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**ACTIVITY #5: ON A SCALE OF 1 TO 10**


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**TIME****Part A:** 40 - 60 minutes**Part B:** 40 - 60 minutes**REQUIRED RESOURCES****Part A:**

- “Air Pollution, Smog and Health Impacts” information sheets
- “On a Scale of 1 to 10” worksheet

**Part B:**

- Computer with Internet access, projector and screen
  - OR Computer lab with internet access
  - “On a Scale of 1 to 10” worksheet and answer key
  - AQHI Historical Data
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**The Big Idea**

1. To understand the health risks that result from poor air quality.
  2. To develop an awareness of illnesses/diseases and types of individuals that are more likely to be affected by poor air quality.
  3. To analyze and interpret the Air Quality Health Index (AQHI) data.
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**Curriculum Connections**

Curriculum connections are listed by province, grade and subject on the Air Aware website (<http://www.airaware.net>).

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**Activity****Part A: Air Pollution, Smog & Health Impacts**

1. Organize the class into 5 groups and distribute one part of the Air Pollution, Smog and Health Impacts information sheets to each group. Have students read the information as a group and then present what they have learned to the class.
2. Distribute the “On a Scale of 1 to 10” worksheet. Have students read the Air Quality Health Index (AQHI) ratings and health messages.
3. Review the differences between the health messages for the “at risk” population and the general population. Discuss who might fit into the “At Risk” group: children, the elderly, those who are physically active outdoors, and those with pre-existing medical conditions (such as: asthma, allergies, diabetes, bronchitis, pneumonia, and heart conditions).

## Part B: Air Quality Health Index (AQHI)

1. Project the Air Aware website ([www.airaware.net](http://www.airaware.net)) on a screen or have students visit the website in the computer lab. Click on the map that says “Check your local AQHI.” Choose your location and look at the current AQHI rating (note that since AQHI is not yet reported in all regions, you may need to select a location close to you if your city is not available). Discuss why the AQHI rating is the number it is today. Discuss how the AQHI number might be related to today’s weather.
2. Have students complete the questions on the “On a Scale of 1 to 10” worksheet using historical AQHI data (provided online with curriculum activities). Please choose the closest city to your school and have students answer questions based on this data.
3. Discuss the worksheet questions and answers.

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## Making It Real

- Record the AQHI for a location closest to your school over the school year. Use a chart similar to the one provided on the worksheet. You could add in more days to track. The data could be used to compare the AQHI with weather patterns and seasonal effects and to compare this year’s data against the historical data analyzed in this activity.

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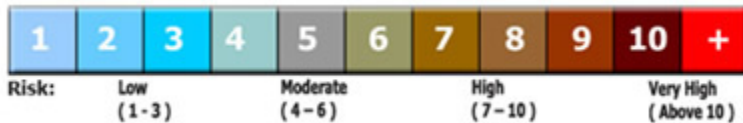
## Active Break

1. Tag with Limits: Play a game of “tag” with limits to simulate what it is like to live with an illness or disease. Select a few students to be “it.” The people who are “it” tag their classmates. When a person is tagged they must place their hand on the spot on their body where they were tagged. They must now try to run away from the taggers while holding their hand on the spot where they were tagged, which makes it more difficult to run. If a person is tagged for a second time, they must then hold one hand on the first spot they were tagged and their second hand on the second spot they were tagged. Then they keep running to avoid being tagged again. If they are tagged a third time, they must freeze. They can be set free by students who are not “it” by verbally stating an action to improve air quality to the person who is freeing them. Teacher can also decide action that releases frozen student.
2. Refer to “Getting Active for Cleaner Air” for other active games.  
<http://www.cleanairchampions.ca/CAC/Ekits.aspx>

## ACTIVITY #5: ON A SCALE OF 1 TO 10 STUDENT WORKSHEET

The Air Quality Health Index (AQHI) is a health protection and prevention tool which helps you make decisions to protect your health. It gives you the information you need to limit how much you are exposed to air pollution. It also lets you know how you can help to improve the air quality – such as walking or taking the bus instead of driving.

The AQHI is measured on a scale ranging from 1-10+ much like the UV index. The AQHI index values are also grouped into health risk categories as shown below.



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



### Did you know?

*Canada is the first country to combine air quality with a health index. Most other countries report just on air quality.*

### Air Quality and Health Index (AQHI) Data

1. What season(s) has the highest AQHI rating?

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2. Explain why the AQHI rating would be higher during this time.

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3. How could a “hotter” than normal summer impact air quality?

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4. How could a “wetter” than normal summer impact air quality?

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5. For the days that are “high” to “very high,” describe what actions you would take to reduce your exposure to poor air quality?

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6. If you were an athlete or worker who spent a lot of time outdoors, what things would you do to protect yourself from poor air quality?

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7. Describe some actions that can be taken to improve air quality.

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### Did you know?

*Did you know that each year, 21,000 deaths occur due to poor air quality? (Canadian Medical Association, 2008).*

**ACTIVITY #5: ON A SCALE OF 1 TO 10  
TEACHER ANSWER KEY**

1. What season(s) has the highest AQHI rating?

*Summer usually has the highest AQHI ratings.*

2. Explain why the AQHI rating would be higher during this time.

*The higher intensity of sunlight allows for more photochemical reactions to occur, which produces high levels of ground-level ozone. Wind speed plays a role in diluting pollutants, and summer can also have times of less wind.*

3. How could a “hotter” than normal summer impact air quality?

*A hotter summer could provide higher intensity sunlight that would produce higher levels of ground-level ozone. If there was less wind, the air pollution would not be diluted or dispersed.*

4. How could a “wetter” than normal summer impact air quality?

*Cooler, wetter weather produces less ground-level ozone and dilutes more air pollution. Winds or breezes could be more common to help disperse air pollution.*

5. For the days that are “high” to “very high,” describe what actions you would take to reduce your exposure to poor air quality?

*I would reduce the amount of time I am outdoors and reschedule any outdoor activities I had planned.*

6. If you were an athlete or worker who spent a lot of time outdoors, what things would you do to protect yourself from poor air quality?

*If I was an athlete and I had to train outdoors, I would also look at the weather to help determine the best time of day to train. It could be earlier in the morning on hot days, or if it was forecast to get windy I could train at that time. I would also try to do my activity away from high-density traffic.*

*If I was an outdoor worker, I would try to schedule the work so most of it is done outside earlier in the day. I would try to take as many breaks as I could and to go inside during the breaks.*

7. Describe some actions that can be taken to improve air quality.

*Anything we do to reduce our use of energy that comes from fossil fuels improves air quality. Actions can be things like walking and biking, using public transportation, using energy efficient appliances, using automatic thermostats, turning off appliances when they are not needed, and installing compact fluorescent light bulbs.*

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## Air Pollution, Smog and Health Impacts: Part 1

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### What is Air Pollution?

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 (e.g., combustion of fossil fuels and industrial processes) are the primary source of most pollutants, although pollutants can also come from natural sources (e.g., fires, wind-blown dust, volcanoes). The main air pollutants are:

1. **Nitrous Oxides** (NO<sub>x</sub>), which are produced during the combustion of fossil fuels, are a pollutant themselves, but also react with water vapour to form fine acidic droplets, and react with VOCs to generate ozone. NO<sub>x</sub> are both air pollutants and GHGs.
2. **Sulphur Dioxide** (SO<sub>2</sub>), which is generated by industrial processes and combustion of fossil fuels, is a pollutant itself, but also reacts with water vapour to form fine acidic droplets (e.g., sulphuric acid). SO<sub>2</sub> is not a GHG.
3. **Carbon monoxide** (CO) is generated by combustion of fossil fuels (primarily from automobiles), but is also released by wild fires and volcanic eruptions. CO is not a GHG.
4. **Volatile Organic Compounds** (VOC) are a group of carbon-containing compounds (both natural and synthetic) released primarily by the evaporation of petroleum products (e.g., gasoline, natural gas), solvents and other volatile products (e.g., paints). VOCs react with NO<sub>x</sub> in the presence of sunlight to form ground level ozone. Some VOCs are carcinogenic (e.g., benzene, formaldehyde). VOCs by themselves do not contribute to the greenhouse effect.
5. **Ground level Ozone** is formed by a chemical reaction between VOCs and NO<sub>x</sub>s, 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 GHG.
6. **Airborne particles** (Particulate matter – PM) include both solids and droplets from a variety of natural sources and human activities. In most cases, coarse particles, (2.5-10 microns) are emitted directly into the air (e.g., dust, pollen, diesel soot, smoke) and fine particles (less than 2.5 microns) are formed through chemical reactions involving NO<sub>x</sub>, SO<sub>2</sub>, water vapour, VOCs and ammonia. Particulate matter is one of the main components of smog, but 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.

## Air Pollution, Smog and Health Impacts: Part 2

### What is Smog?

The term “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. Smog occurs most frequently on hot, sunny, calm days and appears as a yellowish haze that sits over cities, towns and regions.

The two main ingredients of smog are ground-level ozone, which is formed by a chemical reaction between NO<sub>x</sub> and VOCs in the presence of sunlight, and fine airborne particles. Because smog formation depends on heat and sunlight, smog generally peaks in the late afternoon and early evening. It is most obvious in large cities, but wind patterns and topography mean that smog can travel and be trapped in areas distant from the source. (e.g., smog is often worse in the Fraser Valley than in Vancouver). Smog is both an urban and rural phenomenon and can occur at any time of the year although summer tends to be the season with the highest frequency due to the higher temperatures. Smog will stay in an area until it is dispersed by heavy winds or washed out of the local atmosphere by rain (which is why smog is worse on calm, sunny days).

**Stratospheric Ozone – The Good ozone** Stratospheric ozone, or the “good” ozone layer is located 16-50 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.

**Groundlevel Ozone – The Bad ozone** Ground level ozone is formed when VOCs and NO<sub>x</sub>s react in sunlight (or NO<sub>x</sub> + VO<sub>x</sub> + Sunlight = GLO). Ground level ozone is toxic to humans, contributes to smog and climate change, and does not protect us from UV radiation.

### General Impacts of Air Pollution and Smog

Air pollution and smog can affect us in a variety of ways: impair lung function, make breathing more difficult and make us more susceptible to respiratory diseases.

Air pollution and smog can also:

- contaminate soil and water (e.g., by acid rain);
- compromise the health of wildlife by affecting habitat and food quality;
- reduce plant health and productivity (e.g., decrease crop yields);
- diminish our ability to enjoy the outdoor environment (e.g., through reduced visibility on smoggy days, discomfort from exercising/recreating outside on smoggy days);
- damage buildings (e.g., acid rain and deposition of particulates);
- compromise our health and increase risk of mortality;
- impede athletic performance.
- Damage from air pollution is not always localized. The long-range transport of pollutants can mean that soils, water, plants, animals and people can be affected far away from sources of pollutants. The effects of air pollution are not limited to urban areas.

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## Air Pollution, Smog and Health Impacts: Part 3

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### Effects of Air Pollution and Smog on Human Health

The health effects caused by air pollutants may range from subtle biochemical and physiological changes to difficulty breathing, wheezing, coughing and aggravation of existing respiratory and cardiac conditions. These effects can result in increased medication use, increased doctor or emergency room visits, more hospital admissions and even premature death. Exposure to toxic airborne substances (e.g., mercury and lead) can also lead to neurological damage, particularly in children.

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

**The cardio-vascular system** Pollutants are absorbed into the bloodstream, where they can then travel throughout the body, starting a “chemical chain reaction”. Through a variety of complex pathways, this can affect blood vessels and ultimately the heart. 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).

Exposure to air pollution is linked to increased hospital admissions and emergency room visits, increased use of medications, shortened life span and increased mortality (deaths).

### Ozone and Particulate Matter

All air pollutants, including NO<sub>x</sub>, SO<sub>2</sub>, CO, affect our health, but ozone and particulate matter 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, for relatively short periods. Particulates 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. Particles generated by combustion of fossil fuels are particularly toxic.

There is no “safe” level of exposure to air pollution (particularly ozone and PM).<sup>3</sup> Health effects result from both long term and short-term exposure, and even at low levels of pollution. This means that we need to be concerned about ozone and PM levels even on days when no smog warning is in effect.

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## Air Pollution, Smog and Health Impacts: Part 4

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### Who is Affected by Air Pollution and Smog?

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 particularly 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 particulates cause inflammation and swelling in lung tissue and decreased lung function in everyone.

Children are particularly 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 (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 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 deeply, drawing large volumes of dirty air deep into their lungs, and they breathe via their mouth, bypassing the filtration system in the nose. They also have high metabolic rates and are more susceptible to infections, because intense training depresses the immune system temporarily.

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 use oxygen
- Shortness of breath, coughing, wheezing, chest pain, pulmonary congestion
- Heart failure
- Aggravated asthma, chronic obstructive pulmonary disease
- Acute and chronic bronchitis
- Decreased resistance to respiratory infections

## Air Pollution, Smog and Health Impacts: Part 5

### The Connection Between Air Pollution, Smog and Climate Change

There are two main connections:

#### 1. Climate change and air pollution have a common source and thus a common solution.

Combustion of fossil fuels (e.g., burning of coal, gas, and oil in cars, homes and power plants) is the primary source of both air pollutants and the rising levels of GHGs that are contributing to climate change. CO<sub>2</sub>, while not considered an air pollutant, is the GHG that is increasing most rapidly, largely as a result of combustion of fossil fuels. NO<sub>x</sub> is a GHG, a primary air pollutant and leads to the creation of ground level ozone. Ground level ozone is both an air pollutant and a GHG.

We can address both air pollution (the intensity and frequency of smog episodes in particular) and climate change by reducing our reliance on fossil fuels.

#### 2. Climate change is expected to increase air pollution (ground-level ozone and smog) and exacerbate its effects.

Climate change is expected to magnify the effects of air pollution, because hotter, sunnier days will provide optimal conditions for the creation of ground-level ozone. Heat waves can also lead to temperature inversions, where smog is trapped near the Earth, further increasing exposure to pollutants. The combination of more smog and more intense and frequent heat waves will compound health problems for those who are vulnerable (children, elderly, athletes and those with pre-existing respiratory and cardiac disease). Airborne allergens (pollen, moulds, and dust) are also expected to increase with climate change, further aggravating asthma and related respiratory diseases.

### Smog-Related Deaths

- A 2005 study by Toronto Public Health found that air pollution was the cause of 822 deaths a year in Toronto, 818 in Montreal, 368 in Ottawa and 258 in Windsor (based on data from 1954-2000). The study estimates that increased ozone levels from global warming will result in 20 per cent more smog-related deaths by 2050 and 25 per cent more by 2080.<sup>1</sup>
- In 1952, deadly smog descended on London, England. Motor vehicles were abandoned, trains were disrupted and airports were forced to close. The smog lasted for 4 days and resulted in over 4000 deaths.<sup>2</sup>
- A 2005 study by the federal government estimated that air pollution leads to 5900 premature deaths each year in 8 large Canadian cities. (This estimate is probably low because it only considered short term impacts of air pollution). The Ontario Medical Association estimated that in 2005 there were 16,000 hospital admissions and 60,000 emergency room visits in Ontario because of illnesses associated with air pollution, and that air pollution led to direct health care costs of over \$500 million.<sup>3</sup>