

Exercise 16.1

Solubility & K_{sp}

Name: _____

Date: _____ Per: _____

The dissolution of an ionic compound may be described by a dissociation equation representing the formation of ions from the ionic solid. Molecular substances forming ions during dissolution go through a process called ionization. These dissolution processes usually do not go to completion and achieve an equilibrium that may be described using a special equilibrium expression called a solubility product expression.

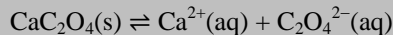
	$\text{AgC}_2\text{H}_3\text{O}_2$	Al(OH)_3
Dissociation Equation:	$\text{AgC}_2\text{H}_3\text{O}_2(\text{s}) \rightleftharpoons \text{Ag}^+(\text{aq}) + \text{C}_2\text{H}_3\text{O}_2^-(\text{aq})$	$\text{Al(OH)}_3(\text{s}) \rightleftharpoons \text{Al}^{3+}(\text{aq}) + 3 \text{OH}^-(\text{aq})$
K_{sp} Expression:	$K_{sp} = [\text{Ag}^+][\text{C}_2\text{H}_3\text{O}_2^-]$	$K_{sp} = [\text{Al}^{3+}][\text{OH}^-]^3$

DIRECTIONS: Write balanced equations for the dissolution reactions and the corresponding expressions for the solubility products of the following:

- | | |
|--|--------------------------|
| 1. MnS | 4. PbI_2 |
| 2. $\text{Ca}_3(\text{PO}_4)_2$ | 5. Cu_2S |
| 3. $\text{Ca}_5(\text{PO}_4)_3(\text{OH})$ | 6. Ni(OH)_2 |

DIRECTIONS: Calculate values of K_{sp} for the following salts using the information given.

Calculate the K_{sp} of calcium oxalate if 4.8×10^{-5} mol dissolves in 1.0 L of water to produce a saturated solution.



$$[\text{Ca}^{2+}] = [\text{C}_2\text{O}_4^{2-}] = 4.8 \times 10^{-5} \text{ M}; K_{sp} = [\text{Ca}^{2+}][\text{C}_2\text{O}_4^{2-}] = (4.8 \times 10^{-5})^2 = 2.3 \times 10^{-9}$$

- The concentration of Mg^{2+} is $6.3 \times 10^{-3} \text{ M}$ at 25°C in a solution of $\text{MgCO}_3(\text{s})$ at equilibrium. Calculate K_{sp} .
- Determine the solubility product constant for PbBr_2 if the concentration of Pb^{2+} in a saturated solution is $2.14 \times 10^{-2} \text{ M}$.
- Find K_{sp} for a saturated solution of aluminum chromate if the concentration of the chromate ion is 0.0990 M .
- The molar solubility of BiI_3 is $1.32 \times 10^{-5} \text{ mol/L}$. Calculate K_{sp} .
- Calculate K_{sp} if the solubility of iron(II) oxalate is 65.9 mg/L , at 25°C .

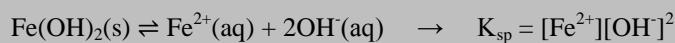
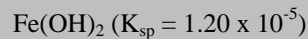
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DIRECTIONS: Calculate the solubility of each of the following compounds in moles per liter and grams per liter.

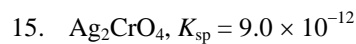
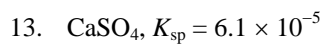
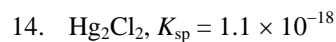
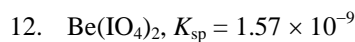


Setting $[\text{Fe}^{2+}]$ to x , and the $[\text{OH}^{-}]$ to $2x$, (the mole ratio of Fe^{2+} to OH^{-} is 1:2), we get:

$$1.2 \times 10^{-5} = [x][2x]^2 \rightarrow 1.2 \times 10^{-5} = 4x^3 \rightarrow 3.0 \times 10^{-6} = x^3 \rightarrow 0.014 = x$$

So, $[\text{Fe}^{2+}]$ is 0.0144 M and $[\text{OH}^{-}]$ would be twice that or 0.0288 M.

Since the concentration of $[\text{Fe}^{2+}]$ produced = $[\text{Fe(OH)}_2]$ consumed, the solubility of $\text{Fe(OH)}_2 = 0.014 \text{ M}$

16. Use the following data to calculate K_{sp} values for each solid.a. The solubility of CaC_2O_4 is $4.8 \times 10^{-5} \text{ mol/L}$.b. The solubility of BiI_3 is $1.32 \times 10^{-5} \text{ mol/L}$ 17. The concentration of Ag^+ in a solution saturated with $\text{Ag}_2\text{C}_2\text{O}_4(\text{s})$ is $2.2 \times 10^{-4} \text{ M}$. Calculate K_{sp} for $\text{Ag}_2\text{C}_2\text{O}_4$.18. Calculate the molar solubility of Al(OH)_3 , $K_{sp} = 2 \times 10^{-32}$.19. The solubility of $\text{Ce(IO}_3)_3$ in a 0.20 M KIO_3 solution is $4.4 \times 10^{-8} \text{ mol/L}$. Calculate K_{sp} for $\text{Ce(IO}_3)_3$.

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20. The K_{sp} for silver sulfate, (Ag_2SO_4) is 1.2×10^{-5} . Calculate the solubility of silver sulfate in each of the following.
- Water

 - 0.10 M AgNO_3

 - 0.20 M K_2SO_4
21. A solution is 1×10^{-4} M in NaF , Na_2S , and Na_3PO_4 . What would be the order of precipitation as a source of Pb^{2+} is added gradually to the solution? The relevant K_{sp} values are $K_{sp}(\text{PbF}_2) = 4 \times 10^{-8}$, $K_{sp}(\text{PbS}) = 7 \times 10^{-29}$, and $K_{sp}(\text{Pb}_3(\text{PO}_4)_2) = 1 \times 10^{-54}$.