

Junior Maths - Measurements & Trigonometry

Units, Accuracy and Estimation and full-series practice

Student workbook edition

Near-A4 print layout with ruled working space

DeepMaths Auckland | Founder: Min Luo

Junior Maths - Measurements & Trigonometry - Table of Contents

Chapter	Title	Target Questions	Chapter Objective
1	Units, Accuracy and Estimation	80	Convert metric units and judge sensible accuracy for length, mass, time, area, and volume.
2	Perimeter and Area	115	Calculate perimeter and area for rectangles, triangles, parallelograms, trapezia, circles, and composites.
3	Surface Area and Volume	129	Find surface area and volume for prisms, pyramids, cylinders, and compound solids.
4	Time, Speed and Compound Measures	90	Use speed, density, pressure, and unit conversion in context.
5	Pythagoras' Theorem	95	Find missing sides and check right triangles using square relationships.
6	Trigonometric Ratios	117	Use sine, cosine, and tangent to find missing sides and angles in right triangles.
7	Bearings, Scale Drawings, Sine Rule and Cosine Rule	101	Interpret and draw bearings, maps, scale diagrams, and non-right-triangle trigonometry models.
8	3D Measurement and Trigonometry	66	Model right triangles inside 3D contexts.
9	Measurement and Trigonometry Mixed Review	66	Combine measurement, Pythagoras, trigonometry, and bearings in structured sets.
10	Similarity in Measurement	56	Use scale factors for length, perimeter, area, surface area, volume, maps, and models.

Name: _____ Class: _____ Start date: _____

Worked Solutions Online

This workbook keeps final answers in print so parents and students can check quickly.

For full worked solutions, please visit deepmaths.co.nz and search by book, page and question number.

Direct link: deepmaths.co.nz/worked-solutions

Chapter 1: Units, Accuracy and Estimation

Chapter Goal

Convert metric units and judge sensible accuracy for length, mass, time, area, and volume.

Calculator Policy

Mostly non-calculator. Use exact unit relationships and simple estimation.

Quick Notes - Page 1

Metric length: $1 \text{ km} = 1000 \text{ m}$, $1 \text{ m} = 100 \text{ cm} = 1000 \text{ mm}$, and $1 \text{ cm} = 10 \text{ mm}$.

Mass and capacity: $1 \text{ kg} = 1000 \text{ g}$, $1 \text{ L} = 1000 \text{ mL}$, and $1 \text{ mL} = 1 \text{ cm}^3$.

Quick Notes - Page 2

Area units square the scale factor: $1 \text{ m}^2 = 10000 \text{ cm}^2$. Volume units cube the scale factor: $1 \text{ m}^3 = 1000000 \text{ cm}^3$.

For rounding bounds, use half the rounding unit below and above the rounded value.

Worked Examples

Example 1

Convert 2.6 km to metres.

Solution: $2.6 \times 1000 = 2600 \text{ m}$.

Example 2

Convert 450 cm to metres.

Solution: $450 \div 100 = 4.5 \text{ m}$.

Example 3

Convert 0.75 L to millilitres.

Solution: $0.75 \times 1000 = 750 \text{ mL}$.

Example 4

Convert 3 m^2 to square centimetres.

Solution: $3 \times 10000 = 30000 \text{ cm}^2$.

Example 5

A length is 12 cm to the nearest centimetre. State the bounds.

Solution: $11.5 \text{ cm} \leq x < 12.5 \text{ cm}$.

Example 6

Estimate 29.7×4.9 .

Solution: Round to $30 \times 5 = 150$.

Skill Practice

1. Convert 3.5 km to metres.

2. Convert 4200 m to kilometres.

3. Convert 2.75 m to centimetres.

4. Convert 640 cm to metres.

5. Convert 38 mm to centimetres.

6. Convert 4.6 cm to millimetres.

7. Convert 0.08 km to metres.

8. Convert 1250 mm to metres.

9. Convert 7.04 m to millimetres.

10. Convert 0.5 m to centimetres.

11. Convert 3.2 kg to grams.

12. Convert 750 g to kilograms.

13. Convert 0.045 kg to grams.

14. Convert 6 L to millilitres.

15. Convert 850 mL to litres.

16. Convert 2.4 L to millilitres.

17. Convert 125 cm³ to millilitres.

18. Convert 1.5 L to cubic centimetres.

19. Convert 5400 g to kilograms.

20. Convert 0.6 L to millilitres.

21. Convert 4 m^2 to square centimetres.

22. Convert 30000 cm^2 to square metres.

23. Convert 12 cm^2 to square millimetres.

24. Convert 2500 mm^2 to square centimetres.

25. Convert 2 m^3 to cubic centimetres.

26. Convert 5000 cm^3 to litres.

27. Convert 3.5 m^2 to square centimetres.

28. Convert 0.25 m^3 to litres.

29. Convert 2.5 hours to minutes.

30. Convert 135 minutes to hours and minutes.

31. Convert 3 minutes 20 seconds to seconds.

32. Convert 5400 seconds to minutes.

33. Convert 1 hour 45 minutes to minutes.

34. Convert 0.75 hours to minutes.

35. Convert 96 hours to days.

36. Convert 2 days 6 hours to hours.

37. Round 48.73 m to the nearest metre.

38. Round 3.846 kg to 1 decimal place.

39. Round 0.0786 L to 2 significant figures.

40. A length is 18 cm to the nearest centimetre. State the lower bound.

41. A length is 18 cm to the nearest centimetre. State the upper bound.

42. A mass is 4.6 kg to 1 decimal place. State the lower bound.

43. A mass is 4.6 kg to 1 decimal place. State the upper bound.

44. Estimate 19.8×5.1 by rounding to 1 significant figure.

45. Estimate $\frac{402}{19.7}$ by rounding to 1 significant figure.

46. Round 12500 m to 2 significant figures.

Structured Practice

1. **[3 marks]** A running track is 0.4 km long. A student runs 6 laps. Find the distance in metres.

2. **[3 marks]** A bottle contains 1.25 L of water. How many 250 mL cups can be filled?

3. **[3 marks]** A rectangle has area 0.6 m^2 . Convert this area to cm^2 .

4. **[4 marks]** A measurement is 7.4 cm to 1 decimal place. State the lower and upper bounds.

5. **[3 marks]** Estimate $\frac{58.9 \times 21}{3.1}$ by rounding each value to 1 significant figure.

6. **[4 marks]** A tank contains 0.08 m^3 of water. Convert this to litres.

7. **[2 marks]** A journey takes 2 hours 35 minutes. Convert the time to minutes.

8. **[3 marks]** A mass of 350 g is placed in a box of mass 1.2 kg. Find the total mass in kilograms.

9. **[4 marks]** A square has side length 30 cm. Find its area in m^2 .

10. **[4 marks]** A length of 5.8 m is rounded to the nearest metre. What rounded value is obtained, and what is the maximum possible error?

11. **[2 marks]** Convert 720 cm^3 to litres.

12. **[3 marks]** A plank is 2.4 m long. It is cut into pieces of 30 cm. How many pieces are made?

13. **[4 marks]** A measurement is 125 m to the nearest 5 m. State the lower and upper bounds.

14. **[3 marks]** A recipe uses 0.75 kg of flour. How many grams are needed for 4 batches?

15. **[4 marks]** A film lasts 1 hour 48 minutes. It starts at 6:35 pm. What time does it finish?

16. **[4 marks]** A length is measured as 3.20 m to the nearest centimetre. State the lower bound in metres.

17. **[3 marks]** A cube has side length 10 cm. Find its volume in litres.

18. **[2 marks]** Estimate 99.6×0.49 by rounding each value to 1 significant figure.

Mixed Review

1. Convert 1.8 km to metres, then round the result to 1 significant figure.

2. A mass is 2750 g. Convert to kilograms and round to 1 decimal place.

3. A rectangle is 50 cm by 80 cm. Find its area in m^2 .

4. A container has 2.5 L. 600 mL is poured out. How much remains in litres?

5. A time of 2.25 hours is written in hours and minutes. Find the time.

6. A length is 46 mm. Convert to centimetres and round to the nearest centimetre.

7. A cuboid volume is 24000 cm^3 . Convert to litres, then to millilitres.

8. Estimate 201×4.8 , then state whether the exact answer is likely above or below the estimate.

9. A distance is 12.5 km. Convert to metres and then to centimetres.

10. A length is 8.0 cm to 1 decimal place. State the bounds and the maximum possible error.

Challenge Questions

1. A rectangle measures 12 cm by 8 cm, each to the nearest centimetre. Find the lower bound for its area.

2. A tank contains 0.125 m^3 of water. Cups hold 250 mL. How many full cups can be filled?

3. A journey distance is 18 km to the nearest kilometre. State the lower and upper bounds in metres.

4. A box has mass 1.2 kg. Items of mass 75 g are added until the total mass is 3 kg. How many items are added?

5. A square area is 0.0225 m^2 . Find the side length in centimetres.

6. A measurement is rounded to 3.50 m to the nearest centimetre. Give the interval of possible values in metres.

Common Mistakes

- Multiplying by 100 instead of 10000 for square metres to square centimetres.
- Forgetting that $1 \text{ mL} = 1 \text{ cm}^3$.
- Rounding before converting when the question asks for an exact conversion first.
- Giving an upper bound as a largest included value instead of a boundary.

Progress Tracker

Skill	Not Yet	Getting There	Confident
I can convert length units.	☐	☐	☐
I can convert mass and capacity units.	☐	☐	☐
I can convert area and volume units.	☐	☐	☐
I can convert time units.	☐	☐	☐
I can round measurements sensibly.	☐	☐	☐
I can state lower and upper bounds.	☐	☐	☐
I can estimate using rounded values.	☐	☐	☐

Chapter 2: Perimeter and Area

Chapter Goal

Calculate perimeter and area for rectangles, triangles, parallelograms, trapezia, circles, and composite shapes.

Calculator Policy

Mostly non-calculator. Leave circular answers in terms of π unless a question asks for a decimal.

Quick Notes - Page 1

Perimeter is distance around the outside of a shape.

Area is the surface covered by a shape.

- Rectangle: area = lw , perimeter = $2(l + w)$.
- Triangle: area = $\frac{1}{2}bh$.
- Parallelogram: area = bh .
- Trapezium: area = $\frac{1}{2}(a + b)h$.

Quick Notes - Page 2

Circle formulae:

- Circumference = $2\pi r = \pi d$.
- Area = πr^2 .
- Semicircle area is half a circle.
- Semicircle perimeter includes the curved arc and the diameter.

For composite shapes, split the diagram into familiar shapes or subtract the missing part.

Worked Examples

Example 1

Find the area of a rectangle 9 cm by 4 cm.

Solution: $9 \times 4 = 36 \text{ cm}^2$.

Example 2

Find the area of a triangle with base 12 cm and height 5 cm.

Solution: $\frac{1}{2} \times 12 \times 5 = 30 \text{ cm}^2$.

Example 3

Find the area of a trapezium with parallel sides 7 cm and 13 cm, and height 6 cm.

Solution: $\frac{1}{2}(7 + 13)6 = 60 \text{ cm}^2$.

Example 4

Find the area of a circle with radius 3 cm.

Solution: $\pi \times 3^2 = 9\pi \text{ cm}^2$.

Example 5

A 10 cm by 8 cm rectangle has a 3 cm by 2 cm corner removed. Find the remaining area.

Solution: $10 \times 8 - 3 \times 2 = 74 \text{ cm}^2$.

Example 6

A semicircle has radius 4 cm. Find its perimeter.

Solution: diameter = 8, arc = 4π , so perimeter = $8 + 4\pi \text{ cm}$.

Progress Tracker

Section	Questions	Completed	Correct	Retry
Skill Practice	67	[]	___ / 67	[]
Exam-Style Structured Practice	25	[]	___ / 25	[]
Mixed Review	14	[]	___ / 14	[]
Challenge Questions	9	[]	___ / 9	[]

Skill Practice

1. Write the formula for the perimeter of a rectangle with length l and width w .

2. Write the formula for the area of a rectangle with length l and width w .

3. Write the formula for the area of a triangle with base b and height h .

4. Write the formula for the area of a parallelogram with base b and height h .

5. Write the formula for the area of a trapezium with parallel sides a and b , and height h .

6. Write the formula for the area of a circle with radius r .

7. Find the perimeter of a rectangle 8 cm by 5 cm.

8. Find the area of a rectangle 12 cm by 7 cm.

9. Find the perimeter of a square with side 9 cm.

10. Find the area of a square with side 11 cm.

11. Find the perimeter of a rectangle 15 m by 6 m.

12. Find the area of a rectangle 18 mm by 4 mm.

13. A rectangle has area 96 cm^2 and length 12 cm. Find its width.

14. A rectangle has perimeter 50 cm and width 9 cm. Find its length.

15. Find the area of a rectangle 2.5 m by 8 m.

16. Find the perimeter of a rectangle 3.2 cm by 4.8 cm.

17. Find the area in square metres of a rectangle 6 m by 350 cm.

18. A rectangle is 0.24 m by 3 cm. Find its perimeter in centimetres.

19. Find the area of a triangle with base 0.1 m and height 7 cm. Give your answer in square centimetres.

20. Find the area of a triangle with base 12 m and height 900 cm. Give your answer in square metres.

21. A triangle has area 48 cm^2 and base 12 cm . Find its height.

22. A triangle has area 45 cm^2 and height 6 cm . Find its base.

23. A right triangle has perpendicular sides 0.08 m and 15 cm . Find its area in square centimetres.

24. A triangle has base 14 units and height 5 units. Find its area.

25. Find the area of a triangle with base 64 mm and height 5 cm . Give your answer in square centimetres.

26. Find the perimeter of a triangle with sides 0.05 m , 120 mm , and 13 cm . Give your answer in centimetres.

27. Find the perimeter of an isosceles triangle with equal sides 0.09 m and base 14 cm. Give your answer in centimetres.

28. Find the area of a triangle with base 0.16 m and height 70 mm. Give your answer in square centimetres.

29. Find the area of a parallelogram with base 0.11 m and height 6 cm. Give your answer in square centimetres.

30. Find the perimeter of a parallelogram with side lengths 9 cm and 4 cm.

31. A parallelogram has area 84 cm^2 and height 7 cm. Find its base.

32. A parallelogram has area 96 cm^2 and base 16 cm. Find its height.

33. Find the area of a trapezium with parallel sides 8 cm and 14 cm, and height 5 cm.

34. Find the area of a trapezium with parallel sides 12 m and 20 m, and height 7 m.

35. A trapezium has area 90 cm^2 and parallel sides 10 cm and 20 cm. Find its height.

36. A trapezium has area 60 cm^2 , height 5 cm, and one parallel side 14 cm. Find the other parallel side.

37. Find the area of a parallelogram with base 13 cm and height 8 cm.

38. Find the area of a trapezium with parallel sides 9 cm and 15 cm, and height 8 cm.

39. Find the perimeter of a parallelogram with side lengths 12.5 cm and 7.5 cm.

40. A trapezium has area 84 cm^2 , height 7 cm, and one parallel side 10 cm. Find the other parallel side.

41. A circle has radius 6 cm. Find its diameter.

42. A circle has diameter 18 cm. Find its radius.

43. Find the circumference of a circle with radius 5 cm, in terms of π .

44. Find the circumference of a circle with diameter 14 cm, in terms of π .

45. Find the area of a circle with radius 4 cm, in terms of π .

46. Find the area of a circle with diameter 20 cm, in terms of π .

47. Find the area of a semicircle with radius 6 cm, in terms of π .

48. Find the perimeter of a semicircle with radius 7 cm, in terms of π .

49. Find the area of a quarter circle with radius 8 cm, in terms of π .

50. Find the perimeter of a quarter circle with radius 6 cm, in terms of π .

51. Find the circumference of a circle with radius 3.5 cm, in terms of π .

52. Find the area of a circle with diameter 12 cm, in terms of π .

53. An L-shape is made from a 10 cm by 8 cm rectangle with a 4 cm by 3 cm corner removed. Find its area.

54. An L-shape is made from a 12 cm by 9 cm rectangle with a 5 cm by 4 cm corner removed from the top right. Find its perimeter.

55. A 14 cm by 10 cm rectangle has a triangular cut-out with base 6 cm and height 4 cm. Find the remaining area.

56. A shape is made from a 9 cm by 6 cm rectangle and a square of side 5 cm, with no overlap. Find its total area.

57. A rectangle 10 cm by 4 cm has a semicircle attached to one short side. Find the outside perimeter in terms of π .

58. Find the area between two circles with radii 6 cm and 4 cm, in terms of π .

59. A T-shape is made from rectangles 6 cm by 4 cm and 3 cm by 10 cm, with no overlap. Find its area.

60. A T-shape is made from a 8 cm by 3 cm rectangle with a 2 cm by 5 cm rectangle attached centrally on top. Find its perimeter.

61. A square of side 8 cm is removed from a circle of radius 8 cm. Find the remaining area in terms of π .

62. A house shape is made from a 10 cm by 6 cm rectangle and a triangular roof with base 10 cm and height 4 cm. Find its area.

63. A house shape has a 10 cm by 6 cm rectangular wall and a roof with two sloping sides of 7 cm. Find the outside perimeter.

64. A rectangular border has outer dimensions 18 cm by 12 cm and inner dimensions 14 cm by 8 cm. Find the border area.

65. A stadium shape is made from a 20 m by 10 m rectangle and two semicircles with diameter 10 m. Find its area in terms of π .

66. A stadium shape is made from two straight lengths of 20 m and two semicircles with diameter 10 m. Find its perimeter in terms of π .

67. A trapezium with parallel sides 8 cm and 14 cm, height 6 cm, is joined to a 14 cm by 5 cm rectangle. Find the total area.

Exam-Style Structured Practice

1. A rectangular field is 24 m long and 15 m wide. Find its perimeter and area.

2. A rectangle has perimeter 74 cm and length 22 cm. Find its width and area.

3. A triangular banner has base 18 m and height 12 m. Its material costs 3 dollars per square metre. Find the area and total material cost.

4. A parallelogram has base 17 cm, perpendicular height 9 cm, and side length 11 cm. Find its area and perimeter.

5. A trapezium has parallel sides 16 cm and 24 cm, height 10 cm, and non-parallel sides 11 cm and 13 cm. Find its area and perimeter.

6. A trapezium has area 180 cm^2 , height 12 cm, and one parallel side 20 cm. Find the other parallel side.

7. A circle has radius 9 cm. Find its circumference and area in terms of π .

8. A semicircular window has diameter 10 cm. Find its area and perimeter in terms of π .

9. An L-shape is made from a 14 cm by 10 cm rectangle with a 5 cm by 4 cm corner removed. Find the area and perimeter.

10. A 12 cm by 8 cm rectangle has a semicircle of diameter 8 cm removed. Find the remaining area in terms of π .

11. A rectangular garden is 30 m by 18 m. A path of width 2 m surrounds it. Find the area of the path.

12. A room is 5 m by 4 m. Square tiles are 50 cm by 50 cm. How many tiles are needed to cover the floor?

13. A house shape is made from a 10 cm by 6 cm rectangle and a triangular roof with base 10 cm, height 4 cm, and sloping sides 7 cm. Find the area and outside perimeter.

14. A shaded ring lies between circles with radii 7 cm and 3 cm. Find the shaded area in terms of π .

15. A quarter circle has radius 12 cm. Find its area and perimeter in terms of π .

16. A triangular garden has side lengths 13 m, 14 m, and 15 m. The side of length 14 m is used as the base, and the height is 12 m. Find its perimeter and area.

17. A trapezium has area 135 cm^2 and parallel sides 18 cm and 12 cm. Find its height.

18. A 20 cm by 12 cm rectangle has a triangular cut-out with base 8 cm and height 6 cm. Find the remaining area.

19. A rectangle is 18 cm by 7 cm. A triangle has base 21 cm and height 12 cm. Show that their areas are equal.

20. A circle of radius 8 cm is drawn inside a square of side 16 cm. Find the area outside the circle but inside the square.

21. A parallelogram paddock has base 35 m, height 8 m, and sloping side 13 m. Find its area and perimeter.

22. A circle has area $49\pi \text{ cm}^2$. Find its radius and circumference.

23. A rectangle 14 cm by 6 cm has a semicircle attached to one short side. Find the total area and outside perimeter in terms of π .

24. A trapezium with parallel sides 8 cm and 14 cm, height 6 cm, is joined to a 14 cm by 5 cm rectangle. Find the total area.

25. A plan shows a rectangle 9 cm by 6 cm. The scale is 1 cm : 2 m. Find the real perimeter and area.

Mixed Review

1. Convert 450 cm to metres.

2. Find the area of a rectangle 3 m by 80 cm, in square metres.

3. Find the perimeter of a rectangle 7.5 cm by 2.5 cm.

4. Find the area of a triangle with base 9 cm and height 8 cm.

5. Find the area of a trapezium with parallel sides 5 cm and 13 cm, and height 4 cm.

6. A circle has diameter 16 cm. Find its circumference in terms of π .

7. An L-shape is made from a 9 cm by 7 cm rectangle with a 3 cm by 2 cm corner removed. Find its area.

8. Estimate 19.8×5.1 by rounding to one significant figure.

9. A length is 12 cm to the nearest centimetre. State its bounds.

10. A square has area 49 cm^2 . Find its perimeter.

11. A shape with area 12 cm^2 is enlarged by scale factor 2. Find the image area.

12. Convert 2 m^2 to square centimetres.

13. Find the perimeter of a semicircle with radius 4 cm, in terms of π .

14. A house shape is made from an 8 cm by 5 cm rectangle and a triangular roof with base 8 cm and height 3 cm. Find its area.

Challenge Questions

1. A rectangle has length 5 cm more than its width. Its perimeter is 58 cm. Find its width, length, and area.

2. A trapezium has parallel sides x cm and $(x + 8)$ cm, height 6 cm, and area 84 cm^2 . Find the two parallel sides.

3. A 15 cm by 12 cm rectangle has a corner rectangle of width x cm and height 4 cm removed. The remaining area is 148 cm^2 . Find x and the outside perimeter.

4. A running track shape is made from a 40 m by 18 m rectangle and two semicircles with diameter 18 m. Find its area and perimeter in terms of π .

5. A square has side 14 cm. Four quarter-circles of radius 7 cm together make one circle inside the square. Find the area of the square outside the four quarter-circles.

6. A shape is made from a semicircle with diameter 12 cm and a triangle with the same base 12 cm and height 8 cm. Find the total area in terms of π .

7. Two similar shapes have perimeters 30 cm and 42 cm. The smaller area is 50 cm^2 . Find the larger area.

8. A circle has circumference $18\pi \text{ cm}$. Find its radius and area.

9. A rectilinear shape has vertices $(0, 0)$, $(10, 0)$, $(10, 4)$, $(6, 4)$, $(6, 9)$, and $(0, 9)$. Find its area and perimeter.

Common Mistakes

- Writing area units as cm instead of cm^2 .
- Using circumference when the question asks for area.
- Counting an internal shared edge as part of the outside perimeter.
- Forgetting to halve the base times height for triangles.
- Using the sloping side instead of the perpendicular height.

Chapter 3: Surface Area and Volume

Chapter Goal

Find surface area and volume for cuboids, prisms, pyramids, cylinders, nets, and compound solids.

Calculator Policy

Mostly non-calculator. Leave circular answers in terms of π unless decimal rounding is requested.

Quick Notes - Page 1

Volume measures the space inside a solid.

- Cuboid volume: lwh .
- Cuboid surface area: $2(lw + lh + wh)$.
- Prism volume: cross-section area $\times$ length.
- Prism surface area: $2 \times \text{end area} + \text{cross-section perimeter} \times \text{length}$.
- Cube surface area: $6s^2$.

Quick Notes - Page 2

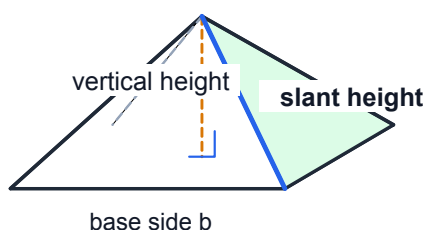
Cylinder formulae:

- Volume: $\pi r^2 h$.
- Curved surface area: $2\pi r h$.
- Total surface area of a closed cylinder: $2\pi r^2 + 2\pi r h$.

For compound solids, add or subtract volumes. For prism surface area, use two ends plus the perimeter of the cross-section times the length.

For pyramids:

- Volume: $\frac{1}{3} \times \text{base area} \times \text{vertical height}$.
- Square pyramid surface area: base area plus four triangular faces.
- If the base side is b and the slant height is s , surface area $= b^2 + 2bs$.



Worked Examples

Example 1

Find the volume of a cuboid 6 cm by 5 cm by 4 cm.

Solution: $6 \times 5 \times 4 = 120 \text{ cm}^3$.

Example 2

Find the surface area of a cube with side 3 cm.

Solution: $6 \times 3^2 = 54 \text{ cm}^2$.

Example 3

A prism has cross-section area 24 cm^2 and length 9 cm. Find its volume.

Solution: $24 \times 9 = 216 \text{ cm}^3$.

Example 4

Find the volume of a cylinder with radius 4 cm and height 7 cm.

Solution: $\pi \times 4^2 \times 7 = 112\pi \text{ cm}^3$.

Example 5

A triangular prism has right-triangle cross-section 3, 4, 5 and length 10. Find its surface area.

Solution: two ends = 12, lateral area = $(3 + 4 + 5)10 = 120$, total 132.

Example 6

A 10 cm by 8 cm by 5 cm cuboid has a 4 cm by 3 cm by 5 cm tunnel removed. Find the remaining volume.

Solution: $10 \times 8 \times 5 - 4 \times 3 \times 5 = 340 \text{ cm}^3$.

Example 7

A square pyramid has base side 9 cm and vertical height 12 cm. Find its volume.

Solution: $\frac{1}{3} \times 9^2 \times 12 = 324 \text{ cm}^3$.

Example 8

A square pyramid has base side 10 cm and slant height 13 cm. Find its total surface area.

Solution: base area = 100, triangular faces = $2 \times 10 \times 13 = 260$, total 360 cm^2 .

Progress Tracker

Section	Questions	Completed	Correct	Retry
Skill Practice	85	[]	___ / 85	[]
Exam-Style Structured Practice	23	[]	___ / 23	[]
Mixed Review	13	[]	___ / 13	[]
Challenge Questions	8	[]	___ / 8	[]

Skill Practice

1. Write the formula for the volume of a cuboid with length l , width w , and height h .

2. Write the formula for the surface area of a cuboid with length l , width w , and height h .

3. Write the formula for the volume of a prism.

4. Write the formula for the volume of a cylinder with radius r and height h .

5. Write the formula for the curved surface area of a cylinder.

6. Write the formula for the total surface area of a closed cylinder.

7. Find the volume of a cuboid 5 cm by 4 cm by 3 cm.

8. Find the volume of a cuboid 12 m by 6 m by 2 m.

9. Find the volume of a cuboid 7 mm by 8 mm by 9 mm.

10. A cuboid has volume 240 cm^3 , length 10 cm, and width 6 cm. Find its height.

11. Find the surface area of a cuboid 4 cm by 5 cm by 6 cm.

12. Find the surface area of a cuboid 10 cm by 3 cm by 2 cm.

13. Find the volume of a cube with side 5 cm.

14. Find the surface area of a cube with side 6 cm.

15. Find the capacity in cubic centimetres of a tank 20 cm by 10 cm by 5 cm.

16. A tank is 30 cm by 20 cm by 10 cm. Find its capacity in litres.

17. An open-top box is 8 cm by 5 cm by 4 cm. Find the outside surface area, excluding the top.

18. Find the volume of a cuboid 2.5 m by 4 m by 3 m.

19. A cuboid has volume 360 cm^3 , width 6 cm, and height 10 cm. Find its length.

20. Find the surface area of a cube with side 9 cm.

21. Find the volume of a cube with side 12 cm.

22. A prism has cross-section area 18 cm^2 and length 7 cm. Find its volume.

23. A triangular prism has right-triangle cross-section with base 6 cm, height 8 cm, and prism length 10 cm. Find its volume.

24. A triangular prism has right-triangle cross-section with sides 3 cm, 4 cm, and 5 cm, and length 12 cm. Find its surface area.

25. A prism has trapezium cross-section with parallel sides 8 cm and 12 cm, height 5 cm, and length 9 cm. Find its volume.

26. An L-shaped prism has cross-section area 68 cm^2 and length 4 cm. Find its volume.

27. A prism has volume 240 cm^3 and cross-section area 30 cm^2 . Find its length.

28. A prism has cross-section area 45 cm^2 and length 11 cm . Find its volume.

29. A triangular prism has right-triangle cross-section with sides 5 cm , 12 cm , and 13 cm , and length 10 cm . Find its surface area.

30. A prism has parallelogram cross-section with base 10 cm , height 6 cm , and length 8 cm . Find its volume.

31. A prism has volume 420 cm^3 and length 14 cm . Find its cross-section area.

32. A triangular prism has right-triangle cross-section with perpendicular sides 9 cm and 12 cm , and length 5 cm . Find its volume.

33. A triangular prism has right-triangle cross-section with sides 6 cm, 8 cm, and 10 cm, and length 7 cm. Find its surface area.

34. Find the volume of a cylinder with radius 3 cm and height 10 cm, in terms of π .

35. Find the volume of a cylinder with radius 5 cm and height 8 cm, in terms of π .

36. Find the volume of a cylinder with diameter 12 cm and height 7 cm, in terms of π .

37. Find the curved surface area of a cylinder with radius 4 cm and height 9 cm, in terms of π .

38. Find the total surface area of a closed cylinder with radius 4 cm and height 9 cm, in terms of π .

39. Find the total surface area of a closed cylinder with radius 5 cm and height 6 cm, in terms of π .

40. Find the volume of a cylinder with radius 7 cm and height 10 cm, in terms of π .

41. A cylinder has volume $48\pi \text{ cm}^3$ and radius 4 cm. Find its height.

42. A cylinder has volume $75\pi \text{ cm}^3$ and height 3 cm. Find its radius.

43. Find the volume of a cylinder with diameter 10 cm and height 12 cm, in terms of π .

44. Find the curved surface area of a cylinder with diameter 8 cm and height 15 cm, in terms of π .

45. Find the total surface area of a closed cylinder with diameter 6 cm and height 10 cm, in terms of π .

46. A cube has side 4 cm. Find the area of its net.

47. A closed cuboid tin is 12 cm by 8 cm by 5 cm. Find its surface area.

48. An open-top box is 10 cm by 6 cm by 4 cm. Find the surface area of material used.

49. A triangular prism has cross-section sides 3 cm, 4 cm, and 5 cm, and length 6 cm. Find its surface area.

50. Find the curved surface area of a cylinder with radius 3 cm and height 12 cm, in terms of π .

51. Find the total area of the two circular ends of a cylinder with radius 6 cm, in terms of π .

52. Find the total surface area of a cylinder with radius 6 cm and height 8 cm, in terms of π .

53. A cuboid has dimensions 7 cm, 4 cm, and 3 cm. Find its volume.

54. A compound solid is made from cuboids 4 cm by 5 cm by 6 cm and 3 cm by 5 cm by 2 cm, with no overlap. Find its volume.

55. A 10 cm by 8 cm by 5 cm cuboid has a 4 cm by 3 cm by 5 cm rectangular tunnel removed. Find the remaining volume.

56. An L-shaped prism has cross-section made from a 10 cm by 8 cm rectangle with a 4 cm by 3 cm corner removed. Its length is 5 cm. Find its volume.

57. A cylinder of radius 5 cm and height 12 cm is removed from a 10 cm by 10 cm by 12 cm cuboid. Find the remaining volume in terms of π .

58. Two cylinders with radius 3 cm have heights 5 cm and 7 cm. Find their total volume in terms of π .

59. A rectangular tank is 80 cm by 50 cm by 40 cm. Find its capacity in litres.

60. Two cubes of side 4 cm are joined face-to-face to make one cuboid. Find the surface area of the new solid.

61. A step solid is made from a lower cuboid 12 cm by 6 cm by 3 cm and an upper cuboid 5 cm by 6 cm by 4 cm. Find the total volume.

62. Write the formula for the volume of a pyramid.

63. Write the formula for the total surface area of a square pyramid with base side b and slant height s .

64. A triangular prism has triangular cross-section with base 8 cm and height 5 cm. The prism length is 12 cm. Find its volume.

65. A triangular prism has right-triangle cross-section sides 6 cm, 8 cm, and 10 cm, and prism length 9 cm. Find its total surface area.

66. A prism has trapezium cross-section with parallel sides 6 cm and 10 cm, height 4 cm, and length 7 cm. Find its volume.

67. A prism has cross-section area 30 cm^2 , cross-section perimeter 26 cm, and length 8 cm. Find its total surface area.

68. A square pyramid has base side 10 cm and vertical height 12 cm. Find its volume.

69. A square pyramid has base side 8 cm and slant height 5 cm. Find its total surface area.

70. A rectangular pyramid has base 12 cm by 9 cm and vertical height 10 cm. Find its volume.

71. A square pyramid has volume 192 cm^3 and base side 8 cm. Find its vertical height.

72. A square pyramid has base side 6 cm and slant height 5 cm. Find its total surface area.

73. A prism has cross-section area 42 cm^2 , cross-section perimeter 28 cm, and length 10 cm. Find its total surface area.

74. A square pyramid has base side 10 cm and total surface area 260 cm^2 . Find its slant height.

75. A square pyramid has base side 12 cm and vertical height 9 cm. Find its volume.

76. A prism has cross-section area 36 cm^2 , cross-section perimeter 30 cm, and length 8 cm. Find its total surface area.

77. A rectangular pyramid has base 15 cm by 8 cm and volume 400 cm^3 . Find its vertical height.

78. A square pyramid has base side 14 cm and vertical height 18 cm. Find its volume.

79. A square pyramid has base side 9 cm and slant height 7 cm. Find its total surface area.

80. A triangular prism has cross-section area 45 cm^2 , cross-section perimeter 32 cm, and length 11 cm. Find its total surface area.

81. A prism has volume 468 cm^3 and cross-section area 39 cm^2 . Find its length.

82. A square pyramid has volume 768 cm^3 and base side 16 cm. Find its vertical height.

83. A rectangular pyramid has base 18 cm by 10 cm and vertical height 12 cm. Find its volume.

84. A square pyramid has total surface area 325 cm^2 and base side 13 cm . Find its slant height.

85. A compound solid is made by placing a square pyramid with base side 8 cm and vertical height 9 cm on top of a cube with side 8 cm . Find the total volume.

Exam-Style Structured Practice

1. A closed storage box is 18 cm by 10 cm by 7 cm. Find its volume and surface area.

2. An open-top tray is 15 cm by 9 cm by 4 cm. Find the volume and the material area excluding the top.

3. A triangular prism has right-triangle cross-section with sides 8 cm, 15 cm, and 17 cm, and length 12 cm. Find its volume and surface area.

4. A closed cylinder has radius 6 cm and height 11 cm. Find its volume and total surface area in terms of π .

5. A rectangular water tank is 60 cm by 45 cm by 30 cm. Find its capacity in cubic centimetres and litres.

6. A compound solid is made from cuboids 10 cm by 8 cm by 4 cm and 6 cm by 8 cm by 5 cm, with no overlap. Find its volume.

7. A cuboid has volume 960 cm^3 , length 16 cm, and width 10 cm. Find its height and surface area.

8. A cylinder has volume $245\pi \text{ cm}^3$ and radius 7 cm. Find its height and curved surface area.

9. A prism has trapezium cross-section with parallel sides 10 cm and 18 cm, height 6 cm, and length 14 cm. Find its volume.

10. A pipe has outer radius 5 cm, inner radius 3 cm, and length 20 cm. Find the volume of material in terms of π .

11. An L-shaped prism has cross-section made from a 12 cm by 9 cm rectangle with a 5 cm by 4 cm corner removed. Its length is 6 cm. Find its volume.

12. A cube has volume 343 cm^3 . Find its side length and surface area.

13. A cuboid has square base, height 20 cm, and volume 500 cm^3 . Find the base side length and total surface area.

14. A tin has radius 4 cm and height 12 cm. Find the label area around the side and the total surface area of the closed tin.

15. A cuboid is 10 cm by 10 cm by 6 cm. A cylinder has radius 5 cm and height 6 cm. Find both volumes.

16. A 15 cm by 10 cm by 8 cm block has a rectangular tunnel 5 cm by 4 cm running through its full 15 cm length. Find the remaining volume.

17. A cuboid is 0.4 m by 30 cm by 200 mm. Find its volume in cubic metres and cubic centimetres.

18. A rectangular tank is 60 cm by 40 cm. It contains 72000 cm^3 of water. Find the water depth.

19. A triangular prism has cross-section sides 7 cm, 24 cm, and 25 cm, and length 9 cm. Find the total area of its three rectangular side faces.

20. A closed cylinder has radius 7 cm and height 10 cm. Find the curved surface area, the area of both circular ends, and the total surface area.

21. Three cubes of side 3 cm are joined in a straight row. Find the volume and surface area of the resulting cuboid.

22. A cuboid has length 8 cm, width 5 cm, and surface area 210 cm^2 . Find its height.

23. A right-triangular prism has cross-section sides 9 cm, 12 cm, and 15 cm, and length 16 cm. Find its volume and surface area.

Mixed Review

1. Convert 0.002 m^3 to cubic centimetres.

2. Find the area of a rectangle 14 cm by 6 cm.

3. Find the volume of a cuboid 9 cm by 5 cm by 4 cm.

4. Find the volume of a cylinder with radius 2 cm and height 9 cm, in terms of π .

5. Find the area of a triangle with base 11 cm and height 8 cm.

6. Find the surface area of a cube with side 4 cm.

7. A length is 8 cm to the nearest centimetre. State its bounds.

8. A prism has cross-section area 32 cm^2 and length 9 cm . Find its volume.

9. Find the total surface area of a cylinder with radius 3 cm and height 7 cm , in terms of π .

10. A 12 cm by 8 cm rectangle has a 4 cm by 3 cm corner removed. Find the remaining area.

11. A tank holds 4500 cm^3 . Convert this to litres.

12. Find the perimeter of a semicircle with radius 5 cm , in terms of π .

13. A cuboid has volume 216 cm^3 , length 9 cm , and width 6 cm . Find its height.

Challenge Questions

1. A cube has surface area 294 cm^2 . Find its side length and volume.

2. A cuboid 12 cm by 10 cm by 5 cm has the same volume as a cylinder of radius 5 cm. Find the cylinder height in terms of π .

3. A 20 cm by 16 cm sheet has 3 cm squares cut from each corner and is folded into an open box. Find the volume and material area after cutting.

4. An L-shaped prism has cross-section made from a 10 cm by 8 cm rectangle with a 4 cm by 3 cm corner removed. The prism length is 5 cm. Find its surface area.

5. A hollow cylinder has outer radius 6 cm, inner radius 4 cm, and length 15 cm. Find the volume of material and the total surface area including both annular ends.

6. Two similar solids have length scale factor 3. The smaller solid has volume 12 cm^3 and surface area 20 cm^2 . Find the larger volume and surface area.

7. A rectangular tank has base 60 cm by 40 cm. It contains 72 L of water. Find the depth of water in centimetres.

8. A right-triangular prism has cross-section sides 8 cm, 15 cm, and 17 cm, and length 20 cm. Find its volume and surface area.

Common Mistakes

- Giving area units for volume answers.
- Using diameter as radius in cylinder formulae.
- Forgetting the two end faces of a prism.
- Using vertical height instead of slant height for pyramid surface area.
- Forgetting the $\frac{1}{3}$ factor in pyramid volume.
- Counting the top face of an open box.
- Mixing centimetres, metres, and millimetres before multiplying.

Chapter 4: Time, Speed and Compound Measures

Chapter Goal

Use speed, density, pressure, flow rate, and unit conversion in context.

Calculator Policy

Calculator allowed for realistic decimal contexts. Show unit conversion before substituting into formulae.

Quick Notes - Page 1

Speed, density, and pressure are compound measures.

- $\text{speed} = \frac{\text{distance}}{\text{time}}.$
- $\text{density} = \frac{\text{mass}}{\text{volume}}.$
- $\text{pressure} = \frac{\text{force}}{\text{area}}.$
- $\text{flow rate} = \frac{\text{volume}}{\text{time}}.$

Quick Notes - Page 2

Always convert units first:

- $1 \text{ h} = 60 \text{ min} = 3600 \text{ s}.$
- $1 \text{ km} = 1000 \text{ m}.$
- $1 \text{ L} = 1000 \text{ cm}^3.$
- To convert m/s to km/h, multiply by 3.6.

Worked Examples

Example 1

A car travels 150 km in 3 h. Find its speed.

Solution: $150 \div 3 = 50 \text{ km/h}.$

Example 2

Convert 20 m/s to km/h.

Solution: $20 \times 3.6 = 72 \text{ km/h}.$

Example 3

A block has mass 240 g and volume 80 cm^3 . Find its density.

Solution: $240 \div 80 = 3 \text{ g/cm}^3.$

Example 4

A force of 500 N acts on area 2 m^2 . Find the pressure.

Solution: $500 \div 2 = 250 \text{ N/m}^2$.

Example 5

A tap fills 18 L in 6 min. Find the flow rate.

Solution: $18 \div 6 = 3 \text{ L/min}$.

Example 6

A journey is 60 km in 1 h, then 30 km in 1 h. Find the average speed.

Solution: total distance = 90 km, total time = 2 h, so speed = 45 km/h.

Progress Tracker

Section	Questions	Completed	Correct	Retry
Skill Practice	52	[]	___ / 52	[]
Exam-Style Structured Practice	20	[]	___ / 20	[]
Mixed Review	11	[]	___ / 11	[]
Challenge Questions	7	[]	___ / 7	[]

Skill Practice

1. Write the formula for speed using distance and time.

2. Write the formula for distance using speed and time.

3. Write the formula for time using distance and speed.

4. Write the formula for density using mass and volume.

5. Write the formula for mass using density and volume.

6. Write the formula for pressure using force and area.

7. Convert 2 h 30 min to minutes.

8. Convert 135 min to hours and minutes.

9. Convert 3.5 h to minutes.

10. Convert 540 s to minutes.

11. Convert 1 h 20 min to minutes.

12. Convert 95 min to hours and minutes.

13. Convert 2 days 6 h to hours.

14. Convert 7200 s to hours.

15. Convert 4.25 h to hours and minutes.

16. Convert 1.2 h to minutes.

17. A car travels 100 km in 2 h. Find its average speed.

18. A bus travels 180 km at 60 km/h. Find the time taken.

19. An object moves at 12 m/s for 8 s. Find the distance.

20. A runner travels 5 km in 30 min. Find the speed in km/h.

21. A swimmer travels 150 m in 25 s. Find the speed.

22. Convert 72 km/h to m/s.

23. Convert 15 m/s to km/h.

24. A train travels 84 km in 1.5 h. Find its average speed.

25. A cyclist travels 360 m at 12 m/s. Find the time.

26. A car travels at 80 km/h for 4.5 h. Find the distance.

27. A journey of 150 km takes 3 h. Find the average speed.

28. A cyclist travels 7.2 km in 12 min. Find the speed in km/h.

29. A runner travels 250 m in 40 s. Find the speed.

30. A car travels at 90 km/h for 20 min. Find the distance.

31. A solid has mass 200 g and volume 50 cm^3 . Find its density.

32. A material has density 2.7 g/cm^3 and volume 10 cm^3 . Find its mass.

33. A solid has mass 600 g and density 3 g/cm^3 . Find its volume.

34. A box has mass 80 kg and volume 0.1 m^3 . Find its density.

35. A liquid has density 1.2 g/cm^3 and volume 250 cm^3 . Find its mass.

36. A material has mass 1.5 kg and density 500 kg/m^3 . Find its volume.

37. A sample has mass 5 g and volume 2 cm^3 . Find its density.

38. A liquid has density 0.8 g/cm^3 and volume 125 cm^3 . Find its mass.

39. A metal has density 2700 kg/m^3 and volume 0.02 m^3 . Find its mass.

40. A liquid has mass 900 g and density 0.6 g/cm^3 . Find its volume.

41. A force of 100 N acts on area 5 m^2 . Find the pressure.

42. A pressure of 30 N/m^2 acts on area 4 m^2 . Find the force.

43. A force of 200 N creates pressure 50 N/m^2 . Find the area.

44. A force of 60 N acts on area 0.2 m^2 . Find the pressure.

45. A force of 1200 N acts on area 3 m^2 . Find the pressure.

46. A pressure of 15 N/cm^2 acts on area 8 cm^2 . Find the force.

47. A force of 500 N creates pressure 25 N/m^2 . Find the area.

48. A force of 800 N acts on area 0.5 m^2 . Find the pressure.

49. A tap fills 24 L in 6 min. Find the flow rate.

50. Water flows at 3 L/min for 7 min. Find the volume.

51. A tap fills 45 L at 5 L/min. Find the time.

52. Water flows at 120 mL/s for 30 s. Find the volume.

Exam-Style Structured Practice

1. A train travels 180 km in 2 h 15 min. Find its average speed.

2. A runner travels 7.5 km at 6 km/h. Find the time in hours and minutes.

3. A car travels at 90 km/h for 2 h 40 min. Find the distance.

4. Convert 18 m/s to km/h .

5. A journey has two parts: 60 km in 1 h , then 90 km in 1.5 h . Find the average speed for the whole journey.

6. A block is 8 cm by 5 cm by 4 cm and has mass 480 g . Find its density.

7. A metal has density 7800 kg/m^3 and volume 0.02 m^3 . Find its mass.

8. A liquid has density 0.9 g/cm^3 . Find the mass of 2 L of the liquid in kilograms.

9. A box exerts force 600 N on a rectangular base 2 m by 1.5 m. Find the pressure.

10. A pressure of 1200 N/m^2 acts on area 0.25 m^2 . Find the force.

11. A cylinder has radius 3 cm, height 10 cm, and density 2 g/cm^3 . Find its mass in terms of π .

12. A tank needs 80 L of water. A tap flows at 5 L/min . Find the filling time.

13. A car uses 6 L of fuel per 100 km. How much fuel is used for 250 km?

14. A driver travels 120 km at 60 km/h, then stops for 30 min. Find the average speed for the whole time including the stop.

15. A force of 90 N acts on area 30 cm^2 . Find the pressure in N/cm^2 .

16. Convert 54 km/h to m/s.

17. A cyclist travels 12 km at 24 km/h, then 6 km at 12 km/h. Find the average speed for the whole journey.

18. Water flows at 2.5 L/min for 12 min. Find the volume.

19. A material has mass 2.4 kg and density 800 kg/m^3 . Find its volume.

20. A cube rests on a square face of side 0.5 m. Its weight is 200 N. Find the pressure on the ground.

Mixed Review

1. Convert 2.5 h to minutes.

2. Find the volume of a cuboid 6 cm by 5 cm by 4 cm.

3. Find the area of a rectangle 11 cm by 7 cm.

4. A person walks 6 km in 1.5 h. Find the speed.

5. A sample has mass 240 g and volume 80 cm^3 . Find its density.

6. A force of 150 N acts on 5 m^2 . Find the pressure.

7. Find the volume of a cylinder with radius 4 cm and height 5 cm, in terms of π .

8. A film starts at 14:35 and lasts 1 h 45 min. What time does it finish?

9. Find the circumference of a circle with diameter 18 cm, in terms of π .

10. Convert 3000 cm^3 to litres.

11. A car travels 36 km in 45 min. Find its average speed in km/h.

Challenge Questions

1. A journey has 120 km at 80 km/h, then 90 km at 60 km/h, with a 30 min stop between them. Find the average speed including the stop.

2. A cuboid 10 cm by 8 cm by 5 cm has a rectangular tunnel 4 cm by 3 cm by 5 cm removed. The remaining solid has mass 850 g. Find its density.

3. A person has weight 600 N. Each shoe has contact area 200 cm^2 . Find the pressure when standing on two feet and when standing on one foot.

4. A tank is 60 cm by 40 cm by 30 cm. It is filled by a tap at 6 L/min. Find the filling time.

5. A car travels from town A to town B at 60 km/h and returns along the same route at 40 km/h . The total travelling time is 5 h . Find the one-way distance.

6. A metal cylinder has radius 2 cm , height 10 cm , and density 7.8 g/cm^3 . Find its mass in terms of π .

7. A pump fills $\frac{3}{5}$ of a 75 L tank in 18 min. Find the flow rate and the extra time needed to fill the rest of the tank.

Common Mistakes

- Dividing by minutes when the speed is in kilometres per hour.
- Averaging speeds directly instead of using total distance and total time.
- Forgetting that $1 \text{ L} = 1000 \text{ cm}^3$.
- Using area instead of volume for density.
- Using only one shoe or both shoes without checking the question.

Chapter 5: Pythagoras' Theorem

Chapter Goal

Find missing sides and check right triangles using square relationships.

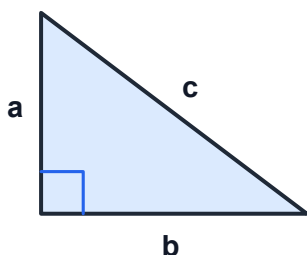
Calculator Policy

Mostly non-calculator. Exact answers are preferred; calculator use is allowed only where a question asks for a decimal approximation.

Quick Notes - Page 1

For a right triangle with shorter sides a , b , and hypotenuse c :

$$a^2 + b^2 = c^2$$



$$a^2 + b^2 = c^2$$

Use only in a right triangle

The hypotenuse is the longest side and is opposite the right angle.

Quick Notes - Page 2

To find the hypotenuse, add the squares.

To find a shorter side, subtract the square of the known shorter side from the square of the hypotenuse.

To check if a triangle is right-angled, square the two shorter sides and compare with the square of the longest side.

Worked Examples

Example 1

A right triangle has shorter sides 3 cm and 4 cm. Find the hypotenuse.

Solution: $c^2 = 3^2 + 4^2 = 25$, so $c = 5$ cm.

Example 2

A right triangle has hypotenuse 13 cm and one shorter side 5 cm. Find the other shorter side.

Solution: $b^2 = 13^2 - 5^2 = 144$, so $b = 12$ cm.

Example 3

Check whether sides 6, 8, and 10 form a right triangle.

Solution: $6^2 + 8^2 = 36 + 64 = 100 = 10^2$, so yes.

Example 4

A rectangle is 9 cm by 12 cm. Find its diagonal.

Solution: $d^2 = 9^2 + 12^2 = 225$, so $d = 15$ cm.

Example 5

Find the distance between $(0, 0)$ and $(5, 12)$.

Solution: $d = \sqrt{5^2 + 12^2} = 13$.

Example 6

A square has side 6 cm. Find its diagonal in exact form.

Solution: $d = \sqrt{6^2 + 6^2} = 6\sqrt{2}$ cm.

Progress Tracker

Section	Questions	Completed	Correct	Retry
Skill Practice	55	[]	___ / 55	[]
Exam-Style Structured Practice	21	[]	___ / 21	[]
Mixed Review	11	[]	___ / 11	[]
Challenge Questions	8	[]	___ / 8	[]

Skill Practice

1. State Pythagoras' theorem for a right triangle with shorter sides a , b , and hypotenuse c .

2. In a right triangle, what is the hypotenuse?

3. If the hypotenuse is c and one shorter side is a , write a formula for the other shorter side b .

4. Can Pythagoras' theorem be used directly on every triangle?

5. Which side should be squared alone when finding the hypotenuse?

6. To check whether sides a , b , and c form a right triangle, which side should be treated as c ?

7. Find $3^2 + 4^2$.

8. Find $13^2 - 5^2$.

9. A right triangle has shorter sides 3 cm and 4 cm. Find the hypotenuse.

10. A right triangle has shorter sides 5 cm and 12 cm. Find the hypotenuse.

11. A right triangle has shorter sides 8 cm and 15 cm. Find the hypotenuse.

12. A right triangle has shorter sides 7 cm and 24 cm. Find the hypotenuse.

13. A right triangle has shorter sides 9 cm and 12 cm. Find the hypotenuse.

14. A right triangle has shorter sides 20 cm and 21 cm. Find the hypotenuse.

15. A right triangle has shorter sides 10 cm and 24 cm. Find the hypotenuse.

16. A right triangle has shorter sides 6 cm and 8 cm. Find the hypotenuse.

17. A right triangle has shorter sides 12 cm and 35 cm. Find the hypotenuse.

18. A right triangle has shorter sides 16 cm and 30 cm. Find the hypotenuse.

19. A right triangle has hypotenuse 13 cm and one shorter side 5 cm. Find the other shorter side.

20. A right triangle has hypotenuse 17 cm and one shorter side 8 cm. Find the other shorter side.

21. A right triangle has hypotenuse 25 cm and one shorter side 7 cm. Find the other shorter side.

22. A right triangle has hypotenuse 10 cm and one shorter side 6 cm. Find the other shorter side.

23. A right triangle has hypotenuse 26 cm and one shorter side 10 cm. Find the other shorter side.

24. A right triangle has hypotenuse 29 cm and one shorter side 20 cm. Find the other shorter side.

25. A right triangle has hypotenuse 15 cm and one shorter side 9 cm. Find the other shorter side.

26. A right triangle has hypotenuse 37 cm and one shorter side 12 cm. Find the other shorter side.

27. A right triangle has hypotenuse 41 cm and one shorter side 9 cm. Find the other shorter side.

28. A right triangle has hypotenuse 34 cm and one shorter side 16 cm. Find the other shorter side.

29. Check whether sides 6 cm, 8 cm, and 10 cm form a right triangle.

30. Check whether sides 5 cm, 12 cm, and 14 cm form a right triangle.

31. Check whether sides 7 cm, 24 cm, and 25 cm form a right triangle.

32. Check whether sides 9 cm, 10 cm, and 15 cm form a right triangle.

33. Check whether sides 8 cm, 15 cm, and 17 cm form a right triangle.

34. Check whether sides 12 cm, 16 cm, and 20 cm form a right triangle.

35. Check whether sides 10 cm, 11 cm, and 15 cm form a right triangle.

36. Check whether sides 9 cm, 40 cm, and 41 cm form a right triangle.

37. A rectangle is 6 cm by 8 cm. Find the diagonal.

38. A rectangle is 9 cm by 12 cm. Find the diagonal.

39. A rectangle is 5 cm by 12 cm. Find the diagonal.

40. A rectangle is 7 cm by 24 cm. Find the diagonal.

41. A rectangle is 10 cm by 24 cm. Find the diagonal.

42. A rectangle is 8 cm by 15 cm. Find the diagonal.

43. A rectangle is 12 cm by 16 cm. Find the diagonal.

44. Find the distance between $(0, 0)$ and $(3, 4)$.

45. Find the distance between $(-2, 1)$ and $(4, 9)$.

46. Find the distance between $(1, -3)$ and $(7, 5)$.

47. Find the distance between $(-5, -2)$ and $(7, 3)$.

48. Find the distance between $(2, 4)$ and $(10, 19)$.

49. A right triangle has shorter sides 2 cm and 3 cm. Find the hypotenuse in exact form.

50. A right triangle has shorter sides 4 cm and 6 cm. Find the hypotenuse in exact form.

51. A right triangle has shorter sides 5 cm and 5 cm. Find the hypotenuse in exact form.

52. A right triangle has shorter sides 6 cm and 7 cm. Find the hypotenuse in exact form.

53. A right triangle has shorter sides 1 cm and 8 cm. Find the hypotenuse in exact form.

54. A right triangle has shorter sides 9 cm and 11 cm. Find the hypotenuse in exact form.

55. A right triangle has shorter sides 3 cm and 10 cm. Find the hypotenuse in exact form.

Exam-Style Structured Practice

1. A ladder is 13 m long. Its foot is 5 m from a vertical wall. How high up the wall does it reach?

2. A wire from the top of a 15 m pole to the ground is 17 m long. How far is the base of the wire from the pole?

3. A rectangular screen is 16 cm wide and 30 cm high. Find its diagonal.

4. Points $A(-3, 2)$ and $B(9, 7)$ are joined. Find AB .

5. A triangle has sides 9 cm, 12 cm, and 15 cm. Show that it is right-angled.

6. A triangle has sides 8 cm, 11 cm, and 14 cm. Is it right-angled?

7. A right triangle has shorter sides 20 cm and 21 cm. Find its hypotenuse and perimeter.

8. A right triangle has hypotenuse 25 cm and one shorter side 7 cm. Find the other shorter side and the area.

9. A person walks 6 km east and then 8 km north. Find the straight-line distance from the start.

10. A square has side 9 cm. Find its diagonal in exact form.

11. An isosceles triangle has equal sides 13 cm and base 10 cm. Find its height and area.

12. An isosceles trapezium has parallel sides 14 cm and 24 cm, and equal sloping sides 13 cm. Find its height.

13. A chord is 16 cm long in a circle of radius 10 cm. Find the perpendicular distance from the centre to the chord.

14. A right triangle has shorter sides 11 cm and 14 cm. Find the hypotenuse to 1 decimal place.

15. A rectangle has length 24 cm and diagonal 25 cm. Find its width and perimeter.

16. Triangle ABC has $A(0, 0)$, $B(12, 0)$, and $C(12, 5)$. Find AC and the area of the triangle.

17. A drone travels 300 m east and 400 m north in 50 s. Find its straight-line displacement and average speed along the straight-line displacement.

18. A right triangle has one shorter side 28 cm and hypotenuse 35 cm. Find the other shorter side and the triangle area.

19. A cuboid is 3 cm by 4 cm by 12 cm. Find the space diagonal.

20. A right triangle has shorter sides 9 cm and 40 cm. A rectangle has the same perimeter as the triangle and width 10 cm. Find the rectangle length.

21. Find the exact distance between $(-1, 2)$ and $(6, 8)$.

Mixed Review

1. A car travels 90 km in 1.5 h. Find its speed.

2. Find the area of a triangle with base 10 cm and height 7 cm.

3. A right triangle has shorter sides 9 cm and 12 cm. Find the hypotenuse.

4. Find the volume of a cuboid 6 cm by 5 cm by 4 cm.

5. A solid has mass 300 g and volume 100 cm^3 . Find its density.

6. Check whether sides 12, 35, and 37 form a right triangle.

7. A rectangle is 20 cm by 21 cm. Find its diagonal.

8. Convert 2 h 45 min to minutes.

9. Find the circumference of a circle with diameter 16 cm, in terms of π .

10. Find the distance between $(2, -1)$ and $(10, 14)$.

11. A force of 180 N acts on area 6 m^2 . Find the pressure.

Challenge Questions

1. A cuboid is 6 cm by 8 cm by 24 cm. Find the space diagonal.

2. A rectangle has diagonal 65 cm and length 56 cm. Find its width and area.

3. A vertical pole is 24 m high. A support cable is fixed to the top and anchored 18 m from the base. Find the cable length.

4. A right triangle has shorter sides x and $x + 7$, and hypotenuse 17. Find x .

5. A rhombus has diagonals 30 cm and 40 cm. Find its side length and area.

6. A point moves 12 m east, 16 m north, and then 15 m vertically upward. Find the straight-line distance from the start to the finish.

7. A rectangle has area 168 cm^2 and diagonal 25 cm. Its side lengths are whole numbers. Find the side lengths.

8. A boat travels 9 km east and 12 km north in 30 min. Find the straight-line displacement and the average speed based on that displacement.

Common Mistakes

- Treating a shorter side as the hypotenuse.
- Adding squares when a shorter side should be found by subtraction.
- Forgetting to take the square root at the end.
- Using Pythagoras on a triangle that is not known to be right-angled.
- Rounding too early in multi-step problems.

Chapter 6: Trigonometric Ratios

Chapter Goal

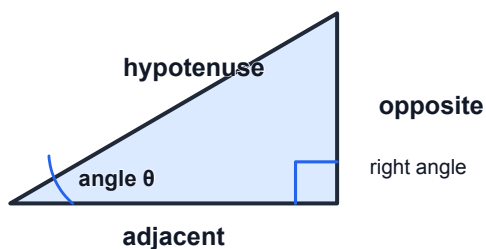
Use sine, cosine, and tangent to find missing sides and angles in right triangles.

Calculator Policy

Calculator allowed. Use degree mode and round only at the final step.

Quick Notes - Page 1

For a chosen angle in a right triangle:



- $\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}}$.
- $\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}}$.
- $\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$.

Quick Notes - Page 2

Use SOH-CAH-TOA to choose the ratio.

For missing angles, use inverse ratios:

- $\theta = \sin^{-1}(\text{opposite/hypotenuse})$.
- $\theta = \cos^{-1}(\text{adjacent/hypotenuse})$.
- $\theta = \tan^{-1}(\text{opposite/adjacent})$.

Worked Examples

Example 1

A right triangle has angle 30° and hypotenuse 10 cm. Find the opposite side.

Solution: $x = 10 \sin 30^\circ = 5$ cm.

Example 2

A right triangle has angle 40° and adjacent side 12 cm. Find the opposite side.

Solution: $x = 12 \tan 40^\circ = 10.1 \text{ cm}$.

Example 3

A right triangle has opposite side 5 cm and hypotenuse 13 cm. Find the angle.

Solution: $\theta = \sin^{-1}(5/13) = 22.6^\circ$.

Example 4

A ramp rises 2 m over a horizontal distance of 18 m. Find its angle to the ground.

Solution: $\theta = \tan^{-1}(2/18) = 6.3^\circ$.

Example 5

A ladder reaches 6 m up a wall and makes an angle of 70° with the ground. Find its length.

Solution: $L = 6 / \sin 70^\circ = 6.4 \text{ m}$.

Example 6

A rectangle has diagonal 20 cm, making angle 35° with the base. Find the height.

Solution: $\text{height} = 20 \sin 35^\circ = 11.5 \text{ cm}$.

Progress Tracker

Section	Questions	Completed	Correct	Retry
Skill Practice	71	[]	___ / 71	[]
Exam-Style Structured Practice	24	[]	___ / 24	[]
Mixed Review	13	[]	___ / 13	[]
Challenge Questions	9	[]	___ / 9	[]

Skill Practice

1. Write the sine ratio for angle θ .

2. Write the cosine ratio for angle θ .

3. Write the tangent ratio for angle θ .

4. In a right triangle, what is the side opposite the right angle called?

5. For a chosen angle, what does the opposite side mean?

6. For a chosen angle, what does the adjacent side mean?

7. Before using trigonometric ratios with degrees, what calculator mode is needed?

8. Write a formula for θ if $\sin \theta = \frac{x}{h}$.

9. A right triangle has angle 30° and hypotenuse 10 cm. Find the opposite side to 1 decimal place.

10. A right triangle has angle 42° and hypotenuse 18 cm. Find the opposite side to 1 decimal place.

11. A right triangle has angle 55° and hypotenuse 12 cm. Find the opposite side to 1 decimal place.

12. A right triangle has angle 18° and hypotenuse 25 cm. Find the opposite side to 1 decimal place.

13. A right triangle has angle 67° and hypotenuse 9 cm. Find the opposite side to 1 decimal place.

14. A right triangle has angle 60° and hypotenuse 14 cm. Find the adjacent side to 1 decimal place.

15. A right triangle has angle 37° and hypotenuse 20 cm. Find the adjacent side to 1 decimal place.

16. A right triangle has angle 25° and hypotenuse 16 cm. Find the adjacent side to 1 decimal place.

17. A right triangle has angle 72° and hypotenuse 11 cm. Find the adjacent side to 1 decimal place.

18. A right triangle has angle 48° and hypotenuse 15 cm. Find the adjacent side to 1 decimal place.

19. A right triangle has angle 35° and adjacent side 12 cm. Find the opposite side to 1 decimal place.

20. A right triangle has angle 28° and adjacent side 20 cm. Find the opposite side to 1 decimal place.

21. A right triangle has angle 64° and adjacent side 9 cm. Find the opposite side to 1 decimal place.

22. A right triangle has angle 15° and adjacent side 30 cm. Find the opposite side to 1 decimal place.

23. A right triangle has angle 50° and adjacent side 16 cm. Find the opposite side to 1 decimal place.

24. A right triangle has angle 40° and opposite side 9 cm. Find the adjacent side to 1 decimal place.

25. A right triangle has angle 53° and opposite side 12 cm. Find the adjacent side to 1 decimal place.

26. A right triangle has angle 25° and opposite side 7 cm. Find the adjacent side to 1 decimal place.

27. A right triangle has angle 70° and opposite side 18 cm. Find the adjacent side to 1 decimal place.

28. A right triangle has angle 32° and opposite side 14 cm. Find the adjacent side to 1 decimal place.

29. A right triangle has angle 30° and opposite side 8 cm. Find the hypotenuse to 1 decimal place.

30. A right triangle has angle 47° and opposite side 12 cm. Find the hypotenuse to 1 decimal place.

31. A right triangle has angle 62° and opposite side 20 cm. Find the hypotenuse to 1 decimal place.

32. A right triangle has angle 25° and opposite side 5 cm. Find the hypotenuse to 1 decimal place.

33. A right triangle has angle 71° and opposite side 16 cm. Find the hypotenuse to 1 decimal place.

34. A right triangle has angle 60° and adjacent side 8 cm. Find the hypotenuse to 1 decimal place.

35. A right triangle has angle 38° and adjacent side 12 cm. Find the hypotenuse to 1 decimal place.

36. A right triangle has angle 57° and adjacent side 14 cm. Find the hypotenuse to 1 decimal place.

37. A right triangle has angle 20° and adjacent side 10 cm. Find the hypotenuse to 1 decimal place.

38. A right triangle has angle 73° and adjacent side 6 cm. Find the hypotenuse to 1 decimal place.

39. In a right triangle, the opposite side to angle θ is 5 cm, and the hypotenuse is 13 cm. Find θ to 1 decimal place.

40. In a right triangle, the opposite side to angle θ is 7 cm, and the hypotenuse is 10 cm. Find θ to 1 decimal place.

41. In a right triangle, the opposite side to angle θ is 9 cm, and the hypotenuse is 15 cm. Find θ to 1 decimal place.

42. In a right triangle, the opposite side to angle θ is 12 cm, and the hypotenuse is 20 cm. Find θ to 1 decimal place.

43. In a right triangle, the adjacent side to angle θ is 8 cm, and the hypotenuse is 17 cm. Find θ to 1 decimal place.

44. In a right triangle, the adjacent side to angle θ is 12 cm, and the hypotenuse is 13 cm. Find θ to 1 decimal place.

45. In a right triangle, the adjacent side to angle θ is 6 cm, and the hypotenuse is 10 cm. Find θ to 1 decimal place.

46. In a right triangle, the adjacent side to angle θ is 15 cm, and the hypotenuse is 25 cm. Find θ to 1 decimal place.

47. In a right triangle, the opposite side to angle θ is 7 cm, and the adjacent side is 24 cm. Find θ to 1 decimal place.

48. In a right triangle, the opposite side to angle θ is 9 cm, and the adjacent side is 12 cm. Find θ to 1 decimal place.

49. In a right triangle, the opposite side to angle θ is 14 cm, and the adjacent side is 10 cm. Find θ to 1 decimal place.

50. In a right triangle, the opposite side to angle θ is 5 cm, and the adjacent side is 8 cm. Find θ to 1 decimal place.

51. A right triangle gives the opposite side and hypotenuse for angle θ . Which ratio should be used?

52. A right triangle gives the adjacent side and hypotenuse for angle θ . Which ratio should be used?

53. A right triangle gives the opposite side and adjacent side for angle θ . Which ratio should be used?

54. A right triangle has angle θ , hypotenuse 20, and opposite side 12. Write the sine equation.

55. A right triangle has angle θ , adjacent side 8, and hypotenuse 17. Write the cosine equation.

56. A right triangle has angle θ , opposite side 9, and adjacent side 12. Write the tangent equation.

57. A ramp is 10 m long and makes an angle of 12° with the ground. Find the vertical rise to 1 decimal place.

58. A tree casts an 18 m shadow. The angle of elevation of the sun is 32° . Find the tree height to 1 decimal place.

59. A plane climbs at an angle of 8° for a horizontal distance of 2500 m. Find its height gain to 1 decimal place.

60. A zip wire is 60 m long and makes an angle of 18° with the horizontal. Find the vertical drop to 1 decimal place.

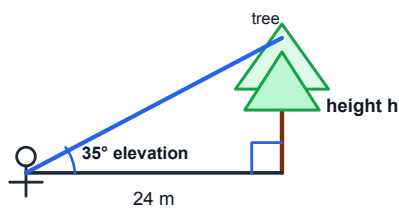
61. A road rises 45 m over a horizontal distance of 300 m. Find the angle of rise to 1 decimal place.

62. A ladder reaches 5 m up a wall and its foot is 2 m from the wall. Find the angle the ladder makes with the ground to 1 decimal place.

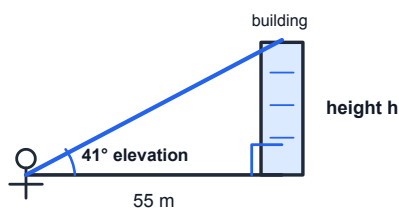
63. An observer is 40 m from a building. The angle of elevation to the top is 38° . Find the building height to 1 decimal place.

64. A ramp rises 1.2 m and makes an angle of 7° with the ground. Find the ramp length to 1 decimal place.

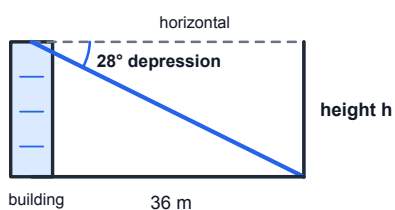
65. From a point 24 m from a tree, the angle of elevation to the top is 35° . Find the height of the tree to 1 decimal place.



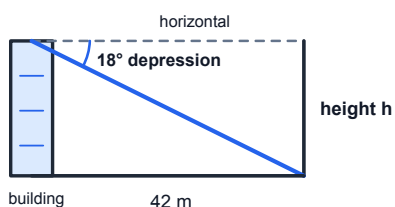
66. An observer stands 55 m from a building. The angle of elevation to the roof is 41° . Find the height of the building to 1 decimal place.



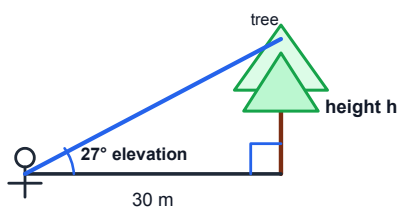
67. A drone is level with the top of a building and 36 m horizontally from it. The angle of depression to the base is 28° . Find the height of the building to 1 decimal place.



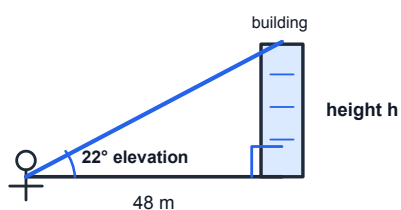
68. From a window at the top of a building, the angle of depression to a marker on the ground 42 m from the base is 18° . Find the height of the window above the ground to 1 decimal place.



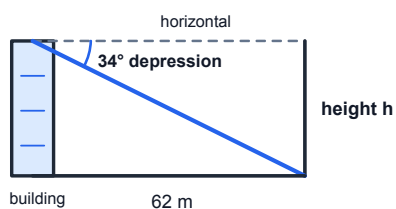
69. A gardener is 30 m from a tall tree. The angle of elevation to the top is 27° . Find the tree height to 1 decimal place.



70. A survey point is 48 m from a school building. The angle of elevation to the roof is 22° . Find the building height to 1 decimal place.



71. From a balcony at the top of a building, the angle of depression to a cyclist 62 m from the base is 34° . Find the balcony height to 1 decimal place.



Exam-Style Structured Practice

1. A ladder makes an angle of 68° with the ground and reaches 7 m up a wall. Find the length of the ladder to 1 decimal place.

2. A tower is 30 m high. An observer is 45 m from its base. Find the angle of elevation to the top to 1 decimal place.

3. A ramp is 12 m long and rises 1.5 m. Find the angle it makes with the ground to 1 decimal place.

4. A roof rafter makes an angle of 35° with the horizontal and covers a horizontal run of 4.5 m. Find the rafter length to 1 decimal place.

5. A kite string is 80 m long and makes an angle of 55° with the ground. Find the height of the kite to 1 decimal place.

6. A boat is 120 m from the base of a cliff. The angle of elevation to the top is 28° . Find the cliff height to 1 decimal place.

7. A solar panel is 2 m long and tilted at 30° to the horizontal. Find its vertical height to 1 decimal place.

8. A support cable reaches 10 m up a pole and is anchored 8 m from the base. Find the angle the cable makes with the ground to 1 decimal place.

9. A right triangle has hypotenuse 15 cm and one angle 36.9° . Find the side opposite the angle to 1 decimal place.

10. A right triangle has hypotenuse 16 cm and angle 41° . Find the adjacent side to 1 decimal place.

11. A right triangle has opposite side 8 cm and adjacent side 15 cm for angle θ . Find θ to 1 decimal place.

12. A right triangle has hypotenuse 18 cm and angle 48° . Find the opposite and adjacent sides to 1 decimal place.

13. A right triangle has hypotenuse 20 cm and angle 30° . Find its area to 1 decimal place.

14. An observer's eye level is 1.6 m above the ground. The observer is 50 m from a building and the angle of elevation to the top is 10° . Find the building height to 1 decimal place.

15. A road rises 12 m over a horizontal distance of 160 m. Find the angle of rise to 1 decimal place.

16. A guy wire is 25 m long and makes an angle of 64° with the ground. Find how high it reaches up the mast to 1 decimal place.

17. A bridge ramp has vertical rise 3.5 m and makes an angle of 14° with the horizontal. Find the ramp length to 1 decimal place.

18. From the top of a 42 m lighthouse, the angle of depression to a boat is 19° . Find the horizontal distance from the boat to the lighthouse to 1 decimal place.

19. A right triangle has adjacent side 14 cm and hypotenuse 20 cm for angle θ . Find θ to 1 decimal place.

20. A right triangle has shorter sides 9 cm and 12 cm. Find the smaller acute angle to 1 decimal place.

21. On a scale diagram, a hill path is shown as 14 cm long at 23° to the horizontal. Find the vertical rise on the diagram to 1 decimal place.

22. A boat travels 3.2 km on a straight course making 37° with an east-west line. Find the northward component to 1 decimal place.

23. A plane climbs along a straight path of 5 km at 6° to the horizontal. Find the height gained to 1 decimal place.

24. A rectangle has diagonal 30 cm, and the diagonal makes an angle of 25° with the base. Find the rectangle's length and height to 1 decimal place.

Mixed Review

1. A right triangle has shorter sides 6 cm and 8 cm. Find the hypotenuse.

2. A car travels 120 km in 2 h. Find its speed.

3. A right triangle has angle 40° and hypotenuse 15 cm. Find the opposite side to 1 decimal place.

4. Find the area of a triangle with base 12 cm and height 5 cm.

5. A block has mass 360 g and volume 120 cm^3 . Find its density.

6. In a right triangle, opposite side 5 cm and adjacent side 12 cm are given for angle θ . Find θ to 1 decimal place.

7. Find the circumference of a circle with diameter 18 cm, in terms of π .

8. A right triangle has angle 58° and adjacent side 9 cm. Find the hypotenuse to 1 decimal place.

9. Find the volume of a cuboid 4 cm by 5 cm by 6 cm.

10. A tower is 18 m high and an observer is 24 m from its base. Find the angle of elevation to 1 decimal place.

11. Convert 2 h 20 min to minutes.

12. A right triangle has angle 25° and hypotenuse 18 cm. Find the opposite side to 1 decimal place.

13. A force of 240 N acts on area 6 m^2 . Find the pressure.

Challenge Questions

1. Two observation points are in a straight line with the base of a tower. The nearer point is 20 m closer to the tower than the farther point. The angles of elevation are 38° and 27° . Find the tower height to 1 decimal place.

2. A ramp is 15 m long and makes an angle of 8° with the ground. Find its vertical rise and horizontal run to 1 decimal place.

3. An isosceles roof has total span 12 m. Each sloping side makes an angle of 35° with the horizontal. Find the roof height and one sloping side to 1 decimal place.

4. A ship travels 13 km in a straight line. Its eastward component is 12 km. Find the northward component and the angle north of east to 1 decimal place.

5. A plane flies 5 km along a path at 6° above the horizontal. Find the height gained and horizontal distance travelled to 1 decimal place.

6. A rectangle has diagonal 30 cm, and the diagonal makes an angle of 25° with the base. Find its dimensions and area to 1 decimal place.

7. A right triangle has hypotenuse 20 cm and area 80 cm^2 . One acute angle is θ . If the opposite side is $20 \sin \theta$ and the adjacent side is $20 \cos \theta$, find θ to 1 decimal place.

8. A cyclist travels along a straight hill path of length 2.4 km at an angle of 5° to the horizontal in 12 min. Find the height gained and average speed along the path.

9. A point is 40 m horizontally from a tower. The angle of elevation to the roof is 31° . A mast on the roof raises the top point by another 6 m. Find the angle of elevation to the top of the mast to 1 decimal place.

Common Mistakes

- Labelling opposite and adjacent from the wrong angle.
- Using sine when the given sides are adjacent and hypotenuse.
- Rounding intermediate values too early.
- Forgetting degree mode.
- Treating angle of depression as a different size from the matching angle of elevation.

Chapter 7: Bearings, Scale Drawings, Sine Rule and Cosine Rule

Chapter Goal

Interpret and draw bearings, maps, scale diagrams, and non-right-triangle trigonometry models.

Calculator Policy

Calculator allowed for trigonometric route modelling. Exact arithmetic is expected for simple scale conversions.

Quick Notes - Page 1

A bearing is measured clockwise from north and is written with three figures.

- North: 000°
- East: 090°
- South: 180°
- West: 270°

Reverse bearings differ by 180° . Add 180° if the bearing is below 180° ; subtract 180° if it is above 180° .

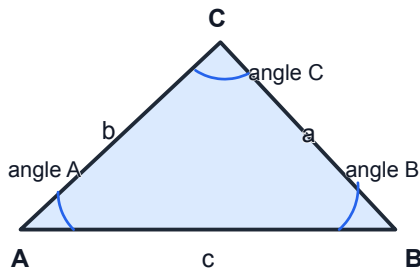
Quick Notes - Page 2

For scale drawings:

- Convert real units before using a ratio scale.
- $1 : 50000$ means 1 cm on the map represents 50000 cm in real life.
- For routes, break a journey into east and north components when a direct distance or bearing is required.

Quick Notes - Page 3

For a non-right triangle, label each side opposite its matching angle.



- Sine rule: $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$.
- Cosine rule: $a^2 = b^2 + c^2 - 2bc \cos A$.
- Use sine rule when you know a matching side-angle pair.
- Use cosine rule when you know two sides and the included angle, or all three sides.

Worked Examples

Example 1

The bearing of B from A is 065° . Find the bearing of A from B .

Solution: $65 + 180 = 245$, so the bearing is 245° .

Example 2

A map has scale 1 : 50000. A path is 4 cm on the map. Find the real distance.

Solution: 1 cm = 0.5 km, so 4 cm = 2 km.

Example 3

A plan has scale 1 : 100. A 6 m wall is drawn. Find its length on the plan.

Solution: 6 m = 600 cm, and $600 \div 100 = 6$ cm.

Example 4

Point B is 3 km east and 4 km north of A . Find AB .

Solution: $AB = \sqrt{3^2 + 4^2} = 5$ km.

Example 5

Point B is 3 km east and 4 km north of A . Find the bearing of B from A .

Solution: $\theta = \tan^{-1}(3/4) = 36.9^\circ$, so the bearing is 036.9° .

Example 6

A route goes 5 km east and 12 km south. Find the direct distance.

Solution: $d = \sqrt{5^2 + 12^2} = 13$ km.

Example 7

In triangle ABC , $A = 40^\circ$, $B = 65^\circ$, and $a = 8$ cm. Find b .

Solution: $\frac{b}{\sin 65^\circ} = \frac{8}{\sin 40^\circ}$, so $b = 11.3$ cm.

Example 8

Two sides of a triangle are 7 cm and 9 cm, with included angle 60° . Find the third side.

Solution: $x^2 = 7^2 + 9^2 - 2(7)(9)\cos 60^\circ = 67$, so $x = 8.2$ cm.

Progress Tracker

Section	Questions	Completed	Correct	Retry
Skill Practice	61	[]	___ / 61	[]
Exam-Style Structured Practice	23	[]	___ / 23	[]
Mixed Review	10	[]	___ / 10	[]
Challenge Questions	7	[]	___ / 7	[]

Skill Practice

1. What is a bearing?

2. Write the bearing of north.

3. Write the bearing of east.

4. Write the bearing of south.

5. Write the bearing of west.

6. Write the bearing of north-east.

7. Write the bearing of south-east.

8. Write the bearing of south-west.

9. Write the bearing of north-west.

10. Convert north 30° east to a three-figure bearing.

11. Convert south 40° east to a three-figure bearing.

12. Convert south 25° west to a three-figure bearing.

13. Convert north 15° west to a three-figure bearing.

14. The bearing of B from A is 060° . Find the bearing of A from B .

15. The bearing of B from A is 285° . Find the bearing of A from B .

16. Find the smaller angle between bearings 070° and 125° .

17. A map uses $1 \text{ cm} : 2 \text{ km}$. A road is 4 cm long on the map. Find its real length.

18. A map uses $1 \text{ cm} : 5 \text{ km}$. A river is 3.6 cm long on the map. Find its real length.

19. A map uses $1 \text{ cm} : 0.5 \text{ km}$. A path is 7.4 cm long on the map. Find its real length.

20. A real distance is 12 km . On a map, 1 cm represents 3 km . Find the map distance.

21. A real distance is 18 km . On a map, 1 cm represents 2 km . Find the map distance.

22. A real distance is 2.4 km. On a map, 1 cm represents 0.4 km. Find the map distance.

23. A map has scale 1 : 50000. A distance is 6 cm on the map. Find the real distance in kilometres.

24. A map has scale 1 : 25000. A distance is 8 cm on the map. Find the real distance in kilometres.

25. A map has scale 1 : 100000. A distance is 4.5 cm on the map. Find the real distance in kilometres.

26. A map has scale 1 : 20000. A distance is 3.5 cm on the map. Find the real distance in metres.

27. A map has scale 1 : 250000. A distance is 2.8 cm on the map. Find the real distance in kilometres.

28. A map has scale 1 : 10000. A distance is 12 cm on the map. Find the real distance in kilometres.

29. A plan has scale 1 : 50. A wall is 3 m long in real life. Find its length on the plan.

30. A plan has scale 1 : 200. A path is 16 m long in real life. Find its length on the plan.

31. A map has scale 1 : 40000. How many kilometres does 1 cm represent?

32. On a map, 1 cm represents 250 m. Write the scale as a ratio.

33. On a map, 5 cm represents 1 km. Write the scale as a ratio.

34. A line of 7.5 cm represents 15 km. How many kilometres does 1 cm represent?

35. From point A , draw a line 5 cm long on a bearing of 070° .

36. From point A , draw a line 4 cm long on a bearing of 145° .

37. A point is due west of A . What bearing should be used from A ?

38. Point B is 3 km east and 4 km north of point A . Find the distance and bearing of B from A to 1 decimal place.

39. Point B is 8 km east and 6 km north of point A . Find the distance and bearing of B from A to 1 decimal place.

40. Point B is 6 km east and 8 km south of point A . Find the distance and bearing of B from A to 1 decimal place.

41. Point B is 5 km west and 12 km north of point A . Find the distance and bearing of B from A to 1 decimal place.

42. Point B is 7 km west and 24 km south of point A . Find the distance and bearing of B from A to 1 decimal place.

43. A route goes 10 km on a bearing of 090° , then 10 km on a bearing of 000° . Find the displacement distance and bearing from the starting point to 1 decimal place.

44. A route goes 12 km on a bearing of 000° , then 5 km on a bearing of 090° . Find the displacement distance and bearing from the starting point to 1 decimal place.

45. A route goes 9 km on a bearing of 180° , then 12 km on a bearing of 090° . Find the displacement distance and bearing from the starting point to 1 decimal place.

46. A journey is 10 km on a bearing of 030° . Find the east and north components to 1 decimal place.

47. A journey is 12 km on a bearing of 150° . Find the east and south components to 1 decimal place.

48. A journey is 8 km on a bearing of 240° . Find the west and south components to 1 decimal place.

49. A journey is 14 km on a bearing of 315° . Find the west and north components to 1 decimal place.

50. Which rule is usually best when a non-right triangle has a known matching side-angle pair?

51. Which rule is usually best when two sides and the included angle are known?

52. In triangle ABC , $A = 40^\circ$, $B = 65^\circ$, and $a = 8$ cm. Find b to 1 decimal place.

53. In triangle ABC , $A = 50^\circ$, $C = 70^\circ$, and $a = 12$ cm. Find c to 1 decimal place.

54. In triangle ABC , $B = 35^\circ$, $A = 80^\circ$, and $b = 9$ cm. Find a to 1 decimal place.

55. In triangle ABC , $A = 30^\circ$, $B = 110^\circ$, and $a = 6$ cm. Find b to 1 decimal place.

56. Two sides of a triangle are 7 cm and 9 cm, with included angle 60° . Find the third side to 1 decimal place.

57. Two sides of a triangle are 10 cm and 14 cm, with included angle 40° . Find the third side to 1 decimal place.

58. Two sides of a triangle are 8 cm and 11 cm, with included angle 50° . Find the third side to 1 decimal place.

59. A triangle has side lengths 7 cm, 9 cm, and 12 cm. Find the angle opposite the 12 cm side to 1 decimal place.

60. A triangle has side lengths 6 cm, 8 cm, and 10 cm. Find the largest angle.

61. A triangle has side lengths 5 cm, 7 cm, and 8 cm. Find the angle opposite the 8 cm side to 1 decimal place.

Exam-Style Structured Practice

1. On a map with scale 1 : 50000, the straight-line distance from A to B is 7.2 cm. The bearing of B from A is 072° . (a) Find the real distance in kilometres. [2] (b) Find the bearing of A from B . [2]

2. A scale drawing uses 1 cm : 2 km. Point B is 6 cm from A on a bearing of 055° . (a) Find the real distance AB . [2] (b) Find the bearing of A from B . [2]

3. A town B is 4 cm east and 3 cm north of town A on a map where 1 cm represents 5 km. Find the real distance and bearing of B from A . [5]

4. A walker goes 8 km north and then 6 km east. Find the distance and bearing from the starting point. [5]

5. A ship travels 12 km due east and then 5 km due south. Find its displacement distance and bearing from the starting point. [5]

6. A hiker walks 9 km on a bearing of 060° . Find the east and north components of the journey to 1 decimal place. [4]

7. A room is 8 m by 5 m. It is drawn on a plan with scale 1 : 50. (a) Find the plan dimensions in centimetres. [4] (b) Find the real area of the room. [2]

8. A walking route measures 12.4 cm on a map with scale 1 : 25000. A walker travels at 5 km/h. Find the real distance and the walking time in minutes. [6]

9. A map uses 1 cm : 4 km. Point B is 5 cm from A on a bearing of 120° . Find the real distance AB and the bearing of A from B . [4]

10. A route goes 4 km on a bearing of 120° , then 3 km on a bearing of 210° . Find the displacement distance and bearing from the starting point. [6]

11. An aircraft flies 40 km on a bearing of 045° . Find the east and north components to 1 decimal place. [4]

12. A checkpoint is 15 km east and 20 km north of base. Find its distance and bearing from base. [5]

13. A scale drawing uses $1 \text{ cm} : 10 \text{ m}$. From A , point B is 6 cm away on a bearing of 070° , and point C is 5 cm away on a bearing of 140° . Find AB , AC , angle BAC , and BC to 1 decimal place. [7]

14. A garden path is 26 m long and is drawn at scale $1 : 200$. Its bearing from the gate is 018° . Find the length on the plan and the reverse bearing. [5]

15. The bearing of a lighthouse from a boat is 305° . Find the bearing of the boat from the lighthouse. [3]

16. A student measures a direction as 65° clockwise from east instead of clockwise from north. Find the correct three-figure bearing. [3]

17. Point B is 9 km west and 12 km north of point A . Find the distance and bearing of B from A , and the bearing of A from B . [7]

18. A route is 7 cm long on a map where 1 cm represents 3 km. The route has bearing 080° . Find the real distance and the east and north components to 1 decimal place. [6]

19. A surveyor walks 10 km on a bearing of 035° , then 10 km on a bearing of 125° . Find the displacement distance and bearing from the starting point. [6]

20. Triangle ABC has $AB = 60$ m, angle $A = 52^\circ$, and angle $B = 71^\circ$. Find AC to 1 decimal place. [4]

21. Two sides of a triangular sign are 8 cm and 11 cm, and the included angle is 48° . Find the third side to 1 decimal place. [4]

22. A boat sails 12 km, turns through an angle of 74° , then sails 16 km. Find the straight-line distance from the start to the finish to 1 decimal place. [5]

23. A triangular field has side lengths 42 m, 55 m, and 63 m. Find the largest angle to 1 decimal place. [5]

Mixed Review

1. A rectangle is 9 cm by 12 cm. Find its diagonal.

2. A drawing has scale 1 : 100. A real wall is 5 m long. Find its drawing length.

3. The bearing of Q from P is 128° . Find the bearing of P from Q .

4. A ramp rises 2.5 m over a horizontal distance of 20 m. Find its angle to the horizontal to 1 decimal place.

5. A cyclist travels 18 km in 36 min. Find the speed in km/h.

6. Find the area of a trapezium with parallel sides 6 cm and 10 cm, and height 4 cm.

7. Find the volume of a cuboid 4 cm by 3 cm by 10 cm.

8. A map has scale 1 : 50000. A route is 5.6 cm on the map. Find the real distance.

9. Point B is 8 km east and 6 km north of A . Find the bearing of B from A to 1 decimal place.

10. A solid has mass 540 g and volume 200 cm^3 . Find its density.

Challenge Questions

1. A treasure route goes 6 km on a bearing of 030° , then 8 km on a bearing of 120° . Find the direct distance and bearing from the start to the treasure.

2. On a 1 : 25000 map, a route goes 4.8 cm on bearing 065° , then 3.6 cm on bearing 155° . Find the actual direct distance and bearing from the start.

3. Ship A is 20 km from harbour on a bearing of 040° . Ship B is 25 km from the same harbour on a bearing of 130° . Find the distance and bearing of ship B from ship A .

4. A hiker walks 10 km on a bearing of 070° , then walks 6 km due south. Find the direct distance and bearing from the start.

5. A rectangular field is 12 m east-west and 9 m north-south. It is drawn at scale 1 : 75. Find the plan length of the diagonal from the south-west corner to the north-east corner, and its bearing.

6. On a map, 9 cm represents 3.6 km. Find the scale as a ratio and state how many kilometres 1 cm represents.

7. A sailing boat travels 15 km on a bearing of 300° , then 10 km on a bearing of 040° . Find its displacement distance and bearing from the starting point.

Common Mistakes

- Measuring a bearing from east or from the route line instead of from north.
- Giving 65° instead of the three-figure bearing 065° .
- Using the bearing from A to B when the question asks for the bearing from B to A .
- Mixing centimetres, metres, and kilometres in scale calculations.
- Rounding components too early in route questions.
- Pairing a side with the wrong opposite angle in the sine rule.
- Using right-triangle trigonometry on a non-right triangle.
- Forgetting the minus sign in the cosine rule.

Chapter 8: 3D Measurement and Trigonometry

Chapter Goal

Model right triangles inside 3D contexts.

Calculator Policy

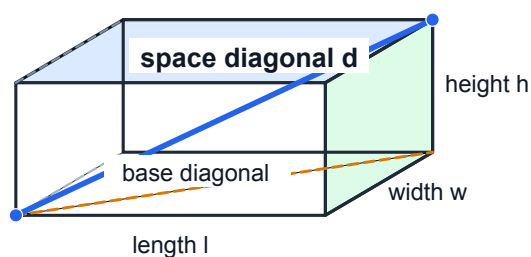
Calculator allowed for decimal diagonals and trigonometric angles. Exact Pythagorean triples should be done without unnecessary decimal rounding.

Quick Notes - Page 1

Most 3D problems become two 2D right-triangle problems.

1. Find the flat projection first, such as the base diagonal.
2. Use that projection with the vertical height.

For a cuboid:



$$d = \sqrt{l^2 + w^2 + h^2}$$

Quick Notes - Page 2

For the angle a space diagonal makes with the base:

$$\tan \theta = \frac{\text{vertical height}}{\text{horizontal projection}}$$

The horizontal projection is not the whole 3D line. It is the line's shadow on the base.

Worked Examples

Example 1

A cuboid is 3 cm by 4 cm by 12 cm. Find the space diagonal.

Solution: $d = \sqrt{3^2 + 4^2 + 12^2} = 13$ cm.

Example 2

A cuboid has base 6 cm by 8 cm and height 10 cm. Find the angle the space diagonal makes with the base.

Solution: base diagonal = 10 cm. $\theta = \tan^{-1}(10/10) = 45^\circ$.

Example 3

A square pyramid has base side 10 cm and height 12 cm. Find the slant height to the midpoint of a side.

Solution: $s = \sqrt{5^2 + 12^2} = 13$ cm.

Example 4

A cylinder has diameter 6 cm and height 8 cm. Find the diagonal of its vertical cross-section.

Solution: $d = \sqrt{6^2 + 8^2} = 10$ cm.

Example 5

A point is 12 m east, 9 m north, and 8 m up from a starting point. Find the horizontal distance.

Solution: horizontal distance = $\sqrt{12^2 + 9^2} = 15$ m.

Example 6

Using the previous horizontal distance, find the angle of elevation to the point.

Solution: $\theta = \tan^{-1}(8/15) = 28.1^\circ$.

Progress Tracker

Section	Questions	Completed	Correct	Retry
Skill Practice	38	[]	___ / 38	[]
Exam-Style Structured Practice	14	[]	___ / 14	[]
Mixed Review	8	[]	___ / 8	[]
Challenge Questions	6	[]	___ / 6	[]

Skill Practice

1. Write the formula for the diagonal of a rectangle with sides l and w .

2. Write the formula for the space diagonal of a cuboid with length l , width w , and height h .

3. In a cuboid, what is the horizontal projection of the space diagonal?

4. To find the angle a space diagonal makes with the floor, which two lengths form the right triangle?

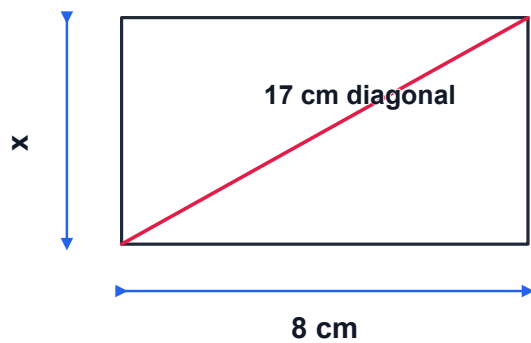
5. What angle does a vertical edge make with the horizontal floor?

6. What angle does a line lying flat on the floor make with the floor?

7. Find the diagonal of a rectangle 3 cm by 4 cm.

8. Find the diagonal of a rectangle 5 cm by 12 cm.

9. Diagram: A rectangle has diagonal 17 cm and one side 8 cm. Find the other side.

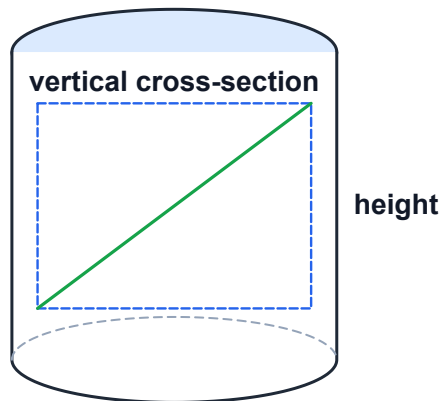


10. A rectangular screen has diagonal 29 cm and height 20 cm. Find its width.

11. A ramp rises 1.2 m over a horizontal distance of 3.5 m. Find the ramp length to 1 decimal place.

12. A square has diagonal 14.1 cm. Estimate the side length to 1 decimal place.

13. Diagram: A cylinder's vertical cross-section has height 12 cm and diagonal 13 cm. Find the diameter and radius of the cylinder.



14. A cuboid has base 9 cm by 12 cm and space diagonal 20 cm. Find its height to 1 decimal place.

15. A square pyramid has vertical height 8 cm and slant height 10 cm to the midpoint of a side. Find the base side length.

16. A cone has slant height 25 cm and radius 7 cm. Find its vertical height.

17. A cuboid has dimensions 2 cm, 3 cm, and 6 cm. Find its space diagonal to 1 decimal place.

18. A cuboid has dimensions 3 cm, 4 cm, and 12 cm. Find its space diagonal to 1 decimal place.

19. A cuboid has dimensions 4 cm, 4 cm, and 7 cm. Find its space diagonal to 1 decimal place.

20. A cuboid has dimensions 6 cm, 6 cm, and 7 cm. Find its space diagonal to 1 decimal place.

21. A cuboid has dimensions 2 cm, 6 cm, and 9 cm. Find its space diagonal to 1 decimal place.

22. A cuboid has dimensions 8 cm, 9 cm, and 12 cm. Find its space diagonal to 1 decimal place.

23. A cuboid has dimensions 5 cm, 10 cm, and 10 cm. Find its space diagonal to 1 decimal place.

24. A cuboid has dimensions 7 cm, 14 cm, and 14 cm. Find its space diagonal to 1 decimal place.

25. A cuboid has dimensions 1 cm, 4 cm, and 8 cm. Find its space diagonal to 1 decimal place.

26. A cuboid has dimensions 12 cm, 16 cm, and 21 cm. Find its space diagonal to 1 decimal place.

27. A cuboid is 3 cm by 4 cm by 5 cm. Find the angle the space diagonal makes with the base to 1 decimal place.

28. A cuboid is 6 cm by 8 cm by 10 cm. Find the angle the space diagonal makes with the base to 1 decimal place.

29. A cuboid is 5 cm by 12 cm by 9 cm. Find the angle the space diagonal makes with the base to 1 decimal place.

30. A cuboid is 8 cm by 15 cm by 17 cm. Find the angle the space diagonal makes with the base to 1 decimal place.

31. A cuboid is 9 cm by 12 cm by 8 cm. Find the angle the space diagonal makes with the base to 1 decimal place.

32. A cuboid is 7 cm by 24 cm by 10 cm. Find the angle the space diagonal makes with the base to 1 decimal place.

33. A cuboid is 10 cm by 24 cm by 26 cm. Find the angle the space diagonal makes with the base to 1 decimal place.

34. A cuboid is 12 cm by 16 cm by 15 cm. Find the angle the space diagonal makes with the base to 1 decimal place.

35. A vertical cross-section of a cylinder has diameter 6 cm and height 8 cm. Find the diagonal of the cross-section.

36. A square pyramid has base side 10 cm and vertical height 12 cm. Find the slant height to the midpoint of a side.

37. A square pyramid has base side 6 cm and height 4 cm. Find the slant edge from the top to a base corner to 1 decimal place.

38. A room is 4 m by 3 m by 12 m. Find the distance from one bottom corner to the opposite top corner.

Exam-Style Structured Practice

1. A room is 8 m long, 6 m wide, and 3 m high. (a) Find the floor diagonal. [2] (b) Find the distance from one floor corner to the opposite ceiling corner. [3] (c) Find the angle this line makes with the floor. [3]

2. A box is 12 cm by 5 cm by 9 cm. Find its base diagonal, space diagonal, and the angle the space diagonal makes with the base. [7]

3. A rectangular box is 6 cm by 8 cm by 24 cm. A thin rod lies from one bottom corner to the opposite top corner. Find the rod length and its angle to the base. [6]

4. A cylinder has radius 5 cm and height 12 cm. A straight line is drawn across a vertical cross-section from the bottom left of the cylinder to the top right. Find the line length and its angle to the base. [6]

5. A square pyramid has base side 16 cm and vertical height 15 cm. Find the slant height to the midpoint of a side and the angle this slant height makes with the base. [6]

6. A square pyramid has base side 10 cm and vertical height 12 cm. Find the slant edge from the top to a base corner and its angle to the base. [7]

7. A storage box is 20 cm by 15 cm by 36 cm. (a) Find the maximum length of a straight rod that fits inside. [4] (b) Will a 44 cm rod fit? [2]

8. A right-triangular prism has triangular end with shorter sides 5 cm and 12 cm. The prism length is 16 cm. Find the diagonal from a vertex of one triangular end to the corresponding far vertex across the prism. [5]

9. A point is 12 m east, 9 m north, and 8 m above a starting point. Find the straight-line distance and the angle of elevation from the start. [6]

10. A rectangular tank is 10 m by 24 m by 18 m. A pipe runs from one bottom corner to the opposite top corner. Find the pipe length and its angle to the base. [6]

11. A cone has radius 7 cm and vertical height 24 cm. Find its slant height and the angle the slant height makes with the base radius. [6]

12. A metal frame is 5 m by 5 m by 10 m. Find the body diagonal and the angle it makes with the floor. [6]

13. Find the distance between $(0, 0, 0)$ and $(4, 12, 3)$ in 3D coordinate space. [4]

14. A cable has horizontal ground projection 20 m and rises 6 m. Find the cable length and the angle it makes with the ground. [5]

Mixed Review

1. A right triangle has shorter sides 9 cm and 40 cm. Find the hypotenuse.

2. A line of length 20 cm makes an angle of 30° with the ground. Find its vertical height.

3. Find the volume of a cuboid 5 cm by 4 cm by 3 cm.

4. A map has scale 1 : 50000. A distance is 6 cm on the map. Find the real distance.

5. The bearing of B from A is 042° . Find the bearing of A from B .

6. Find the area of a circle with radius 7 cm in terms of π .

7. A train travels 120 km in 2 h. Find its speed.

8. Find the surface area of a cuboid 6 cm by 4 cm by 3 cm.

Challenge Questions

1. The base of a cuboid is 9 cm by 12 cm. Its space diagonal makes an angle of 30° with the base. Find the height of the cuboid and the space diagonal.

2. A square pyramid has base side 14 cm and slant height 25 cm to the midpoint of a side. Find the vertical height and the angle the slant height makes with the base.

3. A cuboid has side lengths x , $2x$, and $3x$. Its space diagonal is 21 cm. Find x to 1 decimal place.

4. A tent has a rectangular base 8 m by 6 m. The top point is vertically above the centre and is 4 m above the ground. Find the distance from the top point to a corner and the angle this line makes with the ground.

5. A cylindrical tank has radius 4 m and height 15 m. A straight cable goes across a vertical cross-section from one point on the bottom rim to the opposite point on the top rim. Find the cable length and its angle to the base.

6. A rectangular prism has length 6 m, width 8 m, and space diagonal 13 m. Find the height and the angle the space diagonal makes with the base.

Common Mistakes

- Treating the 3D diagonal as if it were drawn on a single face.
- Using the height and length directly when the width also affects the horizontal projection.
- Forgetting that a pyramid's centre-to-side distance is half the base side.
- Using diameter and radius interchangeably in cylinder cross-sections.
- Rounding a base diagonal before using it in a second calculation.

Chapter 9: Measurement and Trigonometry Mixed Review

Chapter Goal

Combine measurement, Pythagoras, trigonometry, and bearings in structured sets.

Calculator Policy

Calculator allowed for trigonometric ratios, compound contexts, and decimal approximations. Exact arithmetic is expected when answers are left in terms of π or simple radicals.

Quick Notes - Page 1

Before calculating, decide what type of problem it is:

- Unit conversion: convert first, then calculate.
- Area or volume: choose the correct formula.
- Speed, density, pressure: divide the compound quantity by the base quantity.
- Pythagoras: use it only in right triangles.

Quick Notes - Page 2

For trigonometry, bearings, scale, and 3D:

- Draw the right triangle or projection first.
- Bearings are measured clockwise from north.
- Scale calculations require matching units.
- In 3D, find the flat projection before the sloping line.

Worked Examples

Example 1

Convert 2.4 m to centimetres.

Solution: $2.4 \times 100 = 240$ cm.

Example 2

Find the hypotenuse of a right triangle with shorter sides 5 cm and 12 cm.

Solution: $c = \sqrt{5^2 + 12^2} = 13$ cm.

Example 3

A ladder is 10 m long and makes an angle of 60° with the ground. Find the height reached.

Solution: $h = 10 \sin 60^\circ = 8.7 \text{ m}$.

Example 4

A map has scale 1 : 50000. A road is 6 cm long on the map. Find the real distance.

Solution: 1 cm = 0.5 km, so 6 cm = 3 km.

Example 5

The bearing of B from A is 135° . Find the bearing of A from B .

Solution: $135 + 180 = 315$, so the reverse bearing is 315° .

Example 6

A cuboid is 3 cm by 4 cm by 12 cm. Find its space diagonal.

Solution: $d = \sqrt{3^2 + 4^2 + 12^2} = 13 \text{ cm}$.

Progress Tracker

Section	Questions	Completed	Correct	Retry
Skill Practice	38	[]	___ / 38	[]
Exam-Style Structured Practice	14	[]	___ / 14	[]
Mixed Review	8	[]	___ / 8	[]
Challenge Questions	6	[]	___ / 6	[]

Skill Practice

1. Convert 3.6 m to centimetres.

2. Convert 4500 ml to litres.

3. Round 48.372 to 1 decimal place.

4. Find the perimeter of a rectangle 7 cm by 5 cm.

5. Find the area of a triangle with base 12 cm and height 8 cm.

6. Find the area of a circle with radius 5 cm in terms of π .

7. Find the volume of a cuboid 4 cm by 5 cm by 6 cm.

8. Find the surface area of a cuboid 3 cm by 4 cm by 5 cm.

9. Find the volume of a cylinder with radius 3 cm and height 10 cm in terms of π .

10. A triangular prism has triangular cross-section base 6 cm, height 4 cm, and prism length 10 cm. Find its volume.

11. A solid has mass 720 g and volume 240 cm^3 . Find its density.

12. A force of 150 N acts on an area of 6 m^2 . Find the pressure.

13. A car travels 150 km in 3 h. Find its speed.

14. A train travels at 42 km/h for 84 km. Find the time taken.

15. A cyclist travels at 45 km/h for 2.5 h. Find the distance.

16. Convert 12 m/s to km/h.

17. A tap fills 18 L in 3 min. Find the flow rate.

18. A town has 3000 people in 12 km². Find the population density.

19. A car travels 360 km using 30 L of fuel. Find the rate in km/L.

20. A right triangle has shorter sides 9 cm and 12 cm. Find the hypotenuse.

21. A right triangle has hypotenuse 25 cm and one shorter side 7 cm. Find the other shorter side.

22. Find the diagonal of a rectangle 8 cm by 15 cm.

23. A right triangle has hypotenuse 10 cm and angle 30° . Find the opposite side.

24. A right triangle has hypotenuse 13 cm and angle 40° . Find the adjacent side to 1 decimal place.

25. A right triangle has opposite side 7 cm and adjacent side 24 cm. Find the angle to 1 decimal place.

26. A ladder is 8 m long and makes an angle of 70° with the ground. Find how high it reaches to 1 decimal place.

27. The bearing of B from A is 078° . Find the bearing of A from B .

28. The bearing of B from A is 230° . Find the bearing of A from B .

29. A map has scale $1 : 25000$. A distance is 6 cm on the map. Find the real distance in kilometres.

30. A real distance is 4.8 km . On a $1 : 100000$ map, find the map distance.

31. Point B is 5 km east and 12 km north of A . Find the distance and bearing of B from A .

32. A route goes 10 km north and then 10 km east. Find the direct distance and bearing from the start.

33. Find the space diagonal of a cuboid 3 cm by 4 cm by 12 cm.

34. A cuboid is 6 cm by 8 cm by 10 cm. Find the angle the space diagonal makes with the base.

35. A square pyramid has base side 10 cm and height 12 cm. Find the slant height to the midpoint of a side.

36. A cylinder has diameter 8 cm and height 15 cm. Find the diagonal of its vertical cross-section.

37. Find the volume of a cuboid 8 cm by 5 cm by 3 cm.

38. A plan has scale 1 : 50. A real length is 2.5 m. Find the plan length.

Exam-Style Structured Practice

1. A rectangular garden is 12 m by 8 m. A circular pond of radius 2 m is inside it. (a) Find the area of grass in terms of π . [3] (b) Find the perimeter of the outer rectangle. [2]

2. A water tank is 2 m by 1.5 m by 1.2 m. (a) Find its volume in cubic metres. [2] (b) Convert this to litres. [2] (c) If water flows in at 30 L/min, find the filling time. [3]

3. A ladder is 6 m long and makes an angle of 68° with the ground. Find the height reached on the wall and the distance of the foot from the wall, both to 1 decimal place. [5]

4. On a 1 : 50000 map, B is 8 cm from A on a bearing of 062° . Find the real distance AB and the bearing of A from B . [4]

5. A route goes 12 km on a bearing of 040° , then 8 km due east. Find the direct distance and bearing from the starting point. [6]

6. A box is 10 cm by 12 cm by 9 cm. Find its space diagonal and the angle this diagonal makes with the base. [6]

7. A drone flies 6 km east and then 8 km north in 20 min. (a) Find its direct distance from the start. [2] (b) Find its average speed for the route it actually flew, in km/h. [3]

8. A cylinder has radius 4 cm and height 10 cm. Its material has density 2.5 g/cm^3 . Find the volume in terms of π , and the mass to 1 decimal place. [6]

9. An open-top box is 10 cm by 8 cm by 6 cm. (a) Find the outside area to be painted, excluding the top. [4] (b) Paint costs \$0.03 per cm^2 . Find the cost. [2]

10. From an observer, the bearing of a tower is 015° . The observer is 40 m from the tower and the angle of elevation to the top is 35° . Find the tower height and the bearing of the observer from the tower. [5]

11. A rectangular field is drawn 6 cm by 4 cm on a plan with scale 1 : 200. Find the real dimensions and the real area. [6]

12. A point is 9 m east, 12 m north, and 5 m above a starting point. Find the straight-line distance and angle of elevation from the start. [6]

13. A block exerts a force of 240 N on a rectangular base 0.3 m by 0.4 m. Find the pressure on the floor. [4]

14. A cone has radius 3 cm, height 4 cm, and slant height 5 cm. Find its volume and curved surface area in terms of π . [6]

Mixed Review

1. Convert 2.75 km to metres.

2. Find the area of a trapezium with parallel sides 10 cm and 16 cm, and height 5 cm.

3. A car travels 90 km in 1.5 h. Find the speed.

4. A right triangle has shorter sides 20 cm and 21 cm. Find the hypotenuse.

5. A right triangle has adjacent side 14 cm and angle 35° . Find the opposite side to 1 decimal place.

6. The bearing of Q from P is 315° . Find the bearing of P from Q .

7. A map has scale 1 : 20000. A route is 7 cm long on the map. Find the real distance.

8. Find the space diagonal of a cuboid 5 cm by 12 cm by 12 cm.

Challenge Questions

1. An expedition travels 10 km on a bearing of 030° , then 15 km on a bearing of 110° . Find the direct distance and bearing from the start.

2. A water trough is a triangular prism of length 2 m. Its triangular cross-section has base 0.6 m and height 0.4 m. Find its capacity in litres and the time to fill it at 12 L/min.

3. A rectangular hall is 18 m by 10 m. A wire runs from one floor corner to the opposite ceiling corner and makes an angle of 20° with the floor. Find the hall height and the wire length.

4. On a 1 : 25000 map, a right-triangular field has perpendicular sides 6 cm and 8 cm. Find the real perimeter in kilometres and the real area in square kilometres.

5. A cylinder of radius 3 cm and height 8 cm is removed from a cuboid 8 cm by 8 cm by 8 cm. Find the remaining volume to 1 decimal place.

6. A boat travels 12 km on a bearing of 040° , then 9 km on a bearing of 130° . Find the direct distance and bearing from the start. If the whole route takes 42 minutes, find the average speed along the route.

Common Mistakes

- Starting a calculation before units match.
- Using area formulae for perimeter questions or volume formulae for surface area questions.
- Applying Pythagoras to a triangle that is not right-angled.
- Reading a reverse bearing in the wrong direction.
- Treating a 3D diagonal as if it lay on a face.

Chapter 10: Similarity in Measurement

Chapter Goal

Use similarity to solve length, perimeter, area, surface area, volume, scale-model, and real-life measurement problems.

Calculator Policy

Calculator allowed for decimal scale factors and realistic measurement contexts. Exact ratio work should be shown where possible.

Quick Notes - Page 1

Similar shapes have the same shape but different size.

If the length scale factor is k :

- all corresponding lengths are multiplied by k ;
- perimeters are multiplied by k ;
- areas are multiplied by k^2 ;
- volumes are multiplied by k^3 .

Quick Notes - Page 2

Work backwards carefully:

- from area scale factor to length scale factor, take the square root;
- from volume scale factor to length scale factor, take the cube root;
- with maps and models, convert units before writing the final answer.

Worked Examples

Example 1

A shape has perimeter 30 cm. It is enlarged by scale factor 1.6. Find the new perimeter.

Solution: $30 \times 1.6 = 48$ cm.

Example 2

A shape has area 40 cm^2 . It is enlarged by scale factor 3. Find the new area.

Solution: area scale factor $= 3^2 = 9$, so new area $= 40 \times 9 = 360 \text{ cm}^2$.

Example 3

A solid has volume 24 cm^3 . It is enlarged by scale factor 2.5. Find the new volume.

Solution: volume scale factor = $2.5^3 = 15.625$, so new volume = $24 \times 15.625 = 375 \text{ cm}^3$.

Example 4

A model is 8 cm long and the real object is 2 m long. Find the scale.

Solution: 2 m = 200 cm. Scale = $8 : 200 = 1 : 25$.

Example 5

Two similar shapes have areas 45 cm^2 and 180 cm^2 . Find the length scale factor from the smaller to the larger shape.

Solution: area scale factor = $180/45 = 4$, so length scale factor = $\sqrt{4} = 2$.

Example 6

Two similar solids have volumes 64 cm^3 and 1000 cm^3 . Find the length scale factor from the smaller to the larger solid.

Solution: volume scale factor = $1000/64 = 15.625 = 2.5^3$, so length scale factor = 2.5.

Progress Tracker

Section	Questions	Completed	Correct	Retry
Skill Practice	24	[]	___ / 24	[]
Exam-Style Structured Practice	16	[]	___ / 16	[]
Mixed Review	8	[]	___ / 8	[]
Challenge Questions	8	[]	___ / 8	[]

Skill Practice

1. A rectangle is enlarged from width 6 cm to width 18 cm. Find the length scale factor.

2. A side length of 7 cm is enlarged by scale factor 4. Find the image length.

3. A shape has perimeter 36 cm. It is enlarged by scale factor 2.5. Find the new perimeter.

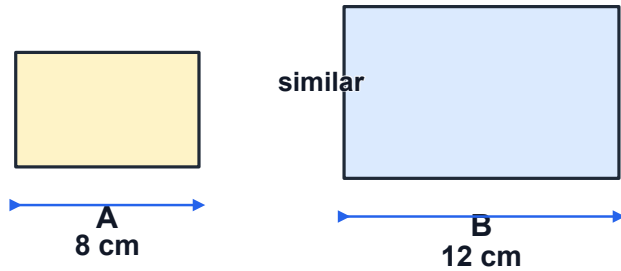
4. A shape has area 32 cm². It is enlarged by scale factor 3. Find the new area.

5. If the length scale factor is 5, state the area scale factor.

6. A solid has volume 18 cm³. It is enlarged by scale factor 2. Find the new volume.

7. If the length scale factor is $\frac{1}{2}$, state the volume scale factor.

8. Diagram: Rectangle A is 8 cm by 5 cm. Similar rectangle B has width 12 cm. Find the height of B.



9. A triangle with sides 6, 8, 10 is enlarged so the shortest side becomes 15. Find the other two sides.

10. A shape has area 45 cm^2 . It is enlarged by scale factor $\frac{4}{3}$. Find the new area.

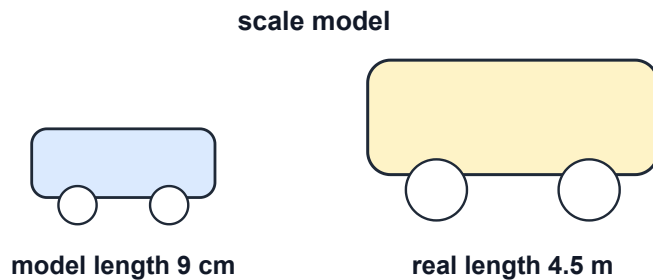
11. A large shape has area 192 cm^2 . It was made by enlarging a smaller similar shape by scale factor 4. Find the smaller area.

12. A solid has volume 54 cm^3 . It is enlarged by scale factor 3. Find the new volume.

13. A large solid has volume 625 cm^3 . The length scale factor from the smaller solid to the larger solid is $\frac{5}{2}$. Find the smaller volume.

14. A plan uses scale 1 : 200. A length on the plan is 8 cm. Find the real length in metres.

15. Diagram: A model car is 9 cm long. The real car is 4.5 m long. Find the scale of model to real.



16. Two similar bottles have heights 12 cm and 18 cm. The smaller bottle has volume 320 mL. Find the larger volume.

17. Two similar cylinders have radii 4 cm and 6 cm. The smaller curved surface area is $80\pi \text{ cm}^2$. Find the larger curved surface area.

18. Rectangle A has area 54 cm^2 . A corresponding side changes from 6 cm to 10 cm. Find the area of similar rectangle B.

19. Two similar cones have heights 8 cm and 12 cm. The smaller cone has volume $96\pi \text{ cm}^3$. Find the larger volume.

20. A shape is enlarged from area 75 cm^2 to area 300 cm^2 . Find the length scale factor.

21. A solid is enlarged from volume 16 cm^3 to volume 250 cm^3 . Find the length scale factor.

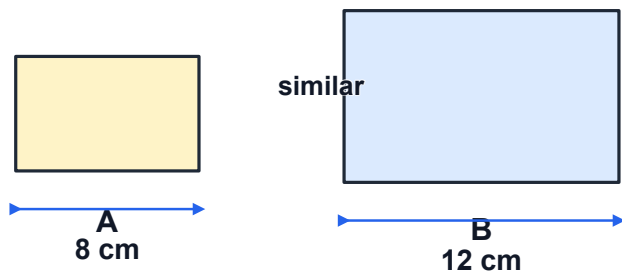
22. A larger similar shape has perimeter 96 cm. The length scale factor from the smaller shape to the larger shape is 4. Find the smaller perimeter.

23. A rectangular plan is 5 cm by 3 cm at scale 1 : 1000. Find the real area in square metres.

24. Two similar solids have surface areas 98 cm^2 and 392 cm^2 . Find the length scale factor from the smaller solid to the larger solid.

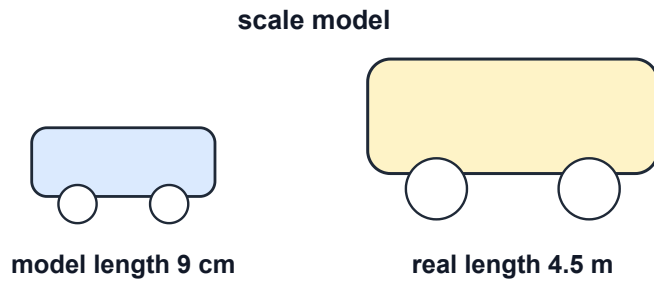
Exam-Style Structured Practice

1. Diagram: Rectangle A is 8 cm by 5 cm. Similar rectangle B has width 12 cm. (a) Find the scale factor from A to B. [1] (b) Find the height of B. [2] (c) Find the area of B. [2]

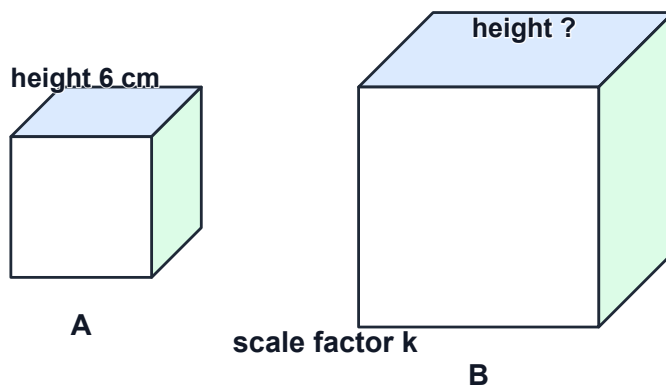


2. A shape has perimeter 42 cm and area 84 cm^2 . A similar shape is enlarged by scale factor $\frac{3}{2}$. Find the new perimeter and area. [4]

3. Diagram: A model car is 9 cm long and 3.6 cm wide. The real car is 4.5 m long. (a) Find the scale. [2] (b) Find the real width. [2] (c) If the model's top-view area is 32.4 cm^2 , find the real top-view area in m^2 . [3]



4. Diagram: Two similar storage boxes have heights 6 cm and 15 cm. The smaller box has volume 96 cm^3 . Find the volume of the larger box. [4]



5. Two similar cylinders have radii 4 cm and 6 cm. The smaller cylinder has height 10 cm and volume $160\pi \text{ cm}^3$. Find the larger height and volume. [5]

6. Two similar cones have length scale factor 3. The smaller cone has total surface area $80\pi \text{ cm}^2$. Find the larger total surface area. [3]

7. Rectangle A has area 48 cm^2 . Similar rectangle B has area 108 cm^2 . A side of A is 8 cm. Find the corresponding side of B. [4]

8. A model tank has capacity 2.56 L. A similar real tank has length scale factor 5 compared with the model. Find the real tank capacity. [3]

9. A photo is 12 cm by 8 cm. It is enlarged to area 864 cm^2 . Find the new dimensions and perimeter. [5]

10. Two similar solids have surface areas 150 cm^2 and 600 cm^2 . The smaller solid has height 9 cm and volume 270 cm^3 . Find the larger height and volume. [5]

11. A swimming pool is 10 m long, 4 m wide and 1.5 m deep. A similar pool is 25 m long. Find the width, depth and volume of the larger pool. [6]

12. A plan of a park has area 24 cm^2 . The scale is 1 : 500. Find the real area in square metres. [4]

13. Solid A is a cube of side 7 cm. Solid B is similar to A and has surface area 1176 cm^2 . Find the volume of B. [5]

14. A triangular prism has cross-section area 30 cm^2 , length 12 cm , and volume 360 cm^3 . A similar prism has length 18 cm . Find its cross-section area and volume. [5]

15. A similar enlargement increases the area of a shape by 216 cm^2 . The length scale factor is 3. Find the original and enlarged areas. [5]

16. A solid is enlarged so its volume becomes 64 times as large. The larger height is 28 cm . Find the smaller height and the surface area scale factor. [4]

Mixed Review

1. A scale drawing 6 cm by 4 cm represents a rectangular field at scale 1 : 2500. Find the real area in square metres.

2. A 9, 12, 15 right triangle is enlarged so the hypotenuse becomes 25. Find the other two sides.

3. Two similar shapes have areas 72 cm^2 and 128 cm^2 . The smaller perimeter is 30 cm. Find the larger perimeter.

4. Two similar solids have volumes 81 cm^3 and 192 cm^3 . The smaller height is 9 cm. Find the larger height.

5. A real car is 1.8 m wide. A model is made at scale 1 : 60. Find the model width in centimetres.

6. A plan has area 18 cm^2 at scale 1 : 200. Find the real area in square metres.

7. Two similar cylinders have length scale factor 3. The smaller volume is $20\pi \text{ cm}^3$. Find the larger volume and the surface-area scale factor.

8. Rectangle B is similar to rectangle A. A corresponding side changes from 5 cm to 7 cm. Rectangle B has area 245 cm^2 . Find the area of A.

Challenge Questions

1. A similar shape B has area 216 cm^2 . Shape A has area 96 cm^2 and perimeter 44 cm . Find the perimeter of B.

2. Two similar solids have surface areas 300 cm^2 and 675 cm^2 . The smaller volume is 500 cm^3 . Find the larger volume.

3. A model sculpture is 18 cm tall and has volume 240 cm^3 . The real sculpture is 2.7 m tall. Find the real volume in cubic metres.

4. Two similar cones have radii in the ratio 1 : 3. The larger cone has volume $864\pi \text{ cm}^3$ and height 24 cm. Find the smaller volume and height.

5. Two similar cuboids have surface areas in the ratio 49 : 64. The smaller cuboid has volume 686 cm^3 . Find the larger volume.

6. Two similar containers have heights 12 cm and 18 cm. The smaller container holds 640 mL. The larger contains 810 mL of water. What fraction full is the larger container?

7. A triangular field is drawn on a map as a 3, 4, 5 right triangle in centimetres. The scale is 1 : 1000. Find the real perimeter in metres and real area in square metres.

8. Two similar solids A and B have volumes 250 cm^3 and 2000 cm^3 . Solid A has surface area 150 cm^2 . Find the surface area of B.

Common Mistakes

- Using the length scale factor for area or volume.
- Forgetting to square or cube the scale factor.
- Taking the square root when a volume problem needs a cube root.
- Mixing centimetres and metres in map and model questions.
- Assuming equal area difference means equal length difference.

Progress Tracker

Skill	Not Yet	Getting There	Confident
I can use length and perimeter scale factors.	☐	☐	☐
I can use area and surface-area scale factors.	☐	☐	☐
I can use volume scale factors.	☐	☐	☐
I can solve reverse similarity problems.	☐	☐	☐
I can handle map and model scales with units.	☐	☐	☐

Chapter 1 Answer Key - Units, Accuracy and Estimation

Skill Practice

- 3500 m
- 4.2 km
- 275 cm
- 6.4 m
- 3.8 cm
- 46 mm
- 80 m
- 1.25 m
- 7040 mm
- 50 cm
- 3200 g
- 0.75 kg
- 45 g
- 6000 mL
- 0.85 L
- 2400 mL
- 125 mL
- 1500 cm³
- 5.4 kg
- 600 mL
- 40000 cm²
- 3 m²
- 1200 mm²
- 25 cm²
- 2000000 cm³
- 5 L
- 35000 cm²
- 250 L
- 150 min
- 2 h 15 min
- 200 s
- 90 min
- 105 min
- 45 min
- 4 days
- 54 h
- 49 m
- 3.8 kg
- 0.079 L
- 17.5 cm
- 18.5 cm
- 4.55 kg
- 4.65 kg
- 100
- 20
- 13000 m

Structured Practice

- 2400 m
- 5
- 6000 cm²
- 7.35 cm, 7.45 cm
- 400
- 80 L
- 155 min
- 1.55 kg
- 0.09 m²
- 6 m; 0.5 m
- 0.72 L
- 8
- 122.5 m, 127.5 m
- 3000 g
- 8 : 23 pm
- 3.195 m
- 1 L
- 50

Mixed Review

- 1800 m; 2000 m
- 2.75 kg; 2.8 kg
- 0.4 m²
- 1.9 L
- 2 h 15 min
- 4.6 cm; 5 cm
- 24 L; 24000 mL
- 1000; below
- 12500 m; 1250000 cm
- 7.95 cm, 8.05 cm; 0.05 cm

Challenge Questions

- 86.25 cm²
- 500
- 17500 m, 18500 m
- 24
- 15 cm
- $3.495 \leq x < 3.505$

Chapter 2 Answer Key - Perimeter and Area

Skill Practice

- $2(l + w)$
- lw
- $\frac{1}{2}bh$
- bh
- $\frac{1}{2}(a + b)h$
- πr^2
- 26 cm
- 84 cm²
- 36 cm
- 121 cm²
- 42 m
- 72 mm²
- 8 cm
- 16 cm
- 20 m²
- 16 cm
- 21 m²
- 54 cm
- 35 cm²
- 54 m²

- 8 cm
- 15 cm
- 60 cm²
- 35 square units
- 16 cm²
- 30 cm
- 32 cm
- 56 cm²
- 66 cm²
- 26 cm
- 12 cm
- 6 cm
- 55 cm²
- 112 m²
- 6 cm
- 10 cm
- 104 cm²
- 96 cm²
- 40 cm
- 14 cm
- 12 cm
- 9 cm
- 10 π cm
- 14 π cm
- 16 π cm²
- 100 π cm²
- 18 π cm²
- $14 + 7\pi$ cm
- 16 π cm²
- $12 + 3\pi$ cm
- 7 π cm
- 36 π cm²
- 68 cm²
- 42 cm
- 128 cm²
- 79 cm²
- $24 + 2\pi$ cm
- 20 π cm²
- 54 cm²
- 32 cm
- $64\pi - 64$ cm²
- 80 cm²
- 36 cm
- 104 cm²
- $200 + 25\pi$ m²
- $40 + 10\pi$ m
- 136 cm²

Exam-Style Structured Practice

- 78 m, 360 m²
- 15 cm, 330 cm²
- 108 m², 324 dollars
- 153 cm², 56 cm
- 200 cm², 64 cm
- 10 cm
- 18 π cm, 81 π cm²
- $\frac{25\pi}{9}$ cm², $10 + 5\pi$ cm
- 120 cm², 48 cm
- $96 - 8\pi$ cm²
- 208 m²
- 80
- 80 cm², 36 cm
- 40 π cm²
- 36 π cm², $24 + 6\pi$ cm
- 42 m, 84 m²
- 9 cm
- 216 cm²
- Both areas are 126 cm²
- $256 - 64\pi$ cm²
- 280 m², 96 m
- 7 cm, 14 π cm
- $84 + \frac{9\pi}{2}$ cm², $34 + 3\pi$ cm
- 136 cm²
- 60 m, 216 m²

Mixed Review

- 4.5 m
- 2.4 m²
- 20 cm
- 36 cm²
- 36 cm²
- 16 π cm
- 57 cm²
- 100
- $11.5 \text{ cm} \leq l < 12.5 \text{ cm}$
- 28 cm
- 48 cm²
- 20000 cm²
- $8 + 4\pi$ cm
- 52 cm²

Challenge Questions

- 12 cm, 17 cm, 204 cm²
- 10 cm and 18 cm
- $x = 8$ cm, perimeter 54 cm
- 720 + 81 π m², 80 + 18 π m
- $196 - 49\pi$ cm²
- $48 + 18\pi$ cm²
- 98 cm²
- 9 cm, 81 π cm²
- 70 square units, 38 units

Chapter 3 Answer Key - Surface Area and Volume

Skill Practice

- lwh
- $2(lw + lh + wh)$
- cross-section area $\times$ length
- $\pi r^2 h$
- $2\pi rh$

- $2\pi r^2 + 2\pi rh$
- 60 cm³
- 144 m³
- 504 mm³
- 4 cm
- 148 cm²
- 112 cm²
- 125 cm³
- 216 cm²
- 1000 cm³
- 6 L
- 144 cm²
- 30 m³
- 6 cm
- 486 cm²
- 1728 cm³
- 126 cm³
- 240 cm³
- 156 cm²
- 450 cm³
- 272 cm³
- 8 cm
- 495 cm³
- 360 cm²
- 480 cm³
- 30 cm²
- 270 cm³
- 216 cm²
- 90 π cm³
- 200 π cm³
- 252 π cm³
- 72 π cm²
- 104 π cm²
- 110 π cm²
- 490 π cm³
- 3 cm
- 5 cm
- 300 π cm³
- 120 π cm²
- 78 π cm²
- 96 cm²
- 392 cm²
- 188 cm²
- 84 cm²
- 72 π cm²
- 72 π cm²
- 168 π cm²
- 84 cm³
- 150 cm³
- 340 cm³
- 340 cm³
- $1200 - 300\pi$ cm³
- 108 π cm³
- 160 L
- 160 cm²
- 336 cm³
- $\frac{1}{3} \times \text{base area} \times \text{vertical height}$
- $b^2 + 2bs$
- 240 cm³
- 264 cm³
- 224 cm³
- 268 cm²
- 400 cm³
- 144 cm²
- 360 cm³
- 9 cm
- 96 cm²
- 364 cm²
- 8 cm
- 432 cm³
- 312 cm²
- 10 cm
- 1176 cm³
- 207 cm²
- 442 cm²
- 12 cm
- 9 cm
- 720 cm³
- 6 cm
- 704 cm³

Exam-Style Structured Practice

- 1260 cm³, 772 cm²
- 540 cm³, 327 cm²
- 720 cm³, 600 cm²
- 396 π cm³, 204 π cm²
- 81000 cm³, 81 L
- 560 cm³
- 6 cm, 632 cm²
- 5 cm, 70 π cm²
- 1176 cm³
- 320 π cm³
- 528 cm³
- 7 cm, 294 cm²
- 5 cm, 450 cm²
- 96 π cm², 128 π cm²
- 600 cm³, 150 π cm³
- 900 cm³
- 0.024 m³, 24000 cm³
- 30 cm
- 504 cm²
- 140 π cm², 98 π cm², 238 π cm²
- 81 cm³, 126 cm²
- 5 cm
- 864 cm³, 684 cm²

Mixed Review

- 2000 cm³
- 84 cm²
- 180 cm³
- 36 π cm³

- 44 cm²
- 96 cm²
- $7.5 \text{ cm} \leq l < 8.5 \text{ cm}$
- 288 cm³
- 60 π cm²
- 84 cm²
- 4.5 L
- $10 + 5\pi$ cm
- 4 cm

Challenge Questions

- 7 cm, 343 cm³
- $\frac{24}{5}$ cm
- 420 cm³, 284 cm²
- 316 cm²
- 300 π cm³, 340 π cm²
- 324 cm³, 180 cm²
- 30 cm
- 1200 cm³, 920 cm²

Chapter 4 Answer Key - Time, Speed and Compound Measures

Skill Practice

- speed = $\frac{\text{distance}}{\text{time}}$
- distance = speed $\times$ time
- time = $\frac{\text{distance}}{\text{speed}}$
- density = $\frac{\text{mass}}{\text{volume}}$
- mass = density $\times$ volume
- pressure = $\frac{\text{force}}{\text{area}}$
- 150 min
- 2 h 15 min
- 210 min
- 9 min
- 180 min
- 1 h 35 min
- 54 h
- 2 h
- 4 h 15 min
- 72 min
- 50 km/h
- 3 h
- 96 m
- 10 km/h
- 6 m/s
- 20 m/s
- 54 km/h
- 56 km/h
- 30 s
- 360 km
- 50 km/h
- 36 km/h
- 6.25 m/s
- 30 km
- 4 g/cm³
- 27 g
- 200 cm³
- 800 kg/m³
- 300 g
- 0.003 m³
- 2.5 g/cm³
- 100 g
- 54 kg
- 1500 cm³
- 20 N/m²
- 120 N
- 4 m²
- 300 N/m²
- 400 N/m²
- 120 N
- 20 m²
- 1600 N/m²
- 4 L/min
- 21 L
- 9 min
- 3600 mL

Exam-Style Structured Practice

- 80 km/h
- 1 h 15 min
- 240 km
- 64.8 km/h
- 60 km/h
- 3 g/cm³
- 156 kg
- 1.8 kg
- 200 N/m²
- 300 N
- 180 π g
- 16 min
- 15 L
- 48 km/h
- 3 N/cm²
- 15 m/s
- 18 km/h
- 30 L
- 0.003 m³
- 800 N/m²

Mixed Review

- 150 min
- 120 cm³
- 77 cm²
- 4 km/h
- 3 g/cm³
- 30 N/m²
- 80 π cm³
- 16:20
- 18 π cm
- 3 L
- 48 km/h

Challenge Questions

- 60 km/h
- 2.5 g/cm³
- 1.5 N/cm², 3 N/cm²
- 12 min
- 120 km
- 312π g
- 2.5 L/min, 12 min

Chapter 5 Answer Key - Pythagoras' Theorem

Skill Practice

- $a^2 + b^2 = c^2$
- longest side
- $b = \sqrt{c^2 - a^2}$
- No, only right triangles
- The hypotenuse
- The longest side
- 25
- 144
- 5 cm
- 13 cm
- 17 cm
- 25 cm
- 15 cm
- 29 cm
- 26 cm
- 10 cm
- 37 cm
- 34 cm
- 12 cm
- 15 cm
- 24 cm
- 8 cm
- 24 cm
- 21 cm
- 12 cm
- 35 cm
- 40 cm
- 30 cm
- Yes
- No
- Yes
- No
- Yes
- No
- Yes
- 10 cm
- 15 cm
- 13 cm
- 25 cm
- 26 cm
- 17 cm
- 20 cm
- 5
- 10
- 10
- 13
- 17
- $\sqrt{13}$ cm
- $2\sqrt{13}$ cm
- $5\sqrt{2}$ cm
- $\sqrt{85}$ cm
- $\sqrt{65}$ cm
- $\sqrt{202}$ cm
- $\sqrt{109}$ cm

Exam-Style Structured Practice

- 12 m
- 8 m
- 34 cm
- 13
- Right-angled
- No
- 29 cm, perimeter 70 cm
- 24 cm, area 84 cm²
- 10 km
- $9\sqrt{2}$ cm
- 12 cm, area 60 cm²
- 12 cm
- 6 cm
- 17.8 cm
- 7 cm, perimeter 62 cm
- 13, area 30 square units
- 500 m, 10 m/s
- 21 cm, area 294 cm²
- 13 cm
- 35 cm
- $\sqrt{85}$

Mixed Review

- 60 km/h
- 35 cm²
- 15 cm
- 120 cm³
- 3 g/cm³
- Yes
- 29 cm
- 165 min
- 16π cm
- 17
- 30 N/m²

Challenge Questions

- 26 cm
- 33 cm, 1848 cm²
- 30 m
- 8
- 25 cm, 600 cm²
- 25 m
- 7 cm and 24 cm

- 15 km, 30 km/h

Chapter 6 Answer Key - Trigonometric Ratios

Skill Practice

- $\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}}$
- $\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}}$
- $\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$
- hypotenuse
- opposite side
- adjacent side
- degree mode
- $\theta = \sin^{-1}(\frac{4}{5})$
- 5.0 cm
- 12.0 cm
- 9.8 cm
- 7.7 cm
- 8.3 cm
- 7.0 cm
- 16.0 cm
- 14.5 cm
- 3.4 cm
- 10.0 cm
- 8.4 cm
- 10.6 cm
- 18.5 cm
- 8.0 cm
- 19.1 cm
- 10.7 cm
- 9.0 cm
- 15.0 cm
- 6.6 cm
- 22.4 cm
- 16.0 cm
- 16.4 cm
- 22.7 cm
- 11.8 cm
- 16.9 cm
- 16.0 cm
- 15.2 cm
- 25.7 cm
- 10.6 cm
- 20.5 cm
- 22.6°
- 44.4°
- 36.9°
- 36.9°
- 61.9°
- 22.6°
- 53.1°
- 16.3°
- 36.9°
- 54.5°
- 32.0°
- $\sin \theta$
- $\cos \theta$
- $\tan \theta$
- $\sin \theta = \frac{12}{20}$
- $\cos \theta = \frac{16}{17}$
- $\tan \theta = \frac{4}{12}$
- 2.1 m
- 11.2 m
- 351.4 m
- 18.5 m
- 8.5°
- 68.2°
- 31.3 m
- 9.8 m
- 16.8 m
- 47.8 m
- 19.1 m
- 13.6 m
- 15.3 m
- 19.4 m
- 41.8 m

Exam-Style Structured Practice

- 7.5 m
- 33.7°
- 7.2°
- 5.5 m
- 65.5 m
- 63.8 m
- 1.0 m
- 51.3°
- 9.0 cm
- 12.1 cm
- 28.1°
- 13.4 cm, 12.0 cm
- 86.6 cm²
- 10.4 m
- 4.3°
- 22.5 m
- 14.5 m
- 122.0 m
- 45.6°
- 36.9°
- 5.5 cm
- 1.9 km
- 0.5 km
- 27.2 cm, 12.7 cm

Mixed Review

- 10 cm
- 60 km/h
- 9.6 cm
- 30 cm²
- 3 g/cm³
- 22.6°
- 18π cm
- 17.0 cm

- 120 cm³
 - 36.9°
 - 140 min
 - 7.6 cm
 - 40 N/m²
- Challenge Questions
- 29.3 m
 - 2.1 m, 14.9 m
 - 4.2 m, 7.3 m
 - 5.0 km, 22.6°
 - 0.5 km, 5.0 km
 - 27.2 cm, 12.7 cm, area 344.7 cm²
 - 26.6°
 - 0.2 km, 12.0 km/h
 - 36.9°

Chapter 7 Answer Key - Bearings, Scale Drawings, Sine Rule and Cosine Rule

Skill Practice

- Clockwise from north
- 000°
- 090°
- 180°
- 270°
- 045°
- 135°
- 225°
- 315°
- 030°
- 140°
- 205°
- 345°
- 240°
- 105°
- 55°
- 8 km
- 18 km
- 3.7 km
- 4 cm
- 9 cm
- 6 cm
- 3.0 km
- 2.0 km
- 4.5 km
- 7.0 km
- 1.2 km
- 6.0 cm
- 8.0 cm
- 0.4 km
- 1 : 25000
- 1 : 20000
- 2 km
- 5 cm at 070°
- 4 cm at 145°
- 270°
- 5.0 km, 036.9°
- 10.0 km, 053.1°
- 10.0 km, 143.1°
- 13.0 km, 337.4°
- 25.0 km, 196.3°
- 14.1 km, 045.0°
- 13.0 km, 022.6°
- 15.0 km, 126.9°
- 5.0 km E, 8.7 km N
- 6.0 km E, 10.4 km S
- 6.9 km W, 4.0 km S
- 9.9 km W, 9.9 km N
- sine rule
- cosine rule
- 11.3 cm
- 14.7 cm
- 15.5 cm
- 11.3 cm
- 8.2 cm
- 9.0 cm
- 8.5 cm
- 96.4°
- 90°
- 81.8°

Exam-Style Structured Practice

- (a) 3.6 km (b) 252°
- (a) 12 km (b) 235°
- 25.0 km, 053.1°
- 10.0 km, 036.9°
- 13.0 km, 112.6°
- 7.8 km E, 4.5 km N
- (a) 16 cm by 10 cm (b) 40 m²
- 3.1 km, 37.2 min
- 20 km, 300°
- 5.0 km, 156.9°
- 28.3 km E, 28.3 km N
- 25.0 km, 036.9°
- 60 m, 50 m, 70°, 63.6 m
- 13.0 cm, 198°
- 125°
- 155°
- 15.0 km, 323.1°, 143.1°
- 21 km, 20.7 km E, 3.6 km N
- 14.1 km, 080.0°
- 67.6 m
- 8.2 cm
- 17.2 km
- 79.8°

Mixed Review

- 15 cm
- 5 cm
- 308°
- 7.1°
- 30 km/h

- 32 cm²
- 120 cm³
- 2.8 km
- 053.1°
- 2.7 g/cm³

Challenge Questions

- 10.0 km, 083.1°
- 1.5 km, 101.9°
- 32.0 km, 168.7°
- 9.7 km, 105.4°
- 20.0 cm, 053.1°
- 1 : 40000, 0.4 km
- 16.5 km, 336.6°

Chapter 8 Answer Key - 3D Measurement and Trigonometry

Skill Practice

- $\sqrt{l^2 + w^2}$
- $\sqrt{l^2 + w^2 + h^2}$
- The diagonal of the base rectangle
- height and floor diagonal
- 90°
- 0°
- 5.0 cm
- 13.0 cm
- 15.0 cm
- 21.0 cm
- 3.7 m
- 10.0 cm
- diameter 5.0 cm, radius 2.5 cm
- 13.2 cm
- 12.0 cm
- 24.0 cm
- 7.0 cm
- 13.0 cm
- 9.0 cm
- 11.0 cm
- 11.0 cm
- 17.0 cm
- 15.0 cm
- 21.0 cm
- 9.0 cm
- 29.0 cm
- 45.0°
- 45.0°
- 34.7°
- 45.0°
- 28.1°
- 21.8°
- 45.0°
- 36.9°
- 10.0 cm
- 13.0 cm
- 5.8 cm
- 13.0 m

Exam-Style Structured Practice

- $\text{rtext{(a)}10.0\text{rtext{ m}}\text{quad}\text{rtext{(b)}10.4\text{rtext{ m}}\text{quad}\text{rtext{(c)}16.7^{\circ}\text{circ}}$
- 13.0 cm, 15.8 cm, 34.7°
- 26.0 cm, 67.4°
- 15.6 cm, 50.2°
- 17.0 cm, 61.9°
- 13.9 cm, 59.5°
- $\text{rtext{(a)}43.8\text{rtext{ cm}}\text{quad}\text{rtext{(b no)}}$
- 20.6 cm
- 17.0 m, 28.1°
- 31.6 m, 34.7°
- 25.0 cm, 73.7°
- 12.2 m, 54.7°
- 13.0
- 20.9 m, 16.7°

Mixed Review

- 41 cm
- 10 cm
- 60 cm³
- 3 km
- 222°
- 49π cm²
- 60 km/h
- 108 cm²

Challenge Questions

- 8.7 cm, 17.3 cm
- 24.0 cm, 73.7°
- 5.6 cm
- 6.4 m, 38.7°
- 17.0 m, 61.9°
- 8.3 m, 39.7°

Chapter 9 Answer Key - Measurement and Trigonometry Mixed Review

Skill Practice

- 360 cm
- 4.5 L
- 48.4
- 24 cm
- 48 cm²
- 25π cm²
- 120 cm³
- 94 cm²
- 90π cm³
- 120 cm³
- 3 g/cm³
- 25 N/m²
- 50 km/h
- 2 h
- 112.5 km
- 43.2 km/h
- 6 L/min

18. 250 people/km²
19. 12 km/L
20. 15 cm
21. 24 cm
22. 17 cm
23. 5 cm
24. 10.0 cm
25. 16.3°
26. 7.5 m
27. 258°
28. 050°
29. 1.5 km
30. 4.8 cm
31. 13.0 km, 022.6°
32. 14.1 km, 045.0°
33. 13 cm
34. 45.0°
35. 13 cm
36. 17 cm
37. 120 cm³
38. 5 cm

Exam-Style Structured Practice

1. (a) 96 – 4π m² (b) 40 m
2. (a) 3.6 m³ (b) 3600 L (c) 120 min
3. 5.6 m, 2.2 m
4. 4 km, 242°
5. 18.2 km, 059.7°
6. 18.0 cm, 29.9°
7. (a) 10 km (b) 42 km/h
8. 160π cm³, 1256.6 g
9. (a) 296 cm² (b) \$8.88
10. 28.0 m, 195°
11. 12 m by 8 m, 96 m²
12. 15.8 m, 18.4°
13. 2000 N/m²
14. 12π cm³, 15π cm²

Mixed Review

1. 2750 m
2. 65 cm²
3. 60 km/h
4. 29 cm
5. 9.8 cm
6. 135°
7. 1.4 km
8. 17 cm

Challenge Questions

1. 19.4 km, 079.5°
2. 240 L, 20 min
3. 7.5 m, 21.9 m
4. 6.0 km, 1.5 km²
5. 285.8 cm³
6. 15.0 km, 076.9°, 30 km/h

Chapter 10 Answer Key - Similarity in Measurement

Skill Practice

1. 3
2. 28 cm
3. 90 cm
4. 288 cm²
5. 25
6. 144 cm³
7. $\frac{1}{8}$
8. 7.5 cm
9. 20 and 25
10. 80 cm²
11. 12 cm²
12. 1458 cm³
13. 40 cm³
14. 16 m
15. 1 : 50
16. 1080 mL
17. 180π cm²
18. 150 cm²
19. 324π cm³
20. 2
21. 2.5
22. 24 cm
23. 1500 m²
24. 2

Exam-Style Structured Practice

1. 1.5, 7.5 cm, 90 cm²
2. 63 cm, 189 cm²
3. 1 : 50, 1.8 m, 8.1 m²
4. 1500 cm³
5. 15 cm, 540π cm³
6. 720π cm²
7. 12 cm
8. 320 L
9. 36 cm by 24 cm, perimeter 120 cm
10. 18 cm, 2160 cm³
11. 10 m, 3.75 m, 937.5 m³
12. 600 m²
13. 2744 cm³
14. 67.5 cm², 1215 cm³
15. 27 cm², 243 cm²
16. 7 cm, 16

Mixed Review

1. 15000 m²
2. 15 and 20
3. 40 cm
4. 12 cm
5. 3 cm
6. 72 m²
7. 540π cm³, 9
8. 125 cm²

Challenge Questions

1. 66 cm

2. 1687.5 cm³
3. 0.81 m³
4. 32π cm³, 8 cm
5. 1024 cm³
6. $\frac{3}{8}$
7. 120 m, 600 m²
8. 600 cm²