SPECIFIC HEAT

Chemists identify substances on the basis of their chemical and physical properties. One physical property of a substance is the amount of energy it will absorb per unit of mass. This property can be measured quite accurately and is called *specific heat* (c or C_p). Specific heat is the amount of energy measured in joules, needed to raise the temperature of one gram of the substance one Celsius degree.

To measure specific heat in the laboratory a *calorimeter* of some kind must be used. A calorimeter is a well-insulated container used in measuring energy changes. The calorimeter is insulated to reduce the loss or gain of energy to or from the surroundings. Energy always flows from an object at a higher temperature to an object at a lower temperature. The heat gained by the cooler substance equals the heat lost by the warmer substance, if we assume no loss of heat to the surrounding environment.

heat (q) lost = heat (q) gained

The specific heat of the metal can now be calculated:

$$\textit{Specific heat of metal} = \frac{\textit{heat gained by the water}}{\textit{mass of metal (g)} \times \Delta T \textit{ of metal (°C)}}$$

$q = m\ c\ \Delta T$

heat (q) lost by metal = heat (q) gained by water

$-[(m_m)(c_m)(\Delta T_m)] = (m_w)(c_w)(\Delta T_w)$

$-[(m_m)(c_m)(T_{final,\,m} - T_{initial,\,m})] = (m_w)(c_w)(T_{final,\,w} - T_{initial,\,w})$

Constant: c of water = 4.184 J/ g °C

PRACTICE PROBLEMS

1) What is the specific heat of a substance that absorbs 2.5×10^3 joules of heat when a sample of 1.0×10^4 g of the substance increases in temperature from 10.0 °C to 70.0 °C?

2) A 2.8 kg sample of a metal with a specific heat of 0.43KJ/KgC is heated to 100.0 °C then placed in a 50.0 g sample of water at 30.0 °C. What is the final temperature of the metal and the water?

3) How much heat energy is required to raise the temperature of 10.0 grams of ice from -100.0 °C to 0 °C? (C_p for ice is 0.5 cal/g°C)

4) A 200. gram sample of iron, initially at 0 °C, absorbs 660 calories of heat. Determine the final temperature attained by the iron sample if the specific heat capacity of iron is 0.11 cal/g°C.

5) A 200. gram sample of Aluminum, initially at 0 °C, absorbs 660 calories of heat. What is the final temperature of the Aluminum sample? The specific heat capacity of Aluminum is 0.22 cal/g°C.

6) A 100.-gram sample of material requires 1220 calories of heat energy to raise its temperature from 20.0°C to 80.0°C. What is the specific heat capacity of the material?

7) How much energy is required to lower the temperature of a bottle of drinking water (280 mL) from 22.0 °C to 4.0 °C?