Solubility Rules

A set of solubility rules is needed to determine if a new combination of cation and anion produces an insoluble ionic compound. Here is an abbreviated set of solubility rules:

1. A compound is probably soluble if it contains the following cations:

- Group 1 metal ions (Li^{+1}, Na^{+1}, K^{+1}, etc.) or ammonium ions (NH_4^{+1})

2. A compound is probably soluble if it contains the following anions:

- Nitrates (NO_3^{-1})
- Perchlorates (ClO_4^{-1})
- Acetates (CH_3COO^{-1}) [often abbreviated as AcO^- or OAc^-]
- Sulfates (SO_4^{-2}) except when combined with these cations: Ba^{+2}, Pb^{+2}, Hg_2^{+2}
- Halide ions (F^-, Cl^-, Br^-, and I^-) except when combined with: Ag^+, Pb^{+2} and Hg_2^{+2} cations

3. A compound is probably insoluble if it contains the following polyatomic anions:

- Carbonates (CO_3^{-2})
- Hydroxides (HO^{-1})
- Oxides (O^{-2})
- Phosphates (PO_4^{-3})

Table 1 illustrates how to apply the solubility rules. It should be noted that **if either the cation or the anion is soluble, then the compound is soluble.** In other words, insoluble anions can be made soluble by combining them with a soluble cation.

Table 1

insoluble		**soluble**	
$Ti(OH)_2$	*insoluble anion*	NaOH	*insoluble anion but soluble cation*
$CaCO_3$	*insoluble anion*	$(NH_4)_2CO_3$	*insoluble anion but soluble cation*
$PbSO_4$	*insoluble cation (with SO_4^{-2})*	K_2SO_4	*soluble cation soluble anion*
$Ba_3(PO_4)_2$	*insoluble anion*	$Ba(NO_3)_2$	*soluble anion*