Chapter 16

2) a) HY ; more dissociated ions
b) X^- (strong acids have negligible bases)
c) left HX doesn't like to break apart
remains reactant favored

3) a) HY completely dissociated
b) smallest Ka = weakest acid HX
c) highest pH most basic least H^+ HX

17) a) conj. base → lose H^+
i) IO_3^- ii) NH_3

b) conj. acid → gain H^+
i) OH^- ii) H_3PO_4

19) a) $NH_4^+ + CN^- \rightleftharpoons HCN + NH_3$
A B CA CB

b) B , A , CA , CB

c) A , B , CB , CA

21) a) $HC_2O_4^- + H_2O \rightleftharpoons C_2O_4^{2-} + H_3O^+$

$HC_2O_4^- + H_2O \rightleftharpoons H_2C_2O_4 + OH^-$

b) conj acid - $H_2C_2O_4$
conj base $C_2O_4^{2-}$

23) a) weak base ; conj acid HCH_3COO
weak acid
b) weak base ; $CA = H_2CO_3$, weak acid
c) O^{2-} , strong base $CA = OH^-$ strong base

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23) d) Cl^- negligible ; CA = HCl strong acid
e) weak base, CA = NH_4^+ weak acid

30) a) $H_2O(l) + H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$

b) $K_w = [H_3O^+][OH^-]$
H_2O is liquid ; heterogenous mixtures only list aq.

c) pH < 7
solutions contains more OH^- than H^+

31) $K_w = 1.0 \times 10^{-14} = [H_3O^+][OH^-]$

a) $1.0 \times 10^{-14} = [H_3O^+][0.00045]$

$[H^+] = 2.2 \times 10^{-11}$ basic

b) 1.1×10^{-6} ; acidic

c) 1.0×10^{-8} ; basic

37) a) decreases H^+, increases pH

b) 6.0×10^{-4} = pH H-3 acidic
$pH = -\log(6.0 \times 10^{-4}) = 3.2$

c) 5.2 pH $= 1.0 \times 10^{-5}$

$10^{-5.2} = 6.0 \times 10^{-6} M = [H^+]$
$1.0 \times 10^{-14} / (6.0 \times 10^{-6}) = 2 \times 10^{-9} M = [OH^-]$

39)

$[H^+]$	$[OH^-]$	pH	pOH	A or B
7.5×10^{-3} M	1.3×10^{-12} M	2.12	11.88	A
2.8×10^{-5} M	3.6×10^{-10} M	4.56	9.44	A
5.6×10^{-9} M	1.8×10^{-6} M	8.25	5.75	B
5.0×10^{-9} M	2.0×10^{-6} M	8.30	5.70	B

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43) a) An acid that completely dissociates in an aqueous solution

b) $[H^+] = 0.500M$

c) HCl, HBr, HI

44) a) A base that completely dissociates in an aqueous solution

b) $[OH^-] = 2 \times 0.035 = 0.070M$

45) a) $pH = -\log(8.5 \times 10^{-3} M) = 2.07$

b) $\frac{1.52g}{} \left| \frac{1 \text{ mol}}{\_\_ g} \right| \frac{}{.575L}$ = conc H^+ = 0.0419M

(molar mass HNO_3)

$-\log(H^+) = 1.377$

c) $M_1V_1 = M_2V_2$ $\frac{5}{1000} \times .250 = \frac{50}{1000} \times M_2$

$[H^+] = .0250M$ $-\log(H^+) = 1.602$

d) $\frac{0.100 \text{ Mol}}{L} \left| .010L \right.$ = .001 moles H^+

+

$\frac{0.200 \text{ mol}}{L} \left| 0.020 L \right.$ = .004 moles H^+

=

$\frac{.005 \text{ moles } H^+}{.03 \text{ L}}$ = .167 M $-\log(.167) =$

pH = 0.778

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47) a) $[OH^-] = 1.5 \times 10^{-3} \times 2 = 0.003$ M

$pOH = -\log(.003) = 2.52$ $\quad 14 - 2.52 = 11.5 = pH$

b) $\frac{2.250\,g}{} \Big| \frac{1\,mol}{\_\_\_\,g} \Big| \frac{}{.250\,L} = [OH^-] = 0.3758$ M

molar mass LiOH

$-\log(.3758) = pOH$

$14 - pOH = 13.5750$

c) $\frac{.175\,mol}{L} \Big| \frac{.001\,L}{} \Big| \frac{}{2\,L} = [OH^-] = 8.75 \times 10^{-5}$ M

$-\log(8.75 \times 10^{-5}) = pOH$

$14 - pOH = 9.942$

d) $\frac{0.105\,mol}{L} \Big| \frac{.005\,L}{} = 5.25 \times 10^{-4}$

$+ \quad = 0.003375 / .020$

2 OH^- in $Ca(OH)_2$

$\frac{9.5 \times 10^{-2}\,mol}{L} \Big| \frac{2}{} \Big| \frac{.015\,L}{} = 0.00285$ $\qquad [OH^-]$ 0.17 M

$-\log(OH^-) = pOH \quad 14 - pOH = 13.23$

49) $10^{-11.5} = 3.16 \times 10^{-12}\,M = [H^+]$

$1.0 \times 10^{-14} = (3.16 \times 10^{-12})(OH^-) =$

$[OH^-] = 3.2 \times 10^{-3}$ M NaOH

51) a) $HBrO_2(aq) + H_2O(l) \rightleftharpoons H^+(aq) + BrO_2^-(aq)$

$Ka = \frac{[H^+][BrO_2^-]}{[HBrO_2]}$ $\qquad Ka = \frac{[H_3O^+][BrO_2^-]}{[HBrO_2]}$

b) $Ka = \frac{[H^+][C_2H_5COO^-]}{[C_2H_5COOH]}$ $\qquad Ka = \frac{[H_3O^+][C_2H_5COO^-]}{[C_2H_5COOH]}$

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53) $K_a = \frac{[H^+][CH_3CH(OH)COO^-]}{[CH_3CH(OH)COOH]}$ $pH = -\log(H^+)$
$2.44 = -\log(H^+)$
$10^{-2.44} = 0.00363 = H^+$

$K_a = \frac{(0.00363)(.00363)}{0.10}$

$K_a = 1.32 \times 10^{-4}$

54) $K_a = \frac{[H^+][CB]}{[A]}$ $10^{-2.68} = 0.00209\ M = H+$

$K_a = \frac{(0.00209)(.00209)}{.085} = 5.14 \times 10^{-5}$

57) $10^{-2.90} = 0.00126\ M = [H^+]$

$1.8 \times 10^{-5} = \frac{(.00126)(.00126)}{[\text{acetic acid}]}$

$[CH_3COOH] = 0.088\ M$

59) $6.3 \times 10^{-5} = \frac{x^2}{.050}$ $[H_3O^+] = 1.8 \times 10^{-3}\ M$
$[C_6H_5COO^-] = 1.8 \times 10^{3}\ M$
$[C_6H_5COOH] = 0.050$

63) $pK_a = 2.32$ $10^{-2.32} = K_a = 0.00479$

$K_a = \frac{[H^+][CB]}{0.10} = 0.00479$

$[H^+] = 0.0219\ M$

$pH = -\log(.0219) = 1.66$

65) percent ionization = $\frac{[H^+]}{[HA]} \times 100\%$

a) $K_a = 1.9 \times 10^{-5} = \frac{[H^+][N_3^-]}{0.400}$

$[H^+] = 0.00276\,M$

$\% = \frac{0.00276}{0.400} \times 100 = 6.89\%$

b) $1.9 \times 10^{-5} = \frac{x^2}{.1}$ $\frac{.00138}{.1} \times 100 = 1.38\%$

c) $1.9 \times 10^{-5} = \frac{x^2}{.04}$ $\frac{8.72 \times 10^{-4}}{.04} \times 100 = 2.18\%$

73) a) $K_b = \frac{[H(CH_3)_2NH][OH^-]}{[(CH_3)_2NH]}$ $(CH_3)_2NH + H_2O \rightleftharpoons H(CH_3)_2NH + OH^-$

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

c) $K_b = \frac{[HCHO_2][OH^-]}{[CHO_2^-]}$

75) $K_b = 6.4 \times 10^{-4} = \frac{[CA][OH^-]}{0.075}$

$[OH^-] = 6.93 \times 10^{-3}$

$-\log(OH^-) = 2.16$

$14 - 2.16 = 11.84 = pH$

76) $4.0\times10^{-6} = \frac{x^2}{0.550}$ $[OH^-] = 1.48\times10^{-3}M$
$-\log(OH^-) = 2.83$
$14 - 2.83 = 11.17$

78) $10^{-9.95} = H^+ = 1.12\times10^{-10}$
$[OH^-] = 8.91\times10^{-5}$

$K_b = \frac{(8.91\times10^{-5})(8.91\times10^{-5})}{(5.0\times10^{-3})}$

$K_b = 1.59\times10^{-6}$
$pK_b = -\log(1.59\times10^{-6})$
$pK_b = 5.80$

81) a) ↑ Ka ↑ acidity
acetic acid = stronger acid
b) hypochlorite ion
c) $10^{-14} = K_b \times K_a$
CH_3COO^- $K_b = 5.56\times10^{-10}$
ClO^- $K_b = 3.33\times10^{-7}$

82) a) ammonia
b) hydroxylamine
c) K_a $NH_4^+ = 5.56\times10^{-10}$
K_a $H_3NOH^+ = 9.09\times10^{-7}$

85) a) NH_4Br dissociates $NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$
acidic
b) $FeCl_3 + H_2O \rightleftharpoons HCl + FeOH$ acidic
strong acid
dissociates H^+

c) Na_2CO_3 dissociates $CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$
basic

d) ~~K~~$ClO_4^- + H_2O \rightleftharpoons HClO_4 + OH^-$
dissociates
strong acid ~~H^+~~ $+ ClO_4^- +$ ~~OH^-~~
neutral