Electrostatics

Electrostatics

Electrostatics **is the study of electrical charges that can be held in one place.**

Electrostatics (Microscopic View)

Atoms are composed of *negatively charged electrons* surrounding a *positively charged nucleus*. The nucleus contains *protons* and *neutrons*.

The positive charge of the nucleus is exactly balanced by the negative charge of the electrons. Therefore, the atom is overall charge *neutral*.

Electrostatics (Microscopic View)

Electrons **can be *removed* from the atom resulting in a *positively charged ion*.**

Electrons **can be *added* to the atom resulting in a *negatively charged ion*.**

Conductors and Insulators

Materials such as metals that allow charges to move about easily are called electrical *conductors*.

Materials through which charges will not move easily are called electrical *insulators*.

Fundamental unit of charge is the *Coulomb* (C)

- ***electron charge*** **is -1.60×10^{-19} C**
- ***proton charge*** **is $+1.60 \times 10^{-19}$ C**

The Electrostatic Force

Force between stationary electric charges

Force can be attractive or repulsive

- **Like charges repel (+,+) or (-,-)**
- **Unlike charges attract (+,-) or (-,+)**

Coulomb's Law

$$F = k\left|\frac{q_1 q_2}{r^2}\right|$$

where:

F **- Electrostatic Force between** q_1 **and** q_2 **(N)**

k **- Coulomb's Law Constant (9.0 x 10^9 N·m^2 / C^2)**

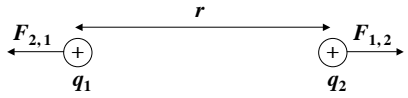
r **- Distance between** q_1 **and** q_2 **(m)**

q **- Electrostatic charge (C)**

Coulomb's Law

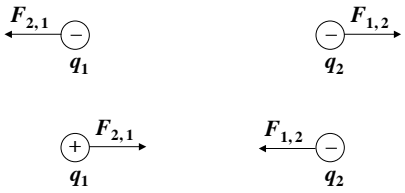
$$F = k\left|\frac{q_1 q_2}{r^2}\right|$$

Both charges experience the same force.



$F_{i,j}$ **is the force that charge** i **exerts on charge** j**.**

Coulomb's Law

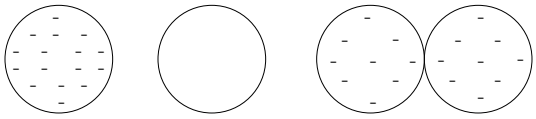


The forces are vectors and

$$\vec{F}_{i,j} = -\vec{F}_{j,i}$$

Charging by Conduction

If a negatively-charged conductor is brought into contact with a neutral conductor, electrons are transferred to the neutral conductor and it becomes ***charged by conduction*****.**

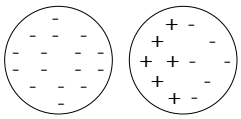


Charged Conductor Neutral Conductor Charging by Conduction

The total charge is conserved.

Induction

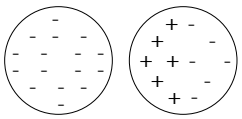
If a negatively-charged object brought near a neutral conductor the mobile electrons in the conductor will be repelled, leaving behind positively charged nuclei.



Charged Object Conducting Sphere

Charging Conductors by Induction

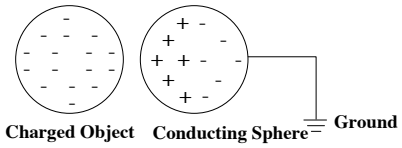
Charge separation can be used to charge an object without touching it.



Charged Object Conducting Sphere

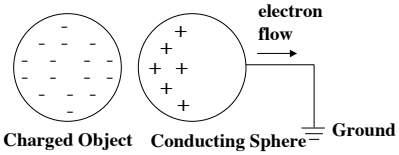
Charging Conductors by Induction

Grounding the sphere provides a source or sink for electrons.



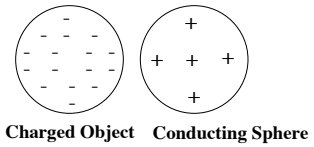
Charging Conductors by Induction

Grounding the sphere allows electrons to leave the conducting sphere leaving behind a net positive charge.



Charging Conductors by Induction

Removing the ground wire while the charged object is still in place, results excess positive charge on the conducting sphere.



This process is called *charging by induction*.