RAFT IDEAS

Topics: Static Electricity

Materials List

- ✓ 2 Cups, foam or paper
- ✓ 1 Flex straw (or a straight straw, a thinner straw, and a paperclip, small, smooth finish)
- ✓ Narrow strip cut from either a clean snack bag that has a reflective inner surface, foil, tinsel, or mylar 2 mm x 10 cm (1/16" x 4")
- ✓ Pencil
- ✓ Tape
- ✓ A collection of sample items to rub together to create a charge imbalance ("static charge"), see page 2 for suggested materials

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

- 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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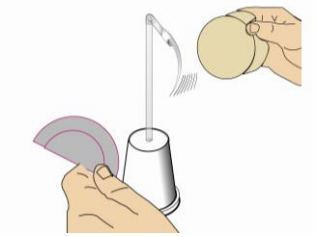
Static Detector

Learn How to Attract, Repel, and "Levitate" with Static Charges!



Investigate the generation, location, charge, and polarity of "invisible" static electrical charges with this simple device.

Assembly

1. Stack and invert 2 cups. Use a pencil to poke a hole, a little smaller than the straw's diameter, in the center of the bottoms of the inverted cups.
2. For a flex straw, bend the flex section to form a right angle (90º). For a non-flexing straw, make a fixed bend by bending out the loops of a paperclip to make an "S" or "C" shape. Then insert the paperclip's narrower loop into the open end of the straw and push the paperclip all the way into the straw. Use a thinner straw to push the paperclip into the straw about 3 cm (~1") further. Bend the middle of the covered paperclip to make a right angle (90º).
3. Insert ¼ of the longer side of the bent straw into the hole in the inverted cups.
4. Overlap the narrow foil strip with the top of the bent straw for a distance of 1 cm (3/8") as shown. Attach the strip to the straw with a piece of tape.

To Do and Notice **Note**: When conditions are warm and/or humid, less charge imbalance (if any) may be generated. Also, any charge imbalance that is generated will dissipate more quickly in a warm and/or moist environment.

1. Choose two items that will generate a static charge when rubbed together (see following page.) Do not rub them yet!
2. Touch the foil strip with a finger to neutralize any charge imbalance. Bring each item in turn near the end of the foil strip. What is observed?
3. Briskly rub the two items together and then bring each of them, in turn, near to the foil strip. What happens? Touch the foil strip with a finger.
4. Bring one item close enough to the foil strip so that the strip moves toward it and then is repelled away. Bring the other rubbed item near the strip. What happens?
5. Touch the foil strip; then repeat step 4 with the other item. What is observed?
6. Hold a finger and a rubbed item on opposite sides of the strip. Bring the rubbed item and finger closer to the strip. Can the strip be made to bounce back and forth between them? Repeat with the other rubbed item.
7. Repeat step 6 using the other rubbed item in place of a finger. What happens?
8. Repeat steps 2 to 7 with other combinations of items. Which combinations, when rubbed together, generate the strongest charge imbalance?

The Science Behind the Activity

Within any uncharged item the number of electrons and protons are relatively equal. Since each electron has a negative charge and each proton has a positive charge, the charges in most items will balance each other so there is no overall charge imbalance. An item with the same number of negative and positive charges is said to be neutral. Some electrons may move from atom to atom. In metals relatively more electrons can move easily between atoms than in most other materials. Other materials will hold on

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to their electrons more strongly. The strength of the materials' "adhesion" will vary. When two different materials are placed in contact (as when rubbed) one material may pull electrons away from the other material.

The material that gains electrons will have more electrons than protons and thus have a net negative charge. The material that lost electrons will have fewer electrons than protons and thus have a net positive charge. Items with either type of charge imbalance are said to be "charged". Note that generating a charge imbalance means electrons have been moved about, not created! Opposite charges (negative/positive) attract each other while like (same) charges (negative/negative or positive/positive) will repel each other.

Now the surprising thing is that an item that is neutral (has no charge imbalance) will be mutually attracted to an item with a negative or positive charge! When a negatively charged item, for example, comes close to a neutral item, some of the electrons in the neutral item will slightly shift their position (orbits) to be farther away from the negatively charged item. The attraction between the negatively charged item and the overall closer positive charges, which do not effectively move, is stronger that the repelling force between the like negative charges. Since no electrons were added or removed the neutral item is still neutral. When a positively charged object approaches a neutral one there is again a net attraction as the electrons in the neutral item shift their orbits to be slightly closer to the positively charged item.

A charged item can lose the charge imbalance. Dust and moisture in the air will be attracted to a charged item and help eliminate the charge imbalance. For a metal or metal-coated item, small charge imbalances can be safely eliminated by touching the metal surface. The human body has a huge amount of positive and negative charges and so can easily give up or take on extra electrons, as needed, to eliminate a small charge imbalance.

In step 2 of **To Do and Notice**, the foil strip is touched with a finger to ensure the strip is neutral. The uncharged items should not attract or repel the strip; however, the act of unpacking an item, such as a foam plate or cup, may cause a charge imbalance. Spraying with water and blotting dry may ensure an item is neutral. In step 3, once the items have been rubbed they will be oppositely charged. The pair of rubbed items should have equal and opposite charges, but this depends on the materials and time. Fabric-like materials tend to quickly lose their charge imbalance by losing or gaining electrons from the moisture in the air, from being held, etc. The strip may thus react more strongly to one item than the other when each of a rubbed pair is brought near in turn. In steps 4 and 5, unseen electrons will transfer from or to the foil strip such that the strip and the charged item will end up with the same type of charge (positive or negative). The strip will thus be repelled from the first item but then will be attracted to the other item, in step 5, that is oppositely charged.

In step 6, the strip has a charged item on one side and a neutral finger on the other side. The neutral strip will be attracted to the charged item, and then repelled when the strip is charged. The charged strip will be attracted to the neutral finger. Contact with the finger will make the strip neutral again. The neutral strip will again be attracted to the charged item, so the process will be repeated. The rubbed item usually has a great enough charge imbalance to repeatedly charge the strip so the strip will "wag" back and forth a number of times before stopping. In step 6, the same general process occurs except the charged strip is more strongly attracted to the oppositely charge item than to a neutral finger. The speed and the number of times the strip moves back and forth can give an indication of how much of a charge imbalance was created.

Material suggestions –Materials that more readily take on extra electrons include foam (#6 PS) trays, plates, or cups; balloons, disposable food containers made of PLA "compostable" material. Materials that more readily "lose" their electrons include fur, wool, silk, and compostable bags (e.g., Biobag) made of Mater-Bi. Thin, fabric-like materials work better if secured to an insulating base. For example a napkin folded to be about the size of the bottom of an inverted cup can be covered with a square of material which is secured to the cup with a rubber band or tape.

Taking it Further

See RAFT Idea Sheet ***Static Merry-go-Round*** for how to make a motor that runs on static electricity.

Web Resources (Visit www.raft.net/raft-idea?isid=496 for more resources!)

Background information and activities with static electricity - http://www.sciencemadesimple.com/static.html and http://www.mos.org/sln/toe/staticmenu.html

