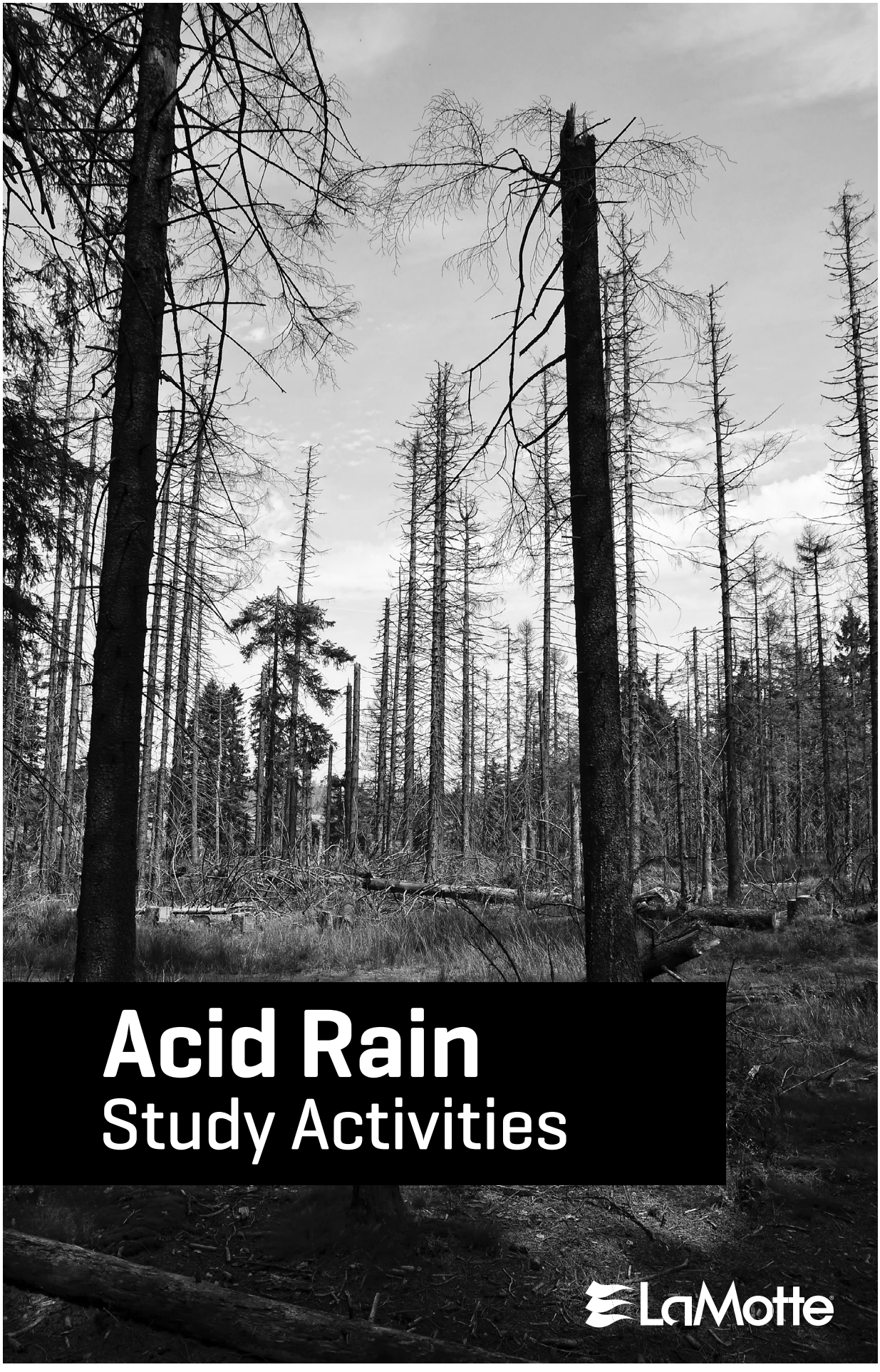


Acid Rain
Study Activities

LaMotte

ACID RAIN STUDY ACTIVITIES

The materials and manual in this kit are provided as the tools needed to conduct many important investigations. It is hoped the students' and teachers' interests will not be limited to the experiments or procedures as they are outlined in the manual.

These work sheets provide a number of suggested activities in the form of additional, open-ended experiments. They provide the basic information needed to conduct many fascinating investigations and activities. They should spur the student's imagination to investigate other problems which are related to the subject. The inquiring student may devise other experiments using the materials provided in this unit or they may make modifications to the methods and incorporate additional materials and test kits.

Thought provoking QUESTIONS are scattered throughout the text and answers are provided in bold type.

RESEARCH IDEAS suggest additional investigations related to the activity.

KEY WORDS can be used to unlock additional information in encyclopedias, libraries and textbooks.

The work sheets may be reproduced for classroom use.

TEACHER TIPS . . . . . .

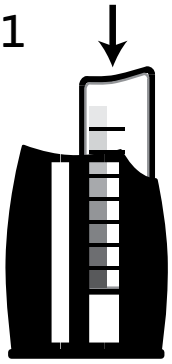
- Read manual and instructions ahead of time to familiarize yourself with the procedures for each section.
- Have students make folders with a rain related theme to hold their data sheets and other materials.
- Make a large poster to record results and to keep as a permanent record.
  Clearly label all containers.
- Pour reacted solutions down the drain with lots of runnning water.
- Help students learn from "failed" experiments and unexpected results.
- Tests can also be done on water from puddles, fish tanks, pools and tapwater.
- Use the Glossary of Terms in the instruction manual to define new terms found in these worksheets.
- Encourage students to seek additional information from other sources using the RESEARCH IDEAS and KEY WORDS.

GENERAL INSTRUCTIONS FOR pH TESTING

*Reagent is a potential health hazard.
READ SDS: lamotte.com
Emergency information:
Chem-Tel USA 1-800-255-3924
Int'l, call collect, 813-248-0585

USE OF THE OCTA-SLIDE 2 VIEWER

1



Insert Wide Range pH Octa-Slide 2 Bar (2193-01 or 2196-01) into the Octa-Slide 2 Viewer (1101).

2

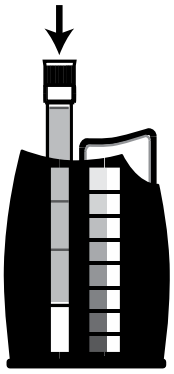
Fill a test tube (0106) to the 10 mL line with rain water from the rain gauge or sample water.

3

Holding the bottle in a vertical position, add 10 drops of *Wide Range Indicator (2218) to the sample.

Cap and mix.

4



Insert test tube into Octa-Slide 2 Viewer (1101). Hold the Viewer so that non-direct light enters through the back.

Match sample color to a color standard. Record as pH.

NOTE: If the color observed in your sample is between two colors on the comparator, the value may be reported to the nearest 0.25 pH unit. If the color produced by your sample is not in the range of the color standards in the comparator, use the following chart to estimate the pH of the sample:

yellow-green	pH 7
green	pH 8
blue-green	pH 9
blue	pH 10
purple	pH 11

ACTIVITY #1

Effect of Acid Rain on Materials

The rusting of metals is an oxidation reaction that is accelerated by the presence of acidic rain, fog and dew. Acid rain also hastens the natural weathering of marble, limestone and mortar. These effects occur very slowly, over a long period of time.

Acid precipitation can affect many of the materials we depend on every day. Discuss and LIST the types of materials you can think of which are frequently exposed to rain.

Colorless vinegar or lemon juice can be used to simulate the effects of acid precipitation.

1. Collect a variety of small items made of the materials you wish to test. Collect TWO samples of each item you wish to test.
   EXAMPLES: aluminum foil, paper clip (steel), chalk (limestone), pieces of concrete chips, copper penny (pre-1983), brass and stainless steel washers, eraser, rocks, plastic, cloth.
2. Obtain TWO shallow bowls, or glass or plastic cups, for EACH type of item you wish to test.
3. For each type of item, label TWO containers with the name of the material. And on one container, write "VINEGAR" or "LEMON JUICE", and on the other, write "WATER".
   EXAMPLE: one cup would say "steel paper clip/lemon juice"; the other would say "steel paper clip/water"
4. Divide the pairs of samples and place a single item in each labeled bowl or cup.
5. To the cups marked "VINEGAR" or "LEMON JUICE", add enough vinegar or lemon juice to barely cover the item. To the cups marked "WATER", add enough tap water to barely cover the item.
6. Cover the containers with plastic wrap so that the liquid will not evaporate.
7. Observe the samples after about five days and add additional liquid if necessary.

Continue the experiment for several weeks, recording your observations weekly. Even if the sample has not visibly changed, a color change or cloudiness in the liquid may indicate the loss of material.

Do your observations indicate that the sample material was affected by the vinegar, lemon juice or water?

Even if the sample has not visibly changed, a color change or cloudiness in the liquid may indicate the loss of material.

RESEARCH IDEAS:

Building and other materials can be protected from corrosion by a variety of methods. Contact architects, engineers and maintenance persons in your area for more information.

KEY WORDS

Corrosion, Oxidation, Surface Coatings

ACTIVITY #2

Collecting & Testing Rain Water

Position the rain gauge in an open area far enough from buildings, trees, overhead wires and other obstructions that may cause air turbulence or contamination. Rain falling on rooftops or trees collects chemicals which will affect the pH of the collected water.

When a rain storm is expected, place the rain gauge outdoors in its holder immediately before the rain begins.

Record the amount of rainfall and empty the rain gauge after each rain event before evaporation occurs. The rain gauge can collect up to 5" of rain. During a very heavy storm, the rain gauge may be recorded, emptied, and reset. Record the partial readings and add them to figure the total rainfall for the storm event.

Perform the pH test as soon as possible after the rain has fallen.

Rain Gauge Sample Data Sheet

Scientist's Name: _____ Date: _____

Time Rain Began: _____

Time Rain Ended: _____

Duration of Rain Event: _____ (Hours)

Total Rain Collected: _____ (Inches) _____ (mm)

Rate of Rainfall: _____ (Inches/Hour) _____ (mm/hour)

pH of Collected Rain: _____

Observations (puddles, flooding): _____

Where does the rain go after it falls?

If rain falls faster than it can be absorbed into the soil, or falls on impervious (hard) surfaces, runoff to streams, ponds and lakes occurs.

Why is it important to test the pH of rainwater soon after it has fallen?

Remember, carbon dioxide in air can change the pH.

RESEARCH IDEAS:

What are sources of dust in the atmosphere?

What substances may be included in these dust particles?

KEY WORDS

Air Pollution, Erosion, Groundwater, Sediment, Hydrologic Cycle

ACTIVITY #3

Collecting & Testing Rain Water

The pH scale ranges from 0 (very acid) to 14 (very alkaline or basic). On this scale a neutral substance is 7 (the mid-point of the scale), an acid substance is lower than 7 on the scale, and a basic or alkaline substance is higher than 7 on the scale.

Strong acids and bases are dangerous!

1. Test the pH of a number of household products that are readily available from your home or school, such as:

   TAP WATER

   VINEGAR SOLUTION - Add 1 teaspoon of colorless vinegar (contains acetic acid) to one quart of distilled water.

   LEMON JUICE SOLUTION - Add 1 teaspoon of fresh-squeezed lemon juice (contains citric acid) to one quart of distilled water.

   BAKING SODA SOLUTION - Dissolve 1 teaspoon of baking soda (sodium bicarbonate, $NaHCO_3$) in one quart of distilled water. Stir well to dissolve.

   †**ASPIRIN SOLUTION** - Dissolve 1 aspirin (acetylsalicylic acid) tablet in one quart of distilled water.

   DISTILLED WATER

   †**HOUSEHOLD AMMONIA SOLUTION** - Add 5 drops of household ammonia (contains ammonia hydroxide, NH_4OH) to one quart of distilled water.

   CLEAR, CARBONATED SODA POP - (contains carbon dioxide and may contain citric acid - check label).

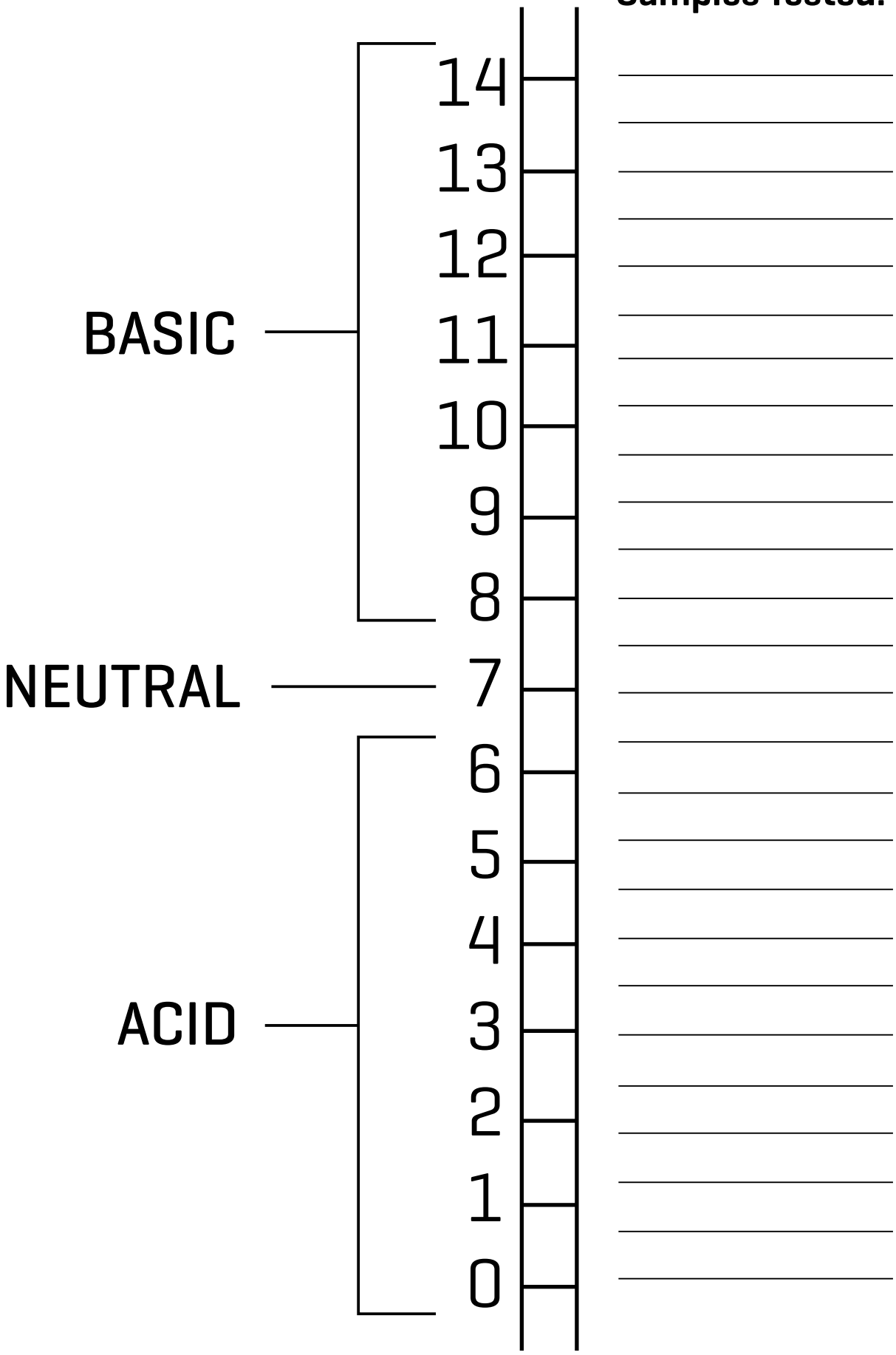
   †**BORAX SOLUTION** - Dissolve 1 teaspoon of borax (an alkaline cleaning agent) in one quart of distilled water. Stir well to dissolve.

   †These solutions should be prepared by an adult.
   [Save these materials for use in other study activities.]

2. List your samples next to their corresponding pH values on the pH scale.
3. Color the pH scale to match the colors produced by the pH indicator. Save this chart to compare the pH of rain and other samples.

The pH Scale

Samples Tested:



ACTIVITY #4

Alkalinity (Acid Neutralizing Capacity) of Water

The pH level of a stream, pond or lake is maintained at a steady level by the presence of "buffering" chemicals in the water, primarily carbonate and bicarbonate ions. The presence of buffering materials helps to neutralize acids as they are added to or created in the water ecosystem. If a body of water has an abundance of buffering materials (high alkalinity), it is more stable and resistant to changes in pH. If a body of water has very little buffering material (low alkalinity), it is very susceptible to changes in pH. Abrupt changes in the pH of the water ecosystem can harm plants and animals.

Distilled water can be used to simulate a poorly buffered stream or lake. Baking Soda Solution (contains sodium bicarbonate, $NaHCO_3$) can be used to simulate a well buffered stream or lake.

1. Place 5 mL of distilled water in one test tube and 5 mL of the Baking Soda Solution (see Activity 3) in another test tube.
2. Holding the bottle in a vertical position, add 10 drops of *Wide Range Indicator (2218) to each tube. Cap and mix. (Colors may be different.)
3. Add the Vinegar Solution (see Activity 3) to each test tube, one drop at a time, mixing after each drop, to each test tube until each sample turns pink (pH = 4). (Some fizzing may occur when mixing.) Count the number of drops required for each sample to turn pink.

Number of Drops:	
Poorly Buffered Water Sample	
Well Buffered Water Sample	

Which solution was quickly affected by the addition of acid (vinegar)?

Which solution was more RESISTANT to change in pH?

Where do natural buffering materials come from?

The buffering chemicals in a stream, pond or lake come from the soils, minerals and rocks in the area.

RESEARCH IDEAS:

What types of solid minerals and rocks provide buffering chemicals to natural waters?

What kinds of rocks and soils are found in this area?

KEY WORDS

Limestone, Calcareous Soil, Carbonate Stone, Stream Liming

ACTIVITY #5

The pH of Rain

Pure water has a pH of 7 but quickly becomes slightly acidic when exposed to small amounts of carbon dioxide (CO_2) in the air. This is also the case with rain water in the atmosphere.

1. Put a small amount (about 25 mL) of tap water into a glass.

2. Remove a 10 mL sample and measure the pH of the tapwater.

   Sample A: _____

3. Place a straw in the remaining water and gently blow bubbles into the water. Bubble your breath through the water for a minute or two.

4. Remove a second 10 mL sample and measure the pH.

   Sample B: _____

What happened?

What do you exhale when you breathe?

You exhale carbon dioxide (CO_2). The carbon dioxide reacts with water to form weak carbonic acid (H_2CO_3). The pH of the water is lowered because a small portion (about 10% or less) of the carbonic acid dissociates into bicarbonate (HCO_3^-) and hydrogen ions (H^+). Normal rain has a pH of 5.6 due to the absorption of small amounts of carbon dioxide in the atmosphere.

RESEARCH IDEAS:

What are other sources of carbon dioxide in the atmosphere?

KEY WORDS

Carbon Dioxide, Atmosphere, Weak Acids, Hydrogen and Hydroxyl Ions

ACTIVITY #6

Collecting & Testing Stream, Pond, or Lake Water

Select a sampling location so that the water sample is typical of the water source and does not represent a localized condition. Do not take a sample next to a pipe. Take the sample from the middle of the lake. Record the date and time of day, weather and other observations such as water color, the presence of aquatic plants, algae, insects, or fish.

Keep the water sample free of foreign matter such as aquatic plants or sediment from the bottom. Use a clean, plastic, or glass water sample container that has a suitable cap. The container should hold enough water to conduct all of the tests that you plan to perform.

Unless the sample is going to be tested immediately, the sample container should be filled until it overflows and then capped. Avoid air bubbles in the sample that can cause chemical changes in the water. Water samples should be tested as soon as possible.

WATER SAMPLE DATA SHEET

Scientist's Name: _____ Date: _____

Scientist's Location: _____ Time: _____

OBSERVATIONS:

Weather: _____

Water Color/Condition: _____

Plants and Animals: _____

pH of Water Sample: _____

Does the pH of the water affect the organisms that live there?

A healthy, productive freshwater lake has a pH of about 8.0, slightly alkaline. If pH drops below 6.0, sensitive species and immature animals are affected first. As food species disappear, even larger, resistant animals are affected.

RESEARCH IDEAS:

What are the sources of the water in the stream, pond or lake?

What species of fish have been caught in this area?

What do they prefer to eat?

KEY WORDS

Habitat, Food Web, Limnology, Hydrology

The Last Page

The last page on the subject of acid rain has not yet been written.

Research is being conducted every day into the causes, effects and solutions to acid rain. Look for articles in newspapers and magazines to keep up with new developments on this subject.

Think of things you can do today ...

Conserve ...

If your home or school uses electricity produced by the burning of coal or fossil fuels, you can help reduce acid rain by conserving electricity:

Turn off lights and appliances when not in use.

Don't waste heat or air conditioning.

Reduce your automobile usage by carpooling and consolidating trips.

Recycle ...

Recycled aluminum requires only a fraction of the electricity needed to produce aluminum from ore.

Recycling steel reduces the need for smelting ore.

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