Electrostatic Charges
Spring 2025

Name ____________________

Partner(s) _________________

Introduction

The objective of these experiments is to observe the behavior of electrostatic charges on insulators and conductors. Keep in mind that like charges repel and opposite charges attract. Also, both negative and positive charges can stick to the surface of an insulator, but **in a solid conductor** the positive charges are bound to the lattice structure of the metal, and therefore only the *negative* charges are free to move, so the positive charges will remain in the same location for each series of drawings. Write Your Answers Directly On These Instructions. Each Person In Your Group Will Hand In Their Own Copy Of This Experiment.

Experiment

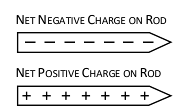
1. *Using an oscilloscope to identify the net charge*:

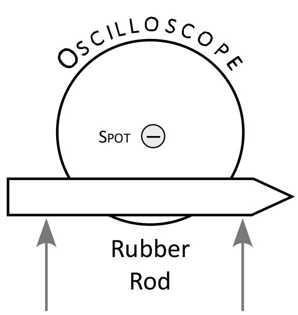
Charges usually are left on the surface of insulators (e.g. plastic, glass, rubber) after they are rubbed with a piece of silk, paper towel or fur. You will use an oscilloscope to test two different insulators (rubber and glass) after they have been rubbed with different materials to see whether the net charge on the insulator is positive or negative. The oscilloscope has been set up to show a bright spot at the center; the spot is caused by electrons (negatively charged) striking a phosphor coating on the back of the glass screen.

a. Bring the two rods, fur, and paper towel to the oscilloscope at the front of the lab. *Vigorously* rub the rubber rod with a piece of fur, and carefully bring it close to the face of the oscilloscope. 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. Move the rod up and down, parallel to the glass screen. Briefly describe your observations in the space below.

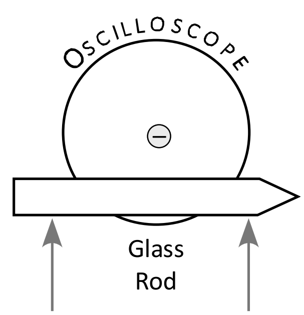
b. Now vigorously rub the glass rod with a piece of paper towel, and again bring the side of the rod close to the glass screen of the oscilloscope. Again, describe your observations.

c. What does the behavior of the oscilloscope spot tell you about the net charge on each rod? **Draw a series of charges on the sketch of each rod below** (*refer to sketches at right*).





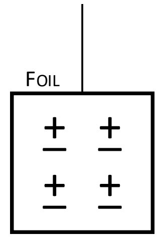
Description/Explanation:



Description/Explanation:

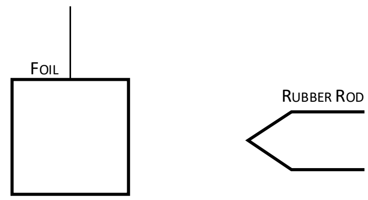
2. *Charging conductors and insulators*:

a. Begin by touching 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 shown in the figure at right. *Note: the sketch (right) shows only four pairs of charges, but obviously there are many more.*

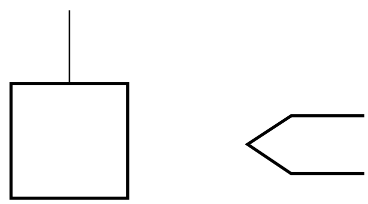


b. *Vigorously* rub the rubber rod with a piece of fur, and carefully bring it close to the *neutral* piece of foil (don't let the foil touch the rod!) Is the foil attracted to, or repelled from the rod? On the sketch at right, draw (i) an arrow showing the direction the foil moves; (ii) the charges on the rod; (iii) the distribution of charge in the foil (does it change, or remain the same?) Which charges move where, and why?

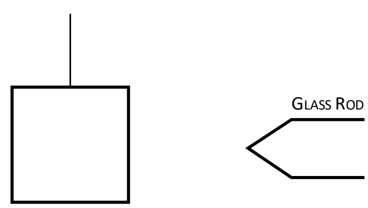
> The number of charges on the foil should be consistent between your sketches. Do they increase, decrease, or stay the same? And what about their positions?



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. Is the foil attracted to, or repelled from the rod? On the sketch at right, draw (i) an arrow showing the direction the foil moves; (ii) the charges on the rod; (iii) the distribution of charge in the foil (*are there the same number as before?*) Which charges move where, and why?

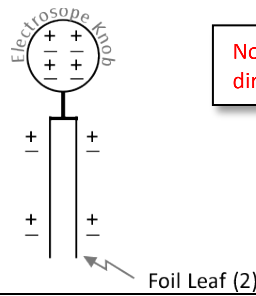


d. DON'T GROUND THE FOIL YET – KEEP ITS CHARGE FROM THE STEP (C)! Rub the *glass* rod with a paper towel. On the sketch at right, draw (i) an arrow showing the direction the foil moves; (ii) the charges on the rod; (iii) the distribution of charge in the foil. Describe the result when the charged glass rod is brought close to the charged piece of foil (don't touch the foil with the glass!). Use this information to explain whether the glass and rubber rods have the same or opposite charge.



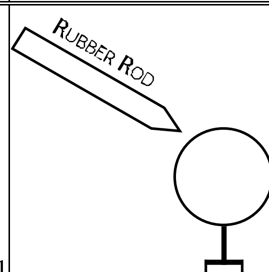
3. *Charging an electroscope by charge transfer*:

a. Touch the knob on top of the electroscope to ensure that it is electrically neutral, as shown at right. The foil leaves should hang downward (don't worry that each leaf curls.) *Note that initially there are **eight** charged pairs in the sketch, evenly distributed throughout the electroscope.*



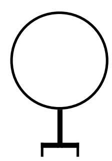
Note that the knob is connected directly to the foil leaves.

b. Charge the rubber rod with a piece of fur and bring it close to the knob of the (neutral) electroscope. On the sketch at right, draw (i) the leaves and an arrow showing how they have moved; (ii) the net charge on the rod (iii) charges on the knob and leaves. Be consistent with the total number of charges and *their expected position*. Briefly explain what happens to each foil leaf.

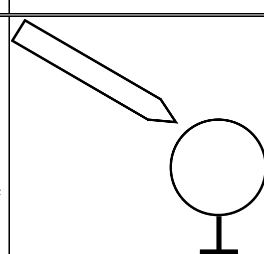


The number of charges on the electroscope should be consistent between your sketches. Do they increase, decrease, or stay the same? And what about their positions?

c. *Transfer charge from the rod to the electroscope as follows*: Scrape the flat part of the metal disc (with insulated handle) along the side of the charged rubber rod, then touch the metal disc to the knob of the electroscope. Draw (i) the leaves to show their position; (ii) the expected number and position of charges in the knob and leaves.



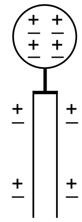
d. Now you will see if the charged electroscope has the same or opposite charge as the rubber rod: bring the charged rod close to the knob *without making contact*. Draw (i) the leaves and an arrow showing how they have moved; (ii) the net charge on the rod (iii) charges on the knob and leaves. Briefly explain the cause of the leaf's movement.



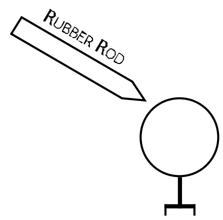
e. What is the net charge on the electroscope now?

4. *Charging the electroscope by induction*:

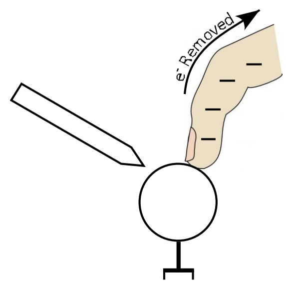
a. Discharge the electroscope with your finger so that the electroscope is neutral. *Note that initially there are **eight** charged pairs in the sketch, evenly distributed throughout the electroscope.*



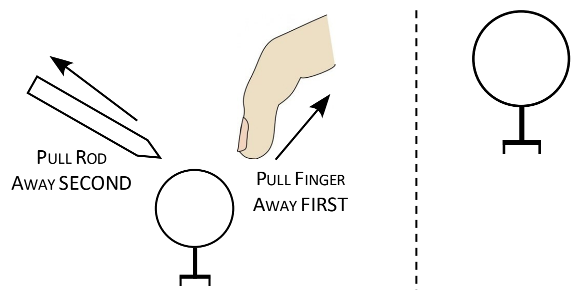
b. Charge the rubber rod with a piece of fur and bring it close to the knob of the (neutral) electroscope. On the sketch at right, draw (i) the leaves and an arrow showing how they have moved; (ii) the net charge on the rod (iii) charges on the knob and leaves. Be consistent with the total number of charges and *their expected position*.



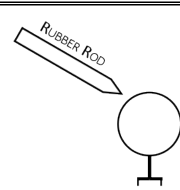
c. Touch the knob with your finger <u>while keeping the rubber rod close to the knob</u>. This will remove some of the negative charge from the electroscope (***four** negative charges are removed in the sketch*.) Draw (i) the leaves and an arrow showing how they have moved; (ii) the net charge on the rod (iii) charges on the knob and leaves. Keep track of the total number of charges.



d. **First**, remove your finger, keeping the rod nearby. **Second**, remove the rubber rod. Draw leaves and charges on the sketch of the knob at the far right.



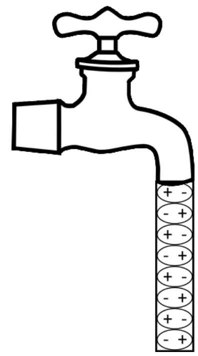
e. Now you will see if the charged electroscope has the same or opposite charge as the rubber rod: bring the charged rod close to the knob *without making contact*. Draw (i) the leaves and an arrow showing how they have moved; (ii) the net charge on the rod (iii) charges on the knob and leaves. Briefly explain the cause of the leaf's movement.



f. What is the net charge on the electroscope now?

5. *Fun with water!*

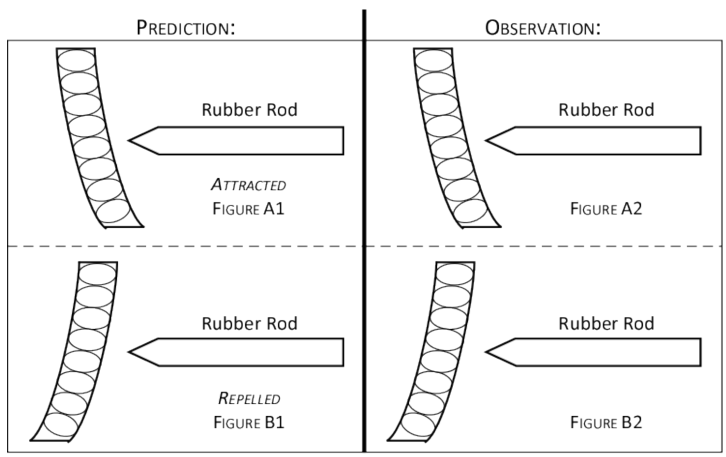
a. Turn on the faucet in the sink to produce a thin, smoothly flowing stream of water. The figure at right is a simplified representation of a neutral stream of charged water molecules (the small ovals). Note the arrangement of charges in the water molecules.



b. *Prediction*: What will happen when you hold a charged *rubber* rod next to the water stream: Will the stream of water bend towards the charged rod (Figure A1) or away from it (Figure B1)? Circle the figure number that will represent the movement of the water stream.

c. *Observation*: Try it (*but don't get the rod or fur wet!*). Circle the figure (A2 or B2) that represents your observation.

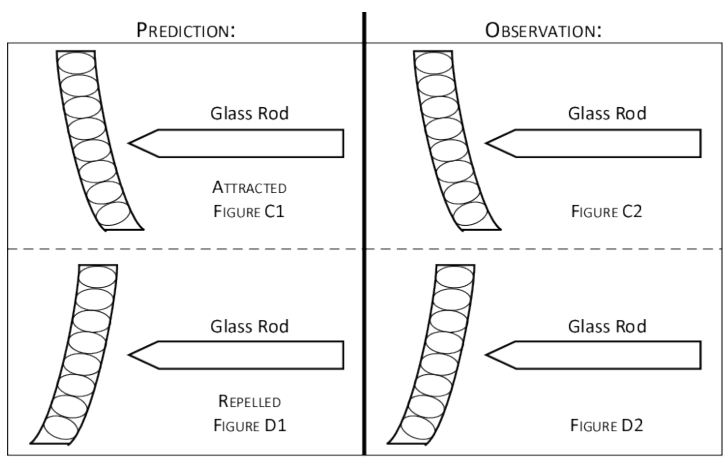
d. On the correct *observation* figure, draw charges on (i) the rubber rod and (ii) the water molecules.



e. *Prediction*: What will happen when you hold a charged *glass* rod next to the water stream: Will the stream of water bend towards the charged rod (Figure C1) or away from it (Figure D1)? Circle the figure number that will represent the movement of the water stream.

f. *Observation*: Try it (*but don't get the rod or paper wet!*). Circle the figure (C2 or D2) that represents your observation.

g. On the correct *observation* figure, draw charges on (i) the glass rod and (ii) the water molecules.



h. Briefly summarize your observations from this part: Why did the water stream react the way it did for each charged rod?

6. *Where are the charges on a charged conductor?* Your instructor will assist you with this experiment. You will find the electrostatic generator on the side bench in the lab. The generator is connected to a large hollow sphere with a hole in it and there is an electroscope nearby.

a. Charge the electroscope by charge transfer from the rubber rod. Discharge the metal disc on the insulated handle by rubbing your fingers on the disc, and then wave the (neutral) disc close to the knob of your electroscope (*don't touch the knob with the disc!*) Record your observations of any motion of the leaves in the electroscope at right.

b. *Gently* turn the electrostatic generator by hand to charge the large sphere; try it again if there is a discharge (a spark) across the gap between the two small metal spheres. *Note that a small, suspended Styrofoam ball in contact with the large sphere will visually show that the sphere is charged*. Move the small Styrofoam ball out of the way.

c. Again, discharge the metal disc with your fingers, and touch the flat side of the disc on the outer surface of the large sphere. Wave the metal disc near the knob of your charged electroscope, noting any motion in the leaves. What does this observation tell you about the charge on the *outside* surface of the large sphere?

d. Discharge the metal disc and *hold the insulated handle at the end*. Without touching the edge of the hole, *carefully* insert the disc into the hole in the large sphere until the disc touches the inside of the sphere; start this step over if a spark jumps between the sphere and your finger.

e. Scrape the metal disc around the inside of the sphere (to make sure you've made good contact), then carefully withdraw the disc, again without touching the edge of the hole. Wave the metal disc near the knob of your charged electroscope, noting any motion in the leaves. What does this observation tell you about the charge on the *inside* surface of the large sphere?

f. Again, discharge the metal disc with your fingers, and touch the flat side of the disc on the outer surface of the large sphere. Wave the metal disc near the knob of your charged electroscope, noting any motion in the leaves. Did you find the same results as in part (c)?

g. On the sketch at right, draw charges representing the net charge on the outside and/or inside surface of the sphere.