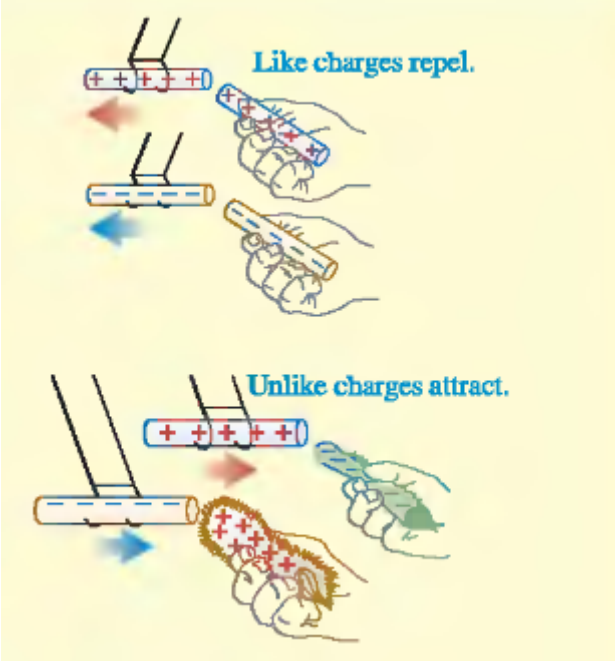
EXPERIMENT 1:	ELECTROSTATIC CHARGE

1.1. Purpose:

The purpose of this experiment is to gain a qualitative understanding of some electrostatic phenomena through charging by friction, contact and induction.

1.2. Overview – Theory:



Electric charge, conductors, and insulators: The fundamental quantity in electrostatics is electric charge. There are two kinds of charge, positive and negative. Charges of the same sign repel each other; charges of opposite sign attract. Charge is conserved; the total charge in an isolated system is constant.

All ordinary matter is made of protons, neutrons, and electrons. The positive protons and electrically neutral neutrons in the nucleus of an atom are bound together by the nuclear force; the negative electrons surround the nucleus at distances much greater than the nuclear size. Electric interactions are chiefly responsible for the structure of atoms, molecules, and solids.

Conductors are materials that permit electric charge to move easily within them. Insulators permit charge to move much less readily. Most metals are good conductors; most nonmetals are insulators.

1.3. Experiment:

In this experiment, the polarity of the charge producers will be determined using charge sensor. Also, the amount of charge transferred to a Faraday Ice Pail by contact with each kind of charge producer will be measured. Finally, the charge sensor will be used to measure the excess charge accumulated on the Faraday Ice Pail caused by induction.

1.3.1. List of Equipment Used:

- Charge Producers
- Charge Sensor
- Faraday Ice Pail

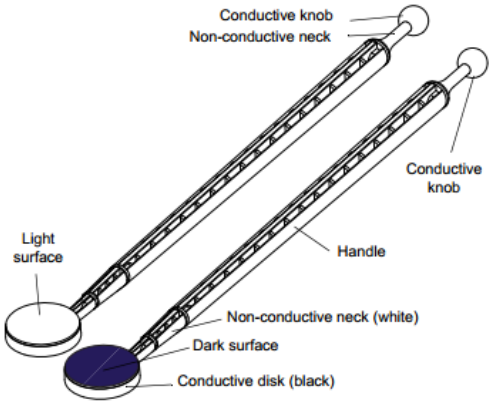


Figure 1. 1: Charge producers

1.3.2. Description of Experimental Setup:

Charge Producers:

The two charge producers are used to generate equal positive and negative charges by contact. When rubbed together a net positive charge will move to one of them. (Figure 1.1)

Charge Sensor:

The Charge Sensor does not directly measure charge, but instead measures the voltage difference between its positive (red) and negative (black) leads (Figure 1.2). It connects the black lead to ground, meaning that as much charge can flow into or out of that lead as is necessary to keep it at "zero potential" (ideally the same voltage as at infinity). The red lead is free to be at any potential, although by pushing the "zero" button on the sensor (Figure 1.2 right), it too can be attached to ground (the potential difference between the red and black leads is set to zero). The gain switch (used to amplify small signals) should be set at 1. The zero button sets the output signal to zero.

Figure 1. 2: Charge Sensor

Faraday Ice Pail:

Our primary apparatus consists of two concentric wire-mesh cylinders. The inner cylinder (the "pail") is electrically isolated by three insulating rods. The outer cylinder (the "shield") will be attached to ground – charge can flow to or from it as necessary. This cylinder will act both as a screen to eliminate the effect of any external charges and other external fields and as a "zero potential" point, relative to which you will measure the potential of the pail.

Figure 1. 3: Faraday ice pail

1.3.3. Procedure:

Before each part of the experiment, ground the ice pail by connecting the inner and outer baskets at the same time with the help of a metal wire. When the ice pail is grounded, press the zero button of the charge sensor to discharge it.

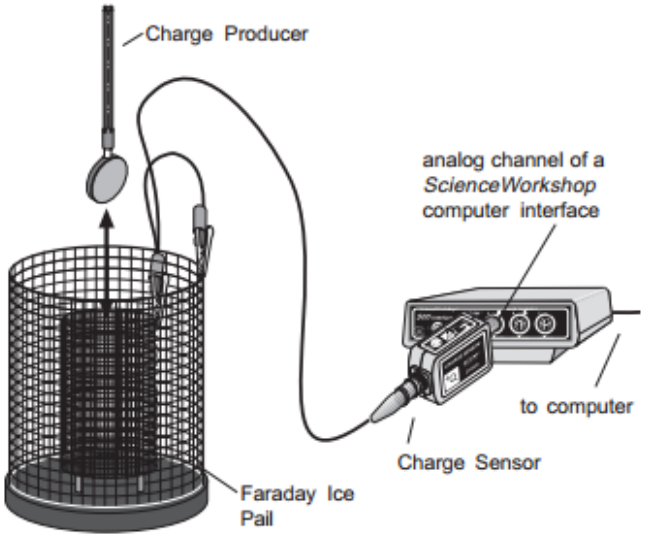


Figure 1. 4: Experimental Set-up

Part-A: Determining the polarity of the charge producers:

1) Rub two charge producers together several times to create a charge on them.
2) Without touching to the pail, lower the white charge producer into the inner basket. Start taking data just before lowering the charge producer.
3) Without touching to the pail, wait up to 10 seconds then remove the white charge producer.
4) While taking data, without touching the ice pail this time lower the blue charge producer, wait up to 10 seconds then remove the blue charge producer.
5) Just after removing the charge producer stop taking data.
6) Record and save your data.

Part-B: Determining the charge on the white and blue charge producers:

1) Rub two charge producers together several times to create a charge on them.
2) Lower the white charge producer into the inner basket, and touch the charge producer to the inner cylinder. Start taking data just before lowering the charge producer.
3) Wait up to 10 seconds and remove the white charge producer, then stop taking data.
4) Record and save your data.
5) Ground the ice pail by connecting the inner and outer baskets at the same time with the help of a metal wire.
6) Repeat the same procedure from 1-4 with blue charge producer.

Part-C: Charging by induction:

1) Rub two charge producers together several times to create a charge on them.
2) Start taking data.
3) Without touching the ice pail, lower the white charge producer into the ice pail. While the charge producer is still inside the inner cylinder, use metal wire to ground the ice pail.
4) Remove the wire, and then remove the charge producer.
5) Stop taking data, and then save.
6) Repeat the above steps for the blue charge producer.

LABORATORY REPORT

EXPERIMENT 1:	ELECTROSTATIC CHARGE

Name-Surname:
ID:
Group no:

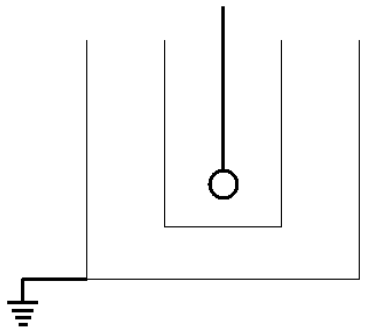
1.4. Data Sheet:

	White Wand Reading	**Blue Wand Reading**
Sign		
Magnitude		

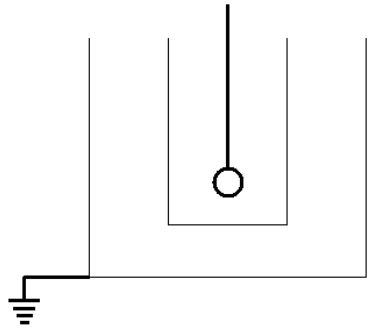
1.5. Analysis, Calculations & Conceptual Questions:

Part-A: Determining the polarity of the charge producers:

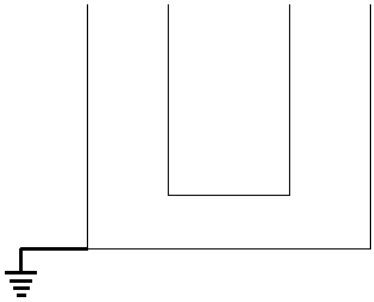
1) Plot charge versus time (Q vs. t) graph.
2) Show charge distribution on the "ice pail" when the white charge producer is lowered into the inner pail without touching it?



3) Show charge distribution on the "ice pail" when the blue charge producer is lowered into the inner pail without touching it?

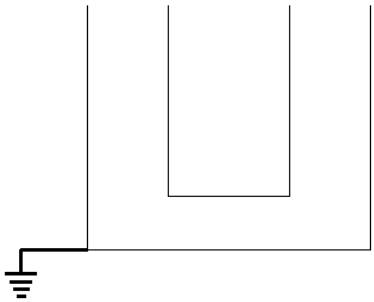


4) What happens to the charge on the “ice pail” after the charge producer is removed from the inner pail?

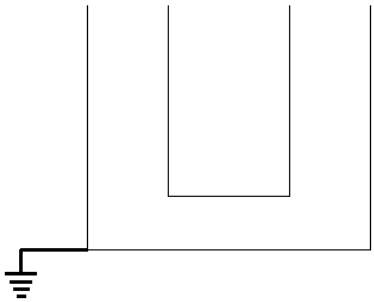


Part-B: Determining the charge on the white and blue charge producers:

1) Plot charge versus time (Q vs. t) graph for both charge producers.
2) What happens to the charge on the “ice pail” when you touch the inner pail with the white charge producer and then remove the charge producer? Explain the charge flow.



3) What happens to the charge on the “ice pail” when you touch the inner pail with the blue charge producer and then remove the charge producer? Explain the charge flow.



Part-C: Charging by induction:

1) Plot charge versus time (Q vs. t) graph for both charge producers.
2) What happens to the charge on the "ice pail" when the "ice pail" is momentarily grounded while the white charge producer is still inside the inner pail? Explain the charge flow.

3) What happens to the charge on the "ice pail" when the "ice pail" is momentarily grounded while the blue charge producer is still inside the inner pail? Explain the charge flow.

1.6. Conclusion:

1) Were your results as expected? What did you expect? What did you find? What may have caused the difference?

2) What is the difference between charging the "ice pail" by contact and charging the "ice pail" by induction? Explain why?

Extra Credit

- **Can you find the breakdown voltage of air with this setup? If so, find it!**
- **If you wait long, you will see the decrease of charge on the stick. How does it decrease? Find the time constant.**