

Physics 30 eLab Investigating Charges

Background:

The theory of electrostatics states that objects can be charged as electrons transfer from place to place. There are several ways electron transfer can take place - it can occur via friction, conduction, or induction.

In this lab, you will investigate the charges on objects that have been charged in different ways. Electrostatic charge can be difficult to measure, but with the charge sensor used in this investigation will make the task somewhat easier.

The Questions:

What is the electrostatic charge on various objects? What is the difference between charging by induction and conduction?

Variables:

This experiment involves these variables: various objects, electrostatic charge. Identify and state the manipulated, responding, and controlled variables in this investigation.

Materials:

- charge sensor
- USB link
- large glass jar
- metal can (such as soup can with label removed)
- heavy duty aluminum foil
- antistatic wrist strap
- various material for electrostatic charge testing, for example - comb, balloons, drinking straw, cellophane tape, acetate rod, ebonite rod, glass rod, cat's fur, glass plate, empty soda cans, etc.

Procedure:

Step 1:

Plug the charge sensor into the USB link (that is connected to the computer).

Step 2:

Configure DataStudio with three displays, a graph, digital, and meter display. These three displays will serve well to show charge magnitude, charge change, and whether charge is positive or negative.

Step 3:

Construct an insulated and sensitive charge detector by placing a empty metal can on top of a glass jar. Place the glass jar on top of a wide square of heavy-duty aluminum foil. The foil will serve as a grounding surface. The detecting lead for the charge sensor connects to the bottom of the metal can. If your charge sensor is equipped with a ground lead (usually colored black), attach this to the aluminum foil. Folding over the aluminum foil a few times at the point of contact will prevent it from tearing. It is highly recommended to attach an anti-static wrist band to the aluminum grounding foil as well. Anyone performing experiments is advised to wear the anti-static wrist band - this will ground the individual and prevent charge they have accumulated on their body from interfering with results. When complete the whole apparatus should look something like this:

**Step 4:**

Conduct your charge experiments using the charge detection apparatus you have constructed. The following are suggested investigations, but you should feel free to perform other charge testing that you see fit. Whatever the case, record the details of your testing and the results in an appropriate table.

Investigation 1 - Detecting Positive and Negative Charge

- Rub the end of a plastic straw with cat's fur (or an equivalent). Bring the straw into close proximity of the charge detection can and observe the readings (remember to record all your observations).
- Slowly lower the charged end of the straw into the can while observing readings.
- Rub the end of the plastic straw vigorously with cat's fur, then drop the fur into the can while observing readings. Now slowly lower the straw into the can and observe any changes.
- Comb your hair with a comb and then slowly bring the comb close to the can while observing readings.
- Rub a balloon on your hair and slowly bring the charged surface of the balloon near the can while observing readings.
- Rub acetate and ebonite rods with cat's fur, then alternately bring the rods close to the can while observing readings.

Investigation 2 - Charging by Contact

- Tear off two pieces of cellophane tape, each approximately 6 cm long. Fold the end of one of the pieces into a point. Fold the end of the other piece over straight. Place the sticky side of the piece of the tape with the pointy end onto the non-sticky side of the piece of tape with the straight end. Touch the two pieces of tape, now stuck together, to the piece of aluminum foil to ground them. Bring the two pieces of tape close to the can and observe the charge to confirm that there is a zero (or near zero) charge on the tape. Now pull the two pieces of tape apart, and alternated bring each one close to the can to test their charge while observing readings. Once you have tested both pieces individually, stick the pieces of tape back together again and bring them close to the can while observing readings.

Investigation 3 - Charging with no Contact

- Place two empty soda pop cans on a glass plate. Use a grounding wire to ground one of the cans, and charge the other can by rubbing an acetate rod with cat's fur and repeatedly touching the rod to the can. Use an insulator (a wooden stick works well) to move the charged can near to the grounded can, then remove the ground wire. Move the previously grounded can close to the charge detection can while observing readings.

Analyzing and Interpreting:

1. Which objects in your investigations obtained positive charges? Explain how and why they obtained their positive charge. Which objects in your investigations obtained negative charges? Explain how and why they obtained their negative charge.
2. What is charging by conduction? Which of your investigations represented charging by conduction? Explain.
3. What is charging by induction? Which of your investigations represented charging by induction? Explain.

Applying and Connecting:

4. Hollow conductors, such as the metal ball on top of Van de Graaff generator, can exhibit unequal charge distribution according to their shape. Explain how a charge sensor like the one you used in this experiment could be used to "map" the charge distribution of a hollow conductor.

Forming Conclusions:

5. Write answers to the following questions:
- What is the electrostatic charge on various objects?
 - What is the difference between charging by induction and conduction?

Extending:

6. Discharging is when an object loses the charge it has acquired. Design an experiment that will demonstrate the loss of charge from an object over time. Alter the experimental conditions to change the rate of discharging.