

Air, pollution and clean water resources

Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet answers

Each answer gives the key idea, the working and the final result in bold with its unit. Check that you can explain the chemistry behind each number, because exam questions often ask you to justify a conclusion as well as calculate it.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-ESS3-6, GCSE C9-C10

Problem 1 Reading the air bar

1. A is **nitrogen, about 78 %**.
2. B is **oxygen, about 21 %**.
3. $0.21 \times 200 = \mathbf{42 \text{ cm}^3}$.
4. **Argon** (or carbon dioxide).

Problem 2 Greenhouse gas or not

1. **Carbon dioxide, methane and water vapour**.
2. Cattle farming, rice fields or landfill sites.
3. Burning fossil fuels or cutting down forests.

Problem 3 Match the pollutants

Carbon monoxide: c and s. **Sulfur dioxide:** a and p. **Nitrogen oxides:** b and r.
Particulates: d and q.

Problem 4 Potable or pure

1. Water that is **safe to drink**.
2. It contains **dissolved minerals and added chlorine**, so it is a mixture.
3. By **distillation** (evaporate and condense).

Problem 5 Water treatment stages

1. **E**, sterilise with chlorine.
2. **D** (the sand and gravel filter), and also C for the fine solids that settle.
3. **Chlorine** (or ozone or ultraviolet light).

Problem 6 Photosynthesis and oxygen

1. $\mathbf{6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2}$. Carbon 6 = 6, hydrogen 12 = 12, oxygen 18 = 6 + 12.

2. Algae and plants **removed carbon dioxide** and **released oxygen**.
3. In **sedimentary rocks (limestone)**, **fossil fuels** or shells.

Problem 7 Carbon dioxide levels

1. $420 - 280 = \mathbf{140 \text{ ppm}}$.
2. $140 \div 280 \times 100 = \mathbf{50 \%}$.
3. $420 \div 1\,000\,000 \times 100 = \mathbf{0.042 \%}$.

Problem 8 Explain the greenhouse effect

1. A: **sunlight reaching the surface**. B: **infrared radiation from the surface**. C: **infrared sent back down** by greenhouse gases. D: **infrared that escapes** to space.
2. More gas absorbs more infrared, so C increases, less escapes and the **average temperature rises**.
3. Without it the average surface temperature would be far below freezing, so liquid water and life could not exist.

Problem 9 Commuting emissions

1. $12 \times 2 \times 5 = \mathbf{120 \text{ km}}$.
2. Car: $120 \times 170 = 20\,400 \text{ g} = \mathbf{20.4 \text{ kg}}$. Bus: $120 \times 80 = 9600 \text{ g} = \mathbf{9.6 \text{ kg}}$.
3. $20.4 - 9.6 = \mathbf{10.8 \text{ kg}}$.

Problem 10 Nitrogen oxides

1. $\mathbf{N_2 + O_2 \rightarrow 2NO}$.
2. $\mathbf{2NO + O_2 \rightarrow 2NO_2}$.
3. $\mathbf{2CO + 2NO \rightarrow 2CO_2 + N_2}$. Carbon 2, oxygen 4, nitrogen 2 on each side.
4. Nitrogen is very unreactive. The very **high temperature** in the engine gives it enough energy to react with oxygen.

Problem 11 Sulfur dioxide from fuel

1. $0.015 \times 40 = \mathbf{0.60 \text{ t}}$.
2. $S + O_2 \rightarrow SO_2$; $M(SO_2) = 64$, $M(S) = 32$, so mass = $0.60 \times 2 = \mathbf{1.2 \text{ t}}$.
3. $\mathbf{2SO_2 + O_2 + 2H_2O \rightarrow 2H_2SO_4}$. Sulfur 2 = 2, hydrogen 4 = 4, oxygen 4 + 2 + 2 = 8 = 8.

Problem 12 Treating fresh water

1. Particles can **shield microbes** from the steriliser and use up chlorine, so solids are removed first.
2. It is **cheap** and keeps working in the pipes after leaving the works.
3. Distillation needs a **very large amount of energy** and is too costly for a whole town when fresh water is available.

Problem 13 Desalination plant

1. $0.40 \times 5000 = 2000 \text{ m}^3$.
2. $2000 \times 1000 = 2\,000\,000 \text{ dm}^3$.
3. $2\,000\,000 \div 150 = 13\,333$, so about **13 000 people** for a day. The brine is $5000 - 2000 = 3000 \text{ m}^3$.

Problem 14 Waste water stages

1. **Screening, sedimentation, aerobic biological treatment** of the liquid; the sludge from sedimentation goes to **sludge digestion**.
2. Large objects such as grit and rags.
3. **Methane** (biogas), which can be burnt for energy.

Problem 15 Trees and a car

1. $1200 \times 2.3 = 2760 \text{ kg}$.
2. $2760 \div 20 = 138 \text{ trees}$.

Problem 16 Carbon dioxide from petrol

1. $2\text{C}_8\text{H}_{18} + 25\text{O}_2 \rightarrow 16\text{CO}_2 + 18\text{H}_2\text{O}$. Oxygen: $32 + 18 = 50 = 25 \times 2$.
2. $M = 8 \times 12 + 18 = 114$; $n = 1000 \div 114 = 8.77 \text{ mol}$.
3. $\text{CO}_2 = 8 \times 8.77 = 70.2 \text{ mol}$; mass = $70.2 \times 44 = 3088 \text{ g}$, about **3.1 kg**.

Problem 17 Oxygen in air experiment

1. Oxygen used = 21 cm^3 , so **21 %**.
2. $21 \div 24\,000 = 0.000875 \text{ mol}$.
3. Copper = $2 \times 0.000875 = 0.00175 \text{ mol}$; mass = $0.00175 \times 63.5 = 0.11 \text{ g}$.

Problem 18 Bottle life cycle

1. $4.8 \div 20 + 0.30 = 0.24 + 0.30 = 0.54 \text{ MJ per use}$.
2. Plastic is **1.1 MJ** per use, so the glass bottle uses about half the energy ($0.54 \div 1.1 = 0.49$).
3. The comparison **ignores transport mass, recycling of plastic and pollution**, and the number of reuses is an estimate.

Problem 19 Faulty atmosphere notes

1. **All four are wrong.**
2. (a) Global warming is caused by **greenhouse gases** absorbing infrared radiation. The ozone hole is a separate problem. (b) Carbon monoxide forms in **incomplete** combustion. (c) Potable water is **safe to drink** but contains dissolved substances. (d) **Oxygen** is second

at 21 %; argon is third at about 0.9 %.

Problem 20 Desalination or groundwater

1. Desalination: $3.5 \times 1.0 \times 10^6 = \mathbf{3.5 \times 10^6 \text{ kWh}}$. Groundwater: $0.5 \times 1.0 \times 10^6 = \mathbf{5.0 \times 10^5 \text{ kWh}}$.
2. $3.5 \times 10^6 - 0.5 \times 10^6 = \mathbf{3.0 \times 10^6 \text{ kWh}}$.
3. The groundwater may **run out or be contaminated by salt**, while sea water is a reliable supply.