Lecture 2, 3

Ch.2 Coulomb`s Law and Electric Fields

(Ch.23 in Serway)

Ch.2 Coulomb`s law and Electric Field

Chapter Sections:

1) Properties of Electric Charges
2) Classification of Materials Electrically, Charging Methods and Charging Applications
3) Coulomb's Law
4) Particle in Electric Field
5) Electric filed of continuous charge distribution [Canceled]
6) Electric field Lines
7) Motion of charged particles in uniform Electric field.

1) Properties of Electric Charges

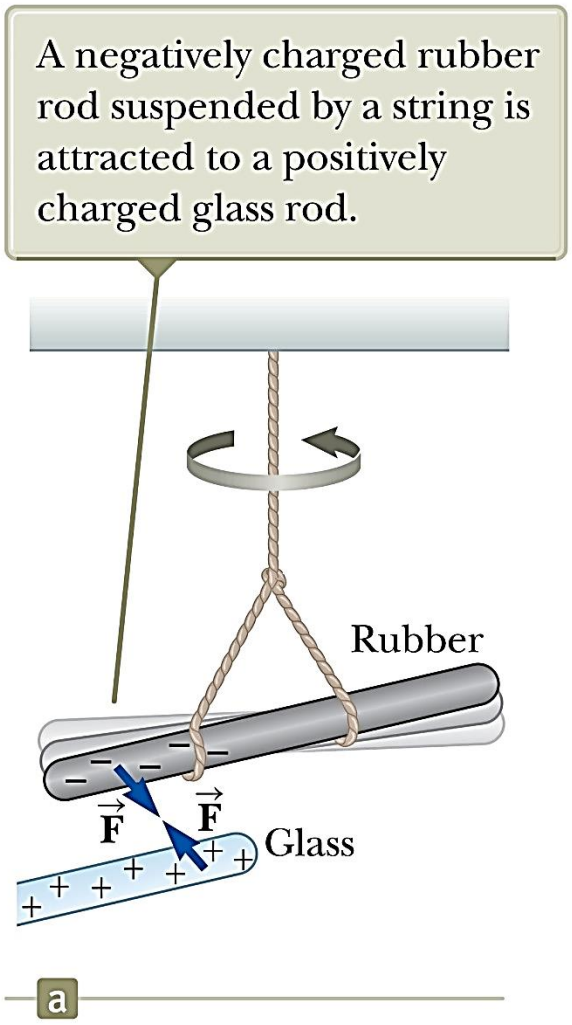
There are four properties of charges

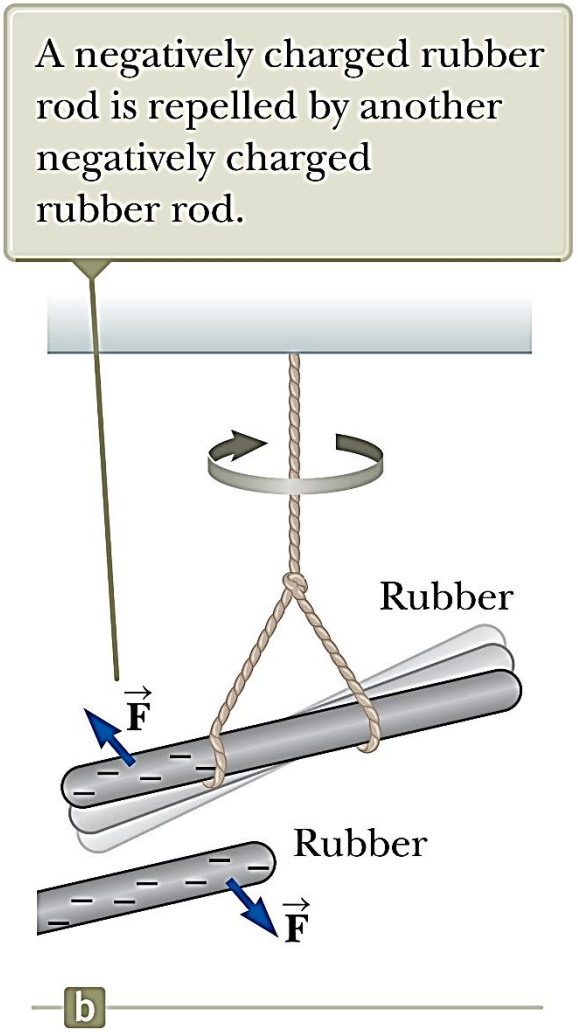
Kinds

- There are two kinds of electric charges: positive and negative
  - Negative charges are the type possessed by electrons.
  - Positive charges are the type possessed by protons.

Forces

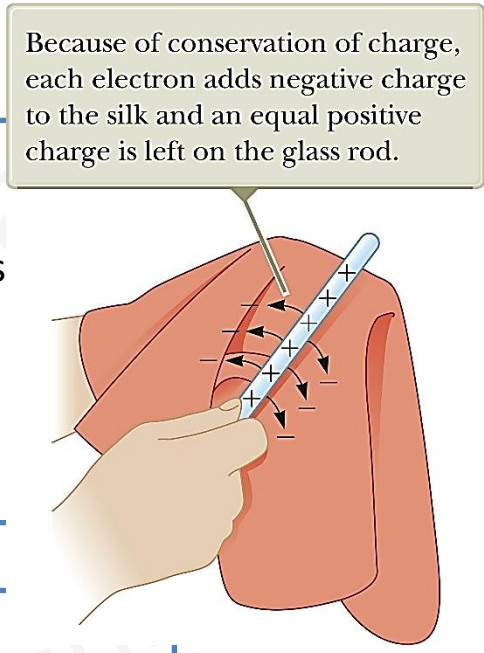
- Charges of the same sign repel one another and charges with opposite signs attract one another.


A negatively charged rubber rod suspended by a string is attracted to a positively charged glass rod.
Rubber
F
F
Glass
a


A negatively charged rubber rod is repelled by another negatively charged rubber rod.
Rubber
F
Rubber
F
b

Conserved

- Electric charge is always conserved in an isolated system.
  - For example, charge is not created in the process of rubbing two objects together.
  - The electrification is due to a transfer of charge from one object to another.



Quantized

- The electric charge, q, is said to be quantized.
  - q is the standard symbol used for charge as a variable.
  - Electric charge exists as discrete packets.
  - $q = \pm Ne$
    - N is an integer
    - e is the fundamental unit of charge
    - $|e| = 1.6 \times 10^{-19}$ C
    - Electron: $q = -e$
    - Proton: $q = +e$

Balloons Example:

2) Classification of Materials Electrically, Charging Methods and Charging Applications

a) There are 3 types of materials that are classified according to the ability of electrons to move.

Conductors

- In which some of the electrons are **free**.
- Free electrons **are not bound** to the atoms and can move freely through the material.
- Examples of good conductors include copper, aluminum and silver.
- When a good conductor is charged in a small region, the charge readily distributes itself over the entire surface of the material.

Insulators

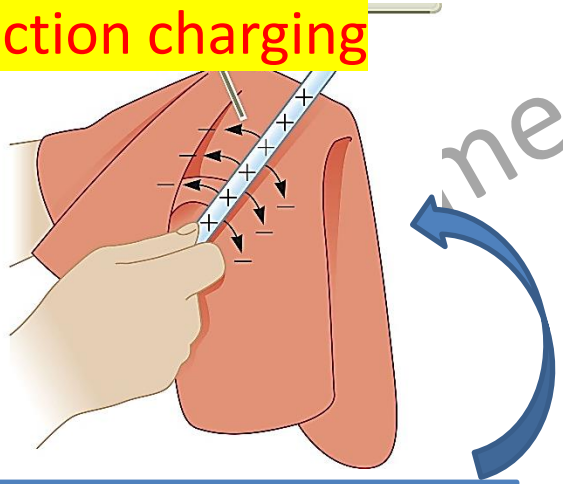
- In which all electrons are **bound** to atoms.
- These **electrons can not move relatively freely** through the material.
- Examples of good insulators include glass, rubber and wood.
- When a good insulator is charged in a small region, the charge is unable to move to other regions of the material.

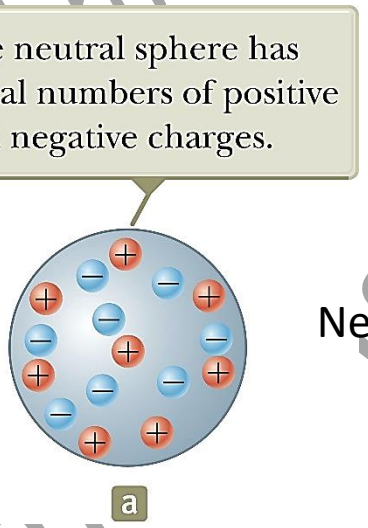
Semiconductors

- In which the electrical properties **are somewhere between those of insulators and conductors.**
- Examples of semiconductor materials include silicon and germanium.
- Semiconductors made from these materials are commonly used in making electronic chips.

b) Charging Methods (Electrification)

John Travoltage: friction charging





Neutral Metallic Sphere

Friction

- The electrification is due to a transfer of charge from one object to another.
- Two objects ends with the different sign.

Induction

- Two objects do not touch
- Two objects ends with the different sign.

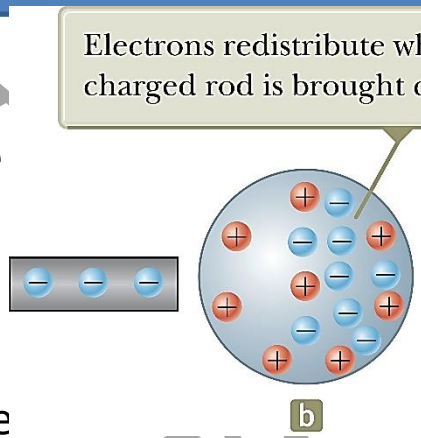
Conduction

- Two objects must touch
- Two objects ends with the same sign.

Charging by Induction

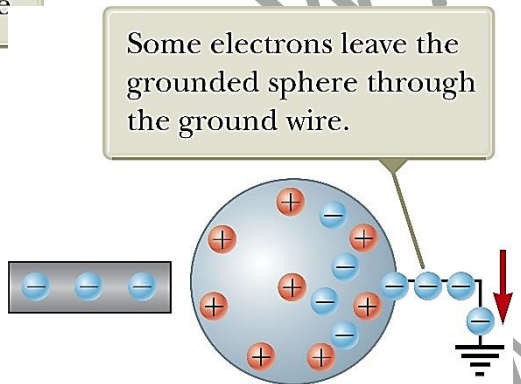
A charged rubber rod is placed near the sphere.

- The electrons are redistributed.



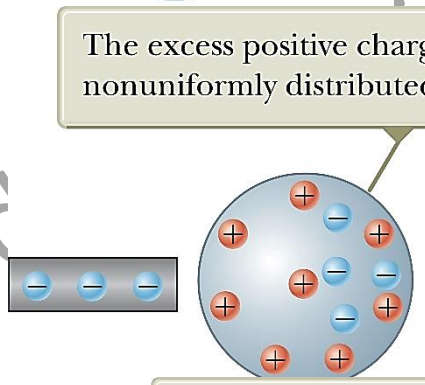
The sphere is grounded.

- Some e through the ground wire.



The ground wire is removed.

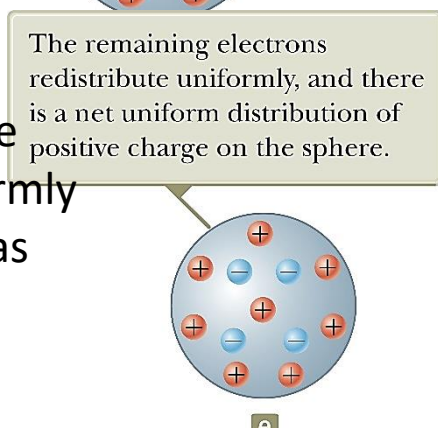
There will now be more +e charges that are not uniformly distributed.



Note : The rod after removal still –ve and sphere becomes +ve

The rod is removed.

The -e redistribute themselves uniformly and the sphere has net +ve charge

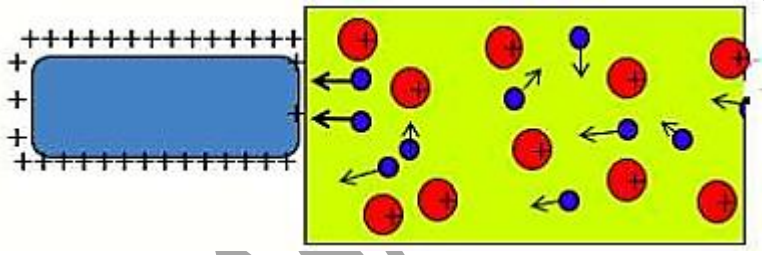


Charging by Induction:

Charging by conduction

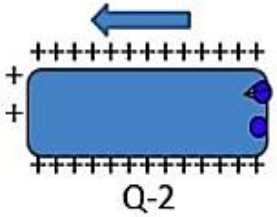
The rod is conducted

- 2electrons are transferred from slab to the rod; for example.

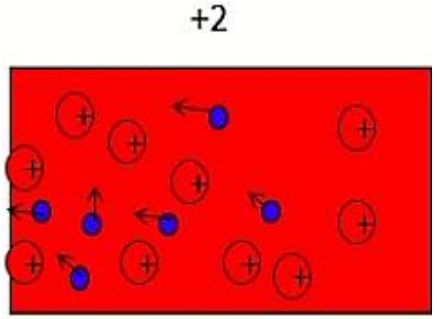


The rod is removed

- The remaining e`s redistribute themselves uniformly and the slab has net +ve charge



Q-2

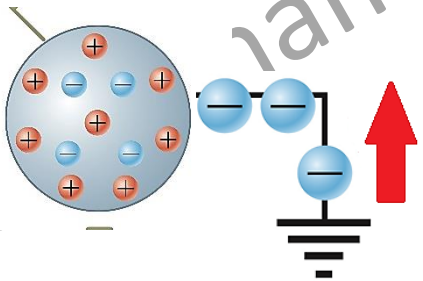


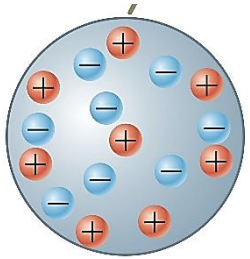
Note : The rod after removal still +ve and Slab become +ve

Charging by conduction:

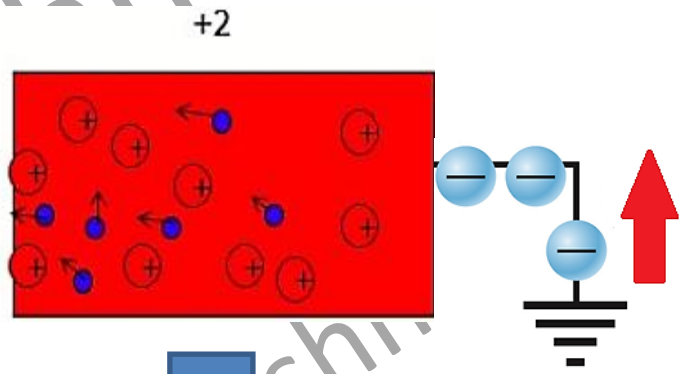
Full video of Charging by conduction and Induction

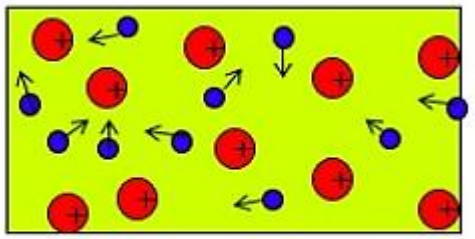
Note that: After the Charging (either in conduction or Induction) the effect of Ground at the Charged +ve charged objects is giving the objects the required electrons –ve charges to be neutral Again.





Neutral Metallic Sphere

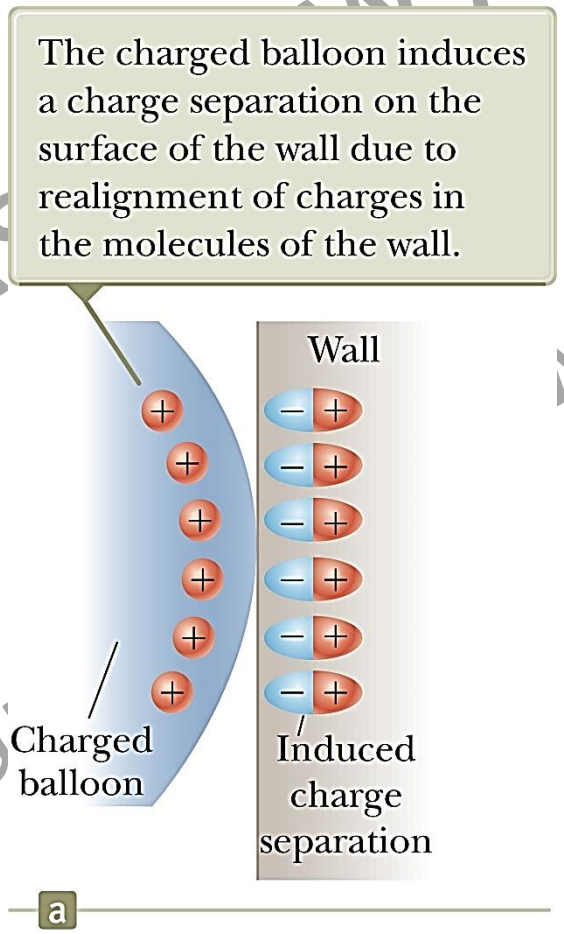




Neutral metal zero charge

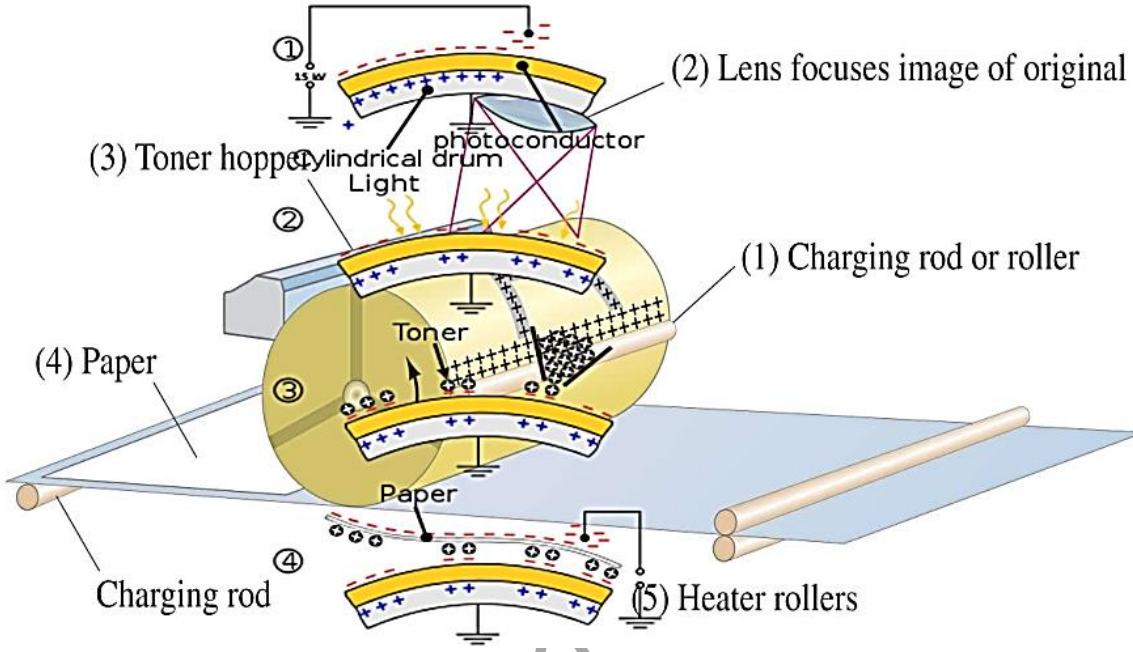
Note: Charge Rearrangement in Insulators

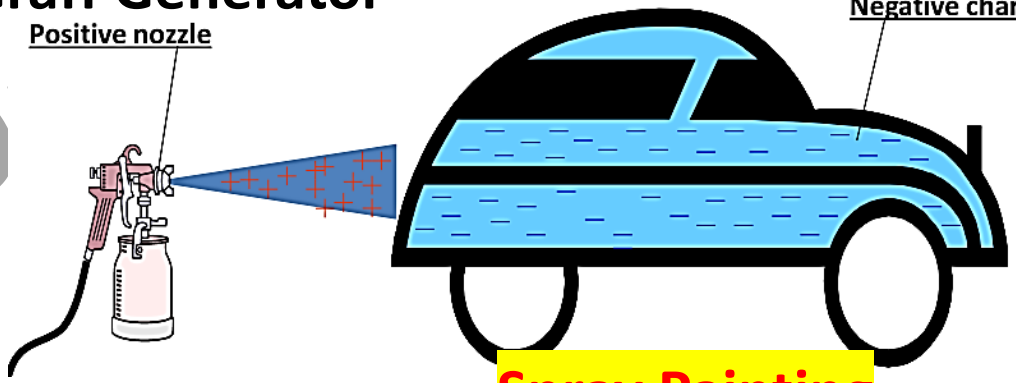
- A process similar to induction can take place in insulators.
- The charges within the molecules of the material are rearranged.
- The proximity of the positive charges on the surface of the object and the negative charges on the surface of the insulator results in an attractive force between the object and the insulator.



C) Charging (Electrification) Applications

Particle Accelerator
"Van de Graff Generator"





Spray Painting

1) Photocopier and 2) Laser Printers for Cannon (1) and Lexmark (2)

Original Videos from YouTube	Links
Spray Painting	https://www.youtube.com/watch?v=lX0bFJc50g0&list=LL&index=5
Photocopier	https://www.youtube.com/watch?v=JtA7B_zSrjE
Canon Laser Printers	https://www.youtube.com/watch?v=HZiuQn8g79A
Lexmark Laser Printers	https://www.youtube.com/watch?v=PHxXmjxcAIo&t=180s