HOME WORK SOLUTION CH # 14

Old New

Q. 28/30

a) $HC_2H_3O_2(aq) \rightleftharpoons H^+(aq) + C_2H_3O_2^-(aq)$ $\quad K_a = \frac{[H^+][C_2H_3O_2^-]}{[HC_2H_3O_2]}$

b) $Co(H_2O)_6^{3+}(aq) \rightleftharpoons H^+(aq) + Co(H_2O)_5(OH)^{2+}(aq)$

$K_a = \frac{[H^+][Co(H_2O)_5(OH)^{2+}]}{[Co(H_2O)_6^{3+}]}$

c) $CH_3NH_3^+(aq) \rightleftharpoons H^+(aq) + CH_3NH_2(aq)$ $\quad K_a = \frac{[H^+][CH_3NH_2]}{[CH_3NH_3^+]}$

Q. 30/32

	Acid	Base	Conj. Base	Conj. Acid
a)	$Al(H_2O)_6^{3+}$	H_2O	$Al(H_2O)_5(OH)^{2+}$	H_3O^+
b)	$HONH_3^+$	H_2O	$HONH_2$	H_3O^+
c)	$HOCl$	$C_6H_5NH_2$	OCl^-	$C_6H_5NH_3^+$

Q. 47/47 Strong Acid dissociate completely: $HA(aq) \rightarrow H^+(aq) + A^-(aq)$

0.250M 0.250M 0.250M

a) Major species present after dissociation = H^+, ClO_4^- and H_2O $\quad pH = -\log[H^+] = -\log(0.250) = 0.602$

b) Major species: H^+, NO_3^- and H_2O, $pH = 0.602$

Q. 54/52: $pH = 5.10$, $pH = -\log[H^+] = 5.10 = -\log[H^+]$, $[H^+] = 10^{-5.10} = 7.9 \times 10^{-6}\ M$

Q. 58/55: $20.0\ mL$ glacial acetic acid $\times \frac{1.05\ g}{mL} \times \frac{1\ mol}{60.05\ g} = 0.350\ mol\ HC_2H_3O_2$

Initial Conc. of $HC_2H_3O_2 = \frac{0.350\ mol}{0.2500\ L} = 1.40\ M$

	$HC_2H_3O_2$	$\rightleftharpoons$	H^+	+	$C_2H_3O_2^-$
Initial	1.40		~0		0
	x mol/L $HC_2H_3O_2$ dissociate to reach equilibrium				
Change	$-x$	$\longrightarrow$	$+x$		$+x$
Equil.	$1.40-x$		x		x

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

$K_a = 1.8 \times 10^{-5} = \frac{[H^+][C_2H_3O_2^-]}{[HC_2H_3O_2]} = \frac{x^2}{1.40-x} = \frac{x^2}{1.40}$

$x = [H^+] = 5.0 \times 10^{-3}\ M$, $pH = 2.30$

Assumption is good (x is 0.36 % of 1.40)

old New
Q.66/64 a) HNO_3 is strong acid; it is assumed 100% dissociated in solution.

b) Nitrous acid: $HNO_2 \rightleftharpoons H^+ + NO_2^-$ $k_a = 4.0 \times 10^{-4}$

	HNO_2	H^+	NO_2^-
Initial	0.20 M	~0	0
	x mol/L HNO_2 dissociate to reach equilibrium		
Change	$-x$ →	x	x
Equil.	$0.20-x$	x	x

$$k_a = \frac{[H^+][NO_2^-]}{[HNO_2]} = \frac{[x]^2}{0.20-x} = \frac{(x)^2}{0.20} = 4.0\times10^{-4}$$

$x = [H^+] = [NO_2^-] = 8.9\times10^{-3} M$; Assumption good.

% Dissociation: $\% = \frac{[H^+]}{[HNO_2]_0} \times 100 = \frac{8.9\times10^{-3}}{0.20} = 4.5\%$

c) $HOC_6H_5 \rightleftharpoons H^+ + OC_6H_5^-$ $K_a = 1.6\times10^{-10}$

	HOC_6H_5	H^+	$OC_6H_5^-$
Initial	0.20 M	~0	0
	x mol/L HOC_6H_5 dissociate to reach equilibrium		
Change	$-x$ →	$+x$	$+x$
Equil	$0.20-x$	x	x

$$k_a = \frac{[H^+][OC_6H_5^-]}{[HOC_6H_5]}$$

$k_a = \frac{[x^2]}{0.20-x} = 1.6\times10^{-10} = x = [H^+][OC_6H_5^-] = 5.7\times10^{-6} M$

% Dissociation: $\frac{5.7\times10^{-6}}{0.20}\times 100 = 2.9\times10^{-3}\%$

d) For the same initial conc, the percent dissociation increase as the strength of the acid increase (as ka increase).

Q.84/80: a) Major species: Na^+, Li^+, OH^-, H_2O (NaOH and LiOH are both strong bases)

$[OH^-] = 0.050 + 0.050 = 0.100 M$, pH = 13.00

b) Major species: Ba^{2+}; Rb^+; OH^-; H_2O; Both $Ba(OH)_2$ and RbOH are strong bases and $Ba(OH)_2$ donate 2 mol OH^- per mol $Ba(OH)_2$ $[OH^-] = (2\times0.0010) = 0.022 M$

$pOH = -\log(0.022) = 1.66$; pH = 12.34

Q.94/90; a) ~~pH = 10.50~~

	$HONH_2 + H_2O$	$\rightleftharpoons$	$HONH_3^+$	$+ OH^-$
Initial	0.10 M		0	0
equil.	$0.10-x$		x	x

$k_b = 1.1\times10^{-8}$

$1.1\times10^{-8} = \frac{x^2}{0.10-x} = \frac{x^2}{0.1}$ $x = [OH^-] = 3.3\times10^{-5} M$.

% Ionization $= [OH^-]/[OHNH_2]_0 \times 100 = 3.3\times10^{-5}/0.10 \times 100 = 0.033\%$

Q. 94/90 (old/new); b) $CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^-$ (3) $K_b = 4.38 \times 10^{-4}$

	CH_3NH_2	$CH_3NH_3^+$	OH^-
Initial	0.10 M	0	~0
Equil	0.10 − x	x	x

$$4.38 \times 10^{-4} = \frac{x^2}{0.10 - x} = \frac{x^2}{0.10} = x = 6.6 \times 10^{-3}$$ assumption fail the 5% rule (x is 6.6% of 0.10)

Using successive approximation and carrying extra significant figure.

$$\frac{x^2}{0.10 - 0.0066} = \frac{x^2}{0.093} = 4.38 \times 10^{-4} \quad x = 6.4 \times 10^{-3}$$ (consistent answer)

% ionization: $\frac{6.4 \times 10^{-3}}{0.10} \times 100 = 6.4\%$

Q. 104/100: ($CaBr_2$) & $Ca(NO_3)_2$ neutral; Ca^{2+} and Br^-/NO_3^- have no acidic/basic properties

KNO_2 / $NaNO_2$: NO_2^- is weak base, $K_b = \frac{1.0 \times 10^{-14}}{K_a (4.0 \times 10^{-4})} = 2.5 \times 10^{-11}$

$HClO_4$: Strong acid

HNO_2: Weak acid, $K_a = 4.0 \times 10^{-4}$

$HONH_3ClO_4$: $HONH_3^+$, weak acid, $K_a = \frac{1.0 \times 10^{-14}}{K_b (1.1 \times 10^{-8})} = 9.1 \times 10^{-7}$

Ignor ClO_4^-

most acidic → most basic: $HClO_4 > HNO_2 > HONH_3ClO_4 > CaBr_2 > KNO_2$

acidic ⟶ Basic

Q. 106/102: Since NH_3 is a weaker base (smaller K_b value) than CH_3NH_2, The conjugate acid of NH_3 will be stronger than the conjugate acid of CH_3NH_2: Thus NH_4^+ is stronger acid than $CH_3NH_3^+$.