IV) Using the Solubility Table

The solubility table in the data booklet is used to predict whether a salt is **soluble** in water or **low solubility** in water. **Soluble** salts can dissociate and produce a solution of at least 0.1M before becoming saturated. **Low Solubility** salts dissociate very little as they become saturated before reaching 0.1M.

use your data booklet

Identify three soluble salts, and three low solubility salts using the table:

SOLUBLE

NaCl KCl
$CaSO_4$ $(NH_4)_2CO_3$
KOH Li_3PO_4 etc...

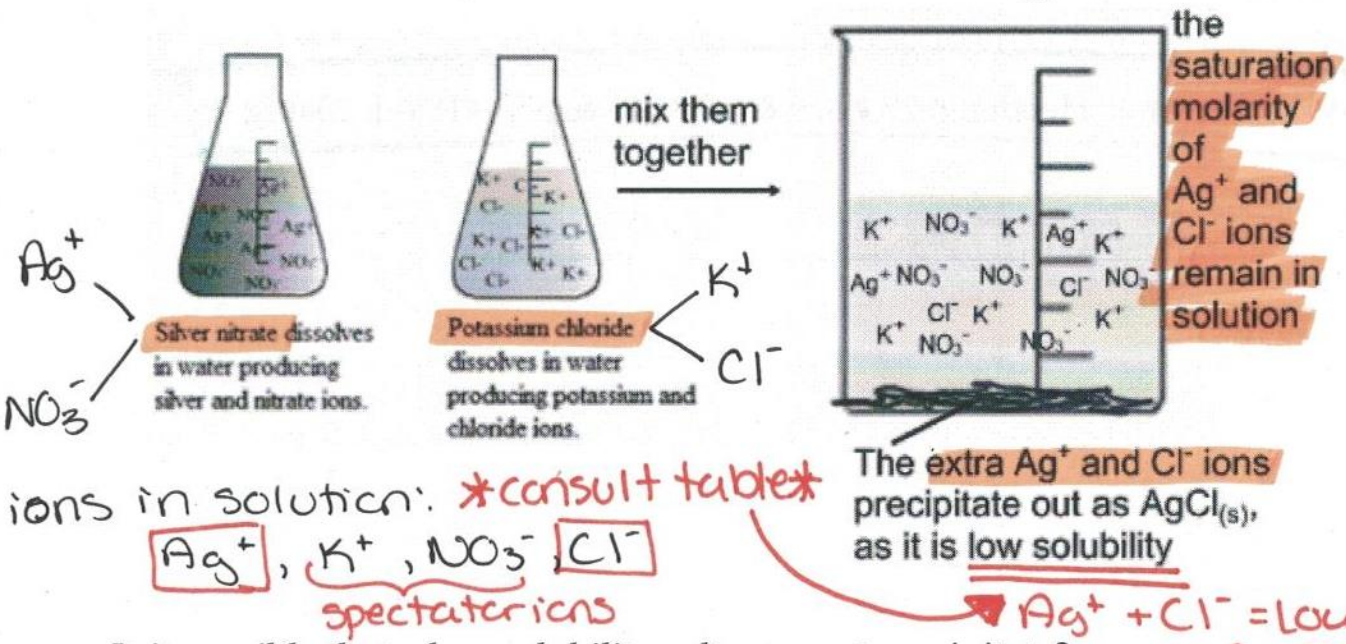
LOW SOLUBILITY

Lead Chloride ($PbCl_2$) CuI
Barium Sulphate (BaS)
Silver phosphate (Ag_3PO_4)
Silver bromide ($AgBr$)

PHET soluble salts animation

If two ions (a cation and an anion) that are low solubility with one another are put into the same solution, and the resulting concentrations of these ions exceed the solubility (molarity at saturation) for that salt, then some of those cations & anions will precipitate out of solution.

Low solubility = precipitate



ions in solution: *consult table*

Ag^+, K^+, NO_3^-, Cl^-

spectator ions

$Ag^+ + Cl^- =$ Low solubility combination

Is it possible that a low solubility salt may not precipitate?

yes, (we saw this in our lab)
if the concentration of low solubility ions mixed with one another are below the solubility (molarity at saturation) for that salt, no precipitate will form. = saturated solution

Is it possible that a soluble salt could precipitate?

yes, only if the solubility (molarity at saturation) is exceeded when two ions are mixed, a precipitate will occur.
eg. NaCl is soluble, but if enough is put into water, saturation is reached, and some collects at bottom

There are two ways you can create a saturated solution for a salt. Explain two ways that a saturated solution of $PbCl_2$ could be created:

1) Direct Method: Add $PbCl_2$ to water, and continue to stir, until excess $PbCl_2$ salt remains at bottom.

2) Indirect Method: Mix two solutions (aq) together: 1 containing
- Pb^{+2} and the other containing Cl^-. (example: $Pb(NO_3)_{2(aq)}$ and $NaCl_{(aq)}$) other ions in solution should be spectator ions, Na^+ and NO_3^-, soluble.
- If the molarities of Pb^{2+} and Cl^- exceed the solubility of $PbCl_2$, a precipitate will form and you'll have a saturated solution.
- the solution will contain $Na^+_{(aq)}$, $NO_3^-{}_{(aq)}$ and $PbCl_{2(s)}$

Use your table to predict whether each salt is soluble or low solubility:

with teacher
1. sodium hydroxide S
2. calcium sulphate LS
3. ammonium phosphate S

on own, then check as class
4. rubidium sulphide S
5. copper (I) iodide LS
6. copper (II) chloride S
7. iron (II) sulphide LS
8. strontium hydroxide S
9. magnesium sulphite LS
10. barium hydroxide LS

S = soluble
LS = Low solubility

i) Will a precipitate form if equal volumes (key) of the following 0.2M solutions are mixed? (double displacement rxn)

$$Pb(NO_3)_{2(aq)} + KI_{(aq)} \Rightarrow KNO_{3(aq)} + PbI_{2(s)}$$

Pb^{2+} NO_3^- K^+ I^-

spectator ions - remain (aq) in solution

very important to show states!

$PbI_{2(s)}$ precipitate will form. Mixing equal volumes of 0.2M solutions creates 0.1M solutions. So anything that is "Low solubility" in the table will form a precipitate.

soluble with: NO_3^-, S^{2-}

OH^- (soluble with: alkali ions, H^+, NH_4^+, Sr^{2+})

ii) Which 1.0M soluble solutions could be mixed in order to produce a precipitate of $Mg(OH)_2$?

Any solution that has Mg^{2+}, and is soluble: $Mg(NO_3)_2$
+ any solution that has OH^-, and is soluble: NaOH.

ex. $Mg(NO_3)_2(aq) + NaOH(aq) \rightarrow 2NaNO_3(aq) + Mg(OH)_2(s)$

spectator ions remain in solution. precipitate

Assignment 3

1) Describe the difference between a soluble salt and a low solubility salt.
2) If you mix two solutions together, and a low solubility ion combination results, explain when a precipitate would form and when it wouldn't.
3) Hebden p.83 #21, 22
4) Hebden p.84 #24

V) Formula, Complete Ionic, and Net Ionic Equations

These equations describe the process of mixing two soluble solutions together.

Suppose 0.2M $CaCl_{2(aq)}$ is mixed with an equal volume of 0.2M $AgNO_{3(aq)}$. Write the formula, complete ionic, and net ionic equations.

Formula Equation (double replacement equation):

Complete Ionic Equation:
The formula equation is inaccurate for the most part, as the salts dissociate into ions in solution. This is reflected in the complete ionic equation.

Net Ionic Equation:
Only ions that react are part of the Net.