

NORTHERN IRELAND AIR  
Air quality in Northern Ireland

# **Pollution Busters!**

## **Teachers' Notes**



[www.airqualityni.co.uk/pollution-busters](http://www.airqualityni.co.uk/pollution-busters)

## What is the aim of these notes?

To provide primary school teachers with supplementary information on the subjects and materials on the 'Pollution Busters' webpages.

## What is air pollution?

"Air pollution" means substances that have been released into the Earth's atmosphere, which may cause effects upon human health, damage to ecosystems such as forests or lakes, harm to wildlife or plants (including trees and food crops), or affect other parts of the natural or built environment.

Some air pollution comes from natural sources, for example volcanic eruptions, forest fires and desert dust-storms. However, these notes mainly deal with 'anthropogenic' air pollution – that is, air pollution caused by humans.

One of the main sources of air pollution is the combustion of fuels. These include the 'fossil fuels', coal, oil and natural gas, and the fuel products made from them (for example petrol, diesel and smokeless domestic solid fuels). Also, biomass (that is, plant-based material such as wood or peat), and fuels made from it.

All of these fuels contain a large proportion of carbon, together with other chemical elements such as hydrogen, nitrogen, oxygen, and sulphur (sometimes spelled 'sulfur'). When these fuels are combusted (or burned), the oxygen (and often, also the nitrogen) in the atmosphere reacts with the elements they contain, and produces many of the gases that contribute to air pollution. Some fuels also produce smoke or soot, consisting of small particles of carbon and other substances, when they burn.

However, fuel burning is not the only source of air pollution. Wind-blown dust (for example from farms, building sites and roads) can also contribute. And pollutants can react together in the atmosphere to form new pollutants.

The term "Air Quality" is often used to convey how much air pollution is in the air around us. Low concentrations of pollutants mean the air quality is good: high concentrations of air pollutants mean poor air quality.

In Northern Ireland, a Daily Air Quality Index is used to express air pollution on a scale of 1-10, where 1 is low and 10 is very high. More information about the Daily Air Quality Index can be found on the "Northern Ireland Air" website<sup>1</sup>.

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<sup>1</sup>Northern Ireland Air: air quality in Northern Ireland: <http://www.airqualityni.co.uk/>

## Air Pollutants: What Are They?

### Particulate Matter

Particulate matter in the air can come from many sources including:

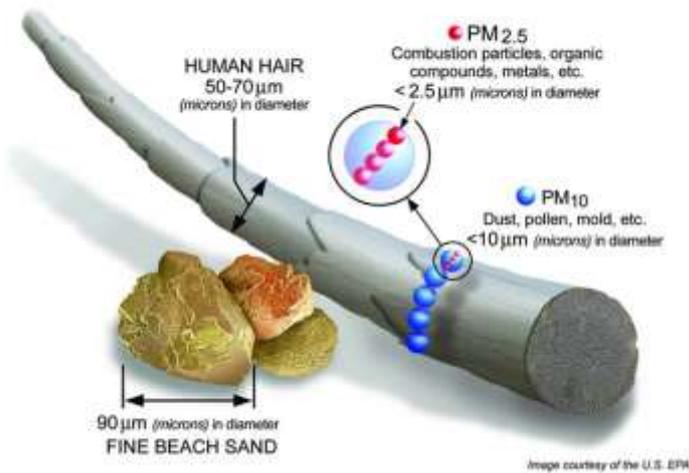
- Exhaust emissions from cars, buses, trucks, planes, ships and other transport.
- Combustion of coal, solid fuels and oil in power stations, factories and homes.
- Natural sources such as sea salt (which can be carried far inland) and dust from the Sahara Desert (which can be carried long distances and be deposited throughout Europe).
- Dust from road surfaces and building sites.
- Sulphate and nitrate particles, formed from chemical reactions between other pollutants in the air.



Particulate matter comes from many different sources therefore it can contain many different materials. Particles are made up of different substances depending on how they are formed and where they come from. The particles themselves can come in different shapes and sizes and can be solid or even liquid droplets.

The size of the particles is important, as it affects the way they behave in air and also how they can affect human health. We know that because smaller particles are lighter they are able to stay in the air longer and therefore they can travel farther. In the summer, forest fires can occur in mainland Europe; if wind conditions are right, particulate matter from the smoke can get transported as far as the UK. This is an example of transboundary pollution (pollution that is carried across national boundaries).

Particles are classified by their effective size (their aerodynamic diameter). One commonly measured size group is known as PM<sub>10</sub> (said as “PM ten”). Particles in this group have a diameter of 10 microns or less (1 micron = 1 micrometre, or one thousandth of a millimetre: it is written as 1 µm). A second commonly measured size group is known as PM<sub>2.5</sub> (said as “PM two point five”). These are even smaller particles with an effective size of 2.5 microns or less. The picture below, which is used courtesy of the United States Environmental Protection Agency, shows how the sizes of PM<sub>10</sub> and PM<sub>2.5</sub> compare to the width of a human hair, and to ordinary fine beach sand. Smaller particles are the most harmful to our health as they can be inhaled deeper into the airways and lungs.



### How does particulate matter affect health?

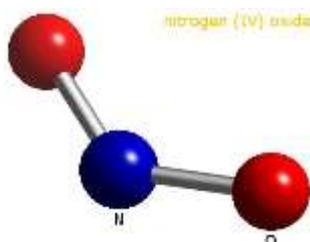
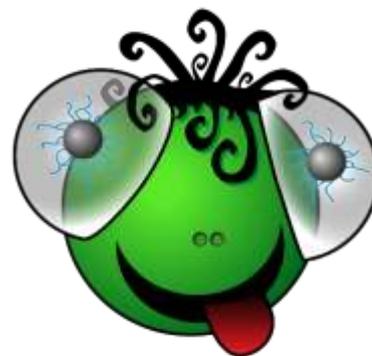
When you inhale, you breathe in air along with any particles that are present in the air around you. The air and the particles travel into your body via your nose and mouth they then travel through your airways and into your lungs. Larger (coarser) particles may be trapped by the hairs in your nose, or the mucus which coats the sides of your airways. These larger particles being caught in your airways can make you cough as it causes the body to produce more mucus and you cough to clear your airways. PM<sub>10</sub> particles can get as far down as the airways in your chest, and PM<sub>2.5</sub> particles can travel right into your lungs. When inhaled, particulate matter can irritate and inflame the airways and lungs. This can worsen the condition of people who already have a heart or lung disease. In addition, they may carry surface-absorbed carcinogenic compounds into the lungs<sup>2</sup>.

<sup>2</sup> Northern Ireland Air: Fine Particles (PM<sub>10</sub>, PM<sub>2.5</sub> and PM<sub>1</sub>) <http://www.airqualityni.co.uk/pollutants?view=fine-particles>

## Nitrogen Dioxide

Nitrogen dioxide is made up of one nitrogen atom and two oxygen atoms. Its chemical symbol is NO<sub>2</sub>.

Nitrogen dioxide is a gas with a sharp smell. It is formed when fuels are burned at high temperature, such as in a vehicle engine. The fuel itself does not need to contain nitrogen: nitrogen in the air can combine with oxygen to form this gas. Most combustion processes produce a mixture of NO (nitric oxide) and NO<sub>2</sub> (nitrogen dioxide). When the gases are released into the surrounding air, the NO reacts with oxygen and forms NO<sub>2</sub>.



Most of the nitrogen dioxide emitted in the UK comes from three main groups of sources: power generation, road vehicle emissions, and other combustion in industry<sup>3</sup>. Almost a third comes from road vehicle emissions and these can impact considerably on air quality in towns and cities.

Nitrogen dioxide has an important role in the formation of other pollutants – including ozone<sup>4</sup>, which can be produced from chemical reactions involving NO<sub>2</sub>, in warm, sunny conditions.

### How does nitrogen dioxide affect health?

Nitrogen dioxide is an irritant to the respiratory system (airways and lungs). Increased levels of nitrogen dioxide in ambient (outdoor) air may result in an increased likelihood of respiratory problems. Exposure to increased concentrations of nitrogen dioxide is also believed to reduce resistance to infections of the respiratory system, and so may make people more vulnerable to catching infections such as colds, coughs, flu and bronchitis.

People who are young and healthy are unlikely to experience serious effects from short-term exposure to moderate concentrations of nitrogen dioxide and other pollutants<sup>5</sup>. But increased levels of nitrogen dioxide can have more serious impacts on people with existing heart or lung problems, because it can cause a worsening of their symptoms.

<sup>3</sup> National Atmospheric Emissions Inventory web page for nitrogen oxides at [http://naei.defra.gov.uk/overview/pollutants?pollutant\\_id=6](http://naei.defra.gov.uk/overview/pollutants?pollutant_id=6)

<sup>4</sup> Northern Ireland Air: Nitrogen Oxides, at <http://www.airqualityni.co.uk/air-quality/pollutants?view=nitrogen-oxides>

<sup>5</sup> Defra: Effects of Air Pollution, at <http://uk-air.defra.gov.uk/air-pollution/effects>

## Sulphur Dioxide

Sulphur dioxide is a gas. It is invisible and has an unpleasant smell: the smell of coal smoke comes partly from the sulphur dioxide it contains. Sulphur dioxide is made up of one sulphur atom and two oxygen atoms (SO<sub>2</sub>).

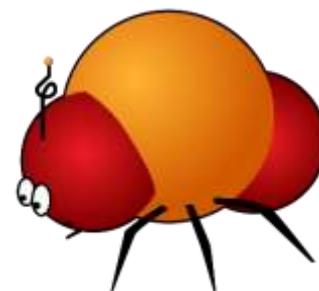


The main source of sulphur dioxide in the air is industrial activity that processes materials that contain sulphur, for example the generation of electricity from coal or oil that contains sulphur. About 82% of the sulphur dioxide emitted in the UK comes from the burning of fuel, mostly from solid fuels<sup>6</sup>.

Ambient concentrations of sulphur dioxide are now very much lower than they used to be in the 1950s and earlier, because less coal is used in power stations, factories and homes. Since the 1970s, legislation has also substantially reduced the concentrations of sulphur permitted in petrol and diesel.

### How does sulphur dioxide affect health?

Sulphur dioxide affects you when it is breathed in. It irritates the nose, throat, and eyes. It causes the airways to become irritated, which can then cause coughing, wheezing, shortness of breath. It may even result in a tight feeling in the chest. People with asthma are believed to be more sensitive to sulphur dioxide. The effects can be felt after just a short time; this is why the UK has an air quality standard based on the 15 minute average SO<sub>2</sub> concentration.



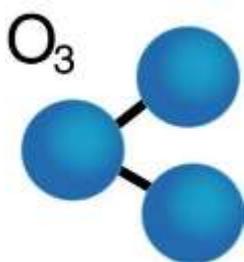
<sup>6</sup> NAEI website: "Pollutant Information: Sulphur Dioxide" at [http://naei.defra.gov.uk/overview/pollutants?pollutant\\_id=8](http://naei.defra.gov.uk/overview/pollutants?pollutant_id=8)

## Ozone



Ozone is a pale blue gas made up of three oxygen atoms. Its chemical symbol is O<sub>3</sub>. The oxygen in the air we breathe (which keeps us alive) is O<sub>2</sub>, two oxygen atoms joined together.

Most people have heard of the ozone layer – a part of the atmosphere 10 – 50 km above the earth's surface, where there are high concentrations of ozone. This ozone protects life on earth from the sun's harmful ultraviolet rays<sup>7</sup>. Human activity has damaged the ozone layer: a group of gases such



as CFCs, once widely used in refrigerators, aerosol cans and in making insulating foams, are now known to increase depletion of this high-level ozone. These damaging gases are being phased out. For more information about the ozone layer, how it has been damaged by human activity, and the steps being taken to help it recover, please see the European Commission's webpage on protection of the ozone layer<sup>8</sup>.

The ozone layer is far above the air that we breathe. Ozone is also formed in the layer of air near the ground (from 0 to 17 km) known as the troposphere. At this level, ozone is a harmful air pollutant that can affect the health of humans, animals and plants.

Unlike most pollutants, ozone is not emitted from sources but is mostly formed from other pollutants. These pollutants are called ozone precursors. They include nitrogen dioxide (NO<sub>2</sub>) and volatile organic compounds (VOC), many of which come from vehicle exhaust. Sunlight and heat are also needed for the reactions that form ozone. The more of the precursors that are available, the more ozone can be produced. Towns and cities that have more traffic or more industry produce more of the precursors for ozone formation; however, because of the time taken for ozone to form, it is often the case that the highest ozone concentrations are measured out in the countryside, far away from the city where the original pollutants were emitted. Ozone concentrations are usually highest on warm sunny days, especially if there is little wind.

<sup>7</sup> NASA "Ozone Hole Watch" web page at <http://ozonewatch.gsfc.nasa.gov/facts/SH.html> .

<sup>8</sup> European Commission "Protection of the ozone layer" at [http://ec.europa.eu/clima/policies/ozone/index\\_en.htm](http://ec.europa.eu/clima/policies/ozone/index_en.htm)

### How does ozone affect health?

Ozone is a powerful oxidising agent, this means it readily transfers oxygen and is highly reactive. These properties make ground level ozone dangerous to living things.

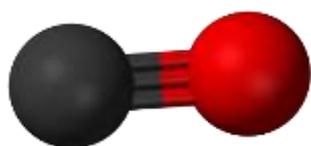
At sufficiently high concentrations, ozone can also be harmful to plants and trees. It can also damage, age or bleach some man-made materials such as fabrics<sup>9</sup>. Ozone has the same kind of effect on human health as NO<sub>2</sub> and SO<sub>2</sub> above – it is an irritant. In contact with living tissues, such as our eyes, airways and lungs, ozone irritates the cells, causing inflammation. This can increase the symptoms of people with asthma and other respiratory diseases.

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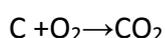
<sup>9</sup>Air Quality in Northern Ireland- Ozone and Volatile Organic Compounds <http://www.airqualityni.co.uk/air-quality/pollutants?view=ozone-vocs>

## Carbon Monoxide

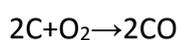
Carbon monoxide is an invisible, odourless, and tasteless (but toxic) gas. Carbon Monoxide is made up of one carbon atom and one oxygen atom.



is produced.

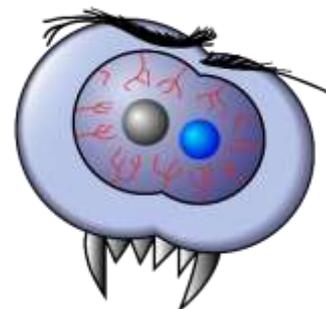


However when there is less oxygen available only one oxygen atom will join with each carbon atom and carbon monoxide will be produced.



### How does carbon monoxide affect health?

Carbon monoxide in high concentrations is dangerous because it combines with the haemoglobin in our blood. This makes the haemoglobin unable to absorb the oxygen we breathe, and unable to transport it around the body<sup>10</sup>. Dangerous concentrations of CO can build up indoors, if there is a faulty boiler or heating appliance. For this reason, heating systems must be well ventilated and regularly checked, and we have carbon monoxide monitors in our home to alert us. Outdoors, carbon monoxide never reaches lethal concentrations. However, near very busy city roads, concentrations of carbon monoxide can become high enough to affect the health of people who have heart disease.



<sup>10</sup> Northern Ireland Air: Carbon Monoxide, at <http://www.airqualityni.co.uk/air-quality/pollutants?view=carbon-monoxide>

## General Information on Air Quality and Health

Air pollution is known to have various effects on human health. However, it should be remembered that according to the Air Quality in Northern Ireland website “... air pollution in the UK does not rise to levels at which people need to make major changes to their habits to avoid exposure; nobody need fear going outdoors” and that “Children need not be kept from school or prevented from taking part in games...<sup>11</sup>” This website provides information on the likely effects that may be experienced when air pollution is high, and also provides specific information and advice for people (including children) with health problems such as asthma.

## Where Teachers Can Find Out More

- On air quality in Northern Ireland: <http://www.airqualityni.co.uk/>
- On sources of air pollution, with an overview of the main pollutants: the National Atmospheric Emissions Inventory at <http://naei.defra.gov.uk/>
- Also, the World Health Organisation (WHO) Factsheet No. 313 on Ambient (outdoor) air quality and health at <http://www.who.int/mediacentre/factsheets/fs313/en/>
- On the general effects of air pollution: “Effects of air pollution” at <http://uk-air.defra.gov.uk/air-pollution/effects>
- On the likely short-term effects of air pollution and who is most likely to experience them: “Short-Term effects of air pollution on health” at <http://uk-air.defra.gov.uk/air-pollution/effects?view=short-term> .
- On the Daily Air Quality Index: <http://uk-air.defra.gov.uk/air-pollution/daq>

## Links with the Northern Ireland Curriculum

Personal Development and Mutual Understanding (PDMU): having an understanding of air quality and how our travel and energy use/production has an impact on air quality.

Thinking skills: the ability to make choices and the consequences of those choices.

### Suggested Learning Intentions

- Understand the effects of renewable energy.
- Understand the consequences of global environmental issues.

Links well to Travelwise Northern Ireland:

<http://www.nidirect.gov.uk/index/information-and-services/travel-transport-and-roads/travelwiseni/travelwise-schools/travelwise-teachers/free-schools-resources.htm> and Best Foot Forward for schools.

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<sup>11</sup> Air Quality in Northern Ireland – web page on “Short-Term Health Effects of Air Pollution” at <http://www.airqualityni.co.uk/air-quality/health-effects>