Lab experiment #3

Discovering Electricity: Basic Experiments on Electrostatics

Pre-lab questions

1. What is the goal of this experiment? What physics and general science concepts does this activity demonstrate to the student?
2. Suppose a glass rod is rubbed with a silk cloth. If the glass rod has a positive electric charge, what is true of the silk cloth?

This experiment investigates the origin, types, and interactions of electric charges. When are electric charges present, and why do we/do we not see their effect in all aspects of everyday life? The goal of the experiment is to examine the qualitative behavior of the electrostatic charges.

Introduction

All ordinary matter is made up of atoms and molecules – that are groups of atoms. And atoms have three primary constituents – protons, neutrons, and electrons. Of these, protons and electrons carry a property known as **electric charge**. Why this is so may not be understood yet, but each proton carries one fundamental unit of positive electric charge while each electron has one fundamental unit of negative charge. Given this fundamental fact, another property of nature is implied – the **conservation of electric charge**. That is, electric charge is neither created or destroyed. It is simply moved from place to place.

Even before direct evidence of the existence of atoms was found, electricity was known to exist and methods to produce accumulations of electric charge (positive or negative) were discovered. Experiment revealed that like (positive-positive, or negative-negative) electric charges repelled each other while unlike (positive-negative) charges attracted.

Along with this, we note that equal magnitudes of positive and negative electric charges in the same location will 'cancel' each other out. The individual electric charges (protons and electrons) are still present, but their opposite influence on other, external electric charges will tend to average to zero on scales much larger than atoms. This is why we do not observe the abundant electric charges in nature attracting or repelling each other (recognizably) in normal, everyday life.

Common materials (like glass or plastics) can be easy charged by rubbing with another material (like cotton, wool cloth, or paper). (Explaining why this works is outside the scope of this course.) If one object becomes charged, so the other object becomes charged in the opposite manner, according to the conservation of charges. Thus, if rubbing an object with wool makes that object positively charged, then the wool itself must be negatively charged.

You can observe for yourself the behavior of electric charges by rubbing easily charged plastic strips with paper or cloth.

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Equipment:
Electrometer**,** ring stand, acrylic rod, glass rod, PVC rod**,** wool cloth**,** silk cloth**,** fur cloth**,** masking tape

The Field Electrometer
The field electrometer is a classic apparatus for demonstrating electrical charges. Its schematic diagram is shown below.

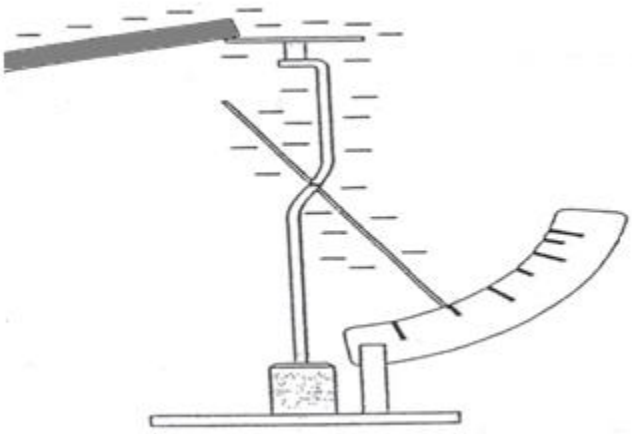

Figure 1: Field electrometer

The metalized pointer, mounted on needle bearings, is conductively connected to a fixed metal support. When an electrical charge is transferred to the metal support, part of the charge flows onto the pointer. The pointer is thus repelled, indicating the relative quantity of charge.

In this activity you will generate the electrical charges by rubbing two materials together and demonstrate the charges using the field electrometer.

This experiment proves also that charges can be transferred between different bodies (from an acrylic or glass rod to the electrometer).

- Charge the PVC rod by rubbing it with the wool cloth. Transfer the charge to the electrometer by touching the metallic part of the electrometer with the rod. What do you observe?

- Touch it again, transferring more charge. What's happened?

- Now charge the glass rod by rubbing it with the silk cloth and touch the electrometer with the glass rod. What do you observe?

- Touch it again transferring more charge. What's happened?

- Finally charge the acrylic rod by rubbing it with the fur cloth and touch the electrometer with the acrylic rod. What do you observe?

- Touch it again transferring more charge. What's happened?

- What do you infer from this experiment?

Conclusions

1. Comment on the your results and whether or not they make sense with respect to the theory presented in the introduction

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2. Have you found one, two or three kinds of charge? Assign names to each kind of charge you have found.

3. Which kind of charge could the substance have? Describe using names of the charges.

4. What general conclusions about the electrification of bodies can you make a result of your observations in this experiment?

5. How can charges disappear?

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Questions:

1. A piece of plastic has a net charge of + 2 μC. Calculate how many more protons than electrons this plastic has. The charge on a proton p = + 1.6 10^{-19} C, on an electron e = - 1.6 10^{-19} C.

2. A negatively charged rod is brought near one end of an uncharged metal bar. The end of the metal bar nearest to the charged rod will be charged

    a) positive
    b) negative
    c) neutral

3. A negatively charged rod is brought near one end of an uncharged metal bar. The end of the metal bar farthest from the charged rod will be charged

    a) positive
    b) negative
    c) neutral

4. A negatively charged rod is brought to a contact with an uncharged metal bar. The metal bar will be charged

    a) positive
    b) negative
    c) neutral