**Unit 6**

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**Chapter 11**

**Extension: Food Energy**

This audio clip is intended to enhance your understanding of how thermochemistry is used to determine the quantity of energy available in our food.

Well-founded knowledge indicates that the food we eat provides us with the energy we require to carry out the activities of daily life: walking, thinking, talking, and so on. Some foods, such as fats, are found to be high-energy foods while chemists have found that other foods provide different nutrients but less energy. The energy content in foods was traditionally measured in calories. A calorie is the quantity of energy (or heat) that must be transferred to increase the temperature of one gram of water by one degree Celsius. Confusingly, the food Calorie is 1000 cal—sometimes called the “big C calorie” because of its capital initial letter. To clarify, scientists use the symbol cal for the small calorie, and kcal for the larger (food) Calorie. Fortunately the internationally accepted and universally applicable unit of energy is now the joule, with the symbol uppercase J. Scientists measure all forms are energy in joules, regardless of the kind or source of energy.

One calorie has the same energy value as 4.186 J, so 1 kcal equals 4.186 kJ. The quantity of energy in various foods can be determined by using an instrument called a bomb calorimeter. This instrument provides an isolated system and works by measuring the energy released as a known mass of food burns completely. The food sample is sealed within a chamber, called the “bomb,” that is filled with oxygen at high pressure. An electrical current moves through a burnable fuse that sits inside the food chamber and ignites the food–oxygen mixture. As the food burns in the chamber, heat is absorbed by a known mass of surrounding water. Because the calorimeter is fully insulated from the outside environment, the increase in the water’s temperature is directly related to the quantity of heat transferred as the food burns. The energy content of the food can therefore be determined with the equation $Q = mc\triangle t$ . The mass, specific heat capacity, and temperature of the water are substituted into the equation to calculate the quantity of heat transferred. For even more accurate results, the mass, specific heat capacity, and temperature change of the calorimeter and associated equipment can also be included on the right-hand side of the calculation.

The calculated value of $Q$, from the calorimeter data, is the quantity of energy released by the burning food sample. This value can then be divided by the mass of food burned to determine the quantity of energy released from one gram of that particular food. Each type of food releases a different quantity of energy. This energy is sometimes called the *specific heat* and is measured in joules per gram.

*Metabolism* refers to the many chemical reactions going on continuously in our bodies to allow normal cell processes. These processes require the energy we get from food. The food we eat is broken down in a series of chemical reactions by biological catalysts called *enzymes*. Much of the energy released is used for cell function and growth. The metabolism of food and the combustion, or burning, of food involve the same overall reactions. However, unlike our multi-step metabolism, which releases energy in a slow and controlled fashion, the combustion reaction of food in the bomb calorimeter is generally explained as a fast one-step process resulting in very high temperatures.

The bomb calorimeter is a very useful piece of technology that can provide us with information about the energy available from the carbohydrates, proteins, and fats in packaged foods—another example of chemistry at work for you.

 