# 5.7: Predicting Solubility Trends

The solubility of many simple ionic compounds can be predicted by applying the set of rules shown below.

1. Salts of the alkali metal ions and the ammonium ion, $Li^+$, $Na^+$, $K^+$, and $NH_4^+$ are almost always **soluble**.
2. Virtually all metal **nitrates** and metal **acetates** are soluble.
3. Metal **halides** are generally **soluble**, *except* for salts of $Ag^+$, $Pb^{2+}$, $Cu^+$ and $Hg^+$.
4. Metal **sulfates** are generally **soluble**, *except* for salts of $Ba^{2+}$, $Pb^{2+}$ and $Ca^{2+}$.
5. With exception of the alkali metal ions and ammonium (*Rule 1*), the following salts are generally **insoluble**: metal carbonates ($CO_3^{2-}$), metal phosphates ($PO_4^{3-}$) and metal chromates ($CrO_4^{2-}$).
6. Metal hydroxides and metal sulfides are generally **insoluble**, except for those covered by *Rule 1* and $Ca^{2+}$, $Sr^{2+}$ and $Ba^{2+}$.

Applying these rules to the reaction between lead nitrate and potassium iodide, the reactants are both **soluble** (Rule 1 and Rule 2). In the products, potassium nitrate will be soluble (Rule 2) and lead iodide will be **insoluble**, based on Rule 3.

> **? Exercise 5.7.1**
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> Mixing each of the following salt solutions results in the formation of a precipate. In each case, identify the insoluble salt.
>
> a. $NaCl + Pb(NO_3)_2$
> b. $Fe(C_2H_3O_2)_3 + KOH$
> c. $Ca(NO_3)_2 + K_2SO_4$
> d. $Li_2S + CuSO_4$
> e. $Co(C_2H_3O_2)_2 + LiOH$

> **? Exercise 5.7.2**
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> For each of the ionic compounds given below, determine whether or not the compound will be soluble in water, according to the trends given above.
>
> a. $AgNO_3$ ☐ soluble ☐ insoluble
>
> b. $MgCl_2$ ☐ soluble ☐ insoluble
>
> c. $Na_2SO_4$ ☐ soluble ☐ insoluble
>
> d. $AgCl$ ☐ soluble ☐ insoluble
>
> e. $Ba(NO_3)_2$ ☐ soluble ☐ insoluble
>
> f. $PbI_2$ ☐ soluble ☐ insoluble
>
> g. $Mg(NO_3)_2$ ☐ soluble ☐ insoluble
>
> h. $BaSO_4$ ☐ soluble ☐ insoluble
>
> i. $FeCl_3$ ☐ soluble ☐ insoluble
>
> j. $Pb(CH_3COO)_2$ ☐ soluble ☐ insoluble