

Solutions

CHEM 104

PLI 35

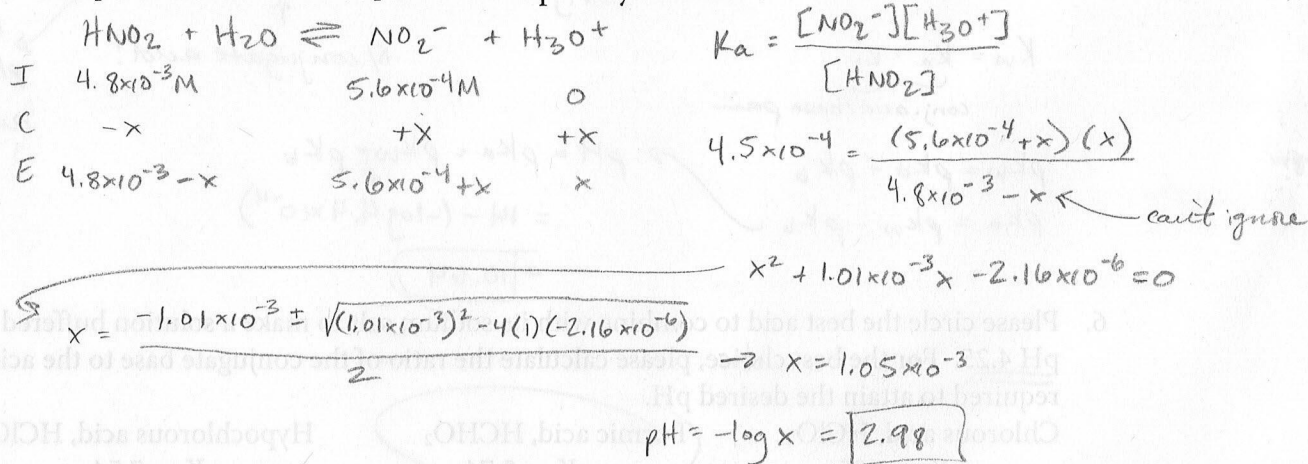
Wednesday, July 20, 2016

Chapter 17

Something to keep in mind: When **equal** amounts of acid and base are mixed (at the equivalence point) the resulting solution will behave as follows:

Strengths of Acid and Base	Resulting Solution pH
Strong Acid + Strong Base	7 (Neutral)
Strong Acid + Weak Base	< 7 (Acidic)
Weak Acid + Strong Base	> 7 (Basic)
Weak Acid + Weak Base	< 7 if acid's $K_a >$ base's K_b = 7 if acid's $K_a =$ base's K_b > 7 if acid's $K_a <$ base's K_b

1. Practice with the common ion effect: In the lab you make a solution that is 0.0048 M HNO_2 and 0.00056 M LiNO_2 . What is the pH of your solution?



2. Which of the following can form a buffer?

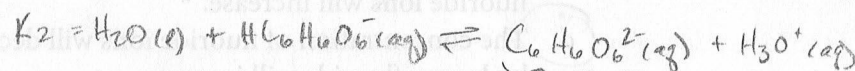
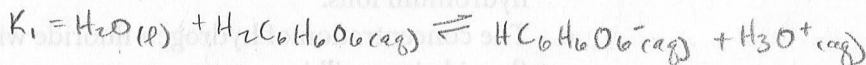
- a. HCl and CH_3COOH → both acids!
- b. H_2CO_3 and NaHCO_3
- c. NaOH and NaCl → both strong
- d. $\text{NaCH}_3\text{COCOO}$ and CH_3COCOOH
- e. HClO and KClO

Four options

weak acid + conjugate base
 weak base + conjugate acid
 strong acid + weak base
 strong base + weak acid

3. Ascorbic acid, $\text{H}_2\text{C}_6\text{H}_6\text{O}_6$ (s), is a diprotic acid with K_1 of 7.9×10^{-5} and K_2 of 1.6×10^{-12} . In a 0.005 M aqueous solution of ascorbic acid, which of the following species is present in the lowest concentration?

- a. H_2O (l) → this one
- b. H_3O^+ (aq) should be obvious!
- c. $\text{H}_2\text{C}_6\text{H}_6\text{O}_6$ (aq)
- d. $\text{HC}_6\text{H}_6\text{O}_6^-$ (aq)
- e. $\text{C}_6\text{H}_6\text{O}_6^{2-}$ (aq)

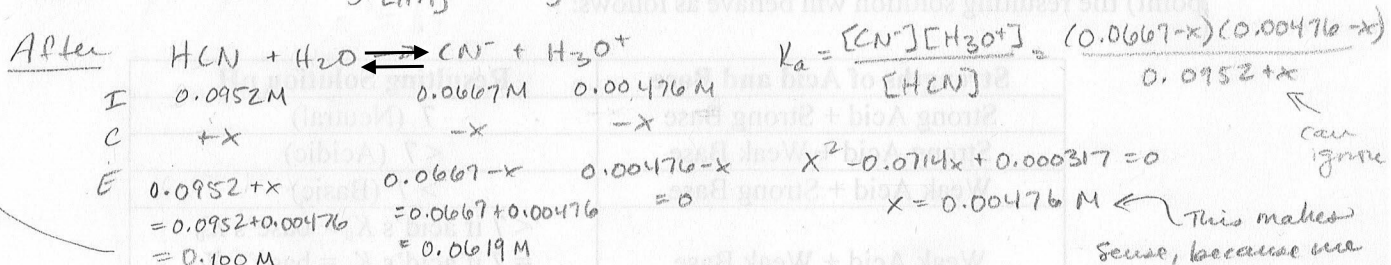


Using H.H. equation: $pH = pK_a + \log \frac{[A^-]}{[HA]} = -\log(4.79 \times 10^{-10}) + \log \frac{0.0619}{0.100} = \boxed{9.11}$

4. Determine the pH of an HCN/KCN buffer containing 0.100 mol HCN and 0.070 mol KCN before and after the addition of 50.0 mL of 0.100M HCl to 1.00 L of buffer.

K_a for HCN is 4.79×10^{-10}

Before $pH = pK_a + \log \frac{[A^-]}{[HA]} = -\log(4.79 \times 10^{-10}) + \log \left(\frac{0.070}{0.100} \right) = \boxed{9.16}$



5. A 25.0 mL sample of 0.175 M methylamine (CH_3NH_2 , a weak base, $K_b = 4.4 \times 10^{-4}$) is titrated with 0.150 M HBr. What is the pH at one-half of the equivalence point?

At $\frac{1}{2}$ equivalence point, $\frac{[A^-]}{[HA]} = 1$ so $pH = pK_a$

$K_w = K_a \cdot K_b$
 conj. acid/base pair

of conjugate acid!

Because $pH = pK_a + \log \frac{[A^-]}{[HA]}$
 and $\log(1) = 0$

$pK_w = pK_a + pK_b$
 $pK_a = pK_w - pK_b$
 $pH = pK_a = pK_w - pK_b$
 $= 14 - (-\log 4.4 \times 10^{-4})$
 $= \boxed{10.64}$

6. Please circle the best acid to combine with its sodium salt to make a solution buffered at pH 4.25. For the best choice, please calculate the ratio of the conjugate base to the acid required to attain the desired pH.

Chlorous acid, $HClO_2$
 $pK_a = 1.95$

Formic acid, $HCHO_2$
 $pK_a = 3.74$

Hypochlorous acid, $HClO$
 $pK_a = 7.54$

pK_a is closest to the desired pH

$pH = pK_a + \log \frac{[A^-]}{[HA]} \rightarrow \frac{[A^-]}{[HA]} = 10^{(pH - pK_a)} = 10^{(4.25 - 3.74)} = 10^{0.51} = \boxed{\frac{3.24}{1}}$

7. What change will be caused by addition of a small amount of HCl to a solution containing fluoride ions and hydrogen fluoride?

- The concentration of hydronium ions will increase significantly.
- The concentration of fluoride ions will increase as will the concentration of hydronium ions.
- The concentration of hydrogen fluoride will decrease and the concentration of fluoride ions will increase.
- ☒ The concentration of fluoride ions will decrease and the concentration of hydrogen fluoride will increase.
- The fluoride ions will precipitate out of solution as their acid salt.