

# Your **E C O L O G I C A L** *footprint*



## Lead and Your Listening Pleasure

Every good or service requires different types and quantities of energy and materials to produce and hence releases different amounts of wastes to the environment. One of the most important determinants of your ecological footprint is the type of consumer goods you purchase. This point is illustrated by the use of lead. In 1996 about 1.5 billion kilograms of lead were consumed in the United States, about 5.8 kilograms per person per year. But some people use far more or far less than the general average due to the choices they make as consumers. Consider our choices in electronic devices. Many people own a Walkman(tm) or portable CD player that they listen to as they Rollerblade(tm), walk to work, or read the paper. Most such devices run on AA batteries. What initially appears as the cheapest option is to buy disposable lead-based alkaline batteries, which cost about 80 cents each. One AA alkaline battery weighs about 25 grams, of which about 40 percent, or about 10 grams, is lead. Let's assume your Walkman(tm) requires two AA batteries and that most of the time you listen to tapes. If you use your Walkman(tm) three to four times per week for a couple of hours each time, your batteries will last about 25 hours. Over a year you will buy and dispose of about 25 batteries, and in doing so release 250 grams of lead into landfills.

Another option is to buy rechargeable batteries, which initially are more expensive (about \$1.25 each) and require the purchase of a recharging unit (as cheap as \$10.00). But a rechargeable battery will last four to ten times longer than a disposable alkaline before it goes dead. Over the long run, rechargeable batteries end up being cheaper and less harmful to the environment than disposable batteries.

Rechargeable batteries aren't free of impacts. They are made from toxic materials, usually nickel and cadmium, and ultimately must be disposed of. But their longer life significantly reduces the release of harmful materials from their production, use, and disposal. All batteries, disposable or rechargeable, can be recycled. The benefits of rechargeable batteries can be enhanced by collecting old batteries and making a periodic visit to your local recycling center.

### STUDENT LEARNING OUTCOME

- Students will be able to discuss the use of lead in regular and rechargeable batteries.

one is from Boston Edison, the regional utility that sells electricity; and one is from Arlington Fuel Oil Company, a local business that sells heating oil. Cutler's family also buys cylinders of liquefied propane gas (LPG). Natural gas is used to heat hot water and cook. Electricity is used to power appliances and lamps. Fuel oil is burned in a furnace to provide space heat. LPG powers the gas grill for summer barbecues.

This example illustrates that energy exists in many different forms. Yet all forms of energy can be expressed in heat equivalents—the quantity of energy they release when converted completely to heat. In this book energy is measured in kilocalories (kcal). For example, one gallon of gasoline contains about 31,254 kcal, one kilowatt-hour of electricity contains about 860 kcal, and one cubic foot of natural gas is equal to about 260 kcal. The conversion of energy to heat equivalents allows us to compare the quantities of different forms of energy.

Energy comes in many forms. **Electromagnetic radiation** or **radiant energy** is the energy carried by light. The energy generated by the sun is a form of radiant energy called solar energy. The radiant energy generated by the sun travels in the form of electromagnetic waves that differ in wavelength and energy content (Figure 2.9). Gamma rays, X-rays, ultraviolet waves, visible light waves, infrared

waves, microwaves, TV waves, and radio waves are defined by their wavelengths. Some forms of radiant energy are familiar to us; others are not. The visible white light that reaches Earth can be passed through a prism to produce the full spectrum of colors from red to blue. That part of the electromagnetic spectrum is called the visible spectrum. But the warmth we feel from the sun is energy from parts of the electromagnetic spectrum that are not visible. The radiant energy that causes sunburn is from the ultraviolet part of the spectrum, which has shorter wavelengths than the visible portion. In general, the shorter the wavelength of a type of radiant energy, the higher its energy content.

The Earth intercepts about  $1.3 \times 10^{21}$  kcal of radiant energy each day. This amount is about 90,000 times the quantity of fossil fuel used by all human societies in 2006. In fact, the total amount of crude oil, natural gas, coal, and other fossil fuels in Earth's crust amounts to only about 11 days of sunshine! This illustrates an important aspect of solar energy: The total *quantity* is enormous, but it is spread out over a very large area. The amount that arrives at a given area of Earth's surface is very small. This presents a challenge to humans who want to use solar energy to run industrial economic systems. Elaborate and expensive collection systems often are required to collect and concentrate solar energy. We return to this important point in Chapter 22.