<u>Chem 1105-2016 Summer Problem Set #2</u>
Note: Values may vary slightly depending on literature source used.

1. Why is ΔS_{vap} of a substance always larger than ΔS_{fus}?

2. Predict the sign of ΔS_{sys} for each process: a) Gasoline vapours mix with air in a car engine. b) A solid explosive converts to a gas. c) Perfume vapours diffuse through a room.

3. For each reaction, predict the sign and find the value of $\Delta S°$:
a) $3NO(g) \rightarrow N_2O(g) + NO_2(g)$
b) $3H_2(g) + Fe_2O_3(s) \rightarrow 2Fe(s) + 3H_2O(g)$
c) $P_4(s) + 5O_2(g) \rightarrow P_4O_{10}(s)$

4. Oxyacetylene welding is used to repair metal structures such as bridges. Calculate $\Delta S°$ for the combustion of 1 mol of acetylene(C_2H_2).

5. With its components in their standard states, a certain reaction is spontaneous only at high T. What do you know about the signs of $\Delta H°$ and $\Delta S°$? Describe a process for which this is true.

6. Calculate $\Delta G°$ for each reaction using $\Delta G_f°$ values:
a) $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$
b) $2CH_3OH(g) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(g)$
c) $BaO(s) + CO_2(g) \rightarrow BaCO_3(s)$

7. Calculate $\Delta G°$ for the reactions in question #6 using $\Delta H_f°$ and $\Delta S°$ values.

8. For the gaseous reaction of xenon and fluorine to form xenon hexafluoride:
a) Calculate $\Delta S°$ at 298 K ($\Delta H°$ = -220. kJ/mol and $\Delta G°$ = -206 kJ/mol).
b) Assuming that $\Delta S°$ and $\Delta H°$ change very little with temperature, calculate $\Delta G°$ at 500. K.

9. One reaction used to produce small quantities of pure H_2 is

$$CH_3OH(g) \rightleftharpoons CO(g) + 2H_2(g)$$

a) Determine $\Delta H°$ and $\Delta S°$ for the reaction at 298 K.
b) Assuming that these values are relatively independent of temperature, calculate ΔG at 28°C, 128°C, and 228°C.
c) What is the significance of the different values of ΔG?

10. The equilibrium constant for the reaction

$$2Fe^{3+}(aq) + Hg_2^{2+}(aq) \rightleftharpoons 2Fe^{2+}(aq) + 2Hg^{2+}(aq) \quad K_c = 9.1\times10^{-6} \text{ at } 298 \text{ K}$$

a) What is $\Delta G°$ at this temperature?
b) If standard-state concentrations of the reactants and products are mixed, in which direction will the reaction proceed?
c) Calculate ΔG when $[Fe^{3+}]$ = 0.20 M, $[Hg_2^{2+}]$ = 0.010 M, $[Fe^{2+}]$ = 0.010 M, and $[Hg^{2+}]$ = 0.025 M. In which direction will the reaction proceed to reach equilibrium?

Answer Set for Chem 1105-2016 Summer Problem Set #2

1. The transition from liquid to gas involves a greater increase in dispersal energy and freedom of motion than does the transition from solid to liquid.

2.a) positive; b) positive; c) positive

3.a) negative, -172.4 J/K; b) positive, 141.6 J/K; c) negative, -837 J/K

4. -97.2 J/K

5. $\Delta S°$ is positive and $\Delta H°$ is positive. Melting is an example.

6. a) -1138. kJ; b) -1380. kJ; c) -224 kJ

7. see question 6.

8.a) -0.047 kJ/mol·K; b) -197 kJ/mol

9. $\Delta H° = 90.7$ kJ, $\Delta S° = 221$ J/K; b) 24.3 kJ(28°C), 2.2 kJ(128°C), -19.9 kJ(228°C); c) For the reaction with the substances in their standard states, the reaction is non-spontaneous at 28°C, near equilibrium at 128°C, and spontaneous at 228°C.

10.a) 2.9×10^4 J/mol; b) The reverse direction, formation of reactants, is spontaneous, so the reaction proceeds to the left; c) 7.0×10^3 J/mol, the reaction proceeds to the left to reach equilibrium.