RAFT IDEAS

Topics: Electrical circuits

Materials List

- ✓ Holiday mini bulbs, 2.5 volt (clear bulbs are preferred for ease of seeing the filaments)
- ✓ Card stock, ~5 cm (2") square (or ½ of a business card), 1 per bulb
- ✓ Paperclips (#1, small size), 2 per bulb
- ✓ Tools to cut and strip bulb wires (if needed)
- ✓ Optional-magnifier

This activity can be used to teach:

- Energy can be transferred from place to place and converted from one form to another (Next Generation Science Standards, Grade 4, Physical Science 3-2 & 3-4)
- Engineering Practices (Next Generation Science Standards: Grades 4-6)

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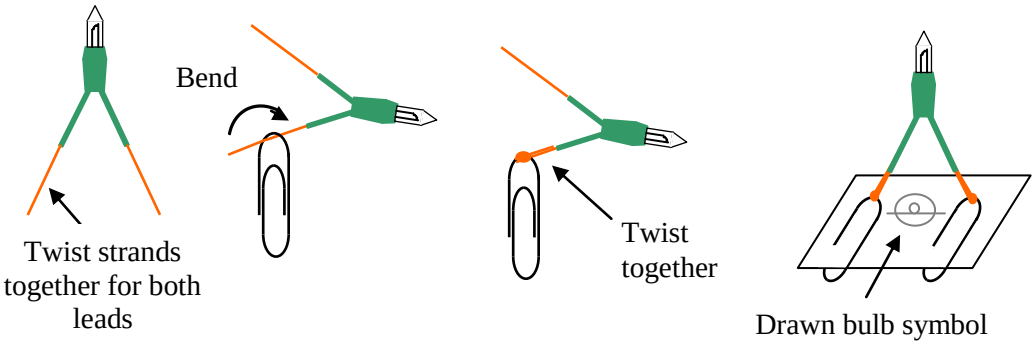
Light up your life!

Using holiday mini light bulbs for hands-on electrical activities



Closed, parallel, and series circuits can be easily explored with inexpensive materials, including this easy-to-make bulb holder.

Assembly 1 - Bulb preparation

(Note: parts in a kit will already be cut apart, stripped, and sorted, Steps 1-3)

1. Cut the wires between the bulbs so the bulbs will have 2 leads of equal length.
2. Strip about 1 - 2cm (½"-¾") of insulation from each of the bulb socket's leads.
3. To reduce confusion, eliminate any bulb sockets that have 3 leads.
4. **Twist the strands of a lead together giving it a string like appearance!** Place a lead's strands in the crease of a folded piece of card stock. Press the sides of the card together and rotate the bulb/lead. Alternatively, if the lead's insulation was cut but not removed then twist the cut piece while pulling it off.

Please note the following reason for step 4: A **short circuit** is a path of conductive (low resistance) material that goes from one end or terminal of a battery to the other end **without** going through a bulb or other high resistive load. Creating a short circuit usually generates a lot of heat! **A thin wire will heat up much faster and to a much higher temperature** than a thicker or wider wire. A short circuit that includes a strand of wire found in the mini bulb leads can create enough heat to cause a burn! There is less risk of overheating if the thin wire strands are twisted together. The risk of creating a hot wire will be greatly reduced once a bulb is mounted in a bulb holder. Another alternative is to cover the leads with a piece of foil or a section of Folded Foil Wire (see the ***Folded Foil Wires*** idea sheet).
Recommended – Wash hands after handling or using the bulbs and sockets.

To Do and Notice

1. Closely examine the mini bulb. A magnifier can be helpful in seeing the small details. Students can be asked to draw what they see. Note:
   - The coiled filament can be compared to the shape of a coiled cord on a telephone handset.
   - All mini bulbs have a wrap of wire around the base of the two wires that support the filament. This wrap of wire is a shunt that allows the rest of the lights to stay lit even if that bulb burns out. The shunt is insulated from the wires holding the filament so it can be ignored when designing these circuits.
2. Optional: Pass around a disassembled bulb, base, and socket. Have students draw the pathway between the wires inside the bulb and the socket leads.
3. Closely examine a battery and note any common symbols and markings (bumpy end, +, -, etc.).

Designed and written by Michael Pollock (RAFT)

4. Connect the bulb leads and battery together in different ways. Have students draw the arrangements that result in the bulb lighting up and the arrangements that did not light the bulb (an **open circuit)**. (**Note**: If the bulb leads are too short then add a piece of Folded Foil Wire or a paperclip to a lead as needed.)
5. Look at the circuits where the bulb lights up and develop the concept of a **closed** or **complete circuit**.

Assembly 2 - Creating a bulb holder (See the illustrations at the top of the first page)

1. Place a stripped lead of the bulb socket into the smaller opening in the paperclip, so that the paperclip is on the middle of the bare part of the wire.
2. Fold the bare wire in half over the larger end of the paperclip and carefully twist the paperclip and/or twist the folded ends of the bare wire. Do this **just until the paperclip is firmly trapped** in the loop of the bare wire. **Do not twist too tightly** as the wire can be pulled out of the bulb holder!
3. Repeat for the other bulb lead using the second paperclip.
4. Slip the paperclips onto the card stock section ~ 5 cm x 5 cm (~2" x 2") and space the paperclips apart.
5. Draw the electrical symbol for a bulb on the card (see the illustration at the top-right of the first page).
6. Folded Foil Wires can be easily slipped under the paperclips (see ***Folded Foil Wires*** idea sheet for details). The end of the Folded Foil Wire should go slightly past the paperclip in the direction of the other paper-clip, then be folded back and **pressed down**. This will help secure the Folded Foil Wire to the paperclip so the Folded Foil Wire does not slip out and touch the other paperclip, creating a short circuit.

To Do and Notice

Use the Bulb Holders for a variety of electricity investigations (see ***Circuits – An Electron Maze*** idea sheet).

The Science Behind the Activity

To understand how light is produced we need to know about electrons. Put simply, an atom's electrons spin around in relatively fixed orbits or paths called electron clouds. Heating energizes atoms and causes the atoms to vibrate or "jiggle". The atoms' movement increases the collisions between and the vibrations of the electron clouds. When the atoms are hot enough these vibrating clouds can give off visible light. Fire, with its glowing embers and flame, has been used for thousands of years to produce light.

Light produced by heating, such as sunlight, is **incandescent light**. Early electric light bulbs were incandescent bulbs containing a tightly coiled wire filament. The coil in a 60-watt bulb is really a coil of a coil and would be over 2 m (~6 ft) long if straightened! This long, thin tungsten wire resists the flow of electrons more than other parts of the circuit. As electrons wiggle back and forth to get through, the filament coils heat up and glow white hot at over 2,000 degrees C (4,000º F). The mini light bulbs are similar except the filament is a single coil. Fluorescent light bulbs produce light (luminescent light) using a different method that takes less electrical energy.

Taking it Further

- Have students try to make a flashlight bulb light up using a battery and a piece of conductive foil, wire, or a paperclip. (Note: Exploring a mini bulb **first** is recommended because the bulb socket's leads make connecting it to a battery, correctly, much easier. With a flashlight bulb the students often have trouble finding and using the two contact points on the bulb that lead to the ends of the filament.)
- Test materials for conductivity by placing them in a gap in a circuit that has a bulb and a battery.

Web Resources (Visit www.raft.net/raft-idea?isid=192 for more resources!)

For more information on the following concepts, go to:

- **Bulbs** – http://home.howstuffworks.com/light-bulb.htm/printable
- **Mini Bulbs (with shunt) -** http://www.howstuffworks.com/christmas-lights.htm/printable

