

LAB: TRIBOELECTRIC EFFECT

Driving Question | Objective

The purpose of this lab is to test and determine how the triboelectric effect influences different objects.

Materials and Equipment

Faraday Cage

PASCO Electrometer

PASCO Wires

Felt disk (White/gray colored)

Blue disk

Plastic Cup

Hair

Wooden Ruler

PVC Pipe

Background

The Triboelectric Effect is a type of electrification where an object gains a charge from being in contact with another object. The charges can be transferred unevenly allowing objects to gain either a positive or negative charge. Some objects have the ability to gain more of a negative charge compared to some that can gain more of a positive charge. From that, a list known as a triboelectric series lists different objects by most negative to most positive charge.

Triboelectricity was first discovered about 2500 years ago by a Greek philosopher named Thales of Miletus. He discovered it by rubbing amber together with fur and noting the amber could pick up straw and dust from a distance. Then in 1757, the first triboelectric series was published by John Carl Wilcke. More recently however, in 2012 a triboelectric nanogenerator was created which can harvest small amounts of mechanical energy.

The triboelectric charging process (as well as any charging process) involves a transfer of electrons between two objects. Charge is not created from nothing. The appearance of negative charge upon a rubber balloon is merely the result of its acquisition of electrons. And these electrons must come from somewhere; in this case, from the object it was rubbed against. Electrons are transferred in any charging process. In the case of triboelectric charging, they are transferred between the two objects

being rubbed together. Prior to the charging, both objects are electrically neutral. The net charge of the system is 0 units. After the charging process, the more electron-loving object may acquire a charge of -12 units; the other object acquires a charge of +12 units. Overall, the system of two objects has a net charge of 0 units. Whenever a quantity like charge (or momentum or energy or matter) is observed to be the same prior to and after the completion of a given process, we say that the quantity is conserved. Charge is always conserved. When all objects involved are considered prior to and after a given process, we notice that the total amount of charge amidst the objects is the same before the process starts as it is after the process ends. This is referred to as the law of conservation of charge.

Safety

- Be careful while using electrical outlets
- Be sure to disconnect all wires from the outlets before disconnecting them from the sensor
- Keep electrical devices such as phones away from electrical equipment.

Procedure

1. Connect the alligator clip that is on the black wire to the bottom of the outer cage of the Faraday Cage.
2. Plug the black wire into the “ground” hole of the outlet.
3. Connect the red wire to the inner cage of the Faraday Cage and the grey wire to the outer edge.
4. Connect another wire from the ground hole into the outlet to turn on the PASCO electrometer and zero it.
5. Ground each material before each attempt by rubbing all sides on the outer cage of the Faraday Cage. Also make sure to press the zero button on the electrometer before each attempt.
6. Take one object and rub it with another object.
7. Dip the first object into the inner Faraday Cage, making sure not to touch the cage with it
8. Determine whether it goes positive (to the right) or negative (to the left) and then dip the other object rubbed into the inner Faraday Cage and observe the results.
9. Repeat steps 6-8 (each time with a different second object).
10. Go onto the next object and repeat steps 6-9 per object.
11. Then rank them from most positively charged to most negatively charged.

Data Analysis

This is where any recorded data should be stored. Not all labs might require tables or graphs than need to be linearized/regressed. However, all labs should seek to collect data of some kind. It will be up to your group to determine how to best represent this data within the experiment.

RANK	OBJECT (1 = most positive, 5 = most negative)
1	Plastic cup (10 volts)
2	Plastic tube (10 volts)
3	Glass test tube (1 volt)
4	Balloon (0.5 volts)
5	Wood (-1 volts)
6	Fur (-10 volts)

Analysis Questions

1. What does grounding the objects before each test do? How was the grounding done?

Grounding objects gets rid of excess charge by transferring electrons between itself and the other object. We grounded objects by touching the proof plane onto the outer edge of the Faraday cage before testing its charge.

2. What affects each charge that is produced for each object?

The electrons on the object interacting with the atmosphere could give it a net charge.

3. What pattern did you notice when attempting the lab?

Plastic objects tend to be more positively charged, and wood is slightly negative. This shows that the type of material of the object affects how charge interacts with the object.

4. What could have affected the results/created errors during the lab? How could you be able to fix those?

Extra charges being stored on the proof plane could have made the charge reading different. To prevent this, we grounded the proof plane before testing each object by touching it to the outer part of the Faraday cage. Humidity could have dissipated the charges, but we can't change that external condition.