INTRODUCTION TO POLLUTION PREVENTION

Many satellites put in orbit by the United States and other countries have included geographic image surveys as part of their missions. Not only have those images clearly illustrated the beauty and diversity of the planet's surface, but also those images have shown that it is isolated and self-contained. Although enormous in scale, the Earth is not infinite nor are its resources. While the planet can support an abundance of life and even can absorb some level of pollution, its carrying capacity (the amount of life supportable through resource allocation and use) is fixed. Because of this, the combination of natural and human-made detrimental effects, including pollution, must be considered to ensure that the carrying capacity is not exceeded.

The effect of natural or human-made change on Earth is often difficult to determine and is speculative on a worldwide scale, although studies of individual ecosystems and smaller geographic areas prove less difficult to measure. Instances of pollution can be investigated to determine effects and risks posed. Environmental studies and analyses have received increasing attention in past decades. Only through education can we as citizens become informed enough to make accurate and responsible decisions about our environment. The focus of this chapter is environmental pollution, either occurring naturally or human-made. There are two fundamental reasons for our concern with environmental pollution: (1) human health, welfare, and resource needs and (2) concern about the rest of nature.

Human Health, Welfare, and Resource Needs

Our personal concern with environmental pollution mainly revolves around health problems from natural, as well as human-made, pollutants. Human health and well-being can be impacted by environmental pollution in two distinctly different ways: (1) on a personal level by detrimental health due to contamination or depletion of water, air, and other needed resources or (2) by reduced social and economic benefits or degradation in a geographic, ecosystem, or global context through slow deterioration of our habitat or decreasing availability of resources.

The cost of control and remediation measures for pollutants sometimes is reflected in health-care costs to treat afflictions caused by pollution. Reduced or eliminated mental well-being or recreational benefits often are overlooked and are underestimated because of the difficulty in quantifying costs. The cost of the inability to fish a stream segment because of aquatic pollution, to stay outdoors for extended periods because of elevated ozone levels, or to play in areas contaminated by pollution is difficult to determine economically. Maintaining a healthy and sustainable environment for these activities often runs contrary to human and economic needs for population, urban, agricultural, and manufacturing growth and development.

Concern for Nature

Concern for nature other than that readily identified as healthful or economically beneficial has been a part of human existence for centuries. For example, there are many things about the balance of nature that we don't know. The loss of some species may throw off that delicate balance in ways that we cannot foresee at the time. This is a major theme of the modern environmental movement. Although many concerns mainly address human enjoyment, nature has value simply in its existence. Consider, for example, the number of people who place value in the protection of endangered species and the national park system, even though they have never seen an Indiana Bat or visited Little River Canyon. This protection of nature does not come without a price to all of us. Some resources have to be left unclaimed, some land has to be left undeveloped, and funds must be spent on protection and preservation of the delicate balance of nature.

Cultural Change

One of the major factors in the creation of environmental pollution stems from the consumption of resources, production and manufacture of goods, and disposal of wastes. Demand from citizens for a ready supply of goods increases as the population increases. Technology offers more products to make our lives better and easier, and our purchasing power increases.

The controversy over the creation of pollution traditionally has focused on finger pointing and on placing economic matters above environmental concerns. Industry, government, and public groups have not always realized that environmental protection and economic growth do not have to be mutually exclusive. Government regulation, industry initiative, and public demand have caused great improvements to be made in the area of environmental protection. Better process design, control measures, and pollution prevention activities to reduce or eliminate pollutants at the source have reduced much pollution. Although great successes have been achieved, much more must be done in order to protect human health and the environment from pollutants.

A cultural change continues in the way many Alabamians work and play. Businesses, industry, agriculture, and other activities continue to make improvements in their operations. Collectively, they are trying to make a difference, as are public environmental groups and government agencies who keep watch over the environment and who encourage progress. These collective actions are important to success, but what can we do individually? We must all consider our activities, taking into consideration the environmental impact they may have. The idea of "throwing it away" is a myth. Wastes do not "disappear" when we "throw it away." All waste must be disposed of somewhere, and consumption of most materials creates at least one form of pollution from solid waste or from discharges in water or emissions into the air.

When purchasing materials and services, we must consider questions such as "What will happen to it after I use it? Can it be recycled? Can I purchase goods with less packaging? Is there a better alternative?" and finally, and most importantly, "Do I really need it?" Unfortunately, we often must act and make decisions without complete information. Educating ourselves, taking the time to get accurate information, and considering the consequences of our actions collectively and as individuals are important first steps in solving the problems created by environmental pollution.

From *World Book Encyclopedia*

A Legacy

OBJECTIVES:

The student will be able to:

1. Analyze the relationships between how people use the Earth today and the impact of these actions on the future.
2. Define the term legacy.
3. List two examples of a legacy.

BACKGROUND:

A legacy is something that is left for the next generation. A legacy could be your great grandmother's locket or your great grandfather's watch left to you. It could be a rare coin collection On a larger scale, the national parks are a legacy left to us. A legacy can even be a story passed down from generation to generation. A legacy is something valuable enough to protect and to continue to pass on to future generations.

Grades:

3-5

Subjects:

Language Arts, Science, Social Studies, Art

Time Needed:

One class period

Materials:

"A Legacy" by Kay Atchinson
student handouts
paper
pencils
art supplies

VOCABULARY:

barren - land not producing plant life
bubble - a round space filled with air kept in by a non-rigid membrane
concrete - a mixture of cement, sand, or gravel and water that hardens as it dries
desert - dry land with few plants and little rainfall
dome - a large, rounded roof on a circular or many-sided base
generation - the average time interval between the birth of parents and the birth of their offspring
humankind - people
legacy - something left for the next generation
withered - dried out and lifeless

ADVANCE PREPARATION:

Read the story "The Legacy" by Kay Atchinson.

PROCEDURE:

Setting the stage

1. Have students tell about special items left to them by others.
2. Lead students to brainstorm the reason we should be concerned about leaving a legacy to future generations.

Activities

Discuss the story "The Legacy" with the class.

- Ask students what a legacy is according to the grandfather. Ask what he meant when he said his generation did not leave one.
- Ask students about the reasons why the grandfather's generation did not listen to those trying to conserve and protect the Earth.
- Ask students to predict when this story could have taken place (past, present, or future). Why?
- Ask if students think the grandfather actually sees the landscape at the end of the story. (This is a

flashback to a time in his life when he could see and feel the beautiful landscape and hear the animals.) These things are no longer available to see or feel on Earth except in books, videos, or museums.

- Ask students what they think the author is trying to say in this story. (What we do today influences what happens in the future.) We can try to do a small part in protecting and conserving the Earth's environment. If everyone would do a small part, we could conserve and protect the Earth for future generations.
- Instruct each student to write a paragraph describing his/her idea of what the Earth will be like when he/she is 50 years old.

Follow-Up

1. Summarize the importance of protecting our legacy.
2. List ways to protect our environment.
3. Recite "A Conservation Pledge" with the class.

EXTENSIONS:

1. Make a class book depicting the characters in the story.
   - Encourage students to include descriptive adjectives about the main characters.
   - Instruct students to design illustrations for the class book.
2. Ask students to retell the story in their own words.
   - Write the vocabulary words on the board or use an overhead projector.
   - Direct students to use the vocabulary words to make meaningful sentences telling about the story.
3. Ask students to identify locations in Alabama where they might find some of the things seen by the grandfather at the end of the story.
   - Plot these items on an Alabama map.
   - Instruct students to make a map key using symbols to represent these items.
4. Read *The Giving Tree* by Shel Silverstein to the class.
5. Read *Just A Dream* by Chris Van Allsburg to the class.
6. Ask students to write a descriptive paragraph about how they view their world today.
   - Place their work in a time capsule (coffee tin or metal box) and bury on the school grounds.
   - Date information for a future finder.
7. Students can interview an older relative or others in the community to find out how the world has changed in their lifetime.

ORIGINAL DEVELOPMENT RESOURCES:

Atchinson, K. (1994). A Legacy.

Banfield, S. (1992). *What in the world?* Troll Associates.

A Legacy
By Kay Atchinson

An old man and a young child sat on a concrete slab. As they looked around at the landscape outside, the small child looked up at the old man.

“Grandfather, was it always like this? The world is such a dreary place to me, with all the concrete streets, tall buildings, and dry, rock-filled lawns. Why do we have to have so much of everything in rocks and concrete?”

“Well, the Earth has a lot of sand, deserts, and rocks, and that makes good concrete,” the old man chuckled.

“But, Grandfather, our teacher tells us it was not always like it is today...the Earth, I mean. What was it like when you were my age?”

The withered old man looked down on the child and his eyes held a forlorn, wistful longing. He hesitated before he spoke, and the child thought he had forgotten. “This world you know and see is so different from the one of my childhood. You can only imagine it from the pictures in your books or in the older videos you watch, but I can see it in my mind’s eye as it used to be long ago. Your teacher was right - the world was different then. But our generation did not realize its worth. We thought it would be here forever. We used it to gratify our wants and needs, never with a thought that we might someday use it up. It had always provided us with what we wanted. We figured it would do so forever. I’m sorry, sweetheart, that we did not think to leave your generation a legacy.”

“What’s a legacy, Grandfather?”

“That’s not easy to put into words that you might understand, but I’ll try. A legacy is like a present you give to someone who comes after you are gone from this Earth. It is like a treasure, but you can’t buy it for all the money in the world. In fact, it must be given freely, without expecting anything. But yet the person getting it has a price to pay, really. That person must also give it freely to those who are here when he is gone. A legacy will always be left to be used and loved by everyone, no matter what happens in the future. Does that make any sense to you?”

“I think so. It’s like the time Uncle Jeff gave me his football card collection when he went away and told me to keep it so I could give it to my children someday.”

The old grandfather smiled, thinking of his grandchild’s materialistic reasoning. “Kinda like that, but a legacy may not always be yours alone. Sometimes a legacy doesn’t belong to just one person, but to all the people of the Earth. That’s what my generation failed to realize...until too late.”

Didn’t your teacher or anyone else teach you about the legacy?”

“Oh, plenty of people taught us or talked about the things we could and should do to preserve and protect our environment (Earth, as you call it), but we were too busy or concerned to pay much attention to it. You see, it wasn’t that we didn’t know or care about it, we did care. We even had organizations that tried to do what they could, but they were only a few compared to the whole. Humans tend to think that as long as they can’t see the future today, that it won’t ever get here. So, we put off facing facts until they hit us in the face and then we try to change overnight. Some things are hard for humans to learn.”

“Why DIDN’T you LISTEN to everyone?”

The old gentleman gazed into the distance for a few minutes, then spoke. “Sometimes we listened a while. But then we thought about how much trouble it was to do, or how much of our comfortable lifestyles we might have to sacrifice, or how much money things cost; but I think the real reason most of us didn’t listen was because we thought that our little contribution wasn’t going to make a difference. We were wrong, but we couldn’t see it.”

“Don’t be sad, Grandfather,” whispered the child, as he snuggled up closer. “I forgive all of you. You didn’t know what would happen in the future. My teacher says the future really never gets here because when it comes, it isn’t the future anymore; but it is today.”

Looking down into the innocence of the child’s eyes, a tear trickled down the old man’s face. “How wise your teacher is, my little one, to make that observation. If my generation had only realized that fact, maybe your Earth would have been a much different place. We failed to see that OUR FUTURE IS WHAT WE DO TODAY, not tomorrow or next week or even years from now. All we are given is TODAY, and we must use it wisely. I hope that you and all your friends listen better than we did, for the future legacy of this planet is in your hands now. But the future is not in the distance, but right at this very moment - TODAY. Your future is today - don’t waste it as we did.”

A loud whistle sounded in the distance, signaling the end of the daylight hours and the beginning of night. The child and the old man rose and walked hand in hand down the concrete path towards the family’s dwelling. Above them loomed the plastic bubble of the city’s atmosphere, where fresh clean, cool air drifted down from the invisible piping network embedded in the dome. Computer sound systems clicked on, bringing the sounds of the night to lull humankind to sleep. Forced air rustled the leaves of the test-tube grown trees.

Turning and gazing outward into the desolate world beyond the bubble, the small child wondered about the past - the past that was long before this time.

Long after the child was asleep, the grandfather crept outside; and he, too, watched the world outside the bubble. But instead of dry cracked earth barren of life, his eyes saw beautiful lush forests, clear blue sky overhead, and clean gurgling waves bumping the sides of his canoe as it slid through the swift water of sparkling rivers and streams. His ears were listening to the shrill cries of gulls and hawks, the songs of the mockingbird, the rat-a-tat-tat of woodpeckers, and the calls of the animals such as the wolves, owls, frogs, coyotes, and bobcats, and yes, even to the sounds of the bees as they busied themselves making fresh, sweet honey.

With a start, the grandfather awakened. It had been a dream. He became more determined to become a better steward of the Earth and to teach his grandson these values.

Our future is today, now and with passing seconds it is slipping away into the past. Will we close our eyes, ears, and minds to our legacy to our grandchildren? Will we let them forget the problems that caused us to implement those methods? The children are the leaders of the future, and we must help them to understand WHY we have begun to take steps to protect and care for our planet. If they are not aware of the problems that caused these methods to be put into use, will they not forget the lessons of the past more quickly? Awareness is the catalyst for continuous change and progress. Alabama leaves a beautiful legacy.

Conservation Pledge

I give my pledge
as an Alabamaian,
To save and faithfully
to defend from waste,
the natural resources
of my state - its soil and minerals,
its forests, waters, and wildlife.

Notes

The Dirty Half Dozen

OBJECTIVES:

The student will be able to:
1. Identify the major sources of each of the six pollutants.
2. Identify the major effects of each of the six pollutants.
3. List three ways to reduce air pollution.

Grades:
3-5

Subjects:
Science, Language Arts, Art, Social Studies

Time Needed:
Four to five class periods

Materials:
magazines
transparency of Major Man-made Air Pollutants
overhead projector
wipe-off markers
student activity pages
art materials

BACKGROUND:

In the United States, the Clean Air Act of 1970 strengthened earlier laws. It required that air quality standards be established. It also set up guidelines for achieving these standards and gave the federal government more responsibility and power in protecting air quality. In the same year, the U.S. Congress created the Environmental Protection Agency (EPA) to be in charge of the federal government's environmental programs. The EPA was given responsibility for implementing the Clean Air Act, regulating air pollution, and enforcing the law.

The Clean Air Act required EPA to set air quality standards so that even the people most sensitive to air pollution (usually the very young, the very old, and the sick) would not suffer adverse health effects from pollution levels in the ambient air (the air around us) if the standards were met. National Ambient Air Quality Standards were set for substances identified as criteria pollutants. These were common, widespread pollutants shown by research to be harmful to human health and to general public welfare. (Welfare includes crops, livestock, vegetation, buildings, and visibility.) Carbon monoxide, lead, nitrogen oxides, photochemical oxidants (such as ozone), particulate matter, and sulfur dioxide were the criteria pollutants. The 1990 Clean Air Act Amendments added further criteria pollutant restrictions. For example, most areas in the country must have attained particulate matter standards by 1994. This includes combating acid rain by reducing sulfur dioxide and nitrogen oxide emissions.

Many efforts are underway to reduce air pollution. Air pollution devices have been installed in factories, power plants, vehicles, and even wood stoves to trap pollutants before they get into the air. Use of cleaner burning fuels and more advanced combustion technology are other ways pollution is reduced. Other efforts include encouraging people to use cars less and to conserve electricity, which will reduce the amount of fuel we burn and, at the same time, reduce the amount of pollutants we put into the atmosphere. Pollution prevention efforts also include using fewer harmful materials.

VOCABULARY:

pollutant - a substance that can harm air, water, soil, and living organisms

ADVANCE PREPARATION:

Prepare transparency.

PROCEDURE:

Setting the stage

1. Show pictures of slides of air pollution. Ask students where they have observed air pollution.

2. Introduce the term pollutant. Many of these come from fuel and power plants that provide us with conveniences.
3. Tell the students this lesson introduces them to six major air pollutants (criteria pollutants) that are regulated by the Environmental Protection Agency in the United States.

Activities

Group Project/Presentation

- Distribute copies of Major Man-made Air Pollutants and Matching Major Air Pollutants with Their Source and Effects.
- Have students read and research their student activity pages.
- Design a unique method of presenting this information to the class. (For example, use a cardboard box car to present carbon monoxide or lead. Write a rap or song about particulate matter.)
- Reports should last about 10 to 15 minutes and must include new solutions to the problem.
- Present three each day.

Follow-Up

1. Hand out all student sheets and make sure they have the correct answers for study.
   - Carbon monoxide - sources: cars, wood stoves; - effects: less oxygen in blood, reduced mental alertness, heart damage.
   - Lead - sources: electric power plants, cars, metal refineries; - effects: brain damage, contaminated crops and livestock.
   - Nitrogen oxides - sources: cars, coal-burning stoves, electric power plant; - effects: lung damage, damage forests, smog.
   - Ozone - sources:exhaust, ozone-forming fumes (paints, gas stations); - effects: eye irritation, respiratory problems, lung damage, damaged vegetation, smog.
   - Particulate matter - sources: diesel engines, wood stove, windblown dust; - effects: eye irritation, damaged crops, lower visibility, discolored buildings and statues.
   - Sulfur dioxide - sources: electric power plants, coal-burning stoves, refineries; - effects: eye irritation, lung damage, harmed aquatic life, damaged forests, deteriorated buildings (effects are due to acid decomposition).
2. List a minimum of two solutions for each of the six criteria pollutants.
3. Design bumper stickers. Create a slogan and an emblem for one of the criteria pollutants.

EXTENSIONS:

1. Have students write to the EPA to request information on air quality legislation.
2. Have interested students research the killer smog in London in December 1952, which resulted in over 4,000 deaths.

ORIGINAL DEVELOPMENT RESOURCES:

Duckworth, C. (September, 1987). The big bad six. *Ranger Rick*. Washington: National Wildlife Federation.

Keep America Beautiful, Inc. (Undated). *Pollution pointers for elementary students*.

Motor Vehicle Manufacturers Association. (Undated). *Saving energy!* Stock no. 22. (Brochure).

Schultz, R.F. (1982). Solids in the air. *Environmental experiment from edison*. Southfield, MI: Thomas Alva Edison Foundation.

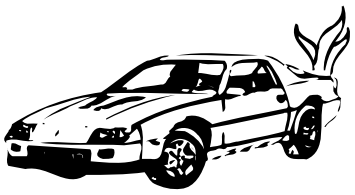
Tennessee Valley Authority. (Undated). *Environmental resource guide: Air quality.*

Major Man-Made Air Pollutants

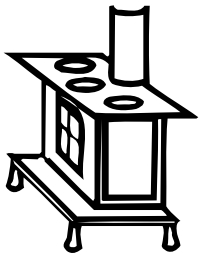
Pollution	Description	Sources	Effects
carbon monoxide (CO)	• Colorless, odorless gas	• Vehicles burning gasoline • Indoor sources include: kerosene or wood burning stoves	• Headaches, reduced mental alertness • Heart damage
Lead (Pb)	• Metallic element	• Old paint • Metal refineries • Vinyl blinds	• Brain & kidney damage • Contaminated crops and livestock
Nitrogen Oxide (NO_x)	• Several gaseous compounds made up of nitrogen & oxygen	• Vehicles • Power plants burning fossil fuels • Coal burning stoves	• Lung damage • React in atmosphere to form acid rain • Deteriorates statues & buildings • Damage forests • Form ozone & other pollutants (smog)
Ozone (O_3)	• Gaseous pollutant	• Vehicle exhaust & certain other fumes • Formed from other air pollutants in the presence of sunlight	• Lung damage • Eye irritation • Respiratory tract problems • Damages vegetation • Smog
Particulate matter	• Very small particles of soot, dust, or other matter, including tiny droplets of liquids	• Diesel engines • Power plants • Industries • Windblown dust • Wood stoves	• Lung damage • Eye irritation • Damage crops • Reduces visibility • Discolors buildings & statues
Sulfur dioxide (SO_2)	• Gaseous compound made up of sulfur & oxygen	• Coal burning power plants and industries • Coal-burning stoves • Refineries	• Lung damage • Eye irritation • Kills aquatic life • Reacts in atmosphere to form acid rain • Damages forests • Deteriorates buildings and statues

Matching Major Air Pollutants with their sources and effects

Sources:

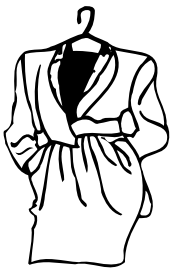


cars



wood stoves

windblown dust

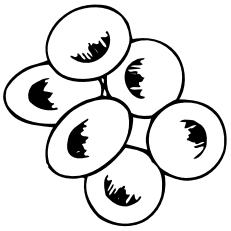


dry cleaners

Effects:

reduced mental alertness

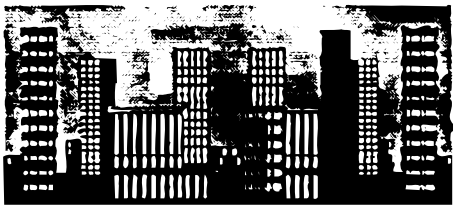
corroded buildings, statues



less oxygen in blood

global warming

heart damage

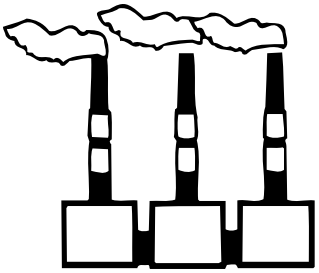


smog

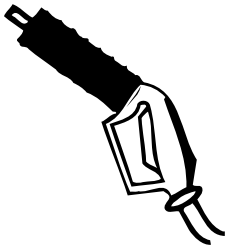
Matching Major Air Pollutants with their sources and effects

(continued)

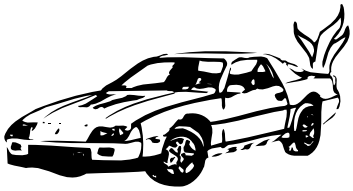
Sources:



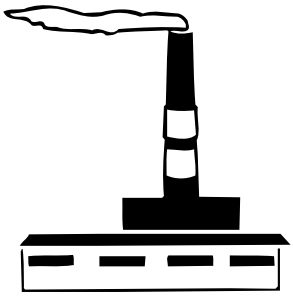
electric power plants



gas stations

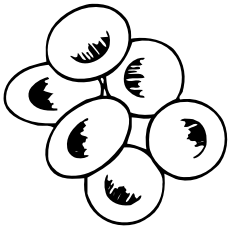


cars

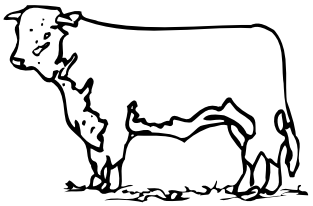


metal refineries

Effects:

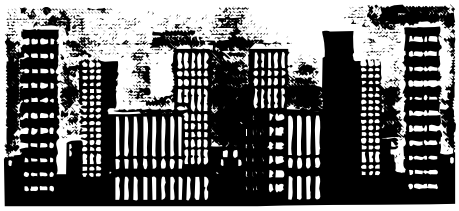


less oxygen in blood

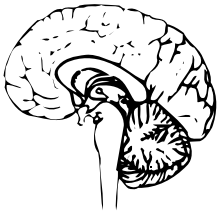


contaminated livestock

eye irritation



smog

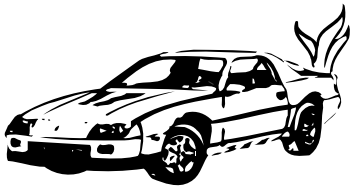


brain damage

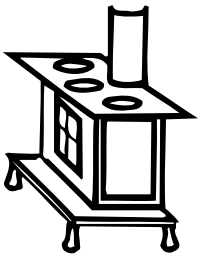
contaminated crops

Matching Major Air Pollutants with their sources and effects

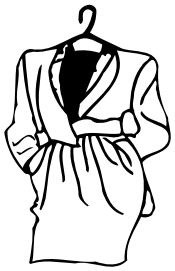
(continued)



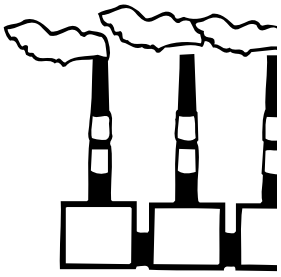
cars



wood stoves

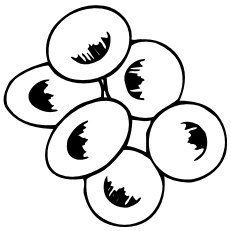


dry cleaners



electric power pla

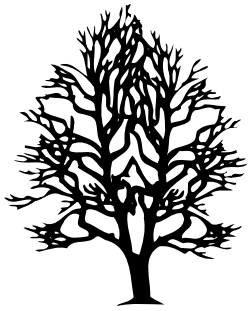
Effects:



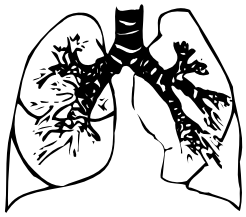
less oxygen
in blood

corroded buildings,
statues

reduced menta
alertness



damaged forests



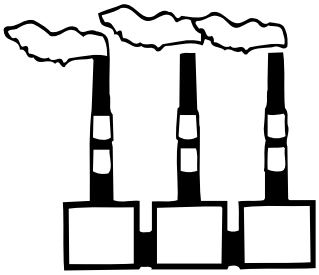
lung damage

smog

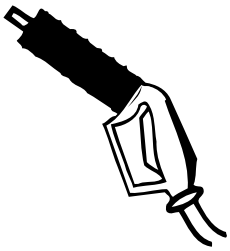
Matching Major Air Pollutants with their sources and effects

(continued)

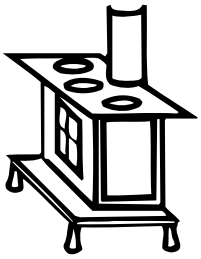
Sources:



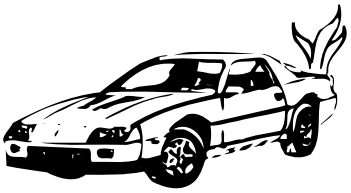
electric power plants



gas stations



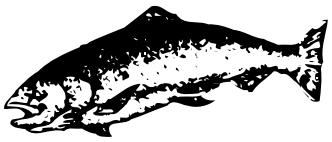
wood stoves



cars

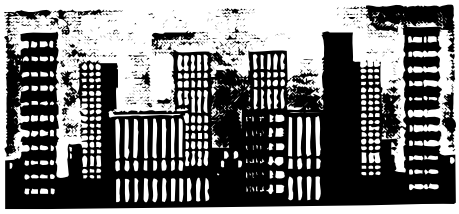
Effects:

eye irritation

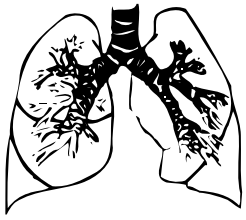


dead aquatic life

respiratory tract problems



smog



lung damage

contaminated crops

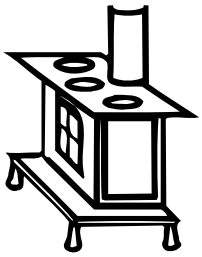
Matching Major Air Pollutants with their sources and effects

(continued)

Sources:

diesel engines

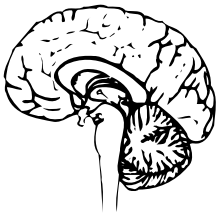
windblown dust



wood stoves

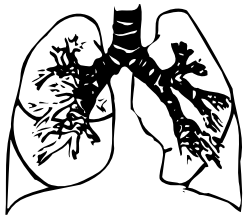
dry cleaners

Effects:



brain damage

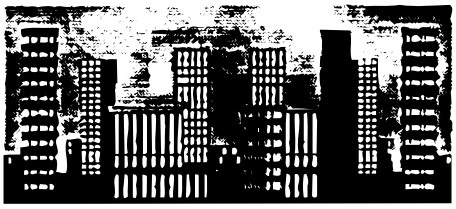
corroded buildings, statues



lung damage

contaminated crops

eye irritation



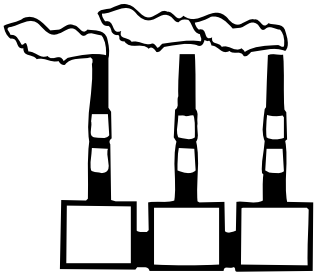
smog

Matching Major Air Pollutants with their sources and effects

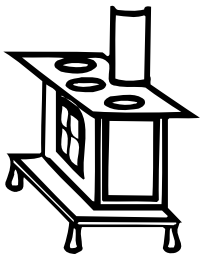
(continued)

Pollutant: *SULFUR DIOXIDE*

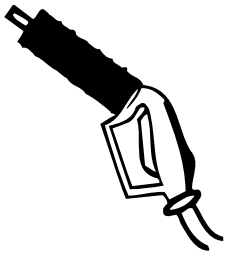
Sources:



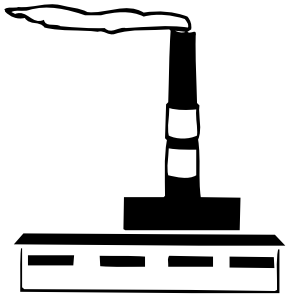
electric power plants



wood stoves



gas stations

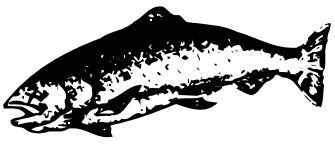


refineries

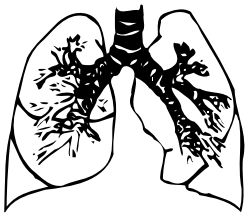
Effects:

eye irritation

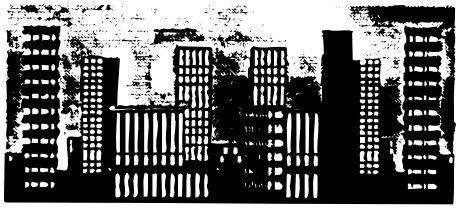
corroded buildings, statues



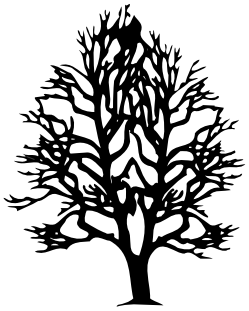
dead aquatic life



lung damage



smog



damaged forests

Notes

It's All In The Air

OBJECTIVES:

The student will be able to:
1. Test the air for visible pollutants.
2. Compare and contrast data collected.
3. Graph the results of pollution collectors.

BACKGROUND:

An air pollutant is anything that makes the air impure. We can see some visible particulants; but air pollutants, such as carbon dioxide and sulfur dioxide, are invisible.

We take 14 to 18 breaths per minute of the air available to us. A breath of country air carries about 40,000 particles of dust, and each breath of city air carries approximately 70,000 particles. These particles contribute to our discomfort and our diseases. The more acidic pollutants can blister paint, erode stone, and etch metal.

Grades:
3-5

Subjects:
Science, Math

Time Needed:
Two class periods, approx. one week apart

Materials:
four to five wide-mouthed, medium-sized jars
petroleum jelly

VOCABULARY:

air pollutant - anything that makes air impure

ADVANCE PREPARATION:

None necessary

PROCEDURE:

Setting the stage

Demonstration

• Darken the room and light a flashlight. Observe dust particles. For emphasis, hit a chalkboard eraser. Name dust as a visible pollutant.

Activities

Collection of Visible Pollutants

• Spread a thin, even layer of petroleum jelly on the inside of each jar.

• Place the jars in various locations - playground, classroom, cafeteria, janitor's storage area, by a heat vent, or other selected locations. Label each with location and date.

• Do not disturb for one week.

• Collect in one week, and examine with a magnifying glass. Describe the debris found by shape, color and amount.

Follow-Up

1. Graph a comparison of what was found in each location.
2. Write a rap or a poem entitled "It's All In The Air".

EXTENSIONS:

1. Demonstration

• Place a sheet of facial tissue over the end of a vacuum cleaner hose. Hold it in place with a strong rubber

band. Hold it in the air and turn it on. Sweep the air for a few minutes. Remove the tissue and examine the collection.

2. Ask a vacuum cleaner representative or dealer to come in and talk about the particles in our air, our carpets, and our beds. They often conduct excellent demonstrations.

ORIGINAL DEVELOPMENT RESOURCES:

Environmental and Energy Education Program. (April, 1988). Ideas can change the world. *Alabama energy education idea book*. University of Alabama in Huntsville, Alabama.

Needham, D. (1970). *Pollution: A handbook for teachers*. CCM Professional Magazines.

Schwartz, L. (1990). *Earth book for kids*. (p. 102). Santa Barbara, CA: The Learning Works, Inc.

Sky Blue, Sunset Red

OBJECTIVES:

The student will be able to:
1. Experiment to discover how visibility is determined.
2. Explain why the sky is blue and the sun is often red at sunset.

Grades:
3-5

Subject:
Science

Time Needed:
One class period

Materials:
3 large clear glass jars or glass beakers
1/2 cup milk
teaspoon
water
large flashlight
prism

BACKGROUND:

The colors perceived by the human eye and brain are the result of differing absorption and reflection of the colors making up visible light. Visible light, such as sunlight, looks white but is really composed of red, orange, yellow, green, blue, indigo, and violet blended together. Different types of materials absorb or reflect the colors that make up white light in different ways. For example, something that appears red reflects mostly red light and absorbs the other colors of the spectrum; something that appears green reflects mostly green light and absorbs the other colors.

The tiny molecules that compose the atmosphere scatter much more of the sun's blue light than other colors. When we look at portions of the sky where the sun is not located, the light we see is mostly scattered light, and appears blue. If those molecules were not there to scatter light, when we looked upward we would see only darkness except at the spot where the sun is located. This is the case on the moon where there is no atmosphere.

The favored scattering of blue light by molecules in the atmosphere also makes the sun itself look redder than it really is because a lot of the blue light is scattered out of its direct rays, leaving the redder colors behind. The redness of the sun's direct rays is accentuated when the sun is low in the sky, for example, at sunrise and sunset. This is because the light must travel a longer path through the atmosphere before it reaches us. Therefore it is subject to more scattering than when the sun is more vertical.

In addition to molecules, the atmosphere also has particulate matter suspended in it. The very tiniest particles of matter in the air also scatter blue light. Most of the particles in the atmosphere are larger and scatter the colors more equally. This is the reason the sky turns milky white, gray, or brownish when the atmosphere contains a lot of particles.

Most of the particles suspended in the air are from natural sources such as soil erosion, volcanic activity, and plant pollen production. In most cases, these are rather large particles that settle out of the air relatively quickly and generally pose no great threat to human and environmental well-being or to normal patterns of weather and visibility. However, human activity can also add particulate matter to the air, and much of the human-created particles are harmful. For this reason, particulate pollutants are identified and regulated as one of the six criteria air pollutants in the United States.

Particulate pollutants from human activities, such as burning fuel in vehicles, power plants, and industries, are harmful to human health. Also, these tiny particles sometimes reduce visibility when they are produced in great enough amounts or concentrated by weather conditions and the land's topography. In extreme cases, the light-absorbing, scattering, and reflecting properties of both natural and human-created particulate matter can also affect weather patterns and plant growth.

VOCABULARY:

hue - shade or tone, often refers to color
particulate matter - very small particles of soot, dust, or other matter including tiny liquid droplets
prism - triangular shaped object that breaks light into the spectrum as it passes through it
spectrum - a series of colors formed when a beam of white light is dispersed so that its parts are arranged in order of their wavelengths
visibility - clarity of the air, how far one can see

ADVANCE PREPARATION:

Collect materials.

PROCEDURE:

Setting the stage

1. Ask the students if they have ever experienced the lowered visibility that sometimes results from a major fire. Some of the students may have experienced forest fires, dust storms, volcanic eruptions, or other events that send large amounts of particulate matter into the air. Ask them to describe what it was like.
2. Share the background information with the students. Explain to them that you are going to demonstrate the relationship of particles in the air to the colors we see in the sky.
3. You may wish to use a prism to demonstrate to the students that visible light is composed of a spectrum of colors. Review this as necessary.

Activity

Demonstrate the effect of particles in suspension on color perceived.

- Fill three glass jars (or large beakers) with cold water.
- Add nothing to jar 1, one teaspoon of milk to jar 2, and three teaspoons of milk to jar 3.
- Darken the room.
- Direct a flashlight beam through the side of jar 1. The water will appear transparent with no color.
- Move the flashlight around so the light shines toward the students through the water in jar 1. The water will still be transparent with no color.
- Repeat the last two steps with jars 2 and 3. The apparent color in both cases will be blue. However, when the light is shining directly through the water toward the observer, it will appear yellow in jar 2 and pink in jar 3.

Follow-Up

1. Observe the students in a discussion helping them to derive the following explanation: The flashlight beam is visible because the light is scattered by the particles of milk that are suspended in the water. The color produced depends on the number of particles and the angles at which light hits them. Milk is an excellent representation of the sky because, like the sky, it has tiny particles suspended in it. Light is scattered when it hits the particles in the atmosphere and in the milk. When there is more milk mixed with water, more of the blue light is scattered; and the direct beam becomes more reddish.
2. Let student volunteers repeat the demonstration after you orally explain the colors observed. This experiment can be tried with larger white particles to show that color changes occur only when the particles are tiny. Ask the students what they think will happen if the rest of the milk is added to the water. Do so and repeat the demonstration. When there is enough suspended matter in the water, very little light penetrates the mixture. Relate this to major episodes of particulate pollution where visibility is affected.
3. Using the data from the experiments, have small groups discuss and answer the following questions:
   - Why does the sky generally appear blue?
   - Why do sunsets often have reddish hues?
   - What are two major sources of particulates in the air?
   - What are three possible effects of particulates in the air? (Answers may include sky color, reduced visibility, changes in weather patterns, changes in plant growth.)

4. Clear up any remaining questions that the groups may have.

EXTENSIONS:

1. Much progress has been made in the fight against particulate air pollution. You may wish to have the students investigate Environmental Protection Agency standards for particulate matter and their community's compliance with these standards. What are the chief sources of particulate in the area?
2. The students may investigate some major historical occurrences of natural particulate pollution. Such occurrences may include the World Trade Center disaster in New York due to a terrorist act. The demolition and clean-up have raised many health concerns. Other occurrences in U.S. history were the volcanic eruption of Mount St. Helens in 1980 and the Yellowstone forest fires in 1988. Almost 200 years ago, large areas of the world experienced "The Year With No Summer" after a massive volcanic eruption in the South Pacific (or Indian Ocean).
3. Some scientists theorize that particulate pollution build-up in the atmosphere could cause global cooling. Even slight changes in global temperature averages could cause global climate change. In the case of particulate pollution, such change could possibly produce enough cooling to usher in a new Ice Age.
4. Have students do a "wash" art project to develop further understanding of hues. Procedure for this will take two days.
   - Let students paint a picture of a sunset on art paper. The picture will dry overnight.
   - Take very watered-down blue paint and paint over the entire picture. Let dry and see the wonderful results.

ORIGINAL DEVELOPMENT RESOURCES:

Amergy, H. (1978). *The know how book of experiments*. St. Paul, MN: E.M.C. Corporation.

Iglauer, E. (April, 1968). The ambient air. *The New Yorker, Vol. 13*. (p. 3)

Tennessee Valley Authority. (Undated). *Environmental resource guide: Air quality*.

Notes

Smoke Gets In More Than Your Eyes

OBJECTIVES:

The student will be able to:
1. Discover what causes smog.
2. Think about how and what we breathe.
3. Associate the dangers of smog with the dangers of smoking.

Grades:
3-5

Subjects:
Science, Math

Time Needed:
One class period

Materials:
stopwatch
matches
aluminum foil pan
clear glass half-gallon bottle
candle (optional)

BACKGROUND:

Air is important to us for many reasons. Of foremost importance to humans and animals is that air contains oxygen we need to live. Air also makes fire possible, which provides us with heat, light, and energy. Other uses of air make our lives easier or more pleasant. For example, air makes it possible to sail sailboats, fly kites, fly air craft, and use windmills. It is also used to dry clothes and inflate tires and balloons.

Clean air, which is composed of nitrogen, oxygen, and other gases, is healthy for us to breathe. However, both indoor and outdoor air can become polluted with particles and gases that are not part of its natural composition, making the air dirty and unhealthy. Air can also become unhealthy with excessive amounts of gases that are part of its natural composition. Because we sometimes see and smell smog, odors, smoke, and other evidence of air pollution, when we're outdoors, we often associate pollution only with outdoor air. Indoor air, however, can be just as dirty and polluted as the outdoor air.

Some outdoor pollution is from natural causes such as sand from sandstorms, ash from volcanoes, and smoke from forest fires. Other outdoor pollution is caused by such things as smoke from woodstoves or campfires, exhaust emissions from automobiles, or fumes from factory smokestacks. Indoor air can be polluted by such seemingly innocent items as plywood, fireplaces, synthetic materials, paints, pesticides, wood stoves, and cleaning products. Biological contaminants, such as mold, mildew, bacteria, viruses, pollen, dust mites, and animal dander, can also occur in high concentrations indoors.

VOCABULARY:

smog - a thick haze caused by the action of sunlight on air polluted by smoke and automobile exhaust

ADVANCE PREPARATION:

1. Collect materials.
2. Show pictures of smog shrouded cities.

PROCEDURE:

Setting the stage

1. Experiment
   - Ask students to sit quietly and think about their breathing. What evidence do they have that they are breathing?
   - With a stopwatch, time how many breaths each student takes in one minute. Use a calculator to compute the mean for the class. What is the range?
   - Using the mean, calculate the number of breaths taken each hour, each day. How important is it to our

bodies that we get sufficient oxygen? What if the air we breathe is heavily polluted?
2. Sit quietly for three minutes. What if we couldn't breathe during that time?
3. Discuss numerous ways we pollute the air. Share background information with the students.

Activity

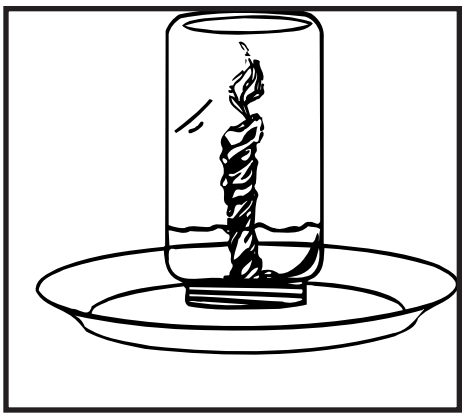
Smog experiment (Teacher Demo Only).

- Drop a burning match into a clear glass half-gallon bottle.
- Press your mouth over the bottle opening and blow hard into it. Release your mouth quickly. What is the result?
- Brainstorm about the combination that caused this reaction (correct combination is water vapor and smoke). Where is smog most frequently found? Why?

Follow-Up

Experiment - amount of O_2 in the air

- Obtain tin pie pan, glass jar, clay, candle, matches, and water.
- Set up experiment as shown.
- Light candle, cover, and quickly pour a cup of water into the pie pan.
- Observe and mark the highest water level on the jar. How high did the water rise?
- What did the H_2O replace? (Our air is 20% or 1/5 oxygen.)
- What effect does smog have on oxygen in the air?



EXTENSIONS:

1. Research the effects of smoking on lungs.
2. Research asthma and other breathing problems.
3. Devise an experiment to test the results of smog on plant growth.
4. Create a cartoon illustrating the dangers of smog and/or the dangers of smoking.

ORIGINAL DEVELOPMENT RESOURCES:

Air and Waste Management Association. (1995). *Air quality environmental resource guide K-12*. Pittsburgh, PA.

Needham, D. (1970). *Pollution: A handbook for teachers*. CCM Professional Magazines.

Let's Sock Car Exhaust

OBJECTIVES:

The student will be able to:

1. Describe different sources of air pollution from motor vehicles.
2. Relate the role of the U.S. Environmental Protection Agency in the federal vehicle control programs and discover what has been accomplished under these programs.

BACKGROUND:

In 1986 there were almost 500 million vehicles operating worldwide. If the present growth rate continues, by the year 2030 there will be one billion vehicles worldwide. As the number of vehicles on the road continues to grow, so does the atmospheric pollution. Presently more than half of the air pollution in North America is the direct result of mobile sources such as airplanes, trains, buses, trucks, boats, and automobiles. Emissions from motor vehicles contribute to five of the six criteria of air pollutants: lead, carbon monoxide, nitrogen oxide, ozone, and airborne particulate matter. Of these pollutants, only lead has decreased dramatically between 1977 and 1986. Strict limitations of the level of lead in gasoline have reduced lead emissions by 94 percent and lead in the air by 87 percent. Levels of lead in the air are expected to continue decreasing as less leaded gasoline is produced.

Grades:

3-5

Subjects:

Science, Social Studies, Art

Time Needed:

Two class periods

Materials:

new white tube socks
a variety of motor vehicles (cars, trucks, buses)
oven mitts or heavy gloves
marker pen
masking tape or small tags with safety pins for labels
rubber bands

Motor vehicles are the main source of carbon monoxide, an invisible odorless gas resulting from incomplete fuel combustion. Inefficient burning of gasoline usually occurs when vehicles are started in the morning, idled, or moved slowly in heavy or congested traffic. Nitrogen dioxide, a reddish-brown toxic gas, is also produced by combustion sources such as motor vehicles. Ozone, a major component of smog, is produced when sunlight triggers a chemical reaction between naturally occurring atmospheric gases and pollutants such as nitrogen oxide and hydrocarbons. Diesel engines are considered a major source of particulate matter pollution.

There are a number of ways that air pollution produced by motor vehicles is already being reduced. In the United States, government agencies - like the Environmental Protection Agency (EPA) - set manufacturer's emission standards for motor vehicles through federal vehicle emission control programs. State and local governments have implemented other important programs: vehicle maintenance inspections, inspections to check for the presence of pollution control devices, and incentives to encourage use of public transportation and car pooling (may be found in some states). New technologies to reduce motor vehicle pollution are actively being developed. Increased fuel economy (more miles per gallon), more efficient burning of gasoline (particularly in city driving), vehicle design changes to reduce wind drag, and vehicle fuel sources other than petroleum-based sources will all be part of future air pollution control. There are also HEVs, or hybrid electric vehicles, that combine the internal combustion engine of a conventional vehicle with the battery and electric motor of an electric vehicle, resulting in twice the fuel economy. Two types are the Honda Insight and the Toyota Prius.

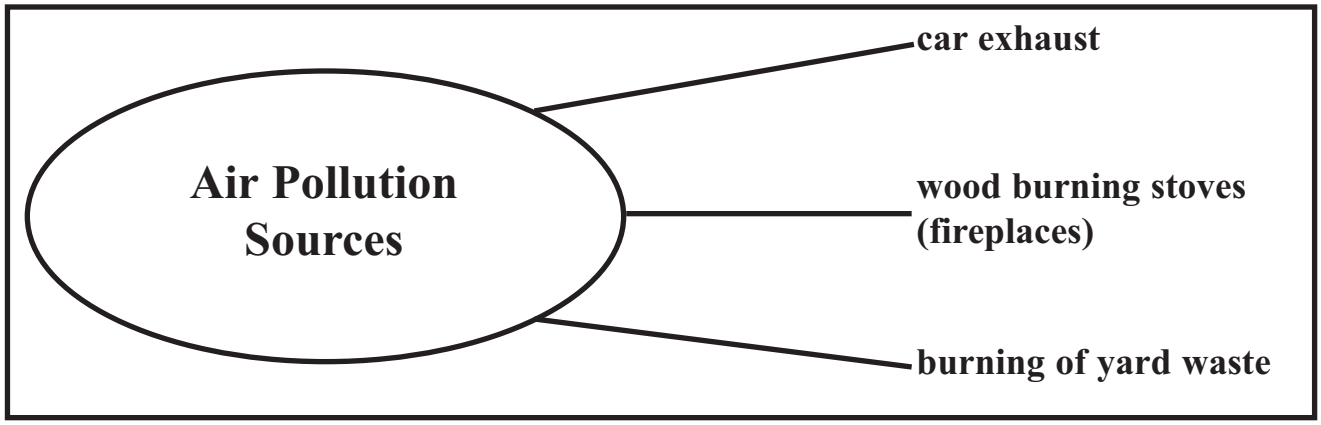
VOCABULARY:

carbon monoxide - toxic, invisible, odorless gas resulting from incomplete fuel combustion.
ozone - a form of oxygen containing three oxygen atoms. The ozone layer is a protective shield high in the atmosphere that filters out the sun's harmful ultraviolet radiation.
particulate matter - very small particles of soot, dust, or other matter including tiny liquid droplets

ADVANCE PREPARATION:

1. Secure permission and keys from owners of the selected cars and trucks. Obtain information about engine types and model year, if needed. (This is an excellent activity to involve community support.)
2 Make transparencies or copies of any of the attached information pages.

PROCEDURE:



Setting the stage

1. In small groups, students should develop a concept map identifying community sources of air pollution.
2. Refer to the attachment, Major Man-made Air Pollutants, to discuss with students when a car burns gasoline or diesel fuel. By-products of the process include heat and air pollutants that exit through the exhaust system.

Activities

1. Have the students assemble in the parking lot around pre-selected vehicles for a demonstration to test exhaust fumes. (Choose vehicles that use a variety of fuels.) Cars using unleaded gasoline and diesel fuels are the most common. You may be able to find vehicles using leaded gasoline or alternative fuels such as alcohol or methane. Old and new vehicles can provide variation. Make arrangements to have a school bus available for the experiment, if possible.

Cautions:

The experiment should never be conducted in a closed building. The emergency brake should be set on each vehicle. Use oven mitts or gloves when putting socks on and taking them off the exhaust tailpipes. Students should stand away from the automobiles during the test. Exhaust tailpipes emit carbon monoxide gas and can cause burns. Do not touch the tailpipes until the cars have cooled for five minutes.

2. Experiment
   - Make a label for each sock that includes the following information about the vehicles: model, make, engine type, model year, type of fuel being used. Also record this information on the Student Activity Page.
   - Place a white tube sock over the tailpipe of each vehicle and then start the engines. *Caution:* Make sure the students are standing away from the vehicles before starting the engines. *Note:* The elastic sock tops

should fit snugly over the tailpipes. If not, secure them with rubber bands.
- After approximately five minutes, turn off the engines. Using extreme caution because of the possibility of burns from the metal tailpipes, remove the socks (using mitts). Turn the socks inside out and attach vehicle labels to the appropriate socks. Record data.
- Discuss the results with the students. Ask them to identify the vehicles that produced the most visible pollution. Ask if the socks were dry or damp. Note: Remind the students that they are seeing particulate matter pollutants and that cars also produce a great deal of invisible air pollutants.

Follow-Up

1. Make a poster board or bulletin board display of socks and data collected.
2. Research air emission standards and tell how car design has met these standards.
3. Design bumper stickers concerning air pollution.
4. Have students role play as if they were Environmental Protection Agency representatives present at the vehicle experiment.

EXTENSIONS:

1. Divide the students into groups and assign each group one of the following tasks.
   - Determine how many service stations within the city or county sell leaded, unleaded, and diesel fuel and find out how much of each kind is sold per month. (If necessary, conduct a random survey.)
   - Determine how many motor vehicles are registered in the county. Are emission inspections required? How often?
   - Contact local automobile and truck dealerships to collect information on what anti-pollution devices are available as standard equipment and as optional equipment on vehicles they sell.
   - Determine the number of employed persons in the city or county. Collect information from the local mass transit company about how many people use that system per month.
   - Contact the local or state government to obtain information on levels of air pollution in the area.
   - Discuss alternative transportation. (Mass transit, biking, and walking could be discussed.)
2. Using the information collected by the groups, have the students prepare a class report on air pollution from motor vehicles. Submit the report to the school paper or local newspaper for publication.

ORIGINAL DEVELOPMENT RESOURCES:

Brown, L. et al.. (1990). *State of the world*. New York, NY: Norton Worldwide Watch Institute.

Hammond, A.L. (Ed). (1990). *World resources: A guide to the global environment*. The World Resources Institute. New York, NY: Oxford University Press.

National Wildlife Federation. (1987). We care about clean air. *National wildlife week educator's guide*. Washington: National Wildlife Federation.

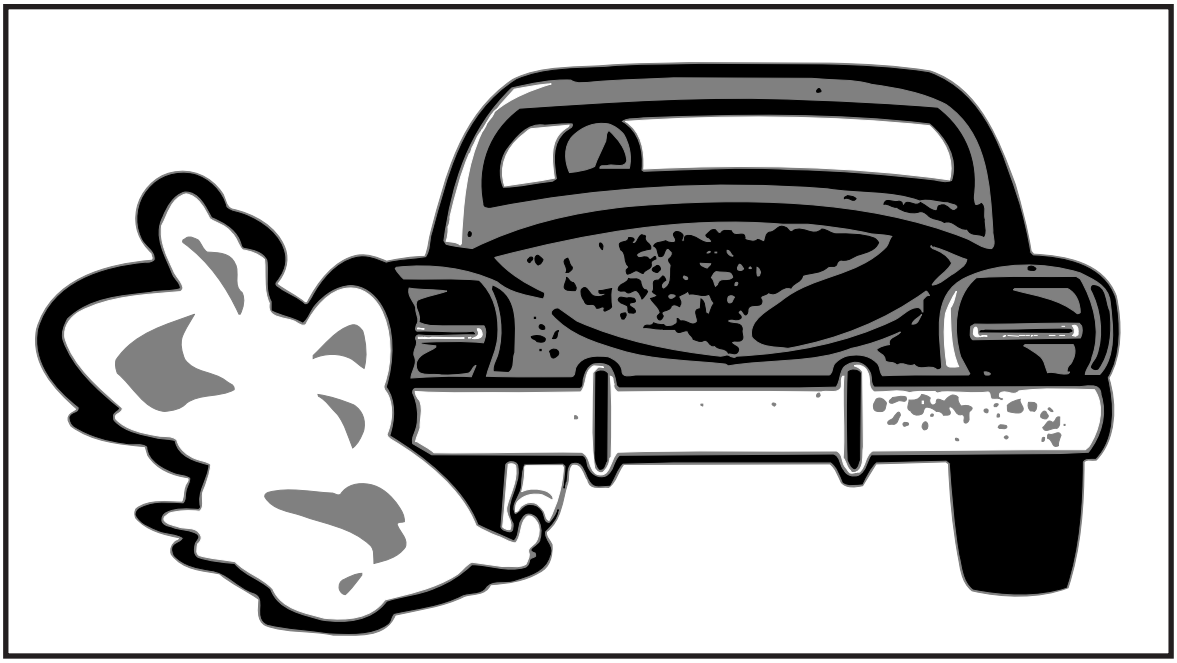
Tennessee Valley Authority. (1991). *Environmental resource guide: Air quality*.

Major Man-Made Air Pollutants

Pollution	Description	Sources	Effects
carbon monoxide (CO)	• Colorless, odorless gas	• Vehicles burning gasoline • Indoor sources include: kerosene or wood burning stoves	• Headaches, reduced mental alertness • Heart damage
Lead (Pb)	• Metallic element	• Old paint • Metal refineries • Vinyl blinds	• Brain & kidney damage • Contaminated crops and livestock
Nitrogen Oxide (NO_x)	• Several gaseous compounds made up of nitrogen & oxygen	• Vehicles • Power plants burning fossil fuels • Coal burning stoves	• Lung damage • React in atmosphere to form acid rain • Deteriorates statues & buildings • Damage forests • Form ozone & other pollutants (smog)
Ozone (O_3)	• Gaseous pollutant	• Vehicle exhaust & certain other fumes • Formed from other air pollutants in the presence of sunlight	• Lung damage • Eye irritation • Respiratory tract problems • Damages vegetation • Smog
Particulate matter	• Very small particles of soot, dust, or other matter, including tiny droplets of liquids	• Diesel engines • Power plants • Industries • Windblown dust • Wood stoves	• Lung damage • Eye irritation • Damage crops • Reduces visibility • Discolors buildings & statues
Sulfur dioxide (SO_2)	• Gaseous compound made up of sulfur & oxygen	• Coal burning power plants and industries • Coal-burning stoves • Refineries	• Lung damage • Eye irritation • Kills aquatic life • Reacts in atmosphere to form acid rain • Damages forests • Deteriorates buildings and statues

Let's Talk Car Exhaust

Make	Engine Type	Model Year	Fuel Type	Wet Dry Stock	Describe Particulate Matter
1.					
2.					
3.					
4.					
5.					



Notes

Don't Take A "Lichen" To Pollution

OBJECTIVES:

The student will be able to:

1. Distinguish three different kinds of lichens.
2. Determine the lichen coverage using grids.
3. Predict air quality based on types, size, and amount of lichens present.

Grades:

3-5

Subjects:

Science, Math, Social Studies

Time Needed:

Two class periods

Materials:

small marking flags (10 of one color per group numbered 1-10)
envelope to store flags
masking tape
erasable felt-tip markers
lichen grid transparencies
pencils
graph paper (one per group of two)
clipboards (optional)
student activity sheets

BACKGROUND:

Lichens (pronounced like-ins) look like plants but are really a combination of a fungus and an alga, growing so closely together that they look like a single organism. Scientists still do not fully understand the relationship between the fungi and algae that make up lichens. They are considered symbiotic organisms because they are mutually beneficial to each other. The photosynthesizing algae provide food for both, while the fungi appear to provide moisture, minerals, and support. However, fungi and algae can live alone without their partners.

Whatever the relationship between the algae and fungi, it is a highly successful one. Lichens can grow in locations where most other plants cannot: bare rocks, tree trunks, bare soil. In some of these locations, they play an important role helping soil formation. By interacting with the bare rocks to help break them down chemically and by trapping dust and organic matter from the air, lichens often start to create and enrich soil where other plants can eventually grow. Every natural habitat from deserts to rain forests has lichens. They are able to survive extreme conditions of heat, cold, and drought. However, few species of lichens can even survive air pollution, particularly acidic air pollution.

Lichens come in a variety of sizes, shapes, colors, and textures. Lichens are often divided into three classifications: crusty, leaf-like, or shrubby. Crusty lichens usually grow flat on rocks and tree trunks and may be embedded in these surfaces. Crusty rock lichens are colorful and range from oranges and yellows to greens, browns, grays, and blacks. Leaf-like lichens have lobed surfaces that are only partially attached to other surfaces. Leaf-like and shrubby lichens are usually some shade of green. Lichens are often confused with moss, but real mosses are tiny plants with leaves and stems. Because lichens were once mistakenly classified with mosses, some common lichens were named Reindeer moss, Oak moss, and Iceland moss.

Lichens are extremely sensitive to air pollution and sometimes can be used as indicators of air quality. Scientists study both the type of lichens present and the size of lichens. Shrubby and leaf-like lichens can only survive in clean air. Lichens are relatively rare in large cities. In areas of heavy air pollution, there are no lichens of any type. The size of lichens is also important. Larger individual lichens generally mean better air quality.

Lichens are also valuable for evaluating air quality in another way. Lichens accumulate metals and other elements from rainwater and dust. By analyzing lichens that live near emission sources for chemicals, scientists can determine how far the pollution has spread.

VOCABULARY:

fungi - large group of plants not containing chlorophyll, roots, stems, or leaves; includes molds, mildews, mushrooms, and bacteria

lichen - formed by two different organisms; fungus and alga living and growing together on a solid surface

ADVANCE PREPARATION:

1. Locate a place where lichens are growing.
2. Make transparencies.
3. Prepare flags.

PROCEDURE:

Setting the stage

1. Share background information. Using "Types of Lichens"handout, introduce three different classes of lichens.
2. Why are lichens used as air quality indicators? Accept all answers. Distribute Lichens as Pollution Indicators.
3. Demonstrate using a grid to find area. Provide each pair of students with a transparency and a marker (wipe off).

Activity

Lichen Mapping

- Transport students or walk to the lichen site and describe the boundaries of the activity site.
- Challenge the students to locate all the places where lichens are growing. Students should work in pairs.
- Give each pair an envelope with 10 flags and masking tape. In 10 minutes, mark every location where lichens are found.
- Have students map the area on a piece of graph paper and mark location of the flags. Allow 10-15 minutes. This should be a simple map. A tree trunk may be marked just with a circle.
- Have students write on the map, under each of their own lichen locations, the number and type of lichen found (crusty, leaf-like, or shrubby).
- Have students trace several different lichens onto the transparency. Measure them, record the approximate area, erase, trace other. Measure at least three.

Follow-Up

1. Remove flags and return to the classroom.
2. Each pair should enter information on a large class map so the pattern of lichen growth may be studied.
3. Discuss results.
   - What kinds of lichens were found? Make inferences about the air quality.
   - What size are the lichens? Make inferences about the air quality.
4. What conclusions might be made about the air quality of the lichen site?

EXTENSIONS:

1. Select several additional sites and repeat this study. Compare and contrast the results.
2. Create lichens from salt dough. Have students choose where their lichens live, classify them, and paint them accordingly. Have students keep a diary for their lichen, and describe the lichen's favorite environment.

ORIGINAL DEVELOPMENT RESOURCES:

Tennessee Valley Authority. (1991). *Environmental resource guide - Air quality.*

Went, F.W. (1963). *The plants*. New York, NY: Time-Life Books.

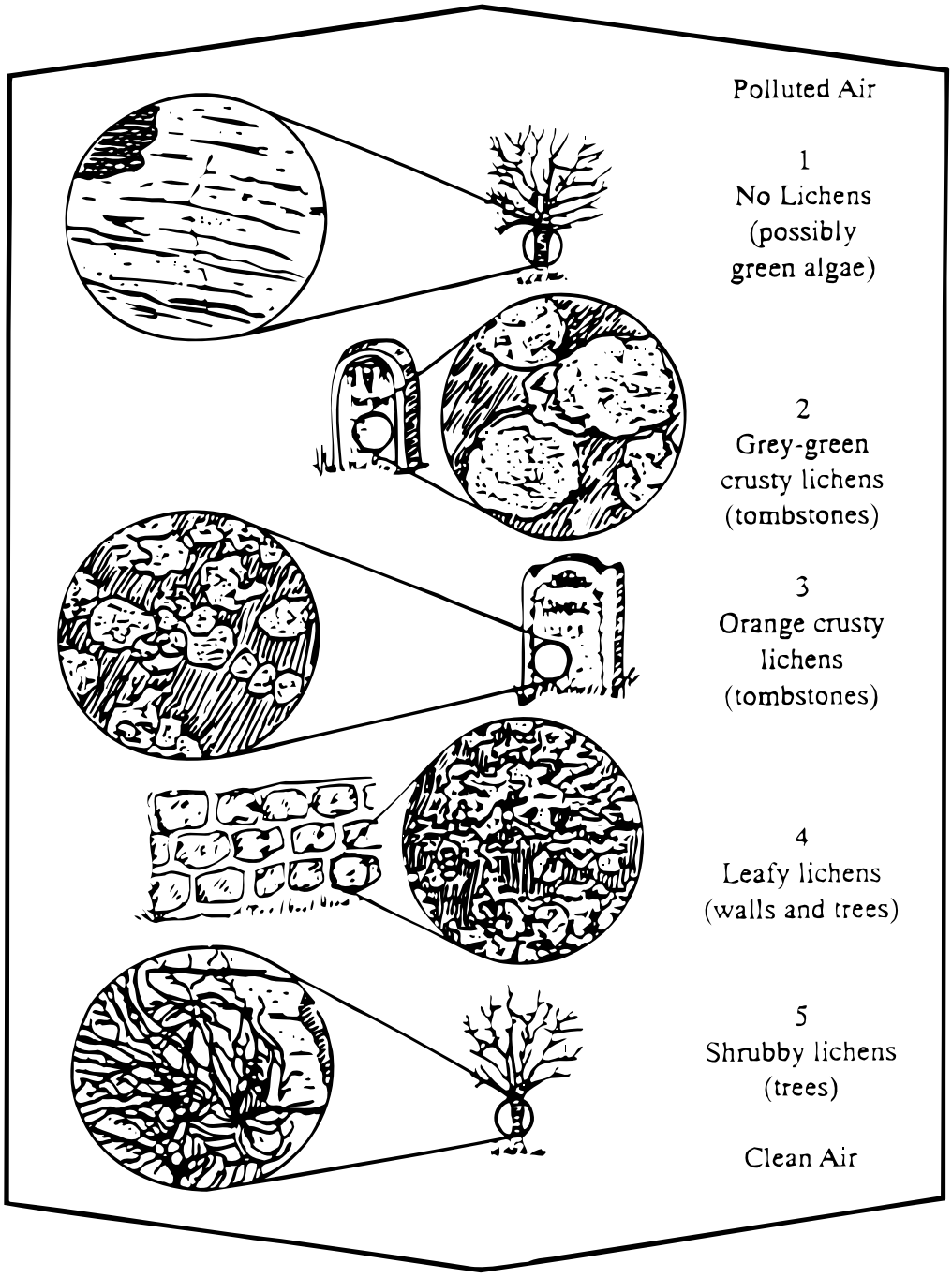
Types of Lichens

Crusty

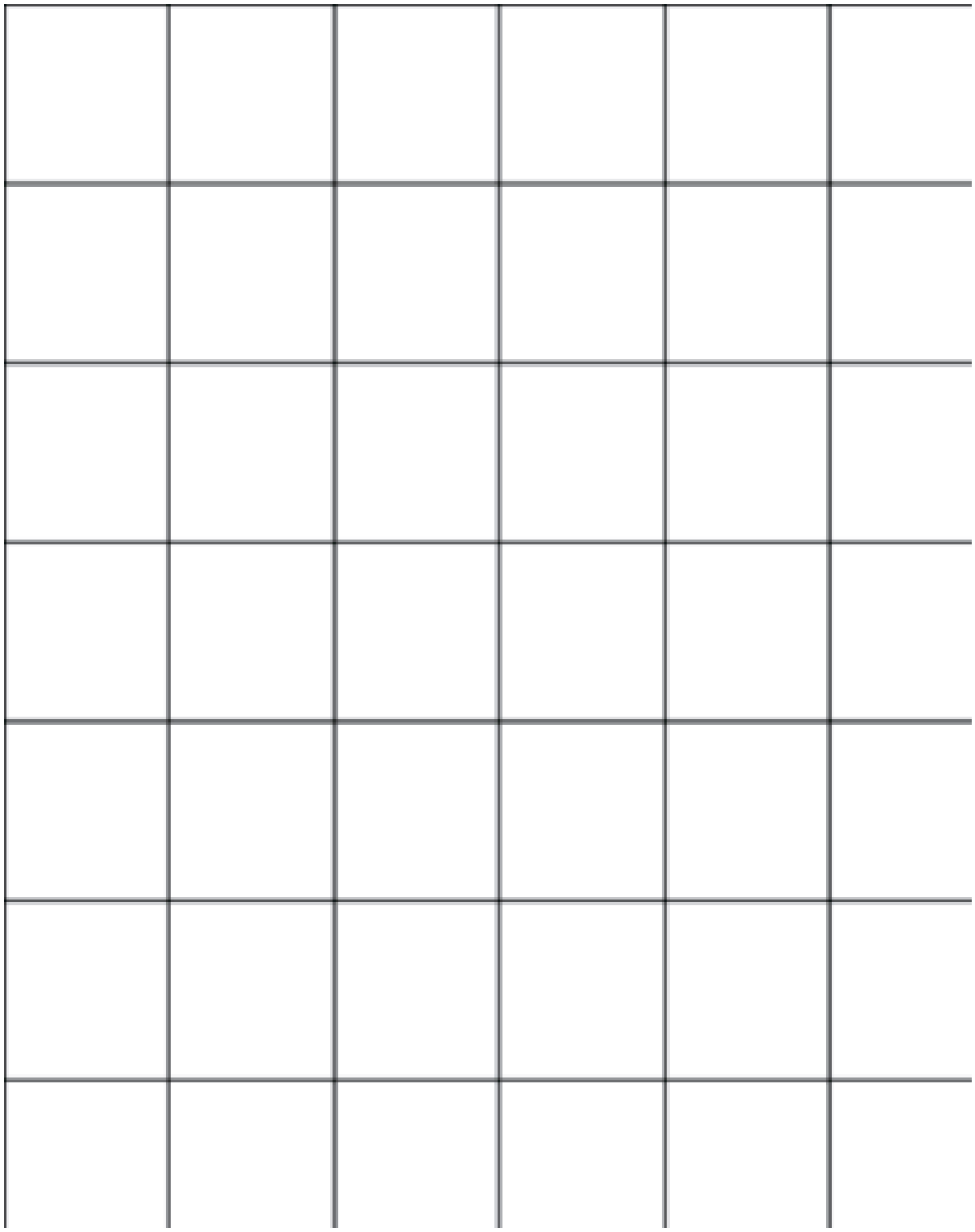
Leaf-like

Shrubby

Lichens As Pollution Indicators



Lichen Grid



Notes

The Great Garbage Caper

OBJECTIVES:

The student will be able to:
1. Classify garbage by various criteria.
2. Apply math skills to a scientific study.
3. Find alternative uses for materials commonly thrown away.

BACKGROUND:

America is a nation of consumers where many people purchase much more than they need or want. Americans are still struggling with developing an effective means of disposal for their unwanted or surplus garbage. Alabamians generate an estimated 14,400 tons of municipal solid waste each day. That equates to about 9.9 pounds of waste per person, per day. Most of this refuse is taken to a landfill and buried. Landfills are reaching their capacity faster than new sites can be acquired. Two ways that students can help to fight the garbage problem are to become wiser consumers and to find new uses for things they currently throw away.

Grades:
3-5

Subjects:
Art, Math, Science

Time Needed:
Two class periods

Materials:
dry trash
scales (metric if possible)
large box
garbage bag
plastic gloves

VOCABULARY:

biodegradable - a compound that can be broken down into simpler compounds by microorganisms.
nonbiodegadable - a compound that cannot be broken down into simpler compounds by microorganisms.
volume - space occupied as measured by cubic units (length x width x height)
upcycling - the process of converting waste materials or useless products into new materials or products of better quality or for better environmental value.

ADVANCE PREPARATION:

1. Gather dry, clean, safe trash from your school's wastebaskets.

PROCEDURE:

Setting the Stage
1. Discuss how much trash the students believe they throw away every day.
2. Wearing plastic gloves, safely investigate the contents. Classify the items in several ways: biodegradable, means of disposal, composition, nonbiodegradable.

Activities
1. Estimate the amount of garbage that weighs 4 1/2 pounds (1.95 kg). Put it in the garbage bag.
2. Weigh the garbage. How far off were you? Measure in centimeters the length, width, and height. Multiply these measurements to get the volume of space the garbage occupies in one week, one month, or one day.

$$\frac{\text{Volume of Classroom (length x width x height)}}{\text{Volume of garbage in 1 day}} = \text{Number of Days}$$

V of 1.95kg x number of students = V of garbage

3 Calculate the volume of garbage produced each day by students in class.
4. Estimate how may days it will take to fill up the classroom.

Follow Up

1. Art: Explore materials in the collected trash to discover other possible uses for them. What can be recycled or upcycled? What might be used again? Plan an art project using some of the discarded materials.
2. Prepare a hall or bulletin board display to inform others about what you have learned.
3. Complete an action plan: "You Can Make A Difference" (Student Activity Page).

EXTENSIONS:

1. Suggest that students make a list of ways they might be better consumers.
2. Visit a local landfill or recycling center.

ORIGINAL DEVELOPMENT RESOURCES:

Braus, J. (1990). *Nature scope of pollution: Problems and solutions.* Washington, D.C.: National Wildlife Federation.

Lewis, M.A. (1994). *Kids CARE.* Dayton, OH: Mead Corporation.

Savan, B.(1991). *Earthcycles and ecosystems*.Toronto: Canada Kids Can Press Ltd.

ADDITIONAL RESOURCES:

Alabama Solid Waste Study Report - August 21, 2012 - http://www.eng.auburn.edu/files/acad_depts/civil/asws/annistonppt.pdf

You Can Make A Difference

Action Plan Written by _____

The Problem

People's garbage habits are hurting the environment because _____

_____

_____

Some of the problems caused by too much garbage are _____

_____

_____.

The Solution

I can help fight the garbage problem by:

1. _____

2. _____

3. _____

Three good habits I can teach others:

1. _____

2. _____

3. _____

Notes

All Tied Up

OBJECTIVES:

The student will be able to:
1. Identify ways litter endangers wildlife.
2. Evaluate how harmful various types of litter are to wildlife.
3. Expand classification skills.

BACKGROUND:

Recreational pollution affects many forms of life. It exposes wildlife to possible injury, illness, and death. According to the Center for Marine Conservation (2000), pollution along our coasts and beaches appears to have become the rule rather than the exception. In Alabama, 3,328 volunteers collected 179,536 pounds of trash during the 2012 Coastal Cleanup Day.

Many people are unaware of the injury, suffering, and death they cause wildlife when they throw trash on the ground or in the water. Plastic fishing lines, fish nets, and six-pack yokes often trap the legs, wings, and beaks of water birds like geese, heron, and pelicans. It may also interfere with swimming and flying. Plastic accounts for most of the collected litter.

Some animals eat litter. It may get caught in their digestive systems, and they die of starvation or illness. Half-open food and soda cans cause numerous cuts, and small animals may become trapped and die.

Grades:
3-5

Subjects:
Language Arts, Science, Art

Time Needed:
Two to three class periods

Materials:
six-pack rings
fishing line
plastic wrap
plastic bags
gum wrappers
Styrofoam cups
aluminum cans
glass jar
posterboard
glue
markers

VOCABULARY:

endanger - to put into danger

ADVANCE PREPARATION:

1. Make a visual aid from the attached sheets.
2. Collect litter samples and put them into a display.

PROCEDURE:

Setting the Stage

1. Introduce the term endanger.
2. Share the hazardous litter display and discuss how these objects are harmful.

Activities

Create a Ranking Scale (Day 1).

- Discuss how scales are used to rank or classify. Explain that each group will be creating a scale from 1-10 with 10 representing litter that is most harmful to wildlife and 1 being the least harmful.
- Have small groups assign a rating to each piece of litter. Groups should be able to defend their decisions.

A sample scale is shown, but allow students to create their own scale.

Example Master Scale

Have students determine their own scale based on their discussions. This is just a guide. There are no right or wrong ratings.

Plastic Six-pack Yokes	10
Monofilament (fishing line)	10
Gum Wrapper	1
Aluminum Can	8
Cigarette Butt	5
Plastic Bag	10
Glass Bottle	6
Styrofoam Cup	8

- Bring the class together and share the visual aids you made. Review the background information.
- Allow five minutes for each group to reevaluate its ranking system. Record the final product on poster board and illustrate it.

Follow-Up

1. Create litter collages. Walk around the playground and search through magazines for litter that endangers wildlife.
2. Each group, using its scale, should total the litter portrayed on its collage.
3. Write an individual paragraph about the group's collage and about how people can help to solve the litter problem.

EXTENSIONS:

1. Create math problems based on the ranking scale. Give them to another group to solve.
2. Invite a wildlife biologist to join the class for discussion.
3. Visit a wildlife preserve.

ORIGINAL DEVELOPMENT RESOURCES:

Aquatic project WILD. (1987). Boulder, CO: Western Regional Environmental Council.

Costa-Pau, Rosa. (1994). *Conservation of the sea (The Junior Library of Ecology)*. www.amazon.com.

The Earthworks Group. (1989). *50 simple things you can do to save the earth*. Berkeley, CA:Earthworks Press.

Litter Endangers Wildlife

Notes

To Fertilize Or Not To Fertilize: That Is The Question

OBJECTIVES:

The student will be able to:
1. Use the scientific process to form an educated opinion.
2. Demonstrate the potential dangers of runoff from fertilizer.
3. Experiment to find the benefits of fertilizer.

Grades:
3-5

Subjects:
Science, Math

Time Needed:
One class period, extended several weeks

Materials:
sod (about 3 inches by 3 inches)
plastic box
large plastic container
red food coloring
sprinkling can
three small pots
three small plants - same kind and size
manure (composted manure product)
water soluble fertilizer

BACKGROUND:

Nutrients are required for plant growth. Fertilizer is an added source of nutrients used for gardens, farms, and sometimes even houseplants. The Tennessee Valley Authority (TVA) was created in 1993 to assist farmers of the Tennessee Valley whose farms were basically unproductive due to the erosion of nutrient-rich topsoil. The TVA Act provided for a long-range program of agricultural readjustment and development, watershed protection, and fertilizer development.

Valley farmers did experience intensified production per acre of land. In 1934 sales per harvested acre in the region were $15.27. By 1976 sales per acre in the region had increased to $487. When fertilizer is misused, it can be extremely harmful. Runoff can get into Alabama's waterways and speed the growth of algae and plants that grow in the water. Microorganisms take in oxygen, thus endangering the fish. Phosphates and nitrates are chemicals found in synthetic fertilizer. They further deplete the oxygen supply because they enhance the growth of microorganisms. Animal waste used as fertilizer adds one more complication because it contains bacteria (unless properly treated or composted) that may spread disease.

VOCABULARY:

fertilizer - natural (manure) or chemical (synthetic) materials used for enriching soil
nitrate - a form of salt that enhances plant growth; found in animal wastes
nutrients - substances that provide nourishment and promote growth
phosphate - a chemical salt usually obtained from rocks and bones and used in fertilizers

ADVANCE PREPARATION:

1. Separate plants into three pots if not brought in separate containers.
2. Copy Activity sheet.

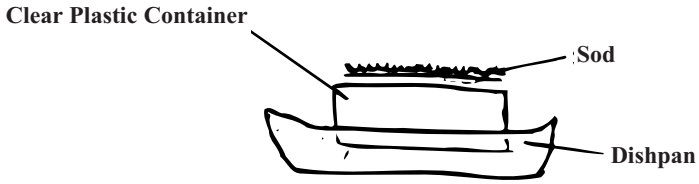
PROCEDURE:

Setting the Stage

1. If possible, visit a local greenhouse or garden center. Ask them to share how they obtain maximum growth and development of their plants.
2. Invite a speaker from your local garden center.
3. Examine a healthy plant and a dying plant. Discuss what is necessary for a green plant to grow: sunlight, water, nutrient-rich soil, and air.

Activities

1. Review the benefits of nutrient-rich soil. Point out that sometimes too much fertilizer can have harmful effects on plants.
2. Demonstration:



   Take a piece of sod with dirt attached and put it on an overturned plastic box and place inside a large container. (See the drawing)
   Pour "fertilizer" (a mixture of water and lots of red food coloring) over the grass.
   Using the sprinkling/water can, create a heavy rainfall and observe the fertilizer flowing out of the soil, down the plastic box, and into the collecting container.
   Discuss: Where would the fertilizer go? What might be the results?
3. Experiment
   Realizing that there are also positive results from fertilizer, set up this experiment and document the results carefully.
   Obtain three nearly identical plants; (geraniums work well). Measure them, draw them, and begin records. Keep all conditions the same except water one pot with water, another with water and manure, and the other with water and a chemical fertilizer. Place near a light source and water/fertilizer weekly.
   Keep accurate growth graphs, about twice a week. Record growth to the nearest centimeter or millimeter.

Follow-Up

1. Graph the plants' growth over the next month and observe all other changes in the plants.
2. Examine labels and ads from different fertilizers. What benefits do they promote? What cautions do they list?

EXTENSIONS:

1. Research the history of TVA fertilizer development.
2. Design a garden for the school yard. How can the soil be enriched and still prevent the fertilizer from running off or seeping into the groundwater?

ORIGINAL DEVELOPMENT RESOURCES:

Henderson, R.A. (Undated). *Developing tennessee valley agriculture*. Division of Agricultural Development, Tennessee Valley Authority.

Savan, B. (1991). *Earthcycles and ecosystems*. Toronto: Canada. Kids Can Press Ltd.

Bellamy, David.(1988). *The river: Our changing world.* New York: Clarkson N. Potter Publishers.

Cherry, Lynne.(1992). *A river ran wild*. New York: A Gulliver Green Book, Harcourt Brace Jovanovich, Publishers.

To Fertilize Or Not To Fertilize:That Is The Question

PLANT A: Water only once a week.

PLANT B: Water and manure once a week.

PLANT C: Water and chemical fertilizer once a week.

PLANT A		PLANT B		PLANT C	
Date	Measurement	Date	Measurement	Date	Measurement

Illustrate:

PLANT A	PLANT B	PLANT C
Beginning	Beginning	Beginning
End	End	End

Notes

Clean Up Your Act

OBJECTIVE:

The student will be able to:
1. Experiment to find a way to clean up an oil spill.
2. Gain an appreciation for the difficulties associated with cleaning up the environment.

Grades:
3-5

Subjects:
Science, Language Arts

Time Needed:
Two class periods

Materials:
jar with tight lid
water
cooking oil dyed with food coloring
household detergent
small shallow pan for each group
variety of cleaning materials

BACKGROUND:

Oil spills, large-scale accidental discharge of liquid petroleum products, are an important cause of pollution along shore lines. One estimate is that out of every million tons of oil shipped, one ton is spilled. Some of the largest spills recorded involved the tankers "Amoro Cadiz" off the French coast in 1976 (1.6 million barrels of crude oil) and the "Ixtoc 1" oil well in the Gulf of Mexico in 1979 (3.3 million barrels). The largest spill in the United States (240,000 barrels) was that of the "Exxon Valdez" in Prince William Sound, Gulf of Alaska, in March 1989. Within only one week with the assistance of high winds, this spill became a 6,700 square kilometer oil slick. It endangered wildlife and fisheries in the entire gulf area.

Oil spills in the Persian Gulf in 1983 and again in 1991 were the results of military conflict. Significant damage was done to marine life.

Oil spills have proven to be incredibly difficult to clean up. Some of the methods used during the "Exxon Valdez" clean up were:

1. chemical dispersants (detergents) - to break the oil slick into small particles.
2. burning - to eliminate up to 90% of fresh oil.
3. fertilizer - to cause marine bacteria that eat oil to multiply.
4. booms - to surround and contain an oil slick.
5. oil skimmers - to pick up oil on the surface of the water and store it in a tank.

Despite the many methods available, rarely is more than 10% of the oil recovered.

VOCABULARY:

boom - long, floating, tube-like barriers

oil skimmer - a container that oil flows into, then is towed through the water, and is finally pumped or vacuumed with a hose into a storage container

ADVANCE PREPARATION:

Collect pictures of oil spills and the destruction caused by them.

PROCEDURE:

Setting the Stage - Day 1

1. With pictures and background information, discuss results of oil spills.
2. Using a long, short-sided pan and cooking oil, create a model oil spill.
3. Using a concept map, brainstorm all possible ways to clean up this spill. (Guide them to include materials such as paper towels, large spoons, dishwashing detergent, laundry detergent, vinegar, eye droppers, cottonballs, cottonpads, sponges.) Accept all solutions.

4. In cooperative learning teams, choose a minimum of four materials the group wishes to test. After checking with the teacher, divide up a list of needed supplies.

Activity - Day 2
Experiment
- Add food coloring to oil to get a deep rich color.
- Add dyed oil to the shallow pan of water to create an oil slick.
- Test various materials to clean up the "oil slick"and record results on the attached sheet.
- At the end of the tests, discuss which materials and methods worked most effectively. Could this method be used to clean a large ocean spill? Could it be modified to work?

How will the collected oil and oil-contaminated materials be disposed of in a way that will not continue to pollute the Earth?

Follow-Up
Compare and contrast your methods to those used by the Exxon Valdez.
- Write a paragraph about how some of these methods might do harm to the environment.
- Discuss the impact of an oil spill to the environment. Discuss the impact to the economy (lost natural resources, local economy where the spills occur, and cost of clean up).

EXTENSIONS:

1. Art Activity: Oil-Swirled Stationery
   - Use a 9x12 cake pan for water and food-colored cooking oil. Place colored oil drops on the water in the pan. Swirl gently with a knife.
   - Lay paper lightly on the surface of the water. Lay it out to dry.
2. Compose an environmental poem and write it on the oil-swirled paper.

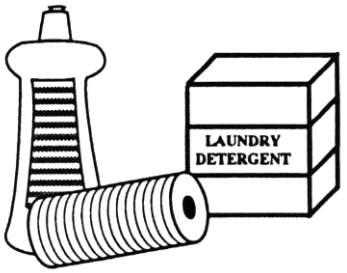
ORIGINAL DEVELOPMENT RESOURCES:

Braus, J. (1990). *Nature scope of pollution: Problems and solutions*. Washington, D.C.: National Wildlife Federation.

Savan, Beth.(1991). *Earthcycles and ecosystems*. Toronto: Kids Can Press Ltd..

Berger, Melvin.(1994). *Oil spill!* New York: Harper Collins Publishers.

Clean Up Your Act!



Oil Remover	Observations

Rank your results in order of effectiveness.

1.
2
3
4
5

Notes

You Dirty Bird

OBJECTIVES:

The student will be able to:
1. Observe the effects of oil on a feather and an egg.
2. Hypothesize and test ways to clean up oil from a bird.

Grades:
3-5

Subjects:
Science, Math

Time Needed:
Two class periods

Materials:
feathers (feather dusters)
six boiled eggs
cooking oil
container of water big enough to float a feather (approx. 1 qt.)
powdered washing detergent
measuring spoon - teaspoon (5 ml)
pie pan
ruler or measuring tape

BACKGROUND:

Oil pollution can be a major problem for our oceans and our coastal shores. Large tankers, carrying in excess of 5,000,000 tons of oil, sometimes have accidents. One such oil spill was when the "Exxon Valdez" ran aground near Valdez, Alaska in 1989. Oil spills can also come from offshore oil rigs, ships discharging oil, and city street runoff.

When oil forms a floating film on top of the sea, it is called an oil slick. Oil slicks destroy marine life by poisoning them, their eggs, and coating their feathers, fur, or scales. It depletes their food supply by killing krill and plankton. The entire food chain then suffers from the effects. Crude oil may even be ingested by land mammals.

Seabirds suffer the most from oil spills. Their feathers become soaked with oil, and they lose their buoyancy in the water. Because they also cannot fly, they become easy prey. Because the oil destroys the birds' natural insulation, many of them freeze to death. As the birds attempt to clean themselves, they are poisoned by swallowing the oil on their feathers.

Detergents used to remove oil from the feathers of the birds may also remove the natural oils that allow birds' feathers to repel water. Thus, the birds are susceptible to drowning or to stress-related illnesses. Their food and water sources are also adversely affected.

VOCABULARY:

barbs - strands attached to the shaft of a feather
embryo - an animal in the earliest stages of development
environmental impact - the effect left on the environment
oil slick - a floating oil film on the water

ADVANCE PREPARATION:

1. Take apart a feather duster.
2. Boil six eggs.
3. Divide students into small groups.

PROCEDURE:

Setting the Stage
1. Show a picture of an oil spill or display a motor oil can.
2. Write the term environmental impact on the board and help the students develop a definition.
3. Divide into small groups.

Activity

1. Examine a bird feather.
   - Draw the feather.
   - Measure it (Student Activity sheet 1).
   - Zip the feather closed by running a fingernail between the barbs. Open and close the feather.
   - Will the feather float?
   - Why is it important for the barbs to close? (insulation, air resistance)
2. Examine a feather dipped in oil.
   - Perform identical tests; record results.
3. What conclusions can be made about the bird's ability to swim, to fly, and to survive?
4. Examine the effect of oil on eggs (total class activity).
   - Place oil in a pie pan and add the eggs.
   - Remove the eggs one at a time on the following schedule: 10 minutes, one hour, 24 hours, and 48 hours.
   - Examine by peeling off the shell. Describe what you observe (Student Activity sheet 2).
   - What consequences are resulting from oil penetration? What would happen to the embryo?

Follow-Up

1. How do you think that this bird might be saved?
2. Experiment - Test the use of detergents on birds.

   Pour one cup of water into a bowl.
   Add one spoon of oil.
   Observe water surface.
   Sprinkle two spoons of powdered detergent over the water surface.
   Gently mix.
   Observe surface.
   Float a feather.
   Discuss results. (The oil spread out into large circles. When the detergent was added, the oil broke apart and some of the oil sank. This happens because oil is lighter than water so it floats. Detergent combines the molecules. Birds have oil in their feathers making them waterproof. The detergent causes the feathers to absorb water. The bird can sink and drown.

EXTENSIONS:

1. Investigate a big oil spill. What damages occurred?
2. Write a children's book about a bird that is saved from an oil spill. Share it with another class.

ORIGINAL DEVELOPMENT RESOURCES:

Florida Department of Environmental Management. (Undated). *4 R's project solid waste management curriculum.*

Whitney, D. *12 steps to cleaner water*. Izaak Walton League of America, Inc., 1701 N. Fort Meyer Drive, Arlington, Virginia, 22209.

Berger, Melvin. (1994). *Oil spill!* New York: Harper Collins Publishers.

You Dirty Bird!

	Sketch	Width/ Length	Weight	Will It Zip?	Will It Unzip?
Dry Feather					
Wet Feather					
Oiled Feather					

Conclusion: Describe how oil is hazardous to the health/life of a bird.

You Dirty Bird!

Directions: At the given times, peel an egg and write a detailed description of what you observe.

10 minutes	
20 minutes	
30 minutes	
40 minutes	
Next Day	
In two days	

Conclusions:

Swim Suitable

OBJECTIVES:

The student will be able to:
1. Simulate the dangers of swimming in polluted water.
2. Grow bacteria on a potato, representing unseen harmful organisms.
3. Explore solutions that may reduce dangerous bacteria in recreational waters.

BACKGROUND:

When looking for a place to swim in Alabama's lakes, streams, and rivers, most people would check to see whether a lake was filled with litter and covered with an oily film. The pollutants we see that destroy the beauty of Alabama, however, are less harmful than those we cannot see. Coliform bacteria is a tiny organism found in human and animal excrement. This microorganism gets in the water when animals come to drink, when fish and ducks swim and eat, when rain drains off farmland, and when boats flush their toilets into the water.

Although large boats sold since 1977 are supposed to have a holding tank, or temporary place to hold the waste, there are few places to dump this waste (pump-out stations receive this waste and treat it before it goes on to a waste treatment facility). There are also many older boats on the water, and people do not usually recognize this dumping to be dangerous.

Fecal coliform bacteria in the water can cause illness. Coliform bacteria can often act as an indicator of other pathogenic organisms.

Grades:
3-5

Subjects:
Language Arts, Science,

Time Needed:
One class period
on-going observation

Materials:
masking tape or safety pins
cottonballs (4)
hot plate
plastic wrap
water
plastic knife
spoon
plastic gloves
tongs
4 glass containers with lids
potato

VOCABULARY:

coliform bacteria - a group of bacteria predominantly living in the intestines and present in fecal waste materials; also found in the soil; often are also indicators of other pathogenic organisms (disease-causing organisms)
microorganisms - a living organism, such as bacteria, that cannot be seen with the unaided eye
pathogenic - a specific agent (as a bacterium) causing disease

ADVANCE PREPARATION:

1. Reproduce the germ page for all the students (except three students)
2. Label two of the germs, coliform bacteria. Laminate, if possible.
3. Copy the Activity page 1.

PROCEDURE:

Setting the Stage

1. Journal prompt: When was the last time a germ caught you? Write about your experience with the germ.. Share.

2. Introduce students to coliform bacteria by sharing background information. Use a germ puppet or a tape recording to make it interesting.

Activity

1. Simulation
   - Divide the class into groups. Group 1 will be the three swimmers, and Group 2 (everyone else in the class) will be organisms. Give all the microorganisms a germ to wear (printed side down). Two germs should be coded as coliform bacteria.
   - Send off the swimmers to float around the classroom.
   - Have each germ attach itself to one of the swimmers.
   - When all the germs are attached, turn the germs over and see who caught the coliform bacteria. They might have made the swimmer sick. The more coliform bacteria that are present, the more likely other more deadly organisms are also present.
2. Brainstorm different ways to cut down on the amount of microorganisms in the water. With each answer, allow one of the germs to go back to his or her seat. Remember that not all microorganisms can be removed from water, but we can decrease their numbers. Record all answers.
3. Experiment: Simulate how sewage (animal waste) allows for the growth of bacteria. Grow bacteria on potatoes.
   - Boil 4 glass jars in hot water bath for 6 minutes. Also sterilize lids and a pair of tongs.
   - Wash and slice one white potato in each jar. Seal one jar with a potato slice enclosed. (This is your control jar.) Jar A
   - Take a cottonball and wipe it on a student's wrist. Place it in a jar on the potato slice and seal the jar closed. Jar B
   - Take a cottonball and wipe it on a desk (or any surface) and place it in a jar on the potato slice and seal the jar closed. Jar C
   - Take a cottonball and wipe it in the floor and place it in a jar on the potato slice and seal the jar closed. Jar D
   - Place the jars in a warm location but not in direct sunlight.
   - Observe the jars for 1 - 2 weeks. Record on the Activity sheet 1.

Follow-Up

1. Have students write and discuss whether they think the amount of coliform bacteria in the water has increased or decreased over the past 100 years. Why/why not?

EXTENSIONS:

1. Have someone from the health industry come and speak about some symptoms of illness caused by bacteria and viruses.
2. Have a guest speaker talk about water quality in local swimming areas.
3. Visit a sewage treatment plant.

ORIGINAL DEVELOPMENT RESOURCES:

TVA river pulse. (1993)

United States Department Of Agriculture. (1998). *Water quality field guild.* (SCS-TP-160).

Bacterial Growth Experiment

HYPOTHESIS:

_____

_____

	Day of Experiment	4 days later	8 days later	12 days later
	Date:	**Date:**	**Date:**	**Date:**
Jar A	Illustrate	Illustrate	Illustrate	Illustrate
Jar B	Illustrate	Illustrate	Illustrate	Illustrate
Jar C	Illustrate	Illustrate	Illustrate	Illustrate
Jar D	Illustrate	Illustrate	Illustrate	Illustrate

Results

Which jar contained the most bacteria? _____

What can be concluded? _____

_____

Swim Suitable

DIRECTIONS Have students color their germs. Cut out the circles and laminate them. Provide each student with a pin or masking tape and redistribute the germs to play the game. If you laminated the germs, collect them and save for the next class.

Down It Goes - Where It Stops, Nobody Knows

OBJECTIVES:

The student will be able to:

1. Perform experiments to determine if a substance is an acid, base, or neutral.
2. Infer the effect a given household cleaner will have on the environment.
3. List characteristics of acids and bases.

Grades:
3-5

Subject:
Science

Time Needed:
One class period

Materials:
household cleaners and detergents
red cabbage juice
litmus paper
eye dropper
coffee filters
wax paper
safety glasses
plastic gloves

BACKGROUND:

Water supply systems are periodically tested for organic chemicals. The organic contaminants for which testing is required are commonly found in the environment as a result of widespread use of solvents and degreasers in homes and industries. The most commonly found contaminants are trichloroethylene, ethylene dibromide, xylene, and toluene. For more information on where these contaminants originate and their possible health effects, see the included charts.

Acids and bases are two categories of chemicals. Acids are usually sour and react with many metals. Some acids are harmful as they can burn or are poisonous. Some are useful in fertilizers, polishes, soft drinks, and car batteries. Most bases are bitter, feel slippery, and can dissolve fat and oil. They can be found in household cleaners, detergents, antacids, plasters, cements, and some medicines. Some substances are neither acids or bases but are considered neutral.

For the procedure described here, red cabbage juice is used. Red cabbage juice is a natural indicator, meaning that through its color it reveals the presence of certain chemicals. This juice can be used to determine whether substances are acids or bases. When added to an acid, red cabbage juice will turn a range of colors from red-pink to deep purple. When added to a base, the indicator will turn blue-green. When added to a neutral substance, the red cabbage juice remains blue-purple.

VOCABULARY:

acid - any compound that reacts with a base to form a salt; reddens litmus paper; tastes sour
base - a chemical compound, like ammonia, that reacts with an acid to form a salt; turns litmus blue; tastes salty
carcinogen - an agent causing ar inciting cancer
compound - made up of two or more independent elements
neutral - neither acid nor base

ADVANCE PREPARATION:

1. Prepare (boil) red cabbage or secure litmus paper.
2. Collect household cleaners and detergents

PROCEDURE:

Setting the Stage

1. Set up a display table of detergents, cleaners, and soaps. Read some of the ingredients on the detergents

and cleaner containers and use the attached information sheets to determine whether or not they correspond. Talk about their purpose and hazards.
2. Introduce pH scale. Most living organisms need a neutral environment. The pH scale tests for acids and bases. Zero is a very strong acid. Fourteen is a very strong base. Seven is neutral. Chemicals that have a very high pH are harmful to the environment.

Activity

Experiment--Note : Safety glasses are recommended when investigating any household cleaners. Many local industries may donate these for the science center.

- Using an eye dropper, the teacher should place three drops of one of the cleaners or detergents onto a piece of coffee filter. (Place wax paper underneath the coffee filter.)
- Put three drops of red cabbage juice onto the filter in the same area so that the two are mixed.
- Wait 15 seconds and compare to three drops of red cabbage juice dropped onto the paper in a clean area. Record all the results on the Student Activity Page.
- Use the information about acids, bases, and neutrals in the background to discuss what type of chemicals the detergents and cleaners might include.

Follow-Up

1. Classify the tested chemicals into acids, bases, or neutrals.
2. Research correct disposal of household cleaners.

EXTENSIONS:

1. Do some acid and base tests with foods (lemons, limes, oranges).
2. Explore how too much acid production can also hurt the human body. (The body becomes unable to carry oxygen to the muscles).
3. Dry coffee filters and display as art.
4. Compare other chemicals found in these products. Use the Legacy Household Hazardous Materials Wheel.

ORIGINAL DEVELOPMENT RESOURCES:

Speakman, G. (Undated). *Disposal of household chemical wastes.* Auburn University, AL: Alabama Cooperative Extension Service.

Household Hazardous Materials Wheel. Legacy, Inc., P.O. Box 3813, Montgomery, AL 36109, www.legacyenved.or, 1-800-240-5115.

Down It Goes - Where It Stops, Nobody Knows

	Substance Tested	Acid	Base	Neutral
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

What have you learned about the hazards and care of home chemicals?

Notes

Do You Get My Point?
Point And Nonpoint Source Pollution

OBJECTIVES:

The student will be able to:

1. Observe the relationship between groundwater and surface water.
2. Simulate the effects of nonpoint source water pollution.
3. Experience the difficulty of cleaning up polluted waters.

Grades:

3-5

Subjects:

Science, Art

Time Needed:

One class period
small groups of two to four

Materials: (per group)

266 ml plastic cup or plastic 2-liter soda bottles
clean pea-size gravel to fill each cup 3/4 full
three small paper cups (app. 240 ml)
water
one bottle of red food coloring
pump dispenser from soft soap or hand lotion containers

BACKGROUND:

Although about 80 percent of the Earth is water, only about one percent of this water is available for our use. About 90 percent of the water we use each day is stored in aquifers.

Water contaminants come from a variety of sources. The massive extent of the underground water system makes contamination difficult to trace. There are two ways to categorize sources of pollution: point and nonpoint sources.

Point sources are easily identified. These might be industrial waste, municipal waste, manufacturing waste, or household waste. Nonpoint sources are not easily identified. They come from agricultural runoff, logging, leaking pipes, underground storage tanks, sewer systems, septic tanks, and chemical discharges.

Surface waters and underground waters are connected in many areas. What affects surface water also invades aquifers. Polluted groundwaters may also discharge to the surface and enter clean streams. Because everything is interconnected, it becomes much harder to clean up the results of pollution.

VOCABULARY:

aquifer - the underground body of porous sand, gravel, and fractured rock filled with water and capable of supplying useful quantities of water to a well or spring
groundwater - water found in the porous spaces of soil and rock
surface water - water on the Earth's surface such as rivers, streams, and oceans

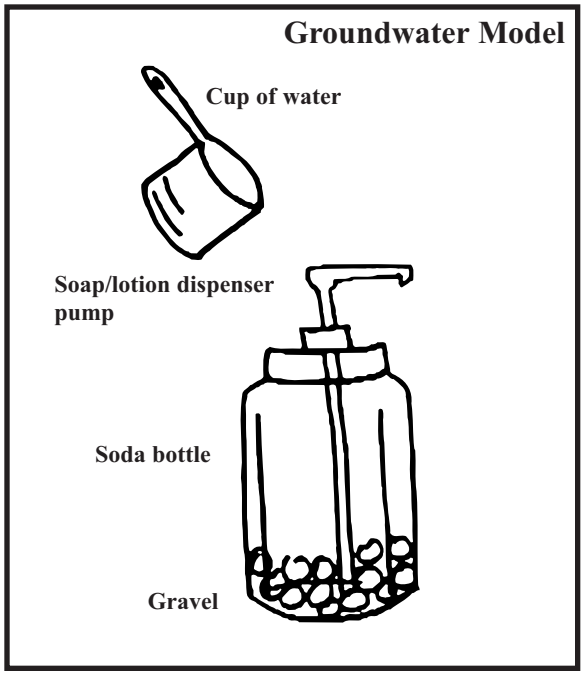
ADVANCE PREPARATION:

1. Punch 8-10 small holes in the bottom of one of the paper cups for each group.
2. Provide each group a 266 ml plastic cup or cut the tops off 2-liter soda bottles (about 1/2 of the bottle) for each group.
3. Provide each group with enough pea-sized gravel (#2) to fill each of the containers 3/4 full. Gravel can usually be purchased where pet or aquarium supplies are sold.
4. Provide each group with one paper cup with no holes, one paper cup 3/4 full of water, and one pump dispenser.
5. Make a transparency of the water cycle (hydrologic cycle).

PROCEDURE:

Setting the Stage

1. Have students illustrate the hydrologic cycle; include the surface water, groundwater, and aquifer. Emphasize the interconnectedness of the entire system.
2. Discuss point and nonpoint sources of pollution. Use the background information as a basis for discussion.



Activity

Simulation

- Hold 240 ml cup with holes over the cup containing the gravel. Add the water to the top cup to simulate rain.
- Explain that rain enters the gravel and becomes groundwater. This process is called infiltration.
- Make a hole in the center of the gravel to make a lake or a pond. What happens to the water level in comparison to the water in the ground?
- Add pollution (food coloring) to each pond (about 1-2 drops).
- Insert the pump into the ground and pump out water. What do you notice about the color of the water? Why?
- Begin adding clean water while the pump continues to work. Keep pumping and adding clean water until the pump water is clear.

Follow-Up

1. What happened to the groundwater?
2. Was the pollution easy to clean up?
3. How are sink holes related to underground water supplies? Research to find the answer.

EXTENSIONS:

Create a mural of a small city showing the water table, the aquifer, the water systems, and pollution contributors.

ORIGINAL DEVELOPMENT RESOURCES:

Alabama Cooperative Extension System. (Undated). *Nonpoint pollution of Alabama waters*. (Circular ANR-319). Auburn University, AL.

American Institution of Professional Geologists. (1984). *Ground water: Issues and answers*.

Mikel, W. & Hariston, J. (Circular HE-620). (1974). *Water, our most valuable resource: Keeping it clean.* Auburn University, AL: Alabama Cooperative Extension System.

Vandas, S. (Undated). *Water quality . . .potential sources of pollution*. U.S. Department of the Interior.

Savan, B. (1991). *Earthcycles and ecosystems*. Toronto: Kids Can Press Ltd.