Dougherty Valley HS AP Chemistry
Thermodynamics – Entropy and Gibbs I

WORKSHEET #2

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

Show all work

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

[1] Calculate G° in kJ for the following reactions, using the appropriate data tables.

(a) SO_3 (g) + $H_2O(l)$ → H_2SO_4 (l)		$\Delta H_f^\circ \left(\frac{kJ}{mol}\right)$	$\Delta G_f^\circ \left(\frac{kJ}{mol}\right)$	$\Delta S^\circ \left(\frac{J}{mol \cdot K}\right)$
(b) 2 NH_4Cl(s) + CaO(s) → $CaCl_2$ (s) + $H_2O(l)$ + 2 NH_3 (g)	$CaCl_2$	-795	-750.2	114
(c) $CaSO_4$ (s) + 2 HCl(g) → $CaCl_2$ (s) + H_2SO_4 (l)	CH_3Cl	-83.7	-60.2	234
(d) C_2H_4 (g) + $H_2O(l)$ → C_2H_5OH(l)	KCl	-436.69	-408.8	82.55
(e) Ca(s) + 2 H_2SO_4 (l) → $CaSO_4$ (s) + SO_2 (g) + 2 $H_2O(l)$	K_2SO_4	-1437.8	-1321.4	175.6

[2] When solid potassium iodide is dissolved in water, a cooling of the mixture occurs because the solution process is endothermic for these substances. 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) → PCl_5(g)	(b) SO_2(g) + CaO(s) → $CaSO_3$(s)
(c) CO_2(g) + $H_2O(l)$ → H_2CO_3(aq)	(d) Ni(s) + 2 HCl(aq) → H_2(g) + NiCl(aq)
(e) I_2(s) → I_2(g)	(f) Cl_2(g) + Br_2(g) → 2 BrCl(g)
(g) NH_3(g) + HCl(g) → NH_4Cl(s)	(h) CaO(s) + $H_2O(l)$ → $Ca(OH)_2$(s)

[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) $CaO(s) + 2\ HCl(g) \rightarrow CaCl_2(s) + H_2O(l)$	(b) $C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$

[7] Predict the probability of the following reactions by approximating the sign of ΔG. Classify each reaction as exothermic or endothermic.

a) $H_2O(l) \rightarrow H_2(g) + ½\ O_2(g)$	ΔH= +285 kJ TΔS = -245 kJ	
b) $C_6H_{14}(g) \rightarrow 6\ C(s) + 7\ H_2(g)$	ΔH = +167 kJ TΔS = +168 kJ	
c) $2\ Fe(s) + ½\ N_2(g) \rightarrow Fe_2N(s)$	ΔH = -3.8 kJ TΔS = -14.6 kJ	
d) $HCl(g) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$	ΔH = -75.3 kJ TΔS = -39.3 kJ	

[8] Calculate ΔG_o in kJ/mole for the following reactions, using the appropriate data tables from your textbook appendix.

(a) $SO_3(g) + H_2O(l) \rightarrow H_2SO_4(l)$
(b) $2\ NH_4Cl(s) + CaO(s) \rightarrow CaCl_2(s) + H_2O(l) + 2\ NH_3(g)$
(c) $CaSO_4(s) + 2\ HCl(g) \rightarrow CaCl(s) + H_2SO_4(l)$

[9] For the 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?

b) At what temperature is $\Delta G_o = 0$?

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