Chem 1104 - 2018 Summer Problem Set #6

1. For each of the following, specify which has the higher entropy:
a) A sample of dry ice(solid CO_2) at -78°C or CO_2 vapor at 0 °C.
b) Sugar as a solid or after being dissolved in a cup of coffee.
c) A chunk of metallic sodium or a flask of argon at room temperature.
d) $NH_4Cl(s)$ or $NH_4Cl(aq)$.

2. The enthalpy of vaporization of liquid diethyl ether is 26.0 kJ/mol at the boiling point of 35.0°C.Calculate ΔS for a) liquid to vapor and b) vapor to liquid at 35.0°C.

3. Calculate the standard entropy change for each of the following reactions at 25°C:
a) $Mg(s) + 1/2O_2(g) \rightarrow MgO(s)$
b) $Pb(s) + Cl_2(g) \rightarrow PbCl_2(s)$
c) $2ICl(g) \rightarrow I_2(s) + Cl_2(g)$
d) $C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$
e) $NaCl(s) \rightarrow NaCl(aq)$

4. Using values of $\Delta H_f°$ and ΔS°, calculate ΔG° for the following reactions:
a) $Pb(s) + Cl_2(g) \rightarrow PbCl_2(s)$
b) $Mg(s) + 1/2O_2(g) \rightarrow MgO(s)$
c) $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$
d) $Br_2(l) + 3F_2(g) \rightarrow 2BrF_3(g)$

5. Calculate ΔG° for the following reactions using $\Delta G_f°$ values listed in the appendix of your textbook.
a) $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(l)$
b) $2H_2S(g) + 3O_2(g) \rightarrow 2H_2O(g) + 2SO_2(g)$

6. Elemental boron can be made by the reduction of boron halide with H_2:

$$BCl_3(g) + 3/2H_2(g) \rightarrow B(s) + 3HCl(g)$$

Given the following data:

Substance	$\Delta H_f°$	ΔS°
$BCl_3(g)$	-403.8 kJ/mol	290 J/K·mol
$H_2(g)$	0 kJ/mol	130.684 J/K·mol
B(s)	0 kJ/mol	5.86 J/K·mol
HCl(g)	-92.307 kJ/mol	186.908 J/K·mol

calculate ΔH°, ΔS°, and ΔG° for this reaction. Is is predicted to be spontaneous under standard conditions? If spontaneous, is it enthalpy driven or entropy driven? If not spontaneous, in your view why is it not?

7. The dissociation of gaseous chlorine to Cl atoms has an equilibrium constant of 0.106 at 1800 K. Calculate the free energy change for this reaction. $Cl_2(g) \leftrightharpoons 2Cl$

Answer Set for Chem 1104-2018 Summer Problem Set #6
Note: Values may vary slightly depending on literature source used.

1.a) CO_2 vapor; b) dissolved sugar; c) argon; d) $NH_4Cl(aq)$

2.a) +84.4 J/K; b) –84.4 J/K

3.a) –108.31 J/K; b) –151.9 J/K; c) –155.89 J/K; d) –138.9 J/K; e) 43.4 J/K

4.

	ΔH°	ΔS°	ΔG°
a)	-359.41 kJ	-151.9 J/K	-314.1 kJ
b)	-601.70 kJ	-108.31 J/K	-569.42 kJ
c)	-176.01 kJ	-284.8 J/K	-91.15 kJ
d)	-511.20 kJ	-175.51 J/K	-459.8 kJ

5.a) –1010.8 kJ; b) –990.41 kJ

6. ΔH° = 126.9 kJ, ΔS° = 81 J/K, ΔG° = +102.8 kJ. The reaction is not spontaneous at room temperature; the enthalpy change is too positive to be outweighed by -TΔS°.

7. ΔG° = +33.6 kJ