Quick Lab

Energy Use in Home Appliances

MATERIALS LIST

- **three small household appliances, such as a toaster, television, lamp, or stereo**
- **household electric-company bill (optional)**

SAFETY

Unplug appliances before examination. Use extreme caution when handling electrical equipment.

Look for a label on the back or bottom of each appliance. Record the power rating, which is given in units of watts (W). Use the billing statement to find the cost of energy per kilowatt-hour. (If you don't have a bill, choose a value between \$0.05 and \$0.20 per kilowatt-hour to use for your calculations.) Calculate the cost of running each appliance for 1 h. Estimate how many hours a day each appliance is used. Then calculate the monthly cost of using each appliance based on your daily estimate.

extension

Practice Problems

Visit go.hrw.com to find a sample and practice problems on the cost of electrical energy.

Keyword HF6ELCX

Electric power is the rate of conversion of electrical energy

Earlier in the text, power was described as the rate at which work is done. *Electric power,* then, is the rate at which charge carriers do work. Put another way, electric power is the rate at which charge carriers convert electrical potential energy to nonelectrical forms of energy.

$$P = \frac{W}{\Delta t} = \frac{\Delta PE}{\Delta t}$$

Potential difference is the change in potential energy per unit of charge.

$$\Delta V = \frac{\Delta PE}{q}$$

This equation can be rewritten in terms of potential energy.

$$\Delta PE = q\Delta V$$

We can then substitute this expression for potential energy into the equation for power.

$$P = \frac{\Delta PE}{\Delta t} = \frac{q\Delta V}{\Delta t}$$

Because current, I, is defined as the rate of charge movement ($q/\Delta t$), we can express electric power as current multiplied by potential difference.

ELECTRIC POWER

$$P = I\Delta V$$

electric power = current × potential difference

This equation describes the rate at which charge carriers lose electrical potential energy. In other words, power is the rate of conversion of electrical energy. Recall that the SI unit of power is the *watt,* W. In terms of the dissipation of electrical energy, 1 W is equivalent to 1 J of electrical energy being converted to other forms of energy per second.

Most light bulbs are labeled with their power ratings. The amount of heat and light given off by a bulb is related to the power rating, also known as *wattage,* of the bulb.

Because $\Delta V = IR$ for ohmic resistors, we can express the power dissipated by a resistor in the following alternative forms:

$$P = I\Delta V = I(IR) = I^2R$$

$$P = I\Delta V = \left(\frac{\Delta V}{R}\right)\Delta V = \frac{(\Delta V)^2}{R}$$

The conversion of electrical energy to internal energy in a resistant material is called *joule heating,* also often referred to as an I^2R loss.