- Introduce the idea of ease of movement of electrons through different substances.
- If they have not already developed the idea of insulators and conductors, introduce the concepts. Refer to Table 1 (p. 280) and discuss some of the substances in each of the three lists. Selenium is covered in more detail in Section 9.11 on page 292.
- Have a brief discussion of the advantages as well as the disadvantages of insulators ([+] use as a safety covering for electrical devices and wires; [-] irritating effects).
- Have a brief discussion of the advantages and disadvantages of conductors. ([+] can transfer electric current in circuits, use as safety devices for preventing electric shocks—grounding wires; [-] can transfer electric current to give electric shocks (large amounts of electric current) to people or objects, have to keep wires separate from one another).
- Discuss the role of water molecules in the air as a means of removing static charge from surfaces.

Challenge

Many cases for electrical equipment are made of metal. If the student was going to use batteries to operate the demonstration circuit boards, either a conductor (metal) or an insulator (wood/plastic) could be used for the case. If the person coming up to the demonstration circuit board has walked over a carpet and might be charged, he or she could use a metal pointer (see Section 9.7) to discharge him or herself. The students should work out the best place for the observer to pick up the pointer. By picking up the pointer at the appropriate place, and then touching the pointer to a metal demonstration case, the static charge could be removed. Another approach could be used if the student wished to use an insulator for the case.

Computer Technology

Students could complete an Internet search to investigate superconductors.

ACCOMMODATING INDIVIDUAL NEEDS

Extra Support

- Students could draw diagrams or sketches to illustrate their observations.
- Have students work in pairs so that students who are having difficulty can be helped by those who understand the concepts. Students might work in pairs trying to classify some new substances that were not used in the previous activity into groups of insulators and conductors. Then different groups in the class could compare results.

Enrichment

- Students could investigate why semiconductors are useful and how electric charge is transferred through them. They could use the Internet to investigate new semiconductor devices.
- Students could investigate superconductors. There are some kits of materials that can be purchased from supply catalogues for making simple experimental versions of superconducting materials. Small pieces of superconducting material (plus simple activities) can also be purchased.

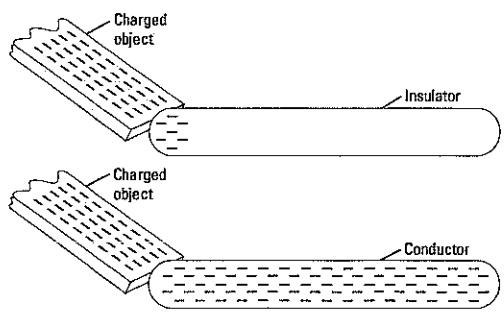
ESL/ELD

- Have students write the key boldfaced terms and draw diagrams to show how the electric charge is distributed on insulators and conductors.
- Allow students to verbally describe their observations and draw sketches to illustrate their understanding (in their notes and on the chalkboard to other students).

SUGGESTED ANSWERS TO QUESTIONS

Understanding Concepts

1. In terms of the transfer of electrons, a conductor is a substance in which electrons can move freely from one atom to another, and an insulator is a substance in which electrons cannot move freely from one atom to another. See diagram.

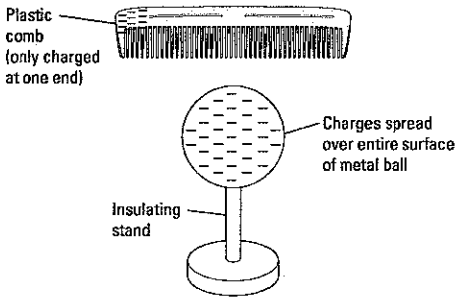


9.6

2. (a) As you continue to rub a glass surface, the amount of static charge increases because the rubbing action allows additional neutral molecules of the two different substances to move close enough together for electron transfer to take place.

(b) If you continue to rub the glass with a cloth, eventually the static charge builds up to such an amount that it begins to leak away from the surface of one or both of the substances.

3. If one end of a plastic comb was charged, the charge would remain where it was placed because the comb is an insulator. If the same kind of charge was placed on one place on the surface of a round metal ball, the charge would spread evenly over the surface of the entire metal surface because the metal is a conductor. See diagram.



4. Problems with static electricity are more common in winter than at other times of the year because the air is drier in winter. There are fewer air molecules in the air to remove charges from charged surfaces. These problems could be reduced by using a humidifier to increase the humidity (and hence the number of water molecules) of the air.

Making Connections

5. Examples of insulators in the home are the following: insulating material covering all the electrical cords used to connect appliances to the wall outlets, insulating material on the handles of tools, and plastic covers on wall outlets and switches. Examples of insulators in the car are the following: insulating material covering the wiring that connects all the circuits to the car battery and covers on the switches and knobs in the car. In all cases the insulating material is being used to isolate the metal wiring so that it does not touch other wires and that users are protected from getting electric shocks.

   Examples of conductors in the home are the following: the wiring in the walls used to connect the main electrical supply to the circuit breakers, connecting cords on appliances, connector cables for computers, and heating coils in toasters.

   Examples of conductors in cars are wiring to all electrical devices and lights, filaments in bulbs, battery cables, aerials in the windshields of cars, and heating wires attached to the back windows to melt snow.

6. Two reasons are the following: to prevent wires from touching one another and to protect people from getting electric shocks from the wiring in the home.

Exploring

7. Initially copper was the least expensive wiring material to use for wiring homes, and it was a good electrical conductor. In the 1970s, as the price of aluminum decreased and copper increased, aluminum wire was used extensively for wiring houses. After a few years, it was found that, unless great care was taken in the installation, electrical problems began to occur with the connections made with aluminum wires. Several fires were traced to problems related to the use of aluminum wire. To ensure the safety of house wiring, the use of copper was mandated, and the use of aluminum was not permitted.

	Advantages	Disadvantages
Copper	Good conductor, flexible	Relatively expensive, corrodes easily in polluted environment
Aluminum	Good conductor, flexible, inexpensive compared to copper	Difficult to make good electrical connections to other materials, can cause fires if poor electrical connections are made

ACCOMMODATING INDIVIDUAL NEEDS

Extra Support

- Students could draw sketches to illustrate their understanding of parts of a circuit.
- Have students write descriptions or explanations related to the key boldfaced terms.
- Students should make point form notes on the electric circuit and the four basic parts.

ESL/ELD

- Explain any terms they do not understand.
- Allow students to verbally describe the parts of the electric circuit and draw sketches to illustrate their understanding (in their notes and on the chalkboard to other students).
- Have students write the key boldfaced terms.

Enrichment

- Have students who completed the At Home activities make a brief presentation to the class.
- Allow students who have a bicycle with a complete lighting system to design and construct the equivalent electric circuit using equipment available in the classroom. If there is time, have them demonstrate and describe the electric circuit to the class.

ANSWERS TO QUESTIONS

Understanding Concepts

1. Static electricity is electric charge that remains in a fixed position or region on an object. Current electricity is electric charge that is moving in one or more paths. The moving electric charge is called an electric current. The electric current may be flowing in an uncontrolled path (lightning stroke) or a controlled path (an electric circuit).
2.

Part of circuit	Function	Examples
Source of electrical energy	Provide energy to the electrical load in the circuit	Dry cell, 120-V source, etc.
Electrical load	Convert electrical energy into another form of energy	Light bulb, motor, etc.
Electric circuit control device	To control the flow of electric current in the circuit	Switch, fuse
Connectors	To provide a conducting path between the parts of the electric circuit	Connecting wires, copper strips on printed circuit boards

3. The electric charge flows from the negative terminal of the dry cell (the yellow wire), through the switch, the bulb and back to the positive terminal of the dry cell (the green wire). Negative charges are released at the negative terminal of the dry cell and are attracted through the circuit toward the positive terminal of the dry cell (law of electric charges).

Making Connections

4. Four electrical loads that convert electrical energy to light energy are: light bulb inside the refrigerator, ceiling light bulb, viewing light on the microwave oven, warning light on the stove (for element). Four electrical loads that convert electrical energy into mechanical energy are: coffee grinder, blender, bread making machine, can opener. Predictions about energy use will vary (most: ceiling light bulb; least: warning light on stove).

10.2

5. (a) Electric control devices in the kitchen: wall switch for the ceiling light, on/off lever switch for the toaster, control knob for stove top element, timer controls on the microwave oven.
   (b) Electric control devices in the basement/laundry room: wall switch for ceiling light, door switch for electric dryer, timer control on the electric dryer, washing cycle switch on the washing machine.
   (c) Electric control devices in a car: switch for headlights, push button for horn, switch to start engine, switch for controlling window defrost heaters. Devices–reasons for design: student answers will vary.

Reflecting

7. Schematic circuit diagrams are used rather than pictorial circuit diagrams because the same symbol can be used for all the many different types of any given circuit component. For example, there are literally tens of different kinds of dry cells and batteries, and new kinds are being invented, designed, and developed all the time. It is much simpler to just draw the same symbol for a dry cell every time than to have to draw a pictorial representation of it.