Lab 1 Electrostatics

What You Need To Know:

The Physics You should already know from lecture that there are two different types of electric charge: *positive* and *negative*. The basic positive charge is the *proton* and the basic negative charge is the *electron*. You should also know that like charges *repel* each other and unlike charges *attract* each other.

It is important to realize that usually when we talk about objects being charged or discharged we are talking about the movement and placement of *only* electrons, not protons. Let's say that we want to charge an object negatively. In order to do this we put an *excess* of electrons on the object. If we want to charge an object positively, we *remove* electrons from the object, *not* add an excess of protons. Protons do not move around because they are stuck in the nuclei of the atoms that make up the object. If an atom has the same number of electrons and protons then it is considered neutral.

In today's lab you will be charging objects in two different ways: *conduction* and *induction*. Usually in a "charging situation" there are two objects: an object that does the charging, and another object that is charged. When conduction occurs, two objects make contact and electrons *flow* from one object to the other. When induction occurs, the objects don't touch but the charges on one will move around the charges on the other.

There's one more idea that you need to know for this lab: *ground*. The best way to think of ground is as an infinite "source" or "sink" of charge. A "source" meaning that ground can supply as much charge as you need. A "sink" meaning that ground can absorb as much charge as you need. Those two ideas seem to conflict but ground can do both. In this lab, your body is going to act as ground. You will "ground" the objects, making them neutral, by touching them with your finger.

The Equipment The main piece of equipment that you are using today is an *electroscope*. **See Figure 1**. An electroscope allows you to observe the presence of charge. When the leaves (pieces of aluminum foil) have the same charge on them, they separate. For example, if you bring a positively charged rod near the metal ball, electrons will accumulate on the ball. This will leave positive charges on the leaves, which will cause the leaves to repel each other. NOTE: **Figure 1** is just an *example* situation. The rod won't always be charged positively, it can be negatively charged as well.

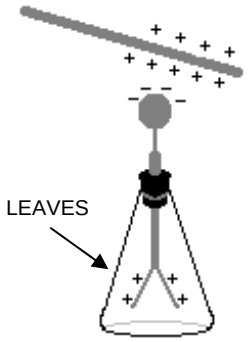

FIGURE 1 –
An example situation
using your electroscope

What You Need To Do:

Part 1 – Charging Up The first thing that you want to do is to try and charge up the five different rods in your equipment box. You should have the following rods: Polypropylene (white), glass (clear with label), PVC (gray), acrylic (clear), and nylon (beige). You are going to vigorously rub each rod with alternately; the fur, the red cloth, and the heavier plastic bag. This should charge the rods. NOTE: You need to apply some decent pressure when rubbing the rod. If you notice that you aren't getting the electroscope to react very much then you probably aren't applying enough pressure. Ask your TA for assistance if it still isn't working.

After you charge a rod, bring it close to (but not touching) the metal ball of the electroscope. Note how the leaves react. Make a chart like **Chart 1**. Write down in the chart what happens to the leaves. Do they move apart A LOT (i.e. the ends of the leaves separate a centimeter or more), A LITTLE (i.e. the leaves separate 1 or 2 millimeters), or NONE? Make sure you discharge the rod between trials.

	Fur	Red Cloth	Plastic Bag
Polypropylene (White)			
Glass			
PVC (Gray)			
Acrylic (Clear)			
Nylon (Beige)			

CHART 1

Question 1 Does the electroscope tell you what kind of charge (positive or negative) you have on your rod? Explain your answer.

NOTE: When answering all of the rest of the following questions it's easier to describe the situations if you just use an example. You can start off your answers with, "Let's say that the rod is negative …", and then continue on from there.

Question 2 Describe in your own words why the leaves separate when you bring a charged rod close to the electroscope's metal ball. Make sure you also explain why charges accumulate on the leaves.

Question 3 Why do the rods become charged when you rub them with the fur, cloth, or bag? What happens to the electrons?

Part 2 – Fur, Cloth, and Bag If you figured out the answer to **Question 3**, then your answer implies that the fur (or cloth or bag) should also be charged. However, it should be charged oppositely to the rod. For combinations in your chart that gave you a result of A LOT, recharge the rod and see if whatever you rubbed the rod with will cause the leaves to separate. If they separate then circle the A LOT in your chart. **Note:** Depending on the weather, this might not work very well.

Question 4 Explain why the fur (or whatever) is oppositely charged to the rod after you rub the fur (or whatever) with the rod.

Question 5 Why should the weather affect how this experiment works? *Hint:* think humidity.

Part 3 – Conduction For this part of the lab you want to make the electroscope remain charged even after you move the rod away. The first way you're going to do this is by conduction. Remember that conduction occurs when the charges *flow* from one object to the other. In other words, you're going to touch the rod to the metal ball.

A) Choose a combination from your chart that resulted in an A LOT with a circle. Charge up the rod and then touch it to the ball at one point.

B) It is possible that the leaves moved apart but came back together after you removed the rod. Recharge the rod and touch the ball again. Keep doing this until the leaves remain apart even after you remove the rod.

Question 6 Why did you have to repeat the charging process so many times before the leaves remained apart?

C) Instead of continually tapping the ball with the rod you can drag the rod across the wand to accumulate more charge. Try it.

Question 7 Explain how dragging the rod makes a difference in leaving more charge. Why didn't all the charge on the rod transfer to the ball when you tapped it? What is special about the rod?

D) With the leaves still apart, bring whatever you charged the rod with nearby the ball. Note what happens to the leaves. Touch the ball with your finger to make the leaves neutral.

Question 8 Explain what happened to the leaves when you brought whatever you charged the rod with nearby the ball. If there was no reaction [and this is highly possible] then explain what you think should have happened.

Part 4 – Induction For this part of the lab you're going to charge the electroscope again, but this time you will use the induction method. Use the same combination you used in the **Conduction** section and charge up the rod. Bring it **nearby** the ball. Touch the ball with your finger for a second and then remove your finger and the rod at the same time. The leaves should remain apart. If you have trouble getting this to work, then ask for help.

Question 9 Why did the leaves remain separated after you removed your finger and the rod? Use the idea of *ground* in your description.

Part 5 – Positive and Negative So far in the lab we haven't talked about what kind of charge [positive or negative] has accumulated on the rods or the leaves. Given the fact that the combination of the gray rod and the fur gives you a negatively charged rod, think of a procedure to determine what type of charge, positive or negative, accumulated on the rod for each combination in your chart that gave you either A LITTLE or A LOT. Put a "+" or a "-" in your chart accordingly.

Question 10 Explain your procedure to determine positive or negative charge.

Part 6 – Faraday's Cup Remove the metal ball from the electroscope and replace it with the metal platform from your equipment box. Place the metal cup on the platform. Charge up combinations from your chart that gave you A LITTLE or NONE. Position the rod inside the metal cup, but don't let the rod touch the cup. Note what happens to the leaves. Did some of the A LITTLE combinations make the leaves separate more than they did with the ball? Did some of the NONE combinations make the leaves raise?

Question 11 Explain why the cup is making the leaves separate more than the ball.

What You Need To Turn In:

Turn in your paper with your chart and the answers to all of the questions.