How Does the Air Get Polluted?

Objective
- Understand how human activity has an influence on the environment.
- Participate in simple science experiments that show and/or simulate pollutants in the air.
- Learn how vehicle emissions and ozone cause air pollution.
- Understand the effects of ozone pollution and become aware of how it is formed.
- Meet TEX, DOT, Cool Jay, and Ollie Ozone.
- Become familiar with simple air quality vocabulary words.

Time Requirements
- Five to ten class periods, depending on activities chosen

Subject Areas
- English
- Language Arts
- Reading
- Science

Sometimes the air we breathe becomes polluted. There are many types of pollution, and it's important to be aware of how our actions can affect the world around us. Cars, trucks, buses, and other vehicles are one source of air pollution because they put out bad chemicals called emissions. Emissions are made up of nitrogen oxides (NO_x), carbon monoxide, carbon dioxide, and particulate matter. Point out to the class that they can see and smell emissions when black, odorous smoke comes out of a vehicle's tailpipe. Introduce TEX, DOT, Cool Jay, and Ollie Ozone and explain how they want to help spread the word about how we can stop pollution and smog from cars and trucks. Refer to the bulletin board display to introduce the characters, and pass out the activity book.

Activity 1: The Story of Pollution

Grades K-5

Objective:
Students will listen to or read a story that introduces awareness of environmental issues and in particular pollution.

Background:
Story telling is a time-honored teaching tool used in many cultures. The storybooks listed below all have environmental themes. They can serve as a starting point for environmental conversations and activities that call on children to synthesize information and experiences and think creatively about themselves and the world around them.

TEKS:

English, Language Arts, and Reading
- Grade K: 1C-D, 2A, 3C, 4B, 8A-B, 9A, 10D, 14C, 14E
- Grade 1: 1C-D, 2A, 3C, 4B, 5J, 7E, 8F, 10B, 12F, 13B, 17E
- Grade 2: 1C-D, 2A, 3C, 4A, 5B, 5G, 8A, 8C, 12B
- Grade 3: 1C-D, 2A, 3C, 4A, 5B, 5E, 7C, 8A-C, 9F, 9K, 12B, 12I-J, 15A
- Grade 4: 4A, 5F, 6A, 6C, 9E, 10A, 11A
- Grade 5: 4A, 5F, 6A, 6C, 9E, 10A, 11A

Time:
One class reading session or more (depending on length of book)

Materials:
One of the books from the reading list below:

- *Keepers of the Earth* by Michael J. Caduto and Joseph Bruchac
- *Chadwick Forever* by Pricilla Cummings
- *The Violators* by Gunnard Landers
- *The Great Kapok Tree* by Lynne Cherry
- *The Talking Earth* by Jean Craighea George
- *Mushroom Center Disaster* by N.M. Bodecker
- *Alvin Fernald, Superweasel* by Clifford B. Hicks
- *Canyon Winter* by Walt Morey
- *Poison Factory* by John Branfield
- *Baney's Lake* by Nan Hayden Agle
- *Beaver Valley* by Walter Dumau Edmonds
- *Who Really Killed Cock Robin?* by Jean Craighea George
- *The Lorax* (picture book) by Dr. Seuss
- *If I Built a Village* (picture book) by Kazue Mizumura
- *All Upon a Stone* (picture book) by Jean Craighea George
- *The Salamander Room* (picture book) by Anne Mazer
- *Once There Was a Tree* (picture book) by N. Natali Romanov
- *Tree House Town* (picture book) by Miska Miles

Take Note! These books should be reviewed to verify their appropriateness for your class. Your school or local librarian can help you choose other environment-related titles suited to your class.

Directions:

1. Depending on your students' reading level, you may choose to read the story aloud to the class or have children take turns reading.

2. Follow up the story by leading children in a conversation about it. Ask questions that challenge their thinking. For example, explore why things happened or people acted in given ways, what changed during the story, how something in the story is alike (or different) from something the child knows or believes. Challenge students to find ways they can use the lesson in the story. For example, what can they do to help care for the air, save the rain forests, take care of animals, or help their parents conserve energy?

3. Whenever possible, create activities to follow up on the lessons taught by the stories to enhance the experience. Use your imagination. If the story is about industrial pollution, take students for a walk and have them point out smokestacks and other things that might be visible examples.

Extensions:
For students in grades 4 and above, you may wish to assign book reports based on fiction involving environmental themes. Have students present book reports to the class and discuss the environmental messages gleaned from the stories. Following is a list of books you may want to consider for this purpose:

- *Emerald River of Compassion* by Rowena Pattee Kryder
- *A Most Unusual Lunch* by Robert Bender
- *Dear Children of the Earth* by Schim Schimmel
- *Necessary Risks: A Novel* by Janet Keller
- *Winter in the Heart* by David Poyer

- *McCampbell's War* by Robert Herring
- *Oh, What a Paradise It Seems* by John Cheever
- *Heyduke Lives: A Novel* by Edward Abbey
- *The Profeteers: A Novel* by Max Apple
- *The Forest Prime Evil* by Alan Russell
- *The Killing Winds: A Novel* by Clare Francis
- *A View from the Air: Charles Lindbergh's Earth and Sky* by Reeve Lindbergh
- *Covered Bridge* by Brian Doyle
- *Bushmaster Fall* by Carl A. Posey

Activity 2: Air Pollution Vocabulary, Coloring, and Word Search

Grades K-5

Objective:
Students will learn air quality vocabulary and general knowledge of air pollution problems from vehicles.

Background:
There are quite a number of words that are used when discussing the subject of air quality and vehicle emissions. Understanding the meaning of these words is an important step in gaining awareness of the problems and solutions to air pollution and, ultimately, a positive change in the future travel behavior of students and their families. The glossary terms can be presented as a spelling/vocabulary list or simply be presented and discussed in class. Some terms are integrated into the Air Quality Coloring and Activity Book and can be presented, as explained in some of the activities below, in the context of assignments out of the book. Assignment difficulty level should be adjusted accordingly depending on grade level.

TEKS:

English, Language Arts, and Reading

- Grade K: 1C-D, 2A, 3C, 10D, 14E
- Grade 1: 1C-D, 2A, 3C, 10D, 17E
- Grade 2: 1C-D, 2A, 3C, 12A, 15A
- Grade 3: 1C-D, 2A, 3C, 9F, 15A
- Grade 4: 1C, 4A, 5F, 10A, 11A
- Grade 5: 1C, 4A, 5F, 10A, 11A

Time:
30-45 minutes

Materials:
- Air Quality Coloring and Activity Book
- Transportation and Air Pollution Glossary

Directions:

1. Pass out the Air Quality Coloring and Activity Books, and explain that TEX, DOT, Cool Jay, and Ollie Ozone are friendly characters who will help them learn about air quality and transportation.

2. Explain that TEX, DOT, Cool Jay, and Ollie Ozone want to spread the word that Texans need to "Drive Clean Across Texas."

3. Read the text and show the pictures on pages 2-4.

4. Ask the students if they have ever seen or smelled air pollution. Talk about where and when they have had these experiences. Share experiences you may have had.

5. Have the students color the pictures.

6. As a question and answer class activity or individually, have the students decode the message on page 5 of the activity book. Have the students color the rest of the page and reinforce the message that air pollution is bad and we need to do something about it.

Extensions:

1. Many groups and agencies are working to preserve our environment. Explain that the "Drive Clean Across Texas" (DCAT) message is similar to the Texas Department of Transportation's "Don't Mess With Texas" message. Both campaigns ask people not to pollute our state—to take care of our air, water, and land. DCAT is sponsored by the Texas Department of Transportation, the Texas Commission on Environmental Quality, the U.S. Environmental Protection Agency, the Federal Highway Administration, the Texas Department of Public Safety, and the Texas Department of Health. Discuss in simple terms what each of these groups does and why they would want to send the message to "drive clean."

2. Create a spelling/vocabulary list from the Transportation and Air Pollution Glossary or from the words in the Air Quality Coloring and Activity Book (see pages 9 and 15). Provide the definitions to the words and discuss their meanings in class as students copy the definitions. Give a spelling and/or vocabulary test at the end of the lesson or unit.

3. Print out the word search in the Air Quality Coloring and Activity Book (page 9) and let the students use it to increase their vocabulary of air pollution and air quality terms.

Resources:
Classroom Materials [PDF]
- Air Quality Coloring and Activity Book
- Transportation and Air Pollution Glossary

Web Sites
- http://www.dot.state.tx.us/
Texas Department of Transportation
- http://www.tceq.state.tx.us/
Texas Commission on Environmental Quality
- http://www.epa.gov/
U.S. Environmental Protection Agency
- http://www.fhwa.dot.gov/
Federal Highway Administration
- http://www.txdps.state.tx.us/
Texas Department of Public Safety
- http://www.dshs.state.tx.us/
Texas Department of State Health Services

Activity 3: Let's Catch Some Dirt from the Air

Grades K-4

Objective:
Students will capture and observe dirt and particulate matter in the air.

Background:
Most major air pollutants are invisible although large amounts of them concentrated in areas such as cities can be seen as smog, which is a pollution-caused, visible haze due largely to a mixture of *ground-level ozone*, vehicle emissions, and heat. *Particulate matter* is another air pollutant that is visible, especially when the surfaces of buildings and other structures have been exposed to it for long periods of time or when it is present in large amounts. Particulate matter is made up of tiny particles in the atmosphere that can be solid or liquid (except for water or ice). It is produced by a wide variety of natural and man-made sources. Natural sources include volcanic ash, pollen, and dust blown about by the wind. Coal and oil burned by power plants and industries, and diesel fuel burned by many vehicles, are the chief sources of man-made particulate pollutants. But not all sources are large scale. The use of wood in fireplaces and wood-burning stoves also produces significant amounts of particulate matter in localized areas although the total amounts are much smaller than those from vehicles, power plants, and industries. Particles below 10 microns in size (about seven times smaller than the width of a human hair) are more likely to travel deep into the respiratory system and be deposited deep in the lungs where they can be trapped on membranes. If trapped, they can cause excessive growth of fibrous lung tissue, which leads to permanent injury. Children, the elderly, and people suffering from heart or lung disease are especially at risk.

Grade K
Grades 1-4

Grade K

TEKS:

Science
- Grade K: 1A, 2B-D, 4A-B

Time:
Two class periods for setup and analyzing results and two days for observation

Materials:
- Cardboard squares (at least 6 inches by 6 inches)
- Aluminum foil
- Scissors
- String
- Petroleum jelly
- Hole puncher
- Clear tape
- Magnifying glasses

Directions:

1. Have children form a line or circle. Tell the students that you need their help to catch something. Let them guess what you are going to catch. Tell them you are going to try to catch some dirt from the air.

2. Have children cover the cardboard squares with aluminum foil, making it as smooth as possible. Secure it with tape if necessary. Punch a hole in the top and tie some string onto it. These will serve as "catchers."

3. Plan some places to hang the "catchers." Try to hang them in a variety of places around the outside of the school.

4. Outside, carefully apply a thin coat of petroleum jelly to both sides of the catcher. Carefully hang it. Repeat with remaining catchers. Be sure to chart locations.

5. Check the catchers and bring them in after a day or two. Check for dirt. Have the children draw the results and make comparisons.

6. Using magnifying glasses, try to determine what the dirt is and try to find out where it came from.

7. Discuss their observations and inferences.

Extension:
- Have children do this at home, with parental supervision, and compare results.
- Invite a guest to come in and speak on air pollution.

Grades 1-4

TEKS:

Science
- Grade 1: 1A, 2B-E, 4A-B, 9A
- Grade 2: 1A, 2B-F, 3A, 4A, 9B
- Grade 3: 1A, 2A-D, 8C
- Grade 4: 1A, 2A-D

Time:
One class period to setup and 10-15 minutes a day for the next four days

Materials:
- Labels
- Colored markers
- Five jar lids
- White cardboard (poster size)
- Magnifying glasses

Directions:
Refer back to the book or story used to introduce the unit. Talk with students about air pollution produced by cars and other machinery with gas-burning engines, as well as emissions produced by furnaces, fireplaces, factories, and incinerators. For example, if referring to *The Lorax* by Dr. Seuss, discuss with children how the smogulous smoke produced by the THNEEDS factory made the Lorax cough, whiff, sneeze, snuff, snarggle, and croak. Then have the students work with a partner to conduct this experiment to see how dirty the air really is.

1. Write the numbers one through five on labels. Then attach a label to the top of each jar lid.

2. Place the jar lids on the cardboard. Carefully trace around the jar lids. Then number these circles to match the labels on the lids.

3. Take the lids and cardboard outside. Place the cardboard flat in an open area with the lids in place. (Note: Rain will spoil the results, so remind students to bring the experiment inside if the weather turns inclement.)

4. At the end of the first day, have the children remove one lid, starting with number one. Repeat this procedure for the next five days, taking away one lid each day. Have students compare the circles as they remove the lids. What observations can they make as the days go by?

5. At the end of the fifth day, take away the last lid and look at the circles. If the air is dirty, the circles covered by the low-numbered lids will have more specks of dirt than the others. Have the children use magnifying glasses to count the dirt specks.

6. Discuss the results of the experiment. Ask the students, "Is our air clean, or is it dirty?"

Extensions:
- See the "Particulate Matter Information, Activities, and Data" web page for suggested activities using particulate matter data collected by the Texas Commission on Environmental Quality and provided in the El Paso Particulate Data, Houston Particulate Data, El Paso Particulate Map, and Houston Particulate Map files.
- Make a list of things students can do to fight air pollution.

Resources:
Web Site
- http://www.tceq.state.tx.us/nav/data/pm25.html
PM 2.5 Data: Soot, Dust, Smoke (Fine Particulate Matter), Texas Commission on Environmental Quality

Activity 4: All about Ozone, Starring Ollie Ozone

Grades K-5

Objective:
Students learn the difference between good and bad ozone and are introduced to the federal Air Quality Index chart colors.

Background:
Ozone is the same molecule regardless of where it is found, but its significance varies. Stratospheric ozone is found 9 to 18 miles high, where it shields us from the harmful ultraviolet rays of the sun. High accumulations of ozone gases in the lower atmosphere, called ground-level ozone, are air pollution and can be harmful to people, animals, crops, and other materials.

These elevated levels of "bad" ozone (above the national standard) may cause lung and respiratory disorders. Short-term exposure can result in shortness of breath, coughing, chest tightness, or irritation of nose and throat. Individuals exercising outdoors, children, the elderly, and people with pre-existing respiratory illnesses are particularly susceptible. Chemists have found that the materials damaged by ozone include rubber, nylon, plastics, dyes, and paints.

Ozone pollution, a component of smog, is mainly a daytime problem during summer months (May-October) because sunlight plays a primary role in its formation. Nitrogen oxides and hydrocarbons are known as the chief "precursors" of ozone. These compounds react in the presence of sunlight to produce ozone. The sources of these precursor pollutants include cars, trucks, power plants, and factories, or wherever natural gas, gasoline, diesel fuel, kerosene, and oil are combusted. These gaseous compounds mix like a thin soup in the atmosphere, and when they interact with sunlight, ozone is formed.

Large industrial areas and cities with heavy summer traffic are the main contributors to ozone formation. When temperatures are high and the mixing of air currents is limited, ozone can accumulate to unhealthful levels. The state environmental agency is able to predict when ozone will form and if it will affect the air we breathe on a particular day. The information is communicated to the public through the federal Air Quality Index system, a color chart that defines the different levels of air pollution watches and warnings.

TEKS:

Science
- Grade K: 7B, 9A
- Grade 1: 3A, 3C, 5B, 9A
- Grade 2: 3A, 5B, 9B
- Grade 3: 3A, 8C, 11D
- Grade 4: 3A, 11C
- Grade 5: 3A

Time:
30-45 minutes

Materials:
- How Vehicles Contribute to the Formation of Ground-level Ozone
- The Colors of Ollie Ozone
- Playing Outside During Ozone Season
- Air Quality Coloring and Activity Book

Directions:

1. Ask the students if anyone has ever heard the word "ozone." What is ozone?

2. Explain "good" and "bad" ozone using the How Vehicles Contribute to the Formation of Ground-level Ozone handout/overhead. Explain that when pollution mixes with heat close to the Earth, bad ozone, also called ground-level ozone, forms. Good ozone is high above the Earth. This ozone layer protects the Earth from the sun's strong heat. It is like a shield that goes all the way around our planet.

3. How do vehicles cause bad ozone? Explain using the How Vehicles Contribute to the Formation of Ground-level Ozone handout/overhead. Pollution from cars, trucks, and factories enters the air and heats up in the sun. This creates the bad ozone.

4. What is an air pollution watch or an air pollution warning? How do we know when the bad ozone is high and dangerous and when it's not? Ollie Ozone is here to help us understand. (Refer to The Colors of Ollie Ozone.)

5. The Air Quality Index warns us when the bad ozone is high and we have to be careful by staying indoors. The index measures levels of ozone, carbon monoxide, sulfur dioxide, and particulate matter. How do you read the color scale?

6. Continue explaining by referring to the balloon display and pages 6-7 in the Air Quality Coloring and Activity Book.

    - Green (0-50) Ollie is happy in the air, because the skies around are clean and fair.
    - Yellow (51-100) means there is cause for concern, and Ollie's lungs may have a little burn.
    - Orange (101-150) is Ollie's mood when the air becomes even more crude.
    - Red (151-200) Ollie is downright sad when the ozone is really bad!
    - Purple (201+) means you absolutely cannot go out, and Ollie gives us a super pout!
7. Have the students color pages 6-7 in the Air Quality Coloring and Activity Book.

8. Discuss Playing Outside During Ozone Season overhead.

Extensions:
- See the "Ground-Level Ozone" web page for suggested activities using ozone data collected by the Texas Commission on Environmental Quality and provided in the Texas Cities Data, Houston and El Paso Data for 1993, and Houston Data for 22 Years files.
- Does your local newspaper or weather channel have a pollution index or other type of report on pollution in your area? Record this information over several days and see how it changes.

Resources:
Classroom Materials [PDF]
- How Vehicles Contribute to the Formation of Ground-level Ozone
- The Colors of Ollie Ozone
- Playing Outside During Ozone Season
- Air Quality Coloring and Activity Book

Web Site
- http://www.tceq.state.tx.us/compliance/monitoring/air/monops/ozonefacts.html
Ozone: The Facts, Texas Commission on Environmental Quality

Activity 5: Smog Alert!

Grades 4-5

Objective:
Students will simulate the development of smog and infer how it occurs in nature.

Background:
Smog is a dirty haze in the air that is caused by air pollution. Weather conditions, such as lack of wind or a "thermal inversion," can cause smog to build up in an area. The nitrous oxides (NO_x) and other volatile organic compounds (VOCs) combine with heat and sunlight to create ground-level ozone and thus smog. Thermal inversion, which occurs when a layer of warm air settles over a layer of cool air that lies near the ground, prevents the smog from rising and dissipating. Mountain ranges near cities may also trap smog in an area.

TEKS:

Science
- Grade 4: 1A, 2A-D
- Grade 5: 1A, 2A-D, 4A, 6B, 7C

Time:
30 minutes

Materials:
- Glass jar
- Water
- Aluminum foil
- Two or three ice cubes
- Paper
- Ruler
- Scissors
- Matches

Directions:
This activity should be done with adult supervision. Do not breathe in the "smog."

1. Hold up a newspaper headline about air pollution. Ask if anyone knows what ozone pollution or smog is. Discuss the two different types of ozone and the definition of smog.

2. Cut a strip of paper about 15 centimeters long x 1 centimeter wide. Fold the strip's length in half and twist the paper.

3. Make a "lid" for a glass jar by shaping a piece of aluminum foil over the open end of the jar. Remove the foil and put it aside.

4. Put some water in the jar and swish it around so that the inside walls of the jar are wet. Pour out the water.

5. Place two or three ice cubes on top of the foil lid to make it cold.

6. Light the strip of paper and drop it and the match into the damp jar. Put the foil lid on the jar and seal it tightly. Keep the ice cubes on top of the foil, in the middle. You must do all of this very quickly.

7. What do you see in the jar? How is this like real smog? When you're finished, release the "smog" outdoors.

Source:
ACTIVITY 1
- Project A.I.R.E. (Air Information Resources for Educators), U.S. Environmental Protection Agency, New England Regional Office, http://www.epa.gov/region01/students/teacher/airqual.html

ACTIVITY 2
- "Better Air—You Hold the Key" school outreach program, prepared by the Junior League of Denver with technical assistance provided by the Colorado Department of Health, Air Pollution Control Division
- Texas Commission on Environmental Quality, http://www.tceq.tx.us/

ACTIVITY 3
Grade K:
- "50 Simple Things You Can Do to Save the Earth," The Earth Works Group, Berkeley, California, 1989
- Patricia Lee Henry, Texas Southern University Houston TES Course, 1995

Grades 1-4:
- Integrated Thematic Units, Scholastic, Inc., 1992
- Clarice Toler, Stephen F. Austin University Nacogdoches TES Course, 1994

ACTIVITY 4
- "What Do All Those Colors Mean?" Air Quality Index Education Program, City of Fort Worth, Environmental Management Program, Haley Summerford, City of Fort Worth
- Texas Commission on Environmental Quality, http://www.tceq.tx.us/

ACTIVITY 5
- Dr. Milton Payne, Dr. Milton Payne's Outdoor Education Class, Department of Elementary Education, Stephen F. Austin State University, P.O. Box 13017, Nacogdoches, TX 75962, spring 1994
- Lois Myers and Kelly West, Teaching Environmental Sciences Class, Stephen F. Austin State University, 1995