



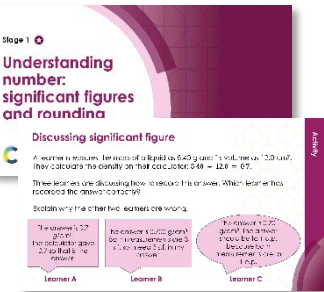
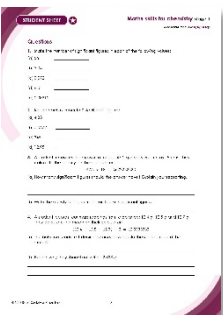
Significant figures and rounding

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:

- Graphs and data, divided into:
 - Creating graphs
 - Interpreting graphs
- Ratio and proportion
- **Understanding number**, divided into:
 - Unit conversion
 - **Significant figures and rounding**
- 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. Understanding number is available at stage 1 only.

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 (★): activities for learners to independently practice their maths skills. Suitable as a classroom activity following the teacher presentation or as a home-learning task.



Key terms support

Key maths 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 skills in a chemistry context. The aim is for learners to develop key skills and then begin to apply these independently.

Learning objectives

- 1 Understand what rounding means and why it is used in science.
- 2 Understand what significant figures are and why they matter in science.
- 3 Round numbers to a given number of significant figures.
- 4 Choose an appropriate number of significant figures when recording measurements and carrying out calculations.

As you move through the presentation, there is a clear progression in skill development. The first slides engage learners' prior knowledge of the chosen maths skills. 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. For significant figure and rounding, this might be alongside practical work or calculations with results to multiple decimal places
- 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 maths 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 maths 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 an introduction, learning objectives, and a chemistry question which uses the maths skills. During the presentation, the learners acquire the skills relevant to the question. At the end of the presentation, learners answer the question posed at the start, using the maths skills they have developed.

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

1. Outline the learning objectives with learners (slide 2)
2. Review the chemistry question (slide 3–4) without answering it, following the teacher notes (provided in the presentation and copied in the slide notes below).
3. Use the rounding recap activity (slides 4–6) to complete the introduction to this lesson.
4. Work through the mathematical modelling slides, making explicit links between maths and science (slides 7–14).
5. Learners complete the ‘checking for understanding’ questions. Ask learners to independently complete the lesson question using the knowledge covered during the lesson (slides 15–16).

Review learning

Use the linked learner worksheet and short activities presentation as a follow-up to this lesson 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.

Slide 1: Title slide

Slide 2: Learning objectives

Slide 3: Session question

This slide introduces the challenge question that learners will return to at the end of the session. Learners are not expected to attempt it at this point. Explain what a eureka can is. Show an example if you have one available.

Briefly talk through the scenario: a learner has measured the mass and volume of a block of wood and calculated the density using a calculator. The calculator has given a long string of digits. By the end of the session, learners will have the skills to decide how this answer should be recorded and be able to explain why.

You can ask learners: 'What do you think the problem is with this answer?' to prompt initial thinking, but a full attempt is not needed here. The question is designed to elicit the most common mistakes made during this type of calculation.

Slide 4: Rounding recap

This slide should feel like revision for most learners, rounding should be familiar from the primary phase. Explain that the purpose is to activate prior knowledge and show that the core rounding process (identify the digit, look at the decider, round up or down) is already familiar from maths.

Discuss each example, asking learners to identify the decider digit before you reveal the answer.

Slide 5: Rounding recap (answers)

(a) Round 3.456 to 1 decimal place (d.p.)

Look at the 2nd decimal place digit: 5. This is 5 or more, so round up.

Answer: 3.5

(b) Round 7.823 to 2 d.p.

Look at the 3rd decimal place digit: 3. This is less than 5, so round down.

Answer: 7.82

(c) Round 0.0483 to 2 d.p.

Look at the 3rd decimal place digit: 8. This is 5 or more, so round up.

Answer: 0.05

Question (c) is the most useful for discussion. Some learners may write 0.048, which is rounding to 3 d.p. rather than 2 d.p. Remind learners that decimal places are



counted from the decimal point: the first decimal place is the 0, the second is the 4, so the divider is 8.

This example also foreshadows the problem with decimal places that comes on the next slide – rounding 0.0483 to 2 d.p. gives 0.05, which has lost most of the useful information. Significant figures will offer a better approach.

Do a quick mini whiteboard check to confirm understanding: 'round 4.271 to 1 d.p.' (answer: 4.3).

This is deliberately quick – the main content of the session is significant figures, which comes next.

Slide 6: The problem with decimal places in science

This slide is the bridge between what learners know (decimal places) and what they need to learn (significant figures).

Ask learners to work out what 0.00247 rounded to 1 d.p. would be before revealing the answer.

Answer: 0.0 g – all the useful information has been lost.

Then ask: what if we round to 2 significant figures instead?

Answer: 0.0025 g – the important information is kept.

Explain that decimal places count from the decimal point, but significant figures count from the first meaningful digit. For very small numbers, rounding to decimal places can destroy the information.

Learners may ask why a scientist would measure such a small mass. Describe how analytical balances in research laboratories can measure to 0.00001 g (five decimal places). Analytical balances in laboratories can measure to 4–6 decimal places depending on the model. This is far more precise than the balances learners use in school, but the principle is the same – the number of digits we record must reflect the precision of the equipment.

Discuss very large numbers to reinforce the point: a population of 7,894,352 rounded to 1 d.p. is still 7,894,352.0 – decimal places don't help there either. Significant figures would give 7,900,000 (2 s.f.), which is much more useful.

Learners should leave this slide understanding **why** significant figures exist, not just **how** to use them. The rest of the session builds on this motivation.

Slide 7: What are significant figures?

Explain that significant figures (s.f.) tell us how precise a number is by counting the meaningful digits, regardless of where the decimal point sits.

Discuss with learners the comparison of 3 g, 3.0 g and 3.00 g. Ask: are these the same number?



Mathematically yes, but in science they communicate different things. 3.00 g means the measurement was made with a more precise instrument than 3 g. The trailing zeros tell the reader something important about the precision of the equipment.

Discuss the fact that all non-zero digits are significant – this is straightforward and learners rarely make errors with this rule. It is deciding whether the zeros are significant or not that makes the process difficult and is where learners make the most mistakes. Emphasise that rules 2, 3 and 4 are all about zeros.

Work through the four rules with learners:

Rule 1: All non-zero digits are significant. 247 has 3 s.f. – this is the easiest rule and learners are usually confident with it.

Rule 2: Zeros between non-zero digits (trapped zeros) are significant. 204 has 3 s.f., not 2. Ask learners: why does this zero count? Because it is part of the number – removing it would change 204 to 24, which is a completely different value.

Rule 3: Leading zeros are **not** significant – they are just placeholders showing where the decimal point is. 0.003 has only 1 s.f. Explain that the zeros in 0.003 are not telling us anything about precision – they are just positioning the 3. Ask: what would happen if we removed them? We couldn't – the number would become 3, which is a thousand times bigger. So, the zeros are necessary, but they don't carry information about precision.

Rule 4: Trailing zeros after a decimal point **are** significant. 2.50 has 3 s.f. Ask learners: why did someone bother writing that zero? Because it tells us the measurement was precise to the hundredths – the equipment could distinguish between 2.50 and 2.51. If the zero didn't matter, they would have just written 2.5.

Discuss: what about trailing zeros **without** a decimal point? For example, is 6500 given to 2, 3, or 4 s.f.? This is genuinely ambiguous, which is why in science we can use standard form to remove doubt ($6.5 \times 10^3 = 2 \text{ s.f.}$, $6.50 \times 10^3 = 3 \text{ s.f.}$). You can mention this briefly here or save it for the practice slide.

Extension task: Ask learners to write down a number that has exactly 4 significant figures and includes at least one zero that **is** significant. Then ask them to write a number that has exactly 2 significant figures and includes at least one zero that is **not** significant. Discuss their examples as a class – this tests whether learners can apply the rules rather than just recall them.

Slide 8: How many significant figures?

Many learners think decimal places and significant figures are the same, this is a common misconception.

Ask learners to identify the number of significant figures for each value. This can be done individually, in pairs, or on mini whiteboards. Encourage learners to write down which rule(s) they used (see previous slide), not just the answer.

Slide 9: How many significant figures? (answers)

45 – 2 s.f.



Rule 1: both digits are non-zero.

This is straightforward and builds confidence before the trickier examples.

3.07 – 3 s.f.

Rules 1 and 2: the 3 and 7 are non-zero (rule 1), and the zero is between two non-zero digits so it is significant (rule 2).

Ask: what would happen if a learner ignored the zero and said 2 s.f.? They would be treating 3.07 as if it were 3.7, which is a different number.

0.025 – 2 s.f.

Rules 1 and 3: the 2 and 5 are non-zero (rule 1), and the leading zeros are not significant (rule 3).

Discuss: learners often count the leading zeros and say 3 or 4 s.f. Remind them that leading zeros are just placeholders – they position the decimal point but don't carry information about precision.

1.00 – 3 s.f.

Rules 1 and 4: the 1 is non-zero (rule 1), and the trailing zeros after the decimal point are significant (rule 4).

Discuss: why isn't this just 1 s.f.? Because someone deliberately wrote those zeros to show that the measurement was precise to the hundredths. Explain that 1, 1.0 and 1.00 are mathematically equal but communicate different levels of precision in science.

0.0040 – 2 s.f.

Rules 1, 3 and 4: the 4 is non-zero (rule 1), the leading zeros are not significant (rule 3), and the trailing zero after the decimal point is significant (rule 4).

This is the most challenging example because it combines three rules. Learners may say 1 s.f. (only counting the 4), or 4 s.f. (counting every digit). Describe how to work through it: start from the left, skip the leading zeros until you reach the first non-zero digit (4), then count from there – the 4 and the trailing 0 are both significant.

Ask learners which examples they found most difficult. Discuss common errors and clarify any confusion before moving on to rounding.

Extension task: Ask learners to identify the number of significant figures in 6500.

Discuss why this is ambiguous – we cannot tell whether the trailing zeros are significant or just placeholders. Explain that in science, standard form removes this ambiguity: 6.5×10^3 is 2 s.f., 6.50×10^3 is 3 s.f., and 6.500×10^3 is 4 s.f.

Slide 10: Worked example

Discuss the worked example step by step with learners before they attempt the practice questions.

Step 1: The leading zeros are not significant (rule 3). The first significant figure is 4.

Step 2: The second significant figure is 5. The decider digit is 7.



Step 3: The decider is 7, which is 5 or more, so round up. The 5 becomes 6.

Answer: 0.046

Ask learners: why do the leading zeros stay in the answer? Because they are placeholders – without them the number would be 46, which is a completely different value. Remind learners that rounding does not remove leading zeros.

Slide 11: Worked example (answers)

- (a) First s.f. is 6, second s.f. is 7. Decider is 8 (≥ 5), so round up. Answer: 68
- (b) Leading zeros are not significant. First s.f. is 3, second s.f. is 6. Decider is 1 (< 5), so round down. Answer: 0.0036
- (c) First s.f. is 4, second s.f. is 9, third s.f. is 9. Decider is 7 (≥ 5), so round up. The third s.f. (9) becomes 10, which cascades: 4.997 becomes 5.00. Answer: 5.00
This catches many learners out. Discuss: why must the answer be written as 5.00 and not 5? Because 5 is 1 s.f. and 5.00 is 3 s.f. – dropping the trailing zeros changes what the number communicates about precision. This links directly to rule 4 from slide 6.
- (d) First s.f. is 2, second s.f. is 5. Decider is 4 (< 5), so round down. Answer: 25000
Discuss why we fill in zeros. Because without them the number would be 25, which is a thousand times smaller. The zeros are placeholders that keep the number the correct size.

Ask learners which question they found most difficult. Question (c) is typically the hardest because of the cascading rounding and the need to keep trailing zeros. Question (d) also causes problems because learners forget to fill in placeholder zeros.

Extension task: Ask learners to round 0.009962 to 2 s.f. This combines the cascading rounding from question (c) with the leading zeros from question 2.

Answer: 0.010 – learners must keep both the leading zeros and the trailing zero. The first significant figure is the 1 (after rounding), and the trailing zero shows it is 2 s.f.

Slide 12: Why do significant figures matter in chemistry?

Explain that in science, the number of significant figures we write tells the reader how precise our measurement was. Different equipment gives different levels of precision.

Describe the three equipment examples:

- A balance reading 12.35 g gives 4 s.f.
- A measuring cylinder reading 25 cm³ gives 2 s.f.
- A thermometer reading 21.5°C gives 3 s.f.

Ask learners: why do these have different numbers of significant figures? Discuss how different instruments measure to different levels of precision – a balance that reads to 2 decimal places is more precise than a measuring cylinder that reads to the nearest cm³.



Introduce the key rule: give your answer to the same number of significant figures as the least precise measurement used in the calculation. Explain that there is no point giving an answer to 4 s.f. if one of the measurements only had 2 s.f. – the answer cannot be more precise than the data it came from.

Worked example

- Ask learners to attempt the example before revealing the answer.
- Ask: which measurement is least precise? The volume, which is 2 s.f.
- Ask: so how many significant figures should the answer have? 2 s.f.
- Ask: what is 0.2168 rounded to 2 s.f.? First s.f. is 2, second s.f. is 1. Decider is 6 (≥ 5), so round up.
- Answer: 0.22 g/cm³

Discuss: why not write 0.2168 g/cm³?

Because the measuring cylinder only measured to 2 s.f. – writing 4 s.f. suggests a level of precision that the equipment did not have. The calculator does not know how precise the measurements were – the learner must decide.

Discuss: why not write 0.2 g/cm³?

Because that is only 1 s.f., which throws away precision that the data does support. The volume justified 2 s.f., so the answer should be 2 s.f.

Explain that this is where science differs from maths. In maths, learners are often told 'give your answer to 2 d.p.' – the precision is specified in the question. In science, the appropriate precision comes from the data itself.

Extension task

A learner measures a mass of 24.81 g on a balance and a volume of 8.2 cm³ using a measuring cylinder. They calculate density = 3.025609756 on their calculator. How should they record their answer?

Answer: 3.0 g/cm³ (2 s.f., matching the volume).

Discuss: why must they write 3.0 and not 3? Because 3 is 1 s.f. but 3.0 is 2 s.f. This reinforces the trailing zero issue.

Slide 13: Do I use significant figure or decimal places?

Explain that the rule learners use depends on the type of calculation they are doing. This is a convention used in science – it is not something learners will have met in maths.

Note: This distinction between the two rules is a simplification appropriate for lower and upper secondary. At post-16, learners calculate uncertainties explicitly using propagation rules, which replaces these guidelines with a more rigorous quantitative approach. However, these two principles are a solid foundation that covers the majority of situations learners will encounter.



Describe how for multiplication or division, the answer should have the same number of significant figures as the least precise value used in the calculation. Walk through the example.

Round to 2 s.f.: first s.f. is 1, second s.f. is 1. Decider is 8 (≥ 5), so round up.

Answer: 1.2 g/cm^3

Ask: why not 1.189? Because the measuring cylinder only measured to 2 s.f. – the answer cannot be more precise than the equipment.

Explain that for addition or subtraction, the answer should have the same number of decimal places as the equipment used. Walk through the example

The values are from a thermometer that reads to 1 d.p.

Calculator gives 2.799... (this occurs because of the way calculators handle decimal arithmetic)

The thermometer reads to 1 d.p., so the answer should be to 1 d.p.

Answer: 21.7°C

Ask: why not write 21.6667? Because the thermometer only measures to 0.1°C – writing four decimal places suggests a level of precision the equipment does not have. A mean of repeated measurements from the same instrument should match the precision of that instrument.

Note for teachers: Many exam boards accept a mean quoted to one more significant figure than the raw data if it is the exact result of the calculation. This nuance is not addressed at this level but may be relevant at upper secondary and post-16.

Slide 14: Recurring numbers

This is a direct conflict with what learners learn in maths, so address it explicitly.

0.33 g/cm^3 (2 s.f., matching the least precise measurement). The recurring dot notation has no place in a science answer.

In maths, recurring notation is elegant and exact. In science, it is meaningless because no measurement is infinitely precise. Some learners may argue that $0.\dot{3}$ is 'more accurate' than 0.33 – the response is that accuracy in science is limited by the equipment, not by the mathematics. The dot notation has no place in a science answer.

Slide 15: Returning to the lesson question

Return to the challenge question from the start of the session. Allow learners time to attempt it independently before discussing as a class. This question tests multiple skills simultaneously: choosing the correct number of significant figures, identifying which digits are significant (including the trapped zero), and rounding correctly. Common errors learners make are written below the answer.

Slide 16: Returning to the lesson question (answers)



The correct answer is 0.304 g/cm^3 (3 significant figures).

The answer should be given to 3 s.f. because this is a division and the rule is to match the least number of significant figures from the data. The mass (15.8 g) is 3 s.f. and the volume (52.0 cm^3) is 3 s.f., so the answer should be 3 s.f.

To round 0.30384615384 to 3 s.f.: the first three significant figures are 3, 0 and 3 (leading zeros are not significant, but the trapped zero is). The decider digit is 8 (≥ 5), so round up to give 0.304 g/cm^3 .

Common errors and misconceptions:

Error 1 – matching decimal places instead of significant figures. Learners write 0.3 g/cm^3 because both measurements are to 1 d.p. This is the wrong rule. For division, match significant figures, not decimal places. The d.p. rule applies to addition and subtraction. This is the most likely error because it sounds reasonable.

Error 2 – truncating instead of rounding. Learners write 0.303 g/cm^3 . They have correctly identified 3 s.f. but chopped rather than rounded. The digit after the third s.f. is 8, so the 3 should round up to 4.

Error 3 – counting leading zeros as significant. Learners write 0.30 g/cm^3 , claiming 3 s.f. They have counted the leading zero as significant. Rule 3 from slide 6: leading zeros are never significant.

Error 4 – miscounting significant figures. Learners write 0.3038 g/cm^3 (4 s.f.) or 0.30 g/cm^3 (2 s.f.). Revisit the rules (see slide 6) the trapped zero between the 3s **is** significant (rule 2), but leading zeros are **not** (rule 3).

Error 5 – copying the calculator. Learners write $0.30384615384 \text{ g/cm}^3$. This is shown on the slide, so learners are unlikely to do it, but it is a useful discussion point. Ask: what does writing 11 significant figures imply about the precision of a school balance and measuring cylinder?