Surname	StemUp Model Solution	Centre Number	Candidate Number
Other Names			0

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GCSE – NEW

3310U60-1

S17-3310U60-1

MATHEMATICS – NUMERACY
UNIT 2: CALCULATOR-ALLOWED
HIGHER TIER

THURSDAY, 8 JUNE 2017 – MORNING

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 continuation page at the back of the booklet, taking care to number the question(s) correctly.

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 **6**, 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.	3	
2.	2	
3.	4	
4.	4	
5.	8	
6.	6	
7.	8	
8.	6	
9.	3	
10.	5	
11.	8	
12.	7	
13.	7	
14.	9	
Total	80	

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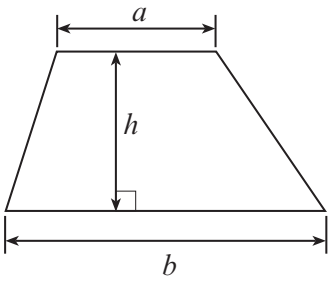
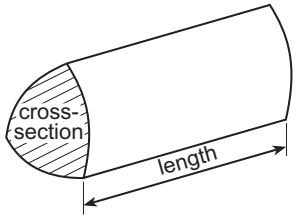
Formula List - Higher Tier

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

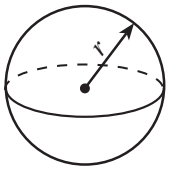


Volume of prism = area of cross-section × length



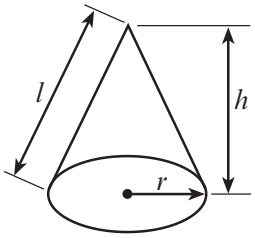
Volume of sphere $= \frac{4}{3}\pi r^3$

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



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

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

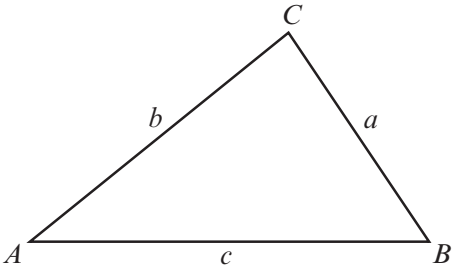


In any triangle ABC

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.

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1. Mali's scooter depreciated (decreased) in value by 24% in the **first** year.
In all further years, her scooter depreciated by 13% of its previous year's value.
She originally paid £850 for her scooter.
Calculate the value of Mali's scooter after 7 years. [3]

Value after 1st year = 850 × 0.76 = £646

Value after 7 years = 646×0.87^6

= 646 × 0.433626...

= 280.1225...

= £280.12

After 7 years, the value of Mali's scooter was £ 280.12

2. Sanjay stacks three boxes in a pile.
The heights of the boxes are 25 cm, 36 cm and 47 cm.
They are all measured correct to the nearest centimetre.
What is the greatest possible height of the stack of the three boxes? [2]

Upper bounds: 25.5 cm, 36.5 cm, 47.5 cm

Greatest height = 25.5 + 36.5 + 47.5

= 109.5 cm

Greatest possible height of the stack of three boxes is 109.5 cm

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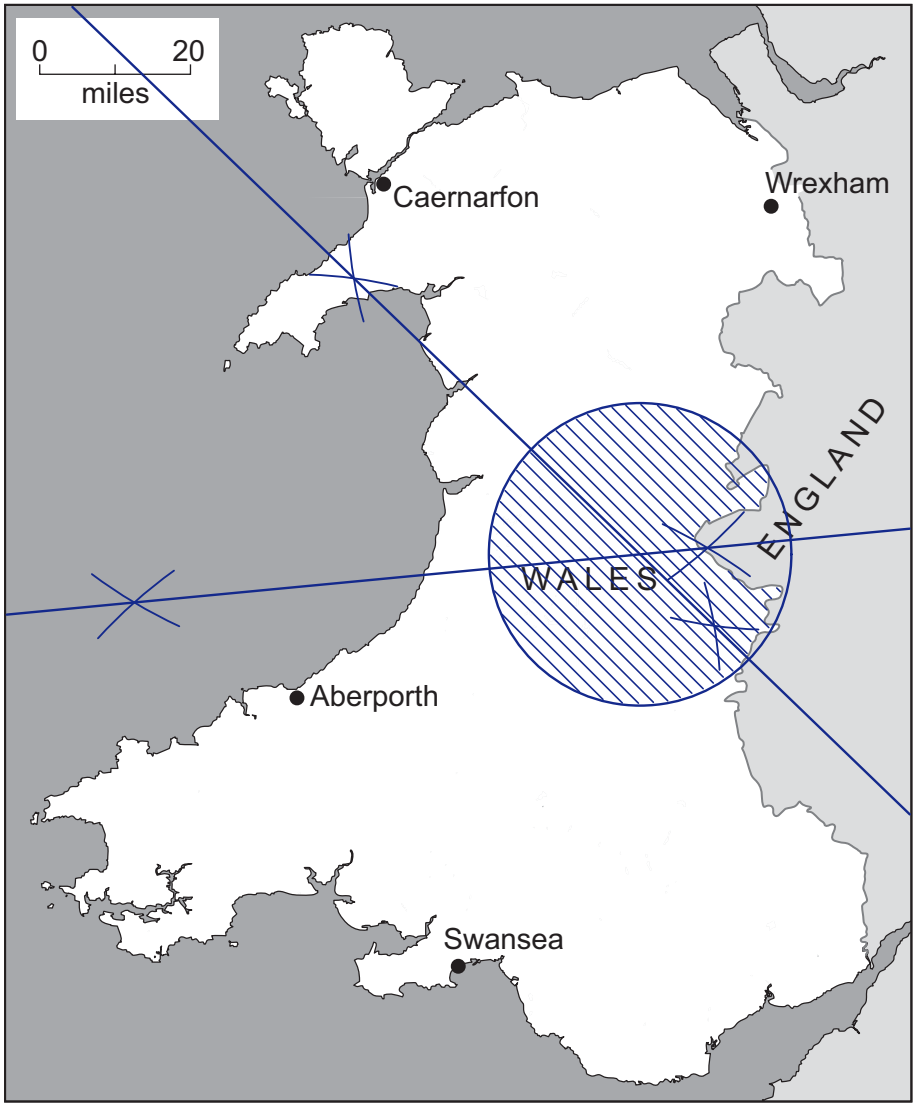
3. *Organics4U* is planning to have its headquarters in Wales.
The manager has instructed Ffion to look for a site for the headquarters.

Here are the instructions that Ffion has been given by her manager.

'Find the point that is
- an equal distance between Wrexham and Aberporth, and
- an equal distance between Caernarfon and Swansea.

The new headquarters needs to be within 20 miles of this point.'

On the map below, shade the region, **in Wales**, that Ffion should identify for her manager. [4]



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4.

Ursula is lying on her surfboard 180 metres away from the foot of a vertical cliff.
The height of the cliff is 146 metres.

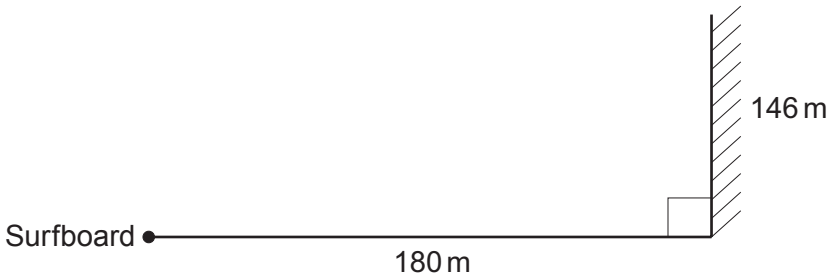

Diagram not drawn to scale

Ursula was told that if the angle of elevation of the top of the cliff from her lying position is between 42° and 45°, it is safe for her to attempt to stand on her surfboard.

Calculate the angle of elevation of the top of the cliff from Ursula's position lying on her surfboard.

State whether it is
- safe for Ursula to attempt to stand, or
- not safe as she is too near the cliff, or
- not safe as she is too far out at sea. [4]

tan(angle of elevation) = opposite ÷ adjacent = 146 ÷ 180

tan θ = 0.81111...

θ = $\tan^{-1}$(146 ÷ 180)

θ = 39.0458...° = 39.0°

39.0° is less than 42°, so it is not safe for Ursula to attempt to stand: she is too far out at sea.

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5. Marta buys a new television.

(a) Marta wants to fit the television in a bookcase on the wall.
In the shop she forgot to write down the length of the television.
She did write down the height and the diagonal of the screen.

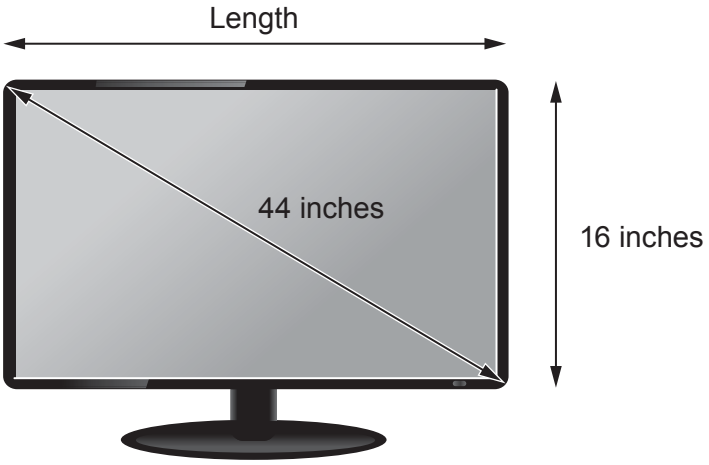

Diagram not drawn to scale

Marta needs to know the length of the screen before she opens the box, in case she wants to return the television.
Calculate the length of the screen.
Give your answer correct to 2 significant figures. [4]

By Pythagoras: $Length^2 + 16^2 = 44^2$

$Length^2 = 44^2 - 16^2 = 1936 - 256$

$Length^2 = 1680$

$Length = \sqrt{1680} = 40.98780...$

Length = 41 inches (2 s.f.)

Length is 41 inches, correct to 2 significant figures.

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(b) The television was reduced in the sale by 26% of its original price.
It cost Marta £710.40 in the sale.
What was the original price of the television? [2]

Sale price = 100% − 26% = 74% of the original price

1% = 710.40 ÷ 74 = 9.60

Original price = 100 × 9.60 = £960

Original price £ 960

(c) A television uses 1 unit of electricity every 10 hours.
A unit of electricity costs 9.8 p.

(i) Calculate the cost of having a television turned on for 24 hours.
Circle your answer. [1]

£23.52 £2.35 40.83 p 23.52 p 2.45 p

24 ÷ 10 = 2.4 units, 2.4 × 9.8 = 23.52 p

(ii) On average, Marta watches 4 hours of television each day.
On average, how much **a week** does it cost her to watch television?
Circle your answer. [1]

27.44 p £27.44 £39.20 39.2 p 10.78 p

4 × 7 = 28 hours = 2.8 units, 2.8 × 9.8 = 27.44 p

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

Elin's old fish tank is leaking.

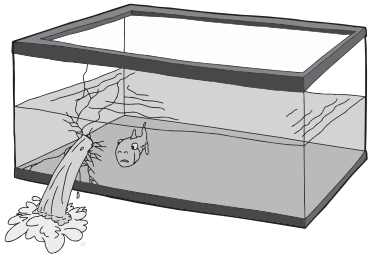

Diagram not drawn to scale

This old fish tank is in the shape of a cuboid.
The base of this tank measures 60 cm by 40 cm.
Before the leak, the height of the water level in Elin's old fish tank was 45 cm.

Elin decides to replace her fish tank with a cylindrical one.

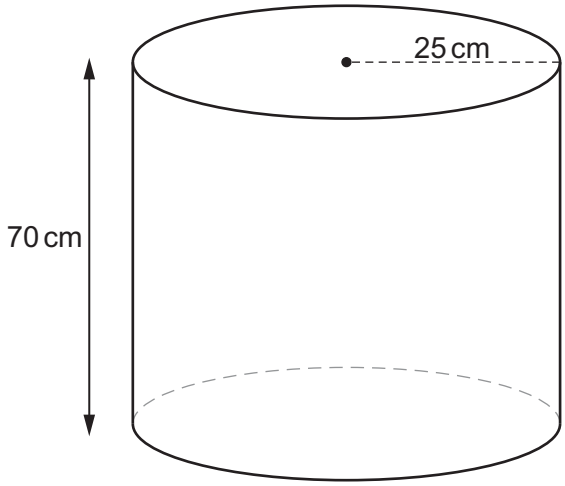

Diagram not drawn to scale

She selects a new cylindrical fish tank that has a radius of 25 cm and a height of 70 cm.

Will all the original contents, including the water and the fish, fit into this cylindrical tank?
You must show all your working. [4 + 2 OCW]

Volume of water in the old tank (cuboid) = length × width × height

= 60 × 40 × 45 = 108 000 cm^3

The contents of the old tank (water and fish) take up 108 000 cm^3.

Volume of the new cylindrical tank = $\pi r^2 h$

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$= \pi \times 25^2 \times 70$

$= \pi \times 625 \times 70$

$= 137\ 444.678...\ cm^3$

$= 137\ 445\ cm^3$ (to the nearest cm^3)

Compare: $137\ 445\ cm^3 > 108\ 000\ cm^3$

Check of water level in the new tank:

$108\ 000 \div (\pi \times 25^2) = 55.0$ cm, which is less than 70 cm.

Conclusion: the volume of the new cylindrical tank is greater than the volume of the contents of the old tank, so all of the water and the fish will fit into the cylindrical tank (with about $29\ 400\ cm^3$ of space to spare).

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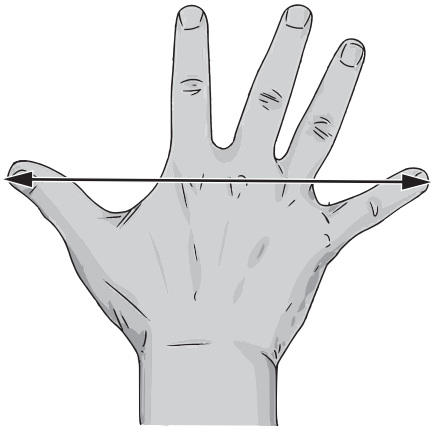
7. Simon plans to make gloves.

(a) One morning, Simon decided to carry out a survey to find the mean hand span of people in Wales.



He decided to sample systematically.
He decided to sample from the first 240 people who pass him in the street during the morning.

He wanted to take 20 people's hand span measurements.
Explain how Simon could use systematic sampling to obtain 20 measurements. [1]

240 ÷ 20 = 12, so Simon should choose one person at random from the first 12 people who pass him, then ask every 12th person after that (e.g. the 5th, 17th, 29th, ... person).

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(b) Yesterday morning, Simon only managed to sample 10 people.
He calculated the mean hand span of these 10 people to be 22·8 cm.

Yesterday afternoon, Simon recorded the hand spans of a **further** 20 people.

The results for these 20 people are shown in the frequency table below.

Hand span, to the nearest mm	Frequency
20·0 cm to 20·8 cm	2
20·9 cm to 21·7 cm	3
21·8 cm to 22·6 cm	10
22·7 cm to 23·5 cm	5

Calculate an estimate of the mean of all **30 hand spans** that Simon measured yesterday. [6]

Mid-points: 20.4, 21.3, 22.2, 23.1

Sum for afternoon = 20.4×2 + 21.3×3 + 22.2×10 + 23.1×5

= 40.8 + 63.9 + 222 + 115.5

= 442.2 cm

Sum for morning = 10 × 22.8 = 228 cm

Sum of all 30 hand spans = 228 + 442.2 = 670.2 cm

Estimate of mean = 670.2 ÷ 30

= 22.34 cm

(c) What could Simon do to improve his estimate of the mean hand span of people in Wales? [1]

Take a bigger sample, using people from different regions of Wales instead of just one street.

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8. The diagram below shows where Levi wants to attach a string of lights to his house.

Levi wants to attach a single string of lights from *B* to *A* and then from *A* to *C*.
The diagram below shows the measurements Levi has taken.

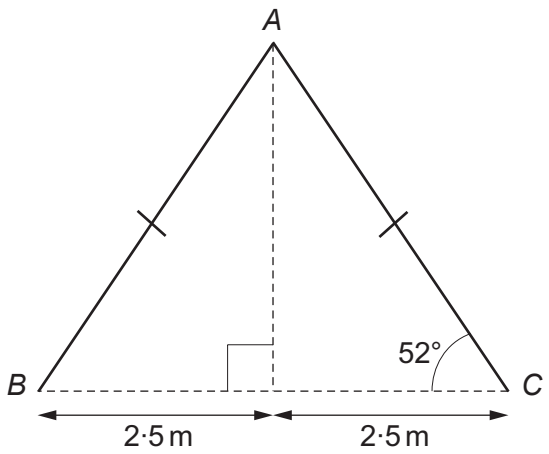

Diagram not drawn to scale

He spends £410 at the electrical store buying a string of lights.
After putting up the lights, Levi finds he has 6 metres of the string of lights left over at one end.

How much did the electrical store charge Levi, per metre, for the string of lights? [6]

Triangle ABC is isosceles, so the perpendicular from A bisects BC.

In the right-angled triangle on the right:

cos 52° = 2.5 ÷ AC

AC = 2.5 ÷ cos 52° = 2.5 ÷ 0.615661...

AC = 4.06067... m (and AB = AC)

Length used = 2 × 4.06067... = 8.12134... m

Length bought = 8.12134... + 6 = 14.12134... m

Cost per metre = 410 ÷ 14.12134...

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= 29.0340... = £29.03 per metre

The electrical store charged Levi £29.03 per metre.

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9. The table shows the number of Year 11 pupils attending schools in Cwmifan.

School	Cwrt Haf	Cwmifan High	Henclwyd
Number of Year 11 pupils	307	239	144

In total there are 690 Year 11 pupils attending these three schools.

A new youth theatre has been set up in Cwmifan.
On the opening night, a total of 80 Year 11 pupils from these three schools are going to be invited to attend.

Use a stratified sampling method to calculate the number of Year 11 pupils from each school who should be invited.
You must show all your working. [3]

Number invited = (number in school ÷ 690) × 80

Cwrt Haf: 307 ÷ 690 × 80 = 35.594...

Cwmifan High: 239 ÷ 690 × 80 = 27.710...

Henclwyd: 144 ÷ 690 × 80 = 16.695...

Rounding gives 36 + 28 + 17 = 81, which is more than 80.

35.594... has the smallest decimal part, so round it down to 35.

Check: 35 + 28 + 17 = 80

School	Cwrt Haf	Cwmifan High	Henclwyd
Number that should be invited	35	28	17

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10. Fatima wants to invest some money in a savings account.
She has picked up leaflets from two building societies advertising their high-interest savings accounts.

'Bannau' account	'Eryri' account
Nominal annual rate of 3·85%	Nominal annual rate of 3·86%
Interest paid monthly	Interest paid every 6 months

By comparing AERs, which account will offer Fatima the better interest rate on her investment? You must show all your working. [5]

$AER = (1 + i/n)^n - 1$

Bannau: $i = 0.0385$, $n = 12$ (monthly)

$AER = (1 + 0.0385 \div 12)^{12} - 1$

$= 1.0032083...^{12} - 1$

$= 0.0391866... = 3.92\%$

Eryri: $i = 0.0386$, $n = 2$ (every 6 months)

$AER = (1 + 0.0386 \div 2)^2 - 1$

$= 1.0193^2 - 1$

$= 0.0389724... = 3.90\%$

$3.92\% > 3.90\%$, so the Bannau account offers Fatima the better interest rate.

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11. A company produces metal badges to be worn by its employees.
The badge is made up of two parts.
One part is in the shape of a sector of a circle as shown in the diagram.

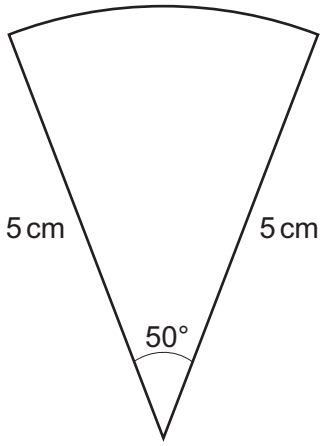

Diagram not drawn to scale

(a) The perimeter of the sector is decorated with a coloured edging strip.
Calculate the length of edging strip needed to decorate the sector. [3]

Arc length = 50/360 × 2 × π × 5

= 4.3633... cm

Perimeter = 4.3633... + 5 + 5

= 14.3633... = 14.36 cm

Length of edging strip needed = 14.36 cm

(b) The other part is in the shape of a quarter-circle of radius 3 cm.

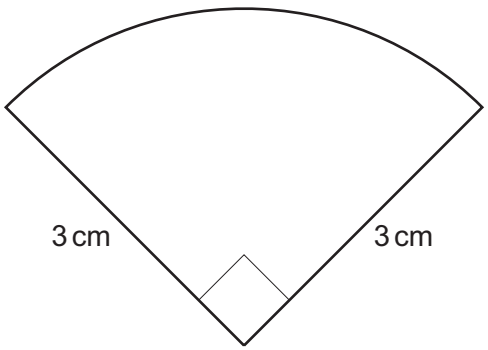

Diagram not drawn to scale

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To make the badge, the two pieces are joined together with the sector in front of the quarter-circle, as shown in the diagram.
The badge has a vertical line of symmetry.

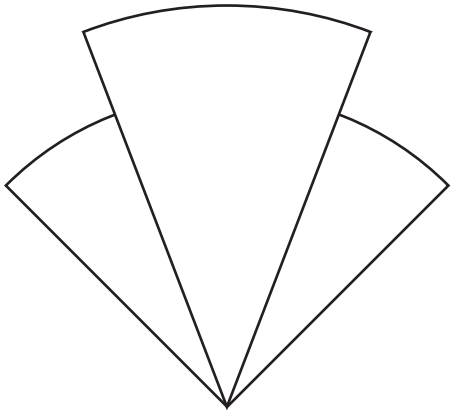

Diagram not drawn to scale

The visible surface of the front of the badge is painted.
Calculate the area that is painted. [5]

Area of quarter-circle = $1/4 \times \pi \times 3^2 = 7.0685...$ cm^2

Area of sector = $50/360 \times \pi \times 5^2 = 10.9083...$ cm^2

The sector covers a 50° sector of the quarter-circle:

Hidden area = $50/360 \times \pi \times 3^2 = 3.9269...$ cm^2

Painted area = $7.0685... + 10.9083... - 3.9269...$

$= 14.0499...$ cm^2

$= 14.05$ cm^2

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12. A plan view of Lowri's garden is shown below.

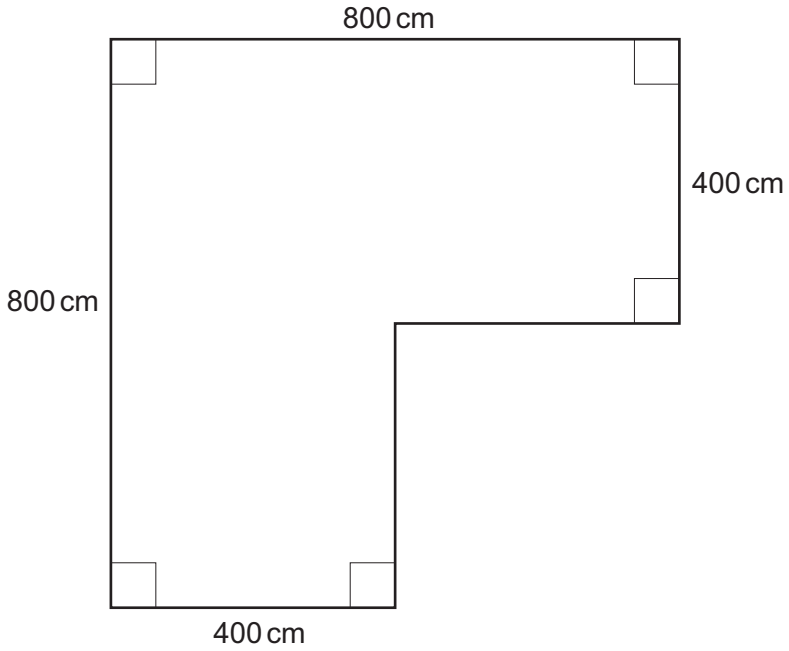

Diagram not drawn to scale

All the measurements are correct to the nearest 10 cm.

(a) Calculate the greatest possible area of Lowri's garden. [4]

Upper bounds: 800 cm → 805 cm, 400 cm → 405 cm

Split the garden into two rectangles:

Top rectangle = 805 × 405 = 326 025 cm^2

Bottom rectangle = 405 × 400 = 162 000 cm^2

Greatest possible area = 326 025 + 162 000

= 488 025 cm^2

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(b) Lowri plans to spread grass seed over her garden using a spreading tool.
Over **each square metre**, the spreading tool spreads 30 g of grass seed, correct to the nearest 5 g.

Lowri has exactly 1·5 kg of grass seed.
Can she be **certain** that she has enough grass seed?
You must show all your calculations. [3]

Greatest area = 488 025 cm^2 = 488 025 ÷ 10 000 = 48.8025 m^2

30 g to the nearest 5 g: upper bound = 32.5 g per m^2

Greatest amount of seed needed = 32.5 × 48.8025

= 1586.08125 g = 1.586... kg

1.586 kg > 1.5 kg

No, she cannot be certain that she has enough grass seed,

as up to 1.59 kg could be needed and she only has 1.5 kg.

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13. The front views of two mathematically similar milk cartons are shown below.

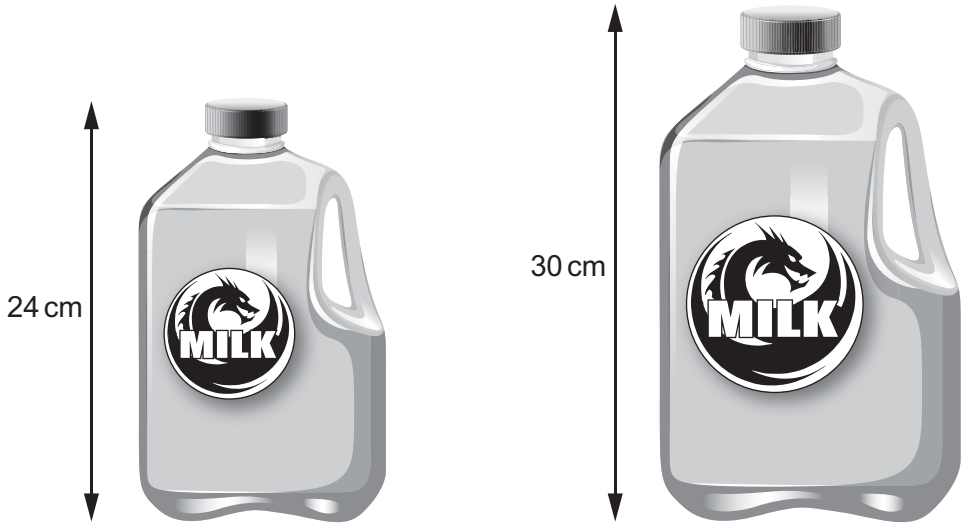

Diagram not drawn to scale

(a) Circle either TRUE or FALSE for each statement given below. [1]

STATEMENT		
The ratio of the lengths of the cartons is the same as the ratio of the heights of the cartons.	TRUE	FALSE
The ratio of the volumes of the cartons is the same as the ratio of the heights of the cartons.	TRUE	FALSE

(b) It is claimed that the larger carton contains double the amount of milk contained in the smaller carton.
Show that this claim is not true.
Explain your answer. [3]

Ratio of heights = 24 : 30 = 4 : 5

Ratio of volumes = $4^3 : 5^3$ = 64 : 125 (13 824 : 27 000)

Volume scale factor = 125 ÷ 64 = 1.953125

Double would need 2 × 64 = 128, but 125 is not double 64.

The larger carton holds 1.95 times as much milk, not double,

so the claim is not true.

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(c) Another similar milk carton has a label with an area that is one quarter of the area of the label on the carton of height 24 cm.

Diagram not drawn to scale

Calculate the height of this new carton. [3]

Area scale factor = 1/4

Length scale factor = √(1/4) = 1/2

Height of new carton = 24 × 1/2

= 12 cm

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14. The diagram shows a 5 m wide section of road that has a uniform gradient.
The shaded area represents level ground.
Two cyclists, Delyth and Ioan, approach this section of road.

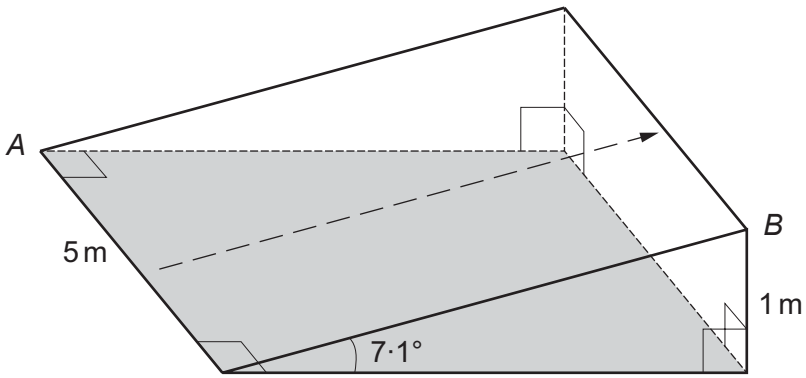

Diagram not drawn to scale

Delyth cycles straight up the middle of the road as shown by the arrow.
Ioan thinks this section of road is too steep to cycle straight up, so he decides to cycle from *A* to *B* in a straight line.

(a) How far does Ioan cycle in going from *A* to *B*? [6]

Length of the slope (up the middle of the road) = L:

sin 7.1° = 1 ÷ L

L = 1 ÷ sin 7.1° = 8.0905... m

The road surface is a rectangle 5 m by 8.0905... m,

and AB is its diagonal. By Pythagoras:

$AB^2 = 5^2 + 8.0905...^2$

$AB^2 = 25 + 65.456... = 90.456...$

$AB = \sqrt{90.456...} = 9.5108...$ m

Ioan cycles 9.5 m (1 d.p.)

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(b) Show that Ioan's route up this section of road is less steep than Delyth's route.
You must show all your working. [3]

Ioan rises 1 m while travelling 9.5108... m along AB:

sin(angle) = 1 ÷ 9.5108...

angle = $\sin^{-1}$(1 ÷ 9.5108...) = 6.0354...° = 6.0°

Delyth's route is at 7.1° to the horizontal.

6.0° < 7.1°, so Ioan's route is less steep than Delyth's route.

END OF PAPER

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

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