

Problem Set 6A. Acid-Base Equilibria and Neutralization Titrations
Chem 2222, Summer 2008

For problems involving equilibrium calculations, show the relevant equilibrium reaction, the equilibrium constant expression (use values given in your text), and a brief derivation of the equation used for the calculation of the equilibrium concentration, unless noted otherwise. Ignore activity coefficients unless required by the question. Write balanced chemical equations for any net reactions involved.

Please complete the recommended exercises in Chapter 12 of your text before attempting these problems.

- 1) Noting that $\text{pH} = -\log a_{\text{H}^+}$, calculate the pH of 0.050 M HCl.
- 2) Calculate the pH of a solution which results from mixing 40.0 mL of 0.100 M butanoic acid with 15.0 mL of 0.100 M sodium hydroxide.
- 3) Consider a solution of HCN.
 - a) Define (mathematical expression) α_{CN^-} , the fraction of HCN present as CN^- .
 - b) Beginning with definition in (a) and the expression for K_a , derive an expression for α_{CN^-} in terms of $[\text{H}^+]$ and K_a .
 - c) Calculate the values of α_{HCN} and α_{CN^-} from pH 4 to 12 and plot each vs pH.
- 4) Calculate the pH of a solution resulting from the addition of 25.0 mL of 0.10 M HCl to 40.0 mL of 0.10 M NaCN.
- 5) Sketch titration curves for each of the following, indicating clearly the volume of titrant and the pH (within 0.1 pH unit) at the midpoint(s) and equivalence point(s). Show your calculations for these points. Label your axes. A carefully constructed and labeled hand-drawn sketch is acceptable.
 - a) titration of 20.0 mL of 0.10 M acetic acid with 0.10 M NaOH.
 - b) titration of 20.0 mL of a solution containing 0.10 M HCl plus 0.20 M acetic acid with 0.10 M NaOH.
- 6) Calculate the pH of a solution resulting from addition of 100 mL of 0.040 M HCl to 100 mL of a solution containing 0.200 M NH_3 and 0.100 M NH_4Cl .

Answers

1. pH = 1.37
2. pH = 4.66
3. See Skoog7e, #12.53
4. pH = 8.99
5. a) See Skoog7e, #12.51
b) See Skoog7e, #13.29
6. pH = 9.31