

Traveling Programs

Build an Electrophorus

The name may be imposing, but this experiment is straightforward and uses simple, easy-to-find materials. Originally created by Alexander Volta, this design has been modified by many sources to be easy with common materials. This particular setup owes a credit to the Exploratorium's formulation for inspiration.

An electrophorus is a device that uses static electricity to make small sparks. You can even use it to investigate why a Van de Graaff generator can make hair lift up. This experiment works best on very dry days, such as in the depths of winter. On humid days the effects are harder to notice, so test it out before you do it with students.

After being shown the steps, this is an experiment that pairs or small groups can build, test, and investigate.

Materials

- Styrofoam plate or similar material
- Styrofoam cup
- Aluminum pie pan
- Tape
- Wool (or even just your hair)

Optional:

- Mylar Balloon, cut into small strips
- Aluminum foil

Directions

Place the pie pan face-up on the table. Tape the Styrofoam cup upside down to the middle of the pan. The cup will be a nice, insulating handle.



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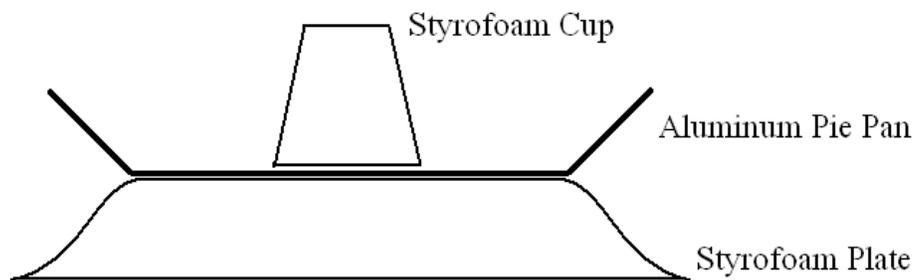
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Next we need to build up static electricity (unbalance the charges) on a flat, insulating material. An easy way to do this is by rubbing wool on a Styrofoam plate for about a minute. There are



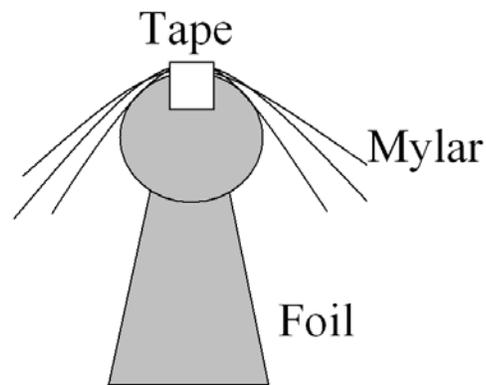
other combinations of materials you can try. For instance, instead of the plate you could try other flat sheets of Styrofoam, or even the lunch trays in your school. Instead of the wool, hair could also work, as might other types of cloth. Just be sure to test it out well in advance.

Once the Styrofoam is well charged, place it on the table. Holding the pie pan by the handle, lower it onto the plate. After a moment, bring your finger close to the metal pie pan and you will get a small shock.



Once the pie pan stops giving you any more shocks, lift it up and away from the Styrofoam plate – again, just touching the handle. Now touch the pie pan to get another shock. You can keep doing this, putting the pan on the Styrofoam then lifting it up. Each time you should get a shock. If it stops working, you simply need to rub the wool on the Styrofoam plate again.

As an extension, have the students build a small person out of the aluminum foil. It should only be a few inches tall, though make sure it has a nice, sturdy base so it won't fall. A cone with a head works well. Use tape if necessary. Put it into the pan, making sure the aluminum figure is touching the metal of the pie pan. Now take a couple strips of Mylar and tape them onto the figure's head to give it hair. It works well to take a few 6-inch strips and tape them across the middle to the head.



Now repeat our experiments. What happens to the figure when you put the pie pan onto the Styrofoam? What happens when you get a shock?

Explanation

When you rub wool against the Styrofoam, the wool loses some of its negative charges to the plate. Now the plate has extra negative charges. Since the foam is an insulator, even though like charges repel, they are stuck in place.

When you put the pie pan on top, it is a good conductor, so charges can flow. Near the charged Styrofoam plate, like (negative) charges get pushed away and opposite (positive) charges attract. Much of the negative charge then ends up on the top of the pan. If you've made the figure, you'll notice that those extra negative charges repel from one another and its hair spreads out.

For reference, this is called charging by induction. Basically, we did not actually put negative charge on the pie pan. The negative charges that are on the Styrofoam stayed there. They simply made the repelling force that rearranged the charges on the pan.

By touching the metal pan, you provide a path for the repelled negative charges to flow away from the pan. You notice this as a shock. Without extra negative charges on the top of the pan, the figure's hair goes down.



Since the pie pan just lost some negative charge, on the whole it now has extra positive charge. Lifting the pan up, away from the electric force of the Styrofoam plate, the net positive charge can spread out evenly on the pan. Again, like charges repel, causing the effects we see in the hair and a small spark. That spark is the effect of negative charges flowing from you and into the positive pie pan. This means that after the shock, the charge on the pan is balanced out once more, just like it was at the beginning. Since the Styrofoam plate still has all its extra negative charges, you can repeat the experiment as many times as you would like.

In reality, of course, it won't work forever. Nothing is a perfect insulator, and charges slowly but surely leak away from the Styrofoam plate, repelled by the electric force. When the force gets too weak, though, we can simply grab the wool and start again.

Notes for Classroom Use

The depth to which you explain this activity depends on the age of the student, where you are in your electricity unit, and whether you've had the assembly from Traveling Programs yet. Here are some possible lines of approach:

- If the students are just starting the unit, aside from getting the students excited about electricity, you could use this activity to discuss when charges attract and repel, as well as give an example of the difference between insulators and conductors.
- For advanced students, you could set this up as an investigation, and see if the groups can figure out what is happening with the electric charges throughout the experiment.
- Does it matter how long you rub the Styrofoam? Can you get larger or smaller sparks? If the lights are sufficiently low and the day is dry, the students can make visual observations about the sparks.
- If your students have seen a Van de Graaff generator in use before, see if they can predict what will happen to the hair of their figure before they put it on the pan. When should it stand up? What will happen to it when



we get a shock? Once they have a hypothesis, have them do the experiment.

- What will happen if you take the pie pans of two groups and bring them together when they are both charged? Will there be a spark? Afterwards, could you still get a shock?