Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3310U60-1

S23-3310U60-1

WEDNESDAY, 7 JUNE 2023 – MORNING

MATHEMATICS – NUMERACY
UNIT 2: CALCULATOR-ALLOWED
HIGHER TIER

1 hour 45 minutes

ADDITIONAL MATERIALS

A calculator will be required for this paper.

A ruler, a protractor and a pair of compasses may be required.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** the questions in the spaces provided.

If you run out of space, use the additional page at the back of the booklet. Question numbers must be given for the work written on the additional page.

Take π as 3·14 or use the π button on your calculator.

INFORMATION FOR CANDIDATES

You should give details of your method of solution when appropriate.

Unless stated, diagrams are not drawn to scale.

Scale drawing solutions will not be acceptable where you are asked to calculate.

The number of marks is given in brackets at the end of each question or part-question.

In question **1**, the assessment will take into account the quality of your linguistic and mathematical organisation, communication and accuracy in writing.

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**7**	
2.	**7**	
3.	**4**	
4.	**13**	
5.	**7**	
6.	**4**	
7.	**6**	
8.	**6**	
9.	**6**	
10.	**20**	
Total	**80**	

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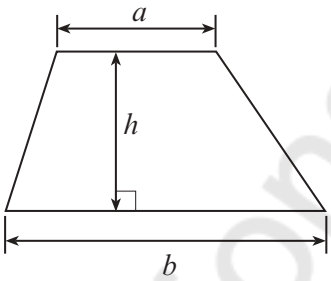
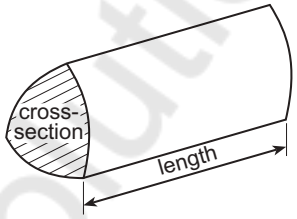
Formula List – Higher Tier

Area of trapezium $= \frac{1}{2}(a + b)h$



Volume of prism = area of cross-section × length

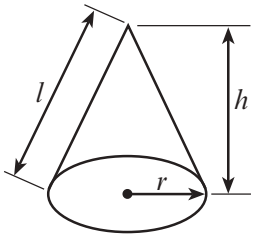


Volume of sphere $= \frac{4}{3}\pi r^3$

Surface area of sphere $= 4\pi r^2$

Volume of cone $= \frac{1}{3}\pi r^2 h$

Curved surface area of cone $= \pi r l$

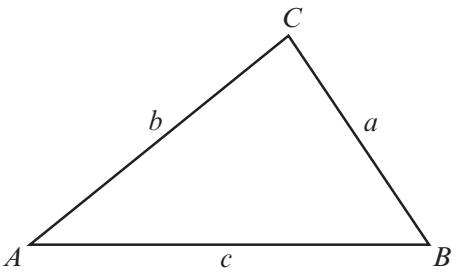


In any triangle ABC

Sine rule $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

Cosine rule $a^2 = b^2 + c^2 - 2bc\cos A$

Area of triangle $= \frac{1}{2}ab\sin C$



The Quadratic Equation

The solutions of $ax^2 + bx + c = 0$ where $a \neq 0$ are given by $x = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a}$

Annual Equivalent Rate (AER)

AER, as a decimal, is calculated using the formula $\left(1 + \frac{i}{n}\right)^n - 1$, where i is the nominal interest rate per annum as a decimal and n is the number of compounding periods per annum.

Examiner only

1. *In this question, you will be assessed on the quality of your organisation, communication and accuracy in writing.*

Southend Pier is the longest pleasure pier in the world.
It is 1·34 miles long.

Gareth walks at a steady pace along Southend Pier.
He walks 84 metres every minute.
He starts walking along the length of the pier at 2 p.m.

At what time does Gareth reach the end of the pier?
Give your time correct to the nearest minute.
You must show all your working. [5 + 2 OCW]

1.34 miles to km; conversion factor is 1.6

$1.34 \times 1.6 = 2.144$ km

Convert to metres $= 2.144 \times 1000$

$= 2144$ metres

84m = 1min

2144m = x min

$x = \frac{2144}{84} = 25.5$ min

≈ 26 min

∴ 2hrs 26min

Examiner only

2. The table gives the heights of the 27 musicians in the Camwen Youth Orchestra.

Height, h cm	Frequency
$150 \leqslant h < 158$	3
$158 \leqslant h < 166$	10
$166 \leqslant h < 174$	9
$174 \leqslant h < 182$	4
$182 \leqslant h < 190$	0
$190 \leqslant h < 198$	1

(a) (i) In which group does the median height of a musician lie?
You must give a reason for your answer. [2]

Group: $166 \leq h < 174$

Reason: 14th height

(ii) Is it certain that there is at least one musician in the orchestra who is less than 154 cm tall?
Give a reason for your answer. [1]

Yes ☐ No ☑

Actual heights are not given
i.e no way of knowing
individual heights.

(b) Calculate an estimate of the mean height of a musician in the Camwen Youth Orchestra. [4]

$\text{Mean} = \frac{\Sigma F(\text{mid points})x}{\Sigma F}$

mid points: 154, 162, 170, 178, 186 & 194

$(154 \times 3) + (162 \times 10) + (170 \times 9) + (178 \times 4) + (186 \times 0) + (194 \times 1) = 462 + 1620 + 1530 + 712 + 0 + 194$

total = 4518

$= \frac{4518}{27} = 167.33 \approx 167$

Examiner only

3. Layla has been set a target by her fitness trainer.
Every day, Layla has to increase the number of steps she does.

Today, Layla did 1800 steps.

Layla's target for the number of steps per day: Increase by 2% every day for the next 28 days

Calculate the number of steps Layla's trainer is expecting her to do on the last of these 28 days. [4]

$1800 \times (1 + 2\%)^n$

$1800 \times (1 + 0.02)^n$

$1800 \times (1.02)^{28}$

$= 3133$ STEPS

Examiner only

4. Paper comes in standard sizes.

Paper size		A0	A1	A2	A3	A4
Dimensions:	Length (cm)	118·9	84·1	59·4	42·0	29·7
	Width (cm)	84·1	59·4	42·0	29·7	21·0

(a) Which paper size has an area of approximately 500 000 mm^2?
Circle your answer. [1]

A0 A1 A2 A3 A4

$84.1 \times 59.4 = 4995.5 \rightarrow 5000 cm^2$

$5000 \times 100 = 500\,000 mm^2$

(b) The mass of paper is measured in grams.
The quality of paper is given by its mass per square metre of paper.

The quality of a sheet of A2 paper used for printing is stated as 120 g/m^2.
Complete the following statement. [4]

'This sheet of A2 paper has a mass of 29.94 g.'

$\frac{59.4 \times 42}{100 \times 100} cm^2 \downarrow \text{to } m^2$

$= 0.249 m^2$

for mass of paper:

mass of $A^2 = 0.249 m^2 \times \frac{120 g}{1 m^2}$

Ans = 29.937 → 29.94 g

Examiner only

(c) Sheets of A4 and A5 paper are mathematically similar.

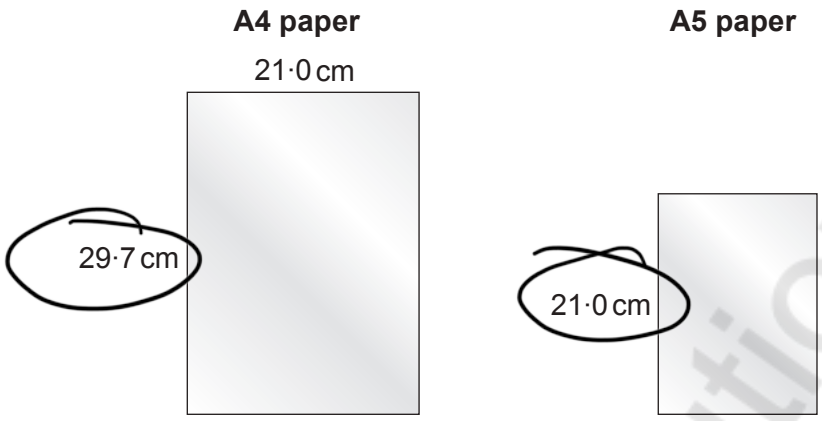


Diagram not drawn to scale

Calculate the length of the **diagonal** of a sheet of A5 paper.
You must show all your working. [5]

$A4^2 = 21^2 + 29.7^2$

$A4 = \sqrt{21^2 + 29.7^2} = \sqrt{441 + 882.09}$

$= \sqrt{1323.09} = 36.37$

Comparison; compare lengths to diagonals.

$36.37 = 29.7$

$x = 21$

$x = \frac{21 \times 36.37}{29.7}$

$= 25.7\text{cm}$

(d) The measurements for the A1 sheet of paper in the table are correct to the nearest mm.
Calculate the greatest possible perimeter of an A1 sheet of paper. [3]

Perimeter $= 2(L + B)$

84.15cm (correct to nearest mm)

59.45cm " " " "

$= 2 \times (84.15 + 59.45) = 287.2\text{cm}$

to mm $= 287.2 \times 10 = 2872\text{mm}$

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Examiner only

5. The cost of sending a package depends on its volume.

Volume (cm^3)	Cost
0 to 1000	£12.55
greater than 1000, up to 2000	£13.60
greater than 2000, up to 4000	£14.85
greater than 4000, up to 10 000	£16.25
Parcels with volume greater than 10 000 cm^3 are not accepted	

A rectangular 'HANDLE WITH CARE' label is stuck on a package.
The label measures 17·5 cm by 11·1 cm.
The package is a cuboid with height 19 cm and width 6·7 cm.
Each vertex of the label touches an edge of the front face of the package.

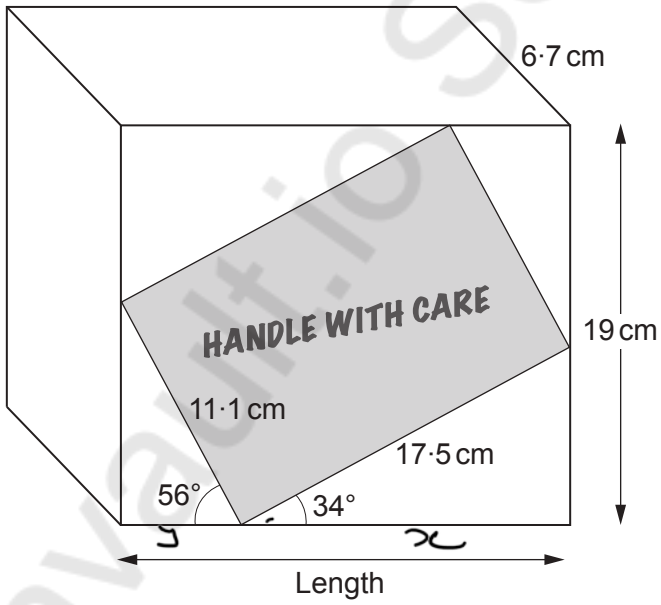


Diagram not drawn to scale

Calculate the volume of the package and hence find the cost of sending this package.
You must show all your working. [7]

Length = x + y

x = 17.5 × cos34 ; y = 11.1 × cos56

14.5 + 6.207 = 20.7

Volume = 19 × 6.7 × 20.7 = 2635 cm^3

∴ Cost = £14.85

Examiner only

The volume of the package is 2635cm3

The cost of sending this package is £14.85

6. Delta Metals makes aluminium chimneys in the shape of open cylinders.

Each chimney has a height of 2·5 m.
The external diameter of each chimney is 0·18 m.

Calculate the external curved surface area of one of these chimneys.
Give your answer correct to 3 significant figures. [4]

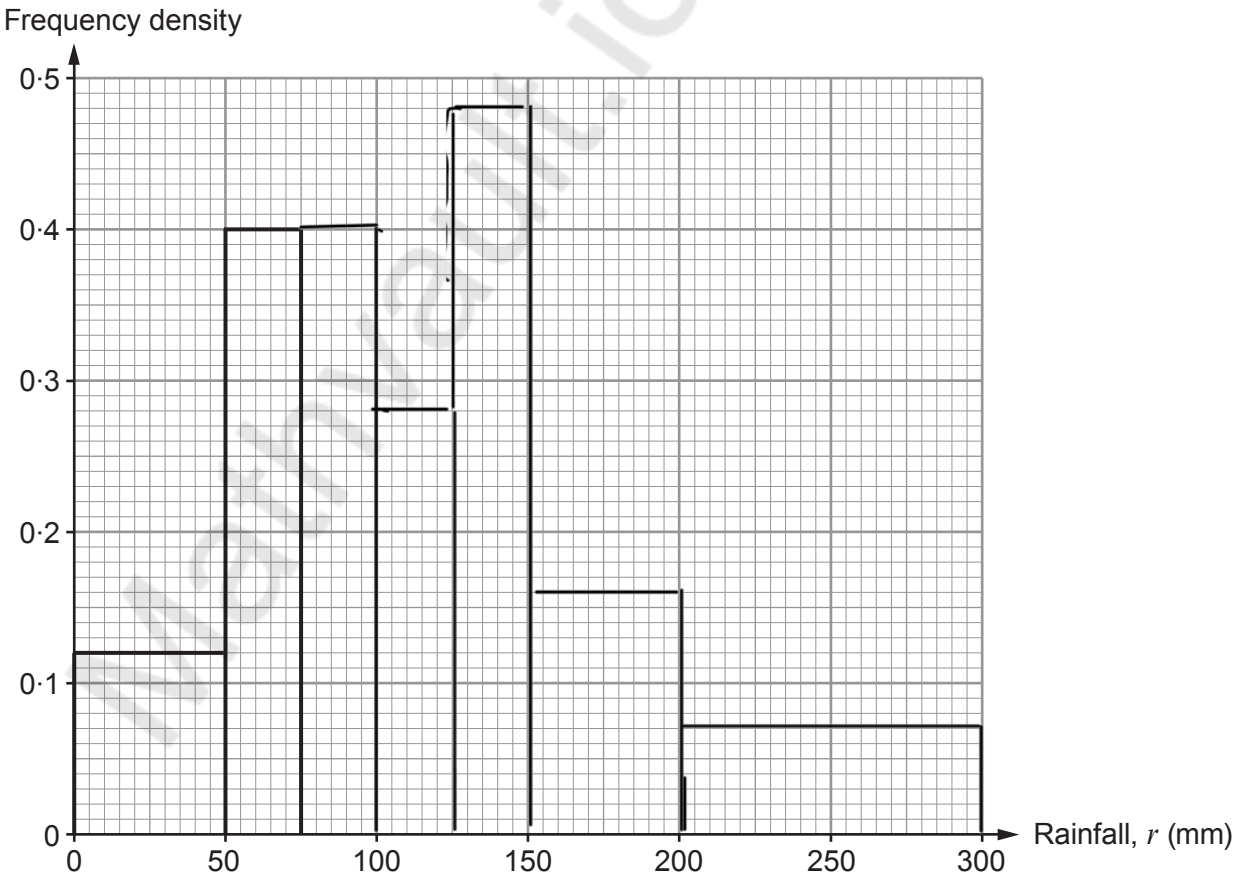
Surface area = πdh
$= \pi \times 0.18 \times 2.5$
$= 1.413$
$= 1.4 m^2$

Examiner only

7. The frequency table below shows the monthly rainfall in Porthislwyn for the 5-year period from January 2010 to December 2014.

Rainfall, r (mm)	Number of months	Frequency density
$0 \leqslant r < 50$	6	0·12
$50 \leqslant r < 75$	10	0·4
$75 \leqslant r < 100$	10	0·4
$100 \leqslant r < 125$	7	0·28
$125 \leqslant r < 150$	12	0·48
$150 \leqslant r < 200$	8	0·16
$200 \leqslant r < 300$	7	0·07

(a) Complete the table above and the histogram below to illustrate this data. [3]



Examiner only

(b) A wet month is classified as one where the monthly rainfall is greater than 60 mm. Calculate an estimate for the percentage of wet months in Porthislwyn in this 5-year period.
You must show all your working. [3]

$\frac{3}{5} \times 10 + 10 + 7 + 12 + 8 + 7$

$= 50$

$\% \quad \frac{50}{60} \times 100$

$= 83.33\%$

Examiner only

8. Central Pivot Irrigation is a method of watering crops.
The sprinkler arm, supported by wheeled towers, rotates around a central pivot.
For each complete rotation, the watered region forms a circle as shown below.

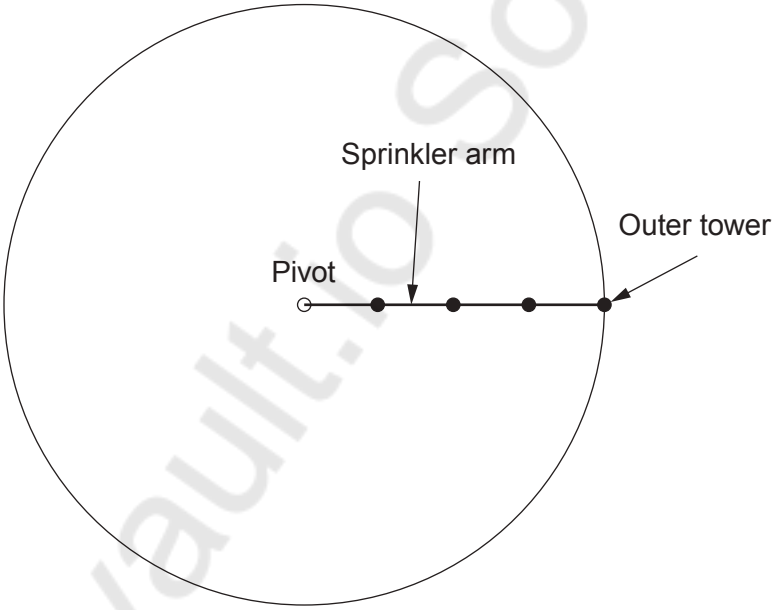


Diagram not drawn to scale

A typical Central Pivot Irrigation system waters a circular region of radius 400 m.
The sprinkler arm rotates through an angle of 30° per hour.

(a) Calculate the area of the region that is watered in one hour. [2]

$\text{Area} = \frac{\theta \pi r^2}{360} = \frac{30}{360} \times \pi \times 400^2$

$= 41887.9 \text{ m}^3$

Examiner only

(b) The outer tower is 400 m from the pivot.
During one watering session, the outer tower moves 1067·6 m.
Calculate the angle the sprinkler arm has turned through. [3]

Circumference $= \frac{\theta}{360} \times 2\pi r$

$1067.6 = \frac{\theta}{360} \times 2 \times \pi \times 400$

$\theta = \frac{1067.6 \times 360}{2 \times \pi \times 400} = 152.9$

(c) The part of the sprinkler arm furthest away from the pivot delivers water at a faster rate than the part of the sprinkler arm closest to the pivot.

Give one reason why the system has been designed in this way. [1]

The part closest to the pivot needs to deliver less water or it would flood the irrigation system.

Examiner only

9. (a) On 1st April 2023, Caitlin invested £10 000 into a savings account.
The account had a nominal annual interest rate of 3%, with interest paid on the last day of every month.
Caitlin did not plan to make any further payments into the account or make any withdrawals.

Calculate the date when Caitlin will first have over £10 500 in her account. [4]

monthly $= 0.25\%$
$= 0.0025$
$\therefore 10000 \times (1+0.0025)^n = 10500$
$10000 \times 1.0025^n = 10500$
$1.0025^n = \frac{10500}{10000}$
$n = \log\left(\frac{10500}{10000}\right) \div \log(1.0025)$
$= \log 1.05 \div \log 1.0025$
$= 19.5 \approx 20$ months

Date when Caitlin will first have over £10 500 in her account is
30th December 2024

(b) Calculate the AER for Caitlin's savings account.
Give your answer as a percentage, correct to 2 decimal places. [2]

$\left(1 + \frac{0.03}{12}\right)^{12} - 1$

3.04%

Examiner only

10. (a) Evan's room, in the roof space of his house, has a uniform triangular cross-section. The uniform cross-section is shown below.

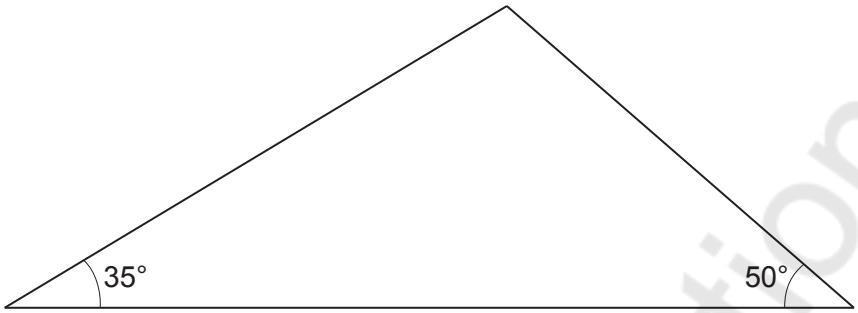


Diagram not drawn to scale

The room is 8 m long.
Calculate the volume of the room. [7]

area = $\frac{1}{2} b \times h$

base = $\frac{6.2 \times \sin 50}{\sin(180-(50+35))} = \frac{6.2 \times \sin 50}{\sin 95}$

$= 4.76$

height = $6.2 \sin 35$

Area = $\frac{1}{2} \times 4.76 \times 6.2 \sin 35$

$= 8.44 = 8$

Volume of room

= Area × approx length

$= 8.44 \times 8$

$= 67.5$

Examiner only

(b) Evan decides to add a symmetrical roof structure to bring light into the room.
The diagrams below show a simple design for this roof structure.
In the diagram below, $AB = 3\,m$, $DC = EF = 2\,m$ and $ED = FC = 2{\cdot}4\,m$.

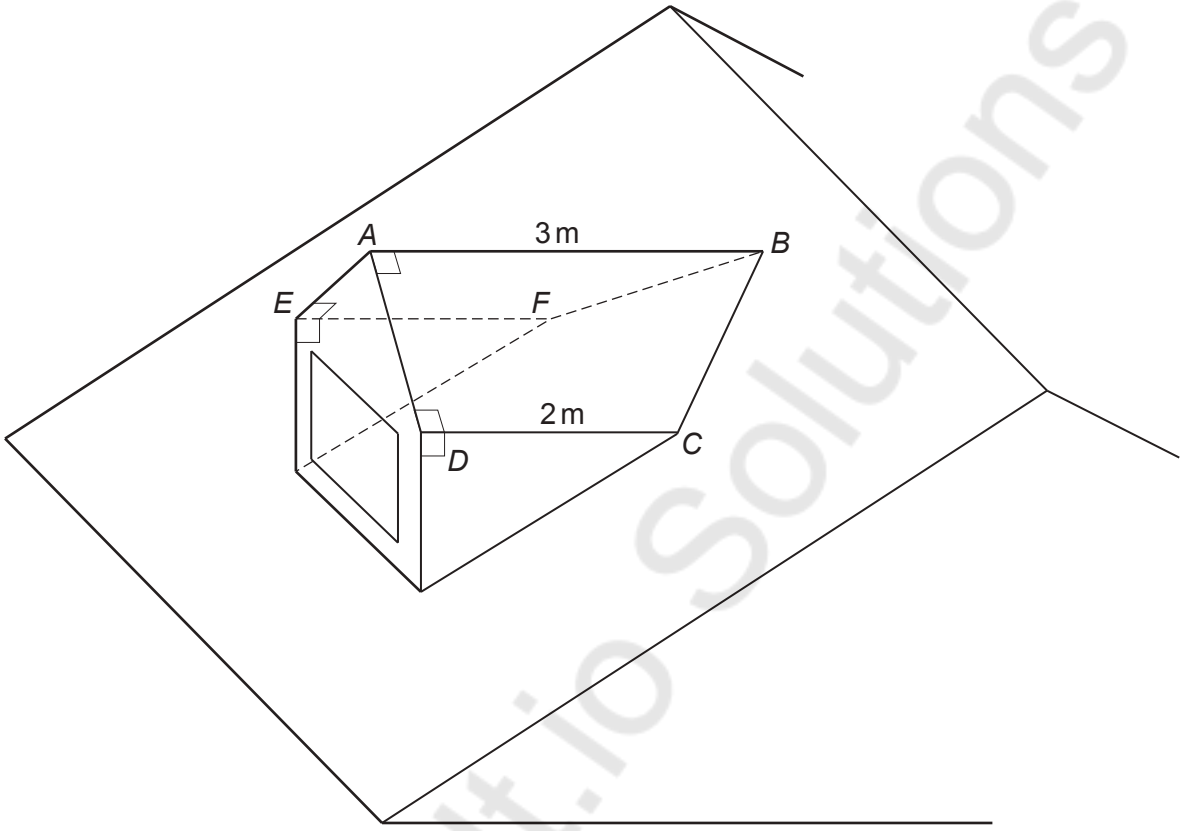


Diagram not drawn to scale

The width of the structure is $2{\cdot}4\,m$ and the vertical height from ED to A is $0{\cdot}7\,m$.

Front View

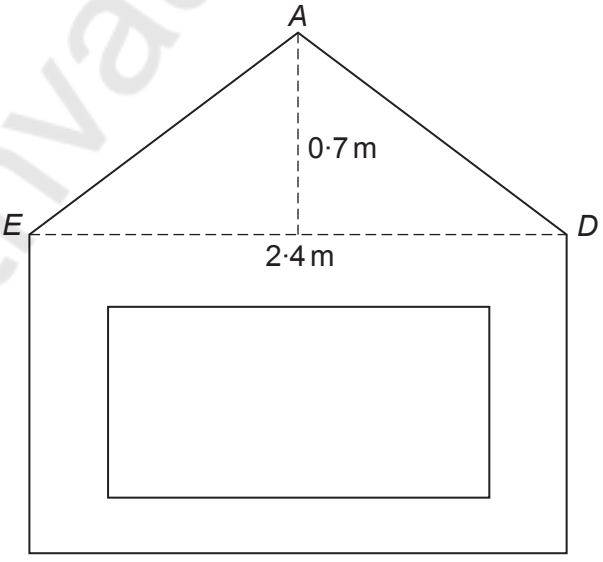


Diagram not drawn to scale

Examiner only

(i) Evan will need to put strips of lead from *B* to *C* and from *B* to *F*.
This is to ensure rainwater does not enter the room.
Calculate the total length of lead that Evan will need. [5]

Total length $= \left(\sqrt{1^2 + 0.7^2 + 1.2^2}\right) \times 2$

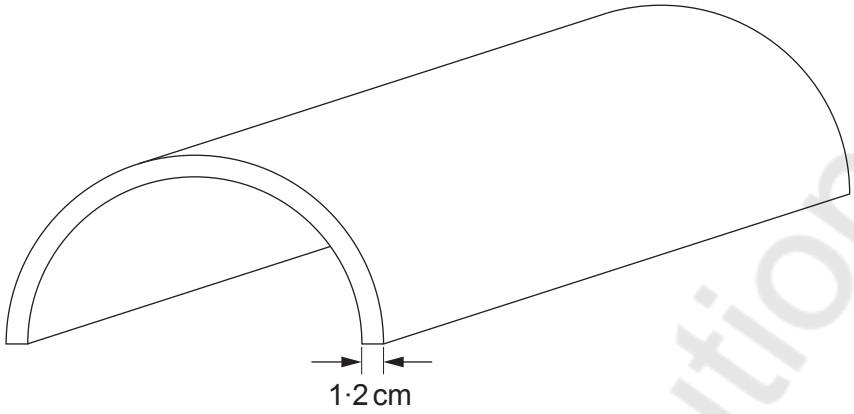
$= \left(\sqrt{1 + 0.49 + 1.44}\right) \times 2$

$= \sqrt{2.93} \times 2$

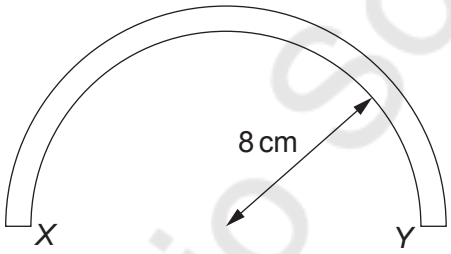
$= 3.42\text{m}$

Examiner only

(ii) The roof of the structure is to be tiled.
For the top edge, Evan has chosen to use half-round clay tiles.



The cross-section of a tile is shown below.



Diagrams not drawn to scale

The length of each tile is 30 cm.
XY is a semi-circular arc of radius 8 cm.
Each tile has a uniform thickness of 1·2 cm.

The tile manufacturer covers all 6 surfaces of each tile with a protective glaze.
Calculate the total surface area of **one** tile that is glazed. [5]

Area of curved surface
$= \pi \times 9 \times 30$ or $\pi \times 8 \times 30 =$
276π cm^3 (866.6) or 240π (cm^3) (753.6)
Area of semi circular ring
$\left(\frac{\pi \times 9.2^2}{2} - \frac{\pi \times 8^2}{2}\right) = 32.4$
Total Surface $= 276\pi + 240\pi + (1.2 \times 30)2$
$+ \left(\frac{\pi \times 9.2^2}{2} - \frac{\pi \times 8^2}{2}\right)2$
$= 866.6 + 753.6 + 36 + 36 + 32.4 + 32.4$
$= 1756.9$ cm^3

Examiner only

(c) Evan has bought roof tiles for the structure from Tuff Tiles.

Tuff Tiles makes 2000 of these roof tiles every hour.
They randomly sample some of these 2000 tiles to check their quality.

Use the following list of random numbers to select the first **7 tiles** for the sample.
You must start with the first number in the list, explaining clearly how you are using the numbers to select the sample. [3]

3205	2002	1924	1521	2735	1205
0114	9533	9507	3969	4941	1521
8377	1098	3473	0769	1003	5421
5533	4788	1003	6432	5630	2483

1) Number tiles from 0001 - 2000
2) Consider successive 4 digit numbers
3) Do not use numbers outside the range
4) Ensure to ignore repeats
∴ using row: 1924, 1521, 1205, 0114, 1098, 0769, 1003

The tiles selected will be
1924 1521 1205 0114 1098 0769 1003

END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

Examiner only