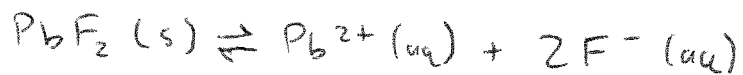
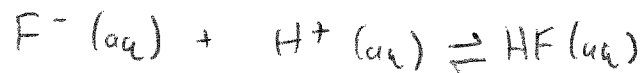


Factors Affecting Solubility

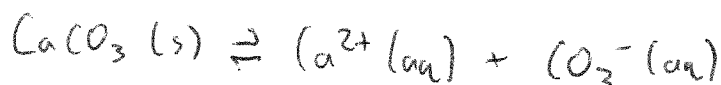
- pH: If a substance has a basic anion, it will be more soluble in an acidic solution



* F^- is a base so it reacts with H^+ to form HF , removing it from the first equilibrium, which shifts right on purpose

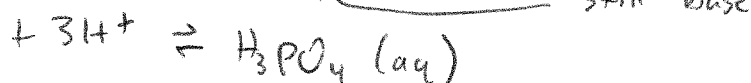
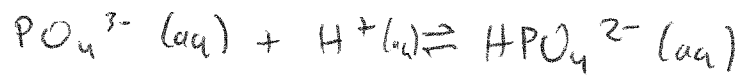
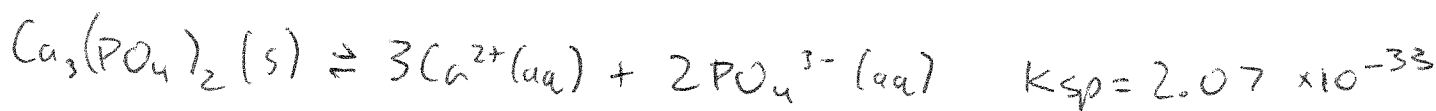
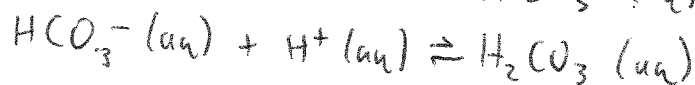
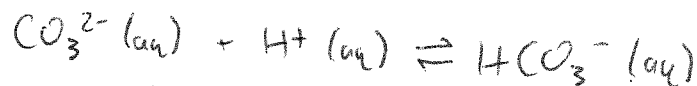


increasing solubility with basic anion



Chalk

$$K_{sp} = [\text{Ca}^{2+}][\text{CO}_3^{2-}] = 1.4 \times 10^{-8}$$



- Transition metal ions can react w/ Lewis bases to form complex ions, increasing solubility of their salts

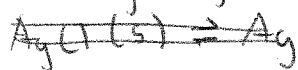
How Complex Ion Formation Affects Solubility

- Silver chloride is quite insoluble ($K_{sp} = 1.6 \times 10^{-10}$)

- In presence of NH_3 , solubility greatly increases because Ag^+ forms complex ions with NH_3



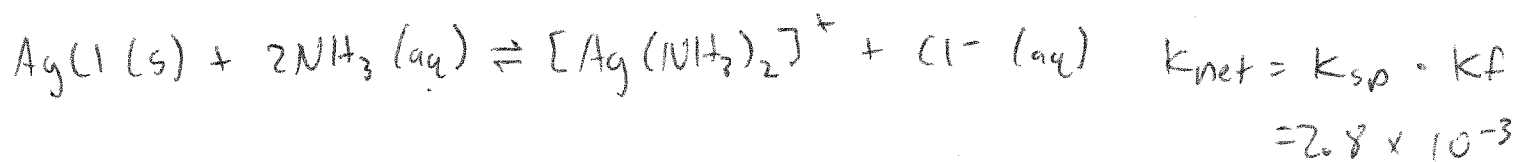
~~Dissolving AgCl in NH_3~~



$$K_f = \frac{[\text{Ag}(\text{NH}_3)_2^+]}{[\text{Ag}^+][\text{NH}_3]^2} = 1.7 \times 10^7$$

(continued...)

(2)



How much AgCl (s) dissolves in 1L H_2O ?

$$K_{sp} = 1.6 \times 10^{-10} = x^2 \quad x = 1.3 \times 10^{-5} \text{ M}$$

1.3×10^{-5} moles AgCl dissolves

How much dissolves in ^{1L of} 0.5M NH_3 ?

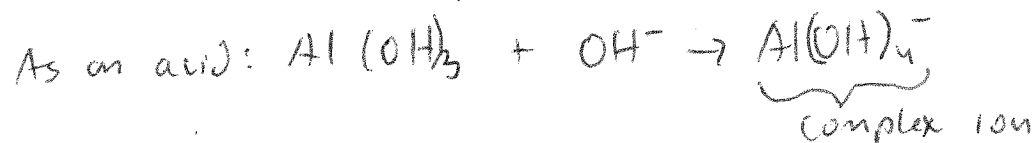
$$K_{net} = 2.8 \times 10^{-3} = \frac{[\text{Ag}(\text{NH}_3)_2]^+ [\text{Cl}^-]}{[\text{NH}_3]^2} = \frac{x^2}{(0.5)^2} \quad x = 0.026 \text{ M}$$

0.026 moles AgCl dissolves

Factors Affecting Solubility

- Amphoteric species can react as an acid or as a base
- Many metals (ie. Co, Zn, Sn, Pb, Al) form amphoteric oxides or hydroxides
- Solubility of amphoteric species will be increased in both acid and base

Example: $\text{Al}(\text{OH})_3$

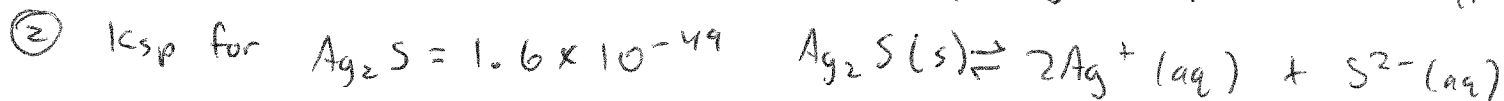


Will a precipitate form?

- Calculate the reaction quotient, Q , and compare it to the solubility product constant, K_{sp} .
 - ✓ If $Q = K_{sp}$, the system is at equilibrium and the solution is saturated.
 - ✓ If $Q < K_{sp}$, more solid can dissolve, so no precipitate forms.
 - ✓ If $Q > K_{sp}$, a precipitate will form

⑤
 $1.0 \times 10^{-4} \text{ M Pb}^{2+}$, $1.0 \times 10^{-4} \text{ M Ag}^{+}$ in solution.

S^{2-} is added. What metal will precipitate first?



① $K_{sp} = [\text{Pb}^{2+}][\text{S}^{2-}] = 7 \times 10^{-29}$

$$[\text{S}^{2-}] = \frac{7 \times 10^{-29}}{[\text{Pb}^{2+}]} = 7 \times 10^{-25} \text{ M} \quad \leftarrow \text{When } \text{Pb}^{2+} \text{ precipitates}$$

$\uparrow 1.0 \times 10^{-4}$ solving for $[\text{S}^{2-}]$ at which $Q = K_{sp}$

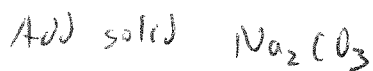
② $K_{sp} = [\text{Ag}^{+}]^2 [\text{S}^{2-}] = 1.6 \times 10^{-49}$ $\leftarrow$ When Ag^{+} precipitates

$$[\text{S}^{2-}] = \frac{1.6 \times 10^{-49}}{(1.0 \times 10^{-4})^2} = 1.6 \times 10^{-41} \text{ M}$$

Selective Precipitation of Ions

- Differences in solubility of salts can be used to separate ions in a mixture

- "Qualitative Analysis" of ions in a solution



How much can we add before we get a precipitate?



$$K_{sp} = [\text{Ni}^{2+}][\text{CO}_3^{2-}] \quad \text{NiCO}_3(s) \rightleftharpoons \text{Ni}^{2+}(aq) + \text{CO}_3^{2-}(aq)$$
$$= 1.5 \times 10^{-6} = [\text{CO}_3^{2-}]$$

$$[\text{CO}_3^{2-}] = 9.3 \times 10^{-2} \text{ M at } Q = K$$