

I. STATIC ELECTRICITY

A. Lesson 1: Basic Terminology and Concepts

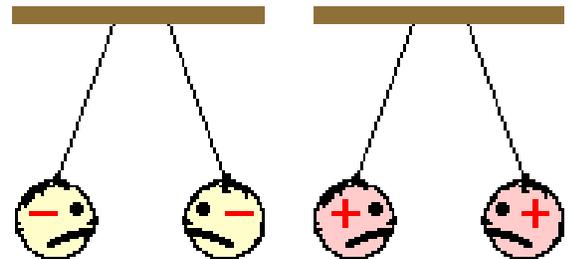
1. The Structure of **Matter**
 - a. Atomic Structure
 - i. **Nucleus**
 1. **protons (+)**, massive, tightly bound
 2. **neutrons (nc)**, massive, tightly bound
 - ii. **Electrons (-)**, outside of nucleus, not massive, weakly bound
 - b. Neutral vs. Charged Objects
 - a. **Charged objects**: unequal protons and electrons
 - i. **(+) charge**: more protons than electrons
 - ii. **(-) charge**: more electrons than protons
 - iii. **neutral charge**: = protons and electrons
 - iv. **Ion**: a charged atom
 - b. Charge as a Quantity
 - i. **Coulomb (C)**: unit describing the charge possessed by an object
 1. single electron = -1.6×10^{-19} Coulomb
 2. single proton = $+1.6 \times 10^{-19}$ Coulomb
 3. Charge Interactions
 - a. **Electric force**: non-contact force exerted by charged objects
 - i. **Oppositely charged objects attract**
 - ii. **Objects with like charges repel**

In the world of static electricity ...



oppositely-charged objects attract

AND



objects with like charges repel

- b. The Electric Force and Newton's Third Law
 - i. When two charged objects interact, they exert a force on one another
 1. The two attractive or repulsive forces have equal magnitudes and are exerted in opposite directions of each other.
- c. Interaction Between Charged and Neutral Objects
 - i. Any **charged object, whether (+) or (-)**, will have an attractive interaction with a neutral object.
4. Conductors and Insulators
 - a. **Conductors**: materials which permit e⁻ to flow freely from atom to atom and molecule to molecule.
 - b. **Insulators**: materials which impede the free flow of e⁻ from atom to atom and molecule to molecule.

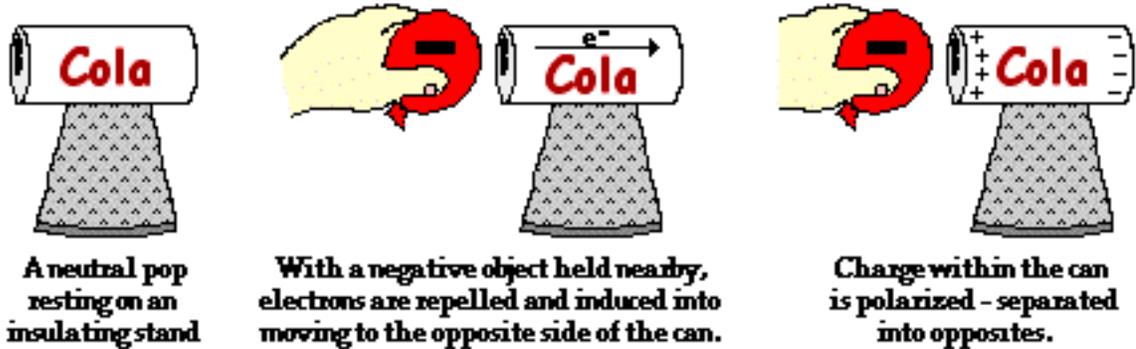
Increasing Conducting Ability



- c. Distribution of Charge via Electron Movement

- i. For charged objects, there is a mass migration of excess electrons throughout the entire surface of the object.
 - ii. Excess electrons migrate to distance themselves from their repulsive neighbors.
5. Polarization
- a. **Polarized**: when positive and negative charge has been separated from each other in a neutral object.
 - b. **Polarization**: the process of separating opposite charges within an object.

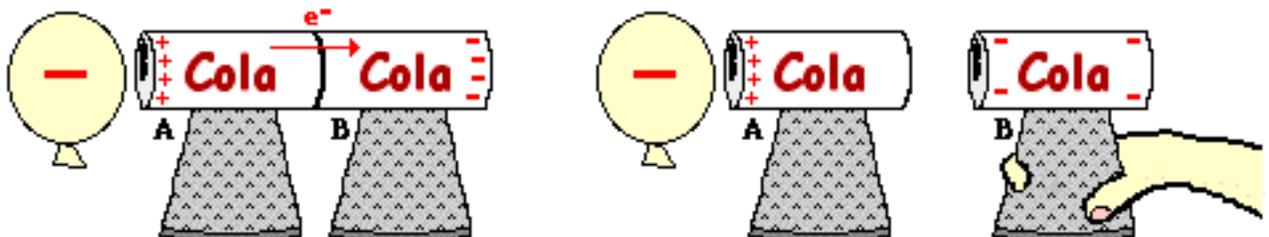
Inducing Electron Movement Within a Conductor



- c. Polarization is Not Charging
 - i. There is simply a redistribution of the centers of positive and negative charges within the object.
 - 1. It is a separation of charge, NOT an imbalance of charge.

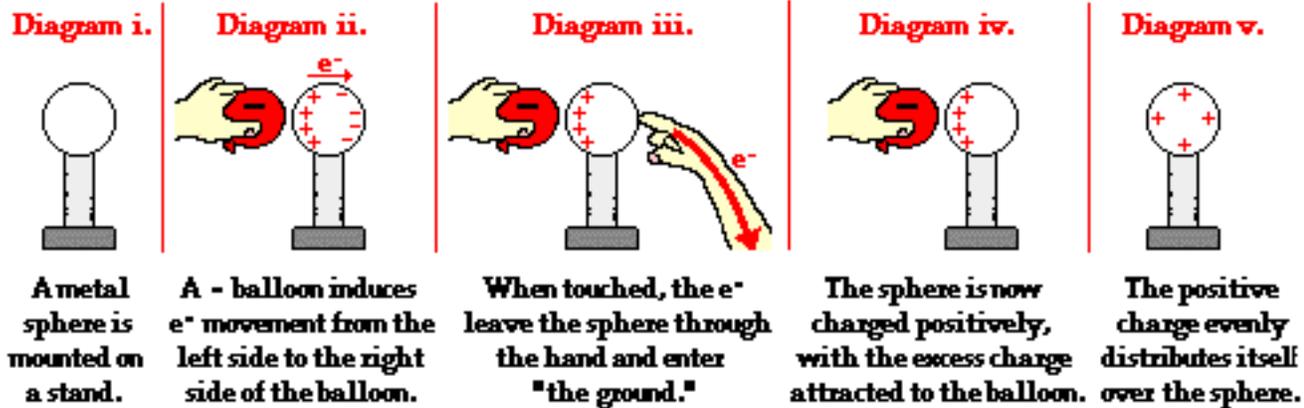
B. Lesson 2: Methods of Charging

1. **Charging by Friction**:
 - a. A transfer of electrons between two objects that are rubbed together.
 - i. **Electron affinity**: the relative amount of affinity (or "love") which a material has for electrons.
 - ii. **Triboelectric series**: an ordering of substances according to their affinity for electrons.
 - 1. HIGH ← celluloid, sulfur, rubber, copper, wood, cotton skin, silk, wool, glass, fur, asbestos → LOW
 - b. **The Law of Conservation of Charge**
 - i. In the charging process, the total amount of charge in the system is the same before the process starts as it is after the process ends.
2. **Charging by Induction**:
 - a. A method used to charge an object without touching the object to any other charged object.
 - b. e.g.) two aluminum cans, balloon



The negatively charged balloon induces movement of electrons within the two pop cans. With electrons moving from Can A to Can B, the two-can system becomes polarized. Once the two cans are separated using the insulating handle, Can A has a + charge and Can B has a - charge.

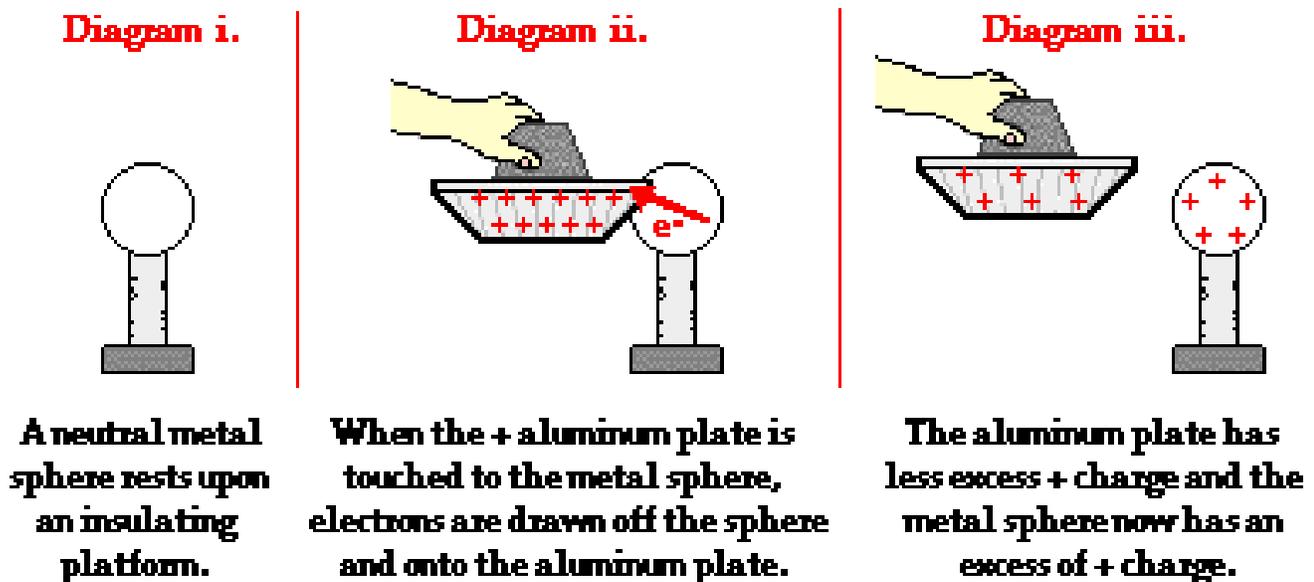
Charging a Single Sphere by Induction



3. Charging by Conduction

- involves touching the charged object to the neutral object.
- only a conductor can conduct charge to another conductor.

Charging a Neutral Object by Conduction



4. Grounding - the Removal of a Charge

is the process of removing the excess charge on an object by means of the transfer of electrons between it and another object.

- Ground:** an object which is capable of transferring e^- to or receiving e^- from a charged object in order to neutralize that object.

C. Lesson 3: Electric Force

1. Coulomb's Law

- the electrical force between two charged objects =

$$F_{\text{elect}} = k \cdot \frac{Q_1 \cdot Q_2}{d^2}$$

d^2

k = constant (given)
Q₁ = charge of object 1
Q₂ = charge of object 2
d = distance btw. obj 1
and obj 2

2. Lightning

Moisture evaporates upward into a cloud and ice crystals move downward within the cloud
rubbing occurs between water droplets and ice crystals

Polarization occurs within the cloud

Electrons migrate to bottom of cloud

Positive charges build up at top of cloud

The (-) cloud bottom repels e- on objects and the surface of the Earth.

The cloud discharges as lightning to the ground