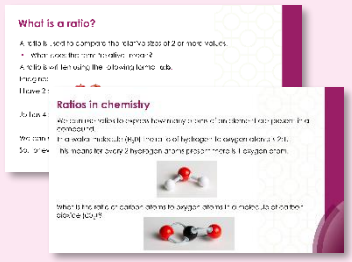
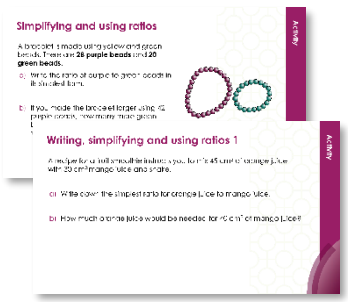
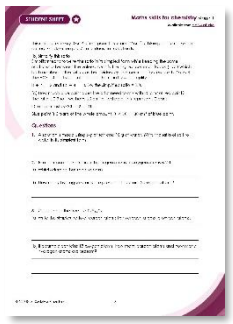
Ratio and proportion

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

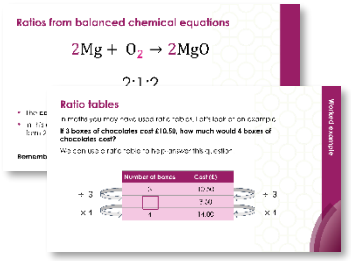
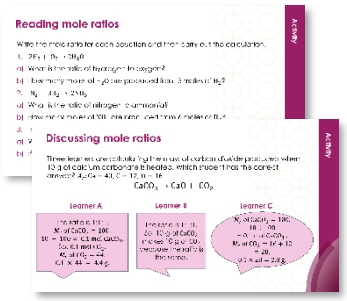
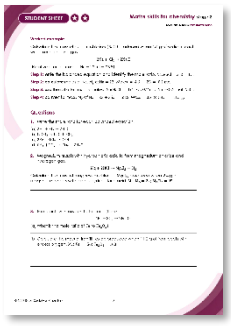
- Graphs and data, divided into:
    - Creating graphs
    - Interpreting graphs
- **Ratio and proportion**
- Understanding number, divided into:
    - Unit conversion
    - Significant figure
- Algebra and equations

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 (✪): 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 sheet** (✪): 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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Stage 2 ✪✪		
		
Teacher-led presentation (✪✪)	**Short activities (✪✪)**	**Learner worksheet (✪✪)**

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 math skills and then begin to apply these independently.

Learning objectives

1. Understand how to write ratios correctly and simplify them.
2. Know how and when to simplify ratios.
3. Work out the ratios of atoms in a chemical formula.
4. Use ratios to calculate required quantities.

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 mathematics 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.

Have the key terms list or accessible glossary available for learners who require additional support with mathematical vocabulary.

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 ratios when calculating mass or using ratios to express how many elements are in a compound
- after summative assessment as an intervention.

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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 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?'
- **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.

Avoid giving learners access to this presentation independently. It is designed to be teacher-led.

1. Outline the learning objectives (slide 2)
2. Review the chemistry question (slide 3) without answering it, following the teacher notes (provided in the presentation and copied below).
3. Present the introduction to ratio and simplifying ratio (slide 4-6).
4. Work through the mathematics modelling slides, making explicit links between maths and science (slides 7−16).
5. Learners complete the 'checking for understanding' questions. Ask learners to independently complete the starting question using the knowledge covered during the lesson (slides 17−20).

Review learning

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

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Common misconceptions

Some of the common misconceptions related to ratio are:

- thinking that the order of the ratio does not matter
- some learners think that bigger numbers mean a substance is more reactive
- to simplify a ratio, we can subtract numbers
- only even numbers can be simplified
- ratios must always be simplified.

In this resource we have not highlighted the difference between a ratio by mass and a ratio by atoms.

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 1–6)

Slide 1: Title slide

Slide 2: Learning objectives

No notes.

Slide 3: Lesson question

This slide introduces a challenge question for learners. We will return to complete the question at the end of the session, or this question could be used as a diagnostic assessment to see what learners already know.

Learners may not know what an alloy is. An alloy is a mixture of two or more elements, where at least one must be a metal and the resulting material has metallic properties. Statues, coins and car wheels are commonly made from alloys, for instance, coins are often made from cupronickel (copper + nickel), car wheels from aluminium alloys, and statues from bronze (copper + tin).

Use this simple explanation above and explain that the focus of learning is about ratios and not about alloys. The following slide describes in more detail what a ratio is.

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Slide 4: What is ratio?

Discuss the term 'relative' with learners. What does it mean? Relative means in relation to each other.

If we use the terms A and B to represent the values, the ratio statement is asking us to compare how much of A there is compared to how much there is of B rather than:

- How big is A?
- How big is B?

Ask learners to say the ratio a:b out loud. They should say a **to** b (or for every a, there is one b).

An example could be:

I have 2 apples and Jo has 4 apples.

The ratio of my apples to Jo's apples is 2:4

Discuss with learners how they know which number to put first. The statements said the ratio of my apples to Jo's apples is … We place the numbers in the order in which the statement or question lists them.

Learners often make a mistake here, so it is important to stress this point. The arrows point from 'my' to the 2 and from Jo's to the 4 to show this visually. This strategy could be used in further modelling opportunities if learners are not sure.

2:4 is simplified to 1:2. So the ratio no longer tells us the exact number of apples each person has anymore, it tells us about the **relationship** between the apples. For every apple I have, Jo has 2. This is the relative size of the values. Learners do not always understand this point.

The next slide discusses simplification in more detail.

Slide 5: What does simplifying a ratio mean?

Key terms on this slide including simplify and highest common factor (HCF) have been defined in our key terms support: rsc.li/4wypuqq.

Discuss how to simplify a ratio using apples and pears as an example.

If learners understand the order of the fruit in the question, then they should be confident that there are 8 pears in the ratio.

There are 4 bananas for every 8 pears. Make sure learners realise that there are not necessarily 4 bananas in total, however. This is important to check.

Demonstrate to learners that $\frac{4}{8}$ and $\frac{1}{2}$ are different numbers but they represent the same relative amounts.

We could divide 4 and 8 in the ratio by 2 and this would give a ratio of 2:4 which can then be further simplified to 1:2

Some learners may find this approach easier.

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When the ratio is 1:2, check again that learners realise there is not suddenly just one banana! It's 1 banana to every 2 pears.

Ask learners how many bananas there would be if there were 6 pears in the fruit bowl? The ratio is still 1:2.

What do we need to multiply 2 by to get 6?

$2 \times 3 = 6$ pears.

Multiply 1 by 3 to get 3 bananas.

The ratio is still 1:2.

Slide 6: Can all ratios be simplified?

No, the ratio cannot be further simplified as there is no common factor other than 1.

All parts of a ratio are whole numbers.

Extension:

Ask learners if the following ratios can be simplified:

2:3 (No)

6:9 (Yes, as can be divided by 3 to get 2:3)

3:9 (Yes, as can be divided by 3 to get 1:3)

7:2 (No, as there is no number larger than 1 that divides into both 7 and 2).

Mathematical modelling (slides 7–16)

Slide 7: Simplifying ratios

Discuss the ratio of red to blue beads without simplifying at this point. Follow the structure given to help learners. Make sure that learners have got the numbers the correct way round.

Discuss the HCF for 20 and 30. What could the factors be?

Factors of 20: 1, 2, 4, 5, 10, 20

Factors of 30: 1, 2, 3, 5, 6, 10, 15, 30

Common factors: 1, 2, 5, 10

Highest Common Factor = 10

Look at the ratio of blue beads to green beads now and ask learners to lay out the answer in a similar way as modelled. The answers are presented on the next slide.

Slide 8: Simplifying ratios (answer)

No notes.

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Slide 9: Ratio in chemistry

Discuss these molecules with learners and ask them to explain why the ratio cannot be written 1:2 for the ratio of hydrogen atoms to oxygen atoms forming water. Stress the importance of noticing which quantity comes first in a statement or question.

Discuss what the subscripts mean in a formula, using the images to help.

The ratio of carbon to oxygen atoms is 1:2. Ask learners what this means. For every 1 carbon atom there are 2 oxygen atoms forming a carbon dioxide molecule.

Slide 10: Ratio and chemical formulas

Encourage learners to have a go even though they will not necessarily recognise the compounds. Modelling initially if necessary.

This lesson is about ratio and not about stoichiometry, but it is always a useful opportunity to talk about the symbols of elements. In HCl we know Cl is one element because the l is a lower-case letter.

Slide 11: Ratios and chemical formulas (answers)

Hydrogen peroxide: 1:1 − learners may say 2:2 here. Ask them to explain why this is not the answer.

Ethane: 1:3 − learners may say 2:6, ask them to simplify

Butane: 2:5 − remind learners who say 4:10 to simplify further.

Slide 12: Using ratios (worked example)

Model how to approach this question.

Ask learners to work out the volume of oxygen present as a check. Oxygen is present in 1 part so $1 \times 4 = 4\ \mathrm{dm}^3$

Slide 13: Using ratios

Model how to approach this question if needed.

Slide 14: Using ratios (answer)

No notes.

Slide 15: An alloy

When learners simplify a ratio, they sometimes incorrectly subtract both parts rather than divide both by a common factor. This slide aims to help with this misconception. This slide is animated as it is helpful to display the questions one at a time.

The value of a ratio is not affected by multiplying or dividing each term by the same number. However, the value of the ratio is affected by adding or subtracting the same number.

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Understanding of alloys could be considered here (while not taught, learners may have some understanding). Alloys are often used because they have improved upon the properties of pure metals. This may be an enhanced colour, strength, easier to shape etc. This mixture of gold and silver is called electrum and has been used since ancient times for coins and jewellery. It tarnishes less readily.

Slide 16: An alloy (answer)

No notes.

Checking for understanding (17–20)

Slide 17: Discussing ratio

Learner A is correct.

Learner B is incorrect because they have treated the ratio numbers as actual quantities without scaling them up. They think there are 2 hydrogen atoms and 1 oxygen atom rather than 18 atoms.

Learner C is incorrect because they have multiplied each part of the ratio by the total number of atoms. This would give 54 atoms in total rather than 18 as per the question.

Slide 18: Discussing ratio (answer)

No notes.

Slide 19: Returning to the lesson question

We are returning to the initial question from the start of the session to complete it using the mathematical skills focused on during the session. The answer is displayed for learners on the next slide.

Slide 20: Lesson question (answer)

No notes.

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