@ equilibrium (max solute has been dissolved)

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**.

$$AgCl_{(s)} \Leftrightarrow Ag^+_{(aq)} + Cl^-_{(aq)}$$

What shift would occur if $[Ag^+]$ is increased? shift left (increased rvs. rxn rate)

How would the amount of $AgCl_{(s)}$ change? more $AgCl_{(s)}$ would be produced.

Since more $AgCl_{(s)}$ is being produced, we can say that the 'solubility of AgCl' has DECREASED. (comparatively, fewer $Ag^+ + Cl^-$ ions are dissolved in solution, than exist in the solution)

By adding more Ag^+ to increase $[Ag^+]$ or more Cl^- to increase $[Cl^-]$, the equilibrium shifts Left, resulting in more $AgCl_{(s)}$. (decrease solubility)
This is called the "common ion affect", because an ion that is already part of the equilibrium (common to the equilibrium) is being added. Keep in mind that Ag^+ would be added with a spectator anion such as NO_3^-, and Cl^- would be added with a spectator cation, such as Na^+.

What kind of concentration change would have to occur to cause a shift right?
decrease in $[Ag^+]$ or $[Cl^-]$

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

What ion could you add (with applicable spectator) to precipitate out Ag^+?
low solubility w/ Ag^+ SO_4^{-2}, Cl^-, Br^-, I^- ..... eg. NaOH

What ion could you add (with applicable spectator) to precipitate out Cl^-?
low solubility w/ Cl^- Pb^{2+}, Cu^+ ..... $Pb(NO_3)_2$ or $CuNO_3$

(spectator ion (alkali))

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

dissolve more = ↑[ions]@saturation = ↑solubility.

Example:

1. In which of the following 0.10M solutions would CaC_2O_4 be least soluble in and most soluble in: NaOH, KCl, $Ca(NO_3)_2$? Start by writing an equilibrium reaction for calcium oxalate.

$$CaC_2O_{4(s)} \rightleftharpoons Ca^{2+}_{(aq)} + C_2O_4^{-2}{}_{(aq)}$$

(most soluble)
add NaOH?
Na^+ OH^-
$OH^- + Ca^{2+} \Rightarrow ppt$
Ca^{2+} is being used up
↓$[Ca^{2+}]$ ∴ shift Right
more $CaC_2O_{4(s)}$ will dissolve
↑ solubility of CaC_2O_4

add KCl?
K^+ Cl^-
both spectator ions
∴ no effect on equilibrium
∴ no effect on solubility

(least soluble)
add $Ca(NO_3)_2$?
Ca^{2+} NO_3^- spect.
↑$[Ca^{2+}]$
"common ion affect"
∴ equilibrium shift Left.
more $CaC_2O_{4(s)}$ is formed
↓ solubility of $CaC_2O_{4(s)}$

2. In which of the following 0.10M solutions would $PbCl_2$ be least soluble?
HCl, $MgCl_2$, $AgNO_3$, NH_4NO_3

ions in

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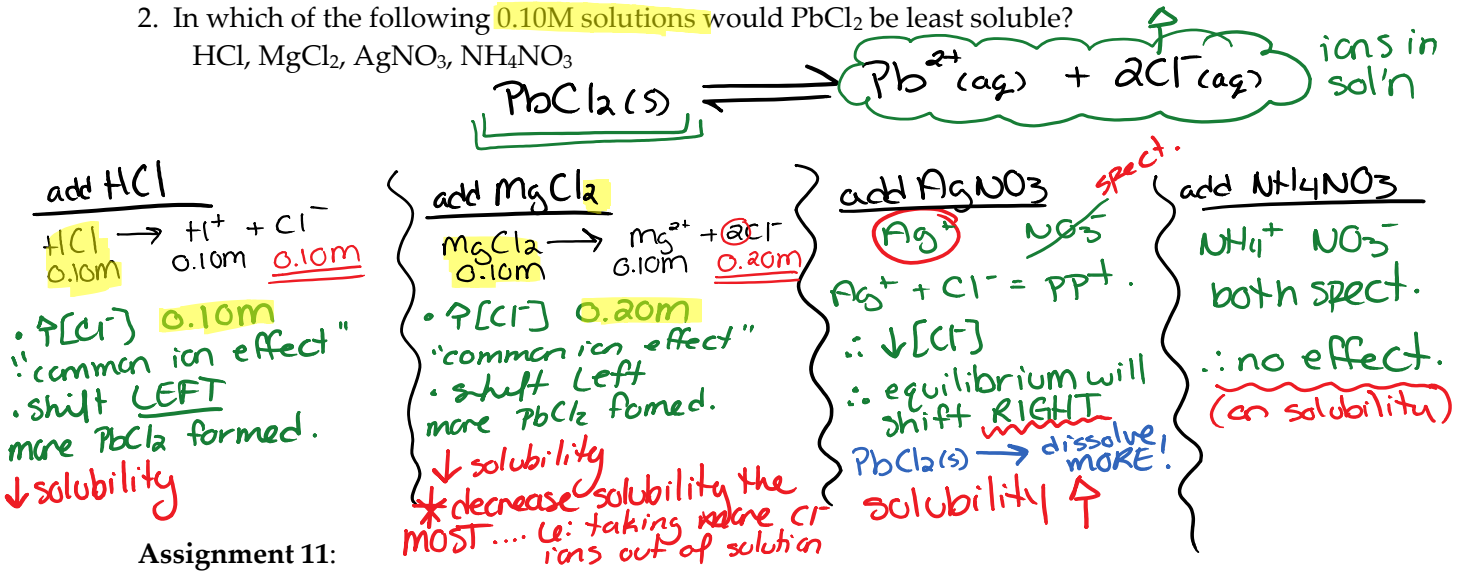

Assignment 11:

1. In which of the following 0.10M solutions would $Sr(OH)_2$ be least soluble in?
   A. $Sr(NO_3)_2$ C. NaCl
   B. MgS D. KBr
2. In which of the following 0.10M solutions would NaCl be most soluble in?
   A. H_2O C. NH_4Cl
   B. $AgNO_3$ D. HNO_3
3. Hebden p. 108 #81, 82, 84-86