Lab: Titration
FOR THE TEACHER

Summary
In this lab, students will learn the difference between strong, weak, and concentrated acids by carrying out various titrations.

Grade Level
High school

AP Chemistry Curriculum Framework
This laboratory experiment supports the following units, topics, and learning objectives:

- **Unit 4: Chemical Reactions**
  - **Topic 4.2:** Net Ionic Equations
    - **TRA -1.B:** Represent changes in matter with a balanced chemical or net ionic equation: a. For physical changes. b. For given information about the identity of the reactants and/or product. c. For ions in a given chemical reaction.
  - **Topic 4.5:** Stoichiometry
    - **SPQ-4.A:** Explain changes in the amounts of reactants and products based on the balanced reaction equation for a chemical process.
  - **Topic 4.6:** Introduction to Titration
    - **SPQ- 4.B:** Identify the equivalence point in a titration based on the amounts of the titrant and analyte, assuming the titration reaction goes to completion.

- **Unit 8: Acids and Bases**
  - **Topic 8.2:** pH and pOH of Strong Acids and Bases
    - **SAP-9.B:** Calculate pH and pOH based on concentrations of all species in a solution of a strong acid or a strong base.
  - **Topic 8.5:** Acid-Base Titrations
    - **SAP-9.E:** Explain results from the titration of a mono- or polyprotic acid or base solution, in relation to the properties of the solution and its components.
  - **Topic 8.7:** pH and pKa
    - **SAP-10.A:** Explain the relationship between the predominant form of a weak acid or base in solution at a given pH and the pKa of the conjugate acid or the pKb of the conjugate base.

Objectives
By the end of this lab, students should be able to
- Differentiate between the phrases strong acid and concentrated acid.
- Carry out a titration.

Chemistry Topics
This lab supports students’ understanding of
- Strong vs. weak acids/bases
- Indicators
- pH
- Titrations

Time
**Teacher Preparation:** 1 hour
**Lesson:** one class period
Materials
For each group:
- Buret (titration apparatus)
- HCl (pH = 2.6)
- CH\textsubscript{3}COOH (pH = 2.6)
- KOH (pH = 11.6)
- Two Erlenmeyer flasks (250 mL)
- Indicator and/or pH meter

Safety
- Always wear safety goggles when working in the lab.
- When working with acids and bases, if any solution gets on your skin be sure to thoroughly flush it with water immediately.
- Students should wash their hands thoroughly before leaving the lab.
- When students complete the lab, instruct them how to clean up their materials and dispose of any chemicals.

Teacher Notes
- Review strong vs. weak acids and bases PowerPoint with students before doing the lab investigation.
- Information about acids and bases that students need to know for this activity:
  - **pH** - pH measures the hydrogen ion concentration of a solution. You may have thought that it measures the strength of an acid, but—to a chemist—the strength of an acid is something else. The most dangerous acid solutions have a pH that is close to zero. The most dangerous bases have a pH that is close to 14.
  - **pOH** - You might say that pOH is the opposite of pH. pOH measures the hydroxide ion concentration of a solution. The most dangerous base solutions have a pOH that are close to zero. The most dangerous acids have a pOH that is close to 14.
  - **Indicator** – These are chemicals that change color as the pH or pOH is changed.
  - **pH meter** – This a device that measures the pH of a solution.

FOR THE STUDENT

Lesson
Background
Write and number everything that you can remember about acids and bases in three minutes.

Purpose
You will determine whether it takes more base to neutralize two different acid solutions that have the same pH (one is a strong acid, one is a weak acid).

Prelab Questions
Which of the following 3 choices do you believe is true? Check one.

- It will require more sodium hydroxide solution to neutralize pH 2.6 hydrochloric acid.
- It will require more sodium hydroxide solution to neutralize pH 2.6 acetic acid.
- It will require the same amount of sodium hydroxide solution to neutralize both acids.

In the space provided below explain why you made the prediction above.

In the space provided below explain how you would test your prediction above.
Procedure
1. Measure 10.0 mL of acetic acid and 10.0 mL of hydrochloric acid into container of your choice.
2. You will be given a large volume of base solution.
3. You and your lab group will need to develop a set of procedures to test whether it takes more base to neutralize a strong acid or a weak acid. Your group can begin your lab once every member of your lab group has the procedures outlined.
4. Both acids and bases are neutralized when the pH reaches 7. You may be using a universal pH indicator or a pH meter to know when your acid solution has been neutralized. Your teacher will show you how to use a pH meter, if that is what you are using. Use the chart on the bottle of universal indicator to see how the color changes to show the approximate pH.
5. Write complete observations from your lab. You are responsible for your own lab observations.

Observations

Analysis
How were your observations different from your predictions and explain why you believe that these differences might have occurred.

Conclusion
In the space below, write what new things you learned from this activity.