Elite Mathematics
Pearson Edexcel International GCSE

IGCSE LINEAR · 4MA1

4WM2/01R May 2025 Worked Solutions

May 2025 paper rebuilt with the worked solution after each question.

25	2020–2026	Single-paper solutions
paper questions	52 past papers	checked by Dr Eslam



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PAST PAPER

4WM2/01R May 2025

May 2025

25	100	2 h
questions	marks	exam time

Each question is followed by its worked solution and final answer.

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Question 1

5 marks | Averages from Frequency Tables

1 The table shows information about the weights, in kilograms, of 50 dogs.

Weight (w kg)	Frequency
$4 < w \leqslant 8$	5
$8 < w \leqslant 12$	17
$12 < w \leqslant 16$	15
$16 < w \leqslant 20$	9
$20 < w \leqslant 24$	4

(a) Write down the modal class.

..... kg

(1)

(b) Work out an estimate for the mean weight of the 50 dogs.

..... kg

(4)

(Total for Question 1 is 5 marks)

WORKED SOLUTION

Question 1 · 4WM2/01R May 2025

1 Required

a Write down the modal class. (b) Estimate the mean weight of the 50 dogs.

2 Part (a)

The **modal class** is the interval with the highest frequency. From the table, the highest frequency is **17**, which belongs to:

3 Answer

Modal class: 8 \< *w* ≤ 12 kg

4 **Find the midpoint of each**

Find the midpoint of each class interval:

5 **Apply the estimated mean formula**

Apply the estimated mean formula:

$$barx = fracsumf!xsumf = frac66050 = 13.2textkg$$

✓ **FINAL ANSWER**

Estimated mean weight = 13.2 kg

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Question 2

3 marks | Prime Factors, HCF & LCM

2 Write 1400 as a product of powers of its prime factors.
Show your working clearly.

(Total for Question 2 is 3 marks)

WORKED SOLUTION

Question 2 · 4WM2/01R May 2025

1 Required

Write 1400 as a product of powers of its prime factors.

2 Divide repeatedly by the smallest

Divide repeatedly by the smallest prime factor each time:

$$1400;\ xrightarrowdiv2;\ 700;\ xrightarrowdiv2;\ 350;\ xrightarrowdiv2;\ 175;\ xrightarrowdiv5;\ 35;\ xrightarrowdiv5;\ 7;\ xrightarrowdiv7;\ 1$$

3 Collect the prime factors

Collect the prime factors:

$$1400 = underbrace2times2times2_2^3timesunderbrace5times5_5^2times7$$

FINAL ANSWER

1400 = 2³ × 5² × 7

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Question 3

3 marks | Simultaneous Equations

3 Solve the simultaneous equations

$$3x + 2y = 10$$
$$3x - 4y = 16$$

Show clear algebraic working.

$x =$ .....

$y =$ .....

(Total for Question 3 is 3 marks)

WORKED SOLUTION

Question 3 · 4WM2/01R May 2025

1 Required

Solve: 3*x* + 2*y* = 10 and 3*x* − 4*y* = 16 algebraically.

2 Label the equations

Label the equations:

Misplaced &

3 Subtract (2) from (1) eliminate

Subtract (2) from (1) to eliminate *x*:

$$(1) - (2) : quad6y = -6impliesboxedy = -1$$

4 Substitute y 1 into (1)

Substitute *y* = − 1 into (1):

$$3x + 2(-1) = 10implies3x = 12impliesboxedx = 4$$

5 Check in equation (2) 3(4)

Check in equation (2): 3(4) − 4(−1) = 12 + 4 = 16

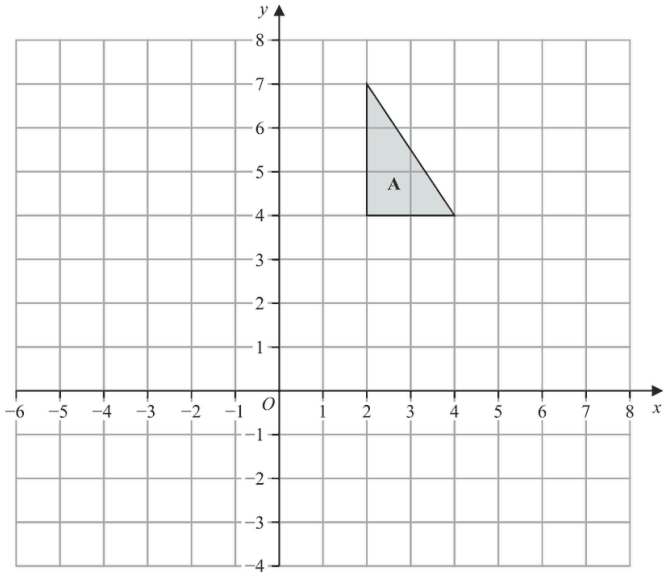
FINAL ANSWER

x = 4, *y* = − 1

Question 4

4 marks | Transformations

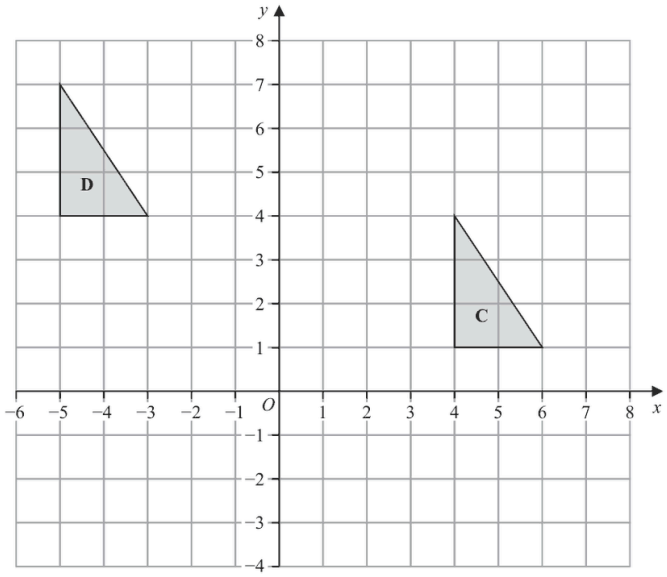
4



(a) On the grid above, rotate triangle **A** 90° anticlockwise about $(1, 2)$

Label your triangle **B**

(2)



(b) Describe fully the single transformation that maps triangle **C** onto triangle **D**

(2)

(Total for Question 4 is 4 marks)

1 Required

a Rotate triangle A 90° anticlockwise about (1,2); label triangle B. (b) Describe fully the transformation mapping C onto D.

2 The rule for 90 anticlockwise

The rule for 90° anticlockwise rotation about (*a*,*b*):

(*x*, *y*) → (*a* − (*y*−*b*), *b* + (*x*−*a*))

About (1,2): (*x*,*y*) → (3−*y*, *x*+1)

3 Triangle A has vertices A

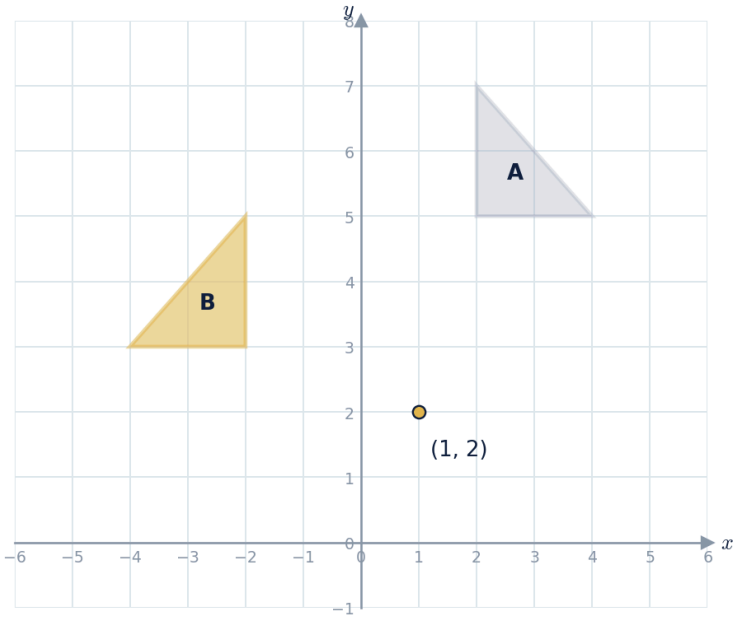
Triangle A has vertices *A*₁(2,7), *A*₂(4,5), *A*₃(2,5).

Apply the rule:

(2,7) → (−4,3), (4,5) → (−2,5), (2,5) → (−2,3)

4 Answer

Triangle B has vertices (−4,3), (−2,5), (−2,3)



5 Identify corresponding vertices of C

Identify corresponding vertices of C and D from the diagram and compute the vector:

$$(4, , 4) longrightarrow (-5, , 7) : quad vec{v} = beginpmatrix - 93 endpmatrix$$

Check: (6,1) → (−3,4) gives the same vector $beginpmatrix - 93 endpmatrix$

FINAL ANSWER

Translation by vector $beginpmatrix - 93 endpmatrix$

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Question 5

5 marks | Reverse Percentages

5 Joshua is going to cover a floor with tiles for a customer.
The area of the floor is 45 m^2

Joshua buys one box of tiles for each 1.5 m^2 of floor area.
Each box of tiles costs £64

Joshua also buys 5 bags of tile adhesive.
Each bag of tile adhesive costs £12

Joshua charges the customer £3000

Work out his percentage profit.
Give your answer correct to one decimal place.

.....%

(Total for Question 5 is 5 marks)

WORKED SOLUTION

Question 5 · 4WM2/01R May 2025

1 Required

Calculate Joshua's percentage profit on the flooring job. Give answer to 1 d.p.

2 Number of boxes of tiles

Number of boxes of tiles needed:

$$frac45, textm^2 1.5, textm^2 / textbox = 30 textboxes$$

3 Cost of tiles 30 64

Cost of tiles:

30 × £64 = £1920

4 Cost of adhesive 5 12

Cost of adhesive:

5 × £12 = £60

5 Total cost (cost price) 1920

Total cost (cost price):

£1920 + £60 = £1980

6 **Profit and percentage profit Profit**

Profit and percentage profit:

Profit = £3000 − £1980 = £1020

7 **Note**

Always divide profit by the **cost price** (£1980), not the selling price (£3000). Dividing by £3000 gives 34.0% — a common but wrong answer.

✓ **FINAL ANSWER**

Percentage profit = 51.5%

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Question 6

3 marks | Standard Form

6 (a) Write $82\,000\,000$ in standard form.

.....

(1)

(b) Write 5.8×10^{-6} as an ordinary number.

.....

(1)

(c) Write 160×10^{300} in standard form.

.....

(1)

(Total for Question 6 is 3 marks)

WORKED SOLUTION

Question 6 · 4WM2/01R May 2025

1 **Required**

a Write 82 000 000 in standard form. (b) Write 5.8 × 10^{−6} as an ordinary number. (c) Write 160 × 10³⁰⁰ in standard form.

2 **Part (a)**

82 000 000 = 8.2 × 10⁷

3 **Answer**

8.2 × 10⁷

4 **Part (b)**

Move the decimal 6 places **left**:

5.8 × 10^{−6} = 0.0000058

5 **Answer**

0.0000058

6 **Part (c)**

160 × 10³⁰⁰ = 1.6 × 10¹ × 10³⁰⁰ = 1.6 × 10³⁰¹

FINAL ANSWER

1.6 × 10³⁰¹

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Question 7

3 marks | Statistics Toolkit

7 The mean of 7 numbers is 60

The mean of 3 of the numbers is 46

Work out the mean of the other 4 numbers.

(Total for Question 7 is 3 marks)

WORKED SOLUTION

Question 7 · 4WM2/01R May 2025

1 Required

Mean of 7 numbers = 60; mean of 3 of them = 46. Find the mean of the other 4.

2 Sum of all 7 numbers

Sum of all 7 numbers:

$7 \times 60 = 420$

3 Sum of the 3 numbers

Sum of the 3 numbers:

$3 \times 46 = 138$

4 Sum of the remaining 4

Sum of the remaining 4:

$420 - 138 = 282$

5 Mean of the 4 numbers

Mean of the 4 numbers:

$$frac2824 = 70.5$$

✓ FINAL ANSWER

Mean of the other 4 numbers = 70.5

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Question 8

3 marks | Reverse Percentages

8 In a sale, normal prices are reduced by 15%

The sale price of a dishwasher is 612 Swiss francs.

Work out the normal price of the dishwasher.

..... Swiss francs

(Total for Question 8 is 3 marks)

WORKED SOLUTION

Question 8 · 4WM2/01R May 2025

1 Required

Sale price (after 15% reduction) = 612 Swiss francs. Find the normal price.

2 A 15% reduction means the

A 15% reduction means the sale price is 85% of the normal price:

612 = 0.85 × Normal price

3 Solve for the normal price

Solve for the normal price:

$$textNormalprice = frac6120.85 = 720$$

4 Note

Never calculate 15% of 612 and add it on — that gives 703.80 (wrong!). Always divide by the decimal multiplier.

✓ **FINAL ANSWER**

Normal price = 720 Swiss francs

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Question 9

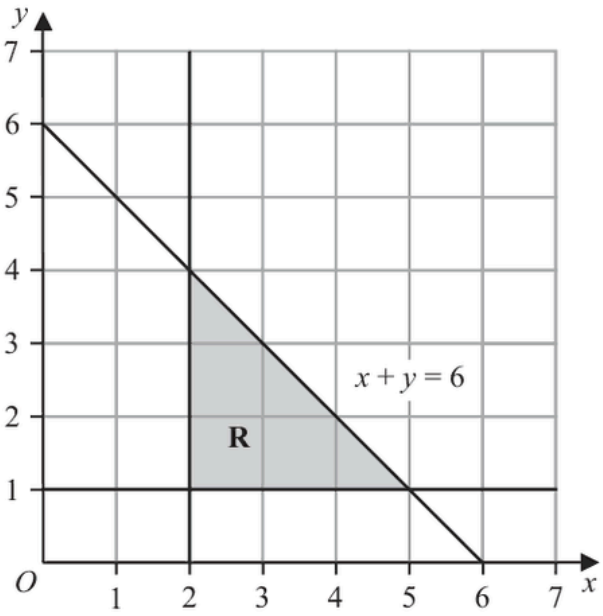
6 marks | Inequalities (Solving & Graphing)

9 (a) Solve the inequality $3x - 22 > 8x - 40$
Show clear algebraic working.

.....

(3)

The region **R**, shown shaded in the diagram, is bounded by three straight lines.



(b) Write down the three inequalities that define the region **R**

.....

(3)

(Total for Question 9 is 6 marks)

WORKED SOLUTION

Question 9 · 4WM2/01R May 2025

1 **Required**

a Solve 3*x* − 22 \> 8*x* − 40 algebraically. (b) Write the three inequalities defining region R.

2 **Find the nth term**

Move all *x* terms to the right and constants to the left:

3*x* − 22 \> 8*x* − 40 ⟹ − 22 + 40 \> 8*x* − 3*x* ⟹ 18 \> 5*x*

3 Divide both sides by 5

Divide both sides by 5:

$$x\backslash<frac185 = 3.6$$

4 Answer

x \< 3.6

5 Identify the three boundary lines

Identify the three boundary lines and their regions using the graph. The shaded region R is bounded by *x* = 2, *y* = 1, and *x* + *y* = 6.

FINAL ANSWER

x ≥ 2,*y* ≥ 1,*x* + *y* ≤ 6

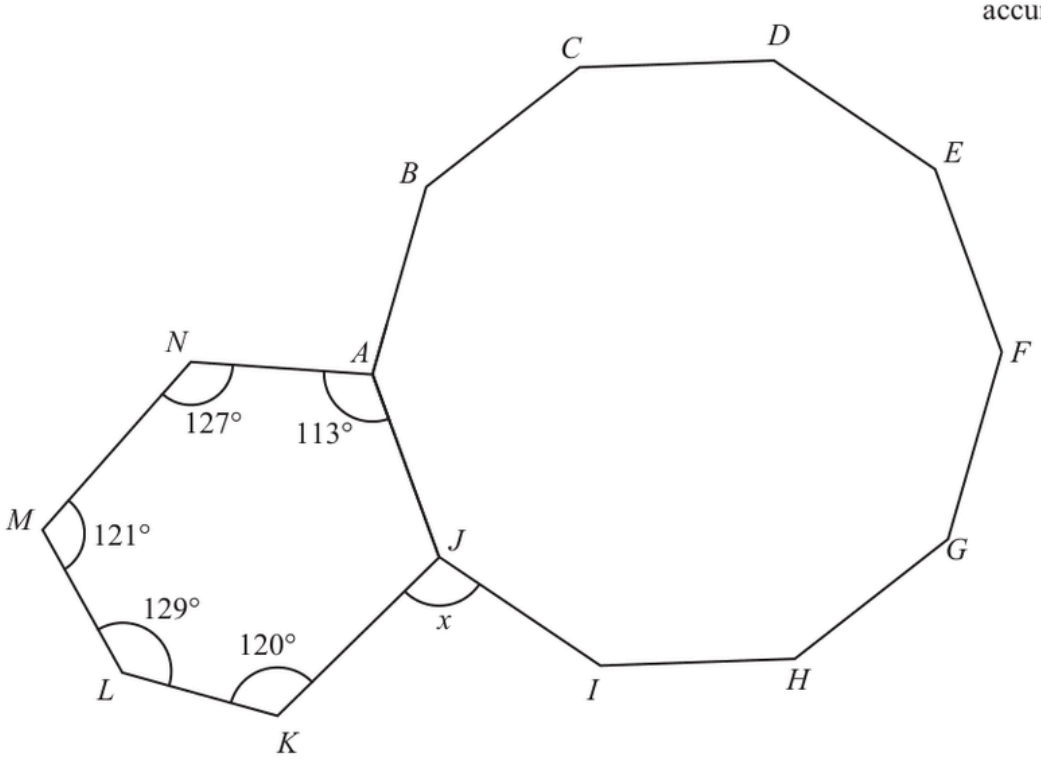
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Question 10

5 marks | Angles in Polygons & Parallel Lines

10 The diagram shows a regular 10-sided polygon *ABCDEFGHIJ* and a hexagon *AJKLMN*

Diagram **NOT** accurately drawn



Work out the size of the angle marked x
Show your working clearly.

.....°

(Total for Question 10 is 5 marks)

WORKED SOLUTION

Question 10 · 4WM2/01R May 2025

1 **Required**

Find angle *x* in the figure combining a regular 10-gon (ABCDEFGHIJ) and hexagon AJKLMN.

2 **Interior angle of a regular**

Interior angle of a regular 10-sided polygon:

$$textInteriorangle = frac(10 - 2)times180^\circ 10 = frac1440^\circ 10 = 144^\circ$$

3 **Use trigonometry**

Find the interior angle of the hexagon at vertex *A*. At point *A*: decagon angle + 113° + hexagon angle at *A* = 360°:

∠*x* = 360° − 144° − 110° = 106°

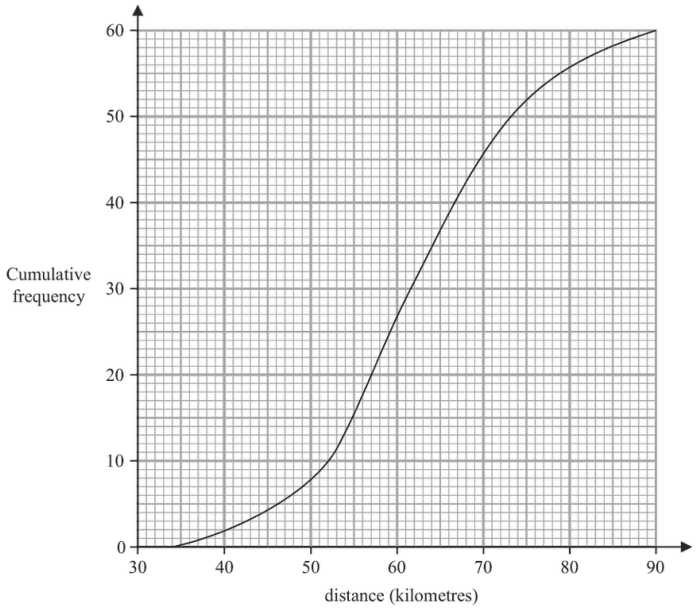
✓ **FINAL ANSWER**

x = 106°

Question 11

7 marks | Cumulative Frequency Diagrams

11 The cumulative frequency graph shows information about the distance, in kilometres, Ehrick drives each day for 60 days.



(a) Use the graph to find an estimate for the median of the distances.

..... kilometres
(1)

(b) Use the graph to find an estimate for the interquartile range of the distances.

..... kilometres
(2)

(c) Work out the percentage of days that Ehrick drives for more than 75 kilometres.
Give your answer correct to one decimal place.
Show your working clearly.

..... %
(3)

Tomas and Alison record the number of kilometres that they drive each day for 60 days.
The table gives information about their results.

	Interquartile range
Tomas	28 kilometres
Alison	15 kilometres

(d) Which of Tomas or Alison is more consistent in the number of kilometres that they drive.
Give a reason for your answer.

.....
(1)

(Total for Question 11 is 7 marks)

1 **Required**

a Median(b) IQR(c) % days \> 75 km(d) More consistent?

2 **Median at the th value**

Median at the $frac602 = 30$th value — read from graph at cf = 30:

3 **Answer**

Median ≈ 62 km

4 **Read the graph**

*Q*₁ at cf = 15, *Q*₃ at cf = 45. Read from graph:

*Q*₁ ≈ 56 km, *Q*₃ ≈ 74 km

IQR = *Q*₃ − *Q*₁ = 69 − 55 = 14 km

5 **Answer**

IQR ≈ 14 km

6 **Note**

Graph-reading answers are accepted within ± 2 km of the model answer.

7 **Use cumulative frequency**

From the graph, read the cumulative frequency at *d* = 75 km:

cf at 75 km ≈ 52

8 **Number of days with distance**

Number of days with distance \> 75 km:

60 − 52 = 8 days

9 **Percentage**

Percentage:

$$frac860times100 = 13.3$$

10 **Answer**

13.3% of days Ehrick drives more than 75 km

✓ **FINAL ANSWER**

Alison is more consistent — her IQR (15 km) is smaller than Tomas's (28 km), meaning less variability in daily distances.

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Question 12

3 marks | Compound Interest & Depreciation

12 Osman buys a car for $16 000

The car depreciates at a rate of 12% each year for the first 2 years.
In the third year, the car depreciates at a rate of $x\%$

At the end of 3 years, the value of the car is $11 461.12

Work out the value of x

(Total for Question 12 is 3 marks)

WORKED SOLUTION

Question 12 · 4WM2/01R May 2025

1 Required

Car bought for $16\,000; depreciates 12 11\,461.12$. Find *x*.

2 Value after 2 years at

Value after 2 years at 12% depreciation:

*V*₂ = 16000 × (0.88)² = 16000 × 0.7744 = $12 390.40

3 Use compound interest

Apply year-3 depreciation and set equal to final value:

$$12390.40 times ! left(1 - frac x 100 right) = 11461.12$$

4 Solve

Solve:

$$1 - frac x 100 = frac 11461.12 12390.40 = 0.925 implies frac x 100 = 0.075 implies x = 7.5$$

✓ FINAL ANSWER

x = 7.5

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Question 13

3 marks | Standard Form

13 The distance from Earth to Andromeda Galaxy is 1.6×10^{11} astronomical units.

- 1 astronomical unit $= 1.5 \times 10^{8}$ km
- 1 light year $= 9.5 \times 10^{12}$ km

Work out the distance, in light years, from Earth to Andromeda Galaxy.
Give your answer in standard form, correct to 2 significant figures.

..... light years

(Total for Question 13 is 3 marks)

WORKED SOLUTION

Question 13 · 4WM2/01R May 2025

1 Required

Distance to Andromeda: 1.6 × 10¹¹ AU. Convert to light years (2 s.f., standard form).

2 Convert AU km 1 6

Convert AU → km:

1.6 × 10¹¹ × 1.5 × 10⁸ = (1.6×1.5) × 10¹⁹ = 2.4 × 10¹⁹ km

3 Convert km light years

Convert km → light years:

$$frac2.4times10^{19}9.5times10^{12} = frac2.49.5times10^{7} = 0.2526ldotstimes10^{7}$$

4 Convert standard form

Write in standard form to 2 s.f.:

= 2.526… × 10⁶ ≈ 2.5 × 10⁶

✓ FINAL ANSWER

Distance = 2.5 × 10⁶ light years

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Question 14

4 marks | Rearranging Formulae

14 Make k the subject of $p = \dfrac{8k^2 + 5}{7 - 3k^2}$

(Total for Question 14 is 4 marks)

WORKED SOLUTION

Question 14 · 4WM2/01R May 2025

1 Required

Make *k* the subject of $displaystylep = dfrac8k^2 + 57 - 3k^2$.

2 Multiply both sides by (7

Multiply both sides by (7−3*k*²):

p(7−3*k*²) = 8*k*² + 5

3 Expand 7 p 3 p

Expand:

7*p* − 3*p***k*² = 8*k*² + 5

4 Collect all k 2 terms

Collect all *k*² terms on one side:

7*p* − 5 = 8*k*² + 3*p***k*²

5 Factorise and solve for k

Factorise and solve for *k*:

$$7p - 5 = k^2(3p + 8) impliesk^2 = frac7p - 53p + 8$$

$$k = pmsqrtdfrac7p - 53p + 8$$

6 Note

Include both ± roots unless the context specifies the sign of *k*.

FINAL ANSWER

$k = pmsqrtdfrac7p - 53p + 8$

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Question 15

3 marks | Circle Theorems

15 A, B and C are points on a circle, centre O

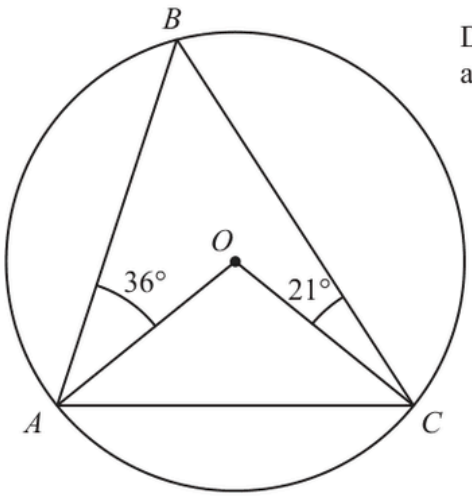


Diagram **NOT** accurately drawn

Angle $BAO = 36°$
Angle $BCO = 21°$

Work out the size of angle ACO

.....°

(Total for Question 15 is 3 marks)

WORKED SOLUTION

Question 15 · 4WM2/01R May 2025

1 Required

A, B, C on circle centre O. ∠*B**A**O* = 36°, ∠*B**C**O* = 21°. Find ∠*A**C**O*.

2 O A B is isosceles

△*O**A**B* is isosceles (*O**A*** = ***O**B*= radius):

∠*O**A**B* = ∠*O**B**A* = 36° ⟹ ∠*A**O**B* = 180° − 36° − 36° = 108°

3 O B C is isosceles

△*O**B**C* is isosceles (*O**B*** = ***O**C*):

∠*O**B**C* = ∠*O**C**B* = 21° ⟹ ∠*B**O**C* = 180° − 21° − 21° = 138°

4 Angles at centre O (on

Angles at centre O (on the same side):

∠*A**O**C* = 360° − 108° − 138° = 114°

5 O A C is isosceles

△*O**A**C* is isosceles (*O**A*** = ***O**C*):

$$angleOAC + angleOCA = 180^\circ - 114^\circ = 66^\circ impliesangleACO = frac66^\circ 2 = 33^\circ$$

FINAL ANSWER

∠*A**C**O* = 33°

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Question 16

3 marks | Vectors

16 OAB is a triangle.

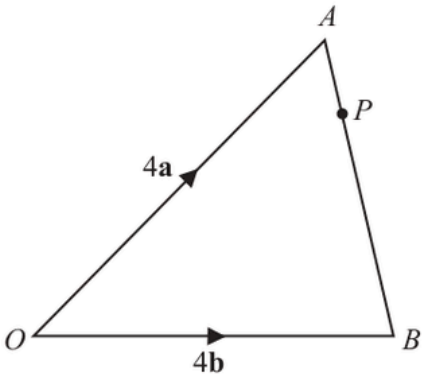


Diagram **NOT** accurately drawn

$\overrightarrow{OA} = \mathbf{4a}$

$\overrightarrow{OB} = \mathbf{4b}$

P is the point on AB such that $AP : PB = 1 : 3$

(a) Write down $\overrightarrow{AB}$ in terms of **a** and **b**

.....

(1)

(b) Express $\overrightarrow{OP}$ in terms of **a** and **b**
Give your answer in its simplest form.

.....

(2)

(Total for Question 16 is 3 marks)

WORKED SOLUTION

Question 16 · 4WM2/01R May 2025

1 Required

$overrightarrowOA = 4mathbfa$, $overrightarrowOB = 4mathbfb$, AP:PB = 1:3. (a) Find $overrightarrowAB$. (b) Express $overrightarrowOP$ in simplest form.

2 Part (a)

$$overrightarrowAB = overrightarrowAO + overrightarrowOB = -4mathbfa + 4mathbfb$$

3 Answer

$$overrightarrowAB = 4mathbfb - 4mathbfa$$

4 **AP PB 1 3 means**

AP:PB = 1:3 means $overrightarrowAP = tfrac14overrightarrowAB$:

$$overrightarrowAP = tfrac14(4mathbfb - 4mathbfa) = mathbfb - mathbfa$$

---

5 **Use**

Use $overrightarrowOP = overrightarrowOA + overrightarrowAP$:

$$overrightarrowOP = 4mathbfa + (mathbfb - mathbfa) = 3mathbfa + mathbfb$$

✓ **FINAL ANSWER**

$$overrightarrowOP = 3mathbfa + mathbfb$$

4WM2/01R MAY 2025

Question 17

4 marks | Functions

17 The function g is defined as

$$g(x) = \frac{3x}{x-2}$$

(a) State the value of x that cannot be included in any domain of g

.....

(1)

(b) Express the inverse function g^{-1} in the form $g^{-1}(x) = \ldots$

$g^{-1}(x) =$ .....

(3)

(Total for Question 17 is 4 marks)

WORKED SOLUTION

Question 17 · 4WM2/01R May 2025

1 Required

$g(x) = dfrac3xx - 2$. (a) Value excluded from domain. (b) Find *g*^{−1}(*x*).

2 Part (a)

The denominator must not equal zero: *x* − 2 ≠ 0.

3 Answer

x = 2 cannot be in any domain of *g*

4 Set y g (x

Set *y* = *g*(*x*) and swap *x* ↔ *y*:

$$x = frac3yy - 2$$

5 Multiply both sides by (

Multiply both sides by (*y*−2):

x(*y*−2) = 3*y* ⟹ *x**y* − 2*x* = 3*y*

6 Collect y terms and factorise

Collect *y* terms and factorise:

*x**y* − 3*y* = 2*x* ⟹ *y*(*x*−3) = 2*x*

7 **Solve for y**

Solve for *y*:

$$y = frac2xx - 3$$

8 **Note**

g^{−1}(*x*) is undefined at *x* = 3, which is the range restriction of *g*(*x*) (horizontal asymptote).

✓ **FINAL ANSWER**

$$g^{-1}(x) = dfrac2xx - 3$$

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Question 18

3 marks | Circle Theorems

18

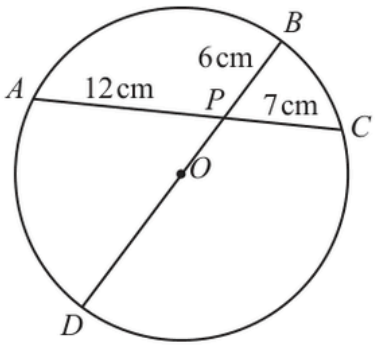


Diagram **NOT** accurately drawn

A, B, C and D are points on a circle, centre O

DB is a diameter of the circle.
AC and DB intersect at the point P

$AP = 12\,\text{cm}$ $PC = 7\,\text{cm}$ $PB = 6\,\text{cm}$

Work out the area of the circle.
Give your answer correct to 3 significant figures.

..... cm^2

(Total for Question 18 is 3 marks)

WORKED SOLUTION

Question 18 · 4WM2/01R May 2025

1 **Required**

DB is a diameter; chords AC and DB intersect at P. AP = 12 cm, PC = 7 cm, PB = 6 cm. Find area of circle (3 s.f.).

2 **Apply the Intersecting Chords Theorem**

Apply the **Intersecting Chords Theorem**: *A**P** × *PC* = *B**P** × *PD*

$$12 times 7 = 6 times PD implies PD = frac{84}{6} = 14 textcm$$

3 **Diameter D B D B**

Diameter *D**B*:

*D**B** = *PD* + *P**B* = 14 + 6 = 20 cm ⟹ *r* = 10 cm

4

Area of circle Area r

Area of circle:

Area = *π**r*² = 100*π* ≈ 314.159… cm²

5

Note

Intersecting Chords Theorem: if two chords cross inside a circle at P, then *A**P* × **P**C* = *B**P* × **P**D*.

✓ **FINAL ANSWER**

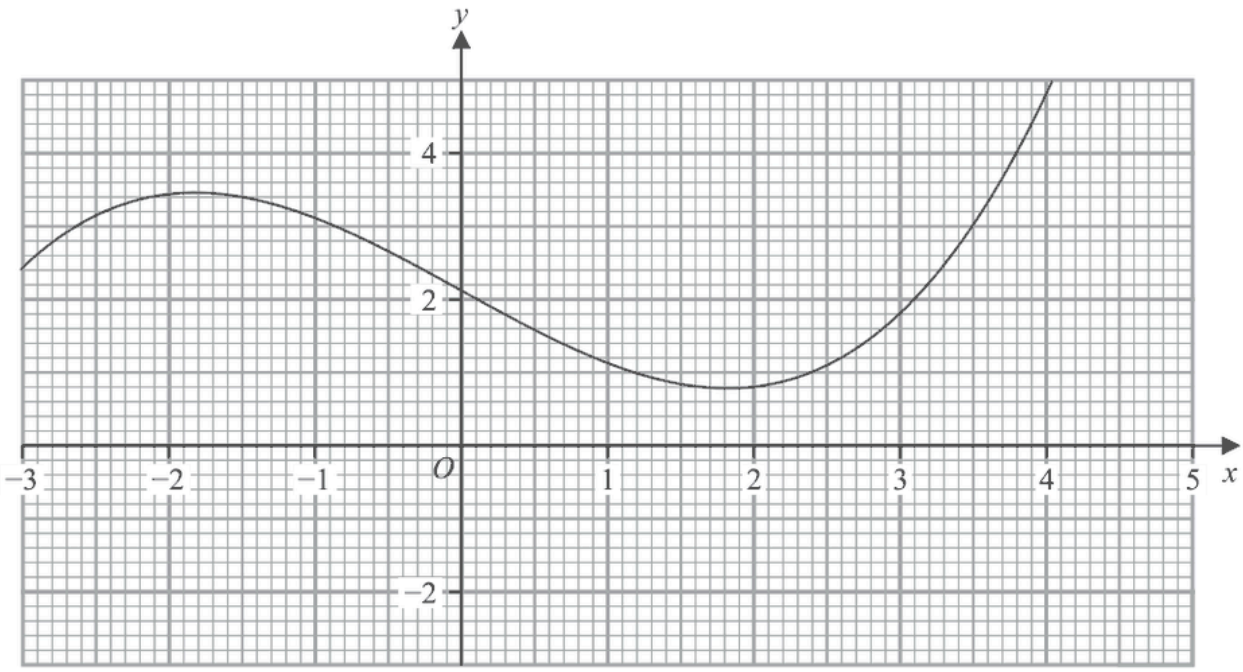
Area of circle = 314 cm² (3 s.f.)

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Question 19

3 marks | Graphs of Functions

19 The diagram shows the graph of $y = f(x)$



Find an estimate for the gradient of the graph at the point where $x = 3$
Show your working clearly.

(Total for Question 19 is 3 marks)

WORKED SOLUTION

Question 19 · 4WM2/01R May 2025

1 **Required**

Estimate the gradient of *y* = *f*(*x*) at the point where *x* = 3.

2 **Draw a tangent to the**

Draw a tangent to the curve at *x* = 3. From the graph, a suitable tangent passes through approximately (1, −2) and (5, 6):

3 **Calculate gradient of the tangent**

Calculate gradient of the tangent:

$$textGradient = fracDeltayDeltax = frac6 - (-2)5 - 1 = frac84 = 2$$

4

Note

Answers in the range 1 to 3 are typically accepted. Draw the tangent triangle as large as possible for the most accurate estimate.

✓ **FINAL ANSWER**

Gradient ≈ 2 at *x* = 3

4WM2/01R MAY 2025

Question 20

3 marks | Inequalities (Solving & Graphing)

20 Solve the inequality $2x^2 - 7x - 15 > 0$

Show clear algebraic working.

(Total for Question 20 is 3 marks)

WORKED SOLUTION

Question 20 · 4WM2/01R May 2025

1 Required

Solve 2*x*² − 7*x* − 15 \> 0. Show clear algebraic working.

2 Factorise the quadratic 2 x

Factorise the quadratic:

2*x*² − 7*x* − 15 = (2*x*+3)(*x*−5)

Check: (2*x*+3)(*x*−5) = 2*x*² − 10*x* + 3*x* − 15 = 2*x*² − 7*x* − 15

3 Set each factor zero

Roots: set each factor to zero:

$$2x + 3 = 0 implies x = -tfrac32; qquad x - 5 = 0 implies x = 5$$

4 Solve inequality

Since the coefficient of *x*² is + 2 \> 0, the parabola opens **upward**. The expression is \> 0 *outside* the roots:

FINAL ANSWER

$x \< - dfrac32$ or *x* \> 5

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Question 21

5 marks | Volume & Surface Area

21 The diagram shows a solid cuboid.

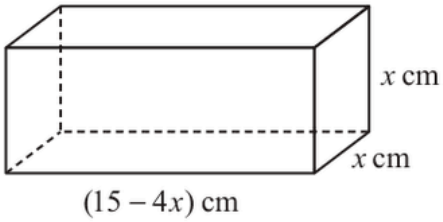


Diagram **NOT** accurately drawn

The volume of the cuboid is V cm^3

Find the maximum value of V

(Total for Question 21 is 5 marks)

WORKED SOLUTION

Question 21 · 4WM2/01R May 2025

1 Required

Cuboid has a square cross-section of side *x* cm and length (15−4*x*) cm. Find the maximum value of the volume *V*.

2 Write V as a function

Write *V* as a function of *x*:

V = *x* · *x* · (15−4*x*) = *x*²(15−4*x*) = 15*x*² − 4*x*³

3 Differentiate

Differentiate:

$$fracdVdx = 30x - 12x^2$$

4 Set (x 0 gives

Set $dfracdVdx = 0$:

$$30x - 12x^2 = 0implies6x(5 - 2x) = 0impliesx = 0; textor; x = tfrac52 = 2.5$$

(*x* = 0 gives zero volume, so the meaningful solution is *x* = 2.5.)

5

Second derivative test to confirm

Second derivative test to confirm maximum:

$$fracd^2Vdx^2 = 30 - 24x; Bigg|_x = 2.5 = 30 - 60 = -30\<0quadcheckmarktext(maximum)$$

6

Calculate V max V max

Calculate *V*_{max}:

*V*_{max} = (2.5)² × (15−4×2.5) = 6.25 × 5 = 31.25 cm³

7

Note

Calculus optimisation: always verify the nature of the stationary point using $dfracd^2Vdx^2$. Also check *x* \> 0 and 15 − 4*x* \> 0 (i.e. *x* \< 3.75) to ensure a valid cuboid.

✓ **FINAL ANSWER**

Maximum volume *V* = 31.25 cm³

4WM2/01R MAY 2025

Question 22

5 marks | Simultaneous Equations

22 Solve the simultaneous equations

$$y^2 + 5y + x^2 = 12$$
$$x = y + 5$$

Show clear algebraic working.

(Total for Question 22 is 5 marks)

WORKED SOLUTION

Question 22 · 4WM2/01R May 2025

1 Required

Solve *y*² + 5*y* + *x*² = 12 and *x* = *y* + 5.

2 Substitute x y + 5

Substitute *x* = *y* + 5 into the first equation:

*y*² + 5*y* + (*y*+5)² = 12

3 Expand (y +5) 2

Expand (*y*+5)² = *y*² + 10*y* + 25:

*y*² + 5*y* + *y*² + 10*y* + 25 = 12 ⟹ 2*y*² + 15*y* + 13 = 0

4 Factorise

Factorise:

$$(2y + 13)(y + 1) = 0 implies y = -tfrac132; textor; y = -1$$

5 Find corresponding x values using

Find corresponding *x* values using *x* = *y* + 5:

FINAL ANSWER

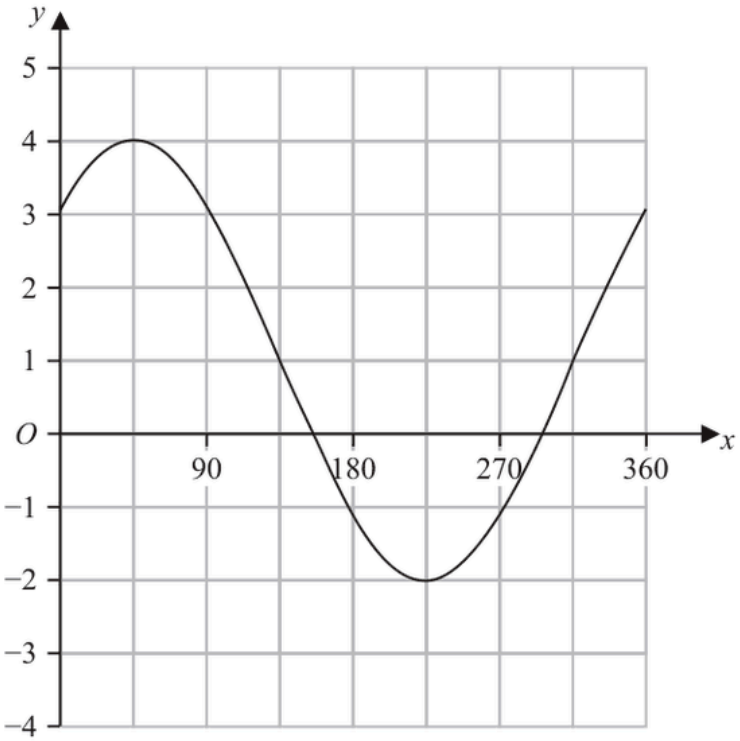
(*x*,*y*) = (4, −1)and$left(-dfrac32, , -dfrac132right)$

4WM2/01R MAY 2025

Question 23

3 marks | Graphs of Functions

23 The graph of $y = a\sin(x + b)^\circ + c$ for $0 \leqslant x \leqslant 360$ is drawn on the grid below.



Find a suitable value for a, for b and for c

$a =$ .....

$b =$ .....

$c =$ .....

(Total for Question 23 is 3 marks)

WORKED SOLUTION

Question 23 · 4WM2/01R May 2025

1 Required

The graph of *y* = *a*sin(*x*+*b*)[∘] + *c* for 0 ≤ *x* ≤ 360 is shown. Find suitable values for *a*, *b*, and *c*.

2 Read the maximum and minimum

Read the maximum and minimum values from the graph to find the **amplitude** *a* and **vertical shift** *c*:

$$a = \frac{\text{max} - \text{min}}{2} = \frac{4 - (-2)}{2} = 3 \quad c = \frac{\text{max} + \text{min}}{2} = \frac{4 + (-2)}{2} = 1$$

3 **Find the phase shift b**

Find the **phase shift** *b*. The standard sin has its peak at *x* = 90°. From the graph, the maximum occurs at *x* ≈ 45°:

x + *b* = 90° ⟹ 45° + *b* = 90° ⟹ *b* = 45°

---

4 **Verify at x 0 consistent**

Verify at *x* = 0: $y = 4sin(0 + 45)^\circ = 4times fracsqrt22approx2.83$ — consistent with graph

---

5 **Note**

The period of the graph is still 360° (unchanged), so no horizontal stretch is applied.

✓ **FINAL ANSWER**

a = 3,*b* = 45,*c* = 1

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Question 24

6 marks | Sequences

24 An arithmetic series P has first term a and common difference d

The sum of the first 40 terms of P is 2070

An arithmetic series Q has first term $2a$ and common difference $3d$

The 25th term of Q is 186

Work out the sum of the first 40 terms of Q
Show clear algebraic working.

(Total for Question 24 is 6 marks)

WORKED SOLUTION

Question 24 · 4WM2/01R May 2025

1 Required

Series P: first term *a*, c.d. *d*; *S*₄₀(*P*) = 2070. Series Q: first term 2*a*, c.d. 3*d*; 25th term of Q = 186. Find *S*₄₀(*Q*).

2 Form equation from S 40

Form equation from *S*₄₀(*P*) = 2070:

$$S_40 = frac402\[2a + 39d\] = 20(2a + 39d) = 2070implies2a + 39d = 103.5tag1$$

3 Form equation from 25th term

Form equation from 25th term of Q = 186:

*T*₂₅(*Q*) = 2*a* + 24(3*d*) = 2*a* + 72*d* = 186

4 Solve simultaneous equations

Solve simultaneously — subtract (1) from (2):

33*d* = 82.5 ⟹ *d* = 2.5

5 Substitute d 2 5 (1)

Substitute *d* = 2.5 into (1):

2*a* + 39(2.5) = 103.5 ⟹ 2*a* = 6 ⟹ *a* = 3

6 Compute S 40 (Q

Compute *S*₄₀(*Q*), with first term = 2*a* = 6 and c.d. = 3*d* = 7.5:

$$S_40(Q) = frac402bigl\[2(6) + 39(7.5)bigr\] = 20bigl\[12 + 292.5bigr\] = 20times304.5 = 6090$$

FINAL ANSWER

*S*₄₀(*Q*) = 6090

4WM2/01R MAY 2025

Question 25

5 marks | Volume & Surface Area

25 The diagram shows a solid hemisphere, H

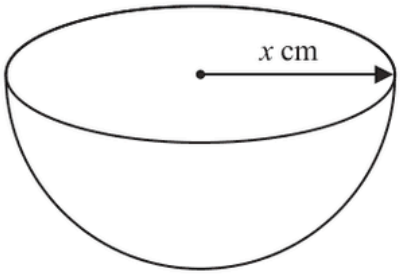


Diagram **NOT** accurately drawn

The radius of H is x cm
The volume of H is 6174π cm^3

A bowl is made by removing a solid hemisphere from H such that the uniform thickness of the bowl is 2 cm

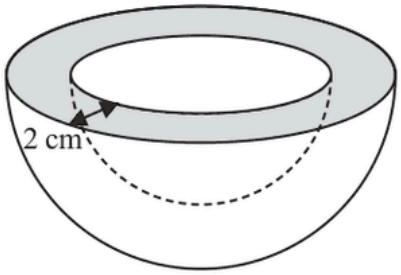


Diagram **NOT** accurately drawn

Work out the **total** surface area of the bowl.
Give your answer in terms of π

..... cm^2

(Total for Question 25 is 5 marks)

WORKED SOLUTION

Question 25 · 4WM2/01R May 2025

1 **Required**

Hemisphere H has radius *x* cm and volume 6174*π* cm³. A bowl is made by removing an inner hemisphere, leaving 2 cm thickness. Find total surface area in terms of *π*.

2 **Calculate volume**

Find outer radius *x*. Volume of hemisphere $= \frac{2}{3}\pi r^3$:

$$\frac{2}{3}\pi x^3 = 6174\pi \implies x^3 = \frac{6174}{3} \times 2 = 9261 \implies x = \sqrt[3]{9261} = 21\,\text{cm}$$

3 **Find inner radius r inner**

Find inner radius:

*r*_{inner} = 21 − 2 = 19 cm

4 **Add 1**

Three surfaces to add:

1. Outer curved surface (half-sphere, radius 21):

*A*₁ = 2*π*(21)² = 2*π* × 441 = 882*π*

2. Inner curved surface (half-sphere, radius 19):

*A*₂ = 2*π*(19)² = 2*π* × 361 = 722*π*

3. Flat annular ring at the top rim:

*A*₃ = *π*(21)² − *π*(19)² = *π*(441−361) = 80*π*

5 **Total surface area A total**

Total surface area:

*A*_{total} = 882*π* + 722*π* + 80*π* = 1684*π*

6 **Note**

Three separate surfaces! Missing the flat annular ring is the most common error on this type of question.

✓ **FINAL ANSWER**

Total surface area = 1684*π* cm²