Advanced Static Lab

Overview: Today is the day we pull all the pieces that we've been talking about together to make a really neat electrostatic lab. You're going to discover how an electrostatic motor can really spin fast by using both plus and minus charges, how to create a charge difference to ring Franklin bells, make pie plates fly, and how to light up a bulb without using batteries.

What to Learn: Pay special attention to see how a *difference* in charge can make things move, roll, spin, chime, fly, light up, and rotate. Plus and minus charges can be used as a push-pull force that works together in tandem.

Materials

- sheet of paper
- two empty, clean steel soup cans
- aluminum foil
- neon bulb
- small foil ball with fishing line or sewing thread attached
- foam cup
- dozen small aluminum pie tart tins
- foam meat tray or slab of Styrofoam
- Fun Fly Stick (also called "Wonder Fly Stick") OR a balloon and one piece of shaped tinsel

Optional: *Electrostatic Motor If you're making the electrostatic motor, you'll also need:*

- three film canisters or M&M containers
- long straight pin
- penny
- 2 paper clips
- hot glue gun with glue sticks
- drill with small drill bit
- scissors
- tape

Lab Time

1. Grab your Fly Stick and make your tinsel float. Does this remind you any experiments we've done before? Which experiment(s)?

2. Set the meat tray upside-down on your table. This will provide an insulating layer for the static charges while you work.

3. Flying Pans: Invert the Styrofoam cup on the meat tray, open-end down. Set a stack of pie tart pans on the bottom of the cup. Gently touch the Fly Stick to the pie pans and press the button. Ta-daa!

    a. Why did the pans fly off the cup?

    b. Where does the Fly Stick need to be for this experiment to work?

    c. Does the Fly Stick have to touch the pans for the pans to move?

4. Neon Bulb: Have one student hold one of the wires of a neon bulb (pictured left) in one hand. Another student brings the Fly Stick up close to the other wire and activates the wand.

    a. What happened?

    b. What if you don't hold the wire? Does this change how it works?

    c. What's inside the bulb?

    d. Why does the neon bulb light up?

5. Franklin Bell: Set two clean, steel soup cans with their bottoms about an inch apart on the meat tray. Hold the foam ball between the cans and have another student touch one of the cans with the Fly Stick.
    a. What happened?

    b. Is there a special spot to hold the ball and/or Fly Stick? If so, where?

    c. What happens if you place your hand on the metal part of the other can during your experiment?

    d. Why does holding your hand on the can do that to the experiment?

6. Wall Paper: Put a sheet of paper on the wall, and run your Fly Stick over the surface a couple of times, then remove it.
    a. What happened?

    b. Why does the paper do that?

    c. Fill out the data table:

Static Electricity Lab Data Sheet

Trial Number	How long did you charge the paper for?	How long did the paper stick to the wall?
1		
2		
3		
4		
5		

7. Optional: Electrostatic Motor Build Steps:
    a. Place three film canisters on the meat tray in a line, about a half inch apart. Make small marks on the tray so you know where they need to be spaced when you glue them.
    b. Glue the tops of the two outer film cans down onto the meat tray. Do not glue the film canister body to the tops.
    c. Wrap the body of a film can with aluminum foil using hot glue to secure into place (not tape). Open up one-half of a paperclip and tape it to the side the film canister you covered with foil. Make sure the metal paperclip is touching the metal foil. Make a small hook at the end of the paperclip for the charge to build up on. Repeat with a second film canister.
    d. Hot glue the pin, pointy-side up in the meat tray at the middle film can position.
    e. Drill a small hole in the bottom of the third film canister and set it right-side up onto the pin. Make sure it slides freely onto the pin.
    f. Now glue a penny inside the lid and drill a hole halfway through the penny. The tip of the pin should rest in the hole when assembled.
    g. Wrap the third film can with foil, gluing sparingly into place. Make three cuts (as shown in video) and fold the foil back a little bit so there are three foil sections not in contact with each other. You want three isolated foil areas for it to work right.
    h. Snap on lid of third canister and slide it on the pin, centering the pin in the hole in the penny. Spin it with your fingers and make sure there's little to no friction. If the rotor doesn't turn freely, add a tiny drop of oil on the penny and/or at the bottom hole.
    i. To activate, touch the Fly Stick to one of the stators (stationary film canister with the paper clip attached) and touch your finger to the other. The rotor will start to turn.

Reading

Hold a Fly Stick in your hand and wave it around, With your other hand, hold a piece of tinsel (which comes with the Fly Stick) and drop it over the Fly Stick as you press the button. The tinsel should fall uneventfully until it hits the wand's electrical field, and then *POOF!* it puffs into shape. What's going on?

Stop pressing the button and watch how the tinsel still reacts with the wand. Play around with the tinsel pieces for a bit until you get one stuck to the ceiling. Charge another piece of tinsel and point out how you are chasing the tinsel. What charge is on the tinsel? What charge is on the Fly Stick?

Flip the wand around and point the butt end of the stick at the tinsel, and can you notice how the tinsel chases you? What charge is on the bottom end of the wand?

The Fly Stick is like a BIG charged balloon, which also charges the tinsel with the same negative charge. Like repels like charges, so the tinsel tries to get as far away from itself as possible, just like the leaves from the electroscope. The tinsel sticks to the ceiling for the same reason the ghost poop stuck - the negative charges in the tinsel repel the wall's electrons, leaving the positive protons to be attracted to the tinsel.

Exercises

1. What is common throughout all these experiments that make them work?
2. What makes the neon bulb light up? What else would work besides a neon bulb?
3. Does it matter how far apart the soup cans are?
4. Why does the foil ball go back and forth between the two cans?
5. Why do the pans take on the same charge as the Fly Stick?
6. When sticking a sheet of paper to the wall, does it matter how long you charge the paper for?
7. Draw a diagram to explain how the electrostatic motor works. Label each part and show where the charges are and how they make the rotor turn.

Answers to Exercises: Advanced Static Lab

1. What is common throughout all these experiments that make them work? (Opposite charges attract, like charges repel.)

2. What makes the neon bulb light up? What else would work besides a neon bulb? (Neon bulbs light up because the electrical field excites the gas, which then gives off a pinkish-orange light. A fluorescent tube is lined with white stuff called phosphor, which gives off light whenever it's struck by UV rays. The tube is filled with a gas that gives off UV rays when placed in an electrical field. When the bulb is brought close to a static charge, electrons rip through the tube and go out the other side. As they go through, they smack into the gas vapor which releases light rays (UV in a fluorescent tube) that hit the phosphor on the inside of the tube, which then emits light. Fluorescent lights, or any tube of gas from the noble gases column on the periodic table… like neon will also glow in an electrically-charged field.)

3. Does it matter how far apart the soup cans are? (Yes – if they are too far apart, the ball isn't attracted to the opposite can.)

4. Why does the foil ball go back and forth between the two cans? (The ball takes on the charge of the negatively charged can (charged by the Fly Stick), and is then repelled since they are both the same charge.
It swings to the opposite can where the charge balance is restored. Then the positive protons see the negatively-charged soup can and are attracted to it and the cycle starts all over.)

5. Why do the pans take on the same charge as the Fly Stick? (Aluminum conducts electricity.)

6. When sticking a sheet of paper to the wall, does it matter how long you charge the paper for? (Yes, but only up to a point. See results from table to determine where this point is.)

7. Draw a diagram to explain how the electrostatic motor works. Label each part and show where the charges are and how they make the rotor turn.

   a. The Fly Stick charges one of the stators with a big negative charge, which is very different from the ground (balance) charge of the opposite stator. The charge is conducted through the paperclip and onto the foil area, which picks up the same charge as the paperclip. Like charges repel, so the rotor starts to turn, bringing a new foil area under the paperclip hook. Tiny sparks jump to the new areas and charge them, which make them attract/repel from the stators and it continues to turn. The foil on the rotor under the paperclip hook is always charged with the same charge as the paperclip, so it's being repelled or attracted sideways. If you put a positive charge instead of grounding it, the rotor will spin even faster.

   b. You can also think of the rotor like a waterwheel. Imagine turning the whole thing sideways and on one side, the negative charge is pouring into the side of the rotor that is falling toward the grounding film can.