**ADVANCED TOPICS**

See "Electron Tunneling" in **Appendix J: Advanced Topics** to learn how electrons behave in the theory of quantum mechanics.

### Electric companies measure energy consumed in kilowatt-hours

Electric power, as discussed previously, is the rate of energy transfer. Power companies charge for energy, not power. However, the unit of energy used by electric companies to calculate consumption, the *kilowatt-hour,* is defined in terms of power. One kilowatt-hour (kW•h) is the energy delivered in 1 h at the constant rate of 1 kW. The following equation shows the relationship between the kilowatt-hour and the SI unit of energy, the joule:

$$1\ \text{kW}\bullet\text{h} \times \frac{10^3\ \text{W}}{1\ \text{kW}} \times \frac{60\ \text{min}}{1\ \text{h}} \times \frac{60\ \text{s}}{1\ \text{min}} = 3.6 \times 10^6\ \text{W}\bullet\text{s} = 3.6 \times 10^6\ \text{J}$$

On an electric bill, the electrical energy used in a given period is usually stated in multiples of kilowatt-hours. An electric meter, such as the one outside your home, is used by the electric company to determine how much energy is consumed over some period of time. So, the electric company does not charge for the amount of power delivered but instead charges for the amount of energy used.

**Why it Matters**

## Household Appliance Power Usage

Hair dryers contain a resistive coil that becomes hot when there is an electric current in the coil.

The electrical energy supplied by power companies is used to generate electric currents. These currents are used to operate household appliances. When the charge carriers that make up an electric current encounter resistance, some of the electrical energy is converted to internal energy by collisions and the conductor warms up. This effect is used in many appliances, such as hair dryers, electric heaters, electric clothes dryers, steam irons, and toasters.

Hair dryers contain a long, thin heating coil that becomes very hot when there is an electric current in the coil. This coil is commonly made of an alloy of the two metals nickel and chromium. This nickel chromium alloy conducts electricity poorly.

In a hair dryer, a fan behind the heating coil blows air through the hot coils. The air is then heated and blown out of the hair dryer. The same principle is also used in clothes dryers and electric heaters.

In a steam iron, a heating coil warms the bottom of the iron and also turns water into steam. An electric toaster has heating elements around the edges and in the center. When bread is loaded into the toaster, the heating coils turn on and a timer controls how long the elements remain on before the bread is popped out of the toaster.

Appliances that use resistive heater coils consume a relatively large amount of electric energy. This energy consumption occurs because a large amount of current is required to heat the coils to a useful level. Because power is proportional to the current squared times the resistance, energy consumption is high.