Solutions

CHEM 104
PLI 37
Friday, July 22, 2016 Chapter 17

$[I^-] = [SO_4^{2-}] = [PO_4^{3-}] = 1\times10^{-4}\ M$

1. A solution is $1x10^{-4}$ M in NaI, Na_2SO_4, and Na_3PO_4. What would the order of precitipation be as a source of Pb^{2+} is added gradually to the solution? The relevant K_{sp} values are:

$K_{sp}\ PbI_2 = 8.5x10^{-9}$ | $K_{sp}\ PbSO_4 = 1.8x10^{-8}$ | $K_{sp}\ Pb_3(PO_4)_2 = 7.9x10^{-43}$

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

$K_{sp} = [Pb^{2+}][I^-]^2 = 8.5\times10^{-9}$

$[Pb^{2+}] = \frac{8.5\times10^{-9}}{(1\times10^{-4})^2}$

$[Pb^{2+}] = 0.85\ M$

$PbSO_{4(s)} \rightleftharpoons Pb^{2+}_{(aq)} + SO_4^{2-}_{(aq)}$

$K_{sp} = [Pb^{2+}][SO_4^{2-}] = 1.8\times10^{-8}$

$[Pb^{2+}] = \frac{1.8\times10^{-8}}{1\times10^{-4}}$

$[Pb^{2+}] = 1.8\times10^{-4}\ M$

$Pb_3(PO_4)_{2(s)} \rightleftharpoons 3Pb^{2+}_{(aq)} + 2PO_4^{3-}_{(aq)}$

$K_{sp} = [Pb^{2+}]^3[PO_4^{3-}]^2 = 7.9\times10^{-43}$

$[Pb^{2+}]^3 = \frac{7.9\times10^{-43}}{(1\times10^{-4})^2}$

$[Pb^{2+}] = 4.29\times10^{-12}\ M$

The solution that can the least Pb^{2+} precipitates first:
$Pb_3(PO_4)_2$, then $PbSO_4$, then PbI_2

2. What is the pH at which $Cr(OH)_3$, $K_{sp} = 6.3x10^{-31}$, just starts to preceipitate from a $1.0x10^{-12}$ M Cr^{3+} solution?

$Cr(OH)_{3(s)} \rightleftharpoons Cr^{3+}_{(aq)} + 3OH^-_{(aq)}$

$K_{sp} = 6.3\times10^{-31} = [Cr^{3+}][OH^-]^3$

$[OH^-]^3 = \frac{6.3\times10^{-31}}{1.0\times10^{-12}}$

$[OH^-] = 8.57\times10^{-7}\ M$

$pOH = 6.07$

$pH = 7.93$

3. Solution A is 1.0 L of pure water. Solution B is 1.0 L of $3.4x10^{-2}$ M NaCl. How many more moles of AgCl ($K_{sp} = 1.77x10^{-10}$) dissolve in solution A than solution B?

+ I know this is way more sig figs than we have in this problem, but just to illustrate the tiny amount dissolved in soln B.

In Solution A: $AgCl_{(s)} \rightleftharpoons Ag^+_{(aq)} + Cl^-_{(aq)}$ $K_{sp} = 1.77\times10^{-10} = [Ag^+][Cl^-] = y^2$

I	doesn't matter	0M	0M
C	$-y$	$+y$	$+y$
E	doesn't matter $-y$	y	y

$1.77\times10^{-10} = y^2$

$y = 1.330413\times10^{-5}\ M$

$[Ag^+] = [Cl^-] = [\text{dissolved } AgCl] = 1.330413\times10^{-5}$ mol

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

I	doesn't matter	0M	3.4×10^{-2} M
C	$-z$	$+z$	$+z$
E	doesn't matter $-z$	z	$3.4\times10^{-2} + z$

$K_{sp} = 1.77\times10^{-10} = z(3.4\times10^{-2} + z)$ ← can ignore

$z = 5.206\times10^{-9}\ M$

$[Ag^+] = [\text{dissolved } AgCl] = 5.206\times10^{-9}$ mol

Difference = 1.330413×10^{-5} mol $- 5.206\times10^{-9}$ mol = 1.3299×10^{-5} more moles in solution A

4. For a specific reaction, which of the following statements can be made about K, the equilibrium constant?
   a. It always remains the same at different reaction conditions.
   b. It increases if the concentration of one of the products is increased.
   c. It changes with changes in the temperature.
   d. It increases if the concentration of one of the reactants is increased.
   e. It may be changed by the addition of a catalyst.

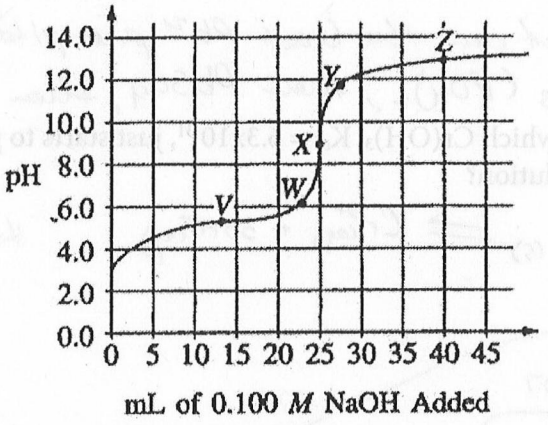
5. Barium sulfate is LEAST soluble in a 0.01 M solution of which of the following?
   a. $Al_2(SO_4)_3$
   b. $(NH_4)_2SO_4$
   c. Na_2SO_4
   d. NH_3
   e. $BaCl_2$

$BaSO_{4(s)} \rightleftharpoons Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)}$

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

common ions decrease solubility

Questions 6-7: The graph below shows the titration curve that results when 100. mL of 0.0250 M acetic acid is titrated with 0.100 M NaOH.



6. Which of the following indicators is the best choice for this titration?

	Indicator	pH range of color change
a.	Methyl orange	3.2 – 4.4
b.	Methyl red	4.8 – 6.0
c.	Bromothymol blue	6.1 – 7.6
d.	Phenolphthalein	8.2 – 10.0
e.	Alizarin	11.0 – 12.4

7. Which part of the curve corresponds to the optimum buffer action for the acetic acid/acetate ion pair?
   a. Point V → this is the point at which the pH is holding relatively steady even though we are adding base
   b. Point X
   c. Point Z
   d. Along all of section WY
   e. Along all of section YZ