Points to remember:

1. These salts and metallic hydroxides are not that soluble and most of them in water just sit at the bottom.
2. Only a very small amount will be dissolved and dissociate in water producing a very low concentration of ions (very small K_{sp} values).
3. Equilibrium is established very quickly.
4. There is NO denominator in the equilibrium expression [therefore] K_{sp} is really equal to the ion product with each ion raised to a coefficient exponent.

Ok…now if we have one of these weird types of equilibrium systems what changes could affect them as follows:

A) cause an increase in solubility
   (1) make more dissolve and dissociate off the bottom
   (2) cause a change in pH or pOH (metallic hydroxides)

B) I know…..Let's call on our dear friend LeChatelier…..not a bad idea !!!

Example #1 Calculate the molar solubility of CaF_2 of solution. K_{sp} (calcium fluoride) = 3.9×10^{-11}. Then calculate it in 100 mL of solution.

Example #2 Calculate the molar solubility in a solution that is 0.010M Calcium nitrate. ICE it in reverse Huh ???????? Don't forget the 5% Rule or else Quadratic it….yuck !!!!

Example #3 What would happen if we were add 0.01 moles of $Ca(NO_3)_2$ to 1 liter of the CaF_2 solution in example #1?

Example #4 What would happen to the pH if 0.05 moles of magnesium acetate Were added to a magnesium hydroxide solution? K_{sp} (magnesium hydroxide) = 1.8×10^{-11}.

Ch. 17 Section 17.5 Solubility Equilbrium

This section deals with "Salts" and "Metallic Hydroxides" that in Chapter 4 we called "Insoluble". We determined this by the "Solubility Rules".

Ion	Solubility	Exceptions
NO_3^-	soluble	none
ClO_4^-	soluble	none
Cl^-	soluble	except Ag^+, Hg_2^{2+}, *Pb^{2+}
I^-	soluble	except Ag^+, Hg_2^{2+}, Pb^{2+}
SO_4^{2-}	soluble	except Ca^{2+}, Ba^{2+}, Sr^{2+}, Hg^{2+}, Pb^{2+}, Ag^+
CO_3^{2-}	insoluble	except Group IA and NH_4^+
PO_4^{3-}	insoluble	except Group IA and NH_4^+
-OH	insoluble	except Group IA, *Ca^{2+}, Ba^{2+}, Sr^{2+}
S^{2-}	insoluble	except Group IA, IIA and NH_4^+
Na^+	soluble	none
NH_4^+	soluble	none
K^+	soluble	none

*slightly soluble

I must confess I was not being totally truthful…these salts and metallic hydroxides are to a very small extent soluble. There solubility is very slight according to their Equilibrium Constant known as: K_{sp}. "sp" stands for "solubility product of the ion concentrations (Molarity) in solution which can experimentally be determined by a Beers Law Experiment.

Table A-10

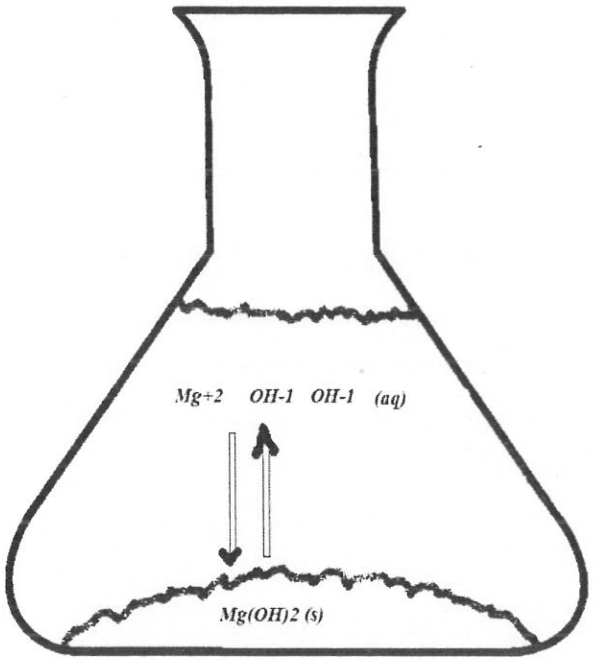
Solubility Product Constants (at 25°C)

Substance	K_{sp}	Substance	K_{sp}	Substance	K_{sp}
AgBr	7.70×10^{-13}	$BaSO_4$	1.08×10^{-10}	$MnCO_3$	1.82×10^{-11}
$AgBrO_3$	5.77×10^{-5}	$CaCO_3$	8.70×10^{-9}	$NiCO_3$	6.61×10^{-9}
Ag_2CO_3	6.15×10^{-12}	CdS	3.60×10^{-29}	$PbCl_2$	1.62×10^{-5}
AgCl	1.56×10^{-10}	$Cu(IO_3)_2$	1.40×10^{-7}	PbI_2	1.39×10^{-8}
Ag_2CrO_4	9.00×10^{-12}	CuC_2O_4	2.87×10^{-8}	$Pb(IO_3)_2$	2.60×10^{-13}
$Ag_2Cr_2O_7$	2.00×10^{-7}	FeC_2O_4	2.10×10^{-7}	$SrCO_3$	1.60×10^{-9}
AgI	1.50×10^{-16}	FeS	3.70×10^{-19}	TlBr	3.39×10^{-6}
AgSCN	1.16×10^{-12}	Hg_2SO_4	7.41×10^{-7}	$ZnCO_3$	1.45×10^{-11}
$Al(OH)_3$	1.26×10^{-33}	Li_2CO_3	1.70×10^{-2}	ZnS	1.20×10^{-23}
$BaCO_3$	8.10×10^{-8}	$MgCO_3$	2.60×10^{-5}		

LQQK how small these values are indicating not much of these substances dissolve and then dissociate in water. Most of these substances stay as "Undissolved Solute" on the bottom of the solution.

Let's take Magnesium Hydroxide (main component in Maalox..an antacid)

$Mg(OH)_2$ $K_{sp} = 1.8 \times 10^{-11}$



Let's solve the following problems:

a. What is the Solubility of magnesium hydroxide in moles/L (molarity)
b. What is the Solubility of magnesium hydroxide in grams/L
c. What is the Solubility of magnesium hydroxide in 50.0 mL of solution
d. What could be added to a magnesium hydroxide solution so that more would dissolve and dissociate off the bottom (hint: LeChatelier)
e. What would be the concentration (M) of magnesium ions in a 0.05M KOH solution?
