Energy Enthalpy Calorimetry Questions

1. Calculate the enthalpy change for the melting of a 30 g ice cube. [ΔH_{fusion} = -6.03 kJ/mol]

2. A calorimeter has a heat capacity of 40.00 kJ/°C. Complete combustion of 1.00 g of hydrogen in this calorimeter causes a temperature increase of 3.54°C. Calculate the molar enthalpy of combustion for hydrogen from this evidence. [$q = C\Delta T$]

3. The molar enthalpy of combustion for octane, $C_8H_{18(l)}$, is reported to be –5.45 MJ/mol.
   (a) Write the balanced chemical equation using whole number coefficients and include the energy change as a ΔH_r value.
   (b) Write the balanced chemical equation using whole number coefficients and include the energy change as a term in the balanced equation.

4. The enthalpy changes for the formation of two wolfram bromides are shown below.

   $W(s) + 2\ Br_2(l) \rightarrow WBr_4(s)$ $\quad\quad$ $\Delta H°1 = –146.7$ kJ
   $W(s) + 3\ Br_2(l) \rightarrow WBr_6(s)$ $\quad\quad$ $\Delta H°2 = –184.4$ kJ

   Calculate the standard enthalpy change for the following reaction.

   $Br_2(l) + WBr_4(s) \rightarrow WBr_6(s)$

5. Calculate the molar enthalpy of the oxidation of ammonia gas to produce nitrogen dioxide gas and water vapour given the following standard enthalpies (heats) of formation:

   $NH_{3(g)}$ $\quad$ $\Delta H_f^o = -46$ kJ mol^{-1}

   $NO_{2(g)}$ $\quad$ $\Delta H_f^o = +34$ kJ mol^{-1}

   $H_2O_{(g)}$ $\quad$ $\Delta H_f^o = -242$ kJ mol^{-1}

   $O_{2(g)}$ $\quad$ $\Delta H_f^o = 0$ kJ mol^{-1} (by definition)

6. For the following combustion, what mass of carbon dioxide is produced when 1500 kJ of energy is released?

   $2\ C_2H_6(g) + 7\ O_2(g) \rightarrow 4\ CO_2(g) + 6\ H_2O(g) + 2502$ kJ

7. How much energy is released when 1.00 t of sulfur trioxide is produced by the following reaction? [1 t = 1000 kg]

   $2\ SO_2(g) + O_2(g) \rightarrow 2\ SO_3(g)$ $\Delta H = –192.8$ kJ

8. In respiration, glucose is oxidized by oxygen gas to produce carbon dioxide gas, liquid water, and energy. What is the energy released when 18.0 g of glucose is consumed?

9. Methanol is burned in a bomb calorimeter. Liquid water is formed as a product. If 3.40 g of methanol reacts, what is the expected temperature change in a calorimeter with a heat capacity of 6.75 kJ/°C?

10. A waste heat exchanger is used to absorb the energy from the complete combustion of hydrogen sulfide gas. What volume of water undergoing a temperature change of 64°C is required to absorb all of the energy from the burning of 15 kg of hydrogen sulfide?

Solutions

1.	ΔH = 10 kJ
2.	ΔHc = -286 kJ/mol
3.	2 $C_8H_{18(l)}$ + 25 $O_{2(g)}$ → 16 $CO_{2(g)}$ + 18 $H_2O_{(g)}$ ΔH_{comb}= –10.9 MJ 2 $C_8H_{18(l)}$ + 25 $O_{2(g)}$ → 16 $CO_{2(g)}$ + 18 $H_2O_{(g)}$ + 10.9 MJ
4.	(1) W(s) + 2 Br2(l) → WBr4(s) $\Delta H°$1 = –146.7 kJ (2) W(s) + 3 Br2(l) → WBr6(s) $\Delta H°$2= –184.4 kJ Calculate the standard enthalpy change for the following reaction. Br2(l) + WBr4(s) → WBr6(s) WBr4(s) → W(s) + 2 Br2(l) $\Delta H°$ = 146.7 kJ W(s) + 3 Br2(l) → WBr6(s) $\Delta H°$=-184.4 kJ Br2(l) + WBr4(s) → WBr6(s) ΔH_{total} = –37.7 kJ
5.	= -283 kJ/mol
6.	2 $C_2H_{6(g)}$ + 7 $O_{2(g)}$ → 4 $CO_{2(g)}$ + 6 H2O(g) + 2502 kJ -626 kJ/mol CO_2 *m* = 106 g
7.	2 $SO_{2(g)}$ + $O_{2(g)}$ → 2 $SO_{3(g)}$ ΔH = –192.8 kJ -96.4 kJ/mol SO_3 1.20 GJ
8.	$C_6H_{12}O_{6(s)}$ + 6 $O_{2(g)}$ → 6 $CO_{2(g)}$ + 6 $H_2O_{(l)}$ -2802.7 kJ 280 kJ
9.	$CH_3OH_{(l)}$ + 3/2 $O_{2(g)}$ → $CO_{2(g)}$ + 2 $H_2O_{(l)}$ -726.0 kJ -726.0 kJ/mol CH_3OH 11.4°C
10.	$H_2S_{(g)}$ + 3/2 $O_{2(g)}$ → $SO_{2(g)}$ + $H_2O_{(g)}$ -518.0 kJ *m*= 850 g *v* = 0.85 L