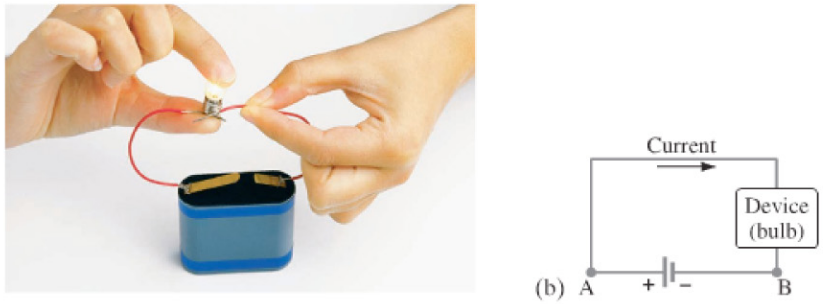

FIGURE 18–6 (a) A simple electric circuit. (b) Schematic drawing of the same circuit, consisting of a battery, connecting wires (thick gray lines), and a lightbulb or other device.

18–2 Electric Current

Electric circuit

The purpose of a battery is to produce a potential difference, which can then make charges move. When a continuous conducting path is connected between the terminals of a battery, we have an electric **circuit**, Fig. 18–6a. On any diagram of a circuit, as in Fig. 18–6b, we use the symbol

Battery symbol

+ − [battery symbol]

to represent a battery. The device connected to the battery could be a lightbulb, a heater, a radio, or whatever. When such a circuit is formed, charge can flow through the wires of the circuit, from one terminal of the battery to the other, as long as the conducting path is continuous. Any flow of charge such as this is called an **electric current**.

More precisely, the electric current in a wire is defined as the net amount of charge that passes through the wire's full cross section at any point per unit time. Thus, the current I is defined as

Electric current

$$I = \frac{\Delta Q}{\Delta t}, \qquad \textbf{(18–1)}$$

where ΔQ is the amount of charge that passes through the conductor at any location during the time interval Δt.

Unit of electric current: the ampere $(1\ \text{A} = 1\ \text{C/s})$

Electric current is measured in coulombs per second; this is given a special name, the **ampere** (abbreviated amp or A), after the French physicist André Ampère (1775–1836). Thus, $1\ \text{A} = 1\ \text{C/s}$. Smaller units of current are often used, such as the milliampere $(1\ \text{mA} = 10^{-3}\ \text{A})$ and microampere $(1\ \mu\text{A} = 10^{-6}\ \text{A})$.

Circuits: complete or open

A current can flow in a circuit only if there is a *continuous* conducting path. We then have a **complete circuit**. If there is a break in the circuit, say, a cut wire, we call it an **open circuit** and no current flows. In any single circuit, with only a single path for current to follow such as in Fig. 18–6b, a steady current at any instant is the same at one point (say, point A) as at any other point (such as B). This follows from the conservation of electric charge: charge doesn't disappear. A battery does not create (or destroy) any net charge, nor does a lightbulb absorb or destroy charge.

CAUTION
A battery does not create charge; a lightbulb does not destroy charge

EXAMPLE 18–1 **Current is flow of charge.** A steady current of 2.5 A exists in a wire for 4.0 min. (*a*) How much total charge passed by a given point in the circuit during those 4.0 min? (*b*) How many electrons would this be?

APPROACH Current is flow of charge per unit time, Eq. 18–1, so the amount of charge passing a point is the product of the current and the time interval. To get the number of electrons (*b*), we divide by the charge on one electron.

SOLUTION (*a*) Since the current was 2.5 A, or 2.5 C/s, then in 4.0 min (= 240 s) the total charge that flowed past a given point in the wire was, from Eq. 18–1,

$$\Delta Q = I\,\Delta t = (2.5\ \text{C/s})(240\ \text{s}) = 600\ \text{C}.$$

(*b*) The charge on one electron is 1.60×10^{-19} C, so 600 C would consist of

$$\frac{600\ \text{C}}{1.6 \times 10^{-19}\ \text{C/electron}} = 3.8 \times 10^{21}\ \text{electrons}.$$