RAFT IDEAS

**Topics:** Static electricity, Experimental variables

**Materials List**

- ✓ 2 different materials that when rubbed together will create a charge imbalance (Foam plate and silk (best) or wool are recommended)
- ✓ Foam item (needed if the material being rubbed is flexible/ thin such as fabric) either soft foam (e.g., polyurethane) or stiff foam (foam cup) Stiff foam may need an in-between layer of bubble wrap/ thin foam
- ✓ Rubber band
- ✓ Scissors (for sheer material such as silk high quality scissors are needed) or a paper cutter

This activity can be used to teach:
Next Generation Science:

- Energy can be transferred /converted (Physical Science, Grade 4, 3-2 & 3-4; High School, 3-3)
- Electric or magnetic interactions (Physical Science, Middle School, 2-5, High School, 3-2, 3-5)

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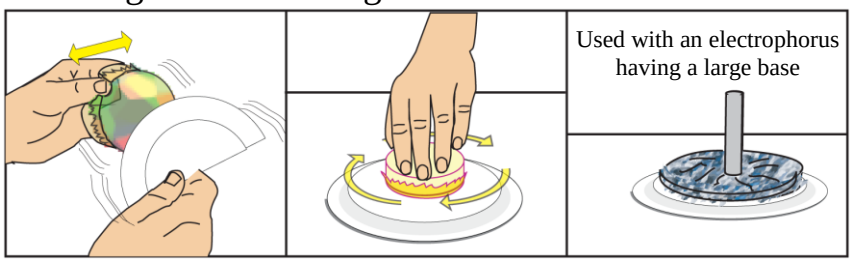
# Charge It!

## Creating electrical charge imbalances for static activities




The first electrical experiments were based on static electricity. Students can create motion, light, and sound relatively easily, on a small scale, with static electricity.

### Material considerations

The key need is to find two different materials that will create a usable charge imbalance when put together and separated (usually by rubbing). Material considerations also include cost, ease of handling, durability, degree of charge imbalance created, and the sensitivity of the material to weather variations (temperature and humidity).

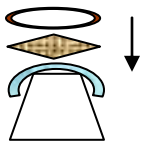
Even the humidity from undetected hand perspiration can be an issue for fabrics. A fabric section should be mounted on a foam block, foam cup, or other moisture blocking item. The surfaces to be rubbed should be touched as little as possible to limit the transfer of hand oil, dirt, or other contaminants to the material.

Certain manufacturing differences and additives can make one item (a foam plate, for example) work well while an apparently identical item from the same distributor or a different manufacturer will not work. The best idea is to always test samples of current materials **before** doing an activity with students.

**Assembly** (**Caution**: Determine if students are allergic to wool before using wool!)

1. Cut a foam plate in 1/2 unless a full plate is needed for a large electrophorus, etc.
2. Cut thin, flexible material (silk, wool) into 10 cm x 10 cm (4" x 4") squares.
3. If needed, cut foam into 6 cm x 8 cm (2" x 3") blocks, ~4-5 cm (1½" - 2") thick.
4. Place a square of thin material on a foam block and secure with a rubber band.

   **Alternate method**: drape a strip of bubble wrap, or flexible foam, over the bottom of an upside foam cup. Longer strips could be folded in ½ first. Place the square of thin material so that 2 opposite corners are on the bubble wrap. Secure the corners of the square to the cup with a rubber band.



### To Do and Notice

1. Briskly rub the covered foam block, or cup, and plate bottom together. For some brands of foam plate one side may work better than the other for generating a charge imbalance.
2. Position the rubbed surfaces as needed for the static based activity.
3. Repeat step 1 as needed to "recharge" the surfaces for the activity.

Possible static activities include those listed on the RAFT idea sheets ***Static Merry-go-Round***, ***Static Spinner***, ***Neon Bulb – Make it Glow***, ***Electrophorus – Charge Carrier***, and ***CD Sparker***. Static based activities will work better on days that are cooler and drier. **Doing static based activities in hot, humid conditions may be impossible.**

Designed and written by Michael Pollock (RAFT)

## The Science Behind the Activity

Placing items in contact and then separating them can move electrons from one item to the other. Items vary in how strongly they "hold on" to electrons. The triboelectric series, see below, is based on this fact. An item that gains electrons will have a net negative (-) charge. An item that loses electrons will have a net positive (+) charge. Electrons are moved, not created! This is sometimes referred to as "triboelectric charging", creating a "charge separation", a "charge imbalance", "charge" or "charging" a material. For solid materials the positive charges (protons) cannot leave or really move about within and between materials as electrons can sometimes do.

Opposite (**unlike**) charges (+/-) are equally **attracted** to each other. Same (**like**) charges (+/+ or -/-) are equally **repelled** by each other. **The force** of attraction and repelling **increases with a decrease in the distance** between the charges. The charges will, in a sense, "stay put" unless the item is a conductor (metal, etc.) that has electrons that move about very easily.

This edited **triboelectric series** can aid in selecting pairs of materials to rub together

| + Gives up electrons to a material lower down + |
|---|
| Human skin (if clean and dry) |
| Rabbit's fur |
| Acetate |
| Glass (jar or rod) |
| Human hair, if not coated with hairspray, etc. |
| Nylon |
| Wool (**check students are not allergic to wool!**) |
| Fur |
| Silk (scarf squares, scraps from a fabric store, etc.) |
| Aluminum |
| Paper |
| Cotton |
| Lucite, Acrylic |
| Amber – the original "plastic" |
| Mylar |
| Polystyrene, "Styrofoam", #6 plastic, foam plates and cups, Bic pens |
| Polyethylene - transparent tape |
| Rubber – balloon |
| Rayon |
| Polyester |
| Polyethylene (#2 / #4) bubble wrap |
| Polypropylene, #5 plastic, yogurt container |
| Vinyl, PVC, #3 plastic |
| Teflon |
| Saran Wrap |
| - Gains electrons from a material higher up - |

This series is arranged with items that more readily take on extra electrons below items that more readily give up electrons. When placed in contact, a material lower on the list will gain electrons, becoming negatively charged, while a material listed higher up will lose electrons, becoming positively charged.

The farther apart the materials are on the list, the greater will be the size of the charge that potentially can be transferred. This should be considered only a general guideline, as actual experience may not agree with the ranking! Composition, manufacturing processes, and surface features can affect how one material will react when placed in contact with a different material.

Adhesive forces cause the transfer of electrons, **not** friction. Rubbing involves frequent surface contact and separation.

Transparent tape can generate a charge separation all by itself, since one side is made of plastic and the other side has an adhesive that is peeled away as the tape is unwound. Unwinding tape can generate voltages of up to 20,000 volts!

Silk (best) or wool rubbed against a foam plate/cup (polystyrene (#6) plastic) will often generate a good charge separation.

## Troubleshooting

Lightly scraping the surface of a foam plate, for example, may increase the charge that can be generated. Unseen dirt, finger oils, etc. can greatly reduce the charge that a previously useable pair of items can generate. Try a new pair of items as some contaminates can spread to other materials when rubbed.

## Taking it Further

Experiment with other pairs of materials. How can a charge be eliminated from a surface?

**Web Resources** (Visit www.raft.net/raft-idea?isid=32 for more resources!)
For basic information on static electricity see the follow website - http://www.sciencemadesimple.com/static.html