

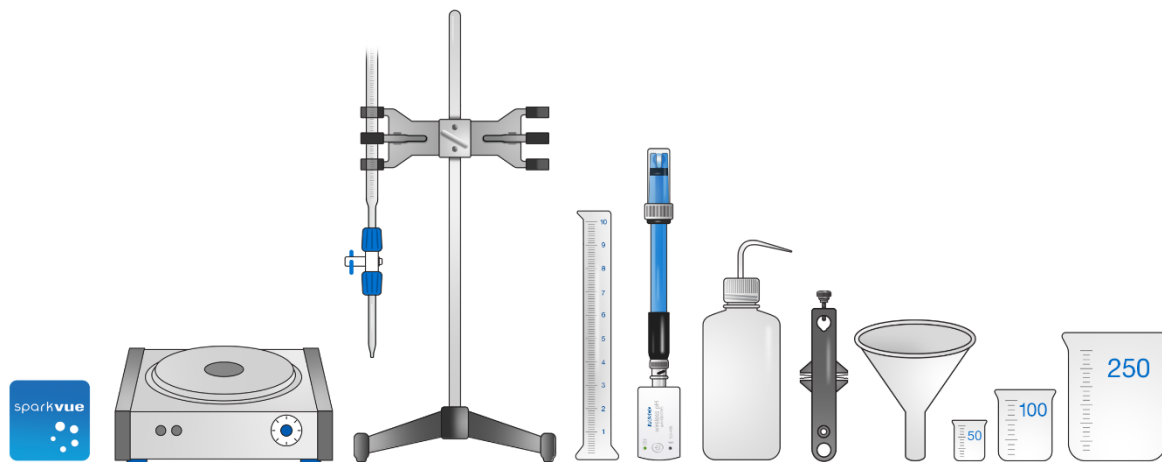
16B – TITRATION OF AN UNKNOWN ACID

INQUIRY

Can the concentration of an acid be determined by titration? How does the titration curve of a strong acid compare to the titration curve of a weak acid?

MATERIALS

- Device with SPARKvue software
- pH sensor
- Electrode support
- Graduated cylinder, 10-mL
- Beaker, 250-mL
- Beaker, 100-mL
- Burette, 50-mL (readability: 0.01 mL)
- Burette clamp
- Funnel to fit burette
- Magnetic stirrer with magnet
- Ring stand
- pH buffer solutions, pH 4 and pH 10
- 0.10 M NaOH solution, 100 mL
- Unknown concentration of acetic acid, $\text{HC}_2\text{H}_3\text{O}_2$, 50 mL
- Unknown concentration of HCl, 50 mL
- Wash bottle with distilled water



BACKGROUND

Titration is a laboratory technique in which a solution of known concentration is used to determine the concentration of an unknown solution. This technique is particularly useful for acids and bases. Recall when an acid reacts with a base in a neutralization reaction, a salt and water are produced. For example:



The point at which the moles of acid are equal to the moles of base is known as the equivalence point. By graphing the pH of the combined acid and base solution against the amount of titrant used, the equivalence point can be found.

SAFETY

Follow these important safety precautions in addition to your regular classroom procedures.

- Wear safety goggles at all times.
- Notify your teacher of all spills and dispose of your chemicals in the proper waste container.

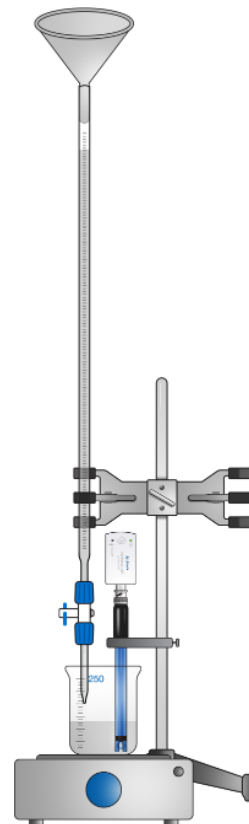


PROCEDURE



Part 1 – Titration of a strong acid

1. Open SPARKvue.
 2. Open the 16B Titration of an Unknown Acid lab file in SPARKvue.
 3. Use the Bluetooth icon to connect the pH sensor. Calibrate the sensor with pH 4 and pH 10 buffer solutions. Rinse the sensor between solutions.
 4. Attach the electrode support and burette clamp to the ring stand. Place the burette in the clamp with the funnel still inside the burette. Place the 100-mL beaker beneath the burette so it will drain into the beaker as shown.
 5. Clean and fill the burette with 0.1 M NaOH titrant.
 - Use the funnel to rinse the burette with distilled water into the 100-mL beaker with the burette open.
 - Use a small amount of 0.1 M NaOH solution for a final rinse into the beaker.
 - Close the burette and fill it just past the 0.00 mL mark with NaOH. Release a small amount of NaOH solution into the 100-mL beaker. Release or add NaOH until the burette reads exactly 0.00 mL.
 - If a drop of NaOH is hanging from the burette tip, rinse the tip with distilled water. Allow the liquid to fall into the beaker.
 - Set the 100-mL beaker aside; this is a waste beaker.
 6. Use the graduated cylinder to measure 10.0 mL of the unknown hydrochloric acid (HCl) solution. Add the HCl to the larger 250-mL beaker. Add a magnetic stir bar to the beaker, and place the beaker on the magnetic stirrer. Position the burette so it will drain into the beaker.
 7. Use the electrode support to suspend the pH probe in the HCl. Add enough distilled water to make sure the glass bulb on the pH sensor is covered.
 8. Turn on the magnetic stirrer making sure that the pH probe stays in the solution and is out of the way of the magnetic stir bar.
 9. Draw a prediction of how the pH versus volume of titrant graph will change as NaOH is added to HCl in Graph 1 on your answer sheet. Fill out the legend to identify the prediction line.
 10. Start collecting data. Record the initial pH at volume = 0 mL of NaOH added in the table in SPARKvue by selecting the check mark.
 11. Adjust the burette to release NaOH very slowly. When 0.50 mL of NaOH has been added, close the burette. Rinse the hanging drop of NaOH if necessary. Read the burette and enter the exact volume of NaOH added in the Volume column in the SPARKvue table. Use the check mark to record the pH.
- Note: When the addition of NaOH causes a change of pH that is greater than 0.5 units, slow down the addition of NaOH to 0.1 mL or drop increments.*
12. Continue adding the NaOH solution in 0.5 mL increments and recording the exact volume and pH in SPARKvue until the pH is greater than 11. Remember to rinse hanging drops of NaOH.



PROCEDURE

13. Sketch a graph of the pH versus volume of titrant added on Graph 1. Fill out the legend to identify the curve for trial 1.
14. Stop collecting data and turn off the magnetic stirrer.
15. Refill the burette with NaOH to the 0.00 mL mark.
16. Dispose of the solution in the 250-mL beaker according to your teacher's directions.
17. Clean and dry the 250-mL beaker. Use the graduated cylinder to add 10.0 mL of HCl to the beaker.
18. Suspend the pH probe in the acid. Add distilled water to cover the glass bulb on the pH sensor.
19. Rinse and dry the magnetic stir bar and place it in the 250-mL beaker. Arrange the beaker, burette and pH probe on the magnetic stirrer as before and turn on the stirrer.
20. Change the run number in SPARKvue by selecting the run number just beneath the Volume label at the top of the table.
21. Repeat Steps 10-20 for a total of 3 trials.

ANALYSIS

Complete the analysis for Part 1 on your answer sheet.

QUESTIONS

Answer the questions for Part 1 on your answer sheet.

PROCEDURE

Part 2 – Titration of a weak acid

1. Make sure the burette is filled to the 0.00 mL line with NaOH. Rinse the hanging drop of NaOH if necessary.
2. Rinse the graduated cylinder with distilled water thoroughly. Rinse and dry the 250-mL beaker and the magnetic stir bar.
3. Use the graduated cylinder to add 10.0 mL of acetic acid to the 250-mL beaker.
4. Place the magnetic stir bar in the 250-mL beaker. Arrange the beaker, burette and pH probe on the magnetic stirrer as before and turn on the stirrer. Add enough distilled water to cover the glass bulb on the pH sensor.
5. You will now titrate a weak acid with a strong base. Draw your prediction of how the pH versus volume of titrant graph will look in Graph 2 on your answer sheet. Fill out the legend to identify the prediction line.
6. Navigate to Page 2 in SPARKvue and start collecting data. Record the initial pH at volume = 0 mL of NaOH added in the table in SPARKvue by selecting the check mark.



PROCEDURE



7. Adjust the burette so the NaOH comes out very slowly. When 0.50 mL of NaOH has been added, close the burette. Record the actual volume of NaOH added in SPARKvue. Rinse the hanging drop of NaOH if necessary and use the check mark to record the pH at volume = 0.50 mL.
8. Continue adding NaOH in 0.5 mL increments and recording the pH until the pH is greater than 11. Rinse hanging drops of NaOH as needed. Record the actual volume of NaOH added in SPARKvue.

Note: When the addition of NaOH causes a change of pH that is greater than 0.5 units, slow down the addition of NaOH to 0.1 mL or drop increments.

9. Sketch a graph of the pH versus volume of titrant added in Graph 2. Fill out the legend to identify the curve for trial 1.
10. Stop collecting data and turn off the magnetic stirrer.
11. Dispose of the solution in the 250-mL beaker according to your teacher's directions.
12. Clean and dry the 250-mL beaker. Use the graduated cylinder to add 10.0 mL of acetic acid to the beaker.
13. Suspend the pH probe in the acid. Add distilled water to cover the glass bulb on the pH sensor.
14. Rinse and dry the magnetic stir bar and place it in the 250-mL beaker. Arrange the beaker, burette and pH probe on the magnetic stirrer as before and turn on the stirrer.
15. Repeat Steps 6-14 for a total of 3 trials.



ANALYSIS



Complete the analysis for Part 2 on your answer sheet.



QUESTIONS



Answer the questions for Part 2 on your answer sheet.