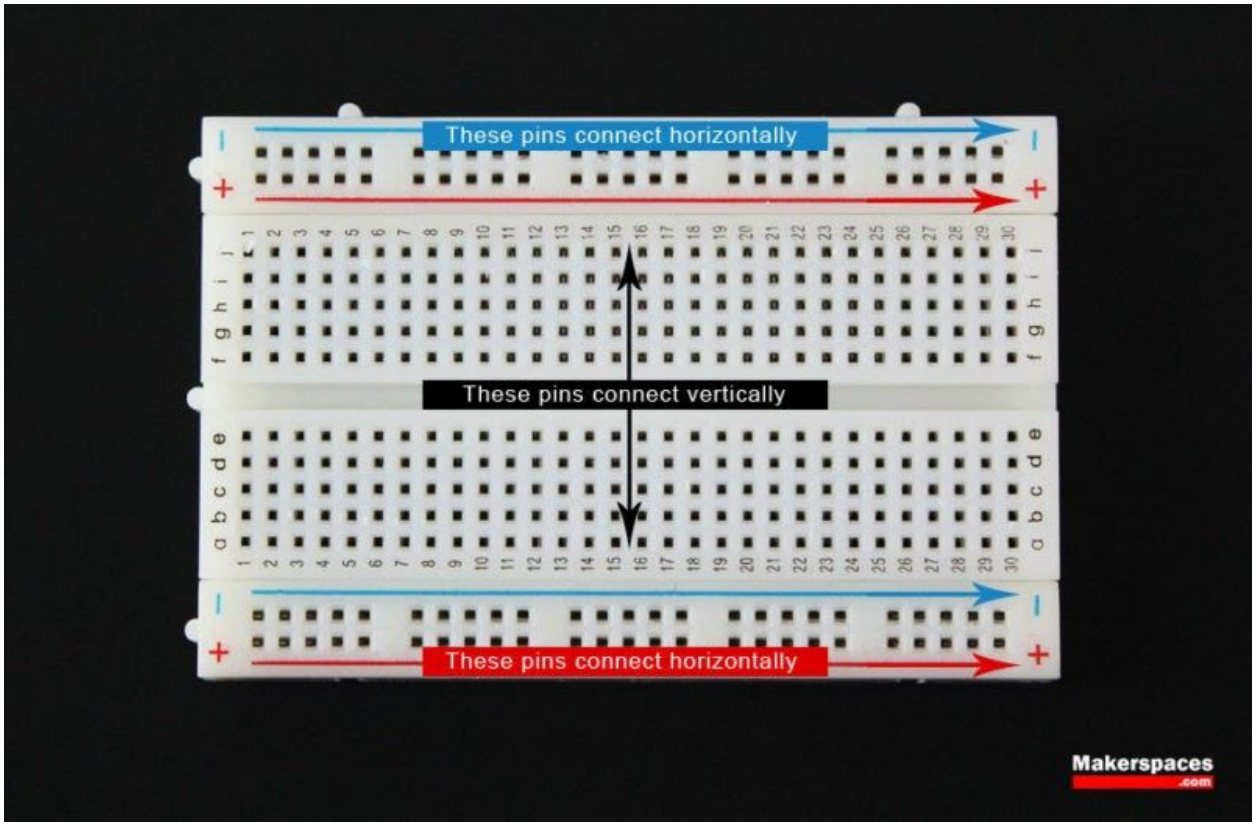
# Breadboard

Breadboards are an essential tool for prototyping and building temporary circuits. These boards contain holes for inserting wire and components. Because of their temporary nature, they allow you to create circuits without soldering. The holes in a breadboard are connected in rows both horizontally and vertically as shown below.



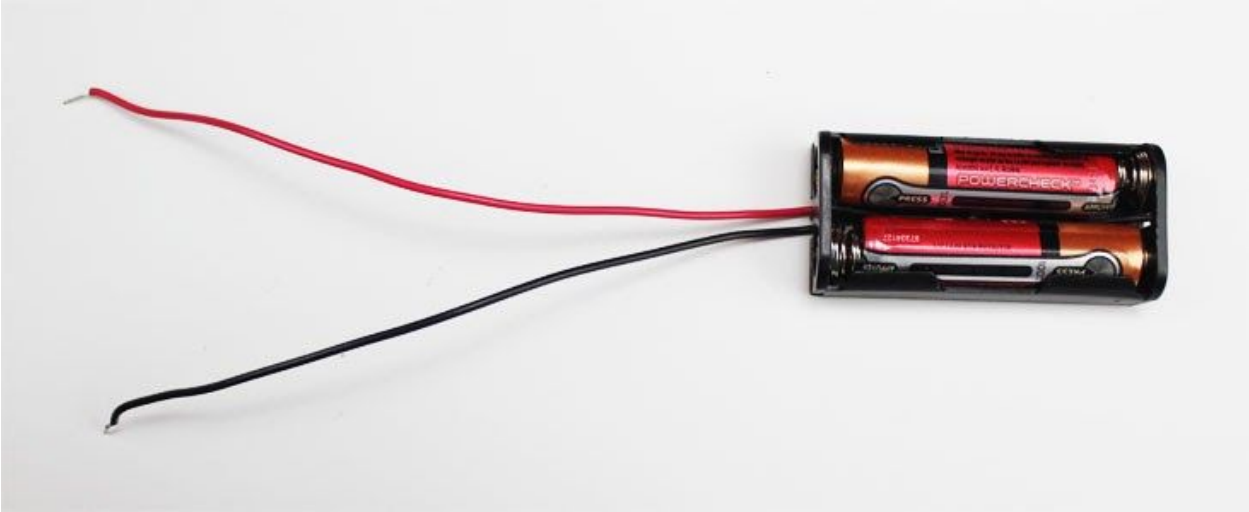

# Digital Multimeter

A multimeter is a device that's used to measure electric current (amps), voltage (volts) and resistance (ohms).  It's a great for troubleshooting circuits and is capable of measuring both AC and DC voltage.

(Assignment: Describe difference between AC and  DC)


# Battery Holders

A battery holder is a plastic case that holds batteries from 9V to AA.  Some holders are enclosed and may have an on/off switch built in.




## Test Leads (Alligator Clips)

Test leads are great for connecting components together to test a circuit without the need for soldering.

## Wire Cutter

Wire cutters are essential for stripping stranded and solid copper wire.

# Precision Screwdriver Set

Precision screwdrivers are also known as jeweler's screwdrivers and usually come as a set.  The advantage of these over normal screwdrivers is the precision tips of each driver.  These are very handy when working with electronics that contain tiny screws.

# Helping 3rd Hand

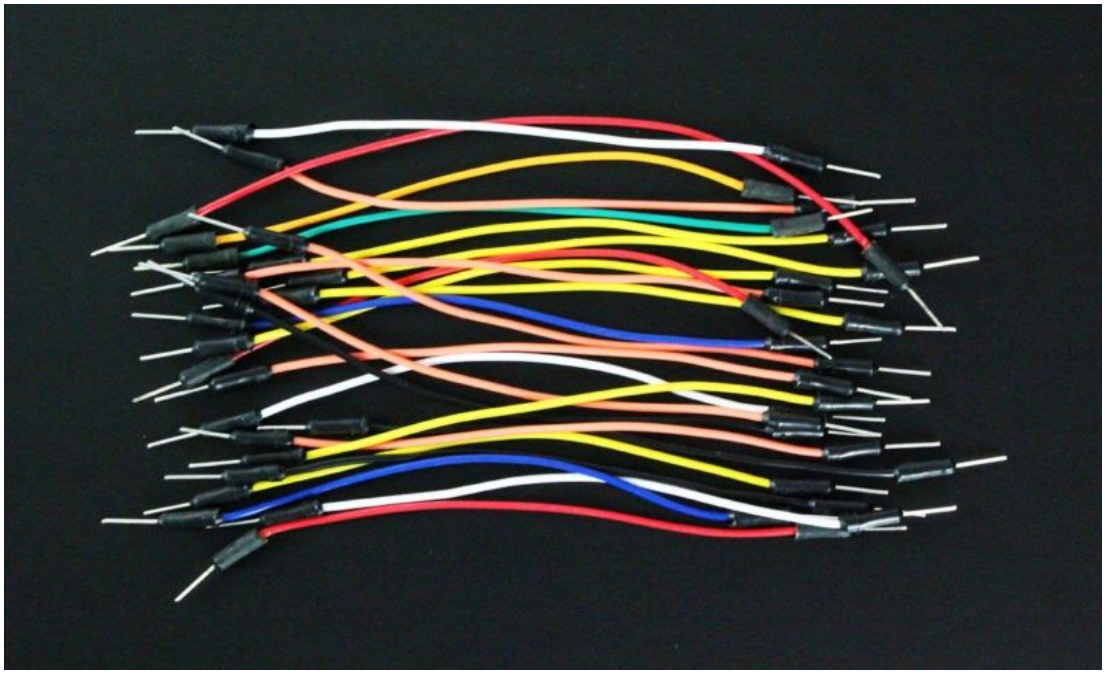
When working with electronics, it seems you never have enough hands to hold everything.  This is where the helping hand comes in.  Great for holding circuit boards or wire when soldering.

# Heat Gun

A heat gun is used to shrink plastic tubing known as heat shrink to help protect exposed wire.  Heat shrink has been called the tape of electronics and comes is used in a wide variety of applications.


# Jumper Wire

These wires are used with breadboard and development boards and are generally 22-28 AWG solid core wire.  Jumper wires can have male or female ends depending on how they need to be used.



# Soldering Iron

When it is time to create a permanent circuit, you'll want to solder the parts together.  To do this, a soldering iron is the tool you would use.You can choose leaded or lead-free solder in a few diameters.

# Electronic Components

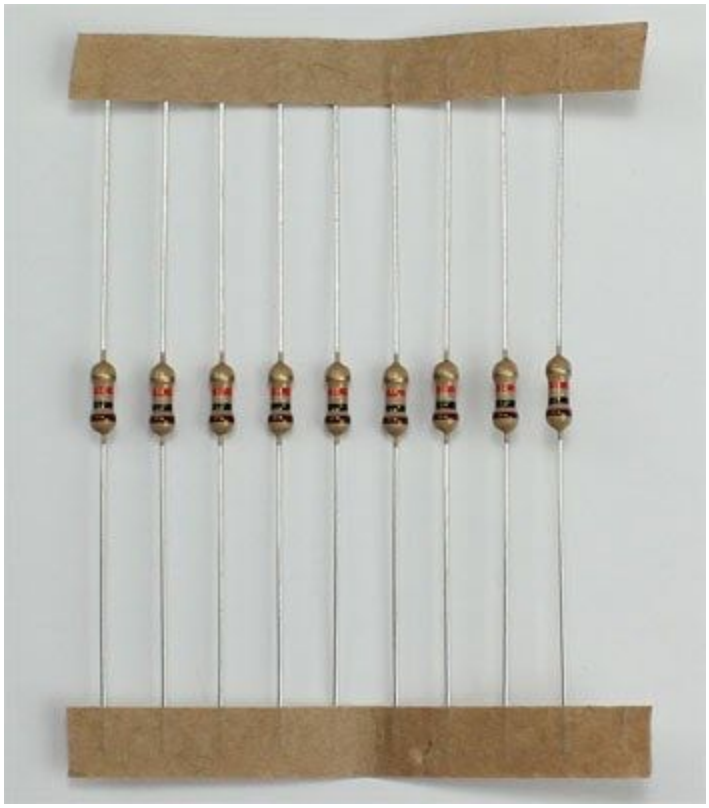
Below is a quick breakdown of the most common components and functions they perform.

# Switch

Switches can come in many forms such as pushbutton, rocker, momentary and others.  Their basic function is to interrupt electric current by turning a circuit on or off.

# Resistor

Resistors are used to resist the flow of current or to control the voltage in a circuit.  The amount of resistance that a resistor offers is measured in Ohms. Most resistors have colored stripes on the outside and this code will tell you it’s value of resistance.



# Variable Resistor (Potentiometer)

A variable resistor is also known as a potentiometer.  These components can be found in devices such as a light dimmer or volume control for a radio. When you turn the shaft of a potentiometer the resistance changes in the circuit.

# Light-Dependent Resistor (LDR)

A light-dependent resistor is also a variable resistor but is controlled by the light versus turning a knob.  The resistance in the circuit changes with the intensity of the light.  These are often found in exterior lights that automatically turn on at dusk and off at dawn.

# Capacitor

Capacitors store electricity and then discharges it back into the circuit when there is a drop in voltage.  A capacitor is like a rechargeable battery and can be charged and then discharged.  The value is measured in F (Farad), nano Farad (nF) or picoFarad (pF) range.


# Diode

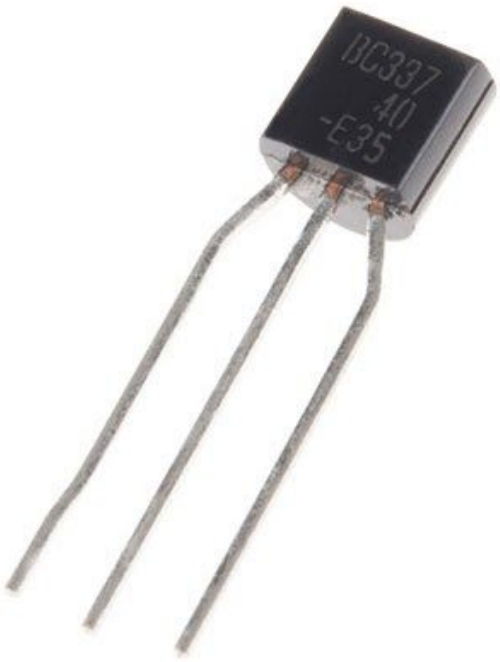
A diode allows electricity to flow in one direction and blocks it from flowing the opposite way.  The diode’s primary role is to route electricity from taking an unwanted path within the circuit.

# Light-Emitting Diode (LED)

A light-emitting diode is like a standard diode in the fact that electrical current only flows in one direction.  The main difference is an LED will emit light when electricity flows through it.  Inside an LED there is an anode and cathode. Current always flows from the anode (+) to the cathode (-) and never in the opposite direction.  The longer leg of the LED is the positive (anode) side.

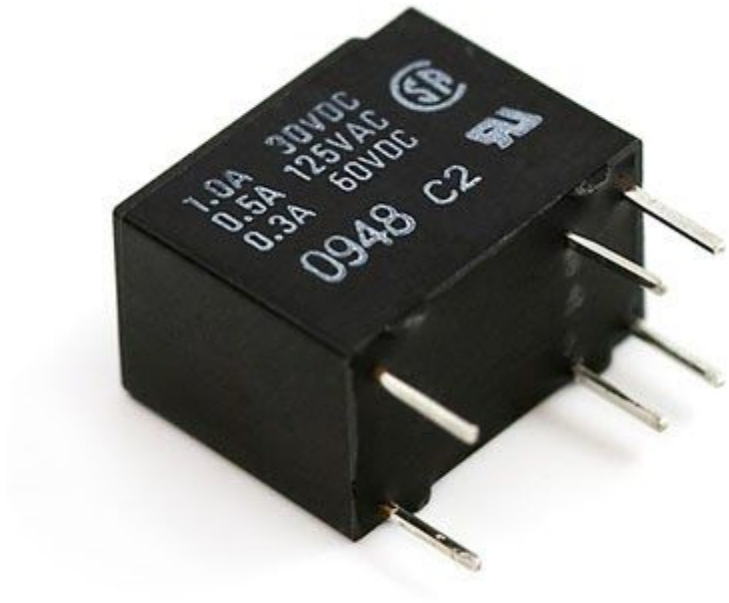
# Transistor

Transistors are tiny switches that turn a current on or off when triggered by an electric signal.  In addition to being a switch, it can also be used to amplify electronic signals.  A transistor is similar to a relay except with no moving parts.




# Relay

A relay is an electrically operated switch that opens or closes when power is applied.  Inside a relay is an electromagnet which controls a mechanical switch.




# Integrated Circuit (IC)

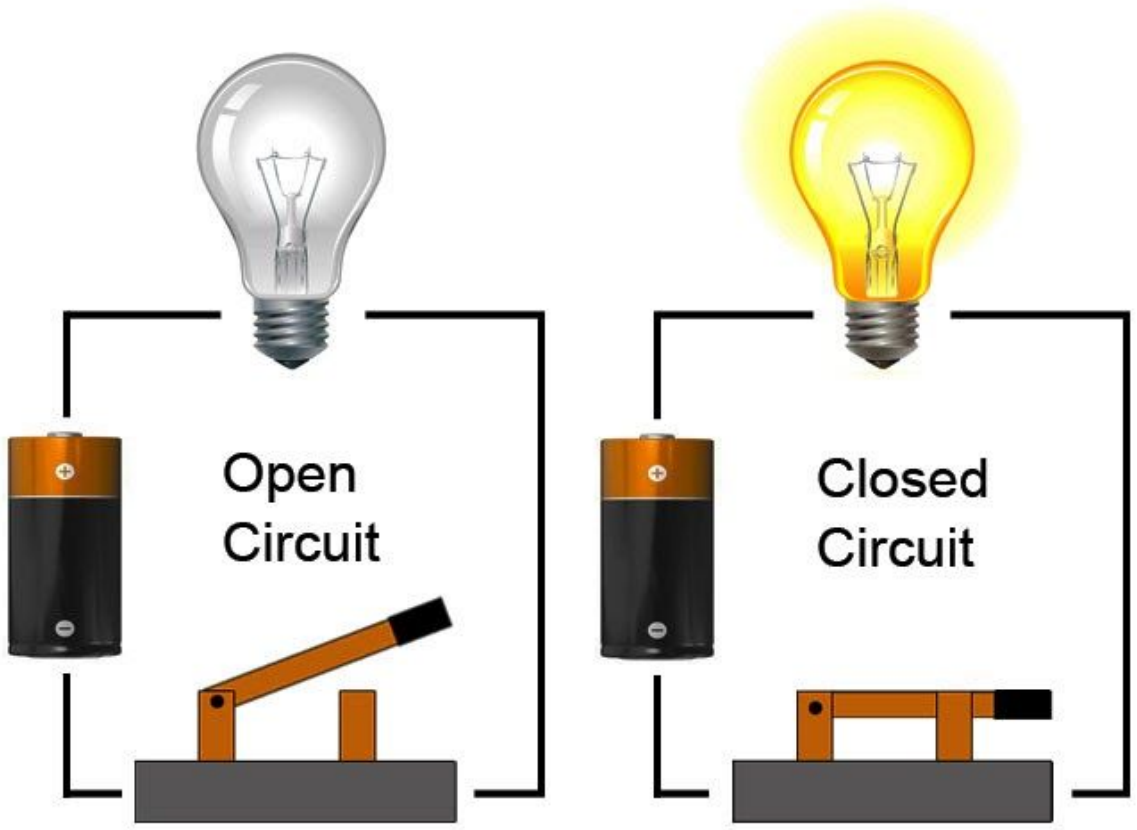
An integrated circuit is a circuit that’s been reduced in size to fit inside a tiny chip.  This circuit contains electronic components like resistors and capacitors but on a much smaller scale.  Integrated circuits come in different variations such as 555 timers, voltage regulators, microcontrollers and many more. Each pin on an IC is unique in terms of it’s function.


# What Is A Circuit?

Before you design an electronic project, you need to know what a circuit is and how to create one properly.

An electronic circuit is a circular path of conductors by which electric current can flow.  A closed circuit is like a circle because it starts and ends at the same point forming a complete loop. Furthermore, a closed circuit allows electricity to flow from the (+) power to the (-) ground uninterrupted.

In contrast, if there is any break in the flow of electricity, this is known as an open circuit.  As shown below, a switch in a circuit can cause it to be open or closed depending on it’s position.




All circuits need to have three basic elements.  These elements are a voltage source, conductive path and a load.

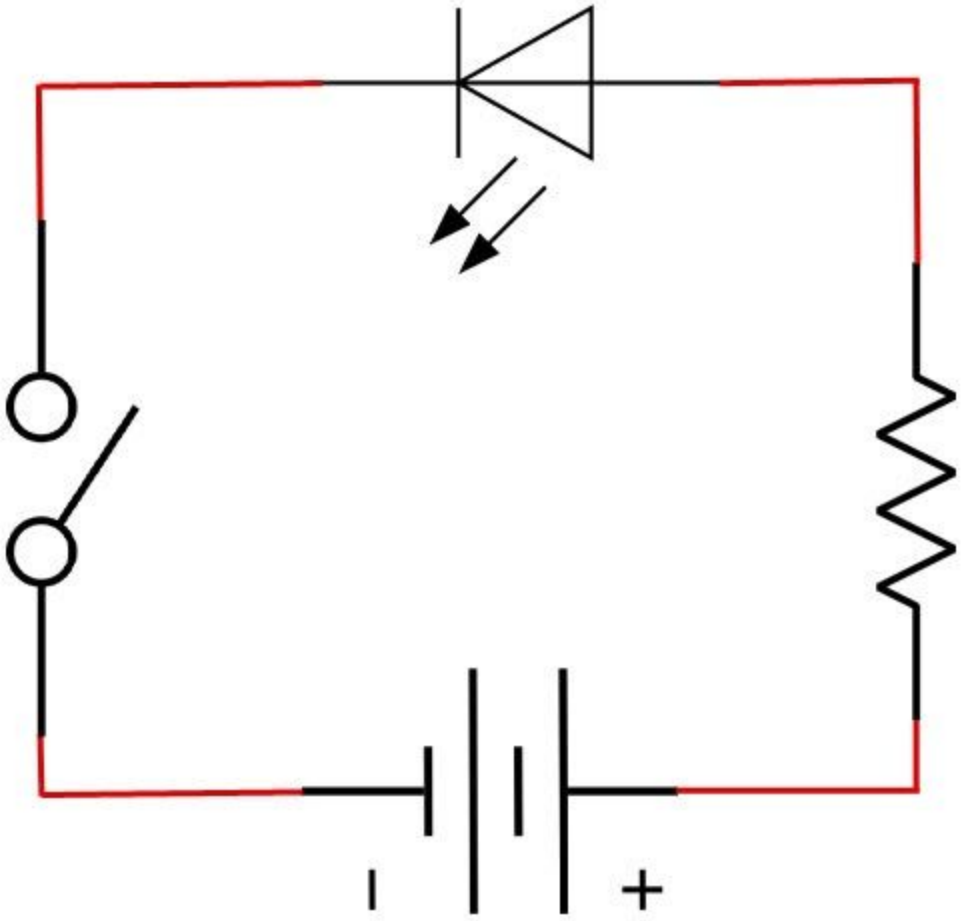
The voltage source, such as a battery, is needed in order to cause the current to flow through the circuit.  In addition, there needs to be a conductive path that provides a route for the electricity to flow.  Finally, a proper circuit needs a load that consumes the power.  The load in the above circuit is the light bulb.

# Schematic Diagram

When working with circuits, you will often find something called a schematic diagram.  These diagrams use symbols to illustrate what electronic

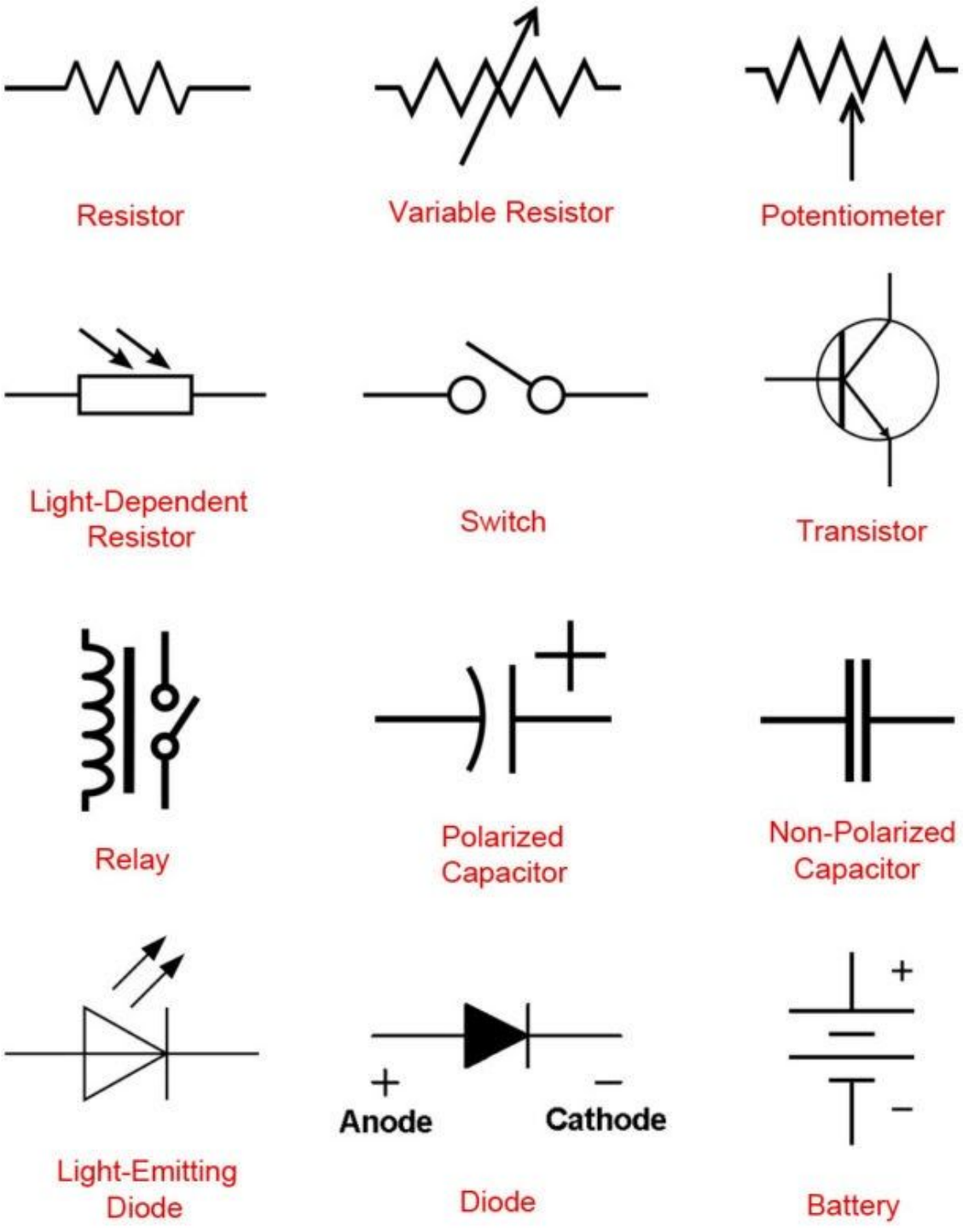
components are used and where they're placed in the circuit.  These symbols are graphic representations of the actual electronic components.

Below is an example of a schematic that depicts an LED circuit that is controlled by a switch.  It contains symbols for an LED, resistor, battery and a switch.  By following a schematic diagram, you are able to know which components to use and where to put them.  These schematics are extremely helpful for beginners when first learning circuits.




**Schematic Diagram For LED Circuit**

There are many types of electronic symbols and they vary slightly between countries.  Below are a few of the most commonly used electronic symbols in the US.




# How To Determine A Resistor Size

Resistors are commonly used in electronics projects and it's important to know which size to use. To find the resistor value, you need to know the voltage and the amps for your LED and battery.

A standard LED generally needs a voltage of around 2V and a current of 20mA or .02A to operate correctly. Next, you need to find out what voltage your battery is. In this example, we will be using a 9V battery. In order to determine the resistor size, we need to use a formula known as Ohm's law as shown below.

**Ohm's Law –** **Resistance (R) = Voltage (V) / Current (I)**

- Resistance is measured in Ohms (Ω)
- Voltage is measured in volts (V)
- Current is measured in amps (A)

$$R = \frac{V_{Bat} - V_{LED}}{I_{LED}}$$

$$350 = \frac{9V - 2V}{.02A}$$

Using Ohm’s law, you need to subtract the LED voltage from the battery voltage.  This will give you a voltage of 7 which needs to be divided by .02 amps from the LED.  This formula shows that you will need a 350 Ω resistor.