Heat Capacity and Specific Heat Problems: II

1. A student used a BIC butane lighter to heat a test tube containing 40.0 mL of water, initially at 5.00 °C. The lighter was allowed to burn until the water reached 39.0 °C. Before the heating process the lighter had a mass of 42.70 g. Afterwards it had a mass of 42.49 g.

   a) Calculate the heat absorbed by the water. The specific heat capacity of water is 4.18 J/g °C.

   b) Assuming all the heat from the burning butane (C_4H_{10}) was captured by the water, calculate the heat of combustion of the butane in kJ/mol.

2. When 0.6484 g of cetyl palmitate $C_{32}H_{64}O_2$ (a fruit wax), was burned in a bomb calorimeter with a heat capacity of 11.99 kJ/°C, the temperature of the calorimeter rose from 24.518°C to 26.746°C. Calculate the molar heat of combustion of cetyl palmitate in kJ/mol.

3. 1.20 g of hydrogen gas is completely burned in the presence of excess oxygen gas in a bomb calorimeter producing water. The heat capacity of the calorimeter is 9.43 kJ/°C and the temperature of the calorimeter rose from 25.55 °C to 41.97°C. Calculate the enthalpy change in J and in kJ/mol or water produced.

4. The combustion of 2.40 g of butane (C_4H_{10}) in a calorimeter causes a rise in temperature of 12.0°C. The calorimeter contains 4000 g of water and the calorimeter has a mass of 450 g.
   c_{water} = 4.18 J/g^{O}C $C_{calorimeter}$ = 1.39 J/g^{O}C
   Determine:
   a) the heat absorbed by the calorimeter
   b) the heat absorbed by the water
   c) ? H in J/mol of butane

5. 5.61 g of potassium hydroxide (KOH) were dissolved in 200.0 mL of water. The temperature of the water rose from 20.0 EC to 27.0EC after dissolving. Calculate the molar heat of dissolving for KOH. (Specific heat of water = 4.18 J/g °C)

6. Calculate the enthalpy change that occurs when 68.0 g of liquid gold at a temperature of 1063°C are cooled to 23.0 The melting point of gold is 1063°C. The heat of fusion and specific heat capacity of gold are 64.0 J/g and 0.130 J/g °C respectively.

7. A 2.64 g sample of sucrose ($C_{12}H_{22}O_{11}$) is burned in a bomb calorimeter. The heat capacity of the calorimeter is 9.43 kJ/°C. The temperature changes from 21.00°C to 25.62 °C. Calculate the heat of combustion of sucrose in kJ/mol.

8. 100 cm^3 of water was placed in a styrofoam cup and its temperature was found to be 18.0 ^{O}C. 0.100 mol of $NH_4Cl_{(s)}$ was added and the temperature fell to 14.0 ^{O}C. Calculate ? $H_{(solution)}$ for the dissolving of 1.00 mol of $NH_4Cl_{(s)}$. Draw a potential energy level diagram.

Answers

1. (a) + 5684.8 J (b) - 1579 kJ mol^{-1} 2. -19800.5 kJ mol^{-1} 3. - 154.8 J, - 258 kJ mol^{-1}
4. (a) + 7056 J (b) + 200640 J (c) ? H = –5.04 x 10^3 kJ mol^{-1}
5. –60.2 kJ mol^{-1}
7. –5.64 kJ mol^{-1}
8. + 16.7 kJ mol^{-1}