Calorimetry

1. Octane, C_8H_{18}, has a specific heat of 2.22 J/(g·K). What quantity of heat, in kJ, is required to raise the temperature of 125.00 g of octane from 15.0 °C to 28.0 °C?

   $q = c \times m \times \Delta T$; $\Delta T = 28.0\ °C - 15.0\ °C = 13.0\ °C$

   $q = 2.22\ J/(g{\cdot}K) \times 125.00\ g \times 13.0\ °C =$ **3.61×10^3 J**

2. Consider the equation below:

   $NH_4NO_3\ (s) \rightarrow NH_4^+\ (aq) + NO_3^-\ (aq)$

   A 4.25 g sample of solid ammonium nitrate is dissolved in 60.0 g of water in a coffee cup calorimeter. The temperature decreases from 22.5 °C to 17.4°C. Calculate ΔH, in kJ/mol of NH_4NO_3, for this dissolution process. Assume the specific heat of the solution is that of water, 4.184 J/(g·K). Is this an endothermic or an exothermic process?

   $q_{solution} = c \times m \times \Delta T$; mass of solution = 60.0 g + 4.25 g = 64.25 g

   $\Delta T = 17.4\ °C - 22.5\ °C = -5.1\ °C$

   $q_{solution} = 4.184\ J/(g{\cdot}K) \times 64.25\ g \times -5.1\ °C = -1370.99\ J$

   The solution (the surroundings) loses heat to the system. The system is the NH_4NO_3. $q_{system} = +1370.99$ J; the dissolution is **endothermic.**

   A 4.25 g sample requires 1370.99 J of heat to dissolve. We need the kJ/mol. M_m (NH_4NO_3) = 80.043 g/mol

$$\frac{1.37\ kJ}{4.25\ g} \times \frac{80.043\ g}{1\ mol} = \mathbf{25.8\ kJ/mol}$$

3. A 1.00 g sample of pine nuts was burned in a bomb calorimeter containing 250.0 grams of water at an initial temperature of 22.5 °C. Once the reaction was completed, the temperature of the water was 49.2 °C. The heat capacity of the calorimeter is 8.74 J/°C. Calculate the heat of combustion for the pine nuts in kJ/g. How many Cal (food calories) is 100. g of pine nuts?

   $q_{rxn} = -q_{water} - q_{bomb}$ $\Delta T = 49.2\ °C - 22.5\ °C = 26.7\ °C$

   $q_{rxn} = -(4.184\ J/(g{\cdot}K) \times 250.0\ g \times 26.7°C) - 8.74\ J/°C \times 26.7\ °C =$

   -28161.6 J per 1.00 g of pine nuts = **28.2 kJ/g**.

   $-28161.6\,\frac{J}{g} \times \frac{cal}{4.184\ J} \times \frac{1\ Cal}{1000\ cal} = 6.73\,\frac{Cal}{g}$ **100 g would be 673 Cal.**