MND Physics

Investigating Static Electricity

A balloon rubbed with a wool cloth or fur will accumulate charge (the evidence of which is easily observed). Clothes removed from a dryer usually cling to each other and spark or crackle when you separate them. When two dissimilar materials rub together, they can become charged. Objects acquire static-electric charges by either gaining or losing electrons. An object that gains electrons has acquired a net negative charge. You can separate charge by rubbing one type of material with another.
Examples:

A piece of flat plastic rubbed with fur:
The plastic acquires a net negative charge, the fur acquires a net positive charge.

Glass rubbed with silk or paper:
The glass acquires a net positive charge, the silk (or paper) acquires a net negative charge.

In this lab, you will investigate the properties of static electricity and through observation, infer the type of charge present in various objects.

EQUIPMENT:

Balloon, pieces of circular paper punch-outs (from a hole-punch), a piece of flat plastic, fur or wool, glass rod, paper towels or silk, electroscope, Styrofoam ball suspended by holder, Leyden jar, wire with clips, Van de Graaff generator, puffed rice, Wimhurst machine, metric ruler, running tap water.

PROCEDURE:

Perform each part of the experiment several times to insure you have the proper observations. NOTE: You will have to rub the glass rod vigorously just to acquire a feeble charge.

PART 1

Observation of static electricity with a charged balloon.

- Take a balloon and rub the outside with fur. Hold the balloon close to the circular hole-punch paper pieces. Record your observations; give an explanation of the results.

- Re-charge the balloon with the fur. Place the balloon on the underside of your out-stretched forearm. Record your observations; give an explanation of the results.

PART 2

Observation of static electricity using a Van de Graff Generator.

- Place a cup of puffed rice on top of the Van de Graaff generator. Turn on the machine taking care not to touch or approach the sphere during operation. Record your observations; give an explanation of the observed behavior.

- Turn off the Van de Graaff and discharge the machine as instructed.

PART 3

Observation of static electricity with a Wimhurst Machine.

- CAUTION: Never touch any metal parts of this machine!
- First, discharge the electrodes as instructed.
- Place the electrodes on the Wimhurst machine about 2 cm apart. Turn the crank of the Wimhurst machine and observe the static discharge. Record your observations.
- Discharge the electrodes.
- Re-adjust the electrode spacing adding another cm distance (to 3 cm).
- Turn the crank of the Wimhurst machine and observe the static discharge. Record your observations.
- Repeat this process until the machine fails to discharge (produce a spark. Record this distance taking care NOT TO CONTACT THE ELECTRODES.
- Discharge the electrodes.
- Explain the relationship between the amounts of charge stored in the machine vs. electrode distance.

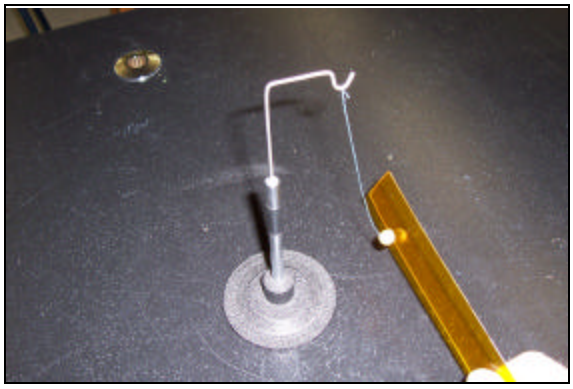
GENERAL INSTRUCTIONS FOR PARTS 4-7:

Static charge builds up on the skin and is easily transferred to the equipment making lab results hard to interpret. Ideally, you will have one person handle the plastic and fur (or wool), another person handle the glass rod and silk (or paper), and a third person handle the electroscope, Leyden jar, and Styrofoam ball and holder. Decide who in your group will handle the charged objects and who will handle the other pieces of equipment; keep this arrangement throughout this portion of the lab.

GROUNDING:
When the procedure calls for grounding an object, the person responsible for that piece of equipment does the grounding; simply touch the object with your fingers for approximately 1-2 seconds then remove your fingers. This should "neutralize" the charge (i.e. same amount of positive and negative charge).

PART 4

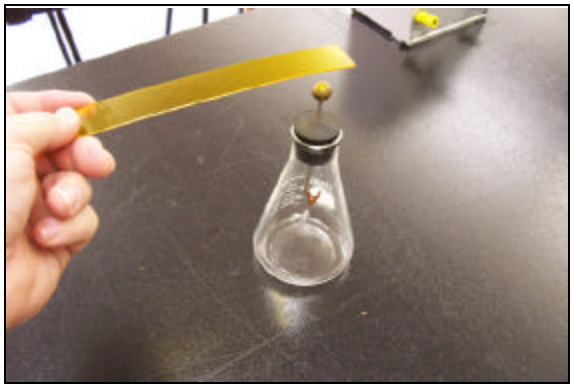
Observation of a charged object interacting with a Styrofoam ball suspended on a string.



- Ground the Styrofoam ball.
- Charge a flat piece of plastic with fur or wool.
- Bring the plastic close to the ball but not touching. Approach the ball slowly and from below, such that the ball cannot swing out and contact the plastic. See how far you can move the ball without contacting it. Record your observations and answer the following question:
- **QUESTION:** If the ball is neutral (i.e. grounded), why the ball is attracted to the plastic?
- Recharge the plastic. Now charge the ball by conduction (touch the ball with the plastic and drag until the ball falls off.
- Recharge the plastic. Now approach the ball slowly. Record your observations and explain the observed behavior.
- Repeat the entire process using a glass rod charged with silk or paper. Record all your observations and answer the questions. NOTE: It is much more difficult to charge the glass rod; you may not observe much of a response (if any).

PART 5

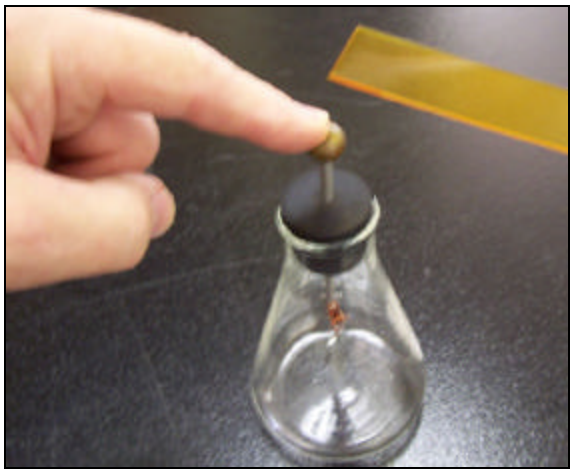
Charging an electroscope by conduction.



- Ground the electroscope.
- Charge a flat piece of plastic with fur or wool.
- Bring the plastic close to the electroscope but not touching. Record your observations and answer the following question:
- **QUESTION:** If the electroscope is neutral (i.e. grounded), why do the leaves separate as you approach with a charged object?
- Recharge the plastic. Now charge the electroscope by conduction (touch the ball on top of the electroscope with the plastic and drag.
- Recharge the plastic. Now approach the electroscope slowly. Record your observations and explain the observed behavior.
- Repeat the entire process using a glass rod charged with silk or paper. Record all your observations and answer the questions. NOTE: It is much more difficult to charge the glass rod; you may not observe much of a response (if any).

PART 6

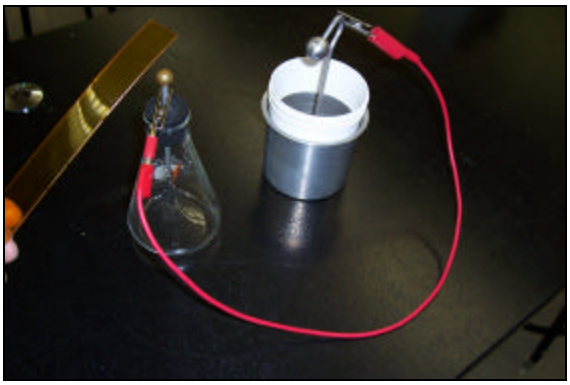
Charging an electroscope by induction.



- Ground the electroscope.
- Charge a flat piece of plastic with fur or wool.
- Bring the plastic close to the electroscope but not touching.
- While the plastic is in the close vicinity of the electroscope (but not touching the top ball), a second person (not in contact with the person holding the plastic) grounds the electroscope as shown above.
- Recharge the plastic. Now approach the electroscope slowly. Record your observations and explain the observed behavior.
- Repeat the entire process using a glass rod charged with silk or paper. Record all your observations and answer the questions. NOTE: It is much more difficult to charge the glass rod; you may not observe much of a response (if any).

PART 7

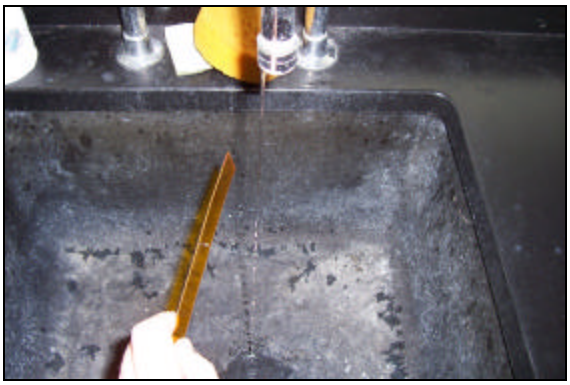
Storage of Charge: The Leyden jar (a simple capacitor).



- Ground the electroscope.
- Connect a wire from the top of the electroscope to the top of the Leyden jar as shown.
- Charge a flat piece of plastic with fur or wool.
- Charge the electroscope by conduction (touch the ball on top of the electroscope with the plastic and drag.
- Recharge the plastic.
- Again, charge the electroscope by conduction (touch the ball on top of the electroscope with the plastic and drag.
- Repeat this process several times.
- Record your observations and explain the observed behavior. **Caution:** in this case, the lack of observed motion in the electroscope leaves does <u>not</u> imply "nothing happened". You know from the previous trials that your plastic contains a significant amount of charge. You further know that charge is transferred when objects come in contact with each other (charging by conduction). Therefore, explain the internal process taking place in terms of:
    1. moving charge and
    2. storage of charge
- Define "capacitance" (use your textbook). State the function of a capacitor.

PART 8

Observation of the effects of charge near a stream of water.



- Turn on the cold water faucet and allow a very thin stream of water to flow.
- Charge a flat piece of plastic with fur or wool.
- Slowly bring the plastic close to the water stream but do not make contact.
- Record your observations and explain the observed behavior.
- Make a drawing of this behavior, showing what is happening on a molecular level (i.e. draw a water molecule, indicating the position and orientation of the molecule relative to the position of the plastic).

ADDITIONAL QUESTIONS:

1. Internet Research: An electrostatic filter is sometimes used to filter air in home heating and air conditioning systems. What role does static electricity play in this filtration process?
2. Internet Research: How do spray products that neutralize static electricity on clothes work?