Practice Selective Precipitation and Kf Key

1. What is the Cr3+ concentration when 0.010 mol of Cr(NO3)3 is dissolved in a liter of solution buffered at pH of 10.0. Cr3+ forms a complex ion with hydroxide shown below:

Cr3+ + 4 OH- Cr(OH)4- Kf =8.0 x 1029

pOH=14.0– 10.0 =4.0 [OH –]=antilog pOH=1.0 x10 –4

Due to the large Kf all of Cr 3+ is converted to the complexion, and some subsequently dissociates back to Cr 3+ .Then at equilibrium

|  |  |  |  |
| --- | --- | --- | --- |
| Cr3+ | + 4 OH- |  | Cr(OH)4-  |
| +x | 1.0 x 10-4 |  | 0.010-x |

$$K\_{f}=\frac{\left[Cr(OH)\_{4}^{-}\right]}{\left[Cr^{3+}\right] \left[OH^{-}\right]^{4}}= \frac{\left[0.010-x\right]}{\left[x\right] \left[1.0 x 10^{-4}\right]^{4}}=8.0 x 10^{29}$$

$$\left[Cr^{3+}\right]=x=1.0 x 10^{-16} M$$

2. Determine the molar solubility of cadmium phosphate, Cd3(PO4)2, in a 1.80 M solution of KI (need 2 equations)

Ksp Cd3(PO4)2 = 2.5 x 10-23 Kf CdI4- =2.0 x 106

Cd3(PO4)2 (s) 3 Cd2+ (aq)+ 2 PO43- (aq)Ksp= 2.5 x 10-23

3 (Cd2+ (aq) + 4 I- (aq)CdI4-2(aq)) Kf = (2.0 x 106)3

Cd3(PO4)2 (s) + 12 I- (aq)3 CdI4-2(aq) + 2 PO43- (aq) Knet= 2.0 x 10-14

I 1.80 M 0 M 0 M

C -12 x +3x +2x

E 1.80 M-12x 3x 2x

$$K\_{f}=\frac{\left[CrI\_{4}^{2-}\right]^{3}\left[PO\_{4}^{3-}\right]^{2}}{\left[I^{-}\right]^{12}}= \frac{\left[3x\right]^{3}\left[2x\right]^{2}}{\left[1.80 M-12x\right]^{12}} =2.0 x 10^{-14}$$

$$\frac{108 x^{5}}{\left[1.80 M-12x\right]^{12}} =2.0 x 10^{-14}$$

$$X =2.9 x 10^{-3} M$$

3. AgNO3 is added to a solution that is 0.10 M in NaCl and 0.010 M K2CrO4. Assume no dilution caused by the addition of AgNO3. Given the Ksp values below:

Ksp for AgCl = 1.6x10–10

Ksp for Ag2CrO4= 9.0x10–12

1. Which precipitates first, AgCl or Ag2CrO4? Calculate the [Ag+] when precipitation first begins

 AgCl*(s)* Ag+*(aq)* + Cl- *(aq)* Ksp = [Ag+] [Cl-]

|  |  |  |  |
| --- | --- | --- | --- |
| *I* |  | *0* | *0.10M* |
| *C* |  | *+x* | *+x* |
| *E* |  | *x* | *0.10M +x* |

Ksp = [*x*] [*0.10M +~~x~~*] =1.6x10–10

[Ag+] = 1.6x10–9 M

 Ag2CrO4*(s)* 2Ag+*(aq)* + CrO42- *(aq)* Ksp = [Ag+]2[CrO42-]

|  |  |  |  |
| --- | --- | --- | --- |
| *I* |  | *0* | 0.10M |
| *C* |  | *2x* | +x |
| *E* |  | *2x* | 0.10M +x |

Ksp = [*2x*]2[0.10M +x]= 9.0x10–12

 $x= \sqrt{\frac{9.0x10^{–12}}{4}}=1.5x10^{–5} M $

The precipitation occurs for the salt which requires the smallest [Ag+] at equilibrium. Therefore AgCl precipitates first at a [Ag+] of 1.6x10 –9 M

1. What is the [Cl–] when Ag2CrO4 first begins to precipitate?

The [Ag+] must equal 3.0x10–5 M. Therefore

Ksp = [Ag+] [Cl-] = (3.0x10–5 M) [Cl-] =1.6x10–10

[Cl-] =5.3 x 10–6 M