GCSE MATHEMATICS

FOUNDATION TIER

COMPREHENSIVE LESSON NOTEBOOK

UNIT 4 | GEOMETRY & MEASURES

TEACH-FROM-SCRATCH • FREE WEBSITE EDITION

16 detailed chapters • original diagrams • worked examples • guided practice • answers

Student: ________________________________ Target grade: ______

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START HERE

STUDY ROUTINE

How to learn from this notebook

Meaning first. Method second. Practice third.

THE FIVE-PASS ROUTINE

1 Read the key idea without a calculator. 2 Cover each solution and reproduce it. 3 Complete the practice independently. 4 Mark in a different colour and repair errors. 5 Retest after 2–7 days.

What a complete mathematics answer contains

- A clear model or calculation, not only a calculator display.
- Enough working for another person to follow the reasoning.
- Exact values until approximation is requested.
- Units and sensible rounding in context.
- A final sentence when the result must be interpreted.

Error log

REPAIR, DO NOT MERELY CORRECT

Label each error: concept, operation, arithmetic, calculator entry, accuracy, unit or interpretation. Write the corrected step and one sentence explaining the change.

Foundation does not mean superficial

Foundation Tier rewards secure fluency and connected reasoning. Grade 4–5 questions often combine several familiar skills, hide the required operation inside a context, or ask whether an answer is reasonable. The notebook therefore explains why methods work as well as how to use them.

SPECIFICATION MAP

PEARSON EDEXCEL 1MA1

Unit 4 coverage map

Geometry and measures content organised into a teachable sequence.

CH 01	**G1, G3**	Geometric language and angle facts
CH 02	**G4, G6**	Parallel lines, triangles and polygons
CH 03	**G2, G14, G15**	Constructions, loci, scale drawings and bearings
CH 04	**G1, G5, G7, G11, G19**	Transformations, symmetry and congruence
CH 05	**G14, G16, G17**	Perimeter, area and composite shapes
CH 06	**G9, G17, G18**	Circles, circumference, arcs and sectors
CH 07	**G12, G13, G14, G16, G17**	Three-dimensional shapes, surface area and volume
CH 08	**G20**	Pythagoras’ theorem
CH 09	**G20**	Right-angled trigonometry
CH 10	**G24, G25 and geometry synthesis**	Vectors and mixed geometry reasoning
CH 11	**G4**	Triangles and special quadrilaterals
CH 12	**G5, G6**	Triangle congruence and simple geometric proof
CH 13	**G8**	Combined transformations and invariance
CH 14	**G12, G13**	Properties, nets, plans and elevations of three-dimensional solids
CH 15	**G19, G21**	Similarity and exact trigonometric values
CH 16	**G12, G16, G17**	Pyramids, cones, spheres and composite solids

IMPORTANT TIER NOTE

This notebook follows the Foundation-assessable content identified in the Pearson Edexcel GCSE Mathematics (1MA1) specification. Higher-only material is excluded from the core lesson sequence unless it is clearly labelled as optional enrichment.

REFERENCE

GEOMETRY FACTS AND FORMULAS

Fast-reference method bank

Understand each formula before memorising it.

Angles on a straight line	180°
Angles around a point	360°
Polygon interior sum	$(n-2)\times180°$
Trapezium area	$1/2(a+b)h$
Circle circumference	$2\pi r$ or πd
Circle area	πr^2
Prism volume	cross-section area × length
Pythagoras	$a^2+b^2=c^2$
Trigonometry	sin=O/H, cos=A/H, tan=O/A
Scale factors	length k, area k^2, volume k^3

CHAPTER 01 • G1, G3

G1, G3

Geometric language and angle facts

Name the object, mark the known facts, then justify every angle.

SPECIFICATION FOCUS

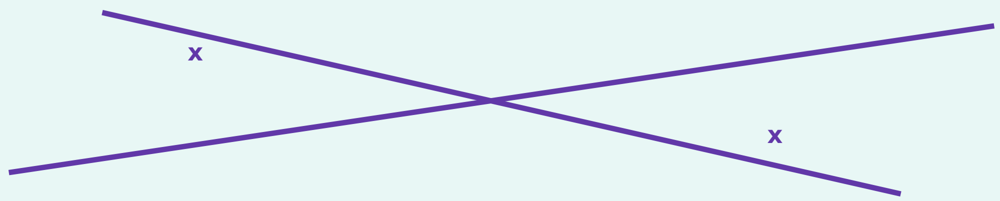
Pearson Edexcel content references G1, G3. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Geometry uses an exact visual language. Points are named with capital letters; a line continues in both directions, a ray has one endpoint and a segment has two. Angles measure turn. At an intersection, vertically opposite angles are equal; adjacent angles on a straight line total 180 degrees; angles around a point total 360 degrees.

KEY VOCABULARY

point • line • segment • ray • vertex • parallel • perpendicular • acute • obtuse • reflex



Vertically opposite angles are equal

Why the method works

- A straight line represents a half-turn, so its angles total 180 degrees.
- A full turn is 360 degrees, so angles around a point total 360 degrees.
- Vertically opposite angles are equal because each is supplementary to the same adjacent angle.
- Perpendicular lines meet at 90 degrees; matching arrow marks, not appearance, prove parallel lines.

CHECK BEFORE MOVING ON

Answer mentally: 1) Classify 38°. 2) Classify 146°. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 01 • G1, G3 • METHODS

G1, G3

Geometric language and angle facts — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Mark equal angles and write the rule beside the diagram.
- Form an equation from the complete angle total.
- Solve the equation, then substitute back for the requested angle.
- Check classification: acute <90, obtuse between 90 and 180, reflex between 180 and 360.

WORKED EXAMPLE 1

Two angles on a straight line are $(3x+10)°$ and $(5x−6)°$. Find x.

1. Their sum is 180°: $3x+10+5x−6=180$.
2. $8x+4=180$, so $8x=176$.
3. $x=22$.

ANSWER: 22

WORKED EXAMPLE 2

Angles around a point are 95°, 128° and y°. Find y.

1. Angles around a point total 360°.
2. $y=360−95−128$.

ANSWER: 137°

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Find the supplement of 67°. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 01 • G1, G3 • APPLICATION

G1, G3

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Road junctions, roof trusses and machine parts are described with line segments and angles. A scale drawing may look convincing, but only stated lengths, angle values and standard markings can be used as evidence.

Common mistakes and how to repair them

MISTAKE 1

Assuming a diagram is drawn to scale. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Writing only a number without the angle rule. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Confusing vertically opposite with adjacent angles. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why vertically opposite angles are equal. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 01 • G1, G3 • PRACTICE

G1, G3

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Classify 38°.**
2. **Classify 146°.**
3. **Find the supplement of 67°.**
4. **Angles around a point are 84°, 116° and x°. Find x.**
5. **Vertically opposite angles are (4x+9)° and (6x−17)°. Find x.**
6. **Find each angle where perpendicular lines meet.**
7. **Find the reflex angle corresponding to 112°.**
8. **Explain why vertically opposite angles are equal.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 02 • G4, G6

G4, G6

Parallel lines, triangles and polygons

Link local angle facts to the structure of a whole shape.

SPECIFICATION FOCUS

Pearson Edexcel content references G4, G6. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

When a transversal crosses parallel lines, corresponding and alternate angles are equal and co-interior angles total 180 degrees. A triangle has interior angle sum 180 degrees. Splitting an n-sided polygon into n−2 triangles gives interior angle sum (n−2)×180 degrees. Exterior angles of any polygon total 360 degrees.

KEY VOCABULARY

transversal • corresponding • alternate • co-interior • triangle • polygon • interior • exterior

Understand | Choose | Calculate | Check | Interpret

A reliable solution is a chain of decisions, not only a calculator display.

Why the method works

- Corresponding angles occupy matching corners at the two intersections.
- Alternate angles lie between parallel lines on opposite sides of the transversal.
- An n-gon can be divided from one vertex into n−2 triangles.
- One exterior turn at every vertex completes a full 360-degree turn.

CHECK BEFORE MOVING ON

Answer mentally: 1) Find the third angle of a triangle with 48° and 73°. 2) Find a missing quadrilateral angle if the others are 82°,91°,104°. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 02 • G4, G6 • METHODS

G4, G6

Parallel lines, triangles and polygons — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Mark the parallel lines and identify the named angle relationship.
- For triangles, use 180°; for a quadrilateral, use 360°.
- For a regular polygon, divide the total by the number of equal angles.
- State the theorem before each calculation.

WORKED EXAMPLE 1

Find each interior angle of a regular octagon.

1. Interior sum$=(8-2)\times180=1080°$.
2. Eight equal angles: $1080\div8$.

ANSWER: 135°

WORKED EXAMPLE 2

A regular polygon has exterior angle 24°. Find its number of sides.

1. Exterior angles total 360°.
2. Number of equal angles$=360\div24$.

ANSWER: 15 sides

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Find the interior sum of a decagon. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 02 • G4, G6 • APPLICATION

G4, G6

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Tessellating floor tiles meet around a point, so their angles must fill 360 degrees without gaps or overlaps. Regular triangles, squares and hexagons tessellate because their interior angles divide 360 exactly.

Common mistakes and how to repair them

MISTAKE 1

Using 360° as the interior sum of every polygon. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Mixing corresponding and co-interior rules. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Dividing by n before subtracting two in the polygon formula. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why exterior angles total 360°. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 02 • G4, G6 • PRACTICE

G4, G6

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Find the third angle of a triangle with 48° and 73°.**
2. **Find a missing quadrilateral angle if the others are 82°,91°,104°.**
3. **Find the interior sum of a decagon.**
4. **Find each interior angle of a regular pentagon.**
5. **Find each exterior angle of a regular nonagon.**
6. **A regular polygon exterior angle is 30°. Find sides.**
7. **Co-interior angle to 117° between parallel lines.**
8. **Explain why exterior angles total 360°.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 03 • G2, G14-G15

G2, G14, G15

Constructions, loci, scale drawings and bearings

Construct accurately from definitions, then interpret the required region.

SPECIFICATION FOCUS

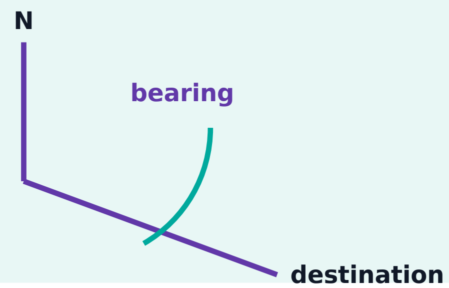
Pearson Edexcel content references G2, G14, G15. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

A ruler-and-compass construction records every point satisfying an exact distance condition. A perpendicular bisector is the locus of points equidistant from two endpoints; an angle bisector is the locus equidistant from two arms. Bearings describe clockwise angles from north using three digits. Scale drawings convert between drawing and real lengths.

KEY VOCABULARY

arc • compass • perpendicular bisector • angle bisector • locus • scale • north line • bearing



Why the method works

- Equal-radius arcs from two endpoints meet on the perpendicular bisector.
- A circle is the locus of points at a fixed distance from its centre.
- A bearing is measured clockwise from a north line and written with three digits.
- Reverse bearings differ by 180 degrees, adjusted to remain between 000° and 360°.

CHECK BEFORE MOVING ON

Answer mentally: 1) Write bearing 7° in three-digit form. 2) Find reverse bearing of 135°. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because ...” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 03 • G2, G14-G15 • METHODS

G2, G14, G15

Constructions, loci, scale drawings and bearings — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Keep compass radius fixed while drawing paired arcs.
- Draw all construction arcs; they are evidence of the method.
- For a bearing, draw north at the starting point and measure clockwise.
- Convert scale units before multiplying or dividing.

WORKED EXAMPLE 1

A bears 068° from B. Find the bearing of B from A.

1. Add 180° because $068° < 180°$.
2. $068° + 180° = 248°$.

ANSWER: 248°

WORKED EXAMPLE 2

On a 1:25,000 map two points are 7.2 cm apart. Find the real distance.

1. $\text{Actual} = 7.2 \times 25{,}000 = 180{,}000$ cm.
2. Convert: $180{,}000 \text{ cm} = 1.8$ km.

ANSWER: 1.8 km

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Find reverse bearing of 294°. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 03 • G2, G14-G15 • APPLICATION

G2, G14, G15

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Emergency planners use loci: “within 3 km of a hospital” is a circle; “closer to road A than road B” is one side of an angle bisector. The feasible region is the overlap satisfying every condition.

Common mistakes and how to repair them

MISTAKE 1

Measuring a bearing anticlockwise. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Erasing construction arcs needed to show method. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Applying a scale before converting units. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why north lines on a diagram are parallel. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 03 • G2, G14-G15 • PRACTICE

G2, G14, G15

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Write bearing 7° in three-digit form.**
2. **Find reverse bearing of 135°.**
3. **Find reverse bearing of 294°.**
4. **What locus is 4 cm from point P?**
5. **What locus is equidistant from points A and B?**
6. **A 1:50 scale drawing shows 8.4 cm. Find actual metres.**
7. **Actual 2 km is 5 cm on a map. Find scale.**
8. **Explain why north lines on a diagram are parallel.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 04 • G1, G5, G7, G11, G19

Transformations, symmetry and congruence

Describe the single transformation completely and test what it preserves.

SPECIFICATION FOCUS

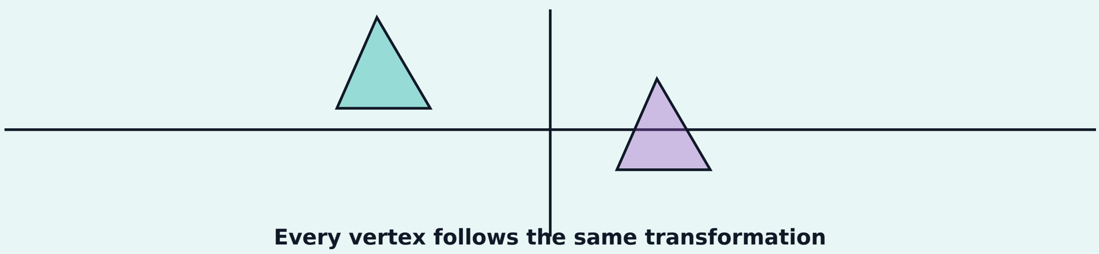
Pearson Edexcel content references G1, G5, G7, G11, G19. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

A transformation maps every point of an object to an image. A translation uses one vector; a reflection uses a mirror line; a rotation needs centre, angle and direction; an enlargement needs centre and scale factor. Translations, reflections and rotations preserve lengths and angles, so the image is congruent. Enlargements preserve angles and proportional lengths.

KEY VOCABULARY

object • image • translation • vector • reflection • rotation • centre • enlargement • congruent



Every vertex follows the same transformation

Why the method works

- A translation adds the same horizontal and vertical movement to every point.
- A reflection maps each point the same perpendicular distance across the mirror line.
- A rotation keeps every point the same distance from its centre.
- Congruent shapes have identical size and shape, even when their orientation differs.

CHECK BEFORE MOVING ON

Answer mentally: 1) Translate (1,−3) by vector (4,2). 2) Reflect (5,−2) in x-axis. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because ...” Use the key vocabulary above and refer to the representation in the diagram.

Transformations, symmetry and congruence — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Record coordinates of every vertex before transforming.
- For reflection, count perpendicular squares to the mirror line.
- For rotation, state centre, angle and clockwise or anticlockwise.
- For enlargement, join corresponding vertices through the centre and apply the scale factor.

WORKED EXAMPLE 1

Translate A(−2,3) by vector (5,−4).

1. Add 5 to x and −4 to y.
2. A′=(−2+5,3−4).

ANSWER: (3,−1)

WORKED EXAMPLE 2

Rotate P(4,1) 90° anticlockwise about the origin.

1. For 90° anticlockwise, (x,y) maps to (−y,x).
2. P′=(−1,4).

ANSWER: (−1,4)

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Reflect (−3,4) in y-axis. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 04 • G1, G5, G7, G11, G19 • APPLICATION

G1, G5, G7, G11, G19

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Computer graphics transform coordinates to move, turn, mirror and resize designs. A negative enlargement scale factor places the image on the opposite side of the centre as well as changing its size.

Common mistakes and how to repair them

MISTAKE 1

Giving only “rotation” without centre, angle and direction. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Swapping vector components. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Assuming orientation must match for congruence. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why enlargement factor 3 does not triple area. Write one sentence explaining why your calculation or conclusion is valid.

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Translate (1,−3) by vector (4,2).**
2. **Reflect (5,−2) in x-axis.**
3. **Reflect (−3,4) in y-axis.**
4. **Rotate (2,5) 180° about origin.**
5. **Enlarge (3,−2) by factor 2 about origin.**
6. **State four details for a rotation.**
7. **Do rotations preserve area?**
8. **Explain why enlargement factor 3 does not triple area.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 05 • G14, G16-G17 G14, G16, G17

Perimeter, area and composite shapes

Choose dimensions by meaning: boundary length is not surface coverage.

SPECIFICATION FOCUS

Pearson Edexcel content references G14, G16, G17. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Perimeter is the total distance around a boundary and uses linear units. Area measures surface coverage and uses square units. Composite figures are split into familiar non-overlapping shapes or found by subtracting a cut-out from a larger shape. For a trapezium, the average of the parallel sides is multiplied by the perpendicular height.

KEY VOCABULARY

perimeter • area • perpendicular height • base • trapezium • composite • square units

A = length x width

A = 1/2(a+b)h

Why the method works

- Rectangle area=length×width because it counts a rectangular array of unit squares.
- Triangle area is half the area of a rectangle or parallelogram with the same base and perpendicular height.
- Trapezium area=1/2(a+b)h because two copies form a parallelogram.
- Changing length scale factor k changes area by k^2.

CHECK BEFORE MOVING ON

Answer mentally: 1) Perimeter of rectangle 8 cm by 5 cm. 2) Area of rectangle 11 m by 4.5 m. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 05 • G14, G16-G17 • METHODS

G14, G16, G17

Perimeter, area and composite shapes — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Write every necessary length on the diagram, deriving missing sides.
- Select a formula and identify the perpendicular height.
- For composites, split or subtract, then label each partial area.
- Use cm^2, m^2 or another squared unit for area.

WORKED EXAMPLE 1

Find area of a trapezium with parallel sides 8 cm and 14 cm, height 6 cm.

1. $A=1/2(a+b)h$.
2. $A=1/2(8+14)\times 6=66$.

ANSWER: 66 cm^2

WORKED EXAMPLE 2

A 12 m by 9 m rectangle has a 4 m by 3 m corner removed. Find area.

1. Large area=108 m^2.
2. Removed area=12 m^2.
3. Remaining=108−12.

ANSWER: 96 m^2

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Area of triangle base 13 cm height 8 cm. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 05 • G14, G16-G17 • APPLICATION

G14, G16, G17

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Flooring is priced by area but skirting board by perimeter. A room with a recess therefore needs separate models: surface coverage for flooring and boundary length for trim.

Common mistakes and how to repair them

MISTAKE 1

Using a sloping side as triangle height. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Adding areas that overlap. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Writing cm instead of cm^2. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why equal perimeters need not mean equal areas. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 05 • G14, G16-G17 • PRACTICE

G14, G16, G17

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Perimeter of rectangle 8 cm by 5 cm.**
2. **Area of rectangle 11 m by 4.5 m.**
3. **Area of triangle base 13 cm height 8 cm.**
4. **Area trapezium sides 7,11 cm height 5 cm.**
5. **Square area 144 cm²: side length.**
6. **An 18×10 rectangle loses 6×4 cut-out: area.**
7. **Length factor 2.5: area factor.**
8. **Explain why equal perimeters need not mean equal areas.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 06 • G9, G17-G18 G9, G17, G18

Circles, circumference, arcs and sectors

Treat arc length and sector area as fractions of a whole circle.

SPECIFICATION FOCUS

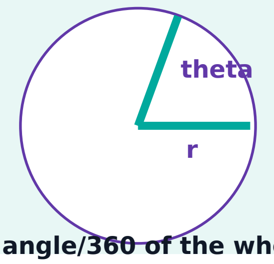
Pearson Edexcel content references G9, G17, G18. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

A circle is the set of points at a fixed radius from its centre. Diameter $d=2r$. Circumference is the boundary length $C=2\pi r=\pi d$, while area is $A=\pi r^2$. A sector with central angle θ occupies $\theta/360$ of the whole circle, so the same fraction applies to circumference for arc length and to area for sector area.

KEY VOCABULARY

centre • radius • diameter • circumference • chord • tangent • arc • sector • pi



sector = angle/360 of the whole circle

Why the method works

- Circumference is proportional to diameter; the constant ratio C/d is π.
- Area depends on two length dimensions, so the radius is squared.
- Arc length$=(\theta/360)\times 2\pi r$.
- Sector area$=(\theta/360)\times \pi r^2$.

CHECK BEFORE MOVING ON

Answer mentally: 1) Diameter 14 cm: radius. 2) Circumference radius 7 cm in terms of π. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 06 • G9, G17-G18 • METHODS

G9, G17, G18

Circles, circumference, arcs and sectors — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Identify whether the question asks for boundary, surface or a fraction of either.
- Convert diameter to radius where necessary.
- Substitute using π, keeping the calculator value unrounded.
- Round only the final answer and attach correct units.

WORKED EXAMPLE 1

Find circumference and area of a circle of radius 5 cm.

1. $C=2\pi\times5=10\pi$.
2. $A=\pi\times5^2=25\pi$.

ANSWER: 31.4 cm and 78.5 cm² (3 s.f.)

WORKED EXAMPLE 2

Find arc length of a 72° sector, radius 10 cm.

1. Fraction$=72/360=1/5$.
2. Arc$=(1/5)\times2\pi\times10=4\pi$.

ANSWER: 12.6 cm (3 s.f.)

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Area diameter 12 cm in terms of π. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 06 • G9, G17-G18 • APPLICATION

G9, G17, G18

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

A bicycle wheel distance per revolution is its circumference. A pizza slice is modelled by a sector: its crust length is an arc, while its cheese coverage is sector area.

Common mistakes and how to repair them

MISTAKE 1

Using diameter in πr^2 without halving. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Using square units for circumference. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Using $\theta/180$ instead of $\theta/360$. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why doubling radius quadruples area. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 06 • G9, G17-G18 • PRACTICE

G9, G17, G18

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Diameter 14 cm: radius.**
2. **Circumference radius 7 cm in terms of π.**
3. **Area diameter 12 cm in terms of π.**
4. **Circumference 10π cm: diameter.**
5. **Arc 90°, radius 8 cm in terms of π.**
6. **Sector area 120°, radius 6 cm in terms of π.**
7. **Find area of semicircle radius 4 cm.**
8. **Explain why doubling radius quadruples area.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 07 • G12-G17

G12, G13, G14, G16, G17

Three-dimensional shapes, surface area and volume

Use nets for exposed faces and cross-sections for volume.

SPECIFICATION FOCUS

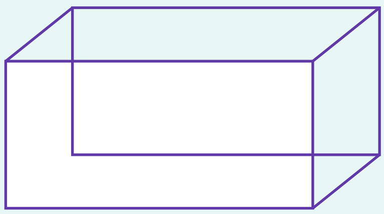
Pearson Edexcel content references G12, G13, G14, G16, G17. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

A prism has a constant cross-section along its length, so volume=cross-sectional area×length. Surface area is the total area of all exposed faces. A cylinder is a circular prism. Nets make every face visible and prevent omissions; units distinguish length, area and volume.

KEY VOCABULARY

face • edge • vertex • prism • cross-section • net • surface area • volume



Volume =

cross-section area

x prism length

Why the method works

- Cuboid volume=lwh counts layers of unit cubes.
- Prism volume=area of cross-section×length.
- Cylinder volume=$\pi r^2 h$.
- For similar solids with length factor k, surface-area factor=k^2 and volume factor=k^3.

CHECK BEFORE MOVING ON

Answer mentally: 1) Cuboid 6×4×9 cm: volume. 2) Cube side 5 cm: surface area. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 07 • G12-G17 • METHODS

G12, G13, G14, G16, G17

Three-dimensional shapes, surface area and volume — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Sketch or identify the constant cross-section.
- Calculate its area first, then multiply by prism length.
- For surface area, list each face or use a net.
- Convert all dimensions to one unit before calculation.

WORKED EXAMPLE 1

A triangular prism has triangle base 8 cm, height 5 cm, length 12 cm. Find volume.

1. Cross-section area$=1/2\times8\times5=20$ cm^2.
2. Volume$=20\times12$.

ANSWER: 240 cm^3

WORKED EXAMPLE 2

Find volume of cylinder radius 3 cm, height 10 cm.

1. $V=\pi r^2h$.
2. $V=\pi\times3^2\times10=90\pi$.

ANSWER: 283 cm^3 (3 s.f.)

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Prism cross-section 18 cm^2 length 7 cm: volume. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 07 • G12-G17 • APPLICATION

G12, G13, G14, G16, G17

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Packaging design balances volume held against surface material used. A closed cylinder needs two circular ends plus the curved surface; an open can has only one circular end.

Common mistakes and how to repair them

MISTAKE 1

Adding edge lengths when surface area is required. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Using circumference instead of circle area in cylinder volume. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Forgetting an exposed face. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain role of a net in surface area. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 07 • G12-G17 • PRACTICE

G12, G13, G14, G16, G17

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Cuboid $6\times4\times9$ cm: volume.**
2. **Cube side 5 cm: surface area.**
3. **Prism cross-section 18 cm^2 length 7 cm: volume.**
4. **Cylinder radius 4 cm height 5 cm: exact volume.**
5. **Cylinder diameter 10 cm height 8 cm: exact volume.**
6. **Length scale factor 3: volume factor.**
7. **Convert 2.5 litres to cm^3.**
8. **Explain role of a net in surface area.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 08 • G20

Pythagoras’ theorem

Use the right angle to identify the hypotenuse before selecting the equation.

SPECIFICATION FOCUS

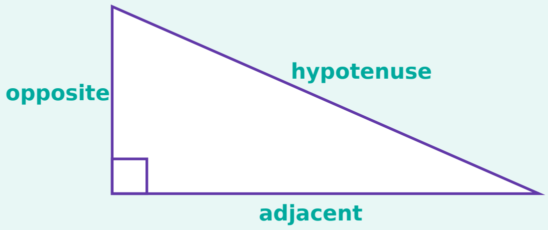
Pearson Edexcel content references G20. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

In a right-angled triangle, the square on the hypotenuse has the same area as the two squares on the shorter sides combined: $a^2+b^2=c^2$. The hypotenuse c lies opposite the right angle and is always the longest side. Rearrangement is needed when a shorter side is unknown.

KEY VOCABULARY

right angle • hypotenuse • shorter side • square • square root • exact value



a^2 + b^2 = c^2

Why the method works

- The theorem applies only to right-angled triangles.
- The hypotenuse is identified by position, not by the diagram orientation.
- For hypotenuse: $c=\sqrt{(a^2+b^2)}$.
- For a shorter side: $a=\sqrt{(c^2-b^2)}$.

CHECK BEFORE MOVING ON

Answer mentally: 1) Sides 6,8: hypotenuse. 2) Sides 9,12: hypotenuse. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

Pythagoras' theorem — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Mark the right angle and label the opposite side c.
- Substitute lengths with brackets before squaring.
- Add for the hypotenuse; subtract for a shorter side.
- Square-root, then round only at the end if requested.

WORKED EXAMPLE 1

Find hypotenuse of a right triangle with shorter sides 7 cm and 9 cm.

1. $c^2=7^2+9^2=130$.
2. $c=\sqrt{130}$.

ANSWER: 11.4 cm (3 s.f.)

WORKED EXAMPLE 2

Hypotenuse 13 m and one side 5 m. Find the other.

1. $a^2=13^2-5^2=144$.
2. $a=\sqrt{144}$.

ANSWER: 12 m

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Hypotenuse 17, side 8: other side. First predict the form or approximate size of the answer; then show a complete method.

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

A ladder, diagonal screen size and shortest straight route across a rectangular floor all form right triangles. The mathematical length must still be checked against practical clearance or safety conditions.

Common mistakes and how to repair them

MISTAKE 1

Using the theorem on a non-right-angled triangle. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Adding when finding a shorter side. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Rounding before taking the square root. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain how to identify hypotenuse. Write one sentence explaining why your calculation or conclusion is valid.

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Sides 6,8: hypotenuse.**
2. **Sides 9,12: hypotenuse.**
3. **Hypotenuse 17, side 8: other side.**
4. **Rectangle 5 by 12: diagonal.**
5. **Square side 10: exact diagonal.**
6. **Do sides 7,24,25 form a right triangle?**
7. **A ladder reaches 4 m up, foot 1.5 m out: length 3 s.f.**
8. **Explain how to identify hypotenuse.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 09 • G20

Right-angled trigonometry

Choose sine, cosine or tangent from the sides named relative to the angle.

SPECIFICATION FOCUS

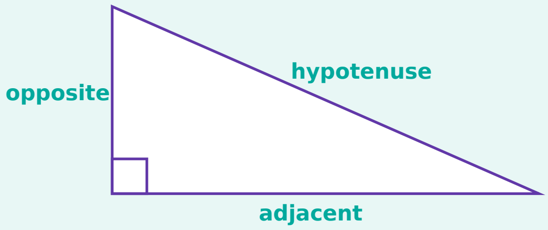
Pearson Edexcel content references G20. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Trigonometric ratios connect an acute angle in a right triangle with side-length ratios. Relative to angle θ, the hypotenuse is opposite the right angle, the opposite side faces θ, and the adjacent side touches θ but is not the hypotenuse. SOHCAHTOA records $\sin\theta = O/H$, $\cos\theta = A/H$ and $\tan\theta = O/A$.

KEY VOCABULARY

sine • cosine • tangent • opposite • adjacent • hypotenuse • inverse function



SOH CAH TOA

Why the method works

- Side names depend on the selected angle except for the hypotenuse.
- A ratio is chosen using the known and required sides.
- To find an angle, apply the inverse trigonometric function to a side ratio.
- Calculator angle mode must be degrees for GCSE degree questions.

CHECK BEFORE MOVING ON

Answer mentally: 1) O=5,H=13: find sinθ. 2) A=12,H=13: find cosθ. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because ...” Use the key vocabulary above and refer to the representation in the diagram.

Right-angled trigonometry — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Mark θ, then label O, A and H.
- Circle the known side and the required side.
- Choose the ratio containing both; substitute and rearrange.
- Use full calculator accuracy, then check that the size is plausible.

WORKED EXAMPLE 1

Find opposite side x when θ=35° and hypotenuse=12 cm.

1. $\sin 35° = x/12$.
2. $x = 12\sin 35°$.

ANSWER: 6.88 cm (3 s.f.)

WORKED EXAMPLE 2

Adjacent=8 m, opposite=6 m. Find θ.

1. $\tan\theta = 6/8$.
2. $\theta = \tan^{-1}(0.75)$.

ANSWER: 36.9° (1 d.p.)

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

$O=8, A=15$: find $\tan\theta$. First predict the form or approximate size of the answer; then show a complete method.

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Surveyors estimate inaccessible heights using a measured horizontal distance and angle of elevation. The model assumes level ground and a straight line of sight; eye height may need adding.

Common mistakes and how to repair them

MISTAKE 1

Naming adjacent as the side next to θ even when it is the hypotenuse. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Using sin instead of inverse sin to find an angle. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Calculator left in radians. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

State a check for a calculated hypotenuse. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 09 • G20 • PRACTICE

G20

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **$O=5, H=13$: find $\sin\theta$.**
2. **$A=12, H=13$: find $\cos\theta$.**
3. **$O=8, A=15$: find $\tan\theta$.**
4. **$\theta=30°, H=20$: find O.**
5. **$\theta=60°, A=7$: find H.**
6. **$O=9, H=15$: find θ to 1 d.p.**
7. **$A=10, O=4$: find θ to 1 d.p.**
8. **State a check for a calculated hypotenuse.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 10 • G24-G25

G24, G25 and geometry synthesis

Vectors and mixed geometry reasoning

Represent movement precisely and connect several geometric facts in one proof.

SPECIFICATION FOCUS

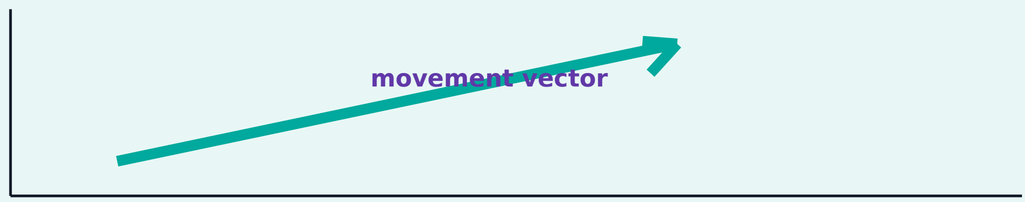
Pearson Edexcel content references G24, G25 and geometry synthesis. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

A vector has magnitude and direction and may be written as a column vector. Equal vectors describe identical movement wherever they are drawn. Vector paths can be added head-to-tail, reversed by changing sign, and scaled by multiplication. In geometry, alternative routes between the same points must give equal vector expressions.

KEY VOCABULARY

vector • scalar • magnitude • direction • column vector • resultant • parallel • collinear



horizontal and vertical components combine separately

Why the method works

- Adding vectors combines horizontal components and vertical components separately.
- The reverse of vector a is −a.
- Multiplying by a scalar changes magnitude and may reverse direction.
- If one vector is a scalar multiple of another, the directions are parallel; shared points may establish collinearity.

CHECK BEFORE MOVING ON

Answer mentally: 1) Add (4,3)+(−1,5). 2) Subtract (7,2)−(3,−4). 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

Vectors and mixed geometry reasoning — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Draw or imagine each vector head-to-tail.
- Choose a route from start to finish and add its vectors.
- Simplify horizontal and vertical components separately.
- Check direction and confirm an alternative route gives the same result.

WORKED EXAMPLE 1

Add vectors (3,−2) and (−5,7).

1. Add horizontal components: 3−5=−2.
2. Add vertical components: −2+7=5.

ANSWER: (−2,5)

WORKED EXAMPLE 2

AB=a and BC=b. Write CA.

1. AC=a+b.
2. CA is the reverse of AC.

ANSWER: −a−b

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Find −3(2,−5). First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 10 • G24-G25 • APPLICATION

G24, G25 and geometry synthesis

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Navigation, forces and animation use vectors to combine movements. A displacement is not the total journey distance: walking 3 km east then 3 km west has zero resultant vector but 6 km travelled.

Common mistakes and how to repair them

MISTAKE 1

Adding magnitudes while ignoring direction. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Forgetting to reverse every component. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Claiming collinearity without showing a scalar multiple. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain difference between distance and displacement. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 10 • G24-G25 • PRACTICE

G24, G25 and geometry synthesis

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Add (4,3)+(−1,5).**
2. **Subtract (7,2)−(3,−4).**
3. **Find −3(2,−5).**
4. **AB=(5,−2). Find BA.**
5. **OA=a, AB=b. Write OB.**
6. **OP=3a and OQ=7a. What can be concluded?**
7. **A rectangle is 6 by 8. Find diagonal.**
8. **Explain difference between distance and displacement.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 11 • G4

G4

Triangles and special quadrilaterals

Use defining properties rather than visual appearance.

SPECIFICATION FOCUS

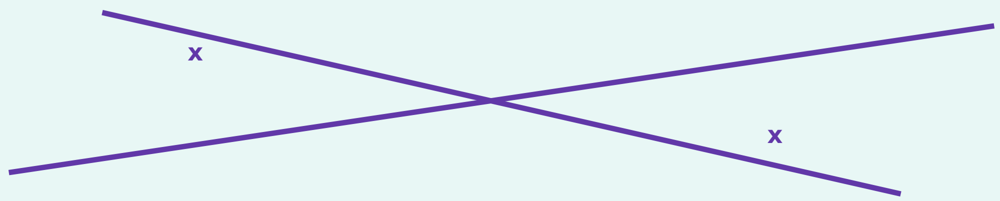
Pearson Edexcel content references G4. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

A shape is classified by properties that must always hold. An isosceles triangle has at least two equal sides and equal base angles. A parallelogram has two pairs of parallel opposite sides; a rectangle adds four right angles; a rhombus has four equal sides; a square satisfies both rectangle and rhombus definitions. A kite has two pairs of adjacent equal sides.

KEY VOCABULARY

equilateral • isosceles • scalene • square • rectangle • parallelogram • rhombus • kite • trapezium



Vertically opposite angles are equal

Why the method works

- Definitions identify necessary properties, not features that happen to appear in one drawing.
- A square is a rectangle and a rhombus because it satisfies both definitions.
- Opposite angles are equal in a parallelogram.
- Diagonals have different properties in different quadrilaterals.

CHECK BEFORE MOVING ON

Answer mentally: 1) Equilateral triangle angle. 2) Isosceles base angles if vertex 30°. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

Triangles and special quadrilaterals — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Mark parallel, equal and right-angle information.
- Match only properties guaranteed by the definition.
- Use angle sums and parallel-line facts to derive missing values.
- State the property used in every conclusion.

WORKED EXAMPLE 1

A parallelogram has one angle 68°. Find the other three.

1. Opposite angles equal; adjacent angles total 180°.

ANSWER: 112°,68°,112°

WORKED EXAMPLE 2

An isosceles triangle has vertex angle 44°. Find each base angle.

1. Remaining total=136°.
2. Equal base angles=68°.

ANSWER: 68°

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Parallelogram adjacent to 125°. First predict the form or approximate size of the answer; then show a complete method.

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Structural frames use triangles for rigidity and parallelograms for linked movement. Correct classification matters because different properties support different conclusions.

Common mistakes and how to repair them

MISTAKE 1

Calling every sloping quadrilateral a parallelogram. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Assuming diagonals of every quadrilateral are equal. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Using appearance rather than markings. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why a rhombus need not be a square. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 11 • G4 • PRACTICE

G4

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Equilateral triangle angle.**
2. **Isosceles base angles if vertex 30°.**
3. **Parallelogram adjacent to 125°.**
4. **Name quadrilateral with four equal sides and four right angles.**
5. **Name quadrilateral with one pair parallel sides.**
6. **Are all squares rectangles?**
7. **Are all rectangles squares?**
8. **Explain why a rhombus need not be a square.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 12 • G5-G6

G5, G6

Triangle congruence and simple geometric proof

Prove identical size and shape using sufficient information.

SPECIFICATION FOCUS

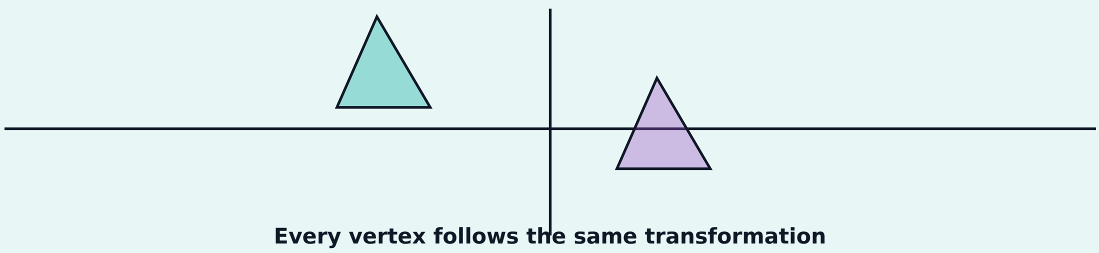
Pearson Edexcel content references G5, G6. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Congruent triangles match exactly under a rigid transformation. The standard criteria are SSS, SAS, ASA and RHS. SSA is not generally sufficient because two different triangles may fit. Congruence permits corresponding sides and angles to be declared equal, forming short geometric proofs.

KEY VOCABULARY

congruent • corresponding • SSS • SAS • ASA • RHS • proof



Every vertex follows the same transformation

Why the method works

- SSS fixes all three side lengths.
- SAS requires the included angle between the two known sides.
- ASA fixes a side and two angles; the third angle then follows.
- RHS applies only to right triangles with equal hypotenuse and one other side.

CHECK BEFORE MOVING ON

Answer mentally: 1) Name criterion: three equal sides. 2) Two sides and included angle. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 12 • G5-G6 • METHODS

G5, G6

Triangle congruence and simple geometric proof — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Match corresponding vertices in order.
- Mark the three facts used.
- Name the valid congruence criterion.
- State the corresponding equality that follows.

WORKED EXAMPLE 1

Triangles ABC and DEF have AB=DE, BC=EF and AC=DF. Prove congruent.

1. All three corresponding sides equal.

ANSWER: SSS

WORKED EXAMPLE 2

Two right triangles have hypotenuse 10 cm and one side 6 cm. Are they congruent?

1. Right angles, equal hypotenuse, equal side.

ANSWER: Yes, RHS

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Two angles and included side. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 12 • G5-G6 • APPLICATION

G5, G6

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Surveying and fabrication use congruent components so measurements transfer reliably from one part to another.

Common mistakes and how to repair them

MISTAKE 1

Using AAA, which proves similarity not congruence. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Using SSA without a right-angle condition. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Failing to match corresponding vertices. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why SAS angle must be included. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 12 • G5-G6 • PRACTICE

G5, G6

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Name criterion: three equal sides.**
2. **Two sides and included angle.**
3. **Two angles and included side.**
4. **Right angle,hypotenuse,one side.**
5. **Does AAA prove congruence?**
6. **What does congruence preserve?**
7. **If ΔABC≡ΔDEF, which side matches BC?**
8. **Explain why SAS angle must be included.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 13 • G8

G8

Combined transformations and invariance

Track each stage in order and describe what remains unchanged.

SPECIFICATION FOCUS

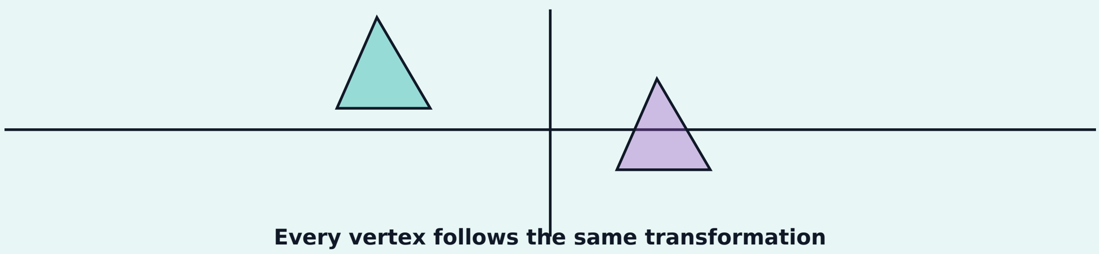
Pearson Edexcel content references G8. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

A combined transformation applies two or more mappings successively; changing the order can change the final image. Translations, rotations and reflections preserve length and angle. Two reflections in parallel lines produce a translation; two reflections in intersecting lines produce a rotation. Foundation questions focus on accurate construction and interpretation.

KEY VOCABULARY

combined transformation • image • invariant • orientation • composition



Every vertex follows the same transformation

Why the method works

- The image of the first transformation becomes the object for the second.
- Rigid transformations preserve lengths, angles and area.
- Reflection reverses orientation; translation and rotation preserve it.
- Composition order matters because transformations generally do not commute.

CHECK BEFORE MOVING ON

Answer mentally: 1) Translate (0,1) by (2,3), then (−1,4). 2) Reflect (5,2) in y-axis then x-axis. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 13 • G8 • METHODS

G8

Combined transformations and invariance — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Label object, intermediate image and final image.
- Apply the first transformation to every vertex.
- Apply the second to the intermediate image.
- Check preserved lengths and the requested final description.

WORKED EXAMPLE 1

Translate (1,2) by (3,−1), then by (−2,4).

1. First image (4,1).
2. Second image (2,5).

ANSWER: (2,5)

WORKED EXAMPLE 2

Reflect (3,−2) in x-axis, then y-axis.

1. First (3,2).
2. Then (−3,2).

ANSWER: (−3,2)

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Rotate (2,−1) 180° then translate (3,0). First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 13 • G8 • APPLICATION

G8

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Graphic-design software applies transformations in a stack. Moving then rotating an object can differ from rotating then moving it.

Common mistakes and how to repair them

MISTAKE 1

Applying both transformations to the original. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Changing vertex order between stages. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Assuming order never matters. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain meaning of invariant. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 13 • G8 • PRACTICE

G8

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Translate (0,1) by (2,3), then (−1,4).**
2. **Reflect (5,2) in y-axis then x-axis.**
3. **Rotate (2,−1) 180° then translate (3,0).**
4. **Name property preserved by all rigid transformations.**
5. **Which rigid transformation reverses orientation?**
6. **Do two translations combine to a translation?**
7. **Can order change final image?**
8. **Explain meaning of invariant.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 14 • G12-G13

G12, G13

Properties, nets, plans and elevations of three-dimensional solids

Connect a solid to its faces and to accurate two-dimensional views.

SPECIFICATION FOCUS

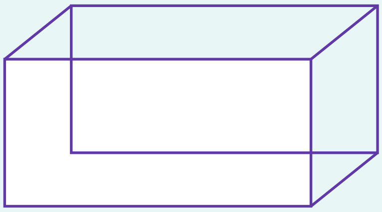
Pearson Edexcel content references G12, G13. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Faces, edges and vertices describe a solid. A plan is the view from above; front and side elevations are orthogonal views with no perspective. A net unfolds every surface face into the plane and must fold without overlap. Prisms have constant cross-section; pyramids taper from a base to an apex.

KEY VOCABULARY

face • edge • vertex • prism • pyramid • net • plan • front elevation • side elevation



Volume =

cross-section area

x prism length

Why the method works

- An elevation records width and height visible from a stated direction.
- A plan records horizontal footprint, not hidden height.
- A valid net contains every face with compatible shared edges.
- Euler’s relation V−E+F=2 checks convex polyhedra.

CHECK BEFORE MOVING ON

Answer mentally: 1) Triangular prism: number rectangular faces. 2) Cube vertices. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 14 • G12-G13 • METHODS

G12, G13

Properties, nets, plans and elevations of three-dimensional solids — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Identify viewing direction.
- Project visible vertices perpendicular to the viewing plane.
- Transfer lengths using the given scale.
- Check views agree on shared dimensions.

WORKED EXAMPLE 1

Cuboid dimensions 8 by 5 by 3. State plan dimensions.

1. From above, footprint is length by width.

ANSWER: 8 by 5

WORKED EXAMPLE 2

Cube: state faces, edges and vertices.

1. Count or use a model.

ANSWER: 6 faces,12 edges,8 vertices

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Cuboid edges. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 14 • G12-G13 • APPLICATION

G12, G13

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Architectural drawings communicate buildings through plans and elevations. Perspective sketches look realistic but are unsuitable for exact measurement.

Common mistakes and how to repair them

MISTAKE 1

Drawing perspective in an elevation. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Including height in a plan footprint. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Omitting a face from a net. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain difference between plan and front elevation. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 14 • G12-G13 • PRACTICE

G12, G13

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Triangular prism: number rectangular faces.**
2. **Cube vertices.**
3. **Cuboid edges.**
4. **Cylinder flat faces.**
5. **Plan of 10×6×4 cuboid.**
6. **Front elevation if front width10,height4.**
7. **Name solid with circular base and apex.**
8. **Explain difference between plan and front elevation.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 15 • G19, G21

G19, G21

Similarity and exact trigonometric values

Link special triangles, corresponding lengths and scale relationships.

SPECIFICATION FOCUS

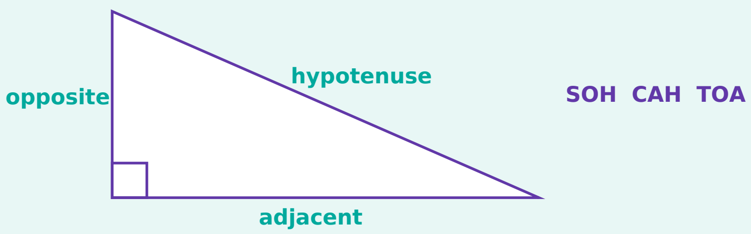
Pearson Edexcel content references G19, G21. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Similar shapes have equal corresponding angles and proportional corresponding sides. For Foundation Tier, exact trigonometric values are learned from special triangles and the unit-circle endpoints: sin and cos at 0°,30°,45°,60°,90°, and tan at 0°,30°,45°,60°. These exact forms avoid decimal approximation. Complete exact table: sin(0°,30°,45°,60°,90°)=0,1/2,√2/2,√3/2,1; cos(0°,30°,45°,60°,90°)=1,√3/2,√2/2,1/2,0; tan(0°,30°,45°,60°)=0,√3/3,1,√3.

KEY VOCABULARY

similar • corresponding • scale factor • exact value • sine • cosine • tangent



Why the method works

- Similar lengths share one scale factor.
- A 45-45-90 triangle has side ratio 1:1:√2.
- A 30-60-90 triangle has side ratio 1:√3:2.
- tanθ=sinθ/cosθ where cosθ is non-zero.

CHECK BEFORE MOVING ON

Answer mentally: 1) sin0°. 2) sin30°. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 15 • G19, G21 • METHODS

G19, G21

Similarity and exact trigonometric values — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Match corresponding vertices and sides.
- Calculate the length scale factor.
- Use a special-triangle ratio for exact trigonometric values.
- Keep roots and fractions exact.

WORKED EXAMPLE 1

State exact sin30° and cos60°.

1. From 30-60-90 triangle, opposite/hypotenuse=1/2.

ANSWER: both 1/2

WORKED EXAMPLE 2

Similar shapes have corresponding sides 6 and 15. A second side is 8 on smaller. Find larger.

1. Scale factor=15/6=2.5.
2. 8×2.5.

ANSWER: 20

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

sin45°. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 15 • G19, G21 • APPLICATION

G19, G21

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Roof pitches and scale models combine similarity and trigonometric ratios. Exact values support exact reasoning before dimensions are rounded for construction.

Common mistakes and how to repair them

MISTAKE 1

Writing decimal 0.707 instead of exact $\sqrt{2}/2$ when exact requested. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Matching non-corresponding sides. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Assuming area uses the length factor. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why similar angles are equal. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 15 • G19, G21 • PRACTICE

G19, G21

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **sin0°.**
2. **sin30°.**
3. **sin45°.**
4. **cos60°.**
5. **cos90°.**
6. **tan45°.**
7. **Length scale 3; corresponding 7 becomes?**
8. **Explain why similar angles are equal.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 16 • G12, G16-G17

G12, G16, G17

Pyramids, cones, spheres and composite solids

Identify the solid, select its perpendicular dimension and keep cubic units.

SPECIFICATION FOCUS

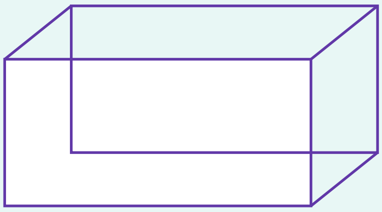
Pearson Edexcel content references G12, G16, G17. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Volume measures three-dimensional capacity. A pyramid or cone has one third of the volume of a prism or cylinder with the same base and perpendicular height. A sphere has volume $4/3\pi r^3$ and surface area $4\pi r^2$. Composite solids are split into non-overlapping familiar solids; removed portions are subtracted. Foundation work requires accurate substitution and contextual interpretation.

KEY VOCABULARY

pyramid • cone • sphere • base area • perpendicular height • composite solid • volume • surface area



Volume =

cross-section area

x prism length

Why the method works

- Pyramid volume=$1/3\times$base area$\times$perpendicular height.
- Cone volume=$1/3\pi r^2h$.
- Sphere volume=$4/3\pi r^3$.
- Sphere surface area=$4\pi r^2$.

CHECK BEFORE MOVING ON

Answer mentally: 1) Pyramid base area 30,height 9: volume. 2) Cone r=4,h=6: exact volume. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 16 • G12, G16-G17 • METHODS

G12, G16, G17

Pyramids, cones, spheres and composite solids — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Identify radius, base area and perpendicular height.
- Write the formula before substituting.
- Split composite solids and track addition or subtraction.
- Keep pi and full accuracy until final rounding.

WORKED EXAMPLE 1

Find volume of cone radius 3 cm, height 8 cm.

1. $V=1/3\pi\times3^2\times8=24\pi$.

ANSWER: 75.4 cm^3 (3 s.f.)

WORKED EXAMPLE 2

Find surface area of sphere radius 5 cm.

1. $A=4\pi\times5^2=100\pi$.

ANSWER: 314 cm^2 (3 s.f.)

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Sphere r=3: exact volume. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 16 • G12, G16-G17 • APPLICATION

G12, G16, G17

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Tank domes, funnels and packaging combine cylinders, cones and hemispheres. A diagram should mark which surfaces are exposed before surface area is calculated.

Common mistakes and how to repair them

MISTAKE 1

Using sloping length as perpendicular height. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Forgetting the one-third factor. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Adding an internal joining face to external surface area. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why pyramid is one third matching prism. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 16 • G12, G16-G17 • PRACTICE

G12, G16, G17

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Pyramid base area 30,height 9: volume.**
2. **Cone r=4,h=6: exact volume.**
3. **Sphere r=3: exact volume.**
4. **Sphere r=2: exact surface area.**
5. **Hemisphere r=3: volume.**
6. **Cylinder 40 cm^3 plus cone 15 cm^3: composite volume.**
7. **Removed cone 12 from cylinder 50: remaining.**
8. **Explain why pyramid is one third matching prism.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

PRACTICE ANSWERS

CHAPTER 01

Practice answers and repair notes

Geometric language and angle facts

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Classify 38°. **ANSWER: acute**

Method cue: Mark equal angles and write the rule beside the diagram. Then check the sign, size, accuracy and units of the result.

2. Classify 146°. **ANSWER: obtuse**

Method cue: Form an equation from the complete angle total. Then check the sign, size, accuracy and units of the result.

3. Find the supplement of 67°. **ANSWER: 113°**

Method cue: Solve the equation, then substitute back for the requested angle. Then check the sign, size, accuracy and units of the result.

4. Angles around a point are 84°, 116° and x°. Find x. **ANSWER: 160°**

Method cue: Check classification: acute <90, obtuse between 90 and 180, reflex between 180 and 360. Then check the sign, size, accuracy and units of the result.

5. Vertically opposite angles are $(4x+9)°$ and $(6x-17)°$. Find x. **ANSWER: 13**

Method cue: Mark equal angles and write the rule beside the diagram. Then check the sign, size, accuracy and units of the result.

6. Find each angle where perpendicular lines meet. **ANSWER: 90°**

Method cue: Form an equation from the complete angle total. Then check the sign, size, accuracy and units of the result.

7. Find the reflex angle corresponding to 112°. **ANSWER: 248°**

Method cue: Solve the equation, then substitute back for the requested angle. Then check the sign, size, accuracy and units of the result.

8. Explain why vertically opposite angles are equal. **ANSWER: both supplement the same adjacent angle**

Method cue: Check classification: acute <90, obtuse between 90 and 180, reflex between 180 and 360. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 02

Practice answers and repair notes

Parallel lines, triangles and polygons

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Find the third angle of a triangle with 48° and 73°. **ANSWER: 59°**

Method cue: Mark the parallel lines and identify the named angle relationship. Then check the sign, size, accuracy and units of the result.

2. Find a missing quadrilateral angle if the others are 82°,91°,104°. **ANSWER: 83°**

Method cue: For triangles, use 180°; for a quadrilateral, use 360°. Then check the sign, size, accuracy and units of the result.

3. Find the interior sum of a decagon. **ANSWER: 1440°**

Method cue: For a regular polygon, divide the total by the number of equal angles. Then check the sign, size, accuracy and units of the result.

4. Find each interior angle of a regular pentagon. **ANSWER: 108°**

Method cue: State the theorem before each calculation. Then check the sign, size, accuracy and units of the result.

5. Find each exterior angle of a regular nonagon. **ANSWER: 40°**

Method cue: Mark the parallel lines and identify the named angle relationship. Then check the sign, size, accuracy and units of the result.

6. A regular polygon exterior angle is 30°. Find sides. **ANSWER: 12**

Method cue: For triangles, use 180°; for a quadrilateral, use 360°. Then check the sign, size, accuracy and units of the result.

7. Co-interior angle to 117° between parallel lines. **ANSWER: 63°**

Method cue: For a regular polygon, divide the total by the number of equal angles. Then check the sign, size, accuracy and units of the result.

8. Explain why exterior angles total 360°. **ANSWER: one complete turn**

Method cue: State the theorem before each calculation. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 03

Practice answers and repair notes

Constructions, loci, scale drawings and bearings

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Write bearing 7° in three-digit form. **ANSWER: 007°**

Method cue: Keep compass radius fixed while drawing paired arcs. Then check the sign, size, accuracy and units of the result.

2. Find reverse bearing of 135°. **ANSWER: 315°**

Method cue: Draw all construction arcs; they are evidence of the method. Then check the sign, size, accuracy and units of the result.

3. Find reverse bearing of 294°. **ANSWER: 114°**

Method cue: For a bearing, draw north at the starting point and measure clockwise. Then check the sign, size, accuracy and units of the result.

4. What locus is 4 cm from point P? **ANSWER: circle centre P radius 4 cm**

Method cue: Convert scale units before multiplying or dividing. Then check the sign, size, accuracy and units of the result.

5. What locus is equidistant from points A and B? **ANSWER: perpendicular bisector of AB**

Method cue: Keep compass radius fixed while drawing paired arcs. Then check the sign, size, accuracy and units of the result.

6. A 1:50 scale drawing shows 8.4 cm. Find actual metres. **ANSWER: 4.2 m**

Method cue: Draw all construction arcs; they are evidence of the method. Then check the sign, size, accuracy and units of the result.

7. Actual 2 km is 5 cm on a map. Find scale. **ANSWER: 1:40,000**

Method cue: For a bearing, draw north at the starting point and measure clockwise. Then check the sign, size, accuracy and units of the result.

8. Explain why north lines on a diagram are parallel. **ANSWER: they indicate the same north direction**

Method cue: Convert scale units before multiplying or dividing. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 04

Practice answers and repair notes

Transformations, symmetry and congruence

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Translate (1,−3) by vector (4,2). **ANSWER: (5,−1)**

Method cue: Record coordinates of every vertex before transforming. Then check the sign, size, accuracy and units of the result.

2. Reflect (5,−2) in x-axis. **ANSWER: (5,2)**

Method cue: For reflection, count perpendicular squares to the mirror line. Then check the sign, size, accuracy and units of the result.

3. Reflect (−3,4) in y-axis. **ANSWER: (3,4)**

Method cue: For rotation, state centre, angle and clockwise or anticlockwise. Then check the sign, size, accuracy and units of the result.

4. Rotate (2,5) 180° about origin. **ANSWER: (−2,−5)**

Method cue: For enlargement, join corresponding vertices through the centre and apply the scale factor. Then check the sign, size, accuracy and units of the result.

5. Enlarge (3,−2) by factor 2 about origin. **ANSWER: (6,−4)**

Method cue: Record coordinates of every vertex before transforming. Then check the sign, size, accuracy and units of the result.

6. State four details for a rotation. **ANSWER: centre, angle, direction, rotation**

Method cue: For reflection, count perpendicular squares to the mirror line. Then check the sign, size, accuracy and units of the result.

7. Do rotations preserve area? **ANSWER: yes**

Method cue: For rotation, state centre, angle and clockwise or anticlockwise. Then check the sign, size, accuracy and units of the result.

8. Explain why enlargement factor 3 does not triple area. **ANSWER: area factor is $3^2=9$**

Method cue: For enlargement, join corresponding vertices through the centre and apply the scale factor. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 05

Practice answers and repair notes

Perimeter, area and composite shapes

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Perimeter of rectangle 8 cm by 5 cm. **ANSWER: 26 cm**

Method cue: Write every necessary length on the diagram, deriving missing sides. Then check the sign, size, accuracy and units of the result.

2. Area of rectangle 11 m by 4.5 m. **ANSWER: 49.5 m²**

Method cue: Select a formula and identify the perpendicular height. Then check the sign, size, accuracy and units of the result.

3. Area of triangle base 13 cm height 8 cm. **ANSWER: 52 cm²**

Method cue: For composites, split or subtract, then label each partial area. Then check the sign, size, accuracy and units of the result.

4. Area trapezium sides 7,11 cm height 5 cm. **ANSWER: 45 cm²**

Method cue: Use cm², m² or another squared unit for area. Then check the sign, size, accuracy and units of the result.

5. Square area 144 cm²: side length. **ANSWER: 12 cm**

Method cue: Write every necessary length on the diagram, deriving missing sides. Then check the sign, size, accuracy and units of the result.

6. An 18×10 rectangle loses 6×4 cut-out: area. **ANSWER: 156 square units**

Method cue: Select a formula and identify the perpendicular height. Then check the sign, size, accuracy and units of the result.

7. Length factor 2.5: area factor. **ANSWER: 6.25**

Method cue: For composites, split or subtract, then label each partial area. Then check the sign, size, accuracy and units of the result.

8. Explain why equal perimeters need not mean equal areas. **ANSWER: shape changes surface coverage**

Method cue: Use cm², m² or another squared unit for area. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 06

Practice answers and repair notes

Circles, circumference, arcs and sectors

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Diameter 14 cm: radius. **ANSWER: 7 cm**

Method cue: Identify whether the question asks for boundary, surface or a fraction of either. Then check the sign, size, accuracy and units of the result.

2. Circumference radius 7 cm in terms of π. **ANSWER: 14π cm**

Method cue: Convert diameter to radius where necessary. Then check the sign, size, accuracy and units of the result.

3. Area diameter 12 cm in terms of π. **ANSWER: 36π cm²**

Method cue: Substitute using π, keeping the calculator value unrounded. Then check the sign, size, accuracy and units of the result.

4. Circumference 10π cm: diameter. **ANSWER: 10 cm**

Method cue: Round only the final answer and attach correct units. Then check the sign, size, accuracy and units of the result.

5. Arc 90°, radius 8 cm in terms of π. **ANSWER: 4π cm**

Method cue: Identify whether the question asks for boundary, surface or a fraction of either. Then check the sign, size, accuracy and units of the result.

6. Sector area 120°, radius 6 cm in terms of π. **ANSWER: 12π cm²**

Method cue: Convert diameter to radius where necessary. Then check the sign, size, accuracy and units of the result.

7. Find area of semicircle radius 4 cm. **ANSWER: 8π cm²**

Method cue: Substitute using π, keeping the calculator value unrounded. Then check the sign, size, accuracy and units of the result.

8. Explain why doubling radius quadruples area. **ANSWER: area contains r^2**

Method cue: Round only the final answer and attach correct units. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 07

Practice answers and repair notes

Three-dimensional shapes, surface area and volume

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Cuboid 6×4×9 cm: volume. **ANSWER: 216 cm³**

Method cue: Sketch or identify the constant cross-section. Then check the sign, size, accuracy and units of the result.

2. Cube side 5 cm: surface area. **ANSWER: 150 cm²**

Method cue: Calculate its area first, then multiply by prism length. Then check the sign, size, accuracy and units of the result.

3. Prism cross-section 18 cm² length 7 cm: volume. **ANSWER: 126 cm³**

Method cue: For surface area, list each face or use a net. Then check the sign, size, accuracy and units of the result.

4. Cylinder radius 4 cm height 5 cm: exact volume. **ANSWER: 80π cm³**

Method cue: Convert all dimensions to one unit before calculation. Then check the sign, size, accuracy and units of the result.

5. Cylinder diameter 10 cm height 8 cm: exact volume. **ANSWER: 200π cm³**

Method cue: Sketch or identify the constant cross-section. Then check the sign, size, accuracy and units of the result.

6. Length scale factor 3: volume factor. **ANSWER: 27**

Method cue: Calculate its area first, then multiply by prism length. Then check the sign, size, accuracy and units of the result.

7. Convert 2.5 litres to cm³. **ANSWER: 2500 cm³**

Method cue: For surface area, list each face or use a net. Then check the sign, size, accuracy and units of the result.

8. Explain role of a net in surface area. **ANSWER: shows every exposed face**

Method cue: Convert all dimensions to one unit before calculation. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 08

Practice answers and repair notes

Pythagoras' theorem

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Sides 6,8: hypotenuse. **ANSWER: 10**

Method cue: Mark the right angle and label the opposite side c. Then check the sign, size, accuracy and units of the result.

2. Sides 9,12: hypotenuse. **ANSWER: 15**

Method cue: Substitute lengths with brackets before squaring. Then check the sign, size, accuracy and units of the result.

3. Hypotenuse 17, side 8: other side. **ANSWER: 15**

Method cue: Add for the hypotenuse; subtract for a shorter side. Then check the sign, size, accuracy and units of the result.

4. Rectangle 5 by 12: diagonal. **ANSWER: 13**

Method cue: Square-root, then round only at the end if requested. Then check the sign, size, accuracy and units of the result.

5. Square side 10: exact diagonal. **ANSWER: $10\sqrt{2}$**

Method cue: Mark the right angle and label the opposite side c. Then check the sign, size, accuracy and units of the result.

6. Do sides 7,24,25 form a right triangle? **ANSWER: yes**

Method cue: Substitute lengths with brackets before squaring. Then check the sign, size, accuracy and units of the result.

7. A ladder reaches 4 m up, foot 1.5 m out: length 3 s.f. **ANSWER: 4.27 m**

Method cue: Add for the hypotenuse; subtract for a shorter side. Then check the sign, size, accuracy and units of the result.

8. Explain how to identify hypotenuse. **ANSWER: opposite the right angle**

Method cue: Square-root, then round only at the end if requested. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 09

Practice answers and repair notes

Right-angled trigonometry

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. O=5,H=13: find sinθ. **ANSWER: 5/13**

Method cue: Mark θ, then label O, A and H. Then check the sign, size, accuracy and units of the result.

2. A=12,H=13: find cosθ. **ANSWER: 12/13**

Method cue: Circle the known side and the required side. Then check the sign, size, accuracy and units of the result.

3. O=8,A=15: find tanθ. **ANSWER: 8/15**

Method cue: Choose the ratio containing both; substitute and rearrange. Then check the sign, size, accuracy and units of the result.

4. θ=30°,H=20: find O. **ANSWER: 10**

Method cue: Use full calculator accuracy, then check that the size is plausible. Then check the sign, size, accuracy and units of the result.

5. θ=60°,A=7: find H. **ANSWER: 14**

Method cue: Mark θ, then label O, A and H. Then check the sign, size, accuracy and units of the result.

6. O=9,H=15: find θ to 1 d.p. **ANSWER: 36.9°**

Method cue: Circle the known side and the required side. Then check the sign, size, accuracy and units of the result.

7. A=10,O=4: find θ to 1 d.p. **ANSWER: 21.8°**

Method cue: Choose the ratio containing both; substitute and rearrange. Then check the sign, size, accuracy and units of the result.

8. State a check for a calculated hypotenuse. **ANSWER: it must be longest side**

Method cue: Use full calculator accuracy, then check that the size is plausible. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 10

Practice answers and repair notes

Vectors and mixed geometry reasoning

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Add (4,3)+(−1,5). **ANSWER: (3,8)**

Method cue: Draw or imagine each vector head-to-tail. Then check the sign, size, accuracy and units of the result.

2. Subtract (7,2)−(3,−4). **ANSWER: (4,6)**

Method cue: Choose a route from start to finish and add its vectors. Then check the sign, size, accuracy and units of the result.

3. Find −3(2,−5). **ANSWER: (−6,15)**

Method cue: Simplify horizontal and vertical components separately. Then check the sign, size, accuracy and units of the result.

4. AB=(5,−2). Find BA. **ANSWER: (−5,2)**

Method cue: Check direction and confirm an alternative route gives the same result. Then check the sign, size, accuracy and units of the result.

5. OA=a, AB=b. Write OB. **ANSWER: a+b**

Method cue: Draw or imagine each vector head-to-tail. Then check the sign, size, accuracy and units of the result.

6. OP=3a and OQ=7a. What can be concluded? **ANSWER: O,P,Q are collinear**

Method cue: Choose a route from start to finish and add its vectors. Then check the sign, size, accuracy and units of the result.

7. A rectangle is 6 by 8. Find diagonal. **ANSWER: 10**

Method cue: Simplify horizontal and vertical components separately. Then check the sign, size, accuracy and units of the result.

8. Explain difference between distance and displacement. **ANSWER: distance is scalar path length; displacement has direction**

Method cue: Check direction and confirm an alternative route gives the same result. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 11

Practice answers and repair notes

Triangles and special quadrilaterals

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Equilateral triangle angle. **ANSWER: 60°**

Method cue: Mark parallel, equal and right-angle information. Then check the sign, size, accuracy and units of the result.

2. Isosceles base angles if vertex 30°. **ANSWER: 75°**

Method cue: Match only properties guaranteed by the definition. Then check the sign, size, accuracy and units of the result.

3. Parallelogram adjacent to 125°. **ANSWER: 55°**

Method cue: Use angle sums and parallel-line facts to derive missing values. Then check the sign, size, accuracy and units of the result.

4. Name quadrilateral with four equal sides and four right angles. **ANSWER: square**

Method cue: State the property used in every conclusion. Then check the sign, size, accuracy and units of the result.

5. Name quadrilateral with one pair parallel sides. **ANSWER: trapezium**

Method cue: Mark parallel, equal and right-angle information. Then check the sign, size, accuracy and units of the result.

6. Are all squares rectangles? **ANSWER: yes**

Method cue: Match only properties guaranteed by the definition. Then check the sign, size, accuracy and units of the result.

7. Are all rectangles squares? **ANSWER: no**

Method cue: Use angle sums and parallel-line facts to derive missing values. Then check the sign, size, accuracy and units of the result.

8. Explain why a rhombus need not be a square. **ANSWER: angles need not be 90°**

Method cue: State the property used in every conclusion. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 12

Practice answers and repair notes

Triangle congruence and simple geometric proof

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Name criterion: three equal sides. **ANSWER: SSS**

Method cue: Match corresponding vertices in order. Then check the sign, size, accuracy and units of the result.

2. Two sides and included angle. **ANSWER: SAS**

Method cue: Mark the three facts used. Then check the sign, size, accuracy and units of the result.

3. Two angles and included side. **ANSWER: ASA**

Method cue: Name the valid congruence criterion. Then check the sign, size, accuracy and units of the result.

4. Right angle,hypotenuse,one side. **ANSWER: RHS**

Method cue: State the corresponding equality that follows. Then check the sign, size, accuracy and units of the result.

5. Does AAA prove congruence? **ANSWER: no**

Method cue: Match corresponding vertices in order. Then check the sign, size, accuracy and units of the result.

6. What does congruence preserve? **ANSWER: all lengths and angles**

Method cue: Mark the three facts used. Then check the sign, size, accuracy and units of the result.

7. If $\Delta ABC \equiv \Delta DEF$, which side matches BC? **ANSWER: EF**

Method cue: Name the valid congruence criterion. Then check the sign, size, accuracy and units of the result.

8. Explain why SAS angle must be included. **ANSWER: otherwise shape may not be fixed**

Method cue: State the corresponding equality that follows. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 13

Practice answers and repair notes

Combined transformations and invariance

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Translate (0,1) by (2,3), then (−1,4). **ANSWER: (1,8)**

Method cue: Label object, intermediate image and final image. Then check the sign, size, accuracy and units of the result.

2. Reflect (5,2) in y-axis then x-axis. **ANSWER: (−5,−2)**

Method cue: Apply the first transformation to every vertex. Then check the sign, size, accuracy and units of the result.

3. Rotate (2,−1) 180° then translate (3,0). **ANSWER: (1,1)**

Method cue: Apply the second to the intermediate image. Then check the sign, size, accuracy and units of the result.

4. Name property preserved by all rigid transformations. **ANSWER: length/angle/area**

Method cue: Check preserved lengths and the requested final description. Then check the sign, size, accuracy and units of the result.

5. Which rigid transformation reverses orientation? **ANSWER: reflection**

Method cue: Label object, intermediate image and final image. Then check the sign, size, accuracy and units of the result.

6. Do two translations combine to a translation? **ANSWER: yes**

Method cue: Apply the first transformation to every vertex. Then check the sign, size, accuracy and units of the result.

7. Can order change final image? **ANSWER: yes**

Method cue: Apply the second to the intermediate image. Then check the sign, size, accuracy and units of the result.

8. Explain meaning of invariant. **ANSWER: property left unchanged**

Method cue: Check preserved lengths and the requested final description. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 14

Practice answers and repair notes

Properties, nets, plans and elevations of three-dimensional solids

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Triangular prism: number rectangular faces. **ANSWER: 3**

Method cue: Identify viewing direction. Then check the sign, size, accuracy and units of the result.

2. Cube vertices. **ANSWER: 8**

Method cue: Project visible vertices perpendicular to the viewing plane. Then check the sign, size, accuracy and units of the result.

3. Cuboid edges. **ANSWER: 12**

Method cue: Transfer lengths using the given scale. Then check the sign, size, accuracy and units of the result.

4. Cylinder flat faces. **ANSWER: 2**

Method cue: Check views agree on shared dimensions. Then check the sign, size, accuracy and units of the result.

5. Plan of 10×6×4 cuboid. **ANSWER: 10 by 6**

Method cue: Identify viewing direction. Then check the sign, size, accuracy and units of the result.

6. Front elevation if front width10,height4. **ANSWER: 10 by 4**

Method cue: Project visible vertices perpendicular to the viewing plane. Then check the sign, size, accuracy and units of the result.

7. Name solid with circular base and apex. **ANSWER: cone**

Method cue: Transfer lengths using the given scale. Then check the sign, size, accuracy and units of the result.

8. Explain difference between plan and front elevation. **ANSWER: above view versus front view**

Method cue: Check views agree on shared dimensions. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 15

Practice answers and repair notes

Similarity and exact trigonometric values

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. sin0°. **ANSWER: 0**

Method cue: Match corresponding vertices and sides. Then check the sign, size, accuracy and units of the result.

2. sin30°. **ANSWER: 1/2**

Method cue: Calculate the length scale factor. Then check the sign, size, accuracy and units of the result.

3. sin45°. **ANSWER: √2/2**

Method cue: Use a special-triangle ratio for exact trigonometric values. Then check the sign, size, accuracy and units of the result.

4. cos60°. **ANSWER: 1/2**

Method cue: Keep roots and fractions exact. Then check the sign, size, accuracy and units of the result.

5. cos90°. **ANSWER: 0**

Method cue: Match corresponding vertices and sides. Then check the sign, size, accuracy and units of the result.

6. tan45°. **ANSWER: 1**

Method cue: Calculate the length scale factor. Then check the sign, size, accuracy and units of the result.

7. Length scale 3; corresponding 7 becomes? **ANSWER: 21**

Method cue: Use a special-triangle ratio for exact trigonometric values. Then check the sign, size, accuracy and units of the result.

8. Explain why similar angles are equal. **ANSWER: shape preserved**

Method cue: Keep roots and fractions exact. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 16

Practice answers and repair notes

Pyramids, cones, spheres and composite solids

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Pyramid base area 30,height 9: volume. **ANSWER: 90 cubic units**

Method cue: Identify radius, base area and perpendicular height. Then check the sign, size, accuracy and units of the result.

2. Cone r=4,h=6: exact volume. **ANSWER: 32π cm^3**

Method cue: Write the formula before substituting. Then check the sign, size, accuracy and units of the result.

3. Sphere r=3: exact volume. **ANSWER: 36π cm^3**

Method cue: Split composite solids and track addition or subtraction. Then check the sign, size, accuracy and units of the result.

4. Sphere r=2: exact surface area. **ANSWER: 16π cm^2**

Method cue: Keep pi and full accuracy until final rounding. Then check the sign, size, accuracy and units of the result.

5. Hemisphere r=3: volume. **ANSWER: 18π cm^3**

Method cue: Identify radius, base area and perpendicular height. Then check the sign, size, accuracy and units of the result.

6. Cylinder 40 cm^3 plus cone 15 cm^3: composite volume. **ANSWER: 55 cm^3**

Method cue: Write the formula before substituting. Then check the sign, size, accuracy and units of the result.

7. Removed cone 12 from cylinder 50: remaining. **ANSWER: 38 cm^3**

Method cue: Split composite solids and track addition or subtraction. Then check the sign, size, accuracy and units of the result.

8. Explain why pyramid is one third matching prism. **ANSWER: same base and perpendicular height relation**

Method cue: Keep pi and full accuracy until final rounding. Then check the sign, size, accuracy and units of the result.

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Unit 4: Geometry and Measures • Foundation Tier

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