Practice Questions Section 3.1

Entropy

1. Predict whether entropy is increasing ($\Delta S > 0$) or decreasing ($\Delta S < 0$)? Give a reason for your answer.

   steam condenses to water

   solid CO_2 sublimes

   $N_2O_{4\,(g)} \rightarrow 2\ NO_{2\,(g)}$

   water is heated from 25°C to 50°C

   $C_6H_{6\,(l)} + O_{2\,(g)} \rightarrow 6\ CO_{2\,(g)} + 3\ H_2O_{\,(l)}$

2. Using a Table of Thermochemical Data, calculate ΔS for the following reaction. Is entropy increasing or decreasing? Is the system becoming more random or less random? Based on entropy changes only, would you predict the reaction to be spontaneous or not?

   $Na_{\,(s)} + \frac{1}{2}Cl_{2\,(g)} \rightarrow NaCl_{\,(s)}$

Practice Questions Section 3.1

Entropy Answers

1. Predict whether entropy is increasing ($\Delta S > 0$) or decreasing ($\Delta S < 0$)? Give a reason for your answer.

Answers:

steam condenses to water

$\Delta S < 0$; entropy decreases because liquid water is less random than gaseous water (steam)

solid CO_2 sublimes

$\Delta S > 0$; entropy increases because gaseous CO2 is more random than the solid state.

$N_2O_{4\,(g)} \rightarrow 2\ NO_{2\,(g)}$

$\Delta S > 0$; entropy increases because two moles of a gas are more random than 1 mole of a gas.

water is heated from 25°C to 50°C

$\Delta S > 0$; entropy increases as particles move about more when heated.

$C_6H_{6\,(l)} + O_{2\,(g)} \rightarrow 6\ CO_{2\,(g)} + 3\ H_2O_{\,(l)}$

$\Delta S > 0$;
entropy increases because there are more moles on the product side of the equation (9 vs 2)

2. Using a Table of Thermochemical Data, calculate ΔS for the following reaction. Is entropy increasing or decreasing? Is the system becoming more random or less random? Based on entropy changes only, would you predict the reaction to be spontaneous or not?

$Na_{\,(s)} + \frac{1}{2}Cl_{2\,(g)} \rightarrow NaCl_{\,(s)}$

Solution:

Look up S° values for all reaction participants, taking care to look in the correct column of the table of thermochemical data. Multiply these values by any coefficients in the balanced equation, then simplify each side of the equation:

Na	+	½ Cl_2	→	$NaCl_{(s)}$
51.2	+	½ × 223.1		72.1
	162.8			72.1

Use the following formula to find $\Delta S°$:

$\Delta S = \Sigma S_{products} - \Sigma S_{reactants}$

$= 72.1 - 162.8$

$= -90.7$ J/K

A negative sign for $\Delta S°$ tells us that entropy is decreasing. The system becomes less random (or more ordered). **On the basis of entropy changes only we would NOT expect this reaction to occur spontaneously.**