1: Conservation Laws

Conservation: stays the same (e.g. energy, charge, momentum)

System: Two or more objects seperated by their environment.

Open system: No boundary between objects and environment

In order for conservation laws to work, it has to be a closed system/ isolated system.

2: Electric Charge

Net charge = sum of all charges in the system

Charges can be transferred from one place to another (definition of current) [movement through a conductor]

Two types of charges: positive & negative

You can do work with a current.

Overall charge is conserved over time.

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3. Positive & Negative Charge

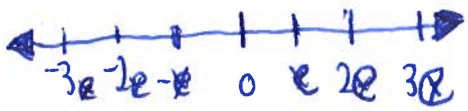
Neutral object: equal amount of positive & negative charges.

Charged object: different amounts of charges.

Two-like objects: repel, oppositely-charged objects: attract.

Polarized: The object is neutral, but the positive charges are on one side, and the negative charges are on the other side.

4: Elementary Charge:



Charge is quantized → $1.6 \times 10^{-19} C = e$

Electrons: negative elementary charge (-e)

Protons: positive elementary charge (+e)

Quantized: ~~Charge~~ Charge comes in specific values. At some point, the value cannot be split into smaller pieces.

5: Electrostatic Induction

Objects can be charged by friction or contact.

Conductors: electrons are mobile in the objects (e.g. metals)

Insulators: all charges are fixed, cannot move freely.

If you take a charged object and put it in a system, there will be a charge distribution.

Induction: moving it close to the object but not physically touching it.

Neutral object: no net charge

Only electrons move and transfer, not protons

Charged Insulator: electrons cannot move around and spread from each other.

Charged Conductor: electrons can move around and spread from each other.

Protons <u>never</u> transfer

6: Calculating the Electric Force

$$\text{Electric force} = k\frac{|q_1 q_2|}{r^2}$$

$k = 9.0 \times 10^9\ N\cdot(m/C)^2$

Example: Calculate the electric force between two ($2.0\ \mu C$) charges that are 4.0cm apart.

$$|\vec{F}| = k\frac{|q \cdot Q|}{r^2} = (9.0\cdot 10^9)\frac{(2.0\times10^{-6}C)(2.0\times10^{-6}C)}{(4.0\times10^{-2}m)^2} = \frac{3.6\times10^{-2}N}{1.6\times10^{-3}}$$

$= 22.5N$, repulsive

$k = 9.0 \times 10^9$

$q = (2.0 \times 10^{-6})$

$r = 4.0 \times 10^{-2}\ m$

7: Resistivity

Resistivity: The property of a material that describes its ability to resist the flow of charge.

Each material has different resistivity. Type of material & temperature determine resistivity.

Resistor: conductors, cross-sectional area, length, resistivity contribute to its resistivity

Resistivity ≠ Resistance

8: Resistors & Capacitors:

Resistor: 

Voltage = potential difference between 2 points

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

I = current

V = voltage, R = resistance (resistor)

$$R = \frac{\rho L}{A}$$

ρ = resistivity

L = length

A = area

$Q = CV$ (capacitor)

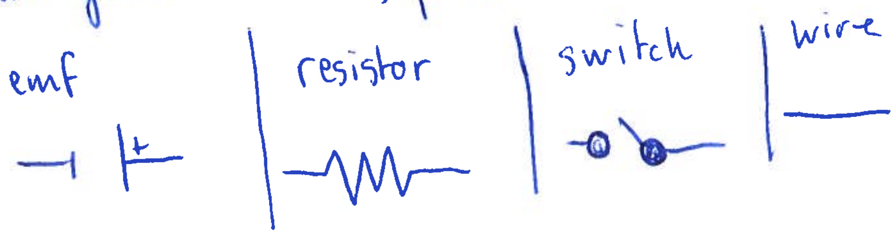
9: Electric Circuits

Voltage: potential difference between parts of a circuit

Current: the flow of electrons through the circuit.

Elements: Electric Motive Forces (emf), resistors, capacitors, switches

Arrangement: series, parallel



Energy is conserved in a circuit

emf returns the energy the electrons lost through the circuit.

$V = IR \qquad \Sigma R = R_1 + R_2 + R_3 \ldots$

parallel circuit = same voltage everywhere

$$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$$

10: Kirchoff's Loop Rule

~~Above~~ Sum of all votages equal 0. : $V_4 - V_1 - V_2 - V_3 = 0$

Battery = charge lift (potential energy) $V = IR$

Kirchoff's Loop Rule = Conservation of Energy (simple circuit)

Voltage $= \frac{\text{work done}}{\text{charge}}$ $\sum V = 0$

11: Kirchhoff's Junction Rule

Kirchoff's Junction Rule = Conservation of Charge (simple circuit)

current in = current out, $\sum I_{in} = \sum I_{out}$