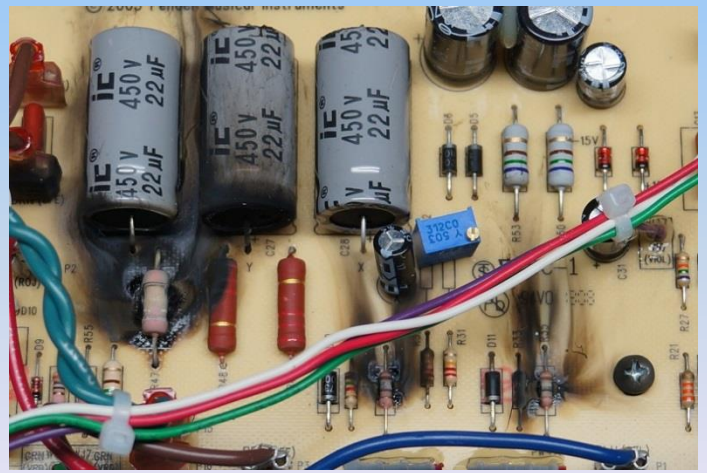
Electronic Components
Physics and Engineering

Electrical Components and Their Characteristics Disclaimer

All electrical/electronic components require voltage and current to make them work. When working with electrical/electronic components it is **VERY IMPORTANT** to understand that these components will only work properly when the correct voltage and current are supplied to them.

All electrical/electronic components are **RATED** for a specific range of voltage and current. Exceeding these ratings results in decreased life expectancy or failure of the component.



Electricity

Electricity is the **flow of charge** around a circuit **carrying energy** from the battery (or power supply) to components such as LEDs and motors.

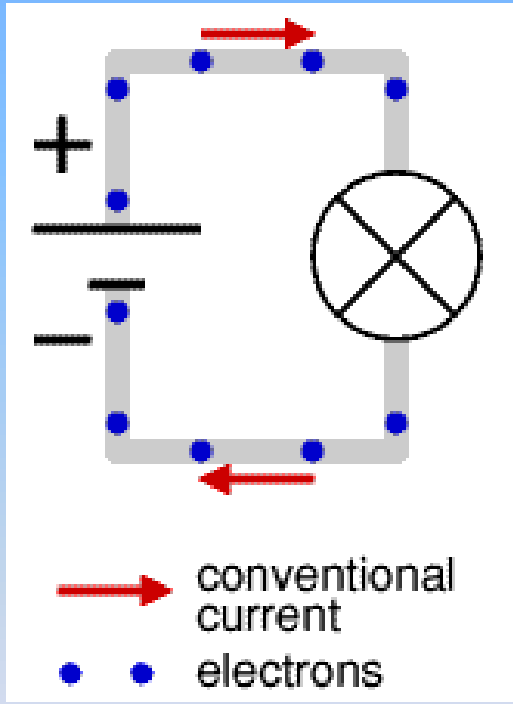
Electricity (electrons) flow from negative to positive.

Voltage –the force or pressure needed to move electrons or is the difference of potential energy that forces electrons to flow in a circuit. The unit of measure is the volt.

Current – the name given to the flow of electrons or the rate of flow of charge of electrons. Current is like the flow of water. The unit of measure is the Ampere. In electronics you typically deal in mA (milliamps)

1amp = 1000mA

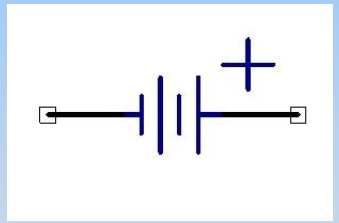
Resistance - restricts the flow of electric current. The unit of measure is the Ohm.

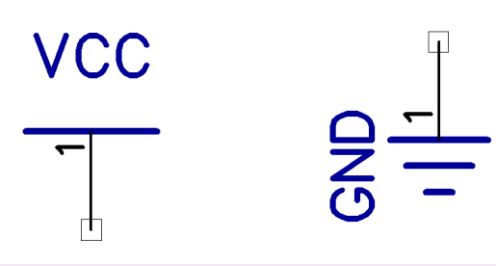


Supplying Power to Circuits

- Electronic components require a Direct Current (DC) power source to operate. For this reason it is **EXTREMELY** important to connect **POSITIVE** and **NEGATIVE** up the correct way for components to work.

- Electronic devices such TVs, Stereos, DVD players and computers are plugged into an Alternating Current (AC) source. They require a conversion from AC to DC for them to work.
- These are the symbols for a DC power source that will be used in this class

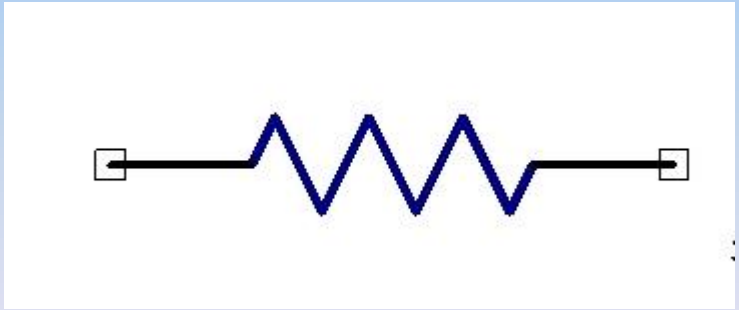




Resistors

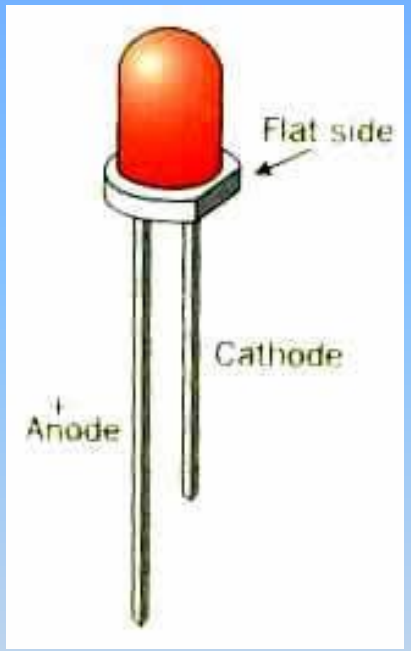
- used to control the amount of electricity flowing through a circuit. Different wattages are required for the amount of current flowing through them.
- Using Ohm's Law and Watt's Law are critical for ensuring the correct resistor value and size

- This is the symbol that will be used in this class



LED
(Light Emitting Diode)

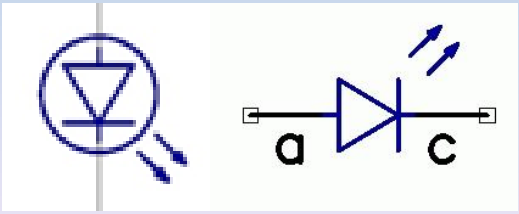
- Gives off light when electricity flows through it. Has a positive (Anode) and negative (Cathode) side.



- An LED has a voltage drop. This is important as you cannot use LEDs unless the power source is greater than its voltage drop.
  - Diffused red, green, yellow – 1.7-2v
  - Ultra bright 2-3v
  - White and Blue 3-4v

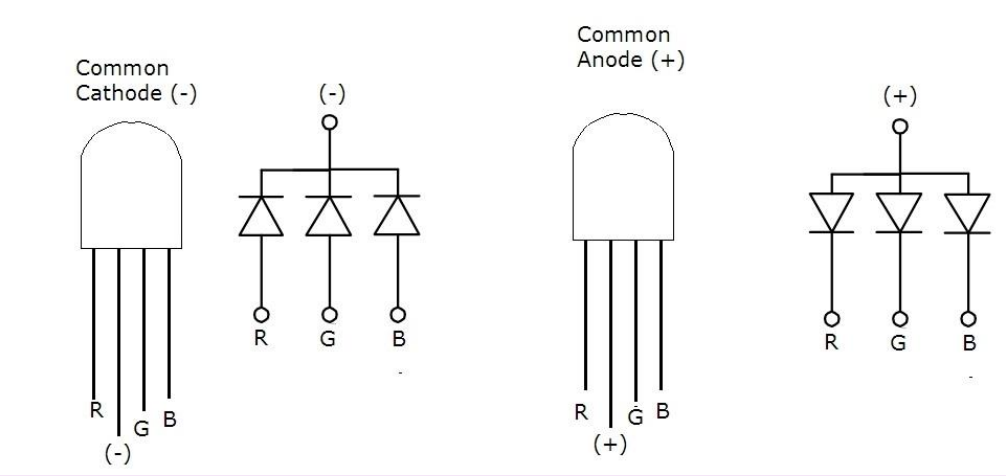
- Requires a resistor to limit the current going through it. Max current on standard LEDs is around 20mA.

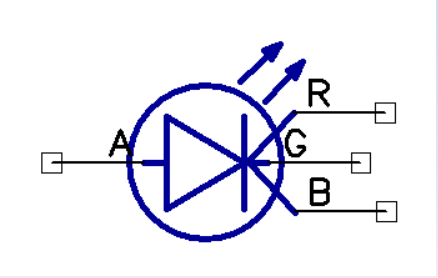
- Either of these 2 symbols will be used in class for an LED



RGB LED

- Each of the legs gives off light (red, green, blue) when electricity flows through them.
- The longest leg is the “common”
- Can have a common Anode or a common Cathode.



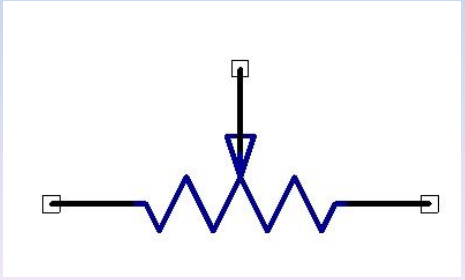


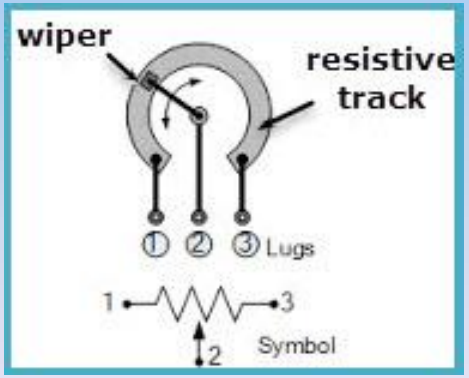
Potentiometer

- variable resistor, as you turn the knob, the resistance changes from 0 ohms (no resistance) to it's maximum value (lots of resistance)

- Like a dimmer switch in a dining room

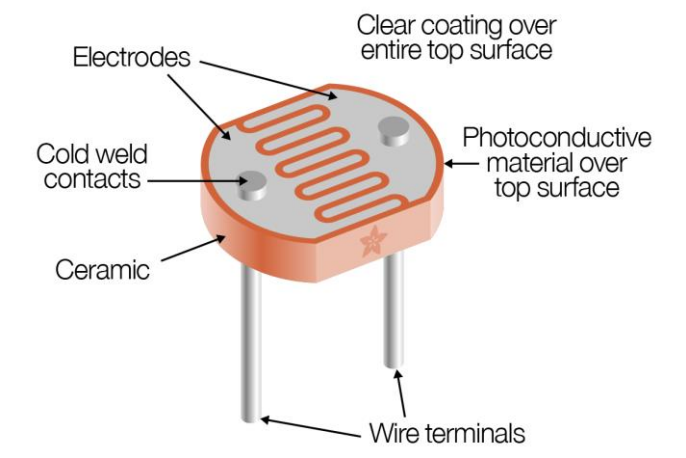
- This is the symbol for a potentiometer

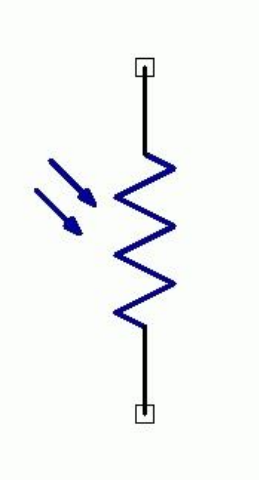


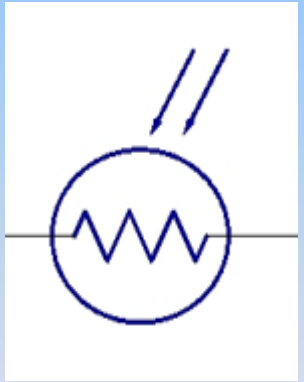


Photocell

Also known as a LDR (Light-dependent resistor) or photo resistor is a special kind of resistor that reacts to light. The more light that hits it, the less resistance it has.



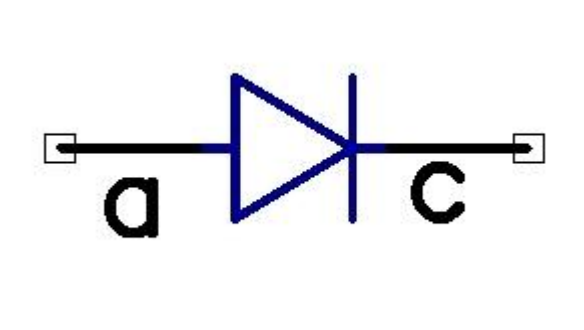


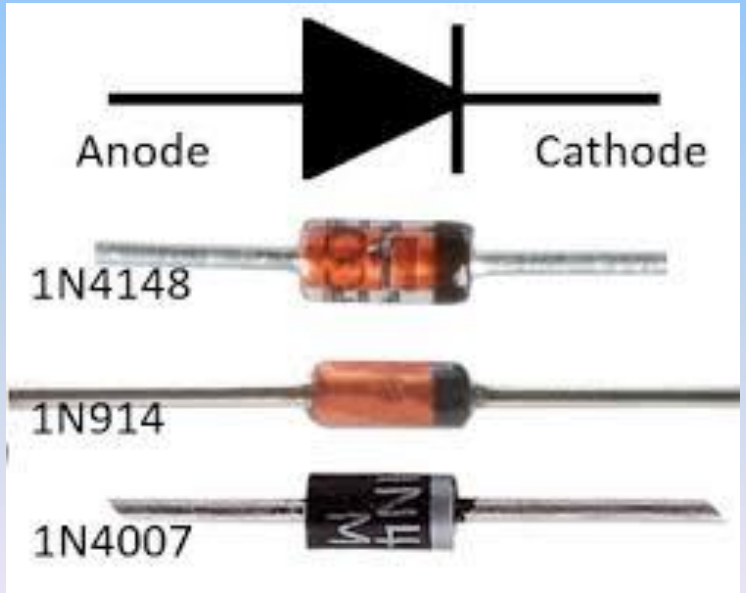


Diode

A diode is a device that allows current to flow through it in ONE direction only. There are two leads; Anode and Cathode. When the cathode is connected towards ground, electricity can flow through it.

Symbol Used in class

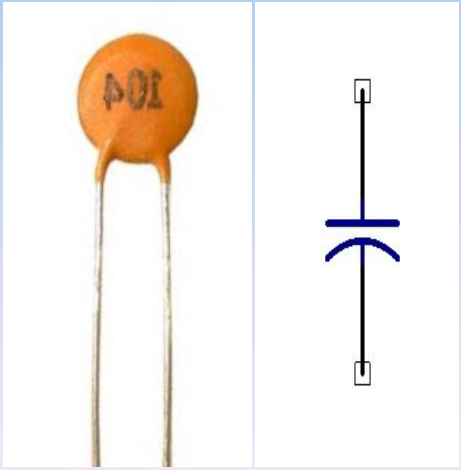




Capacitors

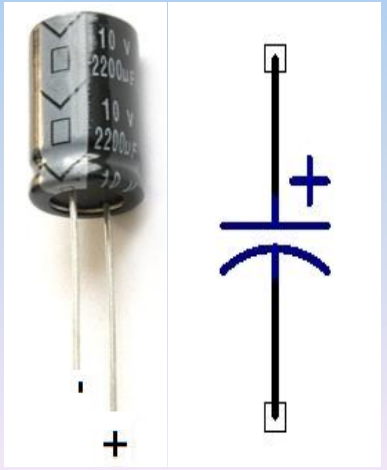
A device used to store energy much like a battery. Can be charged and discharged over and over. There are different types;

Disc Capacitors



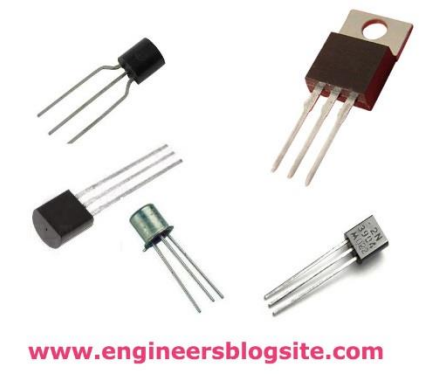
The larger the value of the capacitor, the more electricity it can store

Electrolytic Capacitor

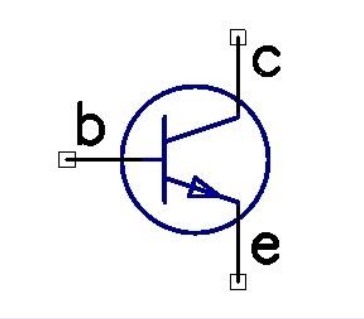


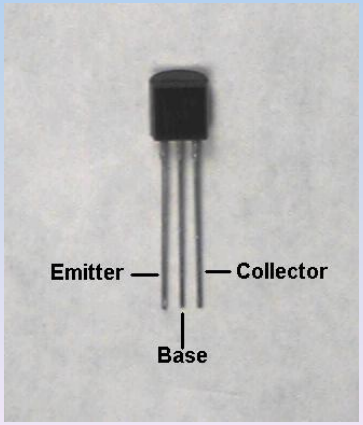
Transistor

The transistor works as a current amplifier. It uses a small base current to control a larger collector current.

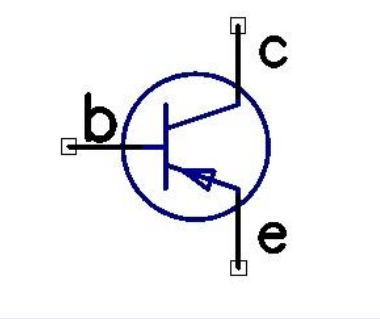


2n3904 NPN Transistor



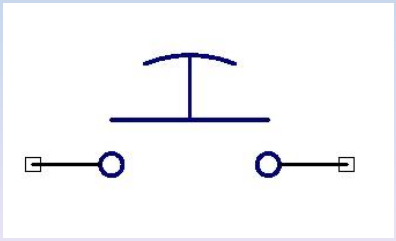


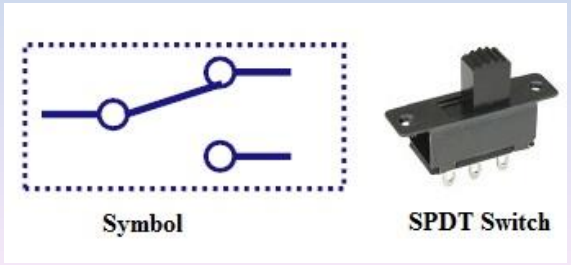
2n3906 PNP Transistor

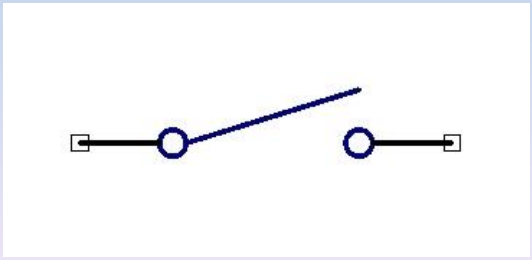


Switches

Devices that are used to turn ON and OFF the flow of electricity to a circuit.







Reading the Value on Resistors
Resistor Colour Code

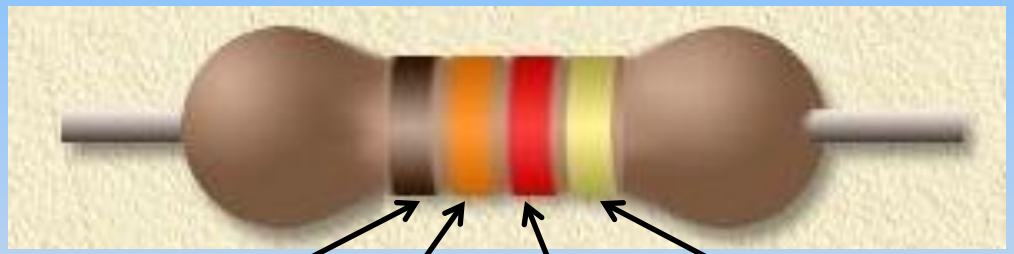
Why the Colour Code?

The Colour code was developed to overcome two basic problems;

- Difficult to print and see numbers on a small resistor
- Even if you could see the numbers, placement on a circuit board might hide the number

The Code

- When you read the colour code the resistor should be read with the gold (or silver) on the **RIGHT!!**

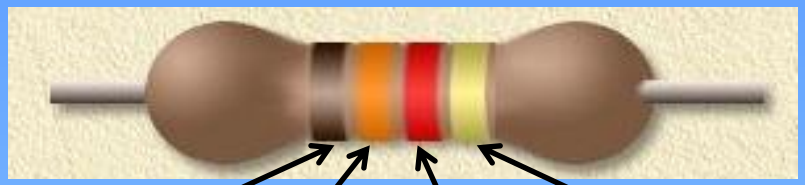


1st Digit

2nd Digit

# of zeros

Tolerance
Gold +/- 5%
Silver +/- 10%



1st Digit

2nd Digit

# of zeros

Tolerance
Gold +/- 5%
Silver +/- 10%

Black	**0**
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

This resistor is read as;
1st Digit is 1
2nd Digit is 3
# of zeros is 2

Answer is; 1300 ohms +/- 5%

Acceptable range
1235 ohms – 1365 ohms

Examples

Black	**0**
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

1) Red, Red, Brown, gold — 220 ohm

2) Blue, Black, Orange, gold — 60,000ohm Or 60K

3) Yellow, Violet, Yellow, gold — 470,000ohm Or 470K

4) Brown, Black, Blue, gold — 10,000,000ohm Or 10M

5) Grey, White, Red, gold — 8900 ohm Or 8.9K

NOTE: when writing a resistor value, the extra zeroes are dropped in favour of Kilo = 1000 or Mega = 1,000,000

1000ohm = 1k

1,000,000ohm = 1M

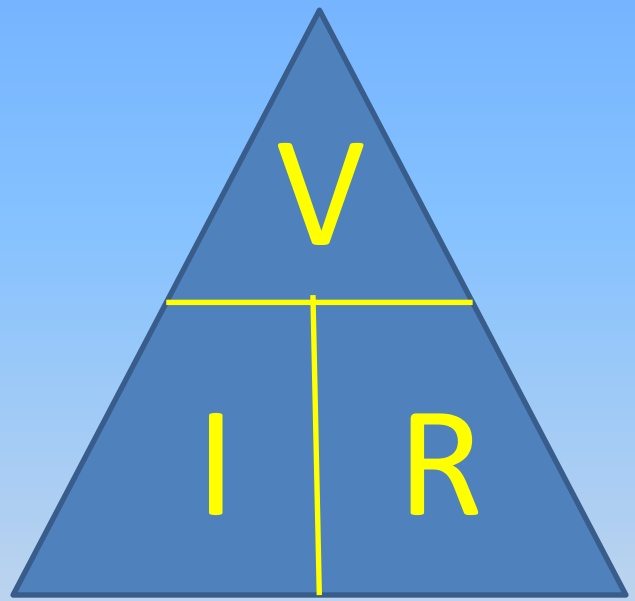
More Examples

Black	**0**
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

- Brown, black, black
- Red, yellow, green
- Blue, black

Ohm's Law

- Ohm's Law is used to **calculate** the correct amount of current being supplied to a component . A resistor is used to limit this current.
- **Example** - If a component requires a maximum of 100ma (.1amps) and the voltage being supplied is 10v, What is the resistance needed?



V = Voltage, I = Current (amps), R = Resistance (ohms)

R = V / I **R = 10V / .1amps** **R = 100ohms**

$$V = I \times R$$

$$I = V / R$$

$$R = V / I$$

Voltage Divider (Potentiometer)

When you have two resistors in series they create a voltage divider. Voltage dividers are used to create SPECIFIC voltages for use in circuits.

How it works

- If the voltage of the circuit is 10 volts and the resistors are 500 ohms each, the current would be .01amp or 10mA (I= V/R)

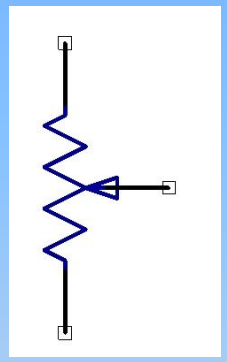
- Since the total current will never change and the resistors are the same, the voltage between the resistors is half the supply voltage. V = I x R

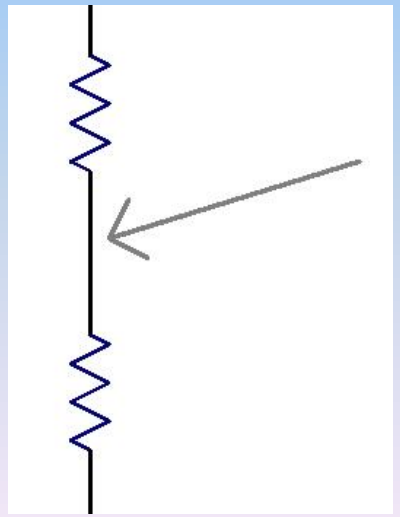
  .01amp x 500ohms = 5volts

- IF the resistors are 800 ohms ad 200 ohms, the current is still .01amp. However, the voltage between the two is NOT 5volts, now. The voltage drop across the top resistor will be greater than the bottom one.

  TOP = .01amp x 800 ohms = 8V

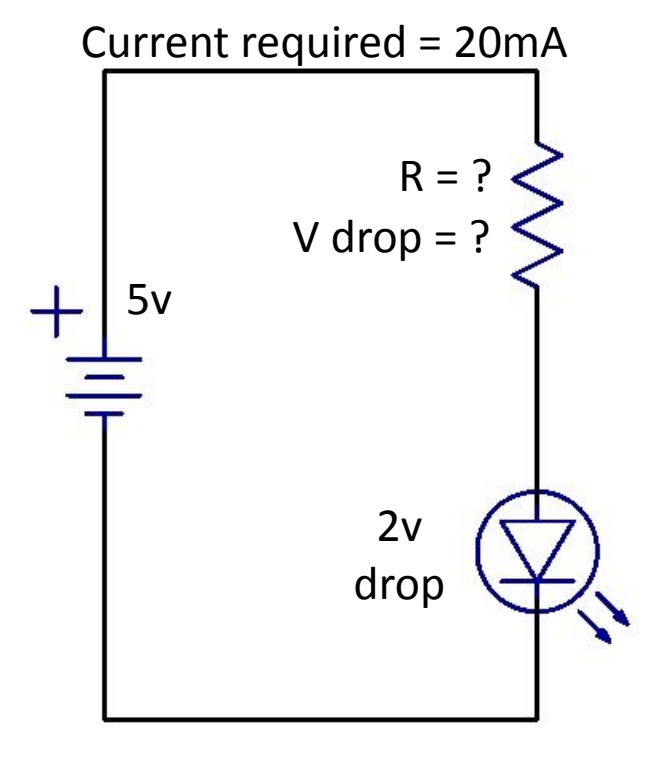
  Bottom = .01amp x 200ohms = 2volts





LED In Circuit Example (Putting it all together)

- You have an LED with a voltage drop of 2 volts and the source voltage is 5 volts. If you want a constant current of 20mA, what resistor do you need?



Here is where Ohm's Law is needed!

Voltage/Current = Resistance

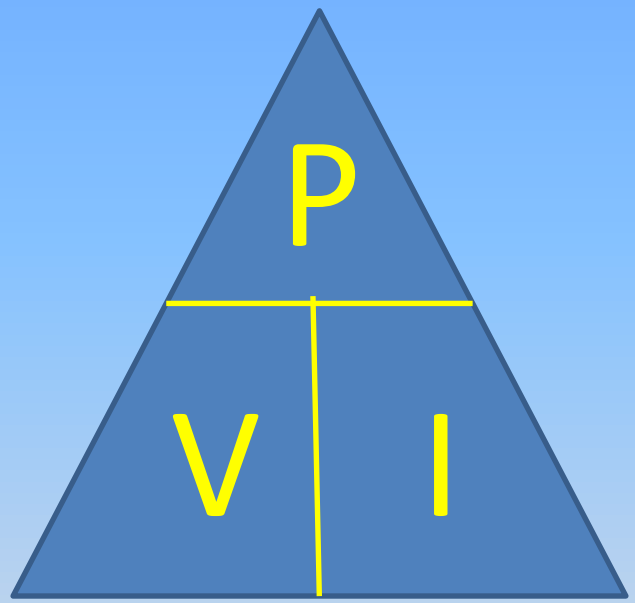
(Source Voltage - LED Voltage Drop) / Current = OHMs

5v - 2v = 3v / .02A = 150ohm

Watt's Law

- When electricity is being used by a load (led, motor, toaster, etc), the electrical energy is being converted into another form (light, heat, motion).

- **Power** is the amount of electrical energy being converted by a load. The unit of measure is the Watt.



P = Watts, V = Voltage, I = Current

Calculating Power;

$$P = V \times I$$

LED In Circuit Example (Putting it all together)

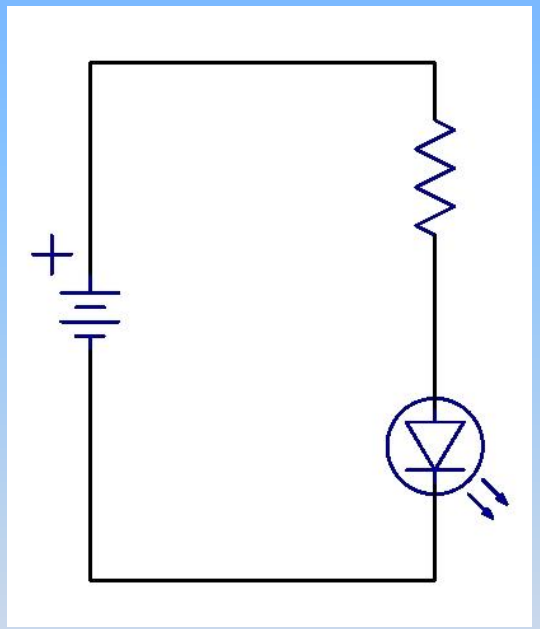
- In this circuit, if an LED is used that has a voltage drop of 2 volts and the source voltage is 9 volts and you want a constant current of 15mA, what resistor do you need?

Here is where Ohm's Law is needed!

Source Voltage - LED Voltage Drop) / Amps = OHMs

9v - 2v = 7v / .015A = 466ohm

Closest resistor is 470ohms



- What wattage resistor do I require to ensure the resistor doesn't overheat and fail?

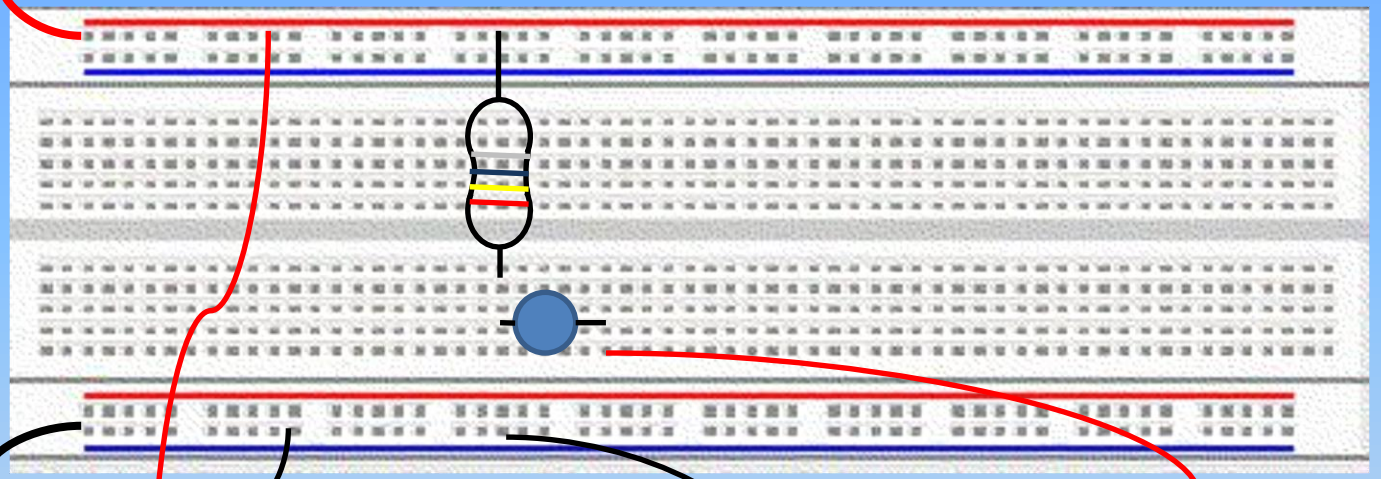
Here is where Watts Law is needed!

Voltage (across resistor) x current = wattage

7V x .015 = .135 watts or just over 1/8watt resistor

Use a ¼ watt resistor

Lab #1 - Setup



Make sure you are on the DC voltage setting or the multimeter will not give you the correct reading.

Make sure the meter dial is on the 200mA range and that the red lead is in the mA hole and the black lead is in the COM hole