

**Chem4411/5411 Dec. 3, 2005**

Extra Practice Questions for Final (Part II, random)

1. The dissociation constant of a monoprotic acid at 298 K is  $1.47 \times 10^{-3}$ . Calculate the degree of dissociation by (a) assuming ideal behavior and (b) using a mean activity coefficient of 0.93. The concentration of the acid is 0.01 M. The degree of dissociation is defined as the fraction of acid dissociated in solution.

2.

(a) For Lysine (abbreviated as  $\text{LysH}_3^{2+}$ ),  $\text{pK}_{a1}$ ,  $\text{pK}_{a2}$  and  $\text{pK}_{a3}$  are 2.18, 8.95, 10.53, respectively, calculate its pI. At pH of 10.00, calculate the ration of  $[\text{Lys}^-]/[\text{LysH}_2^+]$  in solution.

(b) For Valine (abbreviated as  $\text{ValH}_2^+$ ),  $\text{pK}_{a1}$  and  $\text{pK}_{a2}$  are 2.32 and 9.62, respectively, calculate its pI. At pH 4.50, calculate the ratio of  $[\text{ValH}_2^+]/[\text{Val}^-]$  in solution.

3. A 0.400 M formic acid ( $\text{HCOOH}$ ) solution freezes at  $-0.758^\circ\text{C}$ . Calculate the value of  $K_a$  at this temperature (Assume that molarity is approximately equal to molality).

4. One mole of an ideal monatomic gas is compressed from 2.0 atm to 6.0 atm while being cooled from 400 K to 300 K. Calculate the values of  $\Delta U$ ,  $\Delta H$ , and  $\Delta S$  for the process. (Hint: for monatomic ideal gas  $C_p = 5/2R$ )

5.

- a. 0.010 M  $\text{CH}_3\text{COOH}$  ( $\text{pK}_a = 4.76$ ) is added to pure water, calculate the  $[\text{H}^+]$  and pH of this solution; (assume ions behave ideally in this diluted solution)
- b. 0.010 M  $\text{CH}_3\text{COOH}$  is added to 0.50 m NaCl solution, calculate the  $[\text{H}^+]$  and pH this solution; (at 25°C and assume NaCl is the only major contributor to ionic strength)
- c. 0.010 M  $\text{CH}_3\text{COOH}$  is added to equal volume of 0.010 M of NaOH solution, calculate the pH of this solution. (assume ideal diluted solution)
- d. 0.010 M  $\text{CH}_3\text{COOH}$  is diluted by 100 fold in pure water, calculate the pH of this solution. (assume ideal diluted solution).

6. Diamond can be synthesized from graphite (Don't get too excited, you won't become rich by doing this once you can figure out the answer of this question). Given the  $\Delta_r H^\circ$  (1.90 kJ/mol) and  $\Delta_r S^\circ$  (-3.3J/K mol) for the reaction:



(a) Is this reaction spontaneous at 25°C?

- (b) At what temperature would this reaction become spontaneous at standard pressure (1bar)?
- (c) At what pressure would this reaction become spontaneous at 25°C? (The molar volume of graphite is 2.1 cm<sup>3</sup> greater than that of diamond,

7. A solution is made up by dissolving 36.5 g of glucose (molar mass 180.2 g/mol) in 966 g of water. The solution freezes at  $-0.33\text{ }^{\circ}\text{C}$ . Calculate (a) the activity coefficient of glucose in this solution; and (b) the increase of boiling point of this solution.

8. At 373.15 K and 1,000 atm, the molar volume of liquid water and vapor are  $1.88 \times 10^{-5}\text{ m}^3$  and  $3.06 \times 10^{-2}\text{ m}^3$ , respectively. Given that the heat of vaporization of water is  $40.79\text{ kJ mol}^{-1}$ , calculate the values of  $\Delta H$  and  $\Delta U$  for 1 mol of water going from liquid (373.15 K, 1 atm) to vapor (373.15 K, 1 atm).