Ch.18 HW ~~10~~, ~~12~~, ~~14~~, ~~16~~, ~~18~~, ~~24~~, ~~26~~, ~~28~~, ~~30~~, ~~32~~, ~~34~~, 35, ~~42~~, ~~44~~, ~~46~~, ~~48~~, ~~52~~, ~~54~~, ~~61~~, ~~63~~, ~~67~~, ~~69~~, ~~71~~, ~~76~~, ~~77~~, ~~82~~, ~~84~~, ~~91~~, ~~100~~, ~~104~~, ~~106~~, ~~108~~, ~~112~~, ~~114~~, ~~116~~, 120, ~~122a+b~~, ~~128b~~, ~~129b~~, ~~154~~, ~~155~~, 157, 164, 165, 176, 179, 186

10 (a) $CH_3NH_3^+ \rightleftharpoons H_3O^+ + CH_3NH_2$ $\quad Ka = \frac{[H_3O^+][CH_3NH_2]}{[CH_3NH_3^+]}$

(b) $HClO \rightleftharpoons H^+ + ClO^-$ $\quad Ka = \frac{[H^+][ClO^-]}{[HClO]}$

(c) $H_2S \rightleftharpoons H^+ + HS^-$ $\quad Ka = \frac{[H^+][HS^-]}{[H_2S]}$

12 (a) $H_2PO_4^- \rightleftharpoons HPO_4^- + H^+$ $\quad Ka = \frac{[HPO_4^-][H^+]}{[H_2PO_4^-]}$

(b) $H_3PO_2 \rightleftharpoons H_2PO_2^- + H^+$ $\quad Ka = \frac{[H_2PO_2^-][H^+]}{[H_3PO_2]}$

(c) $HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$ $\quad Ka \frac{[H^+][SO_4^{2-}]}{[HSO_4^-]}$

14 Decreasing Acid Strength
$HCl > HNO_2 > HClO > HCN$

$HClO = 2.9 \times 10^{-8}$
$HCN = 6.2 \times 10^{-10}$
$HNO_2 = 7.1 \times 10^{-4}$

16 (a) CH_3NH_2 weak base
(b) K_2O strong base - why? water soluble containg O^{2-}
(c) HI strong acid
(d) $HCOOH$ weak acid

18 (a) $HOCH_2CH_2NH_2$ amine weak base
(b) H_2SeO_4 strong acid
(c) HS^- weak acid
(d) $B(OH)_3$ why weak acid?
alternate formula is H_3BO_3 H-O-B(-O-H)(-O-H) will lose H^+ ions

24 (a) pH of 0.0333M HNO_3 — $-\log(0.033) = 1.48$ acidic

(b) pOH of 0.0347 KOH — $-\log(0.0347) = 1.46$ pH = 12.5 basic

26 (a) pH of 7.52×10^{-4} CsOH ?

pOH = $-\log(7.52\times10^{-4})$

pOH = 3.12

pH = 10.87 basic

(b) 1.59×10^{-3} M $HClO_4$

pH = 2.8

pOH = 11.20

28 (a)

pH = 3.47

pOH = 10.53

$[H^+] = 10^{-3.47} = 3.39\times10^{-4}$ M

$[OH^-] = 10^{-10.53} = 2.95\times10^{-11}$ M

(b)

pOH = 4.33

pH = 9.67

$[H^+] = 10^{-9.67} = 2.14\times10^{-10}$ M

$[OH^-] = 10^{-4.33} = 4.68\times10^{-5}$ M

30 (a) pH = 8.97

pOH = 5.03

$[H^+] = 1.07\times10^{-9}$ M

$[OH^-] = 9.33\times10^{-6}$ M

(b) pOH = 11.27

pH = 2.73

$[OH^-] = 5.37\times10^{-12}$ M

$[H^+] = 1.86\times10^{-3}$ M

32 pH = 9.33 → pH = 9.07

$[H^+] = 4.677\times10^{-10}$ M — $[H^+] = 8.51\times10^{-10}$ M — add 3.83×10^{-10} mol H^+

34 87.5mL of HA to adjust pH = 8.92 to pH = 6.33

pH=8.92 — pH = 6.33

$[H^+] = 1.20\times10^{-9}$ M — $[H^+] = 4.68\times10^{-7}$ M

add 4.66×10^{-7} mol/1L if making 1L

so $$\frac{4.66\times10^{-7}\text{ mol}}{1L} = \frac{x}{0.0875}$$

$x = 4.078\times10^{-8}$ mol needed

(35) H_3O^+ = purple $pH_A = 4.8$ $[H^+] = 10^{-4.8} = 1.58 \times 10^{-5}$ M 2 molec.

Volume = equal $pH_B =$ $[H^+] =$ 25 molecul

(42) (a) $HCOOH \rightleftharpoons H_3O^+ + HCOO^-$ $Ka = \frac{[H_3O^+][HCOO^-]}{[HCOOH]}$

(b) $HClO_3 \rightleftharpoons H^+ + ClO_3^-$ $Ka = \frac{[H^+][ClO_3^-]}{[HClO_3]}$

(c) $H_2AsO_4^- \rightleftharpoons H^+ + HAsO_4^{2-}$ $Ka = \frac{[H^+][HAsO_4^{2-}]}{[H_2AsO_4^-]}$

44 (a) $\underset{A}{HPO_4^-} \rightleftharpoons \underset{CB}{PO_4^{3-}}$

(b) $\underset{A}{NH_4^+} \rightleftharpoons \underset{CB}{NH_3}$

(c) $\underset{A}{HS^-} \rightleftharpoons \underset{CB}{S^{2-}}$

46 (a) $\underset{B}{O^{2-}} \rightleftharpoons \underset{CA}{HO^-}$

(b) $SO_4^{2-} \rightleftharpoons HSO_4^-$

(c) $H_2O \rightleftharpoons H_3O^+$

(48) (a) $\underset{B}{NH_3} + \underset{A}{HNO_3} \rightleftharpoons \underset{CA}{NH_4^+} + \underset{CB}{NO_3^-}$

(b) $\overset{B}{O^{2-}} + \underset{A}{H_2O} \rightleftharpoons \overset{CA}{OH^-} + \underset{CB}{OH^-}$

(c) $\underset{A}{NH_4^+} + \underset{B}{BrO_3^-} \rightleftharpoons \underset{CB}{NH_3} + \underset{CA}{HBrO_3}$

52 (a)

$\overset{A}{HNO_3} + Li_2CO_3 \rightleftharpoons LiNO_3 + LiHCO_3$

$H^+ + \cancel{NO_3^-} + \cancel{2Li^+} + CO_3^{2-} \rightleftharpoons \cancel{Li^+} + \cancel{NO_3^-} + \cancel{Li^+} + HCO_3^-$

$\underset{acid}{H_3O^+} + \underset{base}{CO_3^{2-}} \rightleftharpoons \underset{CA}{HCO_3^-} + \underset{CB}{H_2O}$

(b) $2NH_4Cl + Ba(OH)_2 \rightleftharpoons 2H_2O_{(l)} + BaCl_2 + 2NH_3$

$\underset{A}{2NH_4^+} + \cancel{2Cl^-} + \underset{B}{\cancel{Ba^{2+}}} + 2OH^- \rightleftharpoons \underset{CA}{2H_2O} + \underset{CB}{\cancel{Ba^{2+}}} + \cancel{2Cl^-} + 2NH_3$

$2NH_4^+ + 2OH^- \rightleftharpoons 2H_2O + 2NH_3$

54 $NO_3^- + HF \rightleftharpoons F^- + HNO_3$ $\quad K_c < 1$

$F^- + HNO_3 \rightleftharpoons NO_3^- + HF$ $\quad K_c > 1$

61 0.15M HA blue + green 33% dissociated

1. 5 HA
   4 dissociated
   $\frac{4}{9} \times 100 = 44\%$

2. 7 HA
   2 dissociated
   $\frac{2}{9} \times 100 = 22\%$

3. ☆ 6 HA
   3 dissociated
   $\frac{3}{9} = 33\%$

66

HA	$\rightleftharpoons$	H^+	+	A^-
0.035		0		0
$-x$		$+x$		$+x$
$0.035-x$		x		x

$pH = 4.88$

$[H^+] = 10^{-4.88}$

$= 1.32 \times 10^{-5}$

$K_a = \frac{(1.32 \times 10^{-5})^2}{0.035}$

$K_a = 4.97 \times 10^{-9}$

(67) $HF \rightleftharpoons H^+ + F^-$

HF	H^+	F^-
0.75	0	0
$-x$	$+x$	$+x$
$0.75-x$	x	x

$K_a = 6.8\times10^{-4}$

$$6.8\times10^{-4} = \frac{x^2}{0.75}$$

$x = 0.0226M = [H^+] = [F^-]$

$$[OH^-] = \frac{1\times10^{-14}}{0.0226} = 4.4\times10^{-13}\ M$$

(69) $HClO \rightleftharpoons H^+ + ClO^-$

$HClO$	H^+	ClO^-
0.115	0	0
$-x$	$+x$	$+x$
$0.115-x$	x	x

$pK_a = 7.54$

$K_a = 10^{-7.54} = 2.88\times10^{-4}$

$$2.88\times10^{-4} = \frac{x^2}{0.115}$$

$x = 5.76\times10^{-5}M = [H^+]✓ = [ClO^-]✓$

$pH = 4.24$ ✓

$[HClO] = 0.115 - 5.76\times10^{-5} = 0.115M$

(71) $HA \rightleftharpoons H^+ + A^-$

HA	H^+	A^-
0.735	0	0
$-x$	$+x$	$+x$
$0.735-x$	x	x

% dissociated = 12.5%

$$0.125 = \frac{x}{0.735}$$

$x = 0.0919\ M = [H^+] = [A^-]$

$pH = 1.04$

$pOH = 12.96$

$[OH^-] = 1.096\times10^{-13}M$

$$K_a = \frac{(0.0919)^2}{0.735} = 0.0115$$

(73) $HY \rightleftharpoons H^+ + Y^-$

4.85×10^{-3} mol

0.095L

HY	H^+	Y^-
0.051	0	0
$-x$	$+x$	$+x$
$0.051-x$	x	x

$pH = 2.68$ $K_a = ?$

$[H^+] = 2.09\times10^{-3}M$

$$K_a = \frac{(2.09\times10^{-3})^2}{0.051}$$

$K_a = 8.56\times10^{-5}$

If subtract x

$$K_a = \frac{(2.09\times10^{-3})^2}{0.051-2.09\times10^{-3}}$$

$K_a = 8.93\times10^{-5}$

(77) (a) $HCN \rightleftharpoons H^+ + CN^-$

0.55	0	0
$-x$	$+x$	$+x$
$0.55-x$	x	x

$K_a = 6.2\times10^{-10}$ $pH = ?$

$6.2\times10^{-10} = \frac{x^2}{0.55}$

$x = 1.85\times10^{-5} = [H^+]$

$pH = 4.73$

(b) $HIO_3 \rightleftharpoons H^+ + IO_3^-$

0.044	0	0
$-x$	$+x$	$+x$
$0.044-x$	x	x

$K_a = 0.016$

$0.016 = \frac{x^2}{0.044}$

$X = 0.0265$

$pH = 1.58$ $pOH = 12.42$

☆ technically should not neglect x & use quadratic

(82) $HC_9H_7O_4 \rightleftharpoons H^+ + C_9H_7O_4^-$

0.018	0	0
$-x$	$+x$	$+x$
$0.018-x$	x	x

$K_a = 3.6\times10^{-4}$

$3.6\times10^{-4} = \frac{x^2}{0.018}$

$x = 0.00255$

$pH = 2.59$

(99) Write K_b

(a) $C_5H_5N + H_2O \rightleftharpoons C_5H_5NH^+ + OH^-$ $K_b = \frac{[C_5H_5NH^+][OH^-]}{[C_5H_5N]}$

(b) $CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$ $K_b = \frac{[HCO_3^-][OH^-]}{[CO_3^{2-}]}$

(89) Choose weaker acid

(a) HBr or H_2Se

☆ weaker because less EN = stronger bond = less dissociation = weaker acid

(b) $HClO_4$ H_2SO_4

$HClO_4$: more EN

H_2SO_4: weaker acid

(c) H_2SO_3 H_2SO_4

H_2SO_3: weaker less oxygens

91 (a) HI or HBr

HBr ↑ smaller radius = strong bond = weak acid

(b) H_3AsO_4 H_2SeO_4

H_3AsO_4 ↑ weaker, less EN

(c) HNO_3 HNO_2

HNO_2 ↓ less # oxygens = stronger bond = weaker acid

(100) (a) $C_6H_5COO^- + H_2O \rightleftharpoons C_6H_5COOH + OH^-$

$$K_b = \frac{[C_6H_5COOH][OH^-]}{[C_6H_5COO^-]}$$

(b) $(CH_3)_3N + H_2O \rightleftharpoons (CH_3)_3NH^+ + OH^-$

$$K_b = \frac{[(CH_3)_3NH^+][OH^-]}{[(CH_3)_3N]}$$

(104) pH of dimethylamine

Dmeth $+ H_2O \rightleftharpoons$ DmethH$^+$ $+ OH^-$

$K_b = 5.9 \times 10^{-4}$

0.12	0	0
$-x$	$+x$	$+x$
$0.12-x$	x	x

$$5.9 \times 10^{-4} = \frac{x^2}{0.12}$$

$x = 0.008414$

pOH = 2.07 pH = 11.93

should use quadratic but...

(106) Aniline $\rightleftharpoons$ AnilineH^+ + OH^- $\quad K_b = 4.0 \times 10^{-10}$

Aniline	AnilineH+	OH-
0.26	0	0
$-x$	$+x$	$+x$
$0.26-x$	x	x

$$4.0 \times 10^{-10} = \frac{x^2}{0.26}$$

$$X = 1.02 \times 10^{-5}$$

$pOH = 4.99 \quad pH = 9.01$

(108) (a) ? K_b $\quad C_6H_5COO^- + H_2O \rightleftharpoons C_6H_5COOH + OH^-$

$K_a = 6.3 \times 10^{-5}$ benzoic acid

$K_a K_b = K_w$

$6.3 \times 10^{-5} (K_b) = 1 \times 10^{-14}$

$K_b = 1.59 \times 10^{-10}$

(b) $HOCH_2CH_2NH_3^+ + H_2O \rightleftharpoons H_3O^+ + HOCH_2CH_2NH_2$

$pK_b = 4.49$

$K_b = 3.24 \times 10^{-5}$

$K_a K_b = K_w$

$K_a (3.24 \times 10^{-5}) = 1 \times 10^{-14}$

$K_a = 3.09 \times 10^{-10}$

(112) (a) $C_6H_5O^- + H_2O \rightleftharpoons C_6H_5OH + OH^-$

$C_6H_5O^-$	C_6H_5OH	OH^-
0.100	0	0
$-x$	$+x$	$+x$
$0.100-x$	x	x

$$1 \times 10^{-4} = \frac{x^2}{0.1}$$

$X = 0.00316 M$

$pOH = 2.5$

$pH = 11.5$

C_6H_5ONa

C_6H_5OH WA $\quad$ NaOH SB

$K_a = 1 \times 10^{-10}$

$K_b K_a = K_w$

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

$K_b = 1 \times 10^{-4}$

(b) $CH_3NH_3^+ + H_2O \rightleftharpoons H_3O^+ + CH_3NH_2$

0.15		0	0
$-x$		$+x$	$+x$
$0.15-x$		x	x

$K_b = 4.4 \times 10^{-4}$
$K_a = 2.27 \times 10^{-11}$

$$2.27 \times 10^{-11} = \frac{x^2}{0.15}$$

$x = 1.85 \times 10^{-6}$

$pH = 5.73$

(114) (a) $F^- + H_2O \rightleftharpoons HF + OH^-$

0.75		0	0
$-x$		$+x$	$+x$
$0.75-x$		x	x

$K_a = 6.8 \times 10^{-4}$
$K_b = 1.47 \times 10^{-11}$

$$1.47 \times 10^{-11} = \frac{x^2}{0.75 \cancel{-x}}$$

$3.32 \times 10^{-6} = x$

$pOH = 5.48$

$pH = 8.52$

(b) $C_5H_5NH^+ + H_2O \rightleftharpoons C_5H_5N + H_3O^+$

0.88		0	0
$-x$		$+x$	$+x$
$0.88-x$		x	x

$K_b = 1.7 \times 10^{-9}$
$K_a = 5.88 \times 10^{-6}$

$$5.88 \times 10^{-6} = \frac{x^2}{0.88}$$

$x = 0.002275$

$pH = 2.64$

weak base makes acidic solution

(116) $C_{18}H_{22}NO_3H^+ + H_2O \rightleftharpoons H_3O^+ + C_{18}H_{22}NO_3$

$C_{18}H_{22}NO_3H^+$	H_3O^+	$C_{18}H_{22}NO_3$
0.050	0	0
$-x$	$+x$	$+x$
$0.050 - x$	x	x

$pK_b = 5.80$
$K_b = 1.58 \times 10^{-6}$
$K_a = 6.3 \times 10^{-9}$

$6.31 \times 10^{-9} = \frac{x^2}{0.050}$

$x = 1.78 \times 10^{-5}$

$pH = 4.75$

(120) (a) KBr

KOH HBr neutral

(b) NH_4I

NH_3 HI

$NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$

acidic

(c) KCN

KOH SB HCN WA

$CN^- + H_2O \rightleftharpoons HCN + OH^-$

basic solution

122(a) Na_2CO_3

NaOH SB H_2CO_3 WA

$CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$

basic

(b) $CaCl_2$

$Ca(OH)_2$ HCl

neutral

128 (b) ↑ pH $NaHSO_4 < NH_4NO_3 < NaHCO_3 < Na_2CO_3$

NH_4NO_3
NH_3 HNO_3

$NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$
acidic

$NaHSO_4$
$NaOH$ SB H_2SO_4
amphiteric in water

$NaHCO_3$
$NaOH$ H_2CO_3

$HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + OH^-$
basic

Na_2CO_3
$NaOH$ HCO_3^-

$CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$

129b decreasing pH

$FeCl_2$ hydrated metal acidic

$FeCl_3$

$MgCl_2$

$KClO_2$

$\overset{+1}{KClO_2} > \overset{2+}{MgCl_2} > \overset{2+}{FeCl_2} > \overset{3+}{FeCl_3}$

$K_a = 6 \times 10^{-3}$

smaller + more charged = more acidic

☆ Ka values would be helpful

(154) $HY \rightleftharpoons H^+ + Y^-$ sphere = 0.010 mol

(a) @ equilibrium

$K = \frac{(4)^2}{8}$

$K = 2$

(b)

	$\rightleftharpoons$	0	0
$-x$		$+x$	$+x$
$0.300 - x$		x	x

$Q = \frac{2(2)}{6}$

$Q = 0.667$

(c) $Q = \frac{2(2)}{4}$

$= 1$

(d) $Q = \frac{2(2)}{2}$

$Q = 2$ ☆ at equilibrium

(155) (a) higher $HCl \rightarrow H^+ + Cl^-$ Completely dissociates so produces more ions, higher electrical conductivity than weak acid

(b) about the same because very similar to $[H_3O^+][OH^-]$ is just plain water

won't significantly change amt H^+ or OH^-