Experiment: Electrostatics

Objectives:

- Explore the interaction between objects of similar charge
- Explore the interaction between objects of opposite charge
- Explore the interaction between a charged object and a conducting object
- Determine whether the color of a balloon determines its ability to accumulate excess electric charge

Materials:

- Scotch (transparent tape)
- Two balloons
- Electrostatics kit
- Meter stick
- LabPro Interface w/LoggerPro software
- Vernier Charge Sensor & an extra lead (w/alligator clips)

Introduction:

The objects around us are made up of atoms and molecules, the tiny building blocks of matter. The atoms themselves are made up of neutrons, protons and electrons. Protons and electrons have electric charge of opposite polarity but equal magnitude whereas neutrons are neutral (they have no charge). Protons have positive charge (+) and electrons have negative charge (-). The electric charges of the protons and electrons are necessary for holding the structure of the atom together. In this experiment, we will explore the interactions between various charged objects along with their interaction with non-charged objects.

Sensor Set-up:

1) Obtain a charge sensor and set it to the middle setting (± 2 V).
2) Connect a charge sensor to CH1 of the LabPro interface then start up LoggerPro.
3) Attach the black lead to ground.
4) Connect the red lead to the black lead.
5) Press the "Reset" button for ~5 sec.
6) Place a metal can or bowl in a larger glass bowl.
7) Attach the red lead of the charge sensor to the metal bowl.
8) Observe the charge sensor reading; test whether it is working properly.

It will be useful to use the charge sensor to verify your observations through out this lab.

Procedure:

1) Pull a couple of strips of Scotch tape from a roll. Each one should be about 12-20 cm long. Hold them up by their ends then slowly bring them side-by-side.
   a) What happens?

   b) What is the reason for their behavior?

   c) Do they carry opposite or like charges? *You can verify using the charge sensor.*

2) One at a time, pass each of the strips of tape lightly but completely between your fingers then hold the two strips near each other again. Now what happens? Why?

3) Fold over a couple of centimeters of the end of each strip. This gives you a non-sticky handle to work with. Carefully stick the two strips to each other so the sticky side of one strip adheres to the dry side of the other. Now grasp the tabs and rapidly peel the strips apart. Keep them distantly separated then slowly bring them together again.

   a) Now what happens as the strips come together?

   b) Do they carry opposite or like charges?

   c) Do you think the tape strips were charged <u>before</u> you pulled them apart? Verify and indicate the polarity of the charge.

   d) Where did this initial charge come from?

   e) According to theory, electric charge is conserved. Does their total amount of charge on the 2 tape strips change? How would you verify your prediction?

4) Neutralize both pieces of tape again by rubbing them, and then repeat the previous step, this time with the sticky sides together. Does it work? Why or why not?

5) Which side of the tape tends to give up electrons? Which side tends to steal them?

6) When rubbed against your hair, a balloon becomes negatively charged (i.e. takes electrons from your hair). Now blow up two balloons. Do not rub them against your hair or clothing. Considering what happened in the previous step, do you think that you can create static electricity by rubbing the two electrically neutral balloons together? Why or why not? Try it.

7) What is the polarity of a charged balloon?

8) Paper is a reasonably good conductor compared to plastic tape. Explain why masking tape does not work well for this activity.

9) What happens when you bring a neutral, metal object (not in direct contact with your hand) close to a suspended charged object (such as a charged piece of tape)?

10) Give a detailed explanation of what is happening in **step 9** on an atomic level. What term describes this phenomenon? Should your observation depend upon the type of charge on the suspended object?

11) Locate the electrostatics kit. What happens when you charge the clear plastic rod then hold it close to a lightly running stream of tap water? Why?

12) **Steps 9-11** involved induction with materials known to be good conductors. Interestingly, this can be observed even in materials that are not good conductors, although the molecular interaction is slightly different in this case. Balance the center of mass of a meter stick on the edge of your table so that the end on the table just barely rises off of the surface. Now charge the clear plastic rod and bring it slowly up under the lower end of the meter stick. Surprised? Explain how this could happen even though the electrons in the wood are not free to move throughout the material.

13) Rub a balloon against your hair so that it will stick to the wall. The wall is not a good conductor, so the mechanism here is the same as in the previous step. Draw a picture of the wall and balloon indicating as usual the role of the charges involved.

The Finale:

It has been claimed that different colored balloons retain charge to a different extent because of the various dyes used. In this section, you use a charge sensor to test this claim.

1) You will need to design an experimental procedure to compare the charge accumulation for each balloon color.

Consider the following questions:

- How do you control for different shaped balloons?
- How do you control for the possibility that different brands use different materials?
- How do you charge the balloons? Can this be standardized?

2) Once you have satisfactorily addressed the above questions, describe your experiment.

3) Collect appropriate data to perform the experiment.

Data:

4) What can you conclude from your experiment? Does color really affect the charge retention of a balloon?