8. SOLUBILITY PRODUCT AND PRECIPITATION

These problems are intended to ***supplement*** the problems in the textbook, not ***replace*** them.

Data:

K_{sp} Values at 25 °C							
$BaCO_3$	5.0×10^{-9}		$Ga(OH)_3$	1×10^{-35}		Ag_2CO_3	8.1×10^{-12}
BaF_2	1.7×10^{-6}		$Fe(OH)_3$	2.8×10^{-39}		AgCl	1.8×10^{-10}
$BaSO_4$	1.1×10^{-10}		$PbBr_2$	6.6×10^{-6}		AgI	8.3×10^{-17}
$Ca(OH)_2$	6.5×10^{-6}		$PbCl_2$	1.7×10^{-5}		Ag_2SO_4	1.5×10^{-5}
$Ca(IO_3)_2$	7.1×10^{-7}		$PbSO_4$	6.3×10^{-7}		SrF_2	4.3×10^{-9}
$Ca_3(PO_4)_2$	2.0×10^{-29}		$Mg_3(PO_4)_2$	1.0×10^{-24}		$SrSO_4$	3.4×10^{-7}
$Cr(OH)_3$	6.7×10^{-31}		$Ni(OH)_2$	6.0×10^{-16}		$Zn(OH)_2$	3.0×10^{-16}

Note: Assume the temperature is 25°C, the solvent is water, and volumes are additive.

Questions

1. What is K_{sp} for $MnCO_3$ if its molar solubility is 4.7×10^{-6} M?

2. What is K_{sp} for $Ba_3(PO_4)_2$ if its molar solubility is 1.4×10^{-8} M?

3. What is K_{sp} for MgF_2 if its solubility is 0.015 g/L?

4. What is K_{sp} for $PbCrO_4$ if its solubility is 4.2×10^{-5} g/L?

5. What is the solubility (g/L) of Ag_2CO_3 ?

6. A student found that 0.800 g of $AgC_2H_3O_2$ is able to dissolve in 100.0 mL of water. What are the molar solubility (M) and K_{sp} for this salt?

7. A student prepared a saturated solution of $CaCrO_4$ and found that when 156 mL of the solution was evaporated, 0.649 g of $CaCrO_4$ was left behind. What are the molar solubility and K_{sp} for $CaCrO_4$?

8. What is the molar solubility (M) of $Ca(IO_3)_2$?

9. What is the solubility of $Mg_3(PO_4)_2$ in grams per 100 mL?

10. A salt whose formula is MX has a K_{sp} value of 3.2×10^{-10}. Another sparingly soluble salt, MX_3, must have what value of K_{sp} if the molar solubilities of the two salts are identical?

11. Calculate the molar solubility (M) of $PbBr_2$ in…
    a. pure water
    b. 0.200 M $AlBr_3$
    c. 0.200 M $Pb(NO_3)_2$

12. Calculate the molar solubility (M) of $Ga(OH)_3$ in…
    a. pure water
    b. 0.800 M $Ga(NO_3)_3$
    c. a solution with a pH of 9.88

13. How many moles of BaF_2 will dissolve in 250.0 mL of 0.12 M NaF solution?

14. What is the pH of a saturated zinc hydroxide solution?

15. The pH of a saturated metal hydroxide (MOH) solution is 9.68. What is K_{sp} for this metal hydroxide?

16. Will $BaCO_3$ precipitate if 20.0 mL of 0.10 M $Ba(NO_3)_2$ is mixed with 50.0 mL of 0.10 M Na_2CO_3 ?

17. If 25.0 mL of 0.015 M $Pb(NO_3)_2$ is mixed with 75.0 mL of 0.020 M $AlCl_3$ will precipitation occur?

18. If 2.00 mL of 0.200 M NaOH is mixed with 1.000 L of 0.100 M $CaCl_2$, will precipitation occur?

19. If 35.0 mL of 0.100 M $CaCl_2$ is mixed with 65.0 mL of 0.0400 M K_3PO_4, will precipitation occur?

20. What concentration of F^- is needed to start precipitation of SrF_2 from a saturated $SrSO_4$ solution?

21. Both AgCl and AgI are very sparingly soluble salts. Suppose that a solution contains both chloride and iodide ions, with the concentration equal to 0.050 M for both. If solid $AgNO_3$ is added to 1.00 L of this mixture (and no volume change occurs), what is the concentration of iodide when AgCl first begins to precipitate?

22. A solution of Na_2SO_4 is added dropwise to a solution that is 0.010 M in Ba^{2+} and 0.010 M in Sr^{2+}.
    a. What cation precipitates first?
    b. What concentration of sulfate ion is needed to start precipitation?

23. What range of pH will allow separation of Zn^{2+} from Fe^{3+} by selective precipitation from a solution that is initially 0.010 M in both cations?

24. What range of pH will allow separation of Ni^{2+} from Cr^{3+} by selective precipitation from a solution that is initially 0.050 M in both cations?

Answers

If you cannot figure out how to get the correct answer, go to your instructor, Science Tutoring Center, etc.

1. 2.2×10^{-11}
2. 5.8×10^{-38}
3. 5.5×10^{-11}
4. 1.7×10^{-14}
5. 0.036 g/L
6. 0.0479 M, 0.00229
7. 0.0267 M, 7.13×10^{-4}
8. 0.0056 M
9. 1.6×10^{-4} g/100 mL
10. 2.8×10^{-18}
11. a. 0.012 M
    b. 1.8×10^{-5} M
    c. 0.0029 M
12. a. 8×10^{-10} M
    b. 8×10^{-13} M
    c. 2×10^{-23} M
13. 3.0×10^{-5} mol
14. 8.92
15. 2.3×10^{-9}
16. $Q_{sp} = 0.0021 > K_{sp} \Rightarrow$ yes
17. $Q_{sp} = 7.7\times10^{-6} < K_{sp} \Rightarrow$ no
18. $Q_{sp} = 1.59\times10^{-8} < K_{sp} \Rightarrow$ no
19. $Q_{sp} = 2.90\times10^{-8} > K_{sp} \Rightarrow$ yes
20. 0.0027 M
21. 2.3×10^{-8} M
22. a. Ba^{2+}
    b. 1.1×10^{-8} M
23. 1.81 to 7.23
24. 4.38 to 7.04