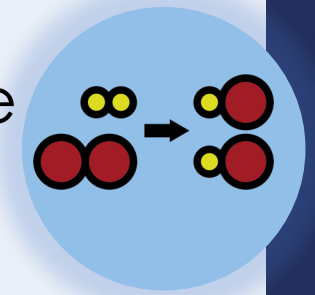
# Taking it Further: Calculating Concentration

**Answer the questions below.**

1. Define concentration.
   **The mass of solute in a given volume of solution.**
2. State a unit used to measure concentration.
   **$g/dm^3$**
3. Calculate the concentration of 500 cm3 of solution that has 20 g of solute dissolved in it.
   $$\text{Concentration} = \frac{\text{mass}}{\text{volume}}$$
   $$\text{Concentration} = \frac{20}{0.5}$$
   $$= 40\ g/dm^3$$
4. State Avogadro's number.
   **$6.02 \times 10^{23}$**
5. State the equation that links number of moles, mass and relative formula mass.
   $$\text{Number of moles} = \frac{\text{mass}}{M_r}$$



Do Now

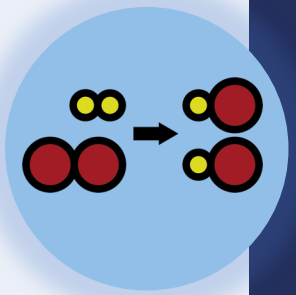
# Taking it Further: Calculating Concentration

**Do Now:**

1. Define concentration.
2. State a unit used to measure concentration.
3. Calculate the concentration of 500 cm3 of solution that has 20 g of solute dissolved in it.
4. State Avogadro's number.
5. State the equation that links number of moles, mass and relative formula mass.

**Drill:**

1. State the unit for amount of substance.
2. Calculate the mass of 1 mole of carbon.
3. Calculate the number of moles in 48 g of carbon.



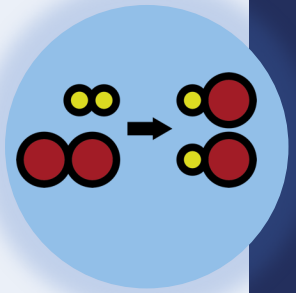
Do Now

# Taking it Further: Calculating Concentration

## Read Now:

Concentration can be measured in terms of grams of solute per unit volume, or in moles per unit volume (usually mol/$dm^3$). We know that concentration = mass/volume, and number of moles = mass/relative formula mass. We can always calculate relative formula mass using the relative atomic masses from the periodic table. This means that we can use these two equations together to work between concentration, volume, mass and number of moles. For example, we want to calculate the mass of sodium hydroxide dissolved in 500 $cm^3$ of 12 mol/$dm^3$ solution, so we can first calculate the amount of substance (number of moles) that would be present in this volume, then use the relative formula mass of sodium hydroxide to determine the mass of this number of moles.

1. State the equation that links concentration, mass and volume.
2. State the equation that links number of moles, mass and relative formula mass.
3. Describe how to calculate the relative formula mass of a compound.
4. State the two different units that can be used for concentration.



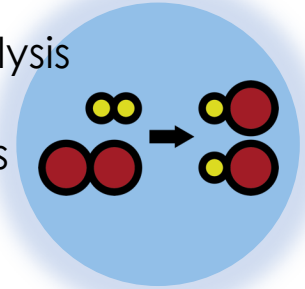
Do Now

# Taking it Further: Calculating Concentration

## C4.3.5

Science Mastery

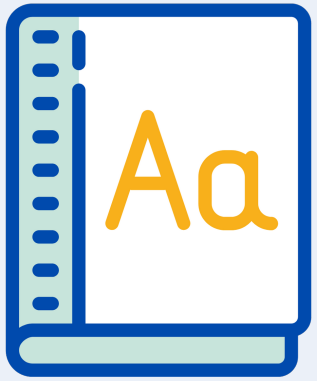
C4.3.1 Prior Knowledge Review
C4.3.2 (HT) Introducing the Mole
C4.3.3 (HT) Mole Calculations
C4.3.4 PKR: Concentration
➢ **C4.3.5 TIF: Calculating Concentration**
C4.3.6 TIF: Calculating an Unknown Concentration
C4.3.7 (HT) Amounts of Substances in Equations
C4.3.8 (HT) Limiting Reactants
C4.3.9 PKR: Reactions of Acids
C4.3.10 Acids, Alkalis and Neutralisation
C4.3.11 TIF: Acid-Alkali Titration
C4.3.12 TIF: Acid-Alkali Titration Analysis
C4.3.13 TIF: Titration Calculations
C4.3.14 (HT) Strong and Weak Acids
C4.3.15 TIF: Volumes of Gases



**Following this lesson, students will be able to:**

- Calculate concentration in mol/$dm^3$
- Calculate the mass of solute from a concentration in mol/$dm^3$
- Explain how the concentration of a solution is related to the mass of solute and the volume of the solution

**Key Words:**




**mass** **volume** **concentration**

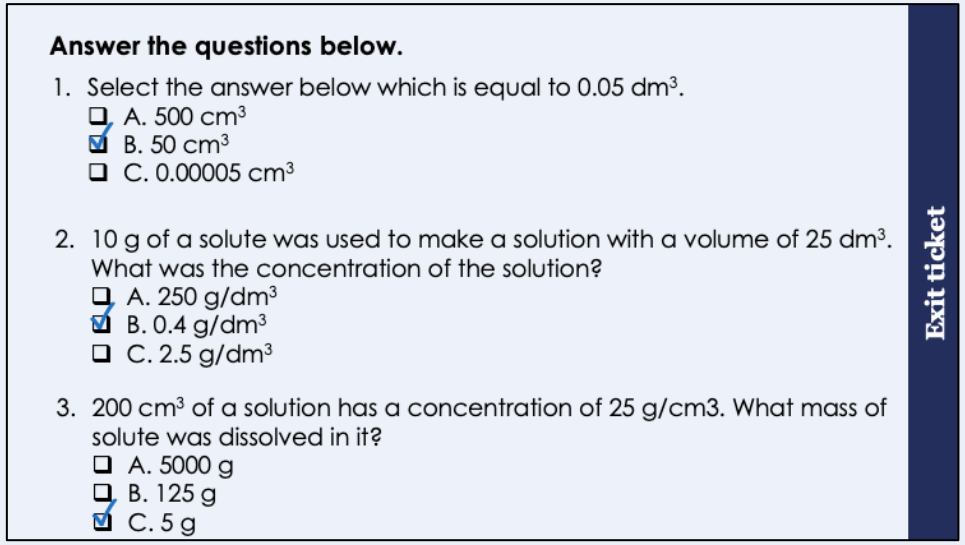
**moles** **solution**

Lesson Objectives

# This is the fix-it portion of the lesson

The **fix-it** is an opportunity to respond to gaps in knowledge, especially those identified by the **pre-unit quiz**.

- The teacher should customise this slide as needed, to facilitate
  - **reteach**, **explanation, demonstration** or **modelling** of ideas and concepts that students have not yet grasped or have misunderstood.
  - **practise** answering specific questions or of key skills.
  - **redrafting** or **improving** previous work.



**Answer the questions below.**

1. Select the answer below which is equal to 0.05 $dm^3$.
   - ☐ A. 500 $cm^3$
   - ☑ B. 50 $cm^3$
   - ☐ C. 0.00005 $cm^3$

2. 10 g of a solute was used to make a solution with a volume of 25 $dm^3$. What was the concentration of the solution?
   - ☐ A. 250 $g/dm^3$
   - ☑ B. 0.4 $g/dm^3$
   - ☐ C. 2.5 $g/dm^3$

3. 200 $cm^3$ of a solution has a concentration of 25 g/cm3. What mass of solute was dissolved in it?
   - ☐ A. 5000 g
   - ☐ B. 125 g
   - ☑ C. 5 g

Exit ticket

Fix-it

# Concentration

We know that:

$$\text{Concentration} = \frac{\text{mass}}{\text{volume}}$$

This gives us a concentration in **g/dm$^3$.**

***Higher Tier only***

When working with chemical reactions, it is much more useful for scientists to have a measure of the number of particles that are actually present.

We can also calculate concentration in moles per cubic decimetre (**mol/dm$^3$**).

This tells us how many particles there are of a substance in a given volume of solution, rather than just the mass in grams.

# Mol/dm$^3$

***Higher Tier only***

We can use the equation:

$$\textbf{Concentration} = \frac{\textbf{number of moles}}{\textbf{volume}}$$

This gives us a concentration in **mol/dm$^3$.**

If we know the mass of solute, we can also use the equation:

$$\textbf{Number of moles} = \frac{\textbf{mass}}{\mathbf{M_r}}$$

This gives us the number of moles.

# Worked Example

***Higher Tier only***

A scientist adds 9.75 g of sodium chloride to make 250 $cm^3$ of salt solution.
What is the **concentration** of the solution in **$mol/dm^3$**?

**Mass = 9.75 g**

**$M_r$ (NaCl) = 23 + 35.5**
**= 58.5**

$$\text{Number of moles} = \frac{\text{mass}}{M_r}$$

$$\text{Number of moles} = \frac{9.75}{58.5}$$

$$\text{Number of moles} = 0.167 \text{ mol}$$

$$\text{Concentration} = \frac{\text{number of moles}}{\text{volume}}$$

$$\text{Concentration} = \frac{0.167}{0.25}$$

$$\text{Concentration} = 0.67 \text{ mol/dm}^3$$

**Which of these statements are correct?**

The mass of solute in grams is equal to the concentration in mol/$dm^3$

Concentration can be described using g/$dm^3$ or mol/$dm^3$

The number of moles of a solute is calculated using the concentration divided by the volume.

The periodic table is used to find the mass of a substance in grams.

Talk Task

**Discuss with your partner how you should solve this question.**

**Work together to find the answer.**

Some glucose ($C_6H_{12}O_6$) was dissolved in 500 $cm^3$ of water.
The concentration of the solution was 0.4 $mol/dm^3$.

What mass of glucose was dissolved in the solution?

$M_r$ glucose = (6x12)+(12x1)+(6x16)
= 180

500 $cm^3$ = 0.5 $dm^3$

$$\text{Concentration (mol/dm3)} = \frac{\text{number of moles}}{\text{volume}}$$

$$\text{number of moles} = \frac{\text{mass}}{M_r}$$

$$0.4 = \frac{\text{number of moles}}{0.5}$$

$$0.2 = \frac{\text{mass}}{180}$$

number of moles = 0.2

mass = 36 g

Talk Task

## True or false?

1. Concentration can be measured in $g/dm^3$ or $mol/dm^3$ **True**
2. The unit for number of moles is mol **True**
3. Concentration can be calculated using number of moles x volume **False**
4. $20\ cm^3 = 0.2\ dm^3$ **False**
5. Relative formula mass is measured in grams **False**

Check for understanding

# Drill

1. State the equation that links concentration, mass and volume.
2. State the equation that links concentration, number of moles and volume.
3. State the equation that links number of moles, mass and relative formula mass.
4. Define relative formula mass.
5. Calculate the relative formula mass of sodium hydroxide (NaOH).
6. State the unit for mass.
7. State the unit for volume.
8. Convert 50 $cm^3$ to $dm^3$.
9. State the two units that can be used for concentration.

Check for understanding

# Drill answers

1. $\text{Concentration} = \frac{\text{mass}}{\text{volume}}$
2. $\text{Concentration} = \frac{\text{number of moles}}{\text{volume}}$
3. $\text{Number of moles} = \frac{\text{mass}}{M_r}$
4. The sum of the relative atomic masses in a formula (or compound).
5. 23+16+1 = 40
6. g
7. $dm^3$
8. 0.05 $dm^3$
9. $g/dm^3$ or $mol/dm^3$

Check for understanding

**Answer the questions below.**

1. Calculate the concentration of a 750 $cm^3$ solution that contains 1.5 mol of solute.
   - ☐ A. 1.5 mol/$dm^3$
   - ☐ B. 0.02 g/$dm^3$
   - ☑ C. 2 mol/$dm^3$
2. Calculate the number of moles in 2 $dm^3$ of 0.5 mol/$dm^3$ solution.
   - ☐ A. 4 mol
   - ☑ B. 1 mol
   - ☐ C. 0.25 mol

3. 80 g of sodium hydroxide ($M_r$ = 40) is dissolved in solution. How many moles of solute are in the solution?
   - ☑ A. 2 mol
   - ☐ B. 0.5 mol
   - ☐ C. 3200 mol

Exit ticket

Feedback

| Lesson C4.3.5 | |
|---|---|
| What was good about this lesson? | What can we do to improve this lesson? |
| | |

Send us your feedback by clicking this link
or by emailing sciencemastery@arkonline.org
Thank you!