Fundamentals of Physics

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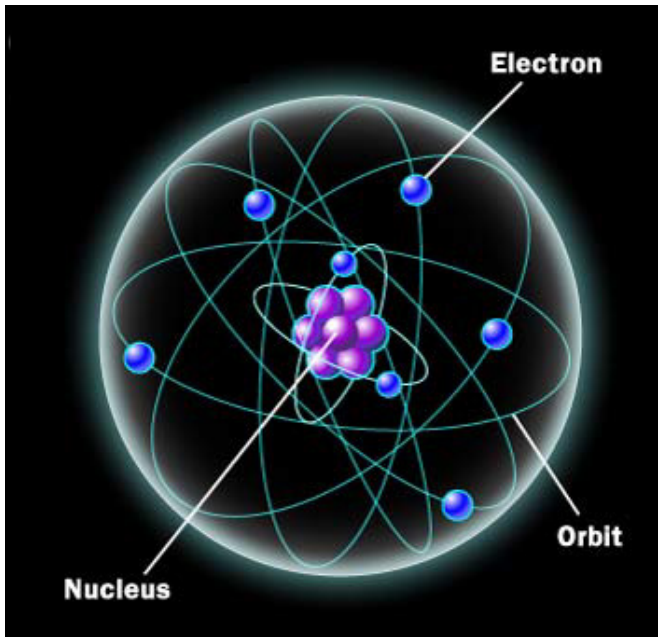
Basic Physics

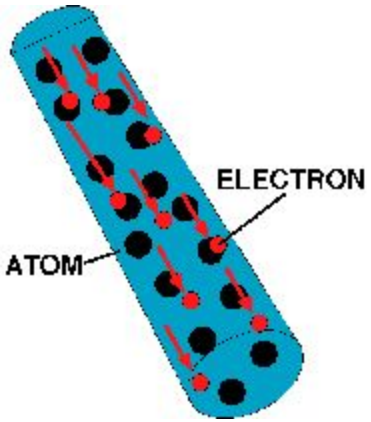
- Introduction
- Kirchhoff's laws
- Measurements of voltages, currents and resistances
- Resistors, Capacitors and inductors

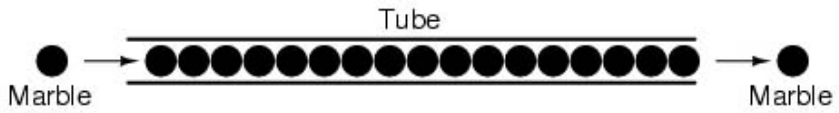
What is Electricity?

- Everything is made of atoms
- There are 118 elements, an atom is a single part of an element
- Atom consists of electrons, protons, and neutrons

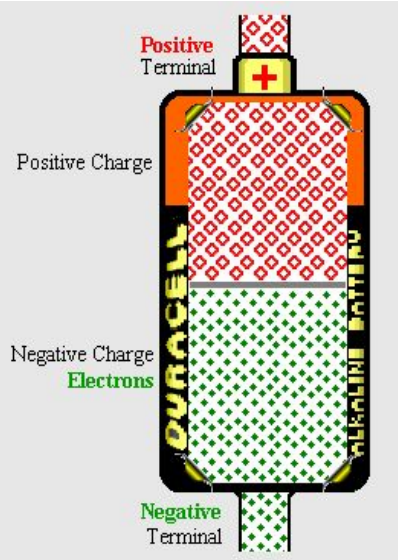


- Electrons (- charge) are attracted to protons (+ charge), this holds the atom together
- Some materials have strong attraction and refuse to loss electrons, these are called insulators (air, glass, rubber, most plastics)
- Some materials have weak attractions and allow electrons to be lost, these are called conductors (copper, silver, gold, aluminum)
- Electrons can be made to move from one atom to another, this is called a current of electricity.

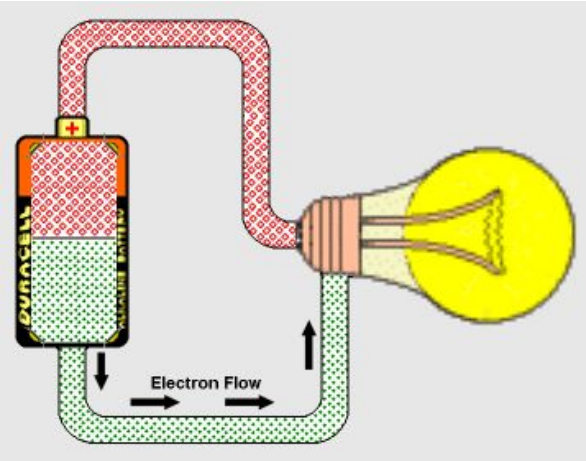




- Surplus of electrons is called a negative charge (-). A shortage of electrons is called a positive charge (+).
- A battery provides a surplus of electrons by chemical reaction.



- By connecting a conductor from the positive terminal to negative terminal electrons will flow.



Voltage

- A battery positive terminal (+) and a negative terminal (-). The difference in charge between each terminal is the potential energy the battery can provide. This is labeled in units of volts.

Water Analogy

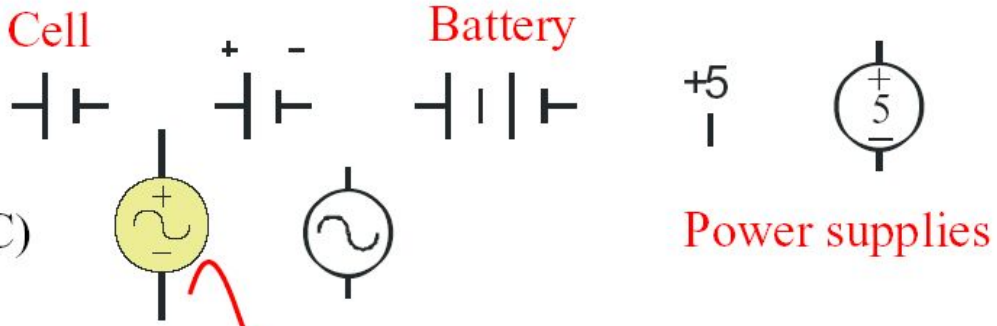
V E Potential

Voltage = **E**lectro-**M**otive **F**orce, the driving force in electron flow

Water Analogy	Electrical Equivalent
High Pressure	High Voltage
$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$	$\text{Voltage} = \frac{\text{Energy}}{\text{Charge}}$
Pump	Low Voltage
Low Pressure	**Unit = Volts**
Pressure without flow	Voltage without flow

Voltage Sources:

Symbols



Properties

Constant Voltage, independent of the amount of current

Usually ideal

Examples

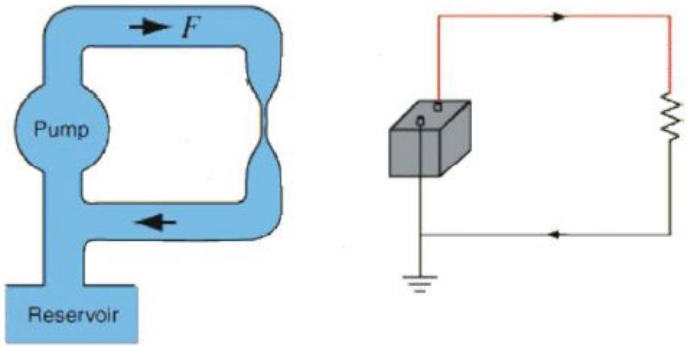
Batteries

Power Supplies

Signal Generators

Ground

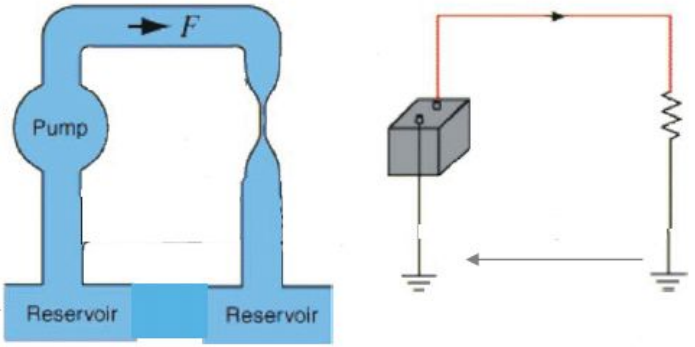
Provides a reference point



Purely a reference point

Does not participate in current flow

An integral path in the current flow



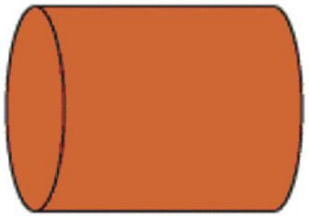
Symbols

Earth

Analog Gnd

Current

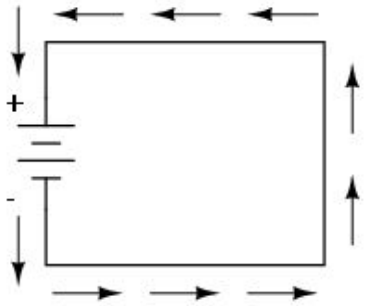
Flow of Water



Flow of Charge

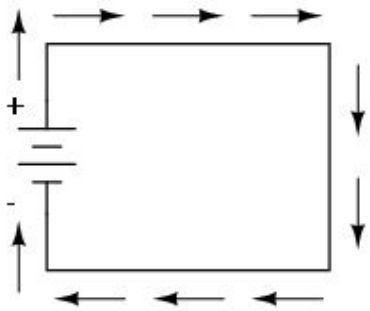
- Uniform flow of electrons thru a circuit is called *current.*

Electron flow notation



Electric charge moves from the negative (surplus) side of the battery to the positive (deficiency) side.

Conventional flow notation

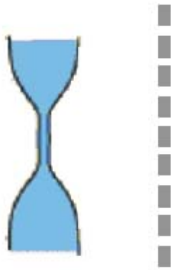


Electric charge moves from the positive (surplus) side of the battery to the negative (deficiency) side.

WILL USE CONVENTIONAL FLOW NOTATION ON ALL SCHEMATICS

Resistance

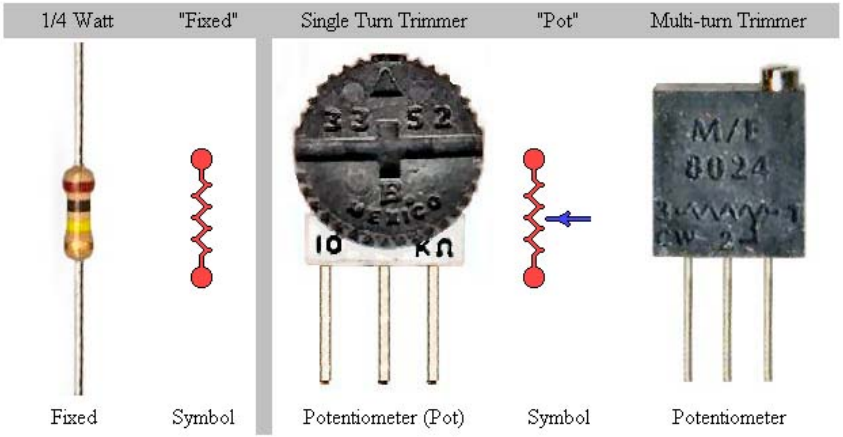
Constriction
creates
Resistance to water flow



Resistor creates
Resistance to current
flow

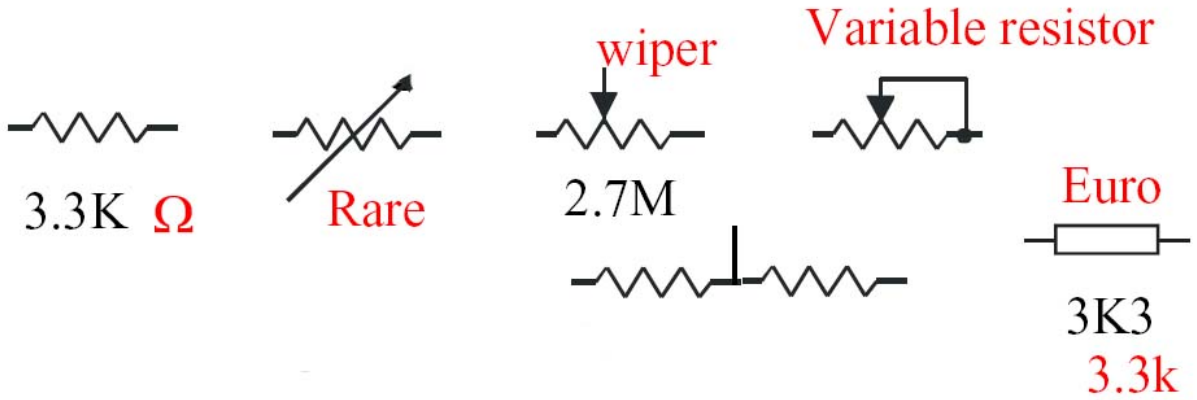
- All materials have a resistance that is dependent on cross-sectional area, material type and temperature.
- A resistor dissipates power in the form of heat

Various resistors types

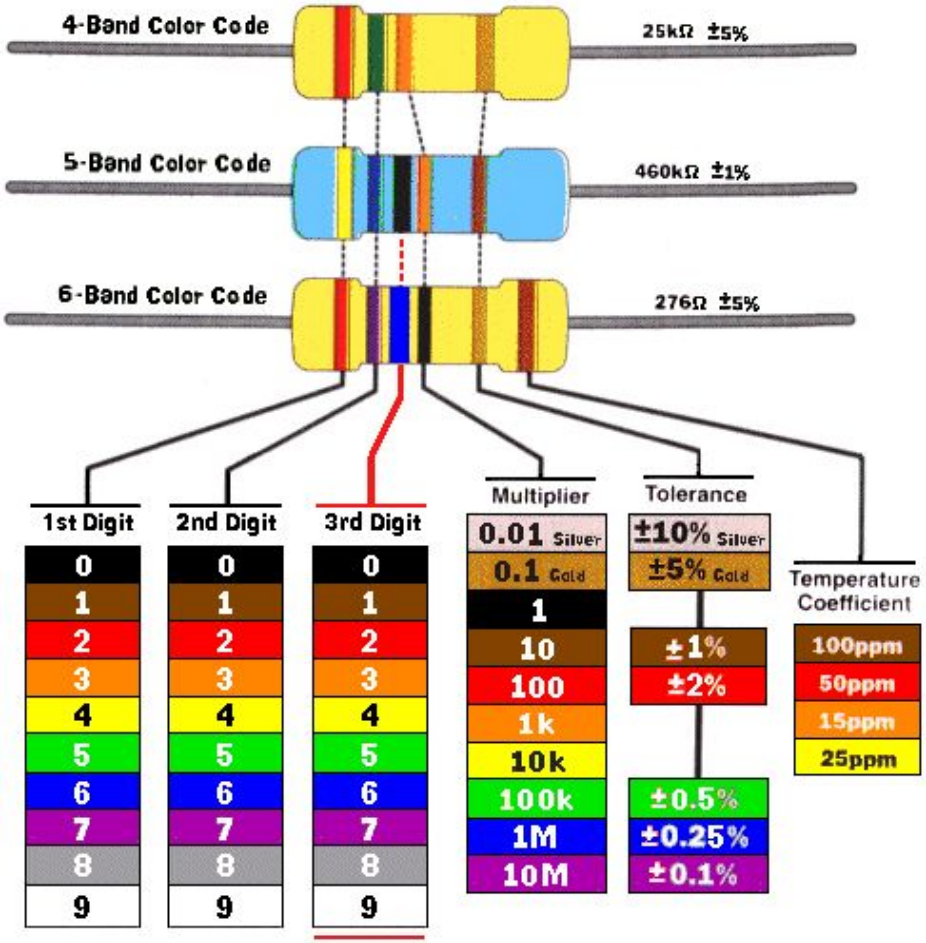


Potentiometer Potentiometer Sliding Potentiometer

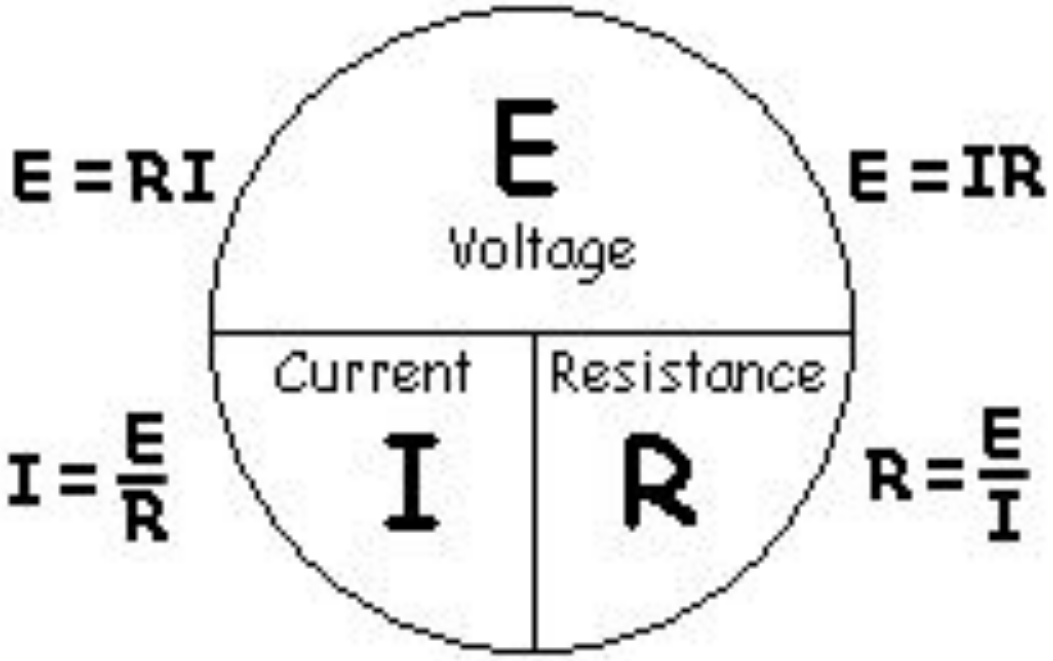
Symbols



Resistor Color Code

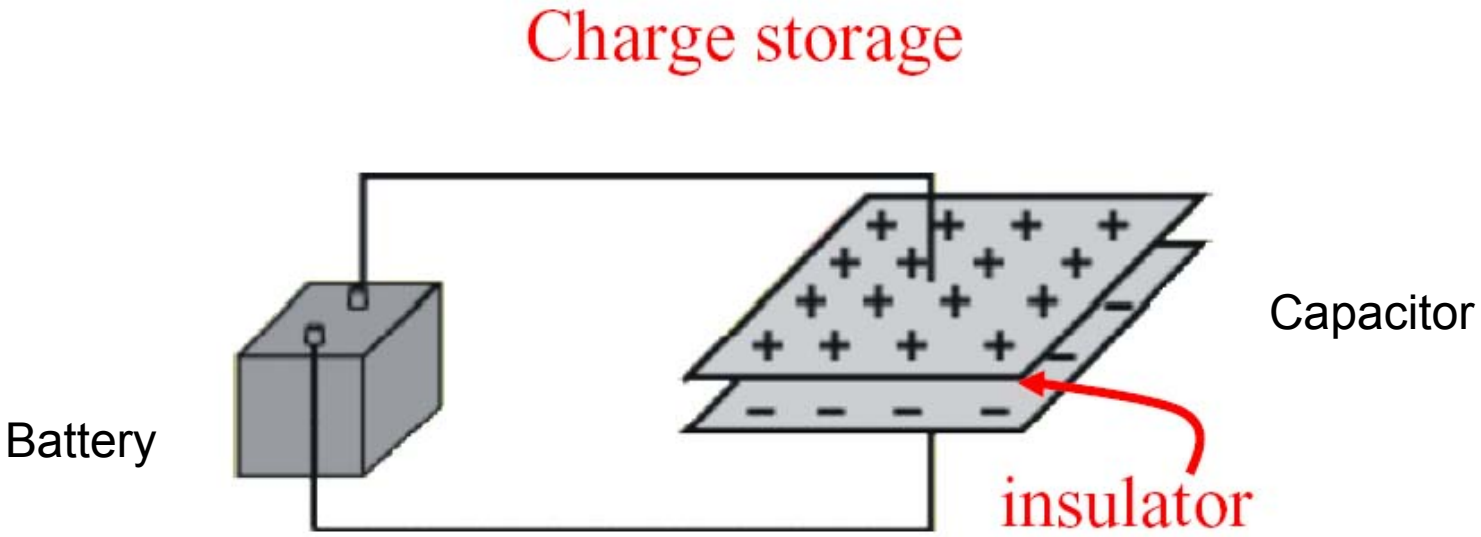


Ohm's Law



Capacitance

A capacitor is used to store charge for a short amount of time



Unit = Farad

Pico Farad - pF = 10^{-12}F
Micro Farad - uF = 10^{-6}F

Symbols

Properties

Characteristic Equations: $I = C\frac{dV}{dT}$

$$V = \frac{1}{C}\int IdT$$

Integrating
Charge (storage)

Markings

Polar vs Non-Polar

Values

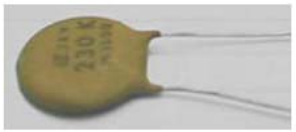
Electrolytics mark (-)
Tantalums mark (+)
Longer lead

Examples

Mylar

Monolythic
Cermamic

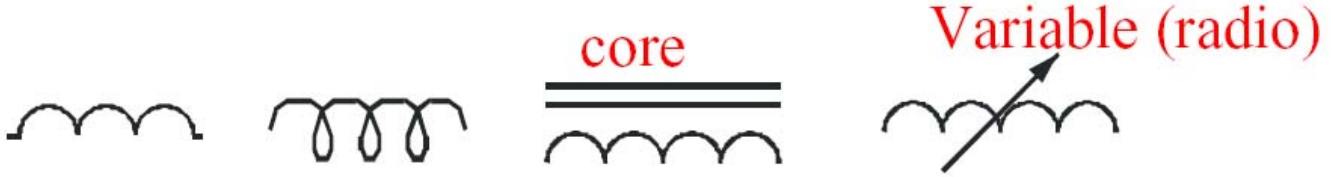
Tantalum



Ceramic

Electrolytic

Symbols



Properties

Characteristic Equation: $V = L\frac{dI}{dT}$

Examples

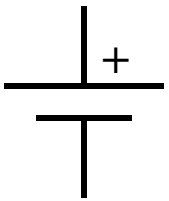
Any where you have wire.

Motor windings have significant inductance

Long leads also have small inductance

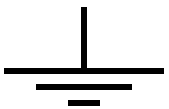
Schematics

- Symbols represent circuit elements
- Lines are wires

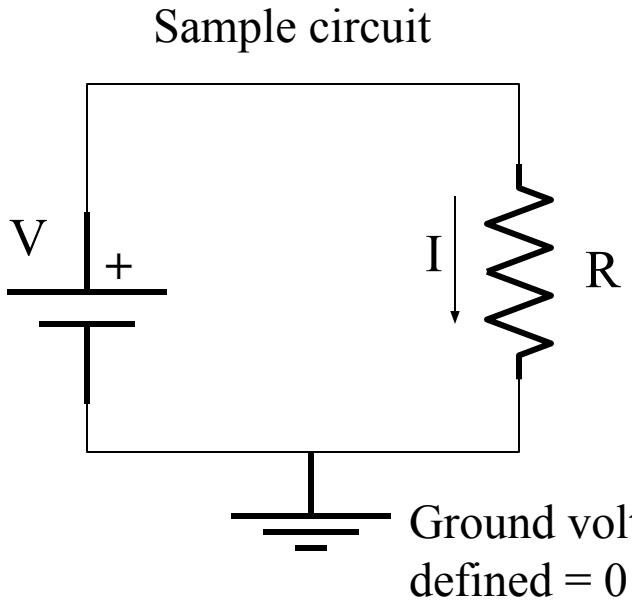


Battery

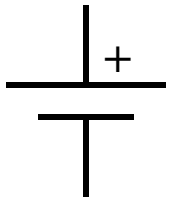
Resistor



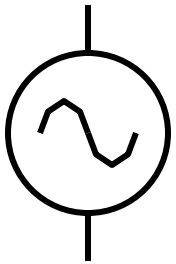
Ground



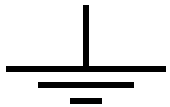
Summary of schematic symbols



Battery



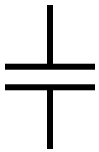
AC voltage source



Ground

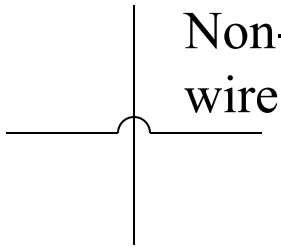
External connection

Resistor



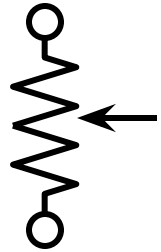
Capacitor

Inductor

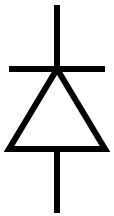


Non-connecting wires

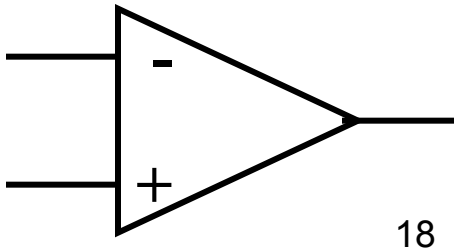
Potentiometer



Potentiometer 2-inputs plus center tap



Diode



Op amp

Conclusion

We discussed about basics of Physics-components related to our subject.