**Water Solutions Lesson: pH of Common Household Chemicals**

**Activity Title:** pH of Common Household Chemicals  
**Grade Level:** 6-9  
**Subject:** Physical Science/Chemistry  
**Lesson Length:** One 50-minute class period  
**Created by:** Regina Donour

**Context**
To understand the chemistry behind the problem of acid mine drainage (AMD), students should know how indicators are used to test for the acidity/alkalinity of different substances. This activity requires students to collect data for different pH ranges between 1-14 (1-7 being acids and 7-14 being bases).

In this activity, students use acid/base indicators to determine the pH of common household chemicals. Red litmus paper is used to test for the presence of hydroxide ions \([\text{OH}^-]\). Red litmus paper turns blue in a base. Blue litmus paper is used to test for the presence of hydronium ions \([\text{H}_3\text{O}^+]\). Blue litmus paper turns red in an acid. Hydrion pH paper provides a more precise measurement of exact pH than litmus paper. Hydrion strips turn different colors depending upon the pH of the substance being tested.

**Objectives**
1. Students will be able to compare the precision and validity of different indicators.  
2. Students will be able to distinguish between an acid and a base by using various indicators.  
3. Students will be able to discuss the properties of common household chemicals based on their pH.

**Connections**
This activity helps students develop their problem-solving skills as they compare different measurements to determine pH and analyze the properties of substances based on pH. As an extension, red cabbage can be boiled down, and the resultant purple liquid can be used to make very exact pH measurements. The activity also can lead to a discussion of the impact that water outside the normal pH range (6-8) can have on the biotic components of an ecosystem.

**Assessment Plan**

<table>
<thead>
<tr>
<th>Objective Number</th>
<th>Type of Assessment</th>
<th>Description of Assessment</th>
<th>Depth of Knowledge Level</th>
<th>Adaptations and/or Accommodations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, and 3</td>
<td>Lab sheets and discussion questions</td>
<td>Students will work in pairs to determine pH, discussion questions will be done independently</td>
<td>DOK 2</td>
<td>Drawings, extended time, scribes (where IEP has accommodations)</td>
</tr>
<tr>
<td>1, 2, and 3</td>
<td>Class discussions</td>
<td>Large and small group discussion of observations, data, analysis, predictions, and reflections</td>
<td>DOK 3</td>
<td>Use of probing, paraphrasing, and modeling</td>
</tr>
</tbody>
</table>
Lab Sheet 1: Materials and Procedures

Materials
- Red and blue litmus paper, Hydrion pH paper, red cabbage
- Bleach, baking soda, distilled water, ammonia cleaning solution or ammonia, vinegar, lemon juice, carbonated soft drink, dishwashing liquid, 2% milk
- Copies of Lab Sheet 2: Observations and Conclusions, one for each group of two to four students

Equipment
- Graduated cylinders for measuring
- Large containers for mixing solutions
- Paper plates
- Small plastic pipettes
- Heat source

Procedures
- Prepare samples ahead of time. Dilution solutions can be made by mass or volume. For a baking soda solution, take 5 grams of baking soda and mix with 50 ml of distilled water. Dilute ammonia as a 5% solution as well (2-3 ml of ammonia for 40 ml of water). Vinegar, lemon juice, carbonated soft drink, dishwashing liquid, and milk do not need to be diluted.

**Caution:** Bleach needs to be a 5% or less solution because it will bleach the indicator papers. Some type of dilute drain cleaner can also be used, but be very cautious using any full strength bleach or cleaner—they are very caustic.

- Break students into groups of two to four, and give each group a paper plate for testing the samples.
- Using a small plastic pipette, give each group 5 drops of a sample at a time as indicated on Observations and Conclusions lab sheet.
- Students will use red and blue litmus paper and pH (Hydrion) paper to determine the pH of each household chemical. As an extension, teachers can boil down purple cabbage and use the cooled purple juice as an indicator. It is an excellent acid/base indicator.
- Students will record their observations and conclusions on Lab Sheet 2.
Lab Sheet 2: Observations and Conclusions

Acid/ Base Lab

<table>
<thead>
<tr>
<th>Test Tube</th>
<th>Solution</th>
<th>Blue Litmus</th>
<th>Red Litmus</th>
<th>pH Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>vinegar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ammonia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>lemon juice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>carbonated soft drink</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>dishwashing soap</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>baking soda solution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>5% bleach solution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2% milk</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusions

• Which of the household solutions are acids? Which are bases? How did you determine this?

• Describe how acids and bases affect the color of blue and red litmus.

• Discuss the advantages and disadvantages of litmus paper and pH Paper. Which indicator do you think is better?
Water Solutions Lesson: Testing Solubility

Activity Title: Testing Solubility
Grade Level: 6-9
Subject: Physical Science/Chemistry
Lesson Length: One 50-minute class periods
Created by: Regina Donour

Context
Water’s structure and properties support its ability to dissolve substances. To understand how the acidity of acid mine drainage (AMD) affects its ability to hold heavy metals in solution, students will investigate the effects of temperature, surface area, pH, and stirring on the rate at which a solute will dissolve in water, in other words, its solubility.

Objectives
1. Students will be able to distinguish among factors that increase the solubility rate of substances.
2. Students will be able to predict the effects of temperature, surface area, pH, and stirring on the rate of dissolution.
3. Students will be able to analyze why altering pH affects the solubility of certain salts and metals.

Connections
This activity helps students develop their problem solving skills as they analyze how various factors affect the dissolving rate of substances. Many ions are not soluble in water, but when the characteristics of the water are changed, the solubility increases. For example, when acid mine drainage releases hydrogen ions [H+] into the water, it also increases the solubility of most ions. When the pH of the water is raised those ions can no longer stay in solution.

Assessment Plan

<table>
<thead>
<tr>
<th>Objective Number</th>
<th>Type of Assessment</th>
<th>Description of Assessment</th>
<th>Depth of Knowledge Level</th>
<th>Adaptations and/or Accommodations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, and 3</td>
<td>Lab sheets and discussion questions</td>
<td>Students will work in groups to determine rates of dissolving and to investigate the effects of various factors on solubility.</td>
<td>DOK 3</td>
<td>Drawings, extended time, scribes (where IEP has accommodations)</td>
</tr>
<tr>
<td>1, 2, and 3</td>
<td>Class discussions</td>
<td>Large and small group discussion of observations, data, analysis, predictions, and reflections</td>
<td>DOK 3</td>
<td>Use of probing, paraphrasing, and modeling</td>
</tr>
</tbody>
</table>
Lab Sheet 1: Materials, Equipment, and Procedures

Materials
Sugar cubes, calcium carbonate, baking soda (NaHCO₃), hydrochloric acid (HCl), distilled water

Equipment (one set for each student group)
- Six large test tubes and rack
- Corks for test tubes
- Mortar and pestle
- 10- and 25-ml graduated cylinders
- Balance or scales
- Two stirring rods
- Stopwatch
- Source of heat (alcohol or Bunsen burner or hot plate)
- Goggles
- Gloves
- Tongs

Procedures
1. Prepare 100 ml of 0.10 molar solution of HCl (use 10 ml of 1 molar, and mix into 90 ml of distilled water.) For safety reasons, the teacher could measure out 10 ml of the 0.10 molar solution for each group of students in a 10-ml graduated cylinder.

Caution: Remember to pour the acid into the water and always wear goggles and gloves when mixing and handling the HCL solution.

2. Divide students into groups of two to four. Give each group a set of the equipment listed above and Lab Sheet 2: Observations and Conclusions, which they will use to record data and observations.

3. Have students measure out 20 ml of distilled water into each of the first 4 test tubes in the six-test tube rack.

4. Have students add about 2 to 3 grams of sugar to the first tube. If the sugar cube is too large to fit into the test tube, it may be broken into pieces, but not pulverized.

5. Using the stopwatch, have students measure the amount of time needed to dissolve the solute (the sugar) into the water. If it does not dissolve in 5 minutes, students should record 5+ for the time.

6. Have students pulverize the same amount of sugar in the mortar and pestle and then place it in the second tube. Once again, students will measure the amount of time needed to dissolve the solute.

7. Students follow the same procedure with test tubes 3 and 4 with the following variations. In test tube 3, the sugar and water will be shaken until the sugar dissolves. In test tube 4, the sugar and water will be heated over the Bunsen burner until the sugar dissolves. As an alternative, students could also make a hot water bath for the test tube by heating a 400 ml beaker on a hot plate.

Caution: Be sure that students use tongs when working with heated objects and surfaces.

Water Solutions, Acid Mine Drainage, “Testing Solubility”
8. In test tube 5, have students measure out 25 ml of water and then add 2 to 3 grams of crushed calcium carbonate (CaCO₃). Students should stir the solution with a stirring rod and then measure the time it takes for the solute to dissolve.

9. In test tube 6, have students again measure out 25 ml of water and add about the same amount of crushed calcium carbonate to the water as in tube 6, using the same stirring rod to stir the mixture. Then have them add 5 ml of the 0.1 M solution of HCl to the water/calcium carbonate mixture. Students should stir the solution with the second stirring rod and measure the time it takes for the solute to dissolve.

**Caution:** Remember to pour the acid into the water and always wear goggles and gloves when mixing and handling the HCL solution.

10. As an extension, after 5 minutes have passed, students could add 5 to 6 grams of baking soda to the solution in test tube 6 and observe how the solution changes.
### Conclusions

- Describe the effect of each factor on the solute's solubility.

- Explain which factor had caused the greatest increase in the solubility of the solute.

- Discuss how the adjustment of the pH to the calcium carbonate solution affected the solubility.