CH16

I. Amplitude of entropy S:

a. $S_g >> S_l > S_s$

b. for a reaction, the side with larger total # of mole of gas molecule has larger *S*

c. complicated molecule (more atoms) has higher *S*

II. Spontaneous process: $\Delta S_{universe} > 0$, $\Delta G < 0$

a. $\Delta S_{universe} = \Delta S_{system} + \Delta S_{surrounding} = \Delta S_{system} - \Delta H/T \rightarrow -T\,\Delta S_{universe} = -T\,\Delta S_{system} + \Delta H$

b. $\Delta G = \Delta H - T\Delta S$

c. calculate ΔG, ΔH, and ΔS for a chemical reaction

III. ΔG, ΔG^0, *K* and *Q*:

a. $\Delta G^0 = -RT\ln K$

b. $\Delta G = \Delta G^0 + RT\ln Q = -RT\ln K + RT\ln Q$

c. $\Delta G^0 > 0$, K<1; $\Delta G^0 = 0$, K = 1; $\Delta G^0 < 0$, K > 1;

d. $\Delta G > 0$, Q>K; $\Delta G = 0$, Q = K; $\Delta G < 0$, Q < K;

CH16

16.I

1. Which one has larger entropy?
   1 mole of HCl(g) vs 1 mole of **HBr(g)**; $CH_3OH(l) + 3/2\ O_2(g) \Rightarrow$ **$CO_2(g) + 2\ H_2O(g)$;** 1 mole of $NO_2(g)$ vs 1 mole of **N_2O_4**(g)

16.II

2. For the combustion of acetylene at 298.15 K,
   $2\ C_2H_2(g) + 5\ O_2(g) \rightarrow 4\ CO_2(g) + 2\ H_2O(g)$
   calculate Δ*S*°(universe) given Δ*S*°(system) = –194.6 J/K and Δ*H*°(system) = –2511.2 kJ. **[+8228.0 J/K]** *can you do 1mole C_2H_2?*

3. Use the table below to answer the question that follows.

Thermodynamic Quantities for Selected Substances at 298.15 K (25 °C)

Substance	ΔH°f (kJ/mol)	ΔG°f (kJ/mol)	S (J/K-mol)
Carbon			
C (s, diamond)	1.88	2.84	2.43
C (s, graphite)	0	0	5.69
C_2H_2 (g)	226.7	209.2	200.8
C_2H_4 (g)	52.30	68.11	219.4
C_2H_6 (g)	-84.68	-32.89	229.5
CO (g)	-110.5	-137.2	197.9
CO_2 (g)	-393.5	-394.4	213.6
Hydrogen			
H_2(g)	0	0	130.58
Oxygen			
O_2 (g)	0	0	205.0
H_2O (l)	-285.83	-237.13	69.91

The combustion of hydrogen in the presence of excess oxygen yields water:
$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

The value of ΔS° for this reaction is ____J/K mol. [**-326.3**]

The value of ΔG° for this reaction is ____KJ/ mol. [**-474.26**]

The value of ΔH° for this reaction is ____KJ/ mol. [**-571.66**]

4. A particular reaction has a ΔH^o value of -10 kJ and ΔS^o of -500 J/mol K at 298 K. Assuming that ΔH^o and ΔS^o hardly change with temperature, determine the temperature in ^oC at which the spontaneity of this reaction changes. [**-253 ^oC**]

5. A particular reaction has a ΔH^o value of 3 kJ and ΔS^o of 10 J/mol K at 298 K. Assuming that ΔH^o and ΔS^o hardly change with temperature, determine the temperature in ^oC at which the spontaneity of this reaction changes. [**27**]

6. Given the following data,
   $2NO(g) + O_2(g) \Rightarrow 2NO_2(g)$ $\Delta G^o = -73$ J
   $N_2(g) + O_2(g) \Rightarrow 2NO(g)$ $\Delta G^o = 178$ J
   $2N_2O(g) \Rightarrow 2N_2 + O_2(g)$ $\Delta G^o = -202$ J
   Determine ΔG_f^o for $N_2O(g) + NO_2(g) \Rightarrow 3NO(g)$ [**113.5 J**]

7. Given the following data,
   $2H_2(g) + O_2(g) \Rightarrow 2H_2O(g)$ $\Delta G^o = -579$ J
   $C_3H_4(g) + 4O_2(g) \Rightarrow 3CO_2 + 2H_2O(g)$ $\Delta G^o = -1936$ J
   $C_3H_8(g) + 5O_2(g) \Rightarrow 3CO_2 + 4H_2O(g)$ $\Delta G^o = -2210$ J
   Determine ΔG_f^o for $C_3H_4(g) + 2H_2(g) \Rightarrow C_3H_8(g)$ [**-305 J**]

16.III

8. At 250 K, ΔG^o equals 4.157 kJ for the reaction, $N_2(g) + 3\ H_2(g) <=> 2\ NH_3\ (g)$. Calculate the value of lnK for the reaction at this temperature to one decimal place. [**-2**]

9. The value of ΔG^o for the reaction, $N_2(g) + 3\ H_2(g) <=> 2\ NH_3(g)$ is -32.90 kJ at 298 K. Calculate the value of ΔG in kJ at 298 K if the partial pressures of N_2, H_2 and NH_3 are 0.5, 1, and 2 atm respectively. [**-27.748 kJ**]

10. What is ΔG for $N_2 + 3H_2 \leftarrow \rightarrow 2NH_3$ under the given conditions at 400K? Will the reaction go toward products, reactants or is it at equilibrium? P_{N2} = 4.2 bar, P_{H2} = 1.8 bar, P_{NH3} = 21 bar, K(400K) = 41. [**-21.9 kJ**]