pH: MEASURING ACIDITY and BASICITY

For this activity the pH of a stream will be measured using a kit to determine if the water is acid or basic (alkaline). The pH of a stream is an important variable in evaluating its health and will determine the kinds of life that it can sustain.

Although the pre and post discussions are necessary to provide important information about each topic, it is the activity that is most vital to this unit. Be sure to allow plenty of time to complete the activity.

Pre-Activity Discussion (Answers can be found in the Background Information section below)

1) What is pH and why is it important? What do the terms acid and basic mean? 2) Can you think of something that is acidic or basic? What would it be like to get something like vinegar or lemon juice in your eyes? 3) How does high acidity or basicity affect stream life?

The Activity

Equipment needed:

--Hach kit for wide range pH; this consists of a color comparator, a wide range pH indicator with dropper, and two sample tubes.
--Sampling bucket or dipper of some sort
--Boots or waders (Generally not needed)
--Data form(s)
--Small table (convenient but not essential)
--Clipboard (for data forms)
--Data forms
--Display board

Optional: You may wish to have a couple of clear glasses, a jug of clear stream water, samples of vinegar (dilute acetic acid) and either dilute ammonia or dilute washing soda (sodium carbonate), and a couple of droppers so that you can show the group how the indicator changes color in the presence of acid (vinegar) or base (ammonia or washing soda solution). **Do not use lye** (sodium hydroxide, caustic soda) for your basic solution; such solutions, even dilute, can cause blindness very quickly.

Measuring pH

Although pH is often measured with an electronic meter, this activity uses a different method that yields visible evidence of the pH of the water. The Hach kit makes use of a colored indicator solution and a color wheel called a disk comparator. The pH indicator changes color depending on the pH of the water and the color can be matched with the colors on the comparator to determine the pH.

Procedure

1. Select a site from which clear stream water (free from lots of silt) can be easily collected with a bucket or dipper. If sampling from a bridge, a bucket attached to a rope

should work well. Check for poison ivy, stinging nettle, etc. if sampling from a bank.

2. Collect the water sample. It may be a little cloudy but must not be very muddy.

3. Rinse the two viewing tubes with some of the water sample.

4. Fill a viewing tube to the first line (5 mL) with sample water. This is the blank.

5. Holding the color comparator so that you can see the numbered dial. Place this tube in the top left opening of the color comparator—the hole through which you can see the colored dots on the color wheel.

6. Fill the second viewing tube to the first line (5 mL) with sample water.

7. Add 6 drops of the Wide Range 4 Indicator Solution to the second tube and swirl carefully to thoroughly mix the indicator and the sample water. If you spill any liquid, empty the tube, rinse it, and refill it with stream water and the indicator solution.

8. Place the second viewing tube in the top right opening of the color comparator.

9. Hold the comparator up to a light source such as the sky, a window, or a light. Look through the openings in the front of the comparator.

10. Turn the color disk until the colors you see in the two openings match.

10. Read the pH through the little window on the front of the comparator. Record this reading on the data sheet.

11. Do at least 2 readings of the water but try for 3. You may wish to leave time to demonstrate the pH of the household liquids.

Post-activity discussion questions:

1) Was the pH measure within a healthy range for river life?
2) Were there variances in the measurements? If so, what may have been the cause?
3) Were there any problems with using the comparator? Did this affect the data?
4) What kinds of human activities can affect the pH of a stream? What do you know about the causes of acid rain and its effect on the environment?

Background Information

pH is a measure of how acidic or basic a water solution is. It uses a scale from 0 to 14. A pH of 7 – right in the middle – is characteristic of pure water, neither acidic nor basic. Levels below 7 are acidic with 0 being the most acidic. Levels above 7 are basic with 14 being the most basic. (Gardeners often measure the pH of soil. What they are in fact measuring is the pH of the water in the soil.)

When water is too acidic or basic it is extremely toxic to fish and other aquatic life such as clams and mussels, crayfish and other crustaceans, aquatic insects and aquatic insect nymphs and larvae (juvenile forms), frogs and other amphibians, turtles, etc. Acid drainage from mining operations (mostly coal) has made thousands of miles of streams in

the U.S. uninhabitable by anything other than acid-tolerant bacteria and algae.

We can easily measure how acid or basic a water sample is by measuring its pH. Pure water has a pH of 7.

It is best for fish and other aquatic life if the pH is greater than 6.5 and less than 8.0. If the pH of a stream is less than 4.5 or greater than 9.0, just about everything dies. Discharge of various industrial wastewaters into a stream can make it too acid or too basic (alkaline)). Acid rain caused mainly by the burning of coal that contains sulfur can put sulfuric acid into streams causing them to become too acidic. Acid mine drainage, particularly from coal mining, is a big problem in the U.S.

The two letters- pH- stand for potential hydrogen. The value of pH is derived from hydrogen ion concentration. Hydrogen ion concentration is important because acids add hydrogen ions to solutions, while bases gobble up hydrogen ions. If we know the hydrogen ion concentration in the water, we know if it is acting as an acid or a base and how strongly it is doing that. The value of pH is related to hydrogen ion concentration, but the relationship is complicated.

In years past, whole ecosystems have been badly damaged- even destroyed- due to acid rain in the US and Canada and elsewhere around the world. The damage that is done can persist for a long time. For instance, even today in Kilarney Provincial Park in Ontario there are many lakes that still have no fish due to acidification of the water despite the fact that mitigation efforts were put in place decades ago.

For this and all other units, advanced level information is available if desired. Contact the HRWC and request an electronic version of the unabridged manual.

pH Data Sheet

First pH reading: _____ **Second pH reading: _____** **Third pH reading: _____** **Sum of all 3 readings** **_____** **Average pH reading -** **_____** **(Sum of readings divided by 3 or number of readings)**	**A pH of 7 is neutral.** **A pH below 7 is acidic.** **A pH above 7 is basic.** **It is best for fish and other aquatic life if the pH is greater than 6.5 and less than 8.0.** **If the pH of the water of a stream is less than 4.5 or greater than 9.0, just about everything dies.**

1. Is the pH of this stream such that the stream can support aquatic life?

2. What are some human sources of acid in streams?

3. What are some human sources of bases in streams?

4. What can you and your family do to help the river have a healthy pH?

KEY TO pH DATA SHEET QUESTIONS

1. Is the pH of this stream such that the stream can support aquatic life?
   If your readings were between 6.5 and 8 the answer is yes.

2. What are some human sources of acid in streams?
   Chemical waste, coal mining waste, burning coal to make electricity which causes acid rain.

3. What are some human sources of bases in streams?
   Chemical waste, household chemicals such as drain cleaners

4. What can you and your family do to help the river have a healthy pH?
   A. **Don't pour chemicals into the storm sewers.**
   B. **Minimize your use of strongly acidic and strongly alkaline cleaning agents.**
   C. **Use less electricity, so that your local power plant will burn less coal.**
   D.

pH Lesson Narrative

Intro. (5 - 8 minutes) The mission is to make the following points: Acids and alkalis (also called bases) are poisonous to fish and other water-living critters. The effects of these substances can be lessened by dilution, but it is better to keep them out of the water. When we measure for chemicals, we are only testing the water as it passes us at this one moment.

We measure how acid or alkaline (basic) a water is by measuring its pH. A pH of 7 is just right—the water is neither acid nor alkaline. If the pH is less than 7 the water is acidic; if the pH is greater than 7 the water is alkaline.

It is best for fish and other aquatic life if the pH is greater than 6.5 and less than 8.0. If the pH of the water in a stream is less than 4.5 (acidic) or greater than 9.0 (alkaline), just about everything dies.

pH Scale

Kills----------| OK |----------Kills

4 5 6 7 8 9 10

1. My name is _____, and I'm a volunteer at the pH station. Please tell me your names. (Go around.)

2. So when you think of things causing water pollution, what do you think of? (2-3 answers: toxic metals like zinc, copper; oxygen-consuming materials , pesticides, acids, alkalis, etc., etc.)

3. Here we'll be concerned only with acids and alkalis (bases), both of which are fairly common toxic water pollutants and are easy to test for.

4. Can you name any household or garage stuff that is a strong acid or strong alkali? (Accept and label 2-3 answers:
Saniflush and other toilet bowl cleaners, Instant Plumber, battery acid, muriatic acid for swimming pools, [acid],
Drano, lye, lime, ammonia, washing soda [alkaline])

5. How do these chemicals get into the river?
(People pour them down their drains, and they pass throught the wastewater treatment plant. People pour them into the storms sewers because they are trying to get rid of them.)
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6. Acids and alkalis (also called bases) are poisonous to fish and other water-living creatures depending upon how strong they are. We can measure how acid or alkaline (basic) a water is by measuring its pH. A pH of 7 is just right—the water is neither acid nor alkaline. If the pH is less than 7 the water is acidic; if the pH is greater than 7 the water is alkaline.
Note that the smaller the pH, the more acidic the water—weird, but, hey, chemists are weird. It is best for fish and other aquatic life if the pH is greater than 6.5 and less than 8.0. If the pH of the water in a stream is less than 4.5 (acidic) or greater than 9.0 (alkaline), just about everything dies.

pH Scale

Kills----------| OK |----------Kills

4 5 6 7 8 9 10

7. pH is often measured with an electronic instrument known as a pH meter. pH is also easily measured with a disk comparator and a few drops of a colored indicator solution. pH indicators change color depending on what the pH of the water is, so by looking at

the color of a water sample with a few drops of pH indicator in it and using the comparator we can measure the pH.

8. When we do a chemical test on the water, we are only measuring the condition of the water in the sample at this moment. This does not tell us what happened yesterday, last week or last year.

The Activity: 7 minutes

The following is to be done by the students. Safety goggles are not needed for this activity; the indicator solution is quite safe. Give as many kids a chance to do the experiment as time permits.

9. Rinse the two viewing tubes in the kit with stream water.
10. Fill one of the viewing tubes to the first line (5 mL) with sample water. This is the blank.
11. Place this tube in the top left opening of the color comparator. (Hold the comparator so that the color disk is sticking out a bit on the right.)
12. Fill the second viewing tube to the first line (5 mL) with sample water.
13. Add 6 drops of the Wide Range 4 Indicator Solution to the second tube and swirl gently to mix the indicator and the sample.
14. Place the second tube in the top right opening of the color comparator.
15. Hold the comparator up to a light source such as the sky, a window, or a light, but not the sun. Look through the openings in the front of the comparator.
16. Turn the color disk (it is sticking out a little bit on the right side of the comparator) until the colors in the two openings match.
17. Read the pH through the little window on the front of the comparator. Record your answer.
18. If you have several results, average them.

pH = _____.

Wrap Up: < 1 minute

19. Is this water OK? _____ (see scale above)

20. What can people do to help keep the pH inside a safe range? (Limit use of household chemicals. Don't dump household chemicals in storm drains. Take unused household chemicals to the Washtenaw County Toxics Drop-Off station. http://www.ewashtenaw.org/government/departments/environmental_health/recycling_home_toxics/hhw/hhw_html

21. Next we'll measure the temperature of the stream.

For especially interested high school chemistry students at the end of the activity: Mathematically, the pH is related to the concentration of hydrogen ion (H^+) in the water by the equation

$pH = - \log_{10}[H^+]$, or equivalently, $[H+] = 10^{-pH}$

Hydrogen ion is characteristic of all acids. Hydroxide ion (OH^-) is characteristic of all bases.