On a Scale of 1 to 10

Abstract

Using five information sheets on air pollution; air quality and health; asthma and allergies; AQHI, and solutions for reducing air pollution; groups of students teach the rest of the class about their topic.

Logistics

Time Required

- **Class Time:** Part A 60 to 80 minutes / Part B 60 to 80 minutes
- **Prep Time:** 5 minutes

Materials

PART A

- "On a Scale of 1 to 10 Information Sheets," five groups of students, each student in a group should get a copy of their topic

PART B

- Copy of "On a Scale of 1 to 10 Student Worksheet," one per student
- Copy of "Teacher Answer Key"

Classroom Requirements

- Computer with Internet access, projector and screen (if required by students for presentations)

Learning Objectives

- Identify air pollutants and the health risks that result from poor air quality.
- Develop an awareness of asthma and allergies and the connection between these and air pollution.
- Demonstrate the Air Quality and Health Index and identify its benefits.
- Identify personal actions that can be taken to improve air quality.

Prescribed Learning Outcomes BC Curriculum:

Transportation

J1 – describe the roles of transportation in society and the effects transportation has on society

Preparation

1. Photocopy the "On the Scale of 1 to 10 Information Sheets" and "On a Scale of 1 to 10 Student Worksheet"

Classroom Implementation

Part A

Students investigate topics of air pollution and construct group presentations.

1. Explain to the class that they are to become experts on topics related to air pollution, air quality, health (especially asthma), and on actions people can take to improve air quality. Part of their role as experts will be to teach the rest of the class about their topic area.

2. Organize the class into five groups. Assign each group one of the five topic areas and provide each group member with a copy of their topic area information sheets.

3. Ask each group to design a method for teaching the rest of the class about their topic. They can use games, skits, PowerPoint presentations, or other means to teach. Remind students that the purpose is to teach. Encourage them to come up with the best way to teach the information.

4. Share all of the topic areas with the groups. If students know what each group is covering, they will be less likely to cover the topic areas of the other groups.

5. Provide the rest of the class period for the students to prepare to teach.

Part B

Students express findings of air pollution investigation through presentations.

1. Distribute the “On a Scale of 1 to 10 Student Worksheet” to each student.

2. Invite the groups to teach. The recommended topic order is Air Pollutants; Effects of Air Pollution and Smog on Human Health; Asthma and Allergies; Air Quality and Health Index (AQHI); and Air Pollution Solutions.

3. As each group teaches their topic area, have the students answer the questions for that topic on the —On a Scale of 1 to 10 Student Worksheet. Ensure there is time for questions and discussion after each group’s teaching session. If you want to generate feedback for the group at this point, you could provide the following statements for students to complete: —I like the way you taught _____. Something that could be improved is _____.

4. Lead a class discussion that deals with all of the topics. From the list provided, which solutions would be easier for them to do in their daily lives?

Extension

1. Record the AQHI (http://www.ec.gc.ca/cas-aqhi/) for a location closest to your school over the school year. Use a spreadsheet to track the information. The spreadsheet could also include the weather and temperature for each day (Weather Network). The data could be used to compare the AQHI with weather patterns and seasonal effects. Students could provide information for announcements or postings on the school's bulletins for days that the AQHI is moderate to very high. They may wish to include other health information such as the UV rating and Pollen report (both are found on the Weather Network - http://www.theweathernetwork.com).

2. Host a—Commuter Challenge to include staff, students, parents and local celebrities. Include three to five people and assign a mode of transportation to each person (e.g., bus, car, bike, long board, and walking). Determine one starting point for all participants and set the end point as the school. Assign a time for participants to leave, and ensure that the start timer and end timer are synchronized. Create a large poster display to list the different participants and their times and post the results in school newsletters or bulletins. Invite the media to share in the event and to share the results.

3. Challenge students to use forms of transportation other than cars for a period of time. Students that come by bus could choose a location close to their home that they visit frequently (or they could be the —tally recorders or —cheerers for their group). Divide the students into small groups and have them choose a name for their group. Post the group names on a poster board. Place a check mark beside the group name each time a student in that group used active transportation for getting to school (or another location they choose to travel to from their home). When the time is up, select the group with the most check marks and award them the —Commuter Challenge prize. You could award certificates and/or create awards like a golden shoe award (paint an old running shoe with a water-based gold paint and glue it to a piece of wood).

4. Refer to the Clean Air Champions website for other quizzes, activities and games: http://www.cleanairchampions.ca/programs/air_aware/quizzes_activities_and_games.php

ON A SCALE OF 1 TO 10 TEACHER ANSWER KEY

1. List the types of air pollution.

   NOx, SO_2, CO, VOC, Ground level ozone, particulate matter and heavy metals.

2. Describe the health impacts of air pollution.

   Air pollution impacts the respiratory and cardiovascular systems. It can irritate the eyes, nose and throat and also irritate and inflame airways and lung tissue. Pollutants can enter the bloodstream and affect blood vessels and the heart. Ground level ozone can damage lung tissue and significantly reduce lung function. Of the particulate matter, fine and ultra- fine particles cause the greatest damage as they can penetrate deep into the lung. Everyone is affected by air pollution but the most vulnerable are children, the elderly, those physically active outdoors and those with lung or heart diseases.

3. What is the connection between asthma and allergies?

   More than 80% of people with asthma also suffer from allergic rhinitis or sinusitis. Asthma and seasonal allergies are related conditions that affect a common airway. Both obstruct the free passage of air into our bodies. Asthma is an inflammation of the bronchioles, and the inflammation increases the production of mucus. Seasonal allergies obstruct the upper section of the airway (in the nose). For people who have asthma as well as seasonal allergies, both the upper airway and lungs are affected and so both need to be treated. If allergic rhinitis is not treated, asthma symptoms can worsen. Treating allergic rhinitis will help both the upper airway and lungs.

4. Describe the Air Quality and Health Index and its benefits.

   The Air Quality Health Index (AQHI) is a health protection tool that is designed to help you make decisions to protect your health by limiting short-term exposure to air pollution and adjusting your activity levels during increased levels of air pollution. It uses a scale from 1 to 10, with 1 being low risk and 10 high risk. The three pollutants the AQHI measures are ozone, particulate matter and nitrogen dioxide. Canada is the first country in the world to develop an air quality and health index.

5. List at least five things people can do to improve air quality.
   Purchase an energy efficient vehicle.
   Walk instead of drive.
   Use public transit instead of drive.
   Turn off electrical items when not in use.
   Use a programmable thermostat.
   Take a shorter shower.
   Install compact fluorescent lights.
   Purchase EcoLogo products.

ON A SCALE OF 1 TO 10 INFORMATION SHEET 1

Air Pollutants

Air pollution is the presence in the air of any substance in high enough concentrations to be harmful to the environment or to human health. Human activities such as the combustion of fossil fuels and industrial processes are the primary source of most pollutants. Pollutants also come from natural sources such as fires, wind-blown dust, and volcanoes. There are seven main types of air pollutants:

1. **Nitrous Oxides** (NOx) are produced during the combustion of fossil fuels. They are pollutants themselves, but they also react with water vapour to form fine acidic droplets, and they react with VOCs to generate ozone. NOx are both air pollutants and greenhouse gases.

2. **Sulphur Dioxide** (SO_2) is generated by industrial processes and the combustion of fossil fuels. It is a pollutant itself, but it also reacts with water vapour to form fine acidic droplets (e.g., sulphuric acid). SO_2 is not a greenhouse gas.

3. **Carbon Monoxide** (CO) is generated by the combustion of fossil fuels, primarily from automobiles. It is also released by wild fires and volcanic eruptions. CO is not a greenhouse gas.

4. **Volatile Organic Compounds** (VOCs) are a group of carbon-containing compounds, both natural and synthetic. They are released primarily by the evaporation of petroleum products such as gasoline and natural gas as well as solvents and other volatile products such as paints. VOCs react with NOx in the presence of sunlight to form ground-level ozone. Some VOCs are carcinogenic (i.e., cancer-causing) such as benzene and formaldehyde. VOCs by themselves do not contribute to the greenhouse effect.

5. **Ground Level Ozone** is formed by a chemical reaction between VOCs and NOx in the presence of sunlight. Ground-level ozone is one of the main components of smog. Because the reaction that generates ozone accelerates at higher temperatures, global warming is expected to increase concentrations of ground-level ozone and lead to more smog. Ground-level ozone is also a greenhouse gas.

6. **Airborne Particles** (Particulate matter, or PM) include both solids and droplets from a variety of natural sources and human activities. In most cases, coarse particles (2.5 to 10 microns) are emitted directly into the air — such as dust, pollen, diesel soot, smoke. Fine particles (of less than 2.5 microns) are formed through chemical reactions involving NOx, SO_2, water vapour, VOCs and ammonia. Particulate matter is one of the main components of smog, but it does not contribute to the greenhouse effect.

7. **Various Heavy Metals** (lead, mercury, cadmium, manganese) and various persistent organic compounds (e.g., PCBs, dioxins) are also found in air pollution. Heavy metals and persistent organic compounds do not contribute to the greenhouse effect.

What is Smog?

Air pollution is a general term covering all forms of pollutants while smog refers to a phenomenon caused by a chemical reaction of certain pollutants in the atmosphere. The term smog — which is a combination of fog and smoke — originated in the United Kingdom after the Great Smog of 1952, an air pollution episode that killed thousands of people in London. Smog most often occurs on hot, sunny, calm days. It appears as a yellowish haze that sits over cities, towns, and regions.

The two main ingredients of smog are ground-level ozone (O3), which is formed by a chemical reaction between NOx and VOCs in the presence of sunlight, and fine airborne particles (PM2.5). Summer smog formation depends on heat and sunlight so smog generally peaks in the late afternoon and early evening. It is most obvious in large cities, but wind patterns and topography allow smog to travel and be trapped in areas distant from the source. As a case in point, smog is often worse in the Fraser Valley of British Columbia than in the city of Vancouver.

Both an urban and rural phenomenon, smog can occur at any time of the year. Summer tends to have more smog due to higher temperatures. Winter smog acts slightly differently than summer smog because it consists of different pollutants such as PM2.5 which is mainly due to wood smoke, road dust, road salt, and industrial activities. Smog will stay in an area until it is dispersed by heavy winds or washed out of the local atmosphere by precipitation (which is why smog is worse on calm, sunny days).

Did you know there are two types of ozone, a good one and a bad one?

The Good Ozone — Stratospheric Ozone.

Stratospheric ozone, the ―good‖ ozone layer, is located 16 to 50 km above the ground. It has a cooling effect on the earth and protects humans and other life from ultraviolet (UV) radiation. When scientists refer to holes in the ozone layer, they are referring to the stratospheric ozone. Stratospheric ozone is not a pollutant; ground-level ozone is.

The Bad Ozone — Ground-level Ozone.

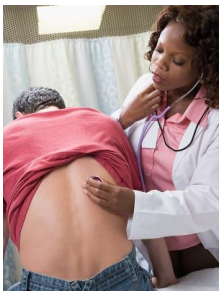
Ground-level ozone is formed when VOCs and NOx react in sunlight (or NOx + VOC + Sunlight = GLO). Ground-level ozone is toxic to humans. This air pollutant contributes to smog and climate change and does not protect us from UV radiation.

ON A SCALE OF 1 TO 10 INFORMATION SHEET 2

Effects of Air Pollution and Smog on Human Health

Air pollutants cause health effects that range from subtle biochemical and physiological changes to difficulty breathing, wheezing, coughing and aggravation of existing respiratory conditions (asthma) as well as cardiac conditions. These effects can lead to increased medication use, increased doctor or emergency room visits, more hospital admissions, and even premature death. Exposure to toxic airborne substances such as mercury and lead can also lead to neurological (brain) damage, particularly in children.

The respiratory system



Air pollutants can irritate your eyes, nose, and throat. They can also irritate and inflame your airways and lung tissue that can reduce your lungs' ability to collect and deliver oxygen, cause long-term lung damage, and aggravate existing respiratory conditions (e.g., asthma, bronchitis, chronic obstructive pulmonary disease). On-going exposure to pollutants, especially ozone, can damage deep portions of the lung. The damage can remain even after symptoms such as coughing or a sore throat disappear. Air pollution can also reduce your resistance to respiratory infections.

The cardiovascular system

Pollutants are either absorbed into the bloodstream, or they interact directly with the cardiovascular system. Pollutants that are absorbed into the bloodstream travel throughout the body, starting a kind of chemical chain reaction. Through a variety of complex pathways, this reaction can affect blood vessels and ultimately the heart. Pollutants that interact directly can cause structural changes in the cardiovascular system. For example, air pollutants can contribute to degenerative necrosis, inflammatory reactions, and arrhythmias. They may lead to the formation of free radicals, which are thought to contribute to narrowing of the arteries (by formation of atherosclerotic plaques).

Ozone and Particulate Matter

All air pollutants, including NOx, SO_2, and CO, affect our health, but ozone and particulate matter (PM) are the biggest concern. Ozone is highly reactive and can damage lung tissue and significantly reduce lung function, even when the exposure is to low concentrations and for relatively short periods. Particulate matter can irritate and inflame the respiratory system, impairing lung function. Fine and ultra-fine particles cause the greatest damage, as they can penetrate deep into the lung, carrying with them allergens and toxins. Particulate that is generated by the combustion of fossil fuels is particularly toxic.

There is no safe level of exposure to air pollution — particularly to ozone and PM. Health effects result from both long-term and short-term exposure, even at low levels of pollution. We need to be concerned about ozone and PM levels even on days when no smog warning is in effect.

Who does Air Pollution and Smog affect?

Everyone. Individual reactions to air pollutants depend on the type of pollutant a person is exposed to, the degree of exposure, the individual's health status, and genetics. Children, the elderly, those who are physically active outdoors, and those with pre-existing medical conditions are especially vulnerable. But the reality is that air pollution affects all of us. Even healthy people have difficulty breathing on days when the air is heavily polluted. Ozone and particulate matter cause inflammation and swelling in lung tissue and decreased lung function in everyone. There is no safe amount of exposure to ground-level ozone or smog!

Children and youth up the age of 18 are very vulnerable to the effects of air pollution because:

- Their respiratory and neurological systems are still developing.
- They tend to spend more time outdoors, being active, and so they inhale more pollutants.
- They breathe more per unit of body weight than adults, meaning they filter more polluted air through their lungs.
- They have smaller airways and lungs.
- Their immune systems are immature, making them more vulnerable to respiratory infections.

Athletes of all levels, including weekend athletes, are also particularly at risk from air pollution and smog because they spend a lot of time training outdoors. During exercise, particularly at high intensity, athletes inhale very deeply, drawing large volumes of dirty air deep into their lungs. They breathe in through their mouths, bypassing the body's filtration system in the nose. Athletes may have high metabolic rates and are more susceptible to infections, because intense training temporarily depresses the immune system.

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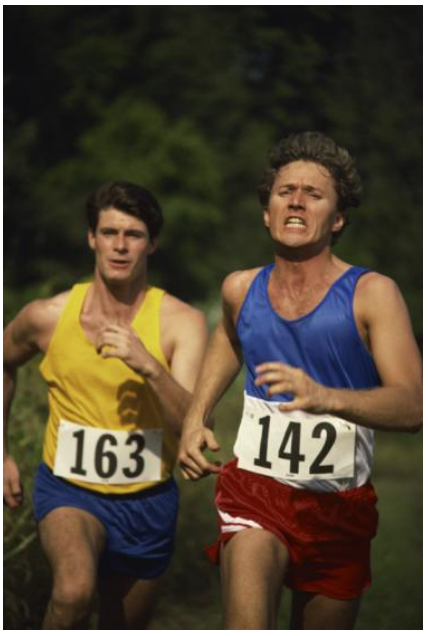
Effects of air pollution on human health:



- Irritation to eyes, nose and throat
- Irritation, inflammation and damage to lung tissues.
- Decreased lung function.
- Impaired ability to transport oxygen.
- Shortness of breath, coughing, wheezing, chest pain, pulmonary congestion.
- Heart failure.
- Aggravated asthma, chronic obstructive pulmonary disease.
- Acute and chronic bronchitis.
- Weakened resistance to respiratory infections.

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ON A SCALE OF 1 TO 10 INFORMATION SHEET 3

Asthma and Allergies

Asthma is a —chronic inflammatory disease of the airway‖ that causes shortness of breath, tightness in the chest, coughing, and wheezing. Asthma can vary in its severity, can vary from person to person, and can flare up from time to time. The cause of asthma is not known, and currently there is no cure.

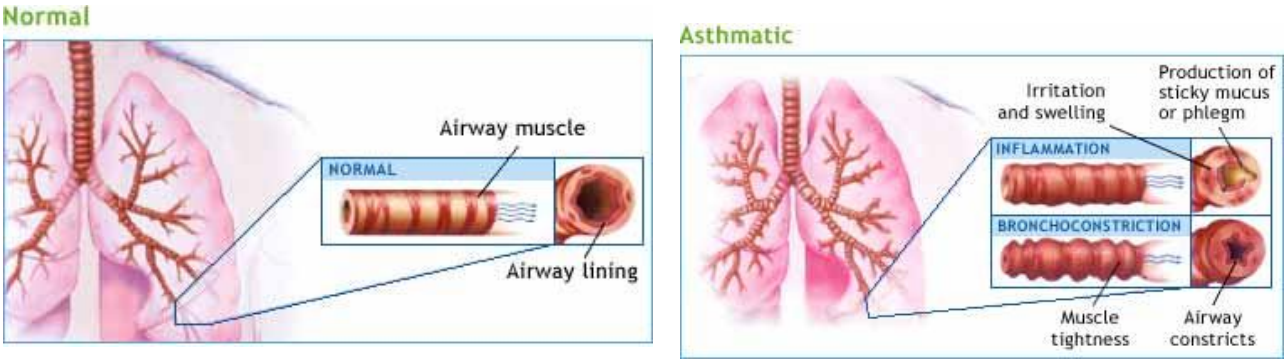
People with asthma often have trouble breathing when they are encounter their triggers. When someone has asthma and their symptoms are triggered, it means that the flow of air is obstructed as it passes in and out of the lungs. There are two types of asthma triggers:

- **allergic triggers** that cause inflammation of airways — dust mites, animals, cockroaches, moulds, and pollen.
- **non-allergic triggers** that can irritate airways that are already inflamed — viral infections, smoke, exercise, cold air, chemical fumes and strong-smelling substances, certain air pollutants, and intense emotions.

Many people with asthma also have allergies. People with allergies as well as asthma who come in contact with their allergic triggers will have a reaction in their airways as well as the usual allergy symptoms (itchy, watery eyes, etc.) An allergy is an abnormal reaction by your body to things that your body becomes sensitive to. These are called allergens. There are two types of allergens: ingested allergens (such as food, drink, and medicines) and inhaled allergens (such as pollen, dust, animal dander, and mold). Inhaled allergens are the most common cause of allergy problems in people with asthma.

Viral infections such as the common cold are one of the most common non-allergic triggers. Another non-allergic trigger is exercise, and this results in what is called exercise-induced asthma. Cold, dry air is believed to be the main cause of exercise-induced asthma. When exercising, we tend to breathe quickly, shallowly, and through the mouth. Air reaching the lungs through the mouth isn't warmed and humidified by the nose. Smoke from smoking cigarettes, second-hand smoke, or smoke from fires is another non-allergic trigger. Strong-smelling substances such as perfume can also trigger asthma. Air pollution such as ground-level ozone, particulate matter and nitrogen dioxide also trigger non-allergic asthma symptoms.

Asthma can affect anyone. Most people with asthma can live full, active lives. Asthma symptoms can be managed, and the goal is to be symptom-free by avoiding asthma triggers, by taking medication, by following an asthma action plan, and by following up regularly with your doctor.



Source: Asthma Society of Canada, http://www.asthma.ca/adults/about/whatIsAsthma.php.

Allergens

Allergies are the bodies' over-reaction to common substances — called allergens — such as pollen, dust, or animal dander. The over-reaction is triggered by the body's immune system which consists of cells, tissues, and organs that work together to defend the body against harmful infections with bacteria, parasites, and fungi. Although we know a lot about the immune system, there is still much to learn about how the body launches an attack on infected cells and tumors but not on healthy tissues. The immune system is amazingly complex. Sometimes the immune system acts inappropriately, and this results in problems
such as allergies and autoimmune diseases.

The immune system produces five types of antibodies or immunoglobulin's (Igs) to protect our bodies. Each Ig has a distinct and specific job. The antibody IgE is the one involved in allergic reactions. When pollen enters the nose, it binds IgE, which triggers the release of histamine from mast cells. This results in inflammation and leads to allergy symptoms such as a runny or stuffy nose, sneezing, and itching. People often take medication such as anti-histamines or nasal steroid sprays to alleviate their allergic symptoms.

Asthma and allergic rhinitis are related conditions linked by a common airway. The air we breathe in passes through our nose, which is at the start of the airway, and continues down the airway into the lungs. Allergic rhinitis and asthma can cause problems with our breathing by obstructing the free passage of air along this path. Allergens such as animal dander and house dust mites can be present all year round whereas tree, grass, and ragweed pollen appear during certain seasons.

With asthma, the breathlessness and wheezing is caused by a narrowing of the bronchioles, which are the small branched airways in the lungs. Inflammation of the membranes of these small airways leads to increased mucus production, airway obstruction, and cough.
For people who have allergic rhinitis and asthma, both the upper airway (nose) and lungs are affected, and so both need to be treated. If allergic rhinitis is not treated, asthma symptoms can worsen. Treating allergic rhinitis will help both the upper airway and lungs.

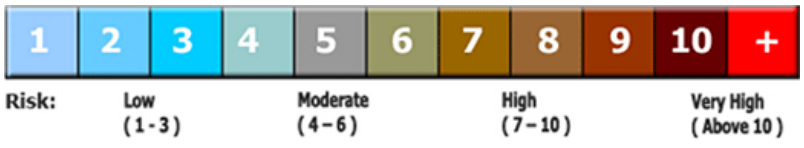
For more information on asthma and allergies, download the fact sheets from the Clean Air Champions website:
http://www.cleanairchampions.ca/programs/air_aware/fact_sheets.phpSource: Asthma Society of Canada – Allergies Count Too (ACT)
http://www.asthma.ca/allergies/allergiesasthma.html

ON A SCALE OF 1 TO 10 INFORMATION SHEET 4

Air Quality Health Index

The Air Quality Health Index (AQHI) is a health protection tool that is designed to help you make decisions to protect your health by limiting short-term exposure to air pollution and adjusting your levels of activity during increased levels of air pollution. The three pollutants the AQHI measures are ozone (O_3), particulate matter ($PM_{2.5}$), and nitrogen dioxide (NO_2).

The AQHI is measured on a scale ranging from 1 to 10+, much like the UV index, with 1 being low risk and 10 high risk. The AQHI index values are also grouped into health risk categories as shown here:



Health Risk	AQHI	Health Messages	
		At Risk Population*	**General Population**
Low	**1-3**	**Enjoy** your usual outdoor activities.	**Ideal** air quality for outdoor activities.
Moderate	**4-6**	**Consider reducing** or rescheduling strenuous activities outdoors if you are experiencing symptoms.	**No need to modify** your usual outdoor activities unless you experience symptoms such as coughing or throat irritation.
High	**7-10**	**Reduce** or reschedule strenuous activities outdoors. Children and elderly should take it easy.	**Consider reducing** or rescheduling strenuous activities outdoors if you experience symptoms such as coughing or throat irritation.
Very High	**above 10**	**Avoid** strenuous activities outdoors. Children and elderly should also avoid outdoor physical exertion.	**Reduce** or reschedule strenuous activities outdoors, especially if you experience symptoms such as coughing or throat irritation.

*People with heart or breathing problems are at greater risk. Follow your doctor's usual advice about exercising and managing your condition.

Did you know? Canada is the first country to combine air quality with a health index. Many other countries report only on air quality.

ON A SCALE OF 1 TO 10 INFORMATION SHEET 5

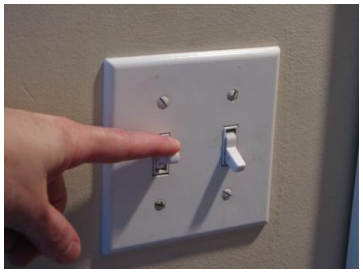
Air Pollution Solutions

Walking. When you travel using your own energy (from food), you don't create any harmful emissions from burning gasoline. Living close to where you work or go to school makes it easier to walk rather than drive. Use Walk Score — http://www.walkscore.com— to see how your neighbourhood score on walkability and to see the locations within walking distance of your home.

Biking/Rollerblading/Skateboarding. Like walking, these modes of travel are easy on the air. Because they do not burn gasoline, they have no harmful emissions. Many communities are making it easier to get around by bike, rollerblades, and skateboards. Some public transit buses have bike racks on the front so you can travel by bike and bus. Some events are now offering bike valet parking to encourage more people to come by bike. The bicycle is the world's most widely used form of transportation and its most energy efficient.

Using Public Transit or Carpooling. Public transportation and carpooling can be a breath of fresh air. Public transit and carpooling reduces the number of individual vehicles that are on the road burning fossil fuels. A single bus, subway or train can carry a lot of people. Carpooling can help a few people travel together especially for getting to work or school. When fewer people drive, they reduce the amount of pollution that is emitted into the air.

Using Less Hot Water. Natural gas or electricity heats the water in our homes. By taking shorter showers or washing clothes in cold water, we can reduce the amount of natural gas or electricity used for heating water and reduces air pollution. You can also check to see if the thermostat on the hot water tank can be turned down a few degrees (sometimes we don't need the hot water to be so hot). Bathroom water use accounts for 65% of the water used in the home.



Turning Off Lights and Appliances. Turning off electrical items — such as lights, TVs, computers, air conditioners, and other appliances — reduces the amount of air pollution that comes from generating electricity. In Canada, much of the electricity we use is produced from coal-fired power plants that release pollutants into the air. Become involved in Lights Out Canada (http://lightsoutcanada.tpweb.ca) or Earth Hour (http://wwf.ca/earthhour/) to see the difference small actions can make on reducing air pollution from using electricity.

Unplug Cell Phone Chargers. Cell phone chargers are usually left plugged in all the time, but they only need to be plugged in while a cell phone is charging. A cell phone charger uses electricity even when it is not charging a cell phone. In fact, only 5% of the electricity used by cell phone chargers is actually used to charge phones. The other 95% is wasted electricity that is often produced from coal-fired power plants that release pollutants into the air. Think of all the cell phone chargers that are left plugged-in across North America!

Purchasing EcoLogo Products. EcoLogo products are reviewed to ensure they meet strict environmental standards. Products such as paints, glues, cleaners and adhesives must be made using less toxic materials that release fewer pollutants into the air to get the EcoLogo logo. Encourage family members and others to purchase EcoLogo products when they can. You can check out the many EcoLogo products at: http://www.ecologo.org/en/greenproducts/consumers

Turning Down the Heat. Turning down the heat is an easy way to save energy. The best time to do this is at night when everyone is sleeping or when the home is unoccupied. A programmable thermostat can be purchased and installed so that it can be programmed to turn down the heat at night and when no one is home. This makes it even easier to turn down the heat, as it does not rely on people to remember.

Driving Energy Efficient Vehicles or Hybrids.

Driving an energy efficient vehicle, like a hybrid vehicle, can have a big impact in reducing air pollution. Transportation fuels made from oil account for a large percentage of air pollution. Transportation emissions are a big contributor to ground level ozone and smog, and these are some of the most harmful air pollutants.

ON A SCALE OF 1 TO 10 STUDENT WORKSHEET

Answer the following questions as each group teaches their topic area.

1. List the types of air pollution.

2. Describe the health impacts of air pollution.

3. What is the connection between asthma and allergies?

4. Describe the Air Quality and Health Index and its benefits.

5. List at least five things people can do to improve air quality.