



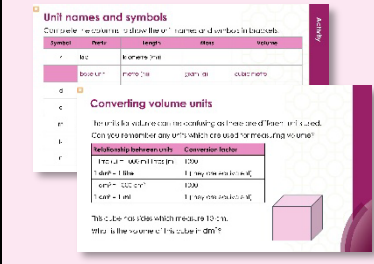
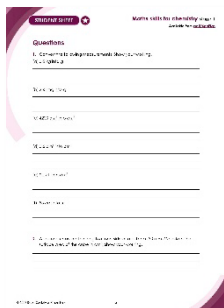
Unit conversion

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 ★ 	Introduction Unit conversion is very important in chemistry and everyday life. Using the correct units is essential to ensure that calculations are correct. For example, if you used the wrong unit for a measurement, it could lead to a dangerous situation. It is always good to check the units of a measurement before you use it. Learning objectives 1. To understand the importance of unit conversion in chemistry and everyday life. 2. To be able to convert between different units of measurement. 3. To be able to convert between different units of measurement.	
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 Recognise the units of measurements we use in chemistry.
- 2 Convert between different units of measurement.
- 3 Know when we need to convert between units.

As you move through the presentation, there is a clear progression in skills development. The first 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 converting between units during a titration experiment
- 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 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 target maths skills. During the presentation, the learners acquire the maths skills relevant to the question. At the end of the presentation, learners answer the question posed at the start, using the 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 3)
2. Review the lesson question (slide 4) without answering it, following the teacher notes (provided in the presentation and copied below).
3. Work through the mathematics modelling slides, making explicit links between maths and science (slides 5–18).
4. Learners complete the 'checking for understanding' questions. Ask learners to independently complete the lesson question using the knowledge covered during the lesson (slides 19–22).

Review learning

You can use the linked learner worksheet and short activities as a follow-up to this lesson or later as a review.

Common misconceptions

Learners often consider ml to be a unit of mass, confusing the 'm' in ml with milligrams. Some learners think of dm^3 as a measurement of length because they see the 'm' and confuse with metre. Make sure learners understand that dm^3 means cubic decimetre in words and is a volume.

The term cubic decimetre is correct in scientific terminology; the term decimetre cubed is also generally understood to mean the same thing. However, if you say decimetre cubed, someone could wonder: are you cubing the decimetre part, or applying the deci- prefix to a metre cubed?

If you cube the decimetre $\rightarrow (\text{dm})^3 = 1 \text{ litre}$

If you put deci- in front of metre cubed $\rightarrow \text{d}(\text{m}^3) = \text{one tenth of a cubic metre} = 100 \text{ litres}$, which is a big difference.

Use the correct terminology (cubic decimetre) for clarity.



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 1–4)

Slide 1: Title slide

Slide 2: Introduction

Ask learners to think of an example of when using the wrong unit could cause a problem.

Slide 3: Learning objectives

No notes.

Slide 4: Lesson question

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

Learners are used to converting units in primary mathematics. Learners may not be familiar with the prefixes, nano- and micro- at this point but this question will apply what they know from using familiar units throughout the presentation.

Discuss the two forms of measurement highlighted in bold (diameter and volume). Ask learners to name any units associated with these types of measurement.

Diameter: learners may recall centimetres, millimetres. You can extend this by asking about length, learners may recall metres, kilometres, nanometres, micrometres.

Volume: learners may recall litres, millilitres, cubic centimetres, cubic decimetres.

The rapid COVID-19 antigen test is an example of a biosensor containing gold nanoparticles that learners may be familiar with. Break down the word biosensor to bio and sensor. Bio means 'to do with life' and sensor means 'to sense or perceive something'.

Mathematical modelling (slides 5–18)

Slide 5: Types of units

This slide should feel like revision for most learners. Explain that the purpose is to activate prior knowledge and refresh learners' identification of units and symbols they are already familiar with from maths.



Encourage learners to say the name of the unit such as millimetre rather than mm. Learners may not be as confident with nanometre, micrometre, cubic decimetre and tonne. A tonne is also called a metric tonne and is equivalent to 1000 kg.

Learners may not realise that 1 litre is equivalent to 1 dm³. The litre is commonly used in maths but in chemistry we use cubic decimetres, so it is helpful to make sure learners realise this.

See page 3 in these teacher guidance notes for common misconceptions on units.

Slide 6: Types of unit (answers)

Discuss any units that students found difficult.

Learners may find dm³ hard to place. Support them to recognise that this is equivalent to a litre. The litre is commonly used in maths and in everyday language, but in chemistry we use cubic decimetres, so it is helpful to make sure students realise this. Highlight that cm³ and ml are equivalent and students may encounter both in different chemistry and maths contexts. Students could look at a measuring cylinder and notice the units used on this piece of common equipment.

As an extension activity, ask students to order the units from smallest to largest. You can demonstrate this on an interactive white board.

Slide 7: Prefix check

Ask learners to fill in the prefix column before revealing the answers. Get them to say each prefix name out loud. In maths the prefixes which tend to be regularly used are kilo-, centi- and milli-.

Remove the final column relating to powers of 10 if you feel this is too challenging for learners and simply leave the value column.

Talk through the table. Ask simple questions such as: if the base unit was a metre – how many metres are in a kilometre? How many centimetres are in a meter?

Point to the base unit row and explain that this is the reference point everything else is measured against. So, if the base unit was 1 metre, then 1000 metres is a kilometre.

The pattern going down the table is $\times 1000$ at each step. Kilo is 1000 times bigger than the base unit, milli is 1000 times smaller, micro is 1000 times smaller than milli, and so on. This is why the conversion factor between adjacent prefixes in this table is always 1000.

Centi- and deci- are the exceptions as they sit between the base unit and milli and do not follow the $\times 1000$ pattern. Centi- is less common in chemistry, but learners will recognise it from centimetres and from maths.

Watch for two common errors: learners confusing milli with million (milli means 1000th, not millionth), and learners mixing up capital M (mega) and lowercase m (milli), which is a mistake that changes a value by a factor of 1,000,000,000.



Ask learners: what is the conversion factor between nano and micro? They should spot it is 1000, just like every other adjacent pair. This supports learners to be able to answer the nanoparticle question at the end of the session.

Slide 8: Prefix check (answers)

Answer slide.

Slide 9: Unit names and symbols

Discuss with learners what the units are for the following different base units: metres, grams, cubic metres. Some of these units are very rarely used in chemistry but are included for completeness and practice in using the prefixes and symbols.

These resources commonly use dm^3 rather than litre. The files for this resource are all available in editable versions, for you to modify as best suits your learners' needs.

Lab equipment is commonly measured in ml. Make sure learners understand that 1 ml and 1 cm^3 are equivalent.

Slide 10: Unit names and symbols (answers)

Note on cubic metres versus metres cubed: the SI (International System of Units) for volume is the cubic metre.

Slide 11: Conversion factor

This slide is the conceptual part of the lesson. Emphasise that the bigger the unit, the smaller the number becomes when we convert between units.

Talk through the image showing the conversion of the base unit grams. When we convert 1 g into kilograms we divide by 1000. When we convert 1 g into milligrams then we multiply by 1000.

Consider a physical analogy. Use metre as the base unit here to make it more relatable. Show students a 1 m ruler. If we break the ruler into centimetre pieces we go from 1 ruler to 100 pieces of 1 cm. A larger unit to a smaller unit makes the number bigger.

Ask students to make their own conversion factor tables for different base units such as meters.

Slide 12: Number line

Before talking through the slide, ask learners what the prefix milli- means. Learners may incorrectly think it is linked to million. Milli means thousandth. The number line provides a visual scaffold for learners who find the abstract idea of conversion factors difficult. By showing the two scales on the same line for mg and g it aids understanding.

Ask learners what 1 g is equivalent to in mg. The word equivalent means they have the same value. When we convert values, we are simply changing them from one



form to another. $1\text{ kg} = 1000\text{ g}$. They are equivalent. $6\text{ g} = 6000\text{ mg}$. They are equivalent.

Talk through the first example if necessary, highlighting the mg and g scales.

Ask these questions repeatedly:

- What is the conversion factor?
- Is the unit getting bigger or smaller?
- Will the number become bigger or smaller?
- Do we multiply or divide by the conversion factor?

Some learners may find d) and e) challenging. If necessary, solve them through ideas from a class discussion and then demonstrate on an interactive whiteboard by adding in extra divisions on the number line to represent 0.5 g or 500 mg.

Slide 13: Number line (answers)

(a) This is the most accessible as the answer is clearly on the line.

(b) This answer reverses the direction. Watch for learners who write 0.008 g as they have used the wrong operation here. Ask learners are we going to a bigger unit or a smaller unit?

(d) Learners who are over-reliant on the number line may struggle as 2.5 sits between the marked divisions.

Ask learners if they can convert 450 mg into g. Check for learners who might give 45 g or 4.5 g as the answer. They are not dividing by 1000 to get 0.45 g. If this happens, provide more conversions to complete using the whole integer values and then use numbers between the marked divisions. The number line is a tool to use and not a replacement for understanding the conversion factor.

Ask learners if they need a number line or can do this just using the conversion factor. The goal is to help learners internalise the $\times 1000$ and $\div 1000$ and not need a visual scaffold.

Slide 14: Worked example

Learners are introduced to unit conversions in the primary phase. Learners are used to the units, litres and millilitres in mathematics and everyday life. This example is about converting units and gaining confidence in the process. This slide provides a scaffolded worked example to help learners lay out their working, in contexts which will be familiar from the primary phase.

Walk through the worked example step by step, narrating every decision aloud to model your thinking process. Encourage learners to lay out their answer in a similar way and always write out the conversion factor and whether they are multiplying or dividing before doing the calculation.



Watch for learners dividing in the second example, ml is smaller than L, so $\times 1000$. You can use this example to discuss that 1 ml is equivalent to 1 dm^3 . The answer is on the next slide.

Slide 15: Worked example (answers)

No notes.

Slide 16: Converting volume units

In maths, 11–14-year-old learners are expected to be able to change freely between related standard units including area and volume. However, explicit teaching of squaring and cubing of conversion factors for units of area and volume can be left until later in the secondary phase.

The unit cubic decimetre is most common in science curriculums. In mathematics and everyday life, most learners will be exposed to the unit litre and its related unit of millilitre. Emphasise repeatedly the equivalence between cubic decimetres and litres. There is also terminology which uses millilitres and cubic centimetres, which are also correct and equivalent.

Discuss the relationship between the units in the table. Artifacts like a 1 ml syringe and a 1 litre plastic bottle can be useful for having a visual representation of how these volumes relate to each other with a $\times 1000$ scale difference.

Learners often think $1 \text{ dm}^3 = 100 \text{ cm}^3$ because $1 \text{ m} = 100 \text{ cm}$. This is incorrect. Ask learners what the prefix deci- means. It means 'tenth', so a decimetre is a tenth of a meter or equivalent to 10 cm. Cubic decimetre means the conversion factor is also cubed.

Show the cube and give learners a moment to calculate the answer. Learners can use mini whiteboards and reveal their answers at the same time. The correct answer is 1 dm^3 because each side of the cube is $10 \text{ cm} = 1 \text{ dm}$, so volume = $1 \text{ dm} \times 1 \text{ dm} \times 1 \text{ dm} = 1 \text{ dm}^3$. This is also equal to 1 litre and 1000 cm^3 (since $10 \times 10 \times 10 = 1000$).

The cube question helps learners to understand that $1 \text{ dm}^3 = 1000 \text{ cm}^3$ rather than just accept it. They will then be less likely to think $1 \text{ dm}^3 = 100 \text{ cm}^3$.

Once learners have accepted $1 \text{ dm}^3 = 1000 \text{ cm}^3$, point out that this is why the conversion factor for dm^3 to cm^3 is 1,000, not 10 or 100 (the conversion factor is cubed $10 \times 10 \times 10$).

Slide 17: Worked example

Walk through the worked example step by step, narrating every decision aloud to model your thinking process. Encourage learners to lay out their answer in a similar way and always write out the conversion factor and whether they are multiplying or dividing before doing the calculation.

**Slide 18: Worked example (answer)**

Watch for learners who do $150 \div 100$ rather than $\div 1000$. This is the dm^3/cm^3 misconception again. If several learners make this error, return to the cube diagram on slide 16 before moving on.

Checking for understanding (slide 19–22)**Slide 19: Chemistry context**

This is a two-step calculation. Learners must realise that litres and dm^3 are equivalent before they can apply the conversion factor.

Slide 20: Chemistry context (answer)

The most likely error is learners trying to convert directly from litres to cm^3 using an incorrect conversion factor (often $\times 100$ or $\times 10$). If this happens, direct them back to the volume relationships table and ask: what is 1 litre equal to in dm^3 ? Once they see they are equivalent, the second step ($\times 1000$) should be obvious. Another common error is that learners stop after step one and write 2.5 dm^3 as their final answer, not realising there is still a conversion to do.

If learners are stuck, ask them to rewrite 2.5 litres using a different unit from the table we looked at earlier. This nudges them toward the litres = dm^3 equivalence without giving the answer away.

This question is good preparation for concentration calculations, where volumes are frequently given in litres or cm^3 in the question, but the formula requires dm^3 . Learners who can fluently move between all three of these units will be well prepared for this.

Slide 21: Returning to the lesson questions

We return to the challenge questions from the start of the session. Allow learners time to attempt them independently before discussing as a class.

Slide 22: Answer

No notes.