

CHEMISTRY 1220

SOLUBILITY

STUDY SESSION

- ☐ **K_{sp} & MOLAR SOLUBILITY**
- ☐ **FACTORS INFLUENCING SOLUBILITY**
- ☐ **COMMON ION EFFECT**
- ☐ **pH & SOLUBILITY**
- ☐ **COMPLEX ION FORMATION**
- ☐ **PRECIPITATION AND SEPARATION OF IONS**
- ☐ **EXAM PREP**

K_{sp} & MOLAR SOLUBILITY

Question #1

The solubility product expression for $\text{La}_2(\text{CO}_3)_3$ is $K_{sp} = ?$

Question #2

The solubility of BaF_2 is 1.3 g/L. What is the solubility product constant?

Question #3

Which compound is the **least** soluble (mol/L) in water?

- (a) CaCO_3 $K_{sp} = 2.8 \times 10^{-9}$
- (b) PbI_2 $K_{sp} = 8.7 \times 10^{-9}$
- (c) AgBr $K_{sp} = 5.0 \times 10^{-13}$
- (d) $\text{Fe}(\text{OH})_2$ $K_{sp} = 8.0 \times 10^{-16}$
- (e) $\text{Co}(\text{OH})_2$ $K_{sp} = 1.6 \times 10^{-15}$

Question #4

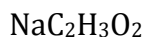
Which of the following salts has the highest concentration of silver ion when dissolved in water?

AgCl	$K_{sp} = 1.6 \times 10^{-10}$
Ag_2CO_3	$K_{sp} = 8.1 \times 10^{-12}$
AgBr	$K_{sp} = 5.0 \times 10^{-13}$

FACTORS INFLUENCING SOLUBILITY

Question #1

A solution is saturated with silver acetate, $\text{AgC}_2\text{H}_3\text{O}_2$ ($K_{\text{sp}} = 1.9 \times 10^{-3}$). Which of the following reagents will increase the solubility of silver acetate?



Question #2

How many of the following salts would be more soluble in acidic solution than in pure water?



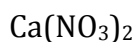
Question #3

Would each of the following reagents increase, decrease, or have no effect on the solubility of $\text{Cu}(\text{OH})_2$?



Question #4

Which salt solubility would be most sensitive to pH?



Question #5

The solubility of which of the listed salts would be unaffected by the presence of a strong acid?



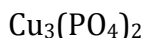
Question #6

How many of the following reagents, when added to a solution in contact with solid NiCO_3 would change the solubility of NiCO_3 ?



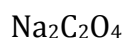
Question #6

The solubility of how many of the following salts will be affected by strong acid?



Question #8

Zinc oxalate is a slightly soluble salt. How many of the following reagents would be expected to decrease the solubility of ZnC_2O_4 ?



COMMON ION EFFECT

Question #1

What is the molar solubility of MgF_2 in 0.40 M F^- ? $K_{\text{sp}} \text{MgF}_2 = 6.4 \times 10^{-9}$

Question #2

The solubility product constant for BiI_3 is 8.1×10^{-19} . Calculate the molar solubility of BiI_3 in 0.20 M $\text{Bi}(\text{NO}_3)_3$.

pH & SOLUBILITY

Question #1

The K_{sp} for $Zn(OH)_2$ is 5.0×10^{-17} . Determine the molar solubility of $Zn(OH)_2$ in buffered solution with a pH of 11.50?

Question #2

What is the pH of a saturated solution of $Cu(OH)_2$ ($K_{sp} = 2.6 \times 10^{-19}$)?

Question #3

What is the molar solubility (mol/L) of $Cr(OH)_3$ at pH = 10.00? K_{sp} for $Cr(OH)_3$ is 6.3×10^{-31} and K_f for $Cr(OH)_4^-$ is 8×10^{29} .

COMPLEX ION FORMATION

Question #1

Calculate the concentration of free cadmium ion, $[\text{Cd}^{2+}]$, in a solution that contains 0.20 M $\text{Cd}(\text{NO}_3)_2$ in 2.0 M NaCN. Cadmium ion forms the complex ion, $\text{Cd}(\text{CN})_4^{2-}$ for which K_f is 6.0×10^{18} .

Question #2

Calculate the molar solubility of CdCO_3 in 1.5 M NH_3 . Note that Cd^{2+} forms the $\text{Cd}(\text{NH}_3)_4^{2+}$ complex ion for which K_f is 1.3×10^7 . K_{sp} for CdCO_3 is 5.2×10^{-12} .

Question #3

Calculate the molar solubility of AgCl in 12 M NH_3 .

$$K_{sp} \text{ AgCl} = 1.8 \times 10^{-10} \quad K_f \text{ Ag}(\text{NH}_3)_2 = 1.7 \times 10^7$$

Question #4

The Ag^+ ion forms the complex ion AgCl_2^- for which $K_f = 2.5 \times 10^5$. Determine the equilibrium constant for the solubility of AgCl in the presence of excess chloride ion. K_{sp} of AgCl is 1.8×10^{-10} .

Question #5

Use the information from the previous problem to calculate the molar solubility of AgCl in 8.5 M HCl.

PRECIPITATION AND SEPARATION OF IONS

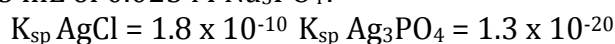
Question #1

A solution contains Ca^{2+} at a concentration of $2.0 \times 10^{-4} \text{ M}$. If 40.0 mL of this solution is added to 25.0 mL of $5.0 \times 10^{-3} \text{ M NaF}$, will a precipitate form? If 40.0 mL of the Ca^{2+} solution is added to 25.0 mL of $5.0 \times 10^{-3} \text{ M Na}_3\text{PO}_4$ will a precipitate form?



Question #2

Which salt precipitates first and what is the minimum concentration of Ag^+ necessary to cause this precipitation in a solution containing 7.5 mL of 0.025 M NaCl and 7.5 mL of 0.025 M Na_3PO_4 ?

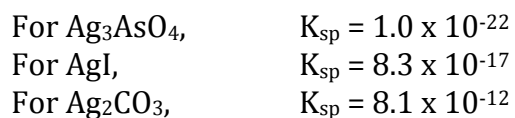


Question #3

A solution contains 0.10 M $\text{Mg}(\text{NO}_3)_2$ and 0.10 M $\text{Ca}(\text{NO}_3)_2$. If solid sodium oxalate, $\text{Na}_2\text{C}_2\text{O}_4$, is added to the solution, what is $[\text{Ca}^{2+}]$ (M) when MgC_2O_4 begins to precipitate? (Assume no volume changes.) At 25 °C, K_{sp} of CaC_2O_4 is 2.3×10^{-9} and K_{sp} of MgC_2O_4 is 8.6×10^{-5} .

Question #4

A solution contains 0.005 M AsO_4^{3-} , 0.005 M I^- , and 0.005 M CO_3^{2-} . If AgNO_3 is slowly added, in what order would the silver salts precipitate?



Question #5

A solution contains 0.010 M Al^{3+} and 0.010 M Ag^+ . Solid Na_3PO_4 is slowly added to separate the two cations. K_{sp} for AlPO_4 is 1.3×10^{-20} and K_{sp} for Ag_3PO_4 is 1.3×10^{-20} . Which cation would precipitate first, and after it precipitates, what concentration of PO_4^{3-} ion should be obtained in the solution for the best separation?