September 2013
EPA-456/B-13-003b

Grades 3-5

Key Messages: Grades 3-5

- Breathing dirty air is not good for people. For example: You might feel like it's harder to breathe, you might cough, or your chest might feel tight.

- You can help protect your health when the air is dirty. Here are three things you can do.

  1. Find out how clean your air is each day.

     - You can do this by checking the AQI, just like checking the weather report. The AQI (or the Air Quality Index) uses colors to tell you how clean or dirty the air is. For example, green means the air is clean. Red means the air is unhealthy.

     - Check the AQI at www.airnow.gov, download the AirNow App, or sign up for air quality emails at www.airnow.gov/enviroflash. Many local newspapers and television and radio stations also present the AQI.

     - Tell your parents about the AQI so they can check how clean or dirty the air is.

  2. If you play outside when you know the air is polluted, you can protect your health by taking it a little easier. For example, walk instead of run, take breaks often, or play outside when the air is cleaner.

  3. If you notice any signs when you are playing outside like coughing, pain when you take a deep breath, chest tightness, or wheezing, stop playing and tell an adult.

     - If you have asthma, pay special attention on polluted days. If you think you or a friend may be having an asthma attack, tell an adult.

Lesson Plans

The Ozone Between Us

Learning Objectives

Students will:

- **Discover that ground-level ozone occurs in many areas of the country.**
- **Discover that ground-level ozone problems are often associated with high-population centers.**

Grade Level: Grades 3-5

Estimated Time: 30 minutes

Background Summary

Ozone is a gas consisting of three oxygen atoms. Ozone can be good or bad depending on where it is in the atmosphere. "Good" ozone occurs naturally in the stratosphere approximately 10 to 30 miles above the earth's surface. This good ozone forms a layer that protects life on earth from too much of the sun's harmful ultraviolet rays.

Ozone at "ground-level"—that is, in the earth's lower atmosphere—is bad because it pollutes the air. Ozone pollution can cause people to have breathing problems. An easy way to remember these differences about ozone is: "good up high, bad nearby."

Ground-level ozone comes mostly from motor vehicles that we drive, factories that make products we use, and power plants that produce our electricity. Ozone pollution is not produced directly from these sources. Rather, heat and sunlight "bake" certain other chemicals (nitrogen oxides, or NO_x, from vehicles and power plants; and volatile organic compounds, or VOCs, from gasoline-powered cars, factories, and products such as paints), which causes a chemical reaction and produces ozone. Weather is an important factor in ozone formation—more ground-level ozone usually is formed in summertime, when there is the most heat and sunlight. Also, wind can transport ozone "downwind" to other areas far from where it was formed, and pollute those areas.

This Internet activity allows students to explore the different concentrations of ground-level ozone in various areas of the country and develop an understanding of why more ground-level ozone may occur in certain areas.

Materials Needed

- Printed color copies of the two AQI color charts on the *Air Quality Index (AQI)—A Guide to Air Quality and Your Health* Web page; or, students can access the charts from the Internet at: www.airnow.gov/index.cfm?action=aqibasics.aqi
- Internet access or color copies of the Ozone Map at: http://ciese.org/curriculum/airproj/airquality-map/
- Student Worksheet (included)
- Teacher Answer Sheet (included)

Key Questions

- Do people contribute to ground-level ozone pollution when they drive or ride in cars? (*Correct answer:* Yes) When they ride bicycles? (*Correct answer:* No) When they walk? (*Correct answer:* No)
- In what parts of the country do you think ozone pollution might be the worst? Why? (*Possible answers:* In cities; in places where the wind has blown the ozone pollution; in places with a lot of cars and/or factories.)

Vocabulary

Chemical reaction—A change that takes place when two or more substances interact to form a new substance.

Ozone—A gas that occurs both in the Earth's upper atmosphere and at ground level. Ozone can be "good" or "bad" for people's health and the environment, depending on its location in the atmosphere. High up in the atmosphere, ozone helps protect people's health from too much ultraviolet radiation from the sun. Near the Earth's surface, ozone is an air pollutant that can result in breathing difficulties.

Air Quality Index (AQI)—A color-coded scale that provides daily air quality and health information.

Steps

1. If you are using printed color copies of the AQI color charts on the *Air Quality Index (AQI)—A Guide to Air Quality and Your Health* Web page, hand them out to the class. If you are using the Internet to access the charts, tell students to go to: www.airnow.gov/index.cfm?action=aqibasics.aqi (The rest of the page can be used for additional background information.)

2. Explain to the class what the Air Quality Index (AQI) is while having them look at the AQI Color Chart. Tell students that the Air Quality Index, or AQI, is an index for reporting daily air quality. It uses a simple color-coded scale to tell you how clean or polluted the air in a particular location is, and how you can protect your health at different levels of pollution. There is an AQI for five pollutants, one of which is ground-level ozone, which we are discussing in this lesson. The AQI is like a yardstick that runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health concern. For example, an AQI value of 50 represents good air quality with little potential to affect public health, while an AQI value over 200 represents very unhealthy air quality. (Note: More information on the AQI is available on the rest of the Guide page and at www.airnow.gov.)

3. If you are using printed color copies of the Ozone Map, hand them out to the class. If you are using the Internet to access the map, tell the class to go to: http://ciese.org/curriculum/airproj/airquality-map/

   Tell students that the AQI colors on the map represent one day only; the AQI, and air quality, can change daily.

4. Have students answer Questions 1-5 on the Student Worksheet, using the AQI color charts and the Ozone Map.

5. Review students' answers for Questions 1-5 on the Student Worksheet with the class.

6. Give students time (approximately 5 to 10 minutes) to answer Questions 6 and 7.

7. As a class, discuss students' answers to Questions 6 and 7.

Adaptation

For Grades K-2, use the first and second paragraphs of the *Background Summary* and simplify the third paragraph to: "Ground-level ozone comes mostly from motor vehicles that we drive, factories that make products we use, and power plants that make our electricity." Also assist the class in answering the Student Worksheet questions #1-6 verbally instead of writing the answers, and skip question #7.

For Further Exploration

- Have students explore more information about ground-level ozone on the AIRNow Web site (www.airnow.gov).
- Have students explore "nitrogen oxides" (NO_x) and "volatile organic compounds" (VOCs) on the Internet.

Acknowledgments/Resources

Air Pollution: What's the Solution? project, developed by the U.S. EPA, the Northeast States for Coordinated Air Use Management, and the Center for Innovation in Engineering + Science Education. See: http://ciese.org/curriculum/airproj/

AIRNow program. The Air Quality Index (AQI) is always available at the AIRNow Web site at: www.airnow.gov

Walking for Health and the Environment Curriculum, by Walk Boston and ERG. Web site: www.walkboston.org/what-we-do/initiatives/safe-routes-school

Next Generation Science Standards

Interdependent Relationships in Ecosystems
Matter and Energy in Organisms and Ecosystems
Earth and Human Activity
Engineering Design

Student Worksheet: The Ozone Between Us

Name: _____

Ozone Map

Look at the two AQI color charts on the page titled *Air Quality Index (AQI)—A Guide to Air Quality and Your Health*, then look at the "Ozone Map" and answer the following questions:

1. Next to each Air Quality category listed below, write the name of the color that is used on the map for that category:

Air Quality Category	Color Used
Good	
Moderate	
Unhealthy for Sensitive Groups	
Unhealthy	
Very Unhealthy	

2. Find Los Angeles, CA on the Ozone Map. What is the air quality in Los Angeles? Circle:

Good Moderate Unhealthy for Sensitive Groups Unhealthy Very Unhealthy

3. Find another city on the map that has the same air quality as Los Angeles. Write the city and state below.

4. Find two cities on the map where the air quality is "unhealthy for sensitive groups." Write the city names and states below.

(continued)

Student Worksheet: The Ozone Between Us

Name: _____

5. Are there any cities on the map with good air quality? If so, list three.

6. Where are most of the red and orange areas on the map, near or far away from cities?

7. Write a sentence that compares the kinds of places where good air quality is found, and the kind of areas where unhealthy air quality is found. Why do you think that is?

Teacher Answer Sheet: The Ozone Between Us

Ozone Map

Look at the two AQI color charts on the page titled *Air Quality Index (AQI)—A Guide to Air Quality and Your Health*, then look at the "Ozone Map" and answer the following questions:

1. Next to each Air Quality category listed below, write the name of the color that is used on the map for that category:

Air Quality Category	Color Used (answers below in italics)
Good	*Green*
Moderate	*Yellow*
Unhealthy for Sensitive Groups	*Orange*
Unhealthy	*Red*
Very Unhealthy	*Purple*

(If students ask, or you wish to inform them, tell them that the color "Maroon," which represents "Hazardous" air quality, is not listed on the chart above because air quality has not been "hazardous" in the U.S. for many years.)

2. Find Los Angeles, CA on the Ozone Map. What is the air quality in Los Angeles? Circle:

Good Moderate Unhealthy for Sensitive Groups Unhealthy Very Unhealthy

(Answer: Unhealthy)

3. Find another city on the map that has the same air quality as Los Angeles. Write the city and state below.

(Answer: Several correct answers—Houston, New York City, Boston)

(continued)
Teacher Answer Sheet: The Ozone Between Us

4. Find two cities on the map where the air quality is "unhealthy for sensitive groups." Write the city names and states below.

(Several correct answers: Sacramento, Charlotte, Richmond, Albany)

5. Are there any cities on the map with good air quality? If so, list three.

(Several possible answers: Seattle, Tuscon, Dallas, Jackson, Miami, Atlanta, Orlando, Detroit, Denver)

6. Where are most of the red and orange areas on the map, near or far away from cities?

(Answer: Near cities)

7. Write a sentence that compares the kinds of places where good air quality is found with the kinds of areas where unhealthy air quality is found. Why do you think that is?

(Answer: Good air quality is found mostly in areas away from cities, in rural areas, where fewer cars and factories are. Or similar answer.)

(Additional information that teachers may want to include: Some cities also have good air quality. This may be because they have taken steps to reduce air pollution, such as having good public transportation so that people take buses or trains instead of driving places, and high-occupancy vehicle lanes to cut down on rush-hour traffic. Or, it could be that wind blew air pollution away from certain cities.)

The Cilia (not Silly!) Game

Learning Objectives

Students will:

- **Learn what particle pollution is.**
- **Understand how particle pollution can affect people's health.**
- **Observe through role playing how our bodies (cilia in particular) help protect us from particle pollution.**
- **Understand the sources of particle pollution (see For Further Exploration).**
- **Learn what people can do to reduce particle pollution (see For Further Exploration).**

Grade Level: Grades 3-5

Estimated Time: 30 minutes

20 minutes—For Further Exploration

Background Summary

One type of air pollution is called particle pollution, which is made up of tiny particles of dust, dirt, smoke, and liquid droplets. Particle pollution comes from things like cars and other vehicles, smokestacks from factories and power plants, fireplaces and wood-burning stoves, volcanoes, and forest fires. When there's a lot of particle pollution in the air, people can get sick from breathing it in. Our bodies help protect us from particle pollution. Cilia, which are tiny hair-like structures that line our respiratory system, try to keep foreign objects like particle pollution out of our lungs. Sometimes the cilia are successful, but not all the time. When particle pollution reaches our lungs, we might feel sick.

Certain people are particularly sensitive to particle pollution, including children, the elderly, people with asthma and other respiratory problems, and people with heart problems. Particle pollution may make people cough or have difficulty breathing, and can make asthma and heart disease worse. People visit hospitals more often when there is a lot of particle pollution. There are things that we can do to help protect our health from particle pollution, such as finding out how clean or dirty the air is, taking it easier outside if the air is not good, and telling an adult if you have trouble breathing on days when the air quality is bad. It's also a good idea to stay away from school bus tailpipes because particle pollution comes out of them.

Tell the class that they are going to play a "Cilia Game" that shows how cilia keep particle pollution out of the lungs, and how some particle pollution gets through to the lungs.

Materials Needed

- Flour (about a handful)
- Flashlight
- Student Handout: Human Hair and Particle Pollution (included)
- 75 (approx. 3-4 per student) pre-made newspaper balls (wadded up newspapers to size of tennis balls, wrapped in masking tape)
- Cilia Game Set-Up (Included)
- 4 orange traffic/sports cones, or other similar size safe objects
- Name tags (optional, that say "Cilia", "Particle Pollution", and "Lung"—see Step 9)
- Sources of Particle Pollution poster (included) (see "For Further Information" section)
- Flip chart and marker

Key Questions

- What is particle pollution? (*Answer:* Particle pollution is made up of tiny particles of dust, dirt, smoke, and liquid droplets in the air.)
- Where does particle pollution come from? (*Answer:* Particle pollution comes from cars and other vehicles, smokestacks from factories and power plants, fireplaces and wood-burning stoves, volcanoes, and forest fires.)

- How can particle pollution affect our health? (*Answer:* Particle pollution may make people cough or have difficulty breathing, and can make asthma and heart disease worse.)
- What can we do to protect our health from particle pollution? (*Answers:* Find out how clean or dirty the air is. Take it easier outside if the air is not good. Tell an adult if you have trouble breathing on days when the air quality is bad. Stay away from school buses' tailpipes.)
- What can we do to reduce particle pollution? (*Answer:* Use fireplaces and wood stoves less often, or not at all. Make sure you have a clean-burning, EPA-certified wood stove. Carpool or use public transportation when possible instead of driving. Turn off lights when not using them.)

Vocabulary

Cross section—A cut through a substance, at a right angle.

Particle pollution—Air pollution that consists of tiny, often microscopic particles of dust, dirt, smoke, and liquid droplets.

Cilia—Small hair-like structures that line the airways in the lungs and help clean out the airways.

Steps

1. Darken the classroom. Gently throw a handful of flour into the air, keeping it away from students.
2. Quickly shine a flashlight on the flour as it is falling. Ask students to describe what they see.
3. Discuss how the flour floats in the air, separating into tiny pieces, like dust. Tell students that these tiny pieces are called "particles." Explain that many different kinds of particles float in the air and can be inhaled into our lungs, sometimes making people cough.
4. Explain that when tiny particles of dust, dirt, or smoke mix with liquid droplets in the air, scientists call this "particle pollution." When there is a lot of particle pollution in the air, people can get sick from breathing it into their lungs. They may have trouble breathing and become more tired. Particle pollution can aggravate heart or lung disease. Breathing particles has been linked to heart attacks and even death.
5. Have one student come up to the blackboard and draw a large circle on it. Tell students to pretend that the circle is a strand of hair, cut open—a "cross section." Have the student label the diameter "70 microns."
6. Have two other students draw two tiny circles inside the large circle and label their diameters "2.5 microns." Explain that microns are very, very small units of measurement. Tell students that particles can be very tiny—we may not be able to see them, but they may still be there.
7. Distribute the Student Handout: Human Hair and Particle Pollution and observe it with students.
8. Explain what cilia are and the role they play in our health and air pollution.

   (*Background information on cilia:* Tell students that cilia (pronounced: sih-lee-uh) are tiny hair-like structures in our respiratory system. The job of cilia is to protect our respiratory system by keeping foreign matter—like particles—from entering our lungs. Cilia do this by moving back and forth to remove particles that enter our nose with the air we breathe. As air is inhaled, the cilia wave around, pushing any foreign matter away from the lungs.)
9. Tell students they are going to play a "Cilia Game." (Not a "Silly" game!) Ask for student volunteers, as follows:
   - Two students as the "Lungs"
   - Half the class, plus a few more, as "Particle Pollution"
   - The remaining students as "Cilia"

   If you are using name tags for the above roles, pass them out now.
10. See the enclosed graphic for the Cilia Game Set-Up. In an open area, set up the boundaries of the game in a trapezoid shape, using 4 traffic cones or similar size (and safe) objects, leaving approximately 15 feet between the "Lungs" boundary and the "Particle Pollution" boundary.
11. Read the game rules to the class.

    (a) The "Lungs" students stand on the short side of the trapezoid.

    (b) The "Particle Pollution" students line up along the longer edge of the game area.

    (c) The "Cilia" students stand in between the "Particle Pollution" and the "Lungs." Tell the Cilia students that they can stretch and wave their

arms like cilia to keep Particle Pollution from entering the Lungs, but they must stand still with their feet together, and must not hit other students. Have the Cilia students practice this movement.

(d) Place some of the pre-made particle pollution newspaper balls near each of the "Particle Pollution" students. Explain that the "Particle Pollution" students will throw the particle pollution balls towards the "Lungs" students, and the "Cilia" students will try to defend the Lungs by waving their arms and batting the particle pollution balls away from the Lungs. Emphasize that the balls should NOT be thrown too hard and not anywhere near anyone's face. Demonstrate by having a Particle Pollution student throw one of the newspaper balls at you.

(e) Tell students to take a deep breath and feel the air moving into their own lungs.

12. Begin the game by declaring the day bright and clear, with little particle pollution, and tell two Particle Pollution students to throw two balls each towards the Lungs. The Cilia students should try to bat the balls away from the Lungs.

    Ask the "Lungs" how they are feeling.

13. Explain that now it is a day with lots of particle pollution. Tell students that when you say "Go," all of the Particle Pollution students should throw all of their balls, one at a time, towards the Lungs, and the Cilia students should try to stop the balls from reaching the Lungs by waving their arms. Then shout out "Go!"

14. When all the balls have been thrown, stop the game and allow time for students to calm down. Then ask the Lungs students how it felt to have all of that particle pollution thrown at them. Tell the Lungs students to count how many Particle Pollution balls reached them. Ask the Cilia students how they felt during the game.

15. Review with students what happened in the Cilia Game: when there was just a little particle pollution, it was easier for the cilia to keep the particle pollution away from the lungs. When there was a lot of particle pollution, it was much harder for the cilia to keep the particle pollution away from the lungs, and the lungs may have felt attacked by the particle pollution.

16. Explain/review that at certain levels, everyone can be affected by particle pollution. Some groups of people are more sensitive, including children, the elderly, people with asthma and other respiratory problems, and people with heart problems. Breathing in particle pollution may make people cough, make it harder to breathe, and can make asthma and heart disease worse. People visit hospitals more often when there is a lot of particle pollution.

17. Discuss with the class what they can do to protect their lungs and hearts from particle pollution in the air. Tell them they can:

    (a) Find out how good or bad the air quality is each day from the Air Quality Index, or AQI. The AQI is often in the newspaper on the weather page, sometimes on the TV news, and always on the Internet (at www.airnow.gov).

    (b) If the air quality is not good, take it easier if you're outside—walk instead of run, and take breaks often.

    (c) If it feels harder to breathe when the air is not good, tell an adult.

    (d) Stay away from the tailpipes of school buses —you don't want to breathe in the particle pollution that comes out of those.

    In addition to the *Human Hair and Particle Pollution* handout included with this lesson, you can also distribute the general student handout in this Toolkit, *Breathe Smart! Four Things Kids Can Do* (see Grades 3-5 Handout in this Toolkit).

    Note: See "For Further Exploration" below for a discussion of sources of particle pollution and ways to reduce particle pollution.

For Further Exploration

If time permits, have a discussion with students about where particle pollution comes from. Share with the class the *Sources of Particle Pollution* poster at the end of this lesson. Ask students if they or their families ever create particle pollution and how. Record answers on a flip chart.

(*Teacher discussion information:* There are many sources of particle pollution created by people's activities. Cars and trucks, factories, and power plants that produce electricity release particle pollution. Unpaved roads, and construction projects that grind or crush rocks or soil, also cause particle pollution. Wood-burning stoves and fireplaces, outside burning of branches or trash, smoke from cigarettes and cigars, and off-road vehicles such as ATVs and lawn mowers also create particle pollution. Sometimes nature

can pollute the air, too. Forest fires and volcanoes can pollute the air with particles. If you lived near a forest fire, what do you think it would feel like to breathe the air that day? *[Wait for an answer or two.]* The air would be very smoky, and it might make you cough, or you might find it harder to breathe.)

Continue the discussion by asking students what they think they, their families, and their communities can do to reduce particle pollution. Write the answers on the flip chart. Guide the class discussion to include the following categories:

- Use fireplaces and woodstoves less often or not at all. Some town or city governments already ban such burning when there's a lot of air pollution. Also, if your family uses a woodstove, make sure it's a clean-burning, EPA-certified unit, which produces less particle pollution than older units. Use only dry seasoned wood; wet wood or plastics cause more smoke and that's not good for you to breathe, indoors or outdoors.
- Use public transportation such as buses, trains, and subways whenever possible instead of driving in cars and trucks.
- Companies and governments can develop cleaner (less polluting) fuels (gas or other fuels) and cars, and people can buy these cleaner cars and fuels.
- Power plants can use cleaner ways to make electricity (such as water, wind, or solar power; cleaner coal; and special equipment to reduce pollution).
- Factories can use cleaner ways to make their products, and special equipment to reduce pollution.

Acknowledgments/Resources

Adapted from Clean Air Campaign, Georgia Learning Connections.

Next Generation Science Standards

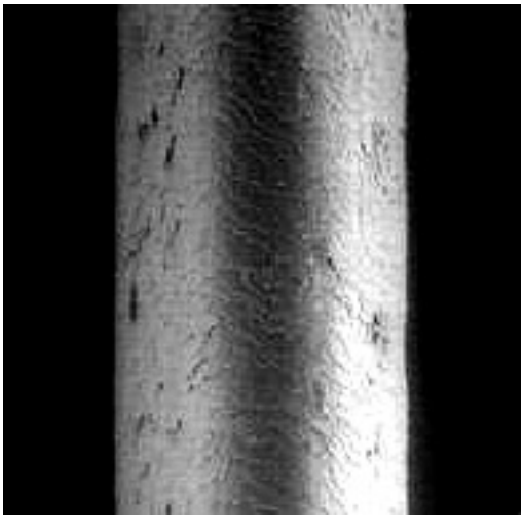
Energy
Interdependent Relationships in Ecosystems
Engineering Design
Matter and Energy in Organisms and Ecosystems

Student Handout: The Cilia (not Silly!) Game

Human Hair and Particle Pollution

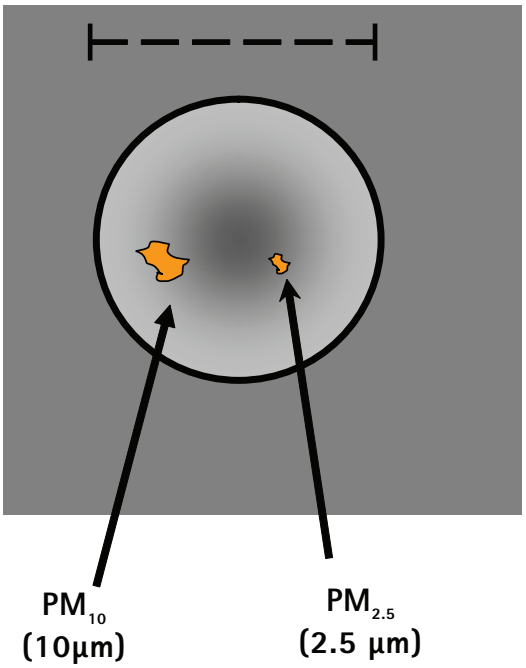
Average Human Hair =

70 microns



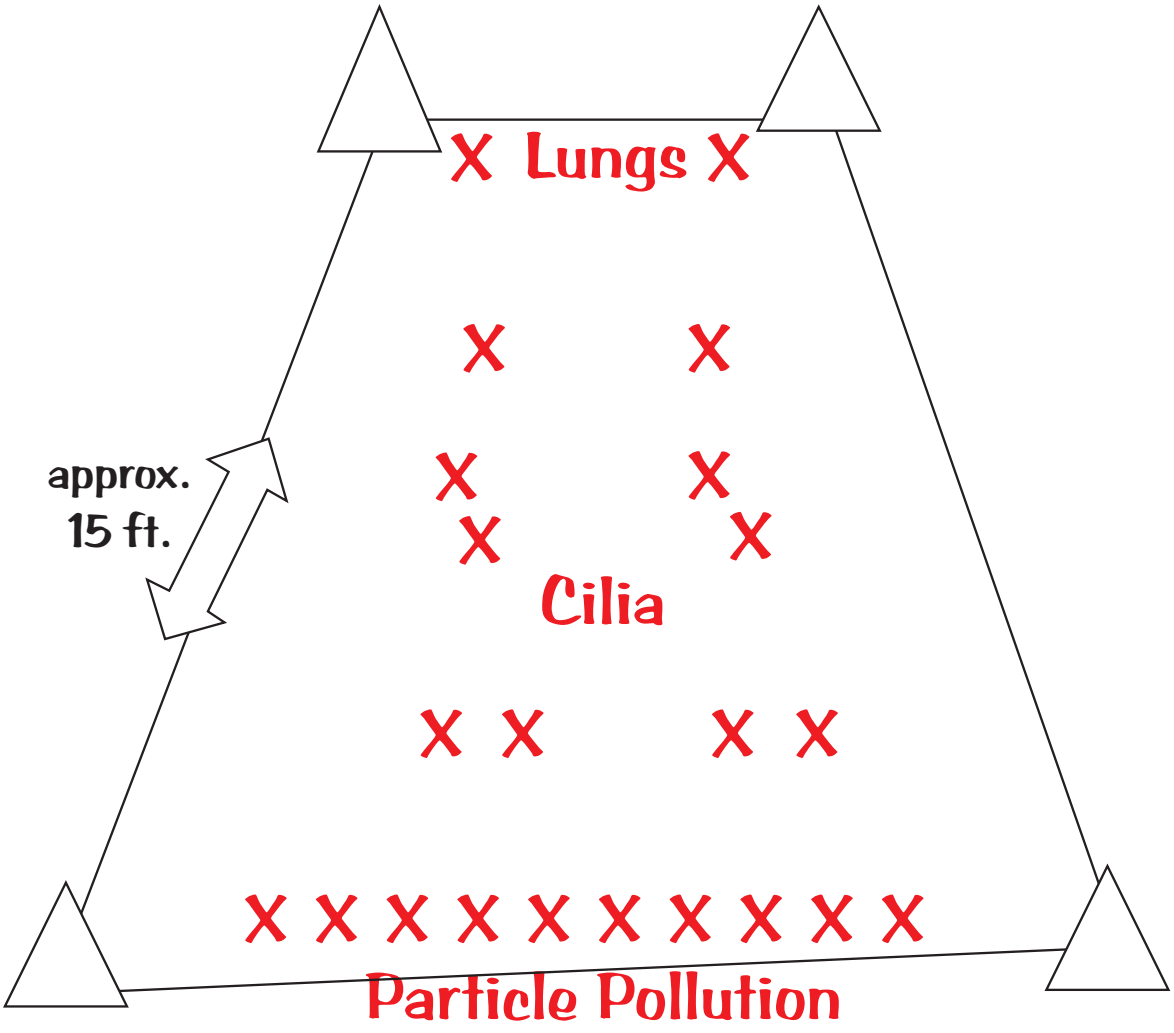
Particle Pollution

(shown as 10 and 2.5 microns)

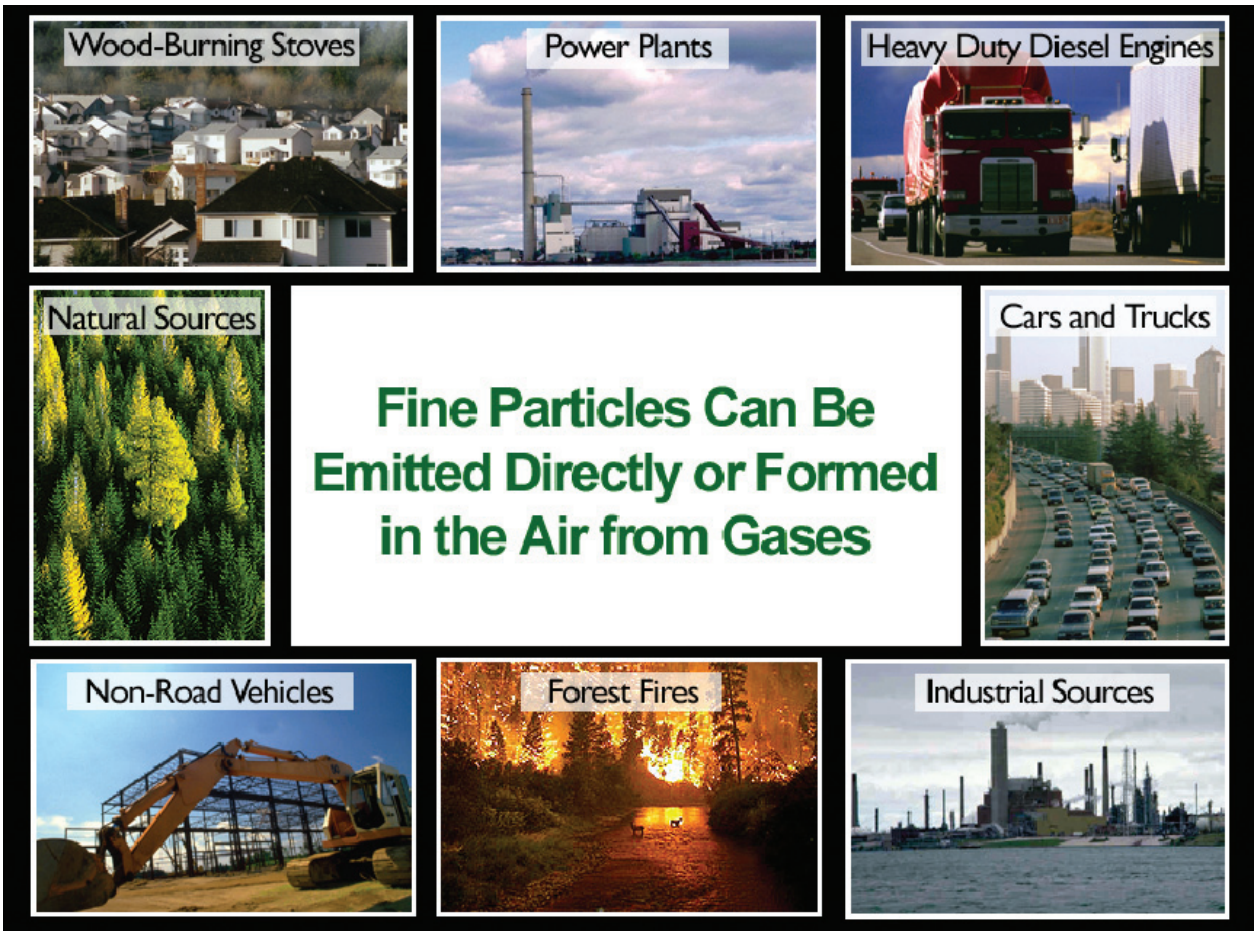


(Particle pollution is also known as particulate matter, or PM)

Cilia Game Set-Up



Sources of Particle Pollution



Source: U.S. EPA, Office of Air Quality Planning and Standards.

Traffic Tally

Learning Objectives

Students will:

- **Design and conduct a traffic survey to explore traffic volume on key local roads.**
- **Collect and analyze observational data.**
- **Understand the connection between traffic volume, modes of transportation, air pollution, and health.**

Grade Level: Grades 3-5

Estimated Time: 1.5-2 hours (2-3 sessions)

Background Summary

Increased traffic is an ongoing problem in many local communities, for several reasons. An increase in traffic often increases accidents, safety problems, traffic jams, and the time it takes to get places. Increased traffic is also a health and environmental concern: more vehicles on the road means more air pollution, since gasoline-powered vehicles release, or emit, several air pollutants (called vehicle emissions). Increased air pollution can cause people to have breathing problems and aggravate heart and lung disease. Also, driving more, instead of walking or bicycling, means we get less exercise, which can potentially contribute to health problems such as obesity, heart disease, and diabetes. Traffic is an environmental and economic concern for another reason as well: more cars on the road means more gasoline is used to run those cars. Gasoline is made from oil, of which there is a limited amount in the world.

This activity is a mini-field trip that provides students with hands-on experience in conducting a traffic survey in their own community, analyzing their data, and exploring the connection between traffic and air pollution. If time permits, students can create presentations of their data.

Materials Needed

- Pencils and erasers
- Watches with minute/second hands, stopwatches, or clicker counters
- Clipboards (if available)
- Additional staff support (classroom assistants or parent volunteers)
- Signed parental consent forms (if taking students off school premises)
- Student Worksheets (included)

Key Questions

- Do you think there is too much traffic along the main (2-lane) roads in your community? If so, how many vehicles do you think travel along these roads during morning rush-hour traffic? How many people do you think are typically in each vehicle?
- How might the amount of traffic be reduced? (*Possible answers:* People could walk, bicycle, carpool, and take subways, trains, and buses more often.)
- How might the amount of air pollution from traffic be reduced? (*Possible answers:* Having fewer vehicles on the road; more people walking, bicycling, carpooling, and taking subways, trains, and buses; driving low-emission vehicles.)
- What might some of the benefits be of reducing traffic and air pollution from vehicles? (*Possible answers:* Fewer traffic jams; safer streets to walk and bike on; fewer health problems from air pollution, such as breathing problems [e.g., asthma], and heart disease, and possibly healthier people because more people might be walking and getting exercise.)
- What things might affect the accuracy of a traffic survey's results? (*Possible answers:* If on the day of the survey there was bad weather or the day was a holiday, the amount of traffic would not represent the usual traffic. Also, the traffic survey results would not be as accurate if: (1) different

groups started counting traffic at different times; (2) some people missed counting some vehicles; (3) some people put some vehicles into the wrong categories; (4) some people "double-counted" some of the vehicles.)

- What vehicles produce the most pollution per person? *(Possible answer:* Cars and trucks with just one person in them.) What vehicles produce the least pollution per person? (*Possible answer:* Bicycles. Or, buses or trains that carry a lot of people.)

Vocabulary

Tally—Counting using marks rather than names or numbers.

Emissions—Substances discharged into the air. Releases of pollutants from a variety of sources and activities, including vehicles, factories, power plants that make electricity, and wood-burning stoves and fireplaces, among others.

Steps

1. Preparation.

- Make important arrangements, such as obtaining parental permission slips to go to off-school premises, and getting commitments from adult classroom assistants and/or parent volunteers to accompany the class groups. (Note: If going offsite is problematic, you can instead conduct the traffic survey on school premises, near the driveway to the school.)

- Choose the roads on which the class will survey traffic volume and vehicle types. Choose a minimum of two roads, for comparison purposes. Choose roads that are within easy walking distance of the school, and are busy two-lane (one travel lane each direction) roadways. Select a time of day when the roads have moderately busy traffic, such as morning rush hour.

  The number of roads chosen will depend on how many groups you want to divide the class into (which in turn will depend in part on how many adult assistants/volunteers you have, and the size of your class). (Note: The class will not be surveying major four-lane or larger highways; the purpose is to determine local/community traffic impacts.)

- Give students an overview of the traffic survey. Inform students that the class will conduct a traffic survey to explore traffic volume on key local roads, and the connection between vehicle traffic and air pollution. Discuss the "Key Questions" above with the class if you have not already done so. Tell the class that they will divide up into groups of at least 8 students per group, and will stand safely by the sides of different busy roads. For a fifteen-minute period (e.g., during morning rush hour), some students will count the number of vehicles driving by, while other students will identify the type of each vehicle (e.g., car, truck, etc.), or the number of people in each vehicle.

- Explain a tally chart. Tell students that to conduct the survey, they will make tally charts that keep track of the number and types of vehicles and the number of people in each vehicle, and that the class is first going to practice making these charts. On the chalkboard, illustrate tally marks.

2. Practice a traffic tally in class. Tell students to use the back of their Student Worksheets to practice recording the number and types of vehicles that you will be calling out to them. For simplicity, tell students to consider SUVs and vans as "trucks" and to ignore motorcycles. Then call out the names of the vehicle types listed below; do it quickly to simulate rapid traffic flow so that students can practice performing quick tallys, which they will need to do by the roadside.

Car	Car	Car	Truck	Bicycle
Truck	Car	Truck	Car	Truck
Car	Car	Truck	Bus	Truck
Bicycle	Car	Car	Car	Car
Car	Car	Bicycle	Truck	Car
Car	Car	Bicycle	Truck	Car
Truck	Car	Car	Car	Truck
Car	Car	Bicycle	Truck	Truck
Car	Car	Car	Car	Truck
Truck	Bus	Bus	Car	Car
Car	Truck	Car	Bicycle	Truck
Car	Car	Car	Car	Truck
Bus	Car	Truck	Bicycle	Car
Car	Car	Car	Car	Car

   Tell students to swap tally sheets and check for correct answers for each type of vehicle as you read aloud the totals listed below:

   Totals: Bicycle = 7, Car = 41, Truck = 18, Bus = 4

3. Explain to students that they will conduct the traffic survey in four pairs. The first and second pairs will focus on the number and types of vehicles;

the third and fourth pairs will focus on the number of people in each type of vehicle:

- **1st Pair:** One person will call out loud to their partner the type of the vehicle (e.g., "car," "truck") each time a vehicle passes in *one direction* (one side of the street), while the other partner will record the data on Student Worksheet #1.
- **2nd Pair:** One person will count vehicles passing in *the other direction* (on the other side of the street), while the other partner records the data (as described in "1st Pair" above).
- **3rd Pair:** One person will call out the number of people in each vehicle in *one direction* and identify the type of vehicle, while the other partner will record the number of persons per vehicle and the vehicle type. Tell students that it may be difficult to identify the number of people, and to do the best they can. For buses, have the students discuss and agree on an estimate of the number of people they will use (e.g., average of 15 people per bus) and make sure all students are using the same number.
- **4th Pair:** One person will call out the number of people in each vehicle in *the other direction* and the vehicle type, while the other partner will record the number of persons per vehicle and the type of vehicle. Again, tell students that it may be difficult to identify the number of people, and to do the best they can. For buses, use the same estimated average number of people as discussed in "3rd Pair" above, and make sure all students are using the same number.

4. Explain ways that conducting the survey can help make it more accurate. That is, it is important for each group and each pair of students to do things exactly the same way. For example, each group must start the survey at the same time, and each group must conduct the survey for exactly 15 minutes—not longer and not shorter.

5. Assign the students to survey groups, and assign an adult assistant to each group. Have students in each group divide up into pairs; help them decide who will be an "announcer" (calling out the type of each vehicle that passes, or the number of people in each vehicle) and who will be the "recorder" in each pair. Assign one person (e.g., the adult assistant) to be the timekeeper, who will tell students when to begin and end the survey and record the exact starting and ending times.

6. Conduct the traffic survey at the designated locations, using Student Worksheet #1. If possible, have students stand in locations where they do not have to cross any streets. Be sure to remind students to practice safety: stand back from the roadway; if crossing a street is necessary, do so carefully when the adult assistant says it is safe to do so. Make sure students are standing in such a way that allows other pedestrians to pass easily, and that they are polite to people. Have adult assistants help students as needed as they count vehicles and people in them.

7. After the survey has been conducted, in class (on the same day or another day), have the student groups compile their survey results, and discuss and analyze the results as a class.

- **Calculate totals**. Back in the classroom, in the top half of Student Worksheet #2, have each group add up the totals for their group, including the total number of each type of vehicle and the grand total number of vehicles. Ask a spokesperson from each group to read aloud the totals for their group, write these on the chalkboard, and add up the totals for the entire class.
- **Calculate data for different vehicle types**. Of the total traffic, have the class calculate the portion of each vehicle type (e.g., cars, trucks, buses, bicycles). For younger students, this might be calculated as fractions. For older students, this might be calculated as fractions and percentages.
- **Discuss results thus far**. Which roadway had the most traffic? Why does the class think this is so? Compare and contrast the numbers of different types of vehicles for each group.

8. Explain the Air Pollution Values table on Student Worksheet #2 to the class. Tell students that you have assigned an "air pollution value" number to each type of vehicle. The number is an estimate of the degree of air pollution each type of vehicle releases for every person it carries, compared to the other vehicle types—the higher the number, the more air pollution. On Student Worksheet #2, in the Air Pollution Values table, tell students to look at the numbers in the "Air Pollution Value Per Person" column.

   Explain the rationale behind these numbers: Trucks with one or two people in them release the most pollution per person, so they are assigned the highest pollution value of "10." Cars with one or two people in them release the next most pol-

lution per person, so they are assigned the next highest pollution value of "9." Cars and trucks with three or more people can be considered carpools (sharing rides) for this exercise; because more people are in the vehicle, it releases less air pollution per person, and is assigned a lower value of "3"—about one-third the pollution values of 9 or 10. (This is because a vehicle with three people in it would release about one-third of the pollution compared to three separate vehicles each carrying one person in it). Because buses can carry many more people than cars and trucks, the pollution value per person for buses is much lower ("0.2") than for cars and trucks. Bicycles don't release any air pollution, so their air pollution value is "0".

9. Tell students to fill in the "Total Number of People" column in the Air Pollution Values table in Student Worksheet #2. Ask students if they know where to get this information. If no one offers the correct answer, tell students they recorded this information on the bottom of Student Worksheet #1 during the traffic survey, in the "Number of People in Each Vehicle" box. Assist students as needed in adding up the data in Student Worksheet #1 and transferring it to the Total Number of People column of the Air Pollution Values table in Student Worksheet #2 (e.g., placing the numbers in the correct "Vehicle Type" rows in the table).

10. Next, demonstrate on the board how to calculate numbers for the "Estimated Air Pollution Value" column in the Air Pollution Value table. For one of the vehicle types listed, ask a student to give you his or her answer for the "Total Number of People" for that vehicle type. Multiply the total number of people for that type of vehicle by the "Pollution Value Per Person" number assigned to that vehicle type. Have students enter this answer in the "Estimated Air Pollution Value" column of the table. Have students work in groups to calculate the Estimated Air Pollution Value for the other vehicle type categories and record these numbers in the Air Pollution Values column in the table.

11. Discuss the results of the Air Pollution Values table. Which vehicle type had the highest air pollution value? Which vehicle type had the lowest air pollution value? Discuss the results for the other categories, and compare the numbers for all five vehicle types. If no buses were identified in the traffic survey, provide a hypothetical scenario for comparison purposes (e.g., two buses, each with 15 people in them, would result in an Estimated Air Pollution Value of 6: Total Number of People [30] x Air Pollution Value Per Person [0.2] = Estimated Air Pollution Value [6]).

12. Discuss the relationship between traffic volume, air pollution, and health.

    Ask: If the number of vehicles on the road were reduced, might this reduce air pollution? (*Correct answer:* Yes). Why? (*Correct answer:* Because gas-powered vehicles release air pollutants, and fewer vehicles would mean less pollution.)

    Ask: How might the number of vehicles on the road be reduced? (*Correct answers:* Carpooling and using public transportation [buses, trains, subways] would reduce the number of vehicles on the road, which would reduce air pollution. Walking and bicycling would also reduce air pollution. You can also mention that new laws requiring vehicles to release fewer emissions would also help vehicles reduce the amount of air pollution.

    Ask: What are some benefits from reducing air pollution? (*Correct answer:* Less breathing problems and fewer asthma attacks and heart problems. People might also be healthier because they might get more exercise by walking or bicycling instead of driving. Also, trees and plants would be healthier if there was less air pollution.

13. Discuss the accuracy of the traffic survey methodology and results. Identify any potential problems regarding the data collection methods: Did one group collect data for 20 minutes instead of 15? Did some people miss counting some vehicles (e.g., because they weren't paying attention, because they sneezed, etc.)? Did some people "double-count" one or more vehicles? Could students really see the number of passengers inside vehicles? Did some people put certain types of vehicles in the wrong categories (e.g., did they remember to count SUVs and vans as trucks)? Did one group start earlier or later than another group? Did the weather suddenly change during the tally? Inform the class that any of these or other factors can affect the accuracy of the survey results. Ask the class if they have any ideas about how the survey could have been done more accurately. (Then tell students they did a great job, given the many things that can affect the accuracy of survey results.)

14. If time permits, have students create a presentation of the traffic survey and air pollution results. Depending on time available, either assign how the class should present the data, or, if more time is

available, have the class discuss different ways of presenting the data and determine the best way to present the information (e.g., line graph, pie chart, pictogram, and/or bar graph). If time permits, you may want to have different groups present their data results in different ways.

Building on prior classroom experience with different graphic presentation formats, explain to the class how to develop the type of presentation format you choose. Decide what units, scales, colors, symbols, spacing, etc. to use, as appropriate. If computers are available, consider having students use the Internet or relevant software to create charts or graphs.

Discuss which type(s) of chart or graph conveys the information most effectively and why.

Adaptation

For Grades K-2, conduct the traffic survey as a whole class instead of dividing up into groups (with enough adult classroom assistants). Have the teacher and adult assistants, rather than the students, count the number of vehicles and people in the vehicles. Back in class, the teacher can call out the totals for the students to record. The teacher can calculate the estimated air pollution values and tell students that the higher the number, the more air pollution that type of vehicle produces. For presentation purposes, help the students develop pictograms and/or pie charts (instead of more complex bar graphs, etc.).

For Further Exploration

- Have students explore the mean and range of the different groups' data sets and of the grand totals.
- Have students develop a database, computerized if possible, of the data collected.
- Conduct an in-class simulation instead of, or in addition to, a traffic survey field trip. See the Traffic Jams lesson at Web site: www.cleanaircampaign.org/Your-Schools/Resources/Air-Quality-Lesson-Plans/Elementary-School. (Step 7 of the Traffic Jams lesson on pollution values was adapted and incorporated into this Traffic Tally lesson).

Acknowledgments/Resources

UK Department of Transport Primary School Teaching Resource – Numeracy: Local Traffic Survey.

The Beacon School Interactive Website—Geography Department at: www.geogweb.com

Traffic Jams. The Clean Air Campaign, Georgia Learning Connections at: http://www.cleanaircampaign.org/Your-Schools/Resources/Air-Quality-Lesson-Plans/Elementary-School

Walking for Health and the Environment Curriculum. WalkBoston and ERG at: http://walkboston.org/resources/maps

Next Generation Science Standards

Energy
Interdependent Relationships in Ecosystems
Engineering Design

Student Worksheet #1: Tally Sheet for Traffic Survey

Location (name of road, and main intersection if appropriate):

_____

_____

Number of Each Vehicle Type

Type	Tally	Totals
Cars		
Trucks		
Buses		
Bicycles		

Number of People in Each Vehicle (keep separate results for each individual vehicle)

Cars	Trucks	Bicycles	Buses (estimate)

Student Worksheet #2: Survey Results and Air Pollution Values

Location (name of road, and main intersection if appropriate):

_____

_____

Using your results in Student Worksheet #1, fill out the following information in the classroom after conducting the survey:

Total number of cars: _____

Total number of trucks: _____

Total number of buses: _____

Total number of bicycles: _____

Total number of all types of vehicles: _____

After your teacher discusses the Air Pollution Values table below with the class, complete the table.

Air Pollution Values

Vehicle Type	Total Number of People	Air Pollution Value Per Person	Estimated Air Pollution Value
Trucks with 1 or 2 people		10	
Cars with 1 or 2 people		9	
Cars and Trucks with 3 or more people (Carpool)		3	
Bus		0.2	
Bicycle		0	

If your teacher instructs you to do so, present your survey results (as a line graph, pie chart, bar graph, and/or pictogram, as your teacher tells you).

Trapping Air Pollution: Temperature Inversions #1

Learning Objectives

Students will:

- **Observe simulations of normal weather conditions compared to conditions during temperature inversions.**
- **Understand how temperature inversions can trap air pollutants and impact health.**

Grade Level: Grades 3-5

Estimated Time: 45 minutes

Background Summary

Air temperature can play an important role in air pollution. Under normal weather conditions, air temperature is cooler as you move upward in the atmosphere; the air closer to the Earth is warmer than the air above it. The word "inversion" means that something is reversed or turned upside down. So when a temperature inversion occurs, the opposite is true about the air. During a temperature inversion, cool air is "trapped" under warmer air above it. Any pollutants in the cooler air are also trapped under the warmer air, and cannot rise and move away, until the weather changes, such as a wind carrying the air pollution away. While the temperature inversion is occurring, air quality in that particular location can get worse if there is a lot of pollution there.

Materials Needed

- Photos showing clean air and air with trapped pollutants (included)
- 4 identical small, clear glass jars (baby food jars work well)
- Very hot tap water
- Ice water (about 500F)
- 2 index cards
- Red food coloring
- Medicine dropper (e.g., eye dropper) (optional)
- 2 shallow pans or baking dishes, each long enough (to hold 2 of the small jars)

Key Questions

- Do you think different layers in the atmosphere have different temperatures?
- Do you think temperature differences in the atmosphere could affect air pollution? How?

Vocabulary

Atmosphere—The mass of air surrounding the Earth.

Inversion—A reversal of the usual order.

Temperature inversion—A layer of warm air that prevents the rise of cooler air and pollutants beneath it.

Steps

1. Show the class the photos of a city with clean air and a city with trapped air pollutants.

Demonstrate normal weather conditions to the class (Steps 2-6):

2. Place two of the jars in one of the shallow pans.
3. Fill one of the jars with hot water and the other jar with ice water. Fill jars to the brim. If you use ice cubes to cool the water in the ice-water jar, do not leave any ice in the jar.
4. Put several drops of red food coloring in the jar with the hot water, and explain to students that the food coloring represents air pollution.
5. Place an index card over the top of the jar with the cold (clear) water and quickly flip this jar on top of the jar with the hot (red) water.

   Align the jar openings.
6. Carefully pull the index card out. Leave the jars one on top of the other for later observation.

Next, demonstrate a temperature inversion (Steps 7-11):

7. Place the last two jars in the other shallow pan.
8. Fill one jar with hot water and the other jar with ice water. Fill jars to the brim. Again, if you use ice cubes to cool the water in the ice-water jar, do not leave any ice in the jar.
9. This time, add several drops of red food coloring to the jar with the ice water, and explain that the food coloring again represents air pollution.
10. Place an index card over the top of the jar with the hot (clear) water and quickly flip this jar on top of the cold (red) water jar.

    Align the jar openings.
11. Carefully pull the index card out. Leave the jars one on top of the other for observation.
12. Discuss the results with the class.

    A. Ask the class: What happened in each experiment? (*Answers:* In the first experiment, the hot [clear] water in the bottom jar and the cold [red] water in the top jar mixed immediately, and water in both jars turned red. In the second experiment, the cold [red] water in the bottom jar was trapped and could not escape upward, and the jar on the top [hot water] stayed clear.)

    B. Which of these experiments do you think reflects normal weather conditions, and why? Which reflects a temperature inversion, and why? (*Answer:* The first experiment reflects normal weather conditions because the colder temperature was above the warmer temperature. The second experiment reflects a temperature inversion because the colder temperature was trapped below the warmer temperature above it.)

    C. What happens to air pollutants under each of these conditions, and how do you think this might affect people's health? (*Answer:* In the first experiment [normal weather conditions], the water in the jars and any pollutants [red coloring] in them mixed together, showing that the air and pollutants can move upward and away. In the second experiment [temperature inversion], the warmer water above trapped the cooler water below and any pollutants [red coloring] in it. This shows that a temperature inversion prevents cool air and pollutants from rising and traps them closer to the Earth in the air that we breathe. Breathing trapped pollutants can make it harder to breathe and can make people feel sick.)

Adaptation

For a more advanced lesson on temperature inversions, see "Trapping Air Pollution: Temperature Inversion #2" (for Grades 6-8) in this Toolkit.

Acknowledgments/Resources

Adapted from Alamo Area Council of Governments (AACOG) Air Quality Curriculum at: www.aacog.com/documentcenter/view/247

Next Generation Science Standards

Weather and Climate
Earth and Human Activity
Engineering Design
Matter and Energy in Organisms and Ecosystems

Clean Air

Pollutants Trapped In Air

Save Smog City 2 from Particle Pollution

Learning Objectives

Students will:

- **Understand how weather and people's activities affect air pollution.**
- **Explore how changes in key variables can affect air pollution.**
- **Learn how air pollution can affect our health.**
- **Identify things people can do to reduce air pollution.**

Grade Level: Grades 3-5

Estimated Time: 1 hour

Background Summary

Air pollution is not good for our health. Particle pollution is one type of air pollution that is made up of tiny particles of dust, dirt, smoke, and liquid droplets that may contain chemicals. Particle pollution "emissions" come from cars and trucks, power plants, and factories. Particle pollution can also come from natural sources, such as fires and volcanoes.

(*Make sure the class understands what emissions are*, since this is an important concept of this lesson and the Smog City 2 Web site used as the basis for this lesson.) *Ask the class* if they know what emissions are. Based on their responses, guide the class to understand that emissions are releases of pollutants from cars and trucks, factories, power plants that make electricity, and even activities we do at home, such as using wood-burning stoves and fireplaces.

Weather can also affect particle pollution. Wind can blow particle pollution away from where it was produced to distant areas. Particle pollution can occur at any time of year, but is often especially bad in the winter, when the winds are calm and when temperature inversions occur. An inversion is when a layer of warm air traps cold air beneath it, including any pollutants in the cold air.

Tell the class that the Air Quality Index, or AQI, tells how clean or polluted the air is in a specific location each day. The AQI has six categories for air quality: Good (green), Moderate (yellow), Unhealthy for Sensitive Groups (orange), Unhealthy (red), Very Unhealthy (purple), and Hazardous (maroon). Tell students that you will discuss the AQI more as the lesson continues.

Particle pollution can be part of "smog"—a term that originally meant a combination of smoke and fog. These days, smog refers to a combination of chemicals and particles. Tell students that they will be playing an online computer game called Smog City 2 about particle pollution that lets them change things like the weather, emissions from cars and power plants, and population to see how these changes affect particle pollution.

Materials Needed

- Internet access
- Teacher Answer Sheet (included)
- Student Worksheet (included)

Key Questions

- What is particle pollution? (*Answer:* Particle pollution is one type of air pollution that is made up of tiny particles of dust, dirt, smoke, and liquid droplets that may contain chemicals.)
- Can people's activities affect air pollution? How? (*Answer:* Yes. Vehicles, power plants, and factories are major sources of air pollution.).
- Can the weather affect air pollution? How? (*Answer:* Yes. See the third paragraph under *Background Summary* above.)
- Can particle pollution affect people's health? How? What can people do to protect their health from air pollution? (*Answer:* Particle pollution can irritate the eyes, nose, and throat; cause coughing, chest tightness, and shortness of breath; and can make asthma and heart disease worse. When particle pollution levels are "Unhealthy"—a "red" air quality day according to the Air Quality Index (AQI)—people with heart or lung disease (including asthma) and older adults and children are advised to avoid strenuous activities. The AQI also provides other health messages for other air quality conditions.)

- What can people do to reduce air pollution? (*Answers might include:* Drive less; take buses, trains, and subways; walk and bicycle. If you drive, drive a hybrid or other car that produces fewer emissions. Use lawnmowers that don't use gasoline or electricity. Reduce use of wood-burning stoves or fireplaces. Also, power plants could use wind power, solar power, or hydroelectric power instead of coal, oil, or natural gas. Factories can use cleaner technologies that produce fewer emissions. Companies can make and sell fuels for cars from waste products instead of gasoline.)

Vocabulary

Emissions—Substances released into the air that may contain pollutants from a variety of sources and activities, including vehicles, factories, power plants that make electricity, and wood-burning stoves and fireplaces, among others.

Particle pollution—Tiny particles of dust, dirt, smoke, and liquid droplets in the air.

Air Quality Index (AQI)—A color-coded scale that provides daily air quality and health information.

Steps

1. Tell students to access the Smog City 2 Web site at www.smogcity2.org and click on "Save Smog City 2 from Particle Pollution." Then have the class minimize the instructions box at the top right of the screen and ignore the "Information" box at the bottom of the screen; they will be exploring several of these concepts in this lesson.

2. Tell the class not to click on anything until you tell them to (it's tempting!). Point out the main categories on the left of the screen with the class, including Weather, Emissions, and Population. Also tell students to notice how each of the settings under these categories are pre-set to a certain level. Tell them that they will explore what happens when they change some of these settings.

   (If students ask, you can mention to students that the "Total Emissions" graph towards the bottom of the page reflects all the different types of emissions at the levels you set when you play the game. Tell them that you will be discussing Emissions later in the lesson. You can also mention that "Random Events" refers to natural events such as fires.)

3. Tell students to look at the black sign in the picture. The signs tells the current temperature and AQI, or Air Quality Index. Remind students that the AQI tells how much air pollution there is.

   Tell students to record the current temperature and the AQI on their Student Worksheet in Question #1—for the AQI, have students enter the AQI under the "Number" column only for now.

4. Tell students to observe the AQI (Air Quality Index) box in the lower right corner of the screen. Tell the class that the default setting is "Red". (Define default for students.) Tell students that the matching health level for a red AQI color is "Unhealthy" (see just below the colored graph where it says "Health.") Under this health level is a corresponding health message.

   Review the health message in the box for a Red, Unhealthy AQI with the class: "People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion."

5. Tell students to add the "Color" and "Health Level" for the AQI in Question #1 of their Student Worksheet (based on the information reviewed in Step 4).

6. Tell students that it's winter in Smog City 2, so they should change the temperature setting to 30 degrees F (lowest setting, farthest to the left).

   Note: Tell students that settings can be changed by clicking on the new level they want. Remind them to wait until you tell them to change any of the settings.

7. Tell the class that the "Population" setting refers to total population in an area, and it can also refer to the number of people using wood-burning stoves and fireplaces. Keeping the same setting established in Step 6 (that is, tell students not to press the Reset button), have students increase the Population to the highest setting (far right), since more people in Smog City 2 are using their wood-burning stoves and fireplaces this winter.

8. Tell students to record the AQI in Question #2 on their Student Worksheet after they lowered the temperature and raised the Population.

   Ask students: What happened to the AQI when you lowered the Temperature and increased the Population setting? Why do you think this happened?

(Answer: The AQI increased from 157 to 184. This occurred because the increase in wood stove and fireplace use produced more particle pollution. Also, while particle pollution can occur at any time of year, it is often higher in the winter. Note that while the AQI increased, it remained in the same —Unhealthy—category.)

9. Tell the class that the mayor of Smog City 2 has just restricted the use of wood-burning stoves and fireplaces this winter to reduce the Unhealthy level of particle pollution. The west side of the city can burn wood on even calendar days, the east side on odd calendar days.

   Keeping the setting established in Step 8 (don't press Reset), tell students to reduce the Population setting to the second to lowest setting (second from left)—remind students that you are using this setting to represent the number of people using wood stoves and fireplaces.

10. Tell students to record the AQI in Question #3 on their Student Worksheet after they reduced the Population using wood-burning stoves and fireplaces.

    Ask students: What happened to the AQI when you lowered the Population? Why do you think this happened?

    (Answer: The AQI decreased from 184 to 119. The AQI category changed from Unhealthy to Unhealthy for Sensitive Groups. Read the Health Message for "Unhealthy for Sensitive Groups" to the class in the box on the lower right. The AQI decreased because reducing the use of wood stoves and fireplaces reduced particle pollution.)

11. Have the class press the "Reset" button on the lower left side so that everything returns to the original settings.

12. Tell students to observe the current Emissions level for "Cars and Trucks" and record the current AQI on Question #4 of their Student Worksheet.

13. Tell students that the mayor of Smog City 2 has just purchased a whole new fleet of hybrid cars and other fuel-efficient cars and trucks to replace all older cars used by city government workers. Therefore, tell students to decrease the Emissions level from Cars and Trucks to the lowest level to reflect this change.

14. Tell students to record the AQI after they made the change in Cars and Trucks emissions in Question #5 on their Student Worksheet.

    Ask students: What happened to the AQI when you lowered the emissions from Cars and Trucks? Why do you think this happened?

    (Answer: The AQI decreased from 157 to 113. The AQI category changed from Unhealthy to Unhealthy for Sensitive Groups. Read the Health Message for "Unhealthy for Sensitive Groups" to the class in the box on the lower right of the Web page. The AQI decreased because the newer fleet of vehicles purchased by the city produced fewer emissions than the older vehicles.)

15. Tell students that particle pollution can irritate the eyes, nose, and throat; cause coughing, chest tightness, and shortness of breath; trigger asthma attacks; and make heart disease worse.

    (Note: If the class is also studying ozone pollution, you can mention that some of the health symptoms of particle pollution and ozone pollution are similar, such as irritation of the throat, coughing, and aggravating asthma, but some health symptoms are different. For example, particle pollution can make heart disease worse. Particle pollution has been linked to heart attacks.)

16. Tell students to look at the top of the column on the left side of the Save Smog City 2 from Particle Pollution page and click on "Air Quality Index (AQI)" (the second heading).

    Look at the color chart at the bottom of this AQI page with the class and read each different color's health message so that students understand how changes in air pollution, as reflected by changes in the AQI, can affect people's health.

17. Ask students what steps they think they or other people could take to reduce emissions and particle pollution. Add to and discuss the answers, as indicated below, and the rest of the Student Worksheet.

    (Correct answers might include: Drive less; take buses, trains, and subways; walk and bicycle. If you drive, drive a hybrid or other vehicle that releases fewer emissions. Use lawnmowers that don't use gasoline or electricity. Reduce use of wood-burning stoves or fireplaces. Also, power plants could use wind power, solar power, or hydroelectric power instead of coal, oil, or natural gas. Factories can

use cleaner technologies that produce fewer emissions. Companies can make and sell alternative fuels for cars from waste products instead of depending so much on gasoline as a fuel.)

(The class can also have a discussion of electricity and emissions. Tell students that generally, the more electricity that we use, the more electricity that power plants need to produce, which produces more emissions of air pollutants. If we use less electricity, power plants will need to produce less electricity, and will produce fewer emissions. So, turn off lights when you're not using them, and also appliances such as computers, TVs, fans, and air conditioning, and turn down the heat when leaving the house [talk to your parents about this first]).

For Further Exploration

Change some of the other settings in Save Smog City 2 from Particle Pollution, such as Wind, Consumer Products, and Industry, and discuss with the class how these changes can affect particle pollution, the AQI, and health.

To challenge students, conduct the "Save Smog City 2 from Ozone" lesson (or portions of it) in this Toolkit (see Grades 6-8).

See the Temperature Inversion lesson(s) in this Toolkit (one for Grades 3-5, another for Grades 6-8) for information on how temperature inversions can affect air pollution.

Acknowledgments/Resources

Smog City 2, U.S. EPA and the Sacramento Air Quality Management District at: www.smogcity2.org

Next Generation Science Standards

Weather and Climate
Energy
Interdependent Relationships in Ecosystems
Engineering Design
Matter and Energy in Organisms and Ecosystems

Student Worksheet: Save Smog City 2 from Particle Pollution

Name: _____

1. Record the current temperature and AQI in "Save Smog City 2 from Particle Pollution":

   Current temperature:

   Current AQI:

Number	Color	Health Level

2. Record the AQI when you lowered the temperature to 30° F and raised the Population to the highest level:

Number	Color	Health Level

3. Record the AQI after you reduced the "Population" that uses wood-burning stoves and fireplaces.

   Current AQI:

Number	Color	Health Level

4. Record the AQI at the current Emissions level for Cars and Trucks:

Number	Color	Health Level

(continued)

Student Worksheet: Save Smog City 2 from Particle Pollution

Name: _____

5. Now record the AQI when the Emissions level for Cars and Trucks was changed to reflect government use of a new fleet of low-emission cars and trucks (changed to lowest level):

Number	Color	Health Level

Teacher Answer Sheet: Save Smog City 2 from Particle Pollution

1. Record the current temperature and AQI in "Save Smog City 2 from Particle Pollution":

   Current temperature: 50° F

   Current AQI:

Number	Color	Health Level
157	Red	Unhealthy

2. Record the AQI when you lowered the temperature to 30° F and raised the Population to the highest level:

Number	Color	Health Level
184	Red	Unhealthy

   Ask: If the AQI changed when you lowered the temperature and raised the Population, why do you think this occurred?

   Answer: The AQI increased from 157 to 184. This occurred because the increase in wood stove and fireplace use produced more particle pollution. Also, while particle pollution can occur at any time of year, it is often higher in the winter. Note that while the AQI increased, it remained in the same—Unhealthy—category.

3. Record the AQI after you reduced the "Population" that uses wood-burning stoves and fireplaces.

   Current AQI:

Number	Color	Health Level
119	Orange	Unhealthy for Sensitive Groups

Teacher Answer Sheet: Save Smog City 2 from Particle Pollution

Ask: If the AQI changed when you reduced the Population using wood-burning stoves and fireplaces, why do you think this occurred?

Answer: The AQI decreased from 184 to 119. The AQI category changed from Unhealthy to Unhealthy for Sensitive Groups. The AQI decreased because reducing the use of wood stoves and fireplaces reduced particle pollution.

4. Record the AQI at the current Emissions level for Cars and Trucks:

Number	Color	Health Level
157	Red	Unhealthy

5. Now record the AQI when the Emissions level for Cars and Trucks was changed to reflect government use of hybrid cars (changed to lowest level):

Number	Color	Health Level
113	Orange	Unhealthy for Sensitive Groups

Ask: If the AQI changed when you reduced Emissions from Cars and Trucks to reflect the city's purchase of a fleet of newer low-emission cars and trucks, why do you think this occurred?

Answer: The AQI decreased from 157 to 113. The AQI category changed from Unhealthy to Unhealthy for Sensitive Groups. Read the Health Message for "Unhealthy for Sensitive Groups" to the class in the box on the lower right of the Web page. The AQI decreased because the newer fleet of vehicles purchased by the city produced fewer emissions than the older vehicles.

Student Handout

Breathe Smart! Four Things KIDS Can Do

1

Find out what AQI color for today is where you live.

- Visit the AIRNow Web site at www.airnow.gov.
- Tell your parents about the AQI so they can help you.

2

Protect your health when the air is dirty.

- Take it easier when you play outside.
- If it feels harder to breathe, tell an adult.

3

Help reduce pollution.

- Turn off lights, TVs, and computers when not using them.
- Walk, bike, or take a bus or train with an adult. But remember, your safety always comes first!

4

Visit the AQI kids' site at www.airnow.gov
(click on "Kids" in the "Learning Center")

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY