LESSON PLAN
~Chemistry, Grade 12, College Preparation~

"Chemistry in the Environment: The Clean Air Game"

-created by Lynn Perreault, Ph.D. (for Idle-Free Windsor)

Date:	**Time:**
School:	**Teacher:**
Special Instructions:	

Ontario Curriculum Connection

By the end of this course, students will:

Overall Expectations:

- Demonstrate an understanding of the nature and role of elements and compounds in the environment, including acids and bases, and gases in the atmosphere;
- Assess the effects and the implications for society of the levels of various substances in the environment, and demonstrate an awareness of the need for both government and individual citizens to take measures that will ensure a healthy environment.

Specific Expectation (Understanding Basic Concepts):

- Identify gases in the atmosphere that affect air quality (e.g., greenhouse gases, tropospheric and stratospheric ozone, carbon monoxide, chlorofluorocarbons).

Specific Expectation (Relating Science to Technology, Society, and the Environment):

- Demonstrate an awareness of how governmental regulations as well as the actions of individual people can improve air and water quality (e.g., discuss how individuals can contribute to the improvement of air quality through their choice of transportation).

MATERIALS & EQUIPMENT:

Playing pieces (e.g., one fruit loop per student);
Dice (one per game board);
Game boards which may be enlarged to fit a laminated 11'' x 17'' sheet of paper
(see Appendix 1 -> there should be approximately 4 to 5 players per game board); and
One photocopy of Appendix 1 for each student to use as a resource for the short discussion paper.

Vocabulary:
Words & concepts your class may be learning

CO: Carbon monoxide is a gas that is emitted from an automobile, for example.
CO_2: Carbon dioxide is a greenhouse gas that is emitted from an automobile, for example.
HAPs or Toxics: Hazardous Air Pollutants come from burning fossil fuels such as wood.
NOx: Nitrogen oxides come from burning fossil fuels at high temperatures, for example, in transportation and industry.
O_3: Ozone is a form of oxygen produced when an electric spark or ultraviolet light passes through air; when near the earth's surface (i.e., tropospheric ozone), it is a harmful irritant and pollutant. It plays a big part in the creation of smog.
Pb: Lead is a naturally occurring metal found throughout the environment. Lead comes from leaded automobile gasoline and emissions from smelters and refineries, for example.
PM: Particulate matter are fine particles emitted from a running vehicle, for example.
SO_2: Sulphur dioxide is a colourless gas with a strong odour, and mostly comes from oil and gas processing, the burning of coal and heavy oil, pulp and paper mills, copper smelters and other metallurgical industries.
VOCs: Volatile organic compounds are released from running vehicles and power plants.

PROCEDURE

Part 1 (Introduction)

Topic Intro - Brainstorming, Connecting ideas (assess students' knowledge!) ~5-10 min.
Ask students:
Can you name some air pollutants? (e.g., CO, CO_2, NOx, O_3, Pb, PM, SO_2, and VOCs)
Where do these pollutants come from? (e.g., automobiles, industrial power plants)
What are the effects of air pollutants? (e.g., contaminated crops & livestock, brain damage, heart damage, dead aquatic life, less oxygen in the blood, global warming, lung damage, eye irritation, damaged forests, reduced alertness, smog)

Part 2 (Setup)

Activity ~ 5 min.
Distribute the game boards, playing pieces, and the dice. Explain the rules of the game to the students (see Appendix 2 for game rules and introduction).

Part 3 (Playing the Game)

Activity ~ 10-15 min.
Students will play the Clean Air Game. The team with the lowest score (cleanest air) wins the game. Celebrate by rewarding the team with the cleanest air with applause or, for fun, a jar of clean air!

Part 4a (Discussion)

Activity ~ 5-10 min.
Engage students in a discussion about the Clean Air Game. Hand out copies of Appendix 1 for students to use as a resource for the group discussion and short discussion paper.

First, ask students: "Based on the Clean Air Game, what are some technologies that lead to air pollution?" (i.e., diesel engines, cars, electric power plants, toxic cleaning solvents, metal refineries, wood stoves, and dry cleaners).

Second, ask students: "What are some of the air pollutants created by the technologies listed in the Clean Air Game?" (i.e., PM, SO_2, O_3, NOx, VOC, Pb, HAPs, CO).

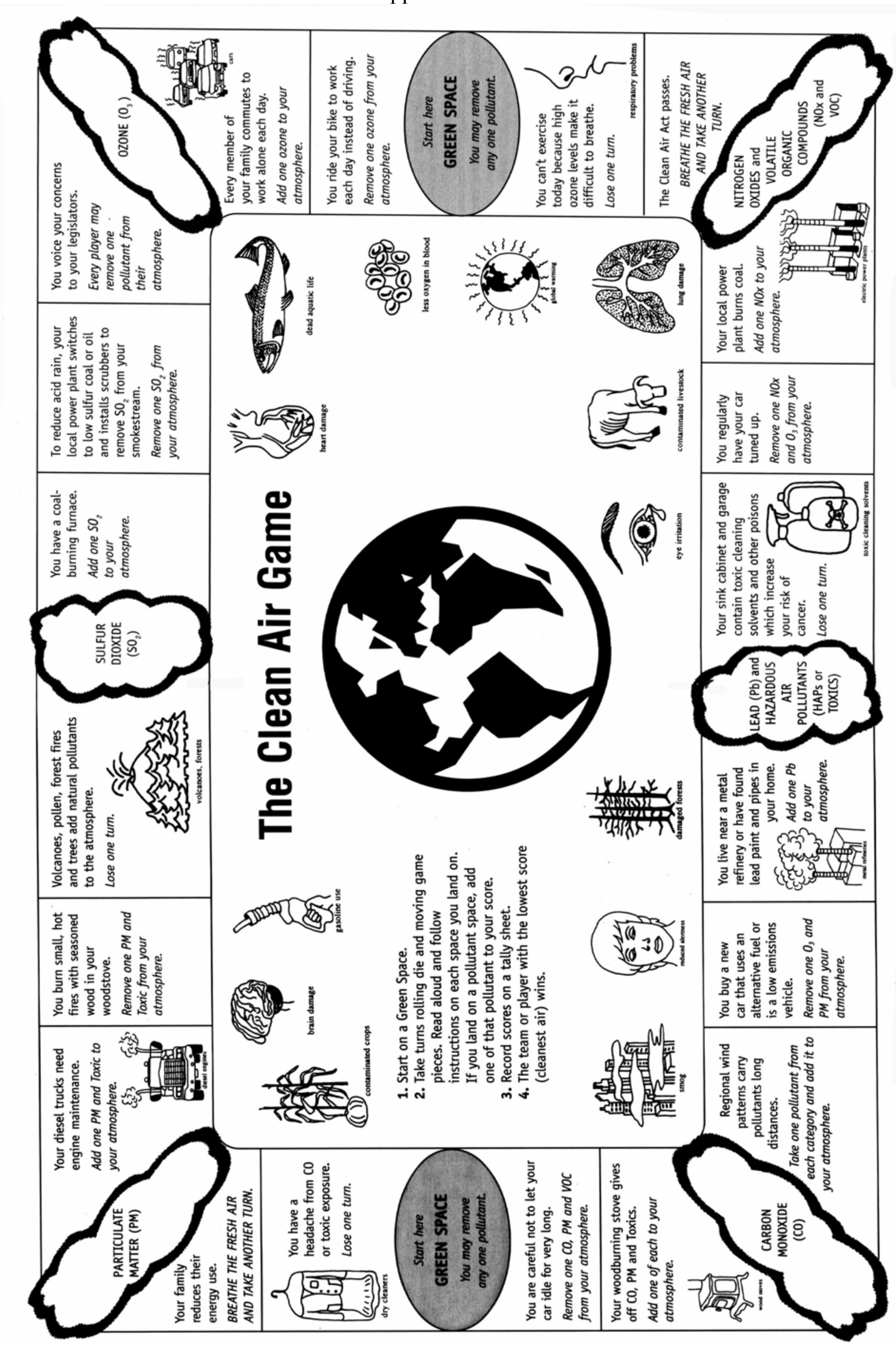
Third, ask students: "What are the effects of the pollutants listed in the Clean Air Game?" (i.e., environmental effects include contaminated crops, dead aquatic life, global warming, contaminated livestock, damaged forests, and smog; health effects include headache, cancer, breathing difficulties, brain damage, heart damage, less oxygen in blood, lung damage, eye irritation, and reduced alertness).

Part 4b (Short Discussion Paper)

Activity ~ 35 min.
Ask students to write a short discussion paper (approximately 750 words, or 3 to 4 pages double-spaced) based on the following questions:

1) As listed in the Clean Air Game, identify the gases that pollute the air. Make sure to list each chemical component and its abbreviation. For example, air pollution includes carbon monoxide (CO).
2) As listed in the Clean Air Game, identify the effects of these gases on health and the environment.
3) List three specific actions that individual people can take to improve air quality. (You may refer to the Clean Air Game for ideas.) Explain in detail how these actions can improve health and the environment.
4) Describe one technique that would effectively convince people to take action in improving air quality. Explain why this technique will be effective.

For more information about Windsor's anti-idling campaign, please visit www.idlefreewindsor.org or call 519-973-1156. (After May 1, 2007, please call the Citizens Environment Alliance at 519-973-1116.)


The Clean Air Game
1. Start on a Green Space.
2. Take turns rolling die and moving game pieces. Read aloud and follow instructions on each space you land on. If you land on a pollutant space, add one of that pollutant to your score.
3. Record scores on a tally sheet.
4. The team or player with the lowest score (cleanest air) wins.
PARTICULATE MATTER (PM)
Your family reduces their energy use. BREATHE THE FRESH AIR AND TAKE ANOTHER TURN.
Your diesel trucks need engine maintenance. Add one PM and Toxic to your atmosphere.
diesel engines
You burn small, hot fires with seasoned wood in your woodstove. Remove one PM and Toxic from your atmosphere.
Volcanoes, pollen, forest fires and trees add natural pollutants to the atmosphere. Lose one turn.
volcanoes, forests
SULFUR DIOXIDE (SO_2)
You have a coal-burning furnace. Add one SO_2 to your atmosphere.
To reduce acid rain, your local power plant switches to low sulfur coal or oil and installs scrubbers to remove SO_2 from your smokestream. Remove one SO_2 from your atmosphere.
You voice your concerns to your legislators. Every player may remove one pollutant from their atmosphere.
OZONE (O_3)
cars
Every member of your family commutes to work alone each day. Add one ozone to your atmosphere.
You ride your bike to work each day instead of driving. Remove one ozone from your atmosphere.
Start here GREEN SPACE You may remove any one pollutant.
You can't exercise today because high ozone levels make it difficult to breathe. Lose one turn.
respiratory problems
The Clean Air Act passes. BREATHE THE FRESH AIR AND TAKE ANOTHER TURN.
NITROGEN OXIDES and VOLATILE ORGANIC COMPOUNDS (NOx and VOC)
Your local power plant burns coal. Add one NOx to your atmosphere.
electric power plants
You regularly have your car tuned up. Remove one NOx and O_3 from your atmosphere.
Your sink cabinet and garage contain toxic cleaning solvents and other poisons which increase your risk of cancer. Lose one turn.
toxic cleaning solvents
LEAD (Pb) and HAZARDOUS AIR POLLUTANTS (HAPs or TOXICS)
You live near a metal refinery or have found lead paint and pipes in your home. Add one Pb to your atmosphere.
metal refineries
You buy a new car that uses an alternative fuel or is a low emissions vehicle. Remove one O_3 and PM from your atmosphere.
Regional wind patterns carry pollutants long distances. Take one pollutant from each category and add it to your atmosphere.
CARBON MONOXIDE (CO)
wood stoves
Your woodburning stove gives off CO, PM and Toxics. Add one of each to your atmosphere.
You are careful not to let your car idle for very long. Remove one CO, PM and VOC from your atmosphere.
Start here GREEN SPACE You may remove any one pollutant.
You have a headache from CO or toxic exposure. Lose one turn.
dry cleaners
contaminated crops
brain damage
gasoline use
heart damage
dead aquatic life
less oxygen in blood
global warming
smog
reduced alertness
damaged forests
eye irritation
contaminated livestock
lung damage

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Appendix 2

Source: Avalone-King, D. (Fall 2000). "The Clean Air Game: A quick introduction to air pollution – its sources, impacts, and solutions." *Green Teacher, 63*, pp. 23-25.

(Deborah Avalone-King is an environmental educator with the Maine Department of Environmental Protection in Augusta, providing air quality resources and services to the educational community.)

When asked what are the essential factors for life, we usually answer food, water and shelter. Why do we forget about the air we breathe – that vital force that keeps us alive? We know the atmosphere exists, but we do not truly appreciate the essential role that it plays in the Earth's processes, from aerobic respiration in living things to the continuous cycling of elements such as water, carbon and minerals. Because human activities continue to disrupt the chemical balance of the atmosphere, there is a growing need to build a greater awareness of how to protect this precious resource.

The Earthminders' Clean Air Game is a great way to introduce a unit on air quality and to initiate a discussion of the importance of protecting the atmosphere. The objectives of the game are to acquaint students with sources and types of air pollutants, with the impact of air pollution on the health of people and the environment, and with actions individuals can take to prevent air pollution. The game can be used in a number of ways: in studies of energy use, it will spark discussion of how the choices we make create or ameliorate environmental problems; in ecology, it will highlight how non-living aspects of the environment change in response to human and other factors; and in science and technology, the game can be part of a unit on assessing the environmental impacts of technology and developing a personal sense of global stewardship. Regardless of where the Clean Air Game fits into your curriculum, it is a fun way to increase your students' awareness of the importance of protecting a resource that is vital to all of the Earth's systems.

Playing the Clean Air Game

The Clean Air Game can be played by students of all ages, from elementary school to high school. The suggested play time is 20 to 30 minutes for younger students and 10 to 15 minutes for older students. Additional time is needed for processing and sharing what is learned.

To play the game, students form teams of four or five. Each student has a playing piece and each team has a die. Players start on one of the two Green Spaces and move clockwise around the board. As players land on spaces, they read aloud the description and add or remove pollutants from their atmosphere as directed. When landing on pollutant spaces, players must add on of those pollutants to their atmosphere. (The purpose of these spaces is to familiarize students with the names and chemical abbreviations of pollutants.) Individual players may wish to keep track of their own scores, but the team score is what matters. The team with the lowest score (cleanest air) wins the game.

Scoring can be done on score sheets… For example, students may keep a general pollution score, with one column for adding pollutants and one column for removing pollutants, and sum it up at the end of the game. Or they may track each of the six pollutants on the board. As a follow-up, students may graph the results, analyse the data, and develop their own Clean Air Act with strategies for reducing each of the six types of air pollution.

Celebrate at the end of the game by rewarding the team that has the cleanest air (least points) with applause or, for fun, a jar of clean air! Have each group share examples of the actions or events that caused them to have dirtier air or cleaner air. This reflection is an important way to process the information and better relate the activity to their own lives and the actions they can take to reduce pollution.

The Clean Air Game was developed by Maine teacher Page Keeley from an activity in the *Environmental Resource Guide – Air Quality*, a curriculum resource for use in grades 6 to 8, produced by the Air and Waste Management Association. The guide is available in English, French or Spanish for US$33.50 plus s&h from A&WMA, (800) 275-5851 or (412) 741-1288.

ASSESSMENT TOOL

Chemistry in the Environment: The Clean Air Game

Teacher Name:

Student Name: _____

CATEGORY	4	3	2	1
Knowledge/ Understanding (Knowledge of facts and terms gained by writing a short discussion paper about the Clean Air Game.)	Demonstrates a thorough knowledge of facts and terms (e.g., includes at least 6 chemical components and abbreviations listed in the game, ***and*** identifies at least 4 environmental effects and at least seven health effects of air pollution).	Demonstrates a considerable knowledge of facts and terms (e.g., includes 4 or 5 chemical components and abbreviations listed in the game, ***and*** identifies 3 environmental effects and 5 to 6 health effects of air pollution).	Demonstrates some knowledge of facts and terms (e.g., includes 2 or 3 chemical components and abbreviations listed in the game, ***and*** identifies 2 environmental effects and 3 or 4 health effects of air pollution).	Demonstrates limited knowledge of facts and terms (e.g., includes less than 2 chemical components and abbreviations listed in the game, ***and*** identifies less than 2 environmental effects and less than 3 health effects of air pollution).
Communication (Communication of information and ideas as presented in a short discussion paper based on the Clean Air Game.)	Communicates information and ideas with a high degree of clarity and precision (e.g., explaining with clarity how specific human actions can improve health and the environment).	Communicates information and ideas with considerable clarity and precision.	Communicates information and ideas with moderate clarity and precision.	Communicates information and ideas with limited clarity and precision.
Making Connections (Proposing of courses of practical action in relation to science- and technology-based problems via a short discussion paper.)	Extends analyses of familiar and unfamiliar problems into courses of practical action with a high degree of effectiveness (e.g., clearly describes one technique that would effectively convince people to take action in improving air quality, and explains why this technique will be effective).	Extends analyses of familiar problems into courses of practical action with considerable effectiveness.	Extends analyses of familiar problems into courses of practical action with moderate effectiveness.	Extends analyses of familiar problems into courses of practical action with limited effectiveness.