Unit Plan: Acids & Bases Unit Plan

FOR THE TEACHER

Summary
The AACT high school classroom resource library and multimedia collection has everything you need to put together a unit plan for your classroom: lessons, activities, labs, projects, videos, simulations, and animations. We constructed a unit plan using AACT resources that is designed to teach the topic of acids and bases to your students.

Grade Level
High School

Objectives
By the end of this unit, students should be able to

- Describe how the various acid and base theories have progressed through the centuries.
- Understand the pH scale.
- Differentiate between acids and bases.
- Identify properties of acids and bases.
- Identify household as acidic or basic based on their properties.
- State the purpose of using logarithms to express pH.
- Estimate pH value from hydrogen ion concentrations using knowledge of logarithms.
- Use a calculator to compute pH from hydrogen ion concentrations and vice versa.
- Classify a substance as acidic, basic, or neutral based on pH or hydrogen ion concentration.
- Categorize strong and weak acids and bases using chemical formula, pH data, or particulate drawings.
- Classify salts as acidic, basic, or neutral and connect to conjugate acids and bases.
- Relate the dissociation reaction and K value to strength of an acid or base.
- Calculate the pH of strong and weak acids and bases as well as salts.
- Apply theoretical pH values and other chemical tests in order to determine the identity of unknown solutions.
- Understand how to set-up the equipment for a titration.
- Describe the purpose and procedure of a titration.
- Accurately follow the procedural steps to perform a titration.
- Identify different indicators and explain their purpose.
- Calculate the molarity of an unknown substance.
- Identify the equivalent point of a titration reaction.
- Write a balance acid/base reaction
- Define the terms: acid, base, titration, titrant, analyte, end point, indicator
- Perform a weak acid – strong base titration.
- Calculate the molarity of citric acid based on the results of the titration.
- Evaluate whether an experimental value is within allowable error from an accepted value.
- Calculate percent composition.
- Determine percent error in a given situation.
- Explain that the pH of a solution containing a dissolved salt may be acidic, basic or neutral.
- Use pH paper and universal indicator to determine if a solution is acidic, basic or neutral.
- Describe the meaning of the term hydrolysis.
- Write a net-ionic equation for a dissolved salt in water.
- Predict the pH of a solution based on the formula of the salt
- Identify a conjugate acid-base pair and determine which one is the acid and which one is the base.
• Write a chemical equation for the reaction of a strong acid to a buffer.
• Write a chemical equation for the reaction of a strong base to a buffer.
• Explain how a buffer is able to resist changes in pH, regardless of whether an acid or a base is added.
• List two examples of buffers in their everyday life.
• Prepare a buffered solution with a desired pH from a weak acid and its salt.
• Prepare a buffered solution with a desired pH by partially neutralizing a weak acid with a strong base.
• Compare the buffering capacity between two buffered solutions.
• Evaluate the predominant form of an acid in a solution of a specific pH.

Chemistry Topics
This unit supports students’ understanding of
• Acid & Bases
• Acid/Base Theories
• pH scale
• History of Chemistry
• Indicators
• pH and pOH
• Logarithms
• Concentration
• Strong vs Weak Acids/Bases
• Salts
• Dissociation
• Conjugate Acid-Base Pairs
• Equilibrium Constants
• Titrations
• Molarity
• Equivalence point
• Balancing Chemical Equations
• Stoichiometry
• Percent composition
• Solutions
• Net Ionic Equations
• Hydrolysis
• Buffers

Time
Teacher Preparation: See individual resources.
Lesson: 10-15 class periods, depending on class level.

Materials
• Refer to the materials list given with each individual activity.

Safety
• Refer to the safety instructions given with each individual activity.

Teacher Notes
• The activities shown below are listed in the order that they should be completed.
• The teacher notes, student handouts, and additional materials can be accessed on the page for each individual activity.
• Please note that most of these resources are AACT member benefits.
Many of the resources used in this plan include alignment to the AP Chemistry Big Ideas and Learning Objectives. The AP-appropriate resources can easily be altered to be used in an on level or honors class.

**Classroom Resources**

- Introduce the unit with the [Acid & Base Guys](#) video which tells the story of how the definition of acids and bases evolved from Lavoisier’s hypothesis that acidity is caused by oxygen atoms, to Arrhenius’s definition of an acid as a producer of positive hydrogen ions, then changed to acids as proton donors by Bronsted and Lowry, finally switching to acids as electron acceptors by Lewis.
  - Have your students use the [Acid & Base Guys Video Questions](#) activity to answer questions while watching the video. You can now have your students access the videos in our [Multimedia Library](#) up to ten times a year with our Student Video Pass. Read more about this member benefit on our [FAQ page](#).

- Then use the lab, *Exploring the Properties of Acids and Bases* to investigate the properties of many household substances and discover the properties of acids and bases in this five station activity.

- Depending on the math level of your students, you may want to use the lesson plan, *Calculating pH, A Look at Logarithms* to introduce the math concepts involved in the study of acids and bases. In this lesson, students are introduced to a base-10 logarithmic scale and use it to calculate pH from hydrogen ion concentration. Often students are able to calculate pH by pushing the correct buttons on their calculators, but they don’t understand what the values mean. This lesson attempts to bridge that gap using a guided inquiry model.

- Then introduce acid-base calculations with the lesson plan, *Categorizing, Calculating and Applying Concepts from Weak Acids, Weak Bases and Salts*. Students will first write dissociation reactions to make connections between conjugate acid-base pairs. They will then use beaker diagrams in a cooperative group activity to better understand why the pH calculation for a weak acid/base is not the same for a strong acid/base. Finally, students apply these concepts in a lab in which they will identify several unknown, clear, colorless solutions using factors such as pH, conductivity and reactivity. The activities in this lesson can be used in sequence or as standalone activities and includes alignment with AP Chemistry Big Ideas and Learning Objectives.

- As you move on to titrations, use the following two lessons to introduce the concept and procedures. All of these resources include alignment with AP Chemistry Big Ideas and Learning Objectives.
  - Use the demonstration, *How to Perform a Titration* to show how a titration is set-up and performed. You will also use different indicators to show how they work and why they are necessary. At the end of the demonstration, you will explain how to calculate the molarity of the unknown substance.
  - Then use the lab, *Lethal Dose* to have students perform several titrations to calculate the concentration of potentially “lethal” medicycloprhofic solutions.

- We have several more labs available in our high school resource library that you can use to help your students understand the concepts involved with acid-base titrations.
  - In the *Titration* lab, students will learn the difference between strong, weak, and concentrated acids by carrying out various titrations.
  - The *Vinegar Quality Control* lab requires students to perform a titration of a vinegar sample to determine if it is it close to the concentration claimed on the bottle.
Use the lab, **Calculating Acid in Lemon-Lime Soda** to have students investigate the molarity of citric acid in a clear, lemon-lime flavored soft drink through titrations with 0.10M NaOH and an indicator.

If you like to encourage your students to connect chemical principles to everyday life, use one of the following resources as a culminating activity for this unit.

- In the **The Egg-straordinary Issue** lab students determine the percent composition of calcium carbonate contained in an eggshell by using a back titration in order to address a farmer’s concerns about his hen’s fragile eggs. Two versions of the student lab are included, a scripted version, and an inquiry version.
- Use the **Town Meeting** activity to have students learn about acid rain, gas scrubbers, half-life, chain reactions, and other topics around electricity production through a debate on nuclear power.
  - Follow up the town meeting with the activity, **Investigating Acid Rain** to let students further investigate the chemistry of acid rain through web based research. Students also have the opportunity to observe the reaction between a common acid and a material in a week long simulation and relate their findings to the effects of acid rain.
- In the project, **Acid Base Creative Letter**, students compare and contrast the properties of acids and bases and define pH.

For those of you who have more advanced classes we have several resources to help you cover the topics of hydrolysis, pH of salts and the preparation/evaluation of buffer solutions. All of these resources include alignment to the AP Chemistry Big Ideas and Learning Objectives.

- In the **Hydrolysis of Salts** lab, students observe the hydrolysis of several salt samples. They first predict which solutions are acidic, basic or neutral, and then discover the pH of each through the use of indicators. They then share and compile their experimental results, as well as have an opportunity to determine the net-ionic equations for each reaction.
- A similar resource, **The pH of Salts** lab, allows students to determine whether an aqueous solution is acidic, basic, or neutral and then write net ionic equations for the hydrolysis of a solution.
- Introduce the topic of buffers with the activity, **What are Buffers?**, which has students complete a card sort that will allow them to understand what makes up a buffer solution and how it works to keep pH from changing.
- Follow up with the **Preparation and Evaluation of Buffers** lesson plan to have students use multiple methods to calculate and prepare buffered solutions with a desired pH. Upon preparation of the solutions, the students will explore differing aspects of buffers including buffering capacity and predominant form.

Finally, use the **Milk of Magnesia Magic** demonstration to help students see the connections between acid-base chemistry and stoichiometry, limiting reactants, LeChatelier’s principle, indicators, and buffer solutions. This resource includes alignment to the AP Chemistry Big Ideas and Learning Objectives.