81 a) $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

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

b) $C_5H_5N + H_2O \rightleftharpoons C_5H_5NH^+ + OH^-$

$$K_b = \frac{[C_5H_5NH^+][OH^-]}{[C_5H_5N]}$$

82) HNO_3 - strong acid = terrible base

Conjugate base of strong acid has no base strength

H_2O $K_b = K_w = 1.0 \times 10^{-14}$ NH_3 $K_b = 1.8 \times 10^{-5}$

C_5H_5N $K_b = 1.7 \times 10^{-9}$

$NH_3 > C_5H_5N > H_2O > NO_3^-$

83) a) $C_6H_5NH_2$ b) $C_6H_5NH_2$

c) OH^- d) CH_3NH_2

8-) $NaOH \rightarrow Na^+ + OH^-$

$[NaOH] = [OH^-]$

a) $[OH^-] = 0.10\,M$ $pOH = -\log(0.10) = 1.00$

$pH = 14 - 1.00 = 13.00$

b) $[OH^-] = 1.0 \times 10^{-10}\,M$ $pOH = -\log(1.0 \times 10^{-10}) = 10.00$

$pH = 14 - 10.00 = 4.00$

* water $[OH^-] = 1.0 \times 10^{-7}$

$pH = 7.00$

c) $[OH^-] = 2.0\,M$ $pOH = -\log(2.0) = -0.30$

$pH = 14.00 - (-0.30) = 14.30$

9-a) K^+, OH^-, H_2O

$[OH^-] = 0.015\,M$ $pOH = -\log(0.015) = 1.82$

$pH = 14.00 - 1.82 = 12.18$

b) Ba^{+2}, OH^- H_2O

$Ba(OH)_2 \rightarrow Ba^{+2} + 2OH^-$

$[OH^-] = 2(0.015\,M) = 0.030\,M$

$pOH = -\log(0.030) = 1.52$

$pH = 14.00 - 1.52 = 12.48$

9) pOH: $14.00 - 11.56 = 2.44$

$[OH^-] = [KOH] = 10^{-2.44} = 3.6 \times 10^{-3}\ M$

$0.80000\ L \times \frac{3.6 \times 10^{-3}\ mol}{1\ L} \times \frac{56.11\ g\ KOH}{1\ mol\ KOH} = 0.16\ g\ KOH$

13) $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ $K_b = 1.8 \times 10^{-5}$

$H_2O \rightleftharpoons H^+ + OH^-$ $K_w = 1.0 \times 10^{-14}$

	NH_3	$+ H_2O \rightleftharpoons$	NH_4^+	$+ OH^-$
I	0.150		0	0
C	$-x$		$+x$	$+x$
E	$0.150 - x$		x	x

$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]} = 1.8 \times 10^{-5} = \frac{x^2}{0.150 - x}$ (insignificant)

$x = [OH^-] = 1.6 \times 10^{-3}\ M$ $\quad 5\% \quad \frac{1.6 \times 10^{-3}}{0.150} \times 100 = 1.1\%$ ✓

$pOH = -\log(1.6 \times 10^{-3}) = 2.80$

$pH = 14.00 - 2.80 = 11.20$

9S) $(C_2H_5)_3N + H_2O \rightleftharpoons (C_2H_5)_3NH^+ + OH^-$

$K_b = 4.0 \times 10^{-4}$

$K_w = 1.0 \times 10^{-14}$

a)

$H_2O \rightleftharpoons H^+ + OH^-$

	$(C_2H_5)_3N$	$+ H_2O$	$\rightleftharpoons (C_2H_5)_3NH^+$	$+ OH^-$
I	0.20		0	0
C	$-x$		$+x$	$+x$
E	$0.20 - x$		x	x

$$K_b = \frac{[(C_2H_5)_3NH^+][OH^-]}{[(C_2H_5)_3N]} = 4.0 \times 10^{-4} = \frac{x^2}{0.20 - x}$$

$\therefore$ x insignificant

$x = [OH^-] = 8.9 \times 10^{-3}\ M$

$\frac{8.9 \times 10^{-3}}{0.20} \times 100 = 4.5\%$ ✓

$[H^+] = \frac{1.0 \times 10^{-14}}{8.9 \times 10^{-3}} = 1.1 \times 10^{-12}\ M$

$pH = -\log(1.1 \times 10^{-12}) = 11.96$

Q5 b) $HONH_2 + H_2O \rightleftharpoons HONH_3^+ + OH^-$

$K_b = 1.1 \times 10^{-8}$

$H_2O \rightleftharpoons H^+ + OH^-$ $\quad K_w = 1.0 \times 10^{-14}$

	$HONH_2$	+ H_2O $\rightleftharpoons$	$HONH_3^+$	+ OH^-
I	0.20		0	0
C	$-x$		$+x$	$+x$
E	$0.20 - x$		x	x

$$K_b = \frac{[HONH_3^+][OH^-]}{[HONH_2]} = 1.1 \times 10^{-8} = \frac{x^2}{0.20 - x}$$

$0.20 - x \approx 0.20$ (insignificant)

$x = [OH^-] = 4.7 \times 10^{-5}\ M$

$\%\ \text{ion} = \frac{1.1 \times 10^{-8}}{0.20} \times 100 = 5.5 \times 10^{-6}\%$ ✓

$[H^+] = \frac{1.0 \times 10^{-14}}{4.7 \times 10^{-5}} = 2.1 \times 10^{-10}\ M$

$pH = -\log(2.1 \times 10^{-10}) = 9.68$

a7) $H_2O \rightleftharpoons H^+ + OH^-$ $\quad K_w = 1.0 \times 10^{-14}$

$C_2H_5NH_2 + H_2O \rightleftharpoons C_2H_5NH_3^+ + OH^-$

I	0.20	0	0
C	$-x$	$+x$	$+x$
E	$0.20 - x$	x	x

$$K_b = \frac{[C_2H_5NH_3^+][OH^-]}{[C_2H_5NH_2]} = 5.6 \times 10^{-4} = \frac{x^2}{(0.20 - x)}$$

insignificant

$x = [OH^-] = 1.1 \times 10^{-2}\ M$

$\frac{1.1 \times 10^{-2}}{0.20} \times 100 = 5.5\%$ ionized

$$\frac{x^2}{0.20 - x} = 5.6 \times 10^{-4}$$

$$x^2 = 1.12 \times 10^{-4} - 5.6 \times 10^{-4} x$$

$$x^2 + 5.6 \times 10^{-4} x - 1.12 \times 10^{-4} = 0$$

$x = 1.0 \times 10^{-2}\ M = [OH^-]$

$$[H^+] = \frac{1.0 \times 10^{-14}}{1.0 \times 10^{-2}} = 1.0 \times 10^{-12}$$

$pH = -\log(1.0 \times 10^{-12}) = 12$

9A) a) $H_2O \rightleftharpoons H^+ + OH^-$

	NH_3	+ H_2O	$\rightleftharpoons$	NH_4^+	+ OH^-
I	0.10			0	0
C	$-x$			$+x$	$+x$
E	$0.10-x$			x	x

$$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]} = 1.8\times10^{-5} = \frac{x^2}{0.10-x}$$

insig.

$x = [OH^-] = 1.3\times10^{-3}$

$$\% \text{ (ionization)} = \frac{1.3\times10^{-3}}{0.10}\times100 = 1.3\%$$ ✓

b)

	NH_3	+ H_2O	$\rightleftharpoons$	NH_4^+	+ OH^-
I	0.010			0	0
C	$-x$			$+x$	$+x$
E	$0.010-x$			x	x

$$K_b = \frac{(x)^2}{0.010-x} = 1.8\times10^{-5}$$

insignificant

$x = [OH^-] = 4.2\times10^{-4}\ M$

$$\% = \frac{4.2\times10^{-4}}{0.010}\times100 = 4.2\%$$

c) $H_2O \rightleftharpoons H^+ + OH^-$

	CH_3NH_2	+ H_2O ⇌	$CH_3NH_3^+$	+ OH^-
I	0.10		0	0
C	$-x$		$+x$	$+x$
E	$0.10-x$		x	x

$$K_b = \frac{[CH_3NH_3^+][OH^-]}{[CH_3NH_2]} = 4.38\times10^{-4} = \frac{x^2}{0.10-x}$$

insign.

$x = 6.6\times10^{-3}\ M = [OH^-]$

$$\%_0 = \frac{6.6\times10^{-3}}{0.10}\times100 = 6.6\%$$

$$\frac{x^2}{0.10-x} = 4.38\times10^{-4}$$

$$x^2 = 4.38\times10^{-5} - 4.38\times10^{-4}x$$

$$x^2 + 4.38\times10^{-4}x - 4.38\times10^{-5} = 0$$

$$x = 6.4\times10^{-3}\ M = [OH^-]$$

$$\%_0\ (\%_0\ \text{ion-atom}) = \frac{6.4\times10^{-3}}{0.10}\times100 = 6.4\%$$

101) pT = p-toluidine ($CH_3C_6H_4NH_2$)

	pT	+ H_2O	⇌	pTH^+	+ OH^-
I	0.016			0	0
C	−x			+x	+x
E	0.016−x			x	x

$$K_b = \frac{[pTH^+][OH^-]}{[pT]} = \frac{x^2}{0.016-x}$$

pH = 8.60 pOH = 14.00 − 8.60 = 5.40

$[OH^-] = 10^{-5.40} = 4.0 \times 10^{-6}\ M$

$$K_b = \frac{(4.0\times10^{-6})^2}{0.016-(4.0\times10^{-6})} = 1.0\times10^{-9}$$