Chapter 10 (and part of Ch. 1) Introduction to Titrations and Acid-Base Titration

NOTE: Review your problem set and lecture notes; pay attention to sample and assigned problems

1. Distinguish between the terms end point and equivalence point of a titration.

2. Explain the following:
   • Problem 10-4. Sketch the general appearance of the curve for the titration of a weak acid with a strong base. Explain (in words) what chemistry governs the pH in each of the four distinct regions of the curve.
   • Problem 10-12. Sketch the general appearance of the curve for the titration of a weak base with a strong acid. Explain (in words) what chemistry governs the pH in each of the four distinct regions of the curve.
   • Problem 10-13. Why is the equivalence-point pH necessarily below 7 when a weak base is titrated with strong acid?
   • Problem 10-19, Harris. Sketch the general appearance of the curve for the titration of a weak diprotic acid with NaOH. Explain (in words) what chemistry governs the pH in each distinct region of the curve.
   • Problem 10-42. Cresol red has two transition ranges listed in Table 10-3. What color would you expect it to be at the following pH values? (a) 0; (b) 1; (c) 6; (d) 9
   • Problem 10-43. Would the indicator bromocresol green, with a transition range of pH 3.8–5.4, ever be useful in the titration of a weak acid with a strong base?

3. Problem 1-45, Harris: Sulfamic acid is a primary standard that can be used to standardize NaOH.

\[ ^{+}H_{3}NSO_{3}^{-} + OH^{-} \rightarrow H_{2}NSO_{3}^{2-} + H_{2}O \]

Sulfamic acid
(MM 97.094)

What is the molarity of a sodium hydroxide solution if 34.26 mL react with 0.3337 g of sulfamic acid?

4. (Adapted from Brown, Lemay and Bursten, 10th ed.) A sample of iron ore is dissolved in acid, and the iron is converted to Fe2+. The sample is then titrated with 47.20 mL of 0.02240 M KMnO4 solution. The oxidation-reduction reaction that occurs during titration is as follows:

\[ MnO_{4}^{-} + 5Fe^{2+} + 8H^{+} \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_{2}O(l) \]

[NOTE: All the other species are in aqueous form.]

(a) How many grams of Fe were in the sample?

(b) If the sample had a mass of 0.8890 g, what is the percentage of iron in the sample?

5. Problem 10-8, Harris. What is the pH at the equivalence point when 0.100 M hydroxy-acetic acid is titrated with 0.0500 M KOH?

Omit.

6. Problem 10-9, Harris. Find the equilibrium constant for the reaction of MES (Table 8-2) with NaOH.
7. Problem 10-10, Harris. When 22.63 mL of aqueous NaOH were added to 1.214 g of cyclohexyl-aminoethanesulfonic acid (MM 207.29, structure in Table 8-2) dissolved in 41.37 mL of water, the pH was 9.24. Calculate the molarity of the NaOH.

8. Calculate the pH of 25.00 mL solution of 0.125 M acetic acid ($K_a = 1.75 \times 10^{-5}$) after the addition of each of the following volumes of 0.100 M KOH: 10.00 mL, $V_{ep}$, and 35.00 mL.

9. Problem 10-19, Harris. Sketch the general appearance of the curve for the titration of a weak diprotic acid with NaOH. Explain (in words) what chemistry governs the pH in each distinct region of the curve.

Chapter 11: EDTA TITRATIONS

1. Be able to explain each of the following terminologies: Back titration, blocking (of indicator), chelate, chelate effect, complexometric titration, direct titration, formation constant, metal ion indicator, multidentate ligand

2. Problem 11-25. Calcium ion was titrated with EDTA at pH 11 using calmagite as indicator (Table 11-3). Which is the principal species of Calmagite at pH 11? What color was observed before the equivalence point? After the equivalence point?

3. Problem solving (see lecture notes on water hardness (as CaCO$_3$) determination).

4. Problem 11-31. How many milliliters of 0.0500 M EDTA are required to react with 50.0 mL of 0.0100 M Ca$^{2+}$? With 50.0 mL of 0.0100 M Al$^{3+}$?

Challenge question: 5. Problem 11-32. A 50.0-mL sample containing Ni$^{2+}$ was treated with 25.0 mL of 0.0500 M EDTA to complex all the Ni$^{2+}$ and leave excess EDTA in solution. The excess EDTA was then back-titrated, requiring 5.00 mL of 0.0500 M Zn$^{2+}$. What was the concentration of Ni$^{2+}$ in the original solution?