

# Circuit Symbols

## OBJECTIVES

Students construct more complex electric circuits than in the previous activity and are introduced to circuit diagrams.

### The students

- ▶ draw and interpret circuit diagrams
- ▶ construct circuits from circuit diagrams
- ▶ recognize series and parallel circuits

## SCHEDULE

About 50 minutes

## VOCABULARY

circuit diagram  
parallel circuit  
series circuit

## MATERIALS

### For each student

- 1 Activity Sheet 3, Parts A and B

### For each team of two

- 1 battery, D-cell
- 1 battery holder with clips
- 2 bulbs, flashlight, #14
- 2 sockets, bulb
- 1 switch, knife
- 5 pcs wire, copper, insulated, stripped ends, 25 cm (about 10 in.)

### For the class

- 4 marking pens\*
- 1 scissors\*
- 4 screwdrivers
- 1 roll tape, masking

\*provided by the teacher

## PREPARATION

- 1 Make one copy of Activity Sheet 3, Parts A and B, for each student.
- 2 Each team of two students will need one D-cell battery, one battery holder with clips, two #14 flashlight bulbs, two bulb sockets, one knife switch, and five pieces of insulated copper wire 25 cm (about 10 in.) long with stripped ends.
- 3 See Activity 2 Preparation for setup instructions.

## BACKGROUND INFORMATION

Within a circuit, electric energy can be transferred between a battery and an energy receiver only if a current moves along a continuous path from one terminal of the battery to the receiver and then to the second terminal of the battery (as well as within the battery itself). In other words, energy is transferred in any part of a circuit through which there is a current.

A circuit that has only one possible path for a current is called a **series circuit**. If a series circuit is opened anywhere in the circuit, no energy is transferred because there is no current. A circuit that has more than one possible path for a current is called a **parallel circuit**. So, any circuit that has two or more branches is a parallel circuit. If all branches

of a parallel circuit are closed, energy is transferred in each branch because there is a current in each branch. If one branch is open, energy is still transferred, but only in the closed branches.

Batteries, bulbs, wires, and switches are used in electric circuits. To illustrate circuits, scientists, electricians, and electrical engineers use symbols to represent parts of a circuit. A **circuit diagram** is a representation of a circuit using these symbols.

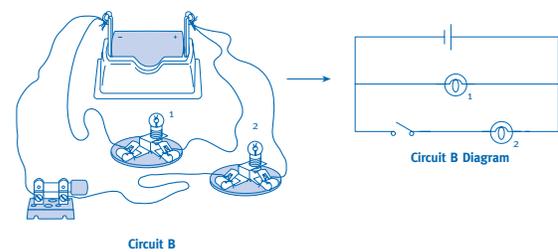
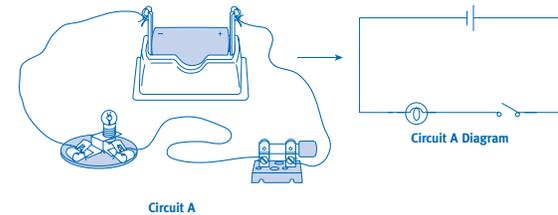
### ▼ Activity Sheet 3, Part A

#### Circuit Symbols

These symbols are widely used to represent parts of an electric circuit.

	battery	wire	bulb	switch
positive (+) terminal				
negative (-) terminal				
material				
symbol				

Circuits A and B can be represented by Circuits A and B Diagrams.



### ▼ Activity Sheet 3, Part B

#### Circuit Symbols

- Construct Circuits A and B. Then complete Tables 1 and 2. Record whether the bulb is on or off.

Table 1 (for Circuit A)	
Switch	Bulb
closed	on
open	off

Table 2 (for Circuit B)		
Switch	Bulb 1	Bulb 2
closed	on	on
open	on	off

- Construct Circuit C and then draw its circuit diagram. Complete Table 3.

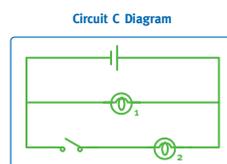
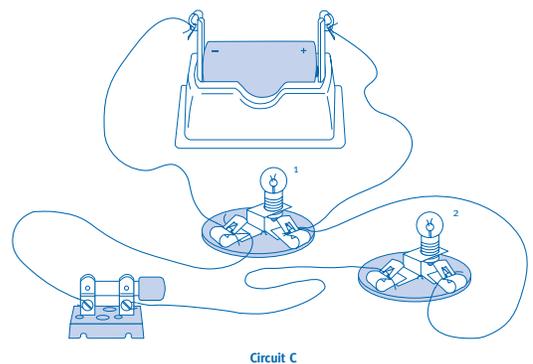


Table 3 (for Circuit C)		
Switch	Bulb 1	Bulb 2
closed	on	on
open	on	off

## Guiding the Activity

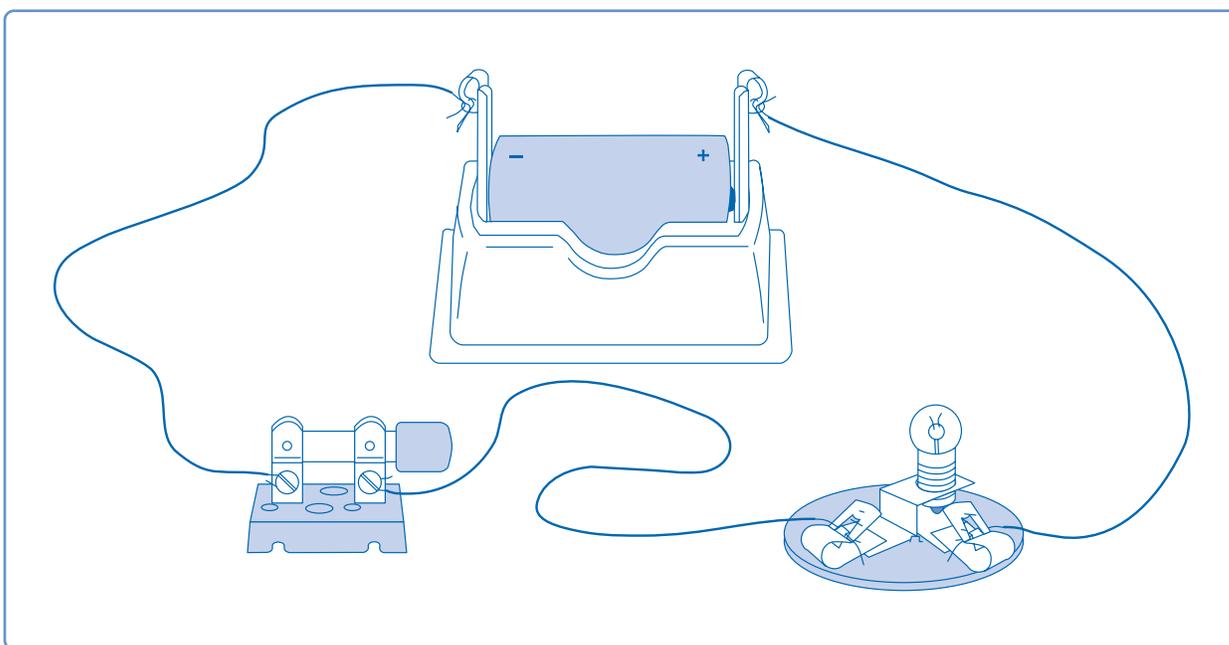
- 1 To initiate a discussion about symbols, write the chemical formula of water on the board ( $H_2O$ ). Ask, **What do the symbols H and O represent? What do the symbols together represent?**

Point out that a symbol is a quick way of representing something.

- 2 Sketch the circuit shown in Figure 3-1 on the board. Have the students identify the battery, bulb, knife switch, and wires.

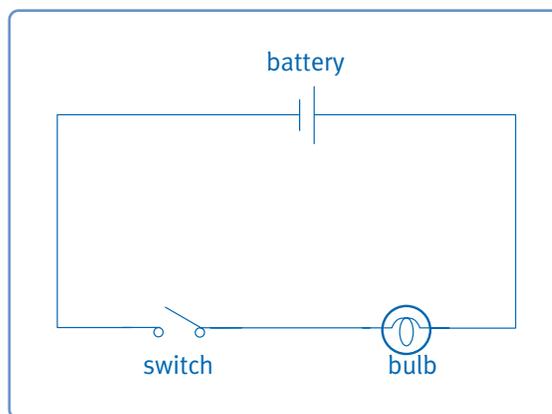
## Additional Information

The H represents a hydrogen atom, and the O represents an oxygen atom. The symbol  $H_2O$  represents a water molecule containing two hydrogen atoms and one oxygen atom.



▲ Figure 3-1. Circuit diagramed in Figure 3-2.

Write the term *circuit diagram* on the board. Explain to the students that a **circuit diagram** is a representation of a circuit using symbols. Draw the diagram shown in Figure 3-2 under the sketch but do not add the labels. Have the students guess what each symbol represents.



▲ Figure 3-2. Circuit diagram of Figure 3-1.

## Guiding the Activity

### Additional Information

**3** Distribute one D-cell battery, one battery holder with clips, two #14 flashlight bulbs, two bulb sockets, one knife switch, five pieces of insulated copper wire, and two copies of **Activity Sheet 3, Part A**, to each pair of students. Ask the students to identify each symbol in your sketch from the chart at the top of the sheet. Tell them to construct a circuit like the one you sketched on the board. Tell teams to share the screwdrivers.

Before proceeding, make sure that all students are able to construct the simple circuit shown in Figure 3-1 using only the circuit diagram.

*Point out that the positive and negative ends (terminals) of a battery are represented by a long and a short line, respectively.*

*If necessary, review how to construct the battery and light bulb assemblies, how to fasten the wires into the clips, and how to attach the wires to the switches.*

**4** Distribute two copies of **Activity Sheet 3, Part B**, to each pair of students. Have the students complete Step 1.

*Suggest that students who are having difficulty building the circuit draw large circuit symbols and attach them to the respective battery, bulb assembly, and switch.*

*Students may have trouble identifying the bulbs when they are constructing Circuit B. Suggest that they use a marking pen to write the numbers of the bulbs (1 and 2) on two strips of masking tape and then attach one strip to each bulb socket base.*

**5** Request that students look at the drawings of Circuits A and B on Activity Sheet 1, Part A, and trace with their pencils the paths in which current can flow in each one. Then have them do the same for the circuit diagrams.

Ask, **How does the number of paths that the current can follow differ between Circuits A and B?**

*Some students may think that in circuit diagrams a branch containing a switch is always open because the symbol for a switch is very often represented in the open position. Explain to the students that when they are interpreting circuit diagrams, they must think of each switch as closed.*

*Circuit A has one path. Circuit B has two paths.*

**6** Write the terms *series circuit* and *parallel circuit* on the board. Explain that in a **series circuit** there is only one path for current to move through. In a **parallel circuit** there is more than one path. Ask, **What type of circuit is Circuit A? Circuit B?**

*Circuit A is a series circuit. Circuit B is a parallel circuit.*

## Guiding the Activity

**In Circuit A, what happened to the bulb when the switch was closed and then opened? Why?**

**In Circuit B, what happened to the bulbs when the switch was opened and closed? Why?**

**7** Now have the class complete Step 2 on Activity Sheet 3, Part B, by building, diagraming, and testing Circuit C.

**8** Invite several volunteers to draw their Circuit C diagrams on the board.

Ask, **Is Circuit C a series or a parallel circuit? How do you know?**

**What happened to the bulbs when the switch was opened and closed in Circuit C?**

Work with the class to compare Tables 2 and 3. Lead the students to recognize that the behavior of the bulbs in Circuit C is similar to that of the bulbs in Circuit B. Then show them that Circuit C can be represented by the Circuit B diagram. Have them trace the path of the current through the drawings of Circuit B and Circuit C. Point out that even though they were constructed differently, both circuits contain two paths. Emphasize that there are different ways of building a circuit represented by a circuit diagram.

## Additional Information

*The bulb lit and then went off. There is only one path for the current in Circuit A, and when the switch was closed, there was a continuous path for the current. When the switch was opened, the path was interrupted and so no current flowed in the circuit.*

*Bulb 1 remained lit all the time. Bulb 2 went on and off. Circuit B has two branches for the current. Bulb 1 is in a branch that has an uninterrupted path for the current, so the bulb remained lit. When the switch was closed in the branch with Bulb 2, there was a continuous path for the current in that branch, so that bulb lit. When the switch was opened, the path was interrupted and no current flowed in that branch, so the bulb went off.*

*The circuit diagram for Circuit C is identical to that of Circuit B.*

*Circuit C is a parallel circuit because it has two branches.*

*Bulb 1 remained lit. Bulb 2 went on and off.*

## REINFORCEMENT

Construct a series circuit containing a battery and two bulbs. Construct a parallel circuit also containing a battery and two bulbs. Ask students to diagram each circuit and classify it as a series or a parallel circuit.

### **Assessment Opportunity**

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

## SCIENCE NOTEBOOKS

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

## CLEANUP

Ask the students to take apart the battery and bulb assemblies and the knife switches. Have them straighten any bent wires, discard the pieces of masking tape, and return the remaining materials to the kit.

## SCIENCE AT HOME

Many operating manuals for DVD players, televisions, radios, and CD players use symbols to represent such things as on-off switches, volume controls, fast-forward buttons, and earphone jacks. Advise the students to look at several operating manuals they may find at home and to list some of the symbols and what they represent. Let the students compare their lists and discuss similarities and differences among different symbols that represent the same thing.

## Connections

### Science Challenge

Provide each group of students with a battery assembly, a bulb assembly, a knife switch, and four lengths of wire. Challenge students to construct a circuit in which the bulb remains lit regardless of whether the switch is open or closed. (Any parallel circuit with the bulb assembly and the switch in separate loops will work.)

### Science Extension

- ▶ Ask volunteers to begin a class master chart of circuit components and their symbols. Let students draw pictures of the components, use pictures cut from catalogs or magazines, or tape actual components to the chart. As other components and their symbols are introduced in later activities, have students add them to the chart.
- ▶ Give students the following instructions for making a model of a light bulb. Punch two holes in a plastic or cardboard lid that will fit on a glass jar. Push two long nails through the holes. Attach a piece of very thin iron wire between the nails, close to their points, to represent the filament in a light bulb. Place the lid on the jar, then wire the nail heads to a switch and two D-cells in series to form a circuit. When the switch is closed and current flows through the circuit, the thin wire will heat up and begin to 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 ask questions about the visitor's work and the education and training it requires.

### Science and Language Arts

Divide the class into groups of four. Have one student in each group write a paragraph describing how to set up a parallel circuit with one D-cell, two switches, and three bulb assemblies. Have the second student read the first student's description and draw a diagram of the circuit it describes. Have the third and fourth students build the circuit, with one student using the written description and the other using the circuit diagram. In a follow-up discussion, have students evaluate the advantages of using diagrams rather than words in designing and building circuits.

### Science and Math

Ask students to research the names of the units that are used to measure various characteristics of electric current and to identify the characteristic that each unit measures. Encourage students to describe the characteristics in their own words rather than repeat sophisticated definitions that they may not understand. To further student understanding, use the flow of water through a hose as an analogy for the flow of electric current through a conductor.

- ampere** Measures the amount of electric current—the rate of electron flow through a conductor.
- volt** Measures the pressure, or force, of an electric current.
- ohm** Measures the resistance of a material.
- watt** Measures electric power—how much work can be done.