Concentration and mass

This resource is from the **Johnstone's triangle** series, which can be viewed at: rsc.li/3YoYMC8. In this series you will also find our Johnstone's triangle worksheet which introduces the triangle in the context of a sodium hydroxide solution: rsc.li/4sCkujW.

Learning objectives

LO	Objective	Where assessed
1	Connect the mass of solute dissolved in equal volumes of water to the relative concentrations of the solutions formed.	Q1
2	Interpret and evaluate particle diagrams of more and less concentrated solutions.	Q2
3	Determine the concentration of a solution in units of g/dm^3.	Q3
4	Calculate the concentration of a solution in units of g/dm^3 from the mass of solute in g and the volume of water in cm^3.	Q4
5	Calculate the mass of solute in a solution of given volume and concentration.	Q5

How to use this resource

This resource aims to develop learners' qualitative and quantitative understanding of concentration.

When to use?	Introduce	**Develop**	**Revise**	Assess
	Use after initial teaching or discussion of this topic to develop ideas further. You can also use as a revision activity.			
Group size?	**Independent**	**Small group**	**Whole class**	**Homework**
	Suitable for independent work either in class or at home. Or use the questions for group or class discussions.			
How long?			15–30 mins	

The questions encourage learners to think about how the concentration both observationally and quantitively as well as how this can be represented using particle diagrams. As a result, learners should develop more secure mental models to support their thinking about this topic. The sub-microscopic understanding of concentration is covered more fully in the 'Developing understanding: concentration and moles' resource (rsc.li/4aLcZAH).

Johnstone's triangle

Johnstone's triangle is a model of the three different conceptual levels in chemistry: macroscopic, sub-microscopic and symbolic. You can use Johnstone's triangle to build a secure understanding of chemical ideas for your learners.

Find further reading about Johnstone's triangle and how to use it in your teaching at rsc.li/3YoYMC8.

Johnstone's triangle and this resource

The icons in the margin indicate which level of understanding each question is developing to help prompt learners in their thinking.

Macroscopic: what we can see. Think about the properties that we can observe, measure and record.

Sub-microscopic: smaller than we can see. Think about the particle or atomic level.

Symbolic: representations. Think about how we represent chemical ideas including symbols and diagrams.

The levels are interrelated. For example, learners need visual representation of the sub-microscopic in order to develop mental models of the particle or atomic level. Our approach has been to apply icons to questions based on what the learners should be thinking about.

Questions may be marked with two or all three icons, indicating that learners will be thinking at more than one level. However, individual parts of the question may require learners to think about only one or two specific levels at a time.

Support

This worksheet is ramped so that the earlier questions are more accessible. The activity becomes more challenging in the later questions. You can give extra explanations for the more challenging questions. If completing as an in-class activity it is best to pause and check understanding at intervals, as often one question builds on the previous one.

It is useful for learners to observe macroscopic properties first-hand. You could circulate examples of substances in the classroom, run a class practical of a chemical reaction or show a teacher demonstration of properties.

Give learners physical models to use and manipulate, such as a Molymod kits or counters.

Additional support may be needed for any learners still lacking in confidence in the required symbolic representation, for example by sharing and explaining a diagram or a simulation that can show movement of the particles.

Answers

1. *Guidance note:* This question develops learners' understanding of the difference in appearance between coloured solutions with different concentrations and the connection with the mass of solute dissolved (macroscopic understanding). This question assumes familiarity with the meaning of the term solute and solution.

(a) B
(b) Left: C, middle: A, right: B

2. *Guidance note:* This question develops learners' understanding of the use of diagrams (symbolic understanding) to compare the number of solute particles (sub-microscopic understanding) in solutions with different concentrations.

(a) A
(b) The diagrams show that a more concentrated solution has more solute particles in the same volume.
(c) This diagram shows that the water is also made up of particles and that the solute particles are mixed with the water particles.

3. *Guidance note:* This question develops learners' understanding of how to quantify concentration in g per dm^3 (macroscopic understanding). This question provides a reminder that 1 dm^3 is equal to 1000 cm^3 but assumes that learners have some familiarity with dm^3 as a unit.

(a) 2 g/dm^3
(b) 3 g
(c) 3 g/dm^3
(d) Solution E
(e) 8 g
(f) 8 g/dm^3
(g) more

4. *Guidance note:* This question develops learners' understanding of how to calculate concentration in g/dm^3 from the mass of solute (in g) and volume of water in cm^3 (macroscopic understanding).

(a)

Volume in cm^3	Volume in dm^3
1000	**1**
5000	**5**
500	**0.5**
50	**0.05**
100	**0.1**
10	**0.01**
250	**0.25**
25	**0.025**

(b)

Mass in g	volume in cm^3	volume in dm^3	concentration in g/dm^3
0.5	50	**0.05**	**10**
0.1	25	**0.025**	**4**
0.2	10	**0.01**	**20**

5. *Guidance note:* This question develops learners' understanding of how calculate the mass of solute in a given volume of a solution with known concentration (macroscopic understanding).

(a) 100 g

(b) The volume must be converted to dm^3 to ensure the answer to the calculation is correct. The concentration in the formula has in the units g/dm^3 so volume must be in dm^3 as well.

(c)

i. 2.5 g
ii. 10 g
iii. 1.5 g
iv. 0.5 g