

Lesson A4–2

Examining Industrial Air Pollution

Unit A. Natural Resources

Problem Area 4. Air

Lesson 2. Examining Industrial Air Pollution

New Mexico Content Standard:

Pathway Strand: Natural Resources and Environmental Systems

Standard: VIII: Understand environmental service systems.

Benchmark: VIII-A: Understand pollution control measures to maintain a safe facility environment.

Performance Standard: 1. Identify types of pollution (e.g. ground, surface water, air, noise, radioactive contamination). 2. Describe environmental impact from industrial and non-industrial processes.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Identify the types and sources of air pollution.
2. Describe the effects of air pollution.
3. Identify ways to protect the air from pollution.

List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

Porter, Lynn, Jasper S. Lee, Diana L. Turner, and Malcolm Hillan. *Environmental Science and Technology, 2nd Edition*. Upper Saddle River, New Jersey: Prentice Hall Interstate, 2003. (Textbook and Activity Manual, Chapter 19)

Other Resources. The following resources will be useful to students and teachers:

Cooper, Elmer L. and L. DeVere Burton. *Agriscience: Fundamentals & Applications*. Albany, New York: Delmar, 2002 (Unit 7).

Lee, Jasper S. *Natural Resources and Environmental Technology*. Danville, Illinois: Interstate Publishers, Inc., 2000. (Chapter 10).

Lee, Jasper S. and Diana L. Turner. *Introduction to World AgriScience and Technology*. Danville, Illinois: Interstate Publishers, Inc., 1997. (Textbook and Activity Manual, Chapter 3).

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Chapter 19
Glasses and 2 water samples

Terms. The following terms are presented in this lesson (shown in bold italics):

Acid rain
Alveoli
Combustion
Photochemical oxidants
Photochemical reactions
Scrubbers
Smog
Volatile organic compound (VOC)

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Place in front of the class two clear drinking glasses. In one glass pour fresh, clean water. In the other pour water that contains shavings from a pencil sharpener. Ask the students from which glass they would

rather drink? Ask them why. After brief discussion, compare the water in the glasses to the air we breathe. Compare the pencil shavings to the many types of air pollution that are in the air. Lead discussion to first objective of the lesson.

Summary of Content and Teaching Strategies

Objective I: Identify the types and sources of air pollution.

Anticipated Problem: What are the various types and sources of air pollution?

- I. Once the air becomes polluted, (see Lesson A4–1 for definition of air pollution) it is often very difficult to remove the sometimes dangerous materials from the air. There are two major types of air pollutants. They are gases and particulate matter.
 - A. Gases—Gas pollutants are difficult to identify because, like gases normally found in air, pollutants that are gases are colorless and odorless. Also, gases can remain in the atmosphere for years. Unlike other types of pollutants, gases do not settle out of the air. There are several classifications of gas pollutants. Some of the major ones are:
 1. Carbon Forms—The most common carbon gases in the air are hydrocarbon, carbon monoxide (CO), and carbon dioxide (CO₂). These pollutants are released through the process of **combustion** or burning of materials the contain carbon and the petroleum industry.
 - a. Hydrocarbons are classified as volatile organic compounds (VOC). A **volatile organic compound (VOC)** is any compound containing carbon that participates in photochemical reactions in the atmosphere. **Photochemical reactions** are reactions that are initiated by the sun. A common form of this reaction is photochemical smog. **Smog** is a mixture of dense radiation fog and gaseous pollutants, such as carbon dioxide and sulfur dioxide.
 - b. The use of engines that use gasoline or other fuels take oxygen from the air and release carbon gases into it. One poisonous gas produced in this process is carbon monoxide. This gas damages the ability of the human blood to carry oxygen. It is critically important that when operating an engine it is done in a well-ventilated area.
 2. Sulfur Oxides—Sulfur that is found in the air is most often found in its oxide form. Common sulfur oxides that are found in the air include sulfur dioxide (SO₂) and sulfur trioxide (SO₃). When the amount of sulfur reaches a certain level it can be detected by the presents of a “rotten egg-type” odor. Higher levels of sulfur can cause lung damage.
 - a. Sulfur dioxide is produced when fuels containing sulfur are burned in the presence of oxygen. Common fuels that contain sulfur are coal and oil.
 - b. Sulfur trioxide is able to combine with water vapor to form sulfuric acid (H₂SO₄). This is a very strong acid that can quickly react with materials when contact is

made. Rain containing sulfuric acid is known as **acid rain**. Acid rain can cause damage to plants and property.

3. Nitrogen Oxides—Nitrogen oxides are formed during combustion when nitrogen in fuel combines with oxygen. Common forms of nitrogen oxides are nitrogen monoxide (NO) and nitrogen dioxide (NO₂). The effects of nitrogen oxides are similar to those of sulfur oxides.
 4. Photochemical oxidant—**Photochemical oxidants** are formed by the interaction of nitric acid, sunlight, and hydrocarbons. These materials are the primary ingredients in smog. A major produce to the reaction is ozone (O₃). Ozone provides a protective shield around the earth, but also can cause problems for living organisms.
- B. Particulate Matter—Particulate includes small particles similar to dust and droplets of liquid. Smoke from factories, burning trash, and forest fires, as well as dust from roads and mines, are sources of solid particles. Most of the particles rise from the earth into the atmosphere; however, some are formed by reactions of other pollutant materials.

There are many techniques that can be used to assist students in mastering this material. Students need text material to aid in understanding the types and sources of air pollution. Chapter 19 in Environmental Science and Technology is recommended. Use TM: A4–2A, TM: A4–2B, TM: A4–2C, and TM: A4–2D to aid in the discussion on this topic.

Objective 2: Describe the effects of air pollution.

Anticipated Problem: What are some of the effects of air pollution on humans, plants, and other organisms?

- II. Air pollution can have devastating effects on the quality of life for humans and other organisms alike. The effects of air pollution can be classified in the following way:
 - A. Human Health Problems—A variety of human health problems are related to air pollution. Most are respiratory diseases. Some of the more common diseases that can be related to air pollution include lung cancer, emphysema, bronchitis, and black lung disease. These diseases, as well as others, can occur when pollutants are inhaled. When in the lungs, the pollutants interfere with the exchange of gases. The area inside the lungs where gases are exchanged is large and contains many tiny alveoli. **Alveoli** are air-containing cells found in the lungs. It is the thin membranes between the alveoli and blood vessels where gas exchange occurs. Some pollutants increase the liquid in the lungs and impair the exchange of gases. The human body does have a few natural defenses against air pollutants. The first point where air is cleansed before reaching the lungs is the nostrils. The nostrils have small hairs and moist membranes that filter dust and some gases. Materials that get past the small hairs may be absorbed by the mucous membranes. They become trapped and are then either blown out or swallowed.
 - B. Other Animals—Pollution may injure farm animals, pets, wildlife, and other animals in ways similar to that of humans. Additionally, animals that have feed produced in areas

near high air pollution may be poisoned by what they eat. Acid rain can also destroy wild fish population in lakes and streams if in a strong enough concentration.

- C. Plants and other organisms—Air pollution may cause damage to fruits, vegetables, flowers, trees, lawn grasses, and other plants. Several pollutants can destroy leaf tissue in plants. This results in the plant not being able to manufacture the needed chlorophyll.

There are many techniques that can be used to assist students in mastering this material. Students need text material to aid in understanding the effects of air pollution. Chapter 19 in Environmental Science and Technology is recommended. Use TM: A4–2D to aid in discussion on this topic.

Objective 3: Identify ways to protect the air from pollution.

Anticipated Problem: What are some ways to protect the air from pollution?

- III. As discussed earlier in this lesson, air pollution can cause severe damage to living organisms. Although we can never completely eliminate air pollution, there are several things that people can do to reduce the amount of pollution found in the atmosphere.
 - A. Controlling emissions—There are several ways that people can work to reduce the amount of emissions placed in the air supply. **Scrubbers** can be used on factory stacks to remove gases and particulate. People could use fuels that produce less sulfur. Also by maintaining engines in good working order, less fuel is burned and fewer pollutants are placed in the environment.
 - B. Reusing and Recycling—By reusing and recycling products, the pollutants that would have been released in the manufacturing of new products is avoided. Recycling a product requires more activity than reusing a product. However, the recycling process does not create as much pollution as initial manufacturing.
 - C. Practicing Safety—By following basic safety guidelines with handling products, fewer accidents will occur. This can reduce the amount of pollutants that are released into the air. Also, when working in areas of high air pollution, people should wear proper safety equipment to avoid health related problems.

There are many techniques that can be used to assist students in mastering this material. Students need text material to aid in understanding ways to protect the air from pollution. Chapter 19 in Environmental Science and Technology is recommended.

Review/Summary. Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at end of chapters in the textbook may also be used in the review/summary.

Application. Have students make a list of specific things that they can do to reduce the amount of air pollution being emitted into the atmosphere. Compile all of the student suggestions into one classroom list. Work with students to implement several of these strategies.

Evaluation. Use the following sample test to evaluate the students' comprehension of the objectives covered in this lesson.

Answers to Sample Test:

Part One: Matching

1 = a, 2 = e, 3 = d, 4 = h, 5 = c, 6 = f, 7 = g, 8 = b

Part Two: Completion

1. Hydrocarbon, carbon monoxide (CO), carbon dioxide (CO₂)
2. Ozone
3. Sulfur dioxide
4. particles
5. leaf tissue

Part Three: Short Answer

See Objective 3 in the lesson for scoring this question.

Test

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Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

- | | |
|--------------|------------------------------------|
| a. Acid rain | e. Combustion |
| b. Scrubbers | f. Volatile organic compound (VOC) |
| c. Alveoli | g. Photochemical oxidants |
| d. Smog | h. Photochemical reactions |

- _____ 1. Rain containing sulfuric acid.
- _____ 2. Same as burning or burning of materials that contain carbon.
- _____ 3. A mixture of dense radiation fog and gaseous pollutants, such as carbon dioxide and sulfur dioxide.
- _____ 4. Reactions that are initiated by the sun.
- _____ 5. Air-containing cells found in the lungs.
- _____ 6. Any compound containing carbon that participates in photochemical reactions in the atmosphere.
- _____ 7. Formed by the interaction of nitric acid, sunlight, and hydrocarbons.
- _____ 8. Used on factory stacks to remove gases and particulate.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

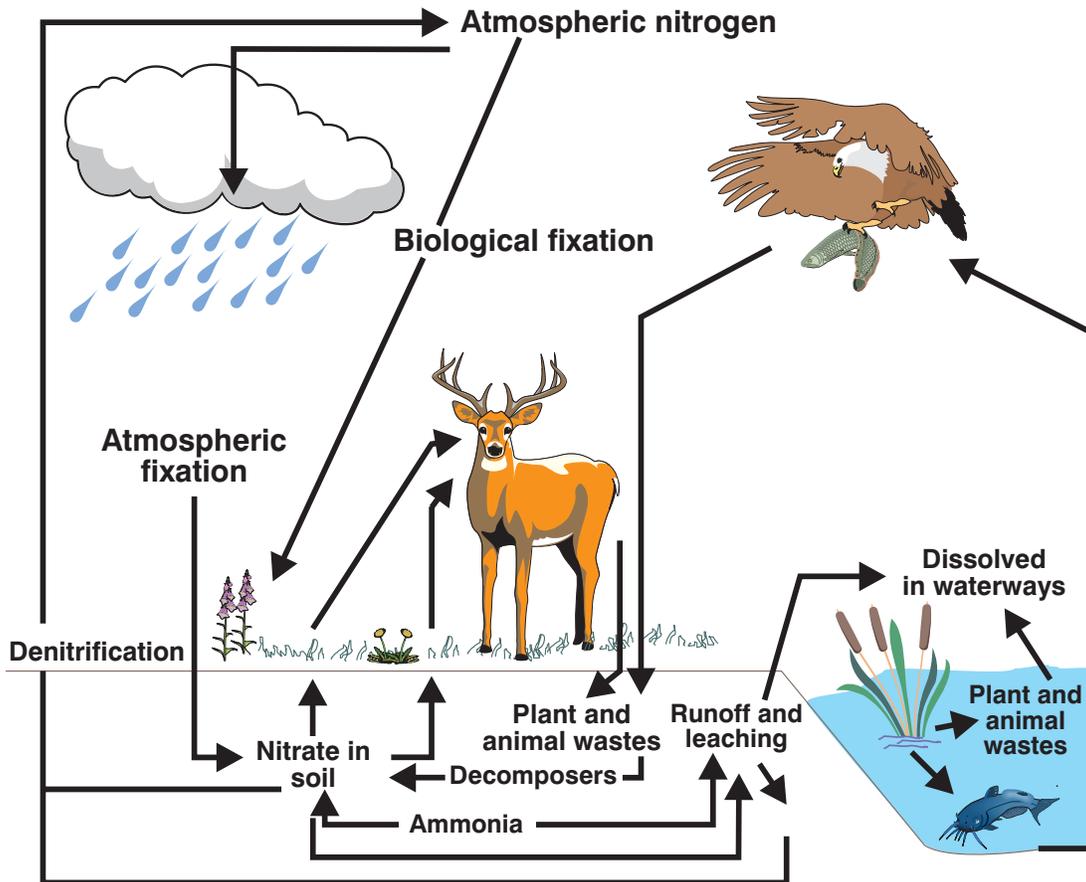
1. The most common carbon gases in the air are _____, _____, _____, and _____.
2. _____ provides a protective shield around the earth, but also can cause problems for living organisms.
3. _____ is produced when fuels containing sulfur are burned in the presence of oxygen.
4. Most of the _____ rise from the earth into the atmosphere; however, some are formed by reactions of other pollutant materials.
5. Several pollutants can destroy _____ in plants.

Part Three: Short Answer

Instructions. Provide information to answer the following question.

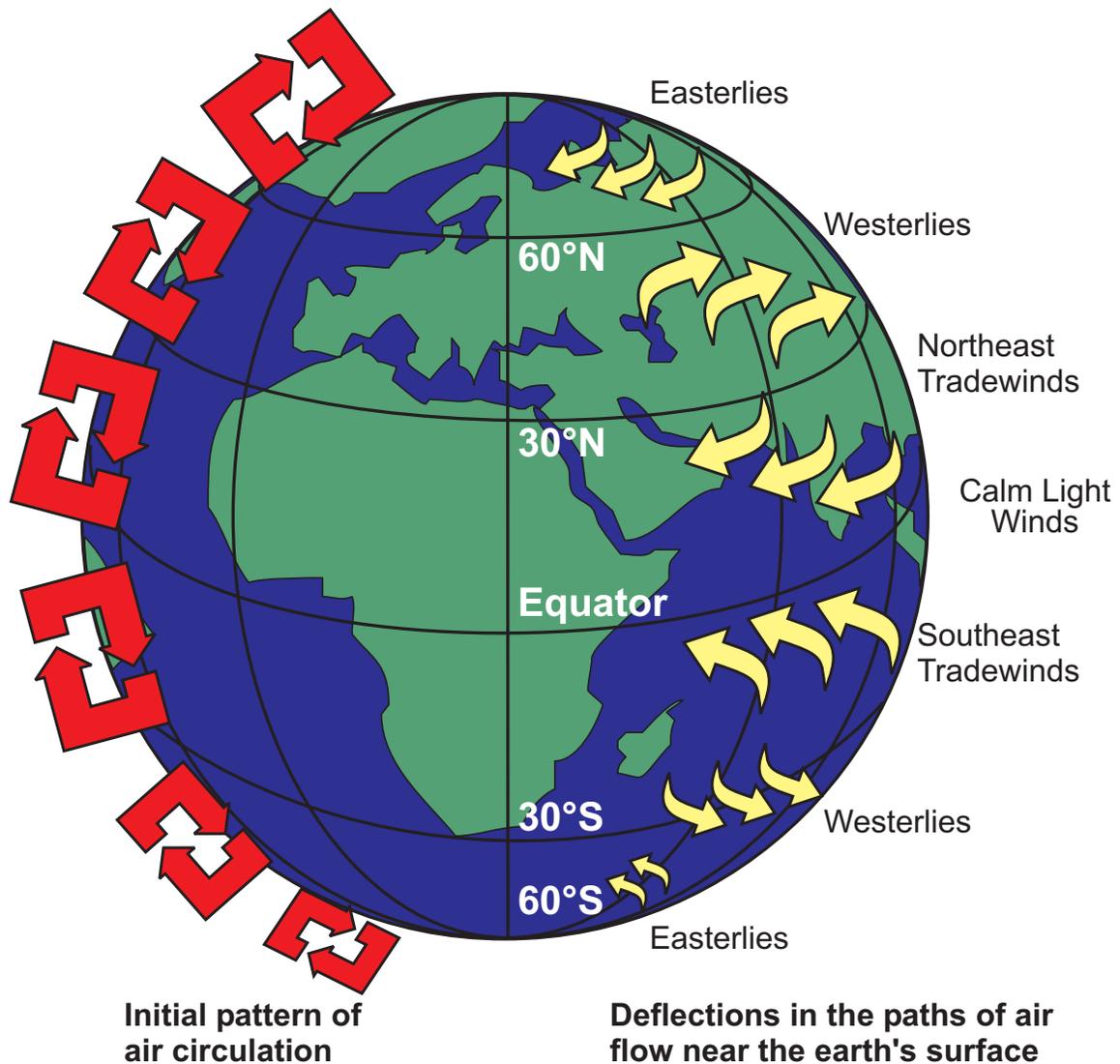
List three things people can do to reduce the amount of pollution in the air.

THE NITROGEN CYCLE



(Courtesy, Interstate Publishers, Inc.)

GLOBAL AIR MOVEMENT CARRIES SOME POLLUTION LONG DISTANCES

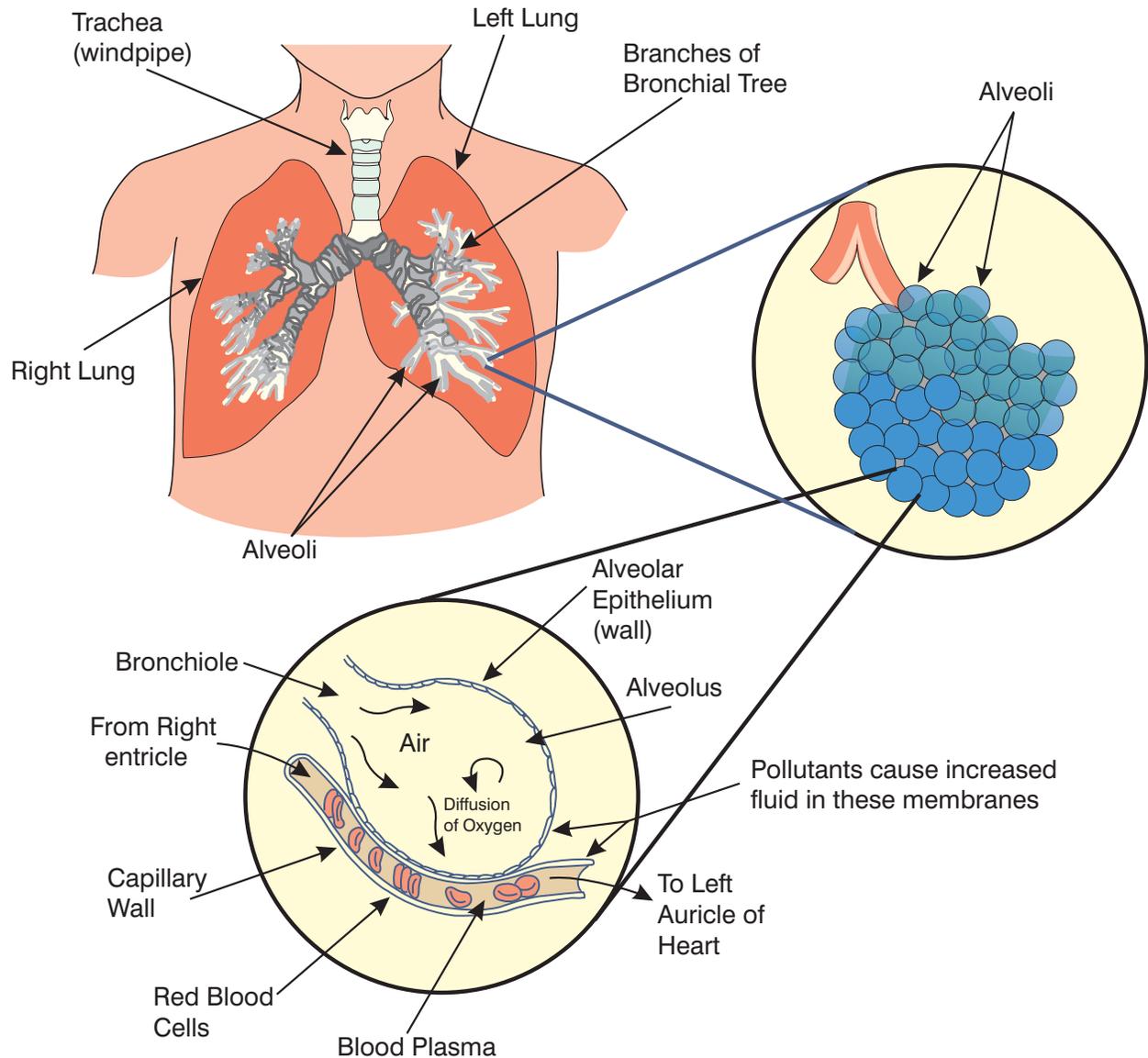


(Courtesy, Interstate Publishers, Inc.)

SOURCES OF AIR POLLUTION AND KINDS OF POLLUTANTS

Major Sources	Kinds of Pollutants Released
Transportation (cars, trucks, airplanes, and trains)	carbon monoxide, volatile organic compounds, nitrogen oxides, particulates, and sulfur dioxide.
Solid waste disposal (burning leaves, garbage, and other materials)	particulates, volatile organic compounds, carbon monoxide, nitrogen oxides, and sulfur dioxide.
Fuel combustion (electric power plants, homes, and offices)	sulfur dioxide, nitrogen oxides, particulates, carbon monoxide, and volatile organic compounds.
Industrial processes (oil refining, steel mills, and chemical manufacturing)	volatile organic compounds, particulates, sulfur dioxides, carbon monoxide, and nitrogen oxides
Other (forest fires, spraying chemicals, other fires)	particulates, carbon monoxide, volatile organic compounds, nitrogen oxides, and sulfur dioxide

EFFECTS OF AIR POLLUTION ON HUMAN HEALTH



(Courtesy, Interstate Publishers, Inc.)