Electrostatics

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Charge

Protons have positive charge

Electrons have negative charge

Neutrons have no charge

Charge is measured in Coulombs (C)

Like charges repel each other

Opposite charges attract each other

Charge cont.

Electrons = -1.6×10-19 C

Protons = +1.6×10-19 C

Quantization of Charge: means that how much charge you can have is restricted to discrete quantities

Quantization of Charge

Q = ne

n = (number protons) - (number of electrons)

Q = total charge

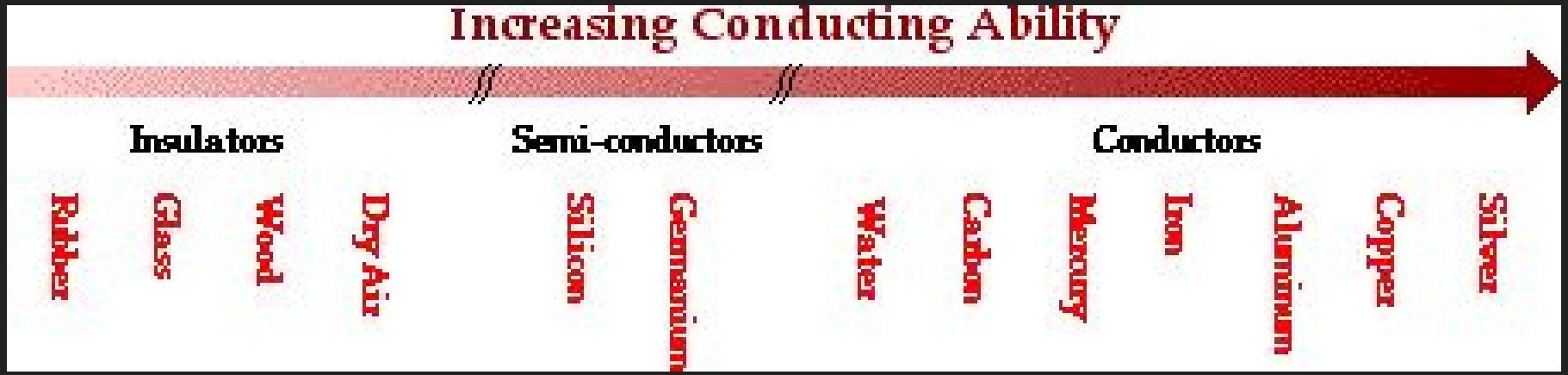
e = 1.6×10-19 C

Key: THIS VERY IMPORTANT WHEN SOLVING EQUATIONS

The Law of Conservation of Charge

Electric charge cannot be created or destroyed.

Insulators vs Conductors



Conductors

Conductors: is an object or type of material that allows the flow of an electrical current in one or more directions.

Ex. Silver, Gold, Copper, Aluminum, Mercury, Brass, Bronze, etc

Typically Metals

Insulators

Insulators: a substance that does not readily allow the passage of heat or sound.

Ex. Wood, Rubber, Glass, Oil, Air, Diamond, Plastic, Fiberglass, Dry Paper, etc

Semiconductors

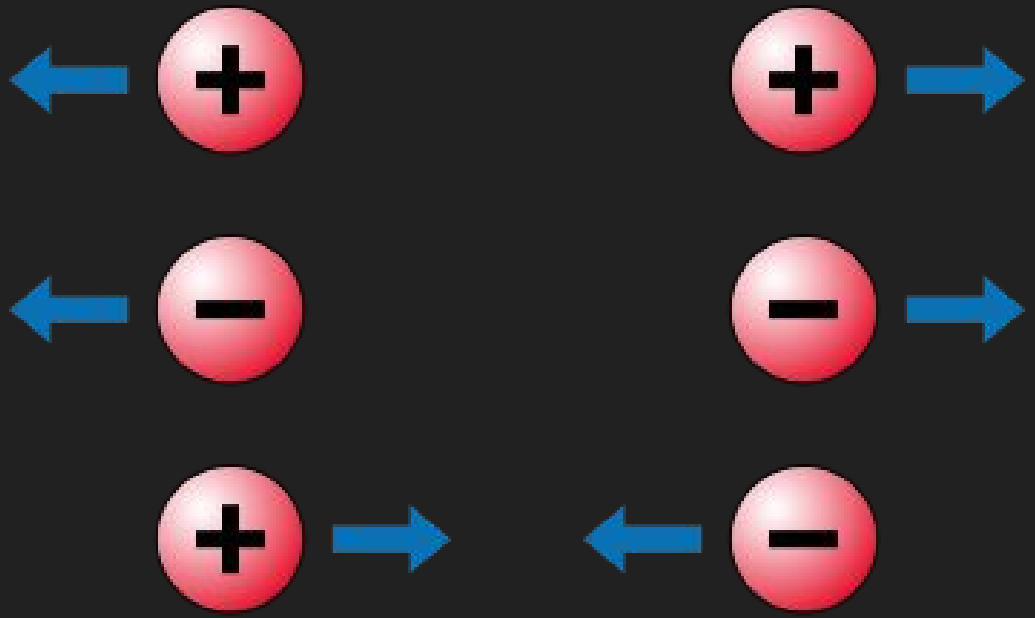
If it’s not a conductor or an insulator, it’s a Semiconductor

Semiconductors: a solid substance that has a conductivity between that of an insulator and that of most metals, either due to the addition of an impurity or because of temperature effects.

Ex: Germanium, Selenium, Silicon, Carbon, etc

3 Ways to Move Charges

1. Induction
2. Conduction
3. Friction

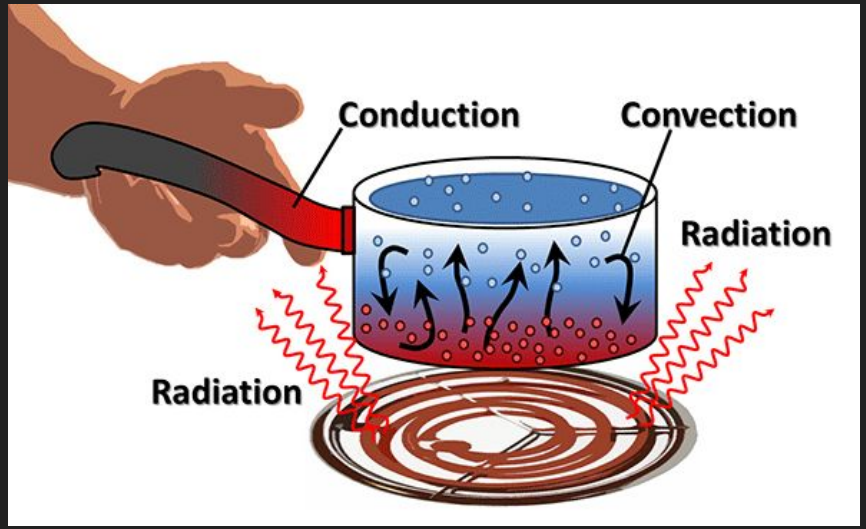


Induction

Induction: is separation of charge within an object because the charges get close to each other without touching

Conduction

Conduction: is where charges move between objects when they touch



Friction

Friction: is where electrons are physically stripped from one material and transferred to another

Electric Force

Q1 = how big the first charge is

Q2 = how big the second charge is

r= how far apart they are

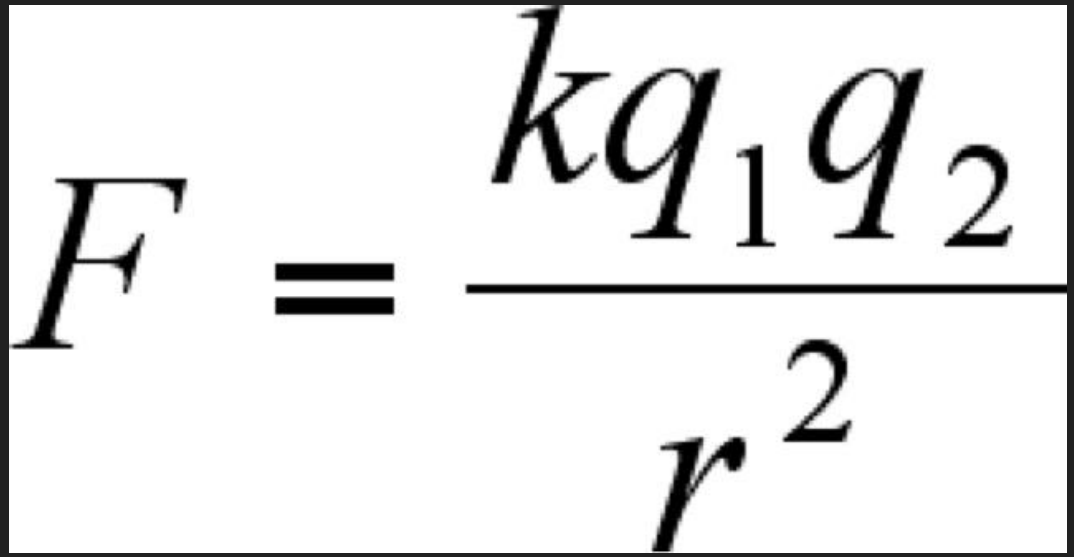
MUST USE COULOMB'S LAW aka Inverse Square Law

COULOMB'S LAW

k = 9.0x10^9

- If Fe is positive, the force is repulsive
- If Fe is negative, the force is attractive

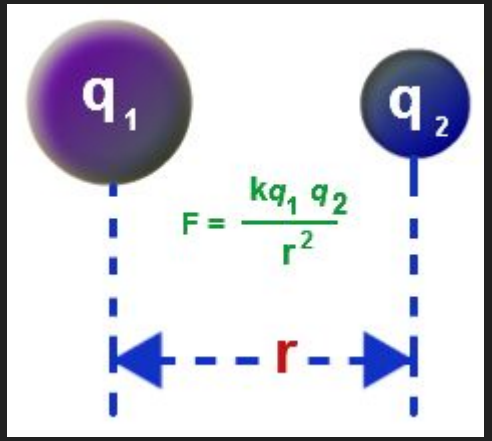
k = 1/4πε0



COULOMB’S LAW cont.

ε0 = 8.85×10^-12 C^2 /Nm^2

This is known as: Permittivity of Free Space



Electric Fields

Michael Faraday came up with the idea of Electric Fields

$E = F/q$

$E = kQ/r^2$

q is the charge feeling the field

Q is the charge creating the field

Measured in N/C

Electric Fields cont.

Electric field lines are drawn to indicate the direction of the force due to the given field on a positive test charge.

REMEMBER: ALWAYS FLOWS FROM POSITIVE TO NEGATIVE

The density of the field lines is proportional to the magnitude of the electric field. The more dense, the more field lines.

Electric Potential Energy

These are the two equations associated with Electric Potential Energy:

$PE_g = -GMm/r$

$PE_e = kQq/r$

Electric Potential

$\Delta V = \Delta PEe/q$

$V = kQ/r$

Measured in Volts

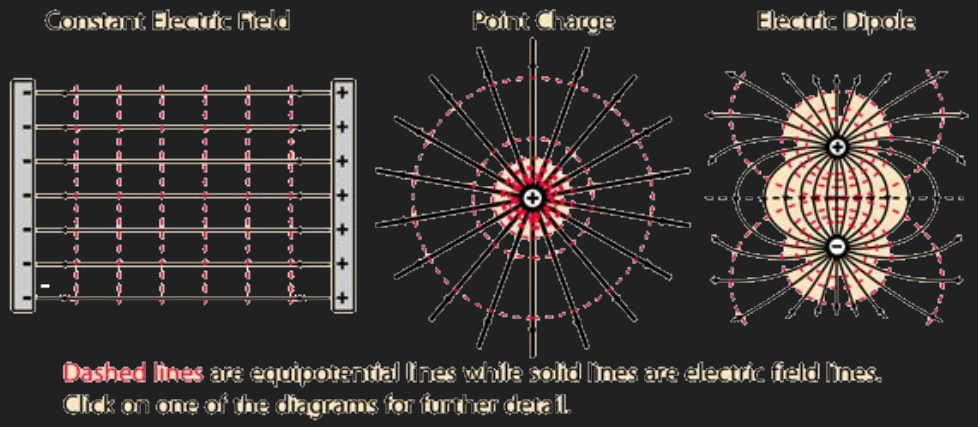
Also known as: potential difference or voltage

Equipotential Lines

Electric potential can be represented diagrammatically by drawing

These are lines or surfaces along which the voltage is the same

An equipotential surface must be perpendicular to the electric field at any point



Capacitance

Device that can store electric charge

$Q = CV$

C = Capacitance

Measured in Farads (f)

$C = \varepsilon_0 A/d$

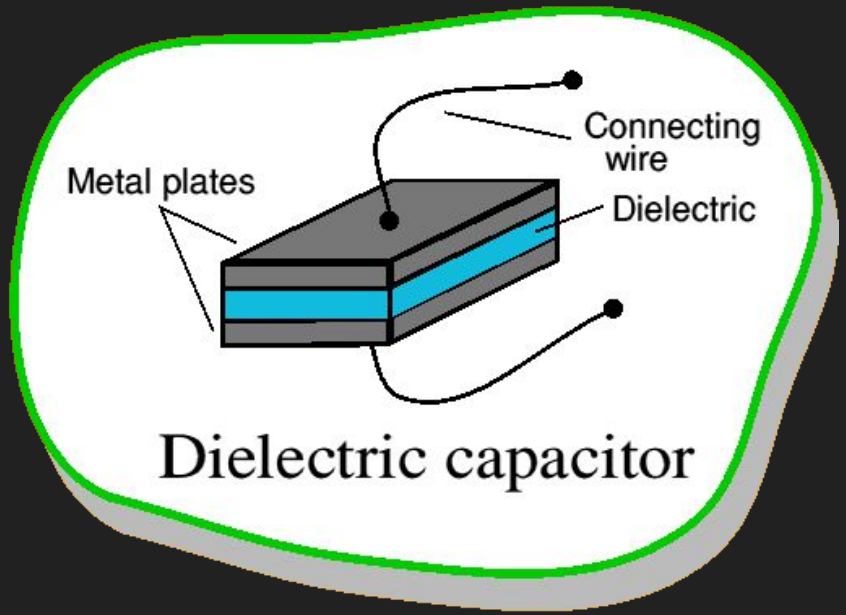
($\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/Nm^2$)

Dielectrics

Dielectrics: insulating sheet sandwiched between the two conducting capacitor plates

Increases capacitance factor by K

$C = K\varepsilon_0 A/d$



Storing Electrical Energy

$U_C = \frac{1}{2}QV$

$= \frac{1}{2}CV^2$

$= \frac{1}{2}Q^2/C$

Energy stored = work done charging

6 Common Mistakes

1. People confuse Electric Potential Energy with electric potential
2. People mix up which way the flow of electricity goes
3. People mix up the charges between protons and electrons
4. LABELING/UNITS
5. People think that energy depends on mass even though it only depends on charge and voltage
6. Speed depends on mass, not charge and voltage

Multiple Choice Question #1

Find Q if there are 15 protons and 12 electrons.

A. 4.8x10^-19
B. 5.8x10^-19
C. 6.3x10^-19
D. 4.8x10^-13

Multiple Choice Question #2

Which of the following is NOT a conductor?

A. Silver
B. Gold
C. Copper
D. Wood

Multiple Choice Question #3

_____ is separation of charge within an object because of the close approach of another charged object but without touching.

A. Induction
B. Conduction
C. Friction
D. All of the Above

Multiple Choice Question #4

What is the force of the object if it has an electric field that is worth 10 N/C and a charge of 1.6x10^-19?

A. 1.6x10^20 N
B. 1.6x10^18 N
C. 1.6x10^17 N
D. 1.6x10^21 N

Multiple Choice Question #5

Find the capacitance of the object which has a voltage of 15 V. What is the capacitance?

A. 1.3x10^10
B. 5.6x10^12
C. 4.5x10^10
D. 2.1X10^10