Experiment 13
ELECTROSTATICS

EQUIPMENT

Pith Ball Stand
Glass Rod
Rabbit Fur
Van de Graaff Generator
Plastic Film
One Metal Coated Pith Ball on Thread
Ebonite Rod
Teflon Disc

INTRODUCTION

The purpose of this lab is to investigate the nature of static electricity, how it is produced, and what its affects are.

Charges and Charge Carriers

Whenever two dissimilar materials are rubbed together static electricity is produced. Charge (usually electrons) is transferred from one of the materials to the other. This second material, then, has an excess of electrons and is said to be *negatively charged*. The first material, on the other hand, now has a deficiency of electrons and is said to be *positively charged*. The charge on each object is *static*, that is, it is stationary as long as there is no path by which it can discharge.

Most of the time these charges are too small to be noticed. Sometimes, however, the accumulation of an electrostatic charge is quite significant and its presence is readily detected. Have you ever been shocked upon touching a doorknob after walking across a carpeted floor? That shock was the result of the discharge of static electricity. A bolt of lightning is similarly such a discharge but on a much grander scale.

In this laboratory exercise you will be given a chance to study some of the characteristics and affects of static electricity. These can be very subtle, so care and patience must be taken to see good results.

PROCEDURE

A. The Van de Graaff Generator

The Van de Graaff generator is an electrostatic device capable of generating electric potential as high as 400,000 volts. The volt is defined as the electric potential energy per unit charge. While the voltage of the Van de Graaff is quite high, there is relatively little charge, reducing the danger from electric shock. In fact there is less danger than from an exposed 115-volt household outlet where there is an unlimited amount of charge. The Van de Graaff generator is useful for studying the affects of high potentials and the force fields associated with charges.

With the help of your instructor you will observe some of these effects, as well as map out the electric field of the Van de Graaff generator.

1. After your instructor has turned on the generator and adjusted it, some special effects will be demonstrated. Observe these carefully and record your observations in the appropriate place on your data sheet.

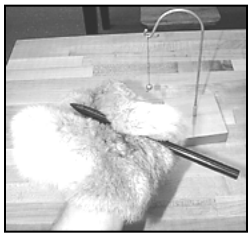
2. Holding the string of a single pith ball in one hand transfer charge from a charged ebonite rod to the ball. This will give the pith ball a negative charge. Now carefully bring the suspended pith ball near the generator. Observe the action of the ball and record.

3. Now hold the pith ball between your fingers, allowing the string to hang free. Bring the string near the generator, but do not allow it to touch the generator. The string will align itself along the field lines. Move the string around the area of the generator and record the direction of the string at different places by drawing lines on the Van de Graaff generator picture on your data sheet.

See data sheet to answer questions 1-3 now.

B. Pith Balls and Charged Rods

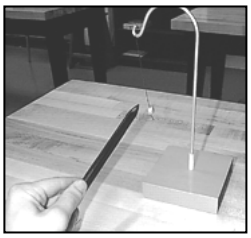
1. Position a single metal coated pith ball on the stand so that it is able to swing freely. Rub the ebonite rod vigorously with the rabbit fur to charge the rod. (Ben Franklin did this in the eighteenth century and



defined the resulting charge on the rod as negative.)

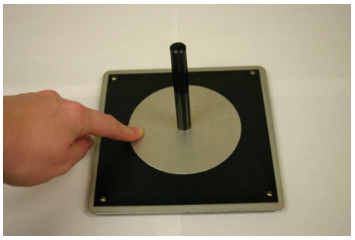
2. Slowly bring the charged ebonite rod close to the suspended pith ball without letting the rod touch the ball. Observe the movement of the pith ball and record this on the data sheet. Repeat the test several times touching both the rod and the pith ball with your free hand between each test. (If the results with the ebonite rod are poor you might try blow drying the fur to remove moisture.) Is the movement of the pith ball consistent?

3. Repeat Step 2 but this time slowly let the rod touch the pith ball. Observe what action the ball takes in this instance and record. Now what happens when the rod is brought near the pith ball? Repeat the test several times to check for consistency.



See data sheet to answer question 4 now.

4. Rubbing plastic film on a glass rod will produce a positive charge. However, we will use an electrophorus to produce the same effect. **Vigorously** rub fur on the ebonite platform, then place the silver disc on top of the platform. The platform has a negative charge just as the rod did in Part A, steps 1 and 2. The negatives in the silver disc are repelled by this charge, so negative charges go to the top of the disc. Touch the disc with your fingertip: This takes the excess negative charges from the disc to your finger, leaving the disc with a positive charge. (Each time you need a positive charge, simply place the disc on the platform and touch your finger to the disc; you don't have to rub the rod with the fur again.)

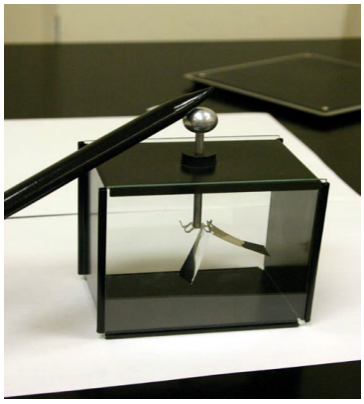


5. Bring the disc (holding it by the handle) near to the pith ball. What happens to the pith ball while the ball is just near the disc? **See data sheet to answer question 5 now.**

6. Now let the disc touch the pith ball. What happens immediately after contact? **See data sheet to answer question 6 now.**

7. Give the pith ball a negative charge, as you did in part A, #1. (**Vigorously** rub the rod with fur and allow the pith ball to touch the rod.) Now, bring the positively charged disc near the ball. Describe the motion of the ball. **See data sheet to answer question 7 now.**

8. Give the ebonite rod a negative charge, and bring it near the sphere on top of the electroscope. What happens to the pieces of foil? **See data sheet to answer question 8 now.**



9. Let the rod touch the sphere. What happens to the foil now? **See data sheet to answer question 9 now.**

10. Touch the sphere with your fingers. What happens to the pieces of foil? **See data sheet to answer question 10 now.**

11. Again give the pieces of foil a negative charge. Bring the positively charged disc from the electrophorus near to the sphere, but not touching. What happens to the pieces of foil as the positive disc comes near? **See data sheet to answer question 11 now.**

12. Again give the pieces of foil a negative charge. Now bring near to the balls a Teflon disc that you have rubbed on your clothes. **See data sheet to answer question 12 now.**

TERMS

Charge — The intrinsic property of matter responsible for all electric phenomena in particular for the force of the electromagnetic interaction, occurring in two forms arbitrarily designated negative and positive.

Static Charge — Stationary charge.

Experiment 13
DATA SHEET

Name: _____

Section: _____ _____ _

A. Observations

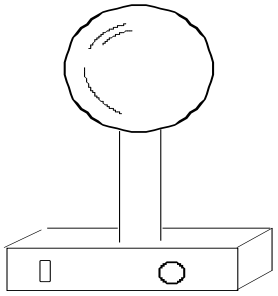
1. Describe one of the special effects or demonstrations performed with the generator by your T.A.

2. What happens to the negatively charged pith ball? _____

3. What is the charge on the Van de Graaff generator? _____

How do you know? _____

Complete the drawing of the generator with field lines after observing the string's reaction to the generator. Be sure to put in arrows for direction!!¨



What happens to the pie pans when they are placed on top of the generator? Why?

Part B:

4. a. What happens when you bring the negatively charged rod near the pith ball? _____

   b. What happens when you let the ball touch the rod? _____

   c. Explain the behavior of the ball you recorded in *a* and *b.* _____

5. What happens to the pith ball while the ball is just near the disc? _____

6. What happens immediately after the pith ball makes contact with the disc? _____

7. Describe the motion of the ball as you bring the positively charged disc near the negatively charged ball. _____

8. What happens to the pieces of foil in the electroscope when you bring the negatively charged rod near to the sphere? _____

9. What happens to the pieces of foil when you let the rod touch the sphere? _____

10. What happens to the pieces of foil when you touch the sphere with your finger? _____

11. After you have given the electroscope a negative charge, what happens to the pieces of foil when you bring the positively charged rod near? _____

QUESTIONS

1) If the sign of the charge on the ebonite rod is negative, as determined by Benjamin Franklin, what then is the sign of the resulting charge on the fur with which the rod was rubbed?

   What is the basis for your conclusion (explain using key concepts)?

2) Explain how a positive charge was given to the disc of the electrophorus?

3) What you observed when you brought a charged object near the electroscope (the box with the shiny leaves). Explain why this behavior (using key concepts). Does it matter whether the charged object is initially negative or positive? Explain

4) What is electrical grounding? Explain where you saw it in this lab.