Electrostatics

Objectives: Develop an intuitive feeling for the movement of charge.

To Do Before Lab: Read this lab, develop a playful mood.

Apparatus: Electroscope with attachable ball and plate, PVC rods and cloth, metal spheres

Note on your write-up

For this lab, you do not need to use the separate sections from Anatomy of a Lab Write-up. An abstract is not required this week. We recommend handwriting your lab write-up as you go, with numbered sections corresponding to the numbered parts in the instructions. You should include the following elements:

- Title of lab, names of lab group members, date of lab.
- A labeled schematic diagram of the electroscope.
- A brief description on how the electroscope works.

For each numbered part, 1 to 7, include descriptions of:

- What you did.
- What you observed. Feel free to use diagrams and brief notes.
- An explanation of why you observed what you did.
- If you feel so moved, or if you find that you have more than ten lines of text for a part, write a summary sentence or table for that part.

Introduction

In this lab, you will qualitatively investigate some basic properties of electric charges using an electroscope. Before getting started, the following information will be useful: When a polyvinylchloride (PVC) rod is rubbed with a wool cloth, the rod and the wool become oppositely charged. Two hundred years ago, Benjamin Franklin decided to call the wool positive and the PVC negative. Of course, PVC did not exist in Franklin's time, but the same result occurs with wool and the natural substance, amber. Franklin mistakenly, but reasonably, thought that the wool gained "electrical fluid" and the rod lost electrical fluid, thus the terms positive and negative. Oops! We now know that rubbing the rod with the wool causes some electrons in the wool to move to the rod. Thus, the wool has fewer electrons than protons and a net positive charge, and the PVC rod has more electrons than protons and a net negative charge.

Procedure

This experiment consists of a series of short tasks, but your real job is to play around until you get comfortable thinking about moving charges. For each task, mess around until you understand what happened, and then briefly explain what happened, remembering that a diagram is worth 1000 words. You will save time by thinking carefully about what a diagram is meant to show and to state your results succinctly. Consider electron flow in your explanations.

1. Effect of negative rod

a. Briefly ground the electroscope by touching the knob and the case of the electroscope with your finger. This is a simple way of making sure the electroscope is uncharged.
b. Slowly bring a negatively charged rod to within a few cm of the knob of the electroscope, and then remove the rod.

2. Determining sign of charge
   a. Ground the electroscope. Touch the knob of the electroscope with a negatively charged rod and drag a few inches of the rod across the knob of the electroscope. Remove the rod.
   b. Bring the negatively charged rod back to within a few cm of the knob of the electroscope.
   c. Charge an acrylic rod by rubbing it with a piece of vinyl. Bring this rod to within a few cm of the knob of the charged electroscope.
   d. Determine the charge on the following rods:
      i) PVC rod rubbed with your hair.
      ii) PVC rod rubbed with vinyl.
      iii) Glass rubbed with vinyl.
      iv) Acrylic rubbed with wool.

3. Positive rod
   a. Ground the electroscope.
   b. Bring a positively charged rod to within a few cm of the knob of the electroscope and remove the rod. Compare the behavior of the electroscope to its behavior in part 1 when a negatively charged rod was used.

4. Shielding
   a. Give the electroscope a positive charge.
   b. Cover the electroscope with the metal screen, being careful not to discharge the electroscope. Bring the negatively charged rod as close to the knob as possible, without touching the screen.

5. Metal spheres
   a. Place two metal spheres mounted on insulating posts next to each other so that they are touching.
   b. Bring a negatively charged rod to within about 1 cm of one of the spheres on the side opposite from the second sphere. With the negatively charged rod still in place, separate the spheres, being careful not to touch either sphere directly.
   c. Use the electroscope to determine the charge on each sphere.

6. Induced charge
   a. Ground the electroscope. Bring a negatively charged rod to within about 1 cm of the knob and hold it steady. Touch the knob of the electroscope, keeping the negatively charged rod in place. Remove your finger from the knob keeping the

rod in place. Remove the negatively charged rod. Determine the sign of the charge on the electroscope. Consider what happens at each step of this procedure.

7. Capacitor
    a. Replace the knob of the electroscope with the circular metal plate and give the electroscope as much negative charge as possible.
    b. Place the glass plate on top of the circular metal plate.
    c. Place the circular metal plate with the insulating handle on top of the glass plate.
    d. Briefly ground the top metal plate.
    e. Remove the top metal plate and use a second electroscope to determine its charge.
    f. Remove the glass plate.
    g. Determine the charge on the electroscope.

    Describe and explain what happens at each step of this procedure.

Imagine that you start with a positively charged electroscope. What happens when you bring your finger near to the electroscope? Justify your answer with an example from your lab book. Check your explanation with your instructor.