RAFT IDEAS

Topics: Static electricity, Charge transfer, Motors

Materials List

- ✓ Narrow straw, 8mm (5/16”) diameter, ~8 cm (3”) long
- ✓ Thinner straw, ~3 mm (**⅛”**) diameter, ~2.5 cm (1”) long
- ✓ Paperclip, reg. (#1)
- ✓ Card, ~8 cm x 13 - 15 cm (~3” x 5-6”)
- ✓ Thin straw, 3 mm (⅛”) diameter, ~ 6 cm (2½”) long
- ✓ Wide tinsel or mirrored Mylar (reflective) strip ~5 mm wide x 5 cm long (3/16” x 2”)
- ✓ Foam lunch plate
- ✓ Silk (best), wool, or plastic wrap, 10 cm x 10 cm (4”x 4”)
- ✓ Foam cup, 6-8 oz.
- ✓ Bubble wrap or thin flexible foam, 5 cm x 25 cm (~2” x 10”)
- ✓ Rubber band, #32

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 Sci., Middle Sch., 2-5; High Sch., 3-2, 3-5)

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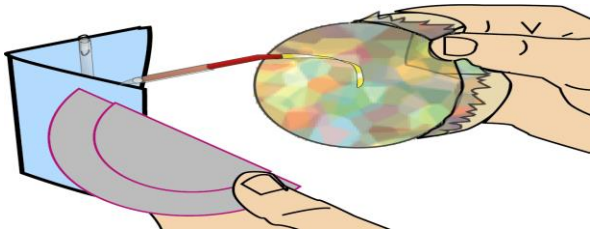
Static Spinner

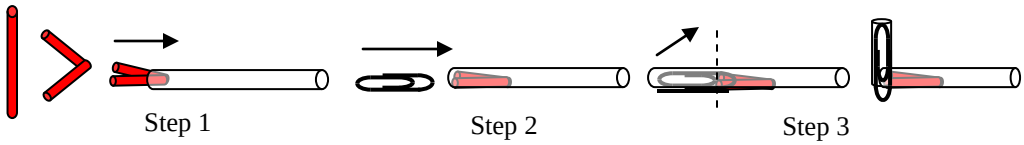
An easy to make variation of the first electric motor!



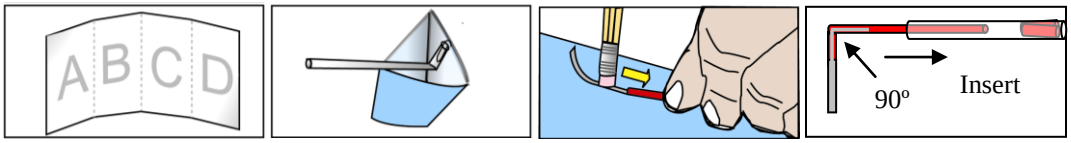
Benjamin Franklin powered his original electric motor using static electricity. This simplified version duplicates his method of converting electrical energy into motion.

Assembly:

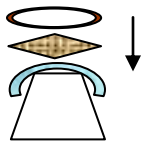
1. Cut an 8 cm (3”) length of an 8 mm (5/16”) diameter straw. Cut a 2½ cm (1”) length of a thinner straw, fold in ½, pinch the ends and insert as shown below.
2. Insert the narrow loop of the paperclip fully into the same end of the narrow, 8 mm (5/16”), straw. The small loop will push the folded thinner straw in further.
3. Bend the straw by holding the paperclip and fold up, paperclip on the outside.



4. Fold an 8 cm x 13 cm (3” x 5”) card in half, narrow ends together. Unfold. Fold each end to the middle. Unfold. The card is now divided into four sections.
5. Refold the card, overlapping the end ¼ sections to form a triangular shape. Use the straw/paperclip unit to secure the overlapped sections together, as shown.
6. Insert ½ of a 5 cm (2”) long wide tinsel or ~5 mm (3/16”) wide mirrored Mylar strip into the slightly flattened **cut** end of a 6 cm (2½”) long thinner straw.
7. Bend the thin straw about 1 cm (⅜”) from the inserted Mylar. Pinch the bend.
8. Insert the other end of the thin straw into the narrow straw from step 5.



9. Fold the strip of bubble wrap, or flexible foam, in half and center over the bottom of an upside foam cup. Cover with a square of fabric, or plastic, so 2 opposite corners are on the bubble wrap.
10. Secure the corners of the fabric to the cup with a rubber band.
11. Cut a foam plate in half for ease of handling or leave whole.



To Do and Notice (results will vary with temperature and, especially, humidity!)

1. Hold the cup and plate. Briskly rub the fabric and plate bottom together. For some brands of foam plates one side may work better (or neither side may work!) for generating a charge imbalance. Repeat the rubbing as needed.
2. Bring one of the items near the strip of Mylar. How does the Mylar strip react?
3. Touch the Mylar briefly. Bring the 2nd item near the Mylar strip. Note reaction.
4. Repeat step 1 and place the fabric and plate on either side of the Mylar strip. Vary the nearness and position of the fabric and plate after rubbing. Repeat.

Created and written by Michael Pollock (RAFT)

The Science Behind the Activity

Placing items in contact and then separating them may move electrons from one item to the other. Items vary in how strongly they "hold on" to electrons. 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! For solid materials the positive charges (protons) cannot leave or move about like the electrons. 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 electrons will, in a sense, "stay put" unless the item is a conductor (metal, etc.) that lets electrons move about more easily. An item with a net charge, positive or negative, is said to be "charged", that is, to have a charge imbalance.

Touching a charged item can eliminate (neutralize) the charge imbalance at the spot touched or all over if the item is a conductor. The human body can safely give up or take on the electrons needed to neutralize small charge imbalances. Touching the Mylar strip removes any existing charge imbalance. The electrons can leap across an air gap unseen or cause a spark, if the charge imbalance is large enough. Charge imbalances can also be neutralized, over time, by charges on dust, etc. in the air. The charge imbalance will diminish more slowly if the air is cool and/or dry. Generating a large or lasting charge imbalance on a damp or humid day may be impossible.

An uncharged, **neutral,** item has an equal number of positive and negative charges. A neutral item will still be mutually attracted to any charged item! The attraction is due to the electrons in a neutral item's atoms rearranging their orbits very slightly when near a charged item. The electrons will move slightly closer to a positively charged item or slightly away from a negatively charge item. The result is a net attraction, as the attractive force from the slightly closer opposite charges is greater than the repelling force of the slightly farther apart like charges. This is the why a neutral Mylar strip, which can turn, will rotate toward a charged item that is being held in place.

When a Mylar strip moves near enough to a charged item, some electrons can bump over the gap. Some electrons will move toward the Mylar from a negatively charged item **or** from the Mylar toward a positively charged item. Either way the Mylar will now end up with the same type of charge (+ or -) as the nearby charged item. A Mylar strip, which can rotate, will be repelled from the charged item, since like (same) charges repel each other. The strip is now strongly attracted to the oppositely charged second item. When a charged strip moves near enough to the second item some electrons are again transferred. The Mylar strip now acquires the same type of charge as the second item. The strip is now repelled from this second item, but will be attracted to the first charged item. The Mylar strip continues rotating due to momentum. When the Mylar strip rotates near the first charged item the process repeats. The attractive force changes to a repelling force. The Mylar strip rotates away, repeating the cycle.

Troubleshooting

Cool and dry days are better for doing static activities; moisture of any kind can be a problem. Wrapping the fabric around bubble wrap or foam and a foam cup helps prevent unseen hand moisture from entering the fabric.
The thinner straw/Mylar unit **must rotate smoothly, with very little friction!** The bottom of the thinner straw should be round, smooth, and cut at a right angle to the straw. The bend in the thinner straw should be about 90 degrees. The bend must be well above the end of the narrow straw. Reform the bend or trim the straws as needed. The Mylar strip may spin easily at first and then "hang up" with the Mylar pointing at an angle instead of pointing downward. The turning of the thinner straw inside the narrow straw may generate a static charge separation such that they seem to "stick" to each other. Remove the thinner straw from the narrow straw and eliminate any charge imbalance by touching or breathing on the straw. Reinsert the thinner straw. Repeat as needed so that the Mylar strip will drop down freely when turned to a 10 or 2 o'clock position and then let go.

Taking it Further

Explore changing a variable such as the shape and/or size of the Mylar strip or the bend in the thinner straw.

Web Resources (Visit www.raft.net/raft-idea?isid=409 for more resources!)

- Basic background information on static electricity - www.sciencemadesimple.com/static.html
- Benjamin Franklin and his electric motor - http://ethw.org/Benjamin_Franklin's_Electric_Motor
- Franklin's inventions and some for which he is credited - http://www.ushistory.org/franklin/info/inventions.htm