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.

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

**SOLUBLE**

- NaCl
- KCl
- CuI
- CaSO₄
- (NH₄)₂CO₃
- KOH
- Li₃PO₄ etc...

**LOW SOLUBILITY**

- Lead chloride (PbCl₂)
- Barium sulphate (BaS)
- Silver nitrate (Ag₂SO₄)
- Silver bromide (AgBr)

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

If the concentration of low solubility ions mixed with one another are below the solubility (molarity of saturation) for that salt, no precipitate will form.

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

Yes, (we saw this in lab)

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 PbCl₂ could be created:

1) Direct Method: Add PbCl₂ to water, and continue to stir, until excess PbCl₂ salt remains at bottom.

2) Indirect Method: Mix two solutions together: 1 containing Pb²⁺ and the other containing Cl⁻. (example: Pb(NO₃)₂(aq) and NaCl(aq)) Other ions in solution should be spectator ions, Na⁺ and NO₃⁻, soluble.

If the molarities of Pb²⁺ and Cl⁻ exceed the solubility of PbCl₂, a precipitate will form and you’ll have a saturated solution.

The solution will contain Na⁺(aq), NO₃⁻(aq), and PbCl₂(s).

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

1. sodium hydroxide  
2. calcium sulphate  
3. ammonium phosphate  
4. rubidium sulphide  
5. copper (I) iodide  
6. copper (II) chloride  
7. iron (II) sulphide  
8. strontium hydroxide  
9. magnesium sulphite  
10. barium hydroxide

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

<table>
<thead>
<tr>
<th>Salt</th>
<th>Solubility</th>
</tr>
</thead>
<tbody>
<tr>
<td>sodium hydroxide</td>
<td>S</td>
</tr>
<tr>
<td>calcium sulphate</td>
<td>LS</td>
</tr>
<tr>
<td>ammonium phosphate</td>
<td>S</td>
</tr>
<tr>
<td>rubidium sulphide</td>
<td>S</td>
</tr>
<tr>
<td>copper (I) iodide</td>
<td>S</td>
</tr>
<tr>
<td>copper (II) chloride</td>
<td>S</td>
</tr>
<tr>
<td>iron (II) sulphide</td>
<td>S</td>
</tr>
<tr>
<td>strontium hydroxide</td>
<td>S</td>
</tr>
<tr>
<td>magnesium sulphite</td>
<td>LS</td>
</tr>
<tr>
<td>barium hydroxide</td>
<td>LS</td>
</tr>
</tbody>
</table>

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

\[ \text{Pb(NO}_3\text{)}_2(\text{aq}) + \text{KI(}aq\text{)} \rightarrow KNO_3(\text{aq}) + \text{PbI}_2(\text{s}) \]

\[ \text{Pb}^{2+} \quad \text{NO}_3^- \quad \text{K}^+ \quad \text{I}^- \]

Spectator ions - remain (aq) in solution

\text{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.
ii) Which 1.0M soluble solutions could be mixed in order to produce a precipitate of Mg(OH)₂?

Any solution that has Mg²⁺, and is soluble: Mg(NO₃)₂
+ any solution that has OH⁻, and is soluble: NaOH.

**ex.**  Mg(NO₃)₂(aq) + NaOH(aq) → 2NaNO₃(aq) + Mg(OH)₂(s)

**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 CaCl₂(aq) is mixed with an equal volume of 0.2M AgNO₃(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.