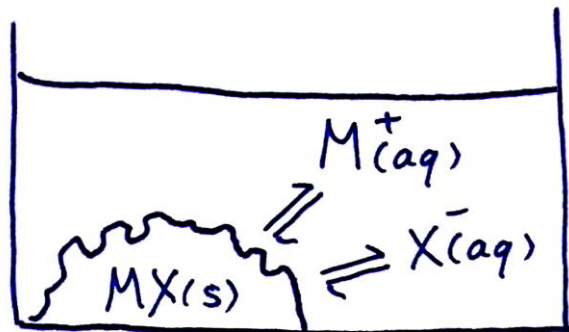
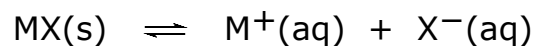


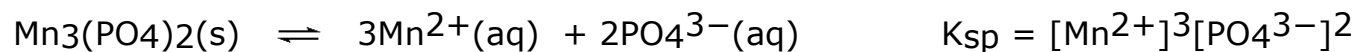
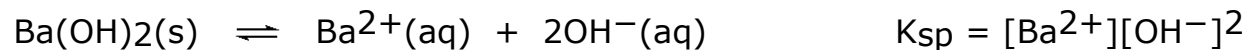
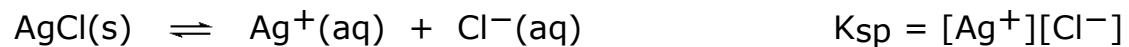
The Solubility Product : K_{sp}



$$K_{sp} = [M^+][X^-]$$

Since $MX(s)$ is a solid in excess, it is not part of the equilibrium constant equation.

Examples of solubility product equilibrium:



Solubility

Solubility is the maximum concentration of a solute that can be dissolved in a solvent. saturation point.

Problem

The solubility of CuBr in water is 7.92×10^{-5} mol/L. Calculate its K_{sp}

Problem

The K_{sp} of CaF_2 is 1.5×10^{-10} . Calculate its solubility in **mg/L**.

K_{sp} and solubility

When the number of ions between two compounds are the same, K_{sp} is an indication of the relative solubility between the two compounds. The higher the K_{sp}, the more soluble it is.

	AgCl		AgBr		AgI
K _{sp}	1.6×10^{-10}	>	5.0×10^{-13}	>	1.5×10^{-16}
Solubility mol/L	1.3×10^{-5}	>	7.1×10^{-7}	>	1.2×10^{-8}
Molar masses: g/mol	143.9		187.8		234.8
Solubility mg/L	1.9		0.13		0.0028

However, one cannot use the K_{sp} to predict the solubility if the number of ions are different.

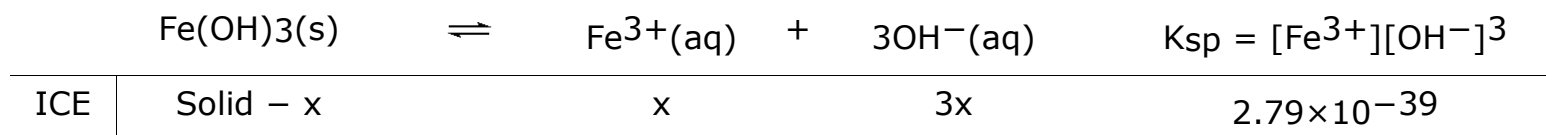
	CuS		Ag ₂ S		Bi ₂ S ₃
K _{sp}	8.5×10^{-45}	>	5.0×10^{-49}	>	1.5×10^{-73}
K _{sp} =	$[\text{Cu}^{2+}][\text{S}^{2-}]$		$[\text{Ag}^+]^2[\text{S}^{2-}]$		$[\text{Bi}^{3+}]^2[\text{S}^{2-}]^3$
Solubility mol/L	9.2×10^{-23}	<	3.4×10^{-17}	<	1.0×10^{-15}

K_{sp} with common ion effect

Calculate the solubility of PbCl₂ in a 0.20 mol/L NaCl solution $K_{sp}(\text{PbCl}_2) = 1.6 \times 10^{-5}$

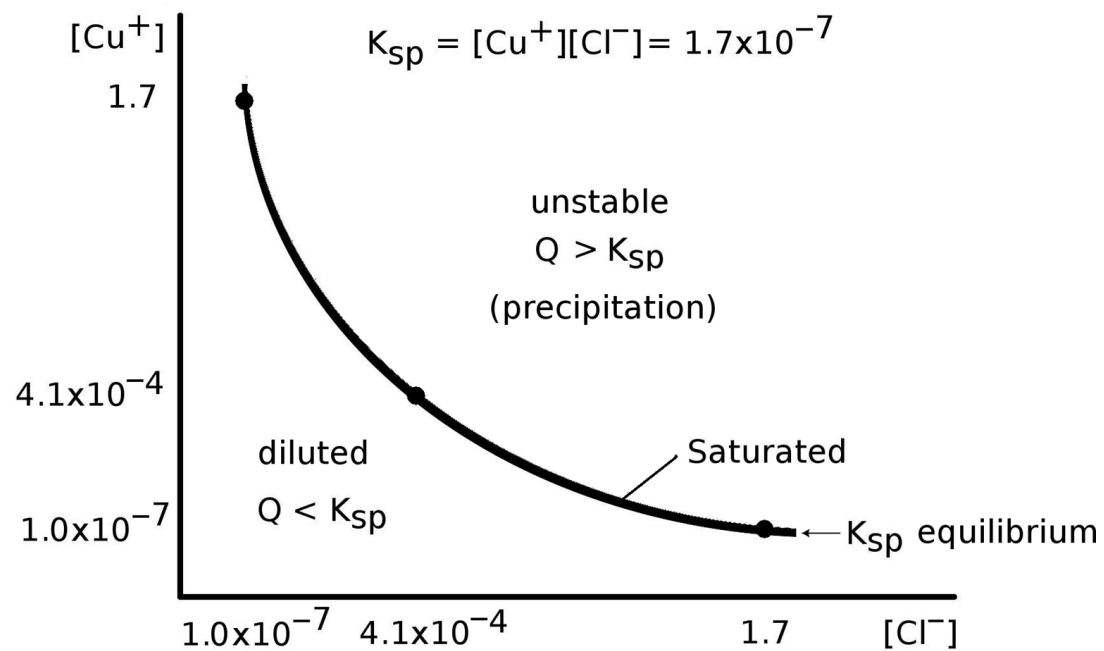
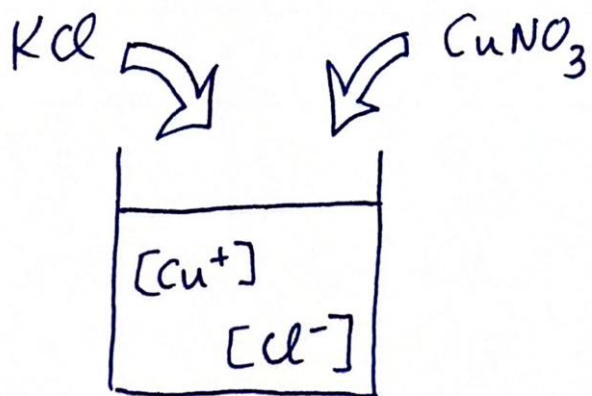
Solubility of a pH sensitive salt

Calculate the solubility for $\text{Fe}(\text{OH})_3$ in water $K_{\text{sp}} = 2.79 \times 10^{-39}$



Q and K_{sp}

Consider the solubility of CuCl with a K_{sp} of 1.7×10^{-7}



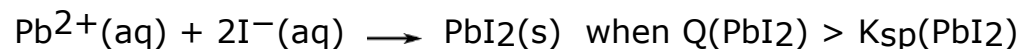
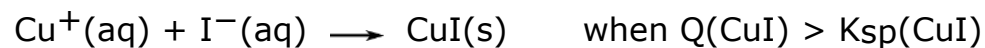
Assuming that $Q = [\text{Cu}^+]_0[\text{Cl}^-]_0$
[]₀ is the initial concentration

1– $Q < K_{sp}$ (diluted solution)

2– $Q = K_{sp}$ (saturated solution = equilibrium)

3– $Q > K_{sp}$ (unstable solution = precipitation reaction)

Selective precipitation

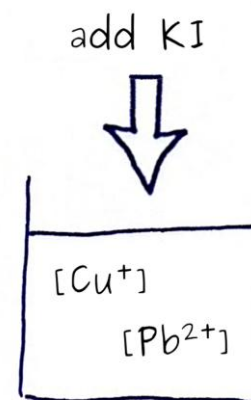


with

$$K_{\text{sp}}(\text{CuI}) = 1.1 \times 10^{-12}$$

$$K_{\text{sp}}(\text{PbI}_2) = 8.5 \times 10^{-9}$$

Since CuI and PbI₂ have different K_{sp} values, it is possible to separate them from each other.



Problem

A solution contains both $\text{Cu}^+(\text{aq}) = 1.0 \times 10^{-5} \text{ M}$ and $\text{Pb}^{2+}(\text{aq}) = 0.50 \text{ M}$. KI is gradually added to the solution.

- Identify the first ion to precipitate and calculate the KI concentration at this point.
- Calculate the concentration of KI when the second ions start to precipitate.
- What is the concentration of the first ion remaining in the solution when the second ions start precipitate.