Exam III General Chemistry II (CHEM 102) Form A 4/10/13 9:30 am MWF Dr. Hahn Exam # blue

Name _____ (print) Name _____ (sign)

Please show work for partial credit on the Long Answers and in some of the Short Answer Questions. Multiple choice questions have no partial credit. Please write anything you want graded legibly. If I cannot read your work, I obviously cannot grade it. (1 pts print and sign exam)

$pH + pOH = 14$ $pK_a + pK_b = 14$ $K_a \times K_b = 1.0 \times 10^{-14}$ $[H_3O^+][OH^-] = 1.0 \times 10^{-14} = k_W$ p(anything) = - log (anything) $pH = pK_a + \log \{ [base] / [acid] \}$ M = molarity = moles / liter

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (4 pts per question, 28 pts pts total)

1) Calculate the pOH in an aqueous solution with a pH of 9.85 at 25°C. (pH + pOH = 14) 1) _____

A) 4.00 B) 4.15 C) 5.15 D) 2.15 E) 3.15

$14 - 9.85 = 4.15$

2) Which of the following solutions is a good buffer system? 2) _____

A) A solution that is 0.10 M H Cl and 0.10 M NH_4^+

B) A solution that is 0.10 M Na OH and 0.10 M K OH

C) A solution that is 0.10 M H $C_2H_3O_2$ and 0.10 M Li $C_2H_3O_2$

D) A solution that is 0.10 M H F and 0.10 M Na $C_2H_3O_2$

E) None of the above are buffer systems.

3) Calculate the concentration of H_3O^+ in a solution that contains 5.5×10^{-5} M OH^- at 25°C. 3) _____

{$[H_3O^+][OH^-] = 1.0 \times 10^{-14}$}

A) 9.2×10^{-2} M

B) 1.2×10^{-1} M

C) 5.5×10^{-10} M

D) 1.8×10^{-10} M

E) 1.8×10^{-12} M

$[H_3O^+] = \frac{1.0 \times 10^{-14}}{5.5 \times 10^{-5}} = 1.8 \times 10^{-10}$

4) Identify the diprotic acid. 4) _____

A) $HClO_4$

B) CH_3COOH

C) HNO_3

D) H_2SO_4

E) HCl

5) Which of the following is NOT a conjugate acid-base pair? 5) _____

A) NH_4^+/NH_3

B) $C_2H_3O_2^-/HC_2H_3O_2$

C) H_2SO_3/HSO_3^-

D) H_3O^+/OH^-

E) All of the above are conjugate acid-base pairs.

6) Determine the K_a for $CH_3NH_3^+$ at 25°C. The K_b for CH_3NH_2 is 4.4×10^{-4}. {$K_a \times K_b = 1.0 \times 10^{-14}$} 6) _____

A) 3.1×10^{-10}
B) 5.6×10^{-10}
C) 6.8×10^{-11}
D) 2.3×10^{-11}
E) 2.3×10^{-3}

$K_a = \frac{1.0 \times 10^{-14}}{4.4 \times 10^{-4}} = 2.3 \times 10^{-11}$

7) What is the conjugate **acid** of HCO_3^- ? 7) _____

A) H_3O^+ B) OH^- C) H_2CO_3 D) CO_3^{2-} E) H_2O

Part II Short Answer: Write the word or phrase or circle the choice that best completes each statement or answers the question. (47 pts)

1. Circle the Strong Base among the following: (5 pts)

NH_3 (K OH) CO_3^{2-} ($Sr(OH)_2$) (NaOH)

2. Write the reaction equation for the acid / base reaction of the weak acid with water by filling in the products in the equation below. (3 pts each, 6 pts)

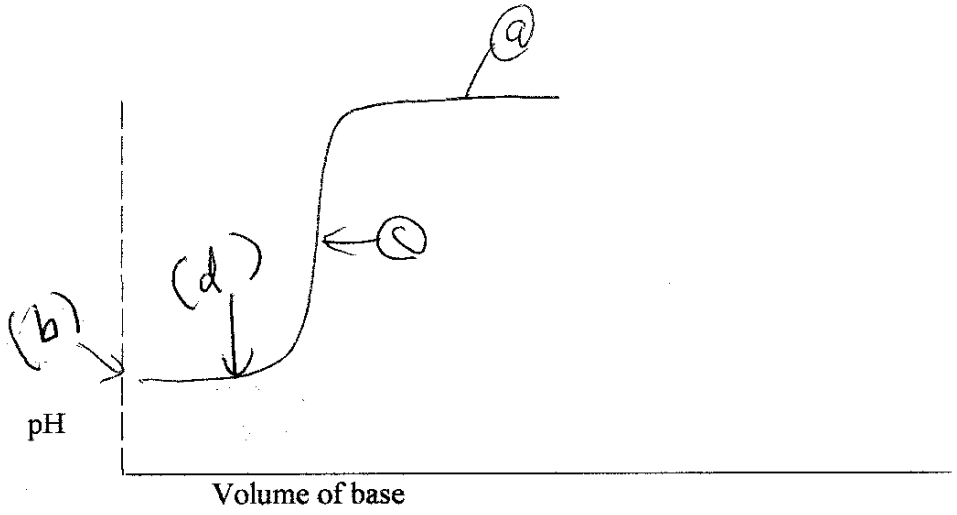
$HCN\ (aq) + H_2O\ (l) \rightarrow$ H_3O^+ + CN^-

3. What is the pH of a H Cl (strong acid) with a concentration of 0.350 M ? Please show work for partial credit & full credit. { pH = - log $[H^+]$ } (6 pts)

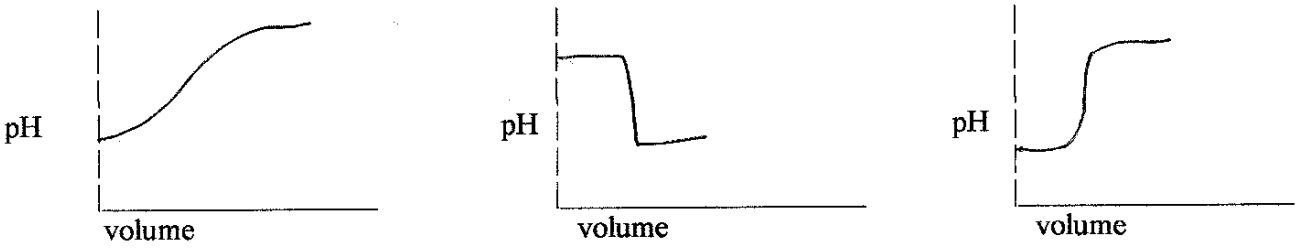
$[H^+] = [H_3O^+] =$ 0.350 pH = 0.46

$pH = -\log(0.350) = 0.456$

4. Match the titration curve for a strong acid being titrated by adding a strong base with the statements below. You may use the letters one time, no time or many times. (a) M = (# moles base - # moles acid) / total volume (b) $[H^+] = [H_3O^+] = [HA]$ (HA is a generic strong acid) (c) pH = 7 (d) M = (# moles acid - # moles base) / total volume (3 pts each, 6 pts)



5 Match the titration curves with the letters shown by circling the matching letter under all diagrams.
(a) a weak acid to which you add a strong base titration (b) strong base to which you add a strong acid
(c) strong acid to which you add a strong ~~acid~~ base (One letter matches one titration curve.) (2 pts each, 6 pts)



(a) or (b) or (c) (circle one)

(a) or (b) or (c) (circle one)

(a) or (b) or (c) (circle one)

6. For the reaction CaF_2 (s) → Ca^{+2} + 2 F^- give the expression for Ksp

Ksp = $[Ca^{+2}]$ $[F^-]^2$ (6 pts)

7 If the K_a of H $C_2H_3O_2$ is 1.8×10^{-5}, set up to find the $[H_3O^+]$ concentration at equilibrium. The initial concentration of H $C_2H_3O_2$ is 0.250 M. (**Do not** actually **calculate the final number for this problem**. Just set up the problem. There are too many problems on this exam to complete this problem.)

a. To do this, complete the ICE table below. x = $[H_3O^+]$ (9 pts, 1 pt per blank)

	[H $C_2H_3O_2$]	$[H_3O^+]$	$[C_2H_3O_2^-]$
Initial	0.250	0	0
Change	$-x$	$+x$	$+x$
Equilibrium	$0.250 - x$	x	x

b. Complete the Ka equilibrium expression by plugging in your results from your ICE table into the brackets below. **(Do not complete this question by solving for the x.** If you complete this problem by solving for x, you will get no more points and you may run out of time on another part of this exam.) (3 pts)

K_a = $\dfrac{[\ x\ ][\ x\ ]}{[\ 0.250 - x\ ]}$

Part III. Long Answer Please show work for full credit and to receive partial credit. (25 pts)

1. Calculate the pH of a buffer solution with a concentration of 0.15 M H CN and 0.30 M Na CN. pK_a of H CN is 9.31 Use the Henderson Hasselbalch: $pH = pK_a + \log \{ [base] / [acid] \}$ (10 pts)

$$pH = 9.31 + \log\left(\frac{0.30}{0.15}\right)$$

$$pH = 9.31 + 0.30 = 9.61$$

2. In a titration, if you add 50.0 mL of a strong base(KOH) with a concentration of 0.35 M to a 30.0 mL solution of a strong acid (HNO3) of concentration of 0.10 M, what is the [OH^-] ? (This is an after equivalence point problem.) (15 pts)

$$[OH^-] = \frac{\#\text{ moles base} - \#\text{ moles acid}}{\text{total volume}}$$

$$\#\text{ moles base} = 50.0\text{ ml} \times \frac{0.35\text{ mole}}{1000\text{ ml}} = 0.0175\text{ mol KOH}$$

$$\#\text{ moles acid} = 30.0\text{ ml} \times \frac{0.10\text{ mol}}{1000\text{ ml}} = 0.003\text{ mol } HNO_3$$

$$[OH^-] = \frac{0.0175\text{ mol KOH} - 0.003\text{ mol } HNO_3}{[(50.0\text{ ml} + 30.0\text{ ml}) \times \frac{1\text{ L}}{1000\text{ ml}}]}$$

$$[OH^-] = \frac{0.0145}{0.080\text{ L}} = 0.181\text{ M } OH^-$$

Exam III General Chemistry II (CHEM 102) Form B 4/10/13 9:30 am MWF Dr. Hahn Exam # _____

Name Key (print) Name _____ (sign)

Please show work for partial credit on the Long Answers and in some of the Short Answer Questions. Multiple choice questions have no partial credit. Please write anything you want graded legibly. If I cannot read your work, I obviously cannot grade it. (1 pts print and sign exam)

$pH + pOH = 14$ $pKa + pKb = 14$ $K_a \times K_b = 1.0 \times 10^{-14}$ $[H_3O^+][OH^-] = 1.0 \times 10^{-14} = k_w$ p(anything) = - log (anything) $pH = pK_a + \log \{ [base] / [acid] \}$ M = molarity = moles / liter

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (4 pts per question, 28 pts pts total)

1) Determine the K_a for $CH_3NH_3^+$ at 25°C. The K_b for CH_3NH_2 is 4.4×10^{-4}. {$K_a \times K_b = 1.0 \times 10^{-14}$} 1) _____

A) 5.6×10^{-10}
B) 6.8×10^{-11}
C) 2.3×10^{-11}
D) 3.1×10^{-10}
E) 2.3×10^{-3}

$K_a = \frac{1.0 \times 10^{-14}}{4.4 \times 10^{-4}} = 2.3 \times 10^{-11}$

2) Which of the following is NOT a conjugate acid-base pair? 2) _____

A) $C_2H_3O_2^-/HC_2H_3O_2$
B) H_2SO_3/HSO_3^-
C) NH_4^+/NH_3
D) H_3O^+/OH^-
E) All of the above are conjugate acid-base pairs.

3) What is the conjugate **acid** of HCO_3^- ? 3) _____

A) OH^- B) H_2CO_3 C) H_3O^+ D) H_2O E) CO_3^{2-}

4) Calculate the concentration of H_3O^+ in a solution that contains 5.5×10^{-5} M OH^- at 25°C. 4) _____

{$[H_3O^+][OH^-] = 1.0 \times 10^{-14}$}

A) 1.8×10^{-10} M
B) 9.2×10^{-1} M
C) 9.2×10^{-2} M
D) 1.8×10^{-12} M
E) 5.5×10^{-10} M

$[OH^-] = \frac{1.0 \times 10^{-14}}{5.5 \times 10^{-5}}$

$[OH^-] = 1.8 \times 10^{-10}$

5) Identify the diprotic acid. 5) _____

A) $HClO_4$

B) CH_3COOH

C) HNO_3

D) HCl

E) H_2SO_4

6) Which of the following solutions is a good buffer system? 6) _____

A) A solution that is 0.10 M H Cl and 0.10 M NH_4^+

B) A solution that is 0.10 M H F and 0.10 M Na $C_2H_3O_2$

C) A solution that is 0.10 M Na OH and 0.10 M K OH

D) A solution that is 0.10 M H $C_2H_3O_2$ and 0.10 M Li $C_2H_3O_2$

E) None of the above are buffer systems.

7) Calculate the pOH in an aqueous solution with a pH of 9.85 at 25°C. (pH + pOH = 14) 7) _____

A) 2.15 B) 4.00 C) 4.15 D) 3.15 E) 5.15

$pOH = 14 - 9,85 = 4,15$

Part II Short Answer: Write the word or phrase or circle the choice that best completes each statement or answers the question. (47 pts)

1. Circle the Weak Base among the following: (5 pts)

$Sr(OH)_2$ NaOH NH_3 K OH CO_3^{2-}

2. Write the reaction equation for the acid / base reaction of the weak acid with water by filling in the products in the equation below. (3 pts each, 6 pts)

$HF(aq) + H_2O(l) \rightarrow$ H_3O^+ + F^-

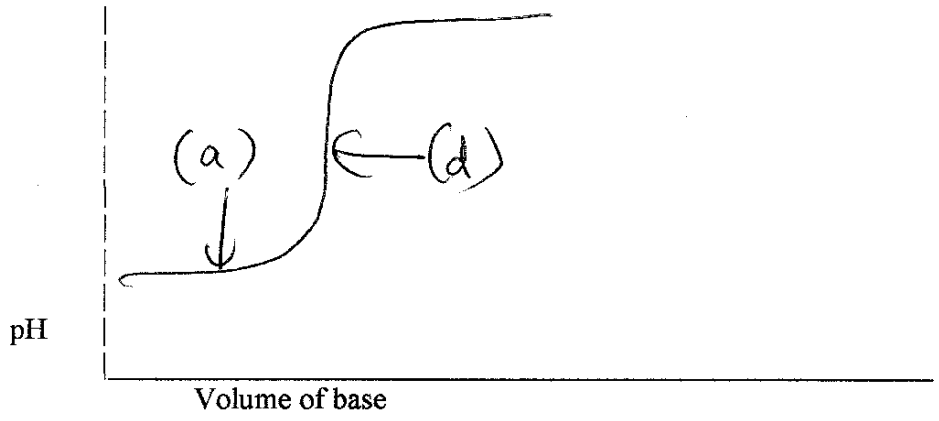
3. What is the pH of a HNO_3 (strong acid) with a concentration of 0.630 M ? Please show work for partial credit & full credit. { $pH = -\log [H^+]$ } (6 pts)

$[H^+] = [H_3O^+] =$ 0.630 M pH = 0.201

$pH = -\log(0.630)$

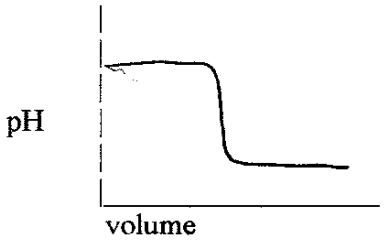
$pH = -(-0.201)$

4. Match the titration curve for a strong acid being titrated by adding a strong base with the statements below. You may use the letters one time, no time or many times. (a) M = (# moles acid - # moles base) / total volume (b) M = (# moles base - # moles acid) / total volume (c) $[H^+] = [H_3O^+] = [HA]$ (HA is a generic strong acid) (d) pH = 7 (3 pts each, 6 pts)

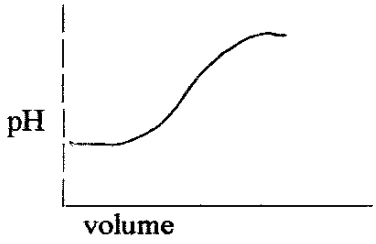


base

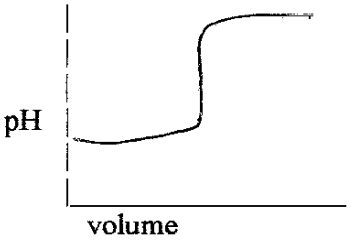
5 Match the titration curves with the letters shown by circling the matching letter under all diagrams.
(a) strong acid to which you add a strong ~~acid~~ (b) a weak acid to which you add a strong base titration
(c) strong base to which you add a strong acid (One letter matches one titration curve.) (2 pts each, 6 pts)



(a) or (b) or (c)
(circle one)



(a) or (b) or (c)
(circle one)



(a) or (b) or (c)
(circle one)

5. For the reaction $Al(OH)_3(s) \rightarrow Al^{+3} + 3\,OH^-$ give the expression for Ksp

Ksp = $[Al][OH^-]^3$ (6 pts)

7 What is the $[H_3O^+]$ at equilibrium of 3.5 M of H F dissolved in water ? The K_a of H F is 3.5×10^{-4}. (**Do not** actually **calculate the final number for this problem**. Just set up the problem. There are too many problems on this exam to complete this problem.)

a. To do this, complete the ICE table below. $x = [H_3O^+]$ (9 pts, 1 pt per blank)

	[HF]	$[H_3O^+]$	$[F^-]$
Initial	3.5	0	0
Change	$-x$	$+x$	$+x$
Equilibrium	$3.5 - x$	x	x

b. Complete the Ka equilibrium expression by plugging in your results from your ICE table into the brackets below. **(Do not complete this question by solving for the x**. If you complete this problem by solving for x, you will get no more points and you may run out of time on another part of this exam.) (3 pts)

$$K_a = \frac{[\,x\,][\,x\,]}{[\,3.5 - x\,]}$$

Part III. Long Answer Please show work for full credit and to receive partial credit. (25 pts)

1. Calculate the pH of a buffer solution with a concentration of 0.15 M CH_3COOH and 0.25 M $CH_3COO\,Na$. pK_a of CH_3COOH is 4.74. Use the Henderson Hasselbalch: $pH = pK_a + \log \{ [base] / [acid] \}$ (10 pts)

$$pH = 4.74 + \log\left(\frac{0.25}{0.15}\right)$$

$$pH = 4.74 + 0.22 = 4.96$$

2. In a titration, if you add 10.0 mL of a strong base (Li OH) with a concentration of 0.15 M to a 10.0 mL solution of a strong acid (HBr) of concentration of 0.50 M, what is the $[H_3O^+]$? (This is a before equivalence point problem.) (15 pts)

$$[H_3O^+] = \frac{\#\text{ moles acid} - \#\text{ moles base}}{\text{total volume}}$$

$$\text{moles acid} = 10.0\text{ ml HBr} \times \frac{0.50\text{ mol HBr}}{1000\text{ ml HBr soln}} = 5.00\times10^{-3}\text{ moles acid}$$

$$\text{moles base} = 10.0\text{ ml LiOH} \times \frac{0.15\text{ mole LiOH}}{1000\text{ ml LiOH soln}} = 1.50\times10^{-3}\text{ mol base}$$

$$[H_3O^+] = \frac{5.00\times10^{-3}\text{ mol} - 1.5\times10^{-3}\text{ mol}}{\left[(10.0+10.0\text{ ml}) \times \frac{1\text{ l}}{1000\text{ ml}}\right]}$$

$$[H_3O^+] = \frac{3.50\times10^{-3}\text{ mol}}{0.02\text{ l}} = 0.175\text{ m}$$

Exam III General Chemistry II (CHEM 102) Form A 4/10/13 11:30 am MWF Dr. Hahn Exam # green

Name Key (print) Name _____ (sign)

Please show work for partial credit on the Long Answers and in some of the Short Answer Questions. Multiple choice questions have no partial credit. Please write anything you want graded legibly. If I cannot read your work, I obviously cannot grade it. (1 pts print and sign exam)

$pH + pOH = 14$ $pKa + pKb = 14$ $K_a \times K_b = 1.0 \times 10^{-14}$ $[H_3O^+][OH^-] = 1.0 \times 10^{-14} = k_w$ p(anything) = - log (anything) $pH = pK_a + \log \{ [base] / [acid] \}$ M = molarity = moles / liter

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (4 pts per question, 28 pts pts total)

1) Which of the following solutions is a good buffer system? 1) _____

A) A solution that is 0.10 M H Cl and 0.10 M NH_4^+

B) A solution that is 0.10 M Na OH and 0.10 M K OH

C) A solution that is 0.10 M H F and 0.10 M Na $C_2H_3O_2$

(D) A solution that is 0.10 M H $C_2H_3O_2$ and 0.10 M Li $C_2H_3O_2$

E) None of the above are buffer systems.

pOH = 14 − 9.85

2) What is the conjugate base of $H_2PO_4^-$? 2) _____

A) H_3O^+ B) OH^- (C) HPO_4^{2-} D) PO_4^{3-} E) H_3PO_4

3) Calculate the pOH in an aqueous solution with a pH of 9.85 at 25°C. { pH + pOH = 14 } 3) _____

A) 4.00 (B) 4.15 C) 5.15 D) 3.15 E) 2.15

4) Determine the K_b for CN^- at 25°C. The K_a for HCN is 4.9×10^{-10}. $\{K_a \times K_b = 1.0 \times 10^{-14}\}$ 4) _____

A) 4.9×10^{-14}

B) 2.3×10^{-9}

C) 1.4×10^{-5}

D) 3.7×10^{-7}

(E) 2.0×10^{-5}

$K_b = \frac{1.0 \times 10^{-14}}{4.9 \times 10^{-10}} = 2.0 \times 10^{-5}$

5) Calculate the concentration of OH^- in a solution that contains 3.9×10^{-4} M H_3O^+ at 25°C. 5) _____

$\{[H_3O^+][OH^-] = 1.0 \times 10^{-14}\}$

A) 3.9×10^{-4} M

B) 2.7×10^{-3} M

(C) 2.6×10^{-11} M

D) 2.7×10^{-2} M

E) 2.6×10^{-12} M

$[OH^-] = \frac{1.0 \times 10^{-14}}{3.9 \times 10^{-4}} = 2.6 \times 10^{-11}$

6) Which of the following is NOT a conjugate acid-base pair? 6) _____

A) $C_2H_3O_2^-/HC_2H_3O_2$

B) NH_4^+/NH_3

C) H_3O^+/OH^-

D) H_2SO_3/HSO_3^-

E) All of the above are conjugate acid-base pairs.

7) Identify the triprotic acid. 7) _____

A) H_2SO_3 B) $HClO_4$ C) HNO_3 D) H_2SO_4 E) H_3PO_4

Part II Short Answer: Write the word or phrase or circle the choice that best completes each statement or answers the question. (47 pts)

1. Circle the ~~Strong~~ Weak Acid among the following: (5 pts)

HBr CH_3COOH H_2SO_4 HF ~~H_2SO_4~~ HNO_3

2. Write the reaction equation for the acid / base reaction of the weak acid with water by filling in the products in the equation below. (3 pts each, 6 pts)

$CH_3COOH\ (aq) + H_2O\ (l) \rightarrow$ H_3O^+ + CH_3COO^-

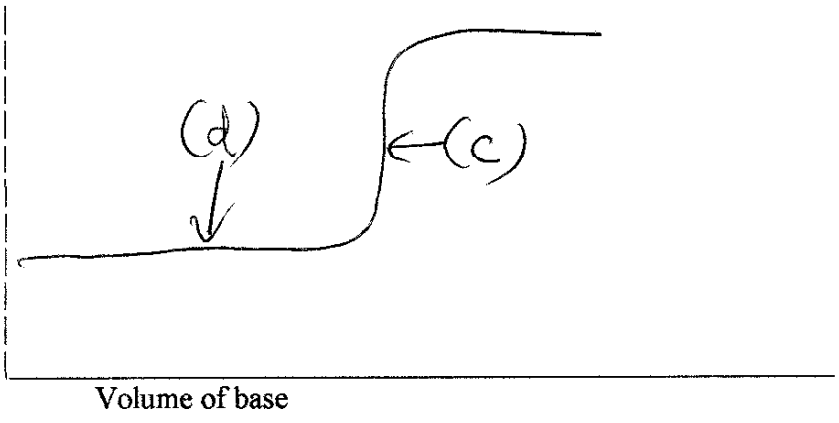
3. What is the pH of a H I solution (strong acid) with a concentration of 0.115 M ? Please show work for partial credit & full credit. { pH = - log $[H^+]$ } (6 pts)

$[H^+] = [H_3O^+] =$ 0.115 M pH = 0.94

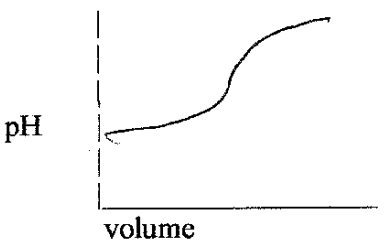
$pH = -\log(0.115) = -(-0.94)$

$pH = 0.94$

4. Match the titration curve for a strong acid being titrated by adding a strong base with the statements below. You may use the letters one time, no time or many times. (a) M = (# moles base - # moles acid) / total volume (b) $[H^+] = [H_3O^+] = [HA]$ (HA is a generic strong acid) (c) pH = 7 (d) M = (# moles acid - # moles base) / total volume (3 pts each, 6 pts)



5 Match the titration curves with the letters shown by circling the matching letter under all diagrams. (a) a weak acid to which you add a strong base titration (b) strong base to which you add a strong acid (c) strong acid to which you add a strong ~~acid~~ base (One letter matches one titration curve.) (2 pts each, 6 pts)



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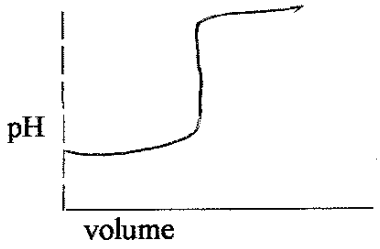
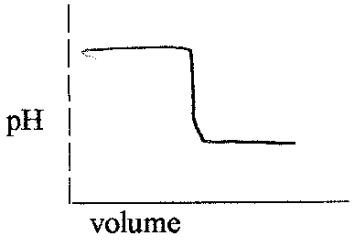
(circle one)



(a) or (b) or (c)
(circle one)



(a) or (b) or (c)
(circle one)

5. For the reaction PbI_2 (s) → Pb^{+2} + 2 I^- give the expression for Ksp

Ksp = $[Pb^{+2}]$ $[I^-]^2$ (6 pts)

7 What is the $[H_3O^+]$ at equilibrium of 0.155 M of CH_3COOH dissolved in water ? The K_a of CH_3COOH is 1.8×10^{-5}. (**Do not** actually **calculate the final number for this problem**. Just set up the problem. There are too many problems on this exam to complete this problem.)

a. To do this, complete the ICE table below. x = $[H_3O^+]$ (9 pts, 1 pt per blank)

	$[CH_3COOH]$	$[H_3O^+]$	$[CH_3COO^-]$
Initial	0.155	0	0
Change	$-x$	$+x$	$+x$
Equilibrium	$0.155 - x$	x	x

b. Complete the Ka equilibrium expression by plugging in your results from your ICE table into the brackets below. (**Do not complete this question by solving for the x**. If you complete this problem by solving for x, you will get no more points and you may run out of time on another part of this exam.) (3 pts)

$$K_a = \frac{[\ x\ ][\ x\ ]}{[\ 0.155 - x\ ]}$$

Part III. Long Answer Please show work for full credit and to receive partial credit. (25 pts)

1. Calculate the pH of a buffer solution with a concentration of 0.50 M H F and 0.25 M Na F. pKa of H F is 3.46 Use the Henderson Hasselbalch: $pH = pK_a + \log \{ [base] / [acid] \}$ (10 pts)

$$pH = 3.46 + \log\left(\frac{0.25}{0.50}\right) \qquad pH = 3.16$$

$$pH = 3.46 + (-0.30)$$

2. In a titration, if you add 20.0 mL of a strong base(K OH) with a concentration of 0.20 M to a 50 mL solution of a strong acid (HNO3) of concentration of 0.45 M, what is the $[H_3O^+]$? (This is a before equivalence point problem.) (15 pts)

$$[H_3O^+] = \frac{\#\text{ moles acid} - \#\text{ moles base}}{\text{total volume}}$$

$$\#\text{ moles acid } HNO_3 = 50.0\text{ ml } HNO_3\text{ soln} \times \frac{0.45\text{ mol } HNO_3}{1000\text{ ml } HNO_3\text{ soln}} = 0.0225\text{ mol } HNO_3$$

$$\#\text{ moles base} = 20.0\text{ ml KOH soln} \times \frac{0.20\text{ mol KOH}}{1000\text{ ml KOH soln}} = 4.0 \times 10^{-3}\text{ mol KOH}$$

$$\text{total volume} = 20.0\text{ ml} + 50.0\text{ ml} = 70.0\text{ ml}$$

$$[H_3O^+] = \frac{0.0225\text{ mol } HNO_3 - 4.0 \times 10^{-3}\text{ mol KOH}}{\left[70.0\text{ ml} \times \frac{1\text{ l}}{1000\text{ ml}}\right]} = \frac{0.0185}{0.0700\text{ l}} = 0.264\text{ M}$$

Exam III General Chemistry II (CHEM 102) Form B 4/10/13 11:30 am MWF Dr. Hahn Exam # _____

Name Key (print) Name _____ (sign)

Please show work for partial credit on the Long Answers and in some of the Short Answer Questions. Multiple choice questions have no partial credit. Please write anything you want graded legibly. If I cannot read your work, I obviously cannot grade it. (1 pts print and sign exam)

$pH + pOH = 14$ $pKa + pKb = 14$ $K_a \times K_b = 1.0 \times 10^{-14}$ $[H_3O^+][OH^-] = 1.0 \times 10^{-14} = k_w$ p(anything) = - log (anything) $pH = pK_a + \log \{ [base] / [acid] \}$ M = molarity = moles / liter

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (4 pts per question, 28 pts pts total)

1) Calculate the concentration of OH^- in a solution that contains 3.9×10^{-4} M H_3O^+ at 25°C. 1) _____

$\{[H_3O^+][OH^-] = 1.0 \times 10^{-14}\}$

A) 3.9×10^{-4} M
B) 2.7×10^{-2} M
C) 2.6×10^{-12} M
D) 2.7×10^{-3} M
E) 2.6×10^{-11} M

$[OH] = \frac{1.0 \times 10^{-14}}{3.9 \times 10^{-4}} = 2.6 \times 10^{-4}$

2) Determine the K_b for CN^- at 25°C. The K_a for HCN is 4.9×10^{-10}. $\{K_a \times K_b = 1.0 \times 10^{-14}\}$ 2) _____

A) 2.0×10^{-5}
B) 1.4×10^{-5}
C) 2.3×10^{-9}
D) 4.9×10^{-14}
E) 3.7×10^{-7}

$K_b = \frac{1.0 \times 10^{-14}}{4.9 \times 10^{-10}} = 2.04 \times 10^{-5}$

3) Which of the following solutions is a good buffer system? 3) _____

A) A solution that is 0.10 M Na OH and 0.10 M K OH
B) A solution that is 0.10 M H Cl and 0.10 M NH_4^+
C) A solution that is 0.10 M H F and 0.10 M Na $C_2H_3O_2$
D) A solution that is 0.10 M H $C_2H_3O_2$ and 0.10 M Li $C_2H_3O_2$
E) None of the above are buffer systems.

4) Calculate the pOH in an aqueous solution with a pH of 9.85 at 25°C. $\{pH + pOH = 14\}$ 4) _____

A) 2.15 B) 4.15 C) 4.00 D) 5.15 E) 3.15

$pOH = 14 - 9.85 = 4.15$

5) Which of the following is NOT a conjugate acid–base pair? 5) _____

A) NH_4^+/NH_3

B) H_3O^+/OH^-

C) $C_2H_3O_2^-/HC_2H_3O_2$

D) H_2SO_3/HSO_3^-

E) All of the above are conjugate acid–base pairs.

6) What is the conjugate base of $H_2PO_4^-$? 6) _____

A) H_3O^+ B) H_3PO_4 C) HPO_4^{2-} D) PO_4^{3-} E) OH^-

7) Identify the triprotic acid. 7) _____

A) $HClO_4$ B) H_3PO_4 C) H_2SO_4 D) H_2SO_3 E) HNO_3

Part II Short Answer: Write the word or phrase or circle the choice that best completes each statement or answers the question. (47 pts)

1. Circle the Strong ~~Weak~~ Acid among the following: (5 pts)

HBr CH_3COOH H_2SO_4 HF ~~H_2SO_4~~ HNO_3

2. Write the reaction equation for the acid / base reaction of the weak acid with water by filling in the products in the equation below. (3 pts each, 6 pts)

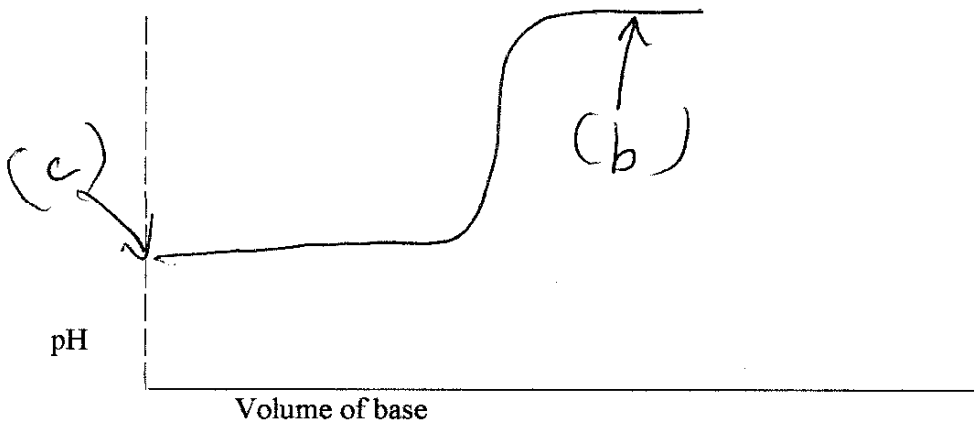
H CN (aq) + H_2O (l) → H_3O^+ + CN^-

3. What is the pH of a HBr (strong acid) solution with a concentration of 0.095 M ? Please show work for partial credit & full credit. { pH = - log $[H^+]$ } (6 pts)

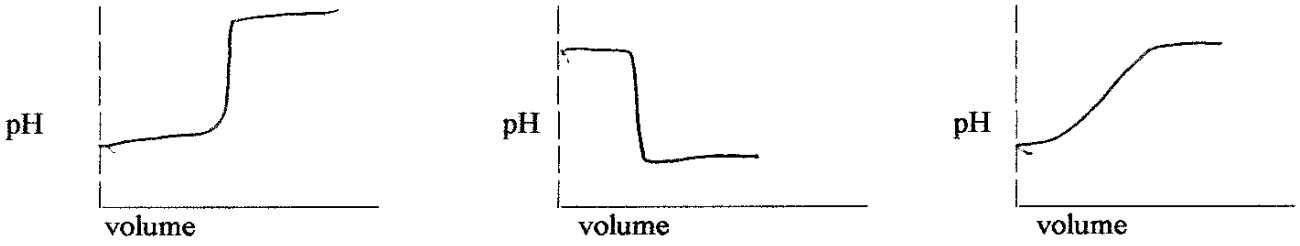
$[H^+] = [H_3O^+]$ = 0,095 M pH = 1,02

$pH = -\log(0.095) = -(-1,02) = 1,02$

4. Match the titration curve for a strong acid being titrated by adding a strong base with the statements below. You may use the letters one time, no time or many times. (a) pH = 7 (b) M = (# moles base - # moles acid) / total volume (c) $[H^+] = [H_3O^+] = [HA]$ (HA is a generic strong acid) (d) M = (# moles acid - # moles base) / total volume (3 pts each, 6 pts)



5 Match the titration curves with the letters shown by circling the matching letter under all diagrams. (a) strong base to which you add a strong acid (b) a weak acid to which you add a strong base titration (c) strong acid to which you add a strong ~~acid~~ base (One letter matches one titration curve.) (2 pts each, 6 pts)



(a) or (b) or (c) (circle one)

(a) or (b) or (c) (circle one)

(a) or (b) or (c) (circle one)

5. For the reaction Ag_2SO_4 (s) → 2 Ag^+ + SO_4^{-2} give the expression for Ksp

Ksp = $\frac{[Ag^+]^2}{}$ $\frac{[SO_4^{-2}]}{}$ (6 pts)

7 If the K_a of H CN is 4.9×10^{-10}, find the $[H_3O^+]$ at equilibrium if the initial concentration of H CN is 5.55 M. (**Do not** actually **calculate the final number for this problem**. Just set up the problem. There are too many problems on this exam to complete this problem.)

a. To do this, complete the ICE table below. $x = [H_3O^+]$ (9 pts, 1 pt per blank)

	[HCN]	$[H_3O^+]$	$[CN^-]$
Initial	5.55	0	0
Change	$-x$	$+x$	$+x$
Equilibrium	$5.55-x$	x	x

b. Complete the Ka equilibrium expression by plugging in your results from your ICE table into the brackets below. **(Do not complete this question by solving for the x**. If you complete this problem by solving for x, you will get no more points and you may run out of time on another part of this exam.) (3 pts)

K_a = $\frac{[\ x\ ][\ x\ ]}{[\ 5.55-x\ ]}$

Part III. Long Answer Please show work for full credit and to receive partial credit. (25 pts)

1. Calculate the pH of a buffer solution with a concentration of 0.25 M $HC_2H_3O_2$ and 0.50 M $NaC_2H_3O_2$. pK_a of $HC_2H_3O_2$ is 4.74 Use the Henderson Hasselbalch: $pH = pK_a + \log \{ [base] / [acid] \}$ (10 pts)

$$pH = 4.74 + \log \frac{[NaC_2H_3O_2]}{[HC_2H_3O_2]}$$

$$pH = 4.74 + \log\left(\frac{0.50}{0.25}\right) = 4.74 + (0.30) = 5.04$$

2. In a titration, if you add 35.5 mL of a strong base(Li OH) with a concentration of 0.25 M to a 25.0 mL solution of a strong acid (HCl) of concentration of 0.20 M, what is the $[OH^-]$? (This is an after equivalence point problem.) (15 pts)

$$[OH^-] = \frac{\#\text{moles base} - \#\text{moles acid}}{\text{total volume}}$$

$$\#\text{moles base (LiOH)} = 35.5\text{ml LiOH} \times \frac{0.25\text{ mol LiOH}}{1000\text{ml LiOH soln}} = 8.88\times10^{-3}$$

$$\#\text{moles acid (HCl)} = 25.0\text{ml HCl} \times \frac{0.20\text{ mol HCl}}{1000\text{ml HCl soln}} = 5.00\times10^{-3}$$

$$[OH^-] = \frac{8.88\times10^{-3} - 5.00\times10^{-3}}{(35.5 + 25.0\text{ml}) \times \frac{1\text{ l}}{1000\text{ml}}} =$$

$$[OH^-] = \frac{3.88\times10^{-3}}{0.0605\text{ l}} = 0.0641\text{ M}$$

Exam III General Chemistry II (CHEM 102) Form A 4/10/13 9:30 am MWF Dr. Hahn Exam # 4-1

Name _____ (print) Name _____(sign)

Please show work for partial credit on the Long Answers and in some of the Short Answer Questions. Multiple choice questions have no partial credit. Please write anything you want graded legibly. If I cannot read your work, I obviously cannot grade it. (1 pts print and sign exam)

$pH + pOH = 14$ $pKa + pKb = 14$ $K_a \times K_b = 1.0 \times 10^{-14}$ $[H_3O^+][OH^-] = 1.0 \times 10^{-14} = k_W$ p(anything) = - log (anything) $pH = pK_a + \log \{ [base] / [acid] \}$ M = molarity = moles / liter

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (4 pts per question, 28 pts pts total)

1) Calculate the pOH in an aqueous solution with a pH of 9.85 at 25°C. (pH + pOH = 14) 1) _____
A) 4.00 B) 4.15 C) 5.15 D) 2.15 E) 3.15

2) Which of the following solutions is a good buffer system? 2) _____
A) A solution that is 0.10 M H Cl and 0.10 M NH_4^+
B) A solution that is 0.10 M Na OH and 0.10 M K OH
C) A solution that is 0.10 M H $C_2H_3O_2$ and 0.10 M Li $C_2H_3O_2$
D) A solution that is 0.10 M H F and 0.10 M Na $C_2H_3O_2$
E) None of the above are buffer systems.

3) Calculate the concentration of H_3O^+ in a solution that contains 5.5×10^{-5} M OH^- at 25°C. 3) _____
$\{[H_3O^+][OH^-] = 1.0 \times 10^{-14}\}$
A) 9.2×10^{-2} M
B) 9.2×10^{-1} M
C) 5.5×10^{-10} M
D) 1.8×10^{-10} M
E) 1.8×10^{-12} M

4) Identify the diprotic acid. 4) _____
A) $HClO_4$
B) CH_3COOH
C) HNO_3
D) H_2SO_4
E) HCl

5) Which of the following is NOT a conjugate acid-base pair? 5) _____
A) NH_4^+/NH_3
B) $C_2H_3O_2^-/HC_2H_3O_2$
C) H_2SO_3/HSO_3^-
D) H_3O^+/OH^-
E) All of the above are conjugate acid-base pairs.

6) Determine the K_a for $CH_3NH_3^+$ at 25°C. The K_b for CH_3NH_2 is 4.4×10^{-4}. {$K_a \times K_b = 1.0 \times 10^{-14}$} 6) _____

A) 3.1×10^{-10}
B) 5.6×10^{-10}
C) 6.8×10^{-11}
D) 2.3×10^{-11}
E) 2.3×10^{-3}

7) What is the conjugate **acid** of HCO_3^- ? 7) _____

A) H_3O^+ B) OH^- C) H_2CO_3 D) CO_3^{2-} E) H_2O

Part II Short Answer: Write the word or phrase or circle the choice that best completes each statement or answers the question. (47 pts)

1. Circle the Strong Base among the following: (5 pts)

NH_3 K OH CO_3^{2-} $Sr(OH)_2$ NaOH

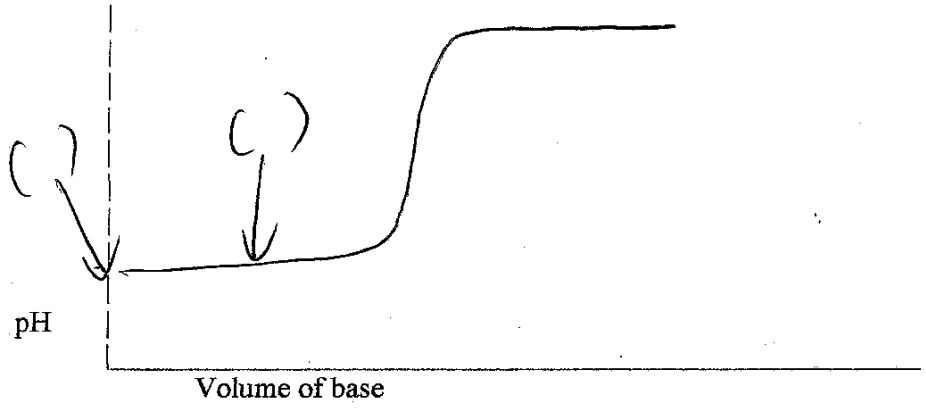
2. Write the reaction equation for the acid / base reaction of the weak acid with water by filling in the products in the equation below. (3 pts each, 6 pts)

H CN (aq) + H_2O (l) → _____ + _____

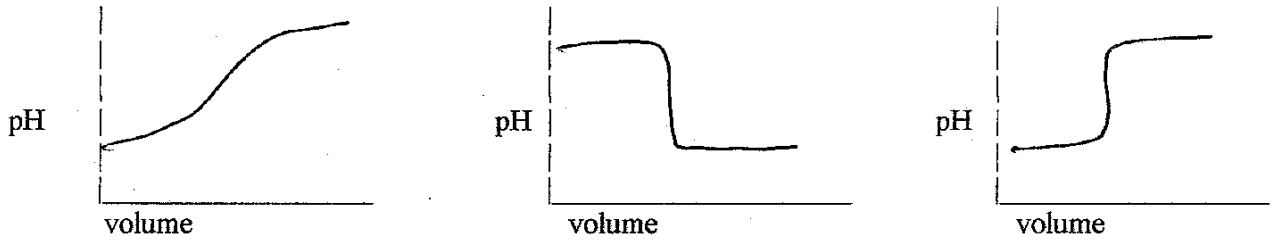
3. What is the pH of a H Cl (strong acid) with a concentration of 0.350 M ? Please show work for partial credit & full credit. { pH = - log $[H^+]$ } (6 pts)

$[H^+] = [H_3O^+]$ = _____ pH = _____

4. Match the titration curve for a strong acid being titrated by adding a strong base with the statements below. You may use the letters one time, no time or many times. (a) M = (# moles base - # moles acid) / total volume (b) $[H^+] = [H_3O^+] = [HA]$ (HA is a generic strong acid) (c) pH = 7 (d) M = (# moles acid - # moles base) / total volume (3 pts each, 6 pts)



5 Match the titration curves with the letters shown by circling the matching letter under all diagrams. (a) a weak acid to which you add a strong base titration (b) strong base to which you add a strong acid (c) strong acid to which you add a strong ~~acid~~ base (One letter matches one titration curve.) (2 pts each, 6 pts)



(a) or (b) or (c) (circle one)

(a) or (b) or (c) (circle one)

(a) or (b) or (c) (circle one)

6. For the reaction CaF_2 (s) → Ca^{+2} + 2 F^- give the expression for Ksp

Ksp = _____ _____ (6 pts)

7 If the K_a of H $C_2H_3O_2$ is 1.8×10^{-5}, set up to find the $[H_3O^+]$ concentration at equilibrium. The initial concentration of H $C_2H_3O_2$ is 0.250 M. (**Do not** actually **calculate the final number for this problem**. Just set up the problem. There are too many problems on this exam to complete this problem.)

a. To do this, complete the ICE table below. $x = [H_3O^+]$ (9 pts, 1 pt per blank)

	$[H\ C_2H_3O_2]$	$[H_3O^+]$	$[C_2H_3O_2^-]$
Initial			
Change			
Equilibrium			

b. Complete the Ka equilibrium expression by plugging in your results from your ICE table into the brackets below. **(Do not complete this question by solving for the x.** If you complete this problem by solving for x, you will get no more points and you may run out of time on another part of this exam.) (3 pts)

K_a = [ ][ ]

[ ]

Part III. Long Answer Please show work for full credit and to receive partial credit. (25 pts)

1. Calculate the pH of a buffer solution with a concentration of 0.15 M H CN and 0.30 M Na CN. pK_a of H CN is 9.31 Use the Henderson Hasselbalch: $pH = pK_a + \log \{ [base] / [acid] \}$ (10 pts)

2. In a titration, if you add 50.0 mL of a strong base(KOH) with a concentration of 0.35 M to a 30.0 mL solution of a strong acid (HNO3) of concentration of 0.10 M, what is the [OH^-] ? (This is an after equivalence point problem.) (15 pts)

Exam III General Chemistry II (CHEM 102) Form B 4/10/13 9:30 am MWF Dr. Hahn Exam # _____

Name_____ (print) Name _____(sign)

Please show work for partial credit on the Long Answers and in some of the Short Answer Questions. Multiple choice questions have no partial credit. Please write anything you want graded legibly. If I cannot read your work, I obviously cannot grade it. (1 pts print and sign exam)

$pH + pOH = 14$ $pKa + pKb = 14$ $K_a \times K_b = 1.0 \times 10^{-14}$ $[H_3O^+][OH^-] = 1.0 \times 10^{-14} = k_W$ p(anything) = - log (anything) $pH = pK_a + \log \{ [base] / [acid] \}$ M = molarity = moles / liter

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (4 pts per question, 28 pts pts total)

1) Determine the K_a for $CH_3NH_3^+$ at 25°C. The K_b for CH_3NH_2 is 4.4×10^{-4}. $\{K_a \times K_b = 1.0 \times 10^{-14}\}$ 1) _____

A) 5.6×10^{-10}
B) 6.8×10^{-11}
C) 2.3×10^{-11}
D) 3.1×10^{-10}
E) 2.3×10^{-3}

2) Which of the following is NOT a conjugate acid-base pair? 2) _____

A) $C_2H_3O_2^-/HC_2H_3O_2$
B) H_2SO_3/HSO_3^-
C) NH_4^+/NH_3
D) H_3O^+/OH^-
E) All of the above are conjugate acid-base pairs.

3) What is the conjugate **acid** of HCO_3^- ? 3) _____

A) OH^- B) H_2CO_3 C) H_3O^+ D) H_2O E) CO_3^{2-}

4) Calculate the concentration of H_3O^+ in a solution that contains 5.5×10^{-5} M OH^- at 25°C. 4) _____

$\{[H_3O^+][OH^-] = 1.0 \times 10^{-14}\}$

A) 1.8×10^{-10} M
B) 9.2×10^{-1} M
C) 9.2×10^{-2} M
D) 1.8×10^{-12} M
E) 5.5×10^{-10} M

5) Identify the diprotic acid. 5) _____

A) $HClO_4$

B) CH_3COOH

C) HNO_3

D) HCl

E) H_2SO_4

6) Which of the following solutions is a good buffer system? 6) _____

A) A solution that is 0.10 M H Cl and 0.10 M NH_4^+

B) A solution that is 0.10 M H F and 0.10 M Na $C_2H_3O_2$

C) A solution that is 0.10 M Na OH and 0.10 M K OH

D) A solution that is 0.10 M H $C_2H_3O_2$ and 0.10 M Li $C_2H_3O_2$

E) None of the above are buffer systems.

7) Calculate the pOH in an aqueous solution with a pH of 9.85 at 25°C. (pH + pOH = 14) 7) _____

A) 2.15 B) 4.00 C) 4.15 D) 3.15 E) 5.15

Part II Short Answer: Write the word or phrase or circle the choice that best completes each statement or answers the question. (47 pts)

1. Circle the Weak Base among the following: (5 pts)

$Sr(OH)_2$ NaOH NH_3 K OH $CO_3^{\,2}$

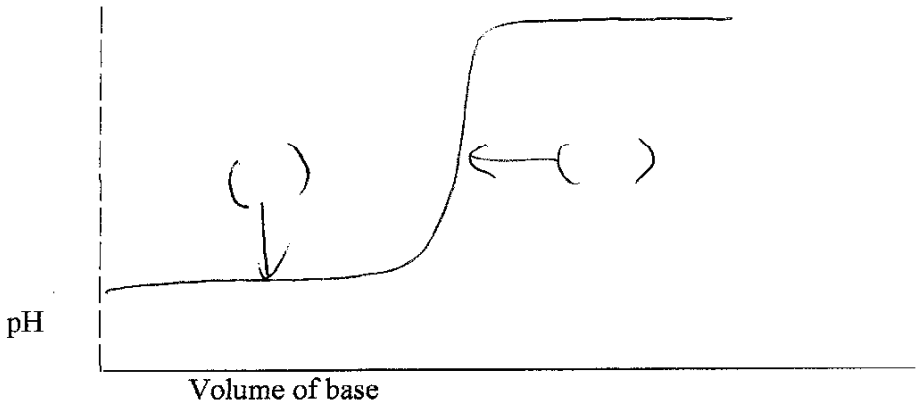
2. Write the reaction equation for the acid / base reaction of the weak acid with water by filling in the products in the equation below. (3 pts each, 6 pts)

H F (aq) + H_2O (l) → _____ + _____

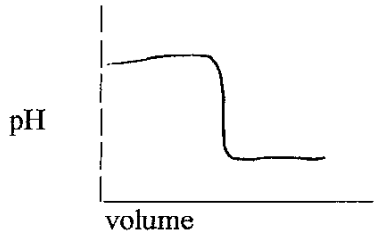
3. What is the pH of a HNO_3 (strong acid) with a concentration of 0.630 M ? Please show work for partial credit & full credit. { pH = - log $[H^+]$ } (6 pts)

$[H^+] = [H_3O^+]$ = _____ pH = _____

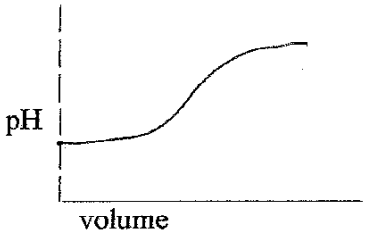
4. Match the titration curve for a strong acid being titrated by adding a strong base with the statements below. You may use the letters one time, no time or many times. (a) M = (# moles acid - # moles base) / total volume (b) M = (# moles base - # moles acid) / total volume (c) $[H^+] = [H_3O^+] = [HA]$ (HA is a generic strong acid) (d) pH = 7 (3 pts each, 6 pts)



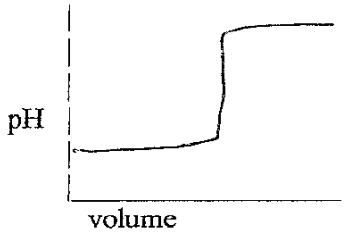
5 Match the titration curves with the letters shown by circling the matching letter under all diagrams. base
(a) strong acid to which you add a strong ~~acid~~ (b) a weak acid to which you add a strong base titration
(c) strong base to which you add a strong acid (One letter matches one titration curve.) (2 pts each, 6 pts)



(a) or (b) or (c)
(circle one)



(a) or (b) or (c)
(circle one)



(a) or (b) or (c)
(circle one)

5. For the reaction $Al(OH)_3(s) \rightarrow Al^{+3} + 3\ OH^-$ give the expression for Ksp

Ksp = _____ _____ (6 pts)

7 What is the $[H_3O^+]$ at equilibrium of 3.5 M of H F dissolved in water ? The K_a of H F is 3.5×10^{-4}. (**Do not** actually **calculate the final number for this problem**. Just set up the problem. There are too many problems on this exam to complete this problem.)

a. To do this, complete the ICE table below. $x = [H_3O^+]$ (9 pts, 1 pt per blank)

	[HF]	$[H_3O^+]$	$[F^-]$
Initial			
Change			
Equilibrium			

b. Complete the Ka equilibrium expression by plugging in your results from your ICE table into the brackets below. (**Do not complete this question by solving for the x**. If you complete this problem by solving for x, you will get no more points and you may run out of time on another part of this exam.) (3 pts)

$K_a =$ [ ][ ]

[ ]

Part III. Long Answer Please show work for full credit and to receive partial credit. (25 pts)

1. Calculate the pH of a buffer solution with a concentration of 0.15 M CH_3COOH and 0.25 M CH_3COO Na. pK_a of CH_3COOH is 4.74. Use the Henderson Hasselbalch: $pH = pK_a + \log \{ [base] / [acid] \}$ (10 pts)

2. In a titration, if you add 10.0 mL of a strong base (Li OH) with a concentration of 0.15 M to a 10.0 mL solution of a strong acid (HBr) of concentration of 0.50 M, what is the $[H_3O^+]$? (This is a before equivalence point problem.) (15 pts)

Exam III General Chemistry II (CHEM 102) Form A 4/10/13 11:30 am MWF Dr. Hahn Exam # 4-5

Name_____ (print) Name _____(sign)

Please show work for partial credit on the Long Answers and in some of the Short Answer Questions. Multiple choice questions have no partial credit. Please write anything you want graded legibly. . If I cannot read your work, I obviously cannot grade it. (1 pts print and sign exam)

$pH + pOH = 14$ $pKa + pKb = 14$ $K_a \times K_b = 1.0 \times 10^{-14}$ $[H_3O^+][OH^-] = 1.0 \times 10^{-14} = k_W$ p(anything) = - log (anything) $pH = pK_a + \log \{ [base] / [acid] \}$ M = molarity = moles / liter

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (4 pts per question, 28 pts pts total)

1) Which of the following solutions is a good buffer system? 1) _____

A) A solution that is 0.10 M H Cl and 0.10 M NH_4^+
B) A solution that is 0.10 M Na OH and 0.10 M K OH
C) A solution that is 0.10 M H F and 0.10 M Na $C_2H_3O_2$
D) A solution that is 0.10 M H $C_2H_3O_2$ and 0.10 M Li $C_2H_3O_2$
E) None of the above are buffer systems.

2) What is the conjugate base of $H_2PO_4^-$? 2) _____

A) H_3O^+ B) OH^- C) HPO_4^{2-} D) PO_4^{3-} E) H_3PO_4

3) Calculate the pOH in an aqueous solution with a pH of 9.85 at 25°C. { $pH + pOH = 14$ } 3) _____

A) 4.00 B) 4.15 C) 5.15 D) 3.15 E) 2.15

4) Determine the K_b for CN^- at 25°C. The K_a for HCN is 4.9×10^{-10}. { $K_a \times K_b = 1.0 \times 10^{-14}$} 4) _____

A) 4.9×10^{-14}
B) 2.3×10^{-9}
C) 1.4×10^{-5}
D) 3.7×10^{-7}
E) 2.0×10^{-5}

5) Calculate the concentration of OH^- in a solution that contains 3.9×10^{-4} M H_3O^+ at 25°C. 5) _____

{ $[H_3O^+][OH^-] = 1.0 \times 10^{-14}$ }

A) 3.9×10^{-4} M
B) 2.7×10^{-3} M
C) 2.6×10^{-11} M
D) 2.7×10^{-2} M
E) 2.6×10^{-12} M

6) Which of the following is NOT a conjugate acid–base pair? 6) _____

A) $C_2H_3O_2^-/HC_2H_3O_2$

B) NH_4^+/NH_3

C) H_3O^+/OH^-

D) H_2SO_3/HSO_3^-

E) All of the above are conjugate acid–base pairs.

7) Identify the triprotic acid. 7) _____

A) H_2SO_3 B) $HClO_4$ C) HNO_3 D) H_2SO_4 E) H_3PO_4

Part II Short Answer: Write the word or phrase or circle the choice that best completes each statement or answers the question. (47 pts)

1. Circle the Weak Acid among the following: (5 pts)

HBr CH_3COOH H_2SO_4 HF HNO_3

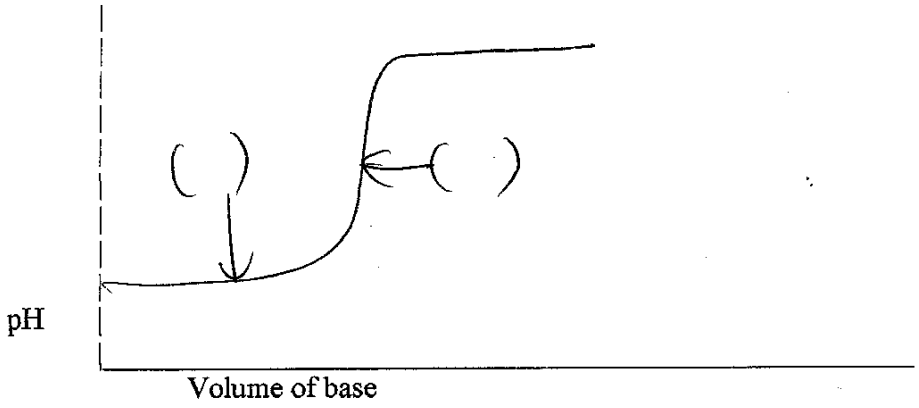
2. Write the reaction equation for the acid / base reaction of the weak acid with water by filling in the products in the equation below. (3 pts each, 6 pts)

$CH_3COOH\ (aq) + H_2O\ (l) \rightarrow$ _____ + _____

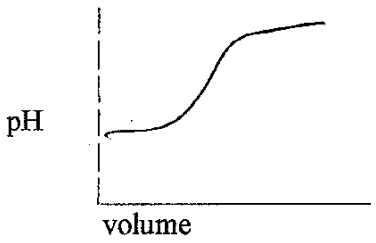
3. What is the pH of a H I solution (strong acid) with a concentration of 0.115 M ? Please show work for partial credit & full credit. { $pH = -\log [H^+]$ } (6 pts)

$[H^+] = [H_3O^+] =$ _____ pH = _____

4. Match the titration curve for a strong acid being titrated by adding a strong base with the statements below. You may use the letters one time, no time or many times. (a) M = (# moles base - # moles acid) / total volume (b) $[H^+] = [H_3O^+] = [HA]$ (HA is a generic strong acid) (c) pH = 7 (d) M = (# moles acid - # moles base) / total volume (3 pts each, 6 pts)



5 Match the titration curves with the letters shown by circling the matching letter under all diagrams. (a) a weak acid to which you add a strong base titration (b) strong base to which you add a strong acid (c) strong acid to which you add a strong ~~acid~~ base (One letter matches one titration curve.) (2 pts each, 6 pts)



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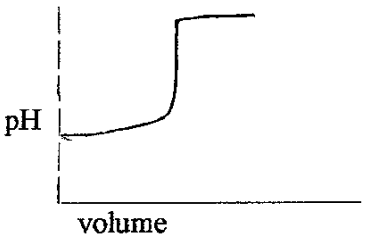

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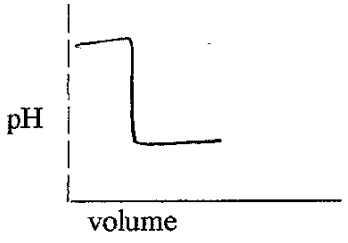


(a) or (b) or (c)
(circle one)

5. For the reaction $PbI_2\ (s) \rightarrow Pb^{+2} + 2\,I^-$ give the expression for Ksp

Ksp = _____ _____ (6 pts)

7 What is the $[H_3O^+]$ at equilibrium of 0.155 M of CH_3COOH dissolved in water ? The K_a of CH_3COOH is 1.8×10^{-5}. (**Do not** actually **calculate the final number for this problem**. Just set up the problem. There are too many problems on this exam to complete this problem.)

a. To do this, complete the ICE table below. $x = [H_3O^+]$ (9 pts, 1 pt per blank)

	$[CH_3COOH]$	$[H_3O^+]$	$[CH_3COO^-]$
Initial			
Change			
Equilibrium			

b. Complete the Ka equilibrium expression by plugging in your results from your ICE table into the brackets below. **(Do not complete this question by solving for the x.** If you complete this problem by solving for x, you will get no more points and you may run out of time on another part of this exam.) (3 pts)

$K_a =$ [ ][ ]

[ ]

Part III. Long Answer Please show work for full credit and to receive partial credit. (25 pts)

1. Calculate the pH of a buffer solution with a concentration of 0.50 M H F and 0.25 M Na F. pK_a of H F is 3.46 Use the Henderson Hasselbalch: $pH = pK_a + \log \{ [base] / [acid] \}$ (10 pts)

2. In a titration, if you add 20.0 mL of a strong base(K OH) with a concentration of 0.20 M to a 50 mL solution of a strong acid (HNO3) of concentration of 0.45 M, what is the $[H_3O^+]$? (This is a before equivalence point problem.) (15 pts)

Exam III General Chemistry II (CHEM 102) Form B 4/10/13 11:30 am MWF Dr. Hahn Exam # 4~6

Name_____ (print) Name _____(sign)

Please show work for partial credit on the Long Answers and in some of the Short Answer Questions. Multiple choice questions have no partial credit. Please write anything you want graded legibly. If I cannot read your work, I obviously cannot grade it. (1 pts print and sign exam)

$pH + pOH = 14$ $pKa + pKb = 14$ $K_a \times K_b = 1.0 \times 10^{-14}$ $[H_3O^+][OH^-] = 1.0 \times 10^{-14} = k_W$ p (anything) = - log (anything) $pH = pK_a + \log \{ [base] / [acid] \}$ M = molarity = moles / liter

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (4 pts per question, 28 pts pts total)

1) Calculate the concentration of OH^- in a solution that contains 3.9×10^{-4} M H_3O^+ at 25°C. 1) _____

$\{[H_3O^+][OH^-] = 1.0 \times 10^{-14}\}$

A) 3.9×10^{-4} M
B) 2.7×10^{-2} M
C) 2.6×10^{-12} M
D) 2.7×10^{-3} M
E) 2.6×10^{-11} M

2) Determine the K_b for CN^- at 25°C. The K_a for HCN is 4.9×10^{-10}. $\{K_a \times K_b = 1.0 \times 10^{-14}\}$ 2) _____

A) 2.0×10^{-5}
B) 1.4×10^{-5}
C) 2.3×10^{-9}
D) 4.9×10^{-14}
E) 3.7×10^{-7}

3) Which of the following solutions is a good buffer system? 3) _____

A) A solution that is 0.10 M Na OH and 0.10 M K OH
B) A solution that is 0.10 M H Cl and 0.10 M NH_4^+
C) A solution that is 0.10 M H F and 0.10 M Na $C_2H_3O_2$
D) A solution that is 0.10 M H $C_2H_3O_2$ and 0.10 M Li $C_2H_3O_2$
E) None of the above are buffer systems.

4) Calculate the pOH in an aqueous solution with a pH of 9.85 at 25°C. $\{pH + pOH = 14\}$ 4) _____

A) 2.15 B) 4.15 C) 4.00 D) 5.15 E) 3.15

5) Which of the following is NOT a conjugate acid–base pair? 5) _____

A) NH_4^+/NH_3

B) H_3O^+/OH^-

C) $C_2H_3O_2^-/HC_2H_3O_2$

D) H_2SO_3/HSO_3^-

E) All of the above are conjugate acid–base pairs.

6) What is the conjugate base of $H_2PO_4^-$? 6) _____

A) H_3O^+ B) H_3PO_4 C) HPO_4^{2-} D) PO_4^{3-} E) OH^-

7) Identify the triprotic acid. 7) _____

A) $HClO_4$ B) H_3PO_4 C) H_2SO_4 D) H_2SO_3 E) HNO_3

Part II Short Answer: Write the word or phrase or circle the choice that best completes each statement or answers the question. (47 pts)

1. Circle the Strong Weak Acid among the following: (5 pts)

HBr CH_3COOH H_2SO_4 HF H_2SO_4 HNO_3

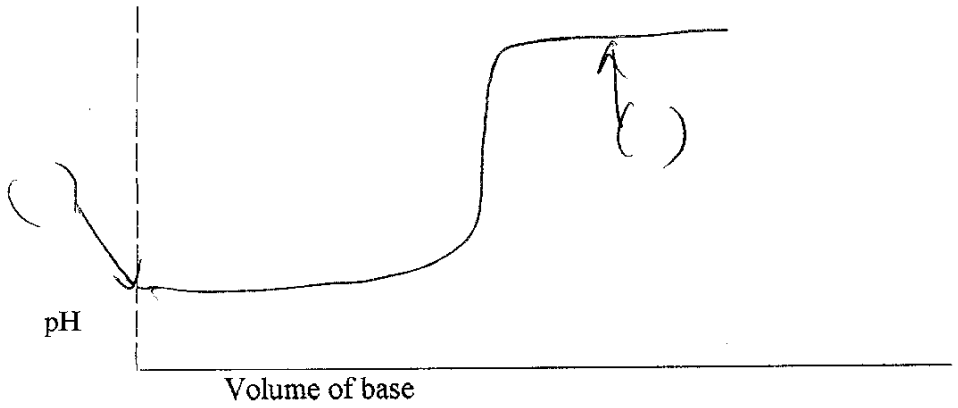
2. Write the reaction equation for the acid / base reaction of the weak acid with water by filling in the products in the equation below. (3 pts each, 6 pts)

H CN (aq) + H_2O (l) → _____ + _____

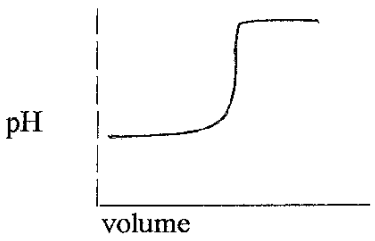
3. What is the pH of a HBr (strong acid) solution with a concentration of 0.095 M ? Please show work for partial credit & full credit. { pH = - log $[H^+]$ } (6 pts)

$[H^+] = [H_3O^+]$ = _____ pH = _____

4. Match the titration curve for a strong acid being titrated by adding a strong base with the statements below. You may use the letters one time, no time or many times. (a) pH = 7 (b) M = (# moles base - # moles acid) / total volume (c) $[H^+] = [H_3O^+] = [HA]$ (HA is a generic strong acid) (d) M = (# moles acid - # moles base) / total volume (3 pts each, 6 pts)



5 Match the titration curves with the letters shown by circling the matching letter under all diagrams. (a) strong base to which you add a strong acid (b) a weak acid to which you add a strong base titration (c) strong acid to which you add a strong ~~acid~~ base (One letter matches one titration curve.) (2 pts each, 6 pts)



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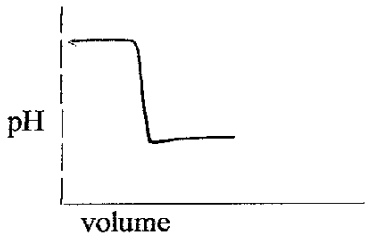

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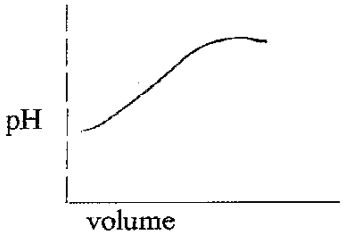

(a) or (b) or (c)
(circle one)

5. For the reaction Ag_2SO_4 (s) → $2\,Ag^+ + SO_4^{-2}$ give the expression for Ksp

Ksp = _____ _____ (6 pts)

7 If the K_a of H CN is 4.9×10^{-10}, find the $[H_3O^+]$ at equilibrium if the initial concentration of H CN is 5.55 M. (**Do not** actually **calculate the final number for this problem**. Just set up the problem. There are too many problems on this exam to complete this problem.)

a. To do this, complete the ICE table below. $x = [H_3O^+]$ (9 pts, 1 pt per blank)

	[HCN]	$[H_3O^+]$	$[CN^-]$
Initial			
Change			
Equilibrium			

b. Complete the Ka equilibrium expression by plugging in your results from your ICE table into the brackets below. (**Do not complete this question by solving for the x**. If you complete this problem by solving for x, you will get no more points and you may run out of time on another part of this exam.) (3 pts)

K_a = [ ][ ]

[ ]

Part III. Long Answer Please show work for full credit and to receive partial credit. (25 pts)

1. Calculate the pH of a buffer solution with a concentration of 0.25 M $HC_2H_3O_2$ and 0.50 M $NaC_2H_3O_2$. pK_a of $HC_2H_3O_2$ is 4.74 Use the Henderson Hasselbalch: $pH = pK_a + \log \{ [base] / [acid] \}$ (10 pts)

2. In a titration, if you add 35.5 mL of a strong base(Li OH) with a concentration of 0.25 M to a 25.0 mL solution of a strong acid (HCl) of concentration of 0.20 M, what is the $[OH^-]$? (This is an after equivalence point problem.) (15 pts)