

Lab 12: Electrostatic Charging

Purpose

To investigate the nature of charging an object by contact as compared to charging an object by induction.

Introduction

Electric charge is one of the fundamental properties of matter. Electrostatics is the study of electric charges and their characteristics. For example, like charges repel and unlike charges attract. An object is electrically neutral most of the time; that is, it has a balance of positive and negative electric charges. Rubbing different materials together, contact with a charged object, and charging by induction are three ways to create an imbalance of electric charge – sometimes called static electricity.

To experimentally investigate electrostatics, some charge-detecting or measuring device is needed. A common instrument for this purpose is the electroscope, a device with two thin gold leaves vertically suspended from a common point. When a charged object is brought near the electroscope, the gold leaves separate, roughly indicating the magnitude of the charge.

Although there are many different versions of the electroscope, all such instruments depend upon the repulsion of like charges to produce an output or reading. Unfortunately, such devices are relatively insensitive (large amounts of charge are needed to make the gold leaves separate), and the device does not have a quantitative reading.

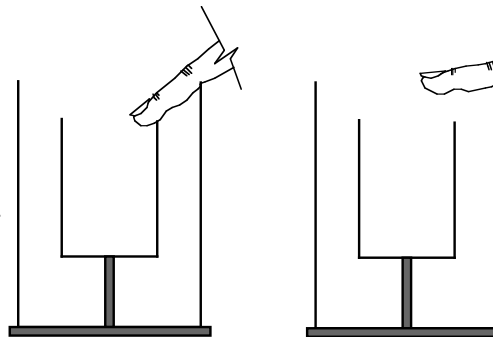
The Charge Sensor is an ‘electronic electroscope’. In addition to providing a quantitative measurement, the Charge Sensor is more sensitive and indicates polarity directly.

Setup

1. Setup the computer and interface with the charge sensor connected to the interface on channel A.
2. Open the *DataStudio* file **64 Charging.ds**.
3. Connect the alligator clips of the sensor’s cable assembly to the inner and outer baskets of the Faraday Ice Pail.



► **Note:** Before starting any experiment using the 'Faraday Ice Pail', the pail must be momentarily grounded. To ground the pail, touch the inner pail and the shield at the same time with the finger of one hand.



Experiment 1: Determine the Polarity of the Charge Producers

Procedure

1. Ground the 'Ice Pail' and press the 'ZERO' button on the Charge Sensor to discharge the sensor.
2. Click 'Start' in *DataStudio* to start recording data.
3. Briskly rub the blue and white surfaces of the Charge Producers together several times.
 - a. Without touching the 'Ice Pail', lower the white Charge Producer into the 'Ice Pail'. Watch the Meter and Graph displays.
 - b. Remove the white Charge Producer and then lower the blue Charge Producer into the 'Ice Pail'. Watch the results.
4. After a few moments, stop recording data.

Analysis

Explain what happening when you rub the two charge producers together?

What polarity is the white Charge Producer? What polarity is the blue Charge Producer?

Experiment 2: Charge the ‘Ice Pail’ by Contact

Procedure

1. Ground the ‘Ice Pail’ and press the ‘ZERO’ button on the Charge Sensor to discharge the sensor.
2. Start recording data.
3. Briskly rub the blue and white surfaces of the Charge Producers together several times.
 - a. Lower the white Charge Producer into the ‘Ice Pail’. Rub the surface of the white Charge Producer against the inner pail and then remove the Charge Producer. Watch the Meter and Graph displays.
4. After a few moments, stop recording data.
5. Repeat 1 to 4 now lowering the blue Charge Producer into the ‘Ice Pail’.

Analysis

What happens to the charge on the ‘Ice Pail’ when you rub the inner pail with the white Charge Producer and then remove the Charge Producer?

What happens to the charge on the ‘Ice Pail’ when you rub the inner pail with the blue Charge Producer and then remove the Charge Producer?

Experiment 3: Charge the ‘Ice Pail’ by Induction

Procedure

1. Ground the ‘Ice Pail’ and press the ‘ZERO’ button on the Charge Sensor to discharge the sensor.

2. Start recording data.
3. Briskly rub the blue and white surfaces of the Charge Producers together several times.
 - b. Without touching the 'Ice Pail' with the Charge Producer, lower the white Charge Producer into the 'Ice Pail'.
 - c. While the Charge Producer is still inside the inner pail, use the finger of one hand to momentarily ground the 'Ice Pail'. Watch the results.
 - d. After you ground the 'Ice Pail', remove your hand and then remove the Charge Producer.
4. After a few moments, stop recording data.
5. Ground the 'Ice Pail' and zero the sensor and repeat the procedure using the blue Charge Producer.

Analysis

What happens to the charge on the 'Ice Pail' when the white Charge Producer is lowered into the inner pail without touching the inner pail?

What happens to the charge on the 'Ice Pail' when the 'Ice Pail' is momentarily grounded while the Charge Producer is still inside the inner pail?

What happens to the charge on the 'Ice Pail' after the Charge Producer is removed from the inner pail?

How does the result of charging by contact differ from the result of charging by induction?