

MEET THE DIRTY HALF DOZEN



OBJECTIVES

Students will do the following:

1. Name the six major (criteria) pollutants
2. Explain why criteria pollutants are of particular concern
3. List characteristics of each of the criteria pollutants
4. State that there are air pollutants other than the criteria pollutants
5. Describe the most notable health and welfare effects of each criteria pollutant

BACKGROUND INFORMATION

The late 1940s and early 1950s brought a noticeable decline in air quality around densely populated areas such as New York City and Los Angeles. Research into the causes of the smoky fog, or "smog," yielded some interesting findings. First, researchers discovered that the culprit chemicals came mostly from the burning of fossil fuels to power transportation vehicles. More distressing perhaps was the discovery that although the smog was most apparent in major metropolitan areas, the chemicals themselves existed almost everywhere in the ambient air.

Research was conducted to determine whether these far-ranging chemicals were harmful to those who breathed them. Study after study indicated that the substances did indeed affect humans adversely, with health consequences ranging from eye irritation and sore throat to bronchitis and more-serious effects. By the early 1970s, the data on the harmful levels and effects of the most common pollutants were sufficient to support regulations for acceptable concentrations of the substances in the ambient air. The data for each chemical were compiled in an air quality criteria document; consequently, these chemicals came to be called the criteria pollutants.

The U.S. Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) for the following six criteria pollutants: particles (particulate matter) that are less than 10 micrometers in diameter (PM_{10}), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxides (NO_x), ozone (O_3), and lead (Pb). Canada and Mexico have similar criteria for ambient air quality. The standards state the maximum "safe" concentration of these pollutants in the ambient air. The standards have been set to protect

TOPICS:

Criteria pollutants, their characteristics, and their effects

TIME:

1-3 class sessions if read play aloud in class; 2 weeks if present it to others

SUBJECTS:

Science, language arts, drama

MATERIALS:

2 microphones
1 hat
1 overcoat
1 pair sunglasses
1 black, 1 white, and 1 yellow t-shirt
Small cans of black, gray, and yellow paint
Cotton
Toy cars and trucks
1 t-shirt with holes
Yellow streamers
Fish cut out of cardboard
Safety pins
Yellow, white, brown, and green construction paper
Poster board (for the play and for posters)
Markers
Scissors
Netting
Tape
String
Copies of play
OPTIONAL: See extension suggestions

both human health and "welfare," which encompasses crops and other vegetation, livestock, buildings and other man-made structures, and visibility. In a given U.S. geographic area, if the ambient concentration of a criteria pollutant is higher than the standard, that area is said to be in nonattainment for that criteria pollutant and steps must be taken to reduce the ambient concentration of the pollutant. In many cases this is done by reducing the amount of that pollutant (or its constituents) that is emitted from sources in that area. Federal law also requires that these standards be periodically revised through a review of the most recent scientific studies on the health effects of each criteria pollutant.

PM₁₀

Although the original standard, in 1970, applied to all particulate matter, the regulation was modified in the late 1980s to restrict only particles that are less than 10 micrometers in diameter, hence the term PM₁₀. (A micrometer is approximately 1/25,000th of an inch. That is 1/50th the size of the period at the end of this sentence and is practically invisible to the human eye.) This change acknowledged numerous studies showing that only the very tiniest particles have the potential to affect human health substantially. Such small particles are more easily inhaled deep into the lungs, where they can have a detrimental effect on lung function and gas exchange between the air and blood. Particles that remain in the lungs for an extended period of time can cause permanent damage to lung tissue.

Particulate matter is a common by-product of most combustion processes. Forest fires, commercial and industrial combustion sources, fireplaces and woodstoves, and vehicle engines all release particles of various sizes. Dust, fine sand, and other debris are other forms of particulate matter that can become air pollution problems under windy, dry conditions. Construction activities and logging and mining operations can also contribute to airborne particulate matter. In addition to the human health effects already mentioned, particulate matter can hasten the deterioration of buildings and other structures, damage vegetation, and severely reduce visibility.

Sulfur Dioxide

Most of the sulfur dioxide in the ambient air comes from coal and fuel oil combustion. Although coal-powered railroad locomotives were once a major contributor to atmospheric sulfur dioxide, today the primary sources are electric power plants. High concentrations of sulfur dioxide in the ambient air are associated with an increase in both the incidence and the severity of various respiratory diseases. Sulfur dioxide emissions are also a critical factor in the development of acid rain. Sometimes we can smell the trace amounts of sulfur in gasoline because of the catalytic converters now used on automobiles.

Nitrogen Oxides

Nitrogen oxides, particularly nitrogen dioxide (NO₂), are also common by-products of fossil-fuel combustion, with motor vehicles being the primary source. NO₂ can irritate the airways and increase one's susceptibility to viral infections and respiratory diseases. It, like sulfur dioxide, is a precursor to acid rain, and it can also stunt plant growth. Under certain atmospheric conditions, especially in the summer, nitrogen oxides are involved in chemical reactions that produce ozone.

Carbon Monoxide

Carbon monoxide is an invisible, odorless product of incomplete fuel combustion. Motor vehicles (especially those that are operating inefficiently) are the primary source of ambient CO, while woodstoves, incinerators, and industrial processes contribute minor amounts. When inhaled, CO displaces oxygen in the blood, thereby creating various adverse health effects ranging from impaired perception to drowsiness to death.

Ozone

Ozone is produced in the atmosphere when sunlight triggers chemical reactions between naturally occurring atmospheric gases and pollutants such as volatile organic compounds (VOCs) and nitrogen oxides. (VOCs contain carbon, the basic chemical element found in living things. Carbon-containing chemicals are referred to as "organic." Volatile chemicals escape easily into the air.) Because the formation of ozone is partly natural, ozone is proving to be the most difficult criteria pollutant to control. The major component of smog, ozone can cause breathing difficulty, asthma attacks, and reduced resistance to infection. Because it is highly reactive, it corrodes many materials, including rubber and paint, and harms most vegetation. It is important to note that ground-level ozone is considered a pollutant, but stratospheric ozone is not a pollutant. It is protective. (See the Fact Sheet for more information on ozone.)

Lead

Lead is highly toxic to humans, especially children, whose bodies are still developing. Even small amounts can cause severe brain and organ damage.

The reduction of lead in the atmosphere is one of the great success stories of environmental regulation. The chief source of atmospheric lead was the burning of leaded fuels. (Adding lead compounds to gasoline was a way of increasing the octane level and preventing engine knock. Canada and the U.S. have banned the use of lead in fuel. Primarily because of regulations that reduced the amount of lead in leaded fuels and that mandated the production of more vehicles that burn unleaded fuels, atmospheric lead levels decreased 98% between 1970 and 1993. Removal of lead has also allowed the use of catalytic converters in automobiles. As a result, 1995 models emit 99% less pollutants than did 1970 models.

Continuing The Battle

Setting the ambient air standards was the first step taken in the United States to combat the harmful effects of the criteria pollutants. By enforcing the standards and helping industries find ways to reduce pollutant emissions, EPA, Environment Canada, other agencies, and the states and provinces have led the way in cleaning up the ambient air. The global nature of ambient air concerns has stirred other governments into action also. International agreements are being developed to try to deal with air quality problems on a global scale.

Individuals can help by decreasing their nonrenewable energy consumption and increasing the use of alternative fuels. Every gallon of gas or oil and every pound of coal not burned helps. Using mass transit, riding a bicycle, hanging clothes out to dry, turning off lights not in use, and installing solar heating units are just a few ways to help take care of the ambient air.

While this lesson deals with the criteria pollutants, it is important to note that there are also other pollutants that also cause health problems. These are referred to as non-criteria pollutants. Among the non-criteria pollutants are a class of pollutants referred to as hazardous air pollutants, or HAPs. In 1990, the Clean Air Act listed 189 compounds as hazardous air pollutants. Although no less a serious threat to health, these hazardous air pollutants tend to be localized near their sources—rather than widespread as are criteria pollutants—and are regulated differently. The regulations regarding HAPs focus on how much of the pollutants are being emitted from a source. They deal with the engineering controls for specific sources rather than on setting allowable levels in the ambient air.

PROCEDURE

I. SETTING THE STAGE

- A. Referring to the background material, share with students some basic information about the criteria pollutants.
- B. Tell them that they will be performing a play about those pollutants.

NOTE: If time does not permit performing the play, have the students read the play aloud in class.

II. ACTIVITY. "CRITERIA POLLUTANT REUNION" PLAY

- A. This activity relates to Objectives 1 through 5. Students will learn the names of the six criteria pollutants and will learn a few facts about their effects and sources.

Third-, fourth-, and fifth-graders

You will need the following materials:

- 2 microphones
- 1 hat
- 1 overcoat
- 1 pair sunglasses
- 1 black, 1 white, and 1 yellow t-shirt
- Small cans of black, gray, and yellow paint
- Cotton
- Toy cars and trucks
- 1 t-shirt with holes
- Yellow streamers
- Fish cut out of cardboard
- Safety pins
- Yellow, white, brown, and green construction paper
- Poster board (for the play and for posters)
- Markers
- Scissors
- Netting
- Tape
- String
- Copies of play

Cast of Characters

Reporters: 2 actors

Soo Clean (prop needed: microphone)

Dee Dirt (prop needed: microphone)

Particulate Matter: 5 actors

Dust (props: dust-covered shirt, dirty face)

Soot (props: black t-shirt and black smears on face)

Sand (props: yellow shirt, taped yellow and white circles on top of shirt)

Pollen (props: poster board to make large flower to encircle face, yellow face paint)

Smoke: (props: cotton, gray spray paint. Use to make gray puffy hat.)

Lead: 1 actor (props: white t-shirt with small metal gray dots.)

Carbon Monoxide: 1 actor (props: hat, overcoat, sunglasses)

Nitrogen Oxides: 2 actors

Nitrous oxide: (prop: small cardboard circles with N's and O's, forming NO)

Nitrogen dioxide: (prop: small cardboard circles with N's and O's. Use 2 O's with 1 N)

Ozone: 1 actor (prop: white or gray netting to simulate smog)

Sulfur Dioxide: 1 actor (prop: old umbrella with "acid rain" holes in it)

Danny Demonstrator and Group

Preparation

- A. Assign roles for the play.
- B. Help students to create their costumes.
- C. Review the vocabulary and pronunciation of words from script.
- D. Rehearse the play.
- E. Have students create posters and invitations announcing the play.
- F. Perform the play for students in grades K-2.

III. ACTIVITY. "POLLUTANT PYRAMID" GAME

- A. This activity relates to objectives 1 through 5. It is intended for fourth- and fifth-graders and should follow either a general discussion of the background material or the play, "Criteria Pollutant Reunion" (preferably both). This activity reinforces the information about the names of the criteria pollutants, their sources, and their effects.

Fourth- and fifth-graders

- B. Divide students into pairs.
- C. Give each pair of students a pyramid sheet and a set of game cards.
- D. Give the students the instructions for playing the game:

1. Shuffle the cards and place one card face down on each square of the pyramid.
2. One student begins on the lower level of the pyramid. The student turns the card over and answers the question. If the answer is correct, the student earns the points indicated on the square of the pyramid. If the answer is incorrect, no points are earned. This player continues until he or she has completed all levels of the pyramid. The player then tallies and records his/her points.
3. Reshuffle the cards. Replace the cards on the pyramid. Player two now answers the questions and tallies and records his/her score.

IV. FOLLOW-UP

- A. This activity relates to Objectives 1 through 5, and is intended to reinforce information learned in the preceding activity. This activity will help students remember the six criteria pollutants, their sources, and their effects.

Third- and fourth-graders

- B. After performing the play, make a large Criteria Pollutant Chart like the one provided. Lead a group discussion in which students help you fill in the chart.

Fifth-graders

- C. After performing the play, have students work in small groups to complete the Criteria Pollutant Chart. Use their results to fill out a class chart.

V. EXTENSION

- A. Contact your local air pollution control agency and ask for daily information on local air quality. Record this information on a chart for several weeks. Display the chart in the school.
- B. Have students prepare skits with each team taking the point of view of a person, animal, or plant that is affected by one pollutant. Students should consider what the things were like without pollutants and what they are like when affected by pollutants.
- C. Have the students create a picture of the effects of one of the criteria pollutants. Paste the picture onto a stiffer piece of paper (card stock or poster board), making sure that the entire piece is covered with glue. On the other side of the stiff paper, the students should write something about that pollutant. After they are finished, have each student make a puzzle by cutting his or her picture into medium- to large-sized pieces. Store each set of pieces in a plastic bag and allow others to solve the puzzle.
- D. Divide the class into groups and have them write and demonstrate a "rap" on air pollutants.
- E. Create and play "Pollution BINGO."
- F. Divide the class into groups. Assign each group a different pollutant. Have them research the effects of their pollutant.
- G. Have students perform a mock news report (about the criteria pollutants) for lower grades. If possible, videotape the report.

RESOURCES

Environmental Resource Guide—Air Quality, Grades 6-8. Pittsburgh, PA: Air & Waste Management Association, 1991.

National Wildlife Federation. "Up in the Air." *Let's Clean Up Our Act.* April 17-23, 1994.

National Wildlife Federation. "The Awful 8: A Play." *Let's Clean Up Our Act.* April 17-23, 1994.

Schultz, R.F. "Solids in the Air." *Environmental Experiments from Edison.* Southfield, MI: Thomas Alva Edison Foundation, 1982.

Criteria Pollutant Reunion

Script

- Soo Clean:** Ladies and gentlemen, we are here at the annual "Criteria Pollutant Reunion" in Smog City, talking to some of the regular attendees. My name is Soo Clean, and I'll be one of your hosts this evening. My colleague, Dee Dirt, is here with me.
- Dee Dirt:** Hi. I'm Dee Dirt. We'll be talking to six of the air's major pollutants this evening to find out who they are and what they do. As you all probably know, these six major pollutants are also called criteria pollutants. They are found almost everywhere in our air, and that's one of the reasons that they are such a problem.
- Soo, can you introduce us to the first one?
- Soo Clean:** Our first interview will be with Carbon Monoxide. Thank you for joining us, Carbon Monoxide. Viewers, you must pay close attention to Mr./Ms. Monoxide because he is a colorless and odorless gas. Mr./Ms. Monoxide, because we can't see you or smell you, how do we know that you are around?
- Carbon Monoxide:** Hey dude, I sneak into the air when cars and trucks burn fuel, or when your heaters and fireplaces aren't working properly. The only way you will know I'm around is that I can make you feel lousy. I can make you feel real tired and confused, feel sick to your stomach, and have a bad headache.
- Soo Clean:** Isn't there any other way to know you're around.
- Carbon Monoxide:** Well, some people have bought carbon monoxide detectors that sound a loud alarm whenever I come around. They don't scare me away, but the people always get out of the house when they hear it, so I can't do anything to them.
- Soo Clean (yawning):** So, Mr./Ms. Monoxide, if you're so tough, what damage do you do other than make people feel sick?
- Carbon Monoxide:** Hey Soo, I just love blood cells. I latch onto them so that Oxygen can't hitch a ride on them. That means that people can't get enough oxygen, which can damage their hearts or kill them.

Soo Clean (nervously): Oh, thank you, Carbon Monoxide. I suppose you'd like to go back to the reunion now. (Carbon Monoxide exits.)

Dee Dirt: Soo, I don't think we want to be around Mr./Ms. Monoxide. He can really be dangerous. Next we will interview the dreaded Particulate Gang. I don't think they are quite so harmful. (The Particulate Gang enters.)

The members of the Particulate Gang are Sand, Soot, Pollen, Dust, and Smoke.

Gee, gang, you are an incredibly dirty group. Who exactly are you?

Dust (grinning): Thank you, Dee, for allowing us to join you. We are those tiny particles that float through the air. My name is Dust, and I enter the air from windstorms, mining activities, logging activities, and farming activities. I make the air look dirty. I can also get into your lungs and cause breathing problems.

Sand: I'm Sand. I fly in the air from windy beaches and deserts. I help dust make the air look dirty, and I can get into your lungs, too. During winter, in snowy areas people drop me on the streets to prevent accidents. Then the car tires grind me up, and I really mess up the air! (Sand soars around the stage.)

Soot: You probably recognize me. I'm Soot. I move through the air and into your lungs from fireplaces, wood-burning stoves, volcanoes, and forest fires. I, too, can make the air look dirty and can get into your lungs. I can also make things look dirty when I land on them.

Pollen: My name is Pollen. I fill the air from flowering plants, trees, and shrubs. I make your eyes red and itchy. I can even make you sneeze, cough, or have breathing problems if you are sensitive to me.

Smoke: You all know me. I'm Smoke. I float into the air from fires. However, I also come out of smoke stacks at factories and power plants. I also come out of cigarettes when people smoke them. I can make the air look real dirty, and I can get into your lungs and make you cough.

Dee Dirt: Well, guys, do you harm only people?

Soot: No way! We can affect animals and plants, too. We can even discolor buildings and statues. (Particulate Gang exits.)

Dee Dirt: Thank you for joining us. Gee, I'm glad that they're gone. I was having a hard time breathing with them around.

Now Soo will interview Lead.

Lead (sadly): Hi, Soo Clean.

Soo Clean: Hi, Mr./Ms. Lead. Why are you looking so sad?

Lead: Well, I used to have a fine time, riding around in gasoline, hitching a ride in car exhaust, and landing on plants and dirt near roads. Then EPA made those regulations saying that I couldn't be in gasoline anymore. If something is not done soon to change that law, I might not get to come to many more of these reunions. I won't be one of the six major pollutants any more. (Lead begins to cry.)

Soo Clean: I'm sorry, Lead. Tell me, how do you get into the air now?

Lead: Thank goodness, some factories still send me out of their smoke stacks.

Soo Clean: Do you harm people in any way?

Lead: Actually, I can affect the nervous system and cause hyperactivity in children. I can even cause brain and kidney damage.

Soo Clean (wiggling around): Well, Lead. I don't know what's wrong with me. I can't seem to stop moving. I guess this will have to conclude our interview. (Lead exits.)

Whew! I'm glad that she/he's gone. Please stay tuned for an interview with the Nitrogen Oxide twins. We are fortunate to have two of them joining us today. Take it away, Dee.

Dee Dirt: Good afternoon, Nitrous Oxide and Nitrogen Dioxide. Thank you both for taking the time to join us. Nitrous Oxide, can you explain to the audience how you are released into the air?

Nitrous Oxide: Sure, Dee! We're produced naturally by lightning and by bacteria in the soil.

Dee Dirt: I thought only people polluted the air. Is that true, Nitrogen Dioxide?

Nitrogen Dioxide: Actually, humans cause only about half of us.

Dee Dirt: Do you mean that you enter the air only naturally, Nitrogen Dioxide?

Nitrogen Dioxide: No way! We also enter the air through exhaust pipes of vehicles and from some power plants. We especially like to get together with water and Sulfur Dioxide to make acid rain. I am also proud to say that we help produce Ozone.

Dee Dirt: Say, are you harmful to people?

Nitrogen Dioxide: Of course. We are able to cause lung damage.

Dee Dirt: Nitrous Oxide, are you capable of damaging the environment?

Nitrous Oxide (proudly) I can help make smog, form acid rain, and even damage rain forests by stunting plant growth.

Dee Dirt: Well, thanks for sharing with us. Please rejoin the rest of your group. [Nitrous Oxide and Nitrogen Dioxide exit.] Take it away, Soo.

Soo Clean: Dee, next we will be joined by ozone. [Ozone enters.] How are you enjoying the reunion, Ozone?

Ozone: Oh, I'm just loving it here—the city life, the sunlight, and the car exhaust.

Soo Clean: Can you provide more information, Ozone, and tell us why?

Ozone: I'm formed when Nitrogen Oxides, volatile organic compounds, and sunlight get together. And if the air above the city does not move, I get trapped down near the earth. Then I get to have a lot of fun, forming smog and causing trouble.

Soo Clean: What harmful things can you do?

Ozone: I can cause breathing problems, harm plants, and deteriorate rubber and fabrics.

Soo Clean: Well, Ozone, please don't let us stop you from enjoying yourself. [Ozone exits.]

Dee Dirt: Our last guest will be Sulfur Dioxide. [Sulfur Dioxide enters.] Sulfur Dioxide, thank you for joining us. Can you explain to our viewers what you are composed of?

Sulfur Dioxide: Sure! I'm a compound made up of sulfur and oxygen.

Dee Dirt: Where do you come from?

Sulfur Dioxide: My main sources are coal-burning factories and power plants, coal-burning stoves, and oil refineries.

Dee Dirt: Are you harmful to people?

Sulfur Dioxide: Of course! I cause eye irritation, and lung damage and other breathing problems.

Soo Clean: Do you harm the environment in any way?

Sulfur Dioxide: Well, when I mix with water and Nitrogen Oxides to form acid rain, I can cause real problems for things that live in water. Then I can kill aquatic life and fish and damage buildings and statues.

Dee Dirt: What's that I hear in the background? [Sulfur Dioxide runs away and Danny Demonstrator and his followers enter.]

Danny and Followers: We want clean air! We want clean air!

Soo Clean: It looks as if you folks aren't too happy with this Criteria Pollutant Reunion.

Danny: You're right, Soo. However, don't forget. We are still searching for additional ways to keep these pollutants out of our town and our air.

Soo Clean: I know, Danny. How do you think we might do this?

Danny: It will happen only if people work together. Remember, people are the solution to pollution. If we work together, maybe there won't be enough pollutants left for a reunion. [They run from the stage.]

Soo Clean: Well, it looks as if the future of the Criteria Pollutant Reunion could be in jeopardy. Who knows, maybe next year there won't be one.

Dee Dirt: You're right, Soo. But aren't there other pollutants that are harmful? There must be more than six harmful pollutants.

Soo Clean: You're right, Dee. There are also hazardous air pollutants. They are chemicals and compounds like benzene, toluene, methylene chloride, and methyl chloroform, and they can cause cancer and other harmful effects on people.

Dee Dirt: Wow, I've never heard such strange names. If the hazardous air pollutants are so harmful, why aren't they at the Criteria Pollutant Reunion?

Soo Clean: It's because they aren't everywhere like the criteria pollutants are. They usually stay close to their sources. But that doesn't mean we shouldn't watch out for them. We certainly don't want to breathe them!

Dee Dirt: You're right, Soo. [Dee turns to the audience.] Well, folks, we hope you've learned a lot joining us at the Criteria Pollutant Reunion. We would say, "hope to see you next year," but actually we hope there won't be enough pollutants left to have a reunion next year.

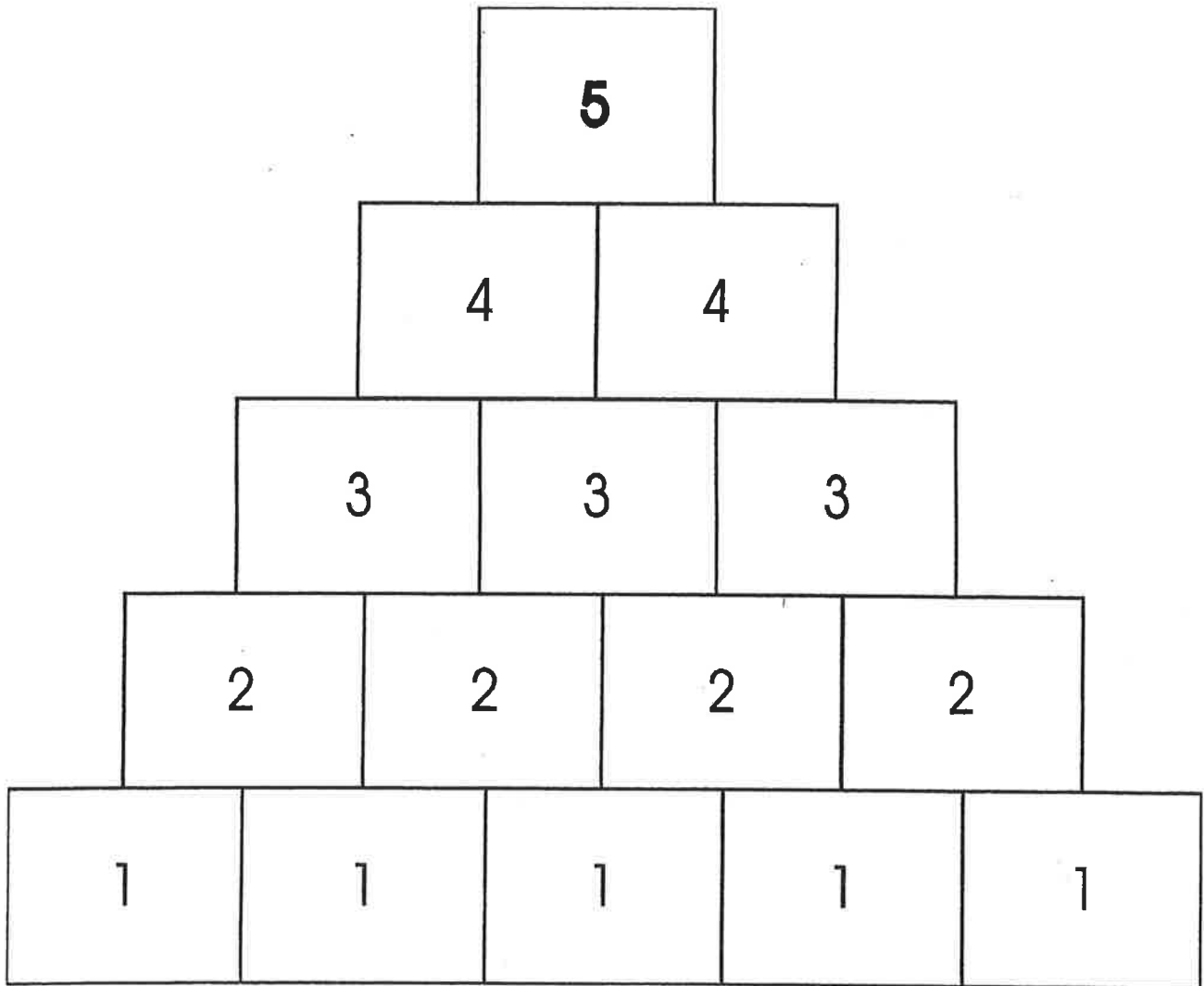
Pyramid Game Cards

1. Name 4 of the 6 major air pollutants.	2. This is a colorless, odorless gas.	3. This pollutant is found in leaded gasoline	4. This pollutant may make you feel confused and tired.	5. This pollutant is a metallic element that can cause brain damage.
6. These pollutants are made up of nitrogen and oxygen.	7. These pollutants combine with hydrocarbons and sunlight to form ozone.	8. Name three types of particulate matter.	9. This type of particulate matter comes from farming and mining activities.	10. This type of particulate matter comes from windy beaches and deserts.
11. This type of particulate matter comes from fireplaces, woodburning stoves, and volcanoes.	12. This type of particulate matter comes from flowering plants, trees, and shrubs.	13. This type of particulate matter comes from fires.	14. This pollutant can cause kidney damage.	15. This pollutant is composed of sulfur and oxygen.
16. This pollutant can cause you to have a headache.	17. This pollutant can cause hyperactivity in children.	18. This pollutant, combined with other elements to form acid rain, can kill fish and other aquatic life.	19. This pollutant, combined with other elements to form acid rain, can deteriorate buildings and statues.	20. This pollutant is formed when nitrogen oxides, VOCs, and sunlight interact.
21. This pollutant reacts with sulfur dioxide, VOCs, and water to form acid rain.	22. This pollutant used to be found in gasoline.	23. Name two of the pollutants that vehicles emit into the air.	24. This pollutant can cause breathing problems, harm plants, and deteriorate rubber and fabrics.	25. This pollutant causes eye irritation and lung damage.
26. This pollutant often makes people's eyes red and itchy and can make people sneeze.	27. This pollutant can cause heart damage.	28. This pollutant reduces the amount of oxygen that red blood cells carry.	29. This pollutant can reduce visibility outdoors.	30. This pollutant has been greatly reduced in our ambient air because it was taken out of gasoline.

Pyramid Game Answer Key

1. Any four of the following: Carbon monoxide, lead, ozone, nitrogen oxides, particulate matter, and sulfur dioxide.
2. Carbon monoxide
3. Lead
4. Carbon monoxide
5. Lead
6. Nitrogen oxides
7. Nitrogen oxides
8. Any three of the following: Dust, sand, soot, pollen, smoke, and exhaust
9. Dust
10. Sand
11. Soot
12. Pollen
13. Smoke
14. Lead
15. Sulfur dioxide
16. Carbon monoxide
17. Lead
18. Sulfur dioxide or nitrogen oxides
19. Sulfur dioxide
20. Ozone
21. Nitrogen oxides
22. Lead
23. Carbon monoxide, lead, nitrogen oxides, and particulate matter
24. Ozone
25. Sulfur dioxide
26. Pollen
27. Carbon monoxide
28. Carbon monoxide
29. Particulate matter
30. Lead

Pyramid Game Board



Criteria Pollutant Chart

Pollutant	Sources	Effects