1. Consider the following equations:

$$[H_3O^+] = \sqrt{\frac{K_{a2}c_{HA} + K_w}{1 + \frac{c_{HA}}{K_{a1}}}} \qquad [H_3O^+] = \sqrt{K_{a1}K_{a2}}$$

   a. What are these equations used for? (4 pts)

See Notes

   b. What are the approximations that simplify the first equation into the second? (6 pts)

See Notes

2. Calculate the pH of a 0.0300 M solution of the intermediate form of phenylalanine. (8 pts)

5.80

3. A buffer solution is prepared by combining 40.0 mL of 0.1200 M NaOH with 160.0 mL of 0.0420 M ammonium chloride.
   a. What is the pH of this buffer solution? (6 pts)

9.64

5. Limestone consists mainly of the mineral calcite, $CaCO_3$. The carbonate content of a 0.5431 g sample of powdered limestone was measured by suspending the powder in water, adding 10.00 mL of 1.396 M hydrochloric acid, and heating to dissolve the solid and dispel carbon dioxide gas. The excess acid required 39.96 mL of 0.1004 M sodium hydroxide for complete titration to a phenolphthalein end point. What is the weight percent of calcite in the limestone? (12 pts)

91.6%

6. Consider a solution prepared by combining 25.0 mL of 0.125 M $CdCl_2$ with 75.0 mL of 0.0750 M sodium hydroxide.
   a. Write the balanced overall reaction that occurs as the solutions are mixed. (4 pts)

$CdCl_2(aq) + 2\ NaOH(aq) \rightarrow Cd(OH)_2\ (s) + 2\ NaCl(aq)$

   b. Write the reaction corresponding to the solubility equilibrium that is established after the reaction is complete. Also write an equilibrium constant expression. (4 pts)

$Cd(OH)_2\ (s) \leftrightarrow Cd^{2+}\ (aq) + 2\ OH^-\ (aq)$

$K_{sp} = [Cd^{2+}][OH^-]^2$

   c. What is the concentration of the excess reagent after the reaction is complete? (6 pts)

$3.125 \times 10^{-3} M$

7. Calculate the pH of the following solutions:
   a. A solution prepared by combining 10.0 mL of 0.100 M trimethylammonium bromide with 4.0 mL of 0.100 M NaOH. (8 pts)

Buffer, pH = 9.623

   b. A solution that results when 50.0 mL of 0.100 M NaCN is mixed with 11.82 mL of 0.438 M $HClO_4$. (6 pts)

Strong Acid, pH = 2.543

8. Consider a saturated solution of silver carbonate.
   a. Write out all the pertinent reactions and equations necessary to determine the solubility of silver carbonate in this solution. (12 pts)

N/A