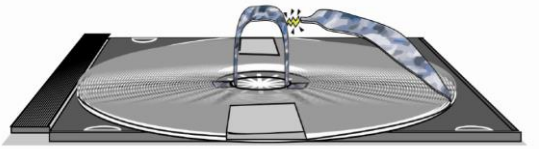
Sparking CD Capacitor

Getting a charge in and out of a pair of CD's!



Build a modern version of the Leyden jar, a "battery" for static electricity.

Topics: Static Electricity

Materials List

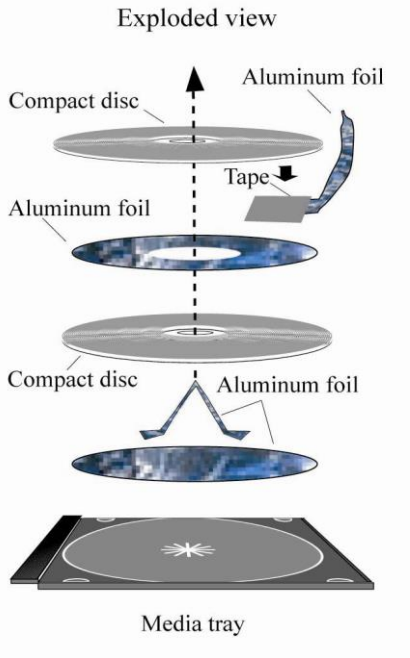
- ✓ Media tray with a hole in the center (from a CD case)
- ✓ Foil
- ✓ 2 CD's
- ✓ Tape
- ✓ Straw, any size
- ✓ Pencil
- ✓ Scissors
- ✓ Electrophorus – see RAFT Idea Sheet ***Electrophorus - a Charge Carrier***
- ✓ 2 items that can be used to create a charge imbalance, (foam plate paired with a foam plate covered with silk (best) or wool)

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

- Energy can be transferred from place to place and converted from one form to another (Grade 4, Physical Science 3-2, 3-4; High School, Physical Science 3-3)
- Electric or magnetic interactions (Middle School, Physical Science 2-5, High School, Physical Science 3-2, 3-5)

Assembly

1. Smooth a 13 x 30 cm (5 x 12") piece of foil. Fold in half so the 13 cm (5") sides are placed together. Place a CD on the folded foil section and then lightly trace around the edge of the CD with the point of a pencil. Cut the folded foil to make two 10 cm (4") foil disks by cutting 1 cm (½") in from the traced edge.
2. Fold one of the foil disks in half and in half again. Trim the pointed end to make a donut shape with a 4 cm (1½") diameter hole in the center.
3. Cut a 4 cm x 30 cm (1½" x 12") section of foil. Fold along the long dimension to make a flat ribbon about 1 cm x 30 cm (3/8" x 12") long. See RAFT Idea Sheet ***Folded Foil Wires*** for an easy way to create this foil ribbon.
4. Tear or cut the foil ribbon to make a piece about 5 cm (2") and a piece about 10 cm (4") long.
5. Center the solid foil disk in the media tray.
6. Fold the 5 cm (2") foil ribbon in half and insert about half way into the hole in a CD starting from the label side of the CD.
7. Bend the protruding ends to be flush with the CD surface on opposite sides of the CD hole.
8. Place the CD, label side down, onto the foil disk and media tray. Press down firmly.
9. Place the donut foil disk over the CD in the media tray and center the holes.
10. Place the 10 cm (4") piece of foil ribbon on the foil donut and position the end to be no closer than 2 cm (3/4") to the center CD hole. Tape this end to the foil donut and CD. Let the rest of the ribbon hanging over the CD's edge.
11. Carefully insert the foil loop from the first CD into the hole of the 2nd CD starting from the label side. Do not tear the foil while inserting!
12. Layer the 2nd CD on top. Press the 2 CD's and media tray "sandwich" together firmly and place tape tightly over the edges on 2 opposite sides, as shown.
13. Insert a pencil into the center foil ribbon and move as needed to "round" the foil.
14. Fold the end of the foil ribbon to form a point. The pointed end should just touch the center loop when the foil ribbon is bent toward the loop.



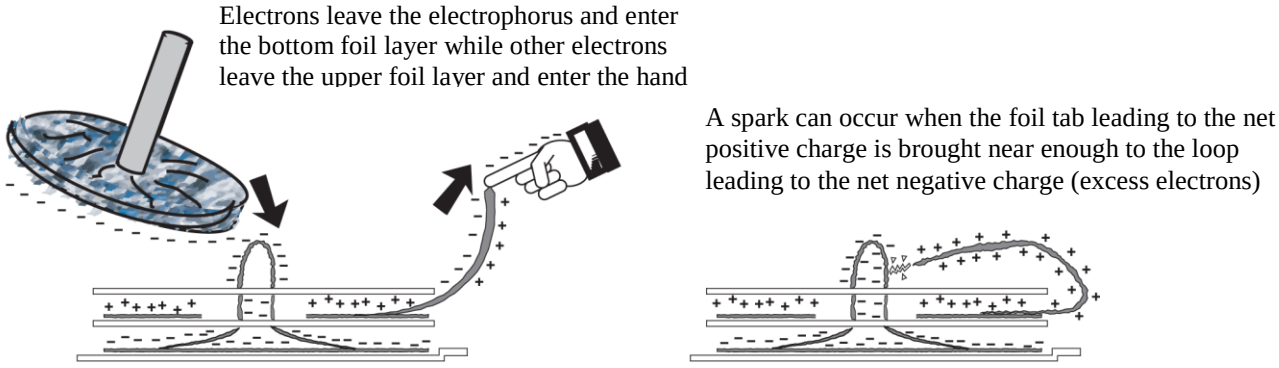
To Do and Notice (Do not touch the center and outer foil tabs at the same time! Doing so may give a static "zap" that can be painful even if harmless. Also do not create sparks around flammable liquids or vapors!)

Note - results will vary with temperature and, especially, humidity!

1. See RAFT Idea Sheet ***Electrophorus - a Charge Carrier*** for details on how to construct and induce a charge on an electrophorus.

Designed and written by Michael Pollock (RAFT), illustrated by Jay Gluckman (RAFT)

2. Bend back the pointed foil tab until the tab is pointing away from the loop.
3. Charge the electrophorus as instructed in the activity ***Electrophorus - a Charge Carrier***.
4. Hold the pointed foil tab and touch the electrophorus's metal rim to the center foil loop. Repeat step 3 and step 4 several times.
5. Slowly bend the pointed foil tip toward the foil loop with a straw (or by holding and bending the foil near the edge of the CD's) until a spark is seen.
6. The spark will go between the tip of the pointed foil and the loop. The spark will be longer and/or brighter if steps 3 and 4 are repeated multiple times (10 to 20) before doing step 5.



The Science Behind the Activity

See the RAFT Idea Sheet Charge Carrier for details on the science behind generating a charge separation and on how to induce a charge imbalance – both of which will create what will be referred to as a "charge".

The early Leyden jars consisted of a glass container with metal foils on the inside and outside surfaces. The glass was the insulator and the foils, which did not touch, were the conductors. The inner foil was connected to a metal chain and/or rod that led through a hole in a cover which was made of an insulating material. A charge separation was created, sometimes using a spinning ball of sulfur. The charge was transferred to the Leyden jars using an electrophorus, a metal surface with an insulating handle. In the CD version of the Leyden jar the foil, and possibly the metal used to plate the CD, provide the conducting surfaces while the plastic of the CD provides the insulating barrier. The process of charging the Leyden jar depends on the fact that like charges repel each other and that charges will concentrate on pointed, or sharply curved surfaces. A negative charge on the electrophorus will cause electrons to leave the electrophorus and enter the Leyden jar. The extra electrons that enter the Leyden jar will spread out, more or less evenly, on the metal surface as they repel each other. Some electrons on the outer metal surface will in turn be repelled, moving into whatever is touching the outer metal surface (hand, metal object, electrical ground).

The Leyden jar will end up with a negative charge on one side and an equal positive charge on the other side. The insulating material between the two oppositely charged metal surfaces prevents the electrons from moving and eliminating the charge. A recharged electrophorus will have another charge that can be transferred to the Leyden jar. When the pointed foil is moved toward the foil loop the distance between the oppositely charged (and conducting) surfaces will be decreased. Depending on the size of the charge on the Leyden jar, the width of the gap and the atmospheric conditions (humidity/temperature), electrons can be forced across the gap, creating a spark.

If instead the electrophorus has an induced positive charge, the process is the same, except that the electrons move toward the electrophorus and away from the Leyden jar as well as away from the object touching the other foil surface. Modern versions of the Leyden jar are called capacitors and are found in almost all electronic equipment.
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Taking it Further

Use the CD capacitor for other static based activities such as flashing a neon bulb. Investigate how long the CD capacitor will hold a charge.

Web Resources (Visit www.raft.net/raft-idea?isid=400 for more resources!)

