Surname StemUp Model Solution	Centre Number	Candidate Number
First name(s)		0

GCSE

3310U60-1

Z22-3310U60-1

TUESDAY, 7 JUNE 2022 – MORNING

MATHEMATICS – NUMERACY
UNIT 2: CALCULATOR-ALLOWED
HIGHER TIER

1 hour 35 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 **3**, 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.	**10**	
2.	**12**	
3.	**7**	
4.	**4**	
5.	**4**	
6.	**6**	
7.	**7**	
8.	**4**	
9.	**5**	
10.	**11**	
Total	**70**	

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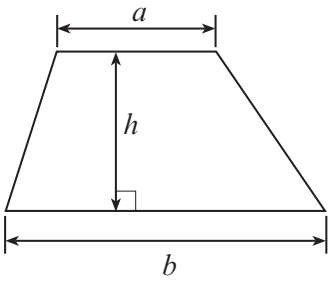
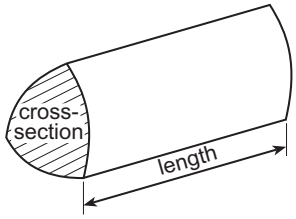
Formula List – Higher Tier

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

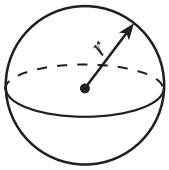


Volume of prism = area of cross-section × length



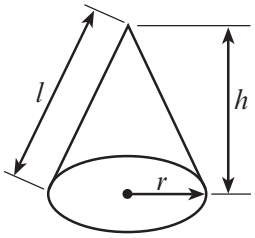
Volume of sphere $= \frac{4}{3}\pi r^3$

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



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

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

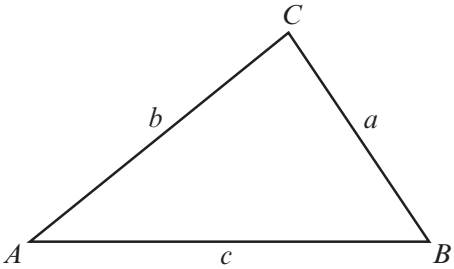


In any triangle ABC

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. (a) Last year, Janita recorded the number of miles she travelled each week in her car. She summarised the information in a frequency table, as shown below.

Number of miles, x	Frequency
$20 \leqslant x < 60$	4
$60 \leqslant x < 80$	8
$80 \leqslant x < 100$	11
$100 \leqslant x < 150$	12
$150 \leqslant x < 200$	17

(i) In which group does the median weekly number of miles lie? Circle your answer. [1]

$20 \leqslant x < 60$ $80 \leqslant x < 100$ $150 \leqslant x < 200$

$60 \leqslant x < 80$ $100 \leqslant x < 150$

(ii) Calculate an estimate of the mean number of miles Janita travelled each week in her car. [4]

Midpoints: 40, 70, 90, 125, 175

Total = 40×4 + 70×8 + 90×11 + 125×12 + 175×17

= 160 + 560 + 990 + 1500 + 2975 = 6185

Total frequency = 4 + 8 + 11 + 12 + 17 = 52 weeks

Mean = 6185 ÷ 52

= 118.9423...

Estimate of mean = 118.9 miles per week

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(b) Last month:
- Janita travelled 440 miles in her car
- the cost of fuel was £1.30 per litre.

Janita's car averages 11 miles per litre of fuel.

Next month, she needs to budget for an increased travel cost.

Janita says,

> The number of miles I travel will increase by 12%.
> The cost of fuel will increase by 10% next month.

Calculate how much Janita should budget for her car travel costs for next month.
You must show all your working. [5]

Number of miles next month = 440 × 1.12 = 492.8 miles

Cost of fuel next month = £1.30 × 1.10 = £1.43 per litre

Fuel needed next month = 492.8 ÷ 11 = 44.8 litres

Cost of fuel next month = 44.8 × £1.43

= £64.064

Janita should budget £64.06 for her car travel next month.

3310U601 05

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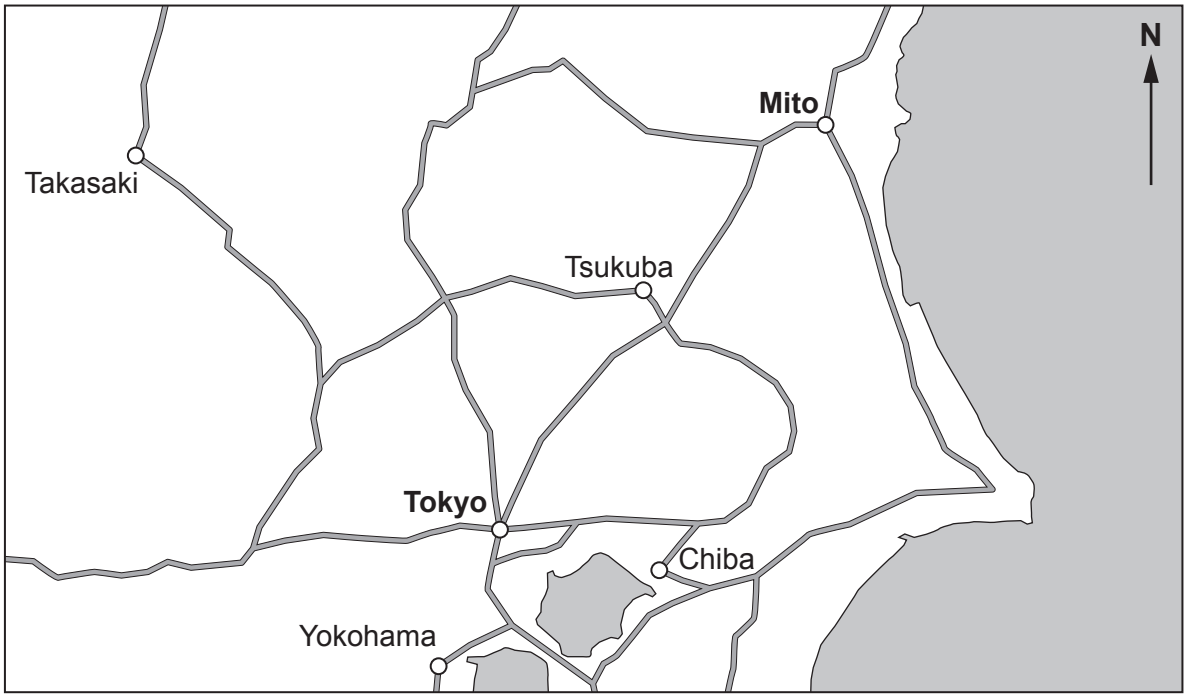
2. Mito is a city in Japan.



(a) The road distance from Mito to Tokyo is 114 km.
Anzu travelled by car from Mito to Tokyo in 1 hour 27 minutes.

Calculate the average speed of Anzu's journey.
Give your answer in km/h. [3]

Time = 1 hour 27 minutes = 1 + 27 ÷ 60 = 1.45 hours

Average speed = distance ÷ time = 114 ÷ 1.45

= 78.6206... km/h

Average speed = 78.6 km/h

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(b) Tilly is travelling to Mito.
She wants to exchange no more than £800 into Japanese yen.

The exchange rate is £1 = 135.72 Japanese yen.

On the day Tilly exchanges her money, the exchange shop only has 1000 Japanese yen notes and 5000 Japanese yen notes available.

Calculate:
- the maximum number of Japanese yen Tilly can buy
- how much, to the nearest penny, this will cost her.

You must show all your working. [5]

Yen for £800 = 800 × 135.72 = 108 576 yen

Notes are only 1000 and 5000 yen, so round down to a whole number of thousands:

Maximum Tilly can buy = 108 000 yen (21 × 5000 + 3 × 1000)

Cost = 108 000 ÷ 135.72 = £795.7559...

Tilly can buy 108 000 yen and it will cost her £795.76

(c) Mito has a population of 270 400.

25% of Mito's population is aged 65 or over.
The ratio of the number of people aged 0 to 14 to the number of people aged 15 to 64 is 9 : 41.

Calculate the number of people aged 0 to 14. [4]

People aged 0 to 64 = 75% of 270 400 = 0.75 × 270 400 = 202 800

9 + 41 = 50 parts, one part = 202 800 ÷ 50 = 4056

People aged 0 to 14 = 9 × 4056 = 36 504

Number of people aged 0 to 14 is 36 504

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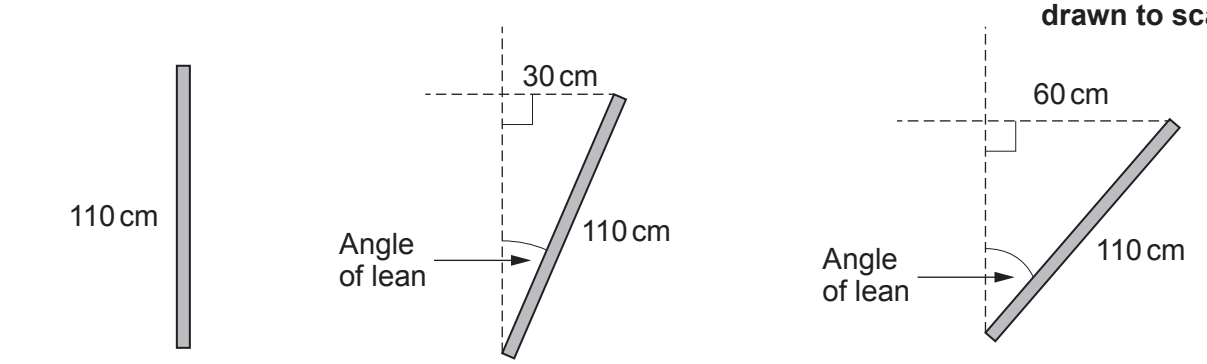
3. *In this question, you will be assessed on the quality of your organisation, communication and accuracy in writing.*

A motorcyclist leans into a corner on a motorcycle.
The angle of lean is the angle between the vertical and the motorcycle.

When the motorcycle is upright, the centre of the handlebars is 110 cm above the ground.
The diagrams below illustrate a front view of a motorbike as its rider goes into a corner.

The motorcycle is vertical to begin with. It then leans 30 cm horizontally into the corner.
The motorcycle then leans a further 30 cm into the corner, with a total horizontal lean distance of 60 cm.

Diagrams not drawn to scale



Before the corner | Lean of 30 cm into the corner | Lean of 60 cm into the corner

Show that the angle of lean more than doubles as the motorcycle leans from 30 cm horizontally to 60 cm horizontally.
Your must show all your working. [5 + 2 OCW]

Lean of 30 cm: angle of lean = x. Right-angled triangle, hyp = 110

sin x = opp ÷ hyp = 30 ÷ 110 = 0.2727...

$x = \sin^{-1}(30 \div 110) = 15.8266...° \approx 15.8°$

Lean of 60 cm: angle of lean = y

sin y = 60 ÷ 110 = 0.5454...

$y = \sin^{-1}(60 \div 110) = 33.0557...° \approx 33.1°$

Double the first angle = 2 × 15.8266...° = 31.653...°

Compare: 33.0557...° > 31.653...°

Conclusion: the angle of lean at 60 cm (33.1°) is bigger than double the angle of lean at 30 cm (31.7°), so the angle of lean more than doubles when the lean goes from 30 cm to 60 cm.

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4. A cylindrical water tank has a radius of 36 cm.
There are 80 litres of water in the tank.

Calculate the height of the water in the tank in centimetres. [4]

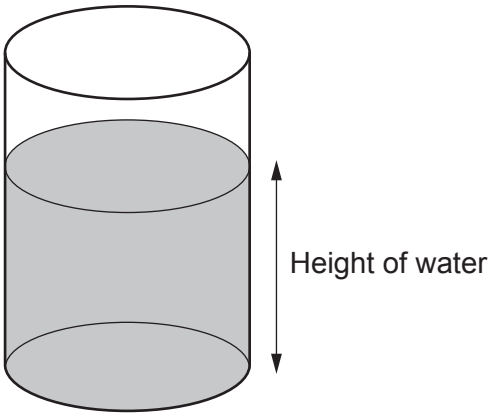

Diagram not drawn to scale

Volume = 80 litres = 80 × 1000 = 80 000 cm^3

Volume of cylinder = $\pi r^2 h$

$80\ 000 = \pi \times 36^2 \times h$

$80\ 000 = 4071.504... \times h$

$h = 80\ 000 \div (\pi \times 36^2)$

$h = 19.6487...$ cm

The height of the water in the tank is 19.6 cm

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5. Last year, Khalida paid 2400 dollars income tax.
The tax bands were as follows.

Band	Taxable income	Tax rate
Personal allowance	Up to 5000 dollars	0%
Basic rate	5000 dollars to 25 000 dollars	20%

Calculate Khalida's income before the deduction of tax. [4]

Tax is 20% of the income above 5000 dollars.

20% of taxed amount = 2400

Income taxed at basic rate = 2400 ÷ 0.2 = 12 000 dollars

Check: 0.2 × 12 000 = 2400 ✓

Income = 12 000 + 5000 (personal allowance)

= 17 000 dollars

Khalida's income was 17 000 dollars

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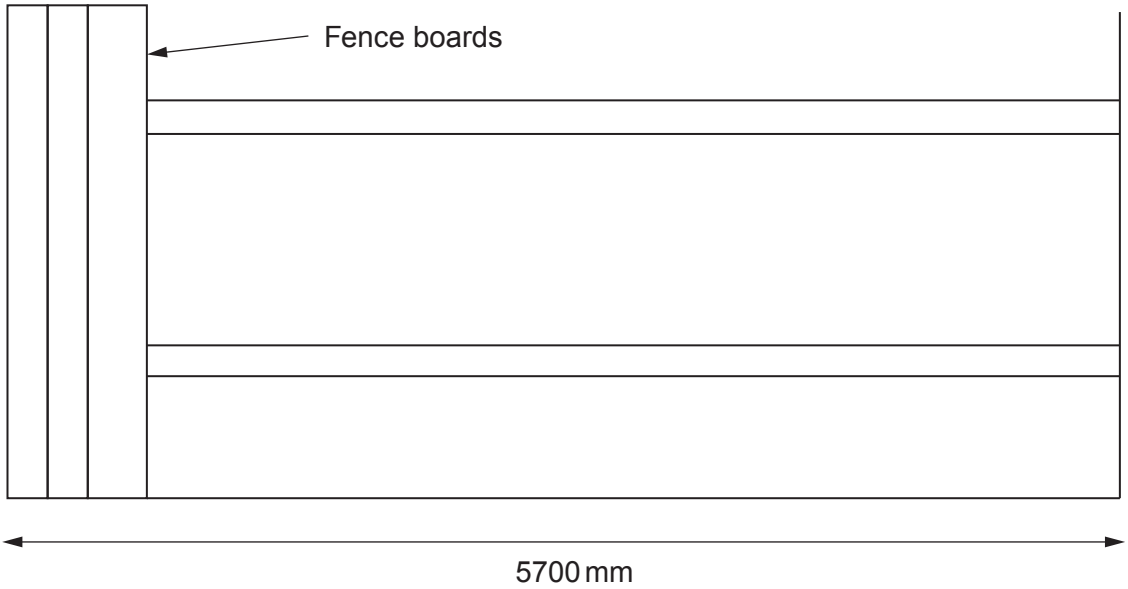
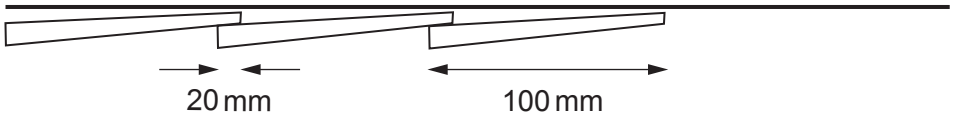
6. Dewi and Cai are building a fence.

They are using fence boards that overlap each other.
The diagrams below show the first 3 boards in position, and how the boards overlap.



Plan view of how the boards overlap



Diagrams not drawn to scale

The fence needs to cover a length of 5700 mm, correct to the nearest 100 mm.
When in position, each board has a width of 100 mm, correct to the nearest 5 mm.
Each overlap is **exactly** 20 mm, as shown in the diagram above.

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Calculate the minimum number of boards that Dewi and Cai need to buy to guarantee that they have enough to build the fence.
You must show all your working. [6]

To guarantee enough boards, use the worst case:

Upper bound of fence length = 5700 + 50 = 5750 mm

Lower bound of board width = 100 − 2.5 = 97.5 mm

First board covers 97.5 mm.

Each extra board adds 97.5 − 20 = 77.5 mm (because of the overlap)

Length left after first board = 5750 − 97.5 = 5652.5 mm

Extra boards needed = 5652.5 ÷ 77.5 = 72.935...

Round up: 73 extra boards

Total boards = 73 + 1 = 74

Check: 97.5 + 73 × 77.5 = 5755 mm ≥ 5750 mm ✓

Dewi and Cai need to buy a minimum of 74 boards.

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7. Tubu is a company that makes chocolate bars.
The packaging for a new chocolate bar is in the shape of an isosceles triangular prism.

To open the packaging, Tubu is considering adding a tear strip.

The tear strip will go from *A* to *B*, *B* to *C*, and then from *C* back to *A*.

Some of the dimensions of the packaging are shown in the diagram below.
DB = *DC*.

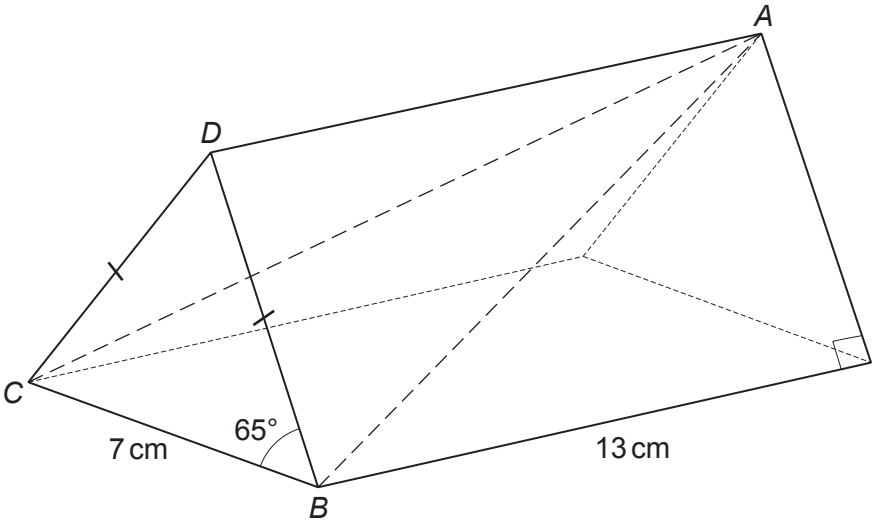

Diagram not drawn to scale

Calculate the **total** length of the tear strip required for the packaging. [7]

Triangle BCD is isosceles, so the perpendicular from D bisects BC: half of BC = 7 ÷ 2 = 3.5 cm

cos 65° = 3.5 ÷ DB, so DB = 3.5 ÷ cos 65°

DB = 8.2817... cm

Triangle ABD is right-angled at D (DB = 8.2817..., DA = 13):

$AB^2 = 13^2 + 8.2817...^2 = 169 + 68.5866...$

$AB^2 = 237.5866...$

AB = √237.5866... = 15.4138... cm (AC = AB = 15.4138... cm)

Total length = AB + BC + CA

= 15.4138... + 7 + 15.4138...

= 37.8276... cm

Total length of tear strip = 37.8 cm

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8. On 1st January 2022, Jay invested £850 in the Savrplus savings account with 'Banc y Ddraig'. The Savrplus account pays interest at a rate of 0·48% every month. The interest is paid on the last day of every month.
Jay does not plan to withdraw any money or make any further payments into the account.

Calculate the date when Jay will first have over £1000 in his account. [4]

Multiplier for 0.48% each month = 1.0048

Amount after n months = 850×1.0048^n

After 33 months: 850×1.0048^{33} = £995.51... (not over £1000)

After 34 months: 850×1.0048^{34} = £1000.29... (over £1000)

So 34 months = 2 years 10 months.

Interest is paid on the last day of each month:

month 12 = 31 Dec 2022, month 24 = 31 Dec 2023,

month 34 = 31 Oct 2024

Date when Jay will first have over £1000 in his account is 31st October 2024

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9. SureCan is a company that makes cylindrical cans for the food industry.
Two of the cans it makes are mathematically similar.
They are shown below.

Diagrams not drawn to scale

The base area of the large can is 2·25 times the base area of the small can.

(a) Show that the height of the small can is 8 cm. [3]

Area scale factor = 2.25

Length scale factor = $\sqrt{2.25}$ = 1.5

Height of small can = 12 ÷ 1.5

= 8 cm, as required

(b) The volume of the small can is 144 cm^3.
Calculate the base area of the large can. [2]

Base area of small can = volume ÷ height = 144 ÷ 8 = 18 cm^2

Base area of large can = 18 × 2.25

= 40.5 cm^2

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10. Rhian is playing golf.
The diagram below shows one of the holes she is playing.
The dotted lines show the recommended route to the hole, taking 2 shots.
The length of a shot is the straight-line distance as measured on horizontal ground.

The recommended first shot is 160 yards. This shot is to a point equidistant from the sand and the tree on the corner. It is then followed by a second shot of 148 yards to the hole.

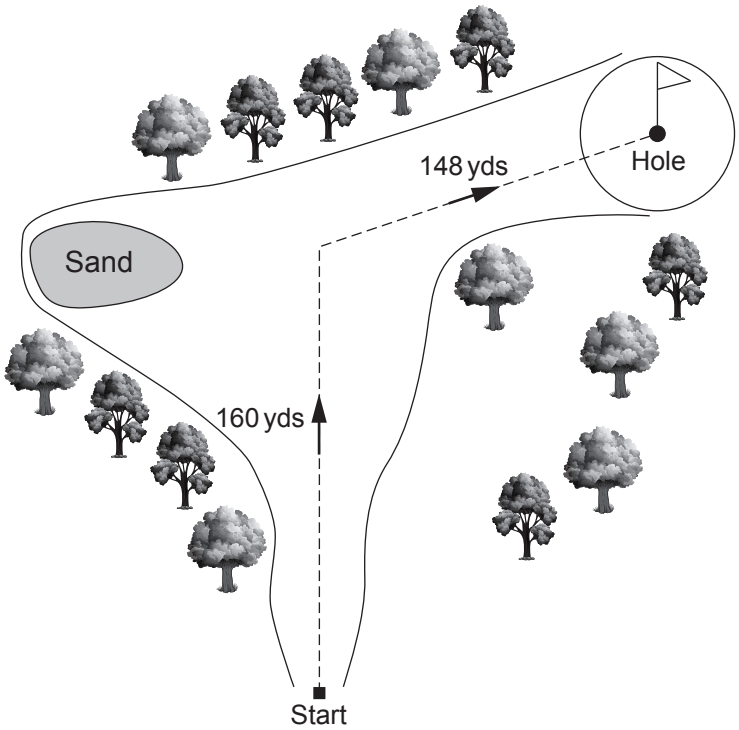

Diagram not drawn to scale

(a) Rhian's map of the golf course shows her the following information about the first shot.

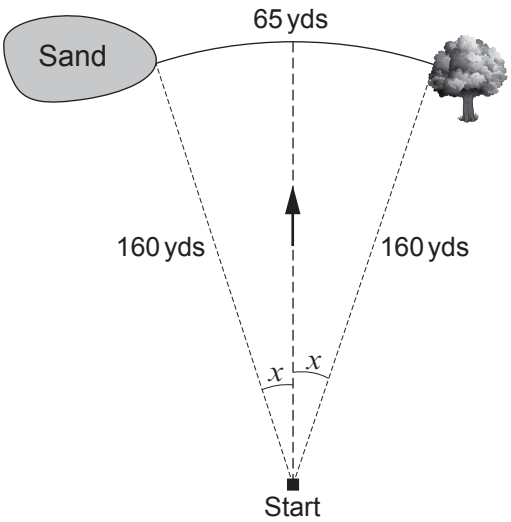

Diagram not drawn to scale

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It shows an arc of a circle of length 65 yards, with its centre at the start.
Rhian does not want her first shot to land in the trees or in the sand.
The greatest angle she can hit her first shot to the right or left of the recommended line has been shown on the diagram as x.

Calculate the size of angle x, giving your answer correct to 3 significant figures. [4]

Total angle at the start = 2x. Arc length = (2x ÷ 360) × 2 × π × 160

65 = (2x ÷ 360) × 2 × π × 160

2x = 65 × 360 ÷ (2 × π × 160) = 23.2764...°

x = 23.2764... ÷ 2 = 11.6382...°

x = 11.6° (3 s.f.)

TURN OVER

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(b) Rhian is considering hitting a single shot over the trees and straight at the hole.
To get over the trees, this shot needs to be longer than 160 yards.

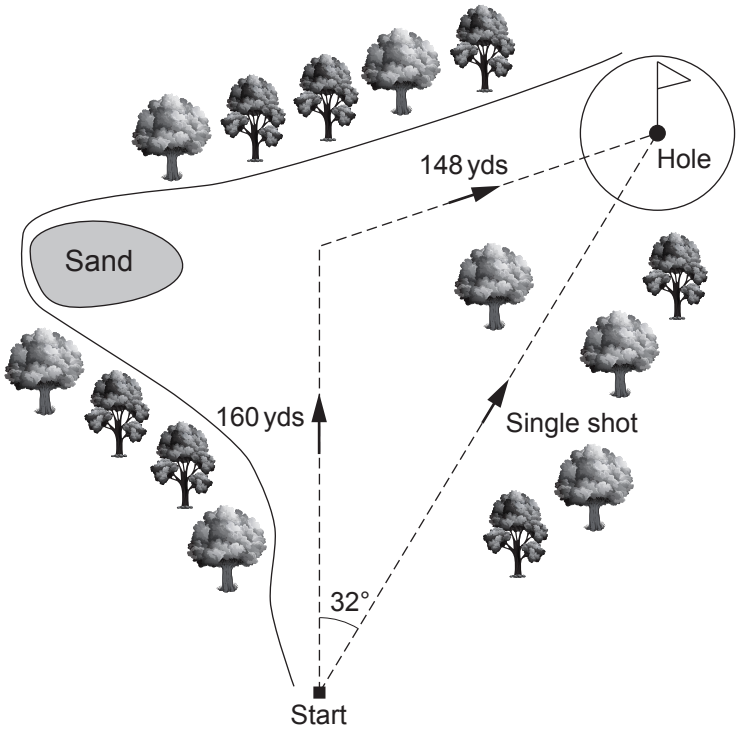

Diagram not drawn to scale

Calculate the length of this single shot. [7]

Triangle Start, Corner (C), Hole (H). Angle at Start = 32°

Use the sine rule to find angle H:

sin H ÷ 160 = sin 32° ÷ 148

sin H = 160 × sin 32° ÷ 148 = 0.57288...

H = $\sin^{-1}$(0.57288...) = 34.9516...°

Angle at corner C = 180° − 32° − 34.9516...° = 113.0483...°

Use the sine rule again to find the single shot:

shot ÷ sin 113.0483...° = 148 ÷ sin 32°

shot = 148 × sin 113.0483...° ÷ sin 32°

shot = 256.9937... yards

Length of the single shot = 257.0 yards (about 257 yards)

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