***Chemistry***

**5: Thermochemistry**

**5.1: Energy Basics**

1. A burning match and a bonfire may have the same temperature, yet you would not sit around a burning match on a fall evening to stay warm. Why not?

Solution

The temperature of 1 gram of burning wood is approximately the same for both a match and a bonfire. This is an intensive property and depends on the material (wood). However, the overall amount of produced heat depends on the amount of material; this is an extensive property. The amount of wood in a bonfire is much greater than that in a match; the total amount of produced heat is also much greater, which is why we can sit around a bonfire to stay warm, but a match would not provide enough heat to keep us from getting cold.

3. Explain the difference between heat capacity and specific heat of a substance.

Solution

Heat capacity refers to the heat required to raise the temperature of the mass of the substance 1 degree; specific heat refers to the heat required to raise the temperature of 1 gram of the substance 1 degree. Thus, heat capacity is an extensive property, and specific heat is an intensive one.

5. Calculate the heat capacity, in joules and in calories per degree, of the following:

(a) 45.8 g of nitrogen gas

(b) 1.00 pound of aluminum metal

Solution

(a) 45.8 ~~g~~  1.04 J/~~g~~°C = 47.6 J/°C; ; (b) 454 g  0.897 J/g °C = 407 J/°C; 

7. How much heat, in joules and in calories, is required to heat a 28.4-g (1-oz) ice cube from –23.0 °C to –1.0 °C?

Solution

*q* = *cm*Δ*T*; *q* = 2.093 J/g °C × 28.4 g × [–1 – (–23)] °C = 1308 J (or 1310 with the correct number of significant digits); the conversion factor is 4.184 J = 1 cal; 1308 J × 1 cal / 4.184 J = 1310 J

9. If 14.5 kJ of heat were added to 485 g of liquid water, how much would its temperature increase?

Solution

*q* = *cm*Δ*T*



11. A piece of unknown solid substance weighs 437.2 g, and requires 8460 J to increase its temperature from 19.3 °C to 68.9 °C.

(a) What is the specific heat of the substance?  
(b) If it is one of the substances found in Table 5.1, what is its likely identity?

Solution

(a) *q* = *cm*Δ*T*, *c = q*/(*m*Δ*T*) = 8460 J / [437.2 g (68.9 – 19.3) °C] = 0.390 J/g °C; (b) Copper is a likely candidate.

13. Most people find waterbeds uncomfortable unless the water temperature is maintained at about 85°F. Unless it is heated, a waterbed that contains 892 L of water cools from 85 °F to 72 °F in 24 hours. Estimate the amount of electrical energy required over 24 hours, in kWh, to keep the bed from cooling. Note that 1 kilowatt-hour (kWh) = 3.6 × 106 J, and assume that the density of water is 1.0 g/mL (independent of temperature). What other assumptions did you make? How did they affect your calculated result (i.e., were they likely to yield ‘positive’ or ‘negative’ errors)?

Solution

We assume that the density of water is 1.0 g/cm3(1 g/mL) and that it takes as much energy to keep the water at 85 °F as to heat it from 72 °F to 85 °F. We also assume that only the water is going to be heated. First, find the mass of water in the bed. The volume is 72 in. × 84 in. × 9 in.

;

second, convert the change of 13 °F to °C:

*q* = *cm*Δ*T* = 4.184 J/g °C(8.92 × 105 g) × 7.22 °C



= 2.69 × 107 J



This resource file is copyright 2015, Rice University. All Rights Reserved.