

Exam Three
Chm 205 (Dr. Mattson)
6 March 2009

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 how 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.

Acid Dissociation Constants for Exam:

Acid	K_a
$\text{HC}_2\text{H}_3\text{O}_2$	1.8×10^{-5}
HNO_2	4.5×10^{-4}
H_2CO_3	$K_{a1} = 4.3 \times 10^{-7}$ $K_{a2} = 5.6 \times 10^{-10}$
HF	3.5×10^{-4}

1. (10 pts) Identify the following substances as strong acid (sa), weak acid (wa), neutral (n), weak base (wb), or strong base (sb).

NaF	sa	wa	n	wb	sb
NH_3	sa	wa	n	wb	sb
NaCl	sa	wa	n	wb	sb
KBr	sa	wa	n	wb	sb
HF	sa	wa	n	wb	sb
NH_4Cl	sa	wa	n	wb	sb
$\text{LiC}_2\text{H}_3\text{O}_2$	sa	wa	n	wb	sb
RbOH	sa	wa	n	wb	sb
Na_2CO_3	sa	wa	n	wb	sb
HNO_3	sa	wa	n	wb	sb

2. (5 pts) Determine the pH of a 0.55 molar solution of sodium fluoride.

- 3(a) (2 pts) Phosphoric acid, H_3PO_4 has $\text{p}K_a$ values of 2.12, 7.21, and 12.32. Which if these three values is $\text{p}K_{a3}$? **Circle: 2.12 7.21 12.32**

- (b) (2 pts) Write the chemical equilibrium that corresponds to K_{a3} .

- 4(a) (5 pts) What is the pH of 0.0100 M H_2CO_3 ?

- (b) (5 pts) What is the $[\text{CO}_3^{2-}]$ in 0.0100 M H_2CO_3 ?

5. NaHCO_3 can serve as either a weak acid or base.

- (a) (3 pts) Write the net ionic equilibrium for bicarbonate acting as a weak acid.

- (a) (3 pts) Write the equilibrium expression, K, for bicarbonate acting as a weak acid, AND determine a numerical value for it.

- (c) (3 pts) Write the net ionic equilibrium for bicarbonate acting as a weak base.

- (d) (5 pts) Write the equilibrium expression, K, for bicarbonate acting as a weak base, AND determine a numerical value for it.

(e) (2 pts) Using what you've learned above, is bicarbonate a better weak acid or weak base?

Circle: **weak acid** **weak base**

6. (4 pts each) For each of the following solutions:

1. Write a **net ionic** equilibrium expression with appropriate long/short arrows.
2. Determine a K expression and a numerical value for each K.

(a) sodium acetate dissolved in water

(b) acetic acid dissolved in water

(c) sodium acetate + strong acid neutralization

(d) acetic acid + strong base neutralization

7(a). (5 pts) Which of the following substances, when mixed in the quantities indicated would create a buffer solution?

- (a) 0.20 mol HF + 0.30 mol NaF
- (b) 0.40 mol HF + 0.20 mol NaOH
- (c) 0.20 mol HF + 0.30 mol NaOH
- (d) 0.20 mol HCl + 0.40 mol NaF
- (e) 0.30 mol HCl + 0.20 mol NaF

(b) (2 pts) Which of the solutions in (a) has the largest buffer capacity towards strong acid?

Circle: **(a)** **(b)** **(c)** **(d)** **(e)**

8(a) (5 pts) What is the pH of a buffer obtained by mixing 0.42 mol acetic acid and 0.53 mol sodium acetate in enough water to make 500.00 mL?

(b) (5 pts) What pH results if 0.05 mol sodium hydroxide is added to the solution?

(c) (2 pts) Instead of adding sodium hydroxide, suppose another 500.00 mL water were added. What pH results?

9. (5 pts) What is the pH of a solution obtained by mixing 0.80 mol HF and 0.50 mol sodium hydroxide in about 500 mL water?

10. Consider the titration of 50.00 mL of 0.1200 M $\text{HNO}_3(\text{aq})$ with 0.1500 M $\text{KOH}(\text{aq})$

(a) (3 pts) What is the pH before KOH is added?

(b) (5 pts) What is the pH after 35.00 mL KOH has been added?

(c) (5 pts) What volume of KOH is required to completely neutralize the acid?

(d) (2 pt) What is the pH at the equivalence point?

Print your name here and sign Academic Integrity Statement.

Answers

1. NaF	sa	wa	n	<u>wb</u>	sb
NH ₃	sa	wa	n	<u>wb</u>	sb
NaCl	sa	wa	<u>n</u>	wb	sb
KBr	sa	wa	<u>n</u>	wb	sb
HF	sa	wa	n	wb	sb
NH ₄ Cl	sa	<u>wa</u>	n	wb	sb
LiC ₂ H ₃ O ₂	sa	wa	n	<u>wb</u>	sb
RbOH	sa	wa	n	wb	<u>sb</u>
Na ₂ CO ₃	sa	wa	n	<u>wb</u>	sb
HNO ₃	<u>sa</u>	wa	n	wb	sb

2. pH = 8.60

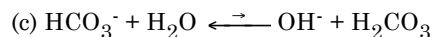
3(a) 12.32 (b) $\text{HPO}_4^{-2} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{PO}_4^{-3}$

4(a) pH = 4.18

(b) $[\text{CO}_3^{-2}] = 5.6 \times 10^{-10}$

5(a) $\text{HCO}_3^- + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{CO}_3^{-2}$

$$(b) K_{a2}^{\text{HCO}_3^-} = \frac{[\text{H}_3\text{O}^+][\text{CO}_3^{-2}]}{[\text{HCO}_3^-]} = 5.6 \times 10^{-10}$$

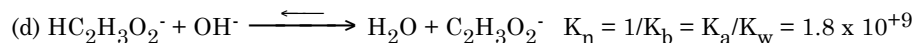
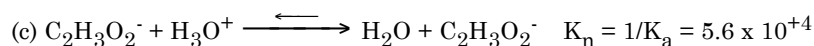
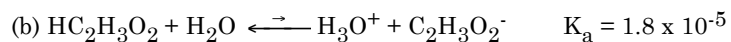
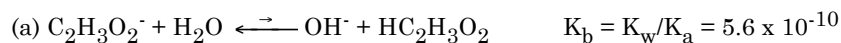


$$(d) K_b^{\text{HCO}_3^-} = \frac{[\text{OH}^-][\text{H}_2\text{CO}_3]}{[\text{HCO}_3^-]} = \frac{K_w}{K_a^{\text{H}_2\text{CO}_3}} = 2.3 \times 10^{-8}$$

(e) better weak base

6. (4 pts each) For each of the following solutions:

- Write a **net ionic** equilibrium expression with appropriate long/short arrows.
- Determine a K expression and a numerical value for each K.



7(a). a, b, and d; (b) Buffer (a)

8(a) pH = 4.84; (b) pH = 4.94; (c) pH = 4.84

9. pH = 3.68

10. (a) pH = 0.92; (b) pH = 2.05; (c) 40.00 mL; (d) pH = 7.0

Name: (only if you answer yes below): _____

Work to be graded on this sheet?

YES: If you have done work to be graded on this sheet, you must submit it with your exam and include your name above. Do not clip it to the exam — simply hand them in together.

NO: If there is nothing to grade on this sheet, simply return it to the pile next to the exams.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.01																1 H 1.01	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.70	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 97	44 Ru 101.07	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.2	77 Ir 192.22	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.37	82 Pb 207.2	83 Bi 208.98	84 Po 209	85 At 210	86 Rn 222
87 Fr 223	88 Ra 226.03	89 Ac 227															