Date: Name: Class:

Skill Builder

Chapter 7

BLM 7-2

More on Entropy and Free Energy

Goal

Provide additional experience working with the concepts of entropy and free energy and, in particular, the equation for free energy.

Procedure

Read the information below and answer the questions that follow.

The following reaction provides a practical example of entropy, Gibb's free energy, and chemical equilibrium:

$CaCO_{3(s)} \leftrightarrow CaO_{(s)} + CO_{2(g)}$

CaO is commonly known as quicklime and is used in steelmaking, the production of calcium metal, and in the paper, water treatment, and pollution control industries. CaO is produced through the decomposition of $CaCO_3$ and is a readily reversible reaction at room temperature.

A mathematical evaluation of this reaction, using the equation for free energy, $\Delta G = \Delta H - T\Delta S$, shows that ΔG is positive and a non-spontaneous process. This means that although CaO and CO_2 will be produced, the amounts will be small. As the temperature is increased, the $T\Delta S$ term in the equation increases to the point at which ΔG becomes negative (this occurs at 835°C) and the production of CO_2 (as measured through the increase in pressure of the reaction vessel) becomes appreciable.

Questions

1. What is the importance of understanding the value of ΔG for a given chemical reaction?

2. **(a)** For a reaction occurring at 25°C, the value of ΔH is determined to be 10.5 kJ and the ΔS is 30 J/K. Is this reaction spontaneous at this temperature?

   (b) Repeat part (a), at the same temperature, but with $\Delta H = 1.8$ kJ and $\Delta S = -113$ J/K.

3. Determine the temperature at which a reaction, whose $\Delta H = 126$ kJ, and $\Delta S = 84$ J/K, will be spontaneous.