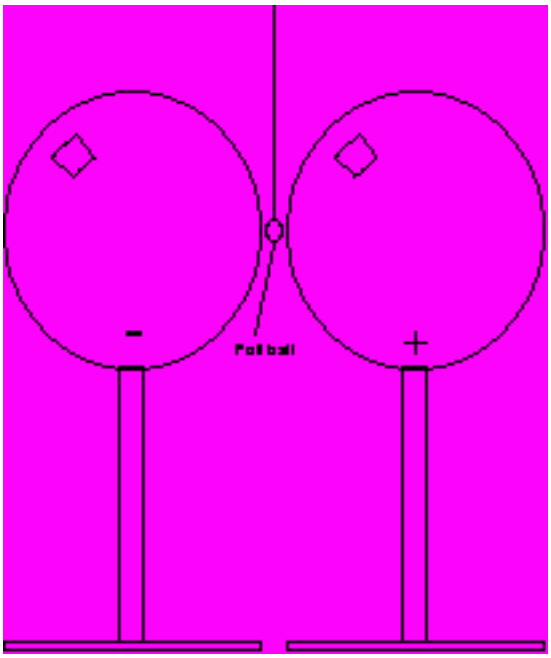
PHYS 223 General Physics
Laboratory Session #1
Static Electricity



Introduction

This lab will use some simple tools to investigate static electricity. You are asked to put aside your "book knowledge" and *observe* what you see in these experiments. Your grade will not depend on whether you get a "right" answer, but whether you communicate in a clear, concise fashion what you observe, and make reasonable inferences from the observations. *Don't rush this lab!* Some activities may seem almost trivial, but they are not.

Mechanical Universe

Watch the Mechanical Universe episode 28 - "Static Electricity" and write a summary.
Watch the Mechanical Universe episode 29 - "The Electric Field" and write a summary.

Induced Charge

A basic tool will be Scotch tape. If you stick a strip of tape two or three inches long on virtually any smooth, dry surface and then quickly pull it off, you'll find the tape has an electric charge. It will be strongly charged when pulled off some materials, and relatively weakly charged when pulled off others. (You'll want to fold over a small bit of the end to provide a "handle" to make the tape easier to work with.)

1. Pull off another piece of tape from the same surface as your first piece. Do the strips attract or repel each other? Try this again with two pieces of tape pulled off other surfaces. (Be sure to describe the surfaces in your notebook.) Can you make a general rule?

2. Stick a strip of tape on the back of another, and then stick both on some surface. Quickly pull them off the surface, and then pull them apart. What do you notice about these strips? Put both strips on the edge of the table so that they hang down, and make them far enough apart that they do not interact. You now have two "leaves" which are somehow charged. The two leaves will serve as an *electroscope.*

   (a) Prepare another pair of strips of tape as before, and bring each (in turn) near each of your electroscope leaves. Write down what you observe. Is there *always* an interaction between charged objects?

   (b) Stick and pull off pieces of tape from several different surfaces and bring them near each of your electroscope leaves. You are not limited to bits of tape; try rubbing glass and fur together, rub your glasses on your shirt, etc.

   (c) Do you ever see a charged object that repels *both* strips of your electroscope? Do you ever see a charged object that attracts both strips?

   (d) From your observations, what do you conclude about how many *kinds* of electric charge there are? Defend your conclusion from your observations only, not from any previous knowledge or from textbook material.

   (e) There is a subtlety that you need to be aware of: what happens if you bring your hand (or any large object) near your two strips of tape? How can we explain what's going on? The repulsive interaction is always clear cut, but the attractive interaction must be carefully checked and cross-checked to see if it is really a force between *charged* objects, or the ever-present attraction between a charged object and an uncharged one.

3. Do all of your objects attract or repel the strips equally strongly? Does the strength of the attraction or repulsion vary with distance?

4. Hold a charged object near your arm, or the back of your hand. (A plastic rod rubbed on cat's fur works well.) Do you feel anything? What is it you are actually feeling?

5. Bring a magnet near your electroscope and observe what happens.

6. Can you explain any of your observations with *gravitational* forces? Do an **order-of-magnitude** calculation for the gravitational force between a strip of tape and, say, your hand. This kind of calculation is often used in science, and can often eliminate unacceptable hypotheses quickly. Here, we are only interested in a rough estimate, not a precise calculation. Don't be afraid to guess!

   To estimate the mass of the tape, guess the mass of a whole roll and divide by the length of the roll, written on the package. Guess the mass of your hand and use a rough distance, like 10 cm, for the distance between masses. Is the force you calculate

enough to cause the bending of the tape you observe? Explain how you know. (Hint: to estimate how much force is required to bend the tape, try estimating how much force would be required to *lift* a 2-inch or so strip of tape. The force to bend it won't be different by more than an order of magnitude.)

7. Make a detailed list of the similarities and differences between the electrostatic and gravitational forces.

The Electrostatic Motor

You are to demonstrate an experiment involving two spheres and a small foil ball on a string, as shown on the front picture of this laboratory. Repeat the experiment, carefully noting each step for your report.

1. Read Ch. 19 from Serway CAREFULLY!
2. Answer "Conceptual Questions" 1-15 from Serway.
3. Watch the "Electrostatic Motor" youtube video: http://www.youtube.com/watch?v=eQrXRCu06

   Clearly explain what happens and why the balls oscillates.

Field Lines with Maple

One of the things Maple can do is find direction fields when solving differential equations. Through a short, but semiconvoluted process, we can use it to draw field lines from electromagnetic charges.

1. Go to Dr. Tovar's Maple web page (http://physics.eou.edu/courses/materials/maple.html) and download the "Electric Field Plot" worksheet.
2. Plot field lines for the following point charges: Q@(1,1), Q@(-1,-1), -Q@(-1,1), -Q@(1,-1).
3. Plot field lines for the following point charges: Q@(1,1), -Q@(-1,-1), -Q@(-1,1), Q@(1,-1).