Solubility Equilibrium CW 3

1. 20.0mL of a 0.0100M $Mg(NO_3)_2$ is mixed with 10.0mL of a 0.0010M $ZnCl_2$. Sodium hydroxide solution is then slowly added to the mixture ~~which substance~~. Assume no volume change with the addition of sodium hydroxide.

   a) Which salt, $Mg(OH)_2$ (Ksp = 6.0 x 10^{-12}) or $Zn(OH)_2$ (Ksp = 4.0 x 10^{-17}) will precipitate first?

   b) What is the hydroxide concentration when the first precipitate begins to form?

NaOH

Mg^{2+} Na^+
NO_3^-
Zn^{2+} OH^- Cl^-
$Mg(OH)_2(s)$ $Zn(OH)_2(s)$
30.0 mL

$K_{sp} = [Mg^{2+}][OH^-]^2$

$K_{sp} = 4x^3$

$6.0 \times 10^{-12} = 4x^3$

$x = 1.1 \times 10^{-4}$

$K_{sp} = [Zn^{2+}][OH^-]$

$4.0 \times 10^{-17} = 4x^3$

$x = 2.2 \times 10^{-6}$

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Mg^{2+} Na^+
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Zn^{2+} OH^- Cl^-
$Mg(OH)_2(s)$ $Zn(OH)_2(s)$
30.0 mL

$(0.01\,M)(.02\,L) = 0.0002\,mol\ Mg^{2+}$

$[Mg^{2+}] = \frac{0.0002\,mol}{.03\,L} = 6.67 \times 10^{-3}\,M$

$(0.001\,M)(.01\,L) = 1.0 \times 10^{-5}\,mol\ Zn^{2+}$

$[Zn^{2+}] = \frac{1.0 \times 10^{-5}\,mol}{.03\,L} = 3.33 \times 10^{-4}\,M$

$Mg(OH)_{2(s)} \rightleftharpoons Mg^{2+} + 2OH^-$

$K_{sp} = [Mg^{2+}][OH^-]^2$

$6.0 \times 10^{-12} = (6.67 \times 10^{-3})[OH^-]^2$

$[OH^-] = 3.0 \times 10^{-5}$ M

$Zn(OH)_{2(s)} \rightleftharpoons Zn^{2+} + 2OH^-$

$K_{sp} = [Zn^{2+}][OH^-]^2$

$4.0 \times 10^{-17} = (3.33 \times 10^{-4})[OH^-]^2$

$[OH^-] = 3.0 \times 10^{-7}$ M

$\therefore Zn(OH)_2$ ppt first

Hydroxide conc. upon 1st ppt.

2. A solution is 0.045M in NaCl and 0.045 M in NaBr. Solid lead(II) nitrate is added without changing the volume of the solution.
   a. Which salt, $PbBr_2$ ($K_{sp}=6.6 * 10^{-6}$) or $PbCl_2$ ($K_{sp}=1.7 * 10^{-5}$) will precipitate first?
   b. What is the $[Pb^{+2}]$ when the first salt begins to precipitate?

$Pb(NO_3)_2$

Na^+ Cl^- Pb^{2+} NO_3^- Na^+ Br^-

$PbCl_{2(s)}$? $PbBr_{2(s)}$

$\therefore PbBr_2$ will ppt first

$PbBr_{2(s)} \rightleftharpoons Pb^{2+} + 2Br^-$

$K_{sp} = [Pb^{2+}][Br^-]^2$

$6.6 \times 10^{-6} = [Pb^{2+}](0.045)^2$

$[Pb^{2+}] = 3.3 \times 10^{-3}$ M (B)

$PbCl_{2(s)} \rightleftharpoons Pb^{2+} + 2Cl^-$

$K_{sp} = [Pb^{2+}][Cl^-]^2$

$1.7 \times 10^{-5} = [Pb^{2+}](0.045)^2$

$[Pb^{2+}] = 8.4 \times 10^{-3}$ M