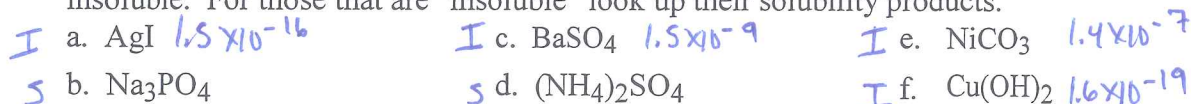


16 • Precipitation Reactions**STUDY QUESTIONS**

1. Predict, on the basis of the solubility rules, which of the following salts are soluble and which are insoluble. For those that are "insoluble" look up their solubility products.



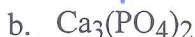
2. Write solubility product expressions for the following salts:



$$K_{sp} = [Pb^{2+}][SO_4^{2-}]$$



$$K_{sp} = [Cu^{2+}][S^{2-}]$$



$$K_{sp} = [Ca^{2+}]^3[PO_4^{3-}]^2$$



$$K_{sp} = [Ca^{2+}][F^-]^2$$

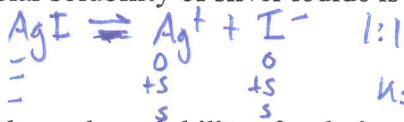
3. If the molar concentration of lead bromide, PbBr₂, in an aqueous solution is 1.6×10^{-6} M, what is [Pb²⁺] and [Br⁻]?

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

$$[Pb^{2+}] = 1.6 \times 10^{-6} M$$

$$[Br^-] = 3.2 \times 10^{-6} M$$

4. If the molar solubility of silver iodide is 1.22×10^{-8} M, what is the solubility product for AgI?



$$K_{sp} = [1.22 \times 10^{-8}][1.22 \times 10^{-8}] = \boxed{1.49 \times 10^{-16} M^2}$$

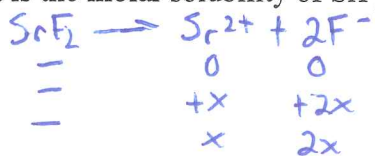
5. What is the molar solubility of cadmium sulfide, CdS, if its $K_{sp} = 3.6 \times 10^{-29}$?



$$3.6 \times 10^{-29} = s^2$$

$$K_{sp} = 3.6 \times 10^{-29} = [Cd^{2+}][S^{2-}] = \boxed{6.0 \times 10^{-15} M} = s$$

6. K_{sp} of strontium fluoride, SrF₂, is 2.5×10^{-9} . What is the [Sr²⁺] and [F⁻] in a saturated solution of SrF₂? What is the molar solubility of SrF₂?



$$K_{sp} = 2.5 \times 10^{-9} = [Sr^{2+}][F^-]^2$$

$$2.5 \times 10^{-9} = s \cdot (2s)^2$$

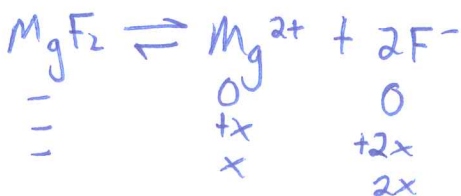
$$[Sr^{2+}] = \boxed{8.5 \times 10^{-4} M}$$

$$2.5 \times 10^{-9} = 4s^3$$

$$s = 8.5 \times 10^{-4} M$$

$$[F^-] = \boxed{1.7 \times 10^{-3} M}$$

7. What is the [Mg²⁺] in a saturated solution of magnesium fluoride, MgF₂ if its solubility product constant is 6.4×10^{-9} ? What is the [Mg²⁺] if the solution also contains 0.30 M sodium fluoride?

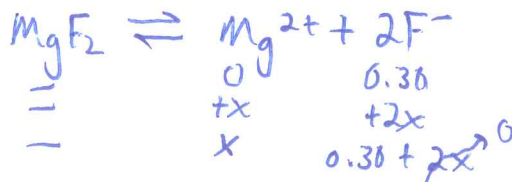


$$K_{sp} = 6.4 \times 10^{-9} = [Mg^{2+}][F^-]^2$$

$$6.4 \times 10^{-9} = s \cdot (2s)^2$$

$$s = 1.2 \times 10^{-3}$$

$$[Mg^{2+}] = \boxed{1.2 \times 10^{-3}}$$

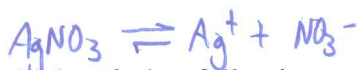


$$K_{sp} = 6.4 \times 10^{-9} = [Mg^{2+}][F^-]^2$$

$$6.4 \times 10^{-9} = (s)(0.30)^2$$

$$s = 7.1 \times 10^{-8} M$$

$$[Mg^{2+}] = \boxed{7.1 \times 10^{-8} M}$$



8. From which of the following mixtures of silver nitrate and sodium sulfite would silver sulfite precipitate? The K_{sp} for silver sulfite = 1.5×10^{-14} .

a. 50 mL of 1.0×10^{-4} M Ag^+ and 50 mL of 1.0×10^{-4} M SO_3^{2-} .

$$[\text{Ag}^+] = \frac{0.050\text{L} \times 1.0 \times 10^{-4} \text{ mol/L}}{0.1\text{L}} = 5.0 \times 10^{-5} \text{ M}$$

$$[\text{SO}_3^{2-}] = \frac{0.050\text{L} \times 1.0 \times 10^{-4} \text{ mol/L}}{0.1\text{L}} = 5.0 \times 10^{-5} \text{ M}$$



$$K_{sp} = 1.5 \times 10^{-14} = [\text{Ag}^+]^2 [\text{SO}_3^{2-}]$$

$$Q = 1.3 \times 10^{-13} > K_{sp} \quad \boxed{\text{yes}}$$

b. 25 mL of 1.0×10^{-3} M Ag^+ and 25 mL of 1.0×10^{-5} M SO_3^{2-} .

$$[\text{Ag}^+] = 5.0 \times 10^{-4} \text{ M} \quad [\text{SO}_3^{2-}] = 5.0 \times 10^{-6} \text{ M}$$

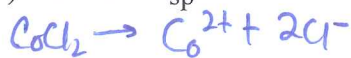
$$Q = 1.3 \times 10^{-12} > K_{sp} \quad \boxed{\text{yes}}$$

c. 50 mL of 1.0×10^{-5} M Ag^+ and 100 mL of 1.0×10^{-3} M SO_3^{2-} .

$$[\text{Ag}^+] = 3.3 \times 10^{-6} \text{ M} \quad [\text{SO}_3^{2-}] = 6.7 \times 10^{-4} \text{ M}$$

$$Q = 7.3 \times 10^{-15} < K_{sp} \quad \boxed{\text{no}}$$

9. Calculate the solubility in moles per Liter of cobalt(II) sulfide in a solution that contains 0.030 M cobalt(II) chloride. K_{sp} for cobalt sulfide $\text{CoS} = 5.9 \times 10^{-21}$.



$$K_{sp} = [\text{Co}^{2+}][\text{S}^{2-}]$$

$$5.9 \times 10^{-21} = (0.030)(s)$$

$$s = \boxed{2.0 \times 10^{-19} \text{ M}}$$

	$\text{CoS} \rightleftharpoons \text{Co}^{2+} + \text{S}^{2-}$
I	- 0.030 0
C	- +s +s
E	- 0.030+s s

10. Addition of a strong acid would increase the solubility of which of the following salts?

~~AgCl~~

~~CaSO₄~~

CdS

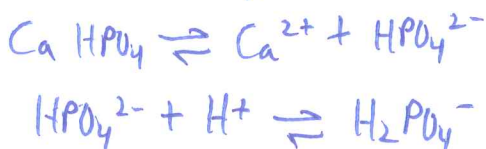
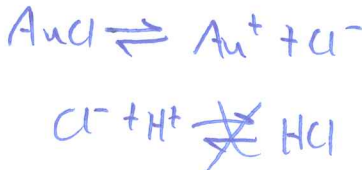
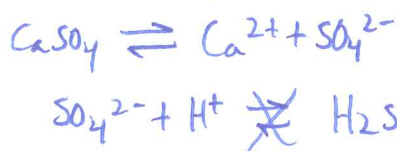
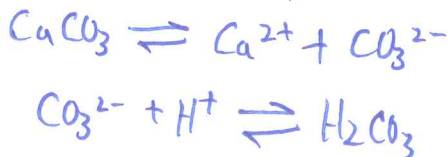
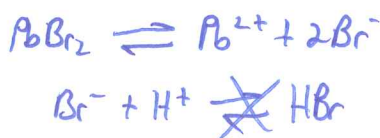
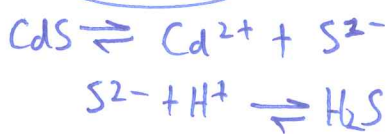
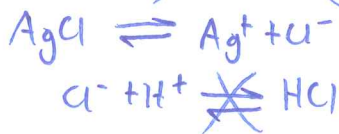
CaCO₃

~~PbBr₂~~

CaHPO₄

Cd(OH)₂

~~AuCl~~



Solubility of slightly soluble salts containing basic anions increases as $[\text{H}^+]$ increases ($\text{pH} \downarrow$)

Go Vikings!!