

General Chemistry II (CHEM 102) Dr. Naleway – Discussion 9

Name _____

Strong acid and strong base titration problems:

1. 15 mL of 0.25 M H_2SO_4 is reacted with 40 mL of 0.25 M NaOH.
Determine the final pH of the solution.

Weak base and strong acid titration problems:

2. 50 mL of 0.25 M NH_3 ($\text{pK}_b = 4.75$) is reacted with 50 mL of 0.25 M HCl.
Determine the final pH of the solution.

3. 25 mL of 0.25 M methylamine (CH_3NH_2 ; $\text{pK}_b = 3.34$) is reacted with 25 mL of 0.25 M HCl. Determine the final pH of the solution.

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- 25 mL of 0.25 M methylamine (CH_3NH_2 ; $\text{pK}_\text{b} = 3.34$) is in solution but is NOT reacted with any acid. Determine the final pH.
- The pK_b of hypiodite ion, IO^- , is 3.36. Determine the pH of a 2.0 M solution of lithium hypiodite.
- The pK_b of the sulfide ion, S^{2-} , is 2.04. Determine the pH of a 1.50 M solution of sodium sulfide.

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Strong Acid/Strong Base Titrations

$$(1) \quad 0.015 \text{ L} \times \frac{0.25 \text{ mol}}{\text{L}} \times 2 = 0.0075 \text{ mol } \text{H}^+$$

$$0.040 \text{ L} \times \frac{0.25 \text{ mol}}{\text{L}} = 0.01 \text{ mol } \text{OH}^-$$

$$0.01 - 0.0075 = 0.0025 \text{ mol excess OH}^-$$

$$\frac{0.0025 \text{ mol}}{0.055 \text{ L}} = 0.045 \text{ M excess OH}^-$$

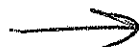
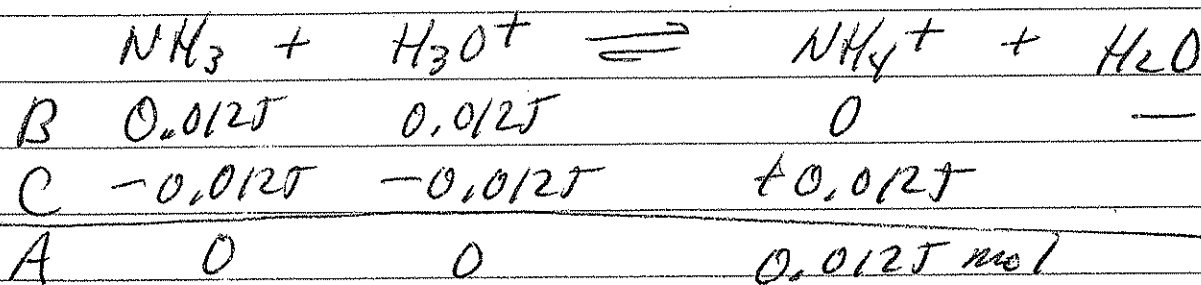
$$\text{pOH} = -\log(0.045) = 1.35$$

$$\text{pH} = 14 - 1.35 = \boxed{12.65}$$

Weak Base/Strong Acid Titrations

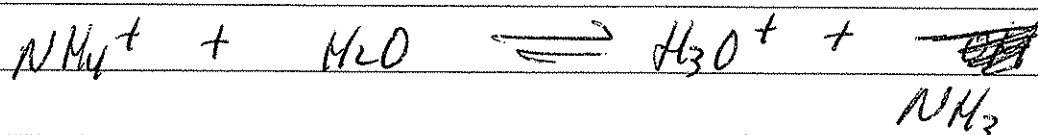
$$(2) \quad 0.050 \text{ L} \times \frac{0.25 \text{ mol}}{\text{L}} = 0.0125 \text{ mol } \text{NH}_3$$

$$0.0125 \text{ mol } \text{H}^+$$



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$$\frac{0.0125 \text{ mol}}{0.1 \text{ L}} = 0.125 \text{ M } \text{NH}_4^+$$



I	0.125 M	—	0	0
C	-x		+x	+x
E	0.125 - x		x	x

$$\frac{x^2}{0.125 - x} = K_a$$

$$\text{NH}_3 \text{ p}K_b = 4.75$$

$$\text{NH}_4^+ \text{ p}K_a = 14 - 4.75 = 9.25$$

$$K_a = 10^{-9.25} = 5.62 \times 10^{-10}$$

$$x = \sqrt{(5.62 \times 10^{-10})(0.125)} = 8.38 \times 10^{-6} = \text{H}^+$$

$$\text{pH} = \boxed{5.08}$$

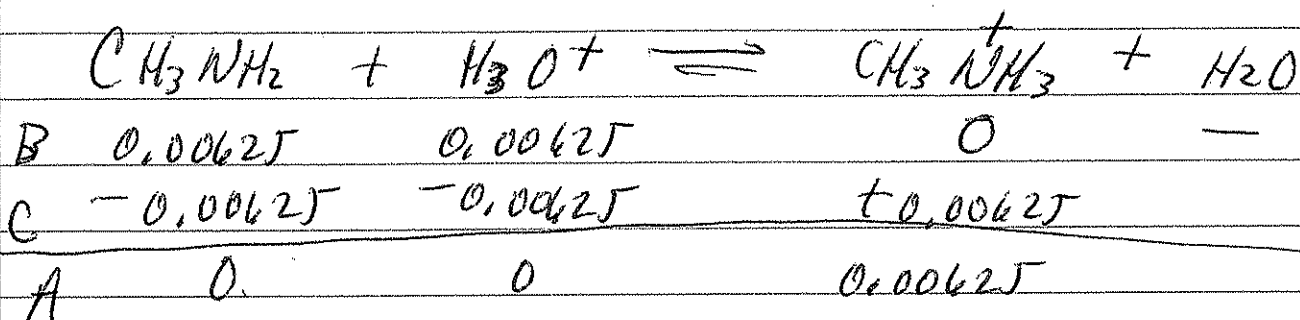
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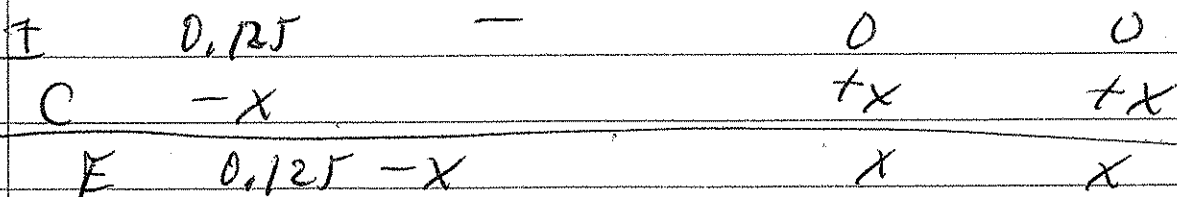
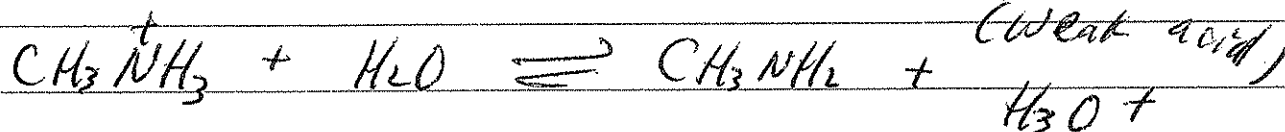
~~0.25 mol~~

$$0.025 \text{ L} \times \frac{0.25 \text{ mol}}{\text{L}} = 0.00625 \text{ mol base}$$

$$0.025 \text{ L} \times \frac{0.25 \text{ mol}}{\text{L}} = 0.00625 \text{ mol } \text{H}^+$$



$$\frac{0.00625 \text{ mol}}{0.050 \text{ L}} = 0.125 \text{ M } \text{CH}_3\text{NH}_3^+$$



$$\frac{x^2}{0.125 - x} = K_a = 2.19 \times 10^{-11}$$

$$\text{p}K_b = 3.34$$

$$\text{p}K_a = 14 - 3.34 = 10.66$$

$$K_a = 10^{-10.66} = 2.19 \times 10^{-11}$$

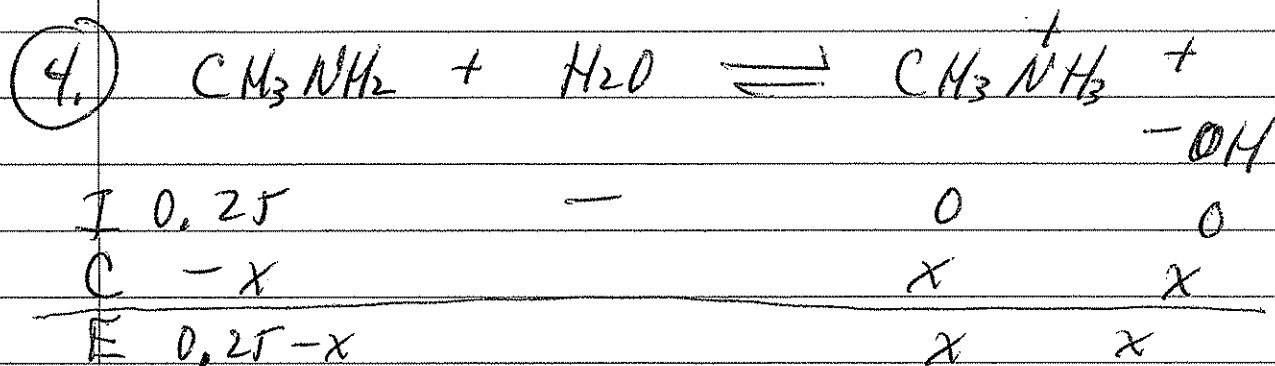
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$$x = \sqrt{(0.125)(2.19 \times 10^{-11})} =$$

$$1.65 \times 10^{-6} = H^+$$

$$pH = -\log(1.65 \times 10^{-6}) =$$

$$\boxed{5.78}$$



$$\frac{x^2}{0.25 - x} = K_b = 4.57 \times 10^{-4}$$

$$K_b = 10^{-3.34}$$

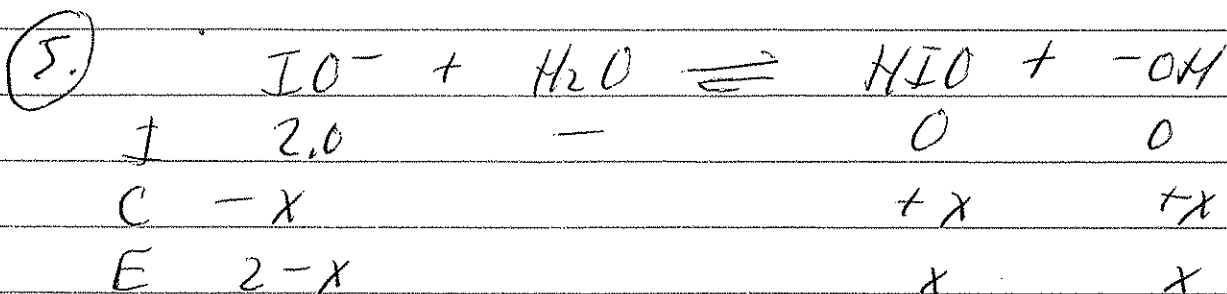
$$x = \sqrt{(0.25)(4.57 \times 10^{-4})} = OH^- =$$

$$0.0107$$

$$pOH = -\log(0.0107) = 1.97$$

$$pH = 14 - 1.97 = \boxed{12.03}$$

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$$10^{-3.36} = K_b = 4.37 \times 10^{-4}$$

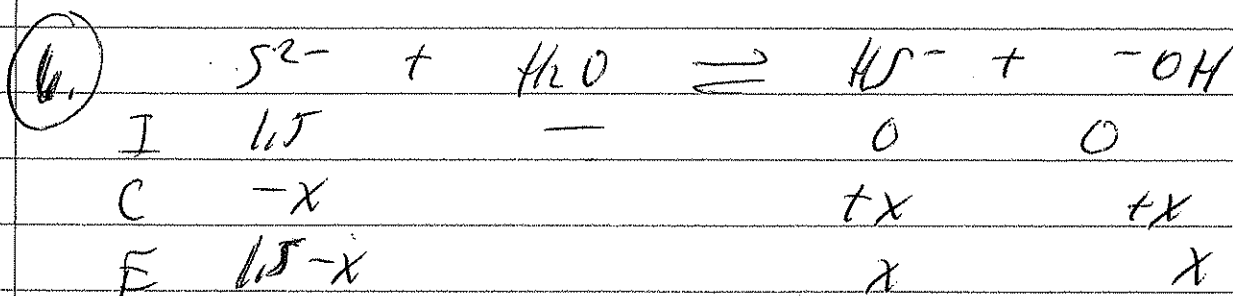
$$\frac{x^2}{2-x} = 4.37 \times 10^{-4}$$

$$x = .0296 = [\text{OH}^-]$$

~~$$x = 6.18 \times 10^{-4}$$~~

$$\text{pOH} = 1.53$$

$$\boxed{\text{pH} = 12.47}$$



$$\frac{x^2}{1.5-x} = K_b = 9.12 \times 10^{-3}$$

$$x = .11696$$

$$10^{-2.04} = 9.12 \times 10^{-3}$$

$$\frac{.11696}{1.5} \times 100 = 7.79\%$$

use quadratic

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$$\frac{-K_b + \sqrt{(K_b)^2 + 4(K_b)(\text{conc})}}{2}$$

$$\frac{-0.00912 + \sqrt{(0.00912)^2 + 4(0.00912)(1.5)}}{2}$$

$$X = 0.11249 = \text{OH}^-$$

$$\text{pOH} = -\log(0.11249) =$$

$$\begin{matrix} 0.95 \\ \boxed{\text{pH} = 13.05} \end{matrix}$$