Laude CH 302Spring 2006 Worksheet 6

(To make your life easier when working the problems, convert the compounds in the problems below to H^+, OH^-, HA, A^-, B, or BH^+ when you are struggling.)

Neutralization

1. Write the balanced neutralization reactions and then calculate the final amount of each compound in solution after neutralization:

a. 2 mol NaHCOO and 1mol HCl

NaHCOO + HCl ↔ HCOOH + NaCl

	A^-	H^+	↔	HA
Final:	1mol	0		1mol

b. 1 mol HNO_3 and 1.5 mol KOH

HNO_3 + KOH ↔ KNO3 + H2O

	H^+	+	OH^-	↔	H2O
Final	0		0.5		1

c. 5 mol NH_4NO_2 and 1 mol HI

NH_4NO_2 + HI ↔ no reaction

	BH^+	+	H^+	↔ no reaction acid and acid
Final	0.5		1	

d. 0.7 mol CH_3NH_3Cl and .5 mol $Ca(OH)_2$

$2CH_3NH_3Cl + Ca(OH)_2$ ↔ $2CH_3NH_2 + CaCl_2 + 2H_2O$

	BH^+	+	OH^-	↔	B
Final	0		..3		.7

Simple buffers

2. Identify buffer solutions. Remember to neutralize when necessary.

a. 1.5 M acetic acid solution (CH_3COOH) and .5M potassium acetate

yes

b. 2 M Na_2CO_3 solution and 1 M HCl

yes, after neutralization

c. .02 M lactic acid and 1M HCl

no strong acid is left

d. 1.5 M $Ba(OH)_2$ and 1 M $BaCl_2$

no

e. 1.0 M NaOH and 2 M hydrazine bromide (NH_3NH_3Br)

yes, after neutralization

f. 1.0 M HNO_3 and 2.0 M sodium acetate ($NaCH_3COO$)

yes, after neutralization

g. 1.0 M HNO_3 and 2.0 M sodium sulfate

yes, after neutralization

h. 1 M ammonia and 2 M ammonium nitrate
yes, after neutralization

3. Write out the equation and then calculate the pH of these solutions:

a. 1.5M $NaNO_2$ and .5 M HNO_2 $K_a = 4.3 \times 10^{-4}$
1.5 moles A- and 0.5 moles HA
Use simple acid buffer equation pH = 3.84

b. 1M ammonia and 2M ammonium nitrate $K_b = 1.8 \times 10^{-5}$
1 mole B to 2 moles of BH+
Use simple basic buffer equation pOH = 5.05   pH = 8.95

c. 3 M $NaCH_3COO$ and 1 M H_2SO_4 $K_a = 1.8 \times 10^{-5}$

	A-	+ H+	↔	HA
Before	3moles	2 moles		
After	1 mole	0 moles		2 moles

so simple acid buffer is left after neutralization   pH = 4.44

d. 2 M Na_sSO4 and 1M HF $K_a = 4.3 \times 10^{-4}$
not a simple buffer, no conjugate acid/base system present

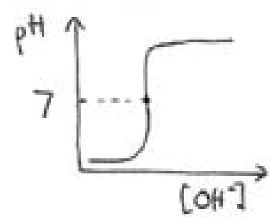
Titration curve

Titration curve

4. Calculate the pH of these solutions after titration, then draw their titration curves:

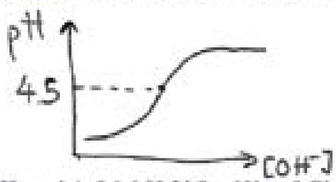
a. 100ml .5M NaOH and 150ml .5M HBr

Total volume = 250 ml
[H+] final = .1M
pH = 1



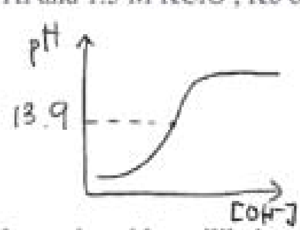
b. Equal amounts of 2M NH_3 and 2M HNO_3, Ka of NH_4+ = 5.55 e-10

[NH_4+] = 2M
pH = 4.5



c. Equal amounts of 1.5M HI and 1.5 M KClO , Kb of ClO- = 3.33 e-7

[ClO-] = 1.5 M
pOH = 7.1
pH = 13.9



Polyprotic acid equilibria

5. Write out the equation expressions and calculate total [H^+] and pH of these solutions. In each case assume the simple (single K) eqilibria:

a. 1.2 M H_2CO_3, K1 = 4.3e-7 and K2 = 5.6e-11

$H_2CO_3 \leftrightarrow HCO^3 - + H+$ (1)
$HCO_3- \leftrightarrow CO^{32-} + H+$ (2)

Since initial concentration of acid is large and both Ks are small and far apart, we use approximations for both [H+] calculations.

From (1), [H+] = 7.2 e-4 M
From (2), [H+] = 2e-7 M
Total [H+] = 7.202 e-4 M
pH = 3.14

b. 2 M H_2SO_4, K1= strong, K2 = 1.2 e-2

$H_2SO_4 \leftrightarrow HSO_4^- + H+$ (1)
$HSO_4^- \leftrightarrow SO_4^{2-} + H+$ (2)

Since initial concentration of acid is large and second K is small, we use approximations on the second [H+] calculation.

From (1), [H+] = 2M
From (2), [H+] = .15M
Total [H+] = 2.15M
pH = -.33

Approximation vs. solving quadratic equation

6. Fill in the blank:

Acid/base equilibrium	K_a	$[H^+]$ approximation	$[H^+]$ quadratic	Approximate?
.001M HF $\leftrightarrow H^+ + F^-$	4.5×10^{-3}	.002	.00084	no
.3M $HSO_4- \leftrightarrow H^+ + SO_4^-$	1.2×10^{-2}	.06	.05	no
.01M $NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$	1.8×10^{-5}	.000424	.0004153	Maybe yes
3 M $CH_3COOH \leftrightarrow CH_3COO^- + H^+$	1.8×10^{-5}	.00536	.005357	Yes