5500 Environmental Test Lab

This kit is designed as a series of laboratory tests for both water and air pollution. The kit provides materials for testing water for oxygen content, pH, hardness, phosphate content, chloride levels, lead and hydrogen sulfide content. Enough materials are provided for about three repetitions of each test. The air testing section tests dust and particle content, chemical pollution, and acidity of rainwater. The kit allows for either a series of teacher demonstrations, small group experiments, or single student project suitable for junior and senior high school level students. These tests often involve extended periods of time, and the collection of various types of water samples. The Teacher/Student instructions are divided into two groups of experiments: water and air pollution. These in turn are divided into individual experiments, to be completed in whatever order the teacher, group, or student desires. Please review all of the instructions before beginning the experiments.

Contents:

- LabForm (1)
- Plastic Syringe (1)
- Magnifying Lens (1)
- Cork Stoppers (3)
- Sodium Chloride (10 grams)
- Labels (6)
- Fertilizer (20 grams)
- Calcium Carbonate (5 grams)
- Water Hardness Test Powder (3 pillows)
- Water Hardness Test Solution (1 - 30 ml bottle)
- Chloride Test Powder (3 pillows)
- Chloride Test Solution (0.14m A_gNO_3) (1 - 30 ml bottle)
- Methylene Blue Stain (1 -30 ml bottle)
- Bromthymol Blue Solution (1 - 30 ml bottle)
- Test Tube (1)
- Pipet (1)
- Rubber Bands (3)
- Nylon Mesh
- Metal Cups (3 - 60 ml)
- Alum Powder (10 grams)
- Plastic Cup (1 - 30 ml)
- Mixing Sticks (2)
- pH Test Strips (5)
- Phosphate Color Chart (1)
- Lead Test Paper (1 strip)
- Hydrogen Sulfide Test Paper (8 cm)
- Phosphate Test Powder (3 pillows)
- Sawdust/Wood chips
- Teacher Manual (1)

Additional Required Materials:

- Access to hot water supply and sink
- Scissors
- Lettuce leaves
- Soap or an aspirin
- Graduated Cylinder (50 ml)
- Small block of wood or cardboard
- Pond water sample
- Vinegar
- Straws (2 or 3)
- 2 Large glass jars with lids
- Matches or lighter
- Yeast (optional)
- Skim milk (optional)

Introduction

Many people talk about pollution these days, but very few of us have a clear idea of what pollution really is, how it happens, and why it is so important to all of us.

The activities which you will perform investigate the pollution of our water and air supplies. Keep in mind that our environment is quite complex. Changes in the air quality may have important effects on the water and many aspects of water and air pollution are closely related to the environment of the soil. Throughout the investigation, pay close attention to how each pollutant affects the living things which depend on the air and water for survival.

Before you perform any of the activities, look over the materials in the kit. One of the most important materials which you will use in these activities is something which you had before you opened this kit: it's the environment around you. You will be testing the quality of your water and air. Keep in mind that many of the materials you will be testing for have a direct effect on you.

Before you perform each test, read the Background Information section and the directions for use. Follow all directions carefully. While the materials in this kit are safe if used properly, they can be harmful if misused. Perform the investigations only as directed by your instructor.

PART 1 • Water Quality

The water in our rivers, streams, oceans, and lakes is essential for the survival of all life, not just those plants and animals which live in the water. Water supplies the fluids for all living things, and is also the medium for many important life forms. About 90% of all plant food production occurs in the water. We are just now beginning to tap the supplies of food in the oceans. At the same time, we have managed to kill much of the life in some inland waterways through pollution.

Testing for Dissolved Oxygen

An essential feature of water is the oxygen which is dissolved in it. You may know that the molecules of water have the formula H_2O and that the O stands for oxygen. This oxygen, however, is not available for use by living things. Dissolved oxygen exists in water in much the same way that carbon dioxide is dissolved in carbonated beverages. The oxygen gas may dissolve in the water at the surface, through the action of waves and waterfalls, or through the action of plants in the water. The amount of oxygen dissolved at any time depends on several factors:

Mixing/Agitation - the greater the currents and wave action, the greater the amount of dissolved oxygen that can be found in the water.

Temperature - more oxygen dissolves at lower temperatures than at higher temperatures. (This is opposite of the behavior of dissolved solids)

Production of Oxygen by Plants - algae are capable of producing oxygen and releasing it into the water. Algae growing on the surface of ponds and lakes can also prevent oxygen from dissolving into the water.

Use of Oxygen by Organisms in the Water - referred to as Biological Oxygen Demand (BOD). The greater the population of organisms, the greater their demand for oxygen. Within narrow temperature ranges, the rate of oxygen used by living organisms increases rapidly with increasing temperature. Thus, only a rise of a few degrees in temperature will both decrease the available oxygen and sharply increase the BOD.

We can test for the presence of dissolved oxygen using a dye called methylene blue. This dye is blue when first combined with oxygen, but it gradually becomes colorless as the dissolved oxygen escapes from the water. The length of time for the color to disappear is related to the amount of dissolved oxygen present.

Materials Required:

Test tube	Methylene Blue solution
LabForm	Stoppers (3)

Procedure:

Pour some cold tap water into the test tube until it is half full. Cap the tube and shake it vigorously for about 30 seconds. Remove the cap for another 30 seconds to allow fresh air to enter the tube, recap and shake again. This insures that the maximum possible amount of oxygen is dissolved in the water. Fill tube A of the LabForm to within 1cm of the top with this oxygenated water. Add three drops of Methylene Blue solution to the water then top off the tube of the LabForm with the remaining water in the test tube. Immediatley stopper the LabForm firmly. Be sure there are no air bubbles in the tube.

Fill tube C of the LabForm with cold tap water, as you did with tube A. Add tbree drops of methylene blue, then top off the tube with the remaining water sample, and stopper the tube. This will be the direct monitoring of your water supply.

Fill tube E of the LabForm with hot tap water, add three drops of dye, top off the tube, then stopper. Check all three tubes to make sure there are no air bubbles.

Observe the tubes for the disappearance of the blue color. Record the number of days which are required for each tube to become clear. Check the color using a sheet of unlined white paper as a background.

This experiment gives you a range of possible oxygen content in water. The first tube is full of highly oxygenated cold water. Consider this the maximum amount of oxygen the water can hold It should require 5 days or more to become clear. The water in tube C can be considered to be your normal water supply. If this water takes fewer than 5 days, it is slightly deficient in oxygen. The warm water is an example of oxygen deficient water, and will probably take 3 days or less to become colorless. Water which is deficient in oxygen cannot support much life.

Use these examples as references, and test samples of water from your area. Try testing water from shallow ponds, from lakes, from running streams or rivers to see how much oxygen they contain. Remember to label your samples with their location and how war:n or cold the water felt. Stopper or cap your collection containers immediately to make sure no more oxygen is dissolved in them than was originally there.

Optional:

You can show how living things use up oxygen with the following experiment. Get some skim milk, and a packet of yeast from the store. Pour equal quantities of milk into two tubes of the LabForm, add three drops of methylene blue to each, add a small amount of yeast to one of the tubes. Fill a styrofoam cup 3/4 full with warm but not hot water, and place the LabForm over the cup so the tubes are immersed in the warm water. Observe the two tubes for about 20 minutes. What happens to the tube with the yeast in it? The yeast uses the milk as a source of food. What can you conclude about the effect of dumping sources of excess food, such as sewage, into lakes and streams?

Acid or Alkali? The pH Test

Many of the chemicals which dissolve in water effect the acidity of the water. Pure distilled water contains no dissolved material, and is considered neutral, neither alkaline or acidic. While some water is essentially neutral, many water supplies are either acid or alkaline. pH is a measurement scale used to describe the acidity or alkalinity of the water. A neutral pH is designated by the number 7. Acid pH ranges from 1 to 6, with 1 being extremely acidic. pH numbers from 8 to 14 indicate an alkaline condition, 14 being the most alkaline.

The presence of alkali or acid in our drinking water effects the taste of the water. Acidic substances, like oranges or lemons, have a sour taste, while alkaline substances like aspirin or soap have a bitter taste. More important than taste is the effect which alkalinity or acidity has on living things in the water. Most organisms enjoy a particular pH level which is most favorable for their growth. Even minor changes in pH can effect the ability of organisms to survive. The pH of water can be changed by materials contained in industrial sewage, by fertilizer runoff from the land, and even by the presence of certain gases in the air. Sulfur dioxide, a major air pollutant, can make rainwater very acidic.

Materials Required:

Pipet	pH Test Paper	Lemon or Vinegar
Aspirin or Soap	LabForm	

Procedure:

You will use a testing paper which has been soaked with a mixutre of pH sensitive chemicals. The color of these indicator dyes will change with pH. The color scale will show you what the pH value is for a given paper color. To perform each test, dip the end of a small strip of the pH paper into the liquid to be tested for about a second, then remove the paper and observe the color.

Add a few drops of vinegar or lemon juice to one of the tubes in the LabForm. Test this liquid with the pH paper. Remember that pH numbers below 7 are acidic, and above 7 are alkaline. Was the liquid acid or alkali? In another tube, place a small piece of soap, or aspirin tablet, and add a few drops of water to dissolve the material. Test this solution to determine whether it is acid or alkaline.

Now that you have learned how to use the pH testing scale, test samples of the tap water in your area, as well as water from a stream, river or lake. If the water is more than 1 pH unit from neutral (7), it is a strong indication of pollution. While variations in pH are normal, large differences indicate a problem. What effect do you think large runoffs of soaps and detergents would have on the pH of rivers and lakes?

Testing Water Hardness

All water supplies have a variety of materials dissolved in the water. As water flows over the soil and rocks, it dissolves a variety of chemicals. Compounds which are very soluble in water (that dissolve readily) tend to be present in higher concentrations. Some minerals may not be poisonous, but can interfere with the sudsing action of soap, and cause a build-up of scale inside hot water pipes. Water hardness is a measurement of the concentration of these minerals, particularly the salts of calcium and magnesium. In extreme cases, water hardness can effect the metabolism of organisms.

Materials Required:

Hardness testing solution	Small Plastic Cup
Hardness Testing Powder	Soap
Labform	Vial of Alum
Graduated Cylinder (50 Ml)	Syringe
Mixing Stick	Scissors

Procedure:

Demonstrate the effect of hard water on the sudsing activity of soap. Make a concentrated soap solution by dissolving a piece of soap about 1 cm square in 25 ml of very warm water. Stir the solution and break up the soap with the wooden mixing stick.

Add 25 ml of lukewarm tap water to a graduated cylinder. Use the syringe to add 3 ml (3 cc) of soap solution to the water in the graduated cylinder. Cover the cylinder and shake it vigorously 30 times. Place the cylinder on the table and measure the height of the suds produced.

Repeat this experiment using "hard" water. Alum is a chemical that is very similar to the "hard" chemicals found in water. First, rinse the graduated cylinder completely. Add another 25 ml of lukewarm water and dissolve half of the alum in the water. Shake several times to dissolve the alum completely. Now add 3 ml (3 cc) of soap solution to this 'hardened' water. Shake as before. What do you conclude about the effect of hard water on soaps?

Notice the appearance of the sample of hard water and soap. The chemicals which make water "hard" combine with the soap to produce an insoluble scum. Over a period of time these chemicals can produce a bard scale inside water pipes, even if soap is not present.

The major components of hard water are calcium carbonate, calcium sulfate, and magnesium sulfate. Water hardness is usually expressed in terms of the concentration of calcium carbonate. If calcium carbonate is present in concentrations of 250 parts per million (ppm) or greater, the water is considered unacceptably hard. Levels between 100 and 250 ppm indicate moderate hardness, and soaps and detergents will not be able to work efficiently. High hardness levels result in increased costs of wasted soap and damage to pipes and boilers. Hardness levels below 50 ppm indicate soft water.

To measure the hardness of the water in your area, place 5 ml of cold tap water in the graduated cylinder, and pour it into tube A of the LabForm. Tap one of the water hardness test pillows so that the powder settles to one end. Cut open the empty end of the pillow and add the contents to the water in the LabForm. Swirl the LabForm several times to thoroughly mix the powder and the water. A red color indicates that hardness is present. If a red color appears, add the hardness testing solution, one drop at a time, to the sample, counting the number of drops needed to change the color from red to blue. Swirl the LabForm after you add each drop. The greater the number of drops required to change the color of the sample, the higher the hardness level. To determine the hardness in terms of parts per million (ppm) of calcium carbonate, multiply the number of drops by 17.1. What is the hardness level of your water supply?

Excessive hardness can be treated at the main water treatment plant, or by individual users. Water treatment plants usually add various chemicals such as calcium oxide and sodium carbonate. Home treatment for hardness utilizes filters such as those filled with ion exchange resins.

Testing for Phosphates

The element phosphorus is necessary for all life. In water, the most common forms of phosphorus are the *phosphates*. These compounds occur in fertilizers, minerals, and until recently, detergents. If large amounts of phosphates are present because of fertilizer runoff or sewage pollution, excessive growth of algae may occur. This creates an imbalance in the aquatic community and may have serious long range consequences. The rapid growth of algae in turn leads to a rapid decomposition of dead algae, using up a great deal of the dissolved oxygen and depriving other forms of aquatic animal life of oxygen.

Materials Required:

Fertilizer Sample	LabForm	2 jars with lids
Phosphate testing powder pillows	Scissors	
Phosphate Color Chart	Pond water samples	

Procedure:

You have enough materials to perform 3 phosphate tests. Collect water samples from a variety of locations, such as a lake, river, or stream. Pour 5 ml of one of your water samples into one of the tubes of the LabForm. Tap one of the phosphate powder pillows so that the powder settles to one end. Cut off the empty end of the pillow and add the contents to the water sample. Stopper the tube and shake well for one minute.

The presence of phosphates in the water sample is indicated by the appearance of a blue or violet color. Compare the color of your sample with the color of the chart by holding the color chart and test tube side by side in front of a white background. Match the color of the chart to the color of the liquid in the tube to determine the concentration of phosphates in the sample. A reading of 10 ppm means that some phosphate pollution is present. A reading over 10 ppm indicates a severe pollution problem. Since the chemicals used in this test are irritating, you should dispose of the empty powder pillows according to local or state regulations and wash the equipment thoroughly after the experiment.

The sample of fertilizer included with this kit contains large amounts of phosphates (you may test the fertilizer for phosphate levels using the above procedure if your teacher so directs). To demonstrate the effect of phosphates on algae, get two large glass jars 3/4 full of pond water. To one of the jars, add the sample of fertilizer. Gently swirl the liquid in the jar to dissolve the fertilizer. Set both jars in a sunny location for several weeks with the caps sitting loosely on top. Open the jars each day for a few minutes to allow fresh air to mix in. Look for changes in the color of the two samples. What do you conclude about the effects of the fertilizer (phosphate level) on the growth of algae?

Testing Chloride Levels

While chlorides are abundant in sea water, fresh water normally contains low levels of chlorides. The organisms which live in or near fresh water are adapted to these low levels of chloride, and may be harmed by excessive amounts. Chloride concentrations build up as water containing small amounts of chlorides evaporates, leaving the chlorides behind. Water which flows through underground caverns may dissolve large amounts of salt, which is the principle source of chlorides. In addition, salt is used in many cold weather areas to control ice on roads. As much as 1500 pounds of salt per mile of highway may be used during a single heavy storm. This salt flows off the road and contaminates the water supplies and land. In high concentrations, salt is very damaging to metals. Automobiles in cold weather climates and ships that sail in the ocean experience a great deal of corrosion.

Materials required:

Chloride testing powder	LabForm	Salt (sodium chloride)
Chloride testing solution (0.14M $A_{g}no_{3}$)	Water sample(s)	
Plant leaf or piece of fresh lettuce	Scissors	

Procedure:

You can demonstrate the harmful effect of excessive chloride concentrations as follows: fill tubes A and C of the LabForm 2/3 full of tap water. Add the packet of salt to tube A and gently swirl the liquid to dissolve the salt.

Now place equal sized pieces of lettuce or other leaves into the two tubes of water and let them soak for 20 to 30 minutes. Remove the two leaf samples and observe. What did the salt (chloride) do to the leaves? Rinse out the tubes with clean water.

To test for the presence of chloride, measure 5 ml of the water sample to be tested into tube E of the LabForm. Tap one of the chloride testing powder pillows so that the powder settles to one end. Cut open the empty end of the powder pillow and add its contents. After the powder has dissolved, add the chloride testing solution, one drop at a time, swirling gently between each drop. Count the number of drops required to change the color from yellow to orange. To determine the chloride concentration in parts per million (ppm), multiply the number of drops by 50. Chloride concentrations of 250 ppm and greater are considered unsafe.

Testing for Direct Poisons - Lead and Hydrogen Sulfide

The previous experiments dealt with materials which are normally found in water. In recent years, man s industries have added a great many foreign chemicals to the water. Materials like mercury and lead have received a great deal of attention recently. Some chemicals like hydrogen sulfide (the smell of a rotten egg) may arise from direct pollution of the water by sewage or by the action of pollution related bacteria. A whole range of sensitive chemical tests are used routinely to monitor the levels of chemicals such as lead or hydrogen sulfide, which indicates serious pollution problems.

Materials Required:

Pipet	Water sample(s)	Lead testing paper
Small plastic cup	Scissors	
Hydrogen sulfide testing paper	LabForm	

Procedure:

Use the small plastic cup to collect a sample of water for testing. Use tap water, or water from a lake or stream. Use the pipet to add a few drops to two of the small depressions in the top of the LabForm.

Cut up a piece of lead testing paper into six strips. Dip a piece into the water sample. If a pink to purple/ red color appears, then the water sample contains dissolved lead ions in a concentration of at least 5 ppm by weight. This indicates possible lead pollution. Lead often enters the water supplies through old pipes which are made of lead. Many older paints are also made from compounds containing lead. If you have samples of oil base paints, test them for the possible presence of lead.

Tear off a small piece of the hydrogen sulfide testing paper and dip it into the other depression containing the water sample. The appearance of a brownish black color indicates a hydrogen sulfide concentration of at least 5 ppm. The darker the color, the higher the level of hydrogen sulfide.

PART 2 • Air Quality

The air around us is important to us, both for what it does and does not contain. Many living things get oxygen from the air and produce carbon dioxide which is released into the air. Beyond the basic processes of gas exchange, air is involved in a variety of events which are important to living things.

Thousands of tons of solid material are introduced into the air every day in the form of smoke and dust. Many components of smoke may be harmful to living things in high concentration. Large quantities of smoke are generated by coal and oil burning power plants, and many large factories. Smoke particles are also released by natural events like forest fires, but these sources of smoke are usually spread apart in both distance and time.

Man's activities are a more serious source of smoke pollution because they are so concentrated and steady. Particles larger than those in smoke are also released into the air by a variety of industrial processes. Wood, plastic, paper, and mineral processing operations all release significant quantities of dust particles into the air. Beside these direct productions of dust, man's activities may lead indirectly to increases in levels of dust. For example, over-cultivation of agricultural areas can lead to a loss of vegetation, followed by wind erosion of the land.

Dust and smoke are potential hazards to life for two reasons: First, the particles interfere with the processes of gas exchange mentioned earlier. The lungs of animals and the leaves of plants become coated with layers of the particles, making gas transfer more difficult. Second, some of the components of smoke and dust may be biochemically harmful. The asbestos particles in the dust from some industries is an example of this second hazard. Asbestos has been shown to be closely related to particular forms of cancer. Coal dust has been linked to black lung disease and emphysema in miners.

Dust and Particle Monitoring

The particles of smoke are quite small. Individually, they can't be seen with the unaided eye. Some other particles, however, are large enough to be seen. These dust particles are transported by the wind and are also effected by gravity. We can collect these windblown particles with the following experimental procedure.

Materials required:

- Magnifying glass
- Scissors
- Shipping container from the kit
- Adhesive paper strip (labels)

Procedure:

Cut the adhesive paper into 6 pieces. Mount one piece on each side of the shipping box, or other rectangular object, with the sticky side facing out. Mount one piece on top of the box. Mount the sixth piece of adhesive paper, sticky side down, on the ceiling of a closet, the underside of a shelf, or the ceiling of your room.

Place the box with its five exposed sections of sticky paper in a location exposed to open air. Leave the labels exposed to the air for 7 days. Remove the adhesive papers from the box and the ceiling, and observe them with a magnifying glass.

Do you see any differences among the six labels? Do the four sides of the box receive equal amounts of particles? Where are most of the large particles? Can you explain any differences in amount of large dust particles collected on the four sides, and the top of the box and the particles collected in the closet?

Examine the particles with the magnifying glass. Do you find any evidence of materials from plants or animals, or of material which appears man made? Using the label from the top of the box, mark off a 1 cm square. Count the particles within the square. If there are too many to count, estimate their number. If your estimate, or actual count, is over 500 particles per square centimeter, then the air in your area can be considered to have a fairly high particle count. Counts from 100 to 500 represent mild particle contamination of the air.

Chemical Pollution of the Air

While most people are worried about air pollutants which they can see, like smoke and dust, the most harmful pollutants are invisible. Many industrial processes produce harmful gases which escape into the air. In addition, the engines of trucks, cars, planes, and other vehicles produce large amounts of chemical fumes. These chemicals may be toxic to living things. They may also cause extensive damage to property, clothing, and buildings. Some of these invisible pollutants act directly from the air, while others have their effect after they are dissolved.

The Deterioration of Nylon

Materials required

- Small amount Sawdust/Woodchips
- Magnifying lens
- Nylon mesh
- Metal cups
- Rubber bands
- Syringe with plunger
- Scissors
- Matches

Procedure:

Cut a piece of nylon mesh large enough to cover the top of the metal cup. Stretch the mesh over one of the cups and secure it with a rubber band. Examine the mesh closely with the magnifying glass. Notice the fine threads of the nylon. Are there any breaks in the weave? Mark down the number of cuts and breaks that you find.
Place the sawdust/woodchips in the other metal cup and light it with a match. Allow the woodchips to burn for about a minute, then blow out the flame. Remove the plunger from the syringe, and trap the smoke produced by holding the open end of the syringe over the smoldering wood. Once the syringe is full of smoke, replace the plunger. Hold the tip of the smoke filled syringe close to, but not touching, the nylon. Gently push the plunger to pass the smoke through the nylon. Keep the smoke directed toward a single small area of the nylon. Repeat this procedure two more times. Rinse the syringe for use later on. Examine the area of nylon where the smoke passed through. Are there any new runs or breaks in the nylon? What has the smoke done to the fine threads of the mesh?

When you are finished examining the nylon, remove it from the metal cup and rinse both cups for use later on. The harmful chemicals in smoke do not have to be this concentrated to have an effect on clothing. We can evaluate the overall level of air borne pollutants in your area as follows: cut two more pieces of mesh to fit the metal cups. Stretch one piece over each cup and secure each with a rubber band. Observe both samples for breaks and runs and record any that you may find. Place one cup outdoors in a location exposed to the air but sheltered from rain. Place the other cup in a sealed cabinet in your classroom. Be sure that both samples are away from direct heat. Allow the two samples to remain undisturbed for 4 weeks.

After exposing the nylon samples for an extended period of time, examine both of them with the magnifying lens. The sample in the sealed cabinet should not have been exposed to as many air borne pollutants as the one outdoors. If the air in you area is relatively unpolluted, then the two samples may have about the same number (close to zero) of new breaks in the mesh. If the sample from the open air has more than 5 new breaks in it, then the air in your region probably has a significant level of destructive air borne chemicals.

Pollutants Dissolved in Rainwater

A variety of chemicals from the air dissolve in falling rain water. Some of these chemicals cause the rain to become very acidic. Acids are substances which can cause the corrosion or breakdown of a variety of metals and minerals. The rain falling near large industrial areas has become very acidic in recent years.

There are three major types of gas that cause acidic rain. All three involve the oxides (oxygen- containing compounds) of an element. Nitrogen oxides, carbon oxides, and sulfur oxides all contribute to the acidity of the rain water. All three are produced by high temperature industrial processes, and by internal combustion engines.

Materials required:

Small amount of Sawdust/Woodchips	Vinegar
Calcium carbonateTest tube	LabForm
Bromthymol Blue solution	Syringe & Metal cup
Plastic measuring cup	Straw

Procedure:

Fill the test tube 1/2 full with water. Add 30 drops of bromthymol blue solution to the water. Bromthymol blue is a chemical which changes color depending on the acidity of the water. Acidity is measured in terms of a *pH scale*. A pH of 7 is neutral. pH values above 7 are *alkaline*, and numbers below 7 are *acidic*. Bromthymol blue is blue in color when the pH is above 7, and green to yellow at pH's below 7. Based on the color of the indicator, what can you say about the pH of the tap water in your area?

Use the straw to blow air gently through the liquid in the tube. Be careful not to suck up the indicator with the straw. Keep blowing until you notice a change in color. Carbon dioxide in your breath has caused the solution to become acidic. The bromthymol blue first turns green and then yellow. A yellow color indicates that the pH has dropped below 7.

All animals produce carbon dioxide. This carbon dioxide, however, is normally used up by plants during the process of photosynthesis. Problems arise when large amounts of carbon dioxide and other similar compounds are produced by industry. The following experiment shows why:

Empty the test tube of the bromthymol blue solution. Refill it half way with water and add another 30 drops of indicator. Place a some of the sawdust/woodchips in the metal cup, light it, and allow it to burn for a few seconds, then blow it out. Remove the plunger from the syringe, and collect some of the smoke in the syringe by holding the syringe open side down over the smoldering woodchips. Replace the plunger, and force the smoke through the water by pushing in on the plunger of the syringe. Repeat this several times. What happens to the color of the indicator? What can you say about the effect of smoke components on the pH of rain water?

Empty the tube and refill it half way with water and 30 drops of bromthymol blue. This time you will test the air in your region. Fill the syringe with air to the 30 cc line. Blow the air through the water. Refill the syringe with air and repeat. Perform this procedure 5 times (total volume of air, 150 cc). Note any color change during this time. If the solution changes color to green or remains blue, then the air in your region has fairly low concentrations of the acidic gases. A color change to yellow indicates a high concentration of acid producing gases and a potential health and property hazard. Rinse the tube and syringe for later experiments.

When the acidic gases dissolve in rain water, they produce a solution which has the ability to corrode many metals, minerals, and rocks, as well as to kill plant life. This corrosion process may appear slow when examined directly, but can produce extensive damage in the course of only a few years. We can simulate the process more rapidly by using a solution which is more acidic than most acidified rain waters. Obtain a small sample of vinegar. Vinegar is a moderately acidic solution. (The rain water in some areas is nearly as acidic as vinegar, about pH 4)
Obtain a small piece of calcium carbonate. This is limestone, a mineral similar to marble, a common building material. Place the sample of calcium carbonate in the center well of the plastic LabForm. Using the pipet, add a few drops of water to the limestone. What happens to the rock? Now add a few drops of vinegar to simulate the effect of adding acidified rain water. What happens to the rock now? What do you think has been the cause of the extensive decay of the limestone statues and buildings in Italy, especially in areas which have developed a great deal of industry?

Clean and rinse all equipment before going on to other experiments.

Suggestions For Further Study

After you have read the material and performed the experiments contained in this kit, you will have gained a basic understanding of the principle aspects of air and water pollution. Many of the tests you used are similar to those used by government agencies monitoring air and water quality. After you have completed the activities, you might want to pursue some of the following areas of interest.

1) Contact a local water supply agency to determine the major problems faced in you area. Some localities use specialized water treatment facilities, while others simply distribute existing water supplies. If you can, visit the local water treatment facilities.

2) Contact the United States Department of Agriculture, or a State Agency dealing with environmental quality. Local officials can probably suggest the appropriate office to contact. Arrange a tour of the testing and monitoring facilities. Many government agencies are quite willing to provide tours and information to tour groups.

3) Write to your congressman to find out what legislation dealing with air and water quality in your area is under consideration. Research the background of the bill, and find out what hearings have been, or will be, held. It's the practical business of putting environmental quality standards into law which takes the greatest amount of time and effort, and yet receives the least attention.

4) If there are factories in you area which use river or lake water for cooling or waste disposal, ask their public relations department for information concerning waste treatment. Many firms are willing to have the public tour their facilities, or at least provide information to the public.