Name _____

CHE-121-001 Exam 2 3/01/02

Problem	Points	Score
Part 1	40	
Part 2 no.1	10	
2	8	
3	16	
4	6	
5	8	
6	12	
Total	100	

For a buffer solution: pH = pKa + log ([base] / [acid])

Part 1 (40 points) Multiple choice. (4 points each)

_____1. The value of an equilibrium constant (K_c) is changed when:

a. the concentration of reactants are changed
b. the volume of the system is changed
c. the pressure of the system is changed
d. the temperature of the system is changed
e. a catalyst is added to the system

_____2. Which of the following statements is correct concerning the following reaction at equilibrium:

$$NH_4(NH_2CO_2)_{(s)} \Leftrightarrow 2NH_{3\,(g)} + CO_{2\,(g)} \quad K_c = 1.6 \times 10^{-8}$$

a. The rate of the reverse reaction is much higher than that of the forward reaction.
b. The rate of the forward and reverse reactions both equal zero and all chemical processes have stopped.
c. The equilibrium expression is $K_c = [NH_3]^2 [CO_2] / [NH_4(NH_2CO_2)]$
d. $[NH_3]$ and [CO] are very small; the equilibrium lies to the left.

_____3. At 700 K, the reaction $2\ SO_{2\,(g)} + O_{2\,(g)} \Leftrightarrow 2\ SO_{3\,(g)}$, $K_c = 4.3 \times 10^6$. If the following concentrations are present, is the reaction mixture at equilibrium? If not at equilibrium, how will the reaction proceed?

$[SO_2] = 0.10$ M; $[SO_3] = 10$ M; $[O_2] = 0.10$ M

a. yes, the mixture is at equilibrium
b. no, the reaction will proceed left to right
c. no, the reaction will proceed right to left
d. There is not enough information to tell.

_____4. Which of the following is the conjugate acid of HPO_3^{2-}?

a. $H_2PO_3^{1-}$ b. $H_2PO_3^{3-}$ c. H_3PO_3 d. PO_3^{3-} e. H_3O^+

_____5. Acid strength decreases in the series: $HNO_3 > HF > CH_3COOH$. Which of the following species is the strongest base?

a. NO_3^{1-}
b. CH_3COO^{1-}
c. F^{1-}
d. CH_3COOH

_____6. Which acid in each of the following pairs is the strongest?

1. H_2O or H_2S **2. CCl_3COOH or CH_3COOH** **3. H_3PO_3 or H_3PO_4**

a. H_2O; CH_3COOH; H_3PO_3
b. H_2O; CCl_3COOH; H_3PO_4
c. H_2S; CH_3COOH; H_3PO_3
d. H_2S; CCl_3COOH; H_3PO_4
e. H_2S; CH_3COOH; H_3PO_4

_____7. Given that the K_a for gallic acid ($HC_7H_5O_5$) is 4.57×10^{-3}, what is the K_b for the gallate ion ($NaC_7H_5O_5$)?

a. 4.5×10^{-3}
b. 2.19×10^{-12}
c. 5.43×10^{-5}
d. 7.81×10^{-6}
e. 2.19×10^{2}

_____8. Which of the following 0.10 M aqueous solutions has the highest pH?

a. $C_2H_5NH_2$ ($K_b = 5.6 \times 10^{-4}$)
b. $HCOO^{1-}$ ($K_b = 6.0 \times 10^{-11}$)
c. CN^{1-} ($pK_b = 4.70$)
d. $C_6H_5NH_2$ ($pK_b = 9.42$)

_____9. Which one of the following combinations cannot function as a buffer solution?

a. HCN and KCN
b. NH_3 and NH_4SO_4
c. HNO_3 and $NaNO_3$
d. HF and NaF
e. HCOOH and NaHCOO

_____10. H_3PO_4 ($K_a = 7 \times 10^{-3}$)
$H_2PO_4^{1-}$ ($K_a = 8 \times 10^{-8}$)
HPO_4^{2-} ($K_a = 5 \times 10^{-13}$)

On the basis of the information given above, a buffer with pH = 6.5 can best be made by using:

a. pure NaH_2PO_4
b. H_3PO_4 and $H_2PO_4^{1-}$
c. $H_2PO_4^{1-}$ and HPO_4^{2-}
d. HPO_4^{2-} and PO_4^{3-}

Part 2. Problems. Show all your work for full credit. (Remember significant figures and units.)

1. (10 points) A mixture of 0.15 mol of NO, 0.082 mol of H_2 and 0.10 mol H_2O is placed in a 1.0 L vessel. The following equilibrium is established. At equilibrium [NO] = 0.098M. Calculate the concentrations of the equilibrium mixture and the value of the equilibrium constant, K_c.

$$2\ NO_{(g)} + 2\ H_{2\,(g)} \Leftrightarrow N_{2\,(g)} + 2\ H_2O_{(g)}$$

2. (8 points) Consider the production of ammonia from hydrogen and nitrogen, known as the Haber process. Based on LeChatelier's principal indicate which of the following conditions will increase the production of ammonia. (Place a check by all that apply.)

$$3\ H_{2\,(g)} + N_{2\,(g)} \Leftrightarrow 2\ NH_{3\,(g)};\ \Delta H = -92.6\ kJ$$

_____a. run at high pressure _____b. run at low pressure

_____c. remove ammonia as formed _____d. add excess ammonia

_____e. run at elevated temperatures _____f. run at low temperatures

_____g. add excess hydrogen _____h. remove nitrogen

3. (16 points) Write equations for ionization and calculate the pH of each solution.

a. 0.16 M H_2SO_4

b. 0.48 M LiOH

c. 0.84 M NH_2NH_2 ($K_b = 1.3 \times 10^{-6}$)

d. 1.2 M C_2H_5COOH ($K_a = 1.3 \times 10^{-5}$)

4. (6 points) The pH of a 0.020 M solution of $Al(NO_3)_3$ is 3.29. What are the $[H_3O^{+}]$ and $[OH^{1-}]$ in the solution? Why is this solution acidic? (BONUS points for writing the equation for the reaction.)

5. (8 points) Predict the pH of each of the following salt solutions (acidic, basic or neutral). Write equations for the hydrolysis reactions that takes place.

a. NH_4Cl

b. $CaBr_2$

c. Na_2CO_3

6. (10 points) Consider the buffer solution made by dissolving 0.20 moles of HNO_2 and 0.30 moles of $NaNO_2$ in enough water to make 1.0 L of solution. (HNO_2, $K_a = 4.5 \times 10^{-4}$)

a. Write the equation for dominant reaction in solution.

b. Calculate the pH of the buffer solution.

c. Write the equation for the reaction that occurs when 0.03 moles of HCl is added to this buffer solution. Calculate the pH of this solution. (Ignore any volume changes.)

d. Write the equation for the reaction that occurs when 0.04 mole of KOH is added to this buffer solution.