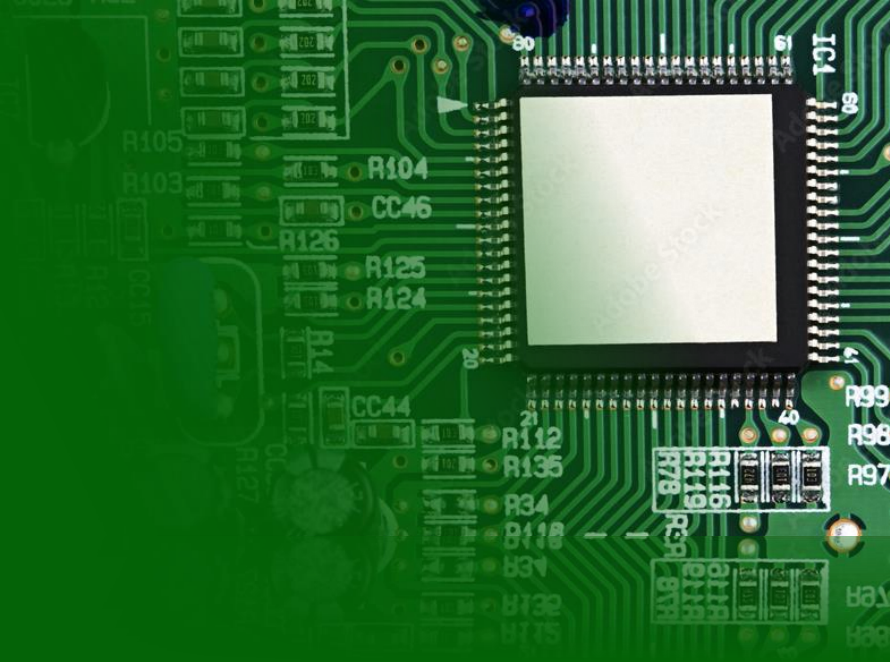
# Day 2: Basic Electronics Workshop




STEM Workshop at ASA Now - MSD2

# Projects Overview:

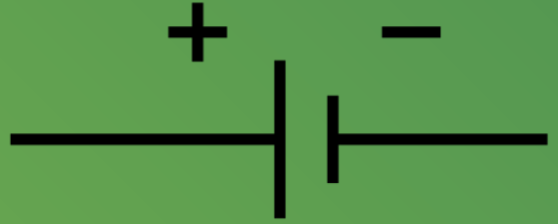
1. Simple LED Circuit
2. Variable Brightness LED Circuit
3. Simple Motor Circuit
4. Variable Speed Motor Circuit

## Time-permitting Challenges

1. Variable Brightness LED using Potentiometer in Parallel

# Batteries


- The Power Source of the circuit
- Creates a “Potential Difference” (aka Voltage) in the circuit it is connected to.
- This Potential Difference causes electrons to flow through the wires of your circuit, provided that your closed loop connects to both the positive and negative terminals of your battery.
- This flow of electrons is known as “Current”, and it can be used to power other devices (such as LEDs and Motors) in the circuit.



# Open vs Closed Circuits

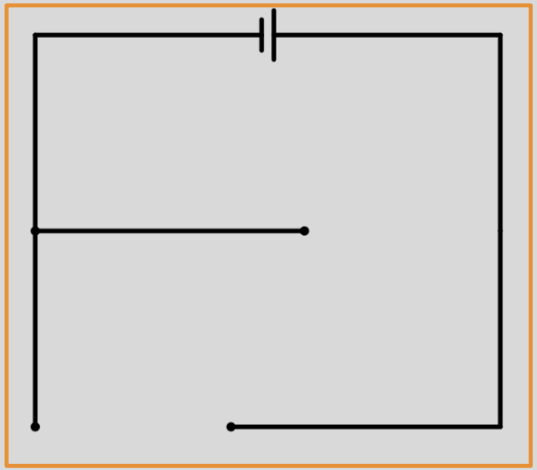
In order to have a functioning circuit, you must have a continuous loop of conductive material connected between the positive terminal of the battery and the negative terminal.

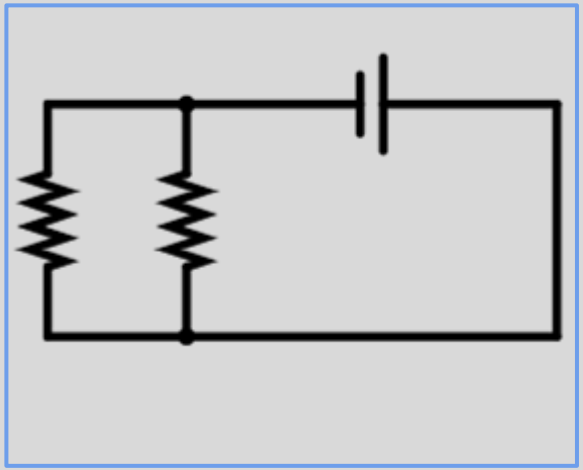
Example of an open circuit:

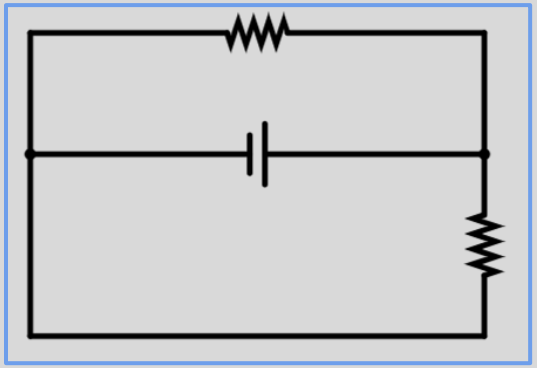
Example of a closed circuit:

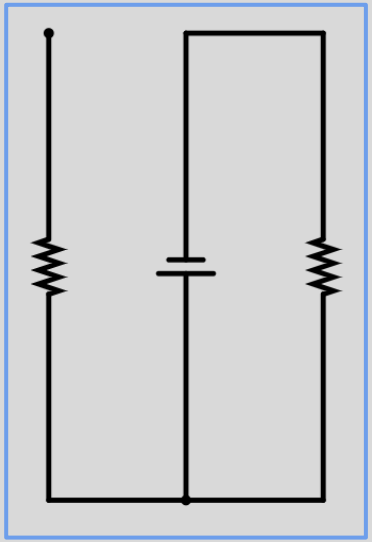
# Open vs Closed Challenge!

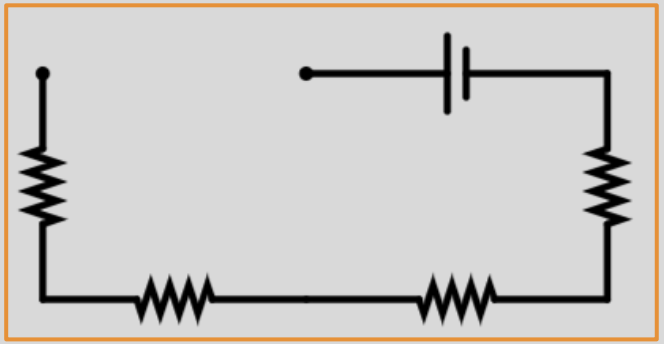
Which of the following circuits would be classified as closed (having at least one complete loop) and which would be classified as open (having no complete loops)?

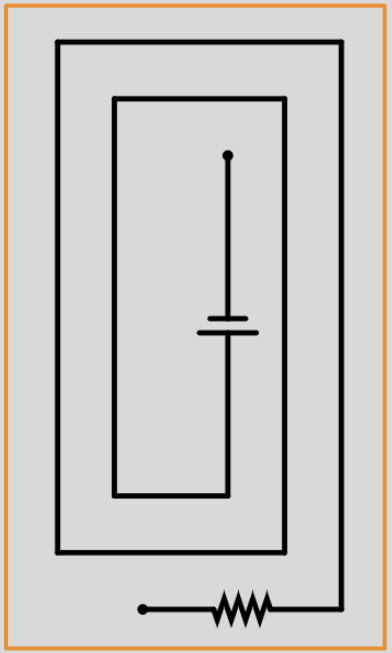




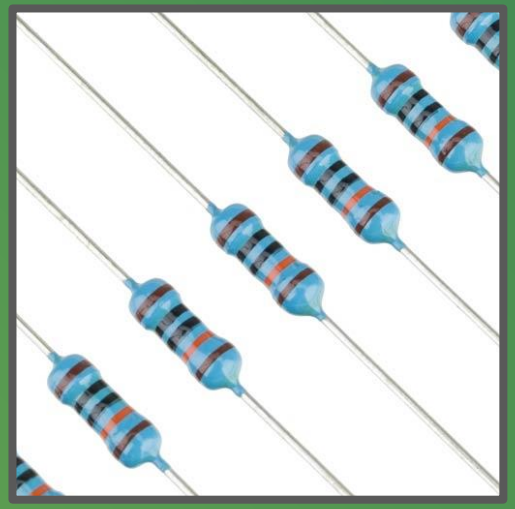








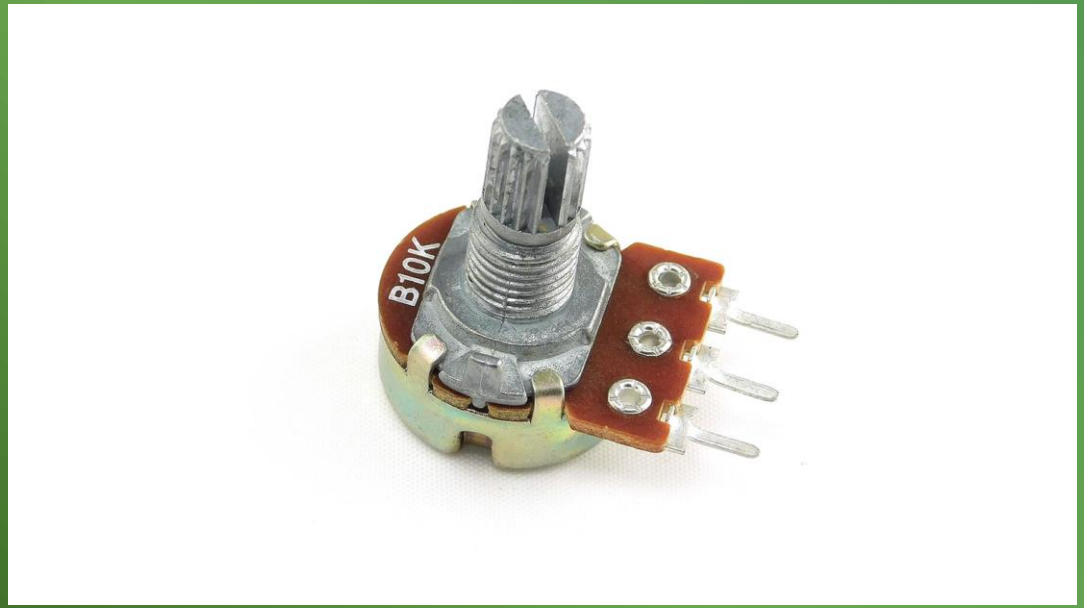
# Resistors



- Resist the flow of current in a circuit
- **Why would we want to do this?**
  - Safety
    - Some components simply cannot handle having too much current flowing through them at once, and will burn if this occurs
  - Control
    - We can use special Variable resistors, called “Potentiometers” to physically control the current flowing through a circuit, and with it, the output of various devices, including LEDs and Motors.

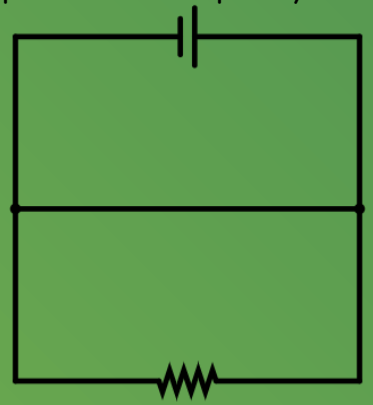
# Potentiometer

- Potentiometers are a resistor that can have it's resistance manually adjusted by turning a knob

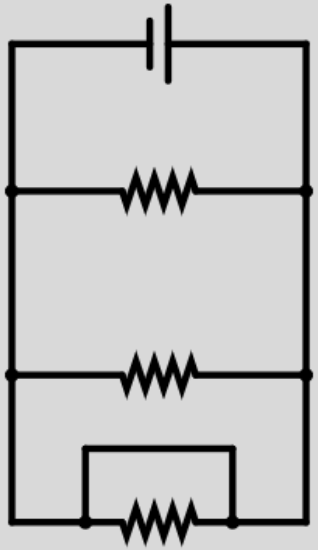


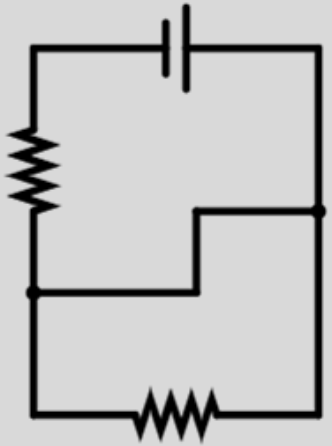
# Short Circuits

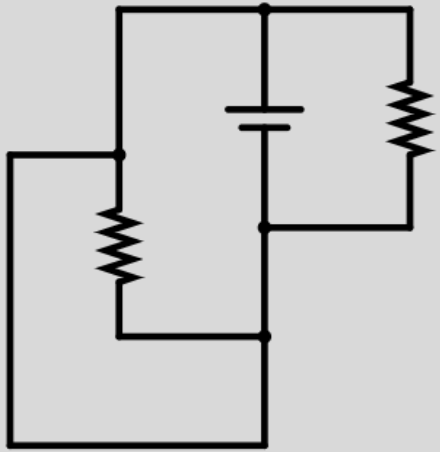
- Created when a battery is connected in a circuit with no resistive elements.
  - This creates a near-infinite current in the circuit
- This can be extremely dangerous
  - Best-case scenario: the battery rapidly discharges, sharply reducing the battery's lifespan to only a few hours.
  - Worst-case scenario: the battery and other components rapidly heat up, causing a fire or explosion.

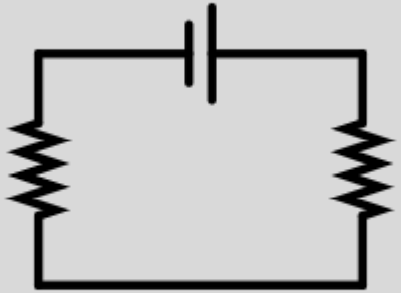


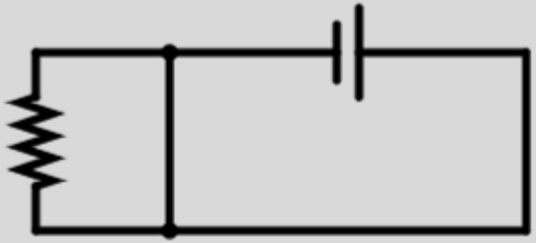
# Is it Shorted Challenge!











# Devices

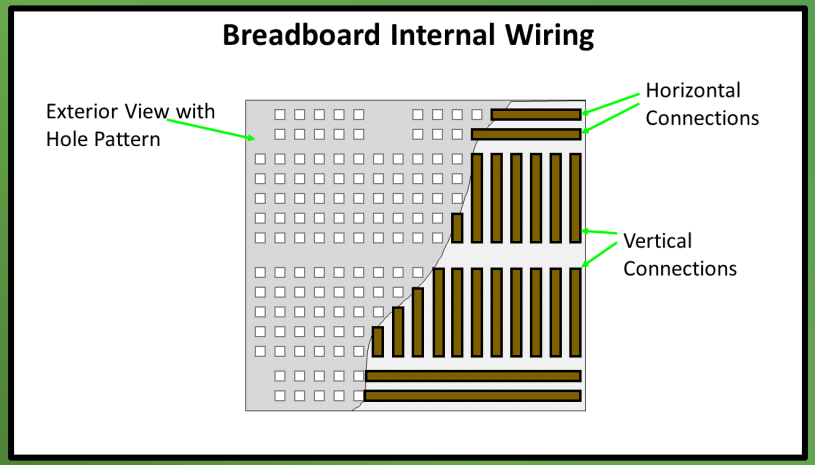
- These are the outputs of our circuits
- For this lab, the two main outputs we will be using are LEDs and Motors.
- **Note**: some larger electronic devices, such as motors, will also introduce a significant amount of resistance to the circuit.

# LEDs

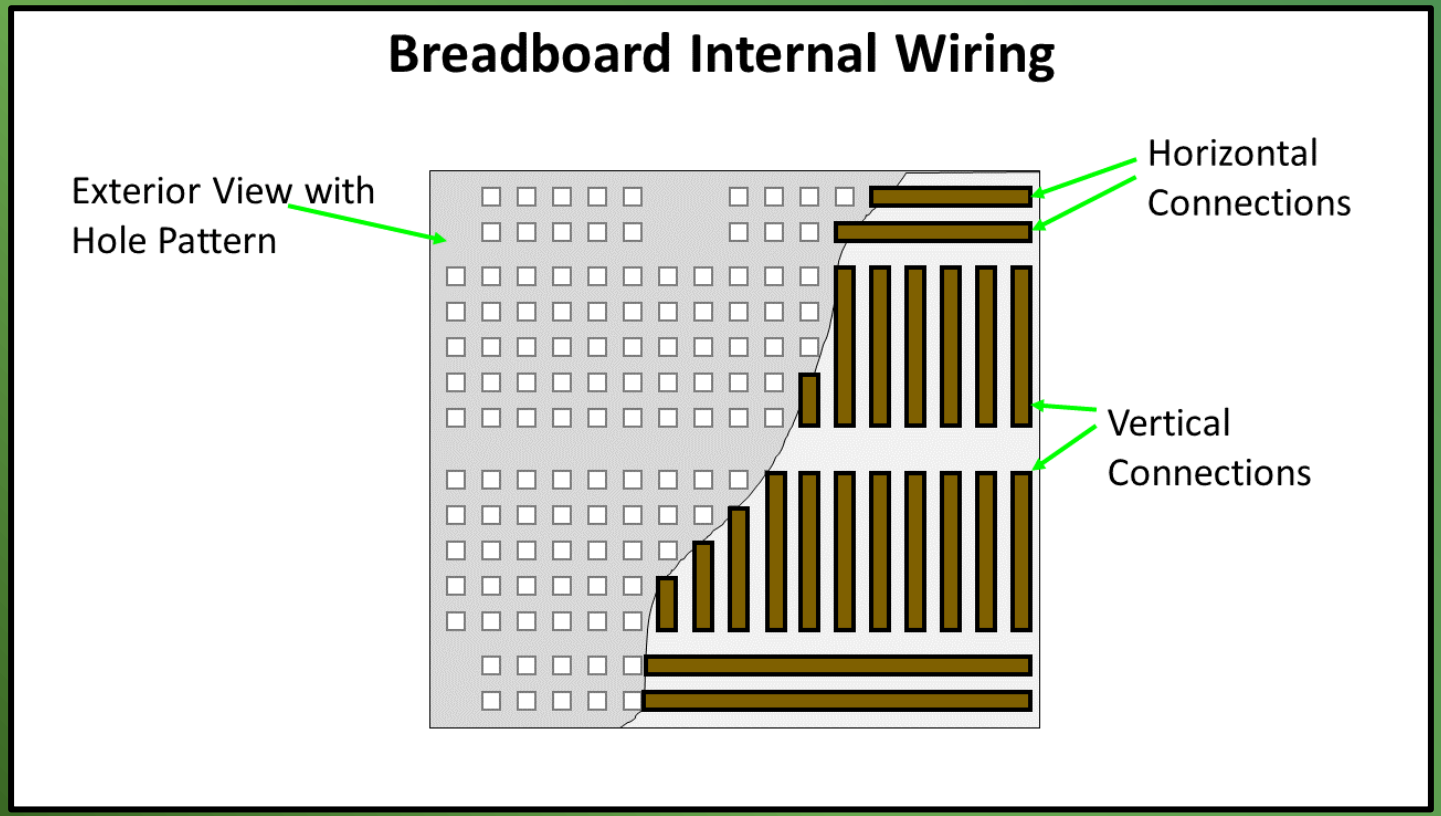
- LED stands for “Light Emitting Diode”
- Diodes are a special type of electronic component that only allow for current to flow through them in one direction.
  - If you think you have built a circuit correctly, but the LED is not glowing, try flipping it around to check if you have just accidentally inserted it in the wrong direction.
- LEDs are very prone to burning out and becoming permanently unusable when connected to a battery without any resistive elements.
  - When working with LEDs, always make sure it is next to a resistor!

# Breadboards

- The base of circuits that we will build.
- Plastic boxes with holes that are interconnected underneath with wires.
- Insert devices in specific sequence and they are connected.



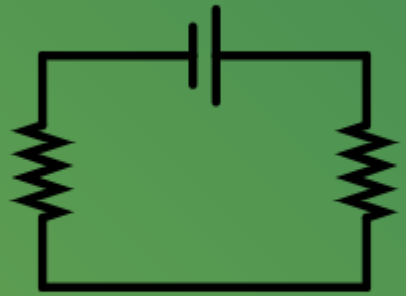
# Breadboards

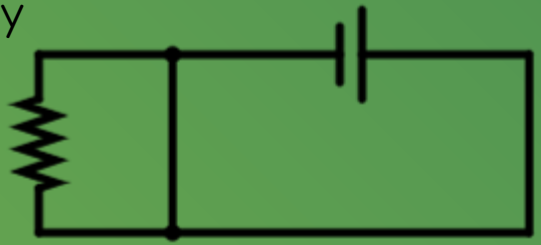


# Series vs Parallel

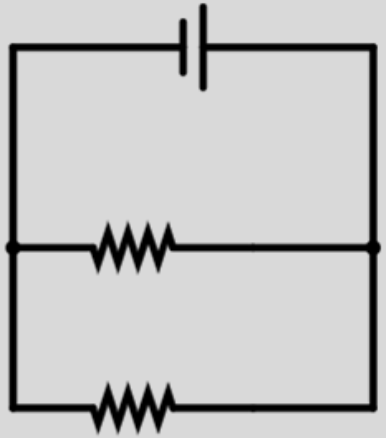
The words “Series” and “Parallel” are used to describe the branches present in a circuit.

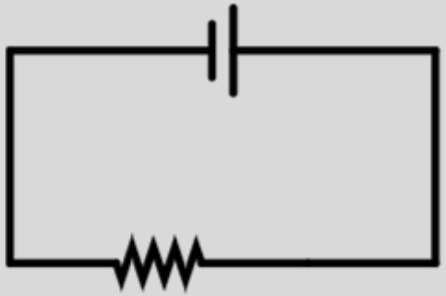
When you describe a component as “in series” to another, you are typically saying that they are in the same circuit branch. On the other side, saying a component is “in parallel” to another means that they are on different branches of the circuit.

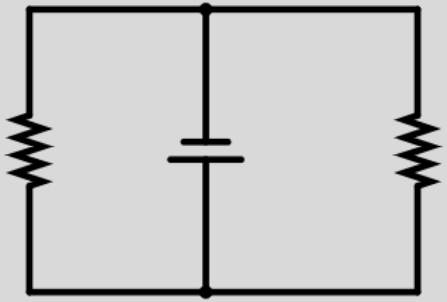


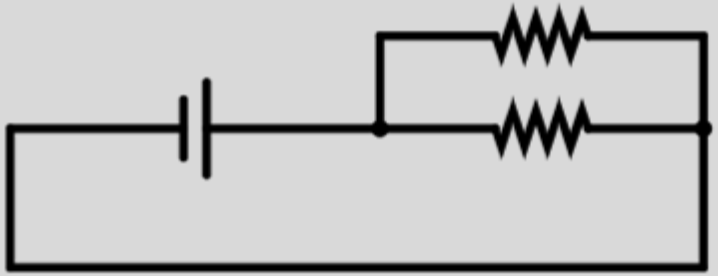


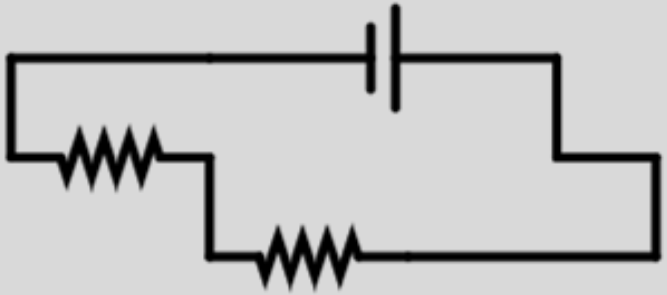
# Series or Parallel?











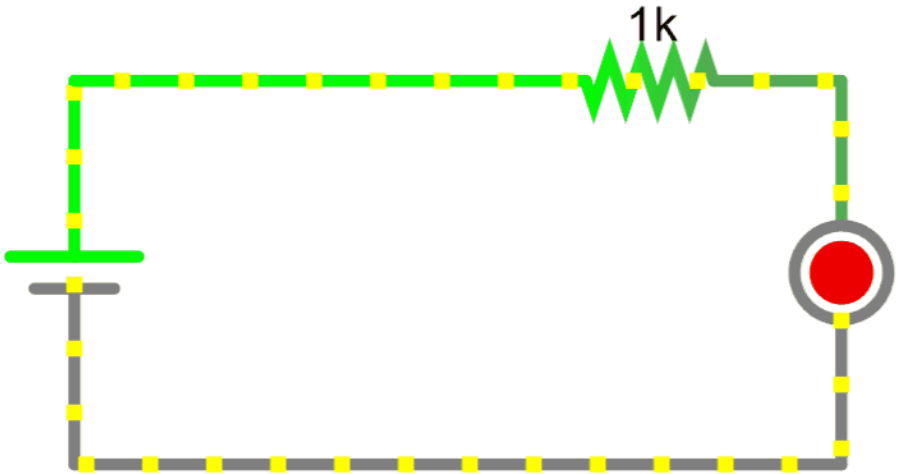
# Project 1: Simple LED Circuit

Let's start with a simple circuit.

Here is a basic LED circuit powered by a battery.

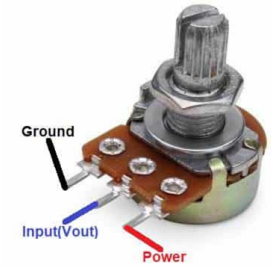
If you successfully recreate the circuit, but your LED is still not glowing, try taking it out and reversing it.

**Make sure you include a resistor next to the LED, or it may become permanently burnt out and destroyed.**



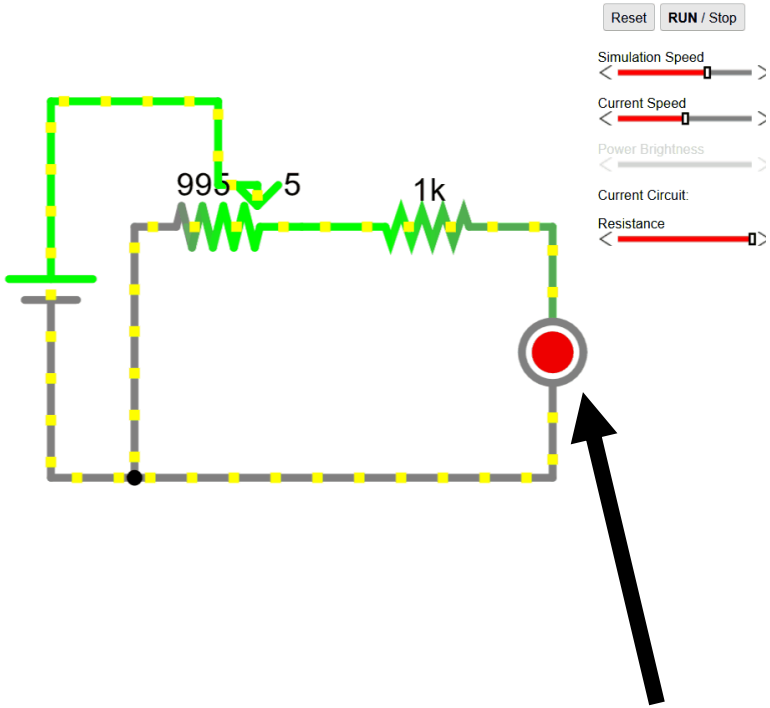
# Project 2: Variable Brightness LED

Let's get a little more advanced and add in the Potentiometer, our variable resistor!




With the pins facing towards you, connect the leftmost one to the negative terminal of the battery, the middle one to the LED, and the right pin to the positive terminal of the battery.

If you are successful, you should be able to control the brightness of the LED by rotating the knob on the potentiometer




Notice how the LED's brightness changes as the current through it changes

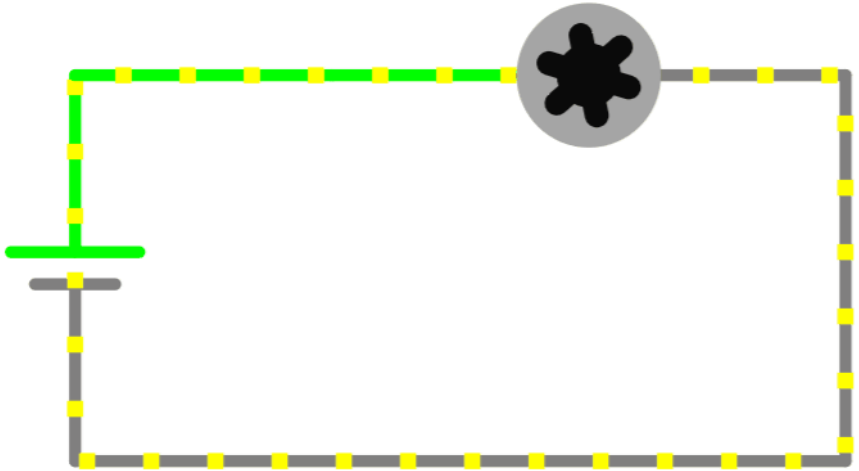
# Project 3: Simple Motor Circuit

Let's try the first circuit, but with the motor instead now.

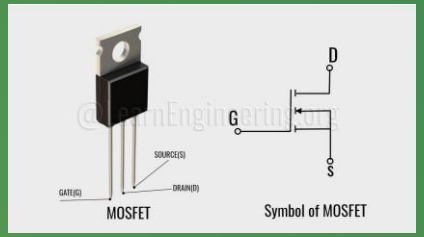
Build this circuit above, being sure to connect the battery last.

**Warning**: the motor will spin VERY fast, potentially startling you if you are not expecting it.

**Note**: Because the Motor has a significant internal resistance, we do not need to connect an additional resistor to prevent a short circuit.



# MOSFET Transistors

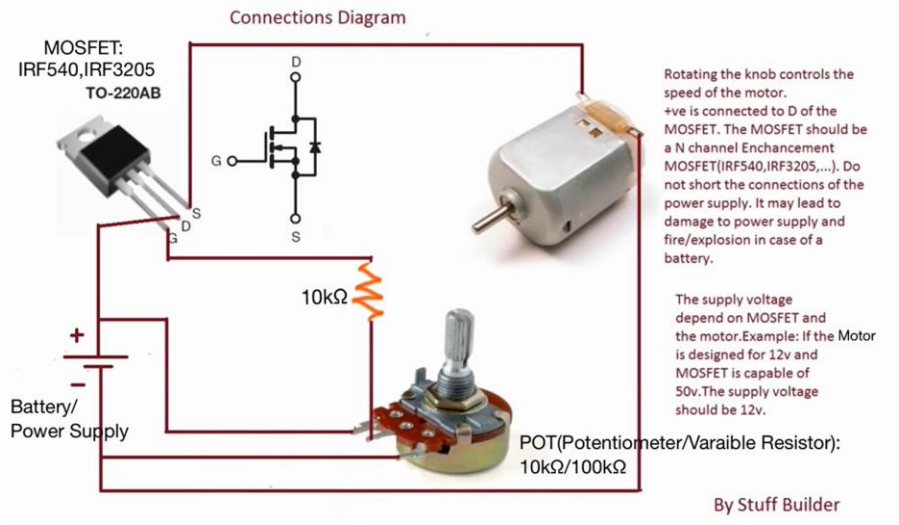



- A little bit advanced, but they are unfortunately necessary to create a potentiometer-controlled Motor Circuit
- The currents needed to allow the Motor to work are unfortunately too high to safely directly connect a potentiometer to.
- As such, in order to amplify the lower output of the Potentiometer into something that the Motor can run on, we have to run it through the MOSFET
- For this workshop, all you need to know is that when the potentiometer and MOSFET are acting together, they effectively become an amplified potentiometer that can handle the power needed to run more demanding Devices, such as the motor.

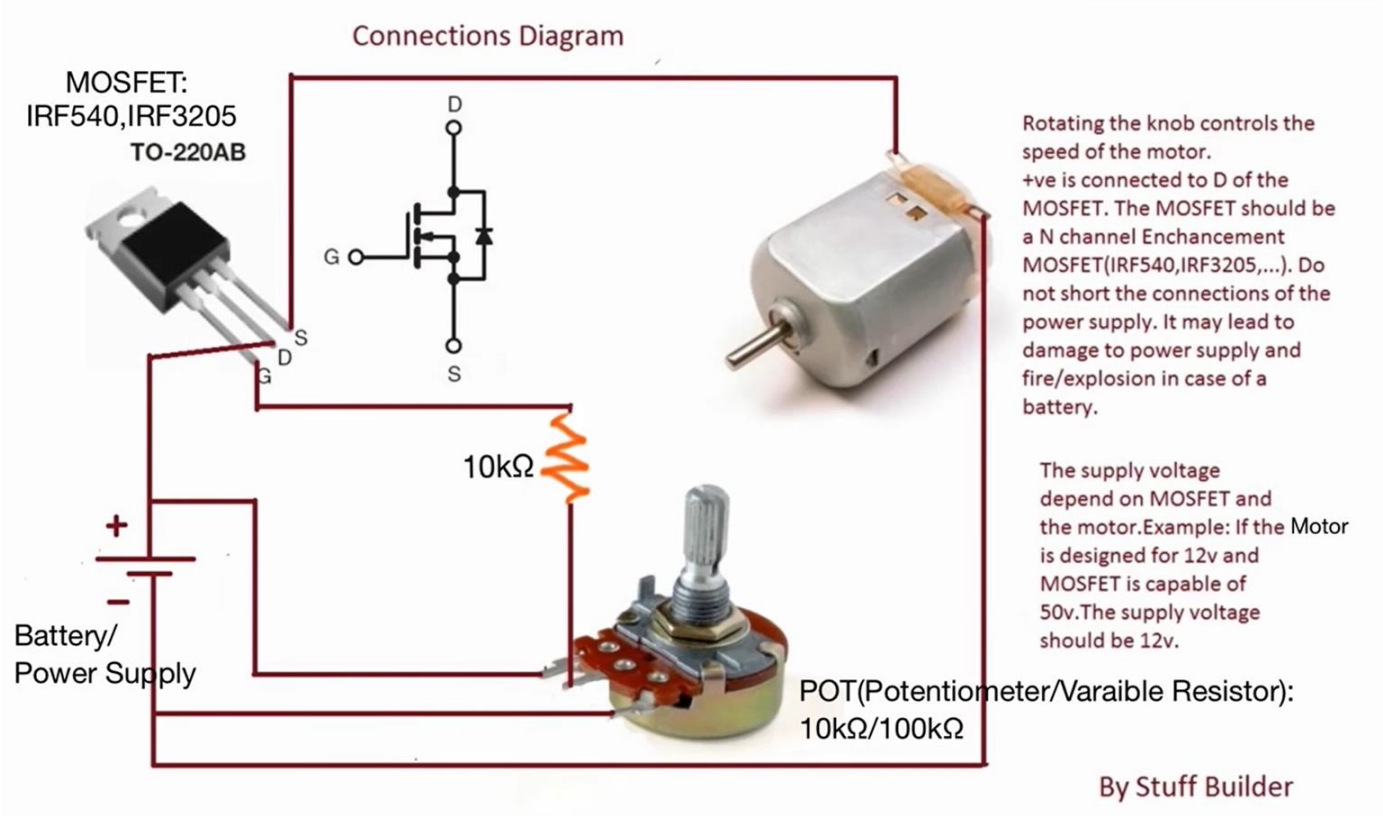
# Project 4: Variable Motor Circuit

Let's build a circuit that uses the potentiometer and MOSFET to control the speed that the motor spins.

Try to follow the diagram to build the following circuit, but if you get stuck, feel free to ask for a volunteer for help!



# Variable Motor Diagram



# Challenge: Parallel Potentiometer Variable Brightness LED Circuit

Using your knowledge of Series and Parallel circuits, design a circuit such that increasing the resistance in the potentiometer increases the brightness of the LED.

Once you have your circuit diagram approved, build it on your breadboard!

# Credits

Thank you to Benjamin Arbit for helping with the content and formatting of this slide show.