

## Chapter 7 - Lecture Worksheet 2

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

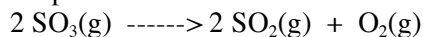
### PRS Answers

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:



A. $\Delta G^0 = \Delta H^0 - T\Delta S^0$ Get $\Delta H^0$ from table of Standard Heats of Formation Get $\Delta S^0$ from table of Standard Absolute Entropies	B. $\Delta G^0 = 2\Delta G_f^0(\text{SO}_2(\text{g})) - 2\Delta G_f^0(\text{SO}_3(\text{g}))$ Get $\Delta G_f^0$ from table of Standard Gibbs Free Energies of Formation
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- For this reaction  $\Delta H_{\text{rxn}}^0 = 197.78 \text{ kJ/mol}$  and  $\Delta S_{\text{rxn}}^0 = 188.06 \text{ J/mol K}$ . Calculate  $\Delta G_{\text{rxn}}^0$  at 298K.

$$\Delta G_{\text{rxn}}^0 = \Delta H_{\text{rxn}}^0 - T\Delta S_{\text{rxn}}^0 = 197.78 \text{ kJ/mol} - (298 \text{ K})(188.06 \text{ J/mol K})(1\text{kJ}/1000 \text{ J}) = 142 \text{ kJ/mol}$$

- Under standard state conditions is the reaction spontaneous at 25°C ? 1. YES    2. NO    2. MAYBE

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

- If it is not spontaneous at 25°C, is there a temperature at which it it will become so ?

Yes. Find this T where  $\Delta G_{\text{rxn}}^0$  changes sign.      Set  $\Delta G_{\text{rxn}}^0 = 0$       then       $\Delta H_{\text{rxn}}^0 = T\Delta S_{\text{rxn}}^0$

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

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