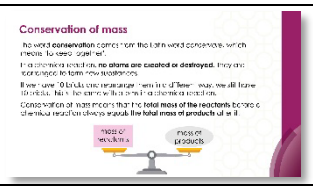
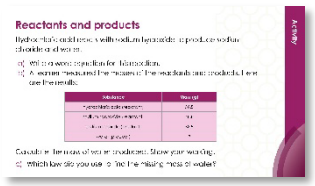
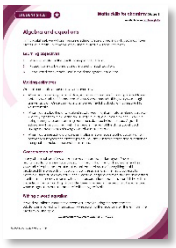
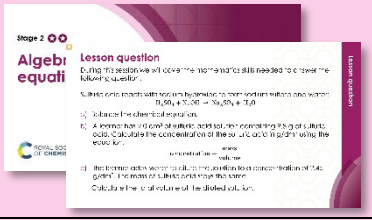
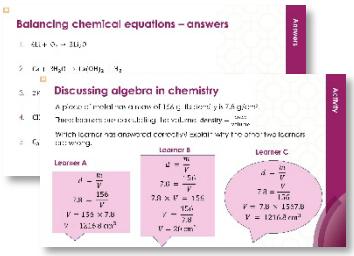
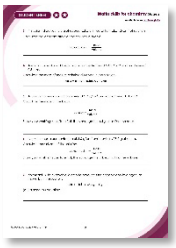
Algebra and chemical equations

This presentation forms part of the Maths skills for chemistry resources series, rsc.li/4A41ezG. The series offers flexible, targeted support for maths skills which are fundamental to chemistry teaching:

- Understanding number, divided into:
    - Unit conversion
    - Significant figures and rounding
- Ratio and proportion
- Graphs and data, divided into:
    - Creating graphs
    - Interpreting graphs
- **Algebra and equations**

Resource series components

The resource series is divided into two stages. Stage 1 (✪) is most suitable for ages 11–14 and stage 2 (✪✪) for ages 14–16. However, older learners with gaps in their fundamental knowledge can use stage 1 as a stepping stone.

Stage 1 ✪		
		
Teacher-led presentation (✪)	**Short activities (✪)**	**Learner worksheet (✪)**
Stage 2 ✪✪		
		
Teacher-led presentation (✪✪): a full lesson including learning objectives, learner-facing instructions and activities.	**Short activities (✪✪):** learner-facing activities, designed as lesson starters or quick activities to engage prior knowledge.	**Learner worksheet (✪✪):** activities for learners to independently practice their maths skills. Suitable as classroom activity following the teacher presentation or as a home-learning task.

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Key terms support

Key vocabulary for each skill area is defined in the key terms support: rsc.li/4wypuqq. You will find the key terms listed by topic area and an accessible glossary slide for each term.

Using the teacher-led presentation

This is a full lesson focused on mastering maths skill in a chemistry context. The aim is for learners to develop key skills and then begin to apply these independently.

Learning objectives

1. Understand the algebra needed for balancing chemical equations.
2. Substitute numerical values into formulas and expressions using appropriate units.
3. Change the subject of an equation.
4. Solve for unknowns in chemical equations and stoichiometry problems.

As you move through the presentation, there is a clear progression in skill development. The early slides engage learners' prior knowledge of the chosen maths skill. These slides link back to their learning from maths lessons as well as prior chemistry knowledge, where applicable.

Following this, the slides move onto some maths–chemistry translation tasks, then learners' complete activities within a chemistry context.

The teacher-led presentation is designed to be used:

- prior to teaching a topic which makes explicit use of the maths skill, such as using when balancing equations or using scientific formulas
- after summative assessment as an intervention.

Scaffolding

The presentation is scaffolded, moving from worked examples ('I do') to faded examples ('we do'), before learners go on to answer questions themselves ('you do').

Metacognition

This resource type supports learners to develop their metacognitive skills in three key areas.

- **Planning** – prompt learners to draw on their existing mathematical knowledge by asking themselves: 'Have I seen a similar question before? Have I come across this mathematical skill before? Have I learned a different method for solving a similar problem?'
- **Monitoring** – prompt learners to ask themselves: 'How confident am I feeling with these mathematical skills? Which parts of the presentation were most helpful to me?'

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- **Evaluation** – prompt learners to ask themselves: 'What have I learned during the presentation? How will I apply this new knowledge in my learning?'

Teaching sequence

Each teacher-led presentation begins with a slide outlining the objectives, followed by a chemistry question which uses the mathematical skill. During the presentation, the learners acquire the mathematical skills relevant to the question. At the end of the presentation, learners answer the question posed at the start, using the mathematical skills they have just developed.

This presentation is designed to be teacher-led and not used independently by learners.

1. Outline the learning objectives with learners (slide 2)
2. Review the lesson question (slide 3) without answering it, following the teacher notes (provided in the presentation and copied in the notes below).
3. Review learning from stage 1 (slide 4) and expand on that prior knowledge (slide 5).
4. Work through the maths modelling slides, making explicit links between maths and science (slides 6–21).
5. Learners complete the 'checking for understanding' questions. Ask learners to independently complete the lesson question using the knowledge covered during the lesson (slides 22–26).

Review learning

Use the complementary learner worksheet and short activities presentation as a follow-up or later as a review.

Slide notes

Below is the teacher guidance by slide, giving detailed information to support your teaching of the maths skill. Answers are provided for all questions. When relevant, common mathematical misconceptions are highlighted. These notes are also provided in the notes section of the PowerPoint presentation.

Introduction (slides 1–5)

Slide 1: Algebra and equations

No notes.

Slide 2: Introduction

No notes.

Slide 3: Lesson question

This slide introduces the challenge question that learners will return to at the end of the lesson. Learners are not expected to attempt it at this point.

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Briefly talk through the scenario. The question combines three skills from the lesson.

- Part (a): balancing a chemical equation
- Part (b): substituting values into a formula
- Part (c): rearranging a formula to find the unknown (making volume the subject)

Ask learners: what skills do you think you will need to answer this? This activates prior knowledge and helps learners identify what they already know and what they need to learn.

Slide 4: Learning from stage 1

A brief recap of algebra and equations stage 1 content to activate prior knowledge.

Quick check answer: $10 - 5.6 = 4.4$ g. This uses conservation of mass – the total mass of products must equal the total mass of reactants.

If learners struggle with this recap, then consider revisiting the stage 1 resource.

Slide 5: What does balancing mean?

This slide introduces the difference between an unbalanced and a balanced equation. It also introduces the key vocabulary: coefficients and subscripts.

Explain that an unbalanced equation tells us what reacts and what is produced, but a balanced equation also tells us how much. Discuss why this matters – without knowing how much, we cannot calculate quantities in chemistry.

Remind learners that the subscript numbers written within the formulas tell us how many atoms of a particular element are in a single molecule. Use the example of O_2 to illustrate this – the subscript 2 tells us there are 2 atoms of oxygen in 1 molecule of oxygen.

Describe the difference between the unbalanced and balanced equation. Ask learners to count the atoms on each side of the balanced equation and confirm that there are 4 hydrogen atoms and 2 oxygen atoms on both sides.

Explain that the key rule is critical: we balance by adding coefficients, never by changing subscripts. Changing subscripts changes the substance itself (H_2O becomes H_2O_2, which is hydrogen peroxide, not water).

Ask: what would happen if we wrote $2O$ instead of O_2? Discuss – $2O$ means 2 separate oxygen atoms, while O_2 means 1 molecule containing 2 oxygen atoms. This reinforces the difference between coefficients (how many molecules) and subscripts (how many atoms within a molecule).

More information on ratios in balanced chemical equations and how this relates to the coefficients can be found in the ratio and proportion stage 2 teacher-led presentation: rsc.li/4zsNyho.

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Mathematical modelling (slides 6–21)

Slide 6: How do we balance equations?

Describe the systematic method for balancing equations. This gives learners a reliable process to follow rather than relying on trial and error.

Explain each step:

Step 1: list all the elements in the equation.

Step 2: count the atoms of each element on both sides. Encourage learners to draw a table with columns for element, left side and right side. This makes it easier to see which elements need balancing.

Step 3: balance one element at a time, starting with the element that appears in the fewest formulas. Explain why – if an element only appears in one formula on each side, changing its coefficient won't affect other elements as much. Leave oxygen and hydrogen until last as they often appear in multiple formulas. Adjust the coefficients. Remind learners that they can only add numbers in front of formulas, not change the subscripts. After each adjustment, recount the atoms – changing one coefficient may unbalance another element.

Step 4: check all elements balance. Every element must have the same count on both sides. Ask learners to go through each element systematically rather than assuming it looks right.

Step 5: simplify. Make sure the coefficients are in the simplest whole number ratio. For example, if all coefficients are even, divide them all by 2. Discuss: $\mathbf{4H_2 + 2O_2 \rightarrow 4H_2O}$ is balanced but not simplified – it should be $\mathbf{2H_2 + O_2 \rightarrow 2H_2O}$.

Link to maths: describe how balancing is like solving a set of constraints – each element gives a condition that must be satisfied on both sides, just like simultaneous equations in maths.

Display these steps on the board for reference during the worked examples and practice questions (the next slides in this presentation).

Slide 7: Balancing equations (worked example)

Walk through this worked example step by step with learners, following the systematic method from slide 6.

Explain each step:

Step 1: list the elements.

Step 2: count the atoms on each side. Magnesium has 1 on each side so it already balances. Oxygen has 2 on the left (O_2 (but only 1 on the right (MgO), so it doesn't balance. Ask learners: which element do we need to fix?

Step 3: fix oxygen by placing a 2 in front of MgO. This gives 2 oxygen atoms on the right, matching the 2 on the left. Remind learners: we add a coefficient in front of MgO, we do not change the subscript.

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Recount all atoms after the change. Oxygen now balances, but the coefficient 2 in front of MgO means there are now 2 Mg on the right and only 1 on the left. Ask learners: what do we do? Fix magnesium by placing a 2 in front of Mg.

Discuss: this is a key teaching point – changing one coefficient can unbalance another element. Learners should always recount after every adjustment.

Step 4: Final check: $\mathbf{2}Mg + O_2 \rightarrow \mathbf{2}MgO$. Mg: $2 = 2$. O: $2 = 2$. All balanced.

Ask learners: could we have started by balancing oxygen a different way, for example by changing O_2 to O? No – O_2 is the correct formula for oxygen gas and we cannot change it. This reinforces the key rule from slide 5.

This is a relatively simple example to build confidence. The final step – simplify is not required. The practice slide has progressively harder equations.

Slide 8: Balancing equations practice

Practice balancing equations. Allow learners time to attempt each one. Encourage them to use the systematic method from slide 6 and draw an atom count table for each one. The questions increase in difficulty.

Slide 9: Balancing equations practice (answers)

1. $2Na + Cl_2 \rightarrow 2NaCl$. There are 2 Cl on the left (Cl_2), therefore, we need 2 $NaCl$. Then we need 2 Na.
2. $H_2 + Cl_2 \rightarrow 2HCl$. There is 1 H and 1 Cl on the right (HCl), but 2 of each on the left. Put a 2 in front of HCl to balance both elements at once. This is a straightforward example to build confidence.
3. $4Fe + 3O_2 \rightarrow 2Fe_2O_3$. This is harder. Fe_2O_3 has 2 Fe and 3 O. Start with oxygen: 3 O on the right means we need 3 O on the left, but O_2 gives us 2 at a time. We need $3O_2$ (6 oxygens) and $2Fe_2O_3$ (6 oxygens). Then $2Fe_2O_3$ needs 4 Fe.
4. $N_2 + 3H_2 \rightarrow 2NH_3$. Start with nitrogen: 4 N on the left (N_2) so we need $2NH_3$ on the right. Now hydrogen: $2NH_3$ has 6 H, so we need $3H_2$ on the left. Check: N: $2 = 2$, H: $6 = 6$.
5. $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$

Balance carbon: 2 C in C_2H_6, 1 in CO_2, so $2CO_2$. But try $2C_2H_6$ giving $4C$, so $4CO_2$.

Balance hydrogen: $2C_2H_6$ has 12 H, so $6H_2O$.

Balance oxygen: right side = $(4 \times 2) + (6 \times 1) = 14$ O. So $7O_2$ on the left.

Check: C: $4 = 4$, H: $12 = 12$, O: $14 = 14$

Equation 5 is the most challenging. Some learners may find $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$. Others may start with $C_2H_6 + \frac{7}{2}O_2 \rightarrow 2CO_2 + 3H_2O$ and then multiply through by 2. Both approaches are valid.

Discuss: ask learners which equations they found easiest and hardest. Equations 1 and 2 only involve two elements. Equations 3 and 4 require larger coefficients. Equation 5 has three elements and multiple products, making it the most complex.

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Slide 10: Discuss balancing

Ask learners to count the atoms on each side for all three attempts, either individually, in pairs or on mini whiteboards, before revealing which is correct.

Slide 11: Discuss balancing (answers)

Learner C is correct: $4Al + 3O_2 \rightarrow 2Al_2O_3$

Al: $4 = 4$. O: $6 = 6$.

Learner A is incorrect because the equation is not fully balanced. Count the atoms: Al: $2 = 2$, but O: $2 \neq 3$. Learner A balanced aluminium but gave up when oxygen didn't work out neatly.

Discuss: what should they have done? They needed to find the number of O_2 and Al_2O_3 that gives the same number of oxygen atoms on both sides. Since O_2 gives oxygens in 2s and Al_2O_3 needs them in 3s, the lowest common multiple is 6, so $3O_2$ and $2Al_2O_3$. Then recount aluminium: $2Al_2O_3$ has 4 Al, so we need 4Al on the left.

Learner B is incorrect because they changed the formula of oxygen from O_2 to O_3. O_3 is ozone, a completely different substance to oxygen gas (O_2). Remind learners of the key rule: we never change the formulas, only the coefficients. The formulas are fixed by the chemistry; the coefficients are what we adjust.

Ask: how could learners check their own answers? By counting every type of atom on both sides. If any element doesn't balance, the equation is not balanced, even if some elements do.

Discuss: this equation is harder than the earlier examples because it requires larger coefficients. Ask learners: what made it difficult? The fact that oxygen atoms come in 2s (O_2) but are needed in 3s (Al_2O_3). Finding the lowest common multiple is a useful strategy when this happens. This links directly to maths.

Slide 12: scientific formulas and algebraic equations

This is the bridge slide between the balancing section and the algebra section.

Explain that every science formula is just an algebraic equation. The letters represent real physical quantities that can be measured.

Ask learners: what is the difference between $a = b \div c$ and $c = m \div V$?

Discuss: mathematically there is no difference. The structure is identical. The only differences are that the science letters have specific meanings (concentration, mass, volume) and the answer needs units.

Explain that if learners can solve equations in maths, they can solve science formulas. The process is identical: substitute the values you know, then solve for the unknown.

You can show other formulas that follow the same pattern:

- $\text{density} = \text{mass} \div \text{volume}$ $\left(d = \frac{m}{V}\right)$

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- speed $=$ distance $\div$ time $(s = \frac{d}{t})$
- pressure $=$ force $\div$ area $(P = \frac{F}{A})$

These include physics formulas, but they use the same algebra. Recognising this helps learners see that the mathematical skill transfers across all sciences, not just chemistry. If learners are also studying physics, they can apply the same substitute–then–solve approach to those equations too.

Ask learners: what do all these formulas have in common? They are all in the form 'something = something ÷ something', just like $a = b \div c$. Recognising this pattern means learners don't need to learn a different method for each formula.

Emphasise the approach that will be used throughout the rest of the lesson: substitute first, then rearrange. This mirrors what learners do in maths when they solve equations by replacing letters with numbers and then working out the unknown.

Slide 13: Substitution – you already do this in maths

This slide makes the connection between maths and science substitution explicit through a side–by–side comparison.

What is the same and what is different?

Ask learners to look at both examples. Discuss: what is the same and what is different?

Same

- Both start by writing the formula
- Both substitute numbers in place of letters
- Both calculate
- The arithmetic is identical

Different

In maths, the letters are abstract (x, y, z). In science, they represent real quantities (density, mass, volume).

The science answer has units (g/cm^3). The maths answer does not.

Why do units matter?

Ask: why do the units matter? 3 on its own is meaningless in science. 3 g/cm^3 tells us it is a density. 3 g would be a mass. 3 cm^3 would be a volume. The units tell the reader what the number represents.

Describe the four steps learners should follow when substituting into a science formula.

Step 1: write the formula

Step 2: substitute the values you know (with units)

Step 3: calculate

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Step 4: write the answer with units

Explain that this is the method learners will use for every substitution question in this lesson and in their exams. Step 1 is important because it shows the examiner which equation is being used. Step 4 is where learners most commonly lose marks, by forgetting units.

Slide 14: Substitution (worked example)

Walk through the four steps with learners. This is the first worked example using a chemistry context.

Step 1: explain that we always write the formula first, both in words and in letters. This shows the examiner which equation is being used and helps learners organise their working.

Step 2: substitute the values from the question. Ask learners: which number goes where? Mass = 14.6 g, volume = 2.0 dm^3. Remind learners to check they are putting the right values in the right places. A common error is dividing the wrong way round ($2.0 \div 14.6$ instead of $14.6 \div 2.0$).

Step 3: calculate. This is just arithmetic: $14.6 \div 2.0 = 7.3$.

Step 4: add units. Ask learners: where do the units come from? Mass is in grams and volume is in dm^3. So, concentration is g/dm^3. The units follow from the formula, grams divided by dm^3 gives g/dm^3.

Ask: what would happen if the volume was given in cm^3 instead of dm^3? The units of the answer would be g/cm^3 instead. Discuss why it is important to check the units of the values before substituting.

This example is deliberately straightforward as it requires substitution only, no rearranging. Ask learners: what if the question asked you to find the mass instead of the concentration? We would need to rearrange, which is covered next.

Slide 15: Substitution practice

Allow learners time to attempt each question using the four–step method from slide 14. Encourage learners to show all four steps in their working.

Slide 16: Substitution practice (answers)

2. Some learners may be unsure about dividing by 0.5. Ask: what is 8 divided by 0.5? Remind them that dividing by 0.5 is the same as multiplying by 2. If the answer seems surprisingly large, encourage learners to check whether it makes sense: if there are 8.0 g in half a dm^3, this means there would be 16.0 in a full dm^3.

3. This last question uses multiplication rather than division.

Ask learners: does the four–step method still work? Yes, the process is identical regardless of whether the formula involves multiplying or dividing.

Some learners may recognise that $\text{mass} = \text{concentration} \times \text{volume}$ is just a rearranged version of $\text{concentration} = \frac{\text{mass}}{\text{volume}}$ from question 2.

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Discuss: these are not two different formulas; they are the same relationship written differently. This links to the next section on rearranging.

Slide 17: Changing the subject of an equation

This slide is purely maths. The purpose is to establish the method and language before applying it to science on the next slide.

Explain that 'changing the subject' means getting a different letter on its own on one side of the equation. In maths this is sometimes phrased as 'make b the subject' or 'find b'. learners will have encountered this language in maths lessons.

Walk through the example step by step.

First: substitute. Explain that once the known values are in, learners are left with a simple equation with one unknown, just like they solve in maths lessons. Ask learners: what do we know? $a = 5$, $c = 4$. What don't we know? b. So, we substitute and get $5 = \frac{b}{4}$.

Then: ask learners where is b? It is being divided by 4. Ask: what is the inverse of dividing by 4? Multiplying by 4. So, we multiply both sides by 4. Explain that we do the same thing to both sides to keep the equation balanced. This gives us $5 \times 4 = b$, so $b = 20$.

Discuss: this is a one–step rearrangement because the unknown (b) is on the top of the division. It only takes one inverse operation to get b on its own. Later in the lesson we will look at examples where the unknown is on the bottom of the division, which requires an extra step.

Discuss: why do we substitute first rather than rearranging the letters? Because once the numbers are in, learners can see what they are working with. $5 = \frac{b}{4}$ is easier to solve than rearranging $a = \frac{b}{c}$ to $b = a \times c$ with letters only.

Remind learners of the inverse operations: × undoes ÷, ÷ undoes ×, + undoes −, − undoes +. These are the same inverse operations learners use in maths.

Slide 18: Changing the subject of an equation (worked example)

This slide shows the maths and science side by side. The numbers are deliberately the same so learners can see that the working is identical.

Explain that this example is harder than slide 14 because the unknown is on the bottom of the division. This means it takes two steps to isolate it instead of one. Ask learners: why can't we just do it in one step like before? Because when the unknown is on the bottom, we first need to get it out of the bottom (multiply by the unknown) and then get it on its own (divide by the number).

Ask learners to compare the two columns line by line. Discuss: what is the same? The steps, the operations and the arithmetic are all identical. What is different? Only the letters and the units.

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Explain that the phrase 'change the subject to c' in maths means the same thing as 'find V' or 'solve for V' in science. Using the maths language reinforces that this is the same skill.

Walk through both examples, emphasising the parallel at each step:

- Substitute: both give a number = a number ÷ an unknown
- Multiply both sides by the unknown: both give a number × unknown = a number
- Divide both sides: both isolate the unknown

Ask: what is the only extra thing we need in science? Units. The maths answer is 4. The science answer is 4 dm^3. Remind learners that units come from the formula: mass in grams divided by concentration in g/dm^3 gives volume in dm^3.

Ask: does it matter that the science formula uses c, m and V instead of a, b and c? No. The letters are different, but the algebra is the same. Once learners substitute the numbers, the letters disappear and they are left with a straightforward equation to solve.

Slide 19: Finding an unknown (worked example)

Walk through this worked example step by step. This is the first full example where the unknown is on the bottom of the division, so learners need the two–step rearrangement from the previous slide.

Step 1: write the formula. Ask learners: which formula links concentration, mass and volume? $\text{concentration} = \frac{\text{mass}}{\text{volume}}$

Step 2: substitute the values we know. Ask: what do we know? $\text{concentration} = 4.9\ \text{g/dm}^3$, $\text{mass} = 9.8\ \text{g}$. What don't we know? Volume. So, we get $4.9 = \frac{9.8}{V}$.

Step 3: change the subject. Ask learners: where is V? It is on the bottom of a division, so this is the harder type from slide 16. We need two steps.

First, multiply both sides by V to get it out of the bottom: $4.9 \times V = 9.8$. Ask: what kind of equation does this look like now? It looks like $4.9 \times V = 9.8$, which is the same as the simple maths equation $4.9c = 9.8$.

Then divide both sides by 4.9 to get V on its own: $V = \frac{9.8}{4.9}$.

Step 4: solve and add units. $V = 2.0\ \text{dm}^3$. Ask: where do the units come from? The mass was in grams and the concentration was in g/dm^3, so the volume is in dm^3.

Ask learners: does the answer make sense? The concentration is 4.9 g/dm^3, meaning there are 4.9 g in every dm^3. We have 9.8 g, which is double 4.9, so we need 2.0 dm^3. This is a useful check.

Discuss: this question uses the same formula as the substitution example on slide 12 ($c = \frac{m}{V}$), but here we are finding a different unknown. The formula is the same, only the subject has changed.

Slide 20: Finding unknowns practice

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Allow learners time to attempt each question. Remind them to substitute first, then change the subject.

Slide 21: Finding unknowns practice (answers)

2. Some learners may be unsure about multiplying by 0.4. Ask: does the answer make sense? The concentration is 5.0 in every dm^3, but we only have 0.4 dm^3, which is less than one dm^3. So, the mass must be less than 5.0 g. 2.0 g makes sense.

Ask learners: how can you tell whether the question needs one calculation or two? Look at where the unknown is after substituting. If it is on the top of the equation (being multiplied or divided by a number), one step is enough. If it is on the bottom of a division, two calculations are needed.

Discuss: all three questions use the same type of formula (something = something ÷ something) but the unknown is in a different position each time. The four–step method works regardless of which quantity is unknown.

Checking for understanding (slides 22–26)

Slide 22: Putting it all together

This slide brings everything together before the final worked example and lesson challenge question. The five–step approach is a general problem–solving framework that works for any chemistry calculation.

Explain the approach briefly.

Balance the equation – not every question will require this, but learners should always check. If the equation is already balanced, they can move on. On examination papers this is often a separate part of the question. (This is the first stage – three step process on slide 7.)

Choose the right formula – ask learners: how do you know which formula to use? Look at what quantities the question gives you and what it asks you to find. The formula must link those quantities.

The rest of the process is this is the same four-step method from the substitution section (slide 14) – or with the additional step to rearrange (slide 19).

Substitute the known values – replace the letters with numbers.

Rearrange and calculate – use inverse operations to make the unknown the subject, just like in maths. Remind learners: if the unknown is on the top, one calculation. If it is on the bottom, two calculations.

Add units – remind learners that this is where marks are commonly lost in exams. The units follow from the formula and the values substituted.

Discuss the note about unit conversions. Ask: when might you need to convert units? Common examples include cm^3 to dm^3 (divide by 1000) when using concentration in g/dm^3. Explain that it is easier to convert units before substituting because once the numbers are in the equation, it is harder to keep track of which values need

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converting. For learners needing further support, use the understanding number unit conversion resources: rsc.li/4gbEt3p.

Not every question will require all stages. Some may not need balancing (stage 1), some may not need rearranging (stage 4), and some may not need unit conversions. But the framework gives learners a reliable starting point for any question.

Slide 23: Discussing algebra in chemistry

Ask learners to work through each learner's answer, in pairs or on mini whiteboards, before revealing which is correct.

Slide 24: Discussing algebra in chemistry (answer)

Learner C is correct: $c = \frac{6.0}{1.5} = 4.0\ \text{g/dm}^3$

Learner A is incorrect because they forgot the units. The calculation is correct ($6.0 \div 1.5 = 4$) but without units the answer is incomplete. Ask learners: what does '4' mean on its own? It could be 4 g, 4 dm^3, 4 mol. Units tell the reader what the number represents. In exams, forgetting units will lose marks.

Learner B is incorrect because they divided the wrong way round. They calculated $\text{volume} \div \text{mass}$ ($1.5 \div 6.0 = 0.25$) instead of $\text{mass} \div \text{volume}$ ($6.0 \div 1.5 = 4.0$). This is a very common error. Remind learners to look at the formula carefully: $\text{concentration} = \frac{\text{mass}}{\text{volume}}$ means mass is on the top and volume is on the bottom.

Ask: how could learner B have spotted their error? Encourage learners to check whether the answer makes sense. A concentration of 0.25 g/dm^3 means there is only 0.25 g in every dm^3. But they started with 6.0 g in 1.5 dm^3, which is clearly more than 0.25 per dm^3. Checking whether an answer is reasonable is a valuable habit.

Discuss: these two errors (forgetting units and substituting values the wrong way round) are the most common mistakes learners make in calculation questions. Ask learners: how can you avoid them? Writing the formula first helps with both, because it shows which value goes where and what units the answer should have.

Slide 25: Returning to the lesson question

We return to the challenge question from the start of the lesson. Allow learners time to attempt it independently before discussing as a class.

Slide 26: Returning to the lesson question (answer)

(a) There are 2 Na on the right (Na_2SO_4), so we need $2NaOH$ on the left. This gives 4 H on the left (2 from H_2SO_4, 2 from $2NaOH$) matching 4 H on the right ($2H_2O$).
Check all elements: H: $4 = 4$, S: $1 = 1$, O: $6 = 6$, Na: $2 = 2$

Common errors

Part a): forgetting to put 2 in front of H_2O as well as $NaOH$. Remind learners to check every element after balancing.

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Part b): dividing the wrong way round ($2.0 \div 9.8$ instead of $9.8 \div 2.0$). Remind learners to write the formula first and substitute carefully.

Part c): not realising the mass stays the same when diluting. Discuss: when you add water to a solution, you are not adding or removing any solute. The same 9.8 g of sulfuric acid is now spread through a larger volume, which is why the concentration decreases.

Part c): substituting incorrectly, for example calculating 2.45×9.8. Remind learners to look at the formula: $\text{concentration} = \frac{\text{mass}}{\text{volume}}$. After substituting, $2.45 = \frac{9.8}{V}$. The unknown is on the bottom, so this is the two–step rearrangement from slide 17.

Discuss: this question combines all three skills from the lesson: balancing (part a), substitution (part b), and changing the subject (part c). Ask learners: which part did you find most difficult?

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