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AP Chemistry

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Period ____

**AP Test Prep: Solubility Product Calculations (2020)**

1. Write the $K_{sp}$ expression for:

$AgCl_{(s)} \rightleftharpoons Ag^+_{(aq)} + Cl^-_{(aq)}$ $\quad K_{sp} = [Ag^+][Cl^-]$

$PbCl_{2(s)} \rightleftharpoons Pb^{2+}_{(aq)} + 2Cl^-_{(aq)}$ $\quad K_{sp} = [Pb^{2+}][Cl^-]^2$

2. The molar solubility of $BaCrO_4$ is $2.1 \times 10^{-10}$ M. What is the $K_{sp}$?

$BaCrO_{4(s)} \rightleftharpoons Ba^{2+}_{(aq)} + CrO_4^{2-}_{(aq)}$

| | $Ba^{2+}$ | $CrO_4^{2-}$ |
|---|---|---|
| | 0 | 0 |
| | $+x$ | $+x$ |
| | $x$ | $x$ |

$x = 2.1 \times 10^{-10}$ (in problem)

$K_{sp} = [2.1 \times 10^{-10}][2.1 \times 10^{-10}]$

$K_{sp} = 4.4 \times 10^{-20}$

3. The molar solubility of $PbBr_2$ is $1.0 \times 10^{-2}$ M. What is the $K_{sp}$?

$PbBr_{2(s)} \rightleftharpoons Pb^{2+}_{(aq)} + 2Br^-_{(aq)}$

| | $Pb^{2+}$ | $2Br^-$ |
|---|---|---|
| | 0 | 0 |
| | $+x$ | $+2x$ |
| | $x$ | $2x$ |

$x = 1.0 \times 10^{-2}$ (in problem)

$K_{sp} = [x][2x]^2$

$K_{sp} = [1.0 \times 10^{-2}][2.0 \times 10^{-2}]^2$

$K_{sp} = 4.0 \times 10^{-6}$

4. $K_{sp}$ for $PbI_2$ is $3.2 \times 10^{-8}$. What is the molar solubility of $PbI_2$?

$PbI_{2(s)} \rightleftharpoons Pb^{2+}_{(aq)} + 2I^-_{(aq)}$

| | $Pb^{2+}$ | $2I^-$ |
|---|---|---|
| | 0 | 0 |
| | $+x$ | $+2x$ |
| | $x$ | $2x$ |

$K_{sp} = 3.2 \times 10^{-8} = [Pb^{2+}][I^-]^2$

$3.2 \times 10^{-8} = [x][2x]^2$

$3.2 \times 10^{-8} = 4x^3$

$x = .002$

5. Silver oxalate, $Ag_2C_2O_4$, has a $K_{sp}$ of $1.0 \times 10^{-11}$. What is the molar solubility of silver oxalate?

$Ag_2C_2O_{4(s)} \rightleftharpoons 2Ag^+_{(aq)} + C_2O_4^{2-}$

| | $2Ag^+$ | $C_2O_4^{2-}$ |
|---|---|---|
| | 0 | 0 |
| | $+2x$ | $+x$ |
| | $2x$ | $x$ |

$K_{sp} = 1.0 \times 10^{-11} = [Ag^+]^2[C_2O_4^{2-}]$

$1.0 \times 10^{-11} = [2x]^2[x]$

$1.0 \times 10^{-11} = 4x^3$

$x = 1.4 \times 10^{-4}$

6. What is the molar solubility of AgCl in a solution which is 0.050 M in KCl?

$AgCl_{(s)} \rightleftharpoons Ag^+_{(aq)} + Cl^-_{(aq)}$

| | $Ag^+$ | $Cl^-$ |
|---|---|---|
| | 0 | .050 M |
| | $+x$ | $+x$ |
| | $x$ | $.050+x$ |

$K_{sp} = 1.8 \times 10^{-10} = [x][.050+x]$

$x = 3.6 \times 10^{-9}$

7. What is the molar solubility of $CaF_2$ in a solution which is 0.010 M in NaF?

$CaF_2(s) \rightleftharpoons Ca^{2+}(aq) + 2F^-(aq)$

0 .010M

+x +2x

x .010+2x

$K_{sp} = 3.9 \times 10^{-11} = [x][.010+2x]^2$

$x = 3.9 \times 10^{-7}$

8. Will a silver chloride precipitate form under the following conditions? Ksp of AgCl is $1.8 \times 10^{-10}$

(a) 0.1 M in $Ag^+$ and 0.1 M in $Cl^-$

$Q = [Ag^+][Cl^-]$ $Q = [.1][.1] = .01$ $Q > K_{sp}$ so yes ppt

(b) $1 \times 10^{-5}$ M in $Ag^+$ and $2 \times 10^{-5}$ M in $Cl^-$

$Q = [1 \times 10^{-5}][2 \times 10^{-5}] = 2 \times 10^{-10}$ $Q > K_{sp}$ so yes ppt

(c) $1 \times 10^{-7}$ M in $Ag^+$ and $1 \times 10^{-6}$ M in $Cl^-$

$Q = [1 \times 10^{-7}][1 \times 10^{-6}] = 1 \times 10^{-13}$ $Q < K_{sp}$ so No PPT forms

"Ions don't find each other"

9. If 200 mL of 0.030 M NaI and 400 mL of 0.040 M $AgNO_3$ are mixed, will a precipitate of AgI form? The Ksp for AgI is $8.3 \times 10^{-17}$. *Assume volumes are additive.*

* get mixed molarity values for each ion that could form ppt
* use total volume 200 + 400 = 600mL = .600 Liters

$[Ag^+] = \frac{(.040)(.400)}{.600 \text{ Liters}} = .027 \text{ M } Ag^+$

$[I^-] = \frac{(.030)(.200)}{.600 \text{ Liters}} = .010 \text{ M } I^-$

$Q = [.027][.010] = 2.7 \times 10^{-4}$

$Q > K_{sp}$ so yes a ppt of AgI will form