

Lab 1: Electrostatics

Objectives

1. To observe the interaction between a charged object and small neutral objects.
2. To verify the existence of two types of charge.
3. To experiment with separating charge from an object.
4. To verify that conductors have charge carriers which can move freely.
5. To demonstrate that charge can be stored after the source of the charge has been removed.
6. To demonstrate that objects can be charged by induction, or by direct contact.
7. To observe the force between two charged spheres and the effect on the force of the distance between them.

Equipment

1. One square of wool cloth
2. One capped PVC rod and stand
3. One capped copper rod and stand
4. One Van de Graff generator
5. One Leyden jar
6. One transparent PET sleeve with aluminum plate covers and conductive styrofoam ball
7. Flakes of aluminum foil and flakes of paper
8. Five 5" aluminum pie plates
9. Four 1" diameter graphite coated (conductive) styrofoam balls on threads
10. Wooden support stand with adjustable cross piece and sliding protractor
11. Two chrome plated spheres and stands

Safety Risk

Persons with implants such as pacemakers, insulin pumps, etc., should not participate in this lab. The static discharge from the Van de Graff generator may damage electronics. Keep laptop computers, cell phones, PDAs, or any other electronic equipment well out of proximity to the Van de Graff generators.

Experiment

The Worksheet Section at the end of this document that will be completed and submitted for evaluation. Running the Van de Graff for a few seconds is usually enough to charge it sufficiently – it need not run continuously. You can ensure the charge on a conductor is initially neutral by touching it. You can ensure the charge on an insulator is neutral by grasping or touching the entire surface with your hands.

Electrostatics experiments are notoriously unpredictable, especially when the relative humidity is high. For this reason, you may have to repeat the procedures, and re-charge objects several times depending on your *expected* outcomes and observations.

- 1. Interaction of Charged Objects with Neutral Objects.** Using the wool cloth, rub the PVC pipe and observe what happens when you bring the pipe into proximity of (i) small pieces of paper, (ii) small pieces of aluminum foil.
- 2. Existence of One Type of Charge (Pipe Charge).** Rub the PVC pipe with the wool cloth to charge it. Bring the pipe into proximity with a **conductive** styrofoam ball that is suspended on the wooden stand. Then make contact between the pipe and the ball. You may have to make contact at different points on the pipe to transfer charge to the ball. Record and explain your observations.
- 3. Existence of Another Type of Charge (Van de Graff Charge).** Charge the Van de Graff generator. Hold a conductive styrofoam ball by a thread and charge the ball by making contact with the Van de Graff. How do you know that the ball has the same type of charge as the Van de Graff? Charge another conductive ball suspended on the wooden stand by rubbing the PVC pipe and making contact with the ball as you did in Part 2 above. You should verify that this ball has the same type of charge as the pipe. Holding by the thread, carefully bring the ball charged by the Van de Graff into close proximity of the ball suspended on the wooden stand. What are your observations and conclusions?
- 4. Storing Energy and Transferring Charge using a Leyden Jar.** The Leyden jar is a device that stores energy. Be careful to hold the jar on its outside – do not touch the inside of the jar or any piece of metal directly connected to the inside. The Leyden jar holds a significantly larger charge across its plates than the Van de Graff and will deliver a very intense electric shock. Charge the Van de Graff. Then grasping the **outside** of the Leyden Jar, make contact between the ball of the Leyden Jar and the Van de Graff. Now transfer charge to a neutral conductive ball suspended on the wooden stand by making contact between the conductive ball and the (ball of the) Leyden Jar. What type of charge has been transferred to the conductive ball?

- 5. Conductors and Insulators.** Place the copper rod into its plastic stand and position a neutral conductive styrofoam ball suspended from the wooden stand such that the ball hangs vertically and is approximately 5 mm from centre of the end cap of the copper tube (see Figure 2.1 below). Charge the Leyden Jar using the Van de Graff. Bring the Leyden jar within several millimetres of the other end of the copper tube without touching or arcing. You may have to repeat this process several times if you inadvertently contact the tube or there is arcing between the Leyden jar and the tube. You must also ensure the conductive styrofoam ball is neutral (by touching with your hand) each time you start this process. Record your observations and conclusions.

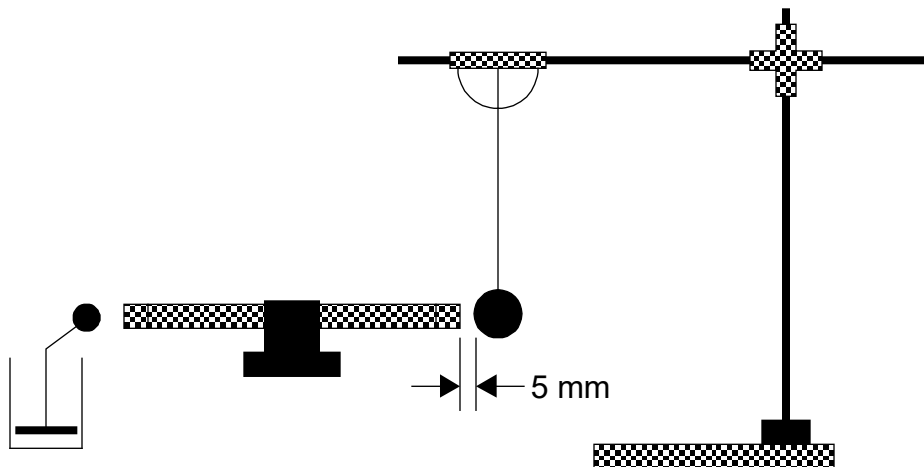


Figure 2.1. Conduction Test Apparatus.

Repeat the process with the copper tube, but this time make contact between the Leyden jar and the copper rod. Record your observations and conclusions. Replace the copper tube with a plastic tube and repeat the entire process. Record your observations and conclusions.

- 6. Charging by Induction.** Place two of the chrome plated spheres (each supported on a plastic stand) side by side and in contact with each other. Charge the Leyden jar with the Van de Graff and bring the Leyden jar close to the far side of the other sphere **without contact and without arcing**. Now grab the plastic support of the sphere on the left and separate the two spheres. Upon separation the two spheres are charged. Contrive and conduct a test to determine the type of charge on each sphere. Is the type of charge the same as that of the Van de Graff? The plastic pipe.

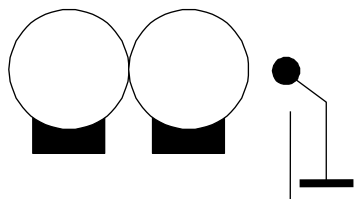


Figure 2.2. Charge by Induction Apparatus.

- 7. *Static Equilibrium.*** This part of the experiment is particularly engaging. Take four of the styrofoam balls and hold them by the threads so that the balls are all the same distance from your hand. Place the Van de Graff generator on the stool and charge the Van de Graff generator. Swing the four balls in to make contact with the Van de Graff generator so they become charged. Now carefully lower the four balls from above the centre of the Van de Graff generator and observe the behaviour of the balls. Record and explain the observation.
- 8. *Van de Graff Pie Plates.*** Discharge the Van de Graff generator. Stack 5 of the aluminum pie plates together. Turn them upside down on top of the Van de Graff generator. Turn the Van de Graff generator on. Record and explain your observation.
- 9. *Van de Graff Rattle.*** Discharge the Van de Graff generator. Tape one of the aluminum pie plates upside down on the Van de Graff generator globe. Now put the PET sleeve over it and tape it on. Place one of the small conductive styrofoam balls in the sleeve. Now seat a second pie plate in the top of the sleeve and tape it lightly in place. Turn the Van de Graff generator on. Record and explain your observation.