

Chemistry 12
Solubility Equilibrium III

Name:
 Date:
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1. One Source vs. Two Source Solubility Problems
2. Challenging Solubility Problems
3. Prediction of Forming a Precipitate

One Source vs. Two Source Solubility Problems

One Source	Two Source
<ul style="list-style-type: none"> • Both ions come from the same salt (source) $\text{PbI}_{2(s)} \rightleftharpoons \text{Pb}^{2+}_{(aq)} + 2 \text{I}^{-}_{(aq)}$	<ul style="list-style-type: none"> • Both ions come from a different salt (source) $\text{Pb}(\text{NO}_3)_{2(s)} \rightleftharpoons \text{Pb}^{2+}_{(aq)} + 2 \text{NO}_3^{-}_{(aq)} \quad \text{KI}_{(s)} \rightleftharpoons \text{K}^{+}_{(aq)} + \text{I}^{-}_{(aq)}$ $\text{PbI}_{2(s)} \rightleftharpoons \text{Pb}^{2+}_{(aq)} + 2 \text{I}^{-}_{(aq)}$
<ul style="list-style-type: none"> • Ion concentrations are related through mole ratio ❖ 1:1 ratio = ❖ 1:2 ratio = ❖ 1:3 ratio = ❖ 2:3 ratio = 	<ul style="list-style-type: none"> • Related through K_{sp} • Ex: Find the $[\text{I}^{-}]$ if $[\text{Pb}^{2+}] = 4.5 \times 10^{-3} \text{ M}$.

Challenging Solubility Problems

1. A solution has a concentration of calcium ions equal to 2.5×10^{-2} M. What is the maximum concentration of sulphate ions allowed to be added without causing precipitation?

2. Determine the maximum $[\text{Na}_2\text{CO}_3]$ that can exist in 1.0L of 0.0010M $\text{Ba}(\text{NO}_3)_2$ without forming a precipitate.

A. 2.6×10^{-12} M

B. 2.6×10^{-9} M

C. 2.6×10^{-6} M

D. 5.1×10^{-5} M

3. What is the maximum $[\text{Sr}^{2+}]$ that can exist in a solution of 0.10 M Na_2SO_4 ?

A. 3.4×10^{-7} M

B. 3.4×10^{-6} M

C. 1.7×10^{-6} M

D. 5.8×10^{-4} M

4. When 100.0 mL of 4.0×10^{-2} M CaCl_2 is added to 150.0 mL of 2.9×10^{-2} M NaOH , a precipitate just starts to form. What is the K_{sp} of this precipitate?

- Write a (balanced) double replacement reaction.
- What is the possible precipitate? Write the K_{sp} expression.
- Calculate the diluted concentrations of each ion.

- Calculate the K_{sp} value.

5. Up to 15.0g of BaCl_2 can be dissolved in 2.5L of $\text{Al}_2(\text{SO}_4)_3$ without a precipitate being formed. Find $[\text{Al}_2(\text{SO}_4)_3]$.

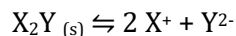
- Write the double replacement reaction. (What is the solute? What is the solvent?)
- What is the possible precipitate that could be formed? Write the K_{sp} expression and determine its value from the data booklet.
- Looking at the K_{sp} expression, is there an ion concentration value that could be determined?

Prediction of Forming a Precipitate

When **two different solutions** are mixed, we can predict whether a precipitate will form. The K_{sp} value represents the maximum product of the ion concentrations in a saturated solution.

If an equilibrium is not present in solution, then we calculate a trial ion product (TIP) – (also called a trial K_{sp} value or reaction quotient, Q)

If Trial $K_{sp} >$ Actual K_{sp} – a precipitate forms.
If Trial $K_{sp} <$ Actual K_{sp} – no precipitate forms.
If Trial $K_{sp} =$ Actual K_{sp} – the solution is saturated.



$$K_{sp} =$$

Example.

(1) Will a precipitate form when 23 mL of 0.020 M Na_2CO_3 is added to 12 mL of 0.010 M $MgCl_2$?

- Write a balanced equation. What is the precipitate that will potentially form? (Use the solubility table)
- What are the concentrations of each of these ions?
- Calculate the value of TIP (Trial K_{sp})
- Compare the TIP (Trial K_{sp}) with the real K_{sp} . Will a precipitate form?

(2) Will a precipitate form when 8.5 mL of 6.3×10^{-2} M lead (II) nitrate is added to 1.0 L of 1.2×10^{-3} M sodium iodate?

(3) Will a precipitate form when 1.5 mL of 4.5×10^{-3} M ammonium bromate is added to 120.5 mL of 2.5×10^{-3} M silver nitrate?