

Air Quality Module

I. Introduction: What's "Air"?

Background: When the Environmental Protection Agency (EPA) was established in 1970, along with it came the Clean Air Act. This legislation was created to protect the air we breathe and guard the stratospheric ozone layer that protects *us* from the sun's radiation. The act established air quality standards and guidelines in order to achieve the standards, while also granting the federal government more responsibility and power to protect air quality.

EPA looks for six main pollutants when evaluating air quality. These include:

- particle pollution (often referred to as particulate matter)
- ground-level ozone
- carbon monoxide
- sulfur oxides
- nitrogen oxides
- lead

These pollutants can harm your health and the environment, and cause property damage. Of the six pollutants, particle pollution and ground-level ozone are the most widespread health threats. EPA has been developing programs to cut emissions of these commonly found air pollutants since the Clean Air Act was passed in 1970. It's a big job, and although a great deal of progress has been made, it will take time to make the air healthy throughout the country (<http://www.epa.gov/air/peg/cleanup.html>).

For more information on the categories of air pollutants visit the following websites:

- www.air.ky.gov/programs/Outreach/Environmental+Air+Pollutant+Gremlins.htm
- www.aacog.com/air/curriculum/TheDayTheAirPollutionGremlinsCameToTown.pdf
- www.teachnology.com/teachers/lesson_plans/science/environment

Subject Area: Science, Practical Living, Social Studies, Writing

Kentucky Connections:

- Learner Goal: #1, #2, #6
- Academic Expectations: 1.12, 2.18, 2.2, 2.3, 2.29, 2.30

- **Core Content:** PL-EP-3.1.04, PL-EP-3.1.05, PL-04-3.1.04, PL-05-3.1.04, , PL-05-3.1.05, SC-04-4.7.2, SC-04-2.3.1, SC-04-4.7.1, SC-05-4.7.1

Activity Description/Goal: Students will make devices and participate in activities to identify different types of particulates (solids) and gases that could contribute to air pollution.

Materials:

- flash light
- index cards
- petroleum jelly
- hand lens or microscope
- hole punch
- yarn
- role of plastic wrap
- tube sock
- microscope slide and cover slip

Length of Lesson: Two 60 minute class periods.

Vocabulary Words:

- **Air pollution:** Harmful substances deposited into the air which lead to a state of dirtiness, impurity, or unhealthiness. (from Project Learning Tree)
- **Air quality:** A comparison of the composition of the air we breathe to an uncontaminated air resource or to air quality objectives.
- **Ozone:** A colorless gas composed of three atoms of oxygen. At ground-level, ozone is a pollutant because breathing it can irritate the lungs.
- **Particulate matter:** Tiny particles of solid matter and/or liquid droplets that are small enough to remain suspended in air.
- **Smog:** A visible combination of water vapor and a variety of air pollutants including smoke, fly ash, and/or gaseous pollutants such as ozone.
- **Hybrid vehicles:** Vehicles that have a combination of electric motor and gas combustion engine.
- **Fossil fuels:** Any combustible carbon-based fuel that is the result of organic deposits of the distant geological past (e.g., natural gas, coal, oil).
- **Volatile organic compounds (VOCs):** Chemical compounds made up of carbon, oxygen, hydrogen and other atoms that can form gases easily. They are found in nature as well as in glue, paint, solvents, gasoline, and many other substances. Some VOCs contribute to the formation of ground level ozone.

- Clean Air Act: Provides for regulations to control air pollution in the U.S. through state and federal actions and gives regulatory and enforcement powers to the federal government; passed by U.S. Congress in 1970, amended in 1977 and 1990.
- Automobile emissions: Pollutants released in car exhaust.

Essential Question: How does air pollution affect air quality?

Guiding Question/Outcomes:

- Students will identify the major categories of air pollutants.
- Students will determine sources of each type of pollutant.
- Student will determine how air pollution affects them and their families.
- Students will recommend ways to improve air quality in their community.

Skills Used:

- Analyzing
- Collecting
- Observing
- Communication
- Discussion

Activity 1: Testing for particulates (Teacher Demonstration)

- (Particulates) Solid particles are suspended in the air we breathe. Many of these particulates are soot and pollutants from burning fossil fuels, industry, automobile emissions, and other sources.
- Have the students sit quietly in their chairs and turn off the lights. If there are windows in the room, either lower the shades or close the blinds.
- After the students have had time to adjust to the dark, turn on a flashlight. (An overhead projector may be used.) As the students look at the beam of light have them list as many different types of particles as they can.
- Ask the students the following questions. Where did the particles come from? Why couldn't they be seen when the lights were on? How can they be removed from the air?
- Explain to the students that many types of particulates are so small that they cannot be seen under normal conditions.

Activity 2: Testing for particulates (Student Activity)

- Divide the students into groups of two. Have each group select two test sites in the school, two test sites at their home, and two test sites in the community. Explain that the groups need to contact the community sites for permission to conduct the test. Each group should select different test sites from all the other groups.

- Give each pair of students two index cards. (Any type of paper may be used.) Cut the index cards into 3 equal strips. Have the students use the hole punch to make a hole in the top of each strip. Below the hole the students should write the location of the test site, their name, and the date.
- The front of each card should be coated with petroleum jelly and covered with plastic wrap.
- Cut six pieces of yarn approximately two feet long. Tie one piece of yarn in the hole on each strip. These will be your pollution test strips.
- Have the students hang their test strips in the previously selected test sites. Leave them in place for two days.
- Bring the test strips to class and observe each with a hand lens or under the microscope.
- As a group, decide on appropriate categories for the different types of particulates.
- Have the students sort the particulates into different categories.

Activity 3: Automobile Emissions (Teacher Demonstration)

- This activity requires at home preparation on the part of the teacher.
- Place a white tube sock over the exhaust pipe of your car. If the sock does not fit snugly, secure it with a rubber band. Be sure the emergency brake is engaged. Start the car and let it run for approximately 5 minutes. After the exhaust pipe has had time to cool, remove the sock and carefully place it in a paper bag.
- On the day of the demonstration, explain to the students how the sock was prepared.
- Turn the sock inside out and carefully place it on the paper bag.
- Have students take turns looking at the particulates collected on the inside of the sock. Students may use the hand lens for their observations.
- After all students have observed the sock, prepare a sample of the particulates and place them under the microscope.
- Ask the students to compare the particulates they collected with the sample that came directly from the car emissions.

Assessment:

- Students will construct pollution test strips and collect particulates in designated areas.
- Students will design posters illustrating the different types of air pollutants.
- Students will compare the particulates they collected with the sample that came directly from car emissions.
- Students will research and identify the air pollution areas in their communities.

TMMK Connections

1. TMMK uses several different types of air filters to reduce particulate emissions such as dust, soot, and smoke. These are much like the air filters we use in our homes.
2. Some pollutants, such as solvents and paint emissions, are captured with the use of “carbon adsorbers”. Carbon is used to “grab”, or *adsorb*, pollutants before air is released into the atmosphere.
3. The use of “thermal oxidizers” in both paint shops at TMMK also helps reduce air pollution. In the thermal oxidation process, heat is used to convert solvent emissions into carbon dioxide and water, which are naturally present in the atmosphere. This conversion process is similar to the way our bodies convert or break down food particles into usable energy.

So what can I do to protect the air in my community?

The choices we make everyday can impact air pollution- positively *or* negatively. Make the right choice! Here are a few suggestions for helping clean up the air:

- Conserve energy - turn off appliances and lights when you leave the room.
- Shop with a canvas bag instead of using paper and plastic bags.
- When possible, use public transportation, walk, or ride a bike.
- Recycle paper, plastic, glass bottles, cardboard, and aluminum cans. (This conserves energy and reduces production emissions.)



TMMK Field Trip Observations

Name _____

While visiting the Toyota plant, you will learn what it means to be an environmental leader in the automotive industry. Look closely at the processes it takes to build each vehicle, and be sure to use all of your senses while touring the facility. Answer these questions following your trip. (Hint: You may need to refer to the “Toyota Connections” section to help you find some of the answers.)

1. Describe what life would be like without clean air.

2. List 2 things that might contaminate the air we breathe.

- a. _____
b. _____

3. What do people call the types of things you listed in Question 2 (things that make the air unclean or unsafe).

4. Can people always see, hear, or smell air pollution? _____

- a. Describe an example. _____

5. What does Toyota do to prevent or reduce air pollution?

6. What can *you* do to prevent or reduce air pollution?



II. Conclusion: What's "Air"?

(Activity adapted from "Designing a Clean-Air Environment", from Project A.I.R.E. by EPA.)

Background: Conscious city planning can help reduce air pollution. By locating the places that consumers visit most frequently within walking or biking distance of neighborhoods, air pollution caused by the burning of fossil fuels can be significantly reduced. The closer we are to the places we go everyday such as school, work, shops, and restaurants, the easier it is to make shorter trips in a car or even walk or bike to where we're going!

Trees and shrubs can also be planted strategically to shade homes in the summer and to provide wind breaks during the winter. This reduces the amount of energy needed for air conditioning and heating. Trees can be planted along highways as well to absorb the carbon dioxide released from car exhaust. While helping prevent air pollution, trees also supply oxygen- a necessity for all human life. As they absorb carbon dioxide, trees "exhale" oxygen (through photosynthesis). What a win-win situation!

For more information on designing a clean-air environment visit the following websites:

- www.cleanairplus.com/html/healthful.html
- www.epa.gov/iaq/greenbuilding/index.html
- www.epa.gov/greenkit/index.htm
- www.keep.ky.gov

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- Core Content: PL-EP-3.1.04, PL-04-3.1.04, PL-04-3.1.05, PL_05-3.1.04, WR-E-1.1.0, WR-4-1.1. 3, WR-05-1.1. 3, WR-E-1.2.0, WR-04-1.2. 3, WR-05-1.2. 3, WR-E-2.3.0, WR-04-2.3. 3, WR-05-2.3.3, WR-E-2.4.0, WR-04-2.4. 3, WR-05-2.4. 3, WR-E-3.5. 0, WR-04-3.5. 3, WR-05-3.5. 3, WR-E-3.6. 0, SC-04-4.7.1, SC-05-4.7.1, SS-EP-3.1.1, SS-EP-4.1.3, SS-EP-4.4.1, SS-04-3.1.1, -, SS-04-4.1.3, SS-04-4.4.1, SS-05-4.1.3, SS-05-4.4.1, RD_EP-2.0.4, RD-EP-2.0.7, RD-EP-5.0.1, RD-04-2.0.4, RD-04-2.0.7, RD-04-5.0.1, RD-05-2.0.4, RD-05-2.0.7, RD-05-5.0.1

Activity Description/Goal: Students will explore how air pollution can be minimized by the arrangement of living areas, working areas, and landscaping.

Materials: Marker board (Chalk board), dry erase markers (chalk), pencil, poster paper, glue, scissors, Student Worksheet

Length of lesson: 60 minutes

Vocabulary words:

- Automobile emissions: Pollutants released in car exhaust.
- Smog: A visible combination of water vapor and a variety of air pollutants including smoke, fly ash, and/or gaseous pollutants such as ozone.
- Carbon cycle: The organic circulation of carbon from the atmosphere into organisms and back again.
- Energy: The ability to do work.
- Greenhouse effect: The warming of the atmosphere caused by the build-up of carbon dioxide and other greenhouse gases.

Essential question: How can the arrangement of living areas, workplaces, and landscaping affect air pollution levels?

Guiding questions/Outcomes:

- Students will evaluate how driving habits contribute to air quality.
- Students will determine how the location of workplaces affects the overall air quality of a community.

Skills:

- Decision making
- Hypothesizing
- Communicating

Activity:

Part 1

- Explain to the students that they are going to make a model of the “city” they live in. Describe the boundaries for the area that they will be modeling.
- Distribute copies of the Student Worksheet to each student. Instruct them to cut out the objects and arrange them on a piece of poster board. The students do not have to use all the objects, only those that fit their community.

Part II

- Discuss with the students the importance of transportation in any community. Ask how much time they spend in their cars and, as a group, make a list of the places most often visited. Remind students

of the results of the car exhaust demonstration from the introduction to this module. Lead the students in a discussion of ways air quality could be improved by reducing the amount of driving.

- Review with the students the types of air pollutants and their causes, the importance of the greenhouse effect, smog, and how the production and use of energy causes air pollution.
- Explain to the students that they are now going to become urban planners. Divide the students into small groups of four or five. Distribute more copies of the Student Worksheet. Their goal is to design the “perfect city” by minimizing air pollution and improving air quality.
- Ask each group to appoint a reporter to give an explanation of their design. After all the groups have made their report, discuss the advantages and disadvantages of each design. As a class, re-position the elements of the city to reduce air pollution.
- Compare the actual city with the “perfect” city. How are they alike? How are they different? What would be the advantage to having workplaces, schools, and recreational areas close to homes? What are advantages and disadvantages of urban areas? What are the advantages and disadvantages of suburban areas?

Assessment:

- Students will construct a poster illustrating the city in which they live and then construct a “perfect city” poster.
- Students will describe the major types and causes of air pollutants.
- Students will develop a conclusion after discussing the amount of time people spend in their cars each day.
- Students will write a plan for reducing air pollution and improving air quality in their community.

Extension:

1. Use computer programs such as *SIM CITY*[™] to allow the students to design a city. While the program allows the user to design a city, numerous built-in modules reflect the effects of the user’s decisions.
2. Invite guest speakers to talk to your class about city planning.

Urban Planning- Teacher Resource

(Adapted from “Designing a Clean-Air Environment”, from Project A.I.R.E. by EPA)

By giving some thought to the location of the different required elements of a city, we can reduce the use of polluting fuels and use environmental processes to aid us in our goals. If the places we visit often are near one another, we drive less and pollute the air less.

Two of the major air pollutants in automobile exhaust are nitrogen oxides and carbon dioxide. These gases react with sunlight to form smog and they contribute to the green house effect. One of the predicted outcomes of the greenhouse effect is global warming. Global warming could cause major shifts in global weather patterns and a rise in sea-levels.

By planting trees near highways, carbon dioxide in automobile exhaust will be absorbed by the leaves and turned into oxygen through the process of photosynthesis. By planting trees and shrubs to shade the roofs, windows, and air conditioning units of our homes in the summer, we don't need to run the air conditioner as much. This, in turn, reduces air pollution because it reduces electricity generation at power plants. Power plants that run on fossil fuels typically emit many pollutants, including sulfur dioxide, carbon monoxide, nitrogen oxides, and suspended particulates. Perhaps more importantly, burning fossil fuels or wood produces large amounts of carbon dioxide, which contributes to the greenhouse effect.

While designing a city with these considerations in mind, students will see that their choices have important consequences and that not all problems have satisfactory solutions. This is related to real tradeoffs such as short-term versus long-term benefits and conveniences versus conservation.

STUDENT WORKSHEET 1

DESIGNING A CLEAN AIR ENVIRONMENT



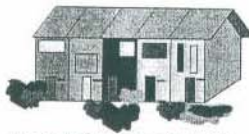
single-family homes



office buildings



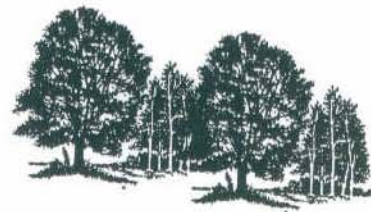
walking & jogging trails



apartments & townhouses



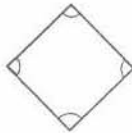
industries



trees, parks, forests



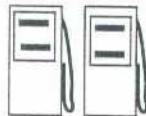
bike trails



playgrounds & ballfields



schools



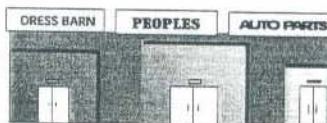
gas stations



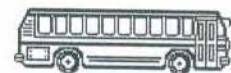
restaurants



highways



stores & shopping malls



bus & subway routes