CHEM 1423
Chapter 20
Homework Questions

TEXTBOOK HOMEWORK

20.14 Without using Appendix B predict the sign of ΔS^o for

(a) $CaCO_3(s) + 2\ HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$

(b) $2\ NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$

(c) $2\ KClO_3(s) \rightarrow 2\ KCl(s) + 3\ O_2(g)$

20.16 Predict the sign of ΔS for each process:

(a) $C_2H_5OH(g)$ (350 K and 500 torr) $\rightarrow$ $C_2H_5OH(g)$ (350 K and 250 torr)

(b) $N_2(g)$ (298 K and 1 atm) $\rightarrow$ $N_2(aq)$ (298 K and 1 atm)

(c) $O_2(aq)$ (303 K and 12 atm) $\rightarrow$ $O_2(g)$ (303 K and 12 atm)

20.21 Without consulting Appendix B, arrange each group in order of increasing molar entropy (S^o):

(a) Glucose ($C_6H_{12}O_6$), Sucrose ($C_{12}H_{22}O_{11}$), Ribose ($C_5H_{10}O_5$)

(b) $CaCO_3$, $Ca + C + (3/2)\ O_2$, $CaO + CO_2$

(c) $SF_6(g)$, $SF_4(g)$, $S_2F_{10}(g)$

20.28 For each reaction, predict the sign and find the value of ΔS^o:

(a) $3\ NO(g) \rightarrow N_2O(g) + NO_2(g)$

(b) $3\ H_2(g) + Fe_2O_3(s) \rightarrow 2\ Fe(s) + 3\ H_2O(g)$

(c) $P_4(s) + 5\ O_2(g) \rightarrow P_4O_{10}(s)$

20.40 Calculate ΔG^o for each reaction using ΔG_f^o values:

(a) $2\ Mg(s) + O_2(g) \rightarrow 2\ MgO(s)$

(b) $2\ CH_3OH(g) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 4\ H_2O(g)$

(c) $BaO(s) + CO_2(g) \rightarrow BaCO_3(s)$

20.46 One reaction used to produce small quantities of pure H_2 is
$CH_3OH(g) \rightarrow CO(g) + 2\ H_2(g)$

(a) Determine ΔH^o and ΔS^o for the reaction at 298 K

(b) Assuming that these values are relatively independent of temperature, calculate ΔG^o at 28 ^oC, 128 ^oC, and 228 ^oC

(c) What is th significance of thedifferent values of ΔG^o

20.48 Use ΔH^o and ΔS^o values for the following process at 1 atm to find the normal boiling point of Br_2: $Br_2(l) \rightarrow Br_2(g)$

20.51 The U.S. government requires automobile fuels to containa renewable component. Fermentation of glucose rom corn yields ethanol, which is added to gasoline to fulfill this requirement.

$$C_6H_{12}O_6(s) \rightarrow 2\ C_2H_5OH(l) + 2\ CO_2(g)$$

Calculate ΔH^o, ΔS^o, and ΔG^o for the reaction at 25 ^oC. Is the spontaneity of this reaction dependent on T? Explain.

20.56 Calculate K at 298 K for each reaction:

(a) $NO(g) + (1/2)O_2(g) \rightarrow NO_2(g)$

(b) $2\ HCl(g) \rightarrow H_2(g) + Cl_2(g)$

(c) $2\ C(graphite) + O_2(g) \rightarrow 2\ CO(g)$

20.64 The equilibrium constant for the reaction
$2\ Fe^{3+}(aq) + Hg_2^{2+}(aq) \rightarrow 2\ Fe^{2+}(aq) + 2\ Hg^{2+}(aq)$ is $K_c = 9.1x10^{-6}$ at 298 K

(a) What is ΔG^o at this temperature?

(b) If standard-state concentrations of the reactants and products are mixed, in which direction does 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 achiece equillibrium?

20.74 (a) Write a balanced equation for the gaseous reaction between N_2O_5 and F_2 to form NF_3 and O_2.

(b) Determine ΔG^o_{rxn}

(c) Find ΔG_{rxn} at 298 K if $P_{N2O5} = P_{F2} = 0.20$ M, $P_{NF3} = 0.25$ atm and $P_{O2} = 0.50$ atm

SUPPLEMENTARY HOMEWORK

S1. If a reaction is spontaneous at any temperature, then ΔH^o is ____ and ΔS^o is
.

a. positive; positive
b. positive; negative
c. zero; positive
d. negative; positive
e. negative; negative

S2. At constant *T* and *P*, in which of the following situations will the reaction never be spontaneous?

a. $\Delta H > 0$ and $\Delta S < 0$
b. $\Delta H > 0$ and $\Delta S > 0$
c. $\Delta H < 0$ and $\Delta S < 0$
d. $\Delta H < 0$ and $\Delta S > 0$
e. none of the above

S3. A reaction is exothermic and has a negative value of ΔS^o. The value of ΔG^o for this reaction is therefore:

a. negative at all temperatures.
b. positive at all temperatures.
c. positive above 0^oC and negative below 0^oC.
d. positive above a certain temperature and negative below it.
e. negative above a certain temperature and positive below it.

S4. The reaction A $\rightarrow$ B is **exergonic** at 25 ^oC and the enthalpy change is +20 kJ. What can be concluded about the entropy change for this reaction?

a. $\Delta S > +67$ J/K
b. $\Delta S > +800$ J/K
c. $\Delta S < -67$ J/K
d. No conclusion can be made about ΔS

S5. For the **endergonic** reaction C $\rightarrow$ D, ΔS= +20 J/K. For this reaction,

a. $\Delta G<0$ & $\Delta H<0$

b. $\Delta G>0$ & $\Delta H<0$

c. $\Delta G<0$ & $\Delta H>0$

d. $\Delta G>0$ & $\Delta H>0$

S6. Consider a sample containing 322 grams of toluene ($C_6H_5CH_3$, M = 92).

Quantity	T_m	T_b	ΔH_{fus}^o	ΔH_{vap}^o	ΔS_{fus}^o	ΔS_{vap}^o
Value	-95 ^oC	+111 ^oC	6.64 kJ/mol	38.1 kJ/mol	37.3 J/mol-K	99.2 J/mol-K

(a) Calculate ΔS_{sys}, ΔS_{surr} and ΔS_{univ} for the vaporization of 322 grams of toluene at:

(1) 130 ^oC , (2) 111 ^oC, (3) 90 ^oC

(b) Calculate ΔG^o for the vaporization of 322 grams of toluene at:

(1) 130 ^oC , (2) 111 ^oC, (3) 90 ^oC

(c) Calculate ΔS_{sys}, ΔS_{surr} and ΔS_{univ} for the freezing (crystallization) of 322 grams of toluene at:

(1) -115 ^oC , (2) -95 ^oC, (3) -75 ^oC

(d) Calculate ΔG^o for the freezing (crystallization) of 322 grams of toluene at:

(1) -115 ^oC , (2) -95 ^oC, (3) -75 ^oC

S7. A certain reaction has $\Delta H°$ = +177.8 kJ, and $\Delta S°$ = +160.5 J/K. Above or below what temperature (in ^oC) does it become spontaneous ?

S8. For the reaction shown, $\Delta G° = -32.8$ kJ at 25°C.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

a. Calculate the equilibrium constant for this reaction at 25°C.

b. Is a mixture of the three gases where $p_{N_2} = 3.5$ bar, $p_{H_2} = 1.2$ bar, and $p_{NH_3} = 0.22$ bar at equilibrium? Justify your answer.

c. What is the value of ΔG under the conditions of part b?

S9. For the reaction, $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$, $\Delta H^o = +178$ kJ/mol and $\Delta S^o = +161$ J/mol-K.

a. What is the value of ΔG^o at 25 °C?

b. What is the value of ΔG^o at 1500 °C?

c. At what temperature, in °C, are the reactants and products in equilibrium? (i.e. $\Delta G^o = 0$)

S10. A hypothetical polypeptide, PP, has two structural forms, PP(α) and PP(β). For the transition, PP(α) $\rightarrow$ PP(β), the entropy change is -120 J/mol-K and the enthalpy change is -42 kJ/mol.

This transition is spontaneous _____ (above or below) _____ °C.