GCSE ONLINE TUTORING

GEOMETRY & MEASURES / TOPIC GUIDE 38

38

Units, measurement and scales

Shared GCSE core

Choose suitable units, read instruments carefully and convert lengths, areas and volumes with the correct scale factors. Use scale drawings and practical rounding while keeping exact values separate from estimates.

Length: k • Area: k^2 • Volume: k^3

Match the units before calculating.

UNDERSTAND THE IDEA. EXPLAIN THE METHOD.

Detailed teaching • Worked examples • Discussion • Original practice • Full solutions

Name: _____

INDEPENDENT GCSE MATHS • WEBSITE EDITION • NOVEMBER 2026

© 2026 GCSE Online Tutoring. All rights reserved.

GCSE ONLINE TUTORING / ABOUT THIS BOOK

Your learning guide

© 2026 GCSE Online Tutoring. All rights reserved.

Free for personal and household educational use. Tutors and schools must obtain permission before copying or distributing these books to learners. Resale, paid redistribution, removal of branding and uploading to third-party websites are prohibited without written permission. For permissions, visit www.gcseonlinetutoring.uk.

Independent educational resource

All explanations, examples, diagrams, questions and marking guidance are independently written. No exam-board questions or mark schemes are reproduced. This book is not affiliated with, approved by or endorsed by any awarding organisation.

Before you begin

Multiply and divide by powers of ten and calculate with decimals and ratios.

Your route through this notebook

1. Length, mass, capacity and time
2. Area and volume conversions
3. Reading instruments and reporting accuracy
4. Scale drawings and practical measurement

How to use it

Read a lesson, cover the worked solutions and try the examples yourself. Complete its practice page before checking the answers at the back. Finish with the mixed review, then return to any method you could not explain.

YOUR PROGRESS

After each lesson, ask: Can I explain the idea? Can I choose a method? Can I check my result? Record any questions you want to revisit.

© 2026 GCSE Online Tutoring. All rights reserved.

LESSON 1 / UNDERSTAND

Length, mass, capacity and time

A measurement combines a number and a unit. Converting units changes the numerical description without changing the quantity. Useful relationships are 1 km = 1000 m, 1 m = 100 cm, 1 cm = 10 mm, 1 kg = 1000 g and 1 litre = 1000 ml. Choose a unit that keeps the numerical size convenient and meaningful.

Time does not follow a decimal scale: 60 minutes make an hour. Convert minutes to a fraction of an hour before using a rate in kilometres per hour. A display such as 1:45 means 1 hour 45 minutes in a duration context, whereas 1.45 hours means 1 hour 27 minutes. State the meaning of an ambiguous notation. Use any supplied conversion factor for non-metric units; for example, if 1 mile is approximated as 1.6 km, 5 miles is approximately 8 km, not an exact identity.

A reliable method

1. Write the conversion relationship with both units.

2. Decide whether the new unit is smaller or larger.

3. For time, use factors of 60 rather than 100.

Worked example 1

Convert 2.35 m to centimetres and 840 g to kilograms.

STEP-BY-STEP SOLUTION

2.35 × 100 = 235 cm. Also 840/1000 = 0.84 kg. The physical quantities are unchanged.

Worked example 2

Convert 2 hours 24 minutes to hours.

STEP-BY-STEP SOLUTION

24/60 = 0.4 hour, so the duration is 2.4 hours. It is not 2.24 hours.

© 2026 GCSE Online Tutoring. All rights reserved.

LESSON 1 / DISCUSS & PRACTISE

Explain it, then try it

DISCUSSION • TEST THE IDEA

A larger numerical answer is expected when converting a fixed length into smaller units. If 3 m becomes 0.03 cm, the direction of conversion is wrong.

Say it in your own words

Explain the key idea to someone else. Use a small example to support your explanation. If you disagree with a claim, show why it fails.

1.1 Convert 4.6 km to metres.

1.2 Convert 75 mm to centimetres.

1.3 Convert 2.08 litres to millilitres.

1.4 Convert 1.75 hours to hours and minutes.

Check before turning to the answers: is the size sensible, is the notation clear, and have you included any required units?

© 2026 GCSE Online Tutoring. All rights reserved.

LESSON 2 / UNDERSTAND

Area and volume conversions

Area measures two dimensions, so a length conversion factor must be squared. A square metre contains 100 × 100 = 10,000 square centimetres. Volume measures three dimensions, so the factor is cubed: 1 m^3 = 100^3 = 1,000,000 cm^3. A linear factor cannot be copied unchanged into area or volume conversions.

Capacity and volume connect through 1 cm^3 = 1 ml and 1000 cm^3 = 1 litre. Therefore 1 m^3 = 1000 litres. Convert all dimensions to the same length unit before finding an area or volume, or convert a completed result using the squared or cubed factor. Record which route you use.

A reliable method

1. Identify whether the quantity is length, area or volume.

2. Square or cube the linear conversion factor as appropriate.

3. Use the volume-capacity link when litres are required.

Worked example 1

Convert 3.2 m^2 to cm^2.

STEP-BY-STEP SOLUTION

Multiply by 10,000: 32,000 cm^2. The factor is 100^2, not 100.

Worked example 2

A tank holds 0.075 m^3. Give capacity in litres.

STEP-BY-STEP SOLUTION

One cubic metre is 1000 litres, so 0.075 × 1000 = 75 litres.

© 2026 GCSE Online Tutoring. All rights reserved.

LESSON 2 / DISCUSS & PRACTISE

Explain it, then try it

DISCUSSION • TEST THE IDEA

A 10 cm by 10 cm square has area 100 cm², but each side is 0.1 m, so its area is 0.01 m². This small check confirms the factor of 10,000.

Say it in your own words

Explain the key idea to someone else. Use a small example to support your explanation. If you disagree with a claim, show why it fails.

2.1 Convert 4500 cm² to m².

2.2 Convert 0.006 m³ to cm³.

2.3 Convert 2800 cm³ to litres.

2.4 A box is 40 cm by 0.3 m by 250 mm. Find volume in litres.

Check before turning to the answers: is the size sensible, is the notation clear, and have you included any required units?

© 2026 GCSE Online Tutoring. All rights reserved.

LESSON 3 / UNDERSTAND

Reading instruments and reporting accuracy

Read the interval between labelled marks before reading a measurement. A ruler measurement is a difference between endpoint readings if the object does not start at zero. For a protractor, align the centre with the vertex and the baseline with one arm, then use the scale beginning at zero on that arm.

A measuring instrument has limited resolution. A length recorded as 8.4 cm to the nearest millimetre represents $8.35 \leq l < 8.45$ cm under the usual positive-value rounding convention. Do not imply more precision than the scale or instructions support. In an exact geometric calculation, however, a printed dimension is normally treated as exact unless the question states that it was rounded.

A reliable method

1. Determine the value of one small division.
2. Align or subtract endpoint readings correctly.
3. Use the requested accuracy and distinguish measured from given exact values.

Worked example 1

An object runs from 2.3 cm to 9.8 cm on a ruler. Find length.

STEP-BY-STEP SOLUTION

Length is $9.8 - 2.3 = 7.5$ cm, not 9.8 cm.

Worked example 2

A scale has five equal intervals between 20 and 30. Find one interval and the value three intervals after 20.

STEP-BY-STEP SOLUTION

One interval is $10/5 = 2$. Three intervals give $20 + 6 = 26$.

© 2026 GCSE Online Tutoring. All rights reserved.

LESSON 3 / DISCUSS & PRACTISE

Explain it, then try it

DISCUSSION • TEST THE IDEA

The numbers on a scale are not enough; count the spaces between adjacent marks. Six marks can enclose five intervals.

Say it in your own words

Explain the key idea to someone else. Use a small example to support your explanation. If you disagree with a claim, show why it fails.

3.1 A scale has four equal intervals from 1 to 2 litres. Find one interval.

3.2 An object spans 1.7 cm to 6.2 cm. Find length.

3.3 A positive length rounds to 12 cm to the nearest centimetre. State its interval.

3.4 Which protractor result is sensible for an acute angle: 38° or 142°?

Check before turning to the answers: is the size sensible, is the notation clear, and have you included any required units?

© 2026 GCSE Online Tutoring. All rights reserved.

LESSON 4 / UNDERSTAND

Scale drawings and practical measurement

A scale of 1:n means one length unit on the drawing represents n of the same units in reality. Match units before taking a ratio. To make a drawing, divide actual length by n; to recover an actual length, multiply the drawing length by n.

Scale drawings preserve corresponding lengths and angles when constructed accurately. They do not make an area n times as small: its factor is n^2. A diagram marked not to scale should be used for relationships, not measured for missing values. In practical purchases, calculate the required quantity before deciding whether whole packs must be rounded up.

A reliable method

1. Translate the scale into matching units.

2. Apply the correct drawing-to-real or real-to-drawing factor.

3. Distinguish a mathematical length from a whole-item purchase.

Worked example 1

Draw an 18 m wall at scale 1:200. Find drawing length.

STEP-BY-STEP SOLUTION

18 m = 1800 cm. Divide by 200 to get 9 cm.

Worked example 2

On a 1:50 plan a rectangle is 8 cm by 6 cm. Find actual area.

STEP-BY-STEP SOLUTION

Actual sides 400 cm and 300 cm = 4 m and 3 m. Area = 12 m^2. Do not multiply the plan area by 50 alone.

© 2026 GCSE Online Tutoring. All rights reserved.

LESSON 4 / DISCUSS & PRACTISE

Explain it, then try it

DISCUSSION • TEST THE IDEA

A labelled drawing can look approximately right while having inaccurate lengths. For construction questions, use measured dimensions; for not-to-scale diagrams, use the supplied facts.

Say it in your own words

Explain the key idea to someone else. Use a small example to support your explanation. If you disagree with a claim, show why it fails.

4.1 A 1:25 model is 14 cm long. Find actual length in metres.

4.2 A real length is 7.5 m. Find its drawing length at 1:100 in cm.

4.3 A 1:10 drawing has area 6 cm². Find actual area in cm².

4.4 A border needs 16.8 m of edging sold in 2.5 m lengths. How many lengths?

Check before turning to the answers: is the size sensible, is the notation clear, and have you included any required units?

© 2026 GCSE Online Tutoring. All rights reserved.

VISUAL EXPLAINER / RELATIONSHIPS, NOT GUESSWORK

Read the geometry

Units and scale factors keep the quantity unchanged

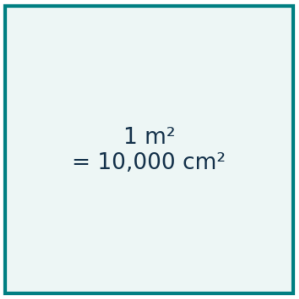
Linear units

1 m = 100 cm

1 km = 1000 m

2 h 24 min = 2.4 h

Area: square the factor



1 m = 100 cm

Volume and capacity

1 m³ = 1,000,000 cm³

1 cm³ = 1 ml

1 m³ = 1000 litres

Scale 1:200

9 cm on drawing

9 × 200 = 1800 cm = 18 m

WHAT THE FIGURES ESTABLISH

Length conversions use a linear factor; area and volume conversions use its square and cube. The scale example uses matching centimetres first, then converts to metres. These explanatory diagrams are not printed measurement exercises; use their labels.

Discuss: identify the given information, the geometric condition and the conclusion. Recalculate a labelled result or explain a theorem without measuring the sketch. Unless explicitly stated, diagrams are illustrative and are not measurement questions.

© 2026 GCSE Online Tutoring. All rights reserved.

MIXED REVIEW / ORIGINAL EXAM-STYLE PRACTICE

Apply your learning • 1

These questions are independently authored, not taken or adapted from past papers. Marks are suggested for self-assessment. Show your method and explain decisions. Use a calculator only where the arithmetic requires it.

R1. Convert 0.84 km to metres. [1 mark]

R2. Convert 2 hours 18 minutes to hours. [2 marks]

R3. Convert 0.72 m^2 to cm^2. [2 marks]

R4. A tank volume is 0.24 m^3. Find litres. [2 marks]

© 2026 GCSE Online Tutoring. All rights reserved.

MIXED REVIEW / ORIGINAL EXAM-STYLE PRACTICE

Apply your learning • 2

These questions are independently authored, not taken or adapted from past papers. Marks are suggested for self-assessment. Show your method and explain decisions. Use a calculator only where the arithmetic requires it.

R5. A box is 50 cm by 0.4 m by 300 mm. Find volume in litres. [3 marks]

R6. An object spans 3.8 cm to 11.4 cm. Find length. [1 mark]

R7. On a 1:500 plan a length is 7.2 cm. Find actual metres. [3 marks]

R8. A rectangle on a 1:20 drawing is 3 cm by 5 cm. Find actual area in m^2. [3 marks]

© 2026 GCSE Online Tutoring. All rights reserved.

SOLUTIONS / LESSON PRACTICE

Check the reasoning

Your layout may differ. Compare the mathematical reasoning as well as the final answer. Correct any error, then reattempt the question without looking.

Lesson 1 • Length, mass, capacity and time

1.1 Convert 4.6 km to metres.

4600 m.

1.2 Convert 75 mm to centimetres.

7.5 cm.

1.3 Convert 2.08 litres to millilitres.

2080 ml.

1.4 Convert 1.75 hours to hours and minutes.

1 hour plus 0.75 × 60 = 45 minutes: 1 hour 45 minutes.

Lesson 2 • Area and volume conversions

2.1 Convert 4500 cm^2 to m^2.

4500/10,000 = 0.45 m^2.

2.2 Convert 0.006 m^3 to cm^3.

6000 cm^3.

2.3 Convert 2800 cm^3 to litres.

2.8 litres.

2.4 A box is 40 cm by 0.3 m by 250 mm. Find volume in litres.

Dimensions 40,30,25 cm. Volume 30,000 cm^3 = 30 litres.

© 2026 GCSE Online Tutoring. All rights reserved.

SOLUTIONS / LESSON PRACTICE

Check the reasoning • continued

Lesson 3 • Reading instruments and reporting accuracy

3.1 A scale has four equal intervals from 1 to 2 litres. Find one interval.

0.25 litre.

3.2 An object spans 1.7 cm to 6.2 cm. Find length.

4.5 cm.

3.3 A positive length rounds to 12 cm to the nearest centimetre. State its interval.

$11.5 \leq l < 12.5$ cm.

3.4 Which protractor result is sensible for an acute angle: 38° or 142°?

38°, because an acute angle is between 0° and 90°.

Lesson 4 • Scale drawings and practical measurement

4.1 A 1:25 model is 14 cm long. Find actual length in metres.

350 cm = 3.5 m.

4.2 A real length is 7.5 m. Find its drawing length at 1:100 in cm.

750/100 = 7.5 cm.

4.3 A 1:10 drawing has area 6 cm². Find actual area in cm².

Area factor $10^2 = 100$, so 600 cm².

4.4 A border needs 16.8 m of edging sold in 2.5 m lengths. How many lengths?

16.8/2.5 = 6.72, so buy 7 lengths.

© 2026 GCSE Online Tutoring. All rights reserved.

SOLUTIONS / MIXED REVIEW

Answers and marking guidance

Award the suggested method marks for valid working, even where a later arithmetic slip occurs. Do not count the same step twice. These are independent teaching allocations, not official exam-board mark schemes.

R1. Convert 0.84 km to metres. [1 mark]

840 m. [1 for conversion.]

R2. Convert 2 hours 18 minutes to hours. [2 marks]

18/60 = 0.3; total 2.3 hours. [1 for minutes; 1 for total.]

R3. Convert 0.72 m^2 to cm^2. [2 marks]

0.72 × 10,000 = 7200 cm^2. [1 for squared factor; 1 for result.]

R4. A tank volume is 0.24 m^3. Find litres. [2 marks]

0.24 × 1000 = 240 litres. [1 for factor; 1 for result.]

R5. A box is 50 cm by 0.4 m by 300 mm. Find volume in litres. [3 marks]

50 × 40 × 30 = 60,000 cm^3 = 60 litres. [1 for units; 1 for volume; 1 for capacity.]

R6. An object spans 3.8 cm to 11.4 cm. Find length. [1 mark]

7.6 cm. [1 for subtraction.]

R7. On a 1:500 plan a length is 7.2 cm. Find actual metres. [3 marks]

7.2 × 500 = 3600 cm = 36 m. [1 for scale; 1 for conversion; 1 for result.]

R8. A rectangle on a 1:20 drawing is 3 cm by 5 cm. Find actual area in m^2. [3 marks]

Actual sides 0.6 m and 1 m, so 0.6 m^2. [1 for each side; 1 for area.]

Reflect, repair and revisit

Record one secure method, one mistake you corrected and one question to retry. Reattempt the questions you missed in a few days. Explain why your new method works before you compare your answer.

© 2026 GCSE Online Tutoring. All rights reserved.