Chapter 8
CALCULATION CORNER
How Heat Changes Temperature

Heat must be applied to increase the temperature of a material. Conversely, heat must be withdrawn from a material in order to decrease its temperature. The amount of heat required for a given temperature change is calculated from the equation

heat = specific heat × mass × temperature change

We can use this formula for any material, provided there is no change of phase over the course of the temperature change. The value of the temperature change is obtained by subtracting the initial temperature T_i from the final temperature T_f:

$$\text{temperature change} = T_f - T_i$$

EXAMPLE 1

How much heat is required to increase the temperature of 1.00 gram of liquid water from an initial temperature of 30.0°C to a final temperature of 40.0°C?

ANSWER 1

The temperature change is

$$T_f - T_i = 40.0°C - 30.0°C = +10.0°C.$$

To find the amount of heat needed for this temperature change, multiply this positive change by the water's specific heat and mass:

heat = (4.184 J/g°C)(1.00 g)(10°C) = 41.8 J

The temperature decrease that occurs when heat is removed from a material is indicated by a negative sign, as is shown in the next example.

EXAMPLE 2

A glass containing 10.0 grams of water at an initial temperature of 25.0°C is placed in a refrigerator. How much heat does the refrigerator remove from the water as the water is brought to a final temperature of 10.0°C?

ANSWER 2

The temperature change is

$$T_f - T_i = 10.0°C - 25.0°C = -15.0°C.$$

To find the heat removed, multiply this negative temperature change by the water's specific heat and mass:

heat = (4.184 J/g°C)(10.0 g)(-15°C) = -628 J

YOUR TURN

1. A residential water heater raises the temperature of 100,000 grams of liquid water (about 26 gallons) from 25.0°C to 55.0°C. Show that 12,552,000 J of heat was applied.

2. Show that 402 J of heat must be extracted from a 10.0-gram ice cube (specific heat = 2.01 J/g°C) in order to bring its temperature from a chilly -10.0°C to an even chillier -30.0°C?

Answers to Calculation Corners appear at the end of the chapter review.