

## What Will You Learn?

Learn how to use an Arduino as a power source to build an LED circuit.

## Why Should You Learn This?

Building a circuit with an LED, or light emitting diode, is an easy first step into the world of engineering. This simple device, now used for household lights because of its low use of energy, just needs power to get it working, but it can also be coded to blink, fade, or turn on and off with the use of sensors and buttons. For this lesson, you will use the Arduino like a battery. To do this, you will also need to use a resistor, which will regulate the flow of electricity to the LED so that you don't burn out the LED.

## Here's What You'll Need:

### Arduino

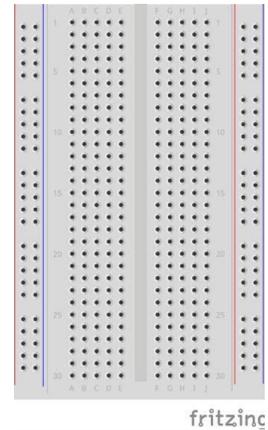


### LED



Notice that one of the wires of the LED is slightly longer than the other, the long leg is the positive side and the short leg is the negative side. This will be important when you go to plug in your LED. Tip: think positive = more = longer leg

### Breadboard



### Red Wire



### Black Wire



### A to B USB Cable



You will power the Arduino from a computer through the USB cord.

### Resistor



Use a range of 100 – 400 ohms, (see challenge #4 below to see why).

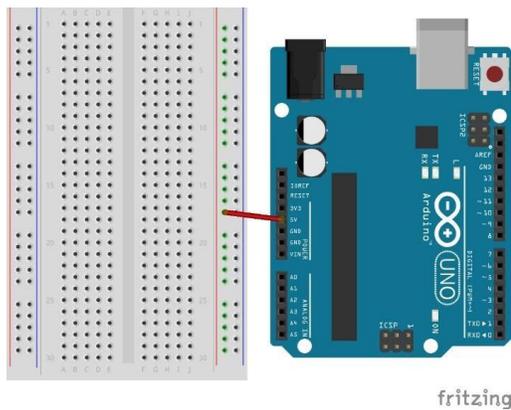
# Safety First!

Never allow the red and black wires to touch together while they are connected to a powered Arduino board, as that creates a short circuit. A short circuit can potentially cause the wires and/or the Arduino board to get hot enough to burn the skin. In addition, in the event of a short circuit, the Arduino board can potentially catch on fire.

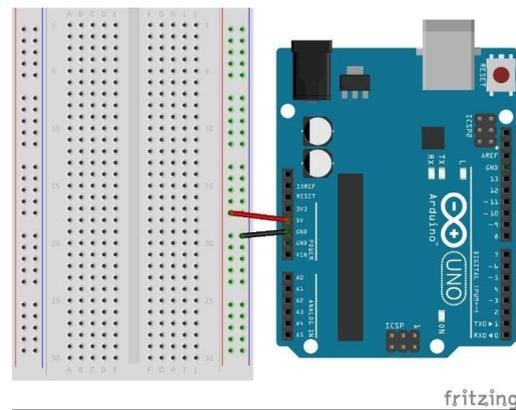
## Let's Get Connected!

1. Connect the Arduino to the computer using the USB cable. Make sure the Arduino's green power light is on (it's ok if other lights are on too). If the light is off, double check to see if the computer is turned on.

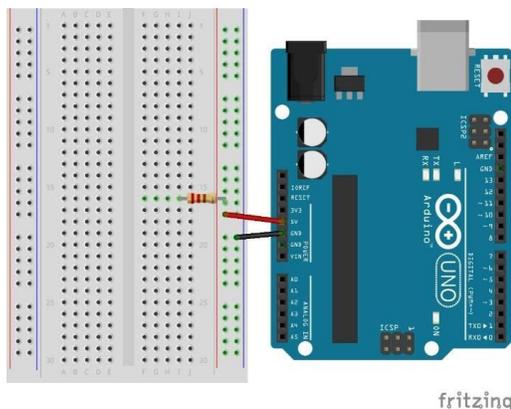
2. Connect the red wire from the 5V pin on the Arduino to the positive rail of the breadboard.



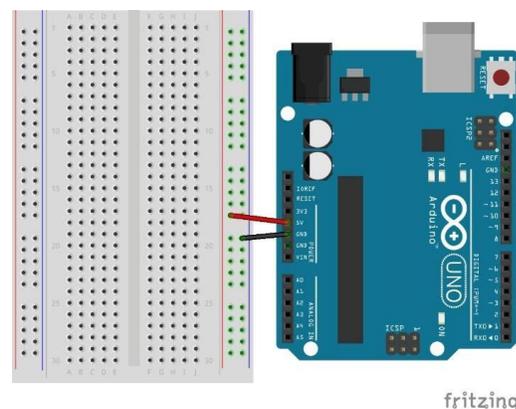
3. Next, connect the black wire from GND on the Arduino to the negative rail of the breadboard.



4. Add the resistor. Use it to connect the positive rail to any row on the breadboard (shown using row 16).



5. Lastly, connect the LED, by placing the long wire (positive) in row 16 and the short wire (negative) in the negative rail.



Congratulations! You have just made an LED light up!

## Tips for Success!

- Make sure that all the wires are plugged into the correct row or column on the breadboard and the correct pin on the Arduino. If one of the wires is in the wrong row or column, then the circuit is incomplete and the LED will not be getting any power.
- Be sure that the long leg of the LED is in the same row as the resistor and the short leg is in the negative rail.
- Try another LED and see if that one works, the LED may be broken.
- Check the resistor. If you're using too large of a resistor, the LED may not be getting enough power to turn on. You can calculate the resistance of a resistor by looking at the color-coded bars on it. There are lots of resources online to find out how to read a resistor.

## Are You Ready for Some Challenges?

1. Try reversing the direction of the LED. Put the long leg in the negative rail and the short leg in row 16. Does the light still turn on?
2. Try reversing the direction of the resistor by switching the leg that was in the positive rail to row 16 and vice versa. Does the light still turn on?
3. Try moving all the pieces so that they are in new places but keep the same circuit (this will challenge you to see if you understand how a breadboard works). Note: be careful not to skip the resistor and connect the LED directly to 5V and GND or you will burn out your LED.
4. Try to calculate the exact resistance value needed for the LED using Ohm's Law.

$$\text{Ohm's Law: Voltage(V) = Current(I) x Resistance}^*$$

The voltage, measured in Volts, would be the voltage being given to the LED (5V) minus the voltage required to turn on the LED (typically 2 volts to 3.5 volts, use 3 volts to make it easy). So,  $V = 5 - 3 = 2$ . The Current, measured in Amps, is how much current is needed to turn on the LED, typically 20 milliamps (.02 amps). Now that you have the voltage ( $V = 2$  volts) and the current ( $I = .02$  amps), you can solve for the resistance needed by using the formula ( $V = IR$ ) to solve for R.

# Challenge Solutions

1. No, the LED will not turn on because the LED has polarity. The electricity must flow from positive to negative, so reversing the direction of the LED will cause it to turn off.
2. Yes, the LED will stay on because the resistor does not have polarity, so the direction in which you place it does not matter.
3. There are many different solutions, but remember not to forget your resistor!
4.  $R = 100$  ohms

$$V = IR > 2 = .02^* > 100 = R$$