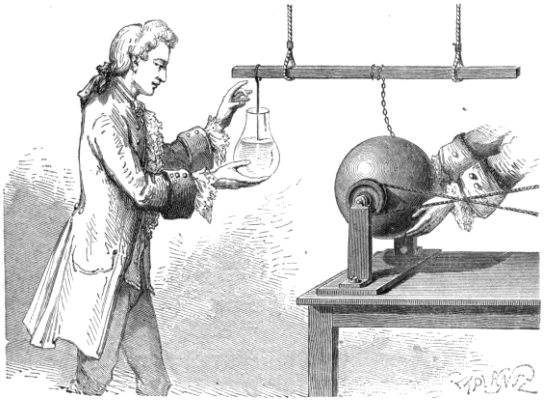
Name _____ Date _____ Period _____

Lab: “Charge and Carry”

CONCEPTUAL PHYSICS: UNIT 6

Background:



Store up an electric charge, then make sparks.
Tired of electrostatic experiments that just won’t work? This experiment will produce a spark that you can feel, see, and hear. Rub a foam plate with wool to give it a large electric charge, and then use the charged foam to charge an aluminum pie pan. The entire apparatus for charging the aluminum plate is called an *electrophorus*—Greek for "charge carrier." An even larger charge can be stored up in a device called a Leyden jar, made from a plastic bottle.

Tools and Materials:

For the electrophorus:

- Tape
- Plastic foam cup
- Disposable aluminum pie pan
- Plastic foam dinner plate or flat sheet of plastic foam packing material (the kind used to pack electronic devices)—the thicker, the better
- Piece of wool or acrylic cloth (other fabrics may work, but wool and acrylic will definitely work)

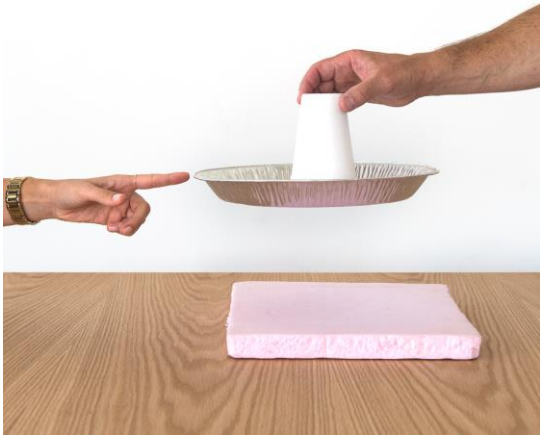
For the Leyden jar:

- A plastic 35mm film canister or similar-sized plastic container, such as a pill bottle
- A nail slightly longer than the film canister
- Aluminum foil
- Tap water

Assembly:

For the electrophorus:

1. Tape the foam cup (mouth-side down) to the middle of the inside of the pie pan. (Note that some household glue won’t work for this because they dissolve the foam.)
2. If you're using a foam dinner plate, turn it upside down. Place your pie pan on top of the upside-down plate or the piece of foam packing material.



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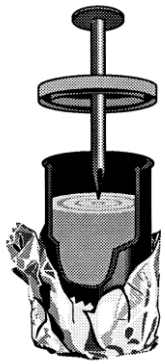
For the Leyden jar:



1. Push the nail through the center of the lid of the film canister.
2. Wrap aluminum foil around the bottom two-thirds of the outside of the film canister. You may tape the aluminum foil in place.
3. Fill the film canister almost full with water and then snap on the lid. The nail should touch the water.

To Do and Notice:

Rub the upside-down foam plate with the wool cloth. If this is your first time using the foam in an electrostatic experiment, rub it for a full minute. Then charge the pie plan by following the next steps exactly:

1. Using the foam-cup handle, place (*carefully drop*) the pie pan on top of the charged foam plate.
2. Briefly touch the pie pan with your finger. You may hear a snap and feel a shock.
3. Remove the pie pan by holding only the foam-cup handle. You may have to hold the foam plate down with your other hand.
4. The pan is now charged. You can discharge it again by touching it with your finger. You'll hear a snap, feel a shock, and, if the room is dark, see a spark

To make the largest spark when discharging, have the pie plate at least one foot (25 centimeters) away from the foam plate. After charging the foam plate once, you can charge the pie pan several more times without recharging the plate. The pie pan is portable and can be used for many electrostatic experiments. Charge the Leyden jar by touching the charged pie pan to the nail while holding the Leyden jar by its aluminum-foil covering. You can make several charge deliveries by recharging the pan before again touching it to the nail. Discharge the jar by touching the aluminum foil with one finger and the nail with another. Watch for a spark.

What's Going On?

When you rub the foam plate with a wool cloth, you charge it negatively. That's because the foam attracts electrons from the cloth. Often, a plate fresh from the package will start with a positive charge. If it does, you will have to rub the plate long enough to cancel this initial charge before you can begin building a sizable negative charge. By using an electroscope you can determine whether the foam is positively or negatively charged. Plastic foam or StyrofoamTM is an insulator; it will hold its charge until it is discharged by current leaking into the air or along a moisture film on its surface.

When you place the pie pan on the foam plate, the electrons on the foam repel the electrons on the pan. Since the electrons can't leave the pie pan because it is completely surrounded by insulating air and foam, the pan remains neutral. If you touch the pie pan while it is near the foam plate, the mobile electrons will be pushed off the pan and onto you. The electrons make a spark as they jump a few millimeters through the air to reach your finger. The air in the spark is ionized as the moving electrons knock other electrons off air molecules. The ionized air emits light and sound. You can also feel the flow of electrons through your finger.

After the electrons leap to your finger, the pan has a positive charge. Physicists say the pan has been charged by induction. You can carry the positively charged pan around by its handle and carry the

positive charge to other objects. For example, if you bring the positively charged pan near your finger again, or near any object that can be a source of electrons, the pan will attract electrons, creating a second spark.

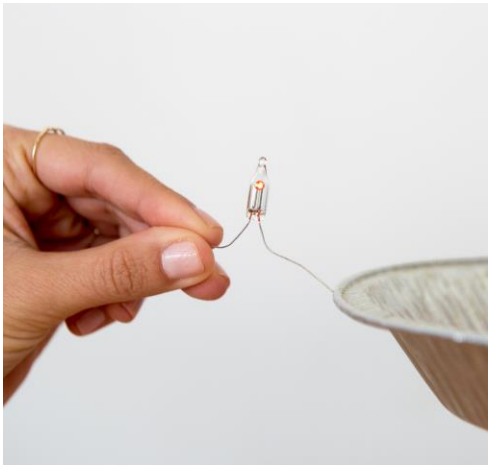
When you touch a positively charged pie pan to the nail on the Leyden jar, electrons from the nail flow onto the pie pan. The resulting positive charge on the nail attracts electrons from your body through your hand onto the aluminum foil of the jar. The Leyden jar will then have a positively charged center separated from the negative foil outside by the insulating plastic of the film can. If you touch one finger to the foil and bring another finger near the nail at the center of the Leyden jar, a spark will jump, as the negative charges are attracted through you to the positive nail. The beauty of the Leyden jar is that it can store charges from several charged pie pans, thus building up to a larger, more visible, more powerful (and more painful) spark.

Going Further

To give the foam plate a positive charge, try rubbing it with a plastic bread bag. Try rubbing it with other materials, too. Try charging the Leyden jar in reverse. That is, while holding the nail, touch the aluminum foil with the pan.

Tie a piece of tinsel (aluminum-coated MylarTM) into a loop, then charge the pie pan and hold it with its bottom upward. Toss the tinsel loop onto the pie pan. Electric charge will flow between the tinsel and the pie pan, making both of them positive. The electrostatic repulsion will allow you to fly the tinsel loop.

While holding onto one of the wires to a small light bulb, touch the other one to the charged pan. Try both with the pan charged (+) and again with the pan charged (-).



The Leyden jar is the forerunner of the modern-day capacitor. It was invented in 1745 at the University of Leyden by Pieter Van Musschenbroek. Early Leyden jars were larger than a plastic film canister and could hold more charge. The inventor discharged one through himself and wrote, “My whole body was shaken as though by a thunderbolt.” At another time, a Leyden jar was discharged through 700 monks who were holding hands. The charge caused them to simultaneously jump slightly off the ground.

Conclusion Questions:

1. What is an *electrophorus*?

2. What is a *Leyden jar*?

Taken from: http://www.exploratorium.edu/snacks/charge-carry

3. What was the purpose of rubbing the upside-down foam plate with the wool cloth?

4. What happened when you placed the pie pan on the foam plate?

5. What happened when you touched the pie pan while it is near the foam plate?

6. What happened after brought the charged pan near your finger again?

7. What happened when you touched a positively charged pie pan to the nail on the Leyden jar?

8. Which way were the electrons moving when you touched the nail on top of the Leyden jar?

9. What would you do in order to make a Leyden jar that stores more charge?

10. What is a capacitor?

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