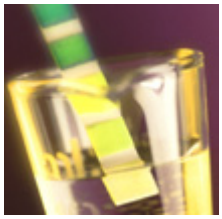

Elements of Chemistry: Acids and Bases

Student Objectives

- Use supporting evidence to predict if common household substances are acids or bases.
- Determine the pH of the substances.
- Describe the results of the investigation and characteristics of each substance.

Materials

- *Elements of Chemistry: Acids and Bases* program
- computer with Internet access
- paper and pencils
- litmus paper
- pH meter (if available)
- plastic cups (to hold the materials to be tested)
- distilled water
- lemon juice
- vinegar
- baking soda
- ammonia
- phenolphthalein (if available)

Prior to the start of the class, decide how you would like to handle the distribution of the materials for the investigation. One student from each group can come up to a central area to collect the materials, or you can hand out the materials to each group. Each group will need the following materials:

- 8 strips of litmus paper
- samples of these materials in a cup: distilled water, lemon juice, vinegar, baking soda, and ammonia
- pH meter (if available)

Procedures

1. Begin the lesson by asking students to write on scrap paper materials they can identify as an acid or a base. (If they cannot answer the question, tell them not to worry.) Then ask them to put their papers away until the end of the lesson.
2. Tell students that they are going to measure the pH of common household substances to determine if they are acids or bases. Explain that pH is measured on a scale of 0–14. Substances with a pH lower than 7 are acids; those with a pH higher than 7 are bases; and a substance with a pH of 7 is neutral. If students would like a little more background information before conducting the investigation, suggest that they watch the first three segments of the program "Elements of Chemistry: Acids and Bases." They can watch the final segment, "China: Surviving Vinegar," to gain an understanding of the important role that chemistry plays in everyday life.
3. Divide students into groups of three. Make sure each group has the materials needed for the experiment and ask the students to predict whether they think these materials are acids or bases. Encourage students to write a reason for their predictions. Then have students put their predictions away until later in the lesson.
4. Give each group a few minutes to read the directions for the investigation, listed below.

Safety note: When working in the lab, always wear goggles, gloves, and an apron. Never touch, sniff, taste, or mix any materials that you are working with as part of a science experiment.

- Have the materials you need in front of you. Then place one end of a strip of litmus paper into each of the materials.
- Compare the color on the strip of litmus paper to the color scale provided by your teacher. Determine the pH of each material. Record the pH on a chart, indicating whether the material is an acid or a base.
- If a pH meter is available, measure the pH of each material with it. Record the pH obtained in this way next to the pH obtained by using litmus paper.

5. Remind students to record their observations as the investigation progresses. They may develop a chart similar to the one shown below. After each group completes the experiment, make sure students clean up.

Material	**pH litmus paper**	**pH pH meter**	**Observations**
distilled water			
lemon juice			
vinegar			
baking soda			
ammonia			

6. During the next class period, discuss the investigations and the outcomes. Ask volunteers to share their predictions with the class. Did any groups predict which substances were acids and which were bases? Were the students able to explain their reasons?
7. Continue to discuss the investigation. Ask students why litmus paper can determine the pH of a substance. If necessary, explain that some materials have the characteristic of changing color in the presence of an acid or a base. In general, litmus paper turns from blue to red in the presence of an acid and from red to blue in the presence of a base.
8. Work as a class to further explain the results of the investigation. Which of the substances tested were acids? *(vinegar and lemon juice)* Which were bases? *(baking soda and ammonia)* What was the pH of distilled water, and what does that reading mean? *(Distilled water has a pH of 7, so it is neutral.)*
9. If students also used a pH meter, ask them to compare the results they obtained with that device to their results with litmus paper. Were the results different? *(Students probably obtained more precise results with the pH meter, but the litmus paper is sensitive enough to indicate an acid or base.)*
10. If time permits, give students the option of performing another experiment. Give each group a beaker containing about 100 ml of water; then hand out droppers. Have each group put about three drops of phenolphthalein, another pH indicator, into the water. Tell each group to record their observations. *(The water is now a colorless solution.)*
11. Next, have students add a few drops of ammonia. What happens to the water now? *(It becomes reddish purple.)* Ask students to explain what they think happened. If they are having trouble, have them refer to their experimental results with litmus paper for some clues. *(Ammonia is a base, so adding it to water causes the solution to become basic as well. Phenolphthalein has the property of turning reddish-purple if its pH exceeds 8.3.)* Then tell students that they will be adding a few drops of vinegar to the solution next. Ask them to predict what they think happens. *(The solution becomes colorless again.)* Ask students to explain why. *(The solution is becoming more acidic, causing it to lose its color.)*
12. Conclude the lesson by asking students to revisit their notes from the beginning of the lesson. Ask students to modify their list and add new materials based on what they have learned. Suggest that

they write a short paragraph summarizing what they learned as a result of completing these investigations.

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- **3 points:** Students were able to predict whether five common household materials are acids or bases; demonstrated a clear understanding of how to measure the pH of substances; and could explain clearly and accurately the results of the experiment.
- **2 points:** Students were able to predict whether three household materials are acids or bases; demonstrated a satisfactory understanding of how to measure the pH of substances; and could explain satisfactorily the results of the experiment.
- **1 point:** Students had difficulty predicting whether any household materials are acids or bases; demonstrated a weak understanding of how to measure the pH of substances; and had difficulty explaining the results of the experiment.

Vocabulary

acid
Definition: A substance that can donate hydrogen ions
Context: Lemon juice and other acids usually have a sour test, sting when touched, and react strongly when combined with metals.

base
Definition: A substance that can accept hydrogen ions
Context: Soap and other bases have a bitter taste, feel slippery to the touch, and do not react when combined with most metals.

indicator
Definition: A material that has the property of changing color in the presence of an acid or a base
Context: Litmus paper is an indicator; it turns from blue to red in the presence of an acid and from red to blue in the presence of a base.

neutralization reaction
Definition: The chemical reaction between an acid and a base that results in both substances losing their distinctive properties
Context: One substance that usually results from a neutralization reaction is a salt, an example of an ionic compound.

pH
Definition: A scale that measures the concentration of hydrogen ions in a solution
Context: In general, acids have a pH below 7; bases a pH above 7; and neutral solutions a pH of 7.

Academic Standards

National Academy of Sciences
The National Academy of Sciences provides guidelines for teaching science in grades K–12 to promote scientific literacy. To view the standards, visit this Web site: http://books.nap.edu/html/nses/html/overview.html#content.
This lesson plan addresses the following national standards:

- Physical Science: Chemical reactions
- Physical Science: Structure and properties of matter