CHEM 105-Fundamentals of Chemistry

Problem Set 6-Thermodynamics

1. Predict the sign (+ or –) of ΔS for the following processes:

a. Br_2 (g) $\rightarrow$ 2Br (g)
b. H_2O (l) $\rightarrow$ H_2O (g)
c. Sugar (s) $\rightarrow$ Sugar (aq)
d. $2SO_2$ (g) + O_2 (g) $\rightarrow$ $2SO_3$ (g)
e. Cooling of water from 70 ^oC to 14 ^oC

2. Calculate ΔS when 1 g of H_2O (l) is reversibly evaporated at 100 ^oC. (ΔH_{vap}=540 cal/g)

3. Some assymetrical compounds like CO may not have third law of thermodynamics (The entropy of a pure perfect crystal at 0 K is zero). Can you explain why?

4. Boiling point of propane is -22 ^oC at 1 atm. Calculate ΔH_{vap} for propane using Trouton's rule.

5. "Dissociation of a diatomic gas is favored by high temperature". Justify this statement by using thermodynamics. Use your knowledge of bond energy and entropy.

6. A traveller goes from California to Colorado. Which of the followings are state functions?

a. distance traveled
b. latitude change
c. altitude change
d. gasoline consumed
e. elapsed time
f. longitude change

7. Given the following information: ΔH^o_f (H_2O)(g)= -242 kJ/mol
ΔH^o_f (CH_4)(g)= -74.9 kJ/mol

the heat of combustion of CH_4 (g) to CO_2 (g) and H_2O (g) is -803 kJ/mol.

a. Calculate ΔH^o_{rxn} for the reaction: C (s) + $2H_2O$ (g) $\rightarrow$ CO_2 (g) + $2H_2$ (g)
b. Calculate ΔU^o for the same reaction

8. Use thermodynamic data at 298 K to decide in which direction the below reaction is spontaneous when the partial pressures of SO_2 (g), O_2 (g) and SO_3 (g) are $1x10^{-4}$, 0.20 and 0.10 atm, respectively.

$2SO_2$ (g) + O_2 (g) $\rightleftharpoons$ $2SO_3$ (g)
ΔG^o_f (SO_2)(g)= -300.2 kJ/mol
ΔG^o_f (SO_3)(g)= -371.1 kJ/mol

9. Assess the feasibility of the reaction:

$N_2H_4\ (g) + 2OF_2\ (g) \rightarrow N_2F_4\ (g) + 2H_2O\ (g)$

by determining each of the following quantities of this reaction at 25 ^{o}C.

a. ΔS^{o}

	S^{o} (J/mol K)
N_2H_4 (g)	238.5
OF_2 (g)	247.4
N_2F_4 (g)	301.2
H_2O (g)	188.8

b. ΔH^{o}

	Bond Energies (kJ/mol)
N-H	389
O-F	222
N-F	301
O-H	464

c. ΔG^{o} (Is the reaction feasible? If so, is it favored at high or low temperatures?)