Changes in Temperature and Phase

SECTION 3

SECTION OBJECTIVES

- Perform calculations with specific heat capacity.
- Interpret the various sections of a heating curve.

SPECIFIC HEAT CAPACITY

On a hot day, the water in a swimming pool, such as the one shown **Figure 12,** may be cool, even if the air around it is hot. This may seem odd, because both the air and water receive energy from sunlight. One reason that the water may be cooler than the air is evaporation, which is a cooling process.

However, evaporation is not the only reason for the difference. Experiments have shown that the change in temperature due to adding or removing a given amount of energy depends on the particular substance. In other words, the same change in energy will cause a different temperature change in equal masses of different substances. This fact is due to differences in the motion of atoms and molecules at the microscopic level.

The **specific heat capacity** of a substance is defined as the energy required to change the temperature of 1 kg of that substance by 1°C. (This quantity is also sometimes known as just *specific heat.*) Every substance has a unique specific heat capacity. This value tells you how much the temperature of a given mass of that substance will increase or decrease, based on how much energy is added or removed as heat. This relationship is expressed mathematically as follows:

SPECIFIC HEAT CAPACITY

$$c_p = \frac{Q}{m\Delta T}$$

$$\text{specific heat capacity} = \frac{\text{energy transferred as heat}}{\text{mass} \times \text{change in temperature}}$$

The subscript p indicates that the specific heat capacity is measured at constant pressure. Maintaining constant pressure is an important detail when determining certain thermal properties of gases, which are much more affected by changes in pressure than are solids or liquids. Note that a temperature change of 1°C is equal in magnitude to a temperature change of 1 K, so ΔT gives the temperature change in either scale.

The equation for specific heat capacity applies to both substances that absorb energy from their surroundings and those that transfer energy to their surroundings. When the temperature increases, ΔT and Q are taken to be positive, which corresponds to energy transferred into the substance. Likewise, when the temperature decreases, ΔT and Q are negative and energy is

Figure 12
The air around the pool and the water in the pool receive energy from sunlight. However, the increase in temperature is greater for the air than for the water.

specific heat capacity

the quantity of heat required to raise a unit mass of homogeneous material 1 K or 1°C in a specified way given constant pressure and volume