Chemistry 12

Solubility Equilibrium III

Name:
Date:
Block:

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
• Both ions come from the **same** salt (source) $PbI_{2(s)} \leftrightharpoons Pb^{2+}_{(aq)} + 2\ I^-_{(aq)}$	• Both ions come from a **different** salt (source) $Pb(NO_3)_{2(s)} \leftrightharpoons \mathbf{Pb^{2+}_{(aq)}} + 2\ NO_3^-{}_{(aq)}$ $\quad KI_{(s)} \leftrightharpoons K^+_{(aq)} + \mathbf{I^-_{(aq)}}$ $PbI_{2(s)} \leftrightharpoons Pb^{2+}_{(aq)} + 2\ I^-_{(aq)}$
• Ion concentrations are related through mole ratio ❖ 1:1 ratio = ❖ 1:2 ratio = ❖ 1:3 ratio = ❖ 2:3 ratio =	• Related through K_{sp} • Ex: Find the $[I^-]$ if $[Pb^{2+}] = 4.5 \times 10^{-3}$ 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 <u>precipitation</u>?

2. Determine the maximum [Na_2CO_3]that can exist in 1.0L of 0.0010M $Ba(NO_3)_2$ without forming a <u>precipitate</u>.

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 [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, <u>a precipitate just starts to form.</u> 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 $Al_2(SO_4)_3$ <u>without a precipitate being formed</u>. Find $[Al_2(SO_4)_3]$.

- 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?

<u>Worksheet 3.3 #1-7</u>

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 Ksp 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.

$$X_2Y_{(s)} \leftrightharpoons 2\ X^+ + Y^{2-}$$

$$K_{sp} =$$

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?

Hebden Workbook Pg. 98 #56-69
Worksheet 3.3 #8-12