Electrostatic Charges
Spring 2009

Introduction

The objective of these experiments is to observe the behavior of electrostatic charges on insulators and conductors. There are several concepts to keep in mind during these experiments: like charges repel; opposite charges attract; and only *negative* charges are free to move in a conductor but stick to the surface of an insulator. For each experiment below, draw sketches, and record and explain your observations.

Experiment

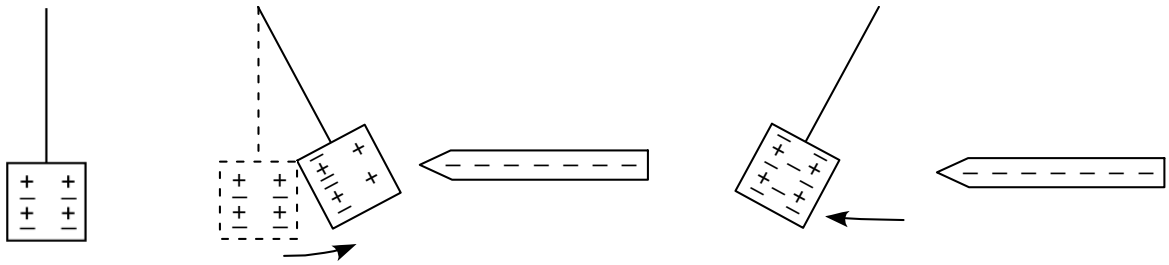

Figure A Figure B Figure C

1. *Charging conductors and insulators*:

   a. Touch the suspended foil conductor with your fingers to ground it (removing any excess charge). The foil starts off electrically neutral – an equal number of positive and negative charges – as indicated in Figure A. Note that the sketch shows only 4 pairs of charges, but obviously there are many more.

   b. After being rubbed with silk, paper towels or fur, charges are usually left on the surface of insulators (e.g. plastic, glass, rubber). *Vigorously* rub the rubber rod with a piece of fur, and carefully bring it close to the *neutral* piece of foil (don't let the foil touch the rod!), as shown in Figure B. Is the foil attracted to, or repelled from the rod? Explain why.

   c. Allow the foil conductor to touch the charged rod, and observe the effect. You have just transferred charge from the rod to the foil by direct contact, as shown in Figure C. Is the foil attracted to, or repelled from the rod? Explain why.

   d. Rub the *glass* rod with a paper towel. Again sketch and describe the result when the charged glass rod is brought close to the charged piece of foil (don't touch the foil with the glass!). Use this information to show whether the glass and rubbers rods have the same or opposite charge. State your reasoning.

2. *Using an Oscilloscope to identify the charge:*

   a. Check the polarity of the charge on the rubber rod (rubbed with fur), and the glass rod (rubbed with a paper towel) by bringing the charged rods, one at a time, close to the face of an oscilloscope that has been set up to show a bright spot in the center of the screen. Use the *side* of the rod, not the tip, for the best results; don't let the rod touch the glass surface of the oscilloscope. The bright spot is caused by electrons (negatively charged) striking a phosphor. Briefly describe your observations and conclusions.

3. *Charging an electroscope by charge transfer*:

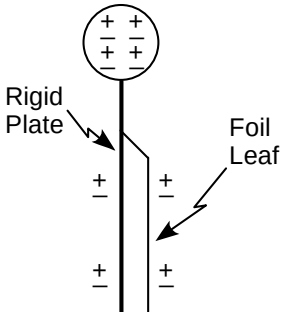

Figure D

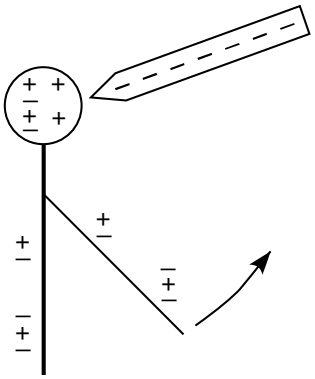

Figure E

a. Touch the knob on top of the electroscope to ensure that it is electrically neutral, as shown in Figure D above. Note that initially there are 8 charged pairs in the sketch, evenly distributed throughout the electroscope.

b. Charge the rubber rod with a piece of fur and bring it close to the knob of the electroscope. Figure E demonstrates the effect when a rod with a net negative charge is brought next to the electroscope. Note that *only the negative charges* in the electroscope have moved; the positive charges are fixed in place!

c. Again charge the rubber rod by rubbing it with a piece of fur. Use the metal disc on the rubber handle to scrape some charge from the rubber rod, then touch it to the knob of the electroscope. This way you transfer charge to the electroscope. Repeat this procedure to add more charge. To remove charge from the electroscope rub your finger across the disc, then touch the disc to the knob and observe how the foil leaf lowers a bit. Explain your observations and include a sketch.

d. The electroscope should have the same polarity as the rubber rod. Check this by bringing the rod close to the knob. What happens to the foil leaf?

e. Confirm the polarity of the charged glass rod by bringing it close to the knob of the charged electroscope.

4. *Charging the electroscope by induction (see handout for sketches).*

a. Discharge the electroscope with your finger, then charge the rubber rod and bring it close to the knob so that the foil leaf rises.

b. Touch the knob with your finger while keeping the rubber rod close to the knob (*the leaf should fall*).

c. Remove your finger, **then** remove the rubber rod and observe how the leaf rises again. The electroscope has been *positively* charged by induction.

d. Explain the process of charging by induction; include sketches with your description.

e. Check the polarity of the electroscope by bringing the charged rod close to the knob. Does the electroscope have the same or opposite charge as the rubber rod?

5. *Fun with water!*

a. Turn on the faucet in the sink to produce a smoothly flowing stream of water. You want a flow rate just fast enough not to give drops but slow enough not to give turbulence. Hold a charged *rubber* rod next to the water stream (don't get the rod or the fur wet!). What happens? Predict what will happen to the stream when the charged *glass* rod is held close. Try it, describe the results, and explain why it happens.

6. *Where are the charges on a charged conductor?* Your instructor will assist you with this experiment. You will use the charge machine, the large sphere with a hole in it and the electroscope at the front of the room. For this part, just create a sketch and record your observations in your report.
   a. Charge your electroscope by charge transfer. Discharge the metal disc on the rubber handle and wave it close to the knob of your electroscope. Note that the leaf is *slightly* affected.
   b. Charge the sphere with the charge machine. Discharge the metal disc and touch it to the outside of the sphere. If the disc is charged, there was charge on the external surface of the sphere. Use your electroscope to check for the presence of charge on the disc.
   c. Discharge the metal disc and insert it carefully into the hole in the sphere so it touches the inside. Then, withdraw it without touching the edge of the hole. Again check if the disc is charged. What can you conclude?
   d. Once again, check the outside of the sphere.
   e. Where are the charges located in the sphere? On the inside? The outside? Both? Justify your answer.

Discussion

- Your report today will consist of your sketches, observations and conclusions for the experiments you performed. Be sure that you explained your results as you performed each experiement.