Ch 17 Acids + Bases Exercises

33. a) $HNO_3(aq) \rightarrow H^+_{(aq)} + NO_3^-(aq)$ A b) $NH_4^+(aq) \rightarrow H^+(aq) + NH_3(aq)/gas$ A

c) $KOH(aq) \rightarrow K^+(aq) + OH^-(aq)$ B d) $HC_2H_3O_2(aq) \rightarrow H^+(aq) + C_2H_3O_2^-(aq)$ A

34 b) $H_2SO_4(aq) \rightarrow 2H^+_{(aq)} + SO_4^{-2}$ A or $(H_2SO_4 \rightarrow H^+ + HSO_4^-)$

d) $Sr(OH)_2(aq) \rightarrow Sr^{+2}(aq) + 2OH^-(aq)$ B or $(Sr(OH)_2(aq) \rightarrow Sr(OH)^{+1}(aq) + OH^-(aq))$

35 a) $\underset{A}{H_2CO_3} + \underset{B}{H_2O} \rightleftharpoons \underset{CA}{H_3O^+} + \underset{CB}{HCO_3^-}$ b) $\underset{B}{NH_3} + \underset{A}{H_2O} \rightleftharpoons \underset{CA}{NH_4^+} + \underset{CB}{OH^-}$

d) $\underset{B}{C_5H_5N} + \underset{A}{H_2O} \rightleftharpoons \underset{CA}{C_5H_5NH^+} + \underset{CB}{OH^-}$

37 a) Cl^- b) HSO_3^- c) CHO_2^- $(COOH^-)$ d) F^-

39) $\underset{A}{H_2PO_4^-} + \underset{B}{H_2O} \rightleftharpoons \underset{CA}{H_3O^+} + \underset{CB}{HPO_4^{-2}}$ $\underset{B}{H_2PO_4^-} + \underset{A}{H_2O} \rightleftharpoons \underset{CA}{H_3PO_4} + \underset{CB}{OH^-}$

41) HNO_3, HCl, HBr] SA d) H_2SO_3 (WA) $H_2SO_3 + H_2O \rightleftharpoons H_3O^+ + HSO_3^-$

43a) $0HA, 10H^+, 10A^-$ b) $3HA, 3H^+, 7A^-$ $K_a = \dfrac{[H_3O^+][HSO_4^-]}{[H_2SO_3]}$

c) $9HA, 1H^+, 1A^-$ a > b > c

44) $HCl > HF\ (K_a = 3.5\times10^{-4}) > HClO\ (K_a = 2.9\times10^{-8}) > HC_6H_5O\ (K_a = 1.3\times10^{-10})$

45 a) F^- stronger than Cl^- HF (WA) HCl (SA) weaker the acid stronger CB

b) $NO_2^- > NO_3^-$ " " " " " "

c) $ClO^- > F^-$ $HF\ (K_a = 3.5\times10^{-4})$ $HClO\ (K_a = 2.9\times10^{-8})$ weaker acid stronger CB

47 a) $1.0\times10^{-14} = (1.2\times10^{-8})(OH^-)$ b) $1.0\times10^{-14} = (8.5\times10^{-5})(OH^-)$

$OH^- = 8.3\times10^{-7}$ Basic $OH^- = 1.2\times10^{-10}$ Acidic

49 c) $pH = -\log(2.2\times10^{-6}) = 5.66$ $pOH = 14.00 - 5.66 = 8.34$ acidic

53) $K_w = 2.4\times10^{-14} = [H_3O^+][OH^-]$ $[H_3O^+] = \sqrt{2.4\times10^{-14}} = 1.5\times10^{-7}$

$pH = -\log(1.5\times10^{-7}) = 6.82$

55) $pH = -\log(0.044) = 1.36$ $pH = -\log(0.045) = 1.35$ $pH = -\log(0.046) = 1.34$

56) $10^{-2.50} = 3.2\times10^{-3}$ $10^{-2.51} = 3.1\times10^{-3}$ $10^{-2.52} = 3.0\times10^{-3}$

2 sfs

57a) 0.25M HCl (SA) $H_3O^+ = 0.25M$ $pH = -\log(0.25) = 0.60$ or $pOH = 13.40$ $[OH^-] = 10^{-13.40}$ $[OH^-] = \frac{1.0\times10^{-14}}{0.25} = 4.0\times10^{-14}$

b) $0.015M\ HNO_3$ $H_3O^+ = 0.015M$ $pH = -\log(0.015) = 1.82$ $[OH^-] = \frac{1.0\times10^{-14}}{0.015} = 6.7\times10^{-13}$

c) total $H_3O^+ = 0.072M$ $pH = -\log(6.072) = 1.14$ $[OH^-] = 1.4\times10^{-13}$

59a) $pH = 1.25$ $H_3O^+ = 10^{-1.25} = 0.056M$ $0.250L \times \frac{0.056\ mol\ HI}{L} \times \frac{127.9g\ HI}{1\ mol} = 1.8g\ HI$

61) $n = \frac{PV}{RT} = \frac{(1.02atm)(0.224L)}{(0.0821\frac{atm\cdot L}{mol\,K})(300.35K)} = 0.00927mol$ $\frac{0.00927mol}{1.5L} = 0.0062M$ $pH = 2.21$

63) $HC_7H_5O_2 + H_2O \rightleftharpoons H_3O^+ + C_7H_5O_2^{-1}$ $K_a = \frac{(x)(x)}{0.100-x} = 6.5\times10^{-5}$

	$HC_7H_5O_2$	H_2O	H_3O^+	$C_7H_5O_2^{-1}$
I	0.100		0	0
C	$-x$		$+x$	$+x$
E	$0.100-x$		x	x

assume x is small compared to 0.100

$x = 2.5\times10^{-3}$ $\frac{2.5\times10^{-3}}{0.100}\times100 = 2.5\%$

$pH = -\log(2.5\times10^{-3}) = 2.60$

65)a) $HNO_2 + H_2O \rightleftharpoons H_3O^+ + NO_2^-$ $\frac{x^2}{0.500-x} = 4.6\times10^{-4}$ assume x is small vs 0.500

	HNO_2	H_2O	H_3O^+	NO_2^-
	0.500		0	0
	$-x$		$+x$	$+x$
	$0.500-x$		x	x

$x = 0.015$ $pH = 1.82$

$\frac{0.015}{0.500}\times100 = 3\%$

b) $\frac{x^2}{0.100} = 4.6\times10^{-4}$ if x is small $x = 0.0068M$ $\frac{0.0068}{0.100}\times100 = 6.8\%$ Not valid (still close)

quadratic $x = 0.00656M$ $pH = 2.18$ $pH = 2.17$

c) $\frac{x^2}{0.0100} = 4.6\times10^{-4}$ if x is small $x = 0.0021M$ $pH = 2.68$ $\frac{0.0021}{0.0100}\times100 = 21\%$ Not valid

quadratic $x = 0.0019$ $pH = 2.72$

67) $15.0mL \times \frac{1.05g}{mL} \times \frac{1mol}{60.05g} = \frac{0.262mol}{1.50L} = 0.1749M$

$\frac{x^2}{0.1749-x} = 1.8\times10^{-5}$ if x is small vs 0.1749 $pH = 2.75$

$x = 0.00177M$ $\frac{0.00177}{0.1749}\times100 = 1.0\%$

69) $HA + H_2O \rightleftharpoons H_3O^+ + A^-$ $pH = 2.95$ $[H_3O^+] = 10^{-2.95} = 0.00112M$

	HA	H_2O	H_3O^+	A^-
	0.185		0	0
	$-x$		$+x$	$+x$
	$0.185-0.00112$		0.00112	0.00112

$K_a = \frac{(0.00112)^2}{(0.18388)} = 6.82\times10^{-6}$

125) a) Fe^{+3} (LA) accepts from H_2O (LB) b) Zn^{+2} (LA) accepts from NH_3 (LB) c) BF_3 (LA) accepts from $(CH_3)_3N$ (LB)

127) a) HF WA molecules in soln (Not ionized) b) HI strong completely ionized
c) $HCHO_2$ WA ↓ d) HNO_3 SA completely ionized

128) a) NH_3 WA (molecules) b) NaOH SB complete dissociation
c) $NaHCO_3$ $HCO_3^- + H_2O \rightarrow H_2CO_3 + OH^-$ d) $Sr(OH)_2$ SB complete dissoc

129) an ↑ in H^+ would shift the eq ← causing less HbO_2 in blood ↓ O_2 carrying capacity

131) $[H^+] = 10^{-1.3} = 0.05\,M$ $\quad Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$

$$4.00\times10^{2}\,mg\,Mg(OH)_2 \times \frac{1\,g}{1000\,mg} \times \frac{1\,mol\,Mg(OH)_2}{58.33\,g} \times \frac{2\,mol\,HCl}{1\,mol\,Mg(OH)_2} \times \frac{1000\,mL\,HCl}{0.05\,mol} = 270\,mL \quad \text{yes}$$

135) $\frac{650\,mg}{8oz} \times \frac{1\,g}{1000\,mg} \times \frac{1\,mol}{180\,g} \times \frac{32oz}{gt} \times \frac{1.06\,g\,t}{1L} = 0.015\,M$ $\quad K_a = 10^{-3.5} = 3.16\times10^{-4}$ ↑ Not small

$$\frac{x^2}{0.015-x} = 3.16\times10^{-4}$$

if x were small compared to

$x = 0.002065$ (138) $\quad pH = 2.68$

x → quadratic $= 2.04\times10^{-3}$ $\quad pH = 2.69 \approx 2.7$

71) $HCN + H_2O \rightleftharpoons H_3O^+ + CN^-$ $\frac{x^2}{0.125-x} = 4.9\times10^{-10}$ $\% = \frac{7.83\times10^{-6}}{0.125}\times100$

I	0.125	0	0
C	$-x$	$+x$	$+x$
E	$0.125-x$	x	x

assume x is small $x = 7.83\times10^{-6}$ $= 0.0063\%$

73) a) $\frac{x^2}{1.00-x} = 1.8\times10^{-5}$ $\% = 0.42$ $x = 0.00424$

d) $\frac{x^2}{0.0500-x} = 1.8\times10^{-5}$ $\% = 1.9\%$ $x = 9.49\times10^{-4}$

lower conc = higher % ionized

79) a) since HBr is strong and $HCHO_2$ is weak HBr will dominate the H_3O^+ conc

$0.115\,M\,HBr \rightarrow 0.115\,M\,H_3O^+$ $pH = -\log(0.115) = 0.939$

c) $0.185\,M\,HCHO_2$ $K_a = 1.8\times10^{-4}$ $0.225\,M\,HC_2H_3O_2$ $K_a = 1.8\times10^{-5}$ Close in conc Ka's 10' apart

since K_a of $HCHO_2$ is larger it will contribute more H_3O^+

$\frac{x^2}{0.185-x} = 1.8\times10^{-4}$ $x = 0.00577$

$HC_2H_3O_2 + H_2O \rightleftharpoons H_3O^+ + C_2H_3O^-$

	0.225	0.00577	0
	$-x$	$+x$	$+x$
	$0.225-x$	$0.00577+x$	x

$K_a = \frac{(0.00577+x)(x)}{(0.225-x)} = 1.8\times10^{-5}$ assume x is small compared to 0.225 but not 0.00577

quadratic $x^2 + 0.00577x - 4.05\times10^{-6}$ $x = 0.000625$

$[H_3O^+] = 0.00577 + 0.000625 = 0.0064$ $pH = 2.19$

d) $0.050\,M\,HC_2H_3O_2$ $K_a = 1.8\times10^{-5}$ $0.050\,M\,HCN$ $K_a = 4.9\times10^{-10}$ K_a's 10^5 apart acetic dominates

$\frac{x^2}{0.050-x} = 1.8\times10^{-5}$ $x = 9.49\times10^{-4}$ $pH = 3.02$

81) a) $0.15\,M\,NaOH$ $[H_3O^+] = \frac{1.0\times10^{-14}}{0.15} = 6.7\times10^{-14}\,M$ $pH = 13.17$ $pOH = 0.83$

c) $4.8\times10^{-4}\,M\,Sr(OH)_2$ $[OH^-]$ 2x $[H_3O^+] = \frac{1.0\times10^{-14}}{2(4.8\times10^{-4})} = 1.04\times10^{-11}$ $pH = 10.98$ $pOH = 3.02$

87) a) $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ $K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$

b) $HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + OH^-$

c) $CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^-$

89) 0.15 M NH_3 $K_b = 1.76 \times 10^{-5}$ $[OH^-]$, pH, pOH?

$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ $\quad K_b = \frac{x^2}{0.15-x} = 1.76\times10^{-5}$ $\quad x = 0.00162\ M$

0.15 − x $\quad$ x $\quad$ x $\quad$ pOH = 2.79 $\quad$ pH = 11.21

91) $\frac{455\ mg\ Caff}{L} \times \frac{1\ g}{1000\ mg} \times \frac{1\ mol}{194.20\ g} = 0.00234\ M$ $\quad \frac{x^2}{0.00234-x} = 3.98\times10^{-11}$

$pK_b = 10.4$ $\quad K_b = 10^{-10.4} = 3.98\times10^{-11}$ $\quad x = 3.05\times10^{-7}\ M$ $\quad \frac{3.05\times10^{-7}}{0.00234} \times 100 = 0.013\%$

$pOH = -\log = 6.5$ $\quad pH = 7.5$

95) a) Br^- neutral b) $ClO^- + H_2O \rightleftharpoons HClO + OH^-$ weak base c) $CN^- + H_2O \rightleftharpoons HCN + OH^-$ weak base

d) Cl^- neutral

97) $F^- + H_2O \rightleftharpoons HF + OH^-$ $\quad K_a(HF) = 3.5\times10^{-4}$ $\quad K_b(F^-) = \frac{1\times10^{-14}}{} = 2.86\times10^{-11}$

$\frac{x^2}{0.140-x} = 2.86\times10^{-11}$ $\quad x = 2.0\times10^{-6}$ $\quad pOH = 5.70$ $\quad pH = 8.30$

99) a) $NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$ (WA) b) Na^+ neutral

c) $Co^{3+} + H_2O \rightleftharpoons Co(OH)^{+2} + H^+$ (WA) d) $CH_2NH_3^+ + H_2O \rightleftharpoons H_3O^+ + CH_2NH_2$ (WA)

101) a) $FeCl_3$ acidic Fe^{+3} attracts OH^- b) NaF basic F^- CB anion of WA HF c) $CaBr_2$ neutral

d) NH_4Br acidic NH_4^+ CA of WB e) $C_6H_5NH_3NO_2$ acidic $C_6H_5NH_3^+$ CA of WB NO_2^- CB of WA

$K_b\ C_6H_5NH_2 = 3.9\times10^{-10}$ $\quad K_a(C_6H_5NH_3^+) = 2.6\times10^{-5} > K_b(NO_2^-) = 2.2\times10^{-11}$

$K_a\ HNO_2 = 4.6\times10^{-4}$

103) $NaOH < NaHCO_3 < NaCl < NH_4ClO_2 < NH_4Cl$ $\quad NH_4^+\ K_a = 5.6\times10^{-10} > ClO_2^-\ K_b = 9.1\times10^{-13}$ acidic

105) a) 0.10 M NH_4Cl $\quad NH_4^+ + H_2O \rightleftharpoons NH_3 + OH^-$ $\quad$ b) 0.10 $NaC_2H_3O_2$ $\quad pOH = 5.13$

$\frac{x^2}{0.10-x} = 5.6\times10^{-10}$ $\quad pH = 5.13$ $\quad \frac{x^2}{0.10-x} = 5.6\times10^{-10}$ $\quad pH = 8.87$

$x = 7.48\times10^{-6} = [H^+]$ $\quad x = 7.48\times10^{-6} = [OH^-]$ $\quad$ c) Neutral

117) a) HCl > HF weaker bond

b) HF > H_2O more polar more acidic (fig 17.14) $\quad$ c) $H_2Se > H_2S$ weaker bond

119) a) H_2SO_4 more O $\quad$ b) $HClO_2$ $\quad$ c) HClO Cl more EN than Br $\quad$ d) CCl_3COOH

Cl more EN than H

123) a) Fe^{+3} lewis acid accepts lone pairs b) BH_3 Lewis Acid B has empty p

empty d c) NH_3 Lewis base donate pair d) F^- Lewis base can donate pairs