Electronics Review

What's Included…

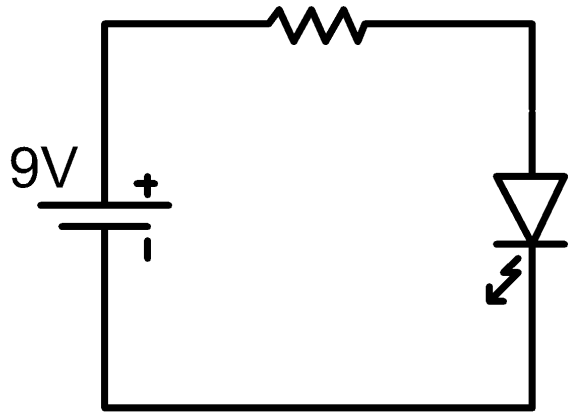
- What's an Electrical Circuit?
- Electrical Quantities (V, I, R)
- Basic Components
  - Resistors, Batteries, Diodes, Light Emitting Diodes (LEDs), Transistors, Capacitors
- Ohm's & Kirchhoff's Laws
- Simple Circuits
- Series/Parallel Circuits

What's an Electrical Circuit?

- At a minimum, what are the three parts of an electrical circuit?

What's an Electrical Circuit?

- At a minimum, what are the three parts of an electrical circuit?
  - Power Source
  - Load
  - Conductor



- Optionally, a circuit may include a "control device" such as a switch

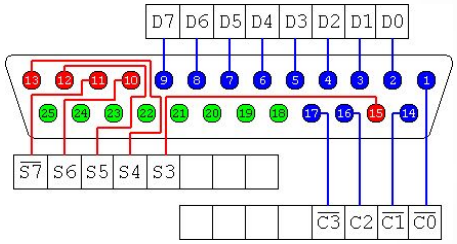
Three Main Invisible Quantities

- Voltage, symbol - V, units - Volts
  - Provides the "push"
- Current, symbol - I, units - Amperes (Amps)
  - Flow of Electrons
  - Amount of Current is dependent on Voltage and Resistance
- Resistance, symbol - R, units - Ohms (Ω)
  - Limits the amount of current
  - Represents the "load" of the circuit

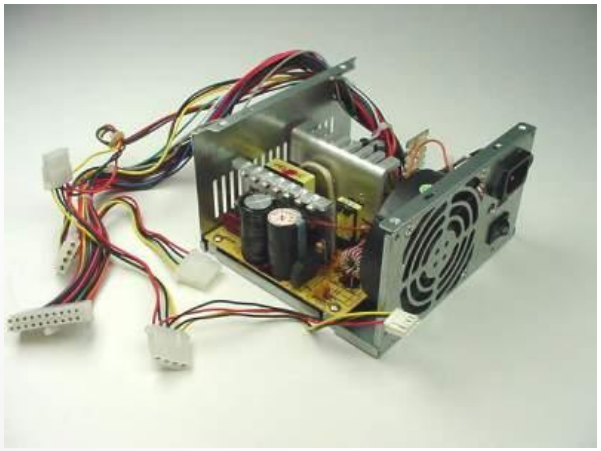
Voltage Can Be Provided From…

- A battery:

- Computer Parallel port:



- Power Supply:



- Red: 5V
- Yellow: 12V
- Black: Ground

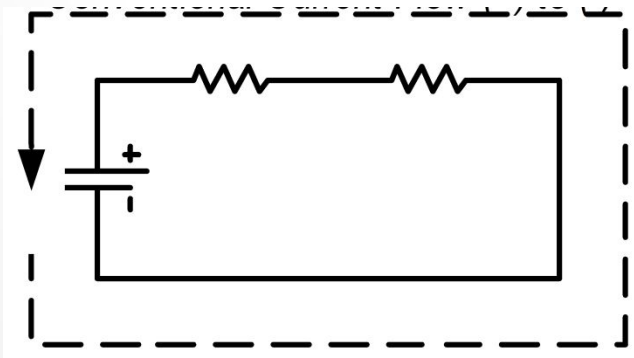
Current

….is simply the flow of electrons

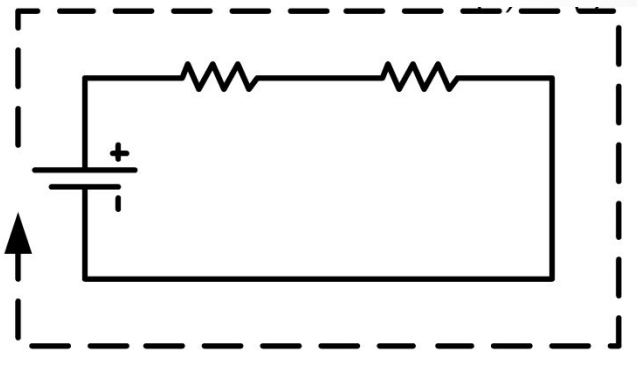
Q: Which way does current flow?

A: Depends upon convention!

Electron Current Flow (-) to (+)



Conventional Current Flow (+) to (-)



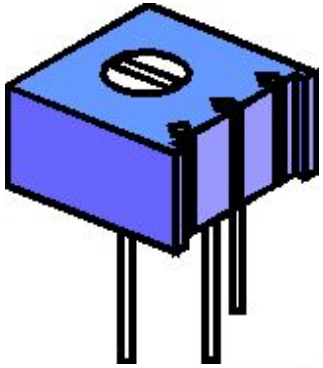
Resistors – Basic Specs

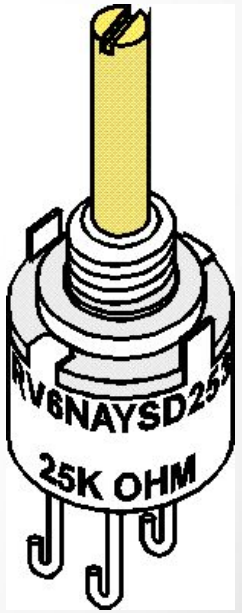
- Can be rated by…
  - Resistance (Ohms, Ω)
  - Tolerance (% of nominal value)
  - Power Rating (Watts)
- Schematic Symbol…

Resistors – Types

- Fixed

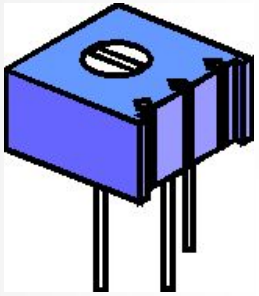
- Variable (Potentiometer, Rheostat)

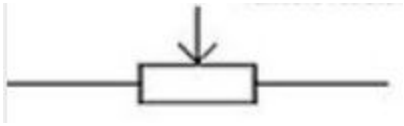




Variable Resistors

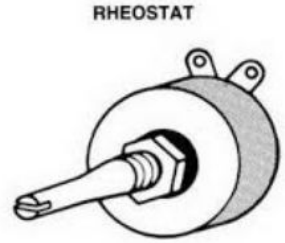
Potentiometer

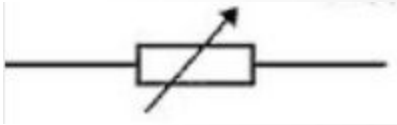




- Potentiometer is a three terminal variable resistor
- Used to vary voltage
- Applications include TV/sound volume control, voltage divider circuits etc.

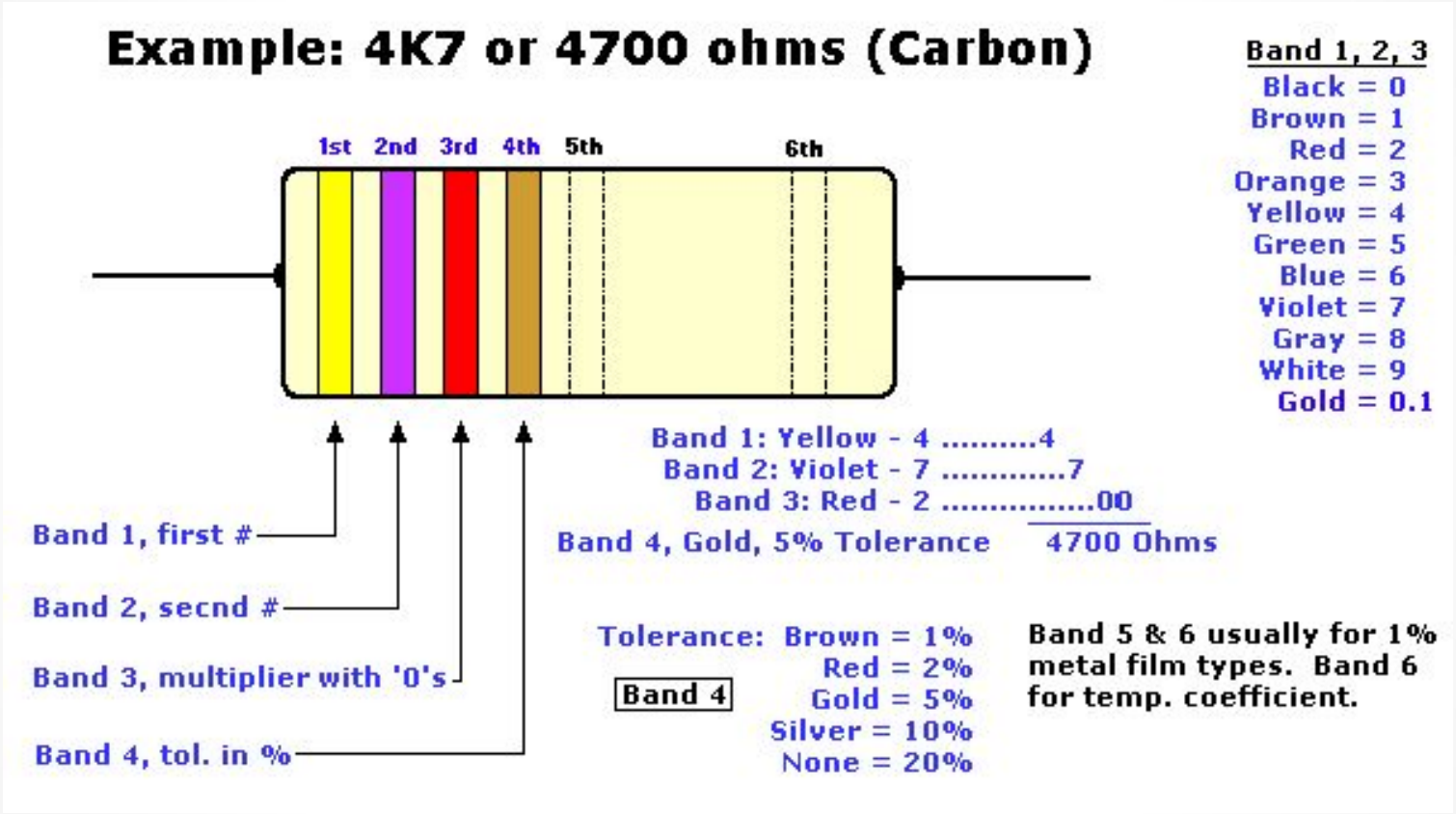
Rheostat





- Rheostat is a two terminal variable resistor
- Used to vary current
- Applications include motor speed control and other high current applications.

Resistors – Colour Code



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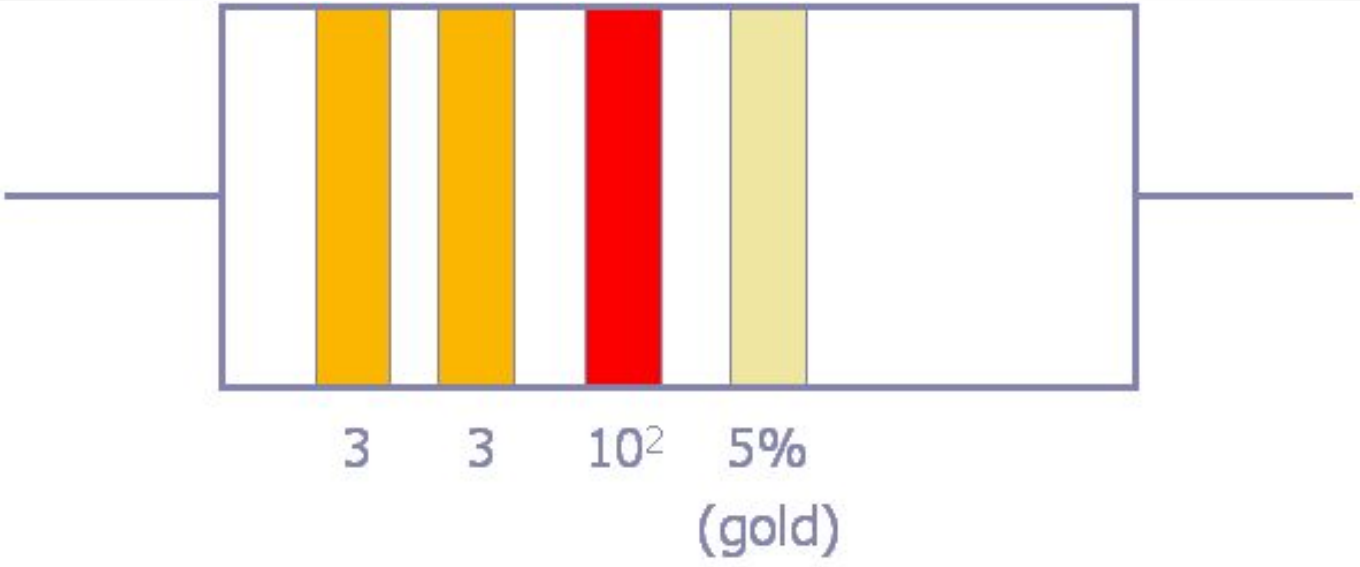
Resistors – Colour Code Example



- 1st band: orange = 3
- 2nd band: orange = 3
- 3rd band: red = 2 (i.e. 10^2)
- 4th band: gold = 5%

33×10^2

$= 3300\ \Omega$

$= 3.3\ k\Omega$

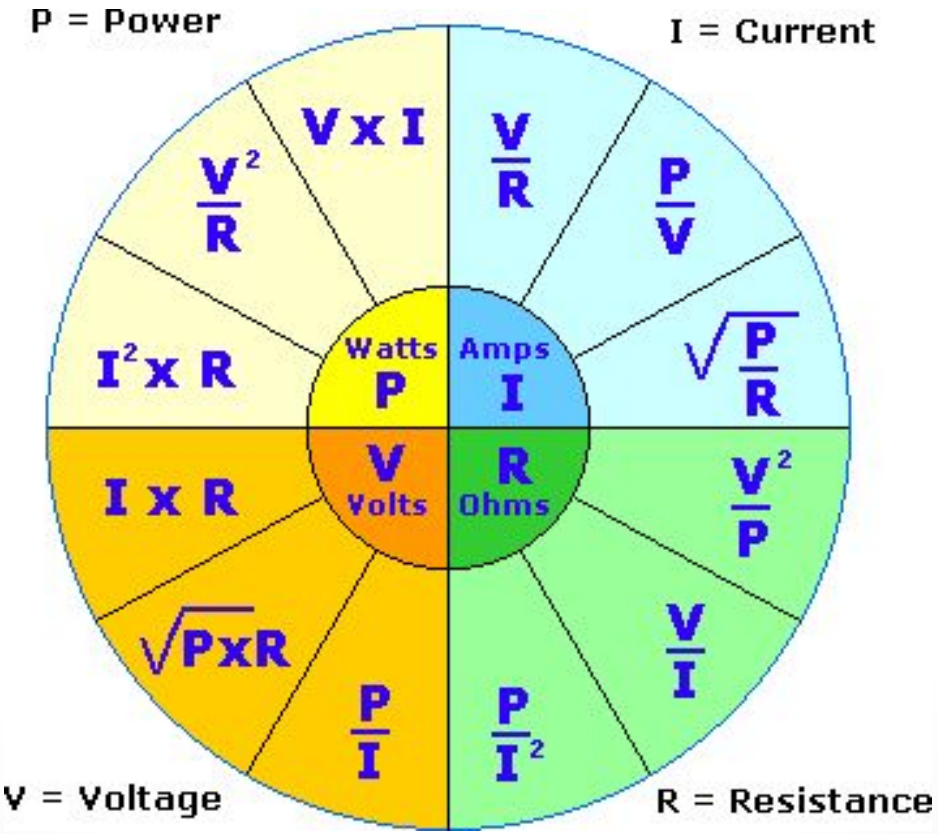
Ohm's Law

"Current (I) is proportional to Voltage (V) and inversely proportional to Resistance (R)"

$$I = \frac{V}{R} \qquad V = I \times R \qquad R = \frac{V}{I}$$

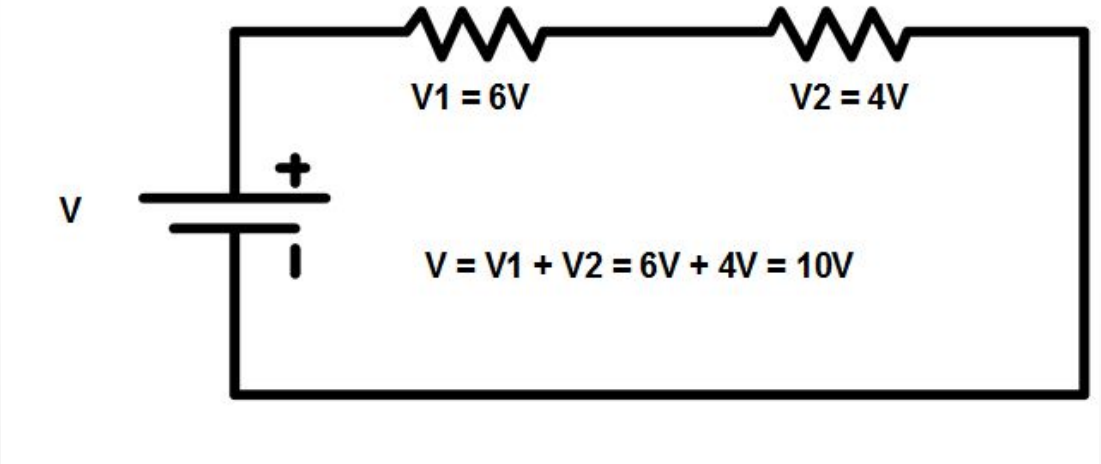
$$P = I \times V$$

Ohm's Law and Power Formulas



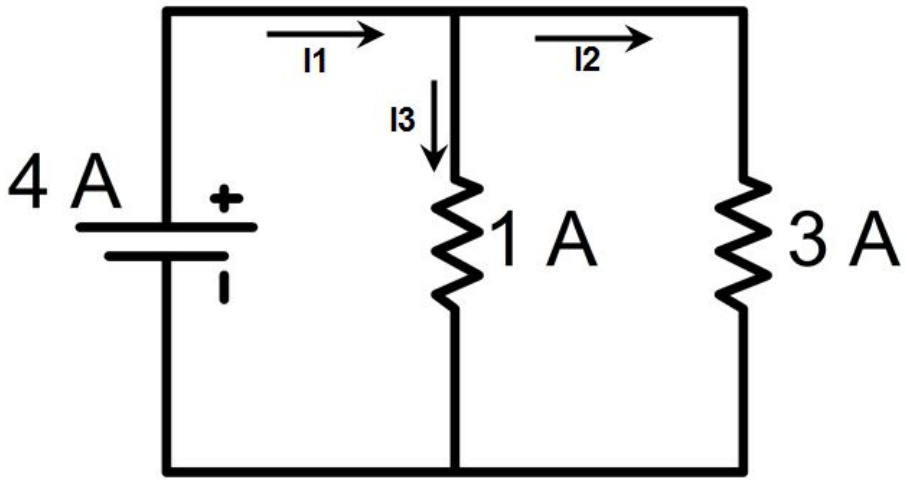
Kirchhoff's Voltage Law

- Used in series circuits
- "The sum of the voltage drops equals the applied voltage", or…
- "The sum of the voltage drops around a closed loop equals zero"



Kirchhoff's Current Law

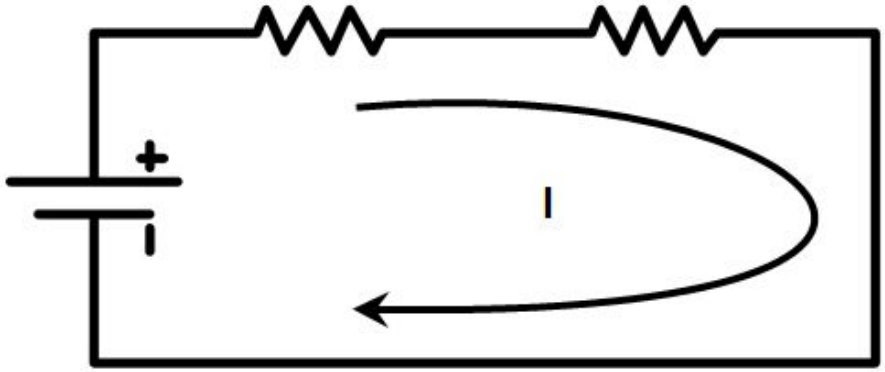
- "The total current entering a junction must equal the total current leaving the junction"
- Use in parallel circuits.



I1 = I2 + I3 = 3A + 1A = 4A

Series Circuits

- One current path, therefore the current is the same everywhere

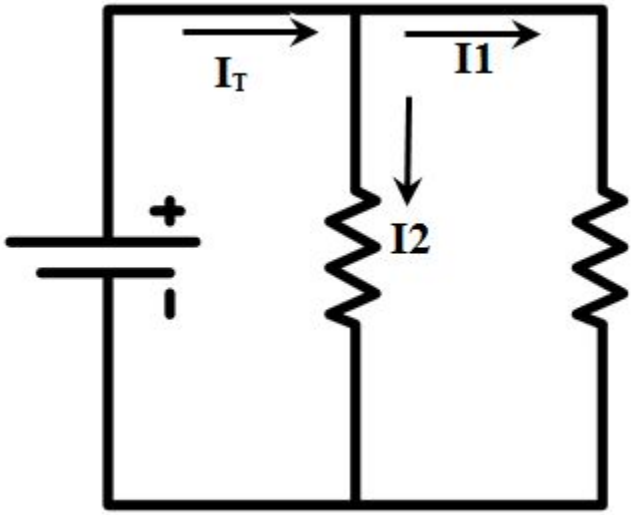


- Total resistance is the sum of the individual resistances

$$R_T = R_1 + R_2 + \ldots$$

Parallel Circuits

- More than one current path



- Total current is the sum of the individual currents

$$I_T = I_1 + I_2 + \ldots$$

Parallel Circuits (2)

$$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots}$$

$$= \frac{R_1 \times R_2}{R_1 + R_2} (if\ 2\ only)$$

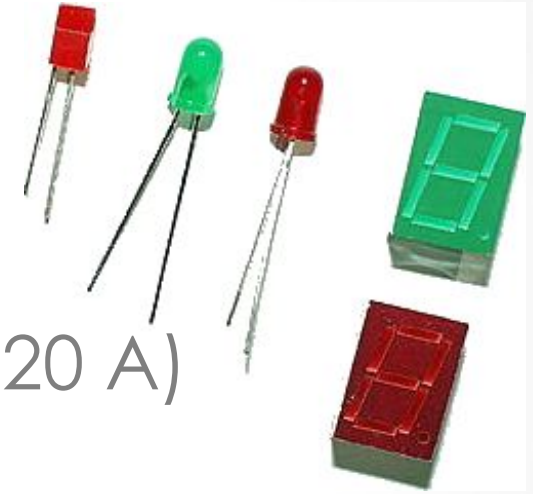
$$= \frac{R}{n} (if\ the\ same\ value)$$

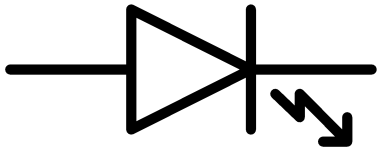
Diodes

- They allow electricity to flow through them in a certain direction only.
- Used in almost all types of electronics.
- Look like resistors but they do not have coloured stripes on them.

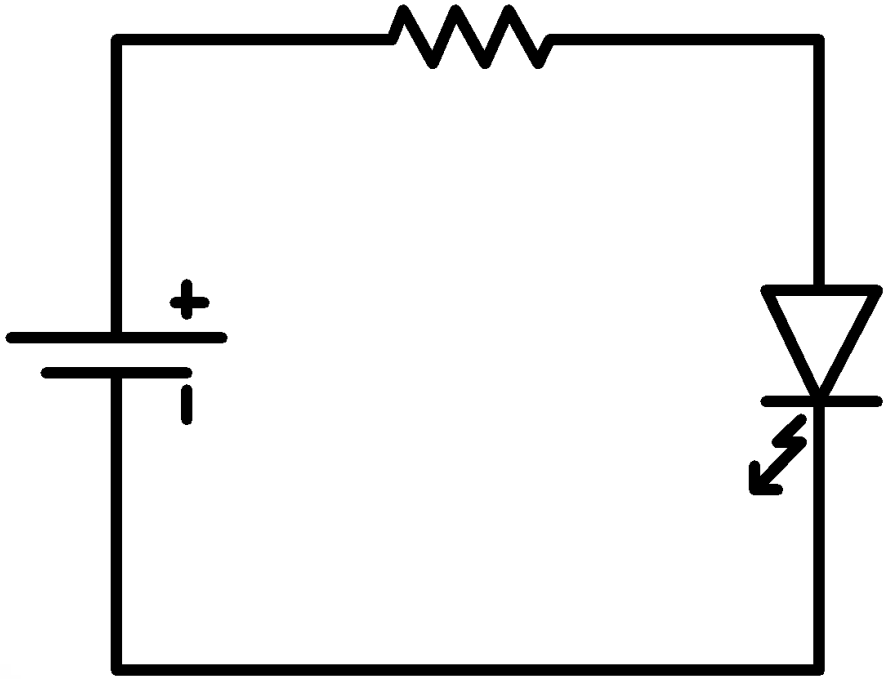
Light Emitting Diodes

- A type of diode designed to emit light
- Can be visible or IR
- 2 V voltage drop
- Typically draws 20 mA (0.020 A)
- Schematic Symbol…





A Simple LED Circuit



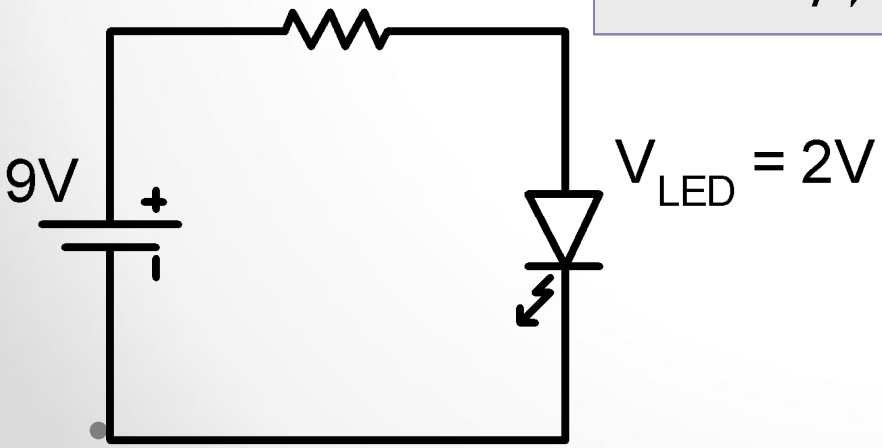
Analyzing a LED Circuit with KVL and Ohm's Law

$$V_T = V_R + V_{LED}$$

$$V_R = V_T - V_{LED}$$
$$= 9 - 2$$
$$= 7V$$

$$I_{LED} = I_R = 20\,mA$$

$$R = \frac{V_R}{I_R}$$
$$= \frac{7\,V}{0.020\,A}$$
$$= 350\,\Omega$$

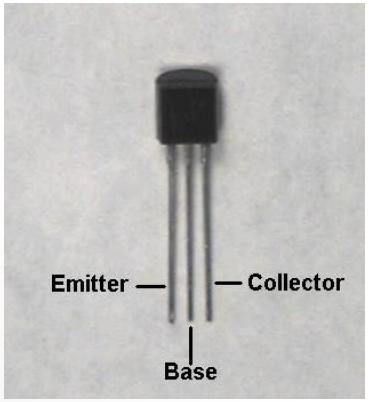


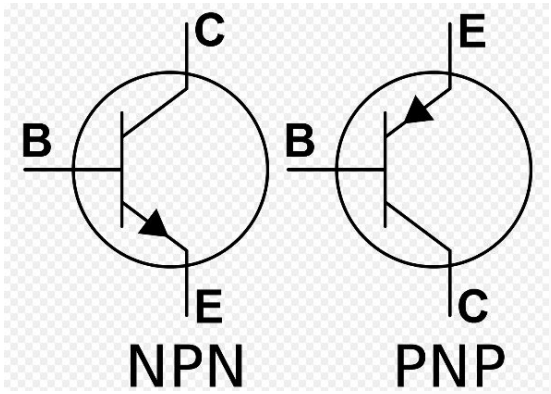
More about LEDs:

- http://www.thebox.myzen.co.uk/Tutorial/LEDs.html

Transistors

- They are used to amplify weak signals
- Also used as switches to (dis)connect other components.
- There are PNP and NPN types
- They have 3 connection points B (base) C (collector) and E (emitter).





Capacitors

- They store electrical energy to smooth out the flow of AC current.
- They also block DC (Direct Current) and allow the flow of AC (Alternating Current) through a circuit
- The farad is the measure of the capacitance (electrical storage capacity)
- A farad is extremely large so many of the values measured are in microfarads.