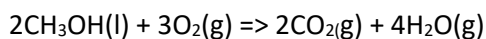


Calorimetry worksheet 2

- 1) Methanol, CH₃OH, undergoes combustion according to the equation



In an experiment to determine its suitability as a fuel, a sample of methanol underwent complete oxidation in a bomb calorimeter.

The calorimeter was first calibrated by passing a current through an electric heater placed in the water surrounding the reaction vessel. A potential of 6.25 volts was applied for 2.80 minutes. The measured current was 1.46 amperes and the temperature of the water and reaction vessel increased by 0.653 °C.

- a) Determine the calibration constant, in kJ °C⁻¹, for the calorimeter and its contents.

$$E = VIt$$

E = joules, V = volts, I = amperes, T = seconds

$$\Rightarrow E = 6.25 \times 1.46 \times 2.80 \times 60 = 1.533 \text{ kJ}$$

$$C_f = E / \Delta T = 1.533 / 0.653 = 2.35 \text{ kJ } ^\circ\text{C}^{-1}$$

- b) A student then used this calorimeter to determine the molar heat of combustion of methanol. 0.894 g of methanol was placed in the reaction vessel and excess oxygen was added. An electric ignition heater provided the energy required to initiate the combustion reaction. On this occasion, the temperature of the water increased by 8.45 °C.

Use this experimental data to determine the value of ΔH for the combustion of methanol given by the following equation. $2\text{CH}_3\text{OH}(\text{l}) + 3\text{O}_2(\text{g}) \Rightarrow 2\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$ Include appropriate units in your answer.

Step 1 calculate the mol of ethanol

$$\Rightarrow 0.894 / M_{\text{ethanol}} = 0.894 / 32.0 = 0.0279$$

Step 2 calculate the amount of energy given out

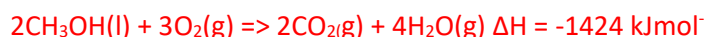
$$\Rightarrow E = 2.35 \text{ kJ } ^\circ\text{C}^{-1} \times 8.45 \text{ } ^\circ\text{C} = 19.86 \text{ kJ}$$

=> Calculate energy per mol

$$\Rightarrow 19.86 / 0.0279 = 712 \text{ kJ/mol}$$

Step 3 calculate the ΔH for the reaction

$$\Rightarrow 2 \times 712 \text{ kJ/mol} = 1424 \text{ kJmol}^{-1}$$



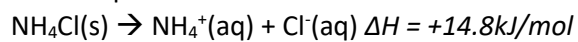
- c) The value of ΔH, calculated using the enthalpy of combustion provided in the data book, is different from the value of ΔH calculated from the experimental data provided in part b). Provide a reason for this difference.

A greater heat loss to the surroundings would cause less of a temperature increase and hence a lower calculated ΔH than that found in the data book.

- d) Why is it necessary for the calorimeter to be calibrated when we can use the specific heat of water (given as 4.18 J g⁻¹ K⁻¹ in the data book) to measure energy output?

The calibration factor gives the relationship between energy output of the reaction and temperature increase of the calorimeter. This value is different for every calorimeter depending on how much energy is absorbed by the material encasing the reaction chamber and the insulating material, how much energy is lost through the insulating material

- 2) A calorimeter is used to produce the temperature vs time graph shown in diagram 1 when 22.7 grams of NH_4Cl dissolves in 100g of water according to the equation below.



Find the calibration factor of the calorimeter.

Step 1 Find the change in temperature

$$\Rightarrow \Delta T = 40.0 - 25.0 = 15.0^\circ\text{C}$$

Step 2 Find the mol of NH_4Cl

$$\Rightarrow 22.7\text{ g} / 53.5 = 0.424\text{ mol}$$

Step 3 Find the amount of energy that was absorbed from the solution.

$$\Rightarrow 0.424 \times 14.8\text{ kJ} = 6.28\text{ kJ}$$

Step 4 find the calibration factor

$$\Rightarrow 6.28\text{ kJ} / 15.0^\circ\text{C} = 0.418\text{ kJ}/^\circ\text{C}$$

