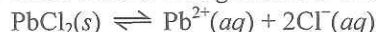


Chapter 15 HW #3: Due 12/7/15 Complete both free response questions. One will be graded. Show all work. Box and clearly label all final answers

#1. Answer the following questions that relate to solubility of salts of lead and barium.

(a) A saturated solution is prepared by adding excess $\text{PbCl}_2(s)$ to distilled water to form 1.0 L of solution at 25°C . The solubility of PbCl_2 is found to be 0.4415 grams/100. ml H_2O . The chemical equation for the dissolution of $\text{PbCl}_2(s)$ in water is shown below.



(i) Write the equilibrium-constant expression for the equation.

(ii) Calculate the molar concentration of $\text{Cl}^-(aq)$ in the solution.

(iii) Calculate the value of the equilibrium constant, K_{sp} .

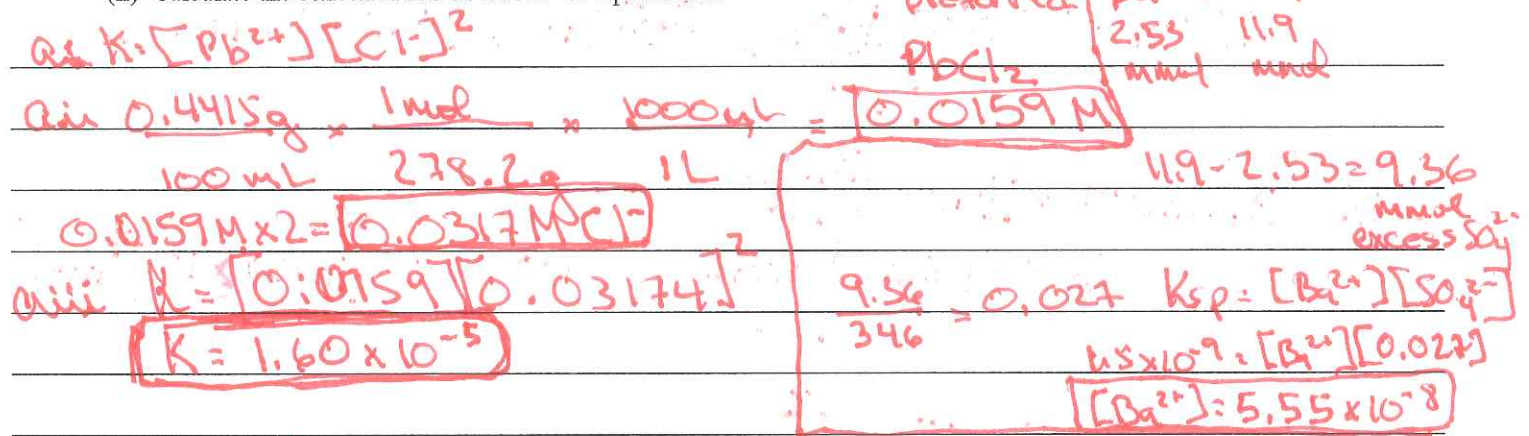
(b) A saturated solution is prepared by adding $\text{PbCl}_2(s)$ to distilled water to form 4.0 L of solution at 25°C . What are the molar concentrations of $\text{Pb}^{2+}(aq)$ and $\text{Cl}^-(aq)$ in the solution? Justify your answer.

(c) Solid NaCl is added to a saturated solution of PbCl_2 at 25°C . Assuming that the volume of the solution does not change, does the molar concentration of $\text{Pb}^{2+}(aq)$ in the solution increase, decrease, or remain the same? Justify your answer.

(d) The value of K_{sp} for the salt BaSO_4 is 1.5×10^{-9} .

(i) When a 117.0 mL sample of $2.16 \times 10^{-2} M \text{Ba}(\text{NO}_3)_2$ is added to 229.0 mL of $5.19 \times 10^{-2} M \text{Na}_2\text{SO}_4$ does a precipitate form (you must justify with calculations).

(ii) Calculate the concentration of the Ba^{2+} at equilibrium.



b. $[\text{Pb}^{2+}] = 0.0159 \text{ M}$
 $[\text{Cl}^-] = 0.0317 \text{ M}$
 These are the same because solution is still saturated.

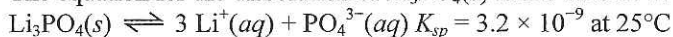
c. $[\text{Pb}^{2+}]$ decreases. Since $K_{sp} = [\text{Pb}^{2+}][\text{Cl}^-]^2$ and K_{sp} is constant if $[\text{Cl}^-] \uparrow$ then $[\text{Pb}^{2+}]$ has to decrease.

d. $\text{Ba}^{2+}: (2.16 \times 10^{-2})(117) = (M)(346)$ $M = 0.00730$
 $\text{SO}_4^{2-}: (5.19 \times 10^{-2})(229) = (M)(346)$ $M = 0.0344$
 $Q = [0.00730][0.0344] = 2.51 \times 10^{-4}$
 $Q > K$ so a precipitate will form

d.i. ALT. b/c 1:1 ratio $0.0344 - 0.0073 = 0.027 \text{ M excess}$
 $1.5 \times 10^{-9} = [\text{Ba}^{2+}][0.027]$
 $[\text{Ba}^{2+}] = 5.55 \times 10^{-8}$

#2. Answer the following questions about the solubility of the salts Li_3PO_4 and PbCl_2 . Assume that hydrolysis effects are negligible.

The equation for the dissolution of $\text{Li}_3\text{PO}_4(s)$ is shown below.



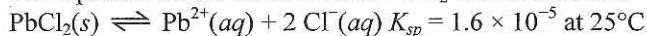
(a) Write the equilibrium-constant expression for the dissolution of $\text{Li}_3\text{PO}_4(s)$.

(b) Assuming that volume changes are negligible, calculate the maximum number of moles of $\text{Li}_3\text{PO}_4(s)$ that can dissolve in

(i) 0.50 L of water at 25°C

(ii) 0.50 L of 0.20 M LiNO_3 at 25°C

The equation for the dissolution of PbCl_2 is shown below.



(c) Calculate the concentration of $\text{Cl}^-(aq)$ in a saturated solution of PbCl_2 at 25°C .

(d) An open container holds 1.000 L of 0.00400 M PbCl_2 , which is unsaturated at 25°C . Calculate the minimum volume of water, in mL, that must evaporate from the container before solid PbCl_2 can precipitate.

a. $K_{sp} = [\text{Li}^+]^3 [\text{PO}_4^{3-}]$

b.i. $3.2 \times 10^{-9} = [3x]^3 [x]$

$x = 0.00330 \text{ Mol} \times 0.50 \text{ L} = 0.0016 \text{ mol}$

b.ii. $3.2 \times 10^{-9} = [0.20]^3 [x]$

$x = 4 \times 10^{-7} \text{ mol/L} \times 0.50 \text{ L} = 2.0 \times 10^{-7} \text{ mol}$

c. $1.6 \times 10^{-5} = [x][2x]^2$

$1.6 \times 10^{-5} = 4x^3$

$x = 0.016 \text{ M solubility} \times 2 = 0.032 \text{ M Cl}^-$

d. $M_1V_1 = M_2V_2$

~~(0.00400)(1.00) =~~

$(0.00400)(1.0) = (0.016)(V_2)$

$V_2 = 0.250 \text{ L}$

$1.0 \text{ L} - 0.250 = 0.750 \text{ L must evaporate}$