

CH 302 Spring 2008 Worksheet 8

1. NaH_2PO_4 (conc. = $C_{\text{NaH}_2\text{PO}_4}$) is dissolved in water. Write the mass balance equation for this system.
2. Write the charge balance equation for the solution in question 1.
3. Write the charge balance equation for a solution containing all of the following ions: H^+ , OH^- , Na^+ , Ba^{2+} , PO_4^{3-} , Ag^{3+} , SO_4^{2-} , and COOH^- .
4. NaH_2PO_4 , LiHCO_3 , HCl , NaCl , and LiOH are all dissolved in water. How many equations are needed to completely describe this system?
5. Write a charge balance equation for the system described in question 4.
6. Write the mass balance equation for H_2CO_3 (conc. = $C_{\text{H}_2\text{CO}_3}$) in water.
7. Find the pH of 10^{-8} M HCl like you would have for the last two quizzes. Then find it using the exact expression, $[\text{H}^+]^2 - [\text{H}^+]C_{\text{HCl}} - K_w = 0$. Compare the two answers.
8. Repeat the same thing as in question 7, this time for 10^{-2} M HCl .
9. Assuming an appropriate C_{HCl} , derive the approximate equation for a strong acid, $[\text{H}^+] = C_a$, from the expression given in question 6.
10. In class, you learned that the exact $[\text{H}^+]$ for a weak acid is given by
$$[\text{H}^+]^3 + K_a[\text{H}^+]^2 - (K_w + K_a C_a)[\text{H}^+] - K_a K_w = 0$$
Assuming appropriate values for K_a and C_a , derive the approximate equation for a weak acid, $[\text{H}^+] = (K_a C_a)^{1/2}$, from this expression.
11. What is the pH of a 0.05 M H_2SO_4 solution if $K_{a2} = 1.1 \times 10^{-2}$? (In class, Dr. Laude did this using a RICE expression and ignored the water equilibrium. Feel free to use his same approach.)
12. Rank the concentrations of ions and neutrals at equilibrium in the solution formed in problem 11. Use some common sense reasoning to explain your answer without doing any calculations.

For Questions 13-20, list the species present in solution and write the system of equations that can be used to solve for their concentrations at equilibrium exactly. You don't have to actually solve the system (but if you're an engineer, go for it).

13. HF (conc. = C_{HF}) in water

14. HCl (conc. = C_{HCl}) in water

15. H_3PO_4 (conc. = $C_{\text{H}_3\text{PO}_4}$) in water

16. HCl (conc. = C_{HCl}) in water

17. HCl (conc. = C_{HCl}) and NH_4Cl (conc. = $C_{\text{NH}_4\text{Cl}}$) in water

18. $\text{Ba}(\text{OH})_2$ (conc. = $C_{\text{Ba}(\text{OH})_2}$) in water

19. HCOOH (conc. = C_{HCOOH}) in water

20. NaOH (conc. = C_{NaOH}) in water

21. NaOH (conc. = C_{NaOH}) added to a beaker containing Na^+ ions at a concentration of C_{Na}