XIII) Altering the Solubility of a Salt

Saturated solution equations (solid on the left, ions on the right) are simply equilibrium equations. In the equilibrium unit, we studied how concentration changes cause a shift.

\[ \text{AgCl(s)} \rightleftharpoons \text{Ag}^{+}(aq) + \text{Cl}^{-}(aq) \]

What shift would occur if \([\text{Ag}^{+}]\) is increased?

How would the amount of \(\text{AgCl(s)}\) change?

Since more \(\text{AgCl(s)}\) is being produced, we can say that the 'solubility of AgCl' has decreased. (comparatively, fewer Ag⁺ and Cl⁻ ions are dissolved in solution, than exist in the solution)

By adding more \(\text{Ag}^{+}\) to increase \([\text{Ag}^{+}]\) or more \(\text{Cl}^{-}\) to increase \([\text{Cl}^{-}]\), the equilibrium shifts left, resulting in more \(\text{AgCl(s)}\). (decrease solubility)

This is called the common ion effect, because an ion that is already part of the equilibrium (common to the equilibrium) is being added. Keep in mind that \(\text{Ag}^{+}\) would be added with a spectator anion such as \(\text{NO}_3^-\), and \(\text{Cl}^-\) would be added with a spectator cation, such as \(\text{Na}^+\).

What kind of concentration change would have to occur to cause a shift right?

Thus, you must add an ion that will be low solubility, and hence precipitate out either \(\text{Ag}^{+}\) or \(\text{Cl}^{-}\).

What ion could you add (with applicable spectator) to precipitate out \(\text{Ag}^{+}\)?

What ion could you add (with applicable spectator) to precipitate out \(\text{Cl}^{-}\)?

Either of these methods would cause a shift right, causing more \(\text{AgCl(s)}\) to dissolve, thereby increase the solubility of AgCl.

Example:
1. In which of the following 0.10M solutions would \(\text{CaC}_2\text{O}_4\) be least soluble in and most soluble in: NaOH, KCl, Ca(NO₃)₂? Start by writing an equilibrium reaction for calcium oxalate.

2. In which of the following 0.10M solutions would \(\text{PbCl}_2\) be least soluble?
   - HCl, MgCl₂, AgNO₃, NH₄NO₃
2. In which of the following 0.10M solutions would PbCl\(_2\) be least soluble?

HCl, MgCl\(_2\), AgNO\(_3\), NH\(_4\)NO\(_3\)

**Assignment 11:**

1. In which of the following 0.10M solutions would Sr(OH)\(_2\) be least soluble in?

   A. Sr(NO\(_3\))\(_2\)
   B. MgS
   C. NaCl
   D. KBr

2. In which of the following 0.10M solutions would NaCl be most soluble in?

   A. H\(_2\)O
   B. AgNO\(_3\)
   C. NH\(_4\)Cl
   D. HNO\(_3\)

3. Hebden p. 108 #81, 82, 84-86