5.111 Principles of Chemical Science: Week 6

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Progress Update

Over the past week I have been introduced to:

1. Bond reaction enthalpy
2. Gibb's free energy

Bond reaction enthalpy

Reaction enthalpy, ΔH, is the measure of how much energy is released or absorbed when a reaction takes place; consider the combustion of methane:

$$CH_4 + 2O_2 \rightarrow CO_2 + H_2O \tag{1}$$

890 kJ are released for each mole of methane burnt, thus $\Delta H = -890kJ$. A few methods exist to estimate bond enthalpy:

1. Difference in energy between bonds broken and bonds formed
2. Difference in standard heat of formation

Gibb's free energy

Gibb's free energy, ΔG is a predictor of whether or not a reaction will be spontaneous. It can be found via the equation

$$\Delta G = \Delta H - T\Delta S \tag{2}$$

where T is temperature in Kelvin, and ΔS is the change in enthalpy.

Review problem

Consider the problem

Using the following bond enthalpy table, calculate the estimated enthalpy of reaction for the following reaction:

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

N-N	163 kJ/mol	N-H	391 kJ/mol
N=N	418 kJ/mol	H-H	436 kJ/mol
N≡N	941 kJ/mol		

ΔH_{rxn} = -97 kJ/mol

Olympiad problem

Now consider the Olympiad problem

The standard enthalpy of reaction for the dissolution of silica in aqueous HF is 4.6 kJ mol^{-1}. What is the standard enthalpy of formation of $SiF_4(g)$?

$$SiO_2(s) + 4\ HF(aq) \rightarrow SiF_4(g) + 2\ H_2O(l)$$
$$\Delta H^\circ_{rxn} = 4.6\ \text{kJ mol}^{-1}$$

Compound	$SiO_2(s)$	$HF(aq)$	$H_2O(l)$	$SiF_4(g)$
ΔH°_f, kJ mol^{-1}	–910.9	–320.1	–285.8	???

(A) –1624.3 kJ mol^{-1} **(B)** –1615.1 kJ mol^{-1}

(C) –949.8 kJ mol^{-1} **(D)** –940.6 kJ mol^{-1}