Chemistry 230 -- Quiz 7 (Take-home)

[No collaboration or help from others permitted on this assignment]

Due October 26, 2001 — Tellinghuisen

Pledge and signature:

1. (5) Calculate the molar entropy $S_m{}^\circ$ of carbon disulfide at 25˚C from the following heat capacity data (units J K^{-1} mol^{-1}) and the heat of fusion at the melting point (161.11 K): $\Delta H_{m,fus}$ = 4389 J mol^{-1}.

T (K)	$C^\circ_{P,m}$	*T* (K)	$C^\circ_{P,m}$	*T* (K)	$C^\circ_{P,m}$
15.05	6.90	75.54	40.04	131.54	52.63
20.15	12.01	89.37	43.14	156.83	56.62
29.76	20.75	99.00	45.94	161-298	75.48
42.22	29.16	108.93	48.49		
57.52	35.56	119.91	50.50		

2. (10) Consider the reaction, $CH_4(g) + 2\ O_2(g) \rightleftarrows CO_2(g) + 2\ H_2O(l)$.
   (a) Use appendix data from Levine to calculate ΔH°, ΔG°, ΔS°, ΔU°, and ΔA° at 25˚C.
   (b) Similarly, use appendix data to calculate ΔH°, ΔG°, and K° at 1750 K for the similar reaction having the product H_2O in the gaseous state.
   (c) In the original reaction (producing liquid H_2O), suppose the methane is just burned at 25˚ C and $P = P^\circ$. Calculate *q* and *w* for this process.
   (d) Now suppose the reaction is carried out reversibly at 25˚C and P° in a fuel cell. Calculate (1) the non-*PV* work done by the system on the surroundings; (2) the *PV* work done by the system on the surroundings; (3) the total work *w* done on the system; and (4) the heat *q* added to the system.
   (e) What is the maximum total work obtainable from this reaction (w_{by}) in any constant-*T* process?

3. (3) Repeat the calculations of 2(b) using the tabulated free energy functions given below.

4. (4) Consider the gaseous dissociation reaction, $O_2 \rightleftarrows 2\ O$. ΔG°_f for O(g) at 2900 K is 14.642 kcal/mol.
   (a) Calculate K° for this reaction at 2900 K.
   (b) Calculate the equilibrium partial *P* of O at this *T* when the total *P* = 1.00 atm.
   (c) What is the degree of dissociation α in this case? [Hint: See Problem 3 on PS 8.]
   (d) What is the total *P* at 2900 K if the equilibrium mixture is 90 mol % O_2?

5. (4) A certain amount of NOBr(*g*) is sealed in a flask, which is then heated to 350K, where the NOBr partially dissociates to NO(*g*) and $Br_2(g)$. At equilbrium the total pressure is 0.675 atm, and the vapor density is 2.219 g/L.
   (a) Write a balanced chemical equation for this dissociation, with ν = –1 for NOBr.
   (b) Calculate the partial pressures of the three components at equilibrium, and the equilibrium constant K°.

Gaseous elements and compounds with values referenced to $H_0{}^\circ$

	$-(G_T - H_0{}^\circ)/RT$					$(H^\circ_{298} - H_0{}^\circ)/R$	$\Delta H^\circ_{f,0}/R$
	298.15 K	**500 K**	**1000 K**	**1500 K**	**2000 K**	**(K)**	**(10^3K)**
H_2	12.301	14.076	16.485	17.921	18.968	1018.5	–
O_2	21.173	22.992	25.521	27.088	28.243	1044.0	–
CO	20.275	22.086	24.558	26.069	27.183	1042.9	–13.69 ± 0.02
CO_2	21.934	24.001	27.246	29.445	31.138	1126.4	–47.29 ± 0.01
H_2O	18.716	20.802	23.674	25.493	26.881	1191.3	–28.736 ± 0.005
CH_4	18.376	20.531	24.00	26.63	28.82	1204.7	–7.999