

Experiment 16

Electrostatics

Advanced Reading:

(Halliday, Resnick & Walker)
Chapter 21 sections 1-3, 4-5

Equipment:

- 1 ebonite rod
- 1 lucite rod
- 1 piece of fur
- 1 piece of silk
- 1 electroscope
- rubbing alcohol
- conducting pith ball on stand
- 1 hair dryer



figure 16-1

Objective:

The object of this lab is to study fundamental properties of electric charges in a qualitative manner.

Theory:

There are two kinds of charges in nature, positive and negative. Positive charge is carried by protons and negative charges are carried by electrons. When we say an object has a charge on it, we mean that it has a slight excess of either positive or negative charge. For instance, in this lab the ebonite rod will be given a negative charge by rubbing it with the fur. We have not "created" more electrons on the ebonite rod, but rather, have moved some electrons from the fur onto the rod. In so doing, the fur has excess protons and is positively charged. This basic fact is commonly referred to as conservation of charge, and is a fundamental concept of electromagnetic theory.

During this experiment, an electroscope will be charged by two methods, *conduction* and *induction*.

To charge the electroscope by conduction negatively, the end of a charged ebonite rod is touched to the ball on top of the electroscope and electrons flow from the rod to the ball and the foil leaves, leaving a net negative charge. Because the leaves have like charges on them, they repel from each other.

To charge the electroscope positively by conduction, the lucite or glass rod is rubbed with silk and touched to the ball on the electroscope. This time electrons flow out of the electroscope onto the rod leaving a net positive charge on the electroscope foil leaves.

To charge the electroscope negatively by induction, a positively charged rod (lucite rubbed with silk) is brought near one side of the ball on top of the electroscope. At the same time, touch the ball on the opposite side from the charged rod. The positively charged rod causes a slight polarization on the ball, with

electrons being attracted to the rod, leaving more positive charges than negative on the side of the ball opposite the rod. When you touch the ball, electrons flow from your finger to the ball, giving the electroscope a net negative charge. When the charged rod is removed from near the ball, the leaves repel.

Procedure:

Note: This lab does not work well in humid conditions. Moisture allows conduction of charge preventing static charges from building up. One way to combat this problem is to clean and dry the rods, silk, and fur. Before attempting this experiment, clean the rods with alcohol, which removes moisture, and dry the silk and the fur with the hair dryer. You will probably need to repeat this process again as moisture from your hands gets on the rods, silk, and fur.

Part 1.

1. Rub the ebonite rod with the fur to charge it. Bring the rod near dry scraps of paper. Note the behavior of the paper scraps. Repeat for damp scraps of paper. (Dry scraps are insulators, wet scraps are conductors. Use this information to analyze what you observed.)

2. Bring the charged ebonite rod near the conducting pith ball, trying not to touch it. Note its behavior. Explain why it behaves as it does. (It should be attracted to the rod.)

3. Bring the charged ebonite rod near the pith ball, this time letting the pith ball touch the charged rod. Note and explain the behavior. (It should be attracted to the rod at first and then repelled after the rod and pith balls make contact.)

Part 2 Charging Electroscope by Conduction

4. Charge the electroscope *negatively* by *conduction*. Draw a series of pictures indicating the movement of charges during this process. Explain the steps in the drawings.

5. Charge the electroscope *positively* by *conduction*. Repeat drawings and explanations.

Part 3: Charging the electroscope by induction

6. Charge the electroscope *negatively* by *induction*. Repeat drawings and explanations.

7. Charge the electroscope *positively* by *induction*. Repeat steps above.

Part 4.

8. Charge the electroscope positively. Hold a lighted match near the bulb on the electroscope. Note and explain the behavior of the electroscope. (The flame of the match is a plasma, consisting of a mixture of positive and negative charges. Plasmas are conductors.)

Questions/Conclusions:

1. Explain the difference between an insulator and a conductor.
2. Explain why the pith ball would be attracted and then repel after it touches the charged rod. (hint: the pith ball is a conductor)
3. Why do charged balloons hang on the wall if the wall is neutral?
4. Explain what is meant by "conservation of charge".