AP Chemistry Problem Set #6

Due: Tuesday, October 24, 2006

20 points – 5 points for completion, 3 random problems will be graded, each worth 5 points.

1. Consider the following reaction:

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ $\Delta H = -572$ kJ

a. How much heat is evolved for the production of 1.00 mol of H_2O? (1 pt) **286 kJ**

b. How much heat is evolved when 4.03 g of hydrogen is reacted with excess oxygen? (1 pt) **572 kJ**

c. How much heat is evolved when 186 grams of oxygen is reacted with excess hydrogen? (1 pt) **3.32×10^3 kJ**

d. The total volume of hydrogen gas needed to fill the Hindenburg was 2.0×10^8 L at 1.0 atm and 25°C. How much heat was evolved when the Hindenburg exploded, assuming all of the hydrogen reacted? (1 pt) **2.34×10^9 kJ**

e. If 2.6×10^4 kilojoules of heat are produced, how many liters of hydrogen gas were reacted at 743 mm Hg and 15 °C? (1 pt) **2200 L**

2. Calculate the change in enthalpy for the following reactions. All heat of formation, ΔH_f data can be found in Appendix Four of your text book. (1 point each)

a. $2NH_3(g) + 3O_2(g) + 2CH_4(g) \rightarrow 2HCN(g) + 6H_2O(g)$ **$\Delta H = -940$ kJ**

b. $Ca_3(PO_4)_2(s) + 3H_2SO_4(l) \rightarrow 3CaSO_4(s) + 2H_3PO_4(l)$ **$\Delta H = -265$ kJ**

c. $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$ **$\Delta H = -176$ kJ**

d. $MgO(s) + 2H_2O(l) \rightarrow Mg(OH)_2(s)$ **$\Delta H = 249$ kJ**

e. $SiCl_4(l) + 2H_2O(l) \rightarrow SiO_2(s) + 4HCl(g)$ **$\Delta H = -20.$ kJ**

3. Calculate the $\Delta H°$ the following problems using Hess's law. (5 points)

a. Given:

$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ $\Delta H° = -23$ kJ

$3Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$ $\Delta H° = -39$ kJ

$Fe_3O_4 + CO \rightarrow 3FeO + CO_2$ $\Delta H° = +18$ kJ

Find: $FeO + CO \rightarrow Fe + CO_2$ **$\Delta H = -11$ kJ**

b. Given:

$P_4 + 6Cl_2 \rightarrow 4PCl_3$ $\Delta H° = -1225.6$ kJ

$P_4 + 5O_2 \rightarrow P_4O_{10}$ $\Delta H° = -2967.3$ kJ

$PCl_3 + Cl_2 \rightarrow PCl_5$ $\Delta H° = -84.2$ kJ

$PCl_3 + \frac{1}{2} O_2 \rightarrow Cl_3PO$ $\Delta H° = -285.7$ kJ

Find: $P_4O_{10} + 6PCl_5 \rightarrow 10Cl_3PO$ **$\Delta H = -610.1$ kJ**

c. Given:

$Sr + \frac{1}{2} O_2 \rightarrow SrO$ $\Delta H° = -592$ kJ

$SrO + CO_2 \rightarrow SrCO_3$ $\Delta H° = -234$ kJ

$C + O_2 \rightarrow CO_2$ $\Delta H° = -394$ kJ

Find: $Sr + C + 3/2\ O_2 \rightarrow SrCO_3$ **$\Delta H = -1220.$ kJ**

4. One method for producing hydrogen gas on a large scale is this chemical cycle:

Step 1: SO_2 (g) + $2H_2O$ (g) + Br_2(g) → H_2SO_4(l) + 2HBr(g)

Step 2: H_2SO_4 (l) → H_2O(g) + SO_2(g) + ½ O_2(g)

Step 3: 2 HBr(g) → H_2(g) + Br_2(g)

All heat of formation, ΔH_f data can be found in Appendix Four of your text book.

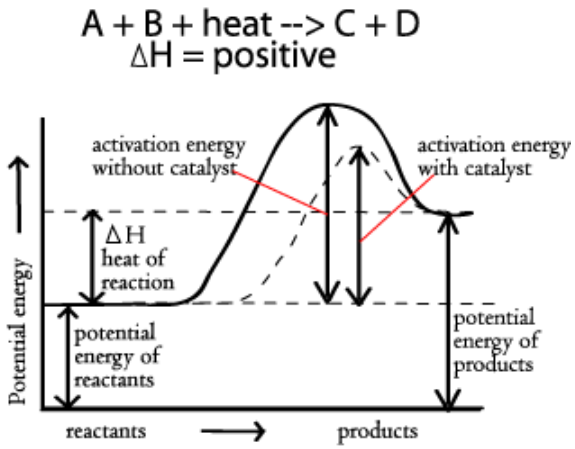
a. Calculate the change in enthalpy, ΔH° for each step. (1 pt)

Step 1: ΔH = -136 kJ, Step 2: ΔH = 275 kJ, Step 3: 103 kJ

b. What is the equation for the overall process? (1 pt) **H_2O → H_2 + ½O_2**

c. What is the overall energy change, ΔH°? (1 pt) **ΔH = 242 kJ**

d. Is this process endothermic or exothermic? Draw a graph to represent the change in energy for the overall reaction. (1 pt) **endothermic**



e. How do you indicate that a thermodynamic process has been carried out at standard conditions? What are standard conditions for compounds and elements? (1 pt) **By using a ° symbol after the state function.**

Standard conditions:

For a Compound

- **The standard state for a gaseous substance is a pressure of exactly 1 atmosphere.**
- **For a pure substance in a condensed state (liquid or solid), the standard state is the pure liquid or solid.**
- **For a substance present in a solution, the standard state is a concentration of exactly 1M.**

For An Element

- **The standard state of an element is the form in which the element exists under conditions of 1 atmosphere and 25°C.**

5. A diamond weighing 310. mg requires 2.38 J to raise its temperature from 23.4°C to 38.7°C.

a. Calculate the specific heat capacity of diamond. (1 pt) **0.502 J/g °C**

b. Calculate the molar heat capacity of the diamond. (1 pt) **6.03 J/mol °C**

c. If 84.8 kJ of energy is used to heat the diamond mentioned above at an initial temperature of 23.4°C, what would be the final temperature? (1 pt) **5.45×10^5 °C**

d. How much heat is released as the diamond used in Part C is cooled (from the temperature you calculate in Part C) to 4.6°C? (1 pt) **-84.8 kJ**

e. Explain the difference between heat and temperature. (1 pt)

Heat & temperature are different. Temperature is a property that reflects the random motions of the particles. Heat involves the transfer of energy between two objects due to a temperature difference