Properties and effects of atmospheric pollutants

4.9.3.2 · Chemistry of the atmosphere · revision notes

The problems caused by carbon monoxide, sulfur dioxide, oxides of nitrogen and particulates in the air. Expect 1 to 3 mark 'give' and 'explain' questions, data questions on pollution levels, and 6-mark answers that link each pollutant to how it forms and the problems it causes.

Key facts

- Carbon monoxide: toxic, colourless and odourless, so not easily detected
- Acid rain: damages buildings and statues, harms trees and plants, acidifies lakes (kills aquatic life)
- Global dimming: particulates reflect sunlight, so less reaches the Earth's surface
- Sulfur dioxide and oxides of nitrogen: respiratory problems and acid rain
- Particulates: global dimming and health problems (lung damage)
- Grade 7+ only Carbon monoxide combines with haemoglobin, so the blood carries less oxygen

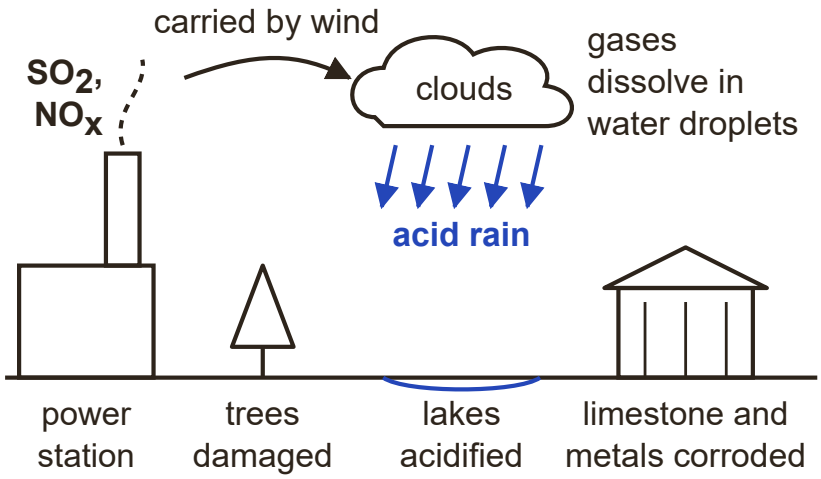
Notes

Carbon monoxide

- Carbon monoxide, CO, is a **toxic** gas.
- It is **colourless and odourless**, so it is not easily detected. People can be poisoned without knowing, which is why homes with fuel-burning boilers, fires or stoves should have carbon monoxide alarms.
- It is toxic because it combines with **haemoglobin** in red blood cells, so the blood can carry less oxygen around the body. This can cause drowsiness, unconsciousness and death. Grade 7+ only

Sulfur dioxide and oxides of nitrogen

- Both cause **respiratory problems** in humans, e.g. breathing difficulties, and can make asthma worse.
- Both cause **acid rain**: they dissolve in water droplets in clouds to form acidic solutions, which fall as rain.



Sulfur dioxide and oxides of nitrogen cause acid rain far from where they are released.

- Acid rain **damages buildings and statues**, especially those made of limestone, which reacts with acids. It also corrodes metals.
- Acid rain **damages trees and other plants**, and makes lakes and rivers more acidic, which can kill fish and other aquatic life.

Particulates

- Particulates are tiny solid particles, such as soot, and unburned hydrocarbons in the air.
- They cause **global dimming**: they reflect sunlight back into space, so less sunlight reaches the Earth's surface.
- They cause **health problems**: very small particles can be breathed deep into the lungs, damaging them and causing breathing problems.

Linking source to effect

- Carbon monoxide: from incomplete combustion; toxic and hard to detect.
- Sulfur dioxide: from sulfur in the fuel; acid rain and respiratory problems.
- Oxides of nitrogen: from nitrogen and oxygen in the air at high temperature; acid rain and respiratory problems.
- Particulates: from incomplete combustion and unburned fuel; global dimming and health problems.

How to answer each type of question

Recall a property or effect of a pollutant

1 to 3 marks | Grade 4

1. Match the pollutant to its problem: CO toxic; SO_2 and NO_x acid rain and breathing problems; particulates global dimming and health problems.
2. Give the specific property asked for, e.g. 'colourless' or 'odourless'.

Example. (a) Give **one** property of carbon monoxide that makes it difficult to detect.
(b) Name **two** pollutants that cause acid rain.

Model answer.

(a) Colourless / odourless (1)
(b) Sulfur dioxide (1); oxides of nitrogen / nitrogen dioxide (1)

Describe how acid rain causes damage

3 to 4 marks | Grade 5

1. Say the gas dissolves in water in clouds to form acid rain.
2. Name what is damaged: buildings and statues, trees and plants, lakes and aquatic life.
3. Say how, e.g. the acid reacts with limestone.

Example. A coal-burning power station releases sulfur dioxide.
Describe how this can damage a forest and a limestone building many kilometres away.

Model answer. The sulfur dioxide is carried by the wind and dissolves in water droplets in clouds (1), forming acid rain (1). The acid rain damages or kills the trees (1) and reacts with the limestone, wearing away the building (1).

Explain why a pollutant is dangerous

2 to 3 marks | Grade 7

1. State the problem (e.g. toxic).
2. Explain how it harms the body (e.g. haemoglobin carries less oxygen).
3. Explain why the danger is hard to notice or avoid (e.g. colourless and odourless).

Example. Explain why a faulty gas boiler that produces carbon monoxide is dangerous, and why people are advised to fit a carbon monoxide alarm.

Model answer. Carbon monoxide is toxic (1). It combines with haemoglobin in the blood, so the blood carries less oxygen (1). It is colourless and odourless, so people cannot tell it is there without an alarm (1).

Use data about a pollutant

3 to 5 marks | **Grade 7**

1. Percentage change = change ÷ original value × 100.
2. Round as the question asks.
3. Link the change to a problem the pollutant causes.

Example. The mean concentration of particulates beside a busy road was 42 μg/m^3. After a clean air zone was introduced, it fell to 30 μg/m^3.
(a) Calculate the percentage decrease. Give your answer to 2 significant figures.
(b) Suggest **one** benefit to people's health.
(c) Explain how particulates cause global dimming.

Model answer.

(a) (42 − 30) ÷ 42 × 100 (1) = 29% (1)

(b) Fewer particles are breathed into people's lungs, so fewer breathing problems or less lung damage (1)

(c) Particulates reflect sunlight (1), so less sunlight reaches the Earth's surface (1)

Don’t lose marks

- Saying carbon monoxide causes acid rain or global warming. Its problem is that it is toxic.
- Saying carbon dioxide causes acid rain. Acid rain is caused by sulfur dioxide and oxides of nitrogen.
- Confusing global dimming (particulates reflect sunlight) with global warming (greenhouse gases absorb long wavelength radiation).
- Writing vague effects such as 'harms the environment'. Name what is damaged: buildings, trees, lakes, fish.
- Saying you can smell carbon monoxide. It is odourless.

More tips

Memory tricks

- Carbon monoxide is the 'silent killer': no colour, no smell.
- Acid rain gases are the 'S and N' pair: sulfur dioxide and nitrogen oxides.
- Particulates: 'Dim and Damage': global dimming and damage to lungs.
- Learn one problem per pollutant first, then add the detail (why or how).

Exam technique

- Link each pollutant to its specific problem: 'causes pollution' does not score.
- For carbon monoxide, 'toxic' is one mark and 'colourless and odourless, so not easily detected' is another.
- In 6-mark pollutant answers, organise by pollutant: how it forms, then the problems it causes.
- Show your working for percentage change: change ÷ original × 100.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

State that carbon monoxide is toxic

Carbon monoxide is a toxic (poisonous) gas.

Grade 4

Name the gases that cause acid rain

Sulfur dioxide and oxides of nitrogen cause acid rain.

Grade 4

Give effects of acid rain

It damages buildings and statues, harms trees and plants, and makes lakes acidic, harming aquatic life.

Grade 5

Explain why carbon monoxide is hard to detect

It is colourless and odourless, so you cannot see or smell it.

Grade 5

Explain how particulates cause global dimming

Particulates reflect sunlight back into space, so less sunlight reaches the Earth's surface.

Grade 5

Describe the health effects of these pollutants

Sulfur dioxide and oxides of nitrogen cause respiratory problems, and particulates can damage the lungs.

Grade 7

Explain why carbon monoxide is toxic

It combines with haemoglobin in red blood cells, so the blood carries less oxygen.

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