

General Chemistry II (CHEM 102) Dr. Naleway – Discussion 8

Name _____

Strong acid and strong base titration problems:

1. 50 mL of 0.25 M HNO_3 is reacted with 100 mL of 0.25 M KOH . Determine the final pH of the solution.
2. 75 mL of 0.25 M H_2SO_4 is reacted with 75 mL of 0.25 M Ca(OH)_2 . Determine the final pH of the solution.

Weak acid and strong base titration problems:

3. 50 mL of 0.25 M chloroacetic acid (ClCH_2COOH ; $\text{pK}_a = 2.85$) is reacted with 25 mL of 0.25 M Ca(OH)_2 . Determine the final pH of the solution.

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- 80 mL of 0.25 M nitrous acid (HNO_2 ; $\text{pK}_a = 3.35$) is reacted with 40 mL of 0.25 M NaOH. Determine the final pH of the solution.
- 30 mL of 0.25 M formic acid (HCOOH ; $\text{pK}_a = 3.17$) is reacted with 10 mL of 0.25 M $\text{Ca}(\text{OH})_2$. Determine the final pH of the solution.
- 20 mL of 0.25 M cyanic acid (HCNO ; $\text{pK}_a = 3.46$) is in solution but is NOT reacted with any base. Determine the final pH.

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Strong Acid/Strong Base Titrations

$$\textcircled{1} \quad 0.050 \text{ L} \times \frac{0.25 \text{ mol}}{\text{L}} = 0.0125 \text{ mol } \text{H}^+$$

$$0.1 \text{ L} \times \frac{0.25 \text{ mol}}{\text{L}} = 0.025 \text{ mol } ^-\text{OH}$$

$$\frac{0.0125 \text{ mol excess base}}{0.150 \text{ L}} = 0.0833 \text{ M } ^-\text{OH}$$

$$\text{pOH} = -\log(0.0833) = 1.08$$

$$\text{pH} = 14 - 1.08 = \boxed{12.92}$$

$\textcircled{2} \quad \boxed{\text{pH} = 7}$ since there are 2 H^+ 's
to react w/ 2 ^-OH 's
and both acid & base
are equal in M & volume,
equivalence pt. is reached.
For a SA/SB titration $\text{pH} \approx 7$ at
the equivalence pt.

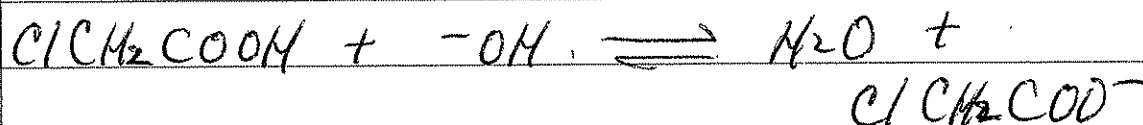
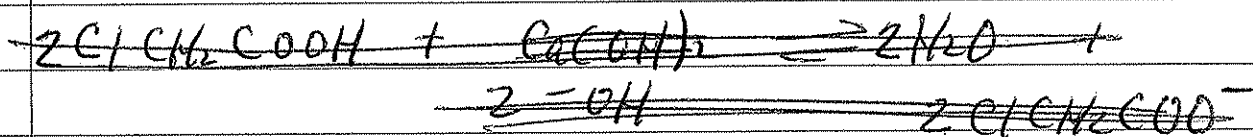
Discussion 8

Weak acid / Strong base Titration Problems

3.

$$0.050 \text{ L} \times \frac{0.25 \text{ mol}}{\text{L}} = 0.0125 \text{ mol} \quad \text{ClCH}_2\text{COOH}$$

$$0.025 \text{ L} \times \frac{0.25 \text{ mol}}{\text{L}} \times 2 = 0.0125 \text{ mol} \quad \text{Ca(OH)}_2$$

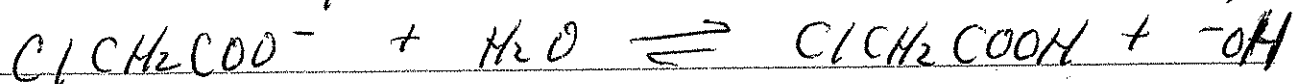


B	0.0125 mol	0.0125 mol	-	0
C	-0.0125 mol	-0.0125 mol		+0.0125 mol
A	0	0		0.0125 mol

$$\frac{0.0125 \text{ mol}}{0.075 \text{ L}} = 0.1667 \text{ M ClCH}_2\text{COO}^-$$

WA/SB Titrations Discussion 8

Dr. Naleway



I	0.1667 M	—	0	0
C	-x		+x	+x
E	0.1667 - x		x	x

$$\frac{x^2}{0.1667 - x} = K_b = 7.08 \times 10^{-12}$$

$$pK_a = 2.85$$

$$pK_b = 14 - 2.85 = 11.15$$

$$K_b = 10^{-11.15} =$$

$$x = \sqrt{(7.08 \times 10^{-12})(0.1667)}$$

$$4.43 \quad 4.44 \times 10^{-7} =$$

$$pOH = -\log(4.44 \times 10^{-7}) = 6.35$$

$$pH = 14 - 6.35 =$$

$$1.09 \times 10^{-6} = [\text{OH}^-]$$

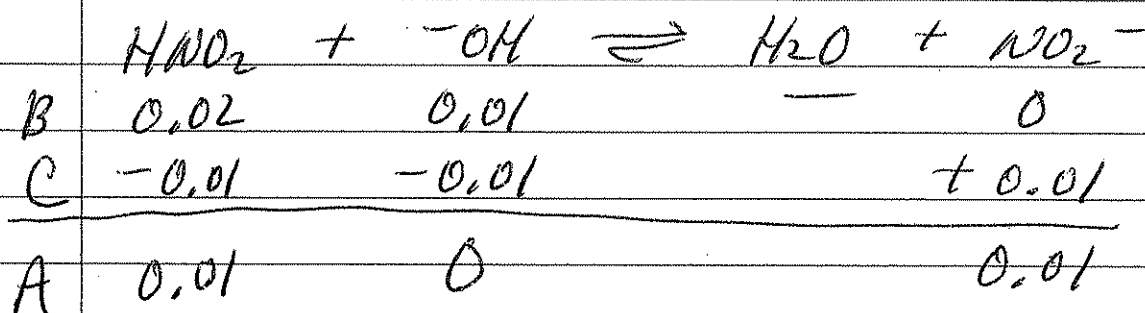
$$pOH = -\log(1.09 \times 10^{-6}) = 5.96$$

$$pH = 14 - 5.96 = \boxed{8.04}$$

WA/SB Titrations

$$(4) \quad 0.080 \text{ L} \times \frac{0.25 \text{ mol}}{\text{L}} = 0.02 \text{ mol HNO}_2$$

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



$$\text{pH} = \text{pK}_a + \log \frac{\text{Base}}{\text{Acid}} =$$

$$\text{pH} = 3.35 + \log \frac{(0.01)}{(0.01)} = \boxed{3.35}$$

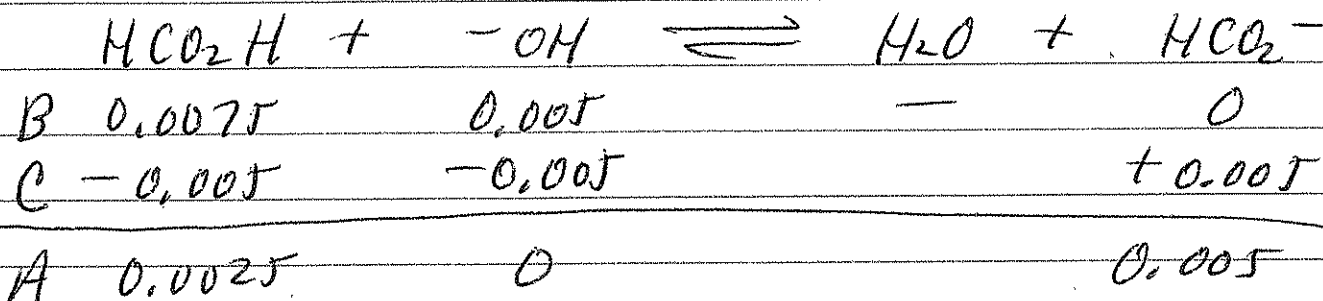
This is called an equimolar buffer

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WA/SB Titrations

$$(5.) \quad 0.030 \text{ L} \times \frac{0.25 \text{ mol}}{\text{L}} = 0.0075 \text{ mol Formic acid}$$

$$0.010 \text{ L} \times \frac{0.25 \text{ mol}}{\text{L}} \times 2 = 0.005 \text{ mol } ^-\text{OH}$$



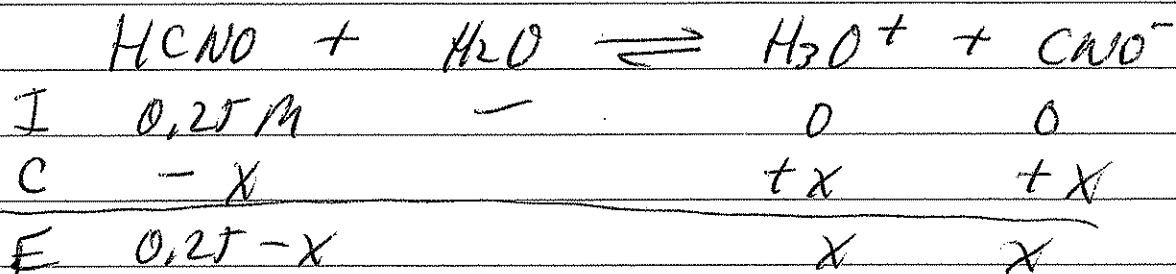
$$\text{pH} = \text{pK}_a + \log \frac{B}{A}$$

$$\text{pH} = 3.17 + \log \frac{0.005}{0.0025} = \boxed{3.47}$$

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WA/No Base

$$(6.) \quad 0.020 \text{ L} \times \frac{0.25 \text{ mol}}{\text{L}} = 0.005 \text{ mol acid}$$



$$\frac{0.005 \text{ mol}}{0.020 \text{ L}} = 0.25 \text{ M}$$

$$\frac{X^2}{0.25 - X} = K_a \quad K_a = 10^{-3.46} = 3.47 \times 10^{-4}$$

$$X = \sqrt{8.675 \times 10^{-5}} = 0.00931 = \text{H}^+$$

$$-\log(0.00931) = \boxed{2.03}$$