Basic Electronics

ICT 41205 Digital Control Systems

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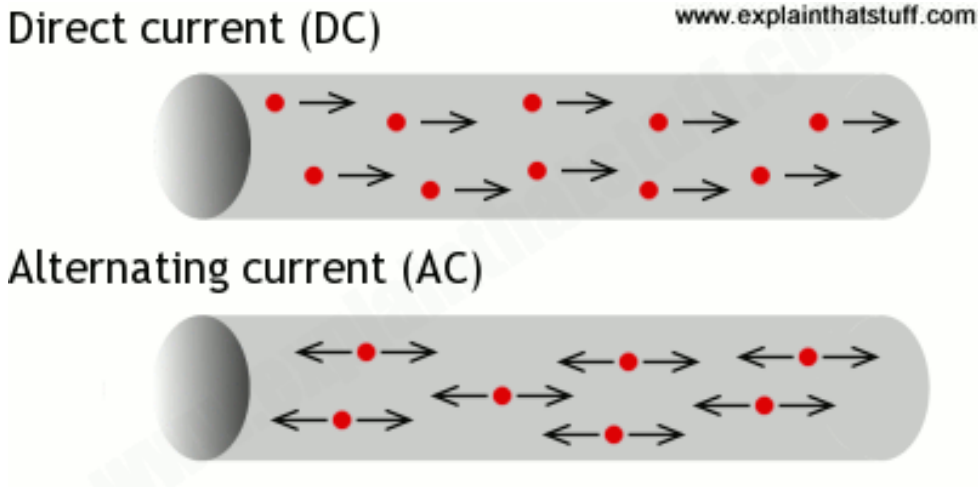
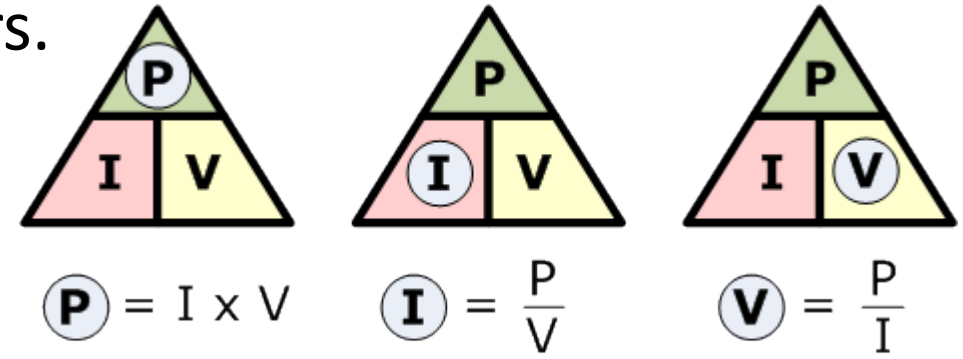
Electricity



- Flow of electrons
- Two types of electrical signals
  - alternating current (AC) – wall socket supply
  - direct current (DC) – battery
- Conductors Vs. Insulators
  - an electrical conductor allows the flow of electricity through it (metal)
  - an insulator prevents the flow of electricity through it (rubber, plastics, wood)
- Circuit
  - a complete and closed path through which electric current can flow
  - closed circuit vs. open circuit

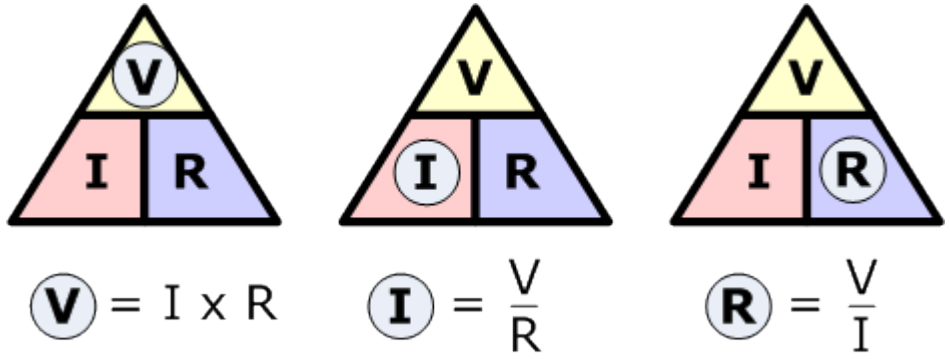
Voltage and Current

- Electricity is typically defined as having
  - V: voltage – Volts (V)
  - I: current rating – Amps (A)
- Voltage, also called electromotive force, is the potential difference in charge between two points in an electrical field.
  - How fast?
- Current is a flow of electrical charge carriers.
  - How much?
- P: $Power = Voltage \times Current$
- $P = VI$



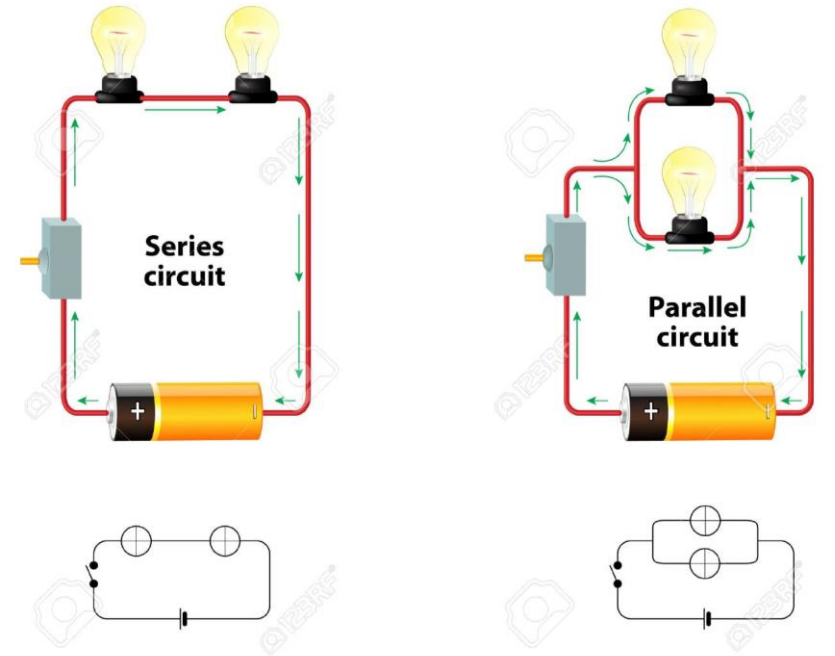
Resistance

- R: Resistance
  - The opposition that a substance offers to the flow of electric current.
  - Ohm – unit of resistance
  - Ω – symbol (uppercase Greek letter omega)
- **Ohm's Law**
  - mathematical relationship among electric current, resistance, and voltage
  - $V = IR$
  - $I = V/R$
  - $R = V/I$
- https://www.youtube.com/watch?v=_-jX3dezzMg
- https://www.youtube.com/watch?v=F_vLWkkOETI



Series vs. Parallel

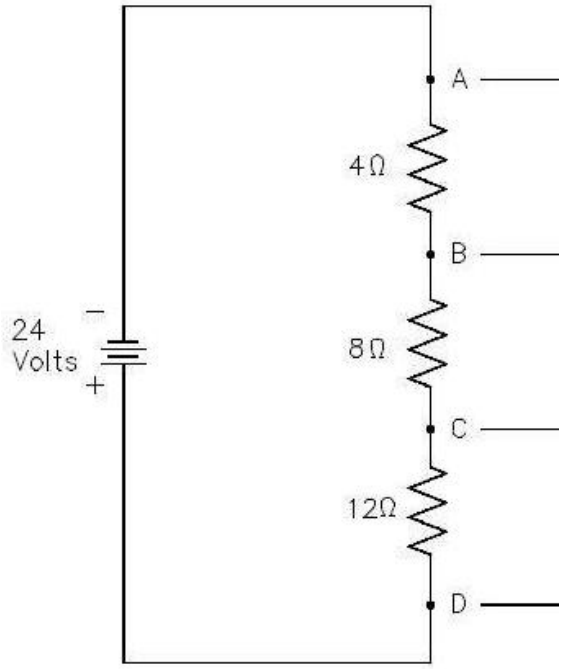
- Series
  - things are wired one after another
  - electricity has to pass through one thing, then the next thing
- Parallel
  - things are wired side by side
  - electricity passes through all of them at the same time, from one common point to another common point

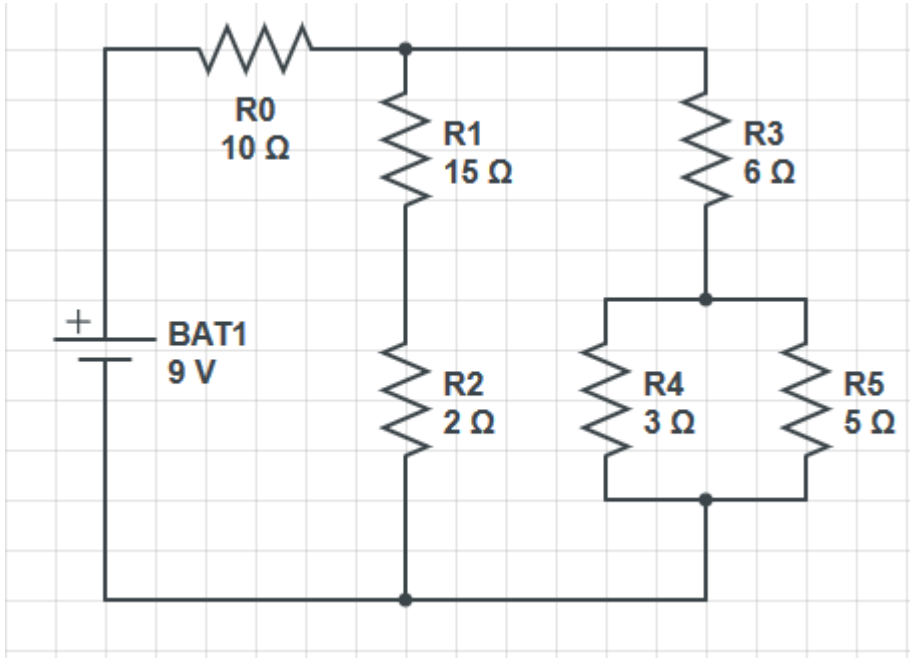


$$R_S = R_1 + R_2$$

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$$

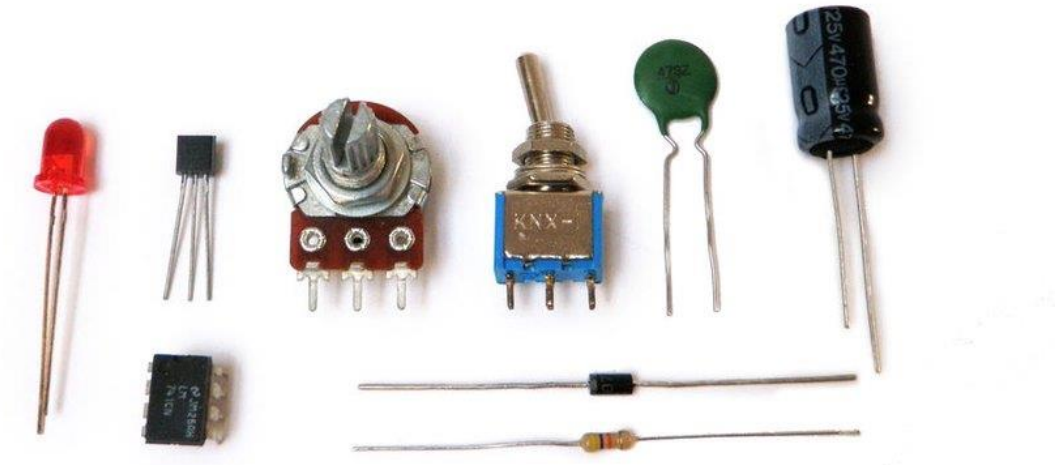
Exercise





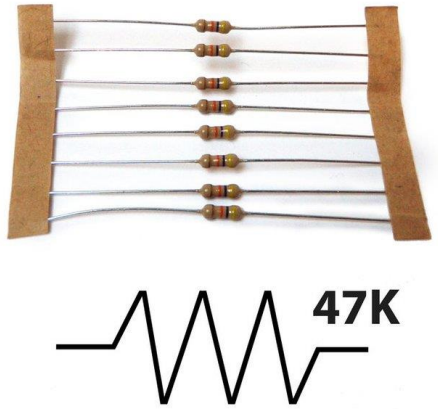
Calculate voltage and current for each resistor.

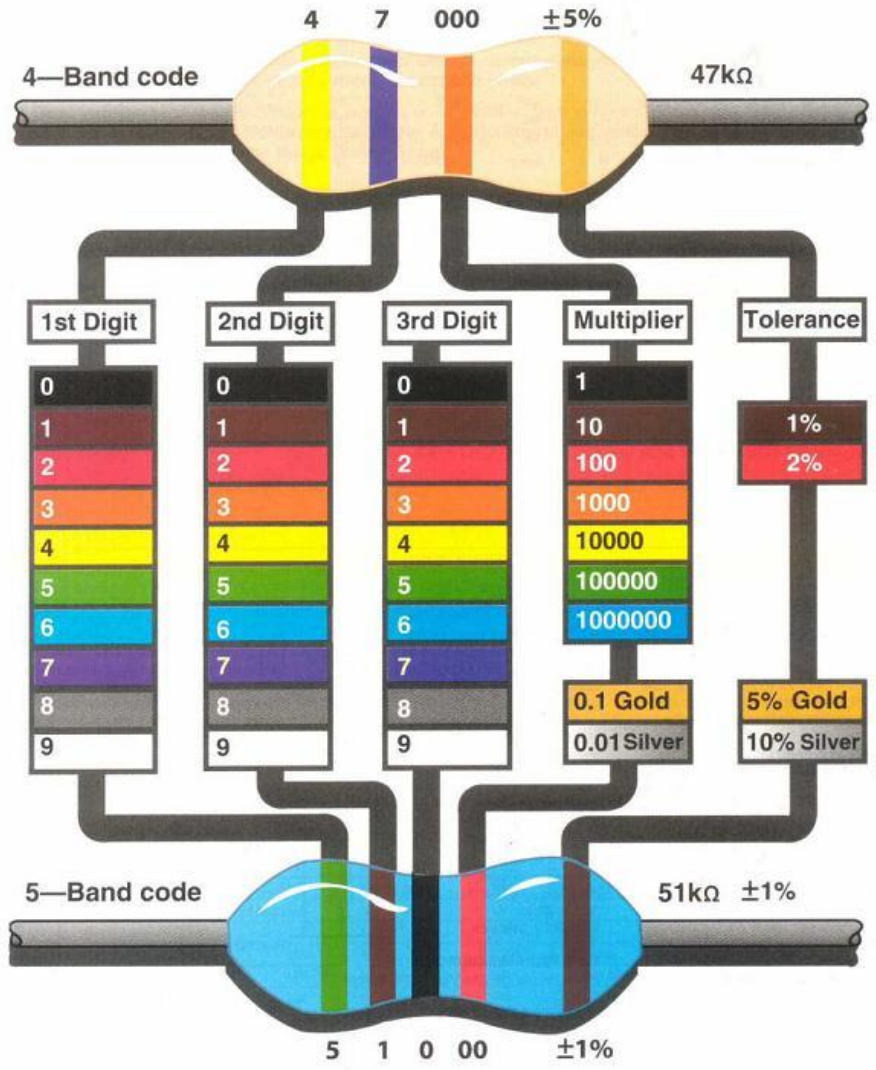
Basic Components



Resistors

- Resistors add resistance to the circuit and reduces the flow of electrical current
- Measured in ohm

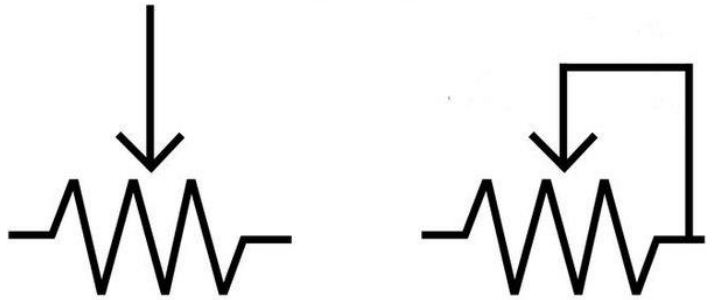




- https://www.youtube.com/watch?v=7w5I-KbJ1Sg

Potentiometers

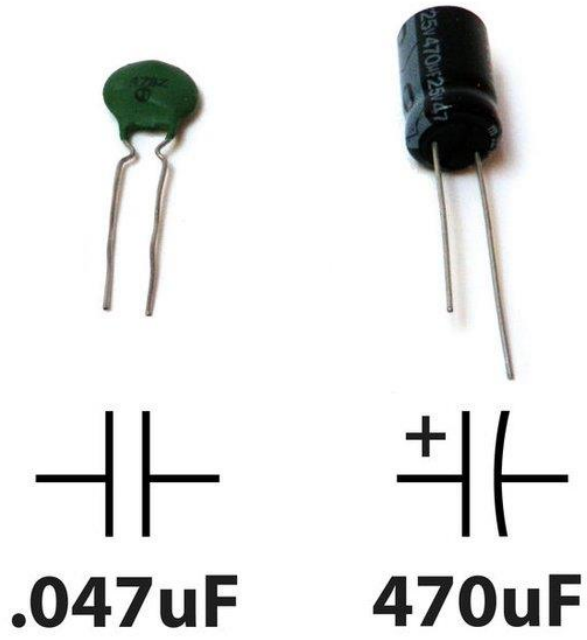
- Potentiometers are variable resistors.
- They have some sort of knob or slider that you turn or push to change resistance in a circuit.



- https://www.youtube.com/watch?v=DsdjHtIkJXM&t=9s

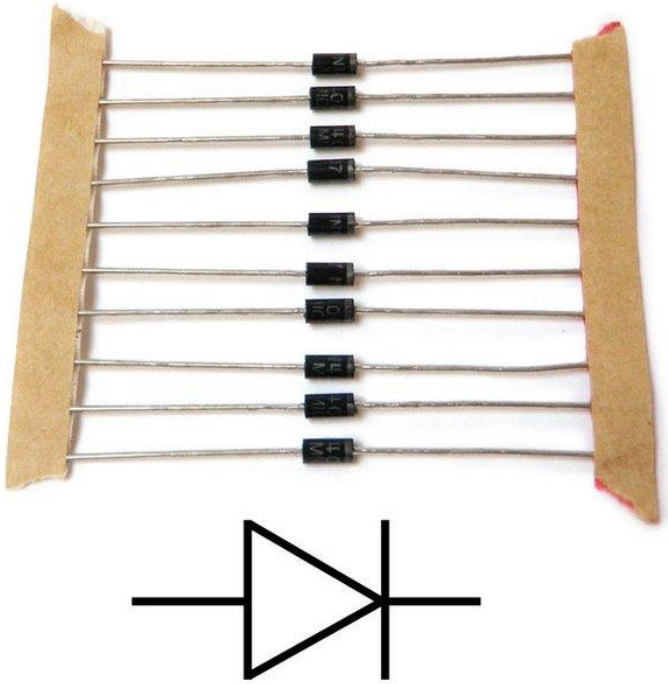
Capacitors

- Stores electricity and then discharges it into the circuit when there is a drop in electricity.
- Measured in Farads, typically picofarad (pF), nanofarad (nF), and microfarad (uF)
- Ceramic disc capacitors are non-polarized. Electrolytic capacitors are typically polarized.
- https://www.youtube.com/watch?v=otQGdPLyF3w



Diodes

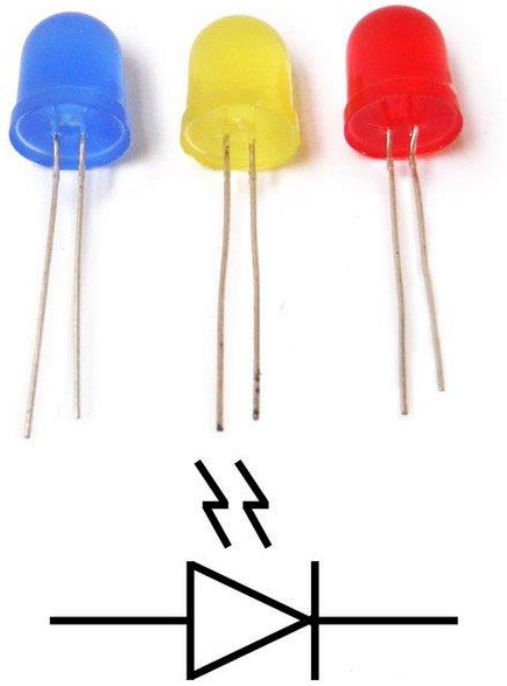
- Diodes are components which are polarized.
- They only allow electrical current to pass through them in one direction.
- Terminals:
  - Ring side: connects to ground - Cathode
  - Other side: connects to power – Anode



- https://www.youtube.com/watch?v=JNi6WY7WKAI

Light Emitting Diode (LED)

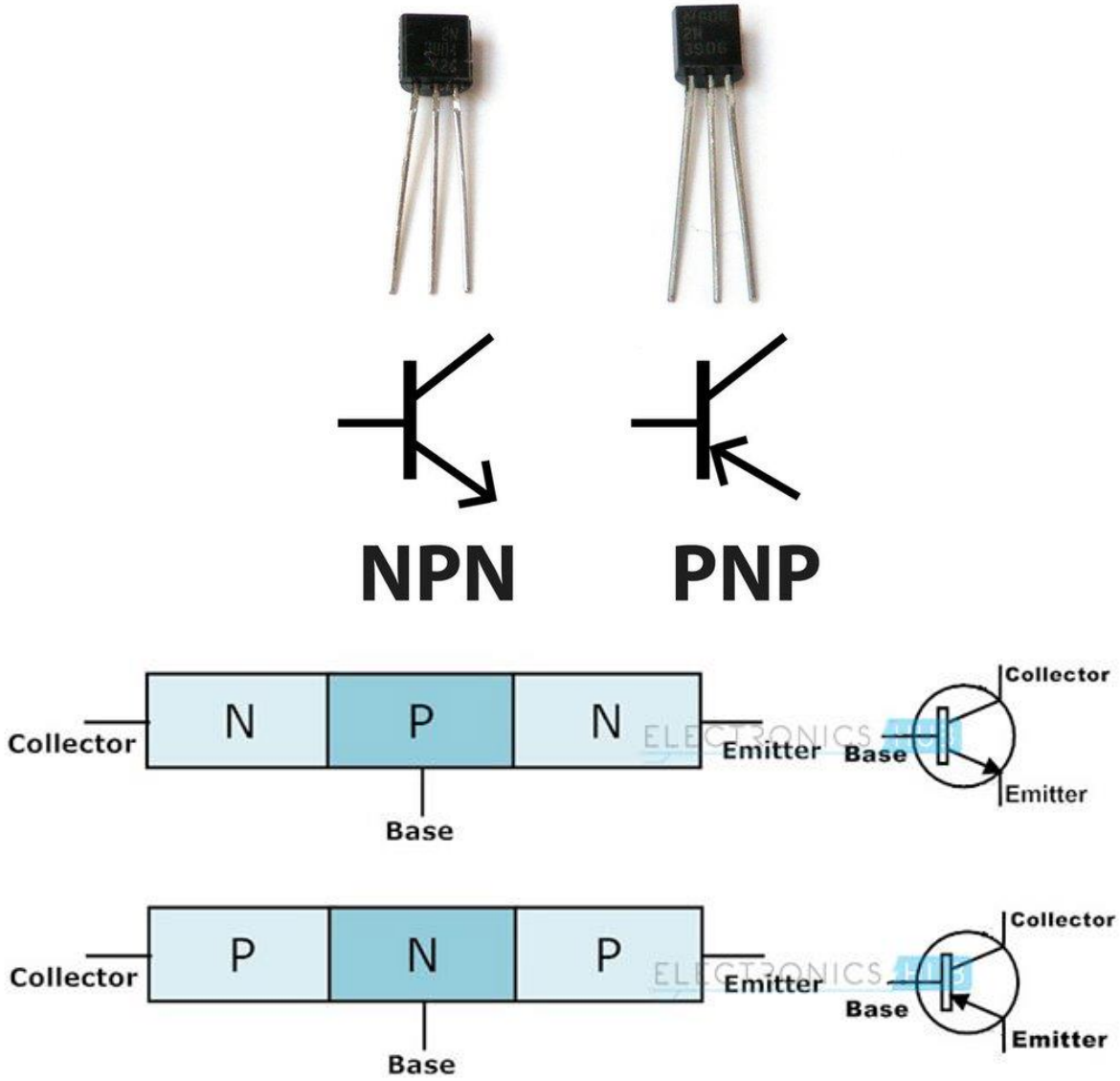
- A special type of diode that lights up when electricity passes through it.
- LEDs typically do not add much resistance.
- In order to prevent the circuit from shorting, you need to add a resistor in series.



- https://www.youtube.com/watch?v=Qlayua3yjuE

Transistors

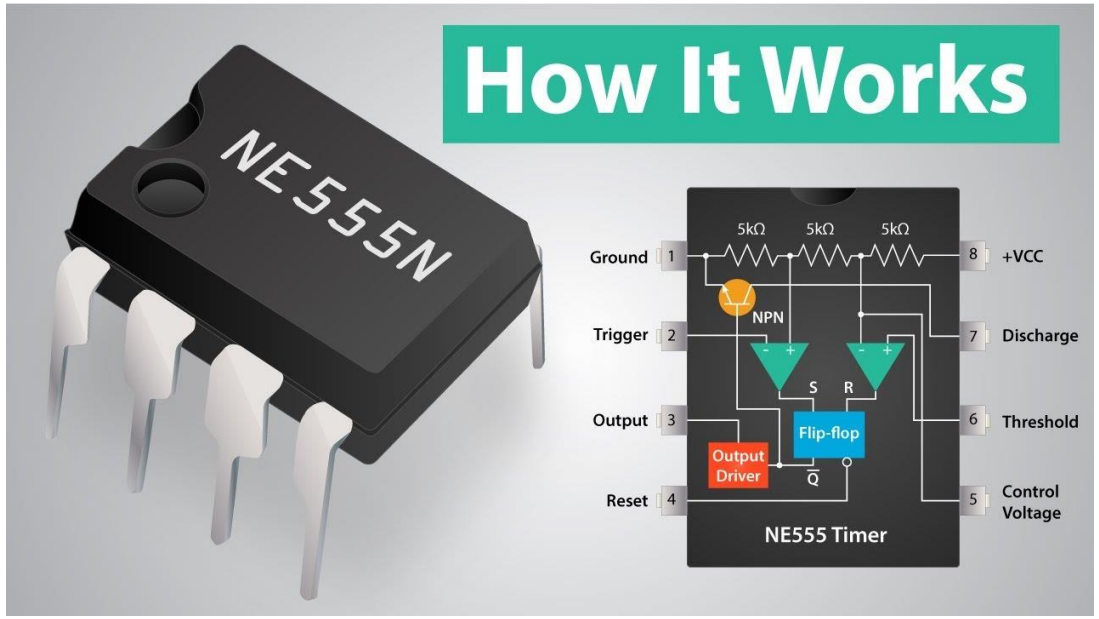
- Takes in a small current at base pin and amplifies it such that a much larger current can pass between collector and emitter pins.
- The amount of current that passes between these two pins is proportional to the voltage being applied at the base pin.



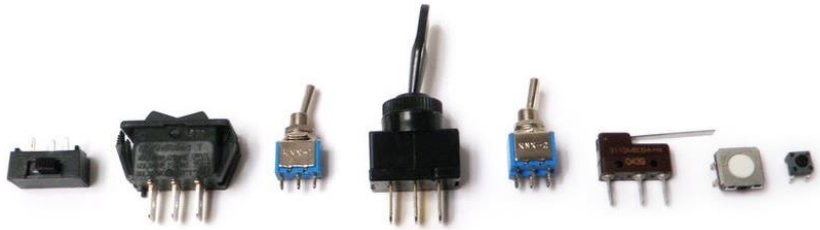
- https://www.youtube.com/watch?v=7ukDKVHnac4

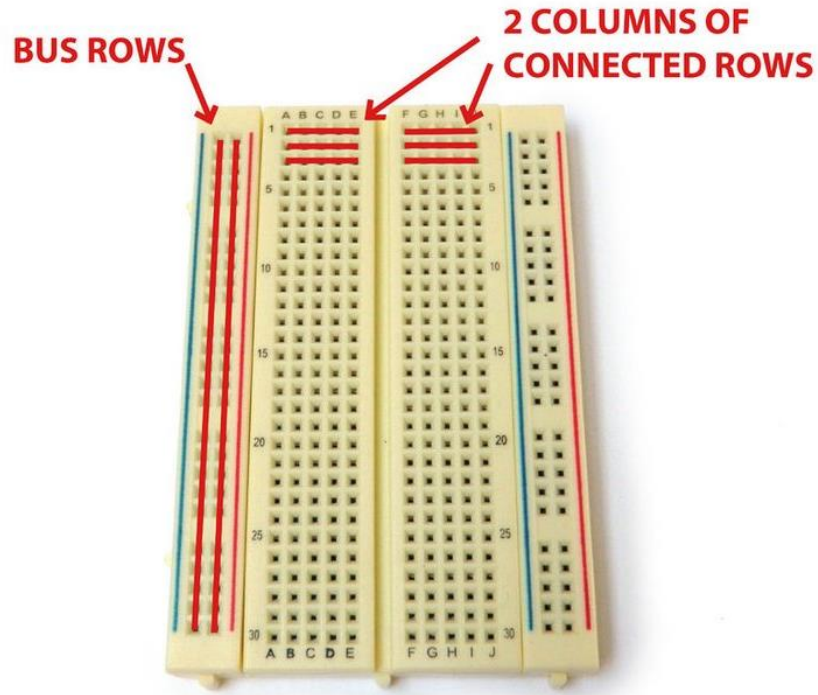
Integrated Circuits

- An entire specialized circuit that has been miniaturized and fit onto one small chip

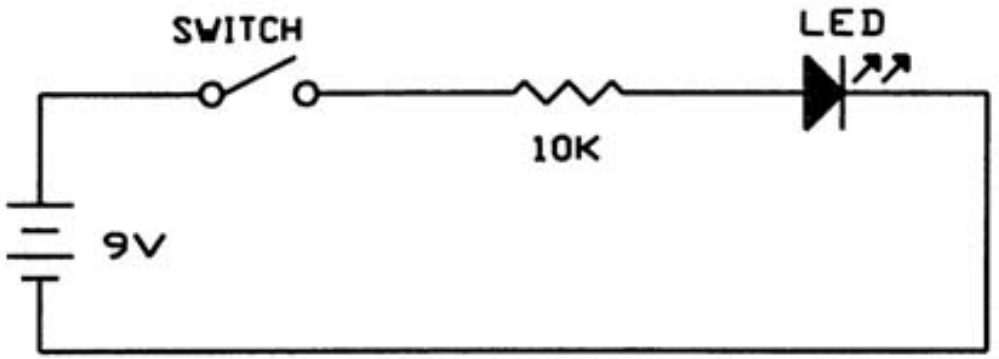


Some more components

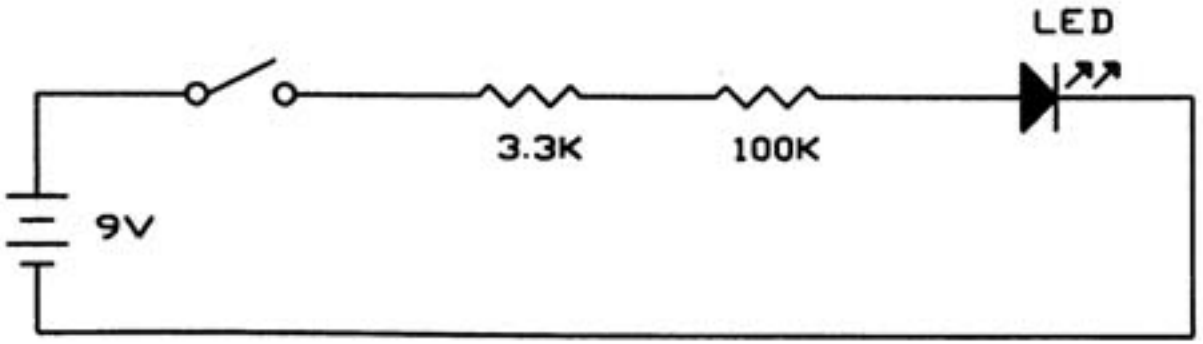


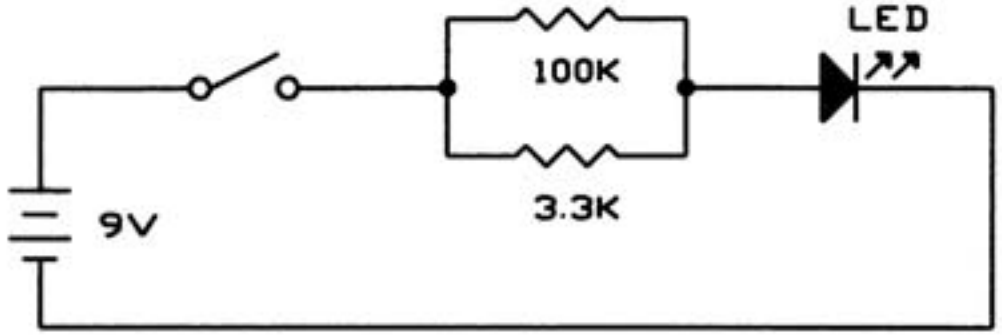


Experiment #1

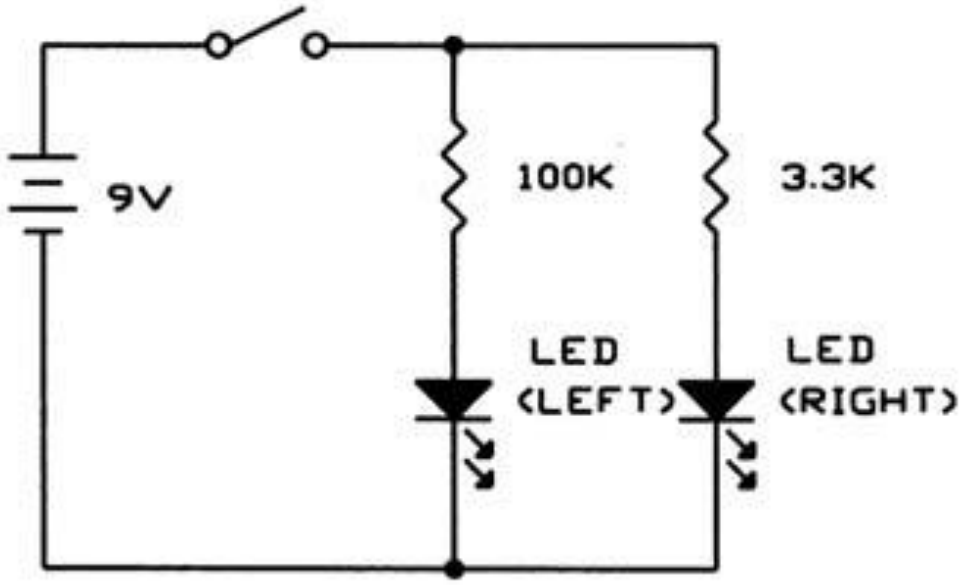


Experiment #2A, #2B



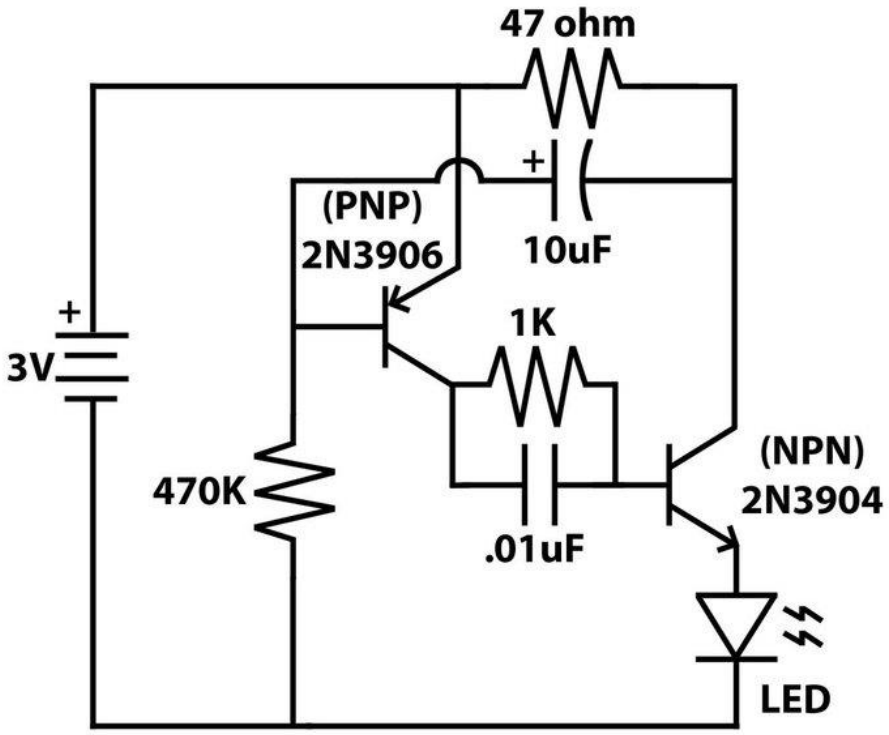


Experiment #3



- Replace the 100kΩ resistor with several values as before (such as 1kΩ, 10kΩ) and observe.

Experiment #4



Experiment #5