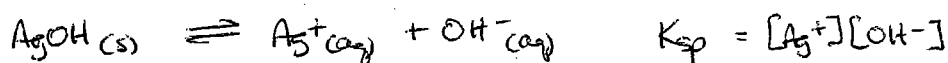


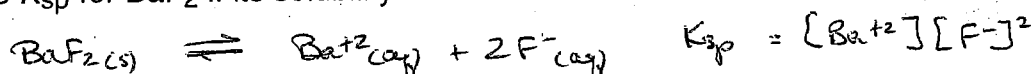
Write out the **equation** for the equilibrium and the **equilibrium expression** as well as the necessary mathematical steps used in solving the following problems. You may have to consult your K<sub>sp</sub> chart.

1. Determine the K<sub>sp</sub> for AgOH if its molar solubility is known to be  $1.4 \times 10^{-4} \text{M}$ .



$$K_{sp} = (1.4 \times 10^{-4})^2 = 2.0 \times 10^{-8} \quad (1.96 \times 10^{-8})$$

2. Find the K<sub>sp</sub> for BaF<sub>2</sub> if its solubility is  $7.5 \times 10^{-3} \text{M}$ .



$$K_{sp} = (7.5 \times 10^{-3})(1.5 \times 10^{-2})^2 = 1.7 \times 10^{-6} \quad (1.6875 \times 10^{-6})$$

3. The solubility of CaSO<sub>4</sub> is 1.15g/L. Determine the K<sub>sp</sub> of CaSO<sub>4</sub>.

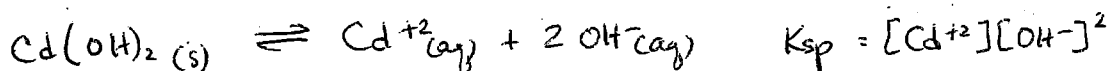


$$\text{mol. sol.} = \frac{1.15 \text{g}}{\text{L}} \times \frac{1 \text{mol}}{136.2 \text{g}} = 8.44 \times 10^{-3} \text{M}$$

$$K_{sp} = (8.44 \times 10^{-3})^2 = 7.13 \times 10^{-5} \quad 3$$

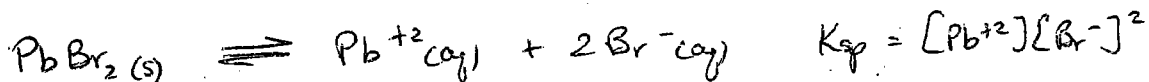
(7.12921 × 10<sup>-5</sup>)

4. A sample of Cd(OH)<sub>2</sub> is added to water and stirred until no more will dissolve. Subsequent analysis shows the [Cd<sup>2+</sup>] to be  $1.7 \times 10^{-5} \text{M}$ . What is the K<sub>sp</sub> for Cd(OH)<sub>2</sub>?



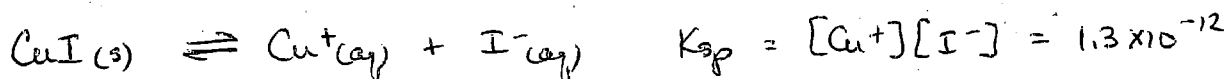
$$K_{sp} = (1.7 \times 10^{-5})(3.4 \times 10^{-5})^2 = 2.0 \times 10^{-14} \quad (1.9652 \times 10^{-14})$$

5. A saturated solution of PbBr<sub>2</sub> is found to have a [Br<sup>-</sup>] of  $2.4 \times 10^{-2} \text{M}$ . Determine the K<sub>sp</sub> for PbBr<sub>2</sub>.



$$K_{sp} = (1.2 \times 10^{-2})(2.4 \times 10^{-2})^2 = 6.9 \times 10^{-6} \quad (6.912 \times 10^{-6})$$

6. What is the molar solubility of CuI if its K<sub>sp</sub> is known to be  $1.3 \times 10^{-12}$ ?



$$\text{sol} = x = \sqrt{1.3 \times 10^{-12}} = 1.1 \times 10^{-6} \text{M} \quad (1.14018 \times 10^{-6})$$

7. What is the solubility of AgI in g/L?

$$\text{AgI}(s) \rightleftharpoons \text{Ag}^+(aq) + \text{I}^-(aq) \quad K_{sp} = 8.5 \times 10^{-17} = [\text{Ag}^+][\text{I}^-]$$

$$x = \text{sol.} = \sqrt{8.5 \times 10^{-17}} = 9.2 \times 10^{-9} \text{ M} \quad (9.21952 \times 10^{-9} \text{ M})$$

$$\text{mass sol.} = 9.21952 \times 10^{-9} \frac{\text{mol}}{\text{L}} \times \frac{234.8 \text{ g}}{\text{mol}} = 2.2 \times 10^{-6} \text{ g/L} \quad (2.16475 \times 10^{-6})$$

8. What mass of FeS will 2.5L of its saturated solution contain at 25 degrees Celsius?

$$\text{FeS}(s) \rightleftharpoons \text{Fe}^{2+}(aq) + \text{S}^{2-}(aq) \quad K_{sp} = 6.0 \times 10^{-19} = [\text{Fe}^{2+}][\text{S}^{2-}]$$

$$x = \text{sol.} = \sqrt{6.0 \times 10^{-19}} = 7.7 \times 10^{-10} \text{ M} \quad (7.74597 \times 10^{-10})$$

$$\text{mass} = 7.74597 \times 10^{-10} \frac{\text{mol}}{\text{L}} \times 2.5 \text{ L} \times \frac{87.9 \text{ g}}{\text{mol}} = 1.7 \times 10^{-7} \text{ g} \quad (1.70218 \times 10^{-7})$$

9. Calculate the molar solubility of  $\text{Cu}(\text{IO}_3)_2$ .

$$\text{Cu}(\text{IO}_3)_2(s) \rightleftharpoons \text{Cu}^{2+}(aq) + 2 \text{IO}_3^-(aq) \quad K_{sp} = 6.9 \times 10^{-8} = [\text{Cu}^{2+}][\text{IO}_3^-]^2$$

$$K_{sp} = 6.9 \times 10^{-8} = (x)(2x)^2 = 4x^3$$

$$\text{sol.} = x = \sqrt[3]{\frac{6.9 \times 10^{-8}}{4}} = 2.6 \times 10^{-3} \text{ M} \quad (2.58382 \times 10^{-3})$$

10. What are the equilibrium concentrations of  $\text{Ca}^{2+}$  and  $\text{F}^-$  in a saturated solution of  $\text{CaF}_2$ ?

The  $K_{sp}$  for  $\text{CaF}_2$  is  $3.9 \times 10^{-11}$ .

$$\text{CaF}_2(s) \rightleftharpoons \text{Ca}^{2+}(aq) + 2\text{F}^-(aq) \quad K_{sp} = 3.9 \times 10^{-11} = [\text{Ca}^{2+}][\text{F}^-]^2$$

$$\text{sol.} = \sqrt[3]{\frac{3.9 \times 10^{-11}}{4}} = 2.1 \times 10^{-4} \text{ M} \quad (2.13633 \times 10^{-4})$$

$$[\text{Ca}^{2+}] = 2.1 \times 10^{-4} \text{ M} \quad [\text{F}^-] = 4.3 \times 10^{-4} \text{ M}$$

11. How many moles of calcium oxalate must dissolve to produce 750mL of a saturated solution?

$$\text{CaC}_2\text{O}_4(s) \rightleftharpoons \text{Ca}^{2+}(aq) + \text{C}_2\text{O}_4^{2-}(aq) \quad K_{sp} = 2.3 \times 10^{-9} = [\text{Ca}^{2+}][\text{C}_2\text{O}_4^{2-}]$$

$$\text{sol.} = \sqrt{2.3 \times 10^{-9}} = \frac{1.5 \times 10^{-5} \text{ M}}{4.8 \times 10^{-5} \text{ M}} \quad (4.79583 \times 10^{-5})$$

$$\text{mol} = \frac{1.5 \times 10^{-5} \text{ mol}}{4.8} \times 0.750 \text{ L} = \frac{1.1 \times 10^{-5} \text{ mol}}{3.6 \times 10^{-5}} \quad (3.59687 \times 10^{-5})$$

12. Calculate the mass of  $\text{SrF}_2$  that must dissolve to make 3.50L of saturated solution.

$$\text{SrF}_2(s) \rightleftharpoons \text{Sr}^{2+}(aq) + 2\text{F}^-(aq) \quad K_{sp} = 4.3 \times 10^{-9} = [\text{Sr}^{2+}][\text{F}^-]^2$$

$$\text{sol.} = \sqrt[3]{\frac{4.3 \times 10^{-9}}{4}} = 1.0 \times 10^{-3} \text{ M} \quad (1.0244 \times 10^{-3})$$

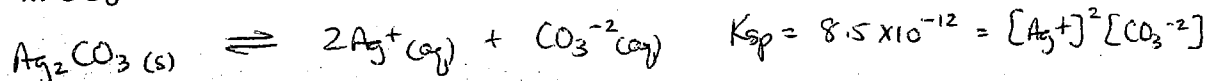
$$\text{mass} = 1.0244 \times 10^{-3} \frac{\text{mol}}{\text{L}} \times 3.50 \text{ L} \times \frac{125.6 \text{ g}}{\text{mol}} = 0.45 \text{ g} \quad (0.450326)$$

13. Determine the maximum  $[Cu^{2+}]$  that can exist in a solution containing 0.015M  $S^{2-}$ .



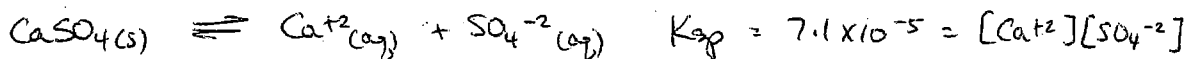
$$[Cu^{2+}] = \frac{6.0 \times 10^{-37}}{0.015} = 4.0 \times 10^{-35} M$$

14. Calculate the highest concentration of  $Ag^+$  ion that can be found in a solution that also contains  $7.6 \times 10^{-3}M CO_3^{2-}$ .



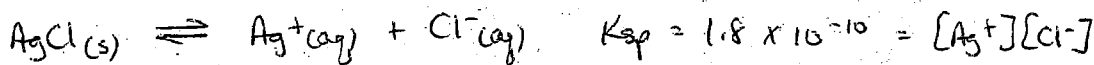
$$[Ag^+] = \sqrt{\frac{8.5 \times 10^{-12}}{7.6 \times 10^{-3}}} = 3.3 \times 10^{-5} M \quad (3.34428 \times 10^{-5})$$

15. Find the maximum  $[Ca^{2+}]$  that can exist in a 0.14M  $Na_2SO_4$  solution.



$$[Ca^{2+}] = \frac{7.1 \times 10^{-5}}{0.14} = 5.1 \times 10^{-4} M \quad (5.07143 \times 10^{-4})$$

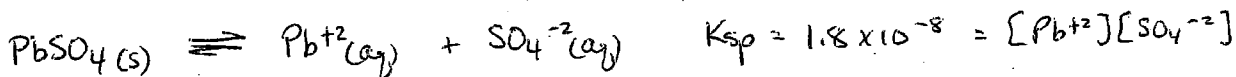
16. What is the maximum  $[Ag^+]$  that can be found in  $2.4 \times 10^{-3}M BaCl_2(aq)$ ?



$$2.4 \times 10^{-3} M BaCl_2 = 4.8 \times 10^{-3} M [Cl^-]$$

$$[Ag^+] = \frac{1.8 \times 10^{-10}}{4.8 \times 10^{-3}} = 3.8 \times 10^{-8} M \quad (3.75 \times 10^{-8}) \quad (1 = 7.5 \times 10^{-8})$$

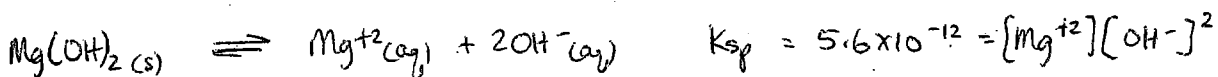
17. Calculate the maximum mass of  $CuSO_4$  that could be dissolved in 3.4L of a solution that contains  $7.8 \times 10^{-5}M Pb^{2+}$  ion. Assume that any increase in volume is negligible.



$$[SO_4^{2-}] = \frac{1.8 \times 10^{-8}}{7.8 \times 10^{-5}} = 2.3 \times 10^{-4} M \quad (2.30769 \times 10^{-4})$$

$$\text{mass } CuSO_4 = 2.30769 \times 10^{-4} \frac{\text{mol}}{L} \times 3.4 L \times \frac{159.6 g}{\text{mol}} = 0.13 g \quad (0.125225)$$

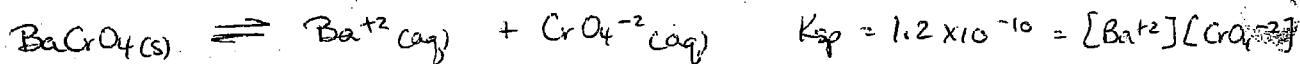
18. Calculate the maximum mass of  $MgCl_2$  that could be dissolved in 1.2L of a 0.010M  $NaOH$  solution. Assume that there is no noticeable change in volume.



$$[Mg^{2+}] = \frac{5.6 \times 10^{-12}}{(0.01)^2} = 5.6 \times 10^{-8} M$$

$$\text{mass } MgCl_2 = 5.6 \times 10^{-8} \frac{\text{mol}}{L} \times 1.2 L \times \frac{95.3 g}{\text{mol}} = 6.4 \times 10^{-6} g \quad (6.40416 \times 10^{-6})$$

19. Will a precipitate form if 25mL of 0.0050M Ba(NO<sub>3</sub>)<sub>2</sub> solution are mixed with 85mL of 5.6 x 10<sup>-6</sup>M Na<sub>2</sub>CrO<sub>4</sub> solution?

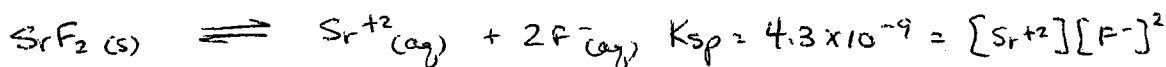


$$[\text{Ba}^{2+}] = \frac{(0.0050 \text{ M})(25 \text{ mL})}{(110 \text{ mL})} = 1.13636 \times 10^{-3} \text{ M} \quad [\text{CrO}_4^{2-}] = \frac{(5.6 \times 10^{-6} \text{ M})(85 \text{ mL})}{(110 \text{ mL})} = 4.32727 \times 10^{-6} \text{ M}$$

$$\text{Trial } K_{sp} = (1.13636 \times 10^{-3})(4.32727 \times 10^{-6}) = 4.9 \times 10^{-9}$$

Since Trial  $K_{sp} >$  Real  $K_{sp}$  ...  
a ppt WILL form

20. Determine whether a precipitate will form when 2.5L of 3.5 x 10<sup>-3</sup>M SrCl<sub>2</sub>(aq) are mixed with 4.2L of 2.7 x 10<sup>-3</sup>M KF(aq).

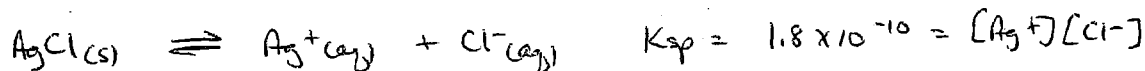


$$[\text{Sr}^{2+}] = \frac{(3.5 \times 10^{-3} \text{ M})(2.5 \text{ L})}{(6.7 \text{ L})} = 1.30597 \times 10^{-3} \text{ M} \quad [\text{F}^{-}] = \frac{(2.7 \times 10^{-3} \text{ M})(4.2 \text{ L})}{(6.7 \text{ L})} = 1.69254 \times 10^{-3} \text{ M}$$

$$\text{Trial } K_{sp} = (1.30597 \times 10^{-3})(1.69254 \times 10^{-3})^2 = 3.7 \times 10^{-9}$$

Since Trial  $K_{sp} <$  Real  $K_{sp}$  ...  
a ppt DOES NOT form

21. Determine whether a precipitate will form when 60.0mL of 4.4 x 10<sup>-5</sup>M MgCl<sub>2</sub> solution are mixed with 30.0mL of 9.8 x 10<sup>-6</sup>M AgNO<sub>3</sub> solution.

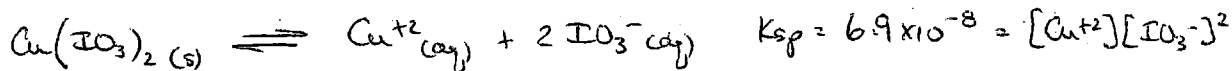


$$[\text{Ag}^{+}] = \frac{(9.8 \times 10^{-6} \text{ M})(30 \text{ mL})}{(90 \text{ mL})} = 3.2667 \times 10^{-6} \text{ M} \quad [\text{Cl}^{-}] = \frac{2 \times (4.4 \times 10^{-5} \text{ M})(60 \text{ mL})}{(90 \text{ mL})} = 5.86667 \times 10^{-5} \text{ M}$$

$$\text{Trial } K_{sp} = (3.2667 \times 10^{-6})(5.86667 \times 10^{-5}) = 1.9 \times 10^{-10}$$

Since Trial  $K_{sp} >$  Real  $K_{sp}$  ...  
a ppt WILL form

22. Will a precipitate form when equal volumes of 3.2 x 10<sup>-4</sup>M Cu(NO<sub>3</sub>)<sub>2</sub>(aq) and 2.6 x 10<sup>-4</sup>M NaIO<sub>3</sub>(aq) are mixed?



$$[\text{Cu}^{2+}] = \frac{(3.2 \times 10^{-4} \text{ M})(x \text{ mL})}{(2x \text{ mL})} = 1.6 \times 10^{-4} \text{ M} \quad [\text{IO}_3^{-}] = \frac{(2.6 \times 10^{-4} \text{ M})(x \text{ mL})}{(2x \text{ mL})} = 1.3 \times 10^{-4} \text{ M}$$

$$\text{Trial } K_{sp} = (1.6 \times 10^{-4})(1.3 \times 10^{-4})^2 = 2.7 \times 10^{-12}$$

Since Trial  $K_{sp} <$  Real  $K_{sp}$  ...  
a ppt DOES NOT form