EXAM THREE **CHM 205 (Dr. Mattson)** **29 FEBRUARY 2008**	***Academic Integrity Pledge:*** *In keeping with Creighton University's ideals and with the Academic Integrity Code adopted by the College of Arts and Sciences, I pledge that this work is my own and that I have neither given nor received inappropriate assistance in preparing it.* *Signature:*

Instructions: Show all work whenever a calculation is required! You will receive credit for <u>how</u> you worked each problem as well as for the correct answer. If you need more space, you may use the back of your periodic table — Write: "See PT" in box and then attach the periodic table. BOX YOUR ANSWERS! Write legibly.

CHAPTER 14. AQUEOUS EQUILIBRIA: ACIDS & BASES

1. (12 pts) Which of these salts are predicted to be acidic in solution?

NaCl	NH_4Cl	KOH	KNO_2
$KHSO_4$	$LiClO_4$	$BaCl_2$	$NaC_2H_3O_2$
KF	NaCN	NH_4NO_3	KOCl

2. (6 pts) Using data found on the data sheet, determine the pH of a 0.72 M solution of KF.

3. Formic acid, HCO_2H, has a $K_a = 1.8 \times 10^{-4}$.

(a) (3 pts) What is the pK_a of this acid?

(b) (3 pts) What is the conjugate base?

(c) (3 pts) What is the pK_b for the conjugate base?

4. (3 pts) If $pK_{a1} = 4.0$ for H_3A, which values are the most reasonable for pK_{a2} and pK_{a3}?

(a) $pK_{a2} = 9$ and $pK_{a3} = 13$.

(b) $pK_{a2} = 2.5$ and $pK_{a3} = 1$.

(c) $pK_{a2} = 5$ and $pK_{a3} = 6$.

(d) $pK_{a2} = 12$ and $pK_{a3} = 8$.

5. (8 pts) Determine if 1.0 M NaH_2PO_4 is a better weak acid or weak base.

CHAPTER 15. APPLICATIONS OF AQUEOUS EQUILIBRIA

6. (12 pts) What is the ***numerical value*** of the equilibrium constants for the following equilibria? Use data from the data sheet. (Note: generic equilibrium arrows are used in this question so as not to give away any hints.)

(a) $HF(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + F^-(aq)$ K =

(b) $HF(aq) + OH^-(aq) \rightleftharpoons H_2O(l) + F^-(aq)$ K =

(c) $F^-(aq) + H_3O^+(aq) \rightleftharpoons H_2O(l) + HF(aq)$ K =

(d) $F^-(aq) + H_2O(l) \rightleftharpoons OH^-(aq) + HF(aq)$ K =

7. A buffer is prepared that contains 0.64 mol $HC_2H_3O_2$ and 0.38 mol $NaC_2H_3O_2$ dissolved in water to make 500 mL solution.

(a) (6 pts) What is the pH of the buffer?

(b) (6 pts) What is the pH after 0.03 mole of NaOH has been added to the buffer in Question 7(a)?

(c) (3 pts) Does this buffer have a better buffer capacity towards strong acid or strong base? *Explain your answer for credit.*

8. (12 pts) Which of these mixtures would produce a buffer solution?

(a) 0.20 mol HF and 0.30 mol NaF

(b) 0.15 mol $NaC_2H_3O_2$ and 0.40 mol $HC_2H_3O_2$

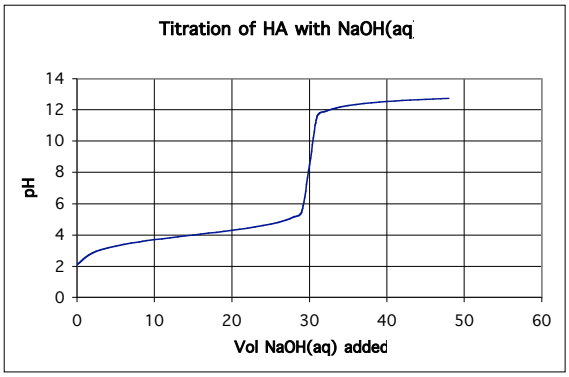
(c) 0.25 mol NaOH and 0.40 mol $HC_2H_3O_2$

(d) 0.35 mol NaOCl and 0.20 mol HCl

(e) 0.15 mol KOH and 0.11 mol HOCl

(f) 0.15 mol $NaC_2H_3O_2$ and 0.40 mol HBr

9. (6 pts) Which is the molarity of a HCl solution if it takes 24.68 mL of a 0.1896 M NaOH solution to titrate 25.00 mL of the acid to a phenolphthalein endpoint?



10. The following questions pertain to the above titration curve for the titration of an unknown weak acid, HA with NaOH.

(a) (3 pts) What is the pK_a of HA?

(b) (4 pts) If 10.00 mL of HA were titrated with 0.2044 M NaOH to give the titration curve shown, what is the molarity of HA?

(c) (2 pts) Carefully circle the buffer region on the titration curve above.

(d) (2 pts) Draw an arrow on the graph indicating where $n_{HA} = M_{HA}V_{HA} = M_{OH^-}V_{OH^-} = n_{OH^-}$

(e) (5 pts) Which of these activities would you have to do in order to determine the pH at the equivalence point for the above titration?

i. Determine the total volume by adding the volume of acid titrated with the volume of NaOH added.
ii. Determine a value of K_b by using the pK_a determined in Part (a).
iii. Look up the value for K_a in a textbook.
iv. Determine the molar mass of HA using $n_a = M_aV_a$ and the mass of the acid added.
v. Determine the number of moles of HA titrated using $n_{HA} = M_{HA}V_{HA} = M_{OH^-}V_{OH^-}$

(1 pts) Print your name here and sign Academic Integrity Statement on other side.

Your exam score (100 possible): _____

Determine your grade:
A+ ≥ 95; A ≥ 90; B+ ≥ 85; B ≥ 80; C+ ≥ 75; C ≥ 70; D ≥ 60

Answers:

Chapter 14. Aqueous Equilibria: Acids & Bases

1. NH_4Cl, $KHSO_4$, NH_4NO_3

2. 8.66

3. (a) 3.74; (b) CO_2H^-; (c) 10.26

4. (a)

5. $H_2PO_4^-$ as a weak acid: $H_2PO_4^- + H_2O \rightleftharpoons H_3O^+ + HPO_4^{-2}$ $K_{a2} = 6.2 \times 10^{-8}$

$H_2PO_4^-$ as a weak base: $H_2PO_4^- + H_2O \rightleftharpoons OH^- + H_3PO_4$ $K_b = K_w/K_{a1} = 1 \times 10^{-14}/7.5 \times 10^{-3} = 1.3 \times 10^{-12}$

Since the K value for the first equation is bigger than the K value for the second equation, $H_2PO_4^-$ is a better weak acid than a weak base.

Chapter 15. Applications of Aqueous Equilibria

6.

(a) $HF(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + F^-(aq)$ $K = K_a = 3.5 \times 10^{-4}$

(b) $HF(aq) + OH^-(aq) \rightleftharpoons H_2O(l) + F^-(aq)$ $K = 1/K_b = K_a/K_w = 3.5 \times 10^{+10}$

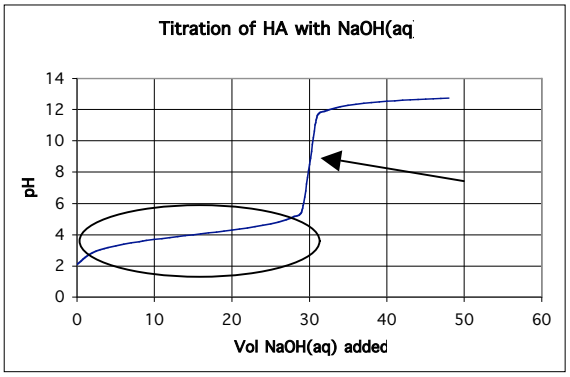
(c) $F^-(aq) + H_3O^+(aq) \rightleftharpoons H_2O(l) + HF(aq)$ $K = 1/K_a = 2.9 \times 10^{+3}$

(d) $F^-(aq) + H_2O(l) \rightleftharpoons OH^-(aq) + HF(aq)$ $K = K_b = K_w/K_a = 2.9 \times 10^{-11}$

7. (a) 4.52 (b) 4.57 (c) (3 pts) towards strong base because there are more moles of weak acid than weak base.

8. a, b, c, and d

9. (6 pts) 0.1872 mol/L



10. (a) $pK_a = 4.0$; (b) 0.6132 M; (c) See graph; (d) See graph; (e) i, ii, and v