

3.091 OCW Scholar

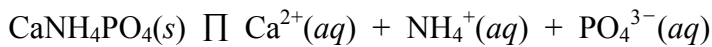
Self-Assessment Exam

Aqueous Solutions

Solution Key

2009 Exam 3, Problem #3

(a) Calcium ammonium phosphate (CaNH_4PO_4) dissolves in water according to



for which the value of the solubility product, K_{sp} , has been determined to be 4.4×10^{-14} . Calculate the solubility of CaNH_4PO_4 in water. Express your answer in units of molarity, i.e., moles of CaNH_4PO_4 per L of solution.

$$K_{sp} = [\text{Ca}^{2+}][\text{NH}_4^+][\text{PO}_4^{3-}]$$

by stoichiometry, $[\text{Ca}^{2+}] = [\text{NH}_4^+] = [\text{PO}_4^{3-}] = c_s$

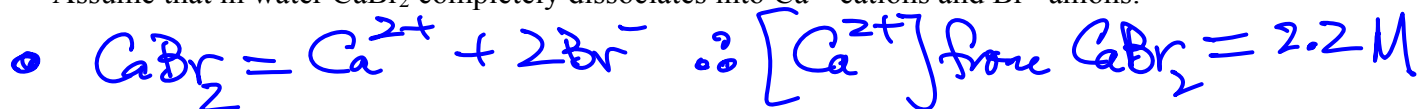
$$\therefore K_{sp} = (c_s)^3$$

$$\therefore c_s = (K_{sp})^{1/3} = \underline{\underline{3.53 \times 10^{-5} \text{ M}}}$$

Solubility of the salt in water

(b) Calculate the solubility of CaNH_4PO_4 in 2.2 M $\text{CaBr}_2(aq)$. Express your answer in units of molarity.

Assume that in water CaBr_2 completely dissociates into Ca^{2+} cations and Br^- anions.



• $2.2 \text{ M} \gg c_s$ from part (a) which sets $[\text{Ca}^{2+}]$ from dissolution of salt in pure water

• assume that $[\text{NH}_4^+] = [\text{PO}_4^{3-}] = c_s$ of CaNH_4PO_4 as before

$$\Rightarrow K_{sp} = [\text{Ca}^{2+}][\text{NH}_4^+][\text{PO}_4^{3-}] = (2.2)(c_s)^2$$

$$\Rightarrow c_s = \left(\frac{K_{sp}}{2.2} \right)^{1/2} = \left(\frac{4.4 \times 10^{-14}}{2.2} \right)^{1/2} = \underline{\underline{1.41 \times 10^{-7} \text{ M}}}$$

Final Exam, Problem #10

- (a) You have 333 mL of alkaline solution at pH = 9.9. You wish to neutralize this by reacting it with 222 mL of acid. What must be the value of the pH of the acid?

$$\begin{aligned} 333 \text{ mL} \times 9.9 + 222 \text{ mL} \times y &= 555 \text{ mL} \cdot 7.0 \\ 3297 + 222y &= 3885 \\ \underline{y = 2.6} \end{aligned}$$

There's probably an elegant way to do this.

- (b) Name the conjugate base of each of the following:



- (c) Classify each of the following as a Lewis acid or a Lewis base:



- (d) Consider the effect each of the following substances has on the ionization of the weak base, ammonia ($\text{NH}_3(\text{aq})$). For each, state whether the substance (1) suppresses ionization, (2) enhances ionization, or (3) has no effect on the ionization of ammonia. In each instance, give a reason for your choice.

(i) KOH suppresses ionization - The presence of OH^- raises pH reducing the capacity of the solution to make available H^+ to ionize NH_3

(ii) HCl enhanced ionization - The presence of H^+ calls for proton acceptor according to Le Chatelier

(iii) NH_4Cl suppresses ionization - The presence of NH_4^+ cations has a "common ion effect" which suppresses ionization of NH_3 .

MIT OpenCourseWare
<http://ocw.mit.edu>

3.091SC Introduction to Solid State Chemistry
Fall 2009

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.