1500 CHEMICAL POLLUTION OF WATER

This kit complements student studies on the chemical pollution of water. A minimum of two class periods are recommended. There are enough materials to analyze sixteen water samples. The class may be divided into four groups with each group can performing the complete set of tests on the three polluted water solutions provided. Excess materials can be used to test locally collected water samples. The following qualitative tests can be done:

pH	Copper	Nitrates	Oil
Ammonium	Iron	Nitrites	Sulfates

Contents:

Pipets (10)
Test Tubes (10)

1M Sodium Hydroxide (30 ml)

Teacher's Manual (1)
Student Instruction (1 Master)

Test Papers:
Ammonium (4 strips)
Copper (4 strips)
Iron (4 strips)
Nitrate (16 strips)
Oil (4 strips)
pH (1 vial)
Sulfate (16 strips)

Water Solutions (2 - 240 ml bottles of each sample)

Solution Content	*Sample A*	*Sample B*	*Sample C*
Ammonium Chloride	✔	✔	
Copper Sulfate	✔		✔
Iron Nitrate	✔		✔
Sodium Nitrate	✔	✔	
Sodium Nitrite	✔		✔
Vegetable Oil	✔	✔	
Citric Acid	✔		
Tap Water	✔	✔	✔

Additional Required Materials:

Test Tube Racks	Lemon or Lime Juice	Distilled Water
Watch Glasses	Baking Soda	

Introduction

Pure water is a colorless, odorless, tasteless and harmless liquid. However, it probably does not exist in nature! Rainwater, potentially the purest water in nature, picks up dusts and gases from the air. When it strikes the earth it accumulates minerals and chemicals from the soil. Additionally, man has contributed significantly to the chemicals in the Earths water bodies. Water pollution occurs when the balance of naturally occurring materials is upset, or when a new, harmful material is added to the water.

We can classify water pollution into three broad categories: natural, biological and chemical. An example of natural pollution is the condition known as red tide where an overgrowth of microscopic organisms makes shellfish inedible. Dumping raw human wastes into water adds disease causing microorganisms resulting in biological pollution. Chemical pollution, the presence of hazardous chemicals in water is principally the byproduct of human technology, inadequate disposal of manufacturing, agricultural and personal wastes.

Background Information

This kit complements the study of chemical pollution in water, where it comes from, and how scientists test for it. This study should start with a discussion on the idea that not all chemicals found in water are bad and that chemical concentration is an important factor to consider. Traces of copper, iron, manganese, zinc, chlorine, sodium, fluoride, and cobalt are essential for plants and animals (including humans). In large amounts, however, they can negatively effect living organisms. Other chemicals, such as lead and mercury, are very dangerous even in very small quantities because they accumulate in living tissue reaching toxic levels.

Discuss environmental standards and laws and their positive impacts on water quality.

pH

Chemical contamination tends to make water acidic or basic. Pure water is neutral, pH 7. Living things flourish in water with a pH between 5.5 and 8.5. A lower pH encourages fungi and slime growth, while a higher pH increases the effects of undesirable chemicals and tends to kill aquatic life. pH is measured on a scale from 0 to 14, with 0 being the strongest acid, and 14, the strongest base.

Oil

Oil pollution immediately brings to mind pictures of oil covered birds and seals, the devastating effects of oil tanker spills. Oil contamination, however, is not limited to crude petroleum. Oil is a generic category with thousands of natural, animal and petroleum based organic compounds with varying physical, chemical and toxicological properties.

Sulfates

Sulfates are one form of several sulfur species found in water. The fact that most metal sulfates are soluble in water and many biological compounds contain sulfur explains why sulfur compounds are very common in natural waters. Pesticide residuals and manufacturing wastes are sources of pollutant sulfur species. Sulfates are reduced by the bacteria *Desulfovibrio* to hydrogen sulfide. It is this degradation product which gives the odor of "rotten eggs". Another bacteria, *Thiobacillus thiooxidans*, can oxidize hydrogen sulfide to sulfuric acid.

Copper

Copper is an essential trace element for plants and animals. However, at high levels it is toxic. Large amounts of copper will kill weeds and algae. Because algae and plants are a food supply for many organisms as a basis of food chains, this die off can be heightened by the animals who ate them will die also. In turn, the flesh eating animals that rely on the plant eaters for food will die. (This concept of a "chain of events" resulting from pollution is important.) Copper is released into water from metal treating plants, mining operations and other commercial practices. Acidic water attack copper pipes and leave a telltale green stain on bathroom fixtures.

Iron

Iron is a trace element needed by plants and animals in small amounts. Iron is derived from minerals in the soil and underlying rocks. Usually, they act as co-enzymes in various organic reactions. Most plants require certain minimum concentrations of this material, and it is commonly available in the soil. However, if the soil is subject to extensive erosion or leaching this element may be present in streams, groundwater or water supplies. The presence of iron in water results in "hard" water. Laundry detergent performance is decreased, rinsing out shampoo is more difficult and a buildup of iron deposits in water pipes are all results of high concentration of iron in water.

Nitrogen Compounds (Ammonium, Nitrates & Nitrites)

Nitrogen is essential for all living things. It is taken from the air by nitrogen fixing plants and into the soil from plant residues and animal wastes. It is acted on by bacteria , bound to the soil, leached into ground water, oxidized or reduced, and released as a gas back to the air in a complex process called the nitrogen cycle. Nitrogen fertilizers, feedlot runoff, and municipal and industrial wastewater have all upset the balance of this cycle. Ammonium, nitrites and nitrates are key intermediaries in the nitrogen cycle and can be toxic at excessive levels.

Lead

Lead is very poisonous and particularly dangerous because it is stored in the bodies of animals and not eliminated by their wastes. Toxic levels are reached by this accumulation. Fish exposed to lead can build up a concentration that is toxic to whatever eats it, including humans. The elimination of: lead piping in new buildings, leaded gasoline and lead based paints has greatly reduced lead in our waters. However, lead from lead mining and smelting, battery manufacture and lead pipes in older homes can still be a problem. The water samples provided to you do not contain lead due to the poisonous effect at low concentrations and disposal concerns, however a discussion about lead (or mercury) water pollution is encouraged.

Preparing the Materials

The kit contains two bottles each of three polluted water samples. Sample A contains all seven chemicals, while Samples B and C, the "unknowns," contain only three or four of the chemicals in Sample A (Ref. table p. 1). Samples A and C require approximately 2ml of vegetable oil be added to each. Shake all bottles before use.

You will need 16 individual pieces of each test strip. Cut each of the ammonium, copper, and oil test papers into four pieces. Cut the potassium iodide starch strips into 2 cm pieces. Use the nitrate, sulfate and pH paper as is.

The kit water samples are acidic. You may wish to make up several solutions to demonstrated the pH range. As suggestions you might try : lime juice (2), vinegar (3), apple juice (3.5), sea water (7.5 - 8), baking soda (8 - 9), and household ammonia (11).

Guide to Student Instructions

Setup

Explain that this is a qualitative testing procedure and only indicates whether the chemicals are present. Environmental laboratories use quantitative methods which measure chemical concentrations in parts per million or parts per billion. The principal techniques they use are calorimetric, atomic absorption and emission spectroscopy, gas chromatography and electropotential sensors.

Divide the class into four or fewer groups and distribute the Student Instructions and Data Sheet. Review the instructions with the students. Ensure they understand good laboratory practices, i.e. , keep hands clean, clean equipment between samples to avoid contamination, and respect the chemicals in this kit, especially the sodium hydroxide.

Distribute 2 test tubes, 2 pipettes, 1 test tube stopper, 1 watch glass and 1 test tube rack to each group. Students should take the test strips as needed.

Explain that Sample A contains all of the pollutants listed on their data sheet. The groups will each take 10 ml of Sample A and test it to confirm the presence of the eight chemicals.

Testing

Students may now proceed with this activity on their own. Test papers make the procedure simple and fun. Each group records their results on their data sheet.

Cleanup

Remind students to thoroughly clean their labware and hands before testing new samples.

Samples B & C

After students finish with Sample A they are ready to detect the "unknowns" in Samples B and C. From their previous exercise students will be able to conduct tests on these samples and determine which of the chemicals is present. Point out that not all samples look polluted. Polluted water cannot always be determined by appearance alone.

Final Cleanup

When you are finished with the water samples you are left with water which is very polluted with some major chemical offenders. Ask the class what they would suggest you do with the samples. This will lead to an interesting and important discussion of what happens to the water you pour down the drain.

Follow your local or state procedures in disposing of these polluted samples.

Collecting & Testing Local Samples

Provide each team with a clean container and ask them to try and find a sample of polluted water in the local area. This is a team homework problem. Once they decide on the spot, the person living the closest can collect the sample. The samples are returned to school and tested by the group. Results are recorded on the data sheet under "Sample (Local)"

NOTE: If your tests show that you do not have polluted water, do not be disappointed! After working with the very polluted kit samples, students may have the idea most water will yield the similar results. However, there is far less polluted water than you might suspect. Environmental legislation has had major impacts on the way businesses, municipalities and individuals treat their wastewater. It should be a pleasant surprise that most water is not as polluted as they might suspect. Stress that we need to keep it that way.

In conclusion, discuss the impact of environmental standards and laws on water quality.

Additional Resources

A Catalog of Water Quality Information & Educational Materials. Maine Department of Environmental Protection, Bureau of Land and Water Quality, State House Station 17, Augusta, ME 04333.
(207) 286-3901. Contains a list of books, pamphlets, tapes, videos, posters, slides and computer software available from the federal and state governments, and private companies. Updated annually.

Environmental Chemistry, 6th Ed., Stanley E . Manahan. CRC Press, Inc.: Boca Raton Fl.,1994. The primer in environmental chemistry.

State Departments of Environmental Protection, Local Water Treatment Facilities, Watershed Associations, Public and College Libraries, Fish and Wildlife Agencies, Environmental Groups, Internet and other On-Line services.

Note: To order **Test Paper Replacement Kits,** order item # 700089-1500 @ $54.00/kit.

Chemical Pollution of Water #1500 Student Instructions

This laboratory procedure allows you to test pH and the presence of seven chemicals in water. Your teacher will provide you with water samples and test papers. If time permits, you may be asked to collect a sample of water to test for pollution. You will record all observations and test results on a data sheet.

Setup

Follow the complete set of tests for each water sample. Start with Sample A which contains all seven chemical pollutants. Then you will test two unknowns (Samples B and C) which may contain one or more of the chemicals.

- Each student group will need: 2 test tubes, 1 test tube stopper, 1 test tube rack, 1 watch glass, 2 pipettes and a set of Student Instructions with Data Sheet.
- Pipet 10 ml of your sample into a clean test tube and place it in the test tube rack. You will use this water to perform all tests.
- Observe the physical characteristics of the sample and record on your data sheet.

Testing Procedure

pH:

- Take a strip of pH indicator paper and place it on the side of your watch glass.
- Pipet 1 drop of water sample to the edge of the paper.
- Compare the color change with the numbered color markings on the color chart provided in the vial. Record the number that matches the color you obtained.

Oil:

- Take a piece of "Test Paper Oil" and place it on the side of your watch glass.
- Stopper the test tube containing the water sample and shake.
- Pipet 1 drop of water sample to the test paper.
- Any shade of dark blue/violet or absorption to moisture indicates the presence of oil. Record your results.

  A negative result will neither change color or become moistened.

Sulfates:

- Pipet 20 drops of water sample to a clean test tube.
- Obtain a piece of "Test Paper Sulfate" and dip the reagent end of the test strip into the water sample in the test tube for one second.
- After 2 minutes, observe reagent pads of test strip.
- One or more reagent pads change to yellow/orange indicates the presence of sulfates. The more reagent pads that react positively indicates a higher amount of sulfates present in the water sample. Record your results.

Copper:

- Take a piece of "Test Paper Copper" and place it on the side of your watch glass.
- Pipet 1 drop of water sample to the test paper.
- A green spot indicates the presence of copper. Record your result.

Iron:

- Take a piece of "Test Paper Iron" and place it on the side of your watch glass.
- Pipet 1 - 2 drops of water sample to the test paper.
- A brownish-red spot indicates the presence of iron. Record your result.

Nitrates:

- Pipet 20 drops of water sample to a clean test tube.
- Obtain a nitrate testing strip and dip the reagent end of test strip briefly (1-2seconds) into water sample.
- Remove and wait 60 seconds, then observe.
- Nitrates are present if the lower reagent pad turns red.
  Nitrites are present if the upper reagent pad turns red.

Ammonium:

- Take a piece of "Test Paper Ammonium" and place on the side your watch glass.
- Add 20 drops of sodium hydroxide to the remaining water sample in the original test tube. (You should have about half (7 ml) a test tube of water remaining.)
- Stopper the test tube and shake while slowly counting to ten.
- Set the test tube in a rack for about a minute. (You may notice a white precipitate. Let it settle to the bottom and do not disturb.)
- Pipet 2 - 3 drops of the solution to the test paper.
- A brownish yellow spot indicates the presence of ammonium. (Look carefully, it fades quickly.) Record your results.

Clean Up

IMPORTANT: Thoroughly clean your pipettes, test tubes, watch glass and your hands before testing a different water sample. Always use distilled water for the final rinse.

Chemical Pollution of Water #1500 Data Sheet

Name(s): _____ **Date:** _____

Test Results

Test	Sample A	Sample B	Sample C	Sample (Local)
Physical Characteristics				
pH				
Oil				
Sulfates				
Copper				
Iron				
Nitrates				
Nitrites				
Ammonium				