

6 WHAT IS ACID RAIN?

GRADES: 7-11

SUBJECTS: Science, Social Science, Civics, Government, Health, Geography, Environmental Science, History

TIME: 3 1/2 Hours; 2 1/3 Blocks or 5 Periods

STATE STANDARDS:

Civics Standard 3 - Citizenship, P.I. C. 416 - Grades 9-11

Geography Standard 1 - Maps, P.I. G.402, G.404 - Grades 9-11

Geography Standard 2 - Environment, P.I.s G.405, G.406, G.407, G.408 - Grades 9-11; 7.423, 8.423 - Grades 7-8

History Standard 1 - Chronology, P.I. H.401 - Grades 9-11; 7.427, 8.428 - Grades 7-8

Science Standard 5 - Earth's Dynamic System (Components of Earth) 5.12; P.I. 9.75 - Grades 9-11

Science Standard 8 - Ecology (Interaction of Humans Within Ecosystems) 8.31; P.I. 9.75 - Grades 9-11

OVERVIEW OF THE LESSON

Scope and Purpose of the Lesson:

This lesson contains a variety of activities that help students understand acid rain which is one form of pollution that results from burning fossil fuels.

◆ Topics Addressed:

- Acid rain
- Causes of acid rain
- Effects of acid rain on vegetation
- Effects of acid rain on water
- Effects of acid rain on manmade objects
- Effects of acid rain on humans
- Solutions to the acid rain problem

Synopsis of the Lesson:

This lesson contains four activities that use a variety of instructional strategies and is focused around the organizing question of "What is acid rain?"

LEARNING OBJECTIVES

Students will be able to:

- ◆ Define acid rain
- ◆ Explain the cause of acid rain
- ◆ Explain the effects of acid rain on vegetation
- ◆ Explain the effects of acid rain on water
- ◆ Explain the effects of acid rain on man-made objects
- ◆ Explain the effects of acid rain on humans
- ◆ Describe what can be done to solve the acid rain problem

BACKGROUND

Since the beginning of time, humans have learned to make use of many things in nature such as fire and electricity. From the early times through the Industrial Revolution to the Space Age, humans have produced inventions that use many of the earth's varied energy resources to make living easier. In many cases the energy comes from burning fossil fuels—coal, oil and natural gas.



Some of the inventions that make our lives easier are also causing pollution. Pollution is the release of harmful substances into the environment. One form of pollution is acid rain. Acid rain can damage plants, animals, soil, water, building materials, and people. Scientists have discovered that burning fossil fuels creates acid rain through air pollution. People burn fossil fuels such as coal and oil to make electricity. Electricity heats and lights buildings and runs appliances such as televisions and video recorders. Fossil fuels power our cars, buses, and airplanes. The air pollution created when these fuels burn does not stay in the air forever. It can return to the earth as acid rain. And when it does, it may weaken the plant and animal life it contacts. Acid rain is only one form of pollution that results from burning fossil fuels. It is one of particular interest, however, because it can be transported over long distances. Scientists, engineers, and researchers are learning how to measure the amount and effects of pollution in the air, forests, water, and soil. They are inventing ways to reduce the amount of pollution that enters the environment and prevent new damage in the future.

LESSON PROCEDURE

INTRODUCTION OF LESSON

Start the lesson with a Warm-up, Mind Set, or Anticipatory Set on the overhead or chalk board. The WARM UP and LARGE GROUP DISCUSSION should take about **10 minutes**.

1. WARM UP, MIND SET OR ANTICIPATORY SET - What is Acid Rain? Give students **3 to 4 minutes** to respond in writing.

2. LARGE GROUP DISCUSSION

Conduct a large group discussion as a follow up to the warm up. Have students discuss their definitions of Acid Rain. (**5-6 minutes**)

3. LESSON OBJECTIVES - The lesson objectives should be presented on an overhead or chalk board. These should be read and explained to the class. (**2-3 minutes**)

OPTION: You may want the students to copy the lesson objectives in their notebooks.

ACTIVITY 1: Reading

1. Description/Overview of Activity:

Students will work individually to complete Reading #1 and Student Worksheet #1 to develop a background and understanding of acid rain.

2. Materials Needed:

Reading #1
Student Worksheet #1

3. Performance Indicators of the Activity:

Geography P.I. G.405, G.407, G.408; 7.423, 8.423
Science P.I. 9.75
History P.I. H.401; 7.427, 8.428

4. Preparation for Activity:

Make copies of Reading #1 and Student Worksheet #1.

5. Activity Outline and Directions to the Teacher:

STEP 1: Students will now complete **Reading #1** to develop a better background and understanding of acid rain. Give the students **Reading #1** and **Student Worksheet #1** and ask them to complete both the reading and the worksheet individually. (**10 minutes**)

STEP 2: CLASS DISCUSSION - Have the class briefly discuss Reading #1 and their answers to Student Worksheet #1—see answer sheet in Teacher Materials (**10 minutes**).

ACTIVITY 2: Role Play Activity

1. Description/Overview of Activity:

Students will participate in a group activity in which they will role play the part of something that is affected by acid rain.

2. Materials Needed:

Handouts 1, 2, 3, 4, 5, 6, and 7
Role Cards 1, 2, 3, 4, and 5

3. Performance Indicators of the Activity:

Geography P.I. G.408
Science P.I. 9.75

4. Preparation for Activity:

Make copies of Handouts 1, 2, 3, 4, 5, 6 and 7 as well as copies of Role Cards 1, 2, 3, 4, and 5. Divide the students into Cooperative Learning Groups of four students each arranged heterogeneously by gender, race, and ability.

5. Activity Outline and Directions to the Teacher:

STEP 1: Divide the class into five groups. Assign each of the groups a number (1-5). Explain to the students that they are now going to role play the part of something that is effected by acid rain. Tell students they will receive a



packet of handouts to be studied for a few minutes before the activity begins. Give each student the packet of 5 handouts. Explain that each group will receive one of the Group role cards (copies for each member of the group) and that they are not to allow any other member of the class to view their sheets in order to conceal their role. Students are to take a few minutes to read their Group Role Cards and examine each of the handouts. The handouts will give them clues to the roles of each group. Each of the groups will then present their role to the class **(5 minutes)**.

OPTION 1 - Have each group select a member of their group to present their role to the class by reading their Group Role Card to the class.

OPTION 2 - Have several group members selected to do the presenting.

OPTION 3 - Have the entire group present their role by reading the statements to the class from their Group Role Cards.

STEP 2: The other four groups will listen and come to a consensus on answering the question: Who or What Am I? Students should take notes on each of the presentations because they will be asked to summarize the effects of acid rain when all the groups are finished. Be sure each student has a copy of Handout 6 to take notes. Next, each of the groups will be called on to reveal who they think the presenting group is representing. The presenting group will then identify their role. **(25 minutes)**

STEP 3: GROUP SUMMARY - Give each student a copy of Handout 7 and have students summarize the effects of acid rain (each member should contribute using notes taken). **(5-10 minutes)**

ACTIVITY 3: Brainstorming

1. Description/Overview of Activity:

Students will participate in a brainstorming activity to brainstorm the question of "What can be done to solve the acid rain problem?"

2. Materials Needed:

Handout 8 (Teachers Materials)
Activity Sheet #1

3. Performance Indicators of the Activity:

Geography P.I. G.404
Science P.I. 9.75

4. Preparation for Activity:

Make copies of Handout #8 and Activity Sheet #1. Divide the students into Cooperative Learning Groups of four students each arranged heterogeneously by gender, race, and ability.

5. Activity Outline and Directions to the Teacher:

STEP 1: Each of the groups will now brainstorm the question of what can be done to solve the acid rain problem. Each group should choose a recorder. **(10 minutes)**

STEP 2: GROUP SHARE - Each group will share their list of ways to solve the acid rain problem. **(5-10 minutes)**

STEP 3: OVERHEAD FOLLOW UP - Overhead 3 will be used to present to the class the list of ways of solving the acid rain problem. **Teacher notes** - see teacher notes on Handout 8 to explain Overhead 3—in Teacher Materials). Students should compare their list of ideas with these. **(5 minutes)**

ACTIVITY 4: Culminating Activity

1. Description/Overview of Activity:

Students will write, produce, and direct a special segment for a TV "weather special" on the effect of acid rain in Delaware.

2. Materials Needed:

Activity Sheet #2
Scoring Rubric

3. Performance Indicators of the Activity:

Geography P.I. G.402, G.406, G.407, G.408
Science P.I. 9.75
History P.I. H.408

4. Preparation for Activity:

Make copies of Activity Sheet 2 and the Scoring Rubric. Divide the students into Cooperative Learning Groups of four students each arranged heterogeneously by gender, race, and ability.

5. Activity Outline and Directions to the Teacher:

STEP 1: Divide the class into Cooperative Learning Groups of four students each. Give the students a copy of the Scoring Rubric and Activity Sheet #2. **(3 minutes)**.



STEP 2: Explain to Students that they will write, produce, and direct a special segment for a TV “weather special” on the effect of acid rain in Delaware. Explain that they will be graded on this project and to be sure to look at the Scoring Rubric. Have students read the directions of Activity Sheet #2. **(3 minutes)**

STEP 3: Have students work together in class to prepare for their presentation. Tell students that they have the option of putting on their presentation live or tape it for the class to view. Presentations will be limited to 10 minutes **(45 minutes)**.

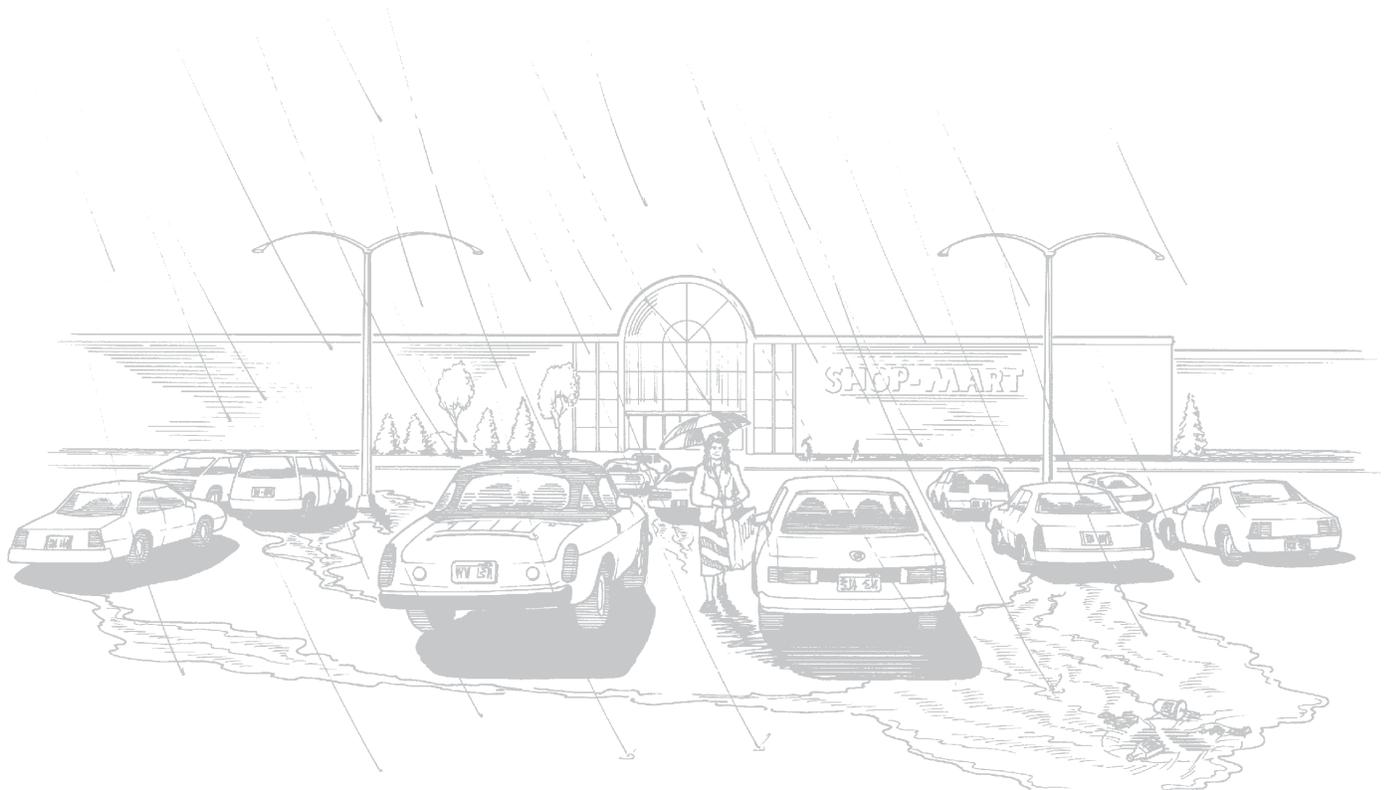
STEP 4: Students will present their TV presentations. **(60-80 minutes)**

CONCLUSION

1. Refer the class back to the objectives to see if they have mastered the material from lesson 8. **(5 minutes)**

EXTENDED ACTIVITY

POSITION PAPER - Students will prepare a position paper on arguments for or against laws to control acid rain that might influence a legislator or government agent. [CITIZENSHIP]



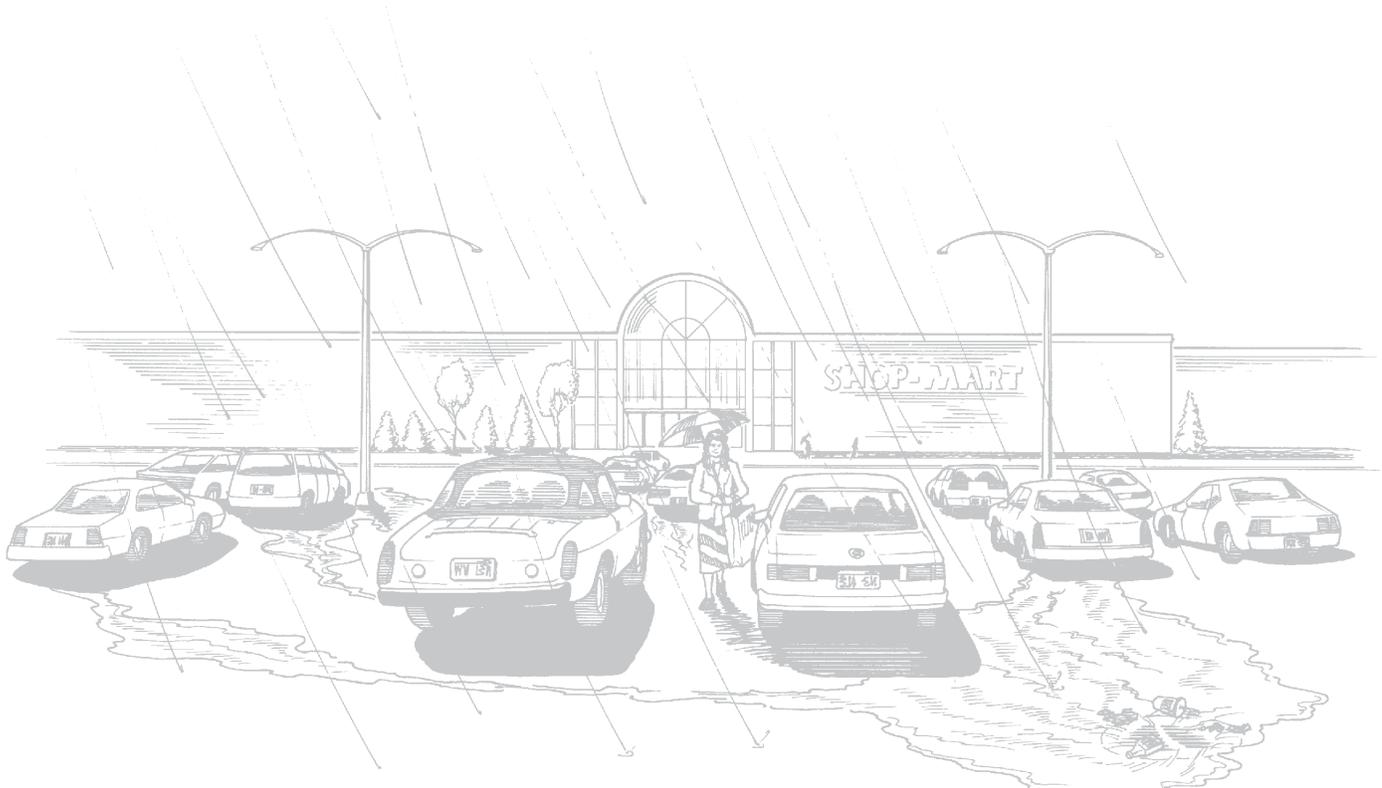
OVERHEAD TRANSPARENCIES

Lesson 6

Introduction of Lesson



OVERHEAD TRANSPARENCY: WARM-UP

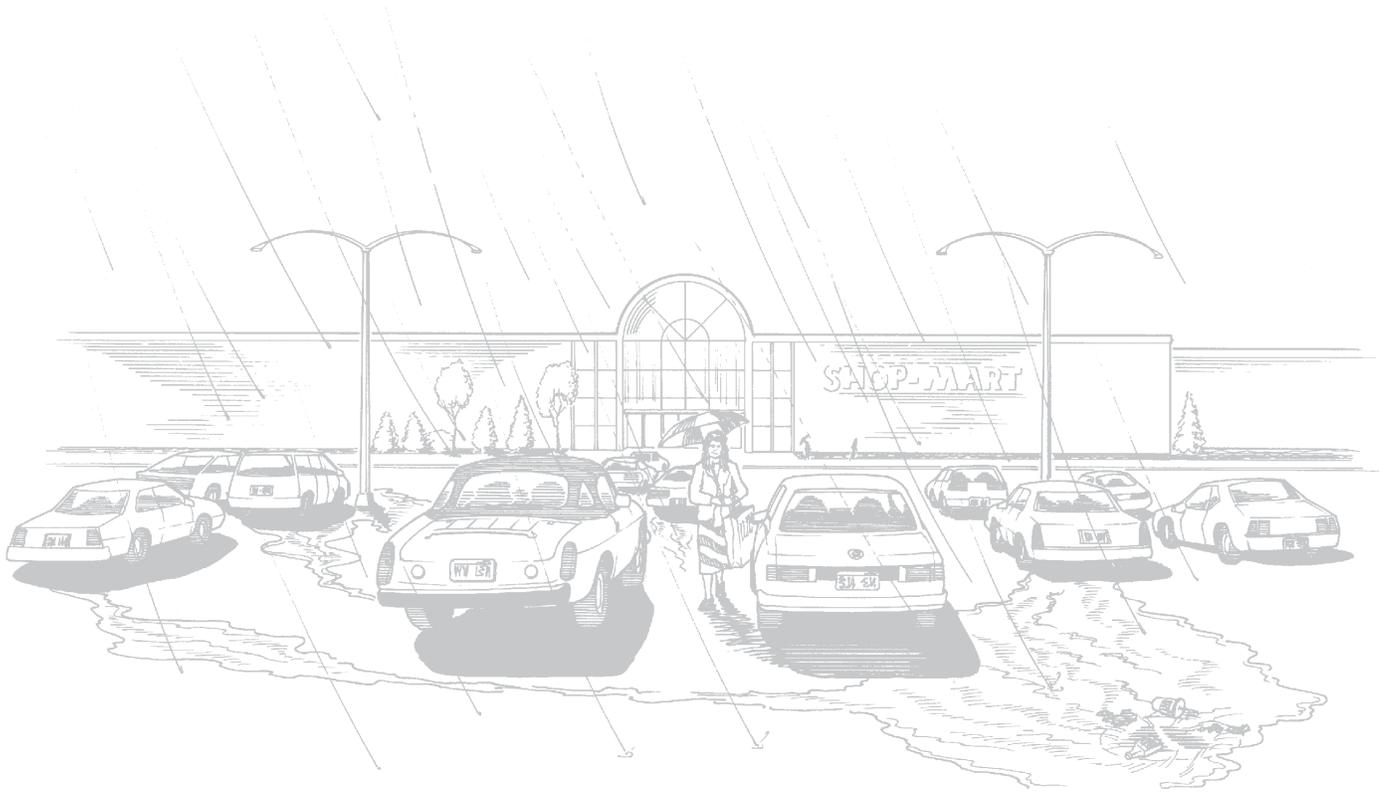


What is Acid Rain?



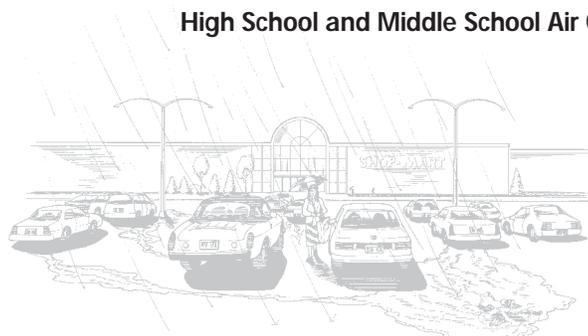
OVERHEAD TRANSPARENCY:
LESSON 6 OBJECTIVES

- ◆ Define acid rain
- ◆ Explain the cause of acid rain
- ◆ Explain the effects of acid rain on vegetation
- ◆ Explain the effects of acid rain on water
- ◆ Explain the effects of acid rain on manmade objects
- ◆ Explain the effects of acid rain on humans
- ◆ Describe what can be done to solve the acid rain problem



STUDENT MATERIALS

LESSON 6 ACTIVITY 1



WHAT IS ACID RAIN

Lesson 6 Activity 1

Reading 1

Since the beginning of time, humans have learned to make use of many things in nature such as fire and electricity. From the early times through the Industrial Revolution to the Space Age, humans have produced inventions that use many of the earth's varied energy resources to make living easier. In many cases the energy comes from burning fossil fuels—coal, oil and natural gas.

Some of the inventions that make our lives easier are also causing pollution. Pollution is the release of harmful substances into the environment. One form of pollution is acid rain. Acid rain is any form of rain that is more acidic than normal (with a pH lower than 5.6). Pure water has a pH of 7, normal rainfall has a pH of a bit less than 7, but acid rain can have a pH of about 5.0-5.5, and even in the 4 range in the northeastern United States.

Acid rain can damage plants, animals, soil, water, building materials, and people. Scientists have discovered that air pollution from the burning of fossil fuels is the major cause of acid rain. People burn fossil fuels such as coal and oil to make electricity. Electricity heats and lights buildings and runs appliances such as televisions and video recorders. Fossil fuels power our cars, buses, and airplanes. The air pollution created when these fuels burn does not stay in the air forever. It can return to the earth as acid rain. And when it does, it may weaken the plant and animal life it contacts. Acid rain is only one form of pollution that results from burning fossil fuels. It is one of particular interest, however, because it can be transported over long distances. Scientists, engineers, and researchers are learning how to measure the amount and effects of pollution in the air, forests, water, and soil. They are inventing ways to reduce the amount of pollution that enters the environment and prevent new damage in the future.

The smoke and fumes from burning fossil fuels rise into the atmosphere and combine with the moisture in the air to form acid rain. The main chemicals in air pollution that create acid rain are sulfur dioxide (SO_2) and nitrogen

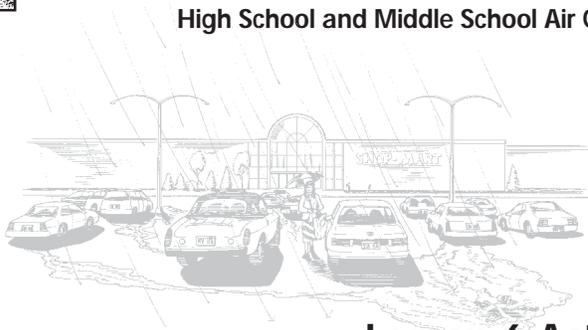
oxide (NO_x). Acid rain usually forms high in the clouds where sulfur dioxide and nitrogen oxides react with water, oxygen, and oxidants. This mixture forms a mild solution of sulfuric acid and nitric acid. Sunlight increases the rate of most of these reactions. Rainwater, snow, fog, and other forms of precipitation containing those mild solutions of sulfuric and nitric acids fall to earth as acid rain.

The chemical reactions that change air pollution to acid rain can take from several hours to several days. Years ago, when smokestacks were only a few stories high, pollution from smokestacks usually stayed near the ground and settled on land nearby. This caused unhealthy conditions for plants and animals near the smokestacks. To reduce this pollution, the government passed a law permitting the construction of very tall smokestacks. At that time, people thought that if the pollution were sent high into the air it would no longer be a problem. Scientists now know that this is incorrect. Sending pollution high into the sky increases the time that the pollution stays in the air. The longer the pollution is in the air, the greater are the chances that the pollutants will form acid rain. In addition, the wind can carry these pollutants for hundreds of miles before they become joined with water droplets to form acid rain. For that reason, acid rain can also be a problem in areas far from the polluting smokestacks.

The region of the Continental United States most affected by acid rain is the Northeast, where pH levels of between 4.0 and 4.5 are commonplace. Notably, the most rapid increase in acid precipitation in the U.S. seems to be in the Southeast, an increase paralleling the expansion of Southeastern urban and industrial activities that result in sulfur and nitrogen emissions.

West of the Mississippi, rain is generally neutral or even alkaline. Colorado, the Los Angeles Basin, the San Francisco Bay Area, Spokane, Tucson, and Portland are the known exceptions. In these locations, as in the Northeast, precipitation ranges from between pH 4.0 to 5.0.

Source: *Acid Rain. A Student's First Sourcebook.* EPA, Washington, DC



WHAT IS ACID RAIN

Lesson 6 Activity 1 STUDENT WORKSHEET 1

1. Define acid rain: _____

2. Explain the pH difference between acid rain and pure water: _____

3. Describe the major cause of acid rain: _____

4. Why is acid rain of particular interest? _____

5. What are the main chemicals in air pollution that create acid rain? _____

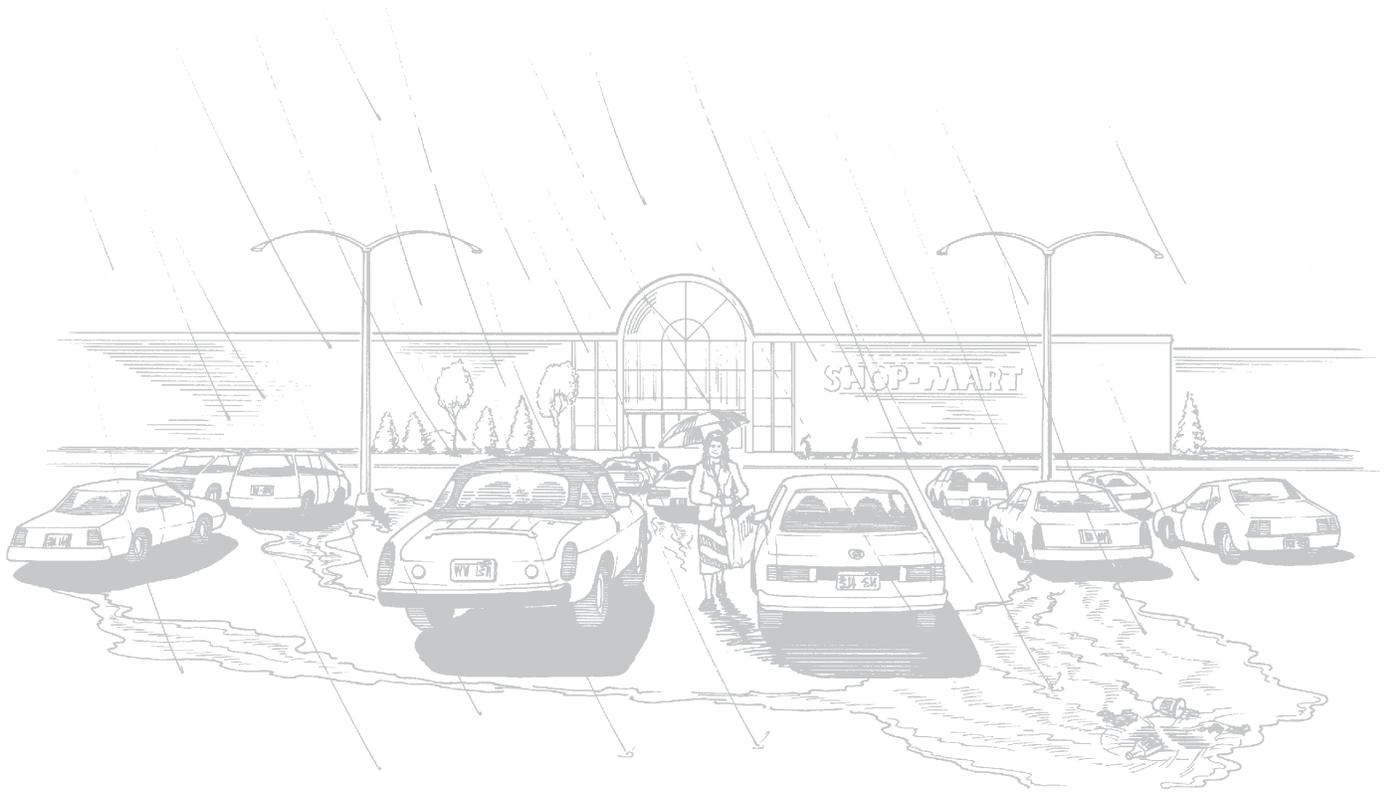
6. How long does the chemical reactions take that change air pollution to acid rain? _____

7. What did the U.S. government do at first to reduce the pollution from smokestacks? _____

8. How successful was this government action? _____

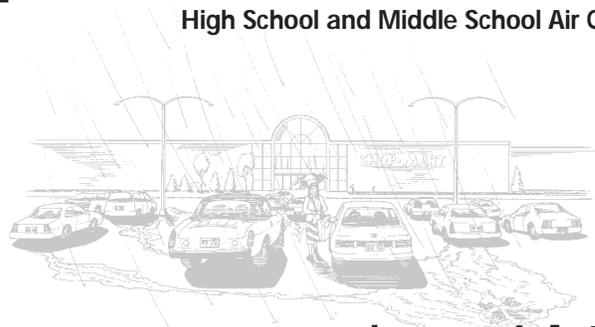
9. Which region of the Continental United States is the most affected by acid rain? _____

10. Which region is the least affected by acid rain? _____



TEACHER MATERIALS

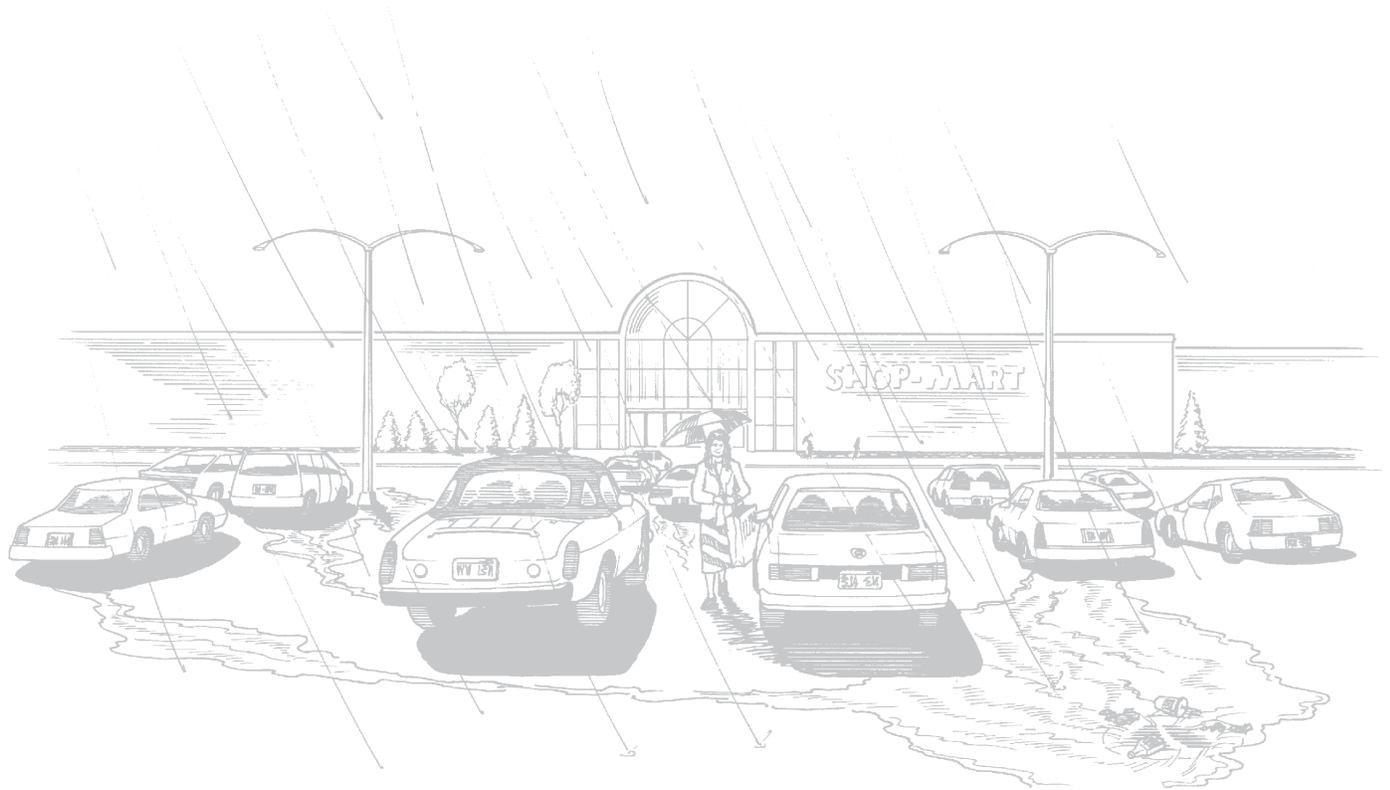
LESSON 6 ACTIVITY 1



WHAT IS ACID RAIN

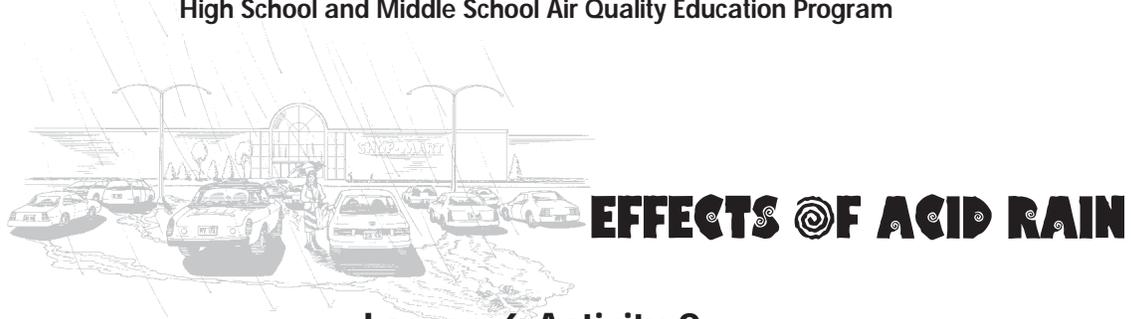
Lesson 6 Activity 1 ANSWER KEY TO STUDENT WORKSHEET 1

1. Define acid rain: **One form of pollution is acid rain. Acid rain is any form of rain that is more acidic than normal.**
2. Explain the pH difference between acid rain and pure water: **Acid rain has a pH lower than 5.6. Pure water has a pH of 7, normal rainfall has a pH of a bit less than 7, but acid rain can have a pH of about 5.0-5.5, and even in the 4 range in the northeastern United States.**
3. Describe the major cause of acid rain: **Scientists have discovered that air pollution from the burning of fossil fuels is the major cause of acid rain. People burn fossil fuels such as coal and oil to make electricity.**
4. Why is acid rain of particular interest? **It is one of particular interest, however, because it can be transported over long distances.**
5. What are the main chemicals in air pollution that create acid rain? **The main chemicals in air pollution that create acid rain are sulfur dioxide (SO₂) and nitrogen oxide (NO_x).**
6. How long does the chemical reactions take that change air pollution to acid rain? **The chemical reactions that change air pollution to acid rain can take from several hours to several days.**
7. What did the U.S. government do at first to reduce the pollution from smokestacks? **To reduce this pollution, the government passed a law permitting the construction of very tall smokestacks. At that time, people thought that if the pollution were sent high into the air it would no longer be a problem.**
8. How successful was this government action? **Scientists now know that this is incorrect. Sending pollution high into the sky increases the time that the pollution stays in the air. The longer the pollution is in the air, the greater are the chances that the pollutants will form acid rain. In addition, the wind can carry these pollutants for hundreds of miles before they become joined with water droplets to form acid rain.**
9. Which region of the Continental United States is the most affected by acid rain? **The region of the Continental United States most affected by acid rain is the Northeast, where pH levels of between 4.0 and 4.5 are commonplace.**
10. Which region is the least affected by acid rain? **West of the Mississippi, rain is generally neutral or even alkaline.**



STUDENT MATERIALS

LESSON 6 ACTIVITY 2

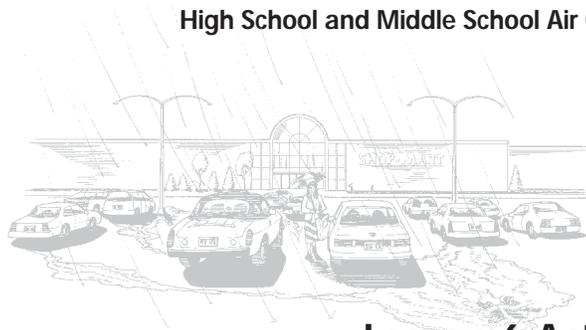


Lesson 6 Activity 2
Handout 1

	pH 6.5	pH 6.0	pH 5.5	pH 5.0	pH 4.5	pH 4.0
TROUT						
BASS						
PERCH						
FROGS						
SALAMANDERS						
CLAMS						
CRAYFISH						
SNAILS						
MAYFLY						

This chart shows that not all fish, shellfish, or their food insects can tolerate the same amount of acid. Fish like trout, bass, and perch are affected at different pH levels. Which type of fish are the most sensitive to acid? Generally, the young of most species are more sensitive than adults. Frogs may tolerate relatively high levels of acidity, but if they eat insects like the mayfly, they may be affected because part of their food supply may disappear.

Source: *Acid Rain. A Student's First Sourcebook*. EPA, Washington, DC



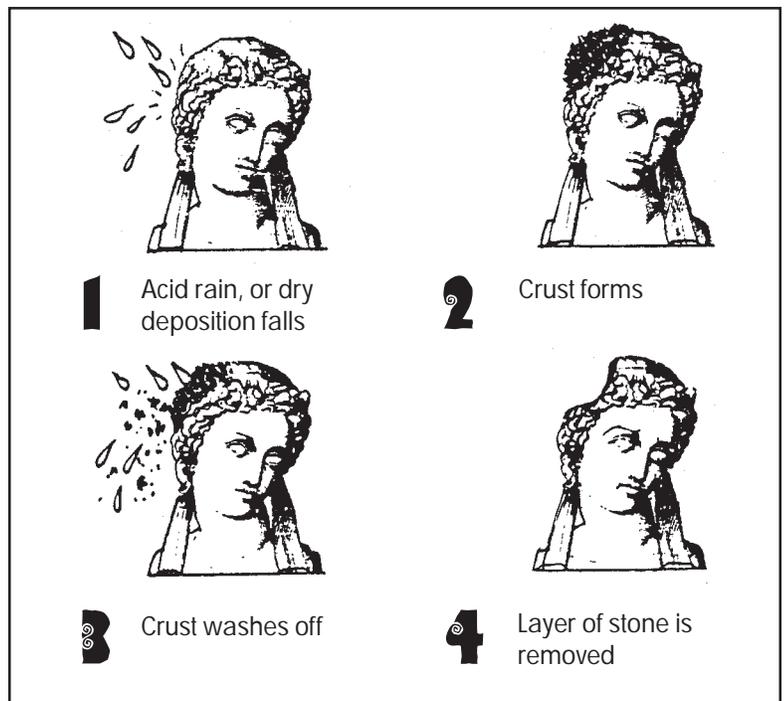
EFFECTS OF ACID RAIN

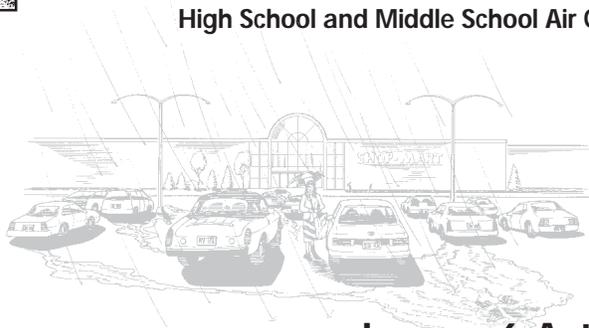
Lesson 6 Activity 2 Handout 2



Forest damage to which acid deposition may have been a contributing cause (photo courtesy of Tom Ripp).

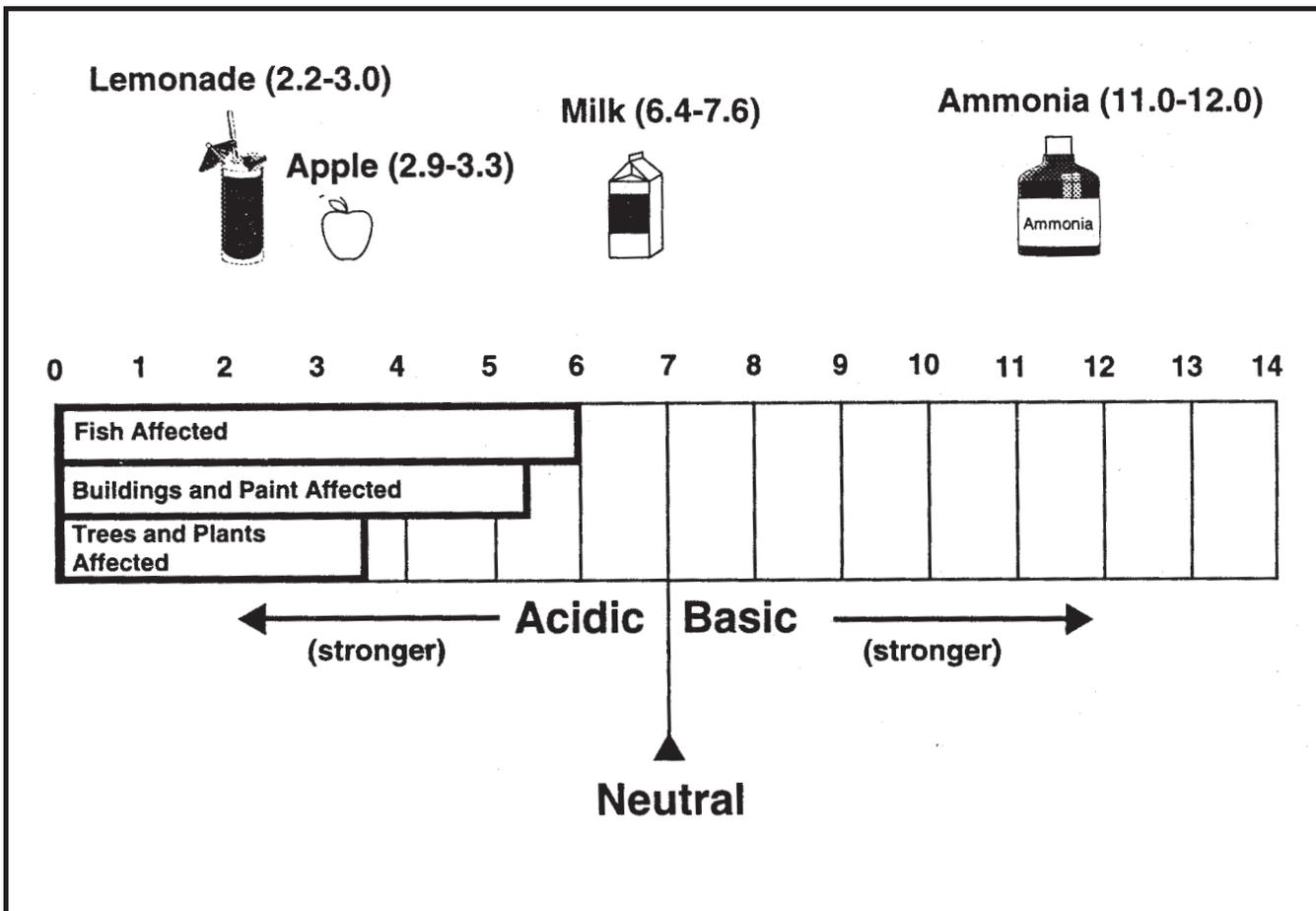
Source: *Acid Rain. A Student's First Sourcebook*, EPA, Washington, DC





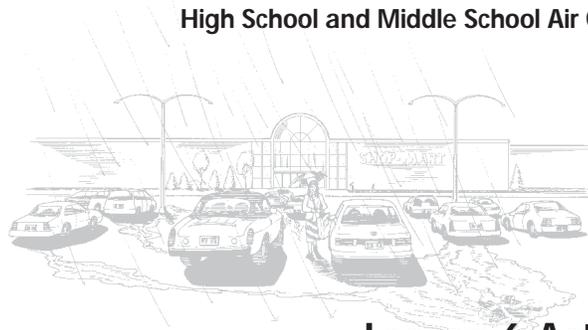
EFFECTS OF ACID RAIN

Lesson 6 Activity 2 Handout 3



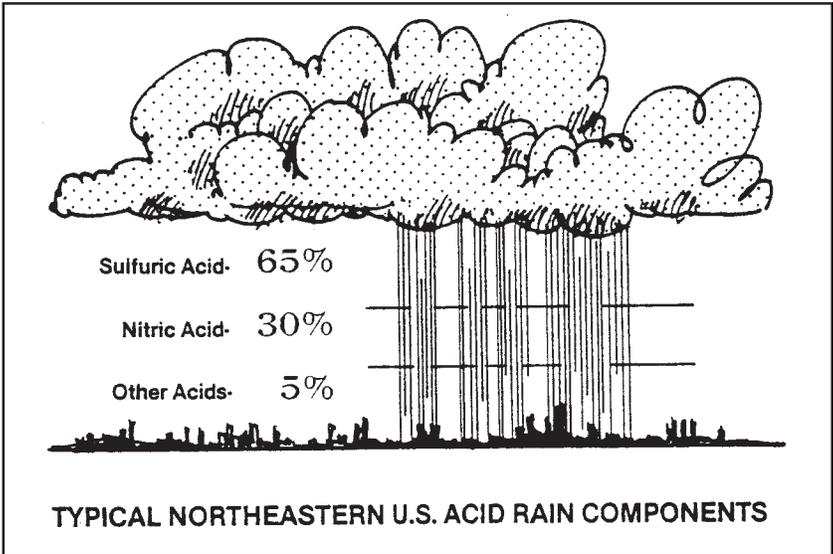
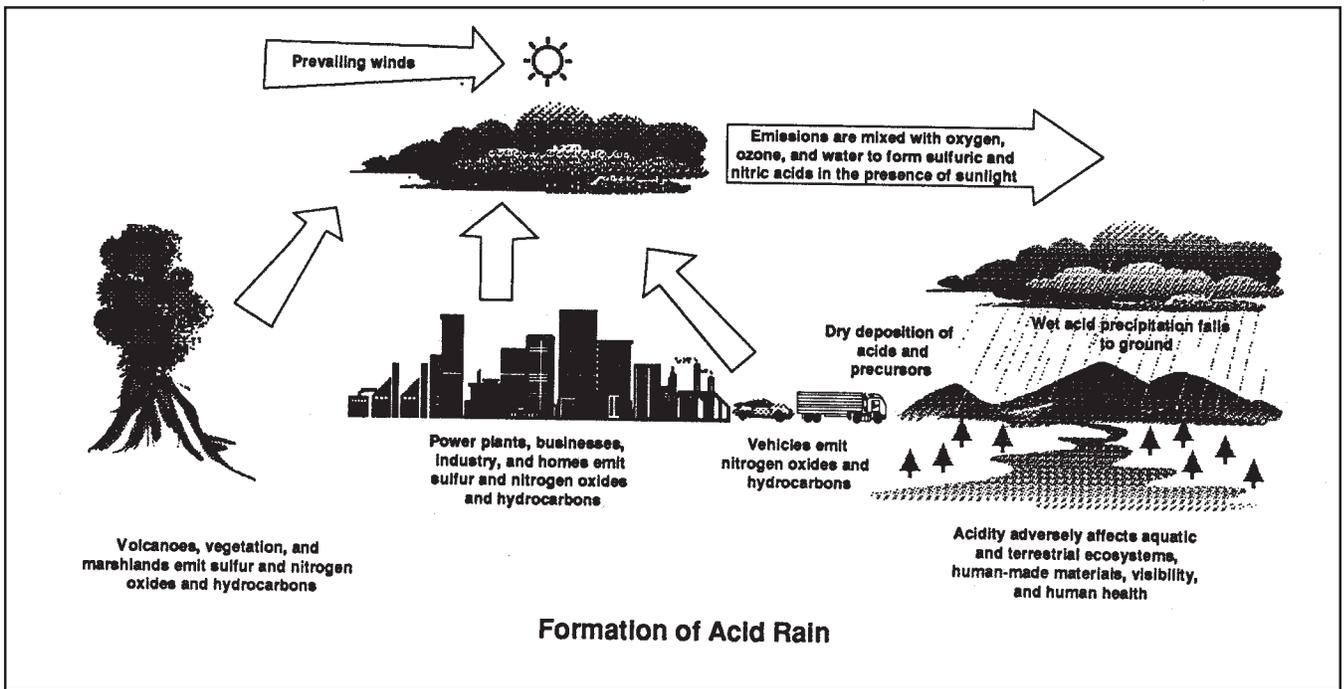
This diagram shows the pH scale. On top are some common items and their pH. A pH stronger than around 5 can harm buildings, metals, paint, other materials. What pH level can harm fish? How about plants? Are these levels of acidity stronger or weaker than the level that affects materials?

Source: *Acid Rain. A Students' First Sourcebook.* EPA, Washington, DC



EFFECTS OF ACID RAIN

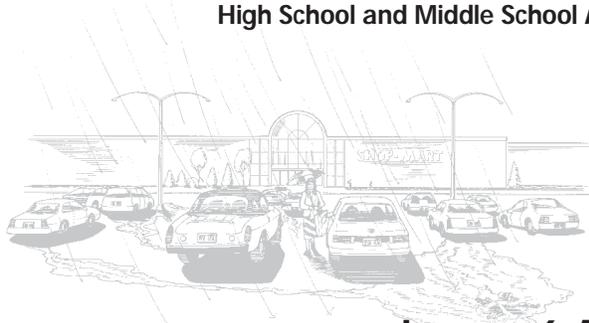
Lesson 6 Activity 2 Handout 4



Source: *Acid Rain. A Students' First Sourcebook*. EPA, Washington, DC

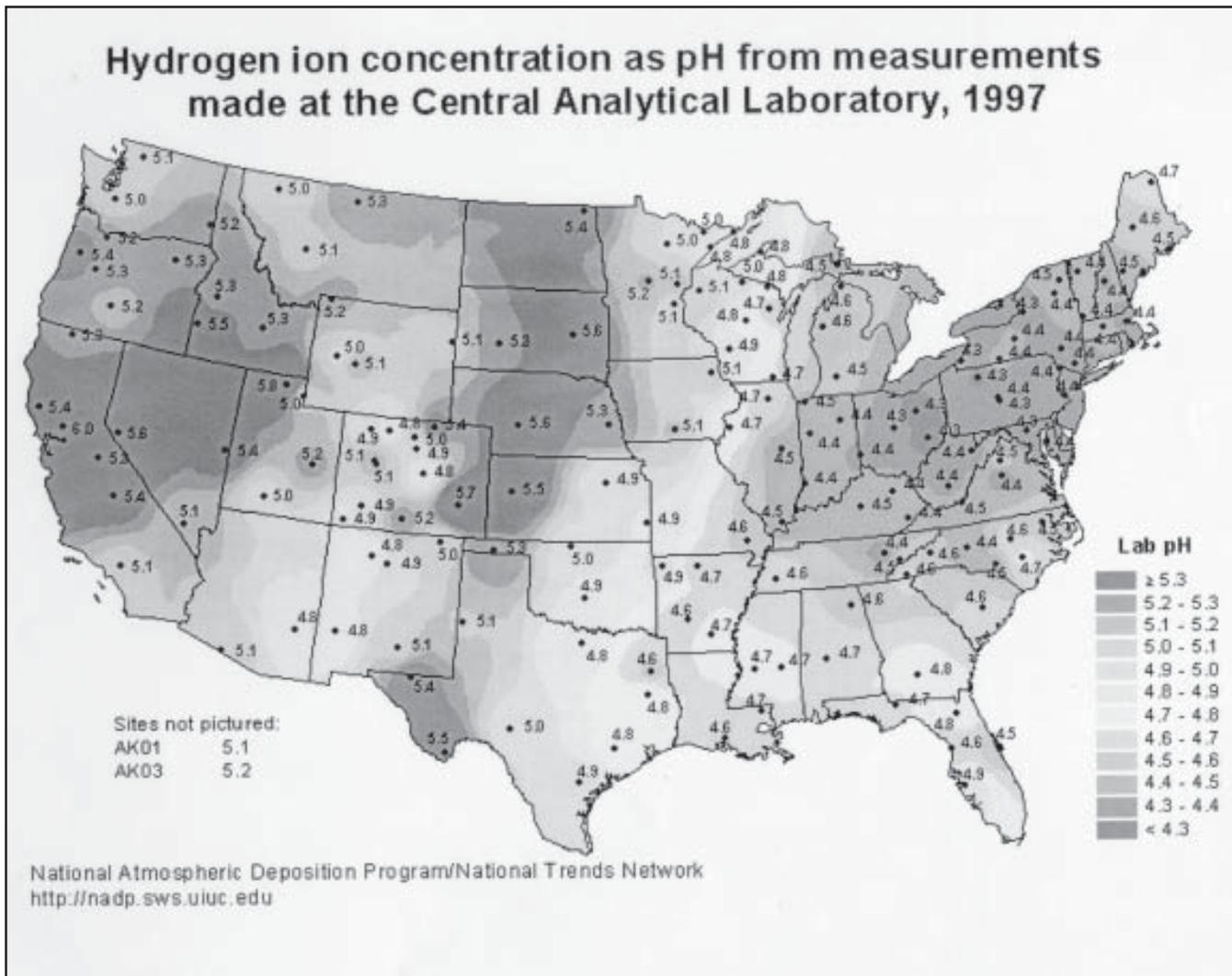


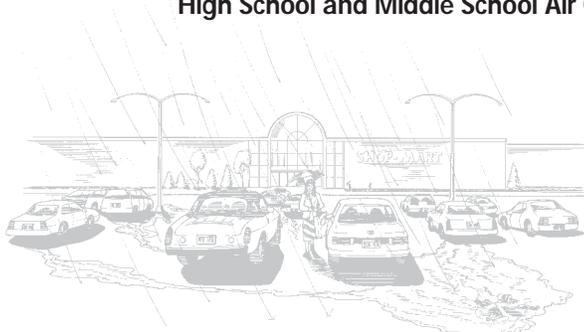
High School and Middle School Air Quality Education Program



EFFECTS OF ACID RAIN

Lesson 6 Activity 2 Handout 5





WHAT IS ACID RAIN

Lesson 6 Activity 2 HANDOUT 6 GROUP BRAINSTORMING

Group _____ (number)

Class: _____ Period or Block: _____ Date: _____

FIRST PRESENTATION

ROLE: _____ (Group consensus)

ROLE: _____ (Answer as revealed by the presenters)

Notes: _____

SECOND PRESENTATION

ROLE: _____ (Group consensus)

ROLE: _____ (Answer as revealed by the presenters)

Notes: _____

THIRD PRESENTATION

ROLE: _____ (Group consensus)

ROLE: _____ (Answer as revealed by the presenters)

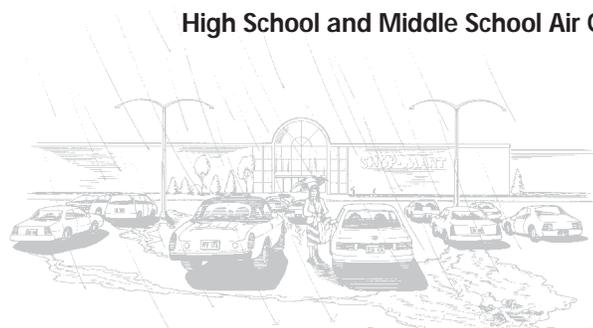
Notes: _____

FOURTH PRESENTATION

ROLE: _____ (Group consensus)

ROLE: _____ (Answer as revealed by the presenters)

Notes: _____



WHAT IS ACID RAIN

Lesson 6 Activity 2 ROLE 1

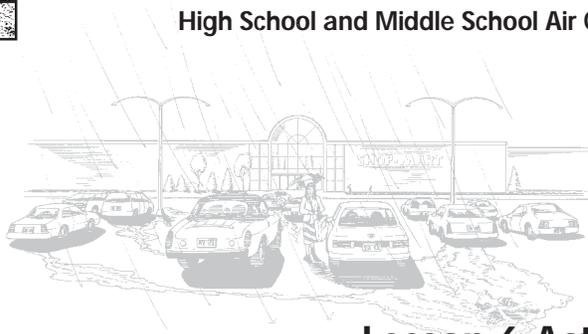
Role: FISH

Type of Fish: BASS

Use this information to present yourself to the class:

- ◆ I live in an environment where the most dramatic effects of acid rain have been clearly observed.
- ◆ Low pH precipitation can kill my unborn.
- ◆ At pH 5, most of my unborn will not survive.
- ◆ The most common cause of decline in my population is failure of the reproductive cycle as a result of acid rain.
- ◆ My kind of species is acid-sensitive and we will be lost as the pH declines.
- ◆ Our adults will die at lower pH levels.
- ◆ My food is also drastically affected by acid rain.
- ◆ My very existence is one of the major reasons many people travel to visit my location.
- ◆ Today, less people travel to visit my environment due to the decline of my sort.
- ◆ The state of Delaware has had a problem with my kind in recent years.
- ◆ The prognosis for my kind in this environment is not good if the current trend continues.
- ◆ My species eat other members of my kind.
- ◆ The extent of the acidity or pH level of my environment depends on the buffering capacity of the surrounding soil.
- ◆ In areas like the Northeastern U.S. and Delaware where soil buffering is poor, my population is being decimated.
- ◆ My specific type of specie dies out at a pH of 5.0.

WHO OR WHAT AM I ?



WHAT IS ACID RAIN

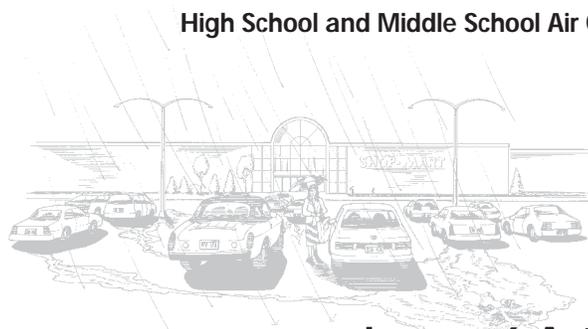
Lesson 6 Activity 2 ROLE 2

Role: TREE

Use this information to present yourself to the class:

- ◆ Acid rain does not usually kill me or my kind directly.
- ◆ Acid rain is more likely to weaken my kind.
- ◆ Acid rain weakens us by damaging an exterior part of our structure.
- ◆ Acid rain also limits the nutrients available to us.
- ◆ Acid rain also weakens us by slowly releasing poison (toxic substances) into our environment.
- ◆ We can be harmed even if our environment is well buffered.
- ◆ Our distance from sea-level determines how much acid rain we must endure.
- ◆ The higher our environment from sea level the more acid we come into contact with.
- ◆ This additional acid is from the acidic clouds and fog that often surround us.
- ◆ These clouds and fog are often more acidic than rainfall.
- ◆ Our protective waxy coats wear away in this acidic fog.
- ◆ Without our coats we develop brown spots.
- ◆ We produce our own food by a process called photosynthesis.
- ◆ Once I am weakened by acid rain, I can more easily be attacked by diseases or insects that ultimately will kill me.
- ◆ Researchers suspect that acid rain may cause my slow growth.
- ◆ Parts of me fall off as a result of acid rain.
- ◆ The safest places for me to live are in the Midwestern states like Nebraska and Indiana which have well buffered environments.
- ◆ Places in the Northeast, like New York and Delaware have environments that are less able to buffer acids.

WHO OR WHAT AM I ?



WHAT IS ACID RAIN

Lesson 6 Activity 2 ROLE 3

Role: PEOPLE

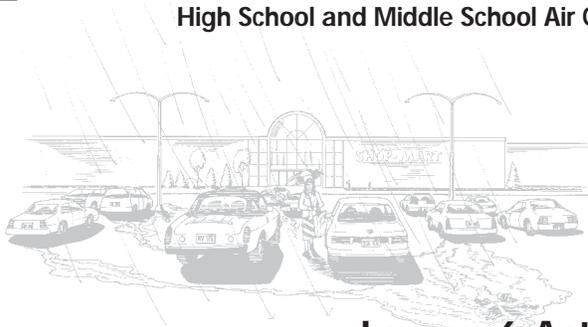
Use this information to present yourself to the class:

- ◆ Acid rain does not harm me directly.
- ◆ The air pollution that causes acid rain is more damaging to me.
- ◆ Sulfur dioxide and nitrogen oxides, the major sources of acid rain, can irritate or even damage my ability to get oxygen.
- ◆ The pollutants that cause acid rain can also reduce my ability to see.
- ◆ Some of my activities worsen the effects of acid rain.
- ◆ According to studies at Harvard and New York Universities, higher levels of sulfate aerosols are associated with increased effects on me.
- ◆ The real direct biological effects of acid rain on me have yet to be established.
- ◆ The pH level that will cause burns on me is not known.
- ◆ The heavy metals released by acid rain do present a potential threat to me.
- ◆ It is thought that the more acidic the liquid I ingest, concurrent increases in heavy metal concentrations may harm me.
- ◆ It is thought that as my liquid reservoirs become more acidic, the heavy metal concentrations will increase and exceed my limits.
- ◆ As my liquids acidify and come into contact with my delivery systems, lead will pass into this liquid at concentrations that exceed my level of tolerance.

WHO OR WHAT AM I ?



High School and Middle School Air Quality Education Program



WHAT IS ACID RAIN

Lesson 6 Activity 2 ROLE 4

Role: MANMADE OBJECTS (statutes, buildings, etc.)

Use this information to present yourself to the class:

- ◆ Acid rain affects me directly.
- ◆ Acid rain eats away at me.
- ◆ It is difficult for experts to separate acid rain's effects from the effects of other air pollution and weathering.
- ◆ I gradually deteriorate even when exposed to unpolluted rain, but acid rain accelerates the process.
- ◆ Repairing acid rain damage to my kind can cost billions of dollars.
- ◆ Some of my friends can never be replaced as a result of acid rain.
- ◆ Acid rain has caused some of my older friends to lose their features.
- ◆ Some individuals of my kind have been totally destroyed.
- ◆ Atmospheric gases dissolved in water react with my surface to form a chemically active solution.
- ◆ This solution and the products it forms then either seep into my surface or mix on my outer layer with environmental soot to form an ugly crust.
- ◆ When this crust is washed away by precipitation it takes a layer of my surface with it.
- ◆ This process is greatly accelerated when the atmosphere contains SO_2 or NO_x and rains are acidic.
- ◆ The SO_2 (Sulfur dioxide) makes me much more soluble in water.
- ◆ I am easily washed away by acid rain.
- ◆ Even as some have attempted to protect me by covering me, but even manufacturers of this covering have acknowledged problems caused by acid rain in many parts of the U.S.

WHO OR WHAT AM I ?



High School and Middle School Air Quality Education Program



WHAT IS ACID RAIN

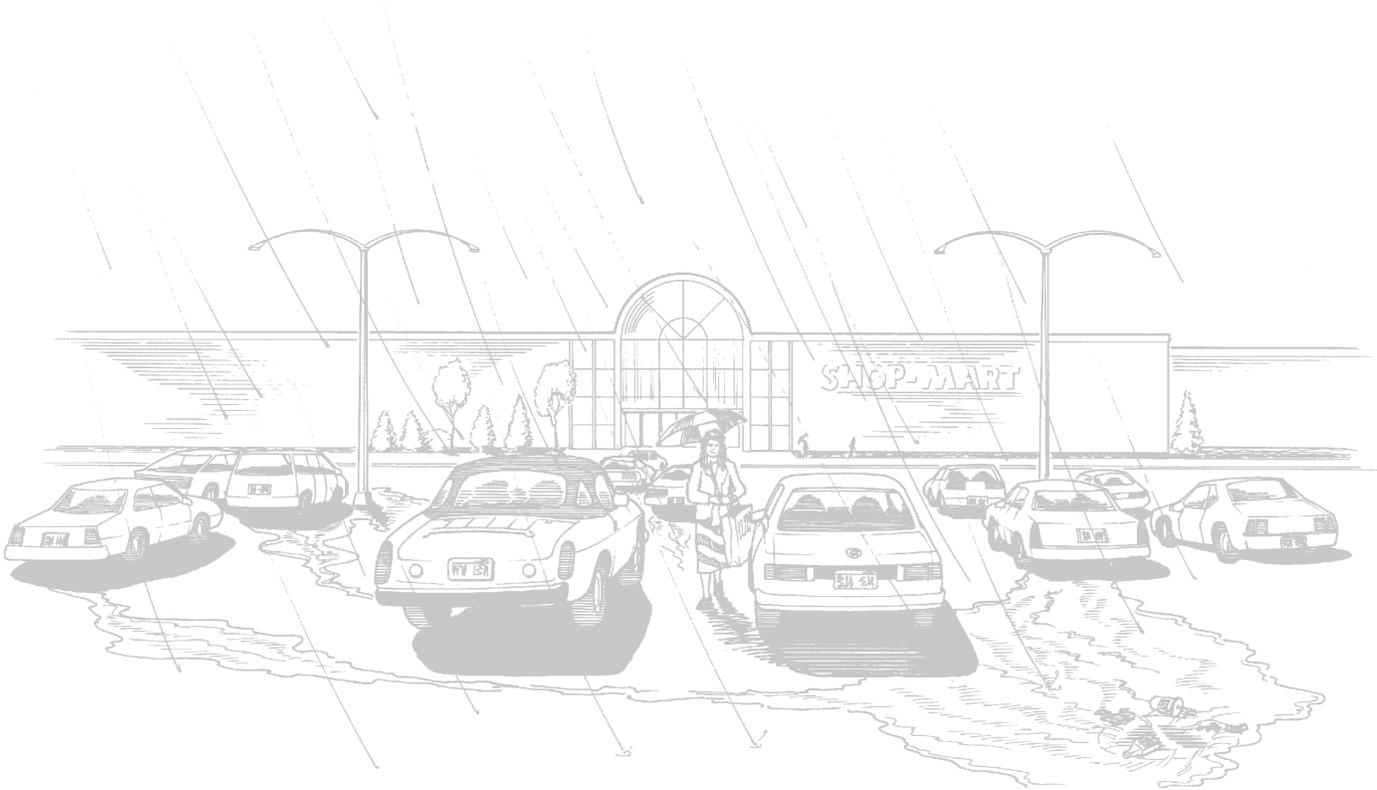
Lesson 6 Activity 2 ROLE 5

Role: SOIL

Use this information to present yourself to the class:

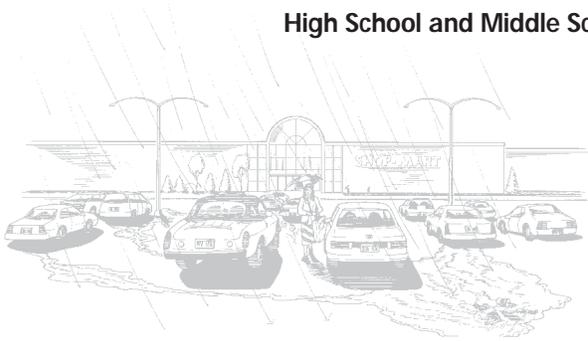
- ◆ Acid rain affects me directly by soaking into me.
- ◆ Some of the acid rain trickles over me and runs elsewhere.
- ◆ I have the ability to neutralize some or all of the acidity of acid rain.
- ◆ My ability to resist pH change is called my buffering capacity.
- ◆ My buffering ability depends on where I am located.
- ◆ If I am located in the Midwestern states, I have great buffering ability.
- ◆ If I am located in the Northeast, my buffering ability is greatly reduced.
- ◆ Natural sources of acids also makes me more susceptible to the impacts of acid rain.
- ◆ I have the ability to protect others from the impacts of acid rain.
- ◆ There is a great concern about the impact that acid rain has on me.
- ◆ Acid rain can strip away vital items that will impact others.
- ◆ Acid rain may disrupt my system of regeneration.
- ◆ Acid rain may affect my storage function.
- ◆ I can greatly increase or decrease the ability of others to thrive.
- ◆ Acid rain may affect my ability to help others be more productive.

WHO OR WHAT AM I?



STUDENT MATERIALS

LESSON 6 ACTIVITY 3



WHAT CAN BE DONE TO SOLVE THE RAIN PROBLEM?

Lesson 6 Activity 3 ACTIVITY SHEET 1 GROUP BRAINSTORMING

Group Name: _____ Date: _____

Subject: _____ Block or Period: _____

Solution One:

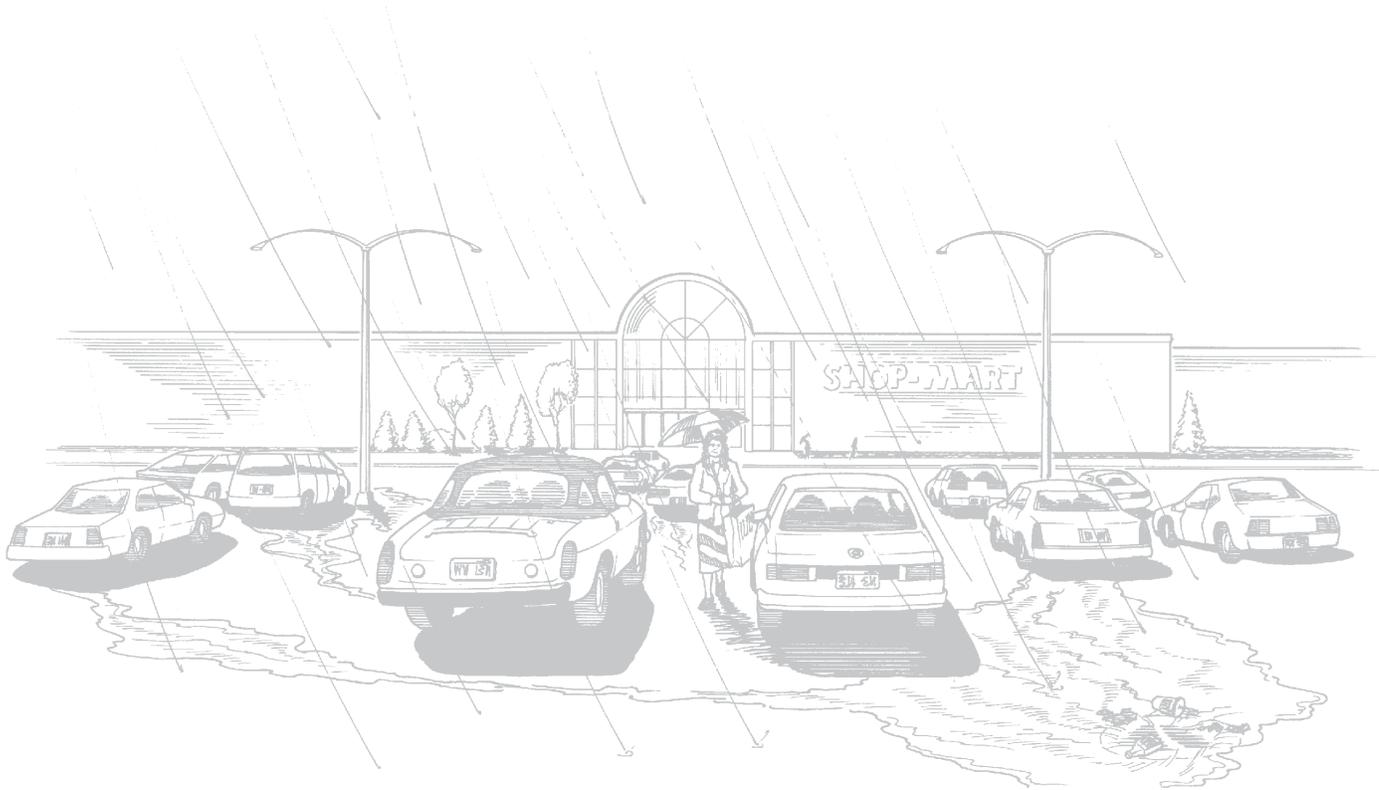
Solution Two:

Solution Three:

Solution Four:

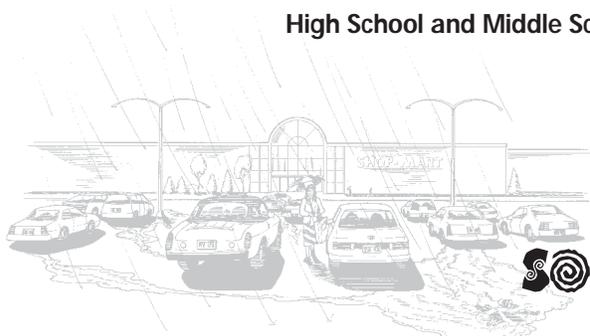
Solution Five:

Solution Six:



TEACHER MATERIALS

LESSON 6 ACTIVITY 3



WHAT CAN BE DONE TO SOLVE THE ACID RAIN PROBLEM?

Lesson 6 Activity 3

HANDOUT 8

TEACHER NOTES ON TRANSPARENCY 3

- 1. SCIENTIFIC RESEARCH** - Experts from the United States Environmental Protection Agency (EPA) have taken samples of pollution and acidity from thousands of streams and lakes in the U.S. From these samples, they determined the number of streams and lakes which are now acidic and which are in danger of becoming acidic. EPA and other scientists are also studying the effects of acid rain on fish, plants, humans and manmade materials. Until we reduce air pollution, acid rain will continue to be a problem.
- 2. CLEANING UP SMOKESTACKS** - Right now, burning fossil fuels is one of the most inexpensive ways to produce electricity for the daily activities of modern life and to power cars, buses and airplanes. In the U.S., sulfur in coal makes up the greatest part of the sulfur dioxide that becomes acid rain. There are several ways to reduce the amount of sulfur entering the air. One way is to **wash the sulfur out of the coal before it is burned** (pre-combustion). Another is to **wash the sulfur out of the smoke before it goes up the smokestacks** (combustion). The third way is to **remove the sulfur after combustion** by the use of scrubbers to remove sulfur from the smoke—spraying a mixture of water and powdered limestone into the smokestack (post-combustion).
- 3. CLEANING UP EXHAUST PIPES** - Nitrogen oxides from burning coal and from vehicles also contribute to acid rain. Vehicles give off nitrogen oxides and other pollutants in their exhaust fumes. Devices such as catalytic converters reduce the pollution from those exhaust fumes. All new cars sold in the U.S. are required to have catalytic converters. These catalytic converters use a 3-way system that reduces carbon monoxide, hydrocarbons, and NO_x simultaneously. To date the primary technique for reducing automobile NO_x emissions has been by lowering combustion temperatures in the engine.
- 4. ALTERNATIVE WAYS OF PRODUCING ENERGY** - There are other sources of energy besides fossil fuels. These include **hydroelectric** power and nuclear power. Dams use the power of water to turn **turbines** and make electricity. **Nuclear power plants** make electricity from the energy released by splitting atoms. A small amount of nuclear fuel can make a very large amount of electricity. Nuclear power plants on the other hand produce nuclear waste that is very deadly to all life. Scientists are looking at other energy sources, such as **solar energy**, using the power of the sun itself.
- 5. CONSERVING RESOURCES** - There are many things individuals can do to stop acid rain. Environmental probes—including acid rain—are caused by the combined actions of individual people. Individuals can take part in solving those problems as well. Each person who turns off lights when no one is using them and uses energy-saving appliances reduces the amount of electricity a power plant needs to produce. **Car-pooling, using public transportation, walking and riding bicycles** reduces the pollutants that come from vehicles. The more informed people are about acid rain and other environmental problems, the more they can do to make the earth a cleaner, healthier place.
- 6. RESTORING A DAMAGED ENVIRONMENT** - It can take years for an acidic lake or stream to recover naturally, even if the acid rain stops. People have brought some lakes and streams back to neutral or basic conditions more quickly than nature could alone. They have added powdered limestone (a natural base) to the water in a process called **liming**.



OVERHEAD TRANSPARENCY:
LESSON 6 ACTIVITY 3
OVERHEAD 3

- ◆ **SCIENTIFIC RESEARCH**

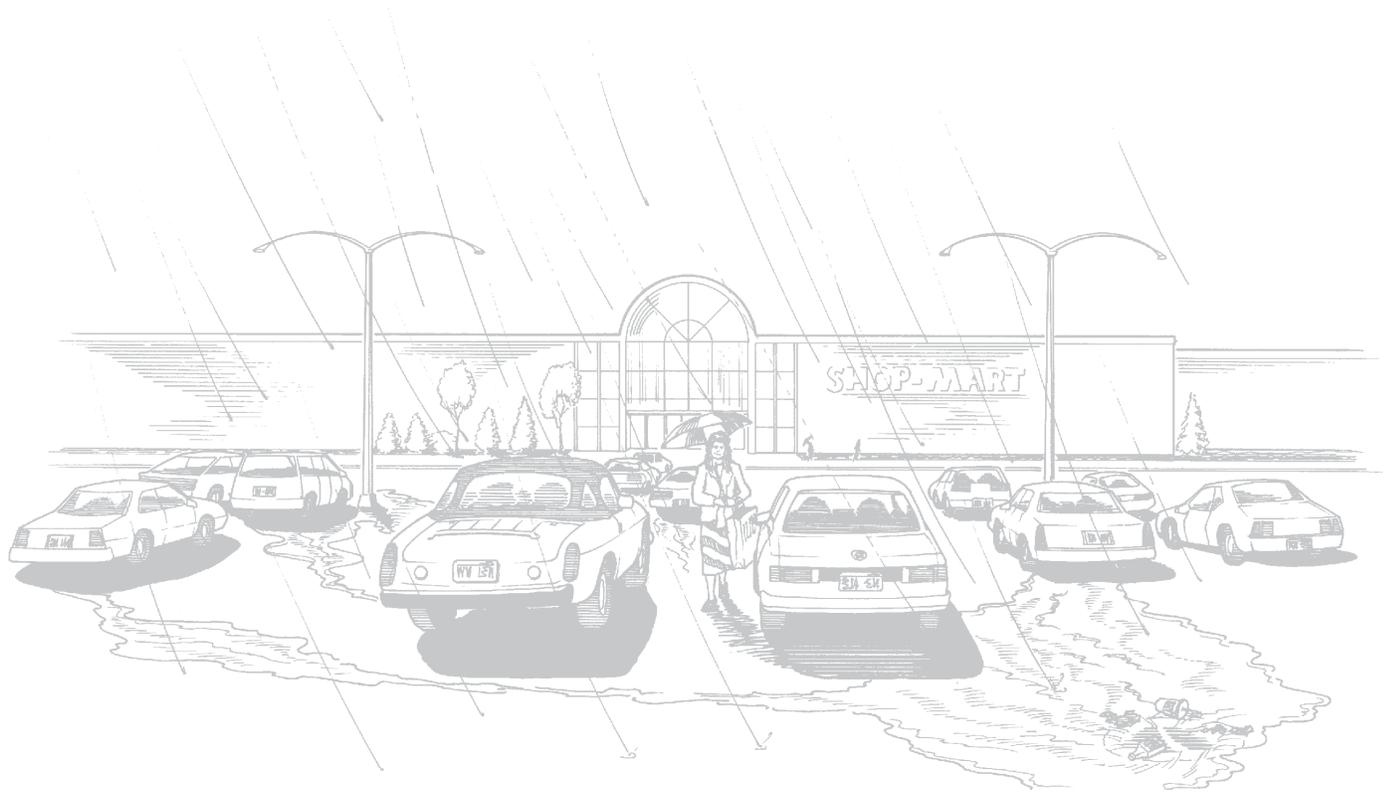
- ◆ **CLEANING UP SMOKESTACKS**
 - ◆ **PRE-COMBUSTION**
 - ◆ **COMBUSTION**
 - ◆ **POST-COMBUSTION**

- ◆ **CLEANING UP EXHAUST PIPES**
 - ◆ **CATALYTIC CONVERTERS**
 - ◆ **LOWERING COMBUSTION TEMPERATURES
IN THE ENGINE**

- ◆ **ALTERNATIVE WAYS OF PRODUCING ENERGY**
 - ◆ **HYDROELECTRIC POWER**
 - ◆ **NUCLEAR POWER**
 - ◆ **TURBINES**
 - ◆ **SOLAR ENERGY**

- ◆ **CONSERVING RESOURCES**

- ◆ **RESTORING A DAMAGED ENVIRONMENT**

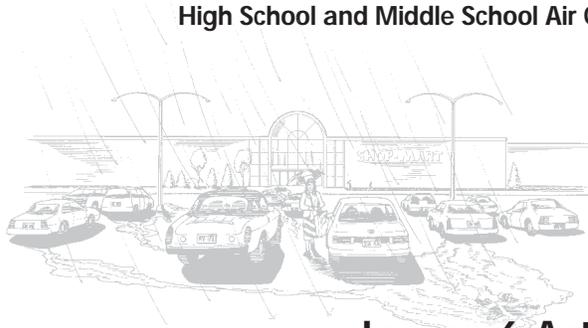


STUDENT MATERIALS

LESSON 6 ACTIVITY 4



High School and Middle School Air Quality Education Program



WHAT IS ACID RAIN

Lesson 6 Activity 4 ACTIVITY SHEET 2

T.V. Weather Special Student Directions

1. Your group will write, produce, and direct a special segment for a T.V. "weather special" on the effects of acid rain in Delaware.
2. You will make a clear statement for depiction of the acid rain issue.
3. Be sure to explain to your audience the cause of acid rain.
4. Describe how acid rain is formed and the pollutants involved in producing it.
5. In a concluding segment, convince the audience what needs to be done to help solve the problem of acid rain.



WHAT IS ACID RAIN?

Lesson 6 Activity 4 SCORING RUBRIC 1 ROLE PLAY ACTIVITY

- 4 – The T.V. Weather Special is clear and informative
- 3 – The T.V. Weather Special is clear and somewhat informative
- 2 – The T.V. Weather Special is vague and somewhat informative
- 1 – The T.V. Weather Special is vague and not informative

	0	1	2	3	4	
1. Explanation of Acid Rain issue P.I. G.402	_____	_____	_____	_____	_____	x 5 = _____
2. Cause of Acid Rain P.I. 9.75 (Science); G.402	_____	_____	_____	_____	_____	x 5 = _____
3. Effects of Acid Rain P.I. G.402; 9.75	_____	_____	_____	_____	_____	x 5 = _____
4. Pollutant identified P.I. G.402; 9.75	_____	_____	_____	_____	_____	x 5 = _____
5. Proposed solutions P.I. C.416; G.404	_____	_____	_____	_____	_____	x 5 = _____

GRADE _____