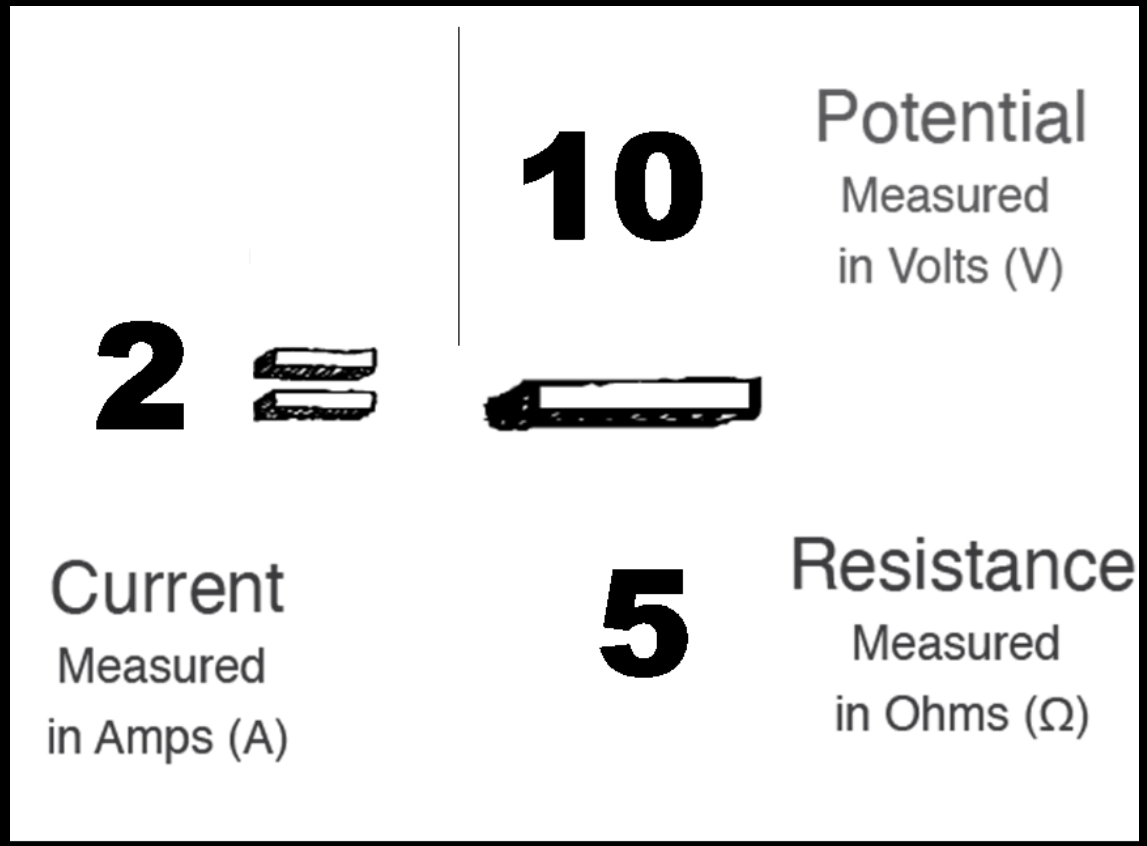
Voltage	120
Resistance	5
	Calculate
Current	24

Resistance	5
Current	24
	Calculate
Voltage	120

Voltage	120
Current	24
	Calculate
Resistance	5

theengineeringmindset.com/ohms-law-calculator

OHM'S LAW



Ohm's Law Calculator. Below are three calculators used for Ohm's law to calculate the Current, Voltage and Resistance. There are basic examples below this for how to use the calculator.

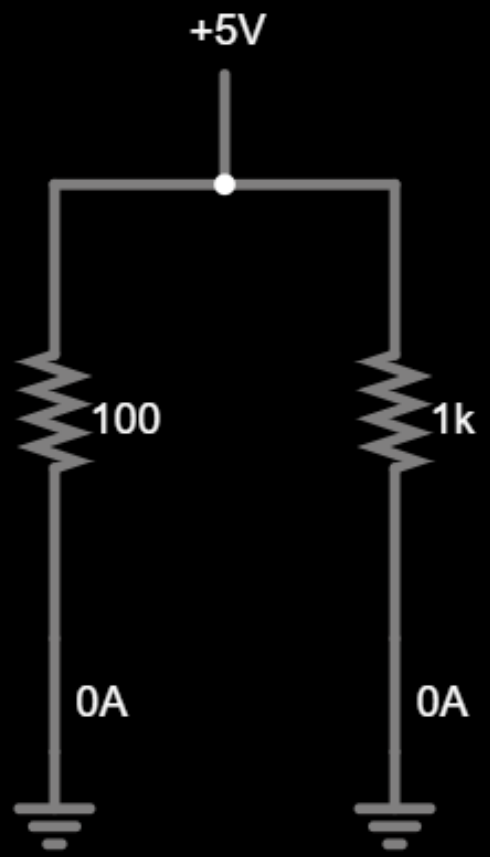
Voltage	120
Resistance	5
	Calculate
Current	24

Resistance	5
Current	24
	Calculate
Voltage	120

Voltage	120
Current	24
	Calculate
Resistance	5

theengineeringmindset.com/ohms-law-calculator

What do you think will happen in this circuit?



Okay, so we have some current flowing. What now?

COMMON COMPONENTS

Switch

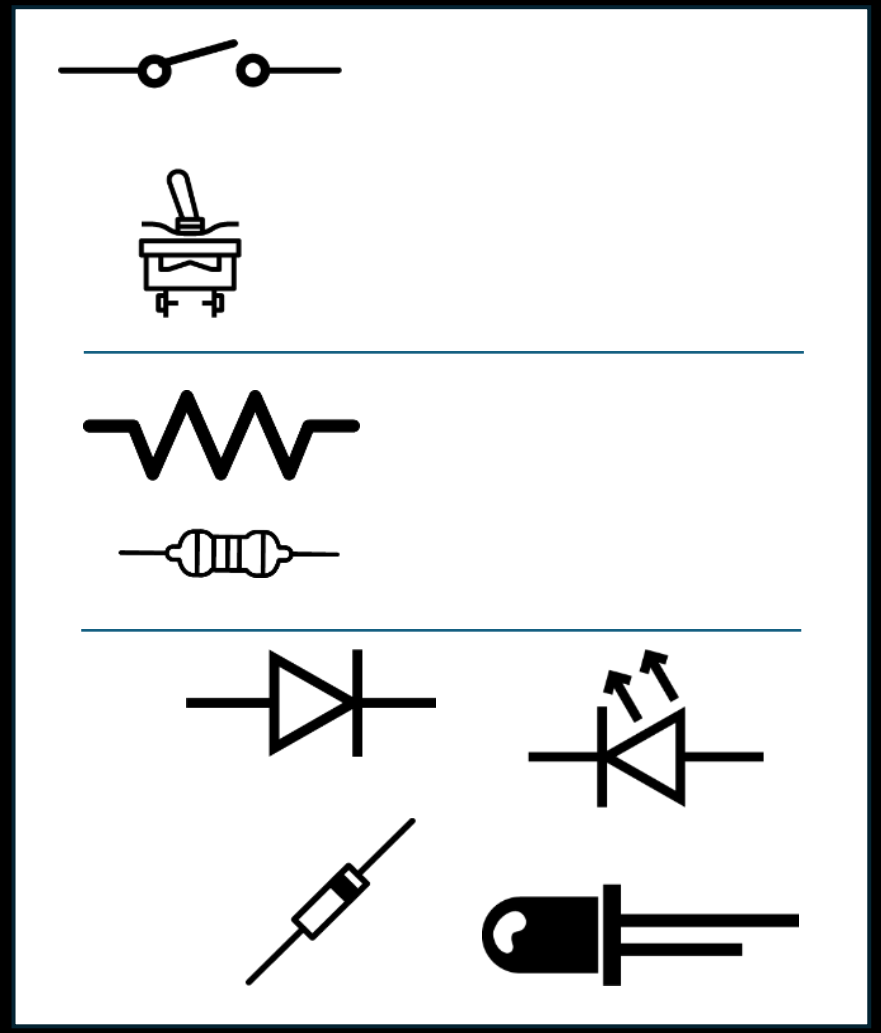
mechanical break in a circuit
that stops the flow of current.

Resistors

Inhibits the flow of current

Diodes (LED)

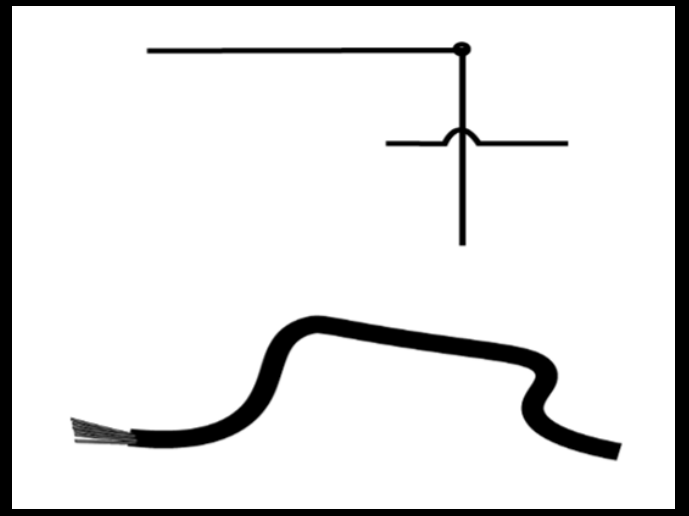
One-way gate



COMMON COMPONENTS

Conductors (wires)

These are wires or other strips of metal designed to carry current and are often surrounded by insulation

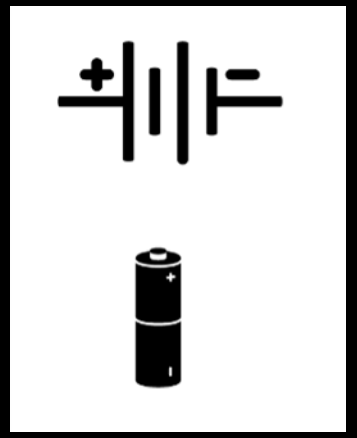


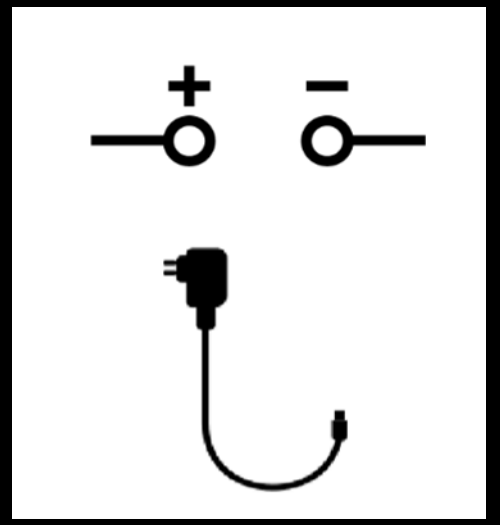
Supply Voltage

Usually a battery

or

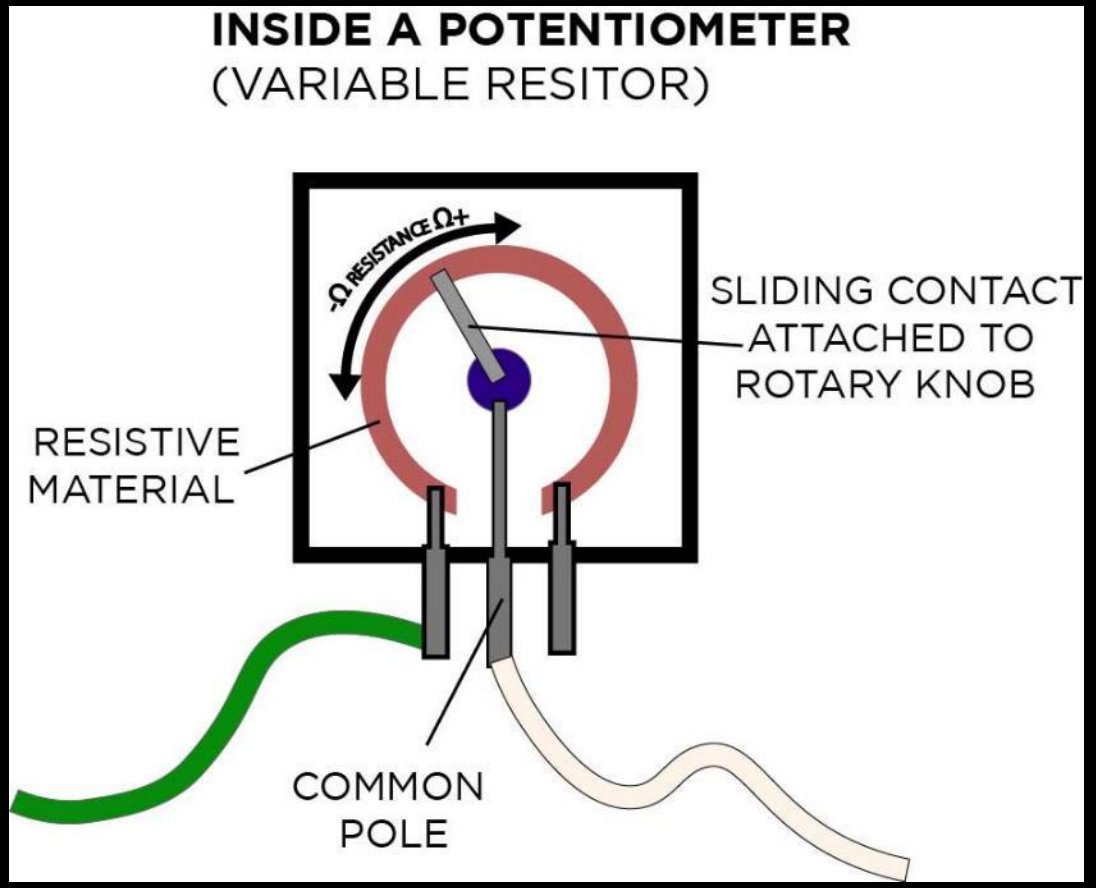
power supplies designed for powering DC circuits

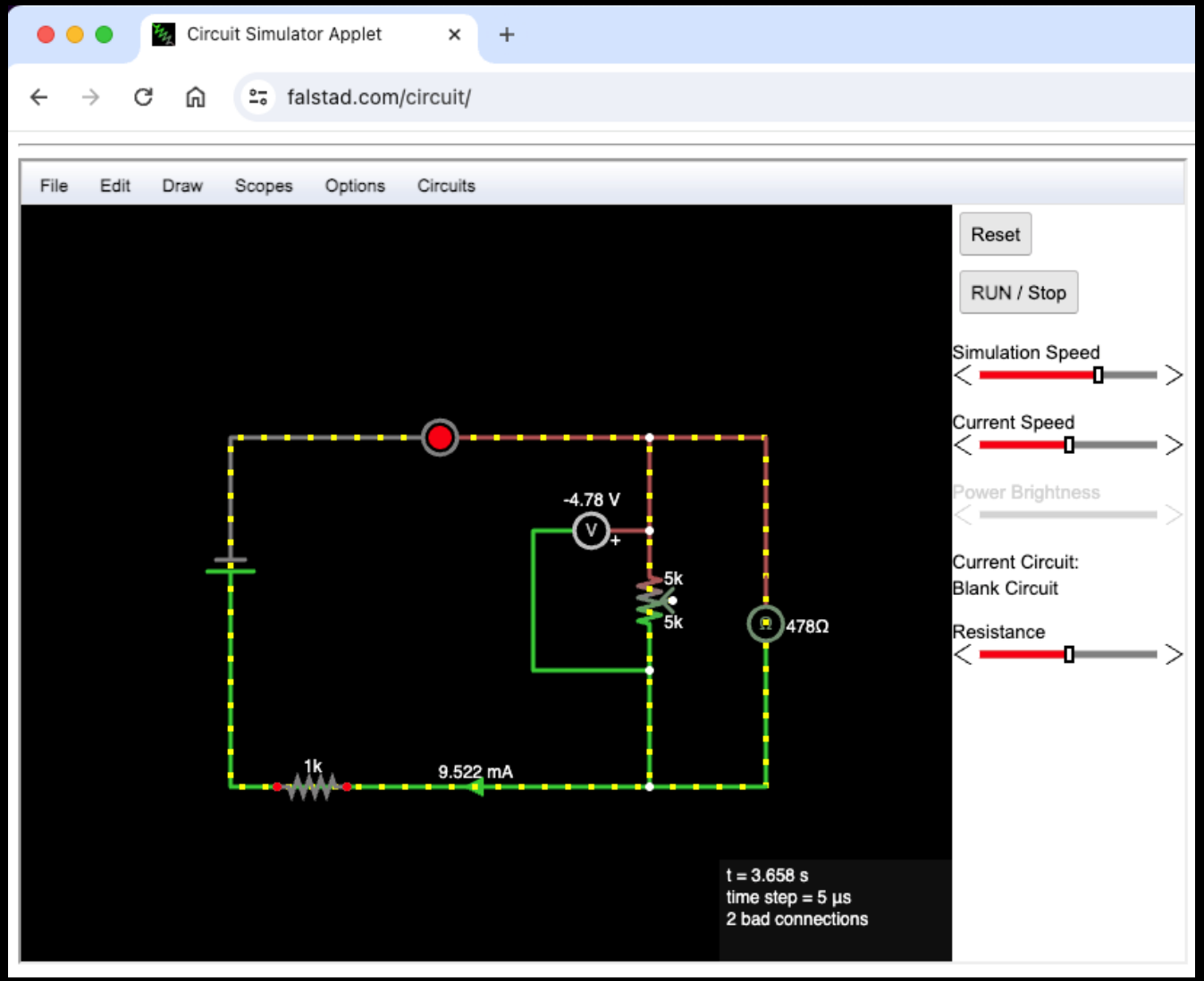




POTENTIOMETERS

Potentiometer is essentially an adjustable resistor that are commonly used to control electrical devices such dimmers or volume controls on audio equipment.

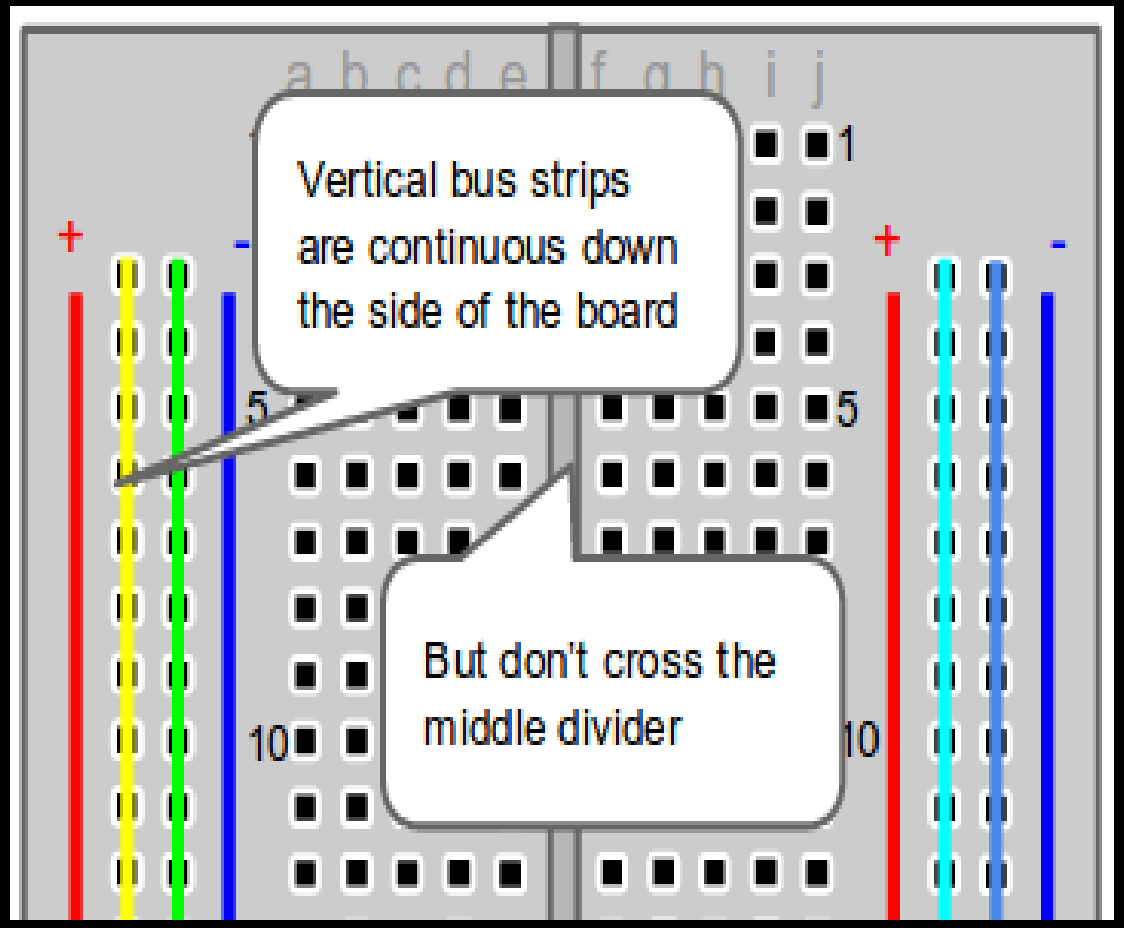


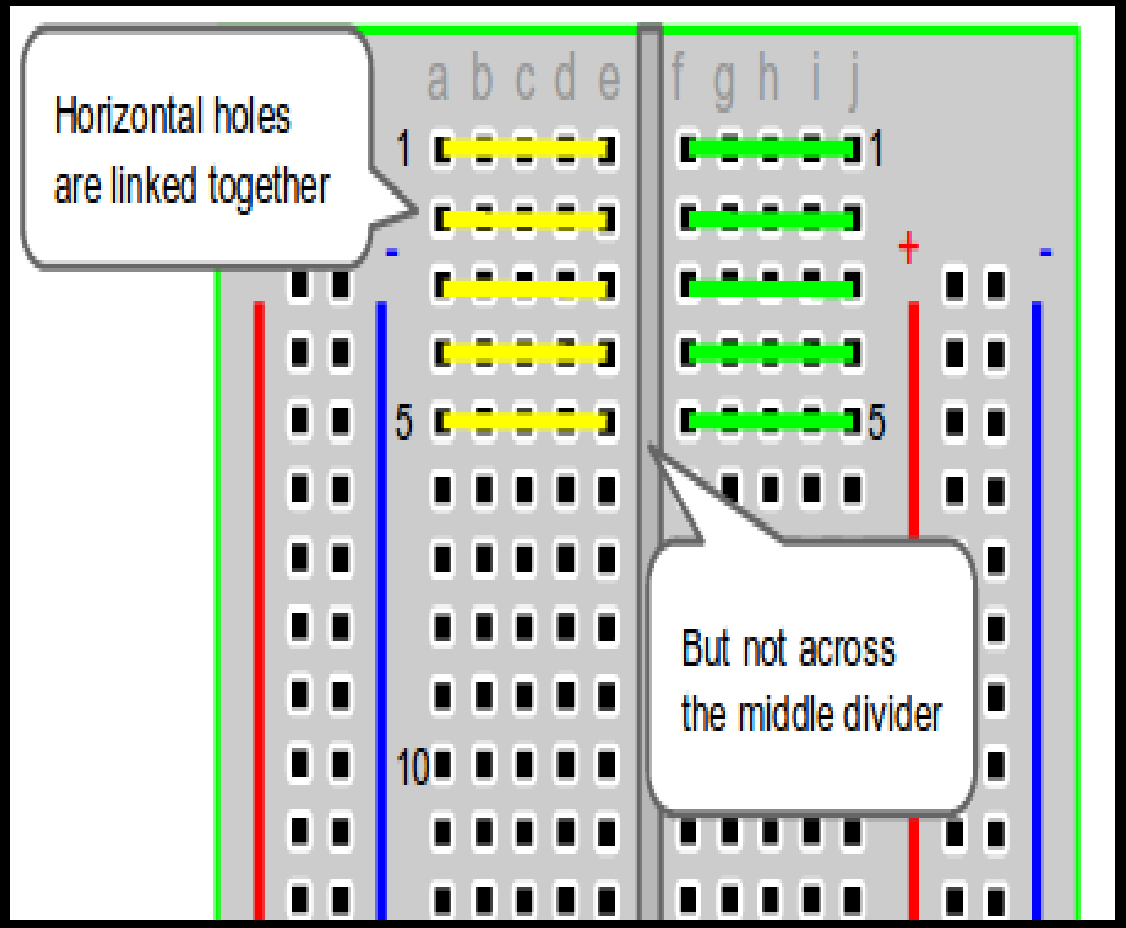


All of these components are available in Falstad, so you can test circuits out quickly and easily.

Try falstad.com/circuit/ it is free and pretty powerful.

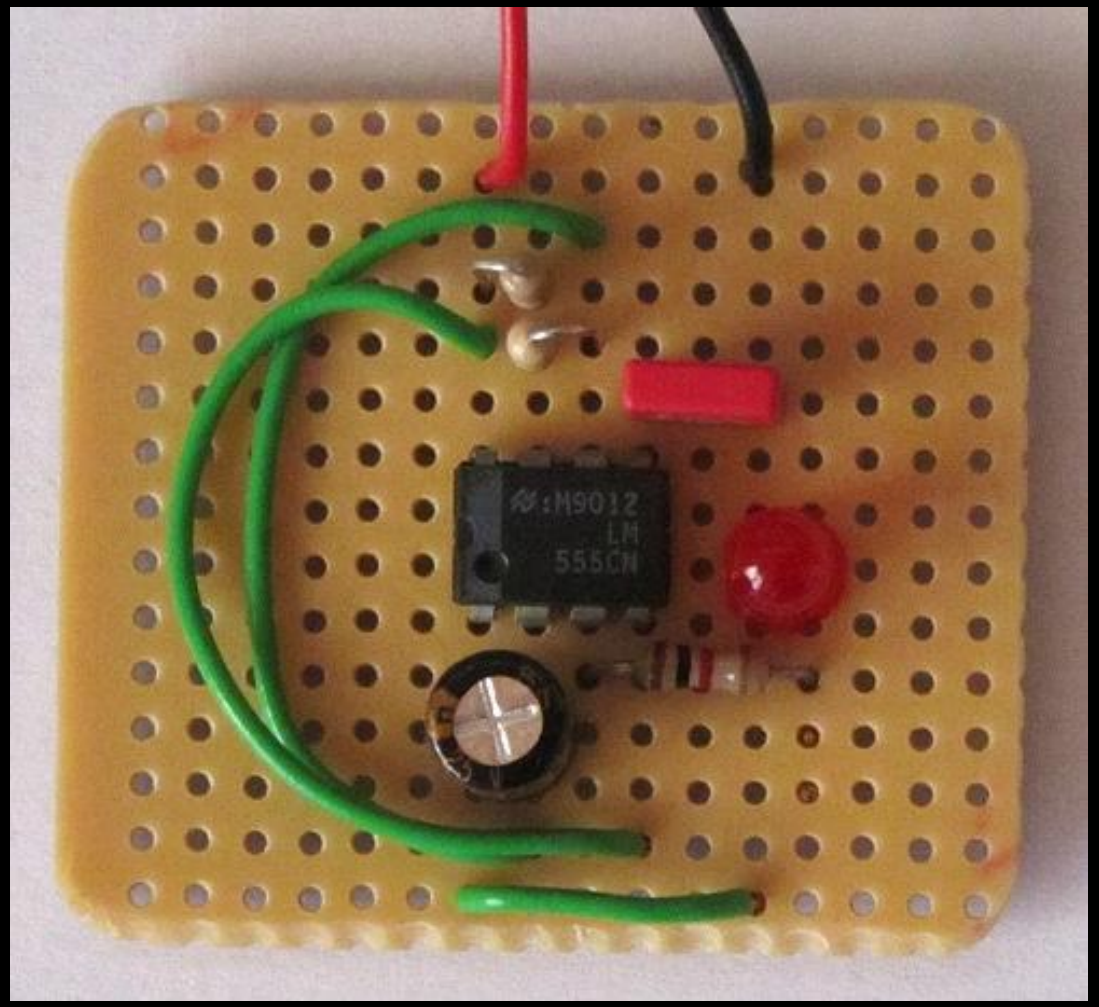
BREADBOARDS

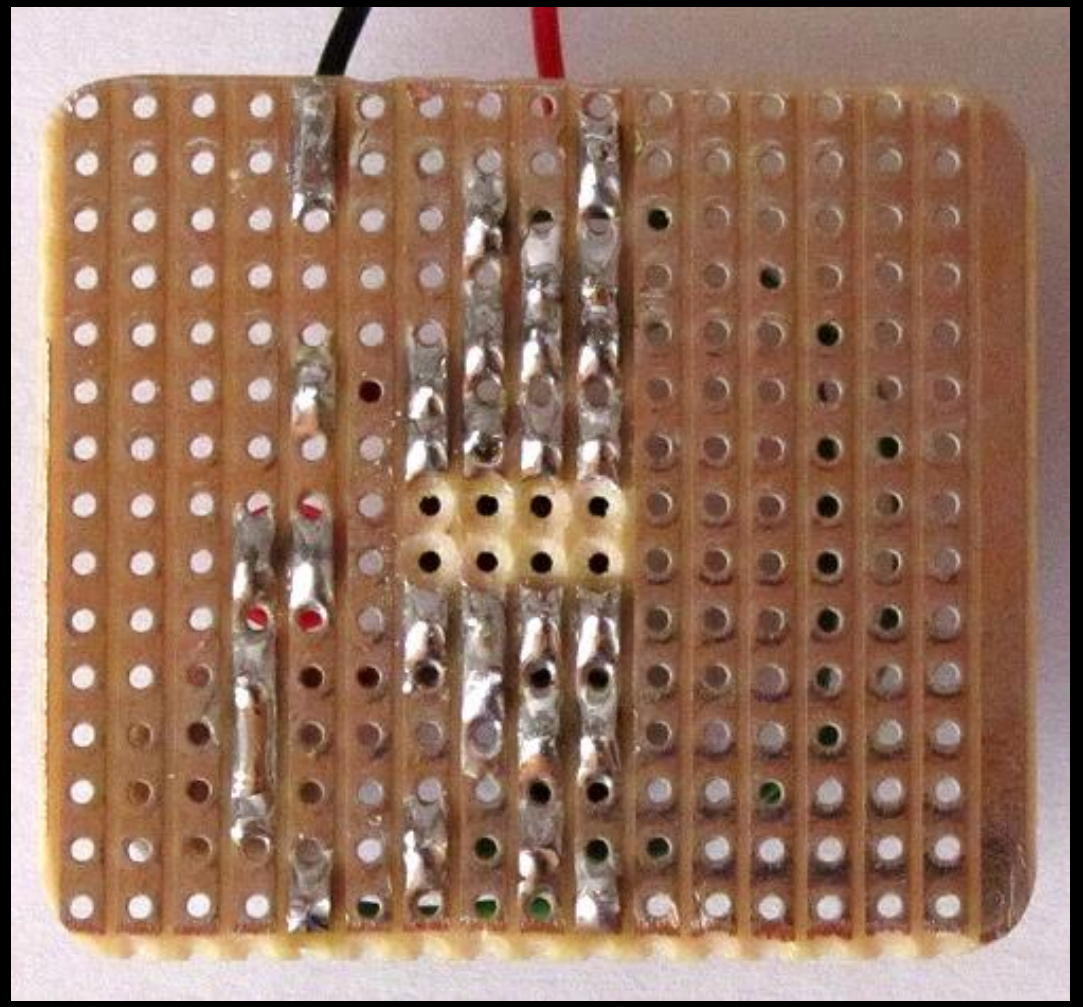




SOURCE: https://www.learnrobotics.org/blog/how-to-wire-a-breadboard/

STRIPBOARD

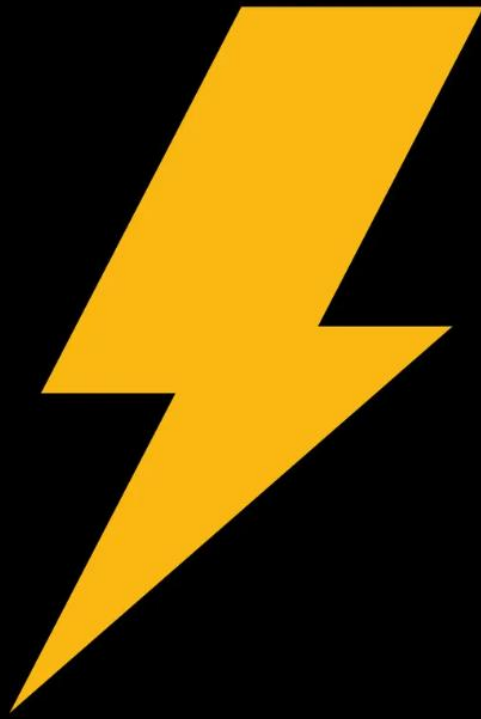




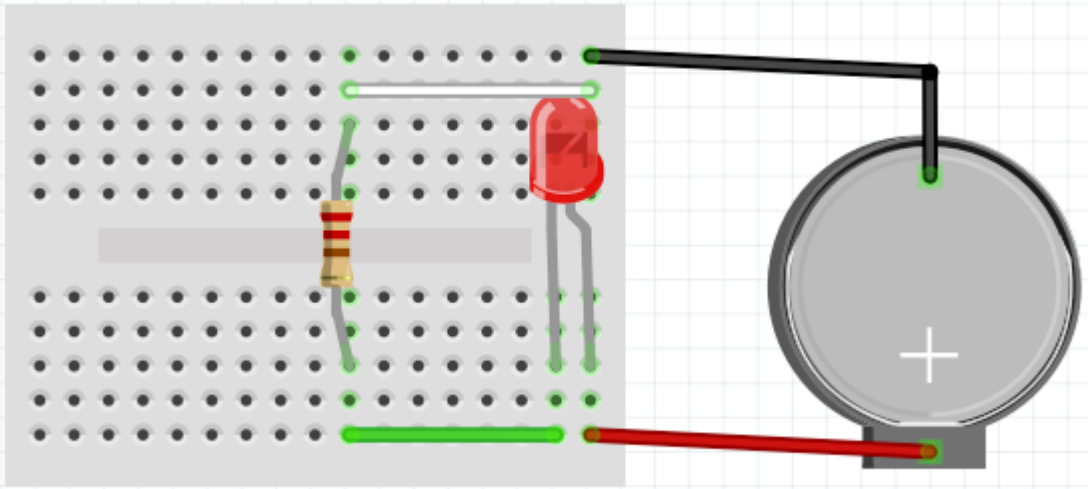
Source: https://startingelectronics.org/beginners/making-a-stripboard-circuit/

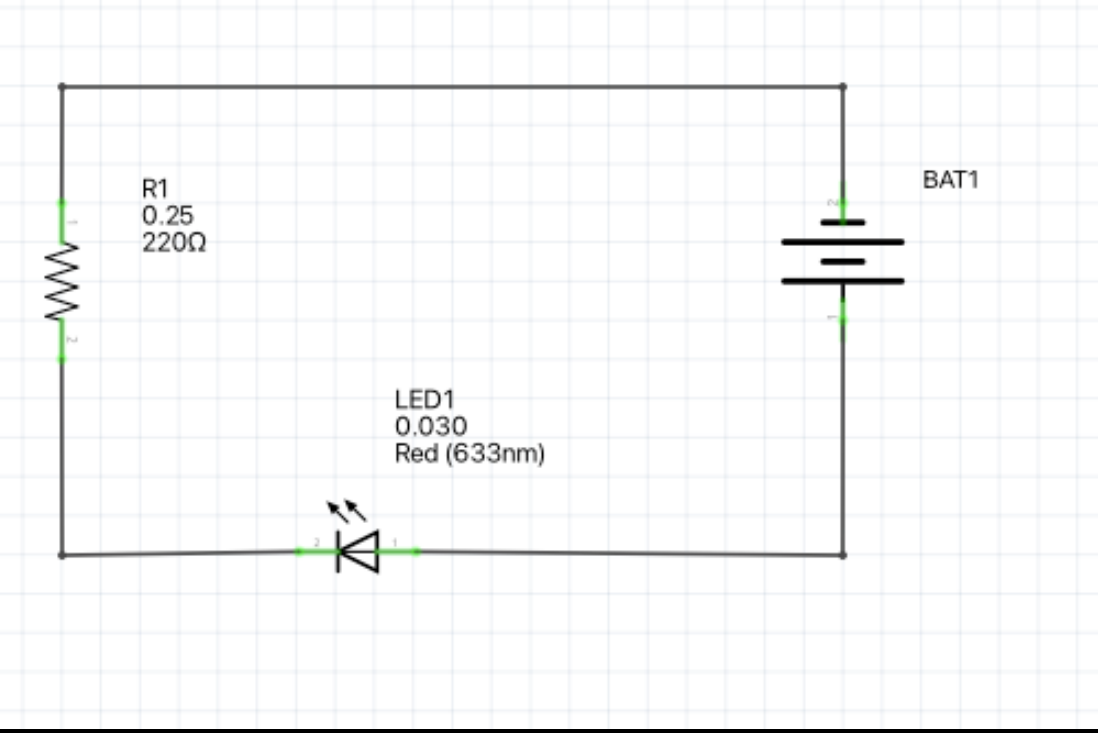
BIG IDEAS

- All components must be connected -- we need a full circuit. Continuity testing helps us confirm this.
- A voltage source (like a battery or a power supply) can be thought of as a big bucket of energy that we pour through our circuit.
- Resistance is like a narrowing of the pipes we use to connect all the bits.
- Current is all the work that this energy + resistance creates. Think of the feeling of pressure behind your thumb when you plug a hose -- that pressure can DO things.
- I=V/R reminds us of this cause-effect relationship. We get current from the combination of voltage and pressure. We can use this relationship to figure out a lot of important stuff when we are designing and debugging circuits.
- I=V/R also confirms our intuition that current will always take the past of least resistance.
- An electronic circuit is basically a machine that uses little gadgets to convert current into different actions, until there's no current left.
- While our rules of thumbs and analogies help us make stuff, at a certain point they do break down. If you want to dive deeper you can look into the theory and math behind all of this (electric charge, Ohm's Law, Maxwell's Equations and so on). This is a great resource: https://www.allaboutcircuits.com/textbook/



Let’s jump in and play with these ideas now.





ACTIVITY 4

LED and a pair of batteries that produce 3V

Using a breadboard, AA batteries, LED, resistor and jumper wires we will power the light.

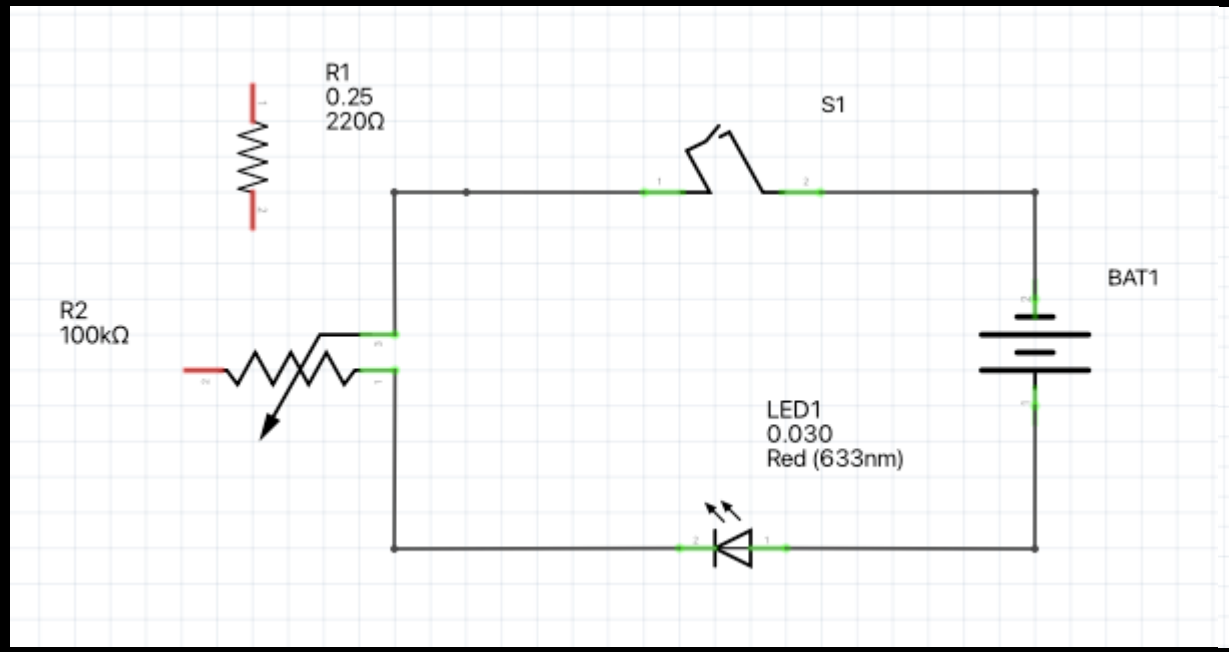
- Battery has a Pos and Neg side
- LED is a Diode – one way gate has a pos and neg

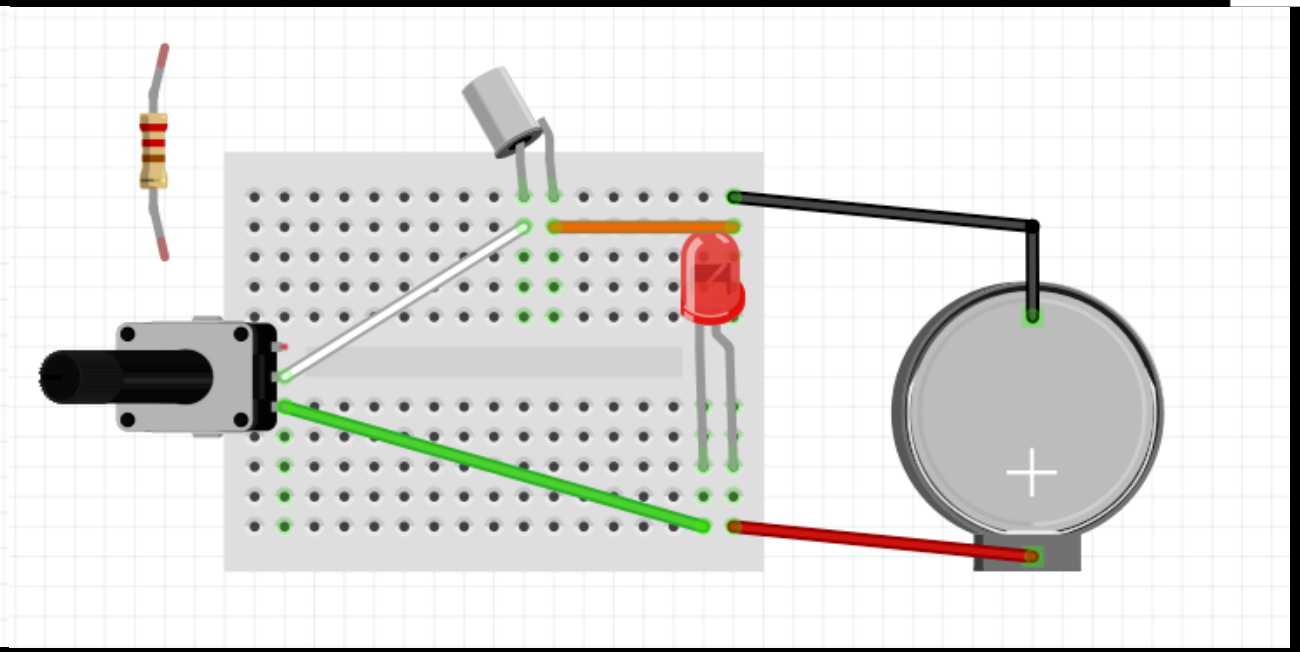
When positioned the right way around the voltage pushes electrons down the LED which activate the semi-conductor which emits photons and then continue around to complete the circuit.

If there is a break in the circuit the electrons – current cannot flow.

If the LED is around the wrong way the electrons get caught at the led and the circuit wont flow.

Let's swap the normal resistor for a potentiometer





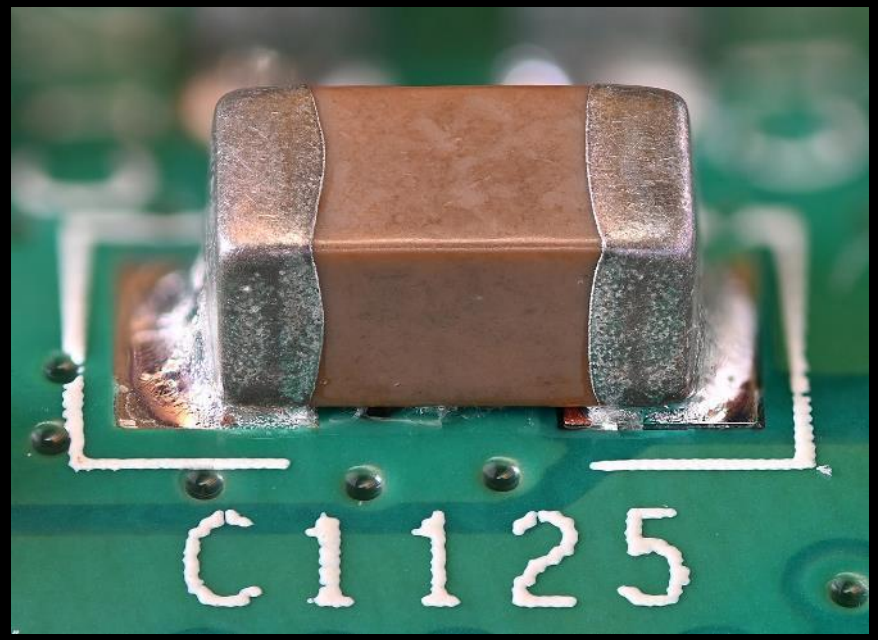
And add a mercury switch

Once we are happy with a prototype, we shift it to our stripboard and solder it in.

SOLDERING

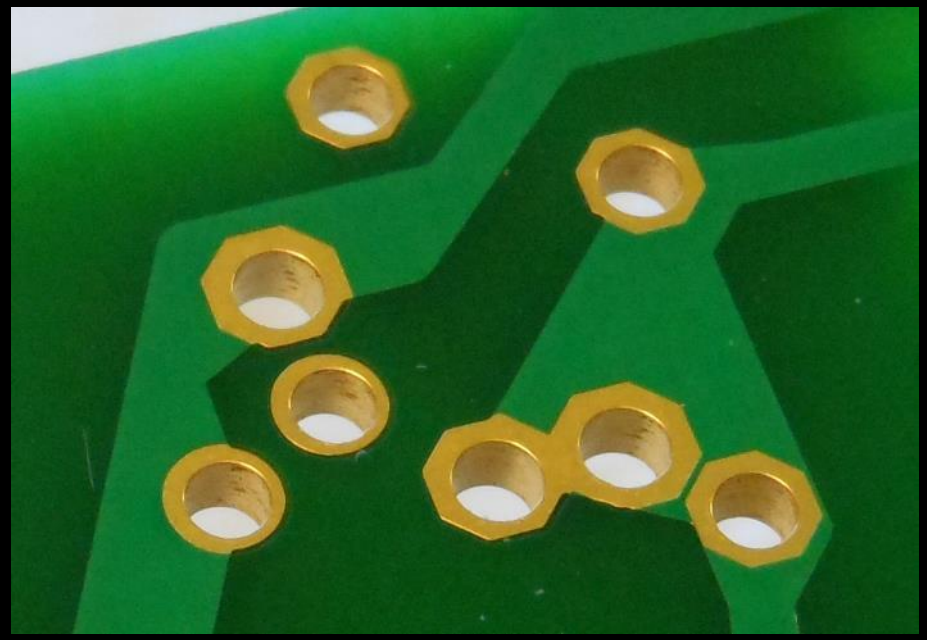
Types of Solder joints

Surface mount



By Phiarc - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=129600962

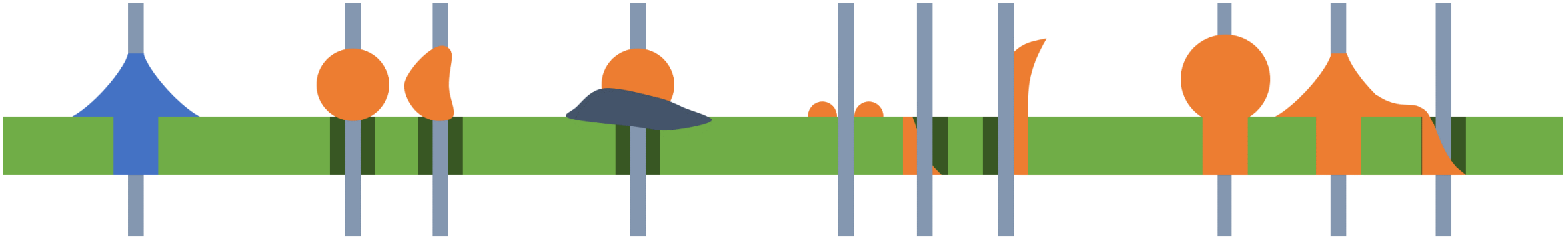
Through hole



By G1MFG- Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=129600962

Soldering practice

What's a good solder joint look like?



PERFECT!
Neat volcano shape, good contact

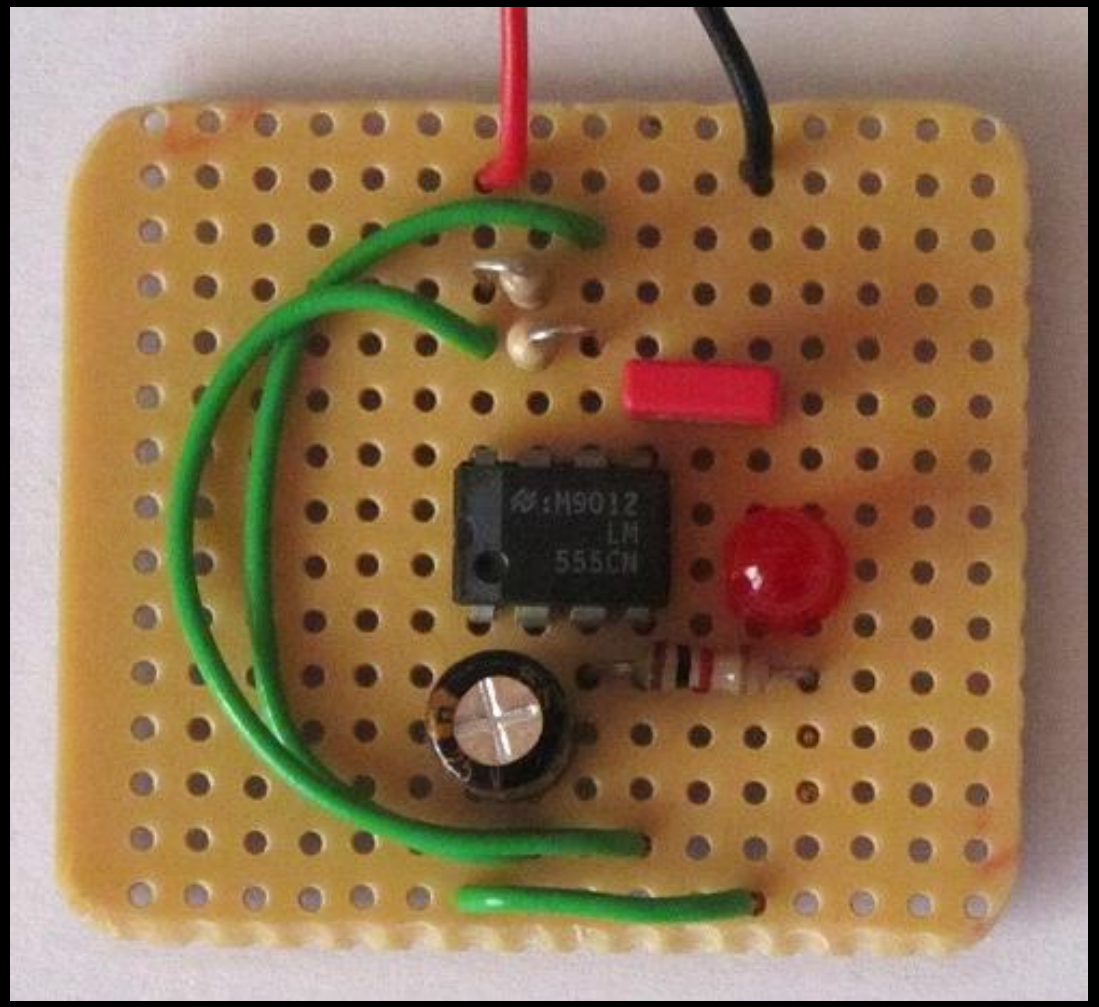
TOO COLD
Add flux & iron

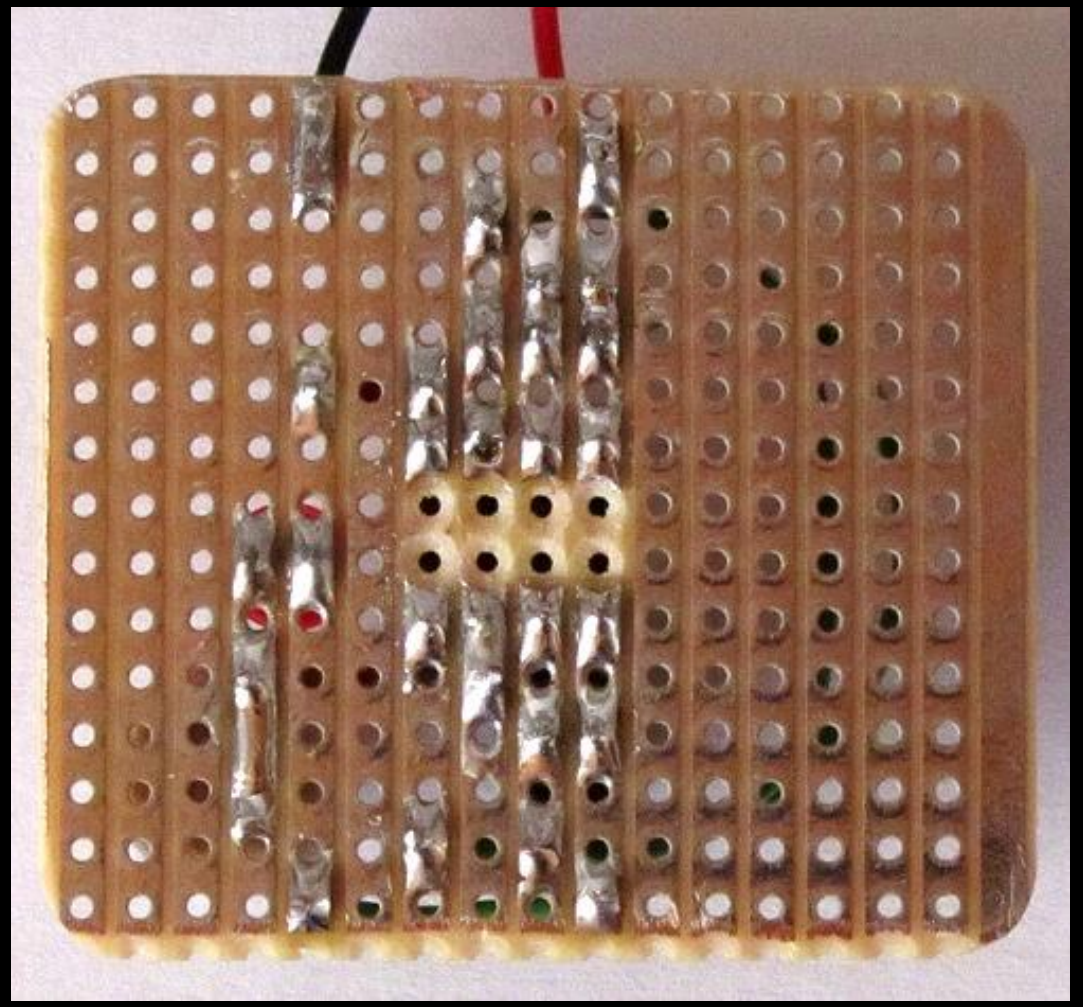
TOO HOT
Lower temp/time

NOT ENOUGH SOLDER
Add flux, more solder, & iron

TOO MUCH SOLDER
Add flux, re-heat and wick/suck away excess

SOLDERING ON BOARD





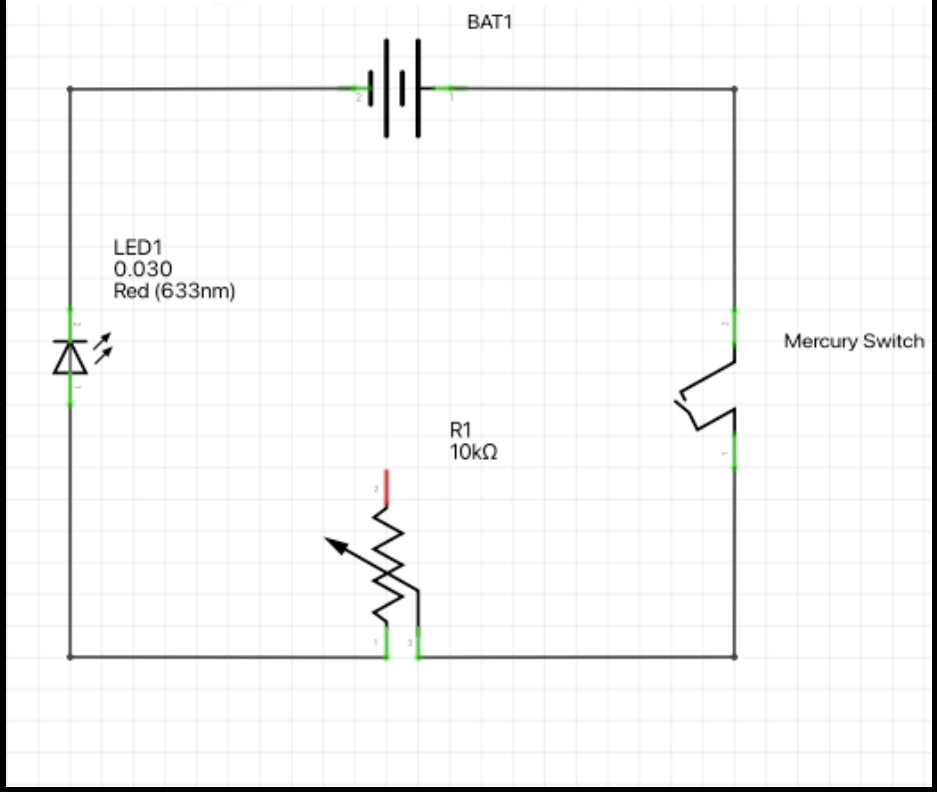
Source: https://startingelectronics.org/beginners/making-a-stripboard-circuit/

Let’s shift our circuit across and solder it in.

ACTIVITY 5

Practical demonstration of soldering

For this activity we will share the soldering irons and work with our neighbours to do some solder joints.



ACTIVITY 6

Layout components on a protoboard

For this activity we'll recreate the circuit in a way that takes advantage of the different Positive and ground rail layout of the protoboard.

And then solder this together.

Then we'll test our circuit. If it does work first time: Ya!

If it doesn't work first time: Ya!

We get an opportunity to fault find and maybe even practice our desoldering.

THANKS FOR ATTENDING

Please complete our survey that will be sent out via Eventbrite.

Tag us on socials @statelibraryqld

Contact us on appliedcreativity@slq.qld.gov.au

STATE LIBRARY QUEENSLAND

Queensland Government

slq.qld.gov.au