

The proportions of different gases in the atmosphere

5.9.1.1 · Chemistry · revision notes

What the air around you is made of today, and how long it has been this way. Expect 1-mark recall questions on Paper 2, and short calculations that use fractions, percentages and ratios of the gases in air.

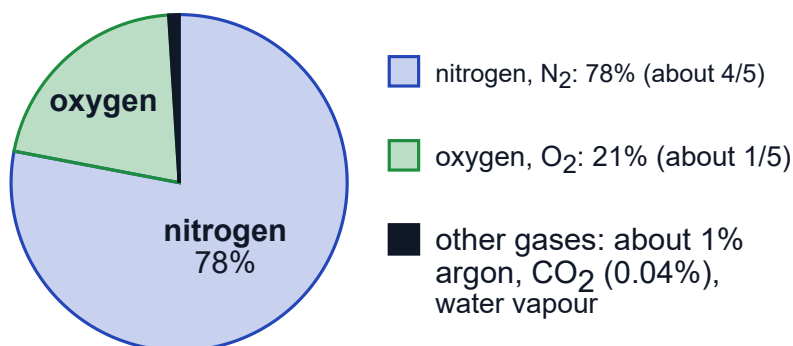
Key facts

- Nitrogen $\approx$ four-fifths $\approx$ 80% of the air
- Small proportions: carbon dioxide (about 0.04%), water vapour, noble gases (mainly argon)
- Nitrogen : oxygen $\approx$ 4 : 1
- Percentage = $\text{part} \div \text{total} \times 100$
- Oxygen $\approx$ one-fifth $\approx$ 20% of the air
- Proportions much the same as today for about 200 million years
- Volume of a gas = $\text{percentage} \div 100 \times \text{total volume}$

Notes

The atmosphere today

- For about the last **200 million years**, the proportions of the gases in the atmosphere have been much the same as they are today.
- About **four-fifths (about 80%)** of the air is **nitrogen**, N_2 .
- About **one-fifth (about 20%)** of the air is **oxygen**, O_2 .
- The rest is small proportions of other gases: **noble gases** (mainly argon, just under 1%), **carbon dioxide** (about 0.04%) and **water vapour** (the amount changes with the weather).



Dry air is about four-fifths nitrogen and one-fifth oxygen.

- Some questions give more exact values for dry air, such as 78% nitrogen, 21% oxygen and 0.9% argon. Always use the numbers the question gives you.
- Air is a **mixture**: the gases are not chemically bonded to each other.

Fractions, percentages and ratios

- Volume of a gas in a sample of air = percentage $\div$ 100 $\times$ total volume.
- Example: 250 cm^3 of air contains about $80 \div 100 \times 250 = 200 \text{ cm}^3$ of nitrogen and $20 \div 100 \times 250 = 50 \text{ cm}^3$ of oxygen.
- To turn a fraction into a percentage, multiply by 100: four-fifths = $4 \div 5 \times 100 = 80\%$.
- Nitrogen : oxygen $\approx 80 : 20 = 4 : 1$, so there is about four times as much nitrogen as oxygen in air.
- To find a percentage from data: percentage = part $\div$ total $\times$ 100.

How to answer each type of question

Recall: name a gas or give its proportion

1 mark each

Grade 3

1. Learn the two big numbers: nitrogen about 80% (four-fifths), oxygen about 20% (one-fifth).
2. Give one clear answer. If you give two answers and one is wrong, you can lose the mark.

Example. (a) Which gas makes up about four-fifths of the Earth's atmosphere?

(b) Give the approximate percentage of oxygen in the atmosphere.

(c) Name **one** other gas that is present in the atmosphere in a small proportion.

Model answer. (a) Nitrogen (1)

(b) 20% (allow 21%) (1)

(c) Any one from: carbon dioxide / water vapour / argon (or another noble gas) (1)

Calculate the volume of a gas in a sample of air

2 marks

Grade 5

1. Write down the percentage of the gas (use the value in the question if one is given).
2. Divide by 100 and multiply by the total volume.
3. Give the unit, the same as the unit of the total volume.

Example. A party balloon contains 3.0 dm^3 of air.

Calculate the approximate volume of oxygen in the balloon.

Model answer. $20 \div 100 \times 3.0$ (1)

= 0.60 dm^3 (1)

(Using 21% gives 0.63 dm^3 , which also scores 2 marks.)

Don't lose marks

- ✗ Saying the air is mostly oxygen. It is mostly nitrogen.
- ✗ Saying carbon dioxide is a major gas in today's air. It is only about 0.04%.
- ✗ Dividing by the final volume instead of the starting volume when working out the percentage of oxygen from an experiment.
- ✗ Writing '200 years' or '2 billion years' instead of about 200 million years.

✗ Leaving the unit (cm^3 or dm^3) off a calculated volume.

More tips

Memory tricks

- Four out of every five parts of the air you breathe in are nitrogen.
- Quick estimate of oxygen: divide the volume of air by 5.
- Calculator: 20% of a number is $\times 0.2$ and 80% is $\times 0.8$.
- Sense check: the percentages of all the gases in air must add up to about 100%.

Exam technique

- If the question gives exact percentages (e.g. 78% and 21%), use those numbers, not 80% and 20%.
- Show your working (e.g. $20 \div 100 \times 250$) so you can still get a method mark if you slip.
- 'Give' and 'Name' questions want a short answer, not an explanation.
- In experiment questions, the decrease in volume is the oxygen that reacted, and the gas left is mainly nitrogen.

What each grade needs

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

Grade 3

Name the two main gases in air

Nitrogen makes up about four-fifths of the air and oxygen about one-fifth.

Grade 3

Give the percentages of nitrogen and oxygen

Air is about 80% nitrogen and about 20% oxygen.

Grade 4

Name the gases present in small proportions

Carbon dioxide, water vapour and noble gases such as argon are present in small proportions.

Grade 4

State how long the proportions have been similar

The proportions of the gases have been much the same as today for about 200 million years.

Grade 5

Calculate the volume of a gas in air

Multiply the total volume by the percentage divided by 100, e.g. $20 \div 100 \times 500 \text{ cm}^3 = 100 \text{ cm}^3$ of oxygen.

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