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 $La_2(CO_3)_3$ 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) $Fe(OH)_2$ $K_{sp} = 8.0 \times 10^{-16}$
(e) $Co(OH)_2$ $K_{sp} = 1.6 \times 10^{-15}$

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, $AgC_2H_3O_2$ ($K_{sp} = 1.9 \times 10^{-3}$). Which of the following reagents will increase the solubility of silver acetate?

$NaC_2H_3O_2$ HNO_3 NH_3 $AgNO_3$

Question #2
How many of the following salts would be more soluble in acidic solution that in pure water?

BaC_2O_4 CaS $AuCl_3$ PbF_2 $ZnCO_3$

Question #3
Would each of the following reagents increase, decrease, of have no effect on the solubility of $Cu(OH)_2$?

$CuCl_2$ HCl NH_3 $NaOH$

Question #4
Which salt solubility would be most sensitive to pH?

$Ca(NO_3)_2$ CaF_2 $CaCl_2$ $CaBr_2$ CaI_2

Question #5
The solubility of which of the listed salts would be unaffected by the presence of a strong acid?

$KClO_4$ BaF_2 $FePO_4$ SnI_2

Question #6
How many of the following reagents, when added to a solution in contact with solid $NiCO_3$ would change the solubility of $NiCO_3$?

HCl $NiCl_2$ $NaCl$ Na_2CO_3 NH_3

Question #6
The solubility of how many of the following salts will be affected by strong acid?

$AgBr$ $Cu_3(PO_4)_2$ $NaNO_3$ BaF_2

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?

$Na_2C_2O_4$ NH_3 $NaOH$ HCl $ZnCl_2$

COMMON ION EFFECT

Question #1
What is the molar solubility of MgF_2 in 0.40 M F^-? K_{sp} MgF_2 = 6.4×10^{-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 $Bi(NO_3)_3$.

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, $[Cd^{2+}]$, in a solution that contains 0.20 M $Cd(NO_3)_2$ in 2.0 M NaCN. Cadmium ion forms the complex ion, $Cd(CN)_4^{2-}$ 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 $Cd(NH_3)_4^{2+}$ 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} AgCl = 1.8×10^{-10} K_f $Ag(NH_3)_2$ = 1.7×10^7

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 2.0×10^{-4} M. If 40.0 mL of this solution is added to 25.0 mL of 5.0×10^{-3} M NaF, will a precipitate form? If 40.0 mL of the Ca^{2+} solution is added to 25.0 mL of 5.0×10^{-3} M Na_3PO_4 will a precipitate form?

For CaF_2, $K_{sp} = 3.9 \times 10^{-11}$
For $Ca_3(PO_4)_2$, $K_{sp} = 2.0 \times 10^{-29}$

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?
K_{sp} AgCl = 1.8×10^{-10} K_{sp} Ag_3PO_4 = 1.3×10^{-20}

Question #3
A solution contains 0.10 M $Mg(NO_3)_2$ and 0.10 M $Ca(NO_3)_2$. If solid sodium oxalate, $Na_2C_2O_4$, is added to the solution, what is $[Ca^{2+}]$ (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?

For Ag_3AsO_4, $K_{sp} = 1.0 \times 10^{-22}$
For AgI, $K_{sp} = 8.3 \times 10^{-17}$
For Ag_2CO_3, $K_{sp} = 8.1 \times 10^{-12}$

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?