

Middle Level Science

Be Particular About Your Matter!

Objectives:

- Demonstrate that particulate air pollution can be invisible to the eye.
- Students will collect and observe particulate matter.
- Students will identify pollen grains and make their own pollen map for Davenport.
- Students will collect and interpret local environmental maps.
- Students will investigate health risks involved in polluted air.

National Science Education Standards:

- Standard A: Students will conduct scientific inquiry
- Standard B: Teacher will guide and facilitate a learning environment.
- Standard D: Students will be provided with time, space and resources to conduct their research.
- Standard F: Risks and benefits; Science and technology in society

Benchmarks for Science Literacy: By the end of 8th grade, students should know that: The benefits of the earth's resources-such as fresh water, air, soil, and trees-can be reduced by using them wastefully or by deliberately or inadvertently destroying them. The atmosphere and the oceans have a limited capacity to absorb wastes and recycle materials naturally. Cleaning up polluted air, water, or soil or restoring depleted soil, forests, or fishing grounds can be very difficult and costly.

Teacher notes:

Air pollution has been evident for a long time. Originally it was from burning wood, coal and other materials. Among other problems one was smog. With the increase use of automobiles – we add carbon monoxide, sulfur dioxide, nitrous oxide and ozone to the growing list of pollutants. With the increased use of technology we have gained the use of many comforts, but at the cost of the environment and our health. Students will discuss allergies and the types of allergies that affect them personally. Unfortunately, there are 800,000 premature deaths due to allergies every year.

At some time there may be a simple activity done to demonstrate what parts per million really means. Teachers can use an aquarium and place a million grains of rice in it. This will be a permanent station in the room. It will be used as a point of reference throughout the year.

The pollen count is a measure of the number of pollen grains of a certain type per cubic meter of air sampled, averaged over 24 hours. Pollen is counted at monitoring sites

around the country. Each of the pollen monitoring sites around the country has a Burkard volumetric spore trap. Traps are usually located on the roof of a suitably accessible building, about two or three stories high. Traps are located at this height to enable the general ambient airflow to be monitored which contains a good mix of the local and further distant pollen sources gathered on the wind. If the trap was at ground level then it would collect mainly pollen from the immediate vicinity and results between sites would not be comparable.

SIZE:

Science measures everything. The SI units are the tools of science. The meter is the SI unit of distance. A meter contains 100 centimeters (cm), so one centimeter = $1/100$ of a meter or $1\text{cm} = 0.01$ meter. A meter contains 1 000 millimeters (mm), so one millimeter = $1/1\ 000$ of a meter or $1\text{mm} = 0.001$ meter. A meter contains 1,000,000 micrometers (μm), so one micrometer = $1/1,000,000$ of a meter or $1\ \mu\text{m} = 0.000,001$ meter

Your pencil is about a centimeter wide. Your pencil graphite leaves a mark about a millimeter wide. You could put about 1,000 microns in that pencil mark. One million microns could fit on a meter stick. The smallest Particulate Matter(PM) that is regulated by NAAQS(National Ambient Air Quality Standards) is 10 to 2.5 microns (μm). The larger PM regulated by NAAQS is $10\ \mu\text{m}$ and larger. We can measure the distance to Alpha Centauri, the equator, or the speck of seemingly insignificant matter that can make people sick or worse. Exposure to particulate matter could require the use of more medications and more doctor and/or hospital visits. Particulate matter of $10\ \mu\text{m}$ and $2.5\ \mu\text{m}$ can and do cause health problems.

Particulate Matter is the term for a mixture of solid particles and liquid droplets, and even some gases found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small, they can only be detected using an electron microscope.

Particulate matter that is $2.5\ \mu\text{m}$ can travel many hundreds of miles. The particulate matter which is $10\ \mu\text{m}$ can go as little as a football field or up to 30 miles. How small is 2.5 micrometers? Think about a single hair from your head. The average human hair is about 70 micrometers in diameter – making it 30 times larger than the largest fine particle. Many of the heavy metals and carcinogens come in the $2.5\ \mu\text{m}$ category. PM that are less than 2.5 micrometers(μm) in diameter are in the fine particle class, whereas those larger than 2.5 but less than $10\ \mu\text{m}$ are in the coarse particle class. The fine particles are easy to inhale deep in your lungs where they stay. The average adult will inhale about 3,000 gallons of air in an average day. The fine particles can remain in the air a long time and travel long distances. Automobile and truck exhaust particles from Los Angeles can end up over the Grand Canyon and can occur year around. Particulate Matter not only ends up in living things, but can settle on soil and water, changing the nutrient and chemical balance, and harming the environment.

The Clean Air Act requires EPA to review the latest scientific information and standards every five years. Before new standards are established, policy decisions undergo rigorous review by the scientific community, industry, public interest groups, the general public and the Clean Air Scientific Advisory Committee (CASAC).

REFERENCES

<http://www.cmar.csiro.au/ar/airwatch/awpollen3.html>glossary
<http://www.geo.arizona.edu/palynology/ppalydef.html#qpsites>
<http://www.geo.arizona.edu/palynology/polkey.html>key

Engage:

Option 1. Teacher would pose the question: Can you always see air pollution? After discussion teacher would take a container – light a piece of paper and put into the container and immediately close it. Students would observe what they see. Discussion will follow and lead to students planning other ways to collect and view pollution?

Option 2. Make a hypothesis (educated guess): Where in your school, home, or neighborhood do you think air might be dirty? Where do you think the air is clean?

Option 3. Ask students brainstorm how sticky tape could be used to test air quality.

Option 4. Run your white gloved hand over a seldom-used shelf to show particulate matter build-up. Ask students from where the dust has come.

Explore:

Activity 1

Part 1:

1. Each student will make a slide to put out in the courtyard.
2. They will lightly place a layer of petroleum jelly one side of the slide.
3. Place the slides outside for 24 hours on 4' bricks. Students will discuss the reason why it should be above the ground. They may also want to try the enclosed courtyard.
4. Students will also place slides in the classroom.
5. The next day they will collect and count, draw and try to identify what they find on their slides..

6.They will start by using hand lenses and come to the conclusion that they must move to dissecting microscopes or lower power on their compound microscopes.

Part 2:

1. Another group will put five cans with filter paper tops outside.
2. Each day they will bring one can in to try to identify and count the particulate matter.
- 3.The last container will be exposed over the weekend.
4. Students will keep records in their journal. The teacher will keep a large class chart of the different size particles, number of, and names of the particles if the class has been able to identify any of the material.

Date	# counted	sizes	drawing	identification

Activity 2

Part 1: How to build a particulate matter trap:

1. For each trap you need to cut 2.5 cm x 2.5 cm piece of heavy acetate(overhead projector plastic).
2. Use a hole punch to put one hole in the corner of the plastic and insert a piece of 20 cm string to hang the plastic.(you could tape it or tack it by a corner to a slightly larger piece of cardboard to place it in a location if it cannot be hung)
3. Put a thin layer of petroleum jelly on the plastic on one side.

Part 2:

1. Decide on 3 places you would like to test your guesses.
A. _____ B. _____ C. _____
2. Which area do you predict will have the most particulate matter? _____
3. Which area do you predict will have the least particulate matter? _____
4. For each place you would like to test, make a particle trap.
5. Make one extra trap. This is your control. Place your extra one in a sealed container. You will use it for a comparison.
6. Place the other traps in the 3 places you previously decided, places that will not be in the way and where they will not be disturbed. Leave them there for two or three days.

Activity 3

1. Students work in groups of 3-4. Each group will form the wire coat hangers into matching rectangular shapes. They will then observe one of the pieces of tape under the microscope and draw what they see in their science notebooks. They will then take six pieces of tape and attach them over the rectangular section of the coat hangers and space them evenly. In their science notebooks draw a picture of what the clothes hanger with tape strips look like. They will then hang one outside and one indoors. Be sure they are located in a variety of places – some in the sun, some in the shade. Record in their science notebook where they are located.
2. Every other day observe the tape, bringing a strip in from each hanger. Use the hand lenses. Then observe it under the microscope. Do not return to the coat hanger. Record observations and draw the tape in their notebooks. Note how much of the tape is covered by particulate matter.
3. Using the hand lenses and microscopes, compare the tape located in the sun and shade, indoors and outdoors. Which had the most particulate matter? Why? What does this have to do with air quality?

Explain:

Option 1: Students will compare their drawings and discuss the conditions on days that they collected the most particles than others. Students with allergies will share their concerns about the results. Students who have had allergy test will share their results.

Option 2: Retrieve the traps for observation. Bring them back in the plastic bags and do not remove the tape labels telling where the PM was collected. Complete the data table below and the following worksheet.

Option 3: Using the same groups, discuss what factors may have affected the cleanliness of the tape. Have them list sources of air pollution that could have been factors. Get back together as a class and share their lists, while creating a class list on the board.

- As a group, visit www.factmonster.com/ce6/sci/A0856525.html and/or http://en.wikipedia.org/wiki/Air_pollution to explore what air pollution is and to include sources not mentioned in the group discussion.

DATA TABLE # 3

Trap	Location	Number of Particles	Comment	Control
A				
B				
C				

Using a hand lens or microscope, try to group the Particulate Matter using the following classification system.

A. Biotic

- | | | |
|-------------|-----------|-------|
| 1. Plant | a. fine | _____ |
| | b. coarse | _____ |
| 2. Animal | a. fine | _____ |
| | b. coarse | _____ |
| 3. Fungus | a. fine | _____ |
| | b. coarse | _____ |
| 4. Bacteria | a. fine | _____ |
| | b. coarse | _____ |

- | | | |
|------------|-----------|-------|
| B. Abiotic | a. solid | _____ |
| | b. liquid | _____ |
| | c. gas | _____ |

Sketch 1 or 2 objects from each category above that you identified on a separate piece of graph paper. Be sure to keep the objects in correct proportions for size comparison.

Sources of pollen grains are generally classified as having come from grasses, trees, or weeds.

Refer to an Iowa Pollen Calendar for possible sources, such as:

<http://www.hycorbiomedical.com/site/education/downloads/calendar3-1.pdf>

To view what might be producing pollen at the present time, but be aware that some pollen might stay in the air for a long time.

1. What might remove the pollen or other PM from the air?

2. What might cause more pollen or PM to be in the air, besides the plants producing it? (hint: how does the pollen get from the male plant to the female plant part)

3. What group of animals carry out most of the pollination of plants?

4. What human activities might place PM in the air? _____,
_____, & _____

Extend:

Option 1: Students will be directed to look up the pollen count from a local source and how it was obtained. Students can make their own pollen count bulletin and post outside the room. Students will realize that there are pollutants that are not seen. This could lead to investigating what are the 7 pollutants that are considered the most important. Students will then check out the local industries in Davenport/Quad Cities to see what their emissions are and if they are in compliance. For example try one of the following: (ALCOA, John Deere, Oscar Meier, IBP, etc.) Teacher will have materials ready if students want to conduct further studies with ozone collecting and further research. Students will look up information on the internet: Some local sources could be:
www.epa.gov/kids/air.htmwww.weather.com/activities/health/allergies/question -

www.websmd.com/content/tools/1/calc_pollen_count.htm local pollen count

http://www.csbsju.edu/pollen/images/pollensummarysheets/images_new_summaries.htm
microscopic pictures of common pollen grains

www.info-on-allergies.com Allergy Quiz on line

Option 2: An optional activity would be to collect pollen samples from local plants for comparison purposes. Take a trap to any plant, tap the pollen producing part (stamen) against the trap, label the trap or bring a representative plant part (branch with flowers) back to class for identification purposes.

Option 3: This activity can be followed up with research on a particular source of air pollution by each student or group of students. They could present what they learned to the class in the form of a poster, PowerPoint presentation, or speech.

Evaluate:

1. Student's journals including their tables, drawings and identifications will be assessed. Students will be graded on their own slide. The data collected from the cans will be done as class data collection. Students will be expected to record data in their journal.
2. Lab techniques will also be critiqued. If improper lab techniques are observed, their microscope operating license will be revoked.
3. A large poster will be made of the results to be placed in the hallway in order to share this information with other students.

Journal Rubric:

Points		20	18	16
Daily Entries		(5)	(4)	(3)
Drawings		(10)	(8)	(6)
ID		(10)	(8)	(6)

Student's Total Score

4. The teacher will observe the group-work while they set up and observe the experiment.
5. The teacher may grade the entries in the science notebooks for completeness and accuracy.
6. Presentations, posters, or projects can be graded for complete information and accuracy, or use a self-created rubric.