CHEMISTRY DAILY PLAN

Class: **Date:**

Subject: ***Standard Enthalpies of Formation*** **Time:**

The standard heat of formation of a compound ($?H_f°$) is the heat change when one mole of the compound is formed from the elements in their standard states - that is, all substances are in their most stable states at 1 atm and 25 °C. The superscript "°" shows that the measurement was made at standard conditions.

Consider the following reaction: $C_{(s)} + O_{2(g)} \Rightarrow CO_{2(g)}$ $?H = -94.0$ kcal (at 25°C and 1 atm)

Since this reaction is carried out under standard conditions, and CO_2 is formed from the elements, we may say that the heat of this reaction is equal to the heat of formation of CO_2. Or $?H_f^o$ of $(CO_2) = -94.0$ kcal.

A list of the standard enthalpies of formation of a number of compounds is given in Table 8.1.

The enthalpy of a reaction (the heat of reaction) can be expressed as the sum of the heats of formation of the products minus the sum of the heats of formation of the reactants. For a hypothetical reaction;

$aA + bB \Rightarrow cC + dD$

The heat of reaction may be written :

$?H^o = S?H_f^o$ (products) - $S?H_f^o$ (reactants)

Or, $?H^o = [c?H_{f(C)}^o + d?H_{f(D)}^o] - [a?H_{f(A)}^o + b?H_{f(B)}^o]$

Some remarks about heat of formation are as follows.

1. The standard heat of formation of an element in its most stable form is arbitrarily assumed to be zero. ($?H_f° O_2 = 0$ but $?H_f° O_3 = +34$ kcal/mol)
2. We must always specify the physical states of the reactants and products because the enthalpy changes depend on them.

   $H_{2(g)} + ½ O_{2(g)} \Rightarrow H_2O_{(g)}$ $?H_f° = -57.8$ kcal

   $H_{2(g)} + ½ O_{2(g)} \Rightarrow H_2O_{(l)}$ $?H_f° = -68.3$ kcal
3. Substances having positive enthalpies of formation are usually less stable and have a greater tendency to react than those having negative enthalpies of formation.

Problem 1: The $?H_f^o$ of $SbCl_{3(g)} = -75.0$ kcal/mol and the $?H_f^o$ of $SbCl_{5(l)} = -105.2$ kcal/mol. Calculate the $?H_f^o$ of the reaction, $SbCl_{3(g)} + Cl_{2(g)} \Rightarrow SbCl_{5(l)}$

Problem 2: The heat absorbed on formation of $NO_{(g)}$ is 720 cal/g. The heat absorbed on formation of $NO_{2(g)}$ is 176 cal/g. Calculate ?H for the reaction, $2NO_{(g)} + O_{2(g)} \Rightarrow 2NO_{2(g)}$.

Problem 3: Given the heat of the following reaction, determine the heat of formation of $CCl_{4(g)}$. Use Table 8.1

$CH_{4(g)} + 4Cl_{2(g)} \Rightarrow CCl_{4(g)} + 4HCl_{(g)}$ $?H = -96.17$ kcal.

Problem 4: The amount of heat produced by the combustion of 10 g of $C_2H_{6\,(g)}$ increases the temperature of 2000 g of H_2O by 57 °C. Calculate the heat of formation of $C_2H_{6(g)}$. $?H_{f\,CO2(g)}^o = -94$ kcal/mol, $?H_{f\,H2O(g)}^o = -58$ kcal/mol.

$C_2H_{6(g)} + 7/2\ O_{2(g)} \Rightarrow 2CO_{2(g)} + 3H_2O_{(g)}$