Examples of Standard Enthalpy of Formation

Example Problem #1

Some chefs keep baking soda, $NaHCO_3$, handy to put out grease fires. When thrown on the fire, baking soda partly smothers the fire, and the heat decomposes it to give CO_2, which further smothers the flame. The equation for the decomposition of $NaHCO_3$ is

$$2\ NaHCO_3(s) \text{ -------> } Na_2CO_3(s) + H_2O(g) + CO_2(g)$$

Calculate the ΔH^o for this reaction in kilojoules

Solution

ΔH^o = sum of products - sum of reactants

= [$Na_2CO_3(s) + H_2O(g) + CO_2(g)$] - [$(2)NaHCO_3(s)$]

Look up the values in the databook tables for each substance.
Make sure the physical states are identical.

= [-1130.7 -241.8 -393.5 kJ/mol]-[(2)(-950.8 kJ/mol)]
= -1766 kJ/mol - (-1901.6 kJ/mol)
= +135.6 kJ/mol

Under standard conditions, the reaction is endothermic by 135.6 kJ/mol.

Example Problem #2

What is the ΔH^o in kilojoules for the combustion of 1 mol of ethanol, $C_2H_5OH(l)$, to form gaseous carbon dioxide and gaseous water?

Solution

First write and balance the combustion equation.

$C_2H_5OH(l) + 3\ O_2(g)$ -----> $2\ CO_2(g) + 3\ H_2O(g)$

Sum of the enthalpies of formation for this equation is:

ΔH^o = $[(2)CO_2(g) + (3)H_2O(g)] - [C_2H_5OH(l) + (3)O_2(g)]$
= [(2)-393.5 + (3)-241.8 kJ/mol] - [-277.1 + (3)0 kJ/mol]
= [-787 -725.4 kJ/mol] - [-277.1 kJ/mol]
= -1512.4 + 277.1 kJ/mol
= -1235.3 kJ/mol

The reaction for the combustion of ethanol is exothermic by 1235.3 kJ/mol.