Concentration of solutions

5.3.2.5 · Chemistry · revision notes

Concentration tells you how much solute is dissolved in a given volume of solution. Here it is measured in grams per dm^3 (g/dm^3). You must calculate concentrations and masses of solute, convert cm^3 to dm^3 and, on the Higher tier, explain how the mass of solute and the volume of solution affect the concentration.

Key facts

- Concentration (g/dm^3) = mass (g) ÷ volume (dm^3)
- Volume (dm^3) = mass ÷ concentration
- cm^3 → dm^3: divide by 1000
- Mass (g) = concentration × volume (dm^3)
- 1 dm^3 = 1000 cm^3
- Grade 7+ only Same volume, more solute → higher concentration; same solute, more volume → lower concentration

Notes

What concentration means

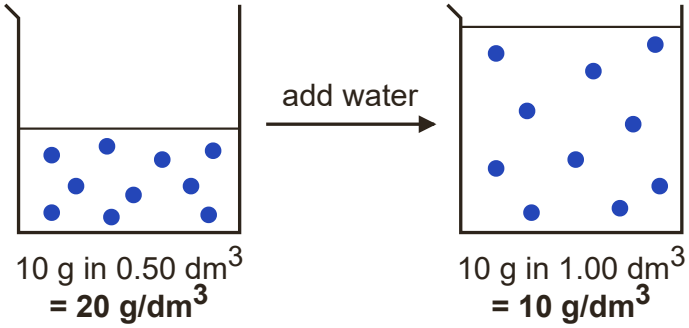
- Many reactions take place in **solutions**. A solution is a **solute** dissolved in a **solvent**.
- The **concentration** of a solution can be measured as the mass of solute per volume of solution, in **g/dm^3**.
- 1 dm^3 = 1000 cm^3 (1 litre). To convert cm^3 to dm^3, divide by 1000.

Calculations

- concentration (g/dm^3) = mass of solute (g) ÷ volume of solution (dm^3)
- mass of solute (g) = concentration (g/dm^3) × volume (dm^3)
- Example: 5.0 g of sodium chloride is dissolved to make 250 cm^3 of solution. Volume = 250 ÷ 1000 = 0.250 dm^3. Concentration = 5.0 ÷ 0.250 = 20 g/dm^3.
- Example: the mass of solute in 50 cm^3 of a 40 g/dm^3 solution = 40 × 0.050 = 2.0 g.

How mass and volume affect concentration (Higher tier) Grade 7+ only

- If the volume stays the same, the concentration is proportional to the mass of solute: double the mass, double the concentration.
- If the mass of solute stays the same, the concentration is inversely proportional to the volume of solution: double the volume (e.g. by adding water), halve the concentration.



Same mass of solute, double the volume: the particles are more spread out and the concentration halves.

- A **concentrated** solution has a lot of solute in each dm^3; a **dilute** solution has only a little.

How to answer each type of question

Calculate the concentration 2 to 3 marks Grade 5

1. Convert the volume to dm^3 (÷ 1000).
2. Divide the mass in grams by the volume in dm^3.
3. Give the unit, g/dm^3.

Example. A student dissolved 3.0 g of copper sulfate in water to make 200 cm^3 of solution. Calculate the concentration of the solution in g/dm^3. [3 marks]

Model answer.

volume = 200 ÷ 1000 = 0.200 dm^3 (1)

concentration = 3.0 ÷ 0.200 (1)

= 15 g/dm^3 (1)

Calculate the mass of solute

2 marks | Grade 5

1. Convert the volume to dm^3.
2. Multiply the concentration by the volume and give the unit, g.

Example. Calculate the mass of sodium hydroxide in 25.0 cm^3 of a solution with a concentration of 80.0 g/dm^3. [2 marks]

Model answer.

25.0 cm^3 = 0.0250 dm^3 (1)

mass = 80.0 × 0.0250 = 2.00 g (1)

Explain how the concentration changes

2 marks | Grade 7

1. Say what stays the same (the mass of solute or the volume).
2. Say what changes and by how much, then give the effect on the concentration.

Example. A student has 100 cm^3 of sugar solution with a concentration of 50 g/dm^3. She adds water until the volume of the solution is 200 cm^3.
Explain what happens to the concentration. [2 marks]

Model answer. The mass of sugar stays the same, but the volume of solution doubles (1). So the concentration halves, to 25 g/dm^3 (1).

Calculate the volume of solution needed

3 marks | Grade 8

1. Rearrange: volume (dm^3) = mass ÷ concentration.
2. Calculate the volume in dm^3.
3. Convert to cm^3 if asked (× 1000).

Example. A plant food solution contains 12 g/dm^3 of a nitrogen compound. A gardener needs 0.60 g of the compound for one plant.
Calculate the volume of solution needed, in cm^3. [3 marks]

Model answer.

volume = 0.60 ÷ 12 (1)

= 0.050 dm^3 (1)

= 50 cm^3 (1)

Don’t lose marks

- Using the volume in cm^3 without dividing by 1000, which makes the concentration 1000 times too small.

- Multiplying by 1000 instead of dividing when converting cm^3 to dm^3.
- Using the volume of water added instead of the final volume of the solution.
- Leaving out the unit, or writing g/cm^3 instead of g/dm^3.
- Leaving a mass in mg: divide by 1000 to get grams before using concentration = mass ÷ volume.

More tips

Memory tricks

- Formula triangle: mass on top, concentration × volume underneath.
- Unit check: g ÷ dm^3 = g/dm^3. If the units do not come out right, the formula is upside down.
- A dm^3 is 1000 times bigger than a cm^3, so the number in dm^3 is always 1000 times smaller.
- Sense check: if the volume is less than 1 dm^3, the concentration is a bigger number than the mass.

Exam technique

- Write the conversion to dm^3 as its own line of working: it is often a mark.
- Give the unit g/dm^3 with every concentration.
- In Higher tier 'explain' questions, say what stays the same (mass or volume) and what changes.

What each grade needs

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

Grade 3 — **Recall the unit of concentration**
Mass of solute per volume of solution, usually grams per dm^3 (g/dm^3).

Grade 4 — **Convert cm^3 to dm^3**
Divide by 1000, e.g. 250 cm^3 = 0.250 dm^3.

Grade 5 — **Calculate concentration in g/dm^3**
Concentration = mass of solute (g) ÷ volume of solution (dm^3).

Grade 5 — **Calculate the mass of solute in a solution**
Mass = concentration (g/dm^3) × volume (dm^3).

Grade 7 — **Explain how mass and volume affect concentration**
More solute in the same volume, or the same solute in less volume, gives a higher concentration.

Grade 8 — **Solve multi-step concentration problems**
Rearrange the equation, e.g. find the volume of solution that contains a given mass.

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