Dougherty Valley HS Chemistry - AP
Thermodynamics – Entropy and Gibbs 1

Worksheet #2

Name: **Period:** **Seat#:**

Directions: Show all work in a way that would earn you credit on the AP Test! This is always the rule! Some answers are provided at the end in italics and underlined. If you need more space, use binder paper and staple to your worksheet.

$$\Delta G° = \Sigma \Delta G_f^\circ \, products - \Sigma \Delta G_f^\circ \, reactants$$

1) Calculate G° in kJ for the following reactions, using thermodynamic data from an appendix or your reference sheet.

a) $SO_3\,(g) + H_2O(l) \rightarrow H_2SO_4\,(l)$

-81.99

b) $2\,NH_4Cl(s) + CaO(s) \rightarrow CaCl_2\,(s) + H_2O(l) + 2\,NH_3\,(g)$

-10.68

c) $CaSO_4\,(s) + 2\,HCl(g) \rightarrow CaCl_2\,(s) + H_2SO_4\,(l)$

72.2

d) $C_2H_4\,(g) + H_2O(l) \rightarrow C_2H_5OH(l)$

-5.42

e) $Ca(s) + 2\,H_2SO_4\,(l) \rightarrow CaSO_4\,(s) + SO_2\,(g) + 2\,H_2O(l)$

-715.9

2) When solid KI is dissolved in water, a cooling of the mixture occurs because the solution process is endothermic. Explain, in terms of what happens to the molecules and ions, why this mixing occurs spontaneously?

3) Predict the algebraic sign of the entropy change for the following reactions?

a) $PCl_3(g) + Cl_2(g) \rightarrow PCl_5(g)$	**b)** $SO_2(g) + CaO(s) \rightarrow CaSO_3(s)$
c) $CO_2(g) + H_2O(l) \rightarrow H_2CO_3(aq)$	**d)** $Ni(s) + 2\,HCl(aq) \rightarrow H_2(g) + NiCl(aq)$
e) $I_2(s) \rightarrow I_2(g)$	**f)** $Cl_2(g) + Br_2(g) \rightarrow 2\,BrCl(g)$
g) $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$	**h)** $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$

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4) Show that ΔS for the melting of ice is positive

Conceptually	*Quantitatively*

5) Calculate the entropy change in J/mol·K for each of the following reactions. $\Delta S° = \Sigma\Delta S^{\circ} products - \Sigma\Delta S^{\circ} reactants$

a) $CaO(s) + 2\ HCl(g) \rightarrow CaCl_2(s) + H_2O(l)$ *-228.34*	**b)** $C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$ *-120.78*

6) Predict the probability of the following reactions by calculating the sign of ΔG. Then classify each reaction as exothermic or endothermic, and if there is increase or decrease to entropy. Then, if spontaneous, identify if it is entropy driven, enthalpy driven, both, or neither.

ΔG Calculation	**Endo or Exo?**	**Spont. or Non-spont.**
a) $H_2O(l) \rightarrow H_2(g) + ½\ O_2(g)$ ΔH= +285 kJ TΔS = +245 kJ		
	Increase or Decrease Entropy?	**What drives the Rxn (if spont)**
b) $C_6H_{14}(g) \rightarrow 6\ C(s) + 7\ H_2(g)$ ΔH = +167 kJ TΔS = +168 kJ	**Endo or Exo?**	**Spont. or Non-spont.**
	Increase or Decrease Entropy?	**What drives the Rxn (if spont)**
c) $2\ Fe(s) + ½\ N_2(g) \rightarrow Fe_2N(s)$ ΔH = -3.8 kJ TΔS = -14.6 kJ	**Endo or Exo?**	**Spont. or Non-spont.**
	Increase or Decrease Entropy?	**What drives the Rxn (if spont)**
d) $HCl(g) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$ ΔH = -75.3 kJ TΔS = -39.3 kJ	**Endo or Exo?**	**Spont. or Non-spont.**
	Increase or Decrease Entropy?	**What drives the Rxn (if spont)**

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7) Calculate ΔG^o in kJ/mole for the following reactions, using the appropriate data tables from your textbook appendix.

a) $2\ NH_4Cl(s) + CaO(s) \rightarrow CaCl_2(s) + H_2O(l) + 2\ NH_3(g)$

--10.68

b) $CaSO_4(s) + 2\ HCl(g) \rightarrow CaCl_2(s) + H_2SO_4(l)$

72.2

8) Use the following reaction at 298.2 K **$2\ NO_2(g) \rightarrow N_2O_4(g)$**

a) The values of ΔH^o and ΔS^o are -58.03 kJ mol^{-1} and -176.61 J $K^{-1}mol^{-1}$ respectively. What is the value of ΔG^o at 298.2 K?

--5.40

b) At what temperature is $\Delta G^o = 0$?

328.6

c) Is ΔG negative above, or below, this temperature?