

Bad Air in Your Backy

By Elaine Brye

Overview: This unit is an investigation of air quality index levels and patterns in the Midwest region of the United States. It combines several inquiry based activities investigating local air quality issues and also uses real data about the region where the students live. This unit will fit in with the air and atmosphere units that meet the Ohio Physical And Scientific Inquiry and Process standards regarding the way the earth absorbs material naturally and how this process can change the environmental quality.

Many students in a rural district believe that air quality is only a problem in urban environments. One of the major goals for this unit is to have students discover that there are air quality issues in “their own backyard” and have them determine actions they can do with their families to make a positive impact.

There is also a significant emphasis on the use of data and manipulating it into graphs and developing scientific investigations.

Target grade : 7th grade science students

Key Investigation questions:

Is there bad air where I live?

How does it affect me?

What can I do about it?



Lesson #1

- Students will be able to describe the types of pollutants affecting air quality
- Students will be able to explain the difference between bad and good ozone
- Students will be able to relate the changing ozone layer and disease processes (skin cancer)

Lesson #2

- Students will be able to design a scientific investigation to detect air quality
- Students will be able to understand how the experiment they design relates to the scientific process
- Students will be able to determine appropriate data to collect.

Lesson #3

- Students will be able to describe the origin and the difference between good and bad ozone
- Students will be able to differentiate ozone data on the website
- Students will be able to complete different graphs using real data and label graphs appropriately.
- Students will be able to list action steps to reduce ozone levels
- Student will be able t

Lesson #4

- Students will be able to describe the effects of ozone on plants
- Students will be able to define the term “bioindicator “ and give examples

Lesson # 5

- Students will be able to describe what happens during an asthma attack
- Students will be able to explain why ozone can trigger attacks
- Students will be able to discover actions that can reduce asthma attacks
- Students can explain the role of the AQI in helping people prevent asthma attacks

Content standards: Ohio

Earth and Space Science

2. Explain that Earth’s capacity to absorb and recycle materials naturally (e.g. smoke, smog and sewage) can change the environmental quality depending on the length of time involved (e.g. global warming).

Scientific Inquiry

2. Identify simple independent and dependent variables.
3. Formulate and identify questions to guide scientific investigations that connect to science concepts and can be answered through scientific investigations.
7. Use graphs, tables and charts to study physical phenomena and infer mathematical relationships between variables (e.g. speed and density).

Math

Data Analysis and Probability Standard

1. Read create and interpret box and whisker plots, stem and leaf plots, and other graphs where appropriate
2. Analyze how decisions about graphing affect the graphical representation; e.g scale, size of classes in a histogram, number of categories in a circle graph
3. Construct opposing arguments based on analysis of same data, using different graphical representations
4. Compare data from two or more samples to compare how sample size can affect results

Measurement

5. Analyze problem situations involving measurement concepts, select appropriate strategies and use an organized approach to solve narrative and increasingly complex problems

Language

Acquisition of vocabulary

2. Apply knowledge of connotation and denotation to determine meanings of words

7. Use knowledge of symbols and acronyms to identify whole words

Reading Process: Concepts of Print, Comprehension Strategies and Self Monitoring strategies

5. Select, create and use graphic organizers to interpret textual information

6. Answer literal, inferential, evaluative, and synthesizing questions to demonstrate comprehension of grade –appropriate print texts and electronic and visual media

Reading Applications: Information, Technical, and Persuasive Text

5. Analyze information found in maps, charts, tables, graphs, diagrams, cutaways, and overlays

Writing applications

Writing applications

13 Rearrange words, sentences, paragraphs, and add transitional words and phrases to clarify meaning.

Research

4. Select an appropriate structure for organizing information in a systematic way (e.g.' notes, outlines, charts, tables and graphic organizers

References:

Glencoe Science Voyages-Exploring the Life, Earth and Physical Sciences, Glencoe/McGraw-Hill, 2000: pg 332-339, Columbus OH, McGraw Hill Publishing

Air Quality Lesson Plans; Michigan Environmental Education Curriculum Support, DEQ, 2005; Lesson 4; pg. 101, 104, 115-116.

Environmental Education for Kids-Hot Summer Days, Wisconsin Department of Natural Resources, 2006,

<http://dnr.wi.gov/org/caer/ce/EEK/earth/air/ozone.htm#ozone>

Air Now Governmental Website, August 20, 2006, www.airnow.gov

Iowa Air Quality Asthma Poster, 2001, Iowa Department of Public Health, http://www.idph.state.ia.us/hpcdp/common/pdf/asthma/asthma_poster.pdf

Allergy and Asthma Network Mothers of Asthmatics, 2006, <http://www.aanma.org/breatherville.htm>

Bad Air in Your Backyard-Lesson #1

Overview: An investigation of air quality index levels and patterns in the Midwest region of the United States.

Investigation question: Is there bad air where I live?

- Students will be able to describe the types of pollutants affecting air quality
- Students will be able to explain the difference between bad and good ozone
- Students will be able to relate the changing ozone layer and disease processes(skin cancer)

Procedure:

1. Introduce the activity by asking students about their prior knowledge of air. Show students overhead with the diagram of the Earth and the layers of the atmosphere. Explain that there are many components in air-some are good and some are bad.
2. Give each table a plastic bag and ask them to capture some air. Ask if it is clean or not. At the demonstration table , fill the bag with air-then blow into it. Light a candle and capture the smoke. Light a cigarette-is the air still clean? Would you like to take a breath of this air?
3. Use overhead to explain that we measure air quality by using the AQI-Air Quality Index. Go thorough the categories of the AQI and define particulate matter, ozone, carbon monoxide, sulfur dioxide, and nitrogen dioxide. Show the students who you write the name(chemical formula) of the chemicals measured. Explain that these are negative components of air-and that they combine to create smog.
4. Explain that there is more than one level of ozone, the stratosphere is good ozone and protects us from UV radiation while ozone created in the troposphere is man made and can be hazardous to plants and animals. "good up high, bad close by"
5. Use Michigan Air Quality Poster to visualize size of particulate matter, movement of air and air pollution pathways.

Discussion Questions:

1. How does air in our area get polluted?
2. Do you ever feel the effects of bad air?

6. Assignment-Read text pages 338, 339 of Glencoe Science Voyages- Exploring the Life, Earth and Physical Sciences. Answer the following question.

“Scientists have noted a rapid increase in the amount of skin cancer in the past twenty years. What do you think is causing the increase? What can you do to prevent skin cancer?”

Bad Air in Your Backyard-Lesson #2

Overview: An investigation of air quality index levels and patterns in the Midwest region of the United States.

Investigation question: How do I measure bad air?

- Students will be able to design a scientific investigation to detect air quality
- Students will be able to understand how the experiment they design relates to the scientific process
- Students will be able to determine appropriate data to collect.

Procedure:

1. Review previous day lesson by reminding them that the air we breathe may not be clean. Review the types of air pollution measured on the AQI.
2. Tell them they are going to design a bad air detector to use in the school area.
3. Design the experiment-questions for students:
 - Decide which ones are **feasible**(that means they are easy to build and will work). Decide what you will measure
 - How you will measure air quality(color change, weight of detector, etc?)
 - Where will you put your monitor?
 - Should you work with other groups to make sure monitors are being placed in different locations?
 - How will you organize your data?
 - How will you display your data? (charts, graphs, diagrams?)
4. State what you think you will find-the **Hypothesis**.
5. What **materials** do you need?
6. List your **procedures** step by step.
7. Build detectors and place in school location

Bad Air in your Backyard-Lesson #2 Student sheet

Air Detector Investigation



As a member of this expedition you have been assigned to determine the amount of particulate pollution in the air at United Local Schools. You will be given the following supplies: You may use any or all of the supplies to build an air quality detector.

Coffee filters
Tape
Index cards
Box
Construction paper
Vaseline

Directions:

1. Your group needs to **brainstorm** (everyone's ideas count) ways to build the detector.
 - Decide which ones are **feasible** (that means they are easy to build and will work). Decide what you will measure
 - How you will measure air quality (color change, weight of detector, etc?)
 - Where will you put your monitor?
 - Should you work with other groups to make sure monitors are being placed in different locations?
 - How will you organize your data?
 - How will you display your data? (charts, graphs, diagrams?)
2. State what you think you will find-the **Hypothesis**.
3. What **materials** do you need?
- 4 List your **procedures** step by step.
5. **Data**-fill in at the end of the observation
6. **Conclusion** –what does your data show? fill in at the end of the observation

Names: _____ Date: _____
_____ Period: _____

Lab Title: Building a Particulate Air Quality Detector

Hypothesis:

Materials:

Procedure:

Data/Observations: (can attach sheets if needed)

Conclusion:

Bad Air in Your Backyard-Ozone-Lesson #3

Overview: An investigation of air quality index levels and patterns in the Midwest region of the United States.

Investigation question: Is there bad ozone where I live?

- Students will be able to describe the origin and the difference between good and bad ozone
- Students will be able to differentiate ozone data on the website
- Students will be able to complete different graphs using real data and label graphs appropriately.
- Students will be able to list action steps to reduce ozone levels

Hypothesis: Students are expected to respond that ozone is not a problem in their life and does not affect them.

Background Information:

Introduce the activity by asking students about their prior knowledge of ozone. Show students overhead with the diagram of the Earth and the layers of the atmosphere. Explain that there is more than one level of ozone, the stratosphere is good ozone and protects us from UV radiation while ozone created in the troposphere is man made and can be hazardous to plants and animals. Show and discuss the transparencies and explain what causes ozone. Explain that ozone is measured in a relative way by the air quality index. Using the AQI, students will focus on the patterns of bad ozone in the Midwest region.

Show students the transparency of the global image of the Earth and the ozone distribution. Explain the key to the map using your classroom poster of air quality index. Ask a few practice questions such as what is the air quality in a few locations. Explain that we will be going to the computer lab to collect data on ozone conditions in our area.

Design of investigation:

- Pass out student worksheet and explain the procedure to the students.
- Students go to the www.airnow.gov website.
- Using a pre-selected month and year, students will create a table of data. The data points are: date and peak ozone concentration measured by the AQI color over a selected city.
- Data will be graphed in a bar graph. Students will need to use correct labels and title and be able to identify dependent and independent variables.
- Groups will hang their graph according to year, make data comparisons and participate in a classroom discussion.

Discussion Questions:

1. Do we have a problem with ozone in our backyard?
2. Is your hypothesis correct or incorrect? What do you think now?
3. What do you think we happen if we looked at a different month? Day of the week?
4. Do seasons make a difference in the amount of ozone in our area?
5. What generalizations can you make about the amount of ozone in our area over the past few years? Can you identify any patterns?
6. What predictions can you make for our future?
7. Does ozone affect your health?
8. What can you do to reduce ozone days in our area?

Anticipated Conclusions:

- The number of days with elevated ozone activity in our area has increased over time.
- The warmer the weather, the more ozone that is created.
- Students will predict that our area will see in increase in the number of ozone action days.

Students will work independently to answer the questions about ozone in their backyard. (Located on the student worksheet.)

After students have learned about the Air Quality Index, select a student who will check the website each day and set the poster to the correct setting for each day.

Lesson #3 Student Sheet

Name _____
Date _____ hour _____

Ozone in My Backyard - Student Response sheet

Question: Is there bad ozone in my backyard?

Hypothesis:

Procedure:

1. Go into the internet to: www.airnow.gov
2. Click on the tab labeled "ozone"
3. To the right of the map click on "map archives"
4. The window above the map should say "Midwest" click on "go"
5. Now use the drop down menu and select our state.
6. Set the window to the month of July of the year your group was assigned
7. Click on the window for July 1 to view the map on the full screen. The first map shows the progression of ozone throughout the day. The second map on the page show the peak ozone for that day. We will be using the peak ozone for the day to record our data today. Find were we are located on the map and record the date and ozone conditions for that day (using the color code) in the table below.
8. Go back to the whole month of maps and click on the next day of the month and repeat the recording procedure.



Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday

When you have finished recording your data for the entire month begin working on your graph.

Read through the following information and the AQI chart:

10 Steps you can Take on Ozone Action Days to help reduce your contribution to ozone formation. (<http://www.epa.gov/ARD-R5/naaqs/o3info.htm>)

Travel Tips

1. Limit driving. Defer errands or share a ride. For short trips, walk or ride a bike.
2. If you drive, avoid excessive idling or jack-rabbit starts.
3. Take transit. Ride the bus or train to work, school or shopping
4. Don't refuel on an Ozone Action Day. If you must refuel do so after 7 pm.
5. Avoid using gasoline powered equipment, such as outboard motors and off-road vehicles.

Home Tips

1. Defer mowing your lawn until late evening or the next day. Also avoid using other gasoline-powered garden equipment.
2. Postpone using oil-based paint. Solvents, or varnishes.
3. Use electric starter or charcoal chimney rather than lighter fluid.
4. Defer using household consumer products that release fumes or evaporate easily.
5. Conserve energy to reduce energy needed from power plants.

Air Quality Index Colors and Health Statements

Color	Descriptor	Health statement
Green	Good	None
Yellow	Moderate	People who are unusually sensitive to air pollution should consider limiting prolonged outdoor exertion.
Orange	Unhealthy for sensitive groups	Active children and adults, and people with lung disease, such as asthma, should reduce prolonged or heavy outdoor exertion.
Red	Unhealthy	Active children and adults and people with respiratory disease, such as asthma should avoid all outdoor exertion; everyone else, especially children, should reduce prolonged outdoor exertion.
Purple	Very Unhealthy	Active children and adults, and people with respiratory disease, such as asthma should avoid all outdoor exertion; everyone else especially children should limit outdoor exertion.
Maroon	Hazardous	<u>Everyone should avoid ALL outdoor exertion</u>

Name _____
Date: _____

Investigation conclusions and reflection



1. Is there bad ozone in your backyard? _____
2. Was your hypothesis correct? _____
3. When the AIQ color wheel is green what does that mean?

4. How many days in the month of July were green? _____
5. When the AIQ color wheel is yellow what does that mean?

6. How many days in the month of July were yellow? _____
7. If you had asthma what would the yellow mean to you?

8. How many days in the month of July were red? _____
9. When the AIQ color wheel is red what does that mean?

10. Would a day that is indicated as red be a good day to cut the grass with a push mower? Explain why or why not.

11. What is an ozone action day?

Bad Air in Your Backyard-Lesson #4 Milkweed Investigation 2-day activity

Overview: An investigation of air quality index levels and patterns in the Midwest region of the United States.

Question: Can I see the effects of ozone where I live?

- Students will be able to describe the effects of ozone on plants
- Students will be able to define the term “bioindicator “ and give examples

Background Information:

Review conclusions from yesterday's computer investigation.

Explain that ground level ozone is unstable and reacts chemically with plants, rubber and living tissue. Ozone is colorless, has no taste and not much odor and can break down lung tissue-if you have asthma, ozone can cause an asthma attack. Ground-level ozone can also damage the leaves of plants and trees. Some plants affected include soybeans, clover, onions, spinach, alfalfa, and milkweed. Trees such as lilac, aspen, ash, and white pine are also injured by ground-level ozone. Ground-level ozone can cause the leaves to fall off these plants, prevent the plants from growing very big, or even cause the plants to die. Then the humans, animals, and insects - like the Monarch butterfly that depend on these plants may not have as much food or shelter



Explain that plants and animals such as milkweed are *bioindicators*-and can be used to see if damage is occurring in our environment. Other examples of bioindicators are

- Canaries in a coal mine - one common cause of the accidents was a build-up of dangerous gases like methane and carbon monoxide in the mine shafts. Large amounts of these gases could lead to violent explosions. Methane and carbon monoxide have no color and no odor. The miners of the 1800s didn't have the special equipment scientists have today to measure chemicals in the air, so it was impossible to tell if the gases were building up to dangerous levels. Miners started to use canaries to test the air quality in the mines. Canaries are very sensitive to carbon monoxide.

- Cracking eggs of Bald Eagles - certain pesticides can build up in the food chain and change natural systems. Eagles began to lay very thin-shelled eggs. The eggs often broke, or if they hatched, the chicks were often weak and died within a few hours or days.

Procedure:

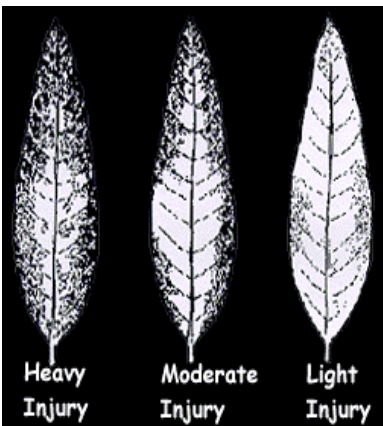
1. Students will view power-point of ozone damage and milkweed
<http://www.dnr.state.wi.us/org/caer/ce/eeek/earth/field/milkweed/slideshowindex.htm>
2. Students will view actual samples already collected indicating ozone injury.

Materials required:

1. Power point projector
2. milkweed leaves with and without ozone injury
3. clipboard
4. worksheet
5. graph paper

Procedure

1. Select study area in September that is at least 50 feet from the road and has at least 20 milkweed stems close together
2. Students are divided in groups of four and each group choose two stems with at least ten or more leaves on it to analyze



3. Students conduct analysis of stems and record the following data: plant location, plant height, total # of leaves, %of injured leaves, %of leaf area injured
 - a. Students should select their first milkweed stem and measure and record the height of the stem from the base to the top. Have students use inches for their measurement and record this on the chart.
 - b. Students should count and record the number of leaves showing ozone injury on the plant (see the picture to identify leaf injury).
 - c. Have students estimate the percentage of leaf area injured using the following code:

Code	% of leaf area injured
0	no visible signs of injury
1	very light to some (1-15%)
2	moderate to moderately heavy (16-50%)
3	heavy (more than 50%)

- d. Have students count and record the number of leaves showing ozone injury on the plant.

Evaluation

1. Fill in data table as a class with each plant number
2. Each group construct 3 graphs
 - plant number / number of injured leaves
 - plant number/ % injured leaves on plant
 - plant number/%leaf area injured

Discussion questions

1. What level of injury did you find?
2. Compare the graphs. Which graph shows the best analysis of your data-why or why not?
3. If you found no injury, what might this mean? How can you verify your results?
4. What is a bioindicator? How can using milkweed help us keep the air clean?

Modification

If no milkweed natural source is available provide students will samples of leaves previously collected to do the analysis of plants-provide in plastic bags with a random number of leaves labeled leaf #1, #1 etc.

Extension

Compare to the data already collected across Wisconsin in the Milkweed Monitoring project

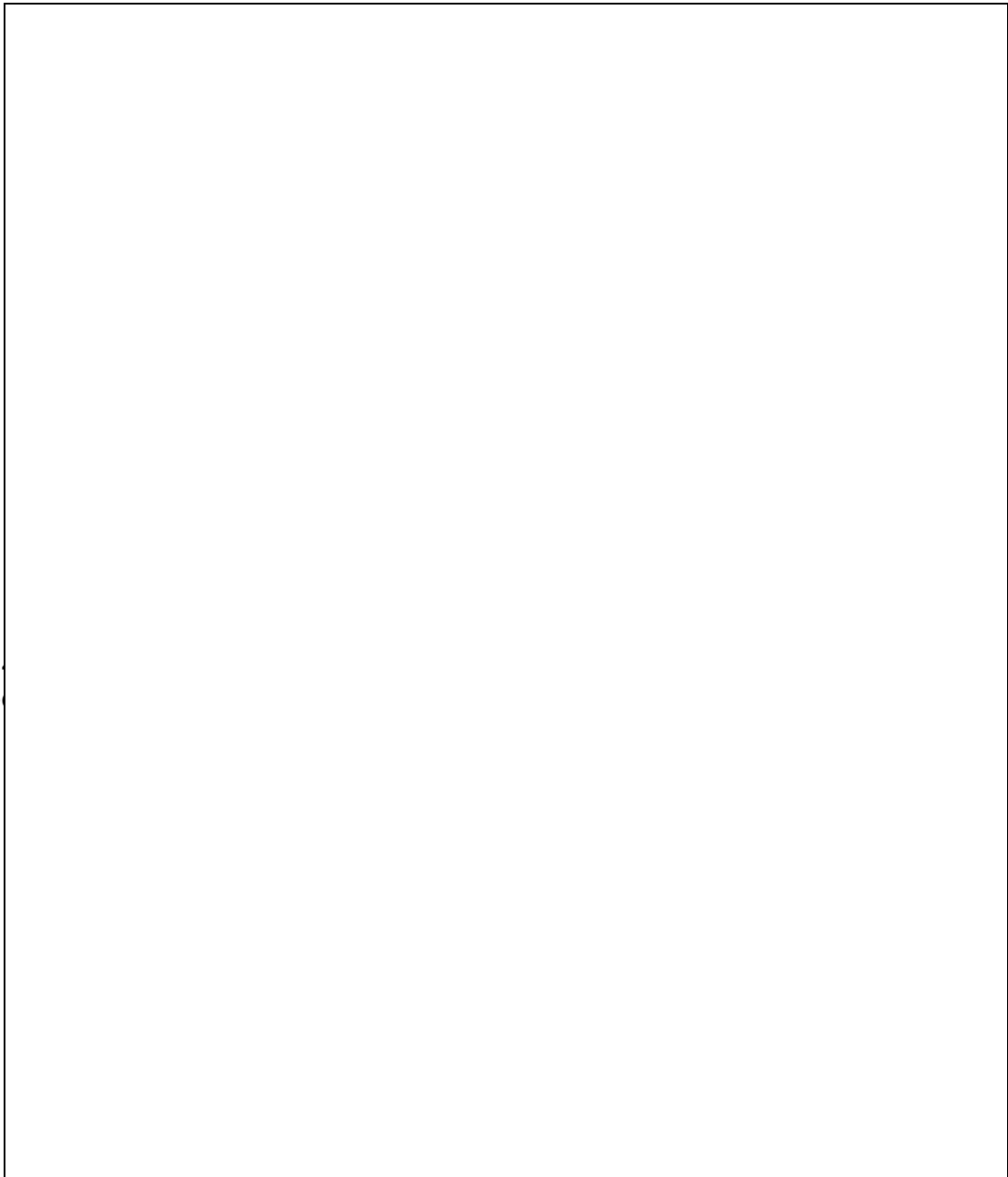
<http://dnr.wi.gov/org/caer/ce/ee/earth/field/milkweed/index.htm>

Milkweed Monitoring Project-Lesson #4 Student Sheet

Directions:

1. Select two milkweed stems to analyze. Each stem should have at least ten or more leaves on the plant.
2. Draw a map showing the location so the study area. Show features near the site like roads, buildings, trails so another person could easily find the site

Map



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5. Estimate the percentage of leaf area injured using the following code:

Code	% of leaf area injured
0	no visible signs of injury
1	very light to some (1-15%)
2	moderate to moderately heavy (16-50%)
3	heavy (more than 50%)

Count and record the number of leaves showing ozone injury on the plant.

Data Table

Plant Number	Plant Height	Total # Leaves	# Injured Leaves	% Injured Leaves on Plant	% Leaf Area Injured
1					
2					

Evaluation

Graph your results-be sure to LABEL YOUR GRAPHS!

Graph #1-plant number / number of injured leaves

Graph #2-plant number/ % injured leaves on plant

Graph #3-plant number/%leaf area injured

Which is the dependent variable for graph 1, 2, 3?

1. _____ 2. _____ 3. _____

Which is the independent variable for graph 1, 2, 3?

1. _____ 2. _____ 3. _____

Discussion questions

1. What level of injury did you find?

2. Compare the graphs. Which graph shows the best analysis of your data-why or why not?

3. If you found no injury, what might this mean? How can you verify your results?

4. What is a bioindicator? How can using milkweed help us keep the air clean?

Bad Air in Your Backyard-Lesson #5 The AQI-Asthma Connection

Overview: An investigation of air quality index levels and patterns in the Midwest region of the United States.

Question: What are the health effects of bad air?

- Students will be able to describe what happens during an asthma attack
- Students will be able to explain why ozone can trigger attacks
- Students will be able to discover actions that can reduce asthma attacks
- Students can explain the role of the AQI in helping people prevent asthma attacks

Background Information

Review classroom conclusions regarding milkweed monitoring/ozone in local area

Lesson:

1. Use AQI transparency to look at AQI Chart and talk about health statements
2. What is asthma-show Iowa Department of Public Health chart to show what happens in asthma attack
3. Pass out straw-(only students without asthma do this activity!) Partner with a buddy.

Directions to students:

- Have your friend run in place really fast for a whole minute.
 - If you don't have a clock or a timer, just have them do 50 jumping jacks or jump rope 100 times instead.
 - When they're finished, they should be breathing hard and fast.
 - Tell them to stop, then put a straw in their mouth.
 - Tell them to close their lips around the straw, plug their nose, and try to breathe through the straw.
3. Each table collect one sentence how it feels to have an attack-write on board.
 4. Explain how ozone and other pollutants exacerbate asthma and other diseases
 5. Students go to <http://www.aanma.org/breatherville.htm> to investigate actions they can do to decrease asthma symptoms

Materials required: Straws

Assignment

Use at least five of the words collected on the board to write a paragraph describing what an asthma attack feels like.

Bad Air in Your Backyard-Lesson # 6

Overview: An investigation of air quality index levels and patterns in the Midwest region of the United States.

Investigation question: How do I measure bad air?

Procedure

1. Retrieve bad air detectors
2. Evaluate data
3. Complete the lab report

4. Data-Fill in at the end of the observation

5.Conclusion –what does your data show? Fill in at the end of the observation

Discussion Questions:

1. What did your detector show?
2. How could we show the results of the entire class-the entire 7th grade?
3. Given what you already learned about local ozone effects and particulate pollution, what do you think the air quality is like in your backyard?

Evaluation/Assignment:

Create a poster to present to class

Answer the question “Why Bad Air Matters and what can you do about it?”

Be sure your poster shows:

- Kinds of air pollution we measure
 - How we know there is problem (AQI Index, Ozone Action Days)
 - What can happen to plants or people when there is bad air(diseases, Asthma?)
 - At least one thing you can do to improve air quality
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Bad Air in Your Backyard-Lesson #7

Overview: An investigation of air quality index levels and patterns in the Midwest region of the United States.

Investigation question: What can I do about bad air?

Content standards:

Procedure

Students present posters they have created on actions steps they can do to increase the air quality in their neighborhood



Discussion Questions:

4. If you were going to teach your family about bad air, what would you say?
5. What can we do as a school to improve our air quality?

Evaluation

Students present posters and reteach class through oral presentation

Take the "Hot summer days " Quizzler

<http://www.dnr.state.wi.us/org/caer/ce/eeek/cool/hotquiz.htm>

Scoring Rubric

Answer the question "Why Bad Air Matters and what can you do about it?"

Be sure your poster shows:

- Kinds of air pollution we measure 10
- How we know there is problem (AQI Index, Ozone Action Days) 10
- What can happen to plants or people when there is bad air (diseases, Asthma?) 10
- At least one thing you can do to improve air quality 10
- Presentation 10
- Creativity 15

Total points possible 75