UNIT 3

More than Meets the Eye

Particulate Matter and Fine Particle Pollution

ACTIVITY DESCRIPTION

This activity is introduced with several teacher-led demonstrations on particulate matter (PM). Demonstrations include revealing by-products of combustion, creating smog, and observing fine, air-born particulates. Students next play a game in which foam balls, representing particulate matter, are thrown at a group of students representing lungs. Students representing cilia surround the lungs and must block the foam balls to keep them away from the lungs. Students will observe the cilia's ability to block different quantities and sizes of particles from reaching the lungs. Following a general discussion of the game and particulate matter (including its effects on health), students work in teams to create PM monitoring devices. Each team places its PM monitor at a different site around the school. Monitors are checked throughout the week and, using a provided scale, accumulated PM is noted on a data sheet. At the end of the week, the PM monitors are brought back to the classroom. Students complete data sheets and a class comparison table and results from the all the monitors are compared and discussed.

curricular ties

See page ix for the list of this lesson's curricular ties to District of the Columbia, Maryland, and Virginia education standards. All Education Standards are articulated in the Appendices.

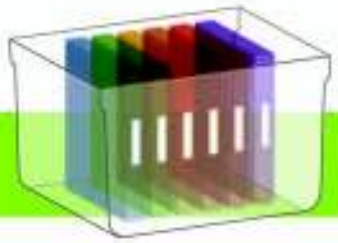
time needed

Two, 45 minute class periods (plus time for checking monitors)

LEARNING OBJECTIVES

Upon completion of this Unit, students will be able to:

- Describe how incomplete combustion contributes to air pollution.
- Define smog and describe how it forms.
- Describe how cilia function to reduce the amount of particulates breathed into the lungs.
- Describe how human activities contribute to PM pollution and list at least three sources of PM.
- Differentiate between PM 10 (coarse) and PM 2.5 (fine) and list sources of each.
- Make predictions as to where PM may be greater based on local environmental factors and human activities.
- Define "monitor" and construct a device to monitor PM.
- Conduct a scientific investigation by making predictions, gathering data, and analyzing results.
- Describe the function of a "control" and a "variable" in a scientific study.
- Use a comparison scale to analyze data.
- Propose strategies for reducing PM around their school.



MATERIALS

Part I—PM Demonstrations (all material provided in kit unless otherwise noted):

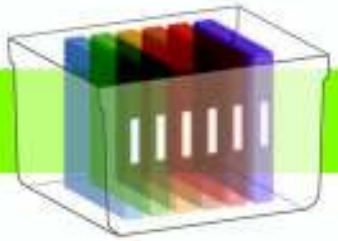
- *Teacher Demonstration Instructions—Particulate Matter*

  Demonstration 1—combustion
  - 1 utility candle
  - 1 tin can (soup can)
  - matches
  - paper towel or rag
  - pot holder

  Demonstration 2—smog
  - 1 large glass jar
  - aluminum foil
  - 2-3 ice cubes (not provided)
  - plastic
  - water (not provided)
  - paper strips
  - matches

  Demonstration 3—Airborne Particulates
  - A small amount of flour
  - flashlight

MATERIALS–continued



Part I—Not-So-Silly Cilia Game:

- *Not-So-Silly Cilia Game Instructions*
- *Not-So-Silly-Cilia Game Set-Up*
- Foam balls (provided)
- Cones or other corner markers (not provided)
- Small puff balls (for size comparison during the discussion)

Part II—PM Monitoring:

Provided in kit:

- Vanilla and container of cotton balls (for short demonstration)
- *Student Handout—PM Monitoring Student Data Sheet*
- *Team Handout—PM Monitoring Team Tasks*
- *Team Handout—PM Monitoring Device—Instructions for Development*
- *Team Handout—PM Monitor Template*
- *Team Handout—PM Comparison Scale*
- *Team Handout—Data Table for Class Comparison*
- Standard cellophane tape
- Double-sided tape
- Compasses
- Magnifying glasses

Not provided:

- Plain, white paper for tracing the *PM Monitor Template* (may use photocopies)
- Scissors
- Empty, 15 oz. tin cans with the lids removed
- Rocks (to place in can for weight, may be collected at study sites)
- Heavy stock paper for "Air Pollution Study in Progress" sign
- Tacks, tape, or string for affixing sign

TEACHER PREPARATION

For Part I:

- Gather all materials together for the demonstrations. Acquire those that are not provided in the kit.
- Do a "dry run" of the demonstrations so that you feel comfortable conducting them.
- Have ready all the materials for the game (included) and designate a space to play the game.

For Part II:

- Review all the steps in the procedures before conducting the activity.
- Check the container with the vanilla-soaked cotton balls to be sure it is fragrant. If necessary, add some more drops of vanilla into the container.
- Acquire all the materials not provided in the kit for the creation of the PM monitors. Consider asking students to bring in 15oz cans from home.
- Following the instructions from the *Team Handout: PM Monitoring Device—Instructions For Development*, create a PM Monitor as a sample. This monitor will also become the class control.
- Create a PM Monitoring Resource Box with all the materials students will need to make their monitors (most of these are provided in the kit).
- Make photocopies of the *Student Handout: PM Monitoring Student Data Sheets*—one copy per student.
- Make photocopies of all of the Team Handouts—one copy of each per team. (Note: The Comparison Scale has three scales per page. Cut out one scale per team.)
- On the day that students collect their monitors, create a *Data Table for Class Comparison* either on the board or by making an overhead transparency of the master.

technology connections

http://www.airnow.gov/index.cfm?action=airnow.currentconditions
AIRNow is a cross-agency government website on our nation's air quality. This link leads students to their region of the country to see the current and previous day's conditions for PM 2.5 and ozone.

http://kidshealth.org/teen/your_body/body_basics/lungs.html
This website presents information on kids' health issues. This specific page, written for an elementary audience, provides an upbeat introduction to the function of the lungs and respiratory system.

ACTIVITY PROCEDURES

Part I—Class Demonstrations and Not-So-Silly Cilia Game

1. Introduce particulate matter by conducting the demonstrations. The demonstrations are best conducted in order. Refer to the *Teacher Demonstration Instructions*.
2. Play the Not-So-Silly Cilia Game. Refer to the game set-up and instructions on how to conduct the game.
3. Discuss particulate matter sizes and sources as described in the *Not-So-Silly Cilia Game Instructions*.
4. Conduct a wrap-up discussion of the demonstrations and game.

Part II—Monitoring Particulate Matter

1. From the kit, obtain the container with the vanilla-soaked cotton balls. Ask students to close their eyes. Open the container. Ask students to raise their hands when they first begin to notice something. Walk around the room waving the container near students. When most students' hands are up, have them identify what they noticed. What sense did they use to detect it?
2. Note that even though students could not see the vanilla, they knew it was there because they could smell it. Their sense of smell detected the tiny particles of vanilla in the air. In this situation their nose acted like a monitor. Write the word "monitor" on the board and discuss the definition of the verb "to monitor" (to check, watch, or keep track of).
3. Explain that scientists monitor air pollution. People that protect our air monitor all 6 criteria pollutants. Depending on the type of pollution being monitored, very specific, scientific monitors are used (other than their noses!). Ask students to suggest reasons why monitoring air pollution might be important.
4. Explain to students that scientists monitor air to be able to inform us of bad air days. Monitoring air also helps us identify the sources of pollution and the locations where pollution is greatest. Knowing where PM comes from is one of the first steps in reducing particle pollution.
5. Tell students that over the next few days they will be working as environmental scientists to monitor air pollution, specifically particulate matter (PM) around their school. Show the students the sample monitor you have made. Explain that each team will make a monitor like the sample and use it to collect particulate matter. What might they learn from this experiment?
6. Discuss where the PM monitors should be placed around the school. Use the following questions to guide students in scientific inquiry about their investigation:
   - What might affect the amount of particles in the air around the school?
   - From which direction are the prevailing winds this time of year?
   - Is there a road by the school?
   - Does the amount of vegetation (plants) in an area have any affect on PM?
   - Where do students think there might be the most PM in the air around the school?
   - How can we test if different areas of the school have different amounts of PM?

7. Explain that students will be working in teams, with each team placing its monitor in a different location. The goal should be to get as much data as possible from different locations around the school. If possible, display a school map and discuss the locations with the class.

8. Divide students into teams of 2—4 students for the creation and placement of the PM Monitors. *(Note: The number of teams will vary depending on the number of sites the class chooses to monitor.)*

9. Decide as a class where monitors should be placed and assign a team to each location. Have students come up with a name for their study site (e.g., cafeteria, north parking lot, etc.). *(Note: Remember that for the best comparison results, PM monitors should be placed in a variety of locations around the school grounds, including at each cardinal direction, by the parking lot, near the busiest road next to the school, and in a less-traveled area of the school grounds. Help students in the selection of these diverse locations.)*

10. Place the *PM Monitoring Resource* Box out where all students may access the materials in it. Also display the sample PM monitor (be sure it is not handled).

11. Distribute all handouts to the teams. Students may share team handouts but will need their own data sheets.

12. Give students time to create their monitoring devices. Remind students to also create a "Please Do Not Disturb—Air Pollution Study in Progress" sign to post with their monitors.

13. Explain that you are first going to set up an experimental "control." Use your sample PM monitor as the class control. Explain that the control will stay enclosed in one place during the experiment so that it won't change. Discuss with students the reasons for using a "control" in a scientific study. *(Note: Be sure to enclose the "control" PM monitor. This can be done by either sealing it inside a bag—being careful not to allow the tape to stick to the sides—or inverting a large jar or can over the top of it.)*

14. Explain that the students' monitors are called the experimental "variables." They will stay exposed at their study sites and collect particulate matter in that area. They are called 'variables' because they might change, or vary, during the experiment.

15. Discuss safety and behavior rules with students before they go out onto the school grounds to place their PM monitors.

16. Allow students to go out and place their monitors at the decided locations. Provide assistance and supervision. Remind them to post their signs with their monitors. The students will need to share the compasses from the kit to correctly align their monitors.

17. Have students complete their *PM Monitoring Student Data Sheets* with their site descriptions and predictions.

18. The monitors should stay in place for a week. Students should check their monitors on or around days 3 and 5 of the monitoring period. They should record the data on their data sheets. They will need to refer to their PM Comparison Scales to determine the level of particulate matter accumulated on their monitors (from "very light" to "heavy").

19 (Optional) Consider having students make and place monitors at home as well. Data from these monitors may be handled similarly to the data from the school monitors.

20 During the week that PM monitors are in place, continue to conduct the other activities in this kit.

21 At the end of the week, have students carefully collect their PM monitors and bring them back to the classroom. Students should analyze their monitors, record results, and complete the team section of their data sheets. Students may use a magnifying glass to look at relative sizes of the different particles and to try to identify any particles.

22 Have student teams enter their results on the *PM Monitoring Data Table for Class Comparison*. Give teams time to enter the results from the completed table onto their own copy of the table.

23 Give students time to complete all sections of their data sheets.

24 Conduct a wrap-up discussion of the activity using the Thinking/Discussion Questions section of the student data sheets as a guide.

Extensions:

1 Have students go online to check the current conditions for PM in their region. Direct students to: **http://www.airnow.gov/index.cfm?action=airnow.currentconditions**.

2 Students should select their state, then particles, date, and type of map they wish to see. They may check out both the current conditions and a 24 hour animation of the previous day's PM conditions.

Teacher Demonstration Instructions

Demonstration 1: Incomplete Combustion and By-Products of Combustion

Materials Needed:

Provided in Kit:

- 1 utility candle
- 1 tin can (soup can)
- Matches
- Paper towel or rag
- Pot holder

Safety Note: *Please observe standard safety procedures when conducting this demonstration. Wear safety goggles, have a fire extinguisher handy, and if possible, perform the procedure under a fume hood so that smoke does not affect asthmatic students.*

Procedure:

1. Light the candle.
2. Holding the can with the pot holder, place the bottom of the can directly over the flame for a few seconds. The top of the flame should be almost touching the can.
3. Show students the bottom of the can. Ask students what they see. *(Black soot.)* Is this evidence of pollution? *(Yes.)*
4. Clean off the bottom of the can with a paper towel. Show students the pollution on the towel.

Demonstration Discussion:

Incomplete combustion means that whatever is being burned does not burn up completely. There is something left over. These left-overs are called "by-products" of combustion. These by-products may be gases such as CO_2, which we can't see, or they may be small particles such as what we collected on the bottom of the can. One of the greatest sources of fine particle pollution is the incomplete combustion of gasoline in car engines.

Teacher Demonstration Instructions

Demonstration 2: Creating Smog

Materials needed:

Provided in Kit:

- 1 large glass jar
- Aluminum foil
- Strip of paper (twisted as per instructions)
- Matches
- Plastic cup

Not provided:

- 2-3 ice cubes
- 1 cup of water

Safety note: *Do not breathe the "smog." Be sure to release it outdoors when you are finished with the demonstration.*

Demonstration Procedure:

1. Prepare your materials prior to the demonstration:
   - Take one of the strips of the paper and fold it in half lengthwise and twist it.
   - Take a piece of the aluminum foil and make a jar lid by molding it to fit the shape of the jar opening (then remove it and set it aside).
2. When you are ready to conduct the demonstration, have all your materials close and ready: twisted paper; glass jar; foil lid; cup of water; matches; ice cubes.
3. Put the ice cubes on top of the prepared foil lid to make it cold.
4. Put some water in the jar and swirl it around until the inside walls of the jar are wet.
5. Attention! All the parts of this next step must be done very quickly:
   - Light the strip of paper and drop it *and* the match into the jar.
   - Place the foil lid on the jar and seal it as tightly as possible.
   - Place the ice cubes back on the middle of the foil lid.
6. Have students observe what happens. Ask them to describe what they see.

Demonstration Discussion:

Originally, the term “smog” was created to describe the combination of smoke and fog, which is what was created in the jar. Today however, smog refers to all kinds of air pollution, from ground level ozone, to volatile chemicals, to particulate matter—specifically, pollution that makes our air hazy. When there is high moisture content in the air (high humidity) polluted skies are even hazier.

Teacher Demonstration Instructions

Demonstration 3: Airborne Particulates

Materials needed:

Provided in Kit:

- A small amount of flour
- flashlight

Safety note: *Be sure to conduct this demonstration at a safe distance from the students to prevent them from breathing in the particles.*

Demonstration Procedure:

1. Darken the classroom.
2. Stand away from students and be sure that there are no drafts to blow the flour in the direction of the students.
3. Gently throw a small handful of flour into the air, being careful to keep far enough away from the students.
4. Shine a flashlight on the falling flour and ask students to describe what they see.
5. Discuss how the flour floats in the air, separating into tiny pieces—like dust. Tell students that these tiny pieces are called "particles" or "particulate matter."

Demonstration Discussion:

Particulate matter is the term used to describe particles that are suspended in the air. Although flour was used for this demonstration, particles may be solid or liquid and are one of the most obvious forms of pollution. When we see a visible haze in the sky over the city it is usually caused by some form of particulate matter. Explain that many different kinds of particles float in the air and can be inhaled into the lungs, making people cough. Indicate that this experiment was done far away from the students so that they would not breathe in the flour.

Additional Discussion Questions:

- Why was it necessary to turn off the lights and use a flashlight to see the particles?
- Are the particles visible with the lights on?
- Can we breathe in particles that we can't see?
- What are some examples of particulate matter that might be in our air?

Not-So-Silly Cilia Game Instructions

Materials Needed:

- *Not-So-Silly-Cilia Game Set-Up*
- Foam balls (provided)
- Cones or other corner markers (not provided)
- Small puff balls (for size comparison during the discussion)

Game Set-Up:

In an open area, designate a trapezoid shape with cones or other obvious markers (see *Not-So-Silly-Cilia Game Set-Up*).

Ask two students to be the Lungs. Divide the rest of class into Particulates and Cilia, choosing a few more students to be Particulates than Cilia. (If the class is large, it may be necessary to have some students observe.)

Refer to the *Not-So-Silly-Cilia Game Set-Up* to place students as follows:

- Have the Lungs stand on the short side of the trapezoid.
- Have the Particulates line up along the longer edge of the area.
- Have the Cilia stand in between the Particulates and the Lungs.

Game Playing Instructions:

1. Ask students to take a deep breath and feel the air moving into their own lungs. Explain that Cilia are tiny little hair-like structures that line our respiratory tract. Their job is to keep all kinds of particles from entering the Lungs by waving around. Particles can be batted away or may be trapped (caught) by Cilia. In the game, the Cilia can stretch and wave their arms, but they must stand still with feet together. Have Cilia practice waving their arms and staying in one place.
2. Explain that the foam balls represent Particulate Matter (PM). Place all the balls near each of the student Particulates. Explain that, on cue from you, the Particulates will pick up and throw the PM toward the Lungs, and the Cilia will try to defend the Lungs by waving their arms and batting away or catching the PM to keep them from reaching the Lungs. (You may demonstrate by being a Cilia and having a Particulate student throw one of the foam balls at you.) Emphasize that the balls should NOT be thrown with too much force or anywhere near the face.
3. Begin the game by declaring the day bright and clear with little PM. The AQI is Green. Have **two** students throw their PM. (Note that even on Green days, there is PM in the air.)
4. The Cilia should be able to easily bat the PM away from the Lungs.
5. Ask the Lungs how they're feeling. Declare another clear, Green AQI day, and have **two** other students throw the PM; again ask the Lungs how they are feeling. Did any of the PM reach the lungs?
6. Next declare it's a very hazy day. It is an AQI Orange day and is unhealthy for sensitive groups! Tell all of the Particulates to throw the PM as fast as they can. When all of the foam balls have been thrown, stop the game and allow time for students to calm down.

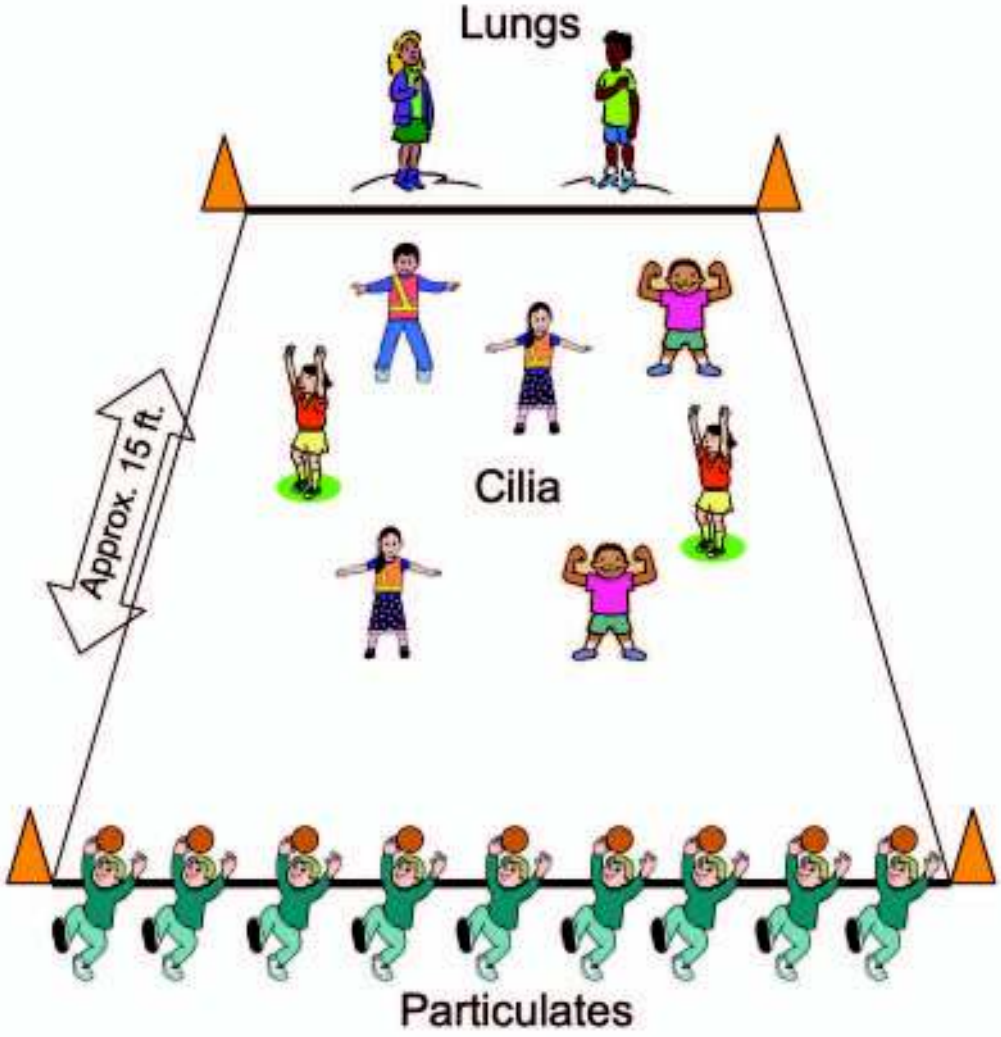
7 Ask the Lungs to count how many PM's reached them (or got past the cilia). Have the Lungs share how they feel to have all that "stuff" in them. Ask the Cilia to tell how they felt during the game.

8 If desired, collect all the balls and play the game again. Students may want to take on different roles.

Game Discussion:

- After students have quieted down from the game, pick up one or two of the foam balls and ask what they might represent. What kinds of things contribute to PM? *(Forest fires, fireplaces, dust from roads, grinding and construction operations, and by-products of incomplete combustion of various fuels used in motor vehicles, power plants and other industries.)*
- Would it have been easier or harder on the Cilia if the PM had been much smaller?
- Ask a few students to hold up some of the foam balls. Ask students if they think that is the actual size of particulate matter we might breathe in.
- Have students imagine that the ball is the same diameter of a human hair. Have students look at a strand of their own hair. Remind them that if they cut a strand of hair and looked at it on end, they are looking at a cross-section of their hair and the width across that cross-section is its diameter. It is so tiny that we can't measure it in inches, instead we use ***microns***. There are 25,400 microns in one inch! Tell them that width of human hair is around 70 microns. Particulate matter is also measured in microns.
- Again have students hold up the foam balls. Hand out the larger of the small puff balls to a student and have him/her hold it up next to the foam ball. Explain that if the foam ball were the size of a human hair (70 microns), this puff ball would be about 10 microns. Particles that are 10 microns or less can be breathed into the lungs.
- Hand out the smallest of the puff balls to another student and have him/her hold it up next to the larger puff ball and foam ball. Explain that this ball would be around 2.5 microns.
- Remind students that particles between 10 and 2.5 microns are called ***PM 10*** or ***coarse PM*** and come from sources such as dusty roads and grinding operations. Particles that are less than 2.5 microns are called ***PM 2.5*** or ***fine PM*** and come from all kinds of combustion including fires, motor vehicles, power plants, and some industrial processes.
- (Note: You might ask the team that created the "Wanted for Polluting Our Air" PM poster to help you with these explanations.)
- Explain that those with sensitive lungs and heart conditions—children, older adults, people with asthma and other respiratory problems—can be affected by particulate matter. In an upcoming activity, the class will learn more about how the lungs work.

Not-So-Silly Cilia Game Set-Up*



**Note: You may have a few more students play than shown in the diagram. Just be sure there are more Particulates than Cilia.*

Student Handout

PM Monitoring—Student Data Sheet: Day 1

Your Name_____
Names of Other Team Members_____

Date_____ **Weather: clear cloudy rainy windy**

Test Site Name:_____

Test Site Description (Describe in detail where on the school grounds your monitor was placed.):

_____
_____
_____
_____

On which side of the school is your monitor placed? (check one)

____ North ____ Northwest ____ West
____ Southwest ____ South ____ Southeast
____ East ____ Northeast ____ Central

Your monitor's proximity to roads (check one):

____ Right beside a road ____ Close to, but not on the road
____ There is a road in sight ____ There are no roads in sight

Amount of traffic on the nearby roads (check one):

____ None ____ A little
____ Moderate ____ A lot ____ It's a busy highway

Relative amount of human traffic (people walking or riding bikes) in the area of your monitor (check one):

____ None ____ A little
____ Moderate ____ A lot ____ It's crawling with people

Relative amount of vegetation (trees and other plants) in the area of your monitor (check one):

____ None ____ A little
____ Moderate ____ A lot ____ It's a jungle

Student Handout (cont'd)

PM Monitoring—Student Data Sheet: Day 1

Based on the location of your PM monitor, do you predict that there will be more or less particulate matter (PM) on your monitor than on the classroom control monitor?

_____ more _____ less _____ same amount

Explain your above response in detail:

_____
_____
_____
_____
_____
_____
_____

Based on the location of your PM monitor, do you predict that there will be more or less particulate matter (PM) than on the other monitors placed around the school?

_____ more than other areas of the school
_____ the same amount as other areas of the school
_____ less than other areas of the school

Explain your above response in detail:

_____
_____
_____
_____
_____
_____
_____

Placement Day Monitor Reading—Compare the test circles on your monitor with the PM Scale. Rate and record the relative amount of PM for each direction:

North_____
South_____
East_____
West_____

Student Handout

PM Monitoring—Student Data Sheet: Mid-Week Monitor Checks

For your monitor readings, you should carefully pick up your monitor and compare the test circles on your monitor with the PM Scale. You do not need to use a magnifying glass for these observations. Remember, don't touch your test circles!

1st Mid-Week Check **Date**_____

Current Weather: **clear** **cloudy** **rainy** **windy**

How was the weather in the days since you last checked your monitor?

_____

_____

1st Mid—Week Monitor Reading
Compare the test circles on your monitor with the PM Scale. Rate and record the relative amount of PM for each direction:

North_____ East_____
South_____ West_____

Describe the changes you observe:

_____

_____

_____

_____

2nd Mid-Week Check **Date**_____

Current Weather: **clear** **cloudy** **rainy** **windy**

How was the weather in the days since you last checked your monitor?

_____

_____

2nd Mid-Week Monitor Reading—Compare the test circles on your monitor with the PM Scale.
Rate and record the relative amount of PM for each direction:

North_____ East_____
South_____ West_____

Describe the changes you observe:

_____

_____

_____

Student Handout

PM Monitoring—Student Data Sheet: Collection Day—Team Analysis

Collection Day
Date_____

Current Weather: **clear** **cloudy** **rainy** **windy**

How was the weather in the days since you last checked your monitor?

_____
_____
_____

Collection Day Monitor Reading—Compare the test circles on your monitor with the PM Scale. Rate and record the relative amount of PM for each direction:

North_____ East_____
South_____ West_____

Describe the changes you observe:

_____
_____
_____

Bring your monitor back to your classroom and take a closer look at the test circles on your monitor. Use a magnifying glass to look at the relative sizes of the different particles and to see if you can identify any particulates. Describe what you observe:

_____
_____
_____

Which direction had the most amount of PM?_____
Which direction had the least amount of PM?_____

Explain your above response in detail (why or why wasn't there more or less PM from a specific direction?):

_____
_____
_____

Was your prediction correct about the amount of PM your monitor collected versus the classroom control monitor?_____

Explain why or why not:

_____
_____
_____

Student Handout

PM Monitoring—Student Data Sheet

Collection Day—Class Comparison and Analysis

Write down your final results (from very light to very heavy) from your PM Monitor for each direction:

North _____

South _____

East _____

West _____

Add your results to the *Data Table for Class Comparison* as instructed by your teacher. When all teams have entered their data, copy the results onto your team's copy of the table. Use the results to answer the questions below:

Was your prediction correct about the amount of PM your monitor collected versus the other team's monitors? _____

Explain your response:

_____

_____

_____

_____

Which study site had the heaviest PM? _____

Which study site had the lightest PM? _____

Thinking/Discussion Questions (use another sheet of paper if you need more space):

1 Does there appear to be a direction from which PM is the heaviest? What might cause a difference in results from different directions?

_____

_____

_____

_____

_____

_____

Student Handout (cont'd)

PM Monitoring—Student Data Sheet

Collection Day—Class Comparison and Analysis

2 What do you think caused the results in the team's site with the most particulate matter? What might be creating particulates in the air in that place?

3 Why do you think we used a "control" and a "variable" in this experiment?

4 Based on the results of your experiment, what recommendations would you have for reducing particulate matter and improving air quality around your school?

5 Now that you have done this experiment, why do you think it is important for scientists to monitor air quality in your city?

6 If you were to do this experiment again, would you change anything and if so, what?

TEAM HANDOUT

Particulate Matter (PM) Monitoring Team Tasks

For this activity, your team will need the following:

- *PM Monitoring Team Tasks* (this paper)
- *PM Monitoring Student Data Sheets* (5 pages)
- *PM Monitoring Device—Instructions for Development*
- *PM Monitor Template*
- *PM Comparison Scale*
- *PM Monitoring Data Table for Class Comparison*

1. Make your PM monitors following the template design and instructions.
2. Create a sign that says, "Please Do Not Disturb—Air Pollution Study in Progress" to inform others about your project. You might include your names, class, and date on the sign.
3. Once your team has been assigned a test site, find a secure location at your site to place your PM monitor. It should be placed on a high, flat surface and filled with rocks to weigh it down. *(Note: The monitor could be hung if necessary.)*
4. Use the compass to be sure you align your monitor with the N (on the can) facing north.
5. Place your "Do Not Disturb—Air Pollution Study in Progress" sign near your monitor. Be sure it does not obstruct air flow around your monitor.
6. While still at the site, complete the "Day 1" section on your data sheet.
7. Check on your monitor after it has been out for about 3 days, and again in about 5 days. You will need to follow the instructions on your data sheet and have your *PM Comparison Scale* during these investigations. Complete your data sheet in the "*Mid-Week Monitor Check*" sections for each visit.
8. Collect your monitor after one week. Be careful not to touch the test circles!
9. Complete the *Collection Day—Team Analysis* section of your data sheet.
10. Add your final results to the class copy of the *Data Table for Class Comparison*. When all teams have added their results, copy them onto your team's copy of the table.
11. Complete the *Collection Day—Class Comparison and Analysis* section of your data sheet. Be sure to answer all the thinking/discussion questions.
12. Share your results and answers during the class wrap-up discussion.

TEAM HANDOUT

PM Monitoring Device–Instructions for Development

Materials:

Provided in kit:

- *PM Monitor Template*
- Sheet of clean, white paper
- Standard cellophane tape
- Double-sided tape
- Compass
- Magnifying glass

You will need to provide:

- Plain, white paper for tracing copies of the PM Monitor Template (you may also make photocopies)
- Scissors
- Empty 15 oz tin can with the lid removed
- Rocks (to place in can for weight)
- Air Pollution Study in Progress sign
- Tacks, tape, or string for affixing the sign

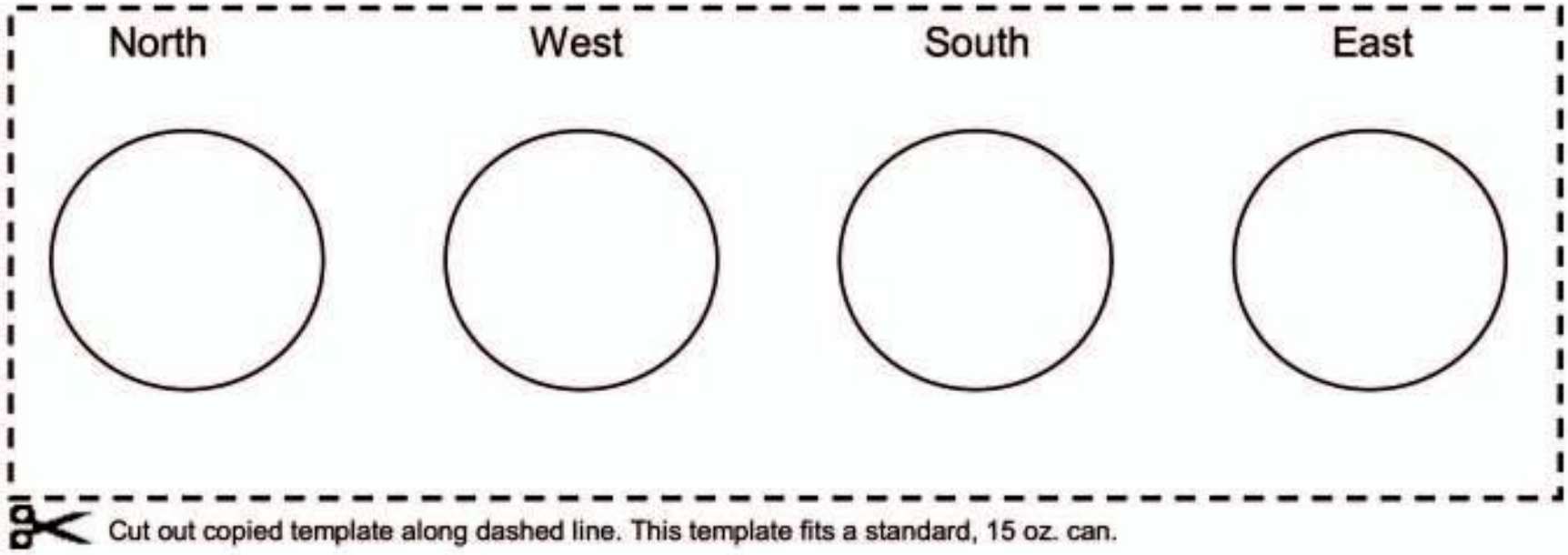
Instructions for creating your PM Monitors:

1. Use the *PM Monitor Template* as a guide to create your monitor. You will want to copy the template on clean, white paper. Be sure your copy is the same size as the template for it to fit correctly around your can. *(Note: If you use a different size can, you will have to adjust the size of your monitor paper.)*
2. Be sure to have your test circles and N, S, E, & W correctly labeled on your monitor paper.
3. Cut out your monitor paper where indicated.
4. Use the standard cellophane tape to tape one end of the monitor paper on your can. Wrap the rest of the monitor paper around the can. Be sure that it wraps fairly straight around the can. Hold the paper in place as you do the next procedure.
5. Very carefully, wrap the double-sided sticky tape over and around the paper on the can. The sticky tape should entirely cover the center of the paper where the test circles are located. It is OK if the tape does not entirely cover the paper, it just needs to cover the test circles. Depending on the width of the tape, you may need to wrap around the paper two or more times.
6. IMPORTANT: HANDLE YOUR MONITOR CAREFULLY AND DO NOT TOUCH THE STICKY TAPE ON THE CAN!
7. Your monitor is now ready for placement!

TEAM HANDOUT

PM Monitor Template Master

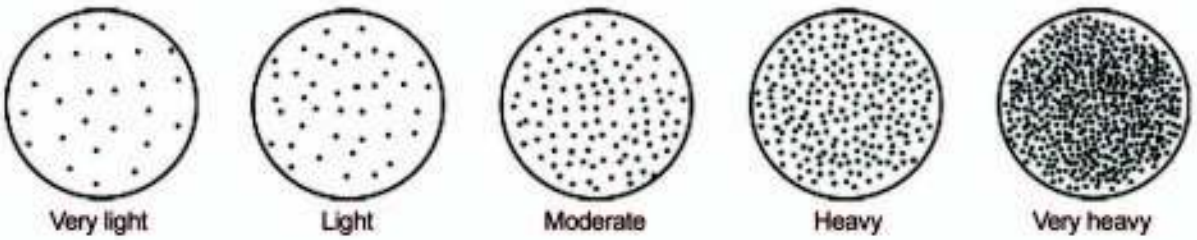
Do not cut up this master.
Use this template as a master to make copies, either by tracing or with a photocopy machine.



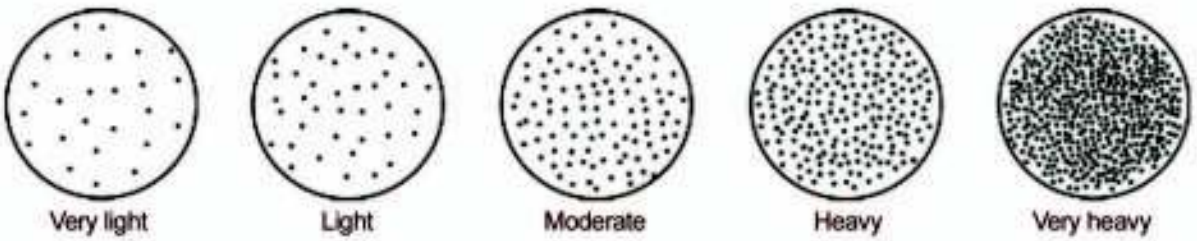
Cut out copied template along dashed line. This template fits a standard, 15 oz. can.

TEAM HANDOUT

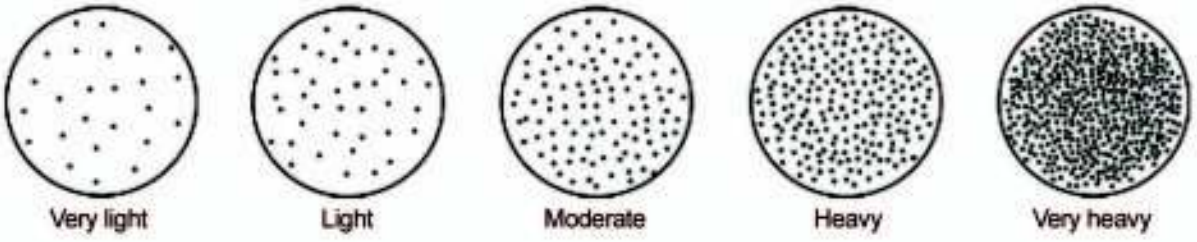
PM Comparison Scale



PM Comparison Scale



PM Comparison Scale



TEAM HANDOUT

PM Monitoring–Data Table for Class Comparison

Add your team's PM Monitoring final results to the table below. Next, enter the results for the rest of the class teams. Use these results to complete the *Class Comparison and Analysis* section of your Data Sheet.

Team Name	North	South	East	West