

Chemistry of the environment

IGCSE Chemistry 0620 · Topic 10 revision notes

Everything from the 4 lessons of this topic on a few pages: the key idea of each lesson, the diagram to remember, the points to learn and the traps examiners set. Read it, cover it, test yourself.

1. Water: tests, treatment and pollution

3. Air pollution

2. Fertilisers

4. Greenhouse gases and climate change

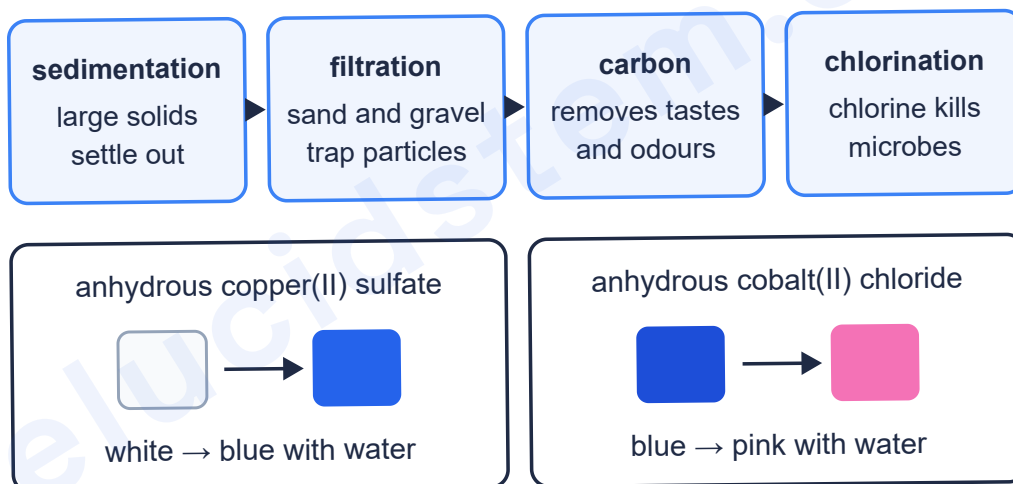
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1 Water: tests, treatment and pollution

Syllabus 10.1

Water is detected with **anhydrous copper(II) sulfate**, which turns from **white to blue**, or **anhydrous cobalt(II) chloride**, which turns from **blue to pink**. These tests show water is present, not that it is pure: **pure water boils at exactly 100 °C and melts at exactly 0 °C**. **Distilled water** is used in practical chemistry because it contains no dissolved substances that could interfere with results. Natural water contains some beneficial substances (dissolved oxygen for aquatic life, some metal compounds as minerals) and some harmful ones (toxic metal compounds, plastics, sewage, harmful microbes, and **nitrates and phosphates** from fertilisers that lead to **deoxygenation** of water). Domestic water is treated by **sedimentation and filtration** to remove solids, **carbon** to remove tastes and odours, and **chlorination** to kill microbes.

treating the domestic water supply



purity: pure water boils at 100 °C and melts at 0 °C

Fig. 1: the four stages of water treatment, and the two chemical tests for water

Present, pure, polluted, treated.

- ✓ **Water present:** CuSO_4 white $\rightarrow$ blue; CoCl_2 blue $\rightarrow$ pink.
- ✓ **Water pure:** boils at $100\text{ }^\circ\text{C}$, melts at $0\text{ }^\circ\text{C}$.
- ✓ **Nitrates and phosphates:** algae, decay, deoxygenation.
- ✓ **Treatment:** sedimentation, filtration, carbon (tastes, odours), chlorine (microbes).

Watch out!

Filtration removes **insoluble** solids only: dissolved salts, nitrates and microbes small enough to pass through are not removed by it. Chlorine **kills microbes**; it does not remove solids, tastes or dissolved substances. And a positive copper(II) sulfate test shows that water is **present**, never that it is pure.

2 Fertilisers

Syllabus 10.2

Ammonium salts (such as ammonium nitrate and ammonium sulfate) and **nitrates** (such as potassium nitrate) are used as **fertilisers** to increase crop yields. **NPK fertilisers** provide the three elements plants need most: **nitrogen (N)**, **phosphorus (P)** and **potassium (K)**. Ammonium fertiliser salts are made by **neutralising ammonia with an acid**, for example $\text{NH}_3 + \text{HNO}_3 \rightarrow \text{NH}_4\text{NO}_3$. **Extended:** plants need **nitrogen** to make proteins for growth (healthy leaves), **phosphorus** for root growth, and **potassium** for flowers and fruit and resistance to disease.

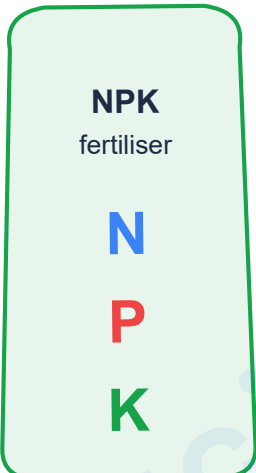
 NPK fertiliser N P K	element	supplied by	(Extended) needed for
	nitrogen	ammonium salts, nitrates	leaf growth, proteins
	phosphorus	phosphates	root growth
	potassium	potassium salts	flowers and fruit

Fig. 1: an NPK fertiliser and the salts that supply each element

N, P, K and the salts that carry them.

- ✓ **Nitrogen:** ammonium salts and nitrates.
- ✓ **Ammonium salts:** ammonia + acid, one product only.
- ✓ **% N:** $(\text{number of N atoms} \times 14) \div M_r \times 100$.
- ✓ **Extended:** N proteins and leaves, P roots, K flowers and fruit.

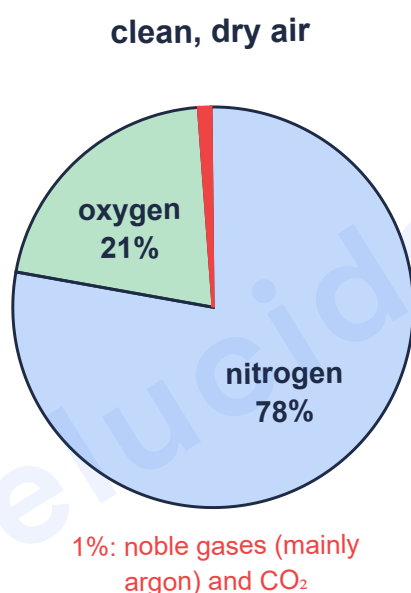
Watch out!

Plants take up **ions** such as nitrate and ammonium dissolved in soil water, not nitrogen gas from the air, which is why the 78% nitrogen in air does not feed most crops. Fertilisers must be **soluble**. And too much fertiliser washes into rivers, where nitrates and phosphates cause deoxygenation of the water.

3 Air pollution

Syllabus 10.3

Clean, dry air is about **78% nitrogen**, **21% oxygen** and the remaining 1% is a mixture of **noble gases** (mainly argon) and **carbon dioxide**. Pollutants each have a source and an effect: **carbon monoxide** (incomplete combustion) is **toxic**; **particulates** (incomplete combustion) cause **respiratory problems and cancer**; **oxides of nitrogen** (car engines) cause **acid rain, photochemical smog** and respiratory problems; **sulfur dioxide** (burning fuels containing sulfur) causes **acid rain**; carbon dioxide and methane cause global warming. Acid rain is reduced by **catalytic converters** in vehicles, **low-sulfur fuels** and **flue gas desulfurisation** with calcium oxide. **Extended:** oxides of nitrogen form when nitrogen and oxygen from the air react at the high temperature inside an engine, and a catalytic converter removes them: $2\text{NO} + 2\text{CO} \rightarrow \text{N}_2 + 2\text{CO}_2$.



pollutant: source → effect

CO₂: burning carbon fuels

→ global warming, climate change

CO: incomplete combustion

→ toxic gas

particulates: incomplete burning

→ respiratory problems, cancer

CH₄: livestock, decomposing waste

→ global warming

oxides of nitrogen: car engines

→ acid rain, photochemical smog

SO₂: fuels containing sulfur

→ acid rain

Fig. 1: the composition of clean air, and the main pollutants with their sources and effects

Pollutant, source, effect, fix.

- ✓ **Air:** 78% N₂, 21% O₂, rest noble gases (mainly argon) and CO₂.
- ✓ **CO and particulates:** incomplete combustion; toxic, lung damage.
- ✓ **SO₂ and NO_x:** acid rain; fix with low-sulfur fuel, FGD, catalytic converters.
- ✓ **Extended:** $2\text{NO} + 2\text{CO} \rightarrow \text{N}_2 + 2\text{CO}_2$.

Watch out!

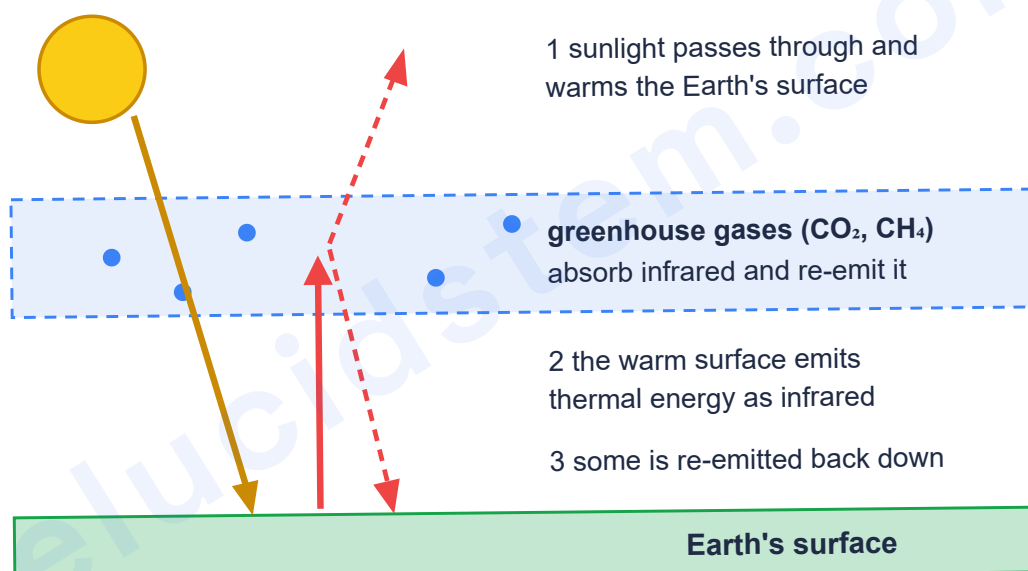
A catalytic converter does **not** remove carbon dioxide: it makes more of it, from carbon monoxide. Carbon dioxide causes **global warming**, not acid rain; acid rain comes from **sulfur dioxide and oxides of nitrogen**. And the nitrogen in NO_x comes from the **air**, not from the fuel.

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4 Greenhouse gases and climate change

Syllabus 10.3

Carbon dioxide and **methane** are **greenhouse gases**: higher levels cause increased **global warming**, which leads to **climate change**. **Extended:** the Earth's surface absorbs energy from the Sun and emits **thermal energy as infrared radiation**; greenhouse gases **absorb** this infrared and **re-emit** it in all directions, including back towards the Earth, so less thermal energy is lost to space. **Photosynthesis** removes carbon dioxide: carbon dioxide + water → glucose + oxygen, using light energy in the presence of chlorophyll (**Extended:** $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$). Strategies to reduce climate change include **planting trees**, **reducing livestock farming**, **decreasing the use of fossil fuels** and **increasing the use of hydrogen and renewable energy** such as wind and solar.



more greenhouse gas: more energy kept in, so the Earth warms

Fig. 1: the greenhouse effect: infrared from the surface is absorbed and re-emitted by greenhouse gases

Gases, effect, sink, strategy.

- ✓ **Greenhouse gases:** carbon dioxide and methane.
- ✓ **Extended:** absorb infrared from the surface, re-emit it, less lost to space.
- ✓ **Photosynthesis:** $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$.
- ✓ **Strategies:** trees, less livestock, fewer fossil fuels, hydrogen and renewables.

Watch out!

The greenhouse effect is **not** the hole in the ozone layer, and acid rain does not cause global warming. Do not write that greenhouse gases "reflect" heat back or "trap the Sun's rays": they **absorb and re-emit infrared** given off by the warm Earth. And the greenhouse effect itself is natural and keeps the Earth habitable; the problem is the **increase** in greenhouse gases.