Chapter 7 - Lecture Worksheet 2

1. Predict the sign of ΔG^0_{rxn} for each of the following reactions.	$\Delta G^0_{rxn} = \Delta H^0 - T\Delta S^0$
A. Melt ice Endothermic, $\Delta H^0_{rxn} > 0$ More Random, $\Delta S^0_{rxn} > 0$	**3.** Negative at HIGH Temperatures
B. Combustion of sucrose, $C_{12}H_{22}O_{11}(s)$ Exothermic, $\Delta H^0_{rxn} < 0$ More Random, $\Delta S^0_{rxn} > 0$	**2.** Negative ALL Temperatures
C. Crystallization of a supersaturated solution of sodium acetate. Exothermic, $\Delta H^0_{rxn} < 0$ Less Random, $\Delta S^0_{rxn} < 0$	**4.** Negative at LOW Temperatures

PRS Answers **1.** Positive ALL Temperatures **2.** Negative ALL Temperatures	**3.** Negative at HIGH Temperatures **4.** Negative at LOW Temperatures

2. Which reaction is favorable in terms of both the enthalpy and the entropy ? **1. A** **2. B** **3. C**

3. Which reaction is "entropy driven" but unfavorable in terms of the enthalpy ? **1. A** **2. B** **3. C**

4. Which reaction is "enthalpy driven" but unfavorable in terms of the entropy ? **1. A** **2. B** **3. C**

5. Write two expressions the show how to calculate the **standard** Gibbs Free Energy change for the decomposition of sulfur trioxide from tabulated values:

$$2\,SO_3(g) \text{ ------> } 2\,SO_2(g) + O_2(g)$$

A. $\Delta G^0 = \Delta H^0 - T\Delta S^0$ Get ΔH^0 from table of Standard Heats of Formation Get ΔS^0 from table of Standard Absolute Entropies	B. $\Delta G^0 = 2\Delta G^0_f(SO_2(g)) - 2\Delta G^0_f(SO_3(g))$ Get ΔG^0_f from table of Standard Gibbs Free Energies of Formation

C. For this reaction $\Delta H^0_{rxn} = 197.78$ kJ/mol and $\Delta S^0_{rxn} = 188.06$ J/mol K. Calculate ΔG^0_{rxn} at 298K.

$$\Delta G^0_{rxn} = \Delta H^0_{rxn} - T\Delta S^0_{rxn} = 197.78 \text{ kJ/mol} - (298 \text{ K})(188.06 \text{ J/mol K})(1\text{kJ}/1000 \text{ J}) = 142 \text{ kJ/mol}$$

D. Under standard state conditions is the reaction spontaneous at 25^{0}C ? **1. Yes** **2. No** **2. Maybe**

$\Delta G^0_{rxn} > 0$ Equilibrium lies toward reactants and under standard state conditions the reaction is not spontaneous.

E. If it is not spontaneous at 25^{0}C, is there a temperature at which it it will become so ?

Yes. Find this T where ΔG^0_{rxn} changes sign. Set $\Delta G^0_{rxn} = 0$ then $\Delta H^0_{rxn} = T\Delta S^0_{rxn}$

$T = (\Delta H^0_{rxn})/(\Delta S^0_{rxn}) = (197.78 \text{ kJ/mol})(1000 \text{ J/kJ}) / (188.06 \text{ J/mol K}) = 1052 \text{ K}$

Above this temp, rxn becomes product favored and spontaneous under standard state conditions.