Total point __/35

1, Calculate the enthalpy change, ΔH_4 for the reaction

$$C + 2H_2 + \tfrac{1}{2} O_2 \longrightarrow CH_3OH \qquad \Delta H_4$$

using Hess's Law and the following information.

$$CH_3OH + 1\tfrac{1}{2} O_2 \longrightarrow CO_2 + 2H_2O \qquad \Delta H_1 = -676 \text{ kJ mol}^{-1}$$
$$C + O_2 \longrightarrow CO_2 \qquad \Delta H_2 = -394 \text{ kJ mol}^{-1}$$
$$H_2 + \tfrac{1}{2} O_2 \longrightarrow H_2O \qquad \Delta H_3 = -242 \text{ kJ mol}^{-1}$$

(Total 4 marks)

2, Consider the following equations.

$$Mg(s) + \tfrac{1}{2} O_2(g) \rightarrow MgO(s) \qquad \Delta H^{\ominus} = -602 \text{ kJ}$$
$$H_2(g) + \tfrac{1}{2} O_2(g) \rightarrow H_2O(g) \qquad \Delta H^{\ominus} = -242 \text{ kJ}$$

What is the $\Delta H°$ value (in kJ) for the following reaction?

$$MgO(s) + H_2(g) \rightarrow Mg(s) + H_2O(g)$$

A. –844 B. –360 C. +360 D. +844

3. The $\Delta H^{\ominus}$ values for the formation of two oxides of nitrogen are given below.

$$\tfrac{1}{2} N_2(g) + O_2(g) \rightarrow NO_2(g) \qquad \Delta H^{\ominus} = -57 \text{ kJ mol}^{-1}$$

$$N_2(g) + 2O_2(g) \rightarrow N_2O_4(g) \qquad \Delta H^{\ominus} = +9 \text{ kJ mol}^{-1}$$

Use these values to calculate $\Delta H^{\ominus}$ for the following reaction (in kJ):

$$2NO_2(g) \rightarrow N_2O_4(g)$$

A. –105 B. – 48 C. +66 D. +123

4. The equations and enthalpy changes for two reactions used in the manufacture of sulfuric acid are:

$$S(s)\ O_2(g) \rightarrow SO_2(g) \qquad \Delta H^{\ominus} = -300 \text{ kJ}$$

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g) \qquad \Delta H^{\ominus} = -200 \text{ kJ}$$

What is the enthalpy change, in kJ, for the reaction below?

$$2S(s) + 3O_2(g) \rightarrow 2SO_3(g)$$

A. –100 B. –400 C. –500 D. –800

5. Using the equations below

$$Cu(s) + \tfrac{1}{2} O_2(g) \rightarrow CuO(s) \Delta H^{\ominus} = -156 \text{ kJ}$$

$$2Cu(s) + \tfrac{1}{2} O_2(g) \rightarrow Cu_2O(s) \Delta H^{\ominus} = -170 \text{ kJ}$$

what is the value of $\Delta H^{\ominus}$ (in kJ) for the following reaction?

$$2CuO(s) \rightarrow Cu_2O(s) + \tfrac{1}{2} O_2(g)$$

A. 142 B. 15 C. –15 D. –142

6. Two reactions occurring in the manufacture of sulfuric acid are shown below:

reaction I $S(s) + O_2(g) \rightarrow SO_2(g)$ $\Delta H^{\ominus} = -297$ kJ

reaction II $SO_2(g) + \tfrac{1}{2} O_2(g) \rightleftharpoons SO_3(g)$ $\Delta H^{\ominus} = -92$ kJ

(i) State the name of the term $\Delta H^{\ominus}$. State, with a reason, whether reaction I would be accompanied by a decrease or increase in temperature.

(3)

(ii) At room temperature sulfur trioxide, SO_3, is a solid. Deduce, with a reason, whether the $\Delta H^{\ominus}$ value would be more negative or less negative if $SO_3(s)$ instead of $SO_3(g)$ were formed in reaction II.

(2)

(iii) Deduce the $\Delta H^{\ominus}$ value of this reaction:

$$S(s) + 1\tfrac{1}{2}\, O_2(g) \rightarrow SO_3(g)$$

(1)

7. A sample of a metal is heated. Which of the following are needed to calculate the heat absorbed by the sample?

I. The mass of the sample
II. The density of the sample
III. The specific heat capacity of the sample

A. I and II only
B. I and III only
C. II and III only
D. I, II and III

8. The following equation shows the formation of magnesium oxide from magnesium metal.

$$2Mg(s) + O_2(g) \rightarrow 2MgO(s) \qquad \Delta H^{\ominus} = -1204kJ$$

Which statement is correct for this reaction?

A. 1204 kJ of energy are released for every mol of magnesium reacted.

B. 602 kJ of energy are absorbed for every mol of magnesium oxide formed.

C. 602 kJ of energy are released for every mol of oxygen gas reacted.

D. 1204 kJ of energy are released for every two mol of magnesium oxide formed.

9. Which statement is correct for an endothermic reaction?

A. Bonds in the products are stronger than the bonds in the reactants.

B. Bonds in the reactants are stronger than the bonds in the products.

C. The enthalpy of the products is less than that of the reactants.

D. The reaction is spontaneous at low temperatures but becomes non-spontaneous at high temperatures.

10 . When 100 cm^3 of 1.0 mol dm^{-3} HCl is mixed with 100 cm^3 of 1.0 mol dm^{-3} NaOH, the temperature of the resulting solution increases by 5.0 °C. What will be the temperature change, in °C, when 50 cm^3 of these two solutions are mixed?

A. 2.5 B. 5.0

C. 10 D. 20

11. Use the bond enthalpy table to calculate the amount of enthalpy change when the following reactions take place. Identify each of the reaction if it is exothermic or endothermic. (6)

a. $CH_4(g) + Br_2(g) \rightarrow CH_3Br(g) + HBr(g)$
b. $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$
c. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

12. Describe and explain how the enthalpy change ΔH would differ in the following two reactions. Draw energy diagram. (both exothermic) (3)

$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$ $H_2(g) + Cl_2(l) \rightarrow 2HCl(g)$

13. a. write and equation for the complete combustion reaction of ethanol. (2)

b. Determine the enthalpy of complete combustion of enthanol, in kJ mol^{-1}, using data from data booklet. (20

14. One important property of a rocket fuel mixture is the large volume of gaseous products formed which provide thrust. Hydrazine, N_2H_4, is often used as a rocket fuel. The combustion of hydrazine is represented by the equation below.

$N_2H_4(g) + O_2(g) \rightarrow N_2(g) + 2H_2O(g)$

a. Draw the Lewis structures for hydrazine and nitrogen. (2)

b. Use Data Booklet to determine the enthalpy change for the reaction in part (a) above. (2)