

**EXAMPLE 18-3 Flashlight bulb resistance.** A small flashlight bulb (Fig. 18-10) draws 300 mA from its 1.5-V battery. (a) What is the resistance of the bulb? (b) If the battery becomes weak and the voltage drops to 1.2 V, how would the current change?

**APPROACH** We can apply Ohm's law to the bulb, where the voltage applied across it is the battery voltage.

**SOLUTION** (a) We change 300 mA to 0.30 A and use Eq. 18-2:

$$R = \frac{V}{I} = \frac{1.5 \text{ V}}{0.30 \text{ A}} = 5.0 \Omega.$$

(b) If the resistance stays the same, the current would be

$$I = \frac{V}{R} = \frac{1.2 \text{ V}}{5.0 \Omega} = 0.24 \text{ A} = 240 \text{ mA},$$

or a decrease of 60 mA.

**NOTE** With the smaller current in b, the bulb filament's temperature would be lower and the bulb less bright. Also, resistance does depend on temperature (Section 18-4), so our calculation is only a rough approximation.

**EXERCISE B** What is the resistance of a lightbulb if 0.50 A flows through it when 120 V is connected across it?

All electric devices, from heaters to lightbulbs to stereo amplifiers, offer resistance to the flow of current. The filaments of lightbulbs (Fig. 18-5) and electric heaters are special types of wires whose resistance results in their becoming very hot. Generally, the connecting wires have very low resistance in comparison to the resistance of the wire filaments or coils, so the wires usually have a minimal effect on the magnitude of the current. In many circuits, particularly in electronic devices, **resistors** are used to control the amount of current. Resistors have resistances ranging from less than an ohm to millions of ohms (see Figs. 18-11 and 18-12). The main types are "wire-wound" resistors which consist of a coil of fine wire, "composition" resistors which are usually made of carbon, and thin carbon or metal films.

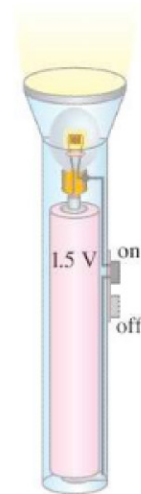
When we draw a diagram of a circuit, we use the symbol



[resistor symbol]

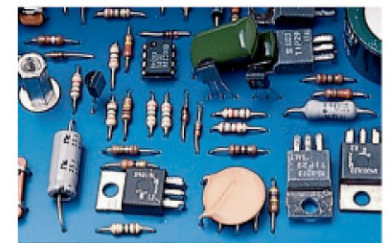
to indicate a resistance. Wires whose resistance is negligible, however, are shown simply as straight lines.

Resistor Color Code			
Color	Number	Multiplier	Tolerance
Black	0	1	
Brown	1	$10^1$	
Red	2	$10^2$	
Orange	3	$10^3$	
Yellow	4	$10^4$	
Green	5	$10^5$	
Blue	6	$10^6$	
Violet	7	$10^7$	
Gray	8	$10^8$	
White	9	$10^9$	
Gold		$10^{-1}$	5%
Silver		$10^{-2}$	10%
No color			20%

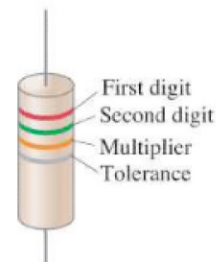


**FIGURE 18-10** Flashlight (Example 18-3). Note how the circuit is completed along the side strip.

**FIGURE 18-11** Photo of resistors (striped), plus other devices on a circuit board.



Resistor symbol



**FIGURE 18-12** The resistance value of a given resistor is written on the exterior, or may be given as a color code as shown above and in the Table: the first two colors represent the first two digits in the value of the resistance, the third color represents the power of ten that it must be multiplied by, and the fourth is the manufactured tolerance. For example, a resistor whose four colors are red, green, yellow, and silver has a resistance of  $25 \times 10^4 \Omega = 250,000 \Omega = 250 \text{ k}\Omega$ , plus or minus 10%.