Chem12 Enthalpy : Notes/WS-10

A chemical reaction is a reaction in which new compounds are formed. The initial compounds are the **reactants**. The new compounds formed are the **products**. In a chemical reaction, heat is absorbed (**endothermic**) or released (**exothermic**).

Enthalpy is the total energy (KE + PE) of the system (symbol H). H is also defined as the heat content of the system (or compound) in Joules per mole or kJ/mole. The energy change (**enthalpy change**) is given by ΔH.

ΔH = H (Products) - H (Reactants) is also called the **Standard Heat of Formation**.

e.g. $2H_2(g) + O_2(g) \rightarrow 2H_2O(g) + 484$ kJ

In this exothermic reaction 484 kJ of energy is released when two moles of H_2 combine with one mole of O_2.

We can also write :

$2H_2(g) + O_2(g) \rightarrow 2H_20(g)$ $\Delta H = -484$ kJ or,

$H_2(g) + (1/2)O_2(g) \rightarrow H_2O(g)$ $\Delta H = -242$ kJ.

The second way is often preferred so ΔH represents the enthalpy change per mole of product formed.

ΔH is (-) if energy is released (exothermic), or (+) if energy is absorbed (endothermic).

The equation above tells us a lot about the reaction, but does not tell us several things such as :

- How difficult is it to start the reaction?
- How rapidly does the reaction proceed?
- How do the molecules interact during the reaction?
- Does the reaction go to completion?

These questions belong to the study of **<u>Kinetics</u>**.

Exercises :

1) Balance each equation assuming one mole of H_2O, give ΔH and state whether the following equations are exothermic or endothermic.

   a) $H_2SO_4(aq) + 2NaOH(aq) \rightarrow 2H_2O(l) + Na_2SO_4(aq) + 125kJ$
   b) $4H_2O(l) + 1130kJ \rightarrow 4H_2(g) + 2O_2(g)$
   c) $BaCl_2 \cdot 2H_2O + 360kJ \rightarrow BaCl_2(s) + 2H_2O(g)$
   d) $2CO_2(g) + 4H_2O(l) \rightarrow 2H_3O^+(aq) + 2HCO_3^-(aq) + 64kJ$

2) The equation for burning sucrose (table sugar) is:

   $C_{12}H_{22}O_{11}(s) + 12O_2(g) \rightarrow 12CO_2(g) + 11H_2O(l) + Energy$

   The energy released = 5647kJ/mole of sugar. Find the amount of energy released by burning 1.000 grams of sugar.

3) Tell whether the following reactions are endothermic or exothermic.

   a)burning, b)photosynthesis, c)digestion
   d) $2Na(s) + Cl_2(g) \rightarrow 2NaCl(s) + heat$
   e) $Fe_2O_3(s)\ 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g) + 27.6kJ$
   f) $N_2O_3(g) \rightarrow NO(g) + NO_2(g)\ \ \Delta H = +39.7kJ$
   g) $C(s) + H_2O(g) \rightarrow CO(g) + H_2(g)\ \ \Delta H = +1313kJ$
   h) $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)\ \ \Delta H = -176.9kJ$

Answers : 1)a) $(1/2)H_2SO_4(aq) + NaOH(aq) \rightarrow H_2O(l) + (1/2)Na_2SO_4(aq) + 62.5kJ$ (ex), b) $H_2O(l) + 282.5kJ \rightarrow H_2(g) + (1/2)O_2(g)$ (en), c)

(1/2)$BaCl_2 \cdot 2H_2O$ + 180kJ -> (1/2)$BaCl_2$(s) + H_2O(g), (en), d) (1/2)CO_2(g) + H_2O(l) -> (1/2)H_3O^+(aq) + (1/2)HCO_3^-(aq) + 16kJ, (ex), 2) 16.50 kJ, 3)a) ex, b) en, c) en, d) ex, e) ex, f) en, g) en, h) ex.