Basic Electronic Components

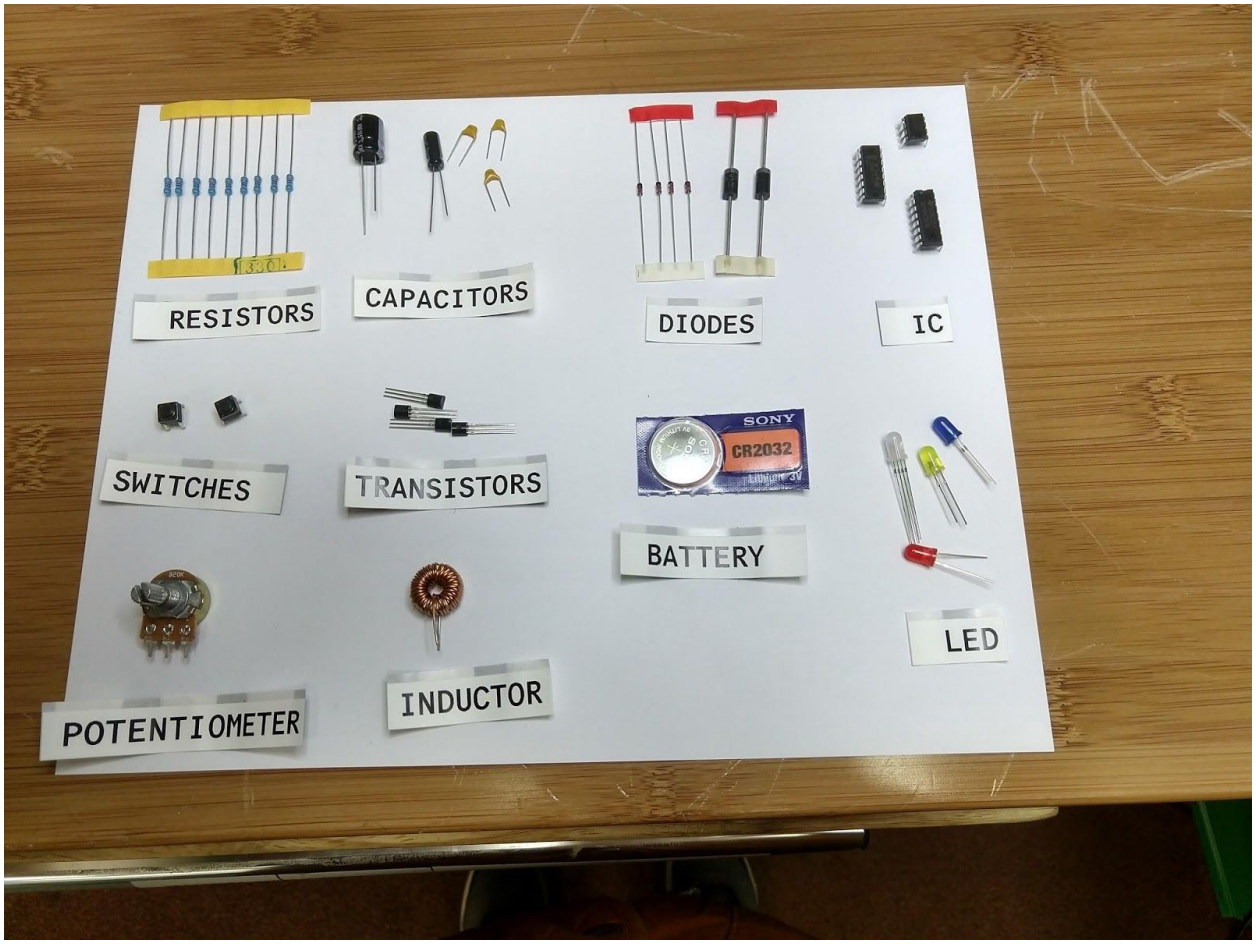
Written by Mark Webster, Connor Sheeran, Ousema Zayati

Summary:
Learn to identify and know the primary features of the common electronics components.

All electronic devices are built from basic components, just as all chemicals are molecules made from a few basic atoms.

What are the basic components

(batteries, resistors, capacitors, inductors, switches, buttons, diodes, LED, transistor, IC)
https://en.wikipedia.org/wiki/Electronic_component



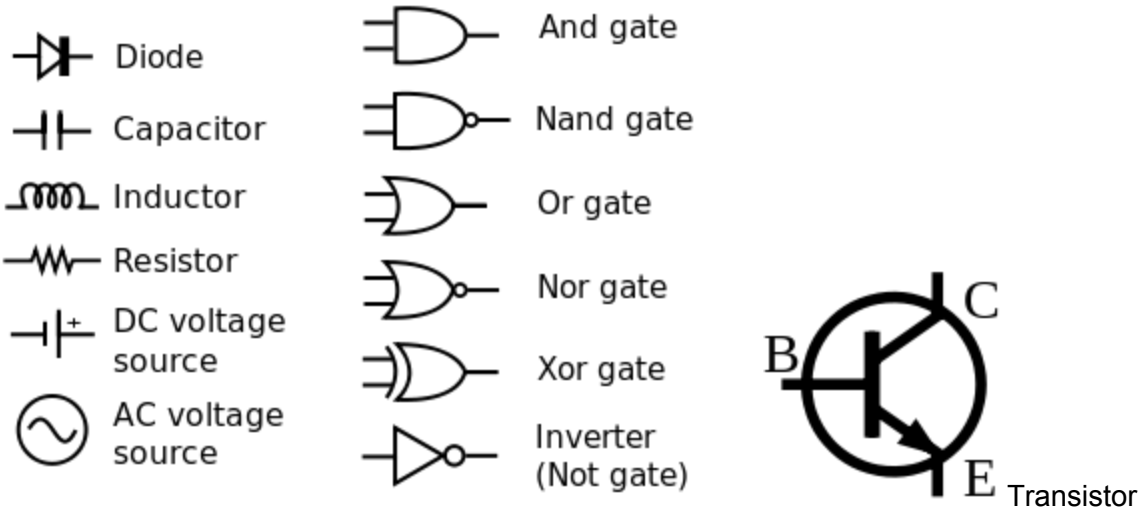
The flow of electrons in a circuit can be related to the flow of water molecules through plumbing. Wires are like pipes that channel water or electrons into a directed flow. Resistors are like a constriction in the pipe that resists water flow. Buttons and switches are like valves that permit or stop the flow of water. Capacitors and inductors are like little storage tanks that hold charge. Diodes, including LEDs or light emitting diodes, are one way valves that force water to go only one way. Transistors are special valves where a small turn of the valve wheel causes a big change in the flow of water.

Resistors can be fixed or variable resistance. The resistance of a potentiometer can be manually varied. Many sensors are fancy variable resistors. For example, a photoresistor changes resistance based on the intensity of light shining on the device.

Voltage (V or E) is like water pressure. Amperage (I) is the quantity of water flowing through the pipes.
Voltage and amperage are related by Ohm's law: $V = IR$, where V is in volts, I is current in amps, and R is resistance in ohms. Electronic Engineers write $E = IR$

How to read a schematic

A schematic diagrams an electronic circuit using standard symbols, with lines representing wires or pc board traces. There are some variations of standard symbols.
https://en.wikipedia.org/wiki/Electronic_symbol



(Images from Wikipedia commons)

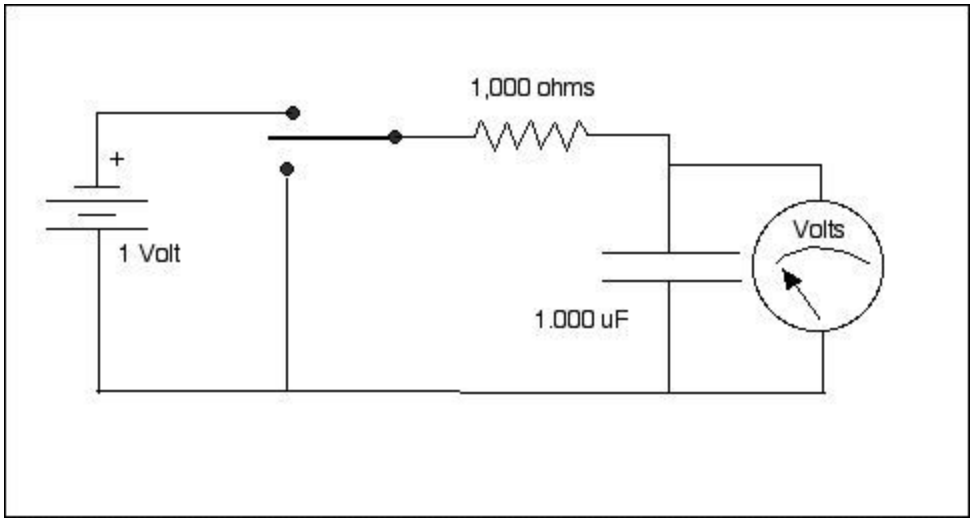


Image From Wikimedia Commons

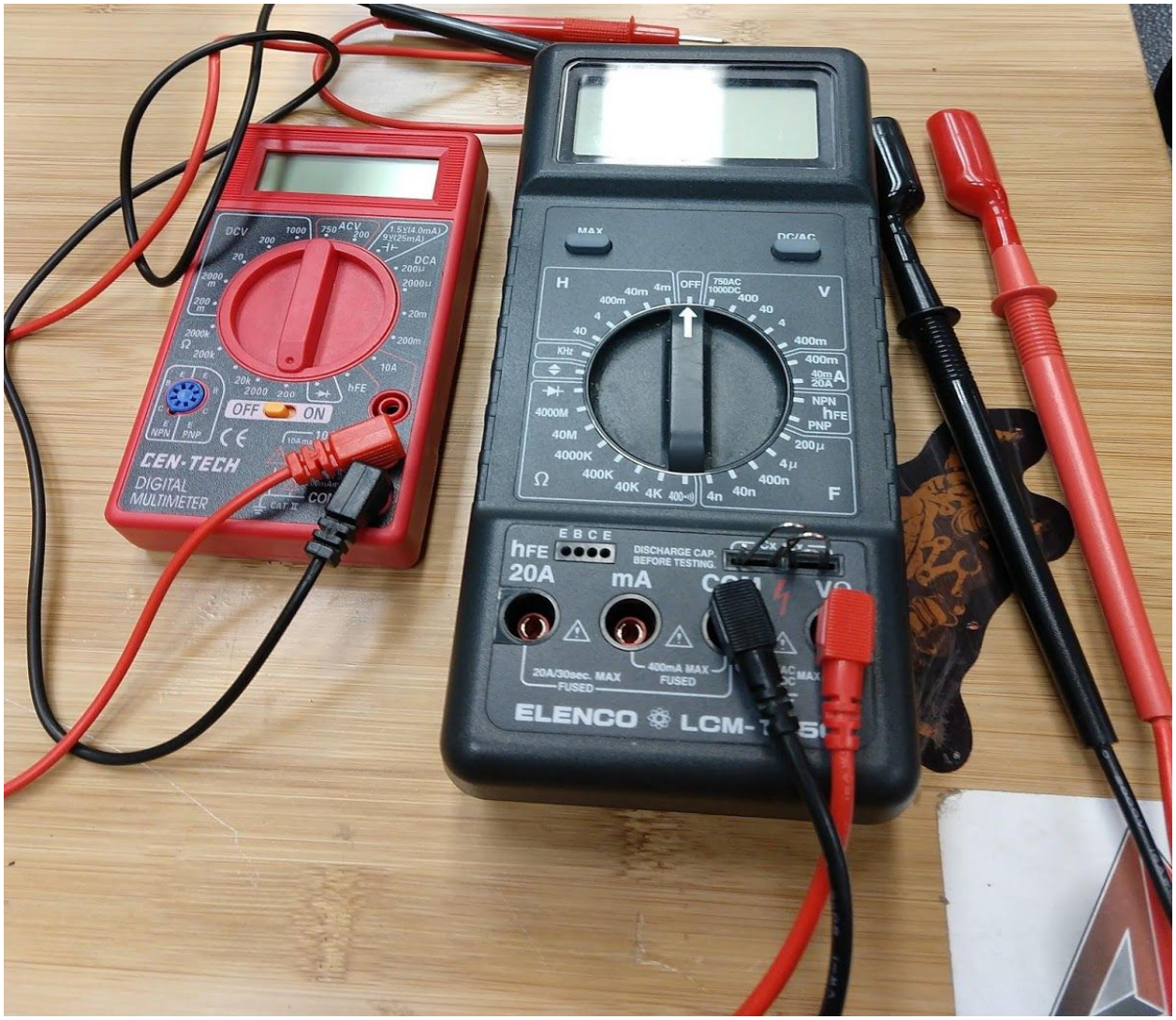
How to read a datasheet

https://learn.adafruit.com/all-about-leds/the-led-datasheet
https://www.sparkfun.com/datasheets/Components/YSL-R596CR3G4B5C-C10.pdf

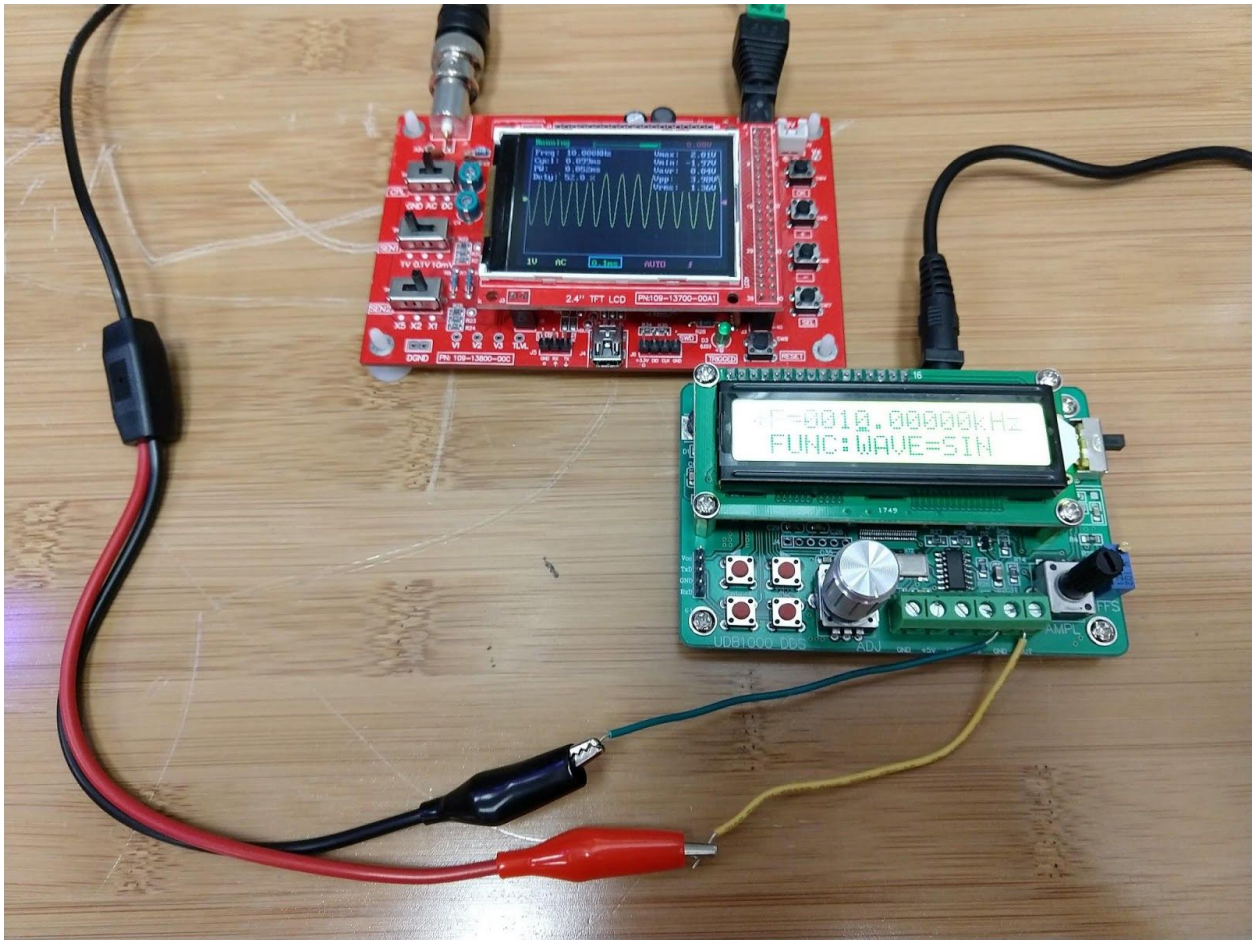
http://www.ti.com/lit/ds/symlink/lm555.pdf

Tools: multi-meter, oscilloscope, bench top power supply

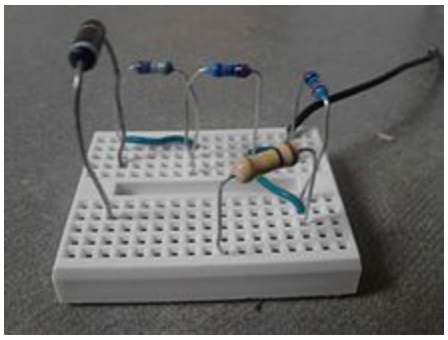
A multimeter measures voltage, current, resistance. Some meters will also measure capacitance and inductance.



An oscilloscope is used to examine AC voltage; a signal that varies with time. (take photo)



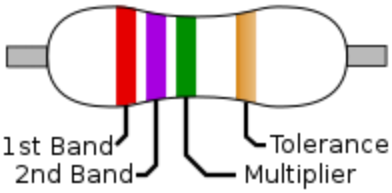
How to breadboard a circuit



EXERCISES

Exercise 1: Read a resistor color code

Grab a random resistor and figure out the resistance from the color bands on the resistor.



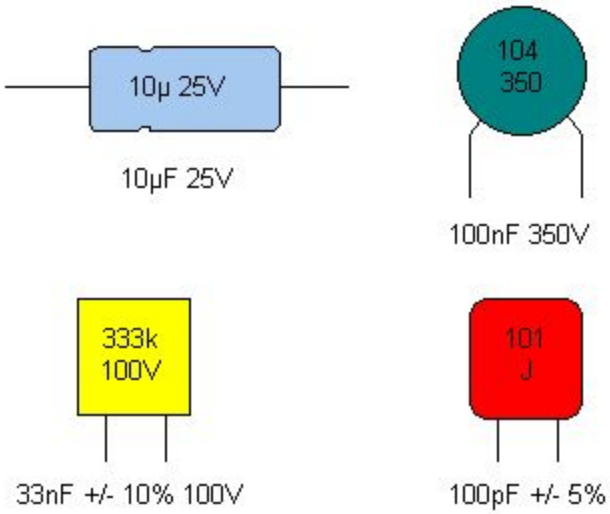
Ring color			Significant figures	Multiplier		Tolerance		Temperature coefficient	
Name	Code	RAL				Percent [%]	Letter	[ppm/K]	Letter
None	–	–	–	–		±20	M	–	
Pink	PK	3015	–	$\times10^{-3}$[3]	×0.001	–		–	
Silver	SR	–	–	$\times10^{-2}$	×0.01	±10	K	–	
Gold	GD	–	–	$\times10^{-1}$	×0.1	±5	J	–	
Black	BK	9005	0	$\times10^{0}$	×1	–		250	U
Brown	BN	8003	1	$\times10^{1}$	×10	±1	F	100	S
Red	RD	3000	2	$\times10^{2}$	×100	±2	G	50	R
Orange	OG	2003	3	$\times10^{3}$	×1000	±0.05[3]	W	15	P
Yellow	YE	1021	4	$\times10^{4}$	×10 000	±0.02[3][nb 1][5]	P	25	Q
Green	GN	6018	5	$\times10^{5}$	×100 000	±0.5	D	20	Z[nb 2]
Blue	BU	5015	6	$\times10^{6}$	×1 000 000	±0.25	C	10	Z[nb 2]
Violet	VT	4005	7	$\times10^{7}$	×10 000 000	±0.1	B	5	M
Grey	GY	7000	8	$\times10^{8}$	×100 000 000	±0.01[3][nb 3][nb 1][5]	L (A)	1	K
White	WH	1013	9	$\times10^{9}$	×1 000 000 000	–		–	

(Images from Wikipedia Resistor Color Codes)
For example,

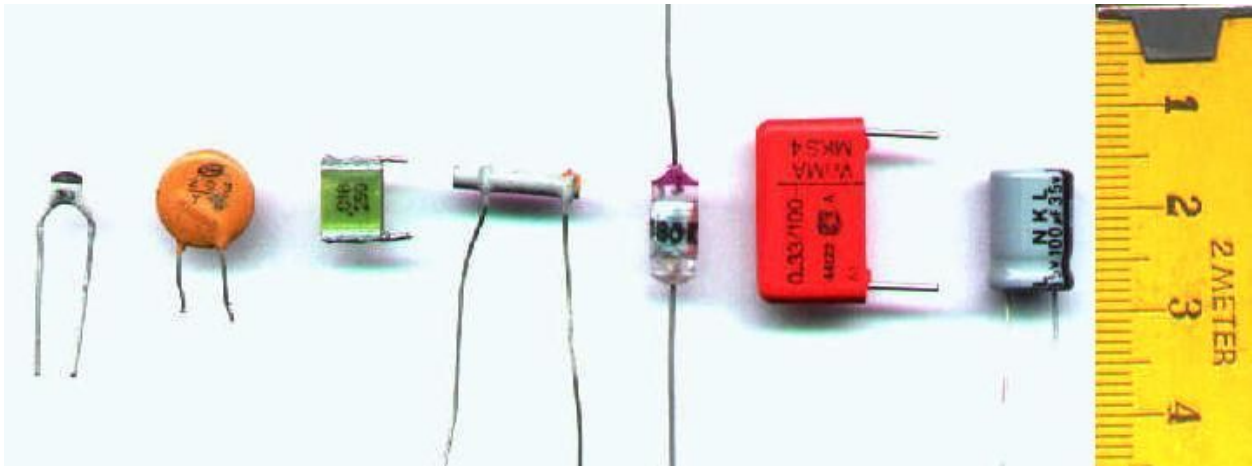
is 100K ohms with a tolerance of 10 percent.

Then measure the actual resistance with a multimeter and verify it is within tolerance.

Capacitors have a color code, but usually they are just marked with numbers.



(Replace the above image)

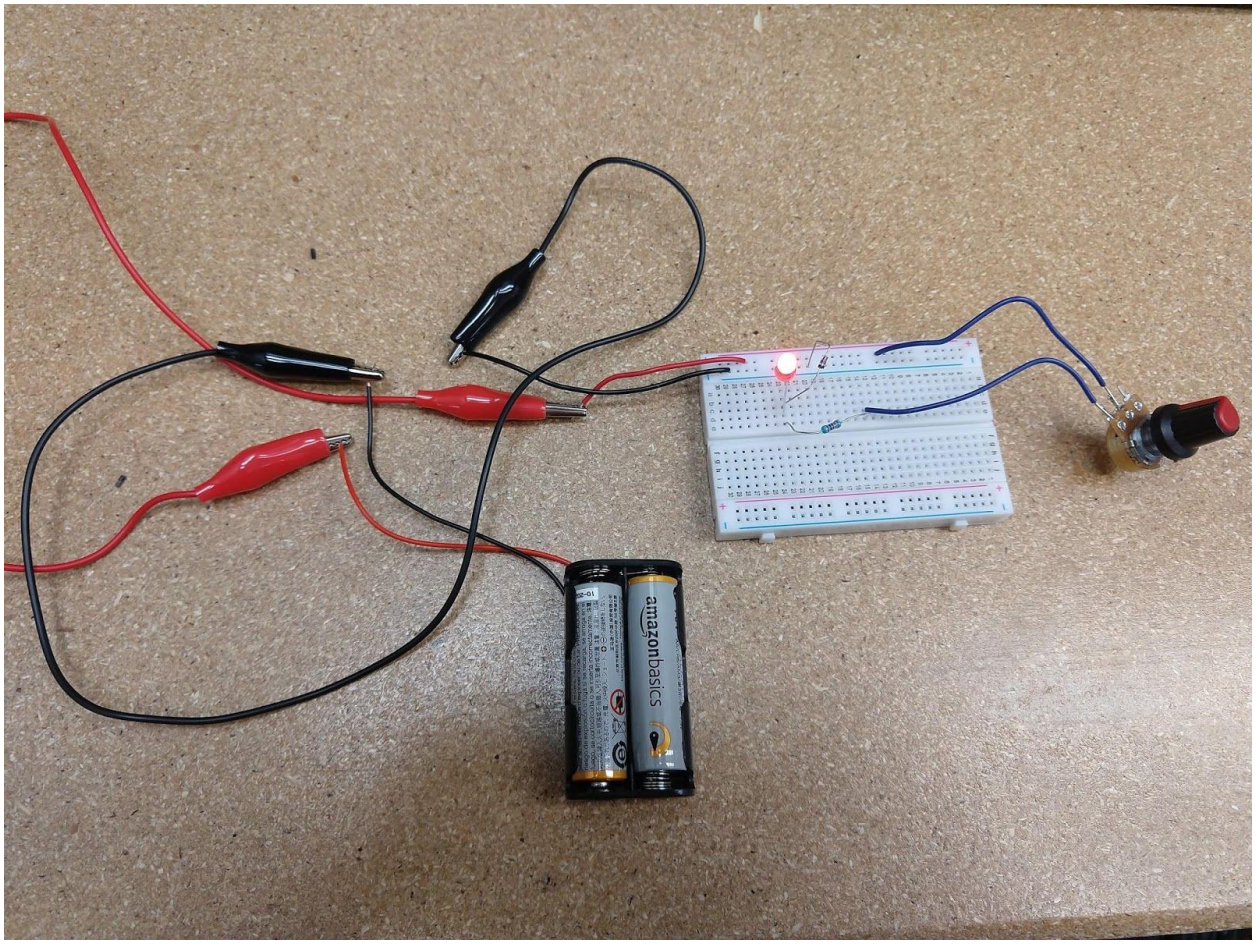


(Image from Wikipedia Capacitors)
Larger value capacitors are often polarized and must be inserted into the circuit with one lead toward the positive, and one lead toward ground.
Just like LEDs and diodes, the short leg is the negative (toward ground) and the positive side is the long leg. Many electrolytic capacitors have + and - marked on the case.

Grab a capacitor and measure the capacitance using a meter.

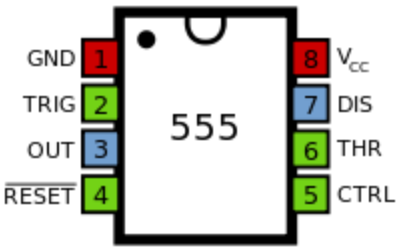
Exercise 2: LED and potentiometer

-- Battery, potentiometer, resistor, LED to have variable intensity light



Exercise 3: 555 timer circuit

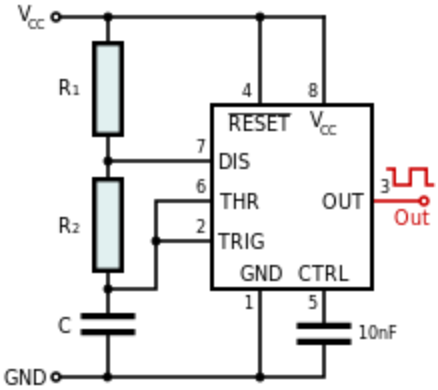
-- 555 timer circuit



A 555 timer chip can be used to create one pulse of electricity after some interval, or can be made to oscillate and give repeated pulses.
Typical datasheet specs are:

Supply voltage (V_{CC})	4.5 to 15 V
Supply current (V_{CC} = +5 V)	3 to 6 mA
Supply current (V_{CC} = +15 V)	10 to 15 mA
Output current (maximum)	200 mA
Maximum Power dissipation	600 mW
Power consumption (minimum operating)	30 mW@5V, 225 mW@15V
Operating temperature	0 to 75 °C

A schematic for the oscillator (astable) circuit is:

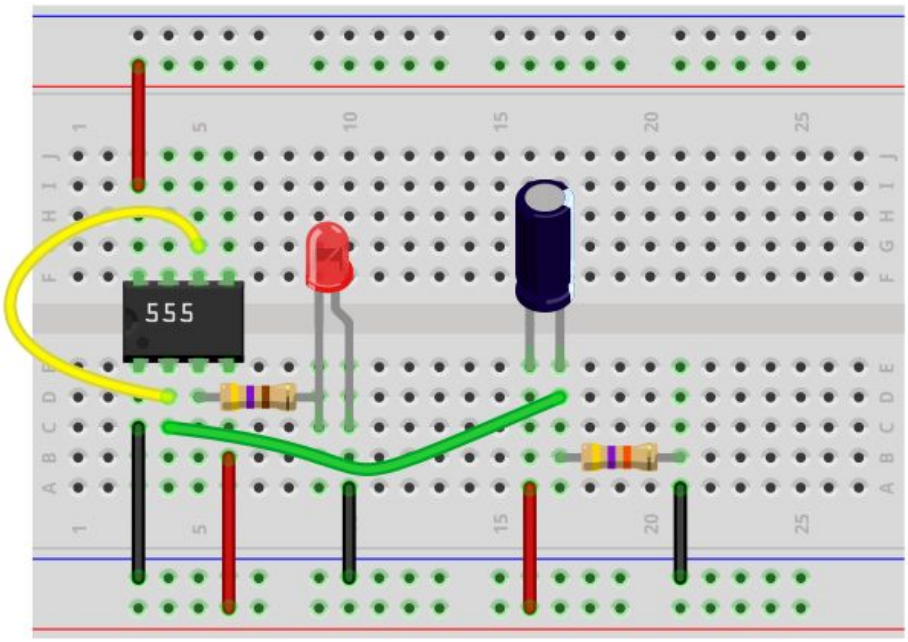


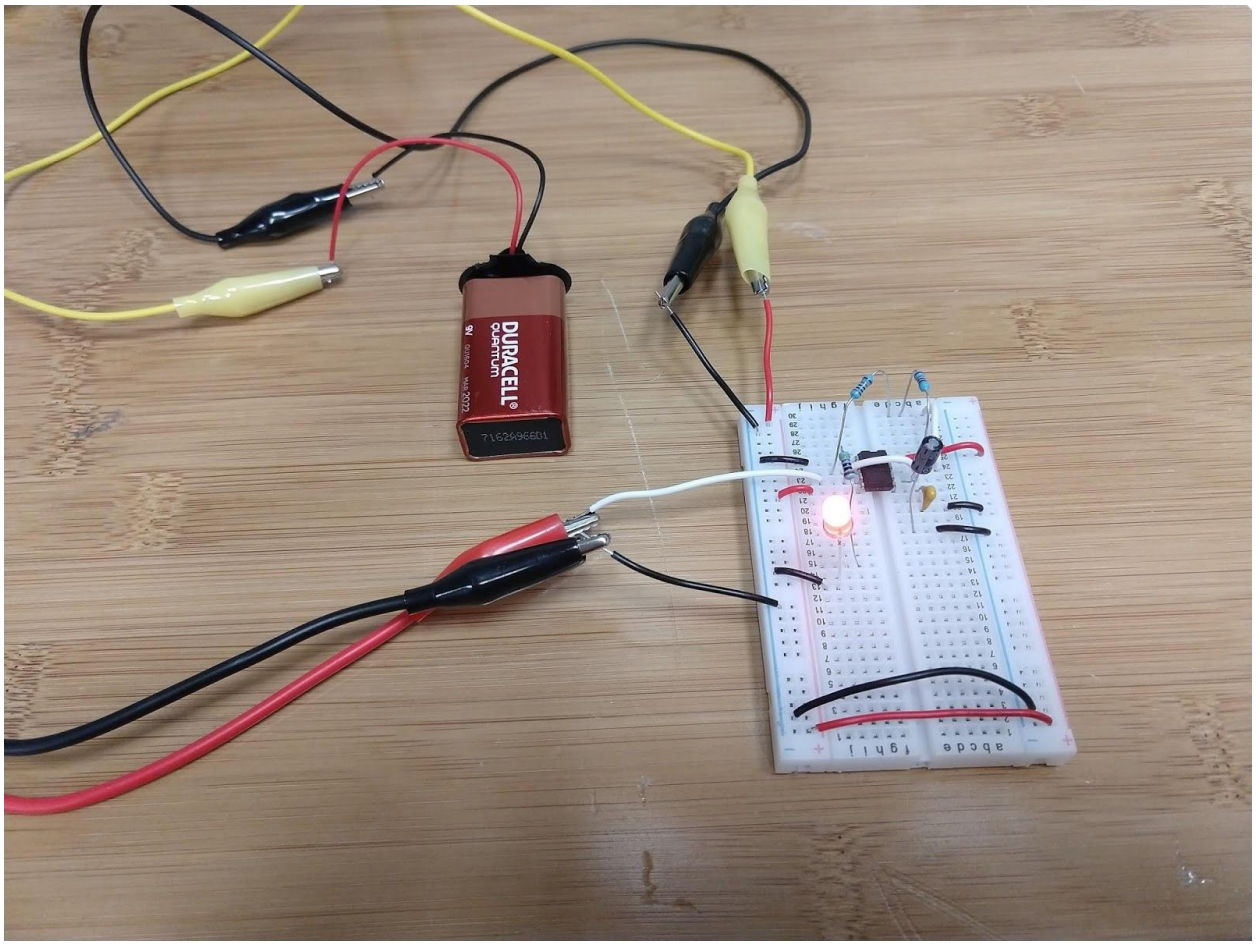
The frequency f of the pulses is

$$f = \frac{1}{\ln(2) \cdot C \cdot (R_1 + 2R_2)}$$

As a first attempt, use C = 480 microfarad, R1 = R2 = 1k ohms.
The frequency of blinking should be around 1 hz.

A fritzing diagram for the oscillator (astable) might be:





If timer permits, solder the 555 timastable timer circuit to a perf board.