

LAB 2: CHARGE DISTRIBUTION ON CONDUCTORS

Equipment List:

- Electrometer (ES-9078A)
- Electrostatic Voltage Source (ES-9077)
- Proof plane (ES-9057B) - wand with aluminum coated disk on the end
- Faraday ice pail (ES-9042A)
- Signal input cable for electrometer - has two alligator clips
- Red banana to fork terminal lead
- Conductive Spheres (ES-9059B)
- Conductive Shapes (ES-9061)
- 2 black banana lead - grounding cables
- 1 alligator clip

Purpose: To investigate how charge distributes itself on conductors and how charge on conductors is effected by electric fields.

Introduction: In this lab you will use the proof plane to sample the charge on the surface of the conducting spheres and conducting shapes. The disk of the proof plane has a layer of aluminum, when it is placed flat along a conducting surface, charge is transferred to or from the proof plane until it has the same surface charge density σ as the conductor's surface. (See figure 1.)

Since charge is conserved, any charge that appears on the proof plane is lost by the conducting object, therefore, do not ground the proof plane between multiple measurements on the same conductor.

The electrostatics voltage source will be used to create a charge on the conductors in this experiment.

Procedure: Part 1 - Using the conductive spheres. Put one of the conductive spheres ("sphere 2") on one side of the lab bench and set up the rest of the equipment, including "sphere 1" on the other side of the lab bench.

1. Plug in the electrostatic voltage source to the mains plug, but do not switch it on. Connect the ground port of the voltage source to the ground of the electrometer. Connect a black ground lead from the ground socket of the power supply to the outer cage of the Faraday ice pail with a alligator clip. Connect another black ground cable with an alligator clip to the outer cage, leaving the other end to just sit on the lab table. This lead will be used to ground the spheres.
2. Set up the Faraday ice pail and electrometer as show in the diagram (Figure 2) with the black clip attached of the signal lead attached to the outer cage and the red clip

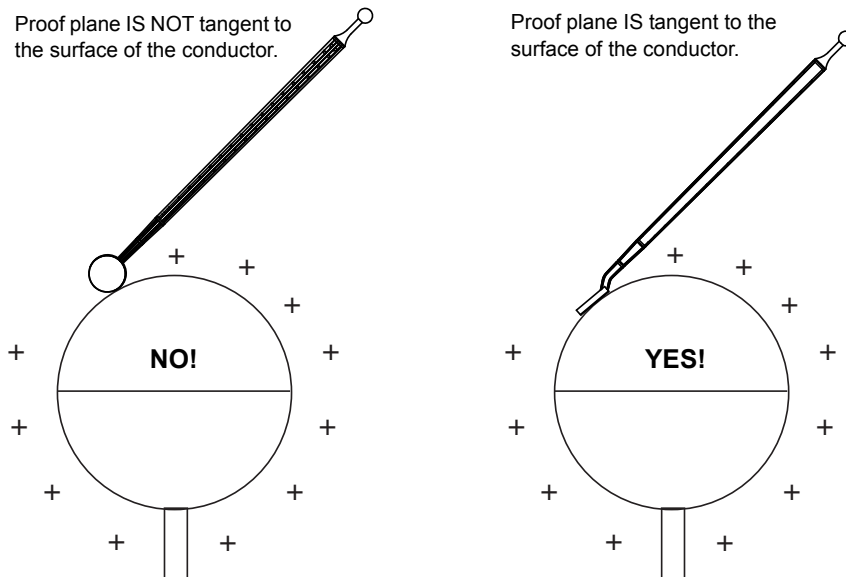


Figure 1: How to use the proof plane to sample charge. Figure from Pasco Electrostatics manual 9080A.

to the inner cage. Ground the inner pail and electrometer circuitry by touching your finger across both pail layers and simultaneously press the “ZERO” button on the electrometer.

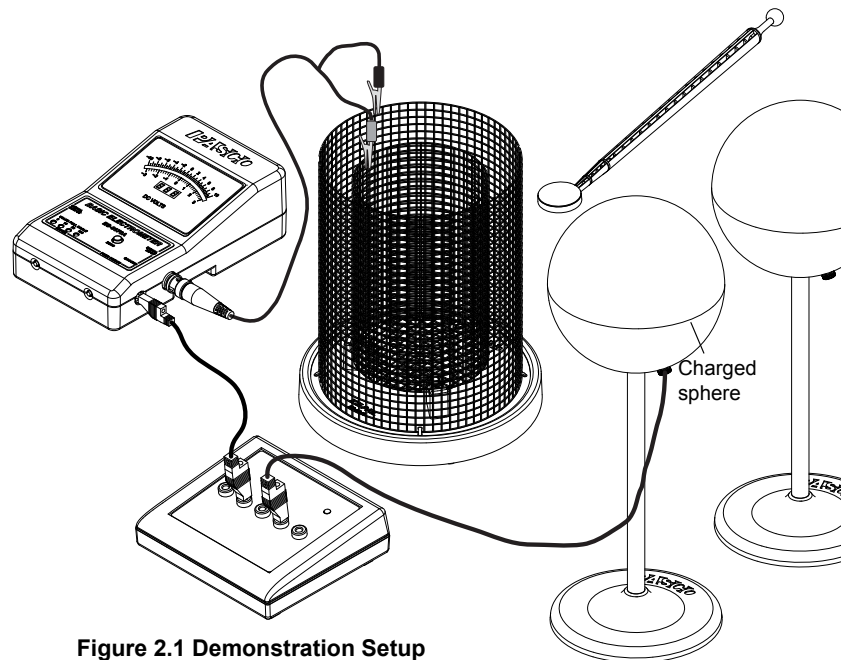


Figure 2.1 Demonstration Setup

Figure 2: Electrostatics voltage source and electrometer setup. Figure from Pasco Electrostatics manual 9080A.

3. Ground conducting sphere 2 by touching it with the black lead clipped to the outer

cage and return it to the far side of the lab bench. Sample the charge from the top, bottom, front, back, left, and right sides of the sphere and record the voltage readings from the electrometer for each.

4. Connect the fork terminal of the red cable to the screw on conducting sphere 1. Turn the screw gently to pin the fork in place. Connect the other end of the lead to the +2000 V output of the electrostatics voltage source. Bring the two spheres close together (surfaces separated by about 1-3 cm). Now switch on the voltage source.
5. Again sample the charge from the top, bottom, front (side facing the charged sphere 1), back, left, and right sides of sphere 2 and record the voltage readings from the electrometer for each.
6. Touch the black lead clipped to the outer cage to sphere 2 again for a moment, then remove the ground cable from the sphere. Sample and record the same points on sphere 2 again.
7. Move sphere 1 and sphere 2 to opposite sides of the lab bench again. Switch off the voltage source. Repeat the sampling procedure on sphere 2 and record the results.

Part 2 - Using the conductive shapes (the rounded cone shape and the sphere with a hole in the top). Put the conducting spheres and hollow sphere away to the side of the bench.

1. Connect the fork terminal of the red cable to the screw on the conical conducting shape. Turn the screw gently to pin the fork in place. Connect the other end of the lead to the +2000 V output of the electrostatics voltage source. Switch on the voltage source.
2. Use the proof plane to sample the charge on the wider rounded end of the shape, the narrower end, and each side. Record your results.
3. Now switch off the voltage source, disconnect the conical shape, and connect the hollow sphere. Switch the source back on.
4. Ground the disk end of the proof plane and the conductive knob at the other end. Use the disk end to sample the charge from several points on the outside of the hollow sphere and record the results. Use the knob end to sample the charge on the inside of the hollow sphere in a couple of places by reaching the end of the knob through the hole in the top. Be careful not to touch the outside of the sphere with the knob while removing the wand!

Conclusion:

In part 1 of the experiment, does the distribution of charge on sphere 2 change? Describe how. Does the net charge change on sphere 2? Explain as fully as you can why and how this happens. When sphere 2 is far from charged objects, is the charge distribution on it close to uniform? Should it be? Could other things in the lab that are not a part of your experiment effect your measurements?

In part 2 of the experiment, is the distribution of charge over the outside of the conical shape uniform? If not, where is the highest charge density? Why is it distributed as it is?

How is the charge distributed on the hollow sphere? Is the surface charge density different inside the sphere? Why?

What sources of error are there in this experiment? Can you think of any ways to reduce them or suggest any improvements to the equipment or procedures in this lab? Can you think of any other experiments you might do to study charged conductors?