1 $Fe(OH)_2 \rightleftharpoons Fe^{2+} + 2OH^-$

$NaCl \longrightarrow Na^+ + Cl^-$

$\mu = \frac{1}{2}[(+1)^2(0.05) + (-1)^2(0.05)] = 0.05M$

$\gamma_{Fe^{2+}} = 0.485$

$\gamma_{OH^-} = 0.81$

$K_{sp} = A_{Fe^{2+}} \cdot A_{OH^-}^2$

$K_{sp} = \gamma_{Fe^{2+}}[Fe^{2+}](\gamma_{OH^-}[OH^-])^2$

$1.8 \times 10^{-15} = (0.485)(s)[(0.81)(2s)]^2$

$1.8 \times 10^{-15} = 1.27s^3$

$1.1 \times 10^{-5} \frac{mol}{L} = s$

	Fe^{2+}	OH^-
I	0	0
C	+s	+2s
E	s	2s

s = molar solubility

9. $NiCO_3 \rightleftharpoons Ni^{2+} + CO_3^{2-}$

$NiCl_2 \longrightarrow Ni^{2+} + 2Cl^-$

$$\mu = \frac{1}{2}\left[(+2)^2(0.01) + (-1)^2(0.02)\right] = 0.03M$$

$\gamma_{Ni^{2+}} = 0.58$

$\gamma_{CO_3^{2-}} = 0.56$

$K_{sp} = A_{Ni^{2+}} \cdot A_{CO_3^{2-}}$

$K_{sp} = \left(\gamma_{Ni}[Ni^{2+}]\right)\left(\gamma_{CO_3^{2-}}[CO_3^{2-}]\right)$

	Ni^{2+}	CO_3^{2-}
I	0.01	0
C	+S	+S
E	0.01+S	S

S = molar solubility

$1.4\times10^{-7} = [0.58(0.01+S)][0.56S]$

assume S is small

$1.4\times10^{-7} = (0.58(0.01))(0.56S)$

$1.4\times10^{-7} = (3.25\times10^{-3})S$

$4.3\times10^{-5}\ \frac{mol}{L} = S = \text{solubility}$

3. $CaF_2 \longrightarrow Ca^{2+} + 2F^-$

$F^- + H_2O \rightleftharpoons HF + OH^-$

$$\mu = \frac{1}{2}\left[(+2)^2(0.02) + (-1)^2(0.04)\right] = 0.06\,M$$

$\gamma_{F^-} = 0.80$

$\gamma_{OH^-} = 0.80$

$\gamma_{HF} = 1$

$$K_b = \frac{A_{HF} \cdot A_{OH^-}}{A_{F^-}}$$

$$K_b = \frac{\gamma_{HF}[HF]\,\gamma_{OH^-}[OH^-]}{\gamma_F[F^-]}$$

$$1.4\times10^{-11} = \frac{(1)(x)(0.80)x}{0.80(0.04-x)}$$

assume x is small

$$1.4\times10^{-11} = \frac{x^2}{0.04}$$

$$7.5\times10^{-7} = x$$

	F^-	HF	OH^-
I	0.04	0	0
C	$-x$	$+x$	$+x$
E	$0.04-x$	x	x

$$K_b = \frac{K_w}{K_a} = \frac{1.0\times10^{-14}}{7.2\times10^{-4}}$$

$$K_b = 1.4\times10^{-11}$$

$pOH = -\log A_{OH^-}$

$pOH = -\log\left[0.80(7.5\times10^{-7})\right]$

$pOH = 6.22$

$pH + pOH = 14.00$

$pH = 7.78$

4. $(NH_4)_2SO_4 \longrightarrow 2NH_4^+ + SO_4^{2-}$

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

$\mu = \frac{1}{2}\left[(+1)^2(0.02) + (-2)^2(0.01)\right] = 0.030M$

$K_a = \frac{A_{NH_3} A_{H^+}}{A_{NH_4^+}}$

$\gamma_{NH_3} = 1 \quad \gamma_{H^+} = \frac{0.914 + 0.86}{2} = 0.89$

$\gamma_{NH_4^+} = \frac{0.898 + 0.80}{2} = 0.85$

$K_a = \frac{\gamma_{NH_3}[NH_3]\,\gamma_{H^+}[H^+]}{\gamma_{NH_4^+}[NH_4^+]}$

$K_a = \frac{K_w}{K_b} = \frac{1.0 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.6 \times 10^{-10}$

$5.6 \times 10^{-10} = \frac{(1)(x)(0.89)(x)}{0.85(0.02 - x)}$

assume x is small + simplify

$5.6 \times 10^{-10} = \frac{0.89x^2}{0.017}$

	NH_4^+	H^+	NH_3
I	0.02	0	0
C	$-x$	$+x$	$+x$
E	$0.02 - x$	x	x

$3.2 \times 10^{-6} = x = [H^+]$

$pH = -\log A_{H^+} = -\log\left[(0.89)(3.2 \times 10^{-6})\right] = -\log(2.9 \times 10^{-6})$

$pH = 5.54$

5. $NaHCO_3 \longrightarrow Na^+ + HCO_3^-$

$H_2CO_3 + H_2O \rightleftharpoons H_3O^+ + HCO_3^-$ $\quad K_{a1} = 4.3\times10^{-7}$

$$\mu = \frac{1}{2}\left[(+1)^2(0.05) + (-1)^2(0.05)\right] = 0.050\,M$$

$$K_{a1} = \frac{A_{HCO_3^-}\cdot A_{H^+}}{A_{H_2CO_3}}$$

$\gamma_{HCO_3^-} = 0.82$ $\quad \gamma_{H_2CO_3} = 1$

$\gamma_{H^+} = 0.86$

$$K_{a1} = \frac{\gamma_{HCO_3^-}[HCO_3^-]\gamma_{H^+}[H^+]}{\gamma_{H_2CO_3}[H_2CO_3]}$$

	H_2CO_3	H^+	HCO_3^-
I	0.10	0	0.05
C	$-x$	$+x$	$+x$
E	$0.10-x$	x	$0.050+x$

$$4.3\times10^{-7} = \frac{0.82(0.05+x)\,0.86(x)}{(1)(0.10-x)}$$

assume x is small, simplify

$$4.3\times10^{-7} = \frac{(0.82)(0.05)(0.86)x}{(0.10)} = \frac{0.0353x}{0.10}$$

$$1.2\times10^{-6} = x = [H^+]$$

$$pH = -\log A_{H^+} = -\log(0.86\cdot 1.2\times10^{-6}) = -\log 1.05\times10^{-6}$$

$$pH = 5.98$$