Experiment 13: Electrostatics

Figure 13.1

EQUIPMENT

Ebonite Rod (Hard Rubber)
Glass Rod (or Lucite Rod)
Rabbit Fur
Plastic Film
Silk
Electroscope

Front Table

Hair Dryer
Rubbing Alcohol
Paper Towels

Advance Reading

Text: Law of conservation of electric charge, electrostatic charge, electron, proton, neutron, atomic model, free electrons, ions, polarization, conductor, insulator, conduction, induction.

Objective

The objective of this lab is to qualitatively study conducting and insulating materials, electric charges, and charge transfer.

Theory

There are two kinds of charges in nature: positive charge carried by protons and negative charge carried by electrons. An object that has an excess of either is said to be charged. Like charges repel each other, and unlike charges attract.

Charge transfer is the exchange of charges between objects. In this experiment, only electrons are exchanged while protons remain stationary. These electrons may move around within materials or move between materials, but they can never be created or destroyed. This is known as the **law of conservation of charge**. The law of conservation of electric charge states that *the net amount of electric charge produced in any process is zero.*

A **conductor** is a material in which some loosely bound electrons can move freely (free electrons) while protons are tightly bound within the nucleus. An **insulator** is a material in which both electrons and protons are tightly bound. Conductors and insulators have the following properties:

Conductors

- Conductors are objects that allow the free flow of electrons throughout the object.
- Charges are easily transferred between conductors.
- Charge can collect at one end of an object in the presence of other charged objects.

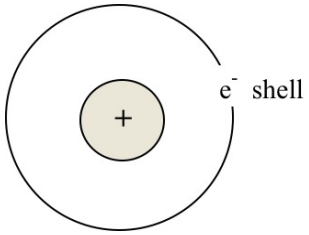
Insulators

- An insulator is a material in which electrons are tightly bound to the nucleus.
- Transferring charge between insulators requires a force, e.g. friction, and direct contact.
- Insulators brought near other charged objects experience **polarization**, a shifting of electrons to one side of an atom. (Fig. 13.2)

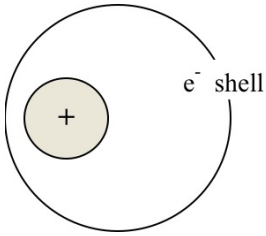
In this experiment, a glass rod or an ebonite rod (insulators) will be electrically charged by rubbing against another insulating material. Whether the rod gains or loses electrons will depend on the combination of materials used (refer to the **electrostatic series** provided in Table 13.1 on Page 11. The charged rod will be used to charge an **electroscope** (a conductor that indicates whether it is charged) by means of **conduction** and by means of **induction**.

To charge by conduction: Bring a charged rod close to, then touch, the electroscope. As the rod nears the electroscope, the free electrons in the electroscope are either attracted to or repelled by the charged rod (*induction*). When you touch the rod to the electroscope, the electroscope becomes charged as electrons transfer to (or from) the electroscope (*charge transfer*).

To charge by induction: Bring a charged rod close to, but do not touch, the electroscope. While holding the rod near the electroscope (*induction*), touch the opposite side of the electroscope with the tip of your finger (*charge transfer*). Your body will act as a reservoir of charge (ground), either giving or receiving electrons to the electroscope. Remove your finger *before* moving the rod from the proximity of the electroscope.



Atom charge distribution, normal



Atom charge distribution, polarized

Figure 13.2: Polarization

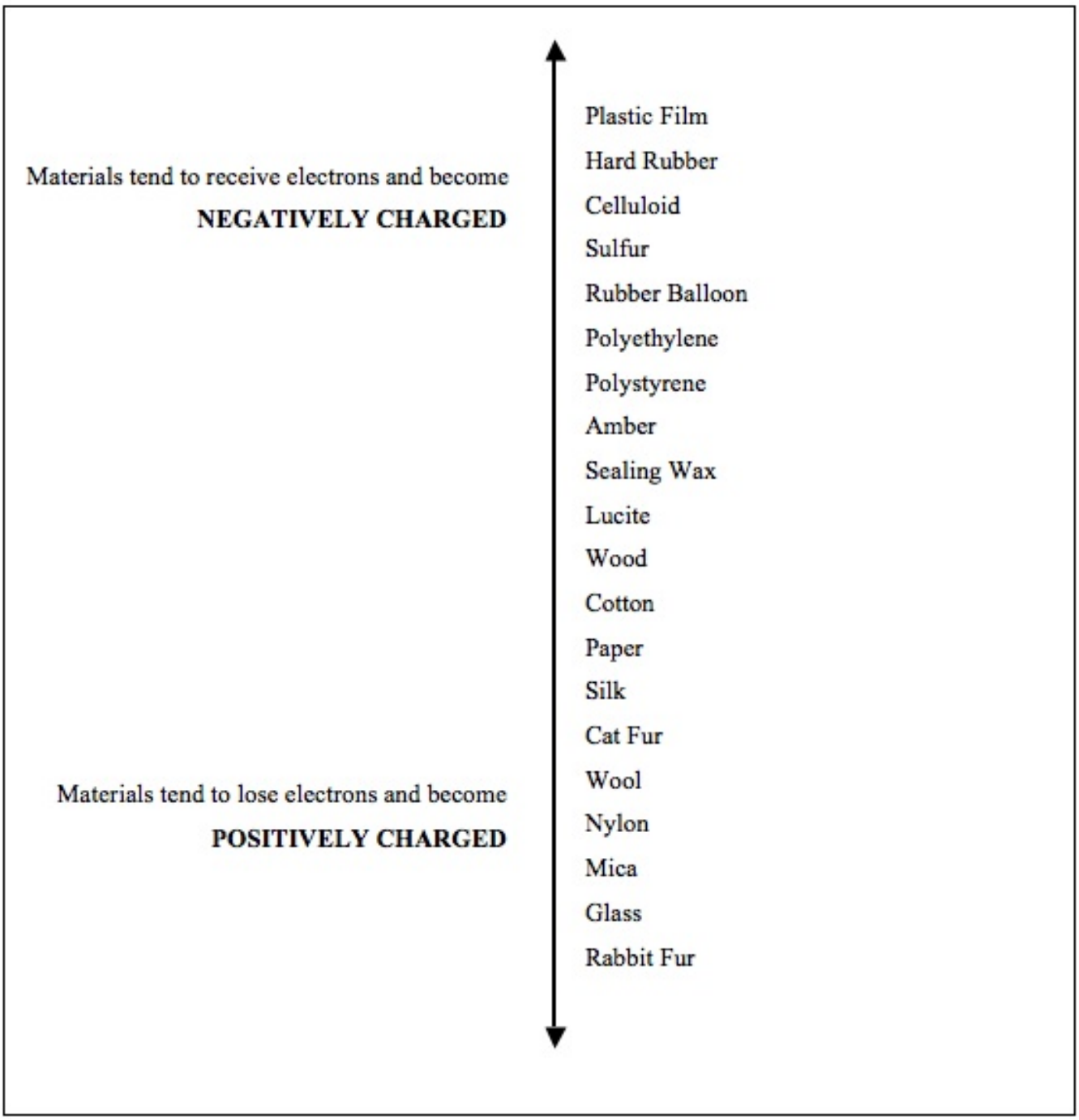


Table 13.1: Electrostatic Series