Exam 2 Chm 205 (Dr Mattson) 26 March 2013

Academic Integrity Pledge: *In keeping with Creighton University's ideals and with the Academic Integrity Code, I pledge that this work is my own and that I have neither given nor received inappropriate assistance in preparing it.*

(1 pt) Signature:

Instructions: Show all work whenever a calculation box is provided! Write legibly. Include units whenever appropriate. 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 data sheet — Write: "See data sheet" in the answer box and then hand the data sheet in with your exam. At your desk you are allowed only pencils (but no pencil pouch), an eraser, and a non-programmable calculator without a slipcover. Backpacks and purses must be stored in the front of the room. Cell phones must be OFF and placed at the front of the room.

Use this information to answer Questions 1 –11.

Chloroacetic acid, HCO_2CH_2Cl $K_a = 1.36 \times 10^{-3}$

Hydrazoic acid, HN_3 $K_a = 2.20 \times 10^{-5}$

1. (4 pts) What is the pH of a 0.150 M solution of hydrazoic acid?

Answer:_____

2. (2 pt) Which acid is a stronger weak acid?

(a) chloroacetic acid (b) hydrazoic acid (c) same

3. (2 pt) Which acid is more likely to require use of the quadratic formula in order to answer a question such as Question 1?

(a) chloroacetic acid (b) hydrazoic acid (c) same

4. (3 pts) What is the pK_b for $CO_2CH_2Cl^-$?

Answer:_____

5. (4 pts) What is the pH of a 0.080 M solution of $NaCO_2CH_2Cl$?

Answer:_____

6. (2 pts) As a 0.10 M solution, which of these would give the highest pH?

(a) HCO_2CH_2Cl (b) $NaCO_2CH_2Cl$

(c) HN_3 (d) KN_3

7. (5 pts) Which of these would produce a buffer when mixed in about 1 L water? Circle all that would.

(a) 400 mL 0.15 M HCO_2CH_2Cl + 600 mL 0.25 M $NaCO_2CH_2Cl$

(b) 0.25 mol $NaCO_2CH_2Cl$ + 0.15 mol HCl(aq)

(c) 0.15 mol HCO_2CH_2Cl + 0.15 mol NaOH(s)

(d) 0.44 mol NaOH(s) + 0.22 mol HCl(aq)

(e) 50 mL 0.19 M HCO_2CH_2Cl + 75 mL 0.10 M NaOH(aq)

8. (4 pts) What is the pH of a solution prepared by adding 100.0 mL 0.358 M HCO_2CH_2Cl to 200.0 mL 0.208 M $NaCO_2CH_2Cl$?

Answer:_____

9. (2 pts) Referring again to the buffer in the previous problem, does this solution have a larger buffer capacity towards strong acid or strong base?

(a) strong acid (b) strong base (c) same

10. (4 pts) A buffer contains 0.0473 mol HCO_2CH_2Cl and 0.0711 mol $NaCO_2CH_2Cl$. What pH results when 0.0050 mol NaOH(s) is added to the buffer?

Answer:_____

11. (4 pts) What is the pH of a solution prepared by adding 0.0300 mol NaOH(s) to 200 mL 0.208 M HCO_2CH_2Cl?

Answer with units:_____

12. (6 pts) Identify the following solutions as being a strong acid, weak acid, neutral, weak base, or strong base.

(a) HNO_3	sa	wa	n	wb	sb
(b) $NaNO_3$	sa	wa	n	wb	sb
(c) KNO_2	sa	wa	n	wb	sb
(d) HNO_2	sa	wa	n	wb	sb
(e) NaOH	sa	wa	n	wb	sb
(f) NH_4NO_3	sa	wa	n	wb	sb

13. (9 pts) Refer again to the K_a value given for hydrazoic acid in the green box on the front. What is the numerical value of K for each of these? Sketch appropriate arrows (⇀↽).

13a. $HN_3 + OH^-$ ( ) $H_2O + N_3^-$

13b. $N_3^- + H_3O^+$ ( ) $H_2O + HN_3$

13c. $N_3^- + H_2O$ ( ) $OH^- + HN_3$

Use the titration curve on the data sheet to answer Questions 14 – 18. Assume Na^+ is spectator ion.

14. (2 pts) In this titration, what is in the flask and what is in the buret? HX represents a strong acid and HA represents a weak acid.

In flask:	HX	HA	H_3O^+	OH^-
In buret:	HX	HA	H_3O^+	OH^-

15. (3 pts) What volume of titrating solution is added to get to the equivalence point? Report this number to the nearest 0.1 mL. Accuracy counts. Include units.

16. (3 pts) What is the pK_a of the acid involved? Report this number to the nearest 0.1. Be accurate!

17. (4 pts) How would you calculate the pH of the solution after the following volumes of titrating solution have been added? Choose from the choices at right.

_____ 0 mL

_____ 10 mL

_____ equiv pt

_____ 30 mL

A. Use Henderson-Hasselbach, and work in moles.
B. Use K_a and do a weak acid calculation.
C. Use K_a to find K_b and do a weak base calculation using V_{tot}
D. Determine moles of excess OH^- divide by V_{tot}, convert to pH
E. Use $M_aV_a = M_bV_b$

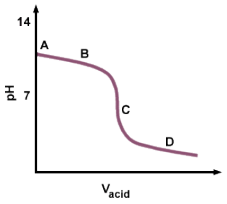
18. (9 pts) What is/are the major species* present in the flask after these amounts of titrating solution have been added? Note: Each part will have 1 – 3 correct answers. (*representing at least 10% of the concentration of the most concentrated species)

(a) 0 mL:	HA	HX	H_3O^+	OH^-	Na^+	A^-	X^-
(b) 10 mL:	HA	HX	H_3O^+	OH^-	Na^+	A^-	X^-
(c) 30 mL:	HA	HX	H_3O^+	OH^-	Na^+	A^-	X^-

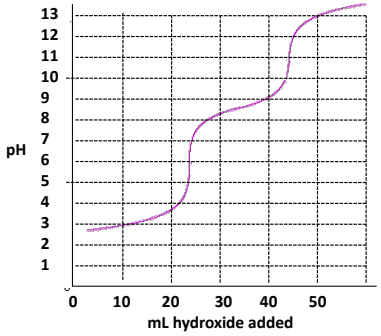
19. (2 pts) Consider this titration curve. The pH at Point B is 10.5. Which of these is true?

(a) $pK_a = 10.5$ (b) $pK_b = 10.5$

(c) $pK_b = 3.5$ (d) $pK_a = 7$



20a. (3 pts) Estimate the pK_a values for this acid. Write answers to the right of graph (± 0.1).



20b. (3 pts) What are the major weak acid and weak base species present in the flask after these amounts of titrating solution have been added?

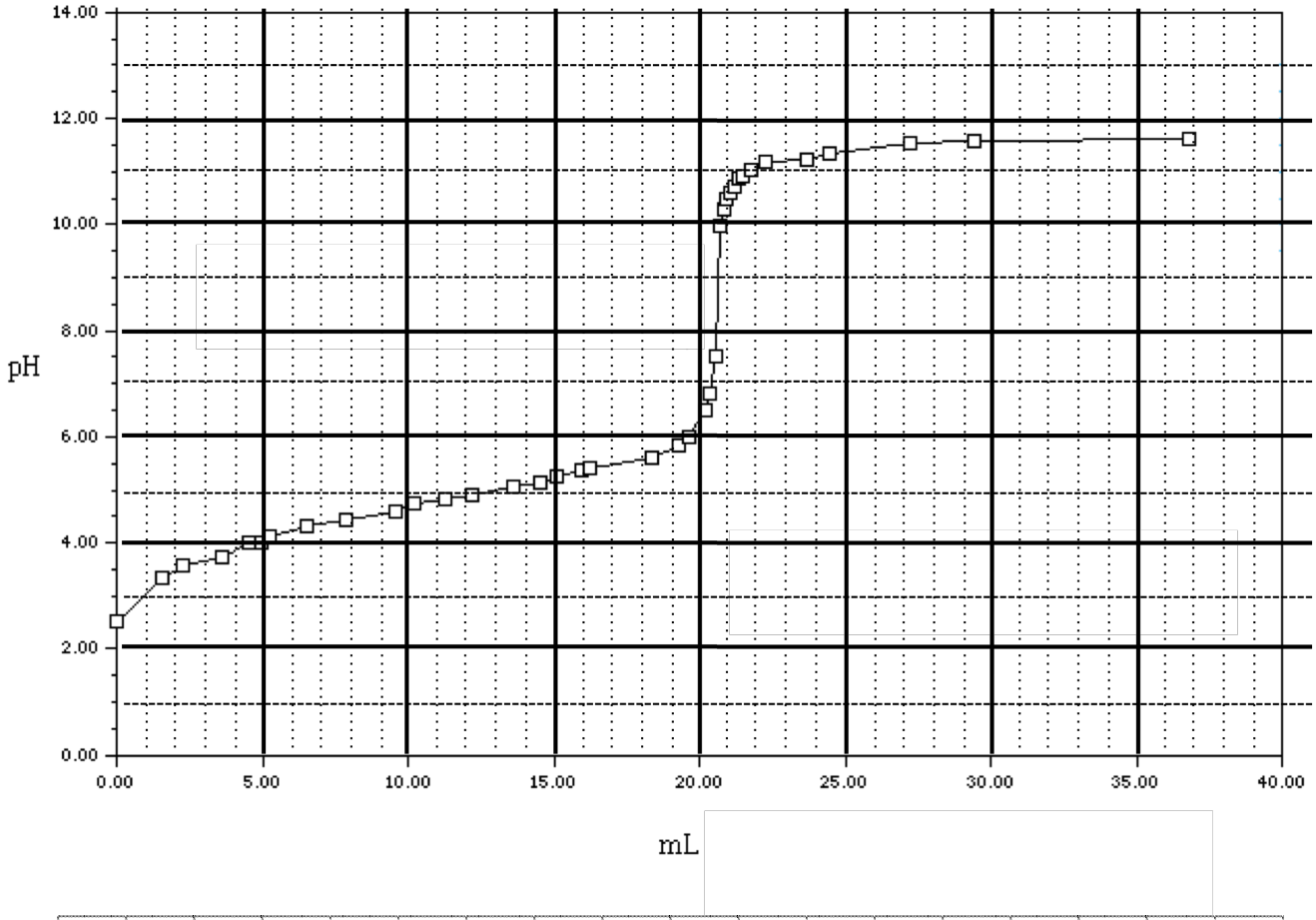
(a) 10 mL:	H_2A	HA^-	A^{-2}	
(b) 30 mL:	H_2A	HA^-	A^{-2}	
(c) 50 mL:	H_2A	HA^-	A^{-2}	

Subtotal from exam: _____

Folder work: (20 max) _____

Total: _____

Name:



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 Ti 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															

Answers:

1. 2.74

2. (a)

3. (a)

4. 11.13

5. 7.88

6. (d)

7. (a), (b), and (e)

8. 2.93

9. (a)

10. 3.13

11. 3.28

12.

(a) HNO_3	sa
(b) $NaNO_3$	n
(c) KNO_2	wb
(d) HNO_2	wa
(e) NaOH	sb
(f) NH_4NO_3	wa

13. a. $HN_3 + OH^- \rightleftharpoons H_2O + N_3^-$ $\quad K_n = 2.2 \times 10^{+9}$

13b. $N_3^- + H_3O^+ \rightleftharpoons H_2O + HN_3$ $\quad K_n = 4.5 \times 10^{+4}$

13c. $N_3^- + H_2O \rightleftharpoons OH^- + HN_3$ $\quad K_b = 4.5 \times 10^{-10}$

14. In flask: HA ; In buret: OH^-

15. 20.6 – 20.8 mL

16. 4.7 – 4.8

17. B, A, C (although one would also have to determine moles wb using n = MV), D

18. (a) 0 mL: HA
(b) 10 mL: HA Na^+ A^-
(c) 30 mL: OH^- Na^+ A^-

19. (a) and (c)

20a. pK_{a1} = 3.1 – 3.2 and pK_{a1} = 8.5 – 8.7.

20b.
(a) 10 mL: H_2A HA^-
(b) 30 mL: HA^- A^{-2}
(c) 50 mL: A^{-2}