Answer Key

Solubility #6

1. Show whether or not a precipitate would be expected to form when 0.0050 g $AgNO_3$ crystals are added to 2.00 L of 0.0010 M NaCl.

2. 2.0 mg of $Ca(NO_3)_2$ and 2.0 mg NaF are dissolved and made up to 500 mL of solution. If the K_{sp} for CaF_2 is 4.0×10^{-11}, will a precipitate form?

3. Will a precipitate of AgCl form when 5.1 mg of $AgNO_3$ crystals are added to 3.0 L of 2.0×10^{-3} M NaCl?

4. Show whether or not a precipitate of silver acetate forms when 15 mL of 1.0 M $AgNO_3$ is added to 45 mL of acetic acid in which the $[CH_3COO^-]$ is 5.2×10^{-3} M. K_{sp} $CH_3COOAg = 3.7 \times 10^{-3}$

5. Determine whether or not a precipitate of $BaSO_4$ will form when 0.15 g of K_2SO_4 solid is added to 2.0 L of 1.7×10^{-5} M $BaCl_2$.

6. Explain why a precipitate of silver chloride will not be produced when 20 mL of 3.0×10^{-6} M $AgNO_3$ is mixed with 30 mL of 1.0×10^{-4} M NaCl.

7. When $AgNO_3$ crystals dissolve in a solution containing 0.010 M NaCl and 0.010 M Na_2CrO_4, AgCl precipitates before the Ag_2CrO_4. Explain this behavior.

8. A 0.010 M solution of $AgNO_3$ is added dropwise to a solution containing a mixture of carbonate and iodate ions, in which $[CO_3^{2-}] = 3.0 \times 10^{-3}$ M and $[IO_3^-] = 5.0 \times 10^{-3}$ M. Which substance precipitates first?

9. Will a precipitate of $Al(OH)_3$ form when 0.50 L of 2.0×10^{-3} M $AlCl_3$ and 0.50 L of 4.0×10^{-2} M NaOH are mixed and diluted to 1000 L with water? K_{sp} $Al(OH)_3 = 3.7 \times 10^{-15}$

10. Will a precipitate form when 400 mL of 0.0020 M $Ba(OH)_2$ are mixed with 200 mL of 0.0020 M H_2SO_4?

1. $AgCl \rightleftharpoons Ag^+ + Cl^-$

$K_{sp} = [Ag^+][Cl^-] = 1.8 \times 10^{-10}$

$[Ag^+] = \frac{0.00509 \div 169.9\ g/mol}{2.00\ L} = 1.47 \times 10^{-5}\ M$

$[Cl^-] = 0.0010\ M$

$TIP = (1.47 \times 10^{-5})(0.0010)$

$= 1.5 \times 10^{-8}$

Since TIP > Ksp a ppt will form.

2. $CaF_2 \rightleftharpoons Ca^{2+} + 2F^-$

$K_{sp} = [Ca^{2+}][F^-]^2 = 4.0 \times 10^{-11}$

$[Ca^{2+}] = \frac{2.0 \times 10^{-3}\ g \div 164.0\ g/mol}{0.500\ L} = 2.44 \times 10^{-5}\ M$

$[F^-] = \frac{2.0 \times 10^{-3}\ g \div 42.09\ g/mol}{0.500\ L} = 9.52 \times 10^{-5}\ M$

$TIP = (2.44 \times 10^{-5})(9.52 \times 10^{-5})^2$

$= 2.2 \times 10^{-13}$

Since TIP < Ksp no ppt will form.

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3. $AgCl \longleftrightarrow Ag^+ + Cl^-$

$K_{sp} = [Ag^+][Cl^-] = 1.8 \times 10^{-10}$

$[Ag^+] = \dfrac{5.1 \times 10^{-3}\ g \div 169.9\ g/mol}{3.0\ L} = 1.00 \times 10^{-5}\ M$

$[Cl^-] = 2.0 \times 10^{-3}\ M$

$TIP = (1.00 \times 10^{-5})(2.0 \times 10^{-3})$

$= 2.0 \times 10^{-8}$

$TIP > K_{sp}$ a ppt will form.

4. $AgCH_3COO \longleftrightarrow Ag^+ + CH_3COO^-$

$K_{sp} = [Ag^+][CH_3COO^-] = 3.7 \times 10^{-3}$

$[Ag^+] = \dfrac{15\ mL \times 1.0\ M}{15\ mL + 45\ mL} = 0.25\ M$

$[CH_3COO^-] = \dfrac{45\ mL \times 5.2 \times 10^{-3}\ M}{45\ mL + 15\ mL} = 3.9 \times 10^{-3}\ M$

$TIP = (0.25)(3.9 \times 10^{-3})$

$= 9.8 \times 10^{-4}$

$TIP < K_{sp}$ no ppt will form.

5. $BaSO_4 \longleftrightarrow Ba^{2+} + SO_4^{2-}$

$K_{sp} = [Ba^{2+}][SO_4^{2-}] = 1.1 \times 10^{-10}$

$[Ba^{2+}] = 1.7 \times 10^{-5}\ M$

$[SO_4^{2-}] = \dfrac{0.15\ g \div 174.3\ g/mol}{2.0\ L} = 4.3 \times 10^{-4}\ M$

$TIP = (1.7 \times 10^{-5})(4.3 \times 10^{-4})$

$= 7.3 \times 10^{-9}$

$TIP > K_{sp}$ a ppt will form

6. $AgCl \longleftrightarrow Ag^+ + Cl^-$

$K_{sp} = [Ag^+][Cl^-] = 1.8 \times 10^{-10}$

$[Ag^+] = \dfrac{20\ mL \times 3.0 \times 10^{-6}\ M}{20\ mL + 30\ mL} = 1.2 \times 10^{-6}\ M$

$[Cl^-] = \dfrac{30\ mL \times 1.0 \times 10^{-4}\ M}{20\ mL + 30\ mL} = 6.0 \times 10^{-5}\ M$

$TIP = (1.2 \times 10^{-6})(6.0 \times 10^{-5})$

$= 7.2 \times 10^{-11}$

$TIP < K_{sp}$ no ppt will form

7. $AgCl \longleftrightarrow Ag^+ + Cl^-$

$K_{sp} = [Ag^+][Cl^-] = 1.8 \times 10^{-10}$

$[Cl^-] = 0.010\ M$

$[Ag^+] = \dfrac{K_{sp}}{[Cl^-]} = 1.8 \times 10^{-8}\ M$ to ppt $AgCl$

$Ag_2CrO_4 \longleftrightarrow 2Ag^+ + CrO_4^{2-}$

$K_{sp} = [Ag^+]^2[CrO_4^{2-}]$

$[CrO_4^{2-}] = 0.010\ M$

$[Ag^+] = \sqrt{\dfrac{K_{sp}}{[CrO_4^{2-}]}} = 1.05 \times 10^{-5}\ M$ to ppt Ag_2CrO_4

When adding the $AgNO_3$, the lower $[Ag^+]$ is reached before to higher one, thus the $AgCl$ precipitates first.

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8. For a precipitate of Ag_2CO_3

$Ag_2CO_3 \longleftrightarrow 2Ag^+ + CO_3^{2-}$

$K_{sp} = [Ag^+]^2[CO_3^{2-}] = 8.5\times10^{-12}$

$[CO_3^{2-}] = 3.0\times10^{-3}$

$[Ag^+] = \sqrt{\frac{K_{sp}}{[CO_3^{2-}]}} = 5.3\times10^{-5}\ M$

For a precipitate of $AgIO_3$

$AgIO_3 \longleftrightarrow Ag^+ + IO_3^-$

$K_{sp} = [Ag^+][IO_3^-] = 3.2\times10^{-8}$

$[IO_3^-] = 5.0\times10^{-3}\ M$

$[Ag^+] = \frac{K_{sp}}{[IO_3^-]} = 6.4\times10^{-6}\ M$

The $AgIO_3$ ppts first

9. $Al(OH)_3 \longleftrightarrow Al^{3+} + 3OH^-$

$K_{sp} = [Al^{3+}][OH^-]^3 = 3.7\times10^{-15}$

$[Al^{3+}] = \frac{0.50\,L \times 2.0\times10^{-3}\,M}{1000\,L} = 1.0\times10^{-6}\,M$

$[OH^-] = \frac{0.50\,L \times 4.0\times10^{-2}\,M}{1000\,L} = 2.0\times10^{-5}\,M$

$TIP = (1.0\times10^{-6})(2.0\times10^{-5})^3$

$= 8.0\times10^{-21}$

$TIP < K_{sp}$ so no ppt will form

10. $BaSO_4 \longleftrightarrow Ba^{2+} + SO_4^{2-}$

$K_{sp} = [Ba^{2+}][SO_4^{2-}] = 1.1\times10^{-10}$

$[Ba^{2+}] = \frac{0.0020\,M \times 400\,mL}{400\,mL + 200\,mL} = 1.33\times10^{-3}\,M$

$[SO_4^{2-}] = \frac{0.0020\,M \times 200\,mL}{400\,mL + 200\,mL} = 6.67\times10^{-4}\,M$

$TIP = (1.33\times10^{-3})(6.67\times10^{-4})$

$= 8.9\times10^{-7}$

$TIP > K_{sp}$ so a ppt will form