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 solubles.
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 \(\PageIndex{1}\)

Mixing each of the following salt solutions results in the formation of a precipitate. In each case, identify the insoluble salt.

a. NaCl + Pb(NO\(_3\))\(_2\)
b. Fe(C\(_2\)H\(_3\)O\(_2\))\(_3\) + KOH
c. Ca(NO\(_3\))\(_2\) + K\(_2\)SO\(_4\)
d. Li\(_2\)S + CuSO\(_4\)
e. Co(C\(_2\)H\(_3\)O\(_2\))\(_2\) + LiOH

Exercise \(\PageIndex{2}\)

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\(_2\)SO\(_4\) □ 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$_3$COO)$_2$ □ soluble □ insoluble

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