

K_{sp} ? Did you mean K_{fc} ?

A Little Review

I. The K's that we have covered:

II. Solubility:

A. Measured in

B. Example:

(a.k.a

)

III. Solubility rules: some combinations of ions form precipitates:

A.

Solubility Equilibria and K_{sp}

I. K_{sp} :

A. Product means

B. It measures

C. We are going to see that

II. Writing solubility product expressions:

A.

B.

C. The

D. Examples:

1. $BaSO_4$

2. $Al(OH)_3$

3. $Mg_3(PO_4)_2$

E.

III.

TABLE 15.4 K_{sp} Values at 25°C for Common Ionic Solids

Ionic Solid	K_{sp} (at 25°C)	Ionic Solid	K_{sp} (at 25°C)	Ionic Solid	K_{sp} (at 25°C)
Fluorides		$Hg_2CrO_4^*$	2×10^{-9}	$Co(OH)_2$	2.5×10^{-16}
BaF_2	2.4×10^{-5}	$BaCrO_4$	8.5×10^{-11}	$Ni(OH)_2$	1.6×10^{-16}
MgF_2	6.4×10^{-9}	Ag_2CrO_4	9.0×10^{-12}	$Zn(OH)_2$	4.5×10^{-17}
PbF_2	4×10^{-8}	$PbCrO_4$	2×10^{-16}	$Cu(OH)_2$	1.6×10^{-19}
SrF_2	7.9×10^{-10}	Carbonates		$Hg(OH)_2$	3×10^{-26}
CaF_2	4.0×10^{-11}	$NiCO_3$	1.4×10^{-7}	$Sn(OH)_2$	3×10^{-27}
Chlorides		$CaCO_3$	8.7×10^{-9}	$Cr(OH)_3$	6.7×10^{-31}
$PbCl_2$	1.6×10^{-5}	$BaCO_3$	1.6×10^{-9}	$Al(OH)_3$	2×10^{-32}
$AgCl$	1.6×10^{-10}	$SrCO_3$	7×10^{-10}	$Fe(OH)_3$	4×10^{-38}
$Hg_2Cl_2^*$	1.1×10^{-18}	$CuCO_3$	2.5×10^{-10}	$Co(OH)_3$	2.5×10^{-43}
Bromides		$ZnCO_3$	2×10^{-10}	Sulfides	
$PbBr_2$	4.6×10^{-6}	$MnCO_3$	8.8×10^{-11}	MnS	2.3×10^{-13}
$AgBr$	5.0×10^{-13}	$FeCO_3$	2.1×10^{-11}	FeS	3.7×10^{-19}
$Hg_2Br_2^*$	1.3×10^{-22}	Ag_2CO_3	8.1×10^{-12}	NiS	3×10^{-21}
Iodides		$CdCO_3$	5.2×10^{-12}	CoS	5×10^{-22}
PbI_2	1.4×10^{-8}	$PbCO_3$	1.5×10^{-15}	ZnS	2.5×10^{-22}
AgI	1.5×10^{-16}	$MgCO_3$	6.8×10^{-6}	SnS	1×10^{-26}
$Hg_2I_2^*$	4.5×10^{-29}	$Hg_2CO_3^*$	9.0×10^{-15}	CdS	1.0×10^{-28}
Sulfates		Hydroxides		PbS	7×10^{-29}
$CaSO_4$	6.1×10^{-5}	$Ba(OH)_2$	5.0×10^{-3}	CuS	8.5×10^{-45}
Ag_2SO_4	1.2×10^{-5}	$Sr(OH)_2$	3.2×10^{-4}	Ag_2S	1.6×10^{-49}
$SrSO_4$	3.2×10^{-7}	$Ca(OH)_2$	1.3×10^{-6}	HgS	1.6×10^{-54}
$PbSO_4$	1.3×10^{-8}	$AgOH$	2.0×10^{-8}	Phosphates	
$BaSO_4$	1.5×10^{-9}	$Mg(OH)_2$	8.9×10^{-12}	Ag_3PO_4	1.8×10^{-18}
Chromates		$Mn(OH)_2$	2×10^{-13}	$Sr_3(PO_4)_2$	1×10^{-31}
$SrCrO_4$	3.6×10^{-5}	$Cd(OH)_2$	5.9×10^{-15}	$Ca_3(PO_4)_2$	1.3×10^{-32}
		$Pb(OH)_2$	1.2×10^{-15}	$Ba_3(PO_4)_2$	6×10^{-39}
		$Fe(OH)_2$	1.8×10^{-15}	$Pb_3(PO_4)_2$	1×10^{-54}

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IV. Solving for K_{sp}

A.

B.

C. Examples:

1. The solubility of copper (I) bromide is $2.0 \times 10^{-4} \text{ M}$. Calculate K_{sp} .

2. The solubility of iron (II) hydroxide is $2.32 \times 10^{-6} \text{ M}$. Calculate K_{sp} .

V. Finding molar solubility from K_{sp}

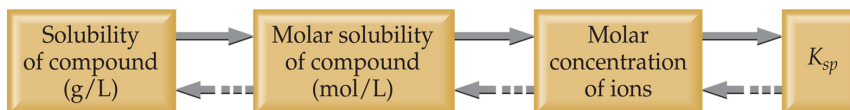
A.

B.

C.

D.

E.



1. What is the molar solubility of silver sulfide? ($K_{sp} = 1.6 \times 10^{-49}$)

2. What is the molar solubility of bismuth (III) sulfide? ($K_{sp} = 1.1 \times 10^{-73}$)

VI. Therefore, given s , you can solve for K_{sp} and given K_{sp} , you can solve for s .

A. General expressions based on formulas:

AB

A_2B

AB_3

A_2B_3

B. Expression is dependent

VII. Watch out for

A. When _____ are in water, you need to

B. Because

C. Ex: What is the molar solubility of iron (III) hydroxide? ($K_{sp} = 4 \times 10^{-38}$)

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D. Ex: If the pH of the final solution is 2.0, what is the molar solubility of iron (III) hydroxide? ($K_{sp} = 4 \times 10^{-38}$)

I.

VIII. Predicting whether or not a precipitate will form:

A. You need to

1. This is the

2. This is

3. This

B. If

C. If

D. If

E. Ex: 50.0 mL of 0.00025 M Na_3PO_4 is mixed with 50.0 mL of 0.0025 M BaCl_2 . Will a precipitate form?

IX. What if TWO precipitates can form?

A. Using K_{sp} and initial concentrations,

B. The

C. There are many variations to this type of problem.

D. Ex: Sodium chloride is added to a 50 mL beaker that contains a mixture of 0.00015 M lead (II) nitrate and 0.00035 M silver nitrate. What precipitate will form first?

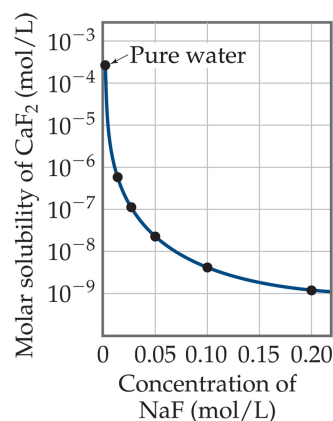
X. The common ion effect revisited.

A. Re: Le Châtelier's principle.

B.

C. Another explanation: The

D. Ex: A sample of solid AgNO_3 is added to a saturated solution of Ag_2CrO_4 . Assuming no volume change, does $[\text{CrO}_4^{2-}]$ increase, decrease or remain the same?



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XI. Volume changes

A.

B. Because, if the solution is still saturated,

Thus,

C. Thus,

XII. Percent of ion remaining.

A. If you have excess unprecipitated ion,

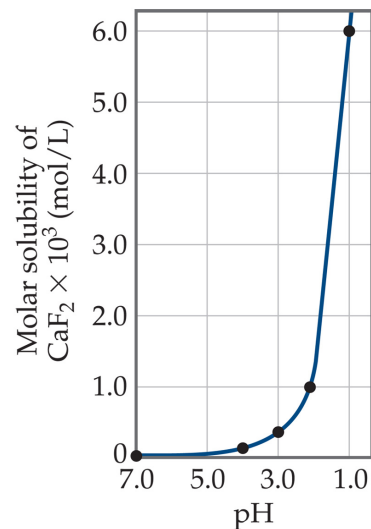
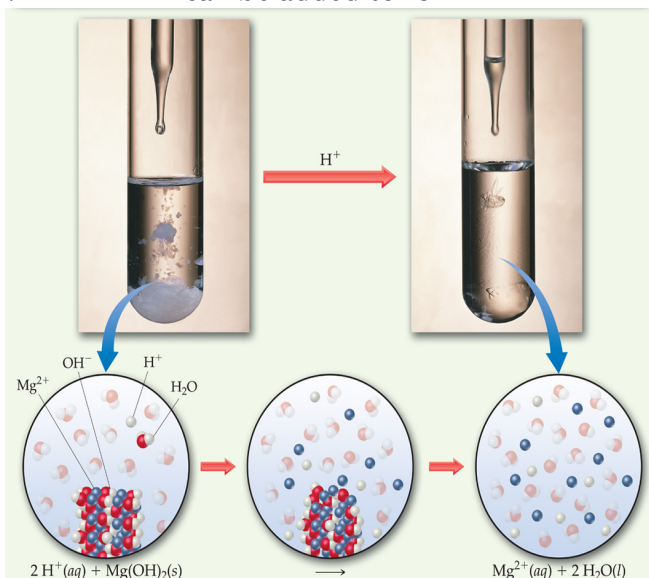
XIII. Dissolving precipitates

A.

1. Hydroxides, carbonates and sulfides.
2. Hydrochloric acid is added to a suspension of zinc hydroxide.
3. Nitric acid is added to solid zinc carbonate.
4. Hydroiodic acid is added to zinc sulfide precipitate.

B. can be added to form

(remember?)



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