

Passage IV

Acid-base titration is a technique in which precise volumes of a *titrant* (an acid or base solution) are added incrementally to a known volume of a *sample solution* (a base or acid solution, respectively). This process can be monitored by adding an *acid-base indicator* (a substance that changes color over a certain pH range) to the sample solution or by measuring the sample solution's *conductivity*. Conductivity (measured in kilosiemens per centimeter, kS/cm) is a measure of a substance's ability to conduct electricity.

Two titration experiments were done at 25°C using a 0.10 M sodium hydroxide (NaOH) solution and either a 0.0010 M hydrochloric acid (HCl) solution or a 0.0010 M acetic acid solution (where M is moles of acid or base per liter of solution). All solutions were aqueous. An acid-base indicator solution of *nitrazine yellow* was also used. Nitrazine yellow is yellow if the pH is less than 6.0 or blue if the pH is greater than 7.0.

Experiment 1

A drop of nitrazine yellow solution was added to a flask containing 100.0 mL of the HCl solution. A probe that measures conductivity was placed in the solution. The NaOH solution was slowly added to the HCl solution in small increments. After each addition, the HCl solution was stirred and then the solution's color and conductivity were recorded (see Figure 1).

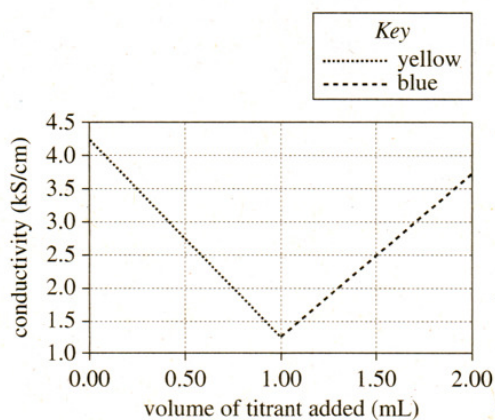


Figure 1

Experiment 2

Experiment 1 was repeated, except that the acetic acid solution was used instead of the HCl solution (see Figure 2).

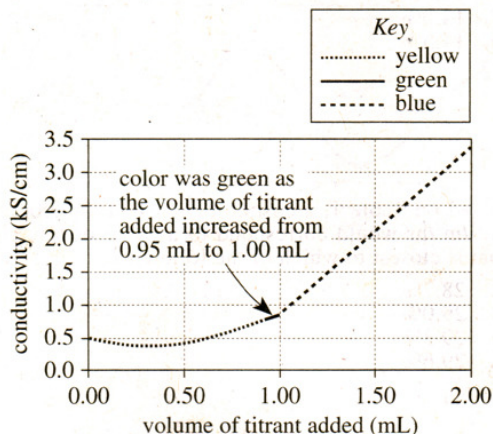


Figure 2

Figures adapted from J. West Loveland, "Conductance and Oscillometry," in Gary D. Christian and James E. O'Reilly, eds., *Instrumental Analysis*, 2nd ed. ©1986 by Allyn and Bacon, Inc.

18. In Experiment 1, the sample solution was yellow at which of the following values for the volume of titrant added?
- F. 0.80 mL
 - G. 1.20 mL
 - H. 1.60 mL
 - J. 2.00 mL
19. In Experiment 2, the sample solution was neutral at which of the following values for the volume of titrant added?
- A. 0.50 mL
 - B. 1.00 mL
 - C. 1.50 mL
 - D. 2.00 mL

20. In Experiment 1, if 2.30 mL of titrant had been added to the sample solution, the conductivity would most likely have been:
- F. less than 0.80 kS/cm.
 - G. between 0.80 kS/cm and 2.30 kS/cm.
 - H. between 2.30 kS/cm and 3.80 kS/cm.
 - J. greater than 3.80 kS/cm.

21. In Experiment 2, which solution was the titrant and which solution was the sample solution?

<u>titrant</u>	<u>sample solution</u>
A. acetic acid	NaOH
B. HCl	NaOH
C. NaOH	acetic acid
D. NaOH	HCl

22. In Experiments 1 and 2, the probe that was placed in the sample solution most likely did which of the following?
- F. Cooled the solution to its freezing point
 - G. Heated the solution to its boiling point
 - H. Detected the concentration of nitrazine yellow in the solution
 - J. Passed an electrical current through a portion of the solution
23. A chemist claimed that in Experiment 2, the pH of the sample solution was greater at a value of 0.2 mL of titrant added than at a value of 1.8 mL of titrant added. Do the results of Experiment 2 support this claim?
- A. No; at a value of 0.2 mL of titrant added, the sample solution was yellow, and at a value of 1.8 mL of titrant added, the sample solution was blue.
 - B. No; at a value of 0.2 mL of titrant added, the sample solution was blue, and at a value of 1.8 mL of titrant added, the sample solution was yellow.
 - C. Yes; at a value of 0.2 mL of titrant added, the sample solution was yellow, and at a value of 1.8 mL of titrant added, the sample solution was blue.
 - D. Yes; at a value of 0.2 mL of titrant added, the sample solution was blue, and at a value of 1.8 mL of titrant added, the sample solution was yellow.