

## 14 THE JOULE

Since heat energy is energy, in the SI system, the unit of heat energy is the same as the unit of energy—the joule (J). It takes 4.184 J of energy to raise the temperature of 1 g of water by 1 °C. This means that 1 cal = 4.184 J.

How many joules are needed to raise the temperature of 1 kg of water by 1 °C?

*Answer:* For each gram of water, it will take 4.184 J of energy to raise its temperature by 1 °C. Since 1 kg is 1,000 g, it will take  $1,000 \text{ g} \cdot 4.184 \text{ J/g} = 4,184 \text{ J}$  (or 4.184 kJ)

From here on out, we are going to use the SI system (joules and kilojoules) when working with heat energy.

## 15 SPECIFIC HEAT

When 4.184 J of heat energy is added to 1 g of water, the water's temperature rises 1 °C. To raise the temperature of 1 g of glycerin by 1°, on the other hand, requires only 2.51 J. And to raise the temperature of 1 g of aluminum by 1° requires only 0.92 J. Specific heat is defined as follows:

Specific heat = the heat energy needed to raise the temperature of a unit mass of a given substance by 1 °C.

The table here lists the specific heats of a number of substances in joules per gram per °C (which is also equivalent to kilojoules per kilogram per °C).

| Material    | Specific heat (J/g/°C)<br>and (kJ/kg/°C) |
|-------------|------------------------------------------|
| Aluminum    | 0.920                                    |
| Copper      | 0.377                                    |
| Glass       | 0.669                                    |
| Glycerin    | 2.510                                    |
| Ice         | 2.092                                    |
| Iron        | 0.460                                    |
| Silver      | 0.251                                    |
| Water       | 4.184                                    |
| Water vapor | 2.092                                    |

When heat energy is added (or removed) from a substance, the resulting temperature change depends on the mass of the substance, the specific heat of