

Air, pollution and clean water resources

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

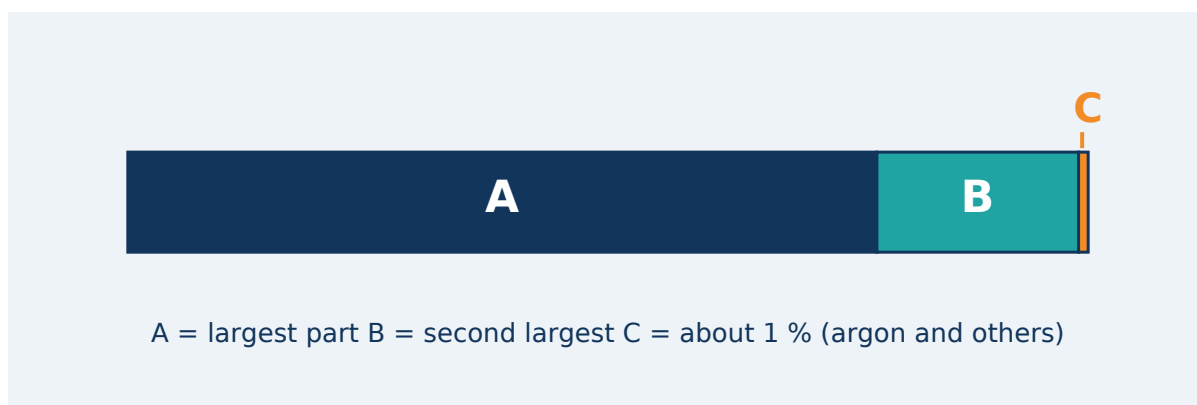
Name: _____ Date: _____ Class: _____

These 20 problems cover the composition of air, the greenhouse effect, air pollutants and how they form, drinking water treatment and life cycle assessment. You will read diagrams, balance equations, work with percentages and masses, and judge claims about the environment. They suit GCSE, IGCSE, O Level, CBSE Class 9-10 and NGSS high school chemistry. Start with the five recall problems; then try the calculations; the last five require several steps.

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 (easy)

Mei in Singapore studies a bar showing the composition of dry air.



Bar chart of the gases in dry air with parts A, B and C.

1. Name gas A and give its percentage.
2. Name gas B and give its percentage.
3. Calculate the volume of oxygen in 200 cm³ of air.
4. Name one gas in section C.

Problem 2 Greenhouse gas or not (easy)

Wanjiru in Nairobi lists gases: nitrogen, carbon dioxide, methane, oxygen, argon, water vapour.

1. Which are greenhouse gases?
2. Name one human source of methane.
3. Name one human source of carbon dioxide.

Problem 3 Match the pollutants (easy)

Match each pollutant (carbon monoxide, sulfur dioxide, nitrogen oxides, particulates) with one source and one harm. Sources: a) sulfur in fuel, b) hot engines, c) incomplete combustion giving a toxic gas, d) soot from diesel. Harms: p) acid rain from sulfur, q) lung damage and dimming, r) smog and acid rain, s) stops blood carrying oxygen.

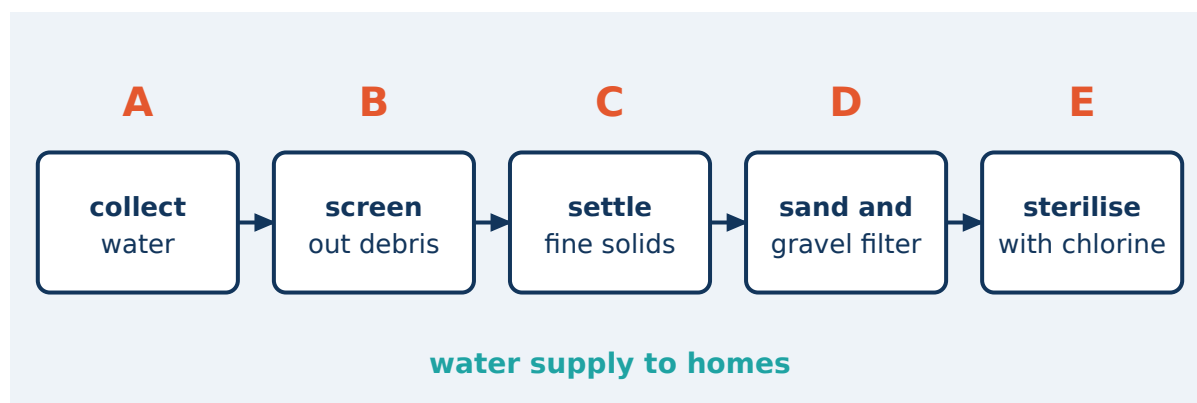
Problem 4 Potable or pure (easy)

Bilal in Lahore says tap water is pure because it is clear.

1. Define potable water.
2. Explain why tap water is not pure water.
3. How could you make pure water from salty water?

Problem 5 Water treatment stages (easy)

The diagram shows the stages in treating water at a works in Leeds.



Five stages A to E of drinking water treatment.

1. Which letter shows the stage that kills microbes?
2. Which stage removes small solid particles?
3. Name one substance used in stage E.

Problem 6 Photosynthesis and oxygen (medium)

Early Earth had very little oxygen. Algae in the oceans changed that.

1. Balance $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2$.
2. Explain how photosynthesis changed the atmosphere.
3. Give two places where carbon dioxide became locked away.

Problem 7 Carbon dioxide levels (medium)

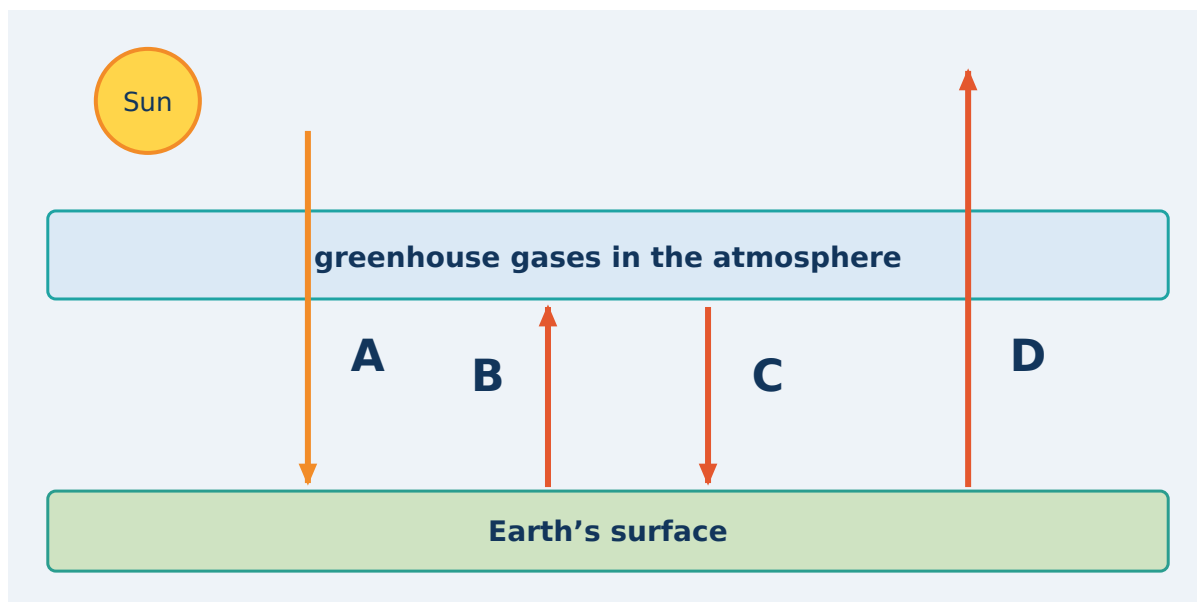
The carbon dioxide concentration in the atmosphere was about 280 parts per million (ppm) before industry, and is now 420 ppm.

1. Calculate the increase in ppm.
2. Calculate the percentage increase.

3. Express 420 ppm as a percentage of the air by volume.

Problem 8 Explain the greenhouse effect (medium)

Diego in Texas studies the arrows in a diagram of the greenhouse effect.



Greenhouse effect with arrows A to D.

1. Describe what each arrow A to D represents.
2. Explain what happens to the average temperature if more carbon dioxide is added.
3. State why some greenhouse effect is needed for life.

Problem 9 Commuting emissions (medium)

Aarav in Pune travels 12 km each way to college on 5 days a week. A car emits 170 g of carbon dioxide per km, and a bus emits 80 g per passenger per km.

1. Calculate the distance travelled in a week.
2. Calculate the weekly emissions by car and by bus in kg.
3. Calculate the saving by taking the bus.

Problem 10 Nitrogen oxides (medium)

Nitrogen oxides form in a petrol engine.

1. Write a balanced equation for nitrogen and oxygen forming nitrogen monoxide (NO).
2. Balance $\text{NO} + \text{O}_2 \rightarrow \text{NO}_2$.
3. Balance $\text{CO} + \text{NO} \rightarrow \text{CO}_2 + \text{N}_2$ for a catalytic converter.
4. Explain why NO forms in an engine but not in cold air.

Problem 11 Sulfur dioxide from fuel (medium)

A ship burns 40 tonnes of fuel oil containing 1.5 % sulfur. (A_r : S = 32, O = 16.)

1. Calculate the mass of sulfur in the fuel.

2. Calculate the mass of sulfur dioxide formed.
3. Balance $2\text{SO}_2 + \text{O}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$ to show how acid rain forms.

Problem 12 Treating fresh water (medium)

A town in Uganda treats water from a lake.

1. Explain why the water is filtered before it is sterilised.
2. Give one advantage of chlorine as a steriliser.
3. Explain why the town does not use distillation.

Problem 13 Desalination plant (medium)

A plant in Dubai treats 5000 m^3 of sea water per hour by reverse osmosis and produces drinking water equal to 40 % of the volume. A person uses 150 dm^3 per day.

1. Calculate the volume of drinking water per hour in m^3 .
2. Convert it to dm^3 ($1 \text{ m}^3 = 1000 \text{ dm}^3$).
3. Calculate how many people have their daily water needs met by one hour of production, and give the volume of brine.

Problem 14 Waste water stages (medium)

Four stages in waste water treatment are: aerobic biological treatment, screening, sludge digestion, sedimentation.

1. Put them in order for the liquid, ending with the sludge.
2. State what screening removes.
3. Name a useful product of sludge digestion.

Problem 15 Trees and a car (medium)

A car in Leeds burns 1200 dm^3 of petrol a year and releases 2.3 kg of carbon dioxide per dm^3 . A tree absorbs about 20 kg of carbon dioxide in a year.

1. Calculate the mass of carbon dioxide released by the car.
2. Calculate how many trees would absorb this.

Problem 16 Carbon dioxide from petrol (hard)

Petrol is modelled as octane, C_8H_{18} . (A_r : C = 12, H = 1, O = 16.)

1. Write a balanced equation for its complete combustion.
2. Calculate the moles in 1.0 kg of octane.
3. Calculate the mass of carbon dioxide produced.

Problem 17 Oxygen in air experiment (hard)

In a school lab in Kisumu 100 cm^3 of air is passed over heated copper. The volume falls to 79 cm^3 . At room temperature 1 mol of gas is $24\,000 \text{ cm}^3$. (A_r : Cu = 63.5)

1. Calculate the percentage of oxygen in the air.
2. Calculate the moles of oxygen used.
3. Calculate the mass of copper that reacted ($2\text{Cu} + \text{O}_2 \rightarrow 2\text{CuO}$).

Problem 18 Bottle life cycle (hard)

An LCA compares two drink bottles. A single-use plastic bottle needs 1.1 MJ of energy to make and nothing else. A glass bottle needs 4.8 MJ to make, is reused 20 times and needs 0.30 MJ to wash each time.

1. Calculate the energy per use of the glass bottle.
2. Compare it with the plastic bottle.
3. State two limitations of this comparison.

Problem 19 Faulty atmosphere notes (hard)

Notes: (a) "The ozone hole causes global warming." (b) "Carbon monoxide forms in complete combustion." (c) "Potable water is pure water." (d) "Argon is the second most abundant gas in air."

1. Decide which statements are wrong.
2. Correct them.

Problem 20 Desalination or groundwater (hard)

A coastal town needs $1.0 \times 10^6 \text{ m}^3$ of drinking water a year. Reverse osmosis uses 3.5 kWh per m^3 . Treating groundwater uses 0.5 kWh per m^3 .

1. Calculate the yearly energy needed for each option.
2. Calculate the extra energy for desalination.
3. Give one reason the town might still choose desalination.