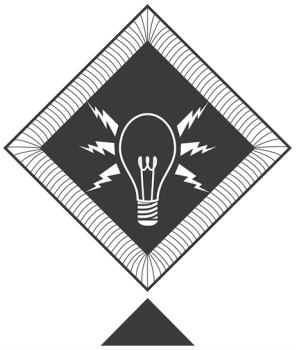

# ELECTRICITY


1. Learn the following **electrical safety rules**.
   - Do not touch anything electrical when your hands or feet are wet.
   - Never run electrical wire or an extension cord under a rug where you can't see it.
   - Do not attempt to defeat the action of a fuse or circuit breaker by bypassing it with some form of jumper of conductive material, installing a fuse or breaker with a higher rating, or interfering with its intended operation..
   - Never fly a kite near electrical transmission lines or during an electrical storm.
   - Never swim during an electrical storm.
   - Never stand under a tree or near a pole during an electrical storm.
   - Never climb a pole marked "High Voltage."

**Date Completed:** **Passed By:**

2. Write the meaning of the following terms.

   Static Electricity _____

   _____

   _____

   _____

   Current Electricity _____

   _____

   _____

   _____

   Direct Current_____

   _____

   _____

   _____

   Alternating Current _____

   _____

   _____

   _____

   Magnetic Field _____

   _____

   _____

   _____

   Discuss these terms with your counselor.

**Date Completed:** **Passed By:**

3. Describe these key electricity terms, indicate their unit of measurement, and describe how they relate to each other.

   a. Voltage

      1) Description _____

      _____

      2) Unit of measurement _____

      3) Relationship_____

      _____

      _____

   b. Current

      1) Description _____

      _____

      2) Unit of measurement _____

      3) Relationship_____

      _____

      _____

c. Resistance

1) Description _____

_____

2) Unit of measurement _____

3) Relationship _____

_____

_____

d. Power

1) Description _____

_____

2) Unit of measurement _____

3) Relationship _____

_____

_____

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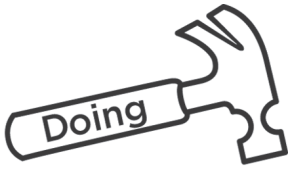
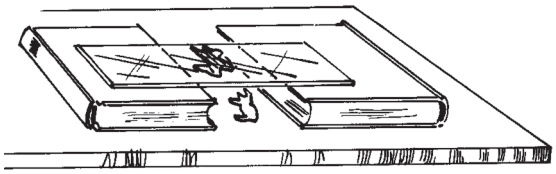


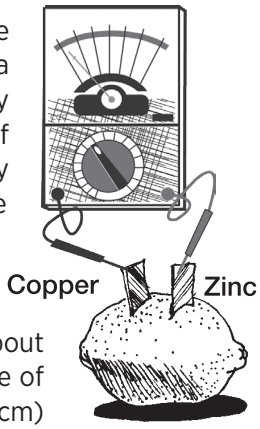

1. **Static electricity** — to discover how it works, do one of the following:
   a. Place pieces of paper cut in the shape of animals underneath a sheet of glass resting on two books. Rub the glass with silk or flannel. Discuss what happened with your counselor.



   b. Spread out a sheet of newspaper and press it smoothly against a wall. Stroke the newspaper with a pencil all over its surface several times. Pull up one corner of the paper and then let it go. Did it stay hanging, or was it attracted back to the wall? Did you hear the crackle of the static charges? Discuss what happened with your counselor.
   c. Take a comb and a fluorescent light bulb into a dark room or closet. Take the comb and rub or comb it thoroughly through your hair. (If you have no hair, a wool shirt or sweater will also work.) Hold the comb to the metal end of the fluorescent light bulb and watch carefully. Did the comb become charged? Did you see small pulses of light in the bulb? Discuss what happened with your counselor.

**Date Completed:** **Passed By:**

2. **Wet cell battery** — cut a piece of zinc from the case of a non-alkaline flashlight battery (be careful not to get any of the mush inside the battery on your skin). Push a piece of zinc into a lemon, leaving about ½" (1 cm) sticking out. Push a copper strip or piece of heavy copper wire about ½" (1 cm) away from the piece of zinc, again leaving about ½" (1 cm) sticking out. Attach or place the multi-tester (available from Radio Shack) probes to the zinc and copper. What voltage of electricity does the multi-tester show? _____

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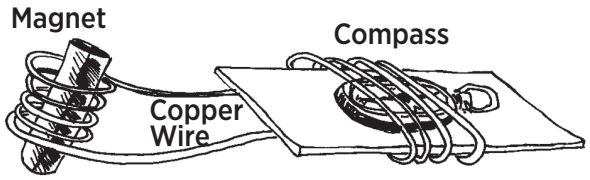
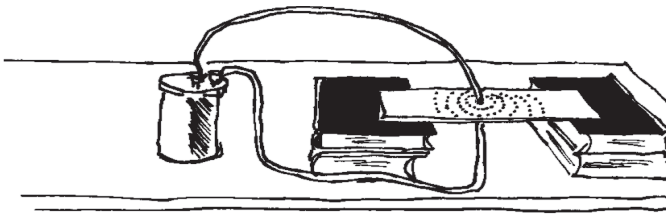
3. **Generator** — wrap a piece of copper wire around a compass and around a magnet as shown below. Move the magnet back and forth, and the needle of the compass will move as well.



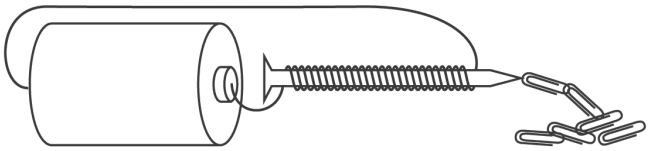

**Date Completed:** **Passed By:**

4. **Electromagnet** — do one of the following:
   a. Place a piece of cardboard on a table suspended between two stacks of books. Run copper wire up through the center and attach it to a 6-volt dry cell battery. Place iron filings on the cardboard. Tap the cardboard lightly with your fingers, and the iron filings will form a magnetic field around the wire.



Be sure not to leave the wire attached to the battery any longer than it takes to generate the pattern, as the wire is basically a short circuit and the battery could get very hot or even explode.

b. Wrap a 6″ (15 cm) piece of enamel insulated copper wire around a large iron nail in neat rows. When ¾ of the nail is covered, start back the other way. The tighter and more times the wire is twisted around the nail, the stronger your magnet will be. Use sandpaper to scrape the enamel insulation off the ends of the wire. Tape one end of the wire to the bottom of the battery and touch the other wire end to the bump on top of the battery. You now have an electromagnet that will pick up paper clips.



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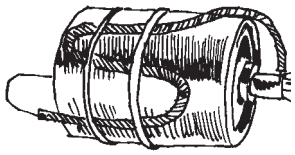
5. **Make your own flashlight** — wrap the end of some bell wire around a flashlight bulb. Bend the wire and fasten it to a flashlight battery with rubber bands (or tape). When you touch the other end to the bottom of the battery, it becomes a switch and turns your flashlight on.



**Date Completed:** **Passed By:**

**Badge Approved by:** _____

**Badge Completed on:** _____

# Electricity

## PURPOSE

To help your Cadets explore the basics of electricity, and thus begin discovering and developing any God-given interests and abilities in this area.

## LEARNING

1. They should be able to say the safety rules in their own words.
2. *Static electricity* — consists of electrons or ions that are not moving. It has few uses.

   *Current electricity* — consists of electrons or ions that are constantly moving. It has many uses.

   *Direct current* — current electricity that flows in one direction (DC).

   *Alternating current* — current electricity that rapidly reverses its direction of flow many times each second (AC).

   *Magnetic field* — the area around a magnet where its force can be felt. When electricity flows through a wire, a magnetic field sets up around the wire.

   Your Cadets probably won't fully understand the meaning of these terms. The projects that follow under "Doing" are designed to illustrate these terms and make them more meaningful. Any current encyclopedia or the Internet will also help you explain the terms more clearly.
3. Key electricity terms, units of measurement, and how they relate to each other.

   *Voltage* — the electric potential between two points. The difference in electrical strength between two spots.

   - Measured in volts. (V)

   More voltage will 'push' the electricity through the wire/device/load harder. A higher voltage through a lamp will make it shine brighter. A higher voltage through a heating element (e.g. electric stove top) will make it produce more heat. A higher voltage to some motors will make them turn faster.

   *Current* — the flow of electricity through a conductor.

   - Measured in amps/amperes. (A)

   In a regular circuit if you increase the voltage, it will cause more electricity to flow, or if you decrease the resistance, it will allow more electricity to flow. It does not take much current running through your body to kill you. Thankfully most things don't have enough voltage to force the electricity through you.

   *Resistance* — anything that restricts the flow of electricity (current).

   - Measured in ohms. (Ω)

   Increasing resistance will lessen the electricity flow, decreasing the resistance will increase the electricity flow.

   Small diameter wires will have more resistance than large diameter wires. Poor connections will increase resistance. Surface moisture reduces resistance – which is why dealing with electricity while your hands are wet can be dangerous, skin has enough resistance to protect us in most situations but water on our hands changes the resistance and can allow the current to flow through us.

   Some of the power that it takes to force electricity through something will be dissipated as heat.

   *Power* — the amount of work that is done by the load (motor, light, heater, etc.)

   - Measured in watts. (W)

   This will commonly be seen with light bulbs. The amount of light that the bulb gives is based on how much work is being done. Since the current and the voltage in the house are the same, increasing the resistance in the bulb will increase the amount of power it takes.

## DOING

As your Cadets complete each of these projects and show them to you, discuss with them how each one relates to the definition of the terms above.

1. *Static electricity* — these projects show that static electricity doesn't have any flow and consequently isn't used by man very much. We need electricity to generate heat, power and light.
   a. The pieces of paper will be drawn up to the glass by the static electricity generated by rubbing the glass.
   b. The newspaper sticks to the wall. When you pull down a corner, it will snap back. Again, static electricity does not flow. If the air is dry, you might even hear the crackle of the static charge.
   c. The friction between hair and a comb causes static electricity. The comb becomes charged. When the comb is touched to the end of the light bulb, the comb discharges into the light bulb causing the bulb to blink.
2. *Wet cell battery* — simply an illustration that a wet cell battery is a combination of acid (lemon juice), zinc, and copper. They do produce electrical current.
3. *Generator* — moving a magnet past a coil of wire produces an electrical current in the wire. This is the principle illustrated in this project.
4. *Electromagnet* — this project illustrates the definition of a magnetic field above. Electricity and magnetism are closely related. Not only does electricity flowing through wire set up a magnetic field, a magnetic field can produce electricity in a wire. If you move a wire so that it cuts across a magnetic field, electricity will be generated in the wire. This again is the principle behind the generator.
5. *Make your own flashlight* — this will illustrate direct current (DC) being used to actually generate electrical energy (light).

## OTHER SUGGESTIONS

To use this as a cadre merit badge:

1. Each Cadet should learn the rules in requirement 1 of "Learning." They should also complete requirement 2 & 3, but you should discuss them as a cadre.
2. The projects under "Doing" can be done as a cadre. Include all the projects under the static electricity requirements.