Intro to Circuits!

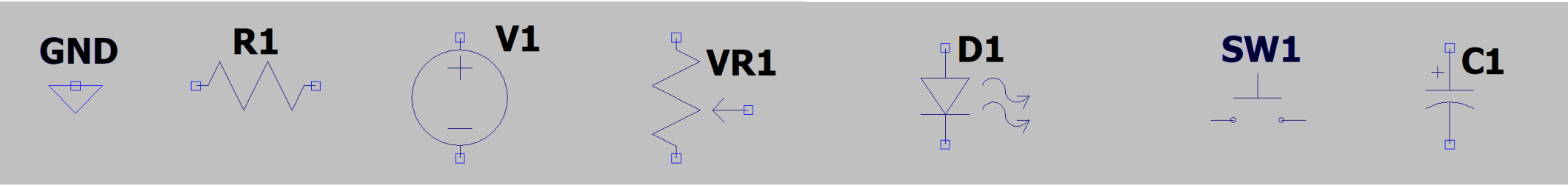
Indiana Tech Robotic Warriors Club

What is a Circuit?

- The definition of a circuit is an electrical path that starts and stops at the same place.
- One of the easiest examples of a circuit would be a battery connected to an LED in order to get it to light up. We will build this circuit in a few slides!

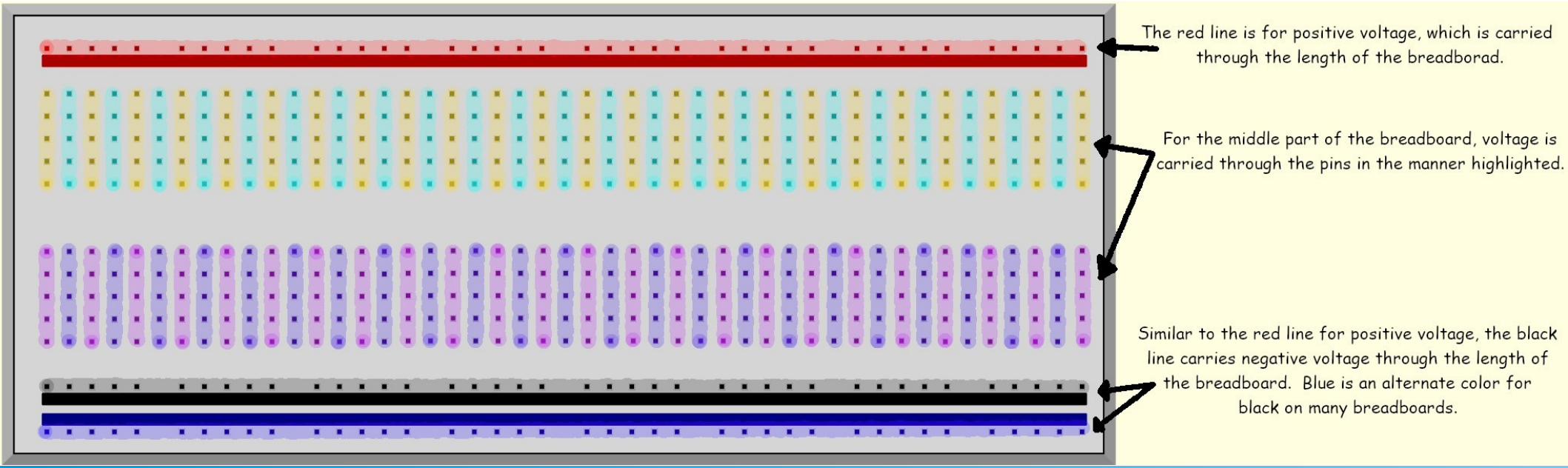
Electrical Diagram Symbols

- In engineering, electrical circuits are often drawn according to set standards given by governing bodies, such as the IEC.
- Today, we will just use the symbols below.
- Keep in mind that just one example will be shown for both the diagram and breadboard symbol, but there are alternatives for many of these symbols as well as for the abbreviations.



Breadboard Functionality

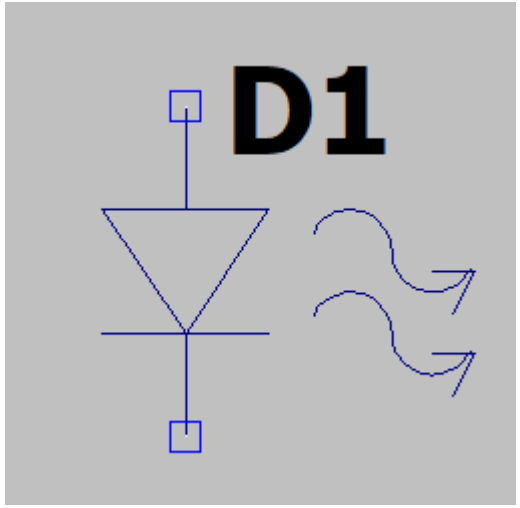
- A breadboard is an excellent tool for prototyping electronics before making a printed circuit board. Refer to the image below for how it works:

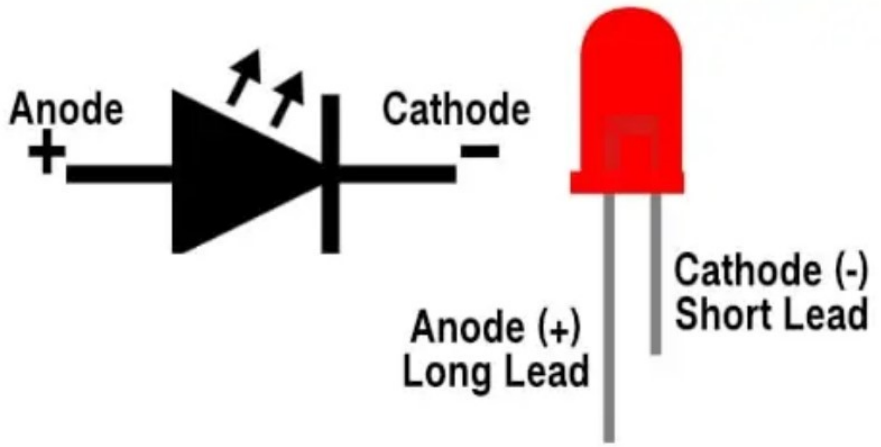


LED

- An LED is represented by the letter ‘D’, short for “Diode”. The negative (cathode) is the bottom where the triangle points. The positive (anode) would be the top, where the triangle is flat.

Electrical diagram symbol



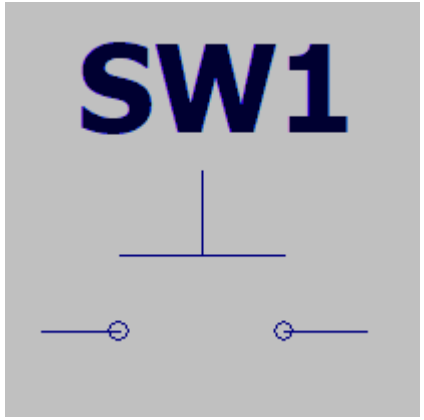


On a breadboard diagram, the flat side is negative

Push Button Switch

- A switch is represented by the letters ‘SW’, short for “Switch”
- A switch has no polarity (no positive or negative). All it does is bridge the connection from one side to another, exactly like if you had two wires and touched them together.

Electrical diagram symbol

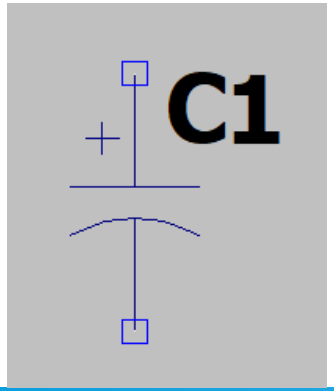


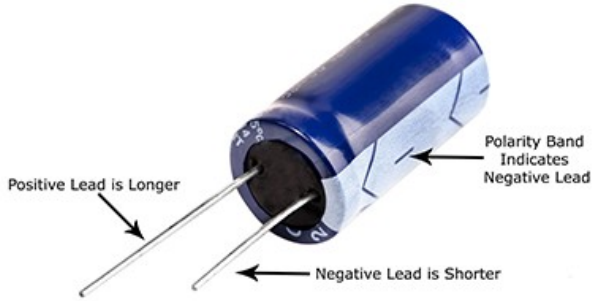
Breadboard symbol

Capacitor

- A capacitor is represented by the symbol ‘C’, short for “Capacitor”. Polarity matters for electrolytic capacitors, but not for ceramic.
- A capacitor is much like a very small battery, where it stores energy to be discharged.

Electrical diagram symbol (polar capacitor)



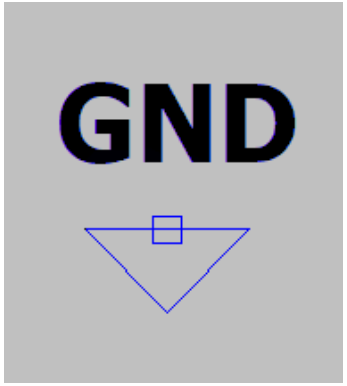


The gray side represents the negative side of the capacitor on a breadboard diagram

Ground

- Ground does not have an abbreviation a lot of the time on circuit diagrams, but when it does it is ‘GND’, short for “Ground”.
- Ground is idealized as an infinite sink to which electrical charge can go to. Think of a lighting rod on a house.

Electrical Diagram Symbol

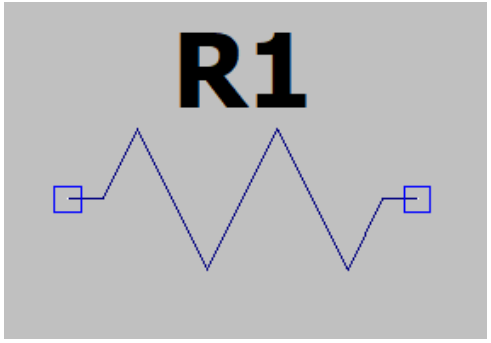


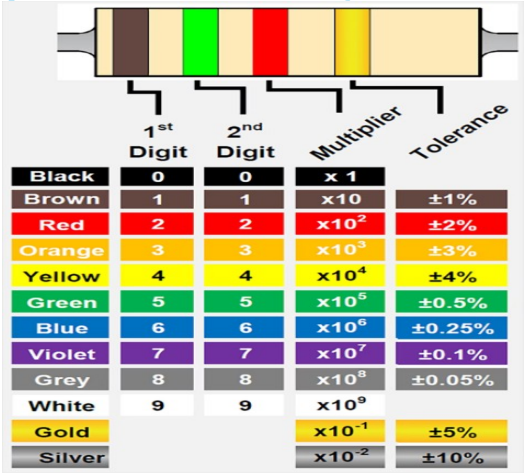
On a breadboard diagram, the ground or negative is represented by the black colored rail.

Resistor

- A resistor is represented by the letter ‘R’, short for “Resistor”.
- Polarity does not matter for a resistor. In either orientation, it will limit current. It affects electrical current the same way a pipe size reduction affects flowing water. A resistor’s resistance value, given in Ohms (Ω), is represented by the colors on it, given below.

Electrical Diagram Symbol





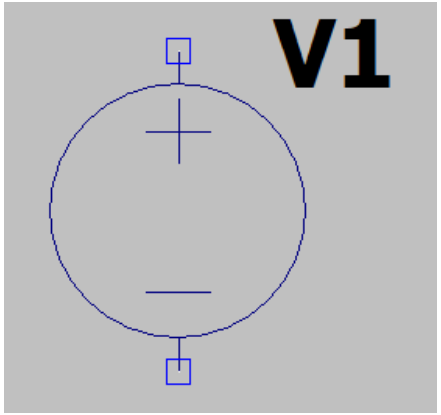
	1st Digit	2nd Digit	Multiplier	Tolerance
Black	0	0	x 1	
Brown	1	1	x10	±1%
Red	2	2	$x10^2$	±2%
Orange	3	3	$x10^3$	±3%
Yellow	4	4	$x10^4$	±4%
Green	5	5	$x10^5$	±0.5%
Blue	6	6	$x10^6$	±0.25%
Violet	7	7	$x10^7$	±0.1%
Grey	8	8	$x10^8$	±0.05%
White	9	9	$x10^9$	
Gold			$x10^{-1}$	±5%
Silver			$x10^{-2}$	±10%

Breadboard diagram example of a 470kΩ resistor

DC Voltage Supply

- A DC voltage supply is represented by the letter ‘V’, short for “Voltage”.
- Polarity is marked with the ‘+’ and ‘-’.

Electrical Diagram Symbol

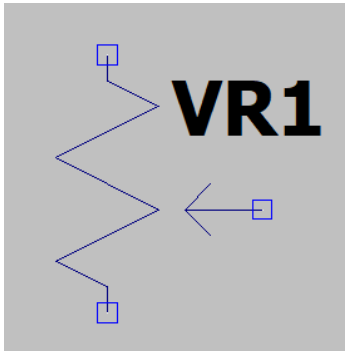


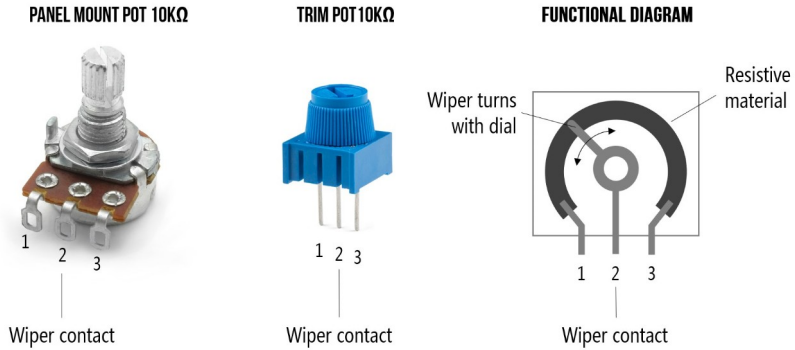
On a breadboard diagram, it is assumed the voltage supply is connected to the red and black power rails. Respectively, the positive and negative power.

Potentiometer

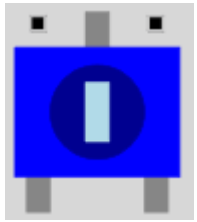
- A potentiometer is represented by the letters ‘VR’, short for “Variable Resistor”. The wiper contact would be the arrow pointing at the resistor symbol.
- As you may have guessed, it behaves much like a resistor, except you can alter the resistance value on the fly.

Electrical Diagram Symbol



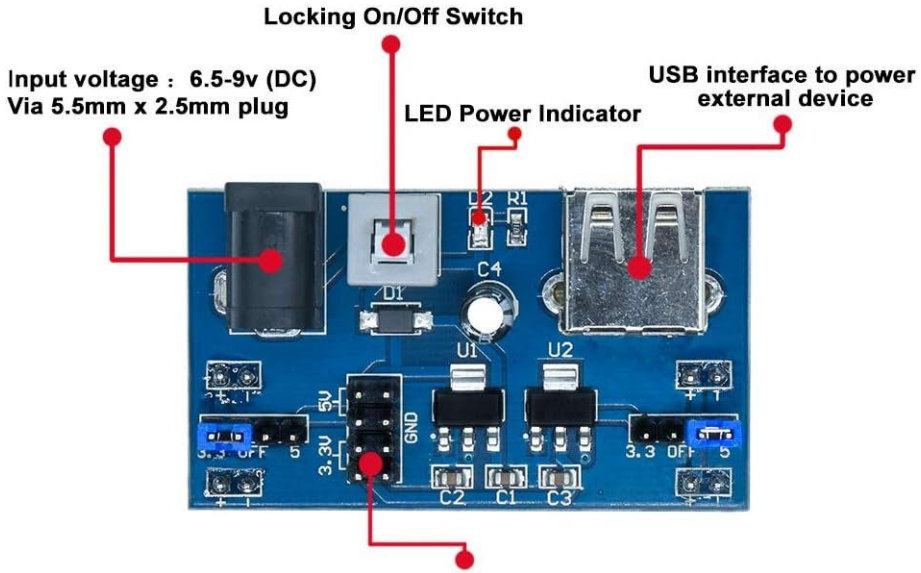


Breadboard Symbol



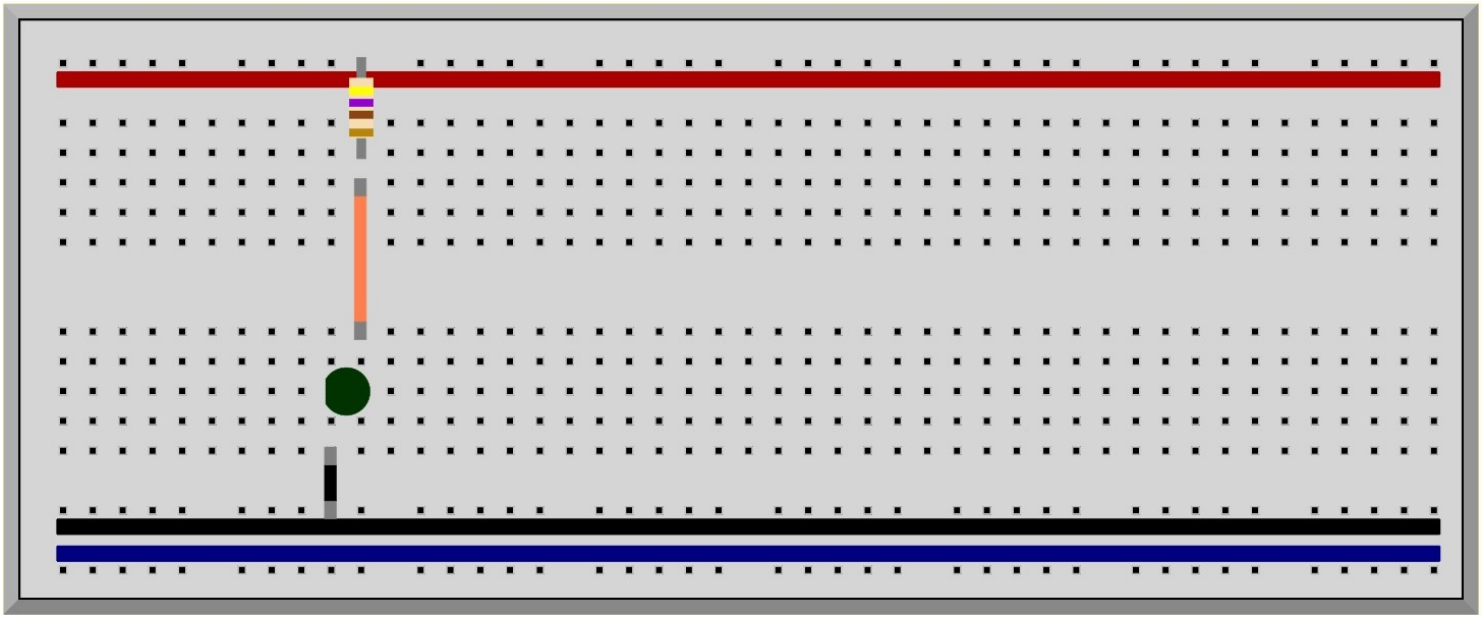
Wiring the Power Supply

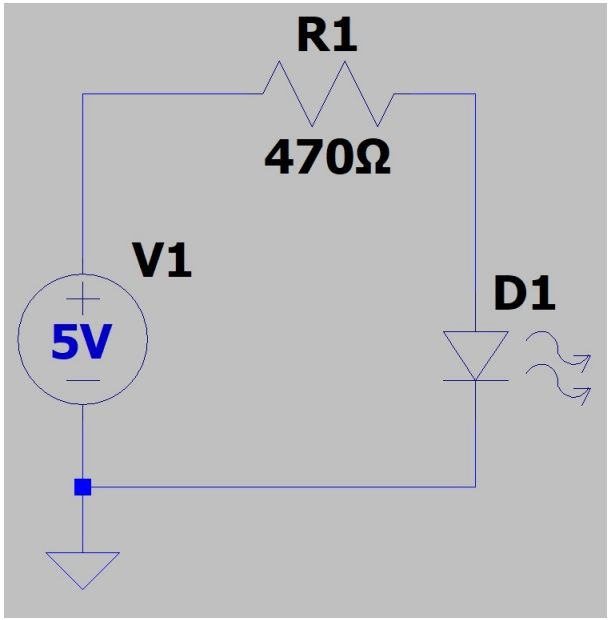
- Using the diagram to the right, wire the power supply unit to output 5V.
- After the jumper pins are set, attach wires to the 5V and GND terminals and attach them to the power rails of your breadboard. One you have that, we are ready to make your first circuit!



Circuit #1: Make an LED Light Up!

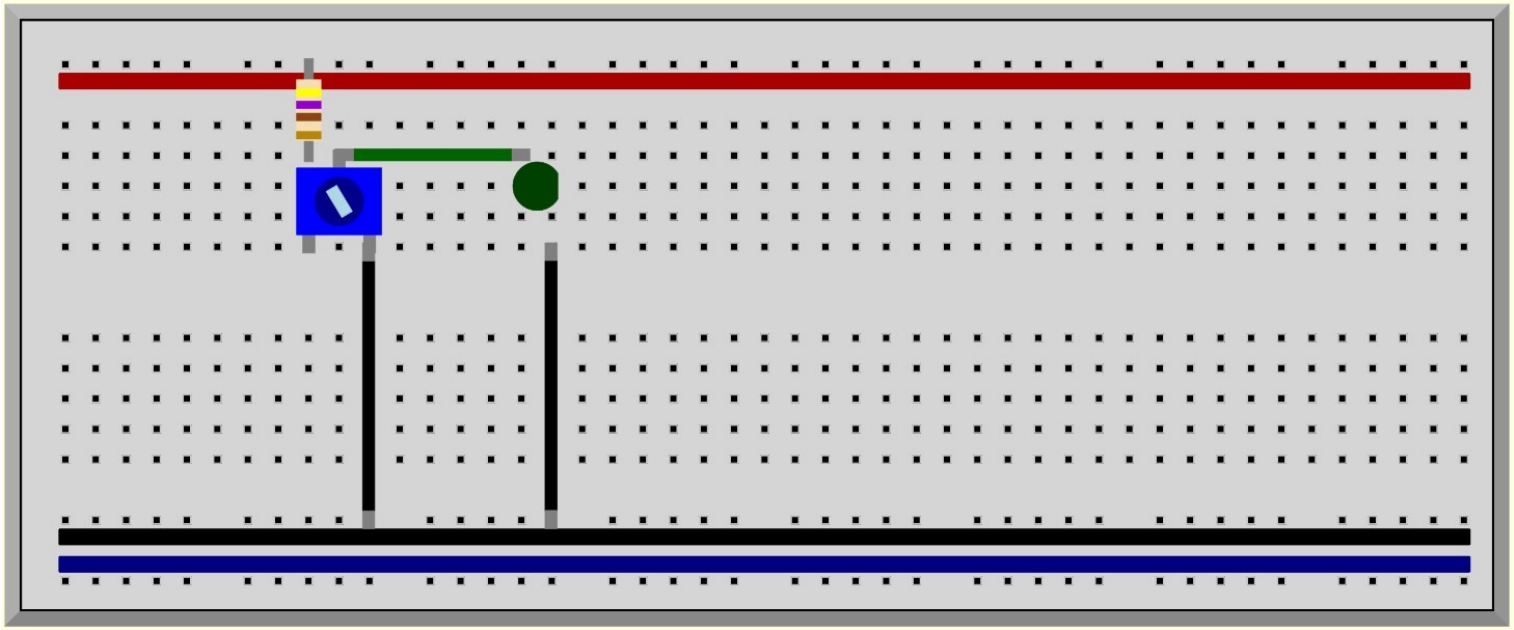
- Now that we have power run to the rails, wire up an LED using a 470Ω resistor as shown below.

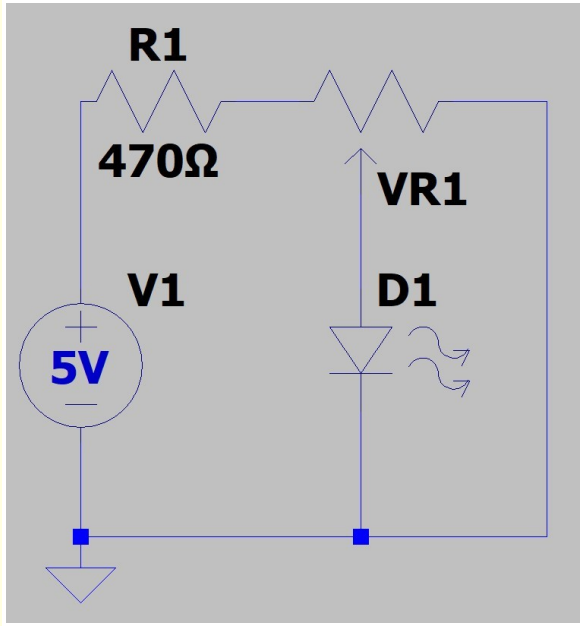




Circuit #2: Dimming an LED!

- Let's add adjustable brightness to that LED using a potentiometer, as shown below. Try adjusting the potentiometer!





Circuit #3: Capacitor Shenanigans!

- Try out this last circuit! As long as the push button is pressed, the LED should be lit up. However, when the push button is released, the LED will slowly dim until it turns off. Try to change the capacitor value and see how it affects the circuit!