Name:_____ Block:____ Date:____/____/____

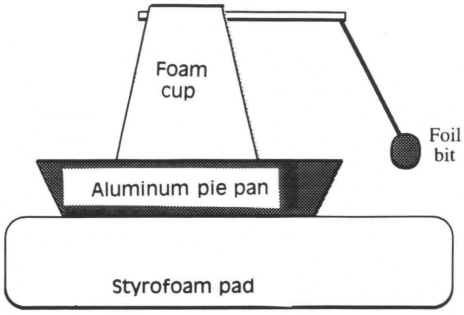
Electrophorus

670

It's a shocking experiment!

Introduction:

When Styrofoam is rubbed with wool, the Styrofoam acquires a negative charge. The Styrofoam is an insulator which holds this charge. You use the charged Styrofoam to charge an aluminum pie pan. The entire apparatus for charging the aluminum plate is called an electrophorus, which is Greek for charge carrier.



Materials:

- Aluminum Pie Plate
- Insulating Styrofoam
- Piece of Wool
- Tape
- Styrofoam cup
- soda straw
- painted pith ball or small foil bit
- string

Assembly

Tape a Styrofoam cup into the middle of a aluminum pie plate. We will be adding the straw and foil bit later.

To do and notice:

Charge the Styrofoam

Scrape the Styrofoam with the wool. Scrape firmly for at least 15 seconds.

Test if the Styrofoam is charged by using formication:

Move the piece of Styrofoam side-to-side an inch or so from your bare arm or face. You should feel a strange sensation as the hairs on your body are moved by electrical forces from the charges on the Styrofoam. This sensation is called formication, which is technically the sensation of ants crawling over your skin. It indicates that the Styrofoam is charged. If you feel nothing have someone else test the Styrofoam.

If they detect no charge, try rubbing the Styrofoam with the wool for another minute. If this fails to charge the Styrofoam try another piece of Styrofoam. You probably will not feel a spark. (The Styrofoam holds its charge.)

1. Based on what you know about wool, what charge have you given the Styrofoam?
   - ➢ You have given the Styrofoam a (positive , negative , neutral) charge.

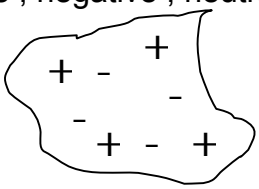
CIRCLE THE CORRECT ANSWER

What is happening with the charges? For the following section, we will explore the charges on the objects. You will be **drawing in the locations of charges**.

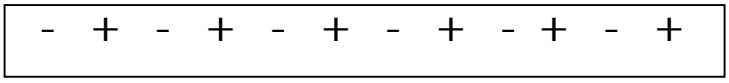
- ✓ For positive charges use: +
- ✓ For negative charges use: -
- ✓ If an object is neutral (not charged), it should have an equal number of positive and negative charges
- ✓ The first set of drawings has been done for you

2. Before scraping the wool on the Styrofoam:

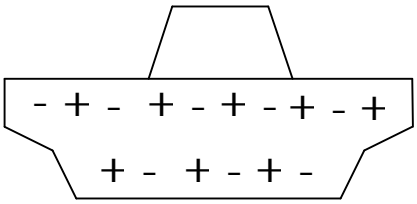
the wool has a: (positive , negative , neutral) charge



the Styrofoam has a: (positive , negative , neutral) charge

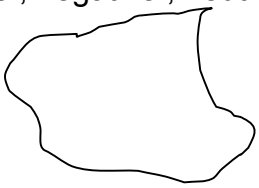


the electrophorus has a: (positive , negative , neutral) charge

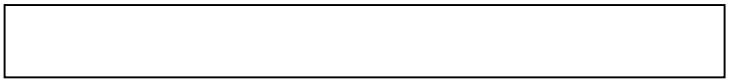


3. After scraping the wool on the Styrofoam:

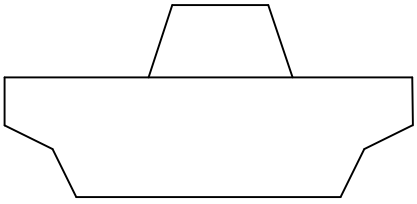
the wool has a: (positive , negative , neutral) charge



the Styrofoam has a: (positive , negative , neutral) charge

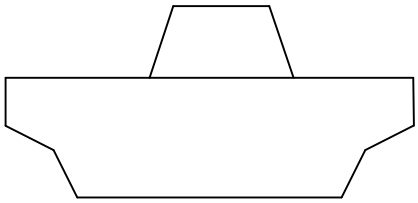


the electrophorus has a: (positive , negative , neutral) charge

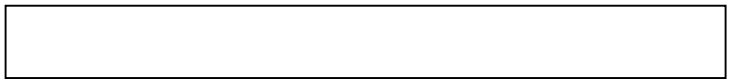


4. Before placing the electrophorus 1 cm above the charged Styrofoam:

   the electrophorus has a: (positive , negative , neutral) charge



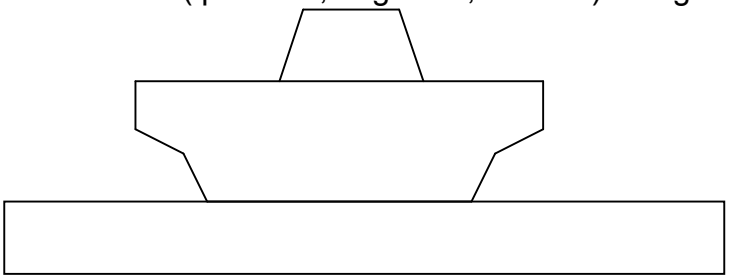
   the Styrofoam has a: (positive , negative , neutral) charge



5. After placing the electrophorus 1 cm above the charged Styrofoam:

   the electrophorus has a: (positive , negative , neutral) charge

   the Styrofoam has a: (positive , negative , neutral) charge



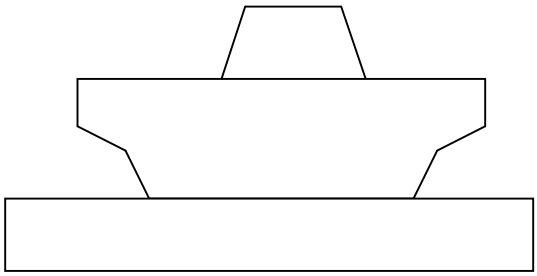
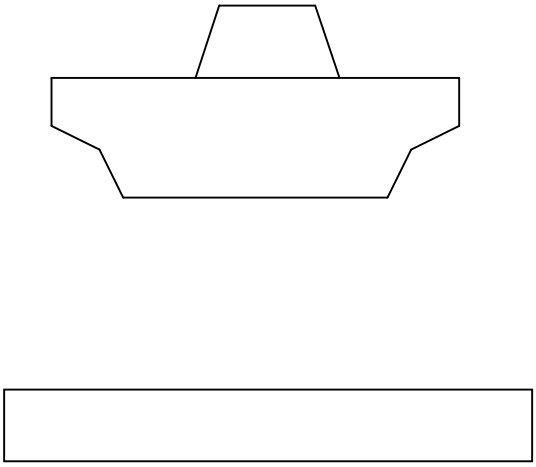
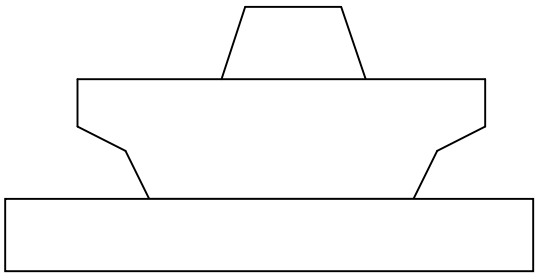
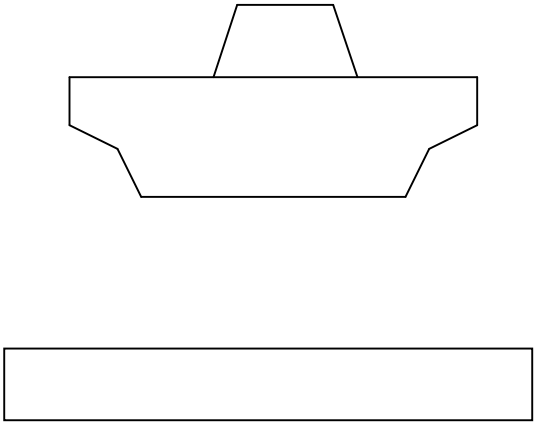
6. What kind of charge (positive or negative) moved within the pie pan of the electrophorus?

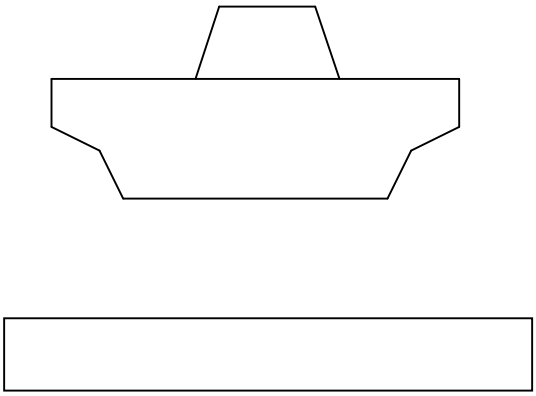
7. If negative charges leave an area, what resulting charge does the area have?

8. What do you think would happen if you touched the pie pan of the electrophorus while it was on the charged Styrofoam?

9. Touch the pie pan. What happens? Why does this happen?

The following set of pictures are listed in the order of the activities. Now that you have had some practice drawing in charges, **draw in charges to show how the locations of the charges have changed**:

10. The Styrofoam has been charged by rubbing it with the wool. The electrophorus has been placed 1 cm above the charged Styrofoam, but it has not been touched. ▪ Draw in the charges on the Styrofoam and the electrophorus	
11. The electrophorus is lifted above the charged Styrofoam using the insulated handle, but the metal plate has not been touched. ▪ Draw in the charges on the Styrofoam and the electrophorus	
12. The electrophorus is placed 1 cm above the Styrofoam again, but this time, you ground it by touching it (& you feel a shock!). ▪ Draw in the charges on the Styrofoam and the electrophorus AFTER touching	
13. The charged electrophorus is lifted above the charged Styrofoam using the insulated handle. ▪ Draw in the charges on the Styrofoam and the electrophorus	

14. While the charged electrophorus is above the Styrofoam, it is once again touched (grounded). ▪ Draw in the charges on the Styrofoam and the electrophorus AFTER touching	

15. In all of the above attempts, it was only one person getting all the shocks (only one person was exchanging electrons with the electrophorus).
    a. Determine if it makes any difference if you shock different people. Does the experiment work the same?

    b. In step #12, a person touches the electrophorus and gets a shock when electrons leave the metal pan. In step #14, the person again touches the electrophorus and gets a shock when electrons enter the pan from the person. Are the electrons that enter the pan in step #14 the same ones who left it in step #12?

How does it work?

This lab is meant for you to explore the concept of INDUCTION: charging something without touching it, only by polarizing it first and then ground it.
Here is how the process works:

a. When the electrophorus is placed 1 cm above the negatively charged Styrofoam, charge within the aluminum <u>separates</u> (this is called POLARIZATION):
   - The negative electrons in the metal pie pan are repelled by the negatively charged Styrofoam.
   - The charges within the aluminum pie pan separate—electrons from the bottom of the pan move to the rim of the pan, which makes the rim negative and leaves the bottom of the pan positive.
   - The electrophorus is still neutral! If the electrophorus is lifted up the charges rearrange (is not polarized anymore) and it is still neutral.

b. When the electrophorus is touched while it is held 1 cm above the Styrofoam, the negative electrons escape to you and the earth. This is why you feel a shock! The electrophorus is now positively charged.

c. When the electrophorus is lifted (right after being touched), it is still charged but not polarized, since it is away from the Styrofoam.

d. When the electrophorus is touched a second time, it is grounded again. Electrons are allowed to move to make the electrophorus neutral again.

We never touched the electrophorus to the Styrofoam (charged object). We only touched the electrophorus ourselves (we are neutral objects). But we were still able to charge the electrophorus. This is called INDUCTION.

An indicating Electrophorus (optional, if time allows it)

Add a plastic straw to the device as is shown in the diagram on the first page.

- Take a plastic straw and tape it to the top of the handle.
- Using some thread, suspend a pith ball or a light, foil covered piece of straw so that it barely touches the outside edge of the aluminum pie plate.

16. Lower the indicating electrophorus onto the charged Styrofoam.
    a. What happens to the small foil-covered straw piece?

    b. Slowly move the electrophorus up and down over the Styrofoam. What happens to the small foil covered piece? What does this tell you about the charges on the rim of the pie plate and the charges on the small foil piece?

17. Discharge the electrophorus (touch it) and place it on the charged Styrofoam. This time touch the pie plate with your finger momentarily.
    a. What happen to the small foil piece?

    b. Slowly bring your finger close to the small foil piece. Describe what happens.

    c. Lift the electrophorus into the air. Bring your finger slowly near the small foil-covered piece. The foil-covered piece should bounce back and forth between your finger and the pie plate. Describe what is happening and why it is happening.