Notes

Physics Tool box

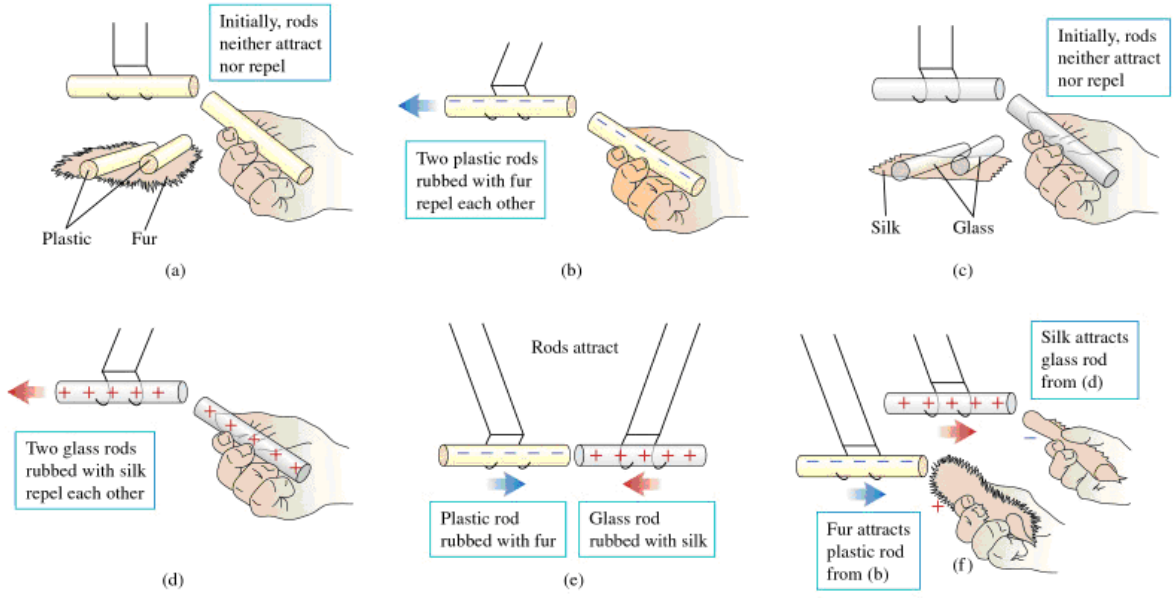
- **The Laws of Electric Charges** – Two positive charges or two negative charges repel each other. A positive charge and a negative charge attract each other.
- **Law of Conservation of Charge** – The total charge (the difference between the amounts of positive and negative charge) within an isolated system is conserved.
- **Types of materials**:
  - **Conductor**: easy movement of electric charges
  - **Insulator**: no easy movement of electric charges
  - **Semiconductors**: can allow easy or difficult transmission of charges.
- There are three ways of charging an object:
  - By friction
  - By contact
  - By induction

The ancient Greeks discovered (as early as 600 B.C.) that when they rubbed amber with wool, the amber would attract other objects. Today we would say that the amber has acquired a net electric charge (or has become charged).The word "electric" is derived from the Greek word elekton, meaning amber.

Plastic rods and fur (real or fake) are typically used to demonstrate electrostatics.

We now that there are exactly two types of charges negative and positive

The Laws of Electric Charges – Two positive charges or two negative charges repel each other. A positive charge and a negative charge attract each other



There are two very important principles when dealing with electrostatics"

- **The Principle of Conservation of Charge:** The algebraic sum of all electric charges in any closed system is constant.
- The magnitude of charge of the electron or proton is a natural unit of charge.

Some materials permit electric charge to move easily from one region of the material to another, while others do not. Depending on the success or failure of the transmission of electric charges, we define materials as either conductors or insulators.

Conductors allows easy movement of charge
Insulators do not allow easy movement of charge.

There is a type of materials that are intermediate in their properties between good conductors and good insulators. This type of material is called a **semiconductor**.

You can charge or transfer charges from one material to another by a variety of techniques.

Charging by friction

For example, an ebonite rod becomes negatively charges when rubbed with fur. An atom holds onto its electrons by the force of electrical attraction to its oppositely charges nucleus. When ebonite and fur are rubbed together, some electrons originally in the fur experience a stronger attraction from the atomic nucleus in the ebonite that from the fur. Consequently, after rubbing, the the ebonite has an excess of electrons, and the fur a deficit.

Charging by Contact

When a charged ebonite rod makes contact with a neutral object, some of the excess electrons on the ebonite rod (repelled by the proximity of their neighboring electrons) move over to the neutral object. Since both objects now have an excess charge (not all the electrons move from the rod to the object) , they are both negative.

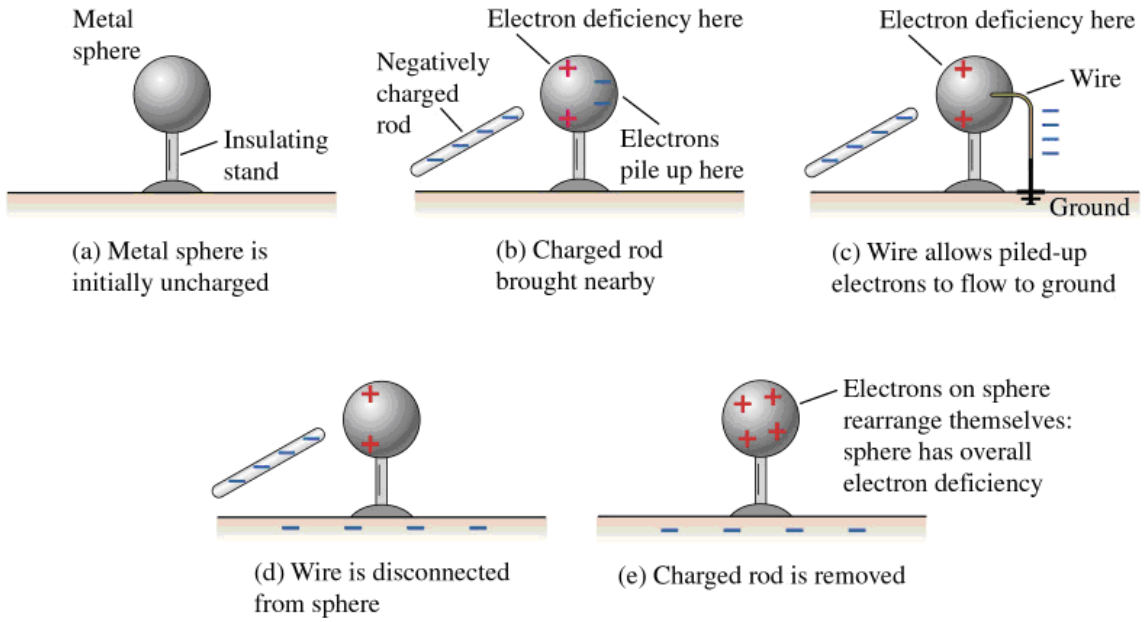
Charge by Induction

When a charged ebonite rod is brought near the knob of a neutral metal ball, the free electrons on the ball move as far away from the ebonite as possible. Now if you touch the ball with grounding wire (still keeping the ebonite rod in place), the electrons from the knob now have an escape route (wire). Thus when the wire is removed, the ball now has a deficit of electrons and is therefore positively charged.

Here the ball was given a positive charge (the opposite of the charge on the ebonite rod) while the ebonite kept its own charge.

Law of conservation of Charge

The total charge (the difference between the amounts of positive and negative charge) within an isolated system is conserved



Example

Three objects are brought close to each other, two at a time. When objects ***X*** and ***Y*** are brought together, they *repel*. When objects ***Y*** and ***Z*** are brought together, they ***attract***. From this, we conclude that (a) objects ***X*** and ***Z*** possess charges of the same sign. (b) objects ***X*** and ***Z*** possess charges of opposite sign. (c) all three of the objects possess charges of the same sign. (d) one of the objects is neutral. (e) we need to perform additional experiments to determine information about the charges on the objects.

Solution

Since X and Y repel, we know that they have the same charge: $X = Y = \pm$
Since Y and Z attract, we know that their charges are opposite: $X = \pm;\ Z = \mp$
Therefore X and Z have opposite charges.

This gives us the following scenarios

$$X = Y = positive \quad \text{or} \quad X = Y = negative$$
$$Z = negative \qquad\qquad Z = positive$$

Therefore our conclusions are: ***b***, ***e***

Extra Notes and Comments