

Electricity and Electric Circuits

Static electric charge may build up to the point that it causes a discharge in the form of lightning strikes or a spark jumping from your hand to a doorknob. Whatever way it happens, electrical energy is transferred by the movement of electric charge. The movement, or flow, of electric charges from one place to another is called an **electric current**. A more detailed discussion of electric current, how it is measured, and the units it is measured in occurs on page 314.

There is one very important difference between the electric current flowing during a lightning strike and that flowing through a light bulb in a flashlight. The current passing through the bulb is flowing in a controlled path called an **electric circuit**. Electric circuits are used to convert electrical energy into the other forms of energy we need.

The Parts of an Electric Circuit

A study lamp, a flashlight, and the experimental circuit shown in **Figure 1** look quite different. However, the electric circuits that operate all three of them are essentially the same. They all have the same four basic parts found in the simple electric circuit shown in **Figure 1**. These four parts are:

1. Source of Electrical Energy

Almost daily scientific and technological developments provide new ways of producing electrical energy. They range from the minute amounts of electrical energy generated for obtaining information from a computer hard drive to the large amounts produced at nuclear power stations. In between these two extremes are such sources as the photoelectric cells used in calculators, cells and batteries, portable generators, and of course wall outlets. Electrical energy is discussed in more detail in Chapter 11.

2. Electrical Load

Although the word “load” normally tends to imply something heavy, an **electrical load** is simply the name given to anything that converts

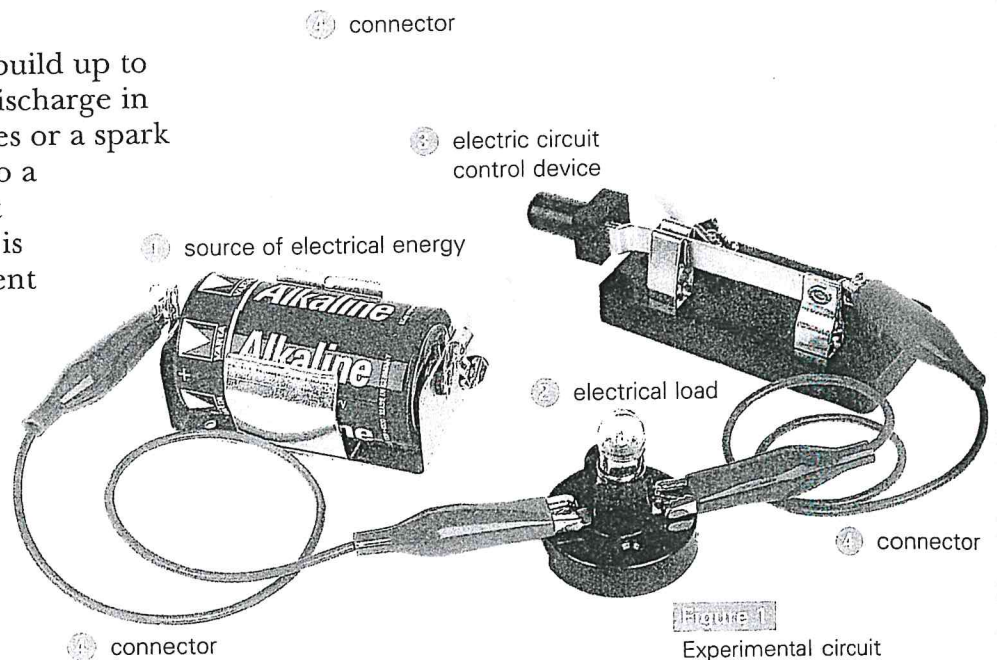


Figure 1
Experimental circuit

Did You Know ?

We often use the term “battery” instead of “cell.” A battery is actually a combination of two or more cells.

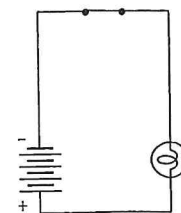


Figure 2
Schematic diagram of a closed circuit shown in Figure 1

electrical energy into whatever form of energy we need. The electrical load is actually the reason the electric circuit exists in the first place. The toaster you use at breakfast is an electrical load. What electrical loads have you used so far today?

3. Electric Circuit Control Device

The most obvious devices for controlling electric circuits are the simple switches we use in our homes, cars, and many kinds of portable electronic equipment. However, there are many more that we never see. They are often hidden inside the appliances, like the clock timer that controls the microwave oven. Many operate automatically, like the thermostat that controls the temperature of the house.

4. Connectors

One of the most amazing electric circuits is the microchip. The conducting wires, or **connectors**, used in these circuits are now so small that they are sometimes only a few atoms wide. However, whether they are the size of the wires on transmission lines or microscopic strands of wire 10 000 times thinner than a human hair, they all have the same purpose: to provide a controlled path for electric current to flow to each part of the circuit.

The words used to describe whether an electric circuit is operating often cause confusion. When a circuit is operating, and current is flowing, there is said to be a **closed circuit**. In the closed circuit shown in the photograph (**Figure 1**), the arm on the switch is connected to the other part of the switch, and the switch is said to be “on.” When the arm of the switch is not connected to the other part of the switch, the switch is said to be “open” or “off” and there is said to be an **open circuit**. The electric current flows in a continuous loop from the negative terminal of the cell, through the wires, the switch, and the light bulb, and returns to the cell’s positive terminal.

Electric Circuit Diagrams and Symbols

To simplify the drawing of electric circuits, a special set of symbols is used. This is much more convenient because we need to draw only one symbol for a switch, instead of different symbols for each kind of switch that exists or will be invented. Drawings of circuits using these symbols are called **schematic circuit diagrams** (**Figure 2**). ^(5D)

In these diagrams, the connecting wires are usually drawn as straight lines, with right-angled corners. This makes it easier to understand complicated circuits.

Understanding Concepts

1. Describe the difference between static electricity and current electricity.
2. Make a chart listing the parts of an electric circuit. State a function for each part and provide two examples.
3. In which direction does the electric charge flow around the circuit in **Figure 1**? What causes it to happen?

Making Connections

4. List four examples of electrical loads in the kitchen that convert electrical energy to (a) light energy and (b) mechanical energy. Predict which load uses the most, and the least, amount of energy.
5. List four different examples of electric control devices
 - (a) in the kitchen;
 - (b) the basement or laundry room;
 - (c) in a car.

Choose two devices from your list and suggest reasons for their design.

Exploring

6. What process is used to create the complex, multilayer circuit diagrams that make up the microchips used in computers? Visit the Internet sites of some of the major computer microchip manufacturers and find out how this is done. Create a flow chart describing the process.




































Reflecting

7. Why are schematic circuit diagrams used rather than pictorial circuit diagrams?

Challenge

What should be included in the schematic circuit diagram for your challenge?

Circuit Diagram Symbols

	DC CIRCUITS	HOUSEHOLD CIRCUITS (additional symbols)
Sources/Outlets	 cell  3-cell battery	 wall outlet  range outlet  single outlet  double outlet (duplex)  weatherproof outlet  special-purpose outlet
Control Devices	 switch  fuse  circuit breaker  switch and fuse  distribution panel <p>S switch</p> <p>S_{WP} weatherproof switch</p>  push button	
Electrical Loads	 light bulb  clock  motor  thermostat  resistor  variable resistor (rheostat)  fluorescent fixture  heating panel	 ceiling light  wall light  lampholder with pull switch  recessed fixture  television outlet  fan  buzzer  bell
Meters	 ammeter  voltmeter	
Connectors	 conducting wire  wires joined  ground connection	

