

**Exam: Chapter 13-17: Version I (70 pts)**

**Section I: Multiple Choice (3 pts each):**

1. C
2. A
3. B
4. A
5. B

$$K_C = (0.14 \times 0.19) / (.42^2) = 0.15$$

	<b>2 NO</b>	<b>N<sub>2</sub></b>	<b>O<sub>2</sub></b>
<b>I</b>	0	0.35 / 1	0.40
<b>C</b>	+0.42	-0.21	-0.21
<b>E</b>	0.42	0.14	.19

6. A
7. D

	<b>ZOH</b>	<b>H<sub>2</sub>O</b>	<b>Z<sup>+</sup></b>	<b>OH<sup>-</sup></b>
<b>I</b>	0.040 / 2	-	0	0
<b>C</b>	-x	-	+x	+x
<b>E</b>	0.02 - x	-	x	x

$$\text{pOH} = -\log[\text{OH}^-] \rightarrow -9.07 = \log[\text{OH}^-] \rightarrow 8.5 \times 10^{-10} = [\text{OH}^-] = x$$

$$= x^2 / 0.02 = (8.5 \times 10^{-10})^2 / (0.02 - x) = 3.6 \times 10^{-17}$$

8. E
9. E
10. B
11. D

**Section II: Free Response**

12. (13 pts)

- a. (3 pts)  $\text{Ag}_2\text{CrO}_4(\text{s}) \leftrightarrow 2 \text{Ag}^+(\text{aq}) + \text{CrO}_4^{2-}(\text{aq}) (+20 \text{ kJ})$
- b. (3 pts)  $K_{\text{sp}} = [\text{Ag}^+]^2 [\text{CrO}_4^{2-}]$
- c. (4 pts)  $K_{\text{sp}}$  would decrease.
- d. (4 pts) common ion effect  $\rightarrow [\text{CrO}_4^{2-}]$  would decrease

13. (12 pts)

a. (6 pts)

	<b>C<sub>6</sub>H<sub>5</sub>O<sup>-</sup></b>	<b>H<sup>+</sup></b>	<b>C<sub>6</sub>H<sub>5</sub>OH</b>
<b>I</b>	0.1000	0.0500	0
<b>C</b>	-0.0500	-0.0500	+0.0500
<b>F</b>	0.0500	0	0.0500

$$\text{pH} = 5.20, [\text{H}^+] = 6.39 \times 10^{-6}$$

$$(0.100\text{M HCl})(0.5000\text{L}) = 0.0500\text{mol H}^+$$

$$\text{pH} = \text{pK}_a + \log(\text{b/a})$$

$$5.20 = \text{pK}_a + \log((0.0500/0.6) / (0.0500/0.6))$$

$$K_a = 1.0 \times 10^{-5}$$

b. (6 pts)

	<b>C<sub>6</sub>H<sub>5</sub>OH</b>	<b>H<sup>+</sup></b>	<b>C<sub>6</sub>H<sub>5</sub>O<sup>-</sup></b>
<b>I</b>	0.1000/1.1	0	0
<b>C</b>	-x	+x	+x
<b>F</b>	0.0909 - x	x	X

$$1.0 \times 10^{-5} = x^2 / (0.0909 - x)$$

$$x = [\text{H}^+] = 9.5 \times 10^{-4}$$

$$\text{pH} = 3.02$$

$$\text{pOH} = 10.98$$

14. (15 pts)

graph is  $x = y^3$  approximately

- Initial pH

$$0.250\text{M}(0.050\text{L}) = 0.0125 \text{ mol H}_2\text{NNH}_2$$

	$\text{H}_2\text{NNH}_2$	$\text{H}_3\text{NNH}_2^+$	$\text{OH}^-$
<b>I</b>	0.25	0	0
<b>C</b>	-x	+x	+x
<b>E</b>	0.25- x	x	X

$$K_b = 1.3 \times 10^{-2} = \frac{x^2}{(0.25-x)}$$

$$0 = \pm x^2 \pm 1.3 \times 10^{-2}x = 3.25 \times 10^{-3}$$

$$x = 0.037589$$

$$x = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a} = \frac{[-1.3 \times 10^{-2} \pm \sqrt{(1.69 \times 10^{-4} - 0.013)}]}{-2}$$

$$x = 0.050878 = [\text{OH}^-]$$

$$\text{pOH} = 1.21$$

$$\text{pH} = 12.71$$

- pH at the equivalence point(s)

	$\text{H}_3\text{NNH}_2^+$	$\text{H}_2\text{NNH}_2$	$\text{H}^+$
<b>I</b>	0.1667	0	0
<b>C</b>	-x	-x	+x
<b>E</b>	0.1667-x	x	x

$$MV = MV$$

$$0.250(0.050) = 0.500V$$

$$V = 0.025\text{L}$$

$$K_a = K_w/K_b = \frac{x^2}{(0.1667-x)} = \frac{1.0 \times 10^{-14}}{1.3 \times 10^{-2}} = \frac{X^2}{(0.1667-x)} = 7.69 \times 10^{-13}$$

$$X = 3.58 \times 10^{-7} = [\text{H}^+]$$

$$\text{pH} = 6.446$$

- The final pH

$$-\log(0.5) = 0.301$$

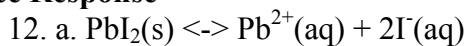
**Exam: Chapter 13-17: Version I (70 pts)**

**Section I: Multiple Choice (3 pts each):**

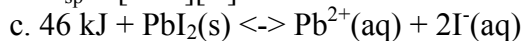
- C
- D
- D
- E
- D
- A
- E
- B

9. B  
10. B  
11. D

**Free Response**



b.  $K_{\text{sp}} = [\text{Pb}^{2+}][\text{I}^{-}]^2$



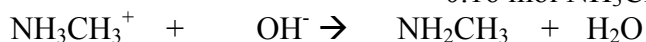
Lower temperature/decrease in energy slows forward reaction; this decreases the concentration of ions, and decreases  $K_{\text{sp}}$

d. Will not change if saturated, increase if unsaturated.



Equivalence point:  $(1.0000\text{L})(0.200\text{M OH}^{-}) = 0.20 \text{ mol OH}^{-}$  added

$= 0.16 \text{ mol NH}_3\text{CH}_3^{+}$  initially



I	0.20 mol	0.1000	0	
C	-0.1000	-0.1000	+0.1000	
F	0.1000	0	+0.1000	

$\text{pH} = \text{p}K_{\text{a}} + \log \left( \frac{[\text{base}]}{[\text{acid}]} \right)$

$3.12 \times 10^{-9} = K_{\text{w}}/K_{\text{b}}$

$-8.50 = +\log(K_{\text{w}}/K_{\text{b}}) + \log(0.1000/0.1000)$

$K_{\text{b}} = 3.2 \times 10^{-6}$



I		$(0.2000/1.2)$	0	0
C		-x	+x	+x
E		$0.1667-x$	x	x

$K_{\text{b}} = \frac{[\text{B}^{-}][\text{OH}^{-}]}{[\text{B}]}$

$3.2 \times 10^{-6} = \frac{x^2}{0.1667}$

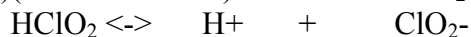
$x^2 = 5.27 \times 10^{-7}$

$x = 7.3 \times 10^{-4} = [\text{OH}^{-}]$

$\text{pOH} = 3.13 \quad \text{pH} = 10.86$

14. Graph: starts from pH of between 1 and 2, then curves up to equivalence point of between pH of 7 and 8 and 25 mL NaOH added, then graph continues curving up until it hits a pH of 13.

- Initial pH



I	0.125	0	0
C	-x	+x	+x
E	$0.125-x$	x	x

$K_{\text{a}1} = 1.1 \times 10^{-2}$

$1.1 \times 10^{-2} = \frac{x^2}{(0.125-x)}$

$x^2 + 1.1 \times 10^{-2}x - 0.001375$

$x = 0.038$

$x = -b \pm \text{sq. root}(b^2 - 4ac)$

$x = 0.031986 \text{ or } -0.0429867$

$\text{pH} = 1.495 \quad (1.5, 0)$

- The pH at the equivalence point

$$\text{ClO}_2^- + \text{H}_2\text{O} \rightleftharpoons \text{HClO}_2 + \text{OH}^-$$

I	0.00625/0.075		0	0
C	-x		+x	+x
E	0.6033-x		x	x

$$M_A V_A = M_B V_B$$

$$0.00625 = (0.250) V_B$$

$$V_B = 0.250 \text{ L}$$

$$K_w / K_a = K_b = x^2 / (0.0833 - x) = 9.09 \times 10^{-13}$$

$$x = 2.75 \times 10^{-7} = [\text{OH}^-]$$

$$\text{pOH} = 6.56$$

$$\text{pH} = 7.44 \quad (7.44, 25)$$

- The final pH

$$\text{pOH} = -\log (0.250 \text{ M OH}^-) = 0.60$$

$$\text{pH} = 13.40 \quad (13.40, >50\sim)$$

Thanks to Calvin Lee, Tina Gong, and Tina Zhou (Class of 2006) for typing this. Please let me know if you find any typos/mistakes.