ACTIVITY 2

Electrical Symbols

OBJECTIVES

In this activity, students discover the usefulness of symbols used to identify parts of a circuit.

The students

- draw and interpret circuit diagrams
- construct circuits from simple circuit diagrams
- compare brightness of bulbs in different circuits

SCHEDULE

About 40 minutes

VOCABULARY

battery terminal
circuit diagram

MATERIALS

For each student

1	Activity Sheet 2

For each team of two

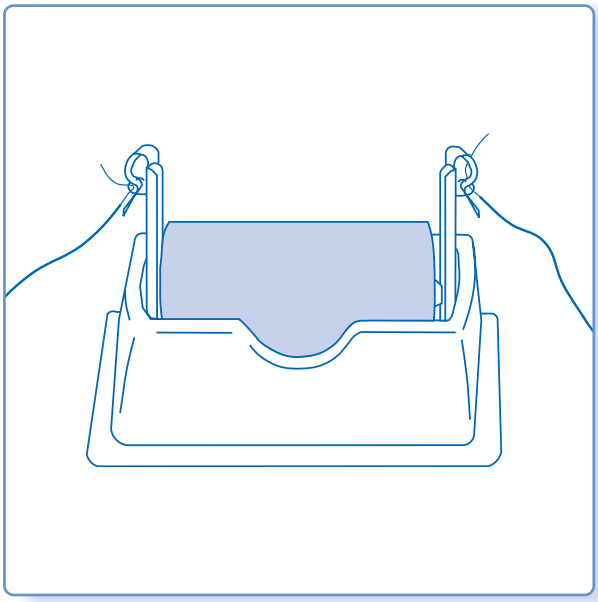
2	batteries, D-cell
2	battery holders
2	bulb holders
2	bulbs, flashlight, #48
4	electrical clips
4 pcs	wire, copper, insulated, 15-cm

For the class

1 roll	wire, copper, insulated
1 pair	wire cutters

PREPARATION

1. Make a copy of Activity Sheet 2 for each student.
2. Gather the pieces of wire from Activity 1. Cut and strip the ends of three new 15-cm (6-in.) pieces of insulated copper wire for each team.
3. Practice placing batteries and electrical clips into the battery holders. Place the clips in first, each so the Fahnestock clip (which is already attached at the top) points to the outside. Then push the battery down into the holder. To attach the wire, push the tab on the Fahnestock clip so that the loop protrudes. Place the end of a wire through this loop and release the tab. When correctly assembled, the end of the wire will be held securely in place (see Figure 2-1).



▲ ***Figure 2-1.*** *An assembled battery holder.*

4. Each team of two will need two batteries, two battery holders, four electrical clips, four pieces of wire, two bulbs, and two bulb holders.

BACKGROUND INFORMATION

Most battery cases are marked positive (+) on one end and negative (–) on the other. These markings indicate the positive and negative ***battery terminals.*** The direction of the electric current in a closed circuit is from the negative (–) terminal of the battery to the positive (+) terminal of the battery. Therefore, the battery terminals are where wires connecting the battery to the circuit should be attached.

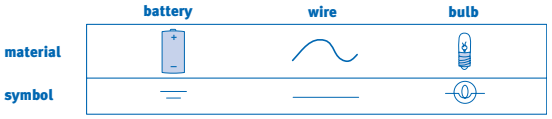
To make the drawing of electric circuits easier, a series of symbols has been standardized to represent electrical components. A drawing of a circuit using these symbols is called a ***circuit diagram.***

In this activity, students learn how to draw and interpret circuit diagrams.

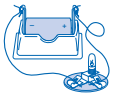
▼ **Activity Sheet 2**

Electrical Symbols

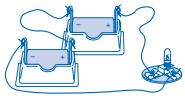
These symbols are used to draw circuit diagrams.



Circuits A and B may also be shown by Circuit Diagrams A and B.



Circuit A



Circuit B

Circuit Diagram A

Circuit Diagram B

1. Draw a circuit diagram of a circuit that contains two batteries and two bulbs.

2. Circuit diagrams will be used often in the remaining activities. Practice reading them. Then build Circuits A, B, and C.

Circuit A

Circuit B

Circuit C

Which circuit had the brightest bulb? Circuit B

Guiding the Activity

1 Review the concept of closed circuit, emphasizing that the path of electric current is from one end of the battery back to the other end of the battery.

Draw a battery on the board. Be sure to illustrate the shapes of both the positive (+) and negative (–) ends of the battery, and position the battery vertically.

Bring the students' attention to the positive and negative ends as you draw a plus (+) and a minus (–) on the battery case next to the appropriate end.

2 Write *battery terminal* on the board to the left of your drawing. Explain that, in a closed circuit, current flows from the end of the battery marked negative (–), through the parts of the circuit, back to the end of the battery marked positive (+). The positive and negative ends of the battery are called **battery terminals.**

Additional Information

The negative side is sometimes not marked but it is the side opposite the positive side. The positive side is usually marked and is always the side with the nib.

Guiding the Activity

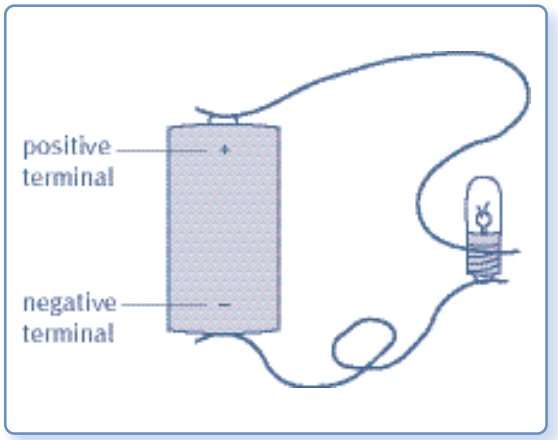
3 Point to your drawing of the battery and tell the students to watch as you draw two wires and a bulb to make a circuit (see Figure 2-2).

Ask, **How do you think that we could make this drawing more quickly and easily?**

Explain that there are many benefits to using symbols when drawing circuits. For example, the symbols representing the parts of the circuit are standardized so that everyone understands which component is being represented and no one has to be particularly artistic to draw the symbols.

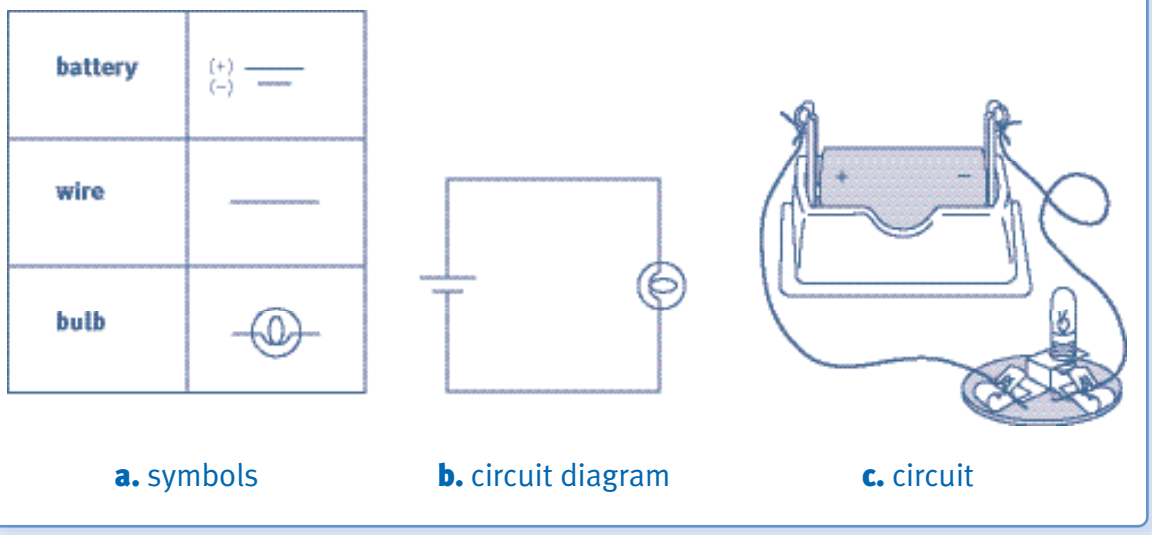
4 Draw the symbols of a battery (including positive and negative terminals), a wire, and a bulb on the board (see Figure 2-3a).

Additional Information



▲ ***Figure 2-2.*** *A circuit.*

Students may suggest using symbols to represent the various components of the circuit.



a. symbols **b.** circuit diagram **c.** circuit

▲ ***Figure 2-3.*** *Symbols, a circuit diagram, and a circuit.*

Guiding the Activity

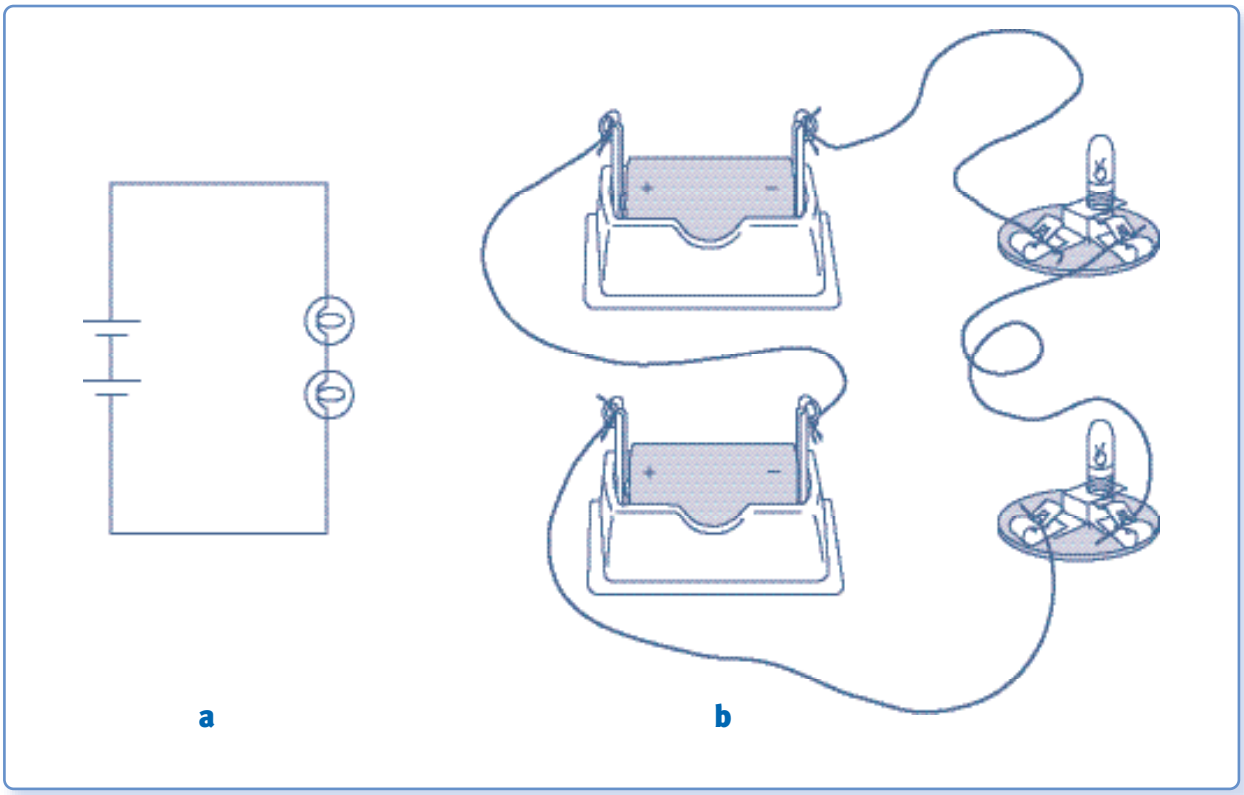
		Additional Information
	Point to each symbol and identify which circuit element the symbol depicts. Explain that the longer horizontal line in the battery symbol depicts the positive (+) terminal and the shorter horizontal line depicts the negative (–) terminal.	
5	Write the words *circuit diagram* on the board. Explain that now that students know the symbols that represent the parts of the circuit, they can connect these symbols to make a drawing of a circuit. A drawing of a circuit using symbols is called a **circuit diagram.** Have students tell you where to move your finger to trace the path of electric current through the circuit depicted by the circuit diagram. Have a student volunteer come to the front of the room and, using the materials from one of the teams, assemble the circuit shown in the circuit diagram. Once the circuit is completed correctly (as shown in Figure 2-3c), hold it up for all students to see. Tell students that they are going to look at some circuit diagrams and then build the circuits represented.	*Draw a circuit diagram, as shown in Figure 2-3b, next to the symbols.* *Make sure that they begin at the negative terminal of the battery symbol (the shorter horizontal line) and proceed through the circuit elements back to the positive terminal of the battery symbol (the longer horizontal line).*
6	Distribute a copy of **Activity Sheet 2** to each student. Distribute two bulbs, two bulb holders, four wires, four electrical clips, two batteries, and two battery holders to each team.	
7	Remind them of the symbols that depict parts of a circuit. Bring their attention to the illustrations and the circuit diagrams of Circuits A and B. Tell them to notice in Circuit Diagram B how two symbols for a battery are placed next to each other to indicate two connected batteries.	

Guiding the Activity

Draw Figure 2-4a on the board. Explain that in order to help students visualize the connection between the two batteries, two battery symbols are sometimes drawn as shown in Figure 2-4a, with a short vertical line depicting the wire that connects the two batteries.

Additional Information

Tell students to omit the vertical line in their circuit diagrams but to remember that the two batteries are in fact connected.



▲ ***Figure 2-4.*** *A two-battery, two-bulb circuit diagram and circuit.*

Ask, **How would you draw a circuit diagram for a circuit that has two batteries and two bulbs?**

Students may be able to guess that two symbols for bulbs are drawn next to each other with one connecting line, which represents a third wire.

Have students draw on their activity sheets a circuit diagram of a circuit that contains two batteries and two bulbs.

8 Have students trace the path of electric current through each of the three circuit diagrams at the bottom of the activity sheet.

Remind students that the shorter horizontal line indicates the negative terminal and the longer line indicates the positive terminal.

Guiding the Activity

		Additional Information
9	Tell students they will now construct these three circuits represented by circuit diagrams. Demonstrate how to place batteries in the holders and how to attach the wires to the electrical clips, as shown in Figure 2-3c. Explain that to construct a two-battery circuit they should connect the negative (–) end of one battery to the positive (+) end of another battery.	*It is important that only one negative-to-positive connection be made between the two batteries. Making two such connections at once will overheat the wire and drain the batteries.*
10	After students have finished assembling the circuits, ask, **What did you observe about the brightness of the bulbs in each of these three circuits?** Ask, **Which circuit had the brightest-glowing bulb? Why do you think this was so?**	*Students' responses should indicate that each of the bulbs glowed at a different brightness.* *Circuit B had more batteries, which provided more current and so made the bulb glow brighter. Circuit C also had two batteries, but here two bulbs had to share the current they provided.*

Reinforcement

Use materials to make various circuits and have students draw circuit diagrams to represent these circuits.

Assessment Opportunity
This Reinforcement also may be used as an ongoing assessment of students' understanding of science concepts and skills.

Science Journals

Have students place their completed activity sheets in their science journals.

Cleanup

Have students return all batteries, battery holders, electrical clips, bulbs, bulb holders, and wires to the kit.

Science at Home

Have students make a list of symbols that they typically see on their way to and from school or on television, radio, car dashboards, and so on. Any symbols are acceptable—they do not have to be electrical symbols.

Connections

Science Extension

Remind students of their discussion of electrons and static electricity in the Science and Language Arts connection in Activity 1. Then give students an opportunity to experiment with static electricity. For example, they could rub balloons against their clothing and then stick the balloons on a wall. They also could rub a plastic comb with a wool cloth and then bring the comb close to small bits of paper, which will "jump" to the comb. Encourage students to offer their own suggestions for other ways to create static electricity. Explain that rubbing an object gives it a negative charge. Just like the opposite poles of two magnets, a negatively charged object and a positively charged object are attracted to each other. Electrons will flow from the negatively charged object to the positively charged object until the two objects have equal charges. Also explain that in a battery, the electrical current—the flow of electrons—is created by chemical interactions inside the battery. When the terminals are connected in a circuit, electrons will continue to flow from the negative terminal to the positive terminal as long as the chemical interactions continue.

Science Challenge

Have students do the following activity after they explore static electricity in the Science Extension connection. Each pair or team of students will need an Ne_2 neon light bulb (available from an electronics store), a reclosable plastic sandwich bag, and a swatch of wool or silk cloth. As an alternative, you could put one set of materials at a work station and let students take turns doing the activity. Tell students to spread the leads of the bulb so they point in opposite directions and then seal the bulb in the plastic bag. Have students rub one side of the bag with the cloth as they watch the bulb. (It will glow faintly.) Ask students to explain what made the bulb light. (An electrical current, the discharge of static electricity, flowing from one side of the plastic bag to the other side.) Based on what they learned about static electricity in the Science Extension connection, what can they infer about the electrical charges on the sides of the plastic bag? (Rubbing one side of the bag gave it a negative charge. The other side had a positive charge, so electrons "jumped" from the negatively charged side to the positively charged side, passing through the bulb and making it glow.)

Science and Careers

Invite an electrician, an electrical engineer, or someone who teaches electrical wiring at a vocational school to visit the class. Ask the visitor to bring samples of circuit diagrams to show students. Encourage students to prepare a list of questions to ask the visitor about his or her work and the training and education it requires.

Science and Health

Ask students whether they have seen high-tension power lines that are used to transmit electricity over long distances. Explain that the powerful electric current running through the wires creates strong electric and magnetic fields. These fields produce a type of energy called *electromagnetic radiation*, or EMR. Many people, including some scientists, believe that long-term exposure to EMR can be harmful to people. For example, some studies suggest a link between prolonged exposure to EMR and increased risk of developing cancer. Encourage interested students to research and report on this issue. You may want to hold a class debate, with volunteers taking either side.