

# **$K_{SP}$ – Molar Solubility Worksheet**

Organic Chemistry Tutor

1. The molar solubility of  $\text{NiCO}_3$  is  $3.74 \times 10^{-4}$  mol/L. Calculate the  $K_{sp}$  value for  $\text{NiCO}_3$ .

3. The solubility of  $\text{Ca}_3(\text{PO}_4)_2$  is  $5.1 \times 10^{-5}$  g/L. Calculate the  $K_{sp}$  value for  $\text{Ca}_3(\text{PO}_4)_2$ .

2. The molar solubility of  $\text{Ca}(\text{OH})_2$  is  $6.875 \times 10^{-3}$  mol/L. Calculate the  $K_{sp}$  for  $\text{Ca}(\text{OH})_2$ .

4. The solubility of  $\text{Ba}^{2+}$  is  $2.667 \times 10^{-8}$  mol/L in a saturated solution of  $\text{Ba}_3(\text{PO}_4)_2$ . Calculate the  $K_{sp}$  value for Barium Phosphate.

5. The  $K_{sp}$  value for AgBr is  $5 \times 10^{-13}$ . Calculate the molar solubility of AgBr.

7. The  $K_{sp}$  value for  $Ag_3PO_4$  is  $1.8 \times 10^{-18}$ .

(a) Calculate the molar solubility of  $Ag_3PO_4$ . (b) What is the concentration of  $Ag^+$  in a saturated solution of  $Ag_3PO_4$ ?

6. The  $K_{sp}$  value for  $PbI_2$  is  $1.4 \times 10^{-8}$ . Calculate the molar solubility of  $PbI_2$ .

8. The  $K_{sp}$  value for  $Pb_3(PO_4)_2$  is  $1 \times 10^{-54}$ . (a) Calculate the molar solubility of  $Pb_3(PO_4)_2$ . (b) What is the concentration of  $PO_4^{3-}$  in a saturated solution of  $Pb_3(PO_4)_2$ ? (c) Calculate the solubility of  $Pb_3(PO_4)_2$  in g/L.

9. The  $K_{sp}$  value for  $PbF_2$  is  $4 \times 10^{-8}$ . (a) Calculate the molar solubility of solid  $PbF_2$  in a 0.5 M NaF solution. (b) What is the molar solubility of  $PbF_2$  in a saturated solution of Lead (II) Fluoride? (c) What effect does the presence of a common ion such as  $F^-$  have on the molar solubility  $PbF_2$ ?

11. The  $K_{sp}$  value of  $Mg(OH)_2$  is  $8.9 \times 10^{-12}$ .

(a) What is the pH of a saturated solution of  $Mg(OH)_2$ ? (b) Calculate the molar solubility of  $Mg(OH)_2$  at a pH of 12.5.

10. The  $K_{sp}$  value for  $AgCl$  is  $1.6 \times 10^{-10}$ . Calculate the molar solubility of solid  $AgCl$  in a solution of 0.35M  $MgCl_2$ .

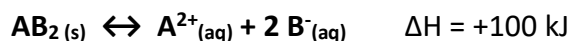
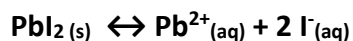
12. A solution is prepared by mixing 200 mL of a 0.10 M  $Ca(NO_3)_2$  solution with 300 mL of a 0.25 M NaF solution. (a) Will precipitation occur in this solution? (b) Calculate the equilibrium concentrations of  $Ca^{2+}$  and  $F^-$  in this solution. The  $K_{sp}$  value for  $CaF_2$  is  $4 \times 10^{-11}$ .

13. A solution contains  $1.6 \times 10^{-4}$  M  $\text{Mg}(\text{NO}_3)_2$  and  $2.0 \times 10^{-6}$  M  $\text{Ca}(\text{NO}_3)_2$ . If  $\text{F}^-$  is added slowly to the solution, will  $\text{MgF}_2$  or  $\text{CaF}_2$  precipitate first? (The  $K_{\text{sp}}$  values for  $\text{MgF}_2$  and  $\text{CaF}_2$  are  $6.4 \times 10^{-9}$  and  $4.0 \times 10^{-11}$ )

15. Consider a saturated solution of  $\text{CaF}_2$ . (a) If the pH of the solution decreases, will the solubility of  $\text{CaF}_2$  increase or decrease? (b) Will precipitation or dissolution occur? (c) What effect will the addition of  $\text{Mg}(\text{NO}_3)_2$  have on the  $\text{CaF}_2$  system?

14. Consider a saturated solution of  $\text{PbI}_2$ . (a) If the concentration of  $\text{Pb}^{2+}$  increases, will dissolution or precipitation occur? (b) What effect will the addition of solid  $\text{PbI}_2$  have on the system? (c) In what direction will the reaction shift if sodium iodide is added to the solution? (d) Will the concentration of  $\text{Pb}^{2+}$  increase or decrease upon the addition of  $\text{NaI}$ ? (e) If the pH of the solution increases, will the solubility of  $\text{PbI}_2$  increase or decrease?

16. Consider a saturated solution of  $\text{AB}_2$ . The dissolution of  $\text{AB}_2$  is an endothermic process. (a) What effect will an increase in temperature have on the solubility of  $\text{AB}_2$ ? (b) Will  $K_{\text{sp}}$  increase or decrease if the temperature increases?



17. Which substance has the highest molar solubility? AgCl, AgBr, or AgI? (The  $K_{sp}$  values for AgCl, AgBr, and AgI are  $1.6 \times 10^{-10}$ ,  $5.0 \times 10^{-13}$ , and  $1.5 \times 10^{-16}$  respectively.)

18. Which substance has the highest molar solubility? NiS, PbBr<sub>2</sub>, or Ag<sub>3</sub>PO<sub>4</sub>? (The  $K_{sp}$  values for NiS, PbBr<sub>2</sub>, and Ag<sub>3</sub>PO<sub>4</sub> are  $3.0 \times 10^{-21}$ ,  $4.6 \times 10^{-6}$ , and  $1.8 \times 10^{-18}$ )

## Answers:

- $1.4 \times 10^{-7}$
- $1.3 \times 10^{-6}$
- $1.3 \times 10^{-32}$
- $6 \times 10^{-39}$
- $7 \times 10^{-7}$  mol/L
- $1.5 \times 10^{-3}$  mol/L
  
- 7a.  $1.6 \times 10^{-5}$  mol/L
- 7b.  $4.82 \times 10^{-5}$  mol/L
  
- 8a.  $6.21 \times 10^{-12}$  M
- 8b.  $1.24 \times 10^{-11}$  M
- 8c.  $5.04 \times 10^{-19}$  g/L
  
- 9a.  $1.6 \times 10^{-7}$  M
- 9b.  $2.2 \times 10^{-3}$  M
- 9c. The common ion  $F^-$  reduces the molar solubility of  $PbF_2$ .
  
10.  $2.29 \times 10^{-10}$  mol/L
  
- 11a. pH = 10.4
- 11b.  $8.9 \times 10^{-9}$
  
- 12a. Yes.  $Q > K_{sp}$ . The reaction will shift to the left causing precipitation.
- 12b.  $[Ca^{2+}] = 8.2 \times 10^{-9}$  M,  $[F^-] = 0.07$  M
  
13.  $CaF_2$  will precipitate first in this solution.
  
- 14a. Precipitation
- 14b. No effect
- 14c. It will shift to the left causing precipitation.
- 14d.  $Pb^{2+}$  will decrease in concentration
- 14e. Dissolution will occur causing the solubility of  $PbI_2$  to increase.
  
- 15a. The solubility of  $CaF_2$  to increase.
- 15b. Dissolution will occur.
- 15c. The reaction will shift to the right favoring dissolution causing the solubility of  $CaF_2$  to increase.
  
- 16a. The solubility will increase.
- 16b.  $K_{sp}$  will increase.
  
17. AgCl
18.  $PbBr_2$

