**Solubility review**

What is the precipitate that forms and what are the spectator ions when KCl(aq) reacts with Pb(NO₃)₂?

1. Break each aqueous compound apart into ions.
   
   \[
   \begin{align*}
   \text{K}^{+1} & (\text{aq}) \\
   \text{Cl}^{-1} & (\text{aq}) \\
   \text{Pb}^{+2} & (\text{aq}) \\
   (2)\text{NO}_3^{-1} & (\text{aq})
   \end{align*}
   \]

2. Switch cations and write the formulas for the new compounds that form.

   \[
   \begin{align*}
   \text{K}^{+1} & (\text{aq}) \\
   \text{Cl}^{-1} & (\text{aq}) \\
   \text{Pb}^{+2} & (\text{aq}) \\
   \text{NO}_3^{-1} & (\text{aq})
   \end{align*}
   \]

3. Take each new compound and decide whether it is solid or aqueous.

   \[
   \begin{align*}
   \text{Pb}^{+2} & \text{Cl}^{-1} \\
   \text{PbCl}_2 \\
   \text{K}^{+1} & \text{NO}_3^{-1} \\
   \text{KNO}_3
   \end{align*}
   \]

4. The solid is the precipitate.

   Using solubility rules:
   
   - Rule #2: all compounds containing nitrates are soluble (aq)
   
   - Rule #1: all compounds of K⁺⁺ ion are aqueous (soluble)
   
   Cl⁻ compounds are soluble unless the cation is Pb⁺⁺ or Ag⁺⁺.
5. The aqueous compound is dissolved in the water of the solution and the ions from that aqueous compound are the “spectator” ions.

overall balanced equation

\[ 2 \text{KCl (aq)} + \text{Pb(NO}_3\text{)}_2 (aq) \rightarrow \text{PbCl}_2 (s) + 2\text{KNO}_3 (aq) \]

precipitate: \( \text{PbCl}_2 (s) \)

spectator ions: \( \text{K}^+ (aq), \text{NO}_3^- (aq) \)

(i.e., ions not a part of the solid but rather part of the solution)