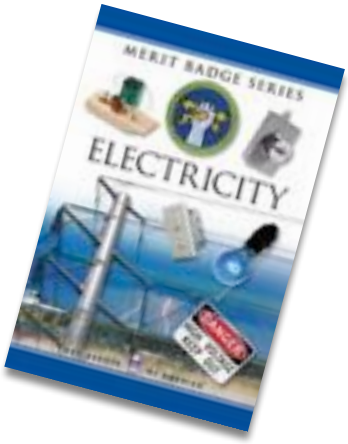
Electricity Merit Badge

This merit badge has 11 requirements that you must complete to earn the Electricity merit badge.

- ✔ We will do 7 of the requirements in a group setting
- ✔ At home, you will complete 4 of the requirements (2, 7, 8, 11)
- ✔ If you have trouble or have questions, just ask!



Although not required for this class you are still encouraged to study the Electricity merit badge book.

- ✔ Will be provided at time of class
- ✔ Relevant sections provided here for home requirements

Enclosed in this packet:

- ✔ Requirements summary
- ✔ Home requirements instructions 2, 7, 8, & 11

Requirements

Most requirements will be satisfied by in-class instruction, demonstrations, and hands-on activities. Group activities will involve the class and in smaller groups of 2-3. Some requirements require each scout to perform tasks in their home (as noted below).

Requirements with the house icon should completed at home and supervised by a parent or guardian. Work must be written and brought to class for discussion and credit.

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1. **Demonstrate that you know how to respond to electrical emergencies by doing the following:**
   a. Explain how to turn off power for a particular circuit and the whole house in the event of an emergency.
   b. Demonstrate how to rescue a person touching a live wire in the home.
   c. Describe how to safely get out of a car in an accident if you suspect a utility wire is on the car.
   d. Show how to render first aid to a person who is unconscious from an apparent electrical shock.
   e. Show how to treat an electrical burn.
   f. Explain what to do in the event of an electrical fire.
   e. Explain what to do if caught out in the open during an electrical storm.

2. **Complete an electrical home safety inspection of your home, using the checklist found in this pamphlet or one approved by your counselor. Discuss what you find with your counselor.**

3. **Make a simple electromagnet and use it to show magnetic attraction and repulsion.**

4. **Do the following:**
   a. Explain the difference between direct current and alternating current, the advantages and disadvantages of each, and give a practical example of the use of each type.
   b. Explain three ways that electricity is produced.

5. **Make a simple drawing to show how a battery and an electric bell work.**

6. **Do the following:**
   a. Define what *overloading* an electrical circuit means. Tell what you have done to make sure your home circuits are not overloaded.
   b. Determine if there is an overload on a branch circuit by either getting the current draw from all the equipment plugged in into the circuit or use the power equation to calculate the current draws.
   c. Explain why a fuse blows and a circuit breaker trips.
   d. Tell how to find a blown fuse and a tripped breaker in your home. Show how to safely reset the circuit breaker.

Requirements

7. **Make a floor plan wiring diagram of the lights, switches, and outlets for a room in your home. Show which fuse or circuit breaker protects each one.**

8. **Do the following:**

a. Read a meter associated with an electric bill. Determine the total power used since the last bill, and the cost of that power.
b. Explain other charges on the bill that were taxes or fees.
c. Discuss with your counselor five ways in which your family can conserve energy.

9. **Explain the following:**

a. Electrical terms - Current, energy, power, resistance, voltage
b. Units of measure - Ampere (amps), ohms, volts, watt-hours
c. Electrical conditions - Generating source with example, ground, open circuit, over-voltage, potential difference, short circuit
d. Equipment and their use - circuit, conductor, Ground Fault Circuit Interrupter (GFCI), insulator, inverter, rectifier, rheostat, substation, surge protection, solar panel, transformer, transmission and distribution systems, wind turbine.

10. **Do TWO of the following:**

a. Connect a buzzer, bell, or light with a battery. Have a key or switch in the line.
b. Make and run a simple electric motor (from a kit, if approved by your counselor ahead of time).
c. Build a simple rheostat. Show that it works.
d. Build a single-pole, double-throw switch. Show that it works.
e. Explain how a 3-way switch wiring works in a lighting circuit
f. Connect two lights together in a series circuit along with a battery and a switch. Then connect the same circuit in Parallel. Discuss the differences in the two circuits.

11. **Identify three career opportunities that would use skills and knowledge in electricity. Pick one and research the training, education, certification requirements, experience, and expenses associated with entering the field. Research the prospects for employment, starting salary, advancement opportunities and career goals associated with this career. Discuss what you learned with your counselor and whether you might be interested in this career.**

Home Activity

Requirement #2

Home Safety Inspection

Parent/guardian participation required!

For requirement 2, you will need to complete an electrical safety inspection of your home. Here are some items you can check in your home today to ensure electrical safety. These tips come from the Electrical Safety Foundation International and can be found online at ***http://www.esfi.org****.*

Make an electrical safety checklist and walk through each room of your house, checking on each aspect of electrical safety. You can go over your list with your counselor later and discuss what you found.

Outlets. Check for outlets that have loose-fitting plugs, which can overheat and lead to fire. Have an adult replace any missing or broken wall plates. Make sure there are safety covers over unused outlets that are accessible to children.

Cords. Make sure cords are in good condition and not frayed or cracked. Make sure they are placed out of traffic areas where people can trip over them or small children can reach them. Cords should never be nailed or stapled to the wall, baseboard, or another object. Do not place cords under carpets or rugs or put furniture on top of them.

Extension cords. Check to see that cords are not overloaded. Extension cords should be used on a temporary basis; they are not intended as permanent household wiring. Make sure extension cords have safety closures to help prevent small children from electrical burns on their mouths and other injuries.

Plugs. Make sure your plugs fit your out- lets. Never remove the ground pin (the third prong) or try to make a three-prong plug fit into a two-conductor outlet. This could lead to an electrical fire. Never force a plug into an outlet if it does not fit. Plugs should fit securely into outlets. Avoid over- loading outlets with too many appliances.

Ground Fault circuit interrupters (GFcis). GFCIs can help prevent electrocution. They should be used in any area where water and electricity may come into con- tact. When a GFCI senses current leakage, it assumes a ground fault has occurred. It then interrupts power fast enough to reduce the chance of serious injury from electrical shock. Test GFCIs frequently according to the manufacturer's instructions and after major electrical storms to make sure they work properly.

Lightbulbs. Check the wattage of all lightbulbs in light fixtures to make sure they are the correct wattage for the rating of the fixture and any interconnecting wires. Replace bulbs that have a higher wattage than recommended. If you do not know the correct size, check with the manufacturer of the device. Make sure bulbs are screwed in securely; loose bulbs can overheat.

Circuit Breakers/Fuses. Circuit breakers and fuses should have the correct size current rating for the circuit wiring and intended purpose. If you do not know the correct rating, have an electrician identify and label the rating to be used. Always replace a fuse with one of the same rating. Make sure everyone in your family knows where the main breaker is located and how to shut off power to your entire house in case of emergency.

Plug-in Appliances. Check to make sure plug-in appliances such as hair dryers are not left plugged in where they can come into contact with water. If a plug-in appliance falls into water, NEVER reach in to pull it out, even if it is turned off. First, turn off the power source at the fuse box or breaker panel, and then unplug the appliance. If you have an appliance that has gotten wet, do not use it until it has been checked by a qualified repair person.

Appliances. If any appliance repeatedly blows a fuse or trips a circuit breaker, or if it has given you an electric shock, unplug it and have it repaired or replaced.

Entertainment/computer equipment. Check to see that the equipment is in good condition and working properly. Look for cracks or damage in wiring, plugs, and connectors. Always use a surge protector bearing the seal of a nationally recognized certification agency to protect your electronic devices from unexpected bursts of voltage that could otherwise cause damage.

Outdoor Safety. Electric lawn mowers and electric power tools should not be used in rain, on wet grass, or in wet conditions. Inspect power tools and electric lawn mowers before each use for frayed power cords, broken plugs, and cracked or broken housings. If a tool is damaged, stop using it immediately. Repair or replace it. Always use an extension cord marked for outdoor use and rated for the power needs of your tools. Unplug all portable power tools when not in use. When using ladders, stay away from overhead wires and power lines. Making contact with power lines can cause serious injury or death.

Lightning. During electrical storms, do not use appliances such as hair dryers, toasters, radios, or telephones, except in an emergency. Do not take a bath or shower. Keep batteries on hand for flashlights in case of power outages. Use surge protectors on electronic devices, appliances, telephones, faxes, and modems. The best protection is to unplug electrical equipment during an electrical storm.

Space heaters. Space heaters are meant to supply supplemental heat. Keep space heaters at least 3 feet away from combustible materials such as bedding, clothing, draperies, furniture, or rugs. Do not use them in rooms where children are unsupervised. Turn off and unplug space heaters when they are not in use. Do not use space heaters with extension cords. Plug the heater directly into an outlet of a relatively unburdened circuit.

halogen Floor lamps. Halogen floor lamps operate at much higher temperatures than standard incandescent lightbulbs. Never place a halogen floor lamp where it can come into contact with drapes, clothing, or other combustible materials. Be sure to turn the lamp off when you leave the room and never use these types of lamps in children's rooms or playrooms. Consider cooler fluorescent floor lamps.

Home Activity

Requirement #7

FLOOR PLAN DIAGRAM

Parent/guardian participation required!

For requirement 7, you will need to draw a simple floor plan of a room in your house with lights, switches, and electrical outlets penciled in.

First, make a drawing that shows the outlines of a room in your house. Then use the electrical wiring symbols to draw in the overhead and wall lights and to show where electric switches and electrical outlets are located.

Next, ask a parent or guardian to go to the main breaker box and turn off the circuit that supplies power to the room you have chosen. Turn on the lights in the room before the adult flips off the circuit breaker. If there is more than one circuit breaker that corresponds to the room, note which breaker supplies power to what outlets, lights, and switches by checking them while the power is off.

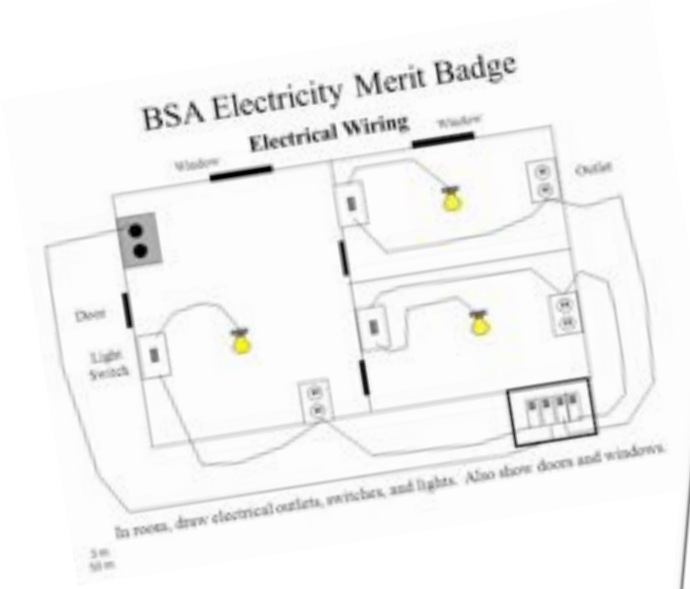
To the side of your room drawing, make a box and highlight the circuit breakers that supply power to the room. Briefly note which breaker supplies power to the various electrical devices in the room. You may also want to note the size fuse or fuses with which the room operates. Ask a parent to check the fuse size at the breaker box.

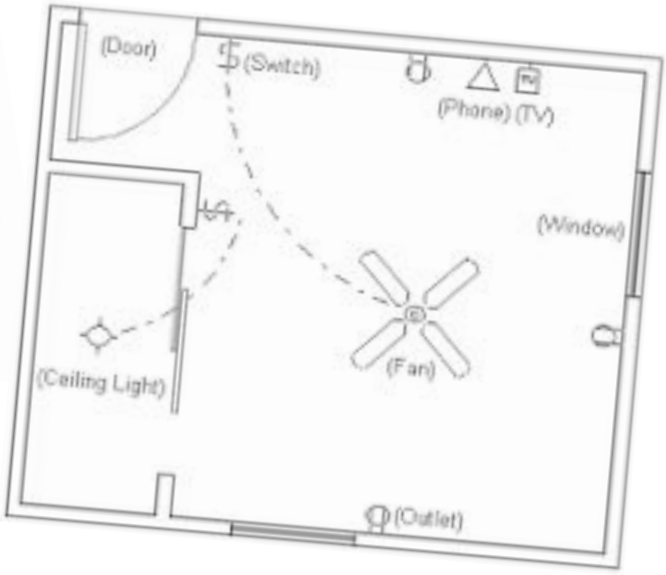
	Electrical switchbox	S	Single Pole Switch
S_3	Three-Way Switch		SinglePlex Receptacle
	Duplex Receptacle	WP	Duplex Receptacle WP= Waterproof
GFCI	GFCI Duplex Receptacle	*	Isolated Ground Receptacle
	Switched Receptacle		FourPlex Four Gang Receptacle
	240-Volt Receptacle	PC	Ceiling Mounted Light Fixture PC= Pullchain
	Wall-Mounted Light Fixture	R	Recessed Light Fixture
WP	Weatherproof Light Fixture		Fluorescent Light Fixture
CF	Ceiling Fan		Combination Light & Fan
VF	Power Vent Fan	2	Electric Motor Number=HP
SD	Smoke Detector		Circuit Breaker
	Telephone Jack	T	Doorbell Transformer
	Doorbell Pushbutton		Ground

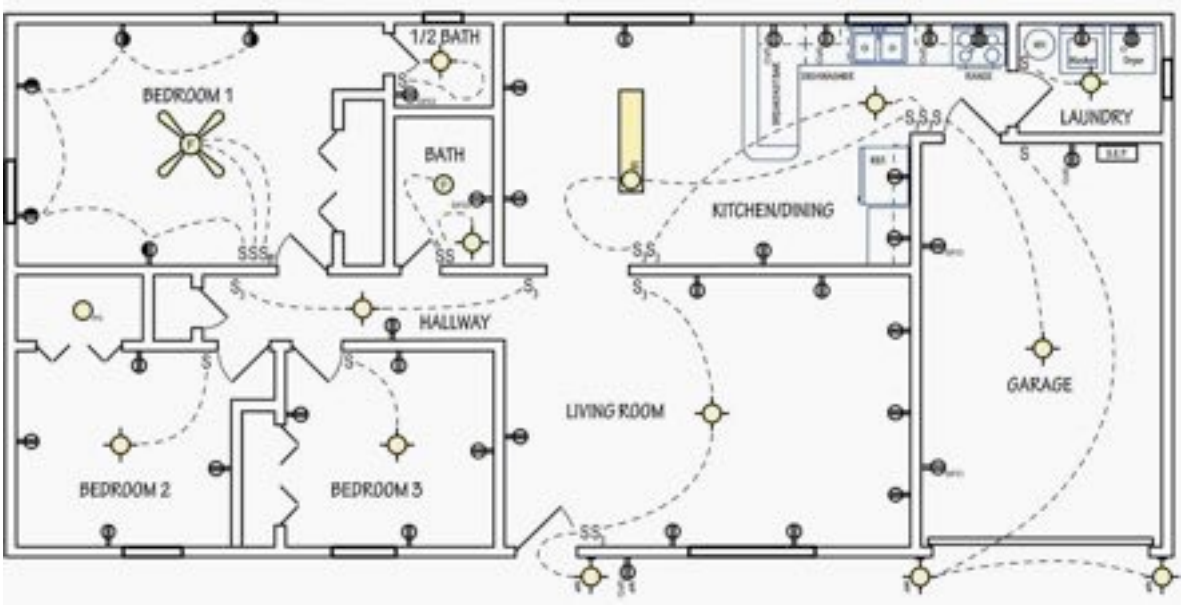
Home Activity

Requirement #7

Examples







Home Activity

Requirement #8

Reading Digital Electric Meter

Parent/guardian participation required!

1. Wait for all digits to turn 888888
2. Read next number that appears (Day 1)
3. Repeat steps 1+2 24 hours later (Day 2)
4. Repeat steps 1+2 24 hours later (Day 3)
5. Calculate kilowatt usage per day

Day 1 kWh: _____ *from step 2*

Day 2 kWh: _____ *from step 3*

Day 3 kWh: _____ *from step 3*

divide! (Day 3 kWh) - (Day 1 kWh) / 2 days = _____ *usage* kWh/day

6. **Calculate daily cost**

multiply! (usage) x (cost per kw) = _____ *cost*

This comes from your electric bill

Determining the cost of electricity without reading meter

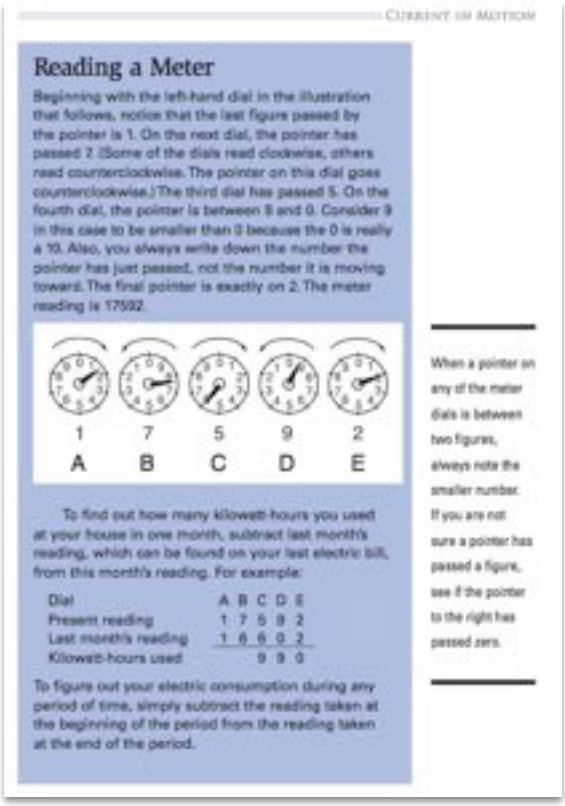
To figure out how much your electricity bill will be, you must know how much your electric company charges per kilowatt- hour. You can find this out by looking at your family's electric bills. If the bill does not show a price per kilowatt-hour, you can get a close estimate by dividing the amount of the bill by the kilowatt-hours used.

For example, an electric bill of $89.96 divided by 1,110 kwh works out to $0.081 (slightly more than 8 cents) per kilowatt- hour. If your electric company charges 8 cents per kilowatt-hour, the bill for 990 kwh (in the earlier meter-reading example) would be 990 x .08 = $79.20.

Home Activity

Requirement #8

Reading Analog (“dial”) Electric Meter



CURRENT IN MOTION

Reading a Meter

Beginning with the left-hand dial in the illustration that follows, notice that the last figure passed by the pointer is 1. On the next dial, the pointer has passed 2. (Some of the dials read clockwise, others read counterclockwise. The pointer on this dial goes counterclockwise.) The third dial has passed 5. On the fourth dial, the pointer is between 8 and 0. Consider 9 in this case to be smaller than 0 because the 0 is really a 10. Also, you always write down the number the pointer has just passed, not the number it is moving toward. The final pointer is exactly on 2. The meter reading is 17592.

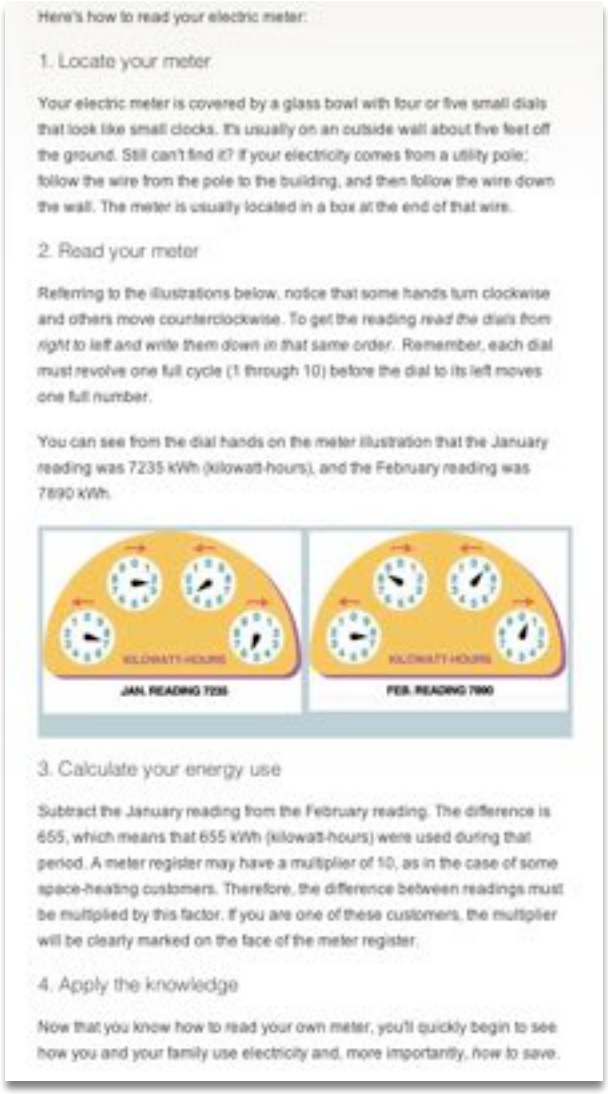
1 7 5 9 2
A B C D E

When a pointer on any of the meter dials is between two figures, always note the smaller number. If you are not sure a pointer has passed a figure, see if the pointer to the right has passed zero.

To find out how many kilowatt-hours you used at your house in one month, subtract last month's reading, which can be found on your last electric bill, from this month's reading. For example:

Dial	A	B	C	D	E
Present reading	1	7	5	9	2
Last month's reading	1	6	6	0	2
Kilowatt-hours used			9	9	0

To figure out your electric consumption during any period of time, simply subtract the reading taken at the beginning of the period from the reading taken at the end of the period.



Here's how to read your electric meter:

1. Locate your meter

Your electric meter is covered by a glass bowl with four or five small dials that look like small clocks. It's usually on an outside wall about five feet off the ground. Still can't find it? If your electricity comes from a utility pole; follow the wire from the pole to the building, and then follow the wire down the wall. The meter is usually located in a box at the end of that wire.

2. Read your meter

Referring to the illustrations below, notice that some hands turn clockwise and others move counterclockwise. To get the reading *read the dials from right to left and write them down in that same order.* Remember, each dial must revolve one full cycle (1 through 10) before the dial to its left moves one full number.

You can see from the dial hands on the meter illustration that the January reading was 7235 kWh (kilowatt-hours), and the February reading was 7890 kWh.

JAN. READING 7235 FEB. READING 7890

3. Calculate your energy use

Subtract the January reading from the February reading. The difference is 655, which means that 655 kWh (kilowatt-hours) were used during that period. A meter register may have a multiplier of 10, as in the case of some space-heating customers. Therefore, the difference between readings must be multiplied by this factor. If you are one of these customers, the multiplier will be clearly marked on the face of the meter register.

4. Apply the knowledge

Now that you know how to read your own meter, you'll quickly begin to see how you and your family use electricity and, more importantly, how to save.

Determining the cost of electricity

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Note that the dials give readings in multiples of 10. The dial farthest to the right shows kilowatt-hours in single digits, the next dial in tens, the next dial in hundreds, then thousands, and the leftmost dial in ten thousands.

As you saw earlier, the hands on the dials of a meter turn either clockwise or counterclockwise. The pointer on the dial to the right must make a complete revolution, that is, reach zero, before the pointer on the next dial will move one space, and so on.

VOCABULARY

Electrical Terms

Prior to class you are invited to review the following electrical terms, most of which will be presented in class.
Although this is optional, doing so will help you learn the in-class topics more easily.

alternating current. Current that regularly reverses direction, traveling first in one direction and then in the opposite direction. Power companies generate alternating current to make it easier to transmit electricity over long distances. Abbreviated *AC*.

ammeter. An instrument for measuring current in amperes.

ampere. A unit measuring the strength of an electrical current, based on the number of electrons transferring past a given point per second. Many elements of a wiring system are rated in amperes for the greatest amount of current they can safely carry. The ampere, abbreviated *amp*, is named for French physicist André-Marie Ampère.

circuit. A loop-shaped path through which electric current travels from the source through some device using electricity, such as a light- bulb, and back to the source.

circuit breaker. A safety switch installed in a circuit to break the transfer of electricity when the current exceeds a set amount. Circuit breakers can be reset once "tripped." *See also* fuse.

conductor. A substance or device through which electricity passes. Most metals are good conductors of electricity—that is, they allow electricity to travel through them with little resistance. Gold and silver are the best conductors of electricity but are too expensive for general use. Copper, which is relatively cheap and plentiful, is used most often, especially in transmission lines that carry electricity from power plants to homes, schools, and businesses. Devices that run on electricity have copper wiring. Aluminum is not as good a conductor as copper, but because it is cheaper and lighter, it is also frequently used.

current. The transfer of electricity in one direction.

cycle. One complete reversal of alternating current; a forward current and backward current. Ordinary household current experiences 60 cycles per second (60 hertz).

direct current. An electric current of constant direction— that is, the transfer of electrons goes only in one direction. Abbreviated *DC*.

fuse. A safety device installed in a circuit to prevent an over- load. Designed to melt or "blow" when current exceeds a set amount, it opens the circuit and stops the transfer of electricity. Fuses cannot be reused once blown. *See also* circuit breaker.

galvanometer. A device that detects and determines the strength of electrical currents.

ground. To connect any part of an electrical wiring system to the ground or to another conducting body, such as a metal water pipe or a metal rod driven into the earth.

grounding wire. Conductor that grounds a metal component but does not carry current during normal operation.

hertz. A unit of frequency equal to one cycle per second. Abbreviated *Hz*.

hot wire. Ungrounded conductor carrying electrical current. Usually identified by black or red insulation.

insulation. Covering of nonconducting material used on wires.

insulator. A material that does not conduct electricity, such as rubber or plastic.

kilowatt. Unit of electrical power equal to 1,000 watts. Abbreviated *kw*.

kilowatt-hour. Unit of energy used for metering and selling electricity. One kilowatt-hour equals 1,000 watts used for one hour (or any equivalent, such as 500 watts used for two hours). Abbreviated *kwh*.

load. The part of an electrical circuit that uses the electric power. In a lighting circuit, the load is the lightbulb.

neutral wire. Grounded conduc- tor that completes a circuit by providing a return path to the source. Always identified by white or gray insulation.

ohm. A unit of measurement for electrical resistance to a current. It is named for German physicist Georg Simon Ohm (1787–1854), whose Ohm's law states that the pressure of one volt will cause a current of one ampere to flow through a resistance of one ohm (Voltage = Current x Resistance). This simple formula shows the relationship between volts, amperes, and resistance in any electric circuit.

outlet. An electrical device where the switch can easily be connected to a fixture or equipment that uses electricity.

overload. Condition in which an electrical circuit carries more current than it can safely handle.

receptacle. The device that you plug electric cords into, sometimes called an outlet.

resistance. The opposition against the free transfer of electrons in a conductor. Measured in ohms.

resistor. A device designed to restrict the transfer of current in (or introduce resistance into) an electric circuit.

rheostat. A resistor built so that the current traveling through the circuit can be adjusted at will. Volume controls and dimmer switches are examples.

short circuit. A completed, low-resistance circuit that allows electrons to follow a shorter, unintended path back to the power source rather than follow the longer path that goes through the load. Occurs when bare wires touch each other; often results from worn insulation.

source. Point of supply, such as a generator or battery.

switch. Device to break the transfer of electricity. When the switch is on, the circuit is closed and current may travel through it. When the switch is off, the circuit is
open and electricity cannot transfer.**volt.** A unit of potential difference, or a unit of measurement of electrical pressure or force. Abbreviated *V*.

voltage. Pressure at which a circuit oper- ates, expressed in volts. Voltage is like the pressure in a water pipe. For example, 120 volts have twice the pushing force of 60 volts.

voltmeter. An instrument for measuring the difference in electric potential (electri- cal pressure) between two points.

watt. Unit that measures electrical power at the point where it is used in a circuit. One watt of power equals one volt of pressure times one ampere of current. Many electrical devices are rated in watts according to the power they consume. Abbreviated *W*.