pH Test #1: Scaling Common Liquids (From a series of 5)

Adapted from: "Acid Tests" in *Environmental Education in the Schools*. Braus, Judy and David Wood. Peace Corps, 1993.

Grade Level: basic

Duration: 20 minutes

Setting: lab or classroom

Summary: Students test the pH of different solutions and make their own pH scale.

Objectives: Students will be able to identify acidic and basic substances, as well as have a concept of the pH ranges of substances.

Related Module Resources:
- "pH Test #2, #3, #4, #5" Activ.
- "pH, Plants and Fish" Activity
- "pH People" Activity
- HANBOOK: p. 57-63
- FIELD MANUAL: p.33-35
- pH Information/Fact Sheet

Vocabulary: pH, neutral, acidic, basic

Materials (Included in Module):
- pH measuring device – pH paper, meter or Hach pH kit (kit will take longer)
- small, clear plastic cups (pre – labeled with blank labels available)
- certain liquid solutions: vinegars, lemon juice, lemonade, bleach, ammonia, distilled water, spring water, sodas, seltzer
- baking soda (add ¼ tsp to 2/3 cup water), antacids
- Interactive pH Scale Poster

Additional Materials (NOT Included in Module):
- certain liquid solutions: creek/pond/ground/tap water, sodas, coffee, milk, orange juice, cleaning agents, others

ACADEMIC STANDARDS (ENVIRONMENT AND ECOLOGY)

7th Grade

4.1.B Understand the role of the watershed.
- Explain factors that affect water quality and flow through a watershed

12th Grade

4.1.C Analyze the parameters of a watershed.
- Interpret physical, chemical and biological data as a means of assessing the environmental quality of a watershed

BACKGROUND:

The pH of water is very important to water quality because it controls the types and rates of many chemical reactions in water, and aquatic organisms have a specific pH range in which they can live.

Water (H_2O) contains both hydrogen ions (H^+) and hydroxyl ions (OH^-), and other solutions also contain free hydrogen ions within them. A **pH** test measures the concentration of free hydrogen ions, which will indicate whether a solution is acidic or basic. Specifically, pH is equal to the negative log of the hydrogen ion concentration ($pH = -\log_{10}[H^+]$). The numerical value does not have a unit (like mg/L) per se, but must be listed alongside the term pH.

The values for pH are arranged on a scale from 0 to 14. A pH of 7 indicates the solution is **neutral** and the concentration of H^+ is equal to the concentration of OH^-. Pure distilled water is considered neutral. Values of pH less than 7 are considered **acidic** (more H^+ are present, less OH^-). Values of pH greater than 7 are considered **basic** (less H^+ are present, more OH^-). Because pH is determined based upon a log scale as indicated above, each unit change in pH indicates a ten-fold difference in the concentration of hydrogen ions. For example, lake water at pH 5 is ten times more concentrated with H^+ than water at pH 6. If the lake was pH 4, it is 100 times more acidic (more H^+) than a lake at pH 6.

Water is not the only solution/substance that registers a pH value. Other liquids found in laboratories but even in your own home have pH levels – some being acidic and some being basic. A pH value can even be assigned to things that are not in liquid form – such as soil or some powders. Gardeners often measure soil pH to help decide what to plant or what needs to be added to the soil for things to grow.

OVERVIEW: Students test the pH of a variety of common solutions to determine whether they are acidic or basic and then rank them on a pH scale. The pH can be tested using a few different methods.

PROCEDURE:

1. Discuss the background information with the students. Warn them about lab safety for this experiment.

2. From the stock containers supplied in the module, place ¾ inch sample of each liquid in appropriately labeled clear, small plastic cup. Make sure they are properly labeled so that the students can record their data accurately.
   Make sure that the students do not get solutions near their eyes or mouth

3. Demonstrate to the students how to use the pH measuring device(s) they will be working with. Operate the device(s) as described in the instructions provided in the Instruction Sheets Section of the Module Resource Guide. Keep in mind that the pH device that you choose to use may alter the amount of time the activity takes (for example, the Hach pH kit method takes longer) and the accuracy of the results (pH meters are most accurate).

4. Ask the students to predict the pH of the solutions they will be testing and to rank the solutions from most acidic (lowest pH) to most basic (higher pH) (See the Data Sheet at the end of this activity).

5. Allow the students to test the pH of the different substances and record it on the Data Sheet at the end of this activity. Have them use the instruction sheets to ensure proper usage of the equipment. Instruct them to RINSE BETWEEN EACH SAMPLE TESTED with distilled or deionized water or results will be compromised.

6. When they are finished testing all of the solutions, have them list the liquids in order from most acidic to least acidic on the back of their Data Sheet. An excellent way to display this information for the entire class to see is to use the *Interactive pH Scale Poster* (enclosed in the module).

7. CLEAN UP NOTE: Do not put liquid sample back in the stock bottles. Discard.

DISCUSSION:

Compare the results obtained by different students. (Although some methods of testing pH may result in different pH values for the same items, the relative placement on the pH scale should be similar.) Compare the results to the pHs listed at the end of the activity:

Were students surprised at any of the results?
Which solutions tested were closest to being neutral (pH =7). *Distilled water, sometimes streams.*

Why are some of the liquids students tested yielding results that are not similar to results listed above? *It is easy to contaminate samples, samples can be diluted with rinsing or accidentally mixed, pH meters can be slightly inaccurate or they may need to be calibrated more often, maybe brands of liquids differ.*

Without showing them the pH answers listed, can the students figure out what pH their stomach (gastric) acids would be based on some of their results. *They may realize that if they drink lemonade and it doesn't hurt, their stomach acids must be stronger.*

EVALUATION:

- Explain the meaning of the following words: basic, acidic, neutral.
- Explain the relationship between common solutions on a pH scale.

EXTENSIONS AND MODIFICATIONS:

- Students can perform other "pH test" activities. You may especially want to do Acid Test #2 because it uses all the same solutions you already have out.
- Students can use different pH measuring methods to determine which is the most precise (gives values that are most consistent) and/or accurate (closest to the actual value).
- Have students make their own pH scale posters based on their data. They can cut out and glue the labels of household products to a poster. Encourage them to make their posters artistic.
- Have students research the pH tolerances of various types of aquatic life and indicate them on the interactive pH scale poster [B-top].
- Have students work in groups doing a number of the different "pH Test" activities at different stations.

NOTES (TEACHERS, PLEASE WRITE ANY COMMENTS ABOUT THIS ACTIVITY BELOW):

COMMON LIQUIDS / SOLUTIONS AND THEIR pH

Gastric juices – pH about 1 *(You will not test this)*
Battery acid – pH about 1 *(You will not test this)*
Lemon juice – pH about 2
Lemonade – pH about 2
Acid Mine Drainage – pH between 2-5
Vinegar – pH about 3
Cola / Sodas – pH between 3-4.5
Tomato Juice – pH about 4
Acid rain – pH between 4 –5.6
Normal rain – pH about 5.6
Saliva – pH about 6.5 *(You May Not Want To Test This)*
Distilled water – pH about 7
Northwest PA streams – pH usually between 7- 8.5
Human Tears / Blood – pH about 7.5 *(Do Not Test This)*
Egg White – pH about 8
Sea Water – pH about 8
Baking soda in water – pH between 8-9
Ammonia – pH about 11
Bleach – pH about 12

DATA SHEET: pH TEST #1: SCALING COMMON LIQUIDS

Name_____ Date_____

On the back of this sheet, rank your liquids from most basic to most acidic both before (your predicted value) and after (the measured value) you test them. Remember, the most acidic solution will have the lowest pH and the most basic will have the highest pH.

Which solution do you think will be most acidic? _____
most basic? _____

SOLUTION	PREDICTED pH	MEASURED pH	COMMON pH FOR THIS SOLUTION
White vinegar			
Seltzer			
Lemonade			
Spring water			
Ammonia			
Lemon juice			
Distilled water			
Bleach			
Baking soda			
Cider vinegar			
Antacid: Type_____			

DATA SHEET FOR pH TEST #1 (Side 2)

Rank your liquids:

	Predicted ranking order	Measured ranking order
Most basic		
Neutral		
Most acidic		