AP Chem Unit 10

WKst: Acid Base Equilibrium Review

1) NH_3 weak Base
2) $HClO_4$ strong Acid
3) HC_2H_3O weak acid
4) NH_4Cl salt
5) $HNO_3 + NH_3$ mixture of strong Acid & weak Base
6) $HNO_2 + NaNO_2$ Buffer
7) $NaCHO_2$ salt
8) $C_2H_5NH_2 + C_2H_5NH_3Cl \rightarrow$ Buffer
9) HF weak acid
10) $KOH + HC_2H_3O_2$ mixture of strong Base & weak acid

strong Acid

Ex1) pH? 0.450 M HCl

$pH = -\log[H^+] = -\log[0.450]$

$pH = 0.347$

strong Base

Ex2) pH = ? 0.710 M KOH

$pOH = -\log[OH^-] = -\log[0.710]$ $pH = 14 - pOH$

$pOH = .149$ $pH = 13.851$

Ex3) pH = ? 0.150 M NH_3 weak Base! $K_b = 1.80 \times 10^{-5}$

$NH_3 + HOH \rightleftharpoons NH_4^+ + OH^-$ ↳ All will not dissolve

	NH_3	NH_4^+	OH^-
I	.150	0	0
C	-x	+x	+x
	.150 - x	x	x

Assume 5% Rule

$K_b = \frac{[NH_4^+][OH^-]}{NH_3}$

$(1.80 \times 10^{-5}) = \frac{x^2}{.150}$

$[OH^-] = x = 1.64 \times 10^{-3}$

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ex 3) cont.

$pOH = -\log[OH^-] = -\log[1.64\times10^{-3}]$

$pOH = 2.785$

$pH = 14 - pOH$

$pH = 11.215$

ex4) pH = ? 0.227 M HCN $K_a = 6.2\times10^{-10}$ weak Acid

$HCN + HOH \rightleftharpoons H^+ + CN^-$

	HCN	HOH	H^+	CN^-
I	.227	-	0	0
C	-x		x	x
E	.227-x		x	x

Assume 5%

$K_a = \frac{[H^+][CN^-]}{[HCN]}$

$6.2\times10^{-10} = \frac{x^2}{.227}$

$[H^+] = x = 1.19\times10^{-5}$

$pH = -\log[H^+]$

$pH = 4.93$

ex5) pH = ? 0.95 M $KC_3H_5O_3$ $HC_3H_5O_3$ $K_a = 7.1\times10^{-12}$

Beaker: Salt

weak Acid: $HC_3H_5O_3$

Strong Base: KOH $\rightarrow KC_3H_5O_3$

Strong wins $HOH \rightleftharpoons OH^-$

Strong spectator: $\cancel{K}C_3H_5O_3$

$C_3H_5O_3^- + HOH \rightleftharpoons OH^- + HC_3H_5O_3$

	$C_3H_5O_3^-$	HOH	OH^-	$HC_3H_5O_3$
I	.95M	-	0	0
C	-x		x	x
	.95-x		x	x

Assume 5% Rule

Wkst: A/B Equil Review

ex5) conti

$K_a K_b = K_w$

$K_b = \frac{1 \times 10^{-14}}{7.1 \times 10^{-12}}$

$K_b = 1.4 \times 10^{-3}$

$K_b = \frac{[OH^-][HC_3H_5O_3]}{[C_3H_5O_3^-]}$

$1.4 \times 10^{-3}(.95) = x^2$

$[OH^-] = x = 0.036\ M$

$pOH = -\log[OH^-] = -\log[0.36]$

$pOH = 1.44$

$pH = 14 - pOH$

$pH = 12.56$

ex6) pH = ? 0.53M $HC_6H_4NO_2$ + 0.50M $NaC_6H_4NO_2$

$K_a = 1.7 \times 10^{-5}$

Acid + its Conjugate Base ⇒ Buffer

$[H^+] = K_a \frac{acid}{Base}$

$[H^+] = 1.7 \times 10^{-5}\left(\frac{.53}{.50}\right)$

$[H^+] = 1.8 \times 10^{-5}$

$pH = -\log[H^+]$

$\boxed{pH = 4.74}$

7) pH = ? 0.245M NH_3 + 0.245 M NH_4Cl.

$K_b = 1.8 \times 10^{-5}$

Base + its Conjugate Acid ∴ Buffer

$K_a = \frac{K_w}{K_b} = \frac{1 \times 10^{-14}}{1.8 \times 10^{-5}}$

$K_a = 5.6 \times 10^{-10}$

$[H^+] = K_a \frac{Acid}{Base}$

$= 5.6 \times 10^{-10}\left(\frac{.245}{.245}\right)$

$[H^+] = 5.6 \times 10^{-10}$

$pH = -\log[H^+]$

$pH = 9.25$

Wkst. A/B Wkst. Review

8) 125 ml 0.525 M HCl mixed w/ 125 ml 1M $HC_2H_3O_2$
1M $NaC_2H_3O_2$

Beaker: Weak acid & Conjugate Base
$HC_2H_3O_2$ $NaC_2H_3O_2$

$HC_2H_3O_2$
$K_a = 1.8 \times 10^{-5}$

HCl is strong Acid → Invader

Acid $HC_2H_3O_2$: (125 ml)(1 M) = 125 mmol

CB $C_2H_3O_2^-$: (125 ml)(1 M) = 125 mmol

Invader - Acid: (125 ml)(0.525 M) = 65.6 mmol

$$[H^+] = K_a \frac{[\text{Acid} + \text{Invader}]}{[\text{Base} - \text{Invader}]}$$

Acid Added

$$[H^+] = 1.8 \times 10^{-5} \frac{125 + 65.6}{125 - 65.6}$$

$$[H^+] = 5.78 \times 10^{-5}$$

$$pH = -\log [H^+]$$

$$pH = 4.24$$

Wkst: A/B Equil Review

9) 125 ml 0.500 NaOH mixed w/ 125 ml 0.500M $HC_2H_3O_2$

$K_a = 1.8 \times 10^{-5}$

Beaker: Strong Base + Weak Acid => Buffer?

NaOH: (125 ml)(.500) = 62.5 mmol

$HC_2H_3O_2$: (125 ml)(.500 M) = 62.5 mmol

		$NaOH$	+ $HC_2H_3O_2$	→ H_2O	+ $NaC_2H_3O_2$
	I	62.5 mmol	62.5 mmol	-	0
x=62.5	C	-x	-x		x
		0	0		62.5 mmol

Basic salt in Beaker!

∴ Now a salt problem

Strong Base NaOH → $NaC_2H_3O_2$

weak Acid $HC_2H_3O_2$

Strong wins HOH → OH^-

Strong spectator ~~Na~~ $C_2H_3O_2$

		$C_2H_3O_2^-$	+ HOH	→ OH^-	+ $HC_2H_3O_2$
	I	62.5 mmol	-	0	0
	C	-x		x	x
		62.5 - x		x	x

Assume 5%

$$K_b = \frac{[OH^-][HC_2H_3O_2]}{[C_2H_3O_2^-]}$$

$$K_b = \frac{1 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.6 \times 10^{-10}$$

Total volume = 125 + 125 = 250

$$\frac{62.5 \text{ mmol}}{250 \text{ ml}} = .25 \text{ mol } C_2H_3O_2^-$$

$$[.25][5.6 \times 10^{-10}] = x^2$$

$[OH^-] = x = 1.19 \times 10^{-5}$ pOH = 4.93 ∴ $\boxed{pH = 9.07}$

WKST: A/B Equil Review

10) 200 mL 0.500 M NaOH mixed w/ 125 mL 0.500 M $HC_2H_3O_2$

$K_a = 1.8 \times 10^{-5}$

Strong Base + weak Acid

NaOH: (200 mL)(0.500 M) = 100 mmol

$HC_2H_3O_2$: (125 mL)(0.500 M) = 62.5 mmol

$$NaOH + HC_2H_3O_2 \rightarrow NaC_2H_3O_2 + HOH$$

		NaOH	$HC_2H_3O_2$	$NaC_2H_3O_2$	HOH
	I	100 mmol	62.5 mmol	0	—
x = 62.5	C	-x	-x	x	
		-62.5	-62.5	62.5	
		37.5 mmol	0	62.5	

Beaker Strong Base + Basic Salt ⇒ Strong Base wins

New volume = 200 + 125 = 325 mL

$$\frac{37.5 \text{ mmol}}{325 \text{ mL}} = .115 \text{ M} = [OH^-]$$

$pOH = -\log [OH^-]$

$pOH = .938$

$pH = 14 - .938$

$\boxed{pH = 13.06}$