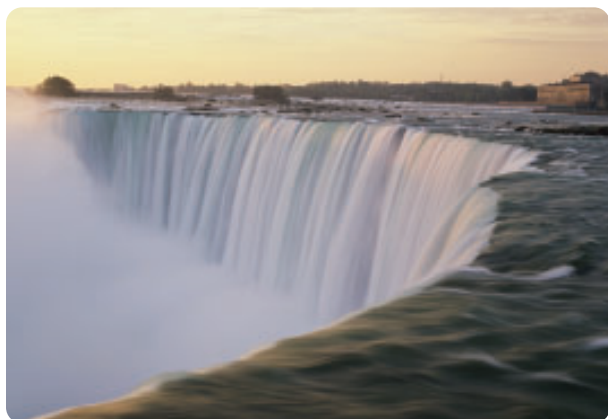


Using Electricity

Key Ideas

Electrical energy is a type of energy that can be converted into other types of energy.

- Electrical energy can be potential energy, such as the energy stored in a battery, or it can be the energy of moving electrons in an electric current that can do work.
- Potential energy is energy that can be stored. Kinetic energy is the energy that is associated with motion.
- Work is done when energy is transformed. Energy is defined as the ability to do work. The metric unit for both work and energy is the joule (J).
- Energy comes in many types and is often only observed when it changes from one type to another. Energy is always conserved.
- We can use various equations to calculate the electrical energy of a device.



Electrical energy

$$\Delta E = P\Delta t$$

$$\Delta E = VI\Delta t$$

Electrical power is the rate of transforming electrical energy into another type of energy.

- Power is the rate of doing work or the rate of transforming energy. The metric unit for power is the watt (W).
- We can use various equations to calculate the electrical power of a device.

Electrical power

$$P = \frac{\Delta E}{\Delta t}$$

$$P = VI$$

Vocabulary

work (W), p. 336

energy (E), p. 336

potential energy (PE), p. 336

kinetic energy (KE), p. 336

law of conservation of energy,
p. 337

power (P), p. 338

watt (W), p. 338

kilowatt•hour (kW•h), p. 350

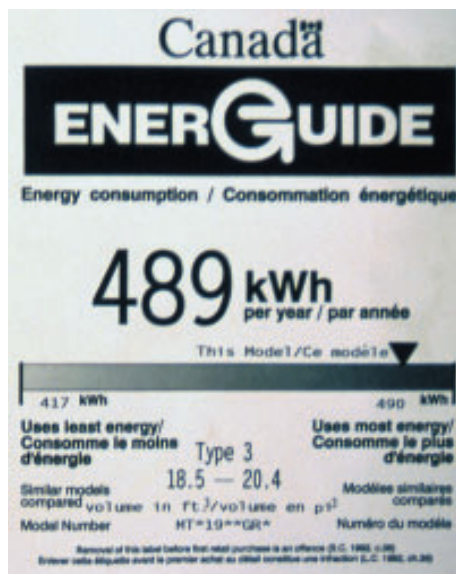
Electrical energy is produced from renewable and non-renewable resources.

- Electricity can be generated from renewable resources including water (hydro), the Sun (solar), wind, biomass, tides, geothermal, and landfill gas.
- Electricity can be generated from non-renewable resources, including fossil fuels and nuclear reactions.



Energy consumption can be determined given the power rating of a device and the duration of use.

- Electrical energy is often measured in kilowatt•hours (kW•h).
- Household electrical energy is sold in units of kilowatt•hours (kW•h), not joules, and is measured by kilowatt•hour meters (electric meters).
- EnerGuide labels provide information about the energy consumption and efficiency of appliances in Canada.



Review Key Ideas and Vocabulary

- Give an example of a device that converts electrical energy into each of the following types of energy:
 - heat
 - kinetic energy
 - light energy
- A warm cup of coffee has 20 000 J of energy. After being heated in a microwave, the cup of coffee has 70 000 J of energy. How much work was done by the microwave to heat the coffee?
 - 20 000 J
 - 50 000 J
 - 70 000 J
 - 90 000 J
- What is the reading shown by the kilowatt•hour meter dials in Figure 1?



kilowatt•hour meter reading

Figure 1

- 72912
 - 72923
 - 83023
 - 73913
- A family uses a 1200 W microwave oven for 30 min. If electrical power costs \$0.063/kW•h, what is the cost to use the microwave oven?
 - \$0.038
 - \$0.43
 - \$2.27
 - \$37.80
 - A watt is to power as a _____ is to work.
 - Is a kilowatt•hour a unit of electrical energy or a unit of power? Explain your answer.

Use What You've Learned

- A hair dryer is rated at 1200 W. How much current flows through the hair dryer when it is plugged into a 120 V outlet?
- Calculate the power rating of an electric toaster that uses 210 000 J while toasting bread for 140 s.
- How much electrical energy does a 2 W clock use in one day?
- A Segway® Personal Transporter (PT), shown in Figure 2, has two electric motors (one for each wheel) and one 72 V battery. If each motor consumes 180 W of power when travelling up a hill, how much current would the motors get from the battery?



Figure 2

- An electric drill has a current of 0.55 A flowing through it for 48 s. If the drill is connected to a 120 V outlet, how much energy is used?
- How much energy does a calculator use in two minutes if it draws 0.2 mA of current from a 2.8 V battery?
- What is the power of a 1.2 kA lightning bolt with a voltage of 1.5 MV?



Figure 3

14. An electric utility company provides 250 kW of power over transmission lines at 240 kV. What is the current in the transmission lines (Figure 3)?
15. (a) What is the current in a 373 W motor using a 120 V outlet?
(b) If the motor is plugged into a 240 V outlet, what happens to the current in the motor?
16. An electric heater, rated at 2600 W, is plugged into a household outlet. If the current from the outlet exceeds 15 A, a circuit breaker shuts off the circuit. Will the heater cause the breaker to stop the current flow? Show your calculations, and explain your reasoning.
17. A standard dishwasher has an EnerGuide rating of 592 kW•h. What is the cost per week to run the appliance if electricity costs \$0.068/kW•h?
18. An electric refrigerator operates on 120 V and uses 2 A. To keep the refrigerator cool, the motor operates one-quarter of the time. What is the cost of operating the refrigerator for seven days if the cost of electrical power is \$0.065/kW•h?

19. Find the EnerGuide rating of an appliance in your home and determine the cost of electrical energy in your area. Use this information to determine the weekly cost of the appliance.
20. Batteries are often rated in ampere•hours (A•h), which is a measure of how much electric charge the battery has. This can be shown as follows:

$$1 \text{ ampere}\cdot\text{hour} = \frac{1 \text{ coulomb}}{\text{second}} \times 3600 \text{ seconds} \\ = 3600 \text{ coulombs}$$

How much energy is stored in each of the following batteries?

- (a) Two 1.5 V AA batteries, each rated at 2 A•h, are used in a CD player.
- (b) A 12 V truck battery rated at 100 A•h is used to start the engine.
- (c) A 12 V golf cart battery rated at 260 A•h is used to run the electric engine.

Think Critically

21. A multimeter can be set to either AC or DC. What will a multimeter read if it is set to the DC current mode, but placed in an AC circuit?
22. Use $P = VI$ to explain why Edison's DC system was inefficient.
23. Most small electronic devices, such as electronic games, digital cameras, cell phones, and MP3 players, come with a transformer. Research to determine how a transformer works, the purpose of a transformer, and the type of current that a transformer requires.

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Reflect On Your Learning

24. How has what you have learned about work, energy, and power affected your use of these words in everyday language?

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