



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Junior Cycle Final Examination 2025

Mathematics

Higher Level

Friday 6 June Afternoon 1:30 - 3:30

270 marks

Examination Number

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Date of Birth

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For example, 3rd February
2005 is entered as 03 02 05

Centre Stamp

Instructions

There are 13 questions on this examination paper. Answer **all** questions.

Questions do not necessarily carry equal marks. To help you manage your time during this examination, a maximum time for each question is suggested. If you remain within these times you should have about 10 minutes left to review your work.

Write your Examination Number in the box on the front cover.

Write your answers in blue or black pen. You may use pencil in graphs and diagrams only.

This examination booklet will be scanned and your work will be presented to an examiner on screen. Anything that you write outside of the answer areas may not be seen by the examiner.

Write all answers into this booklet. There is space for extra work at the back of the booklet. If you need to use it, label any extra work clearly with the question number and part.

The superintendent will give you a copy of the *Formulae and Tables* booklet. You must return it at the end of the examination. You are not allowed to bring your own copy into the examination.

In general, diagrams are not to scale.

You may lose marks if your solutions do not include supporting work.

You may lose marks if you do not include the appropriate units of measurement, where relevant.

You may lose marks if you do not give your answers in simplest form, where relevant.

Write the make and model of your calculator(s) here:

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Question 1

(Suggested maximum time: 5 minutes)

- (a)** A sports shop sells 3 different brands of running shoes, **A**, **B**, and **C**.

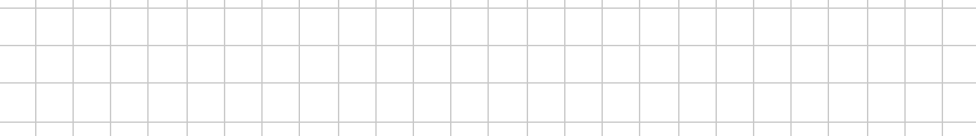
Each brand comes in the 4 different colours and 4 different sizes shown in the table below.

Brand	Colour	Size
A	Red	7
B	Blue	8
C	Black	9
	Yellow	10



How many **different** choices of running shoe does the shop sell?

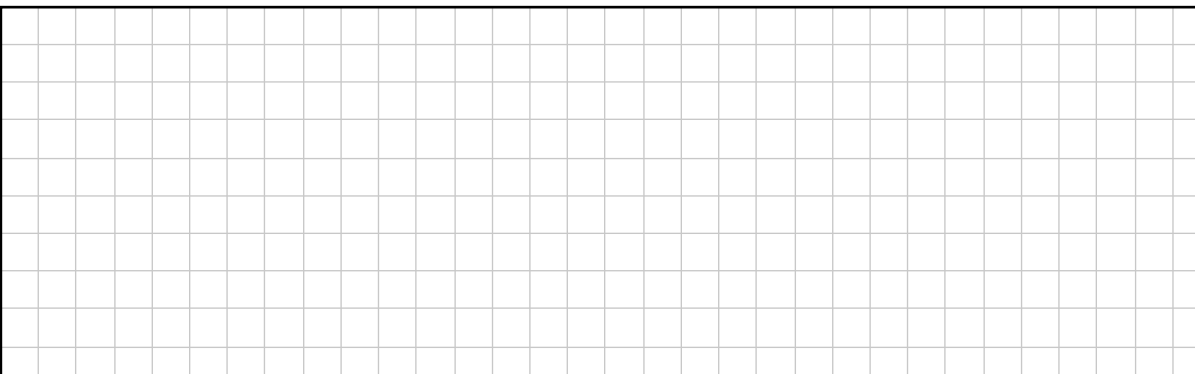
For example, one choice would be brand **B**, yellow, and size 7.



- (b)** A pair of running shoes normally cost €140.

In a sale, they cost €93.80.

Work out the **percentage discount** in the sale.

A large grid of graph paper, consisting of 20 columns and 10 rows of squares, intended for drawing a picture.

Question 2 (Suggested maximum time: 10 minutes)

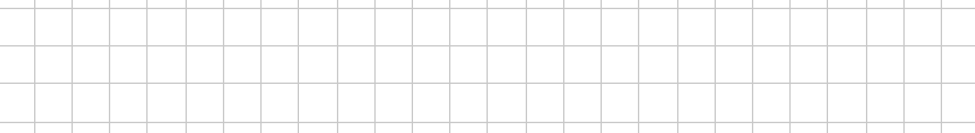
Question 2 (Suggested maximum time: 10 minutes)


- (a) Write down the next two terms in each of the following sequences. The type of each sequence is given.

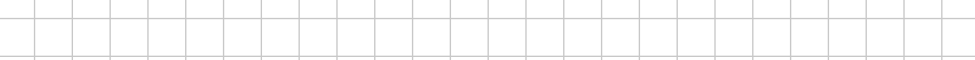
(i) **Linear:** 1, 5, 9, ,

(ii) **Tripling:** 4, 12, 36, ,

(iii) Quadratic: 12, 19, 23, ,



- 
- Red Red Blue Green Red Red Blue

- 

-
- A full-page sheet of white graph paper with a light gray grid. The grid consists of small squares, approximately 1 cm by 1 cm each. There are 20 columns and 20 rows of squares. A thicker black border surrounds the entire grid area.

Question 3 (Suggested maximum time: 5 minutes)

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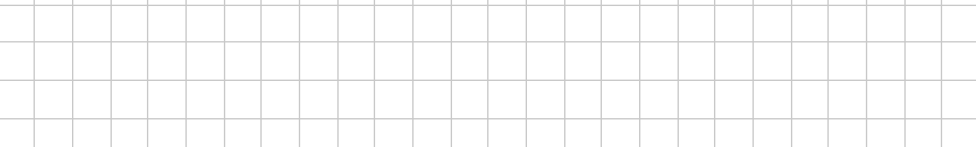
Mae decides to paint her living room.

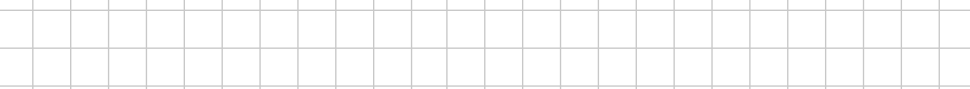
She needs supplies to carry out the work and someone to do the work.

She makes estimates of how much these will cost, and makes the bill below to show this information. Some of the values are missing, and are labelled **A**, **B**, **C**, **D**, **E**, and **F**.

Item Description	Unit Price	×	Number of Units	=	Total Cost
Tin of paint	€42.50	×	3	=	A.
Paint brush	€6.99	×	B.	=	€13.98
Dust sheet and tape pack	€33.80	×	1	=	C.
Labour	€120 a day	×	3.5	=	D.
	Subtotal				€595.28
	VAT @ 13.5%				E.
	Total Cost				F.

- (a)** Work out the missing values labelled **A**, **B**, **C**, and **D**. Fill your answers into the table.



- 

- [illegible]

Question 4 (Suggested maximum time: 10 minutes)

Question 4 (Suggested maximum time: 10 minutes)

12 students sit class tests in Art and Business on Monday.

The students' marks in both subjects are as follows:

Business		
59	64	52
67	68	67
59	65	54
53	66	69

- (a)** Complete the back-to-back stem and leaf diagram below to show the students' marks.

Art								Business						
							3							
							4							
							5							
							6							
							7							

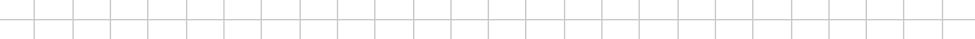
Key: 4|5| = 54 marks

Key: |5|3 = 53 marks

- (b) Based on the shape** of the stem and leaf diagram, write a sentence to compare the students' results in Art and in Business. You should refer to how well students did, on average, **and** to how spread out the marks are.

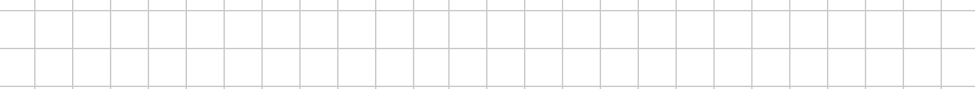
A large grid of graph paper, consisting of 20 columns and 10 rows of squares, intended for drawing a picture.

- (c)** Work out the **range** of the marks for Business.



- (d) Michael is one of the 12 students. He sits the Business test again, and gets a higher mark than the first time he took the test. When the teacher uses Michael's new mark and works out the range of the marks, the range does **not** change.

Explain how this could happen.



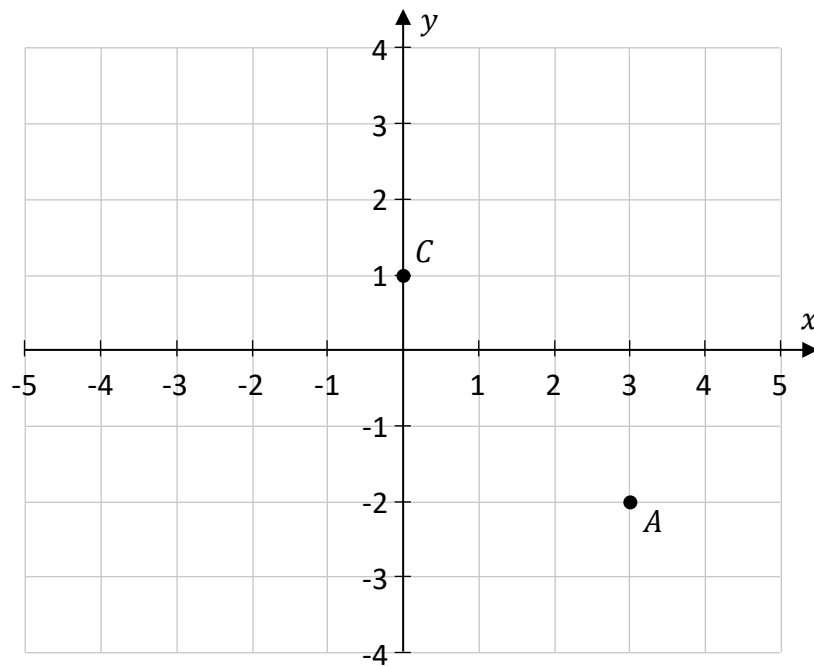
- (e) A 13th student, Ajani, was absent for the two tests on Monday. He sits the tests the following day. When his mark is included, the **mean mark** in **Art increases** from 50 to 51.

Work out Ajani's mark in Art.

[illegible]

Question 5**(Suggested maximum time: 5 minutes)**

The points A and C are shown on the co-ordinate diagram below.



(a) Write the co-ordinates of the points A and C in the spaces below.

$A =$ $C =$

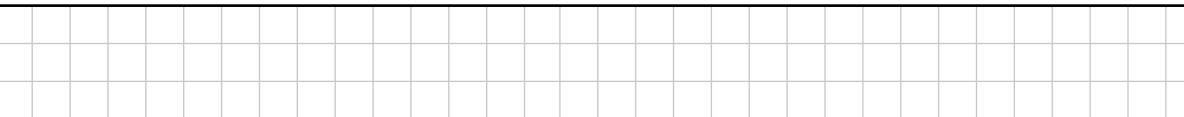
B , D , and E are three more points.

- (b) Plot and label the point $B(4, 3)$ on the diagram on the previous page.**

[illegible]

- (c) $ABCD$ is a **parallelogram**.

Use this information to **plot and label** the point D on the diagram on the **previous page**.



- (d)** The point C is the **midpoint** of the line segment $[AE]$.

Write down the co-ordinates of the point E .

$E = (\quad , \quad)$

Question 6

(Suggested maximum time: 10 minutes)

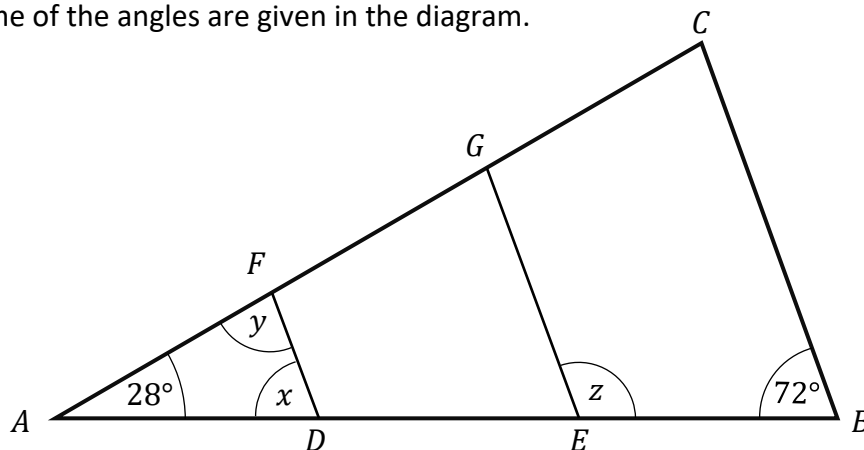
- (a) The line segment $[PQ]$ is shown below.

Divide the line segment $[PQ]$ into **three equal** lengths, without measuring it.
Show all of your construction lines clearly.



The diagram below shows a triangle ABC . The points D and E are on $[AB]$ and the points F and G are on $[AC]$, so that DF , EG and BC are all parallel.

The size of some of the angles are given in the diagram.



- (b) (i) Work out the size of the angles marked x , y , and z in the diagram.

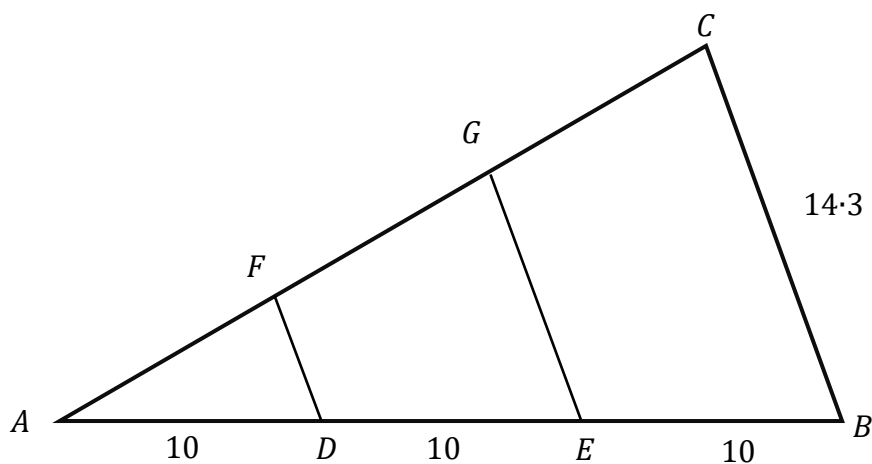
$x =$ _____	$y =$ _____	$z =$ _____
-------------	-------------	-------------

(ii) Explain why the triangles ABC and ADF are **similar** but **not congruent**.

Similar:

Not congruent:

(c) The same triangles are shown again below.
This time, the lengths of some sides are shown.
 $|AD| = |DE| = |EB| = 10$ and $|BC| = 14 \cdot 3$.
Using similar triangles, work out the length $|GE|$.

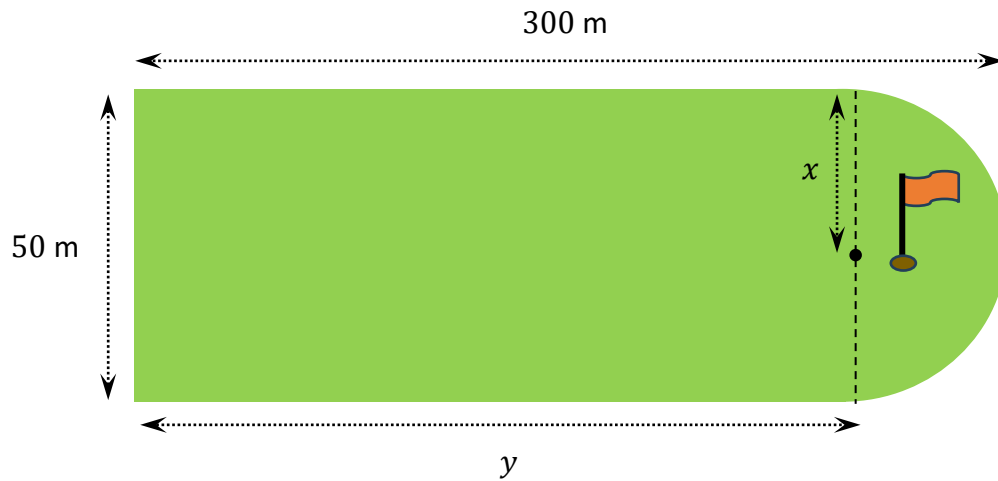


Question 7 (Suggested maximum time: 15 minutes)

Question 7 (Suggested maximum time: 15 minutes)

One section of a golf course, shown in the diagram below, is in the shape of a rectangle with a semi-circle at one end.


This shape has a width of 50 m and a total length of 300 m, as shown.



- (a) (i) Work out the distances marked x and y on the diagram.
 x is the **radius** of the semicircle.

$x =$ _____ $y =$ _____

- (ii) Hence, work out the **total area** of this section of the golf course. Give your answer correct to the nearest m^2 .



- (b) Maciej is spreading fertiliser on the whole golf course.
The packet of fertiliser has these instructions:

Use 6 litres of fertiliser per 250 m^2 of ground to be covered.

Maciej needs to cover $809\,371 \text{ m}^2$ with fertiliser.

How many litres of fertiliser will Maciej need to use?

Give your answer correct to the nearest whole number.

- (c) The fertiliser is made up of three ingredients, **A**, **B**, and **C**, in the following ratio:

A	:	B	:	C
1	:	$\frac{3}{2}$:	$\frac{5}{3}$

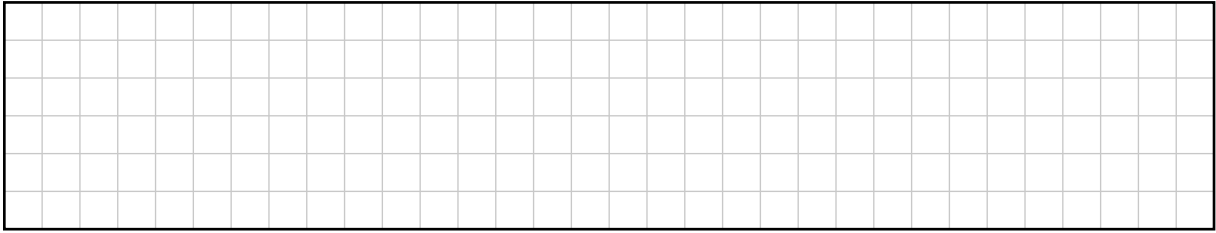
Work out the number of **millilitres** of **B** in 1 litre of fertiliser.

This question continues on the next page.

Question 8

(Suggested maximum time: 5 minutes)

- (a) $\cos A = 0.27$. Work out the size of the angle A , correct to the nearest degree.



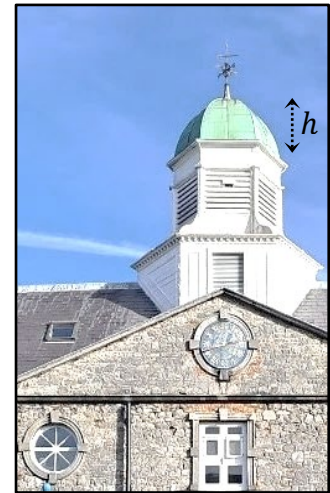
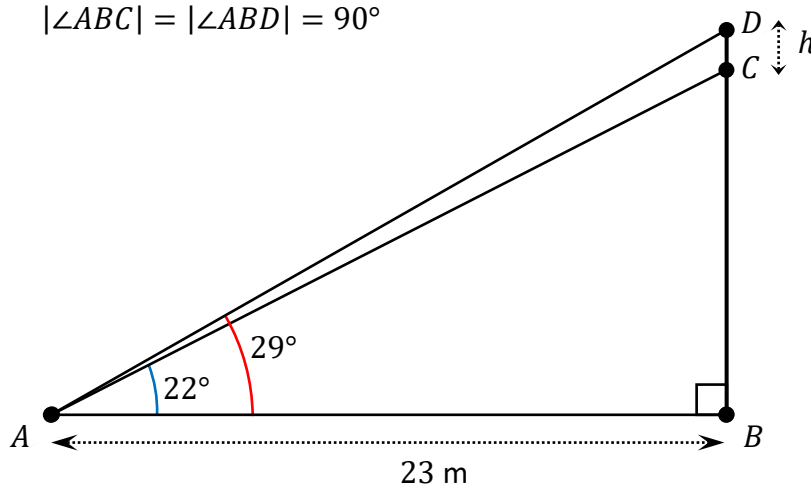
- (b) Olga would like to know the vertical height, h , of the roof of a building. Olga takes the following measurements and shows them on the diagram below, where $h = |DC|$:

$$|\angle CAB| = 22^\circ$$

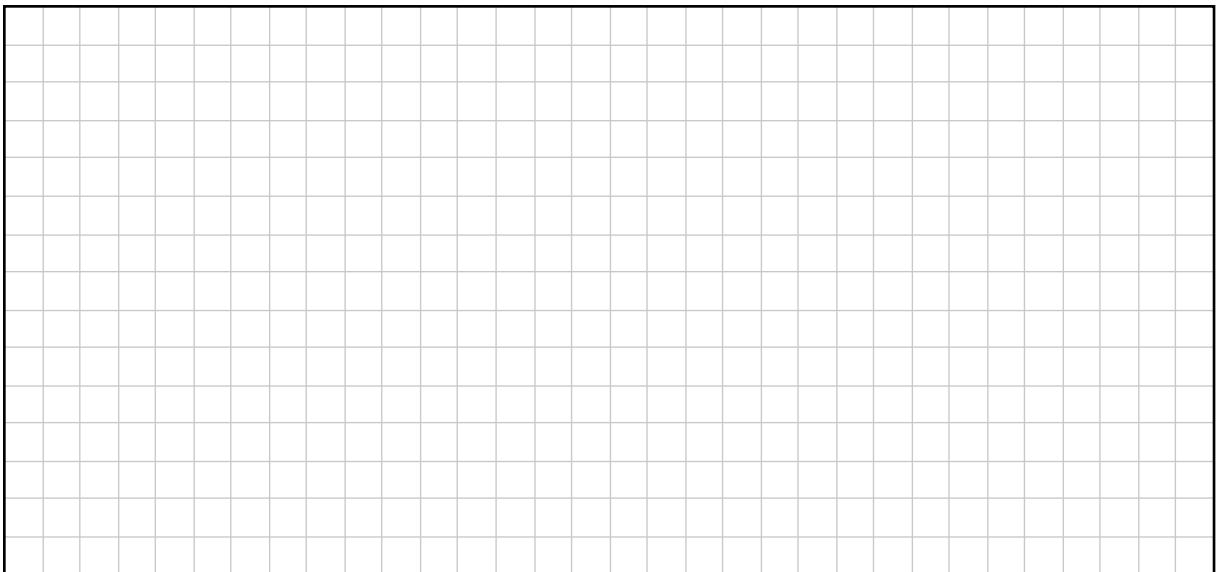
$$|\angle DAB| = 29^\circ$$

$$|AB| = 23 \text{ m}$$

$$|\angle ABC| = |\angle ABD| = 90^\circ$$



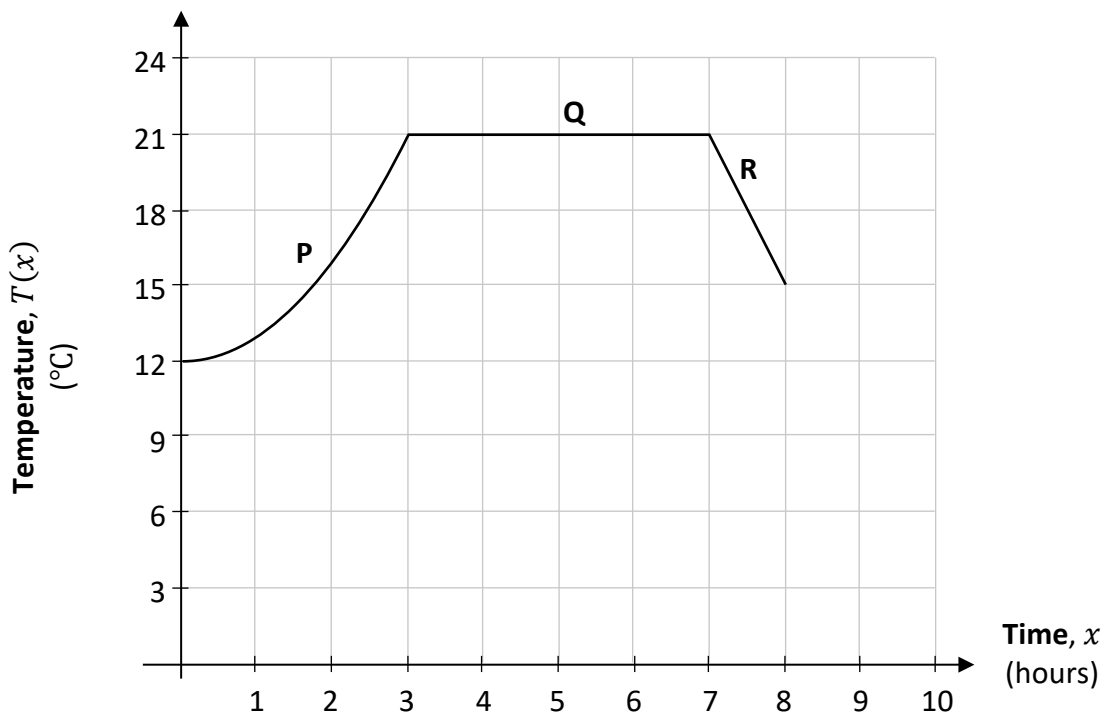
Use trigonometry to work out the vertical height, h , of the roof.
Give your answer correct to 1 decimal place.



(Suggested maximum time: 15 minutes)

$T(x)$ is the temperature x hours after Fiadh starts recording it, for $0 \leq x \leq 10$.

The graph below shows $T(x)$ for **the first 8 hours**. It is in three sections, labelled **P**, **Q**, and **R**. Use the information in the graph to answer parts **(a)** to **(f)**.



- (a)** Estimate how long it takes for the temperature to reach 20°C for the first time. Give your answer in hours, correct to 1 decimal place. Show your work on the graph.

[illegible]

- (b)** For how many hours does the temperature remain constant, for $0 \leq x \leq 8$?

[illegible]

During section **S** of the graph, the rate of change of the temperature is $+3^{\circ}\text{C}$ per hour.

- (c) Use this to **draw** section **S** of the graph on the diagram above, for $8 \leq x \leq 10, x \in \mathbb{R}$.

[illegible]

- (d) The table below gives a function for the temperature in each of the three sections, P, Q, and R. Write the correct letter (P, Q, or R) in the appropriate space in the table to show which function corresponds to each section of the graph. **Use each letter only once.**

Section (P, Q, or R)	During this section, the function for the temperature is:
	$T(x) = 21$
	$T(x) = x^2 + 12$
	$T(x) = -6x + 63$

- (e) Which of the following functions gives the temperature in section **S** of the graph (the section you drew in part (c))? Tick (✓) **one** box only.

Justify your answer, for example, by checking points in section S.

$$T(x) = 3x - 9$$

1

$$T(x) = -3x - 12$$

7

$$T(x) = 3x + 12$$

7

Justification:

- (f)** Remember that the graph shows the temperature in Fiadh's kitchen. The temperature in Fiadh's bedroom is always 3°C **less** than the temperature in the kitchen. On the diagram on the **previous page**, **draw** a graph to show the temperature in Fiadh's bedroom for the first 8 hours ($0 \leq x \leq 8$, $x \in \mathbb{R}$). Use the same axes and scales.

[illegible]

Question 10 (Suggested maximum time: 5 minutes)

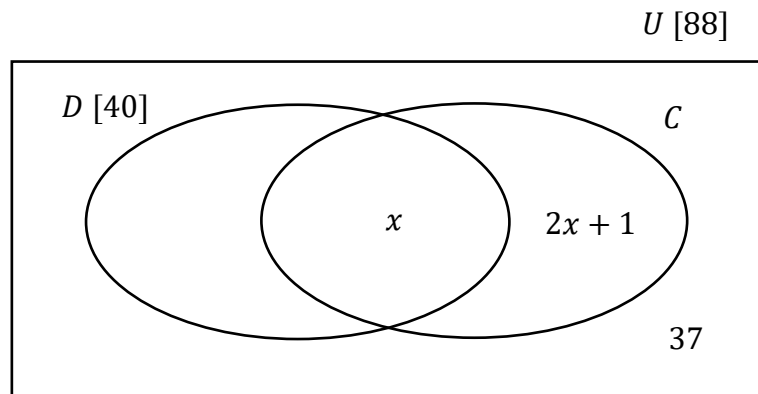
Question 10 (Suggested maximum time: 5 minutes)

There are 88 students in 3rd year in a school.

The Venn diagram below shows the number of these students who are members of the debating club (D) and the chess club (C). Some of these values are given in terms of x , where $x \in \mathbb{N}$.

In total, there are 40 students in the debating club (D).

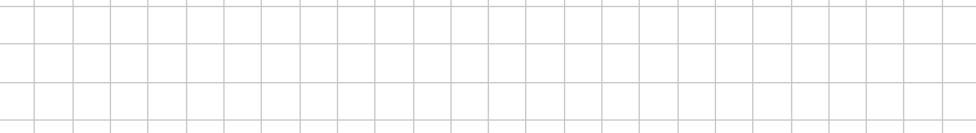
There are 37 students in neither club.



- (a) (i)** Fill in the missing value in the Venn diagram, in terms of x .

[illegible]

- (ii)** Hence, or otherwise, work out the value of x .



- (b)** Michael is in the set $D \setminus C$.
What information does this give about the clubs that Michael is in?

[illegible]

Question 11**(Suggested maximum time: 5 minutes)**

- (a)** Simplify $5x^2 - 7x + 3x^2 - 6x$.

- (b)** Divide $(x^3 + 11x^2 + 15x - 27)$ by $(x + 3)$.

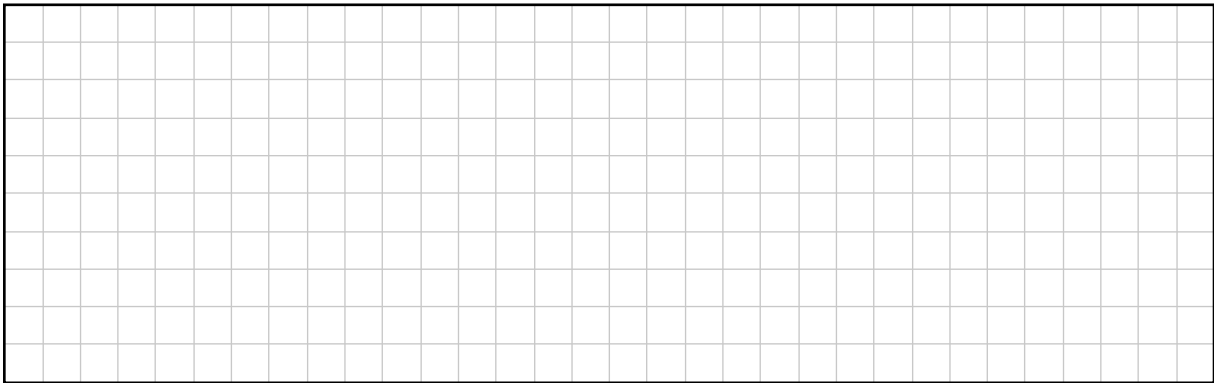
(a) The function $f(x)$ is:

$$f(x) = \frac{2}{x + 2}$$

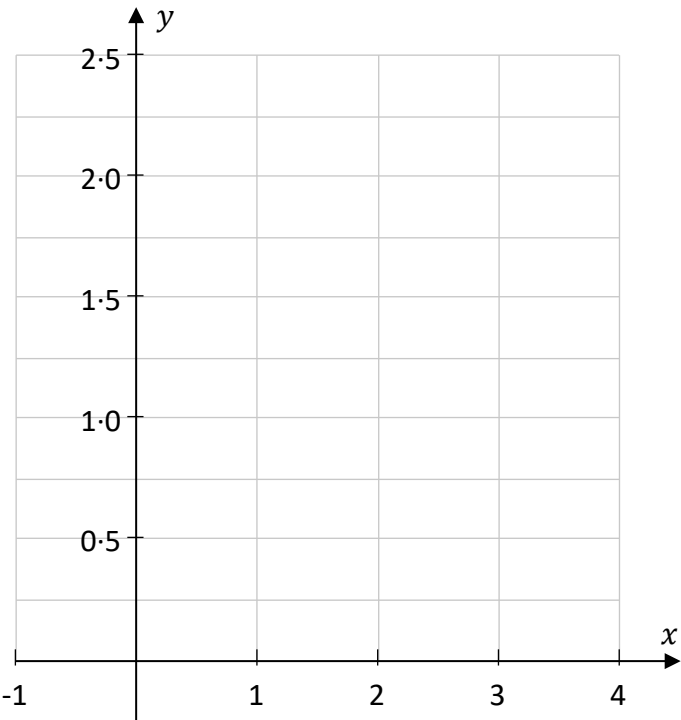
for $x > -2$.

- (i) Complete the table below, showing the values for $f(x)$ for the given values of x . Give values correct to 2 decimal places, where appropriate.

x	-1	0	1	2	3	4
$f(x)$		1		0.5	0.4	



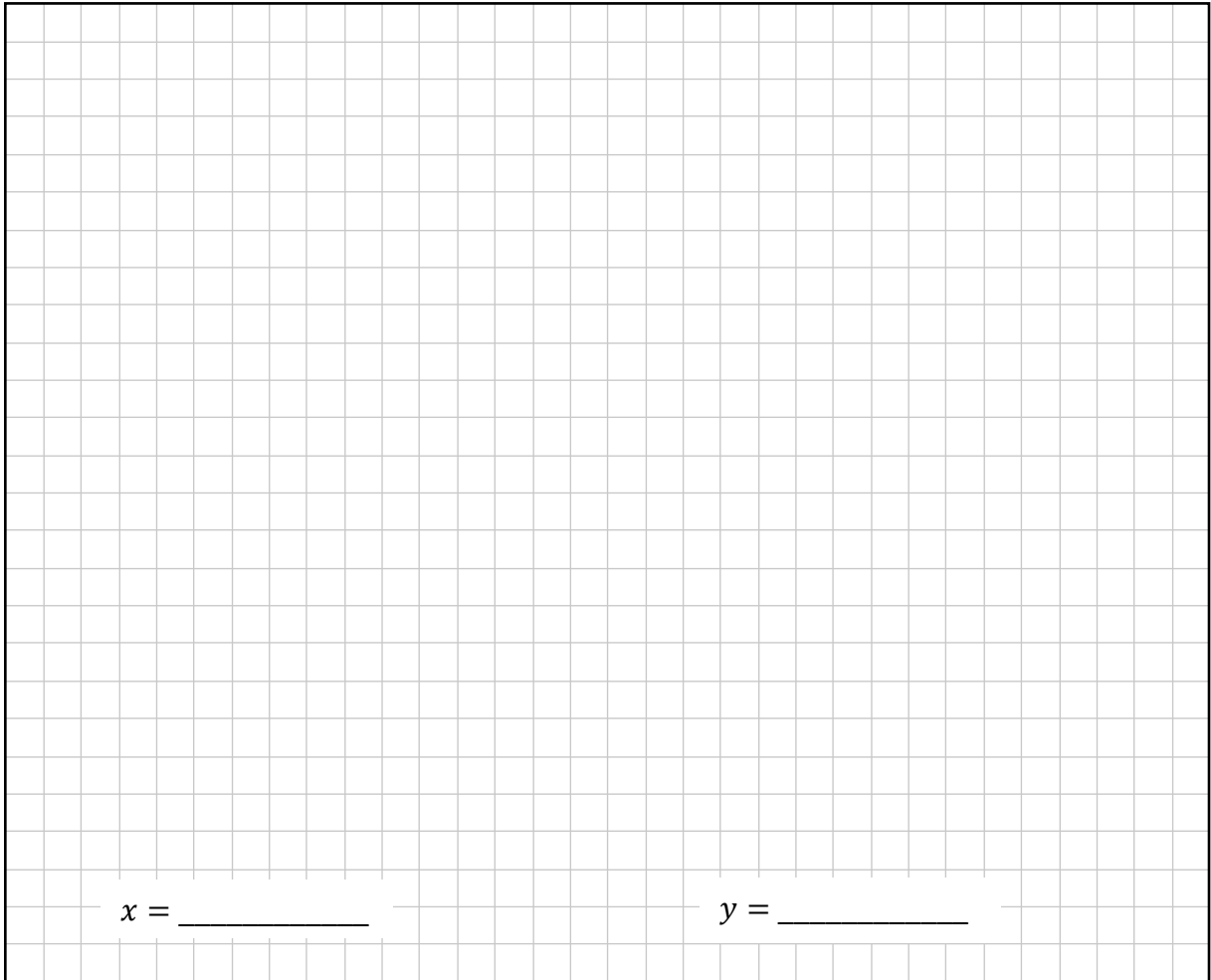
- (ii) Use the values in the table to draw the graph of the function $y = f(x)$ on the axes below, for $-1 \leq x \leq 4, x \in \mathbb{R}$.



(b) Solve the following simultaneous equations to find the value of x and the value of y :

$$3x + 4y = 29$$

$$2x + y = 9$$



$x =$ _____

$y =$ _____

Question 13

(Suggested maximum time: 10 minutes)

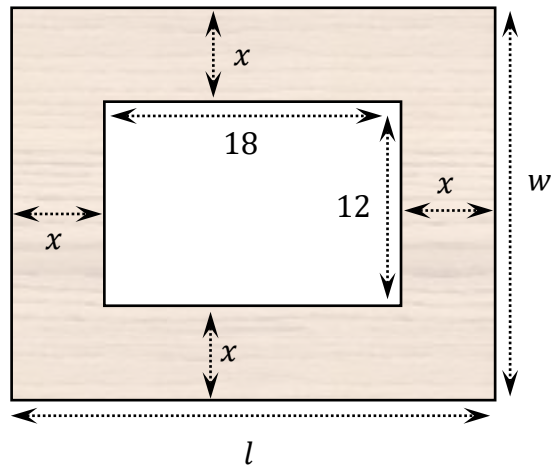
In this question, all lengths are in cm.

The diagram below shows a rectangular frame for a photo, where $w, l, x \in \mathbb{R}$.

The width of the frame is w and the length is l .

There is a rectangular hole in the middle for the photo, measuring 12 by 18.

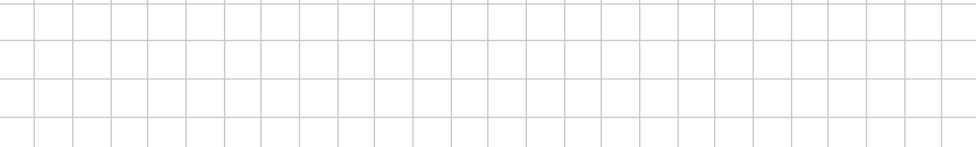
The internal width of the frame is x , as shown.



- (a) The length of the frame $l = 18 + 2x$.
Write the **width** of the frame, w , in terms of x .

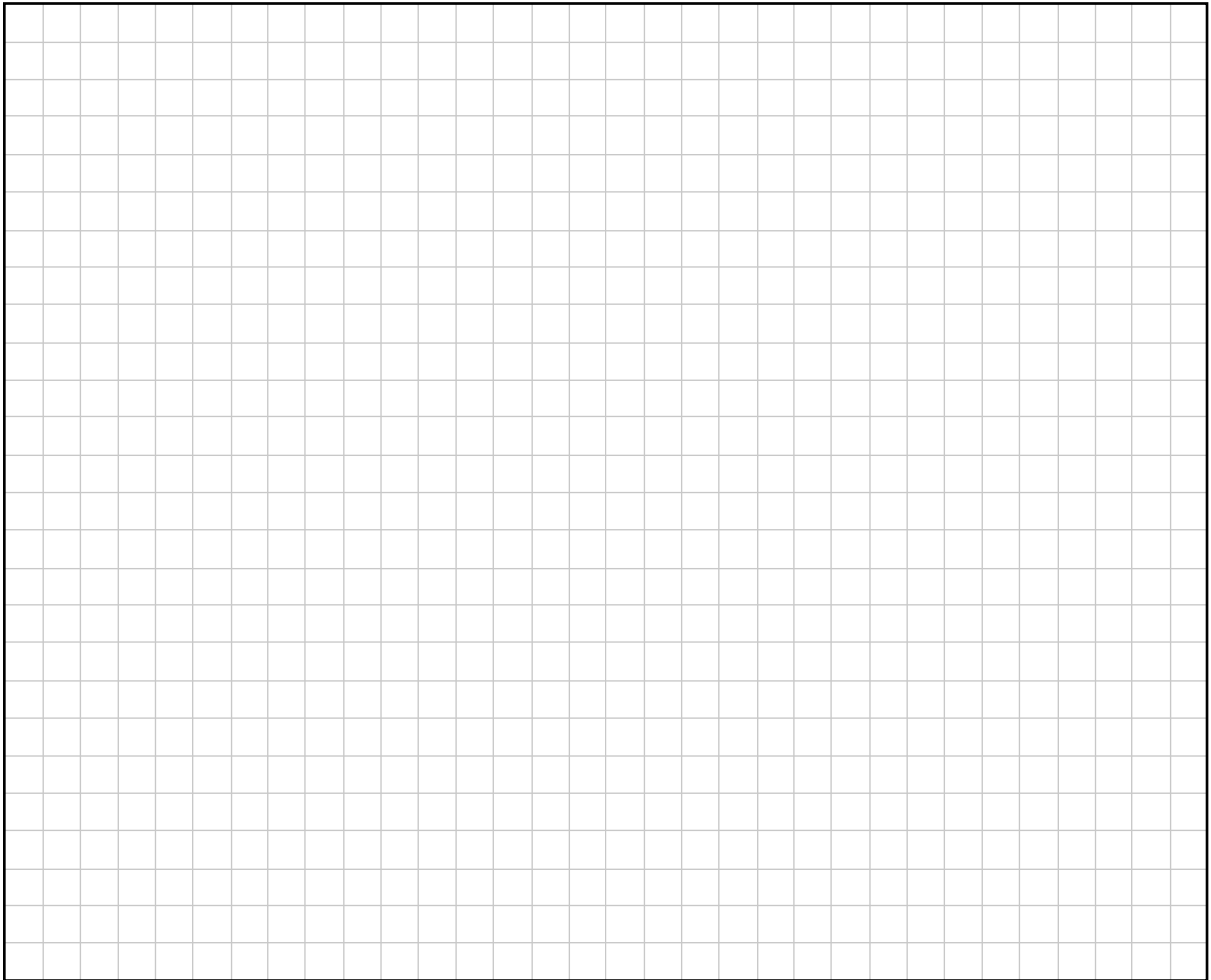
- (b)** Hence, show that:

$$l \times w = 4x^2 + 60x + 216$$

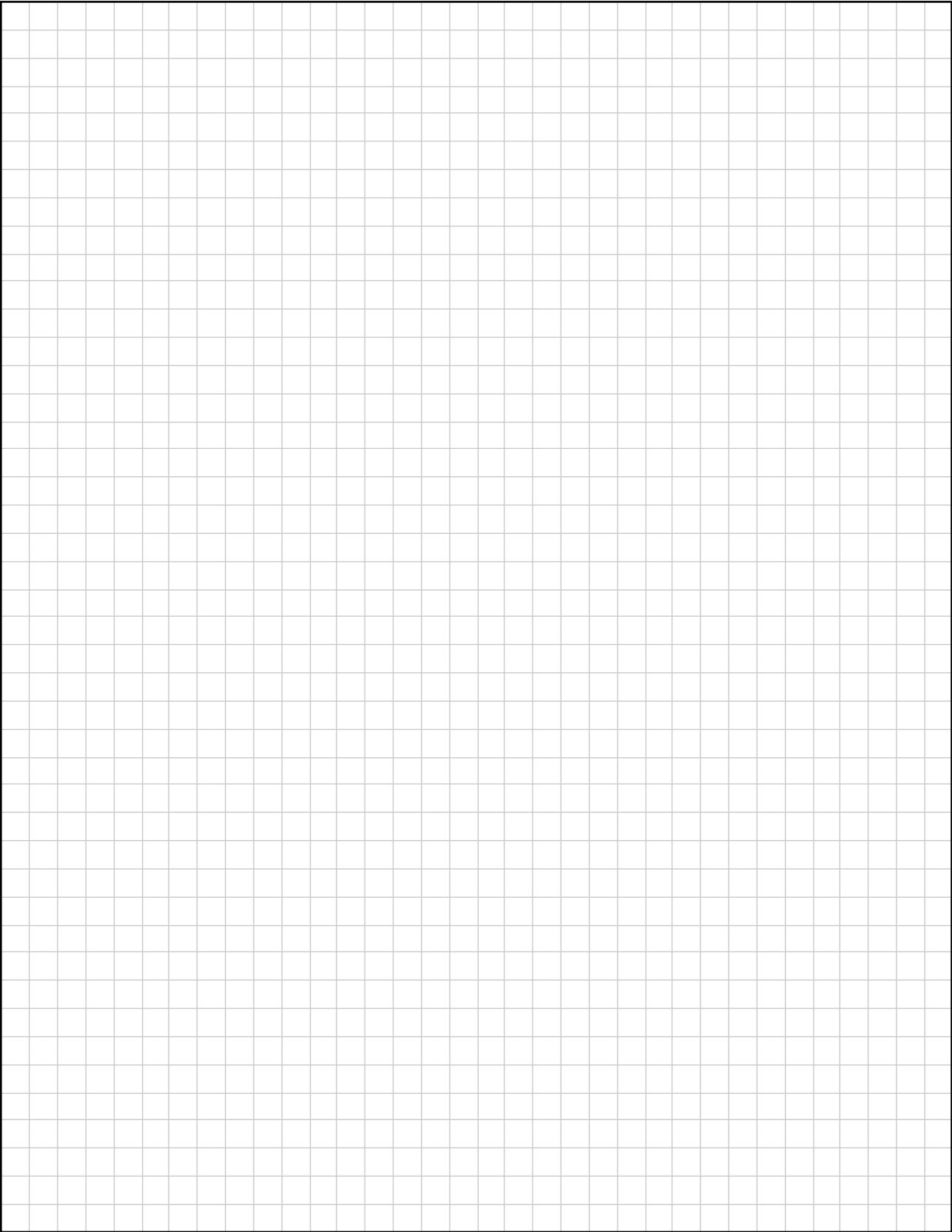


(c) $l \times w = 648 \text{ cm}^2$.

Use this, and the information from part (b), to find the value of x .
Give your answer in cm, correct to 1 decimal place.

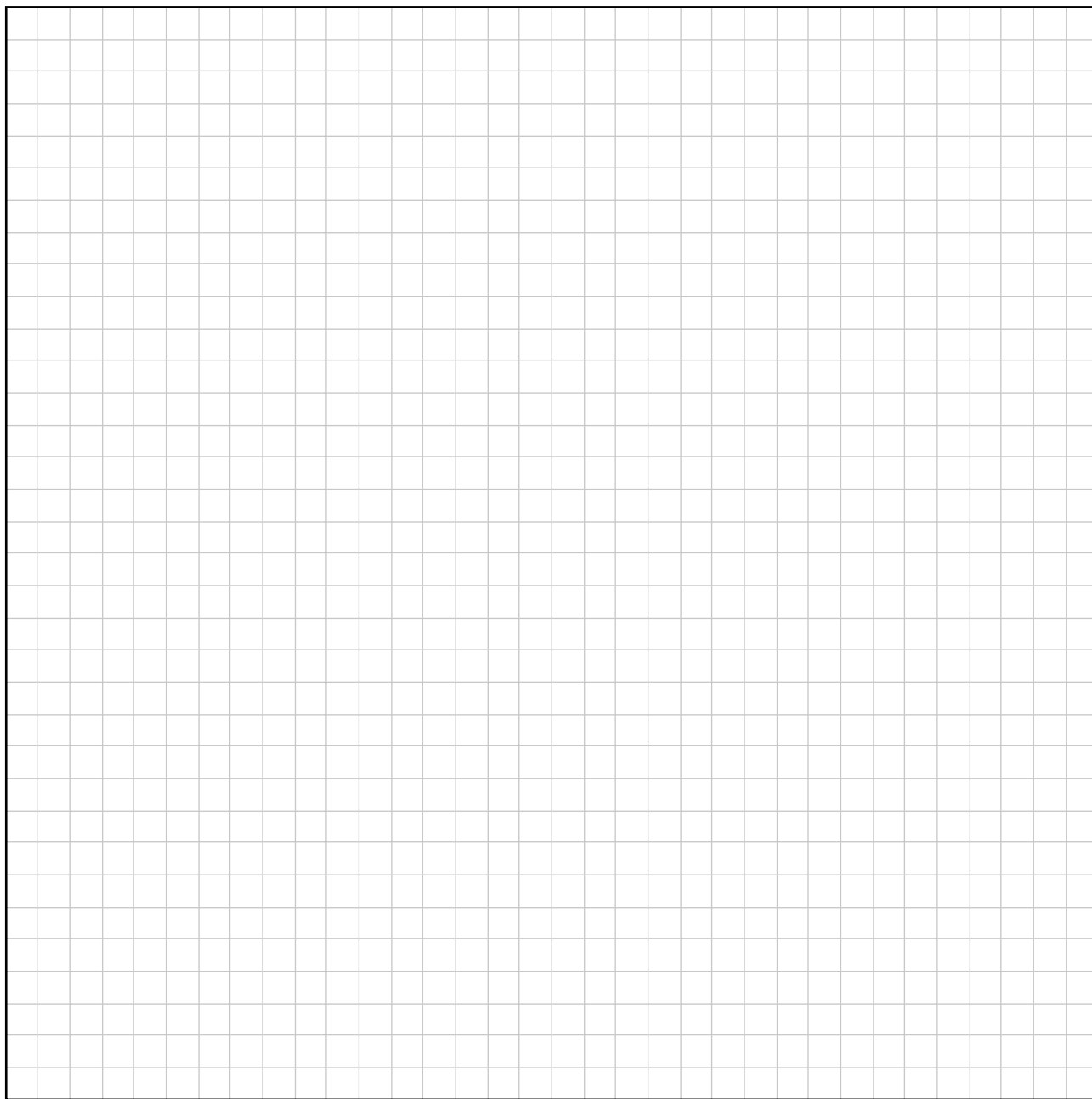


Page for extra work.
Label any extra work clearly with the question number and part.



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Acknowledgements

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Junior Cycle Final Examination – Higher Level

Mathematics

Friday 6 June

Afternoon 1:30 - 3:30



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Junior Cycle Final Examination 2024

Mathematics

Higher Level

Friday 7 June Afternoon 1:30 - 3:30

270 marks

Examination Number

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Date of Birth

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Write the make and model of your calculator(s) here:



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Question 1 (Suggested maximum time: 5 minutes)

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Bea has eight numbered counters.

There are four red counters numbered 1 to 4 and four blue counters numbered 7 to 10.

Red counters	Blue counters
	

Bea picks one red counter at random and one blue counter at random.

- (a)** Complete the table to show all 16 different pairs of counters Bea could pick. One has already been done for you.

		Blue counters			
		7	8	9	10
Red counters	1				
	2		(2, 8)		
	3				
	4				

- (b)** Find the **probability** that one of the counters Bea picks is a 7.

[illegible]

- (c) List the pairs of counters where **both** numbers are **prime**.

[illegible]

Question 2 (Suggested maximum time: 15 minutes)

Question 2 (Suggested maximum time: 15 minutes)

The table below shows the distances in centimetres jumped by a group of students during a school long jump competition.



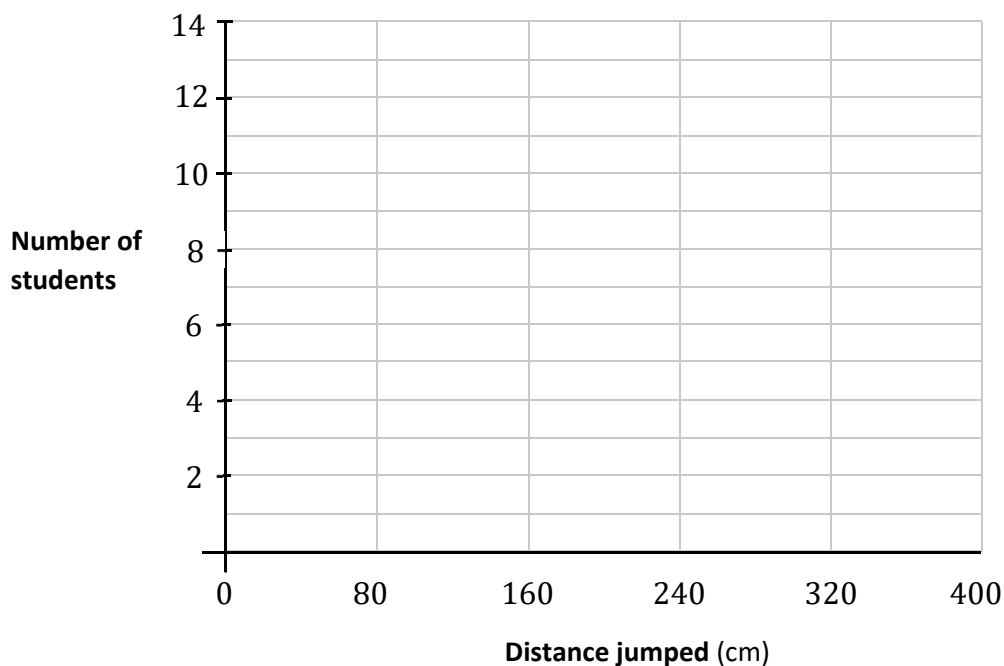
Distance jumped (cm)	0 – 80	80 – 160	160 – 240	240 – 320	320 – 400
Number of students	0	2	7	12	3

[Note: 80 – 160 means 80 cm or more, but less than 160 cm, etc.]

- (a)** Work out the number of students who jumped less than 240 cm.

[illegible]

- (b)** Draw a **histogram** to show the information in the table. Use the axes and scales below.

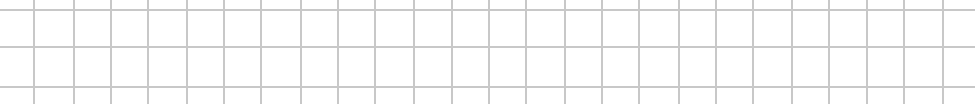


- (c)** Work out the maximum number of students who could have jumped more than 200 cm.

- (d)** Use mid-interval values to estimate the mean distance jumped by the group of students. Give your answer correct to the nearest centimetre.

A full-page sheet of white graph paper with a light gray grid. The grid consists of small squares, approximately 1 cm by 1 cm each. There are 20 columns and 20 rows of squares. A thicker black border runs along the top, bottom, left, and right edges of the page, framing the grid.

- (e) Estimate the median distance jumped, as accurately as you can. Show your working out.



Estimate of median =

Question 3 (Suggested maximum time: 10 minutes)


Question 3 (Suggested maximum time: 10 minutes)

Tomás works as a chef in a restaurant.

- (a) The table below shows the hours he worked one weekend. His basic pay is €19 per hour.

Day	Friday	Saturday	Sunday
Numbers of hours worked	7	8	6

- (i) How much money in **total** did Tomás earn for working on Friday and Saturday?

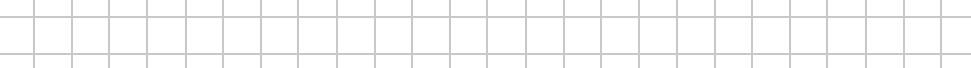


- (ii) Tomás is paid 50% extra for working on Sunday. How much did he earn for working on Sunday?

A large rectangular grid consisting of 20 columns and 6 rows of squares, intended for drawing or writing.

- (b)** Tomás's gross income was €1900 last month. He pays tax at a rate of 20%. His monthly Tax Credit is €312.50. Work out Tomás's **net income** for the month.

A full-page sheet of white graph paper with a light gray grid. The grid consists of small squares, approximately 1 cm by 1 cm each. There are 20 columns and 20 rows of squares. A thicker black border runs along the top, bottom, left, and right edges of the page, framing the grid.

- 

- [illegible]

Question 4 (Suggested maximum time: 10 minutes)

Question 4 (Suggested maximum time: 10 minutes)

Ciara is making an orange drink.

The orange drink is made by mixing concentrate and water.

The ratio of concentrate to water is 1 : 4.

- (a)** Ciara makes 15 litres of the orange drink.

Work out how many **litres of concentrate** Ciara uses to make the drink.

- (b)** Ciara sells glasses of the orange drink for €0.20 each.

Each glass contains 250 ml of the drink.

She sells 10 litres altogether.


The total cost was €5.50.

Work out her **profit** as a **percentage** of the total cost.

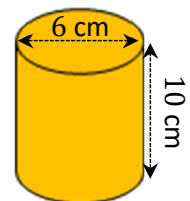
Give your answer correct to 1 decimal place.

A full-page sheet of white graph paper with a light gray grid. The grid consists of small squares, approximately 1 cm by 1 cm each. There are 20 columns and 20 rows of squares. A thicker black border runs along the edges of the page, framing the grid.

- (c) Each glass is approximately the shape of a cylinder with **diameter** 6 cm and **height** 10 cm. Find the volume of a glass correct to the nearest cm^3 .



A yellow cylinder is shown on the right side of the grid. The diameter of the top circular face is labeled as 6 cm, and the height of the cylinder is labeled as 10 cm.

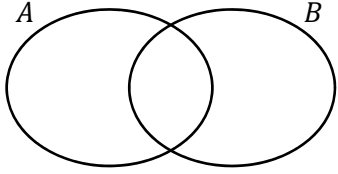


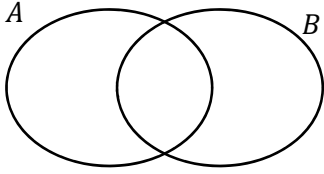
Question 5

(Suggested maximum time: 5 minutes)

- (a) A and B are two sets.

Complete the tables below by shading in each of the given sets in the diagram.

Set	$A \cap B$
Venn diagram	

Set	$A \setminus B$
Venn diagram	

- (b) The sets U, P, Q , and S are as follows:

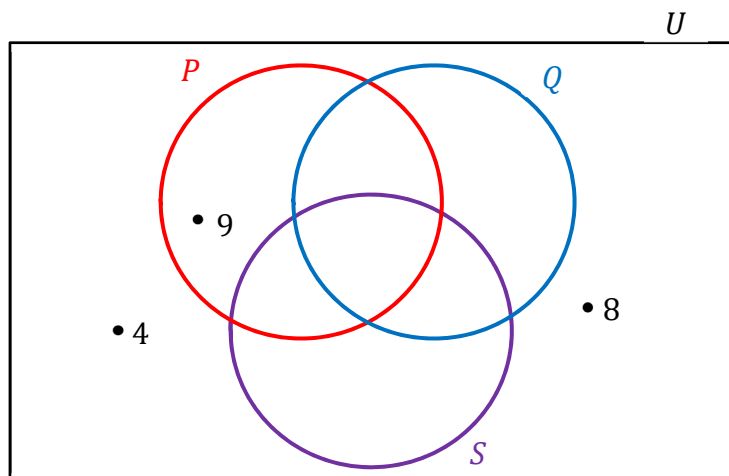
$$U = \{\text{Natural numbers from 1 to 10}\}$$

$$P = \{3, 5, 6, 9\}$$

$$Q = \{3, 5, 10\}$$

$$S = \{\text{factors of 10}\}$$

Complete the Venn diagram below by writing each element of the set U in the correct region of the Venn diagram.



- (i) List the element(s) of the set $P \cap Q \cap S$.

$P \cap Q \cap S =$

- (ii) List the elements of the set $P \setminus Q$.

$P \setminus Q =$

Question 6**(Suggested maximum time: 5 minutes)**

A chocolate bar in the shape of a prism is shown below.

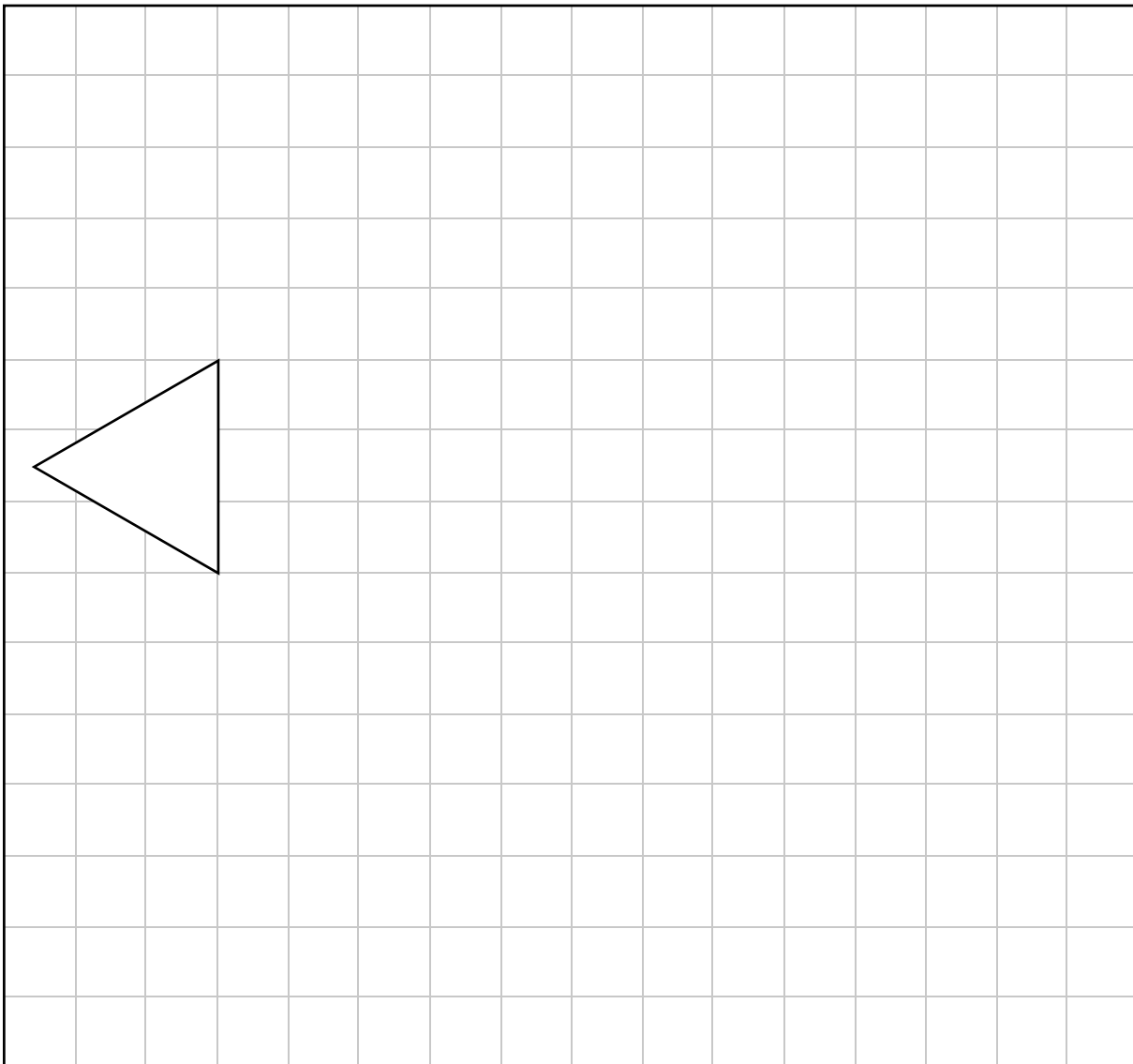


The front and back faces are each in the shape of equilateral triangles, with sides of length 3 cm. The other three faces are each in the shape of rectangles that are 9 cm in length, as shown above.

Complete an accurate net of the prism below, by drawing in the four missing faces.

One of the triangular faces has already been drawn.

Each small square in the grid has sides of length 1 cm.



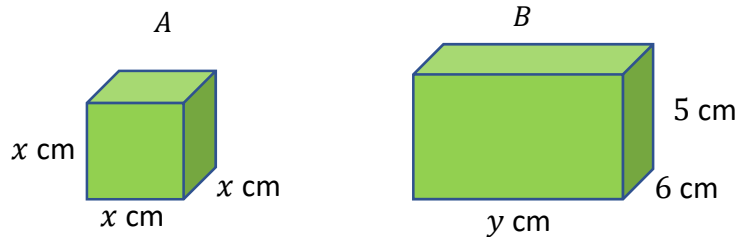
Question 7 (Suggested maximum time: 10 minutes)

Question 7 (Suggested maximum time: 10 minutes)

Two rectangular solids, a cube A and a cuboid B , are shown in the diagram below (not to scale).

The edges of cube A have length x cm, where $x \in \mathbb{R}$.

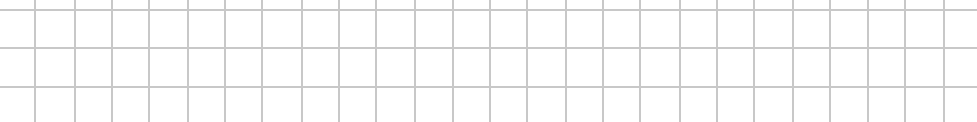
Cuboid B has dimensions 5 cm, 6 cm, and y cm, where $y \in \mathbb{R}$.




- (a) The **volume** of A is 216 cm^3 .
Find the value of x .

[illegible]

- (b) (i)** Show that the **surface area** of B is $(22y + 60) \text{ cm}^2$.



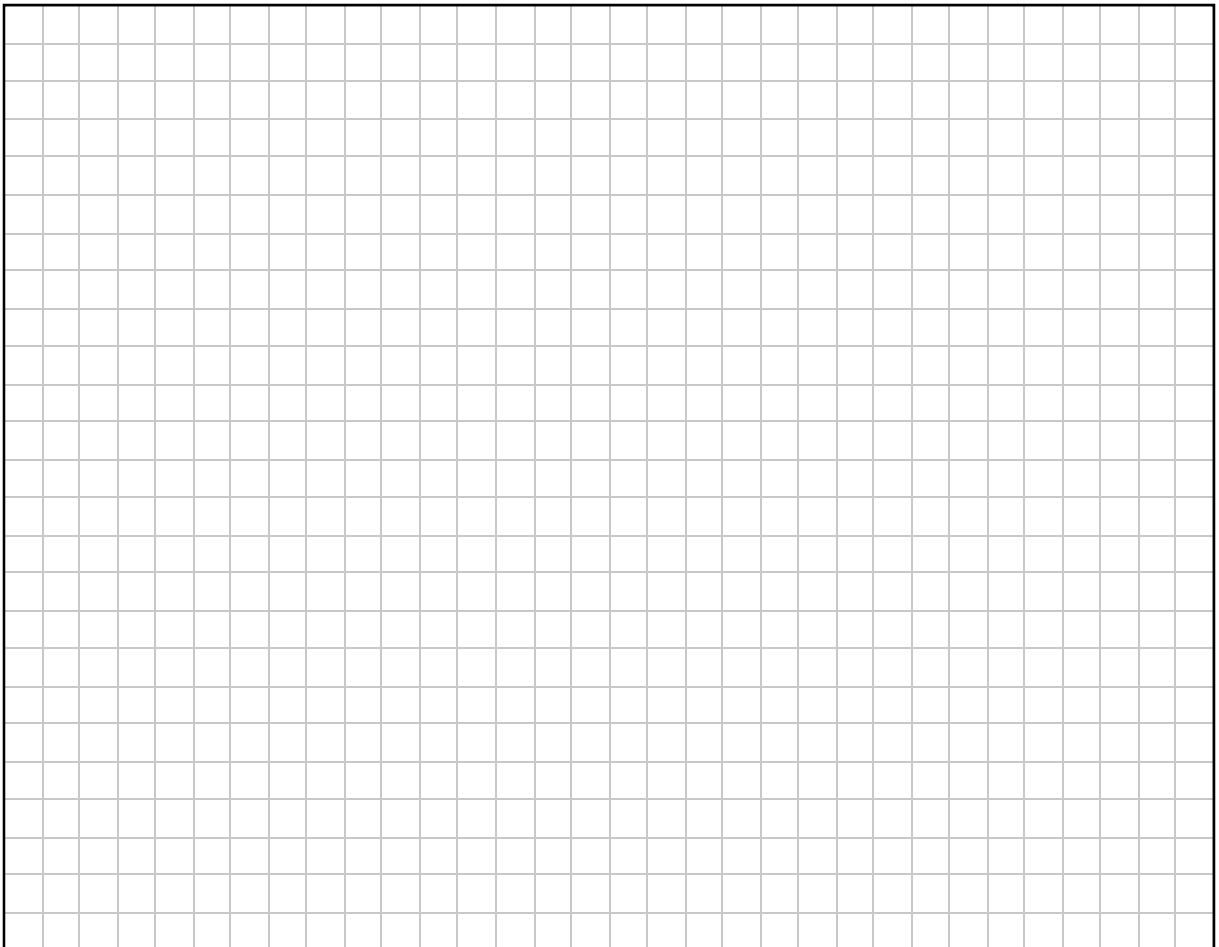
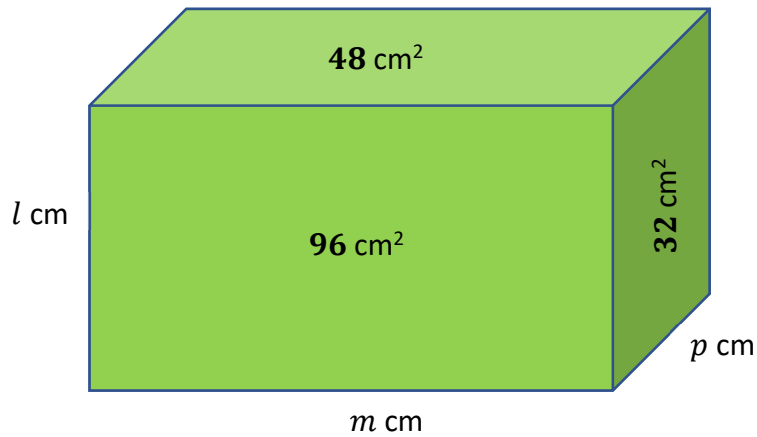
- (ii) The **surface area** of B is 269 cm^2 .
Work out the value of y .



This question continues on the next page

- (c) The area of three faces of a different cuboid are shown on the diagram below (not to scale). The dimensions of this cuboid are l cm by m cm by p cm, where l , m and p are all **whole numbers**.

Work out the **volume** of the cuboid.
Give your answer in cm^3 .

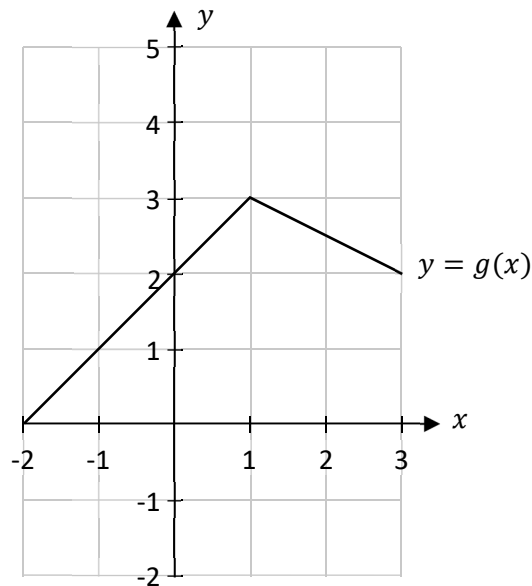


Question 8 (Suggested maximum time: 5 minutes)

Question 8 (Suggested maximum time: 5 minutes)

The graph below shows the function $g(x)$ for $-2 \leq x \leq 3$, $x \in \mathbb{R}$.

Use this graph to answer the following questions.



- (a)** Write down the value $g(3)$.

$$g(3) = \boxed{}$$

- (b)** Write down the value of x for which $g(x) = 1$.

$x =$

- (c) **Draw** the graph of the function

$$y = g(x) - 2$$

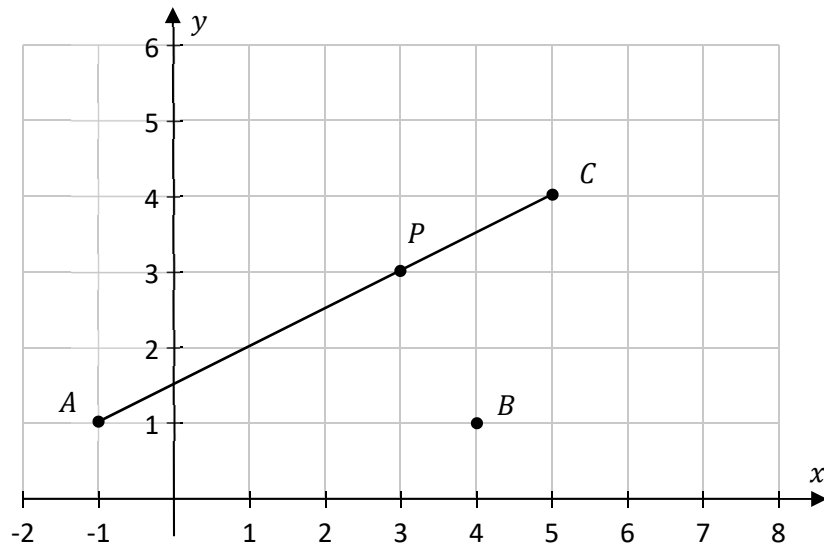
on the diagram above, for $-2 \leq x \leq 3, x \in \mathbb{R}$.

Calculations, if needed:

Question 9

(Suggested maximum time: 10 minutes)

The co-ordinate diagram below shows a line segment $[AC]$ and the points $B(4, 1)$ and $P(3, 3)$.



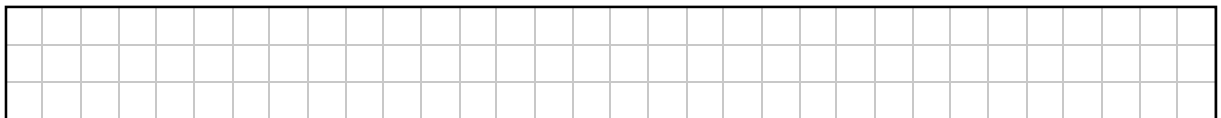
- (a) Write down the co-ordinates of the point A and the point C .

$A = (\quad , \quad)$

$C = (\quad , \quad)$

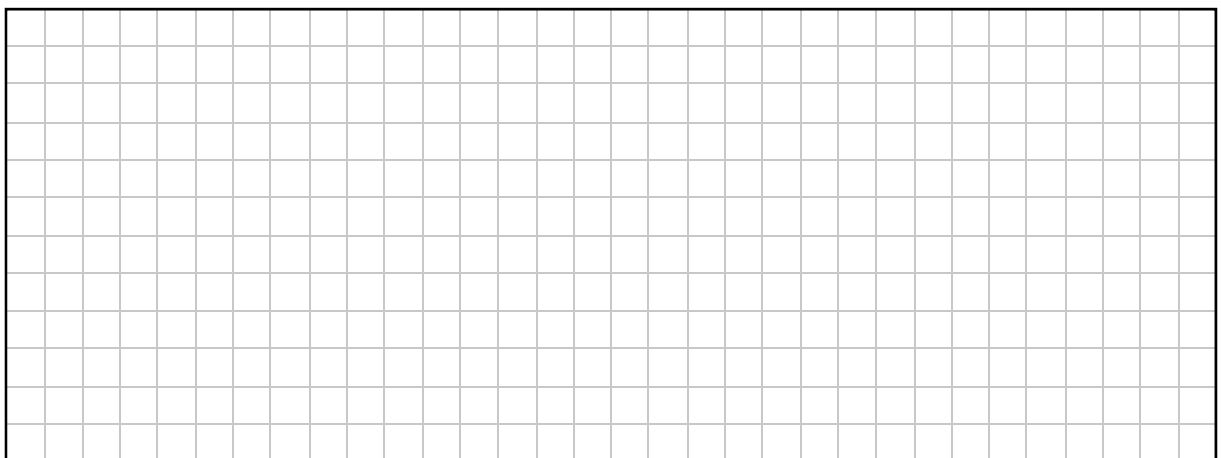
- (b) (i) D is a point (not shown).
 D is the image of the point B under **central symmetry** in the point P .

Plot and label the point D on the diagram above and **join** the points A, B, C and D to form the quadrilateral $ABCD$.



- (ii) Kate says the quadrilateral $ABCD$ is **not** a parallelogram.

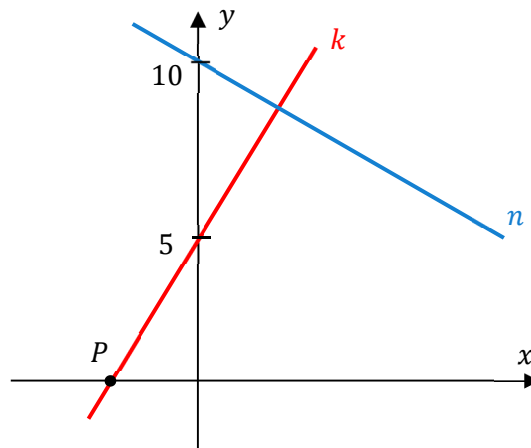
Find $|AB|$ and $|CD|$ and use these values to explain why Kate is correct.



Question 10**(Suggested maximum time: 5 minutes)**

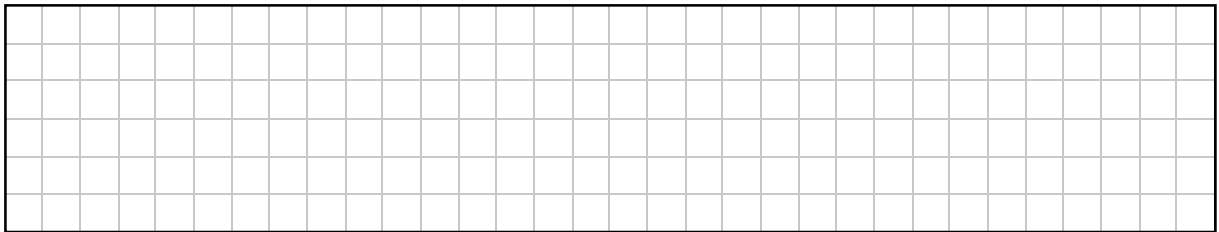
The equation of the line k is $y = 2x + 5$.

The line k intersects the y -axis at the point $(0, 5)$ and the x -axis at the point P .

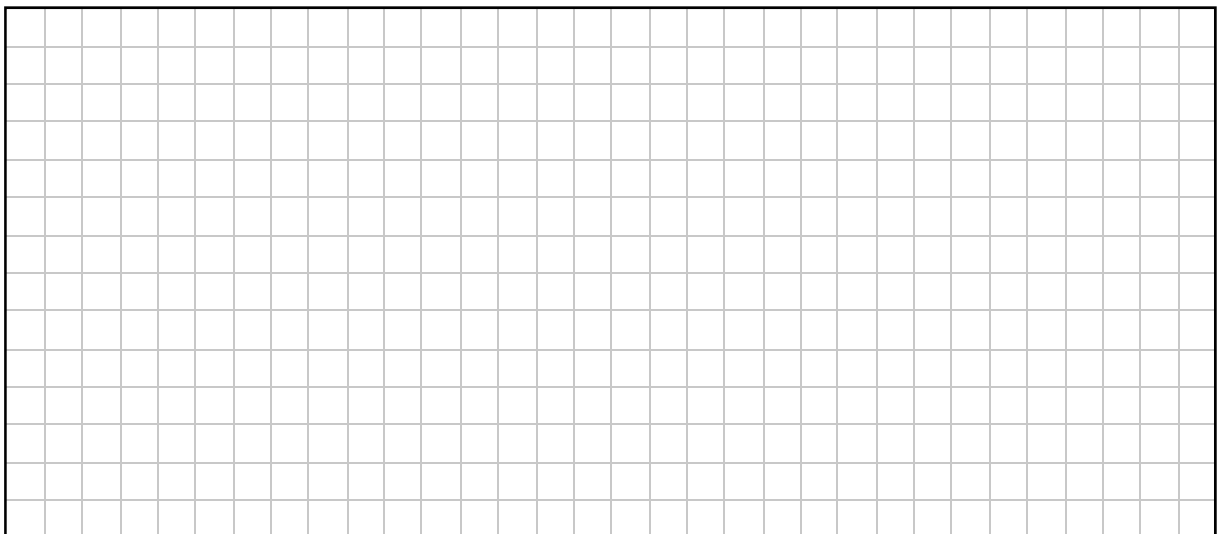


- (a) Find the co-ordinates of the point P .

$P = (\quad , \quad)$



- (b) The line n is **perpendicular** to the line k , and goes through the point $(0, 10)$.
Find the equation of the line n .
Give your answer in the form $ax + by + c = 0$, where $a, b, c \in \mathbb{Z}$.



Question 11

(Suggested maximum time: 10 minutes)

(a) Work out the value of $12 - 3k^2$ when $k = -2$.

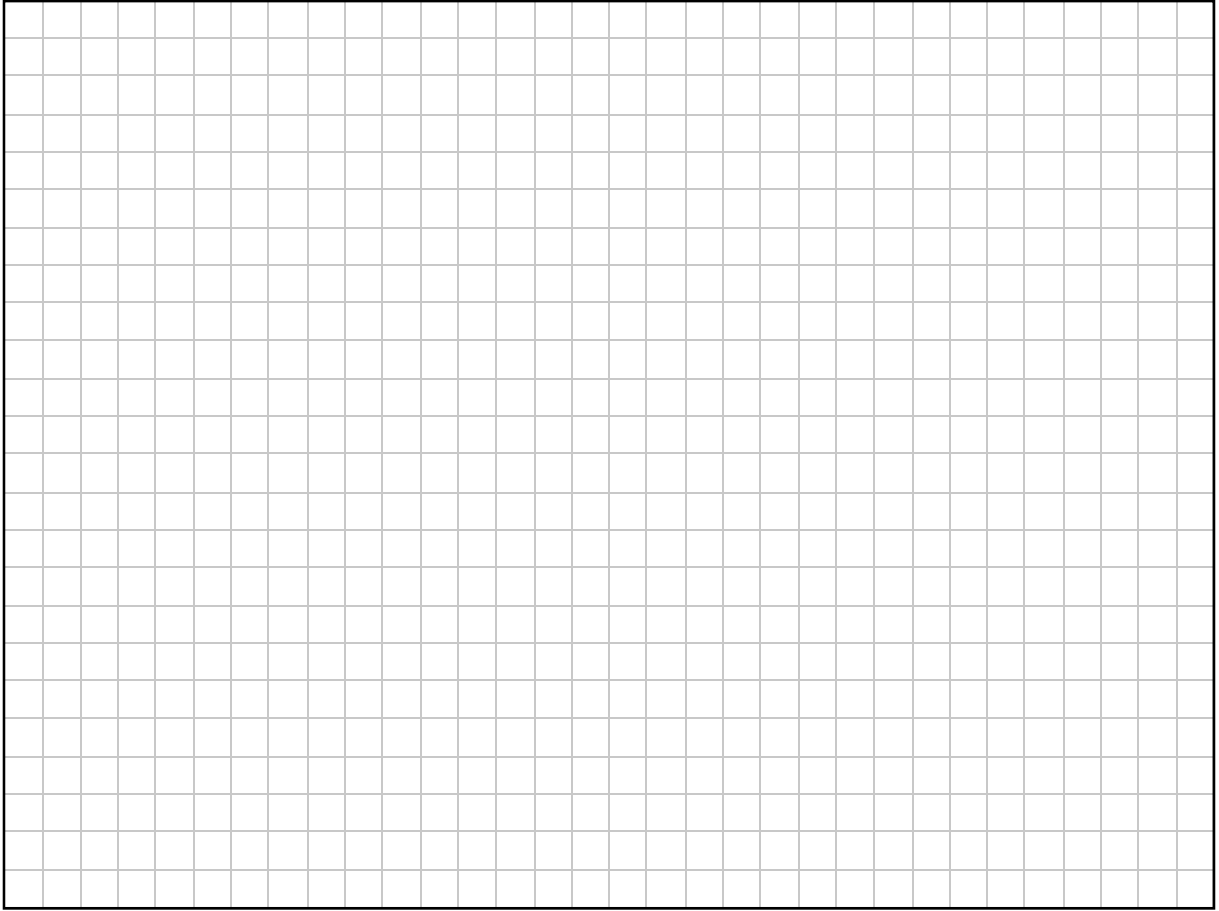
(b) Factorise fully $pm + 3p - m - 3$.

(c) Graph each of the following inequalities on the number line given.

Inequality	Number line
$x < 2$, where $x \in \mathbb{Z}$	<div> <div></div> <div>-4-3-2-101234</div> </div>
$x \leq 3$, where $x \in \mathbb{N}$	<div> <div></div> <div>-4-3-2-101234</div> </div>
$-2 < x \leq 4$, where $x \in \mathbb{R}$	<div> <div></div> <div>-4-3-2-101234</div> </div>

- (d) Write the following expression as a single fraction in its simplest form:

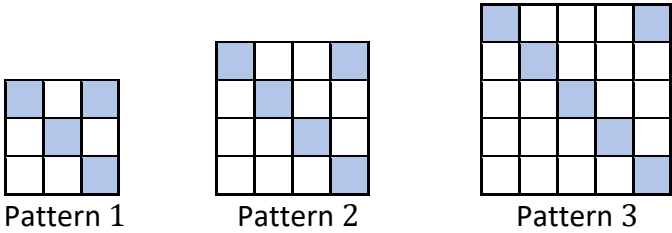
$$\frac{5x - 2}{3} + \frac{2}{5x + 2}$$



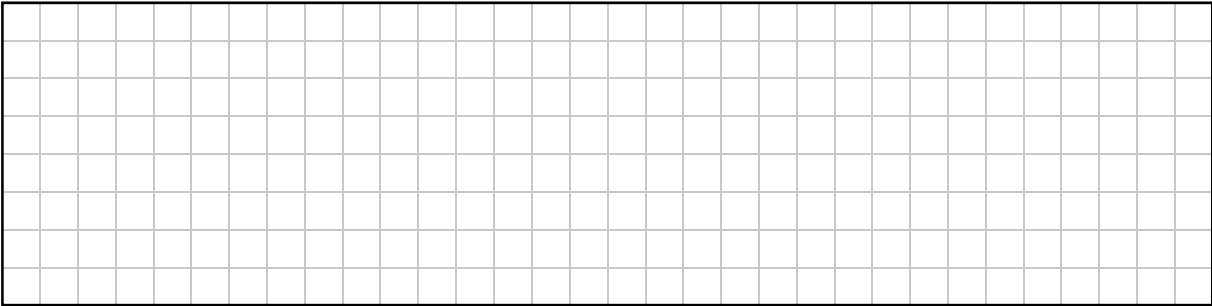
Question 12

(Suggested maximum time: 10 minutes)

The first 3 patterns in a sequence are shown below.
 Each pattern consists of white squares and shaded squares.

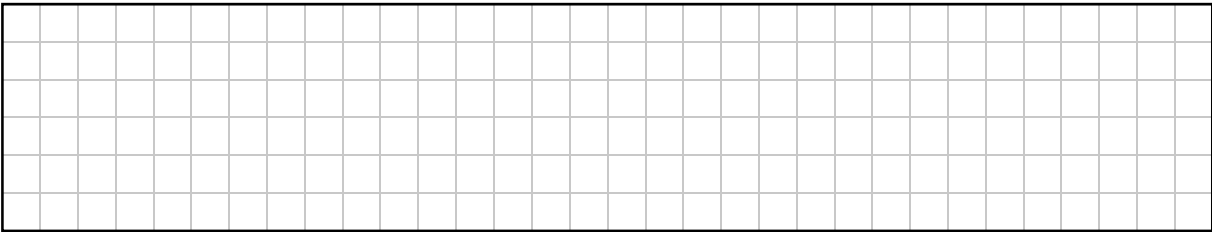


(a) Draw Pattern 4 in the sequence.



(b) Complete the table to show the number of **shaded squares** and the **total** number of squares in the sequence. Give your answer in the last row in terms of n , where $n \in \mathbb{N}$.

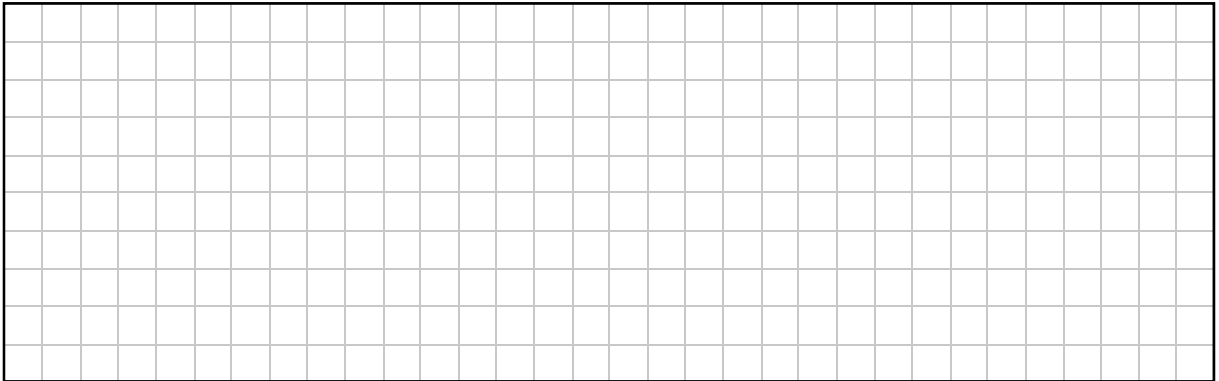
Pattern	Number of shaded squares	Total number of squares
1	4	9
2		
3		
4		
5		
n		$(n + 2)^2$



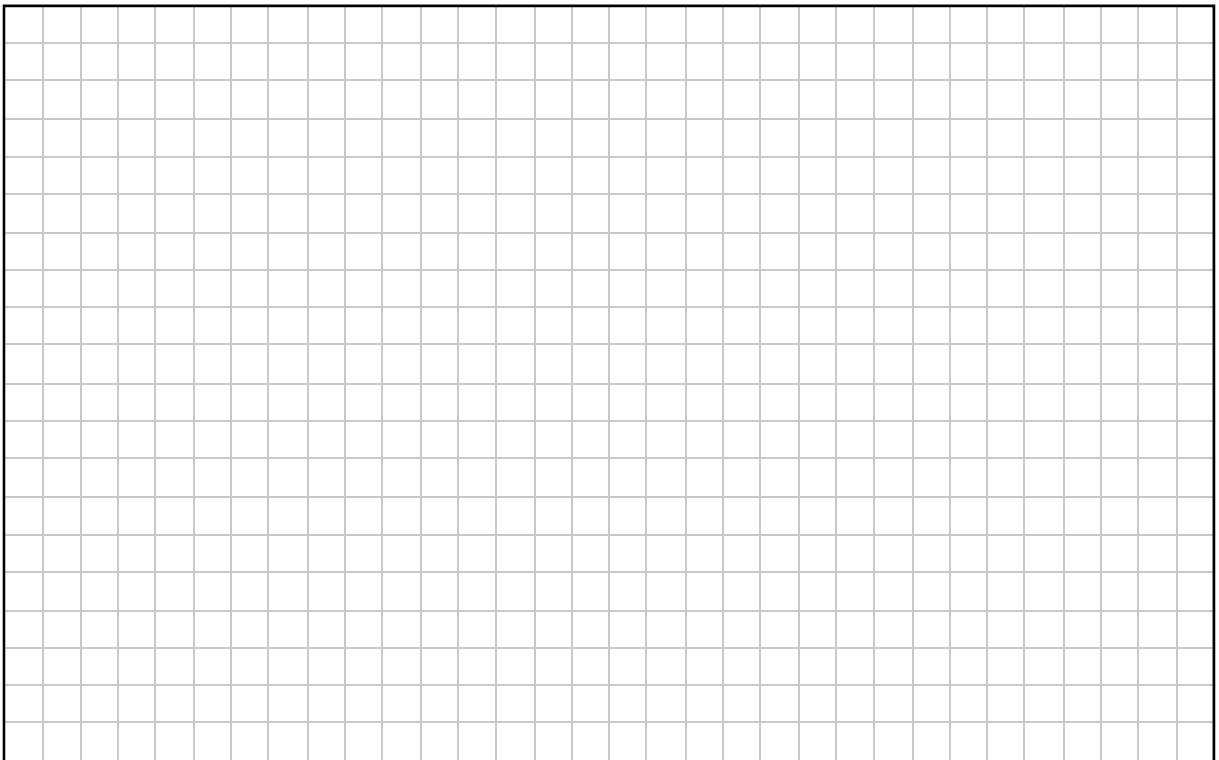
- (c) In pattern k , the **difference** between the **total number of squares** and the **number of shaded squares** is **271**.

- (i) Show that this means that:

$$k^2 + 3k + 1 = 271$$



- (ii) Solve the equation $k^2 + 3k + 1 = 271$ to work out the value of k .

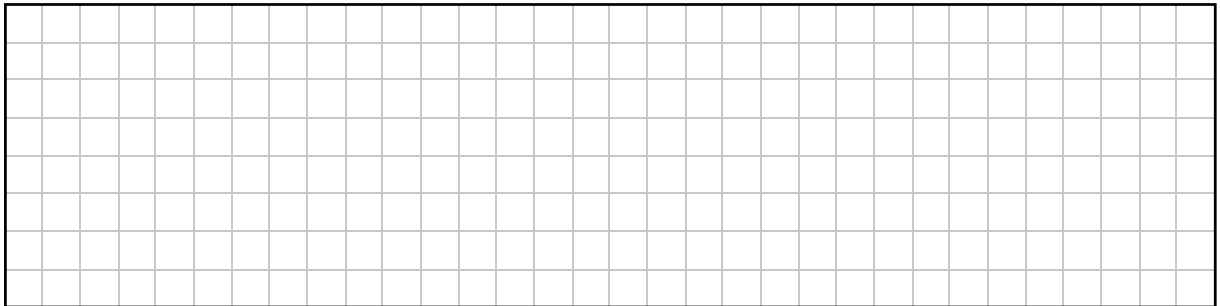
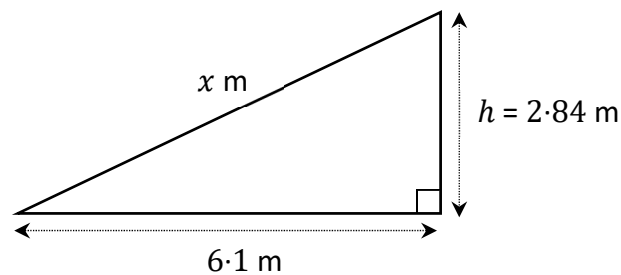


Question 13**(Suggested maximum time: 10 minutes)**

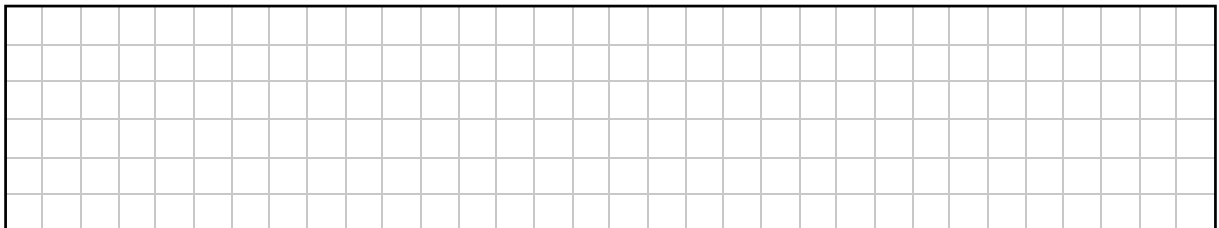
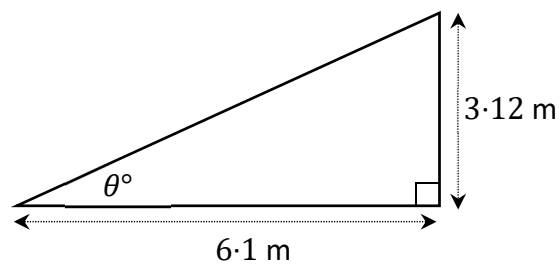
Michael is designing the roof of a house.
The width of the roof is 6.1 m.
The roof will be in the shape of a right angled triangle of height h , where $h \in \mathbb{R}$.
Michael can choose different values for h .



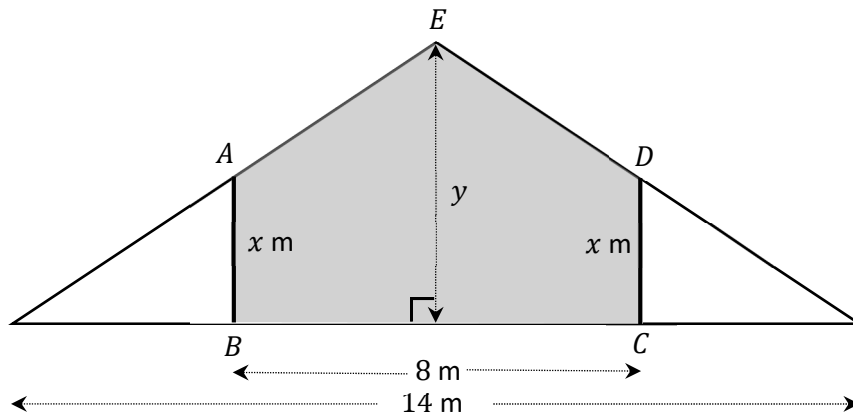
- (a) The diagram below shows one possible design for the roof (not to scale).
Calculate the slant height (x m) of the roof in this diagram, correct to 2 decimal places.



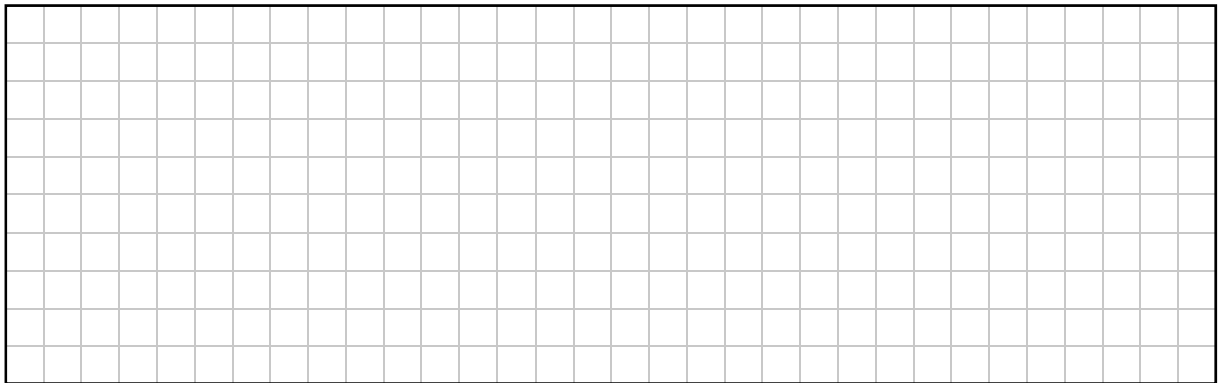
- (b) The diagram below shows a different design for this part of the roof (not to scale).
Use trigonometry to work out the size of the angle marked θ in the diagram.
Give your answer in degrees, correct to the nearest degree.



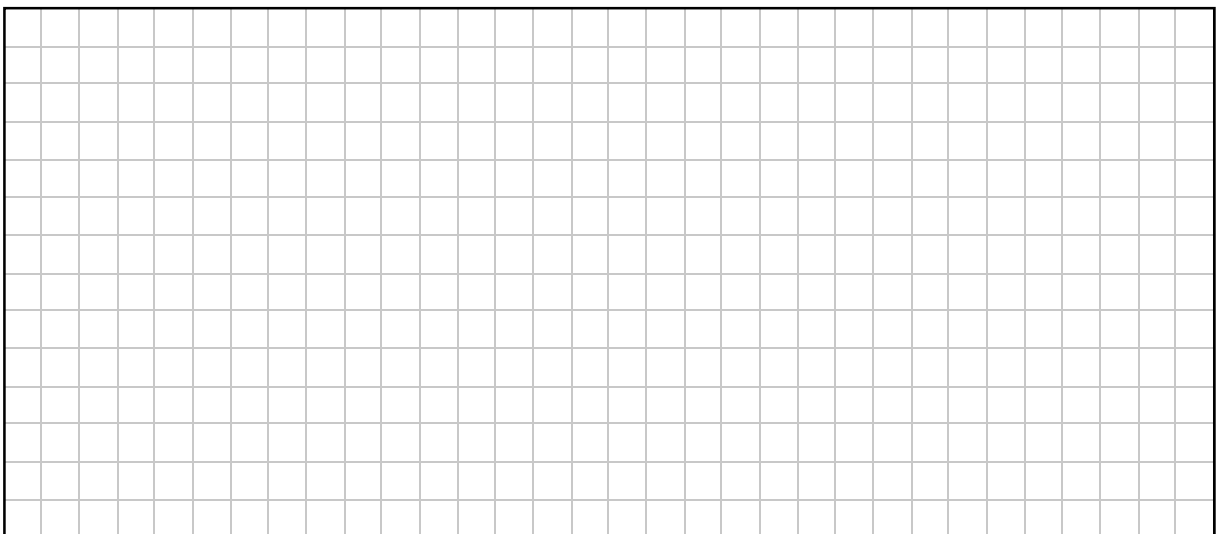
A different part of the roof is in the shape of an isosceles triangle, with base 14 m. In this part of the roof Michael makes an attic room, by putting in the two vertical side walls $[AB]$ and $[DC]$ shown in the diagram below (not to scale). The distance from B to C is 8 m. The total height of the roof is y metres, and $|AB| = |DC| = x$ metres, where $x, y \in \mathbb{R}$.



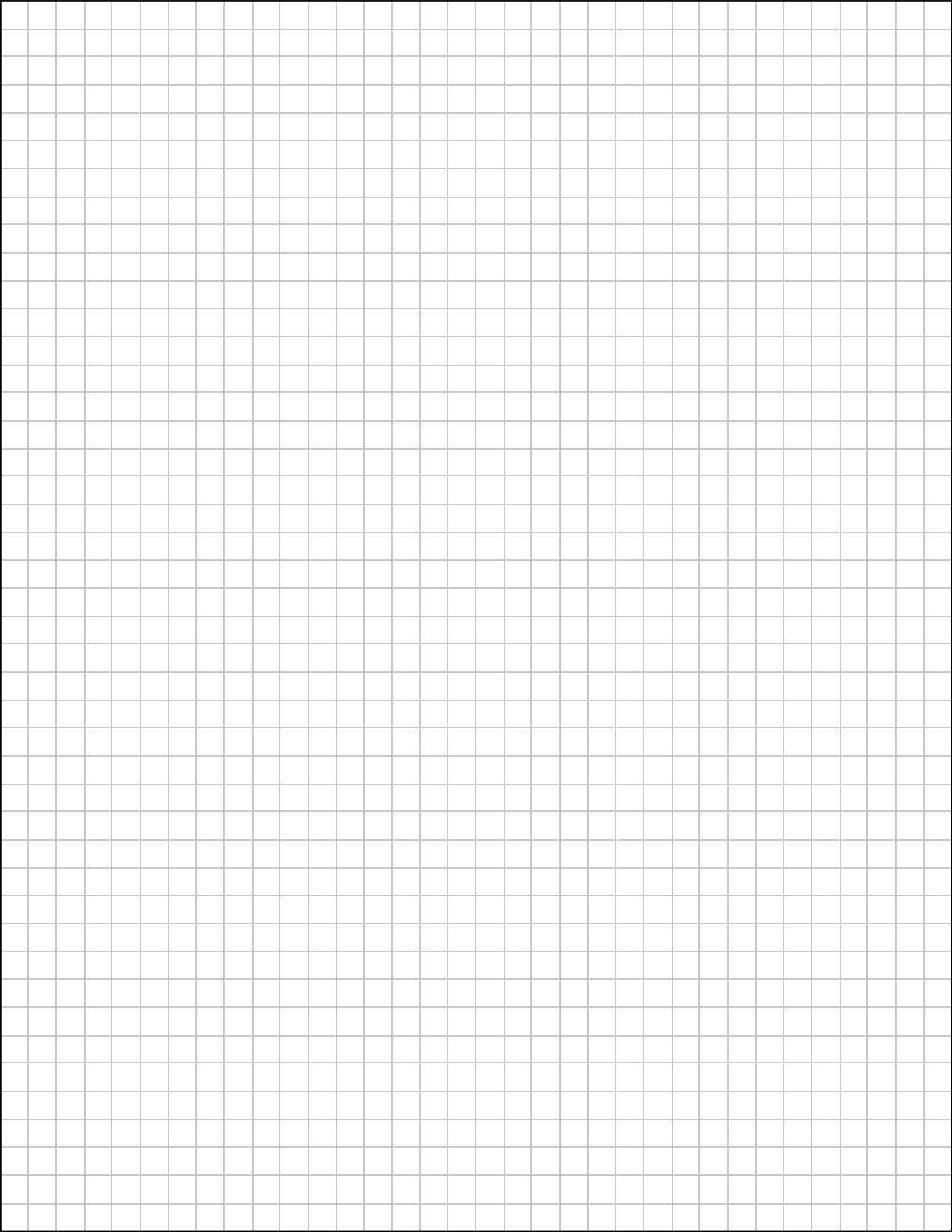
- (c) (i) Use similar triangles to show that $x = \frac{3y}{7}$.



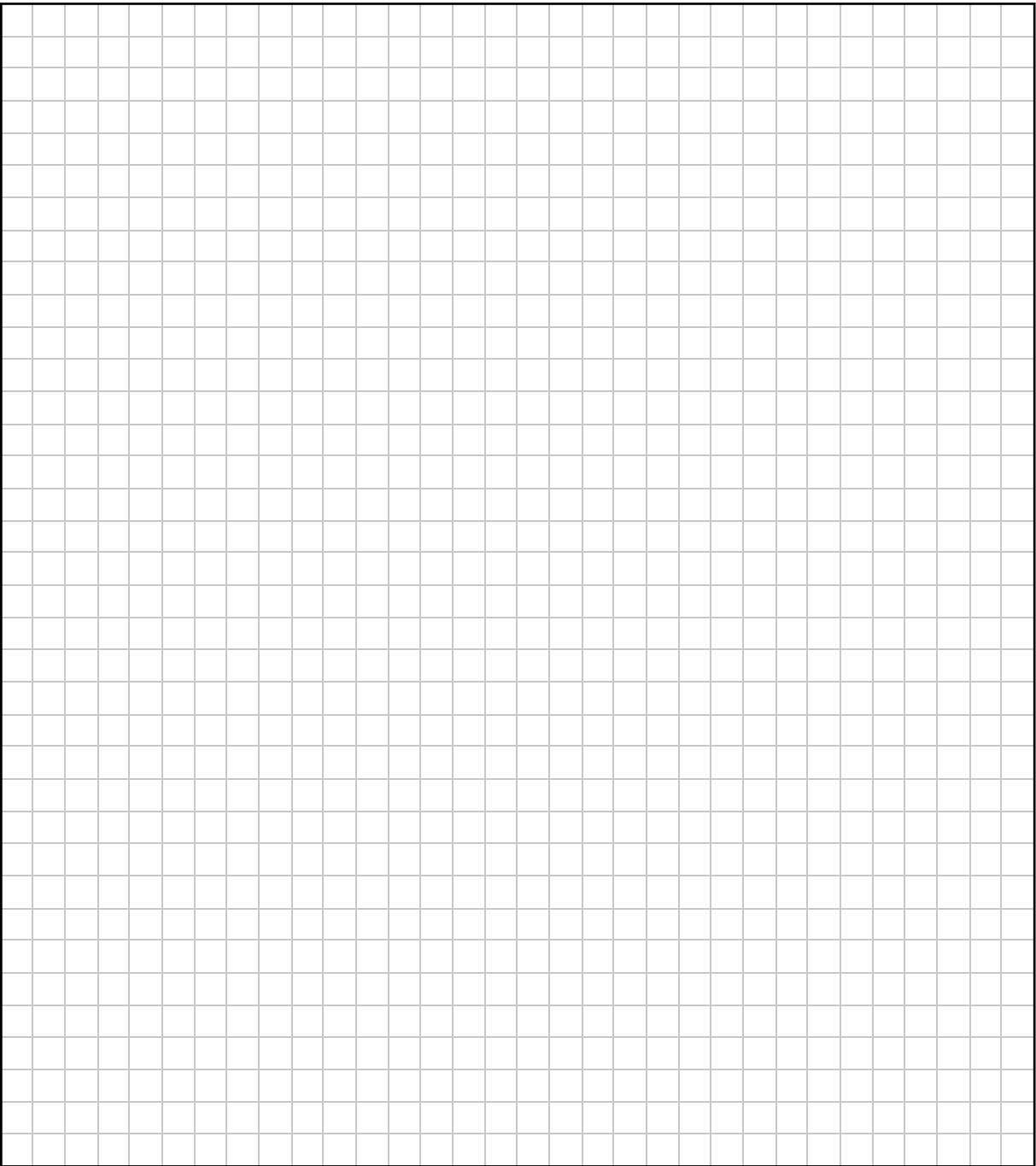
- (ii) The area of the shaded region $ABCDE$ in the diagram is 12 m^2 . Using your answer from **part (c)(i)**, or otherwise, work out the value of y .



Page for extra work.
Label any extra work clearly with the question number and part.



Page for extra work.
Label any extra work clearly with the question number and part.



Acknowledgements

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Junior Cycle Final Examination – Higher Level

Mathematics

Friday 7 June

Afternoon 1:30 - 3:30



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Junior Cycle Final Examination 2023

Mathematics

Higher Level

Friday 9 June Afternoon 1:30 - 3:30

270 marks

Examination Number

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Day and Month of Birth

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For example, 3rd February is
entered as 0302

Centre Stamp

Instructions

There are 14 questions on this examination paper. Answer **all** questions.

Questions do not necessarily carry equal marks. To help you manage your time during this examination, a maximum time for each question is suggested. If you remain within these times you should have about 10 minutes left to review your work.

Write your answers in the spaces provided in this booklet. You may lose marks if you do not do so. You may ask the superintendent for more paper. Label any extra work clearly with the question number and part.

The superintendent will give you a copy of the *Formulae and Tables* booklet. You must return it at the end of the examination. You are not allowed to bring your own copy into the examination.

You may lose marks if your solutions do not include supporting work.

You may lose marks if you do not include the appropriate units of measurement, where relevant.

You may lose marks if you do not give your answers in simplest form, where relevant.

Write the make and model of your calculator(s) here:

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Question 1 (Suggested maximum time: 5 minutes)

When Xena was going to work one day, the temperature on the screen was 18 °C.



- (a) Write down **three** possible values that the **actual** temperature could have been when Xena was going to work.

☐ , ☐ , ☐

Let t represent the **actual** temperature at a given time.

- (b)** Fill in the missing values in the inequality in t below to show the range of possible values of t when Xena was going to work.

☐ $\leq t <$ ☐

- (c) If you were to graph the **actual** temperature, t , over the course of a day, would it be more appropriate to graph $t \in \mathbb{N}$, $t \in \mathbb{Z}$, or $t \in \mathbb{R}$? Give a reason for your answer.

Answer:

$$t \in \mathbb{N}$$
$$t \in \mathbb{Z}$$
 $t \in \mathbb{R}$

(Tick (✓) **one** box only)

1

9

1

Reason:

Question 2

(Suggested maximum time: 10 minutes)

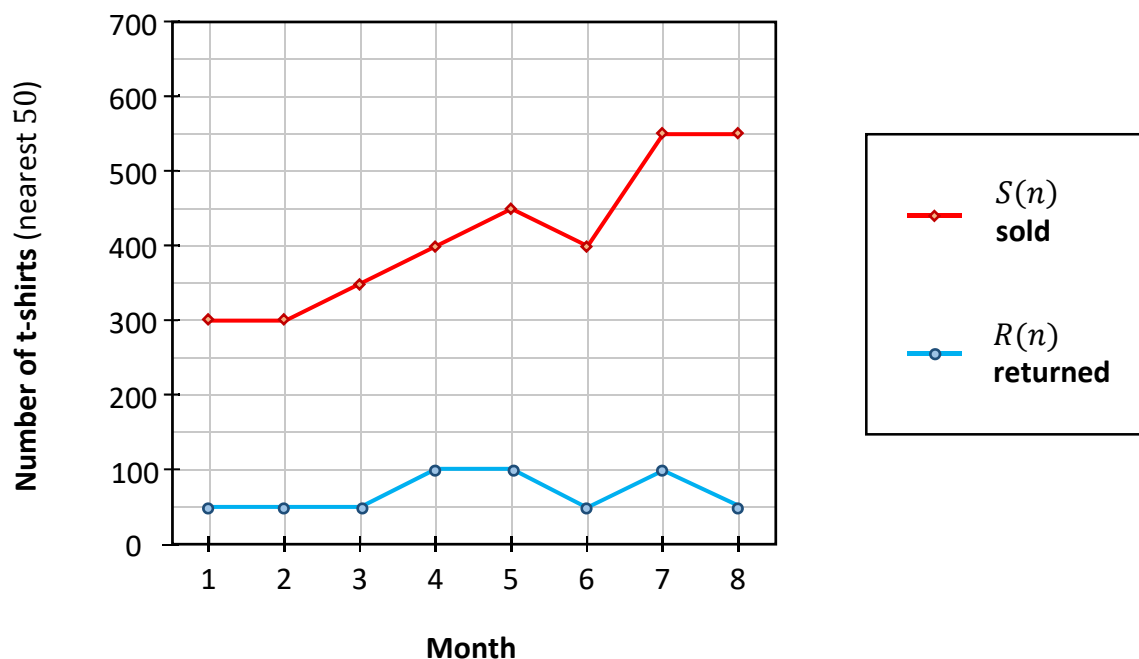
A company sells t-shirts on a website. Sometimes, when people buy a t-shirt, they return it again to get their money back.

The diagram below shows the following information for an 8-month period:

- $S(n)$, the number of t-shirts **sold** on the website in month n , and
- $R(n)$, the number of t-shirts sold in month n that were **returned**,



for $n \in \mathbb{N}$ and $n \leq 8$. All values are rounded to the nearest 50.



Use the information in the diagram to answer the following questions.

- (a) (i) How many t-shirts were **sold** in Month 1?

Answer =

- (ii) How many t-shirts were **returned** in Month 2?

Answer =

Question 3

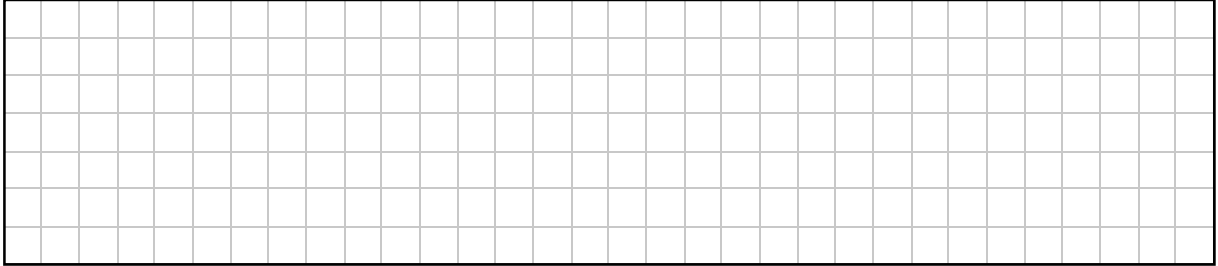
(Suggested maximum time: 10 minutes)

The students in a Transition Year mini-company make and sell candles.

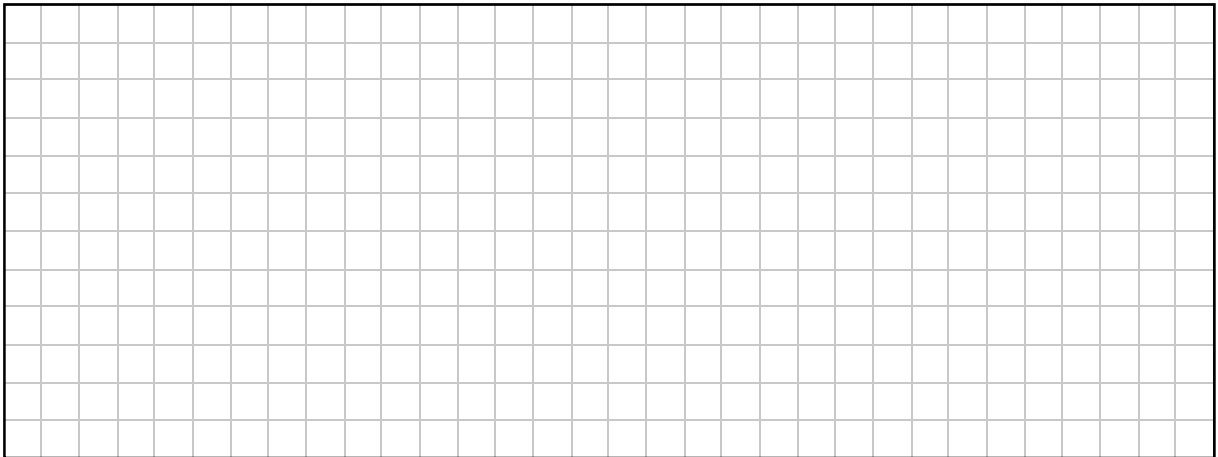
They buy a solid rectangular block of wax measuring 35 cm by 45 cm by 16 cm.



- (a) Work out the **volume** of the block of wax.

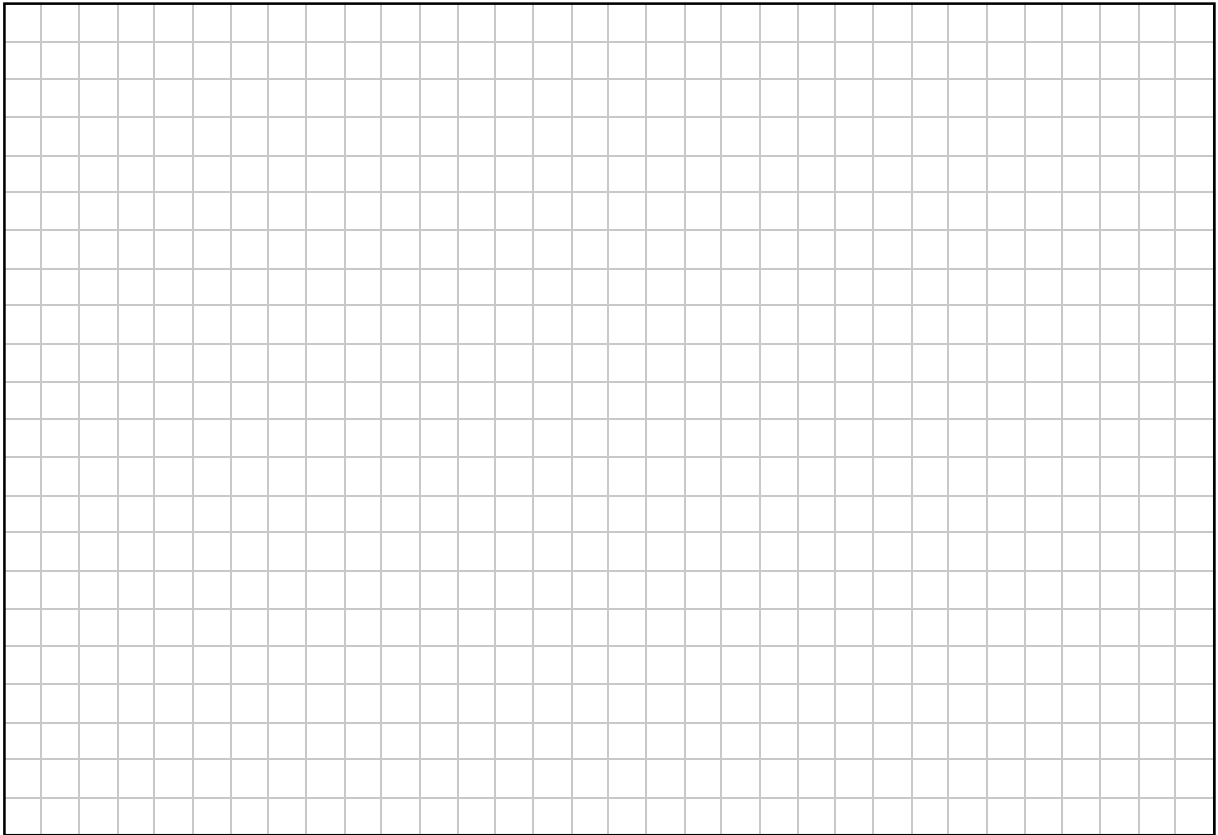


- (b) The students are going to use this wax to make candles in the shape of cylinders.
Each candle will have a radius of r cm and a height of 9 cm.
Work out the **volume** of each candle, in terms of r and π .



- (c) The students make 100 candles from the block of wax.
In making the candles, 10% of the wax in the block is wasted.

Use this information to work out the value of r , the **radius** of each candle.
Give your answer correct to 1 decimal place.



Question 4

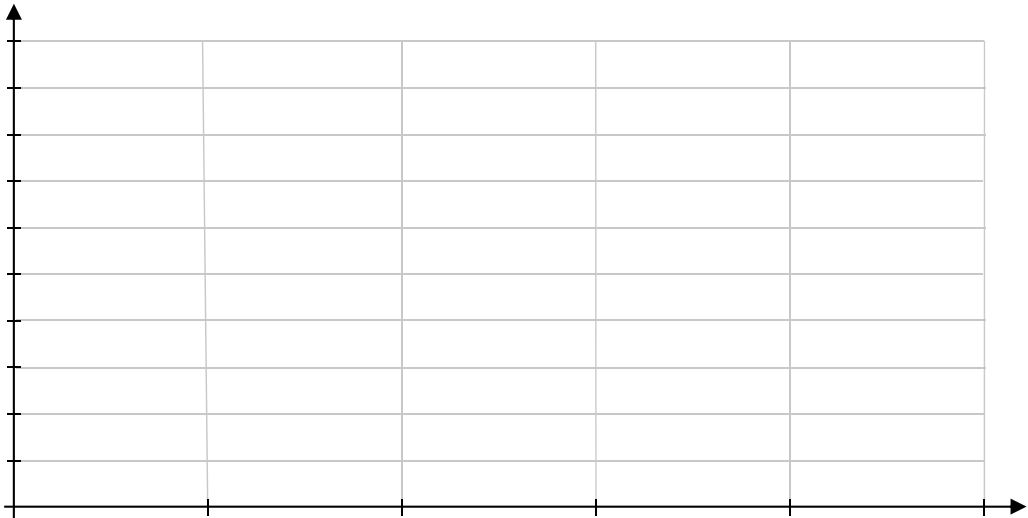
(Suggested maximum time: 10 minutes)

The ages of children in a crèche were recorded.
The data are shown in the table below.

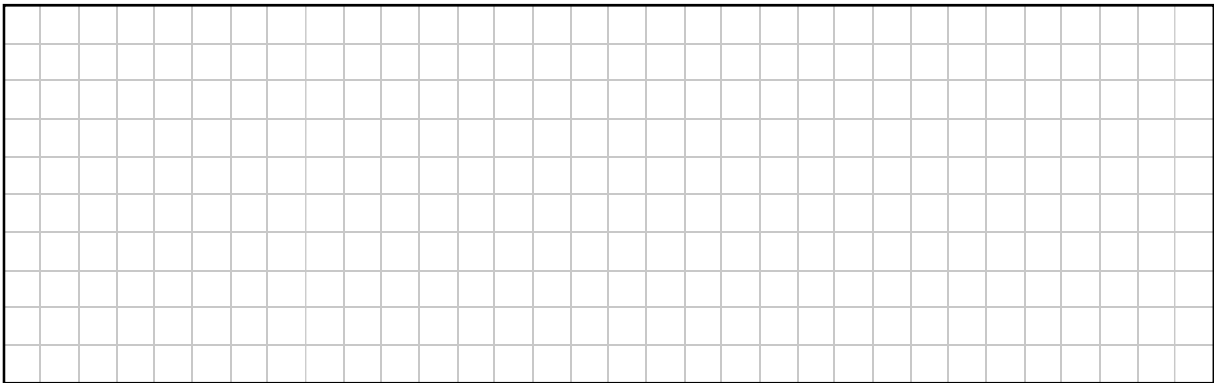
Age (years)	0 – 1	1 – 2	2 – 3	3 – 4	4 – 5
Number of children	6	10	19	3	5

[Note: 2 – 3 means “2 years or more, but less than 3 years”, etc.]

(a) Represent the data on a **histogram**. Label the axes clearly.



(b) Work out the **percentage** of children in the crèche who are aged 1 – 2 years.
Give your answer correct to the nearest percent.



- (c) Use mid-interval values to estimate the **mean** age of the children in the crèche. Give your answer in years, correct to 1 decimal place.

- (d) The table below shows the **maximum** number of children that **one** staff member in the crèche can mind, depending on the age of the children. So, for example, one staff member can mind up to 3 children aged 0 – 1 years, **or** up to 5 children aged 1 – 2 years, and so on.

Age (years)	Maximum number of children that one staff member can mind
0 – 1	3
1 – 2	5
2 – 3	6
3 – 6	8

Work out the **least** number of staff members that are needed to mind all of the children in the crèche.

Question 5 (Suggested maximum time: 5 minutes)

Question 5 (Suggested maximum time: 5 minutes)

- (a) The table below shows the outcome when the numbers a and b are multiplied together, for $a, b \in \mathbb{N}$.

Write “**odd**” or “**even**” in each box to complete each of the mathematical statements correctly. The first one is done for you.

	a	\times	b	$=$	c
1.	even	\times	even	$=$	even
2.	odd	\times	odd	$=$	
3.	odd	\times	even	$=$	

[illegible]

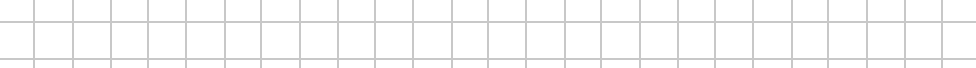
Ruairí rolls a regular, unbiased, six-sided die three times. He writes down the number on each roll of the die.



- (b)** Complete the sample space below, showing the different possible combinations of odd numbers (**O**) and even numbers (**E**) that Ruairí could roll. Two possible outcomes have been filled in for you.

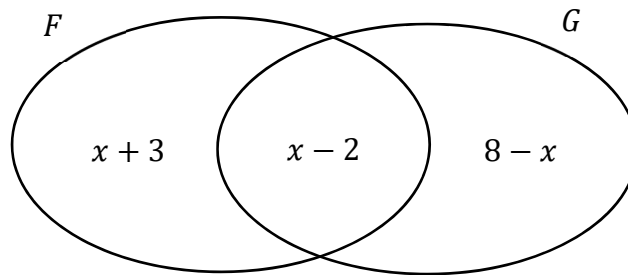
EEE	EEO		

- (c) Each outcome in the table is equally likely.
Ruairí **multiplies** together the three numbers that he rolls.
Find the **probability** that Ruairí will get an **even number** as his answer.



Question 6**(Suggested maximum time: 5 minutes)**

The Venn diagram below shows the number of elements in three regions in the sets F and G , where $x \in \mathbb{N}$.



- (a) Write down the value of $\#(F \setminus G)$, in terms of x .

Answer =

- (b) From the Venn diagram, find the **greatest** possible value of x .
Justify your answer.

Answer:

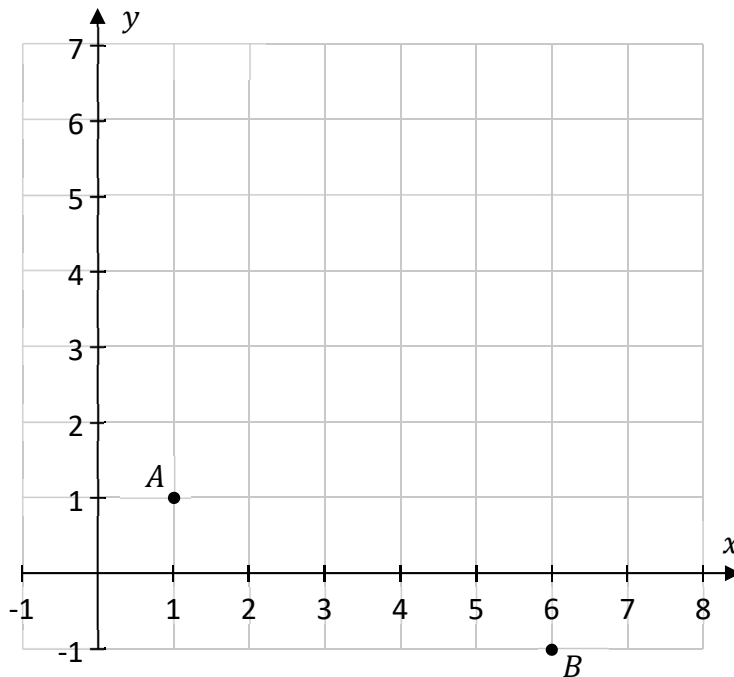
Justification:

Question 7

(Suggested maximum time: 10 minutes)

A , B , C , and D are four points in the co-ordinate plane.

- (a) (i) The points A and B are shown on the co-ordinate diagram below.
Plot and label the points $C(8, 4)$ and $D(3, 6)$ on the same co-ordinate diagram.

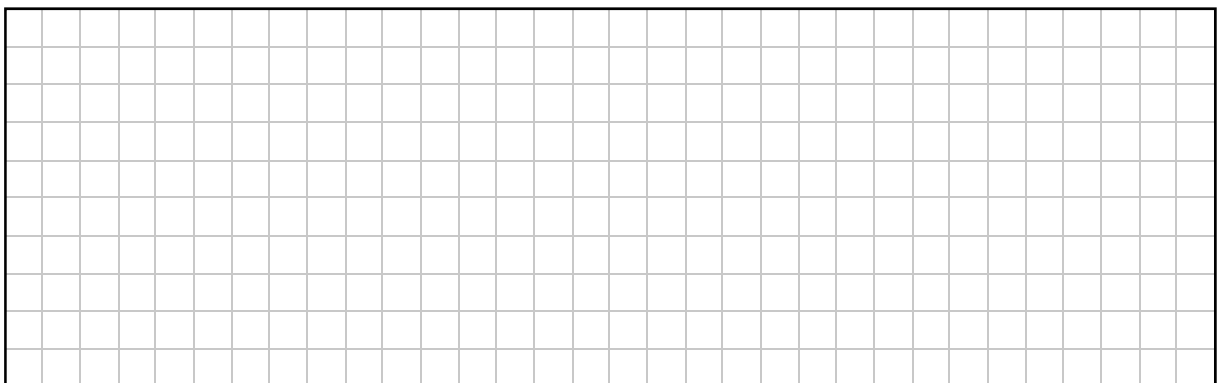


- (ii) **Write** the co-ordinates of the points A and B in the spaces below.
 The co-ordinates of the points C and D are already given.

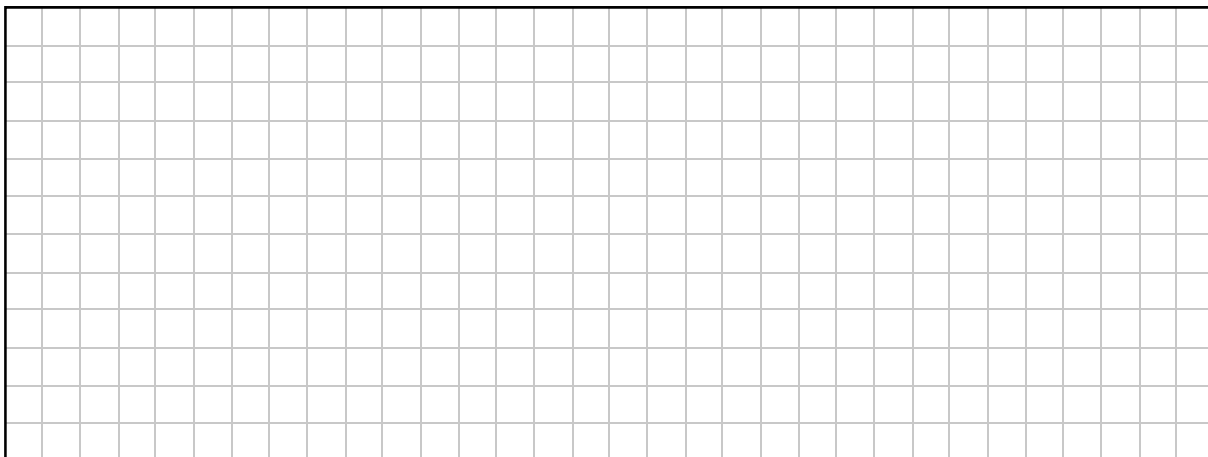
$$A = \left(\quad , \quad \right) \quad B = \left(\quad , \quad \right) \quad C = (8, 4) \quad D = (3, 6)$$

- (b) Paulina wants to prove that $ABCD$ is actually a **square**.
 Answer (b)(i) and (b)(ii) below to show that $ABCD$ is a square.

- (i) Show that $|AB| = |BC|$.



- (ii) Without measuring the diagram, show that AB is **perpendicular** to BC .



- (c) Ciarán makes the following statement:

Ciarán's statement: "Every parallelogram is a square."

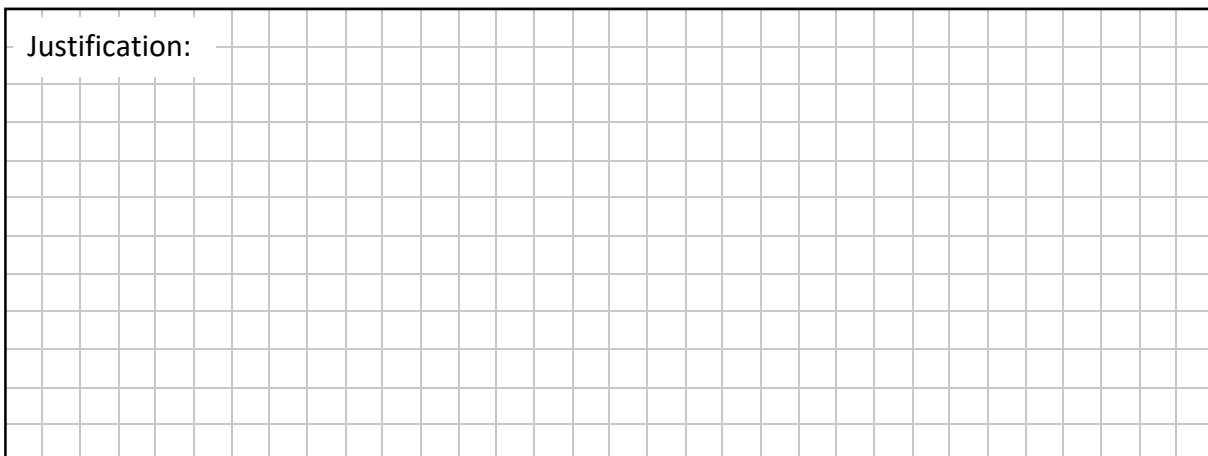
- (i) Is Ciarán's statement true or false? Justify your answer.

Ciarán's statement is: true false

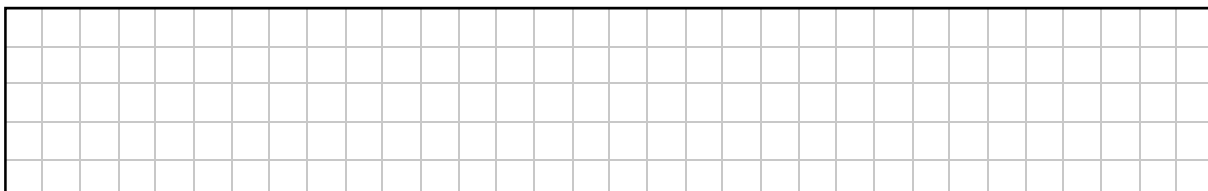
(Tick (✓) **one** box only)

☐☐

Justification:



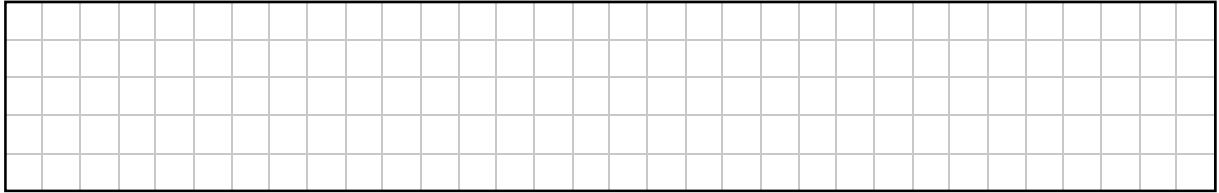
- (ii) Write down the **converse** of Ciarán's statement.



Question 8**(Suggested maximum time: 10 minutes)**

- (a)** Convert 7.5 kilometres to **metres**.

$$7.5 \text{ km} = \boxed{} \text{ m}$$

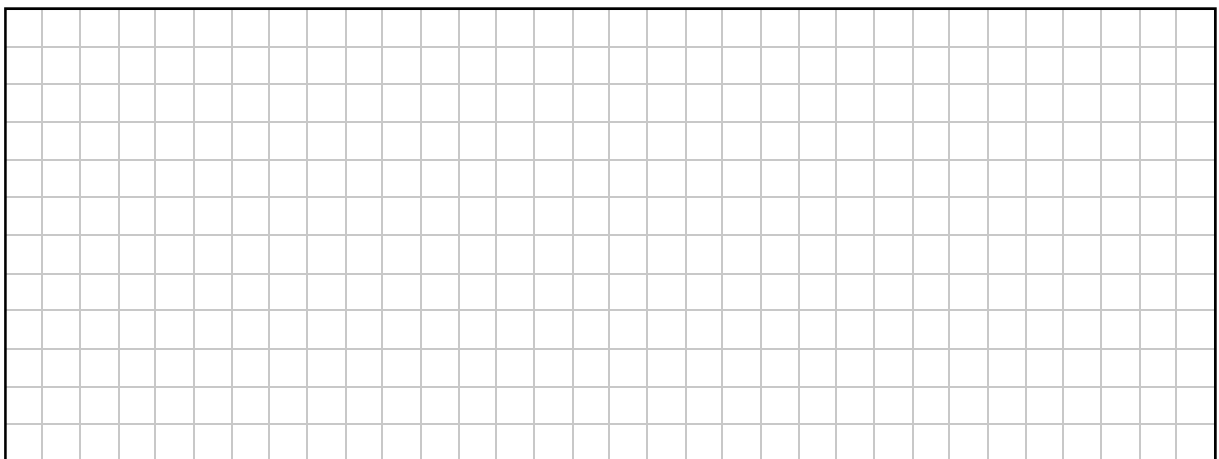
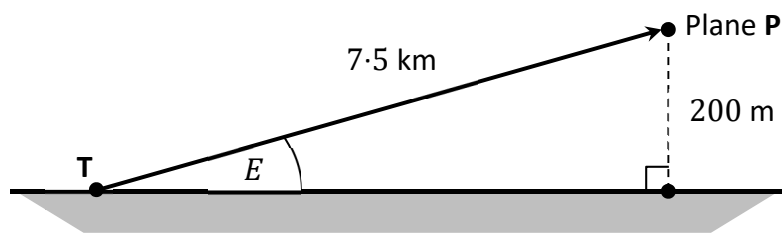


- (b)** A plane, **P**, took off from an airport.
It left the ground at the point **T**.

After a few minutes, it was 7.5 km from **T**, and it was 200 m directly above level ground, as shown in the diagram below (not to scale).



Use trigonometry to work out the size of the angle marked **E** in the diagram.
Give your answer in degrees, correct to 1 decimal place.



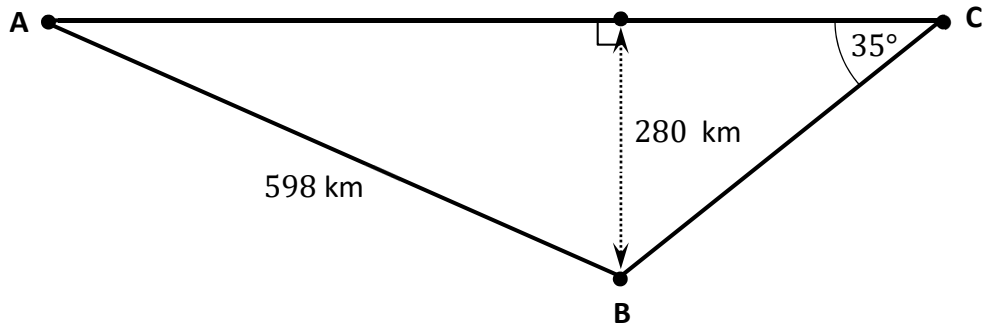
- (c) (i) Write 20 minutes as a fraction of an **hour**. Give your answer in simplest form.

$$20 \text{ minutes} = \frac{\boxed{}}{\boxed{}} \text{ hour}$$

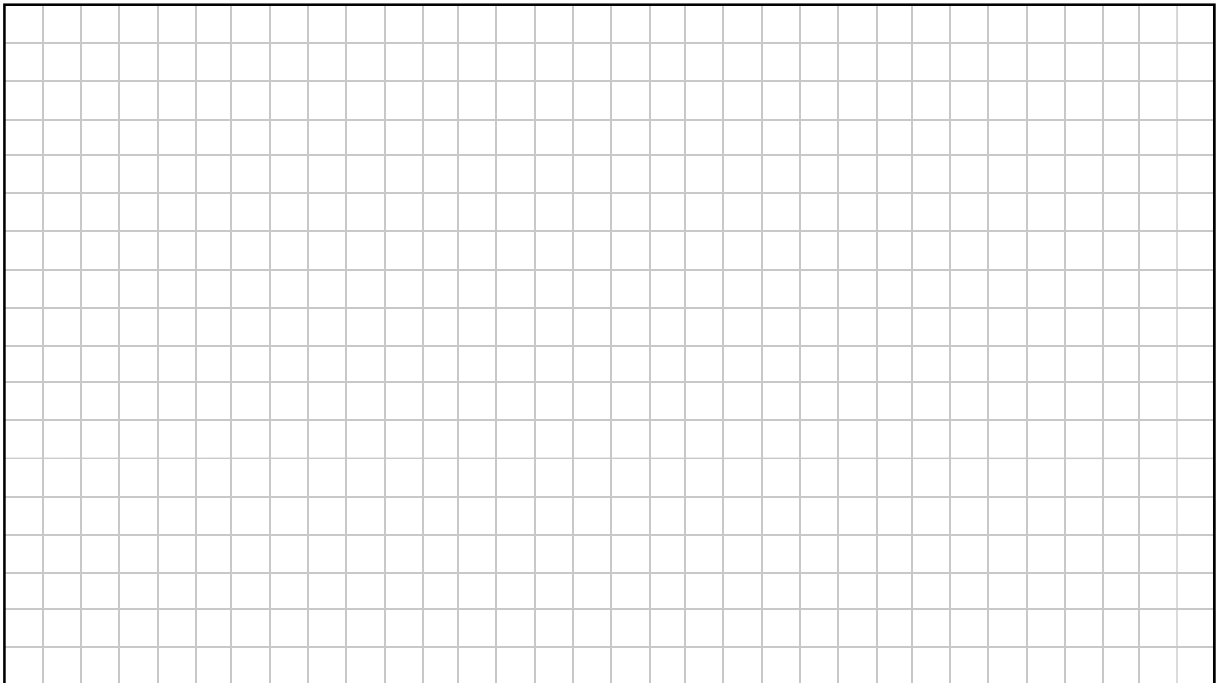
- (ii) During part of its flight, plane **P** travelled 598 km in two hours and twenty minutes. Work out the average **speed** of plane **P** during that time, in km per hour. Give your answer correct to 1 decimal place.

This question continues on the next page

- (d) In the diagram below, each of the points **A**, **B**, and **C** represents an airport. The plane travelled 598 km from Airport **A** to Airport **B**, and then travelled on to Airport **C**.



Work out the distance $|AC|$, correct to the nearest km.



Question 9**(Suggested maximum time: 5 minutes)**

- (a)** Multiply out and simplify $4x(5x + 4) - 3(x - 2)$.

- (b)** Factorise fully $9 - 25y^2$.

- (c)** Write $\frac{5^7 \times 25^3}{\sqrt{5}}$ in the form 5^p , where $p \in \mathbb{Q}$.

Question 10 (Suggested maximum time: 10 minutes)

Question 10 (Suggested maximum time: 10 minutes)

Michelle must pay Universal Social Charge (USC) on all of her gross income.

The income bands and rates of USC that Michelle must pay are given in the table below.

Income Band	Rate of USC
Up to €12 012	1.5%
Next €5564	3.5%
Above €17 576	7%

Michelle pays USC at all three rates.

- (a)** Find the amount of USC that she must pay at each of the first two rates (1.5% and 3.5%).

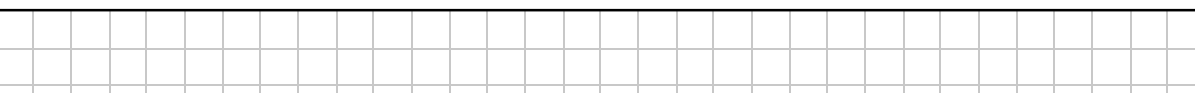
USC @ 1.5% = _____

USC @ 3.5% = _____

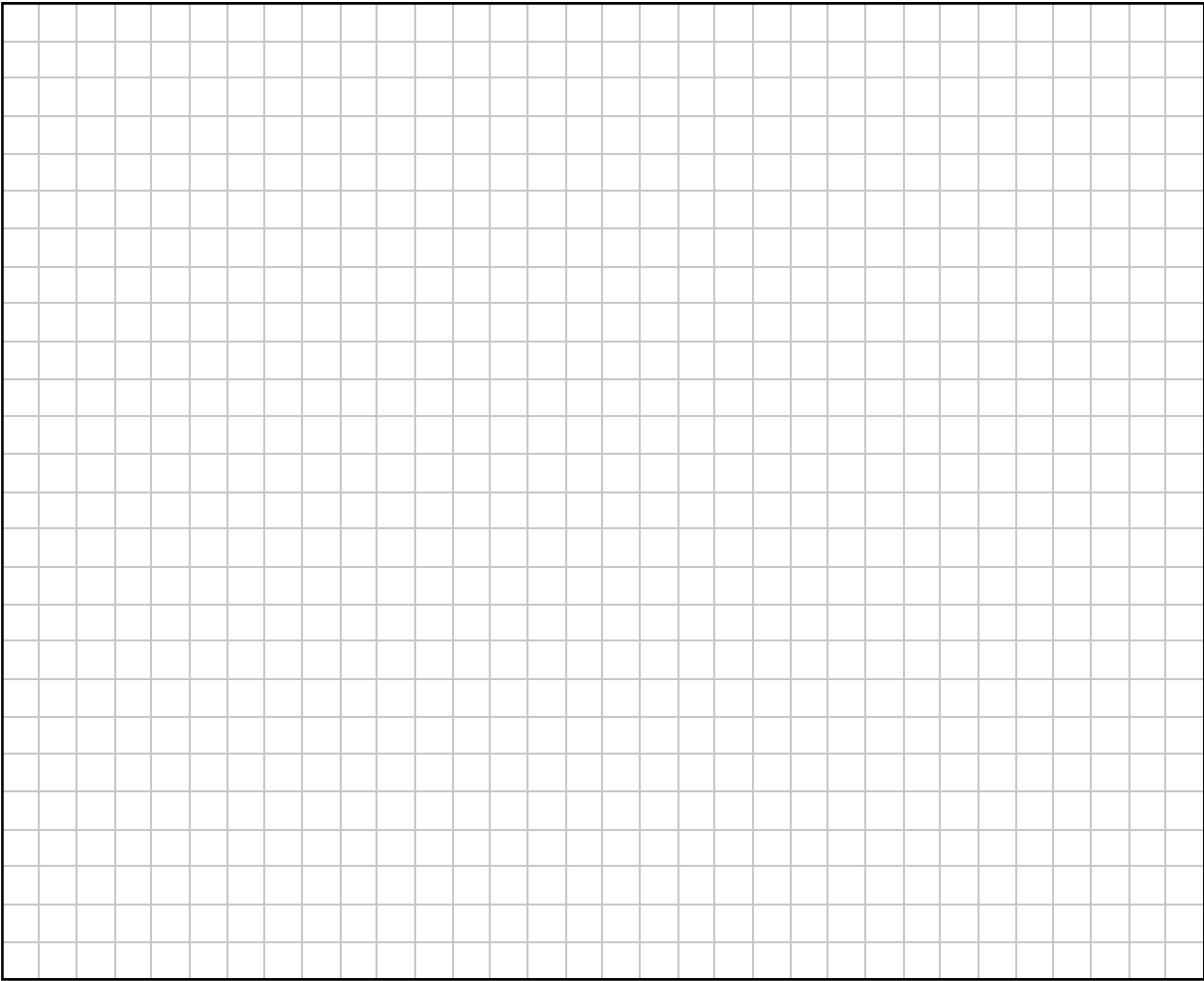
Michelle's gross income is x .

Michelle pays a total of 5% of her gross income in USC.

- (b) Write an expression, in terms of x , for the **total amount** of money that Michelle pays in USC.



(c) Find the value of x , Michelle’s gross income.



(Suggested maximum time: 5 minutes)

After the match, the 30 000 people left the stadium at a constant rate.

The graph shows a linear decrease in the number of people left in the stadium over time. The vertical axis represents the number of people left, and the horizontal axis represents the minutes after the end of the match. The line starts at 30,000 people at time 0 and passes through point G at (6, 21,000). The line ends at point W on the horizontal axis, which represents the time when the stadium is empty.

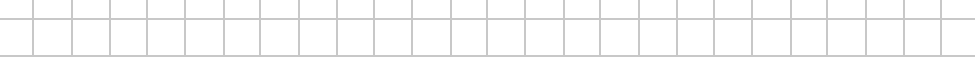
-
- A large rectangular area filled with a light gray grid pattern, intended for students to draw their own picture related to their story. The grid consists of approximately 30 columns and 8 rows of squares.

- $$\mathbf{w} = \begin{pmatrix} \quad , \quad \end{pmatrix}$$

- (c)** The equation of the graph can be written as:

$$P = 30\,000 - 1500\,t$$

- (i) How many people were in the stadium 12 minutes after the match had finished?

A large rectangular area filled with a light gray grid pattern, intended for drawing or writing. The grid consists of 20 columns and 10 rows of squares.

- (ii) Explain what the 1500 in this equation means, in terms of the number of people in the stadium.

Question 12**(Suggested maximum time: 10 minutes)**

The diagram below shows a curved shape ABC .

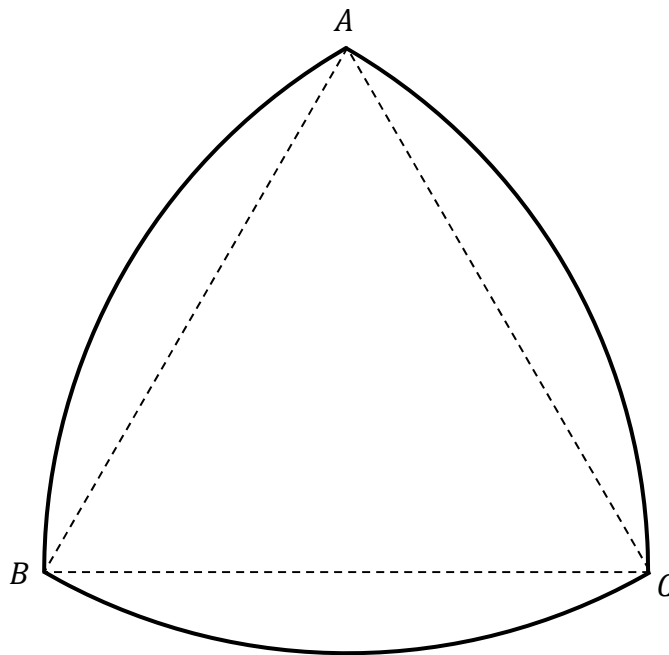
C is the centre of the circular arc from A to B .

A is the centre of the circular arc from B to C .

B is the centre of the circular arc from C to A .

The dotted triangle ABC is an equilateral triangle.

- (a)** Using only a compass and straight edge, **construct one** of the axes of symmetry of the curved shape ABC . Show all of your construction lines clearly.



Question 13

(Suggested maximum time: 10 minutes)

A company is making a large rectangular poster, as shown in the diagram on the right.

The top section will be a square image.

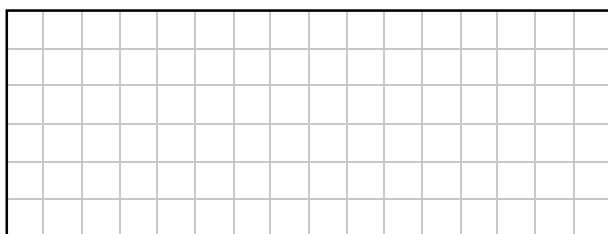
The bottom section will be a rectangle of height 0.5 m, which will have the sponsors' logos.

The width of the poster is x m, as shown.

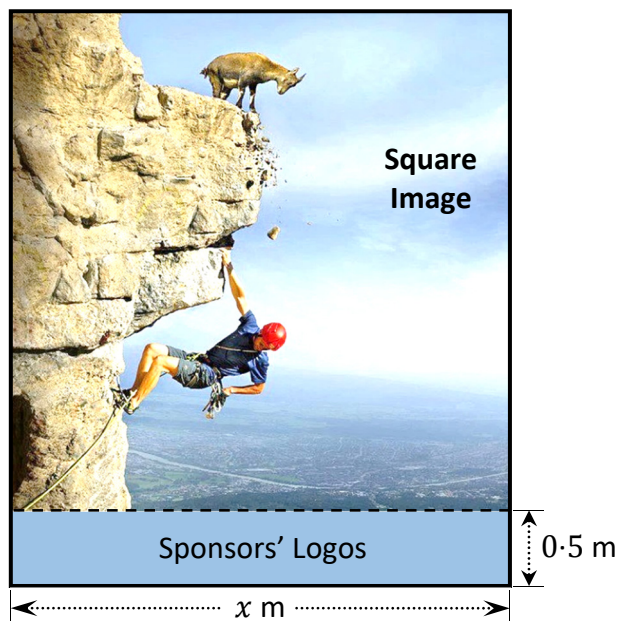
- (a) Write the **total height** of the poster, in terms of x .

Total height = m

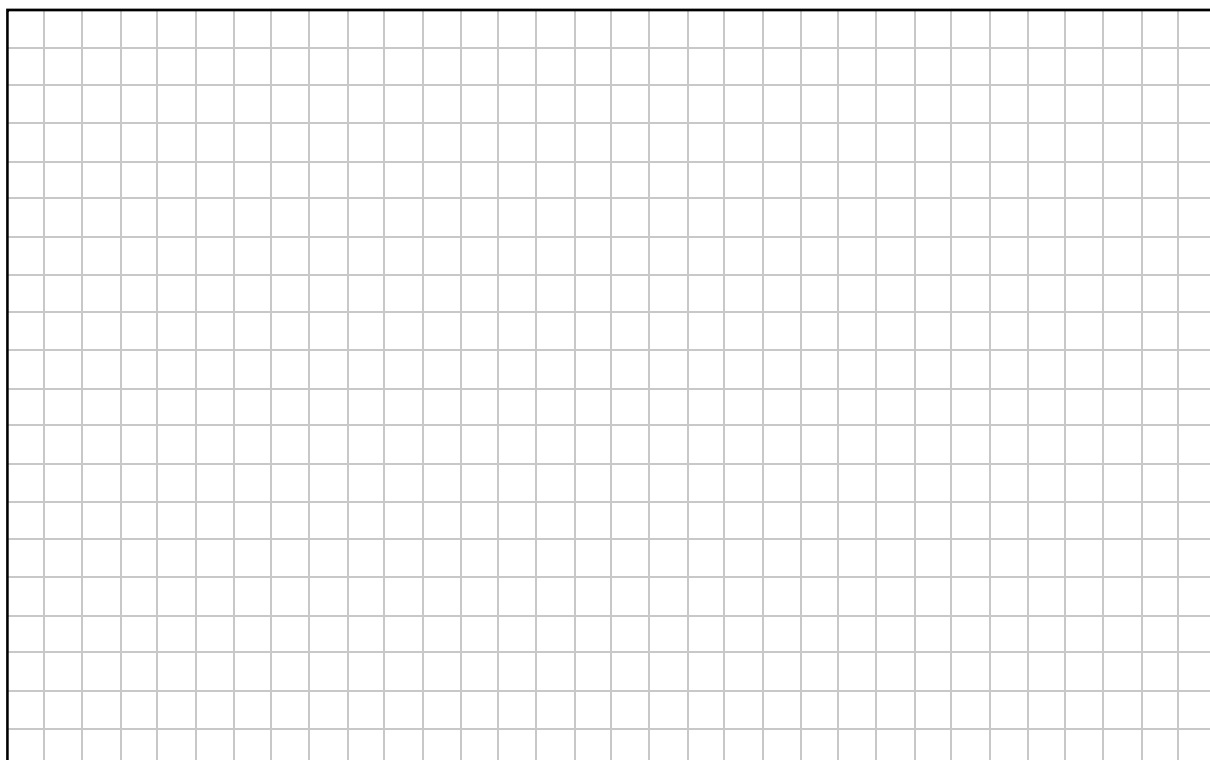
- (b) The **total area** of the poster is 50 m^2 . Show that $2x^2 + x - 100 = 0$.



Rectangular Poster



- (c) Solve the equation $2x^2 + x - 100 = 0$ to find the value of x , the width of the poster. Give your answer in **metres**, correct to the nearest **centimetre**.

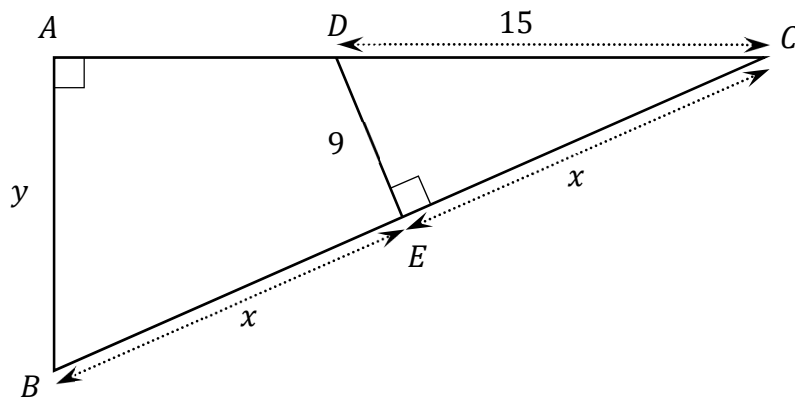


Question 14**(Suggested maximum time: 5 minutes)**

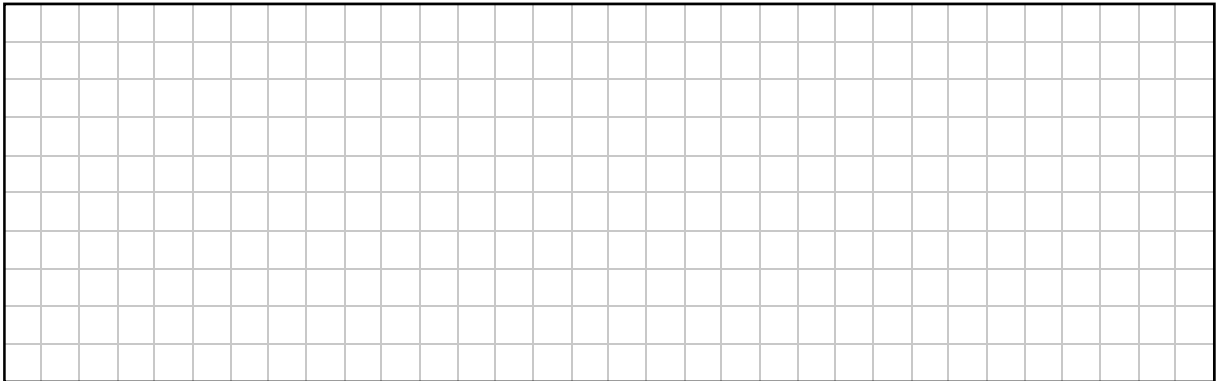
The diagram below shows a triangle ABC (not to scale).

The points D and E lie on $[AC]$ and $[BC]$, respectively. $|\angle CAB| = |\angle DEC| = 90^\circ$.

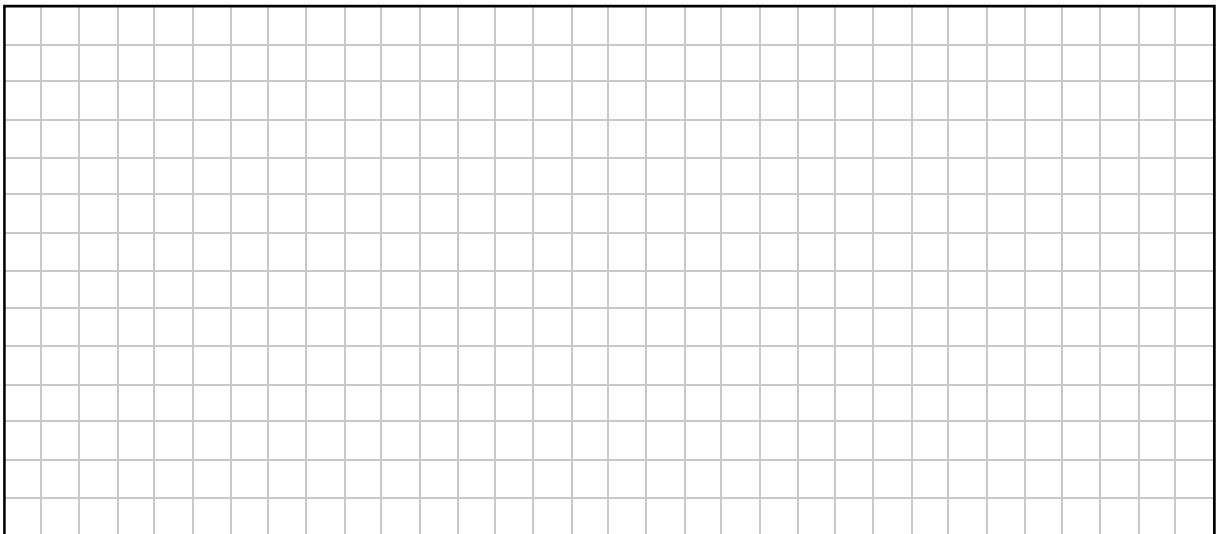
The lengths of some of the sides are given in the diagram, with $x, y \in \mathbb{R}$.



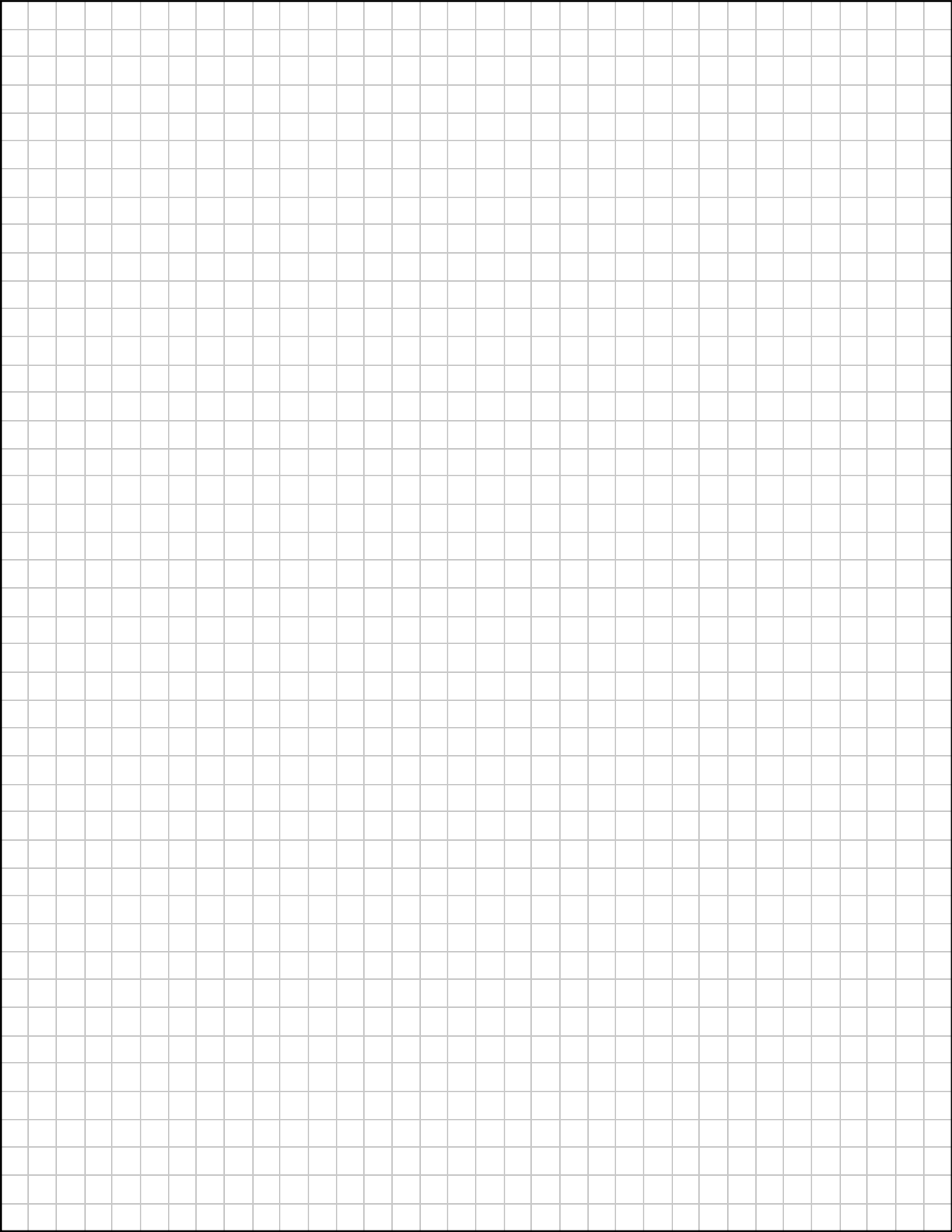
- (a) Work out the value of x .



- (b) Using similar triangles, work out the value of y .

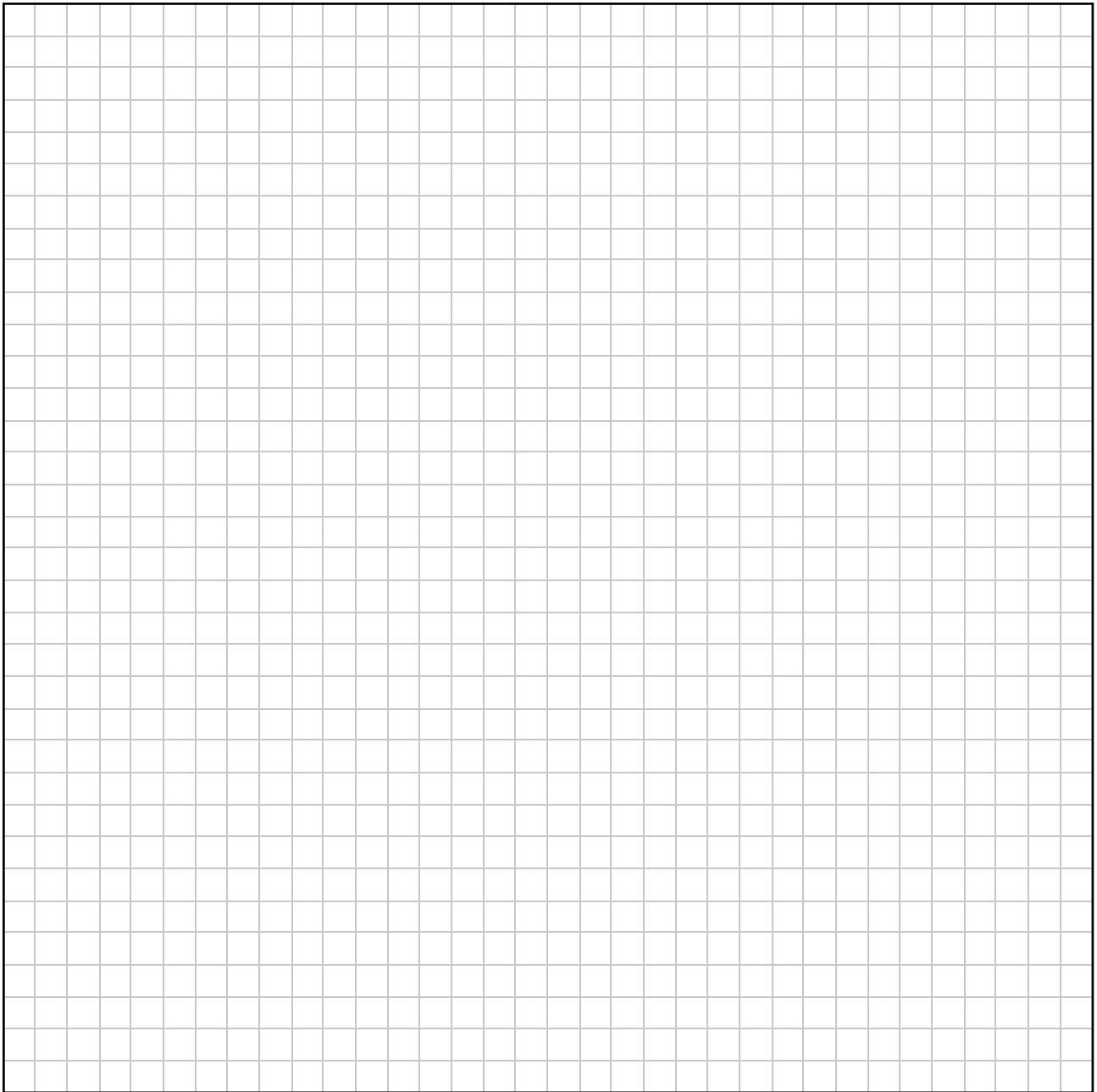


Page for extra work.
Label any extra work clearly with the question number and part.



Page for extra work.

Label any extra work clearly with the question number and part.



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Junior Cycle Final Examination – Higher Level

Mathematics

Friday 9 June

Afternoon 1:30 - 3:30



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Junior Cycle Final Examination 2022

Mathematics

Higher Level

Friday 10 June Afternoon 1:30 - 3:30

270 marks

Examination Number

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Day and Month of Birth

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For example, 3rd February
is entered as 0302

For Superintendent	
Centre Stamp	

For Examiner	
Running total	
Grade	

For Examiner					
Q.	Ex.	Adv. Ex.	Q.	Ex.	Adv. Ex.
1			11		
2			12		
3					
4					
5					
6					
7					
8					
9					
10			Total		

Instructions

There are 12 questions on this examination paper. Answer **all** questions.

Questions do not necessarily carry equal marks. To help you manage your time during this examination, a maximum time for each question is suggested. If you remain within these times you should have about 10 minutes left to review your work.

Write your answers in the spaces provided in this booklet. You may lose marks if you do not do so. You may ask the superintendent for more paper. Label any extra work clearly with the question number and part.

The superintendent will give you a copy of the *Formulae and Tables* booklet. You must return it at the end of the examination. You are not allowed to bring your own copy into the examination.

You may lose marks if your solutions do not include supporting work.

You may lose marks if you do not include the appropriate units of measurement, where relevant.

You may lose marks if you do not give your answers in simplest form, where relevant.


Write the make and model of your calculator(s) here:

--

Question 1**(Suggested maximum time: 10 minutes)**

- (a)** Jane buys a laptop online for \$699, plus a shipping cost of \$30.
The exchange rate is $\$1 = \text{€}0.90$.

Work out **in euro** the total cost to Jane of buying the laptop online.



A large grid for working out the total cost of the laptop.

- (b)** Jane has a gross annual income of €56 000.

Jane pays income tax on her gross income at a rate of 20% on the first €44 300,
and 40% on the balance.

- (i)** Work out Jane's annual income tax at each of these two rates (20% and 40%).

A large grid for working out Jane's annual income tax.

Income tax at 20% = €_____ Income tax at 40% = €_____

- (ii)** Jane has annual tax credits of €3300.
Work out Jane's annual take-home pay.

A large grid for working out Jane's annual take-home pay.

Question 2 (Suggested maximum time: 15 minutes)

Question 2 (Suggested maximum time: 15 minutes)

When Maeve's team play a match, they can win (**W**), draw (**D**), or lose (**L**).

- (a) Fill in the table below to show the 9 possible outcomes when Maeve's team play **two** matches. One is already done. **WD** means they win Match 1 and draw Match 2.

		Match 2		
		W	D	L
Match 1	W		W D	
	D			
	L			

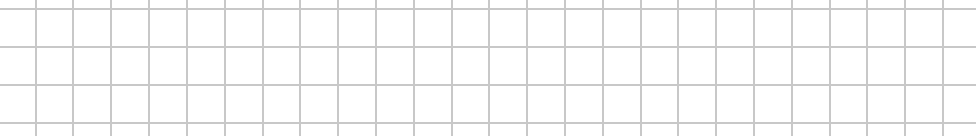


- (b)** Maeve thinks that each outcome in the table is equally likely. Based on this, find the **probability** that, when Maeve's team play two matches, they **win at least one** match. Give your answer as a fraction.

[illegible]

- (c)** Maeve's team play 5 matches in a competition.

Work out the total number of different possible outcomes for Maeve's team for these 5 matches. For example, one possible outcome would be **W W L D W**.

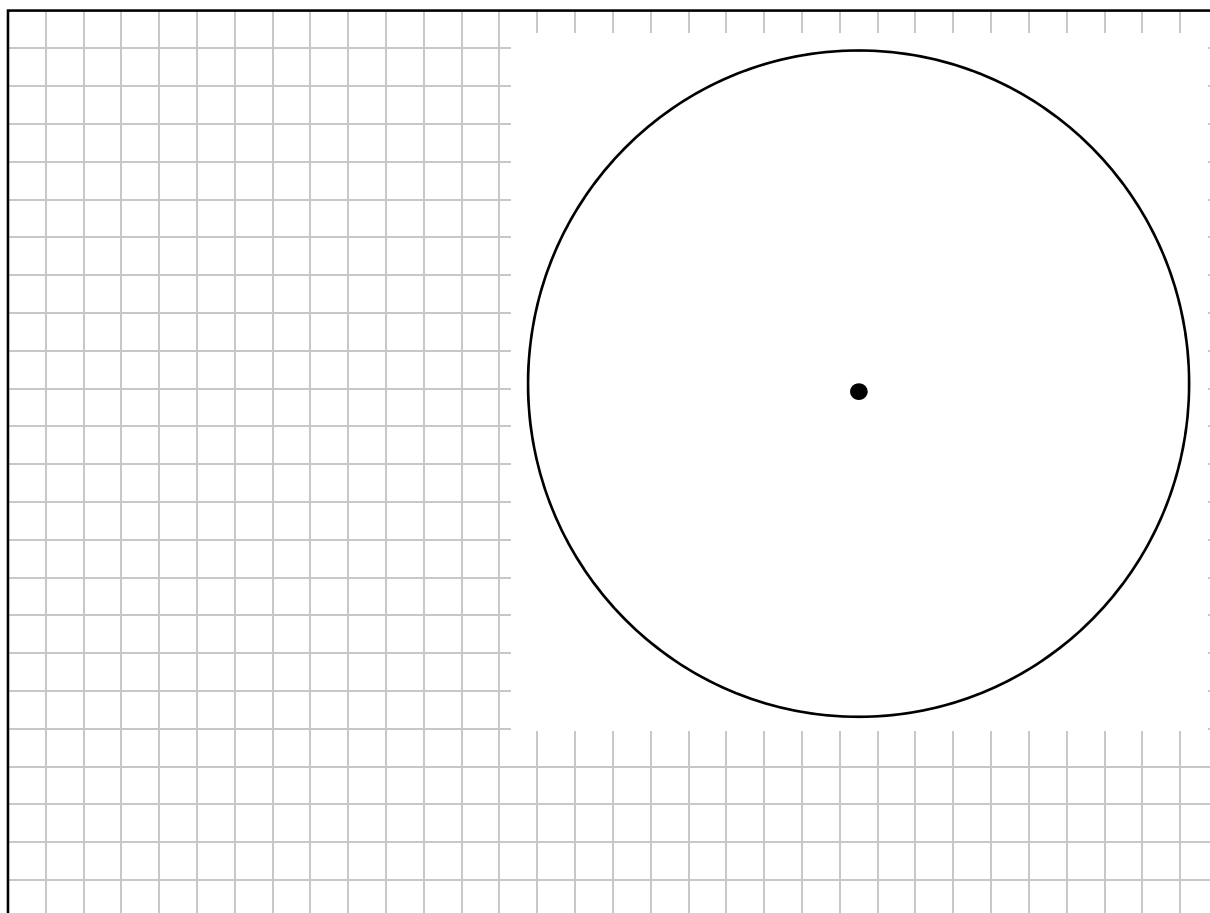


Maeve's team plays 11 matches in a league. The table below shows the number of goals that Maeve's team score in each of these 11 matches.

3	1	1	0	2	7	1	0	2	1	3
---	---	---	---	---	---	---	---	---	---	---

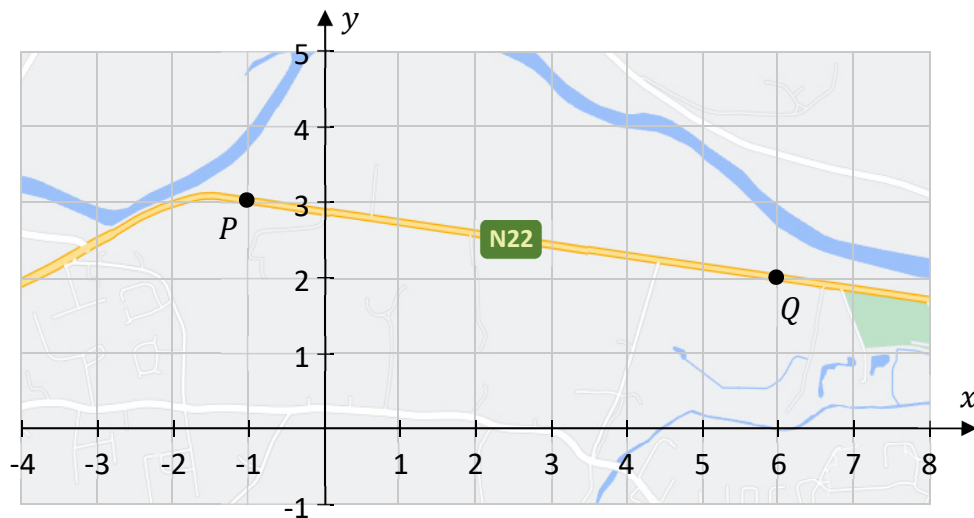
- (d) Work out the **mean** number of goals that Maeve's team score per match.
Give your answer correct to 1 decimal place.

- (e) Complete the **pie chart below**, to summarise the data above, showing the proportion of their games in which Maeve's team scored 0 goals, 1 goal, and so on.
Label each sector **and** the size of the angle clearly. Show any working out and construction lines.



Question 3**(Suggested maximum time: 10 minutes)**

The co-ordinate diagram below shows part of the N22 road in County Cork.
Two points on the road, P and Q , are marked on the diagram.



- (a) The point Q has co-ordinates $(6, 2)$.
Write down the co-ordinates of the point P .

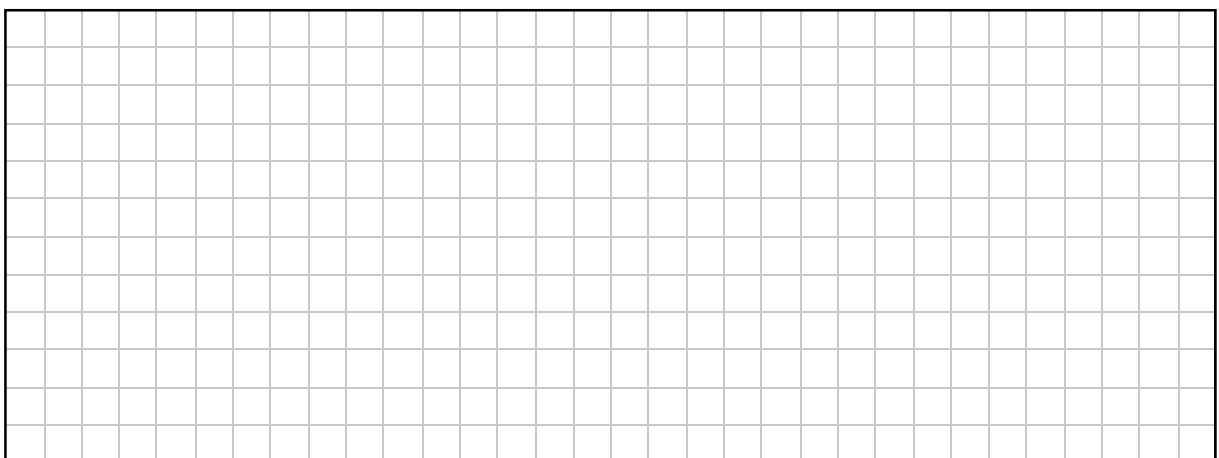
$$P = (\quad , \quad)$$

- (b) The equation of the line PQ is:

$$x + 7y = 20$$

Using this, or otherwise, find the co-ordinates of the point where the line PQ crosses the **y-axis**.

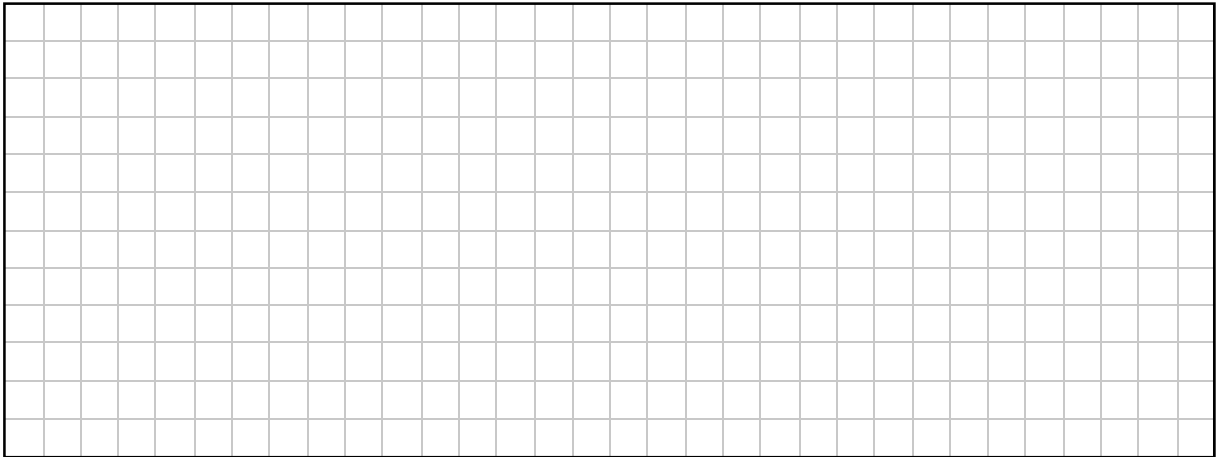
$$\text{Answer} = (\quad , \quad)$$



- (c) A new road is being built through the point $Q(6, 2)$.
On the co-ordinate diagram, it will be a straight line segment which is **perpendicular** to PQ .

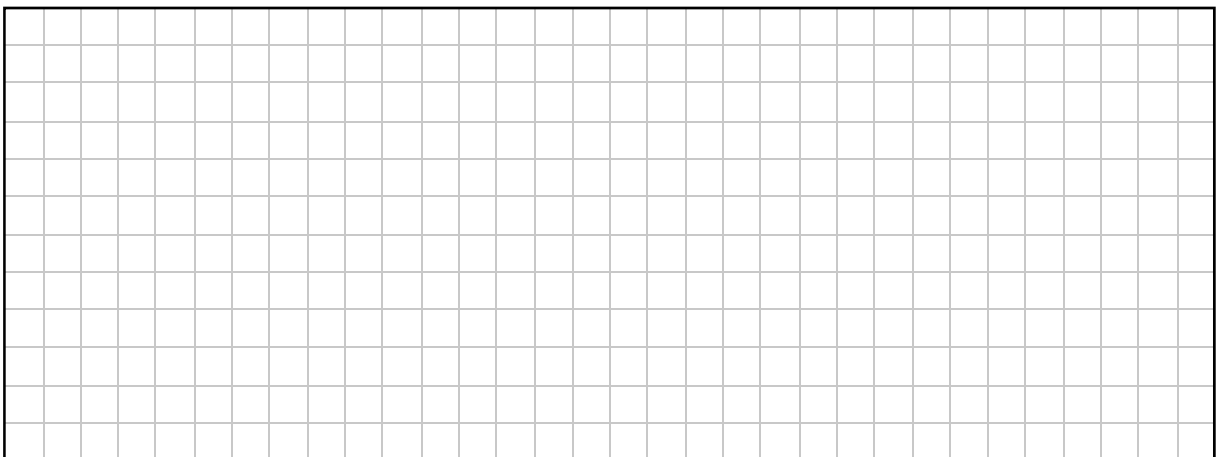
Work out the equation of this new road.

Give your answer in the form $ax + by + c = 0$, where $a, b, c \in \mathbb{R}$.



- (d) The distance $|PQ|$ on the diagram is 7.1 cm, correct to 1 decimal place.
5 mm on the diagram represents 100 m.

Use this to work out the **actual** distance from P to Q . Give your answer in km.



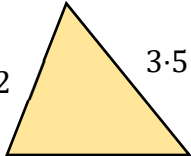
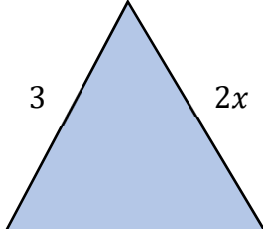
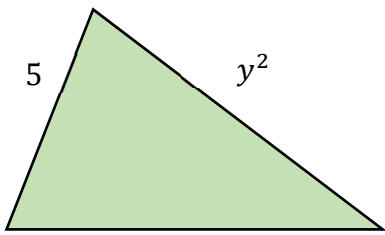
Question 4 (Suggested maximum time: 10 minutes)

Question 4 (Suggested maximum time: 10 minutes)

The three triangles **A**, **B**, and **C** are shown below.


The given lengths of the sides of each triangle are in centimetres, where $x, y \in \mathbb{N}$.

In this question, take “the perimeter” to mean “the length of the perimeter”.

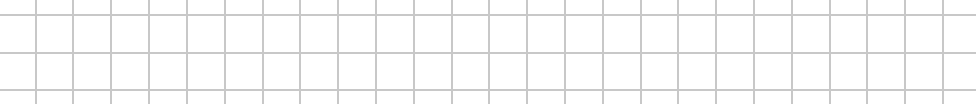
Triangle A	Triangle B	Triangle C
 <p>Triangle A has side lengths 2, 3.5, and 2.5.</p>	 <p>Triangle B has side lengths 3, $2x$, and $2x + 1$.</p>	 <p>Triangle C has side lengths 5, y^2, and $y^2 + 3$.</p>

- (a) The perimeter of Triangle **A** is 8 cm.
Two of the sides have length 2 cm and 3.5 cm, respectively, as shown.
Work out the length of the third side of Triangle **A**.

- (b) (i)** Write down the perimeter of Triangle **B**, in terms of x .



- (ii) The perimeter of Triangle **B** is 24 cm.
Use this to work out the value of x .

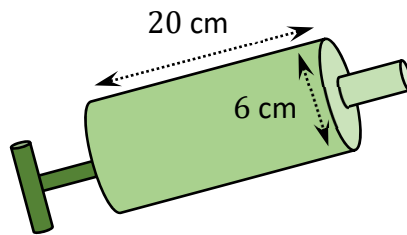


- [illegible]

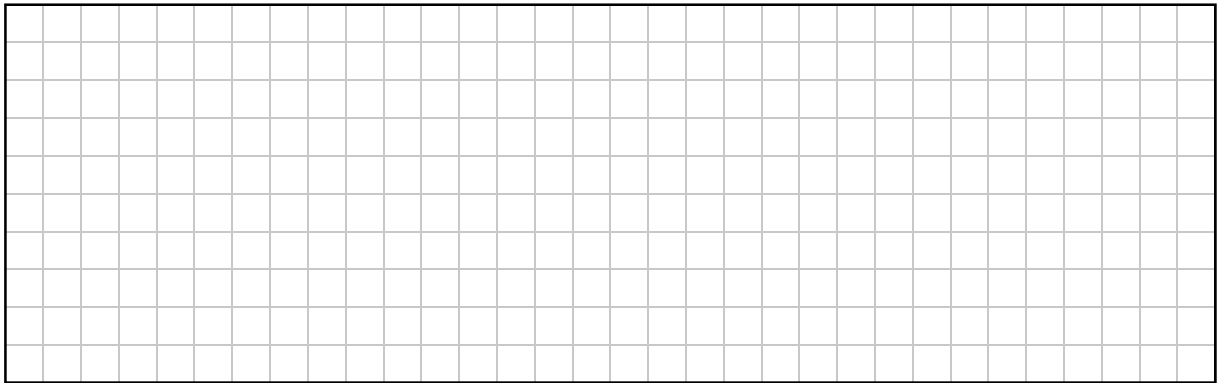
-
- A full-page view of a blank sheet of graph paper. The page is covered by a uniform grid of small squares, formed by thin gray lines. There are no margins, text, or other markings on the paper.

Question 5**(Suggested maximum time: 10 minutes)**

A balloon pump is made from a cylinder with an internal diameter of 6 cm and a height of 20 cm, as shown. Each time the pump is pumped, it passes one full cylinder of air into a balloon.

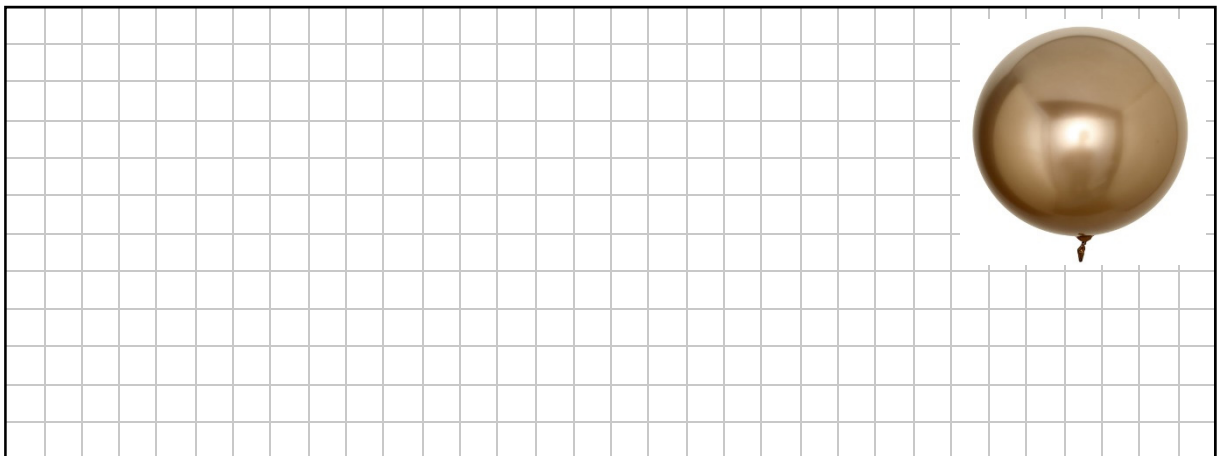


- (a) Show that the **volume** of one full cylinder of air is $180\pi \text{ cm}^3$.



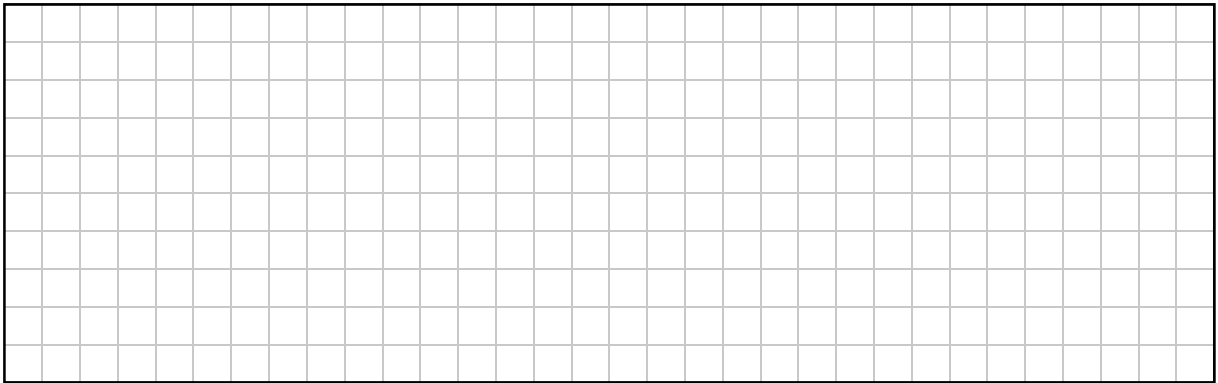
- (b) Darragh is inflating a balloon in the shape of a **sphere**.
When fully inflated, the balloon has a radius of 15 cm.

- (i) Find the **volume** of Darragh's balloon when it is fully inflated.
Give your answer in cm^3 , in terms of π .



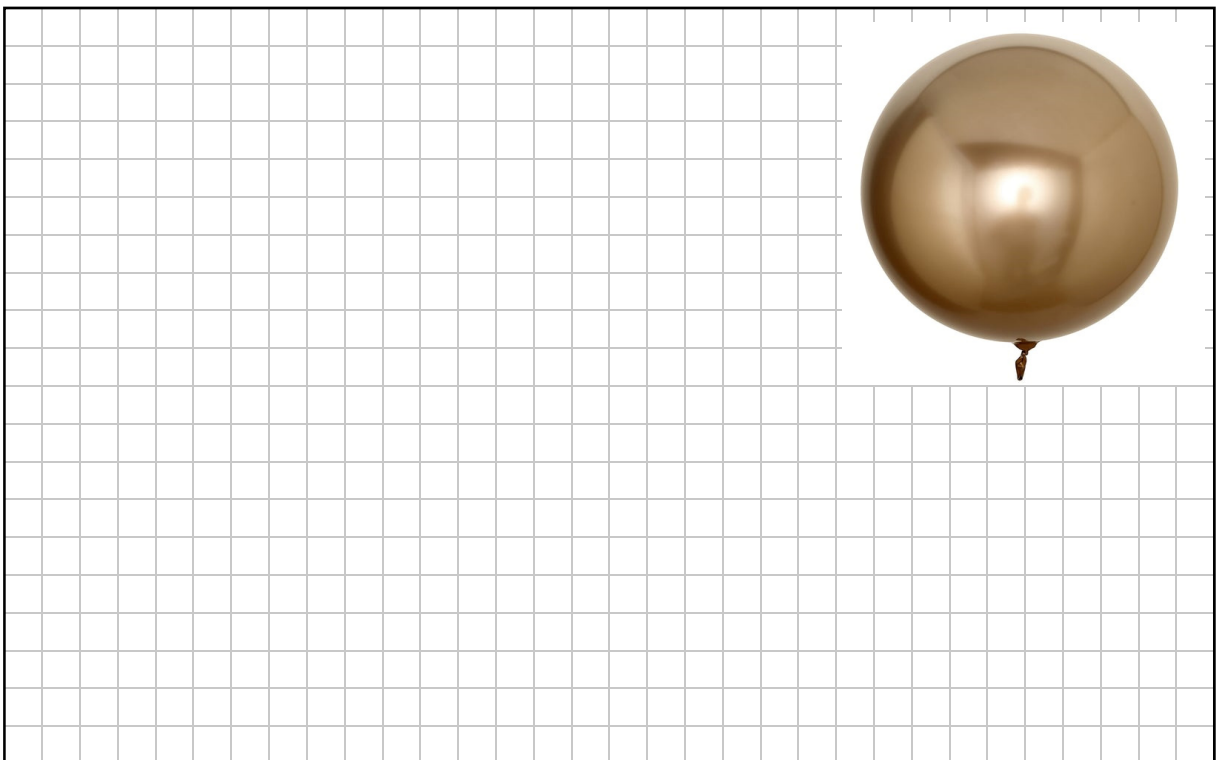
Darragh pumps the pump once every second.

(ii) How many seconds will it take Darragh to fully inflate his balloon?



(c) Gustav is inflating a bigger balloon in the shape of a sphere. He also pumps the pump once every second. His balloon is fully inflated after 50 seconds.

Find the radius of Gustav's balloon when it is fully inflated. Give your answer correct to 1 decimal place.



Question 6**(Suggested maximum time: 5 minutes)**

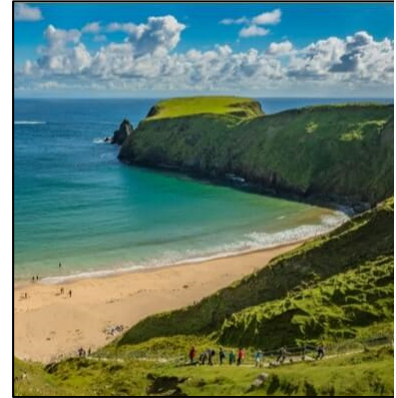
80 students in a group were asked what they had done during their summer holidays.

Some of the students got a job (J), some went on holidays (H), some did both, and some did neither.

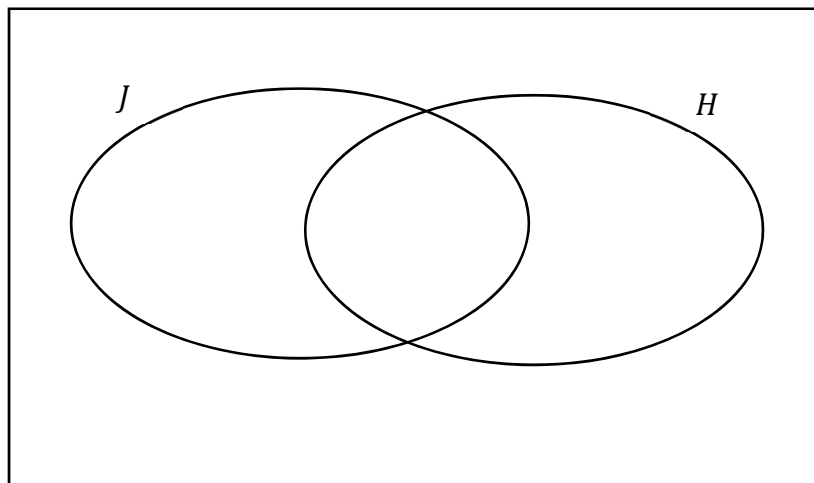
$\frac{1}{5}$ of the students in the group did neither.

25% of the students got a job.

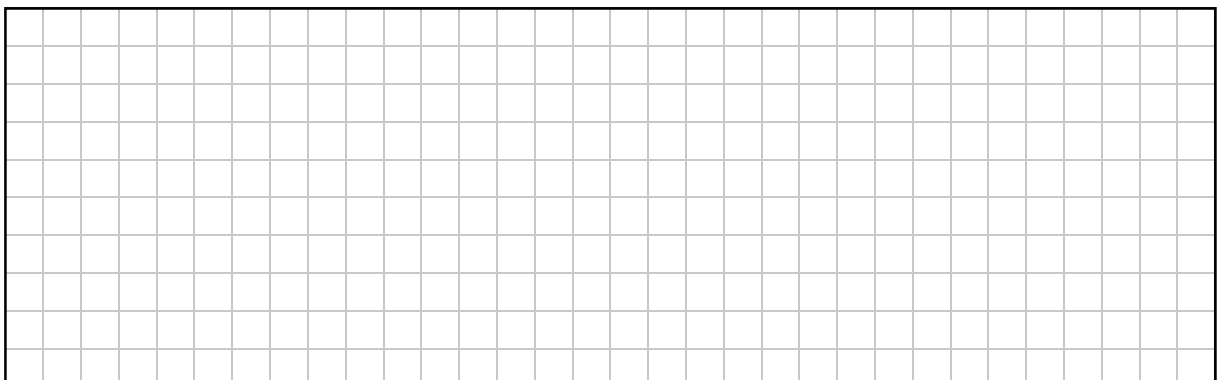
Of those students who got a job, half also went on holidays.



Work out the **total** number of students in the group who went on **holidays**.
You may use the Venn diagram below to help answer the question.



Answer =



(Suggested maximum time: 5 minutes)

- $$a^p \times a^q \times a^r = a^{12}$$

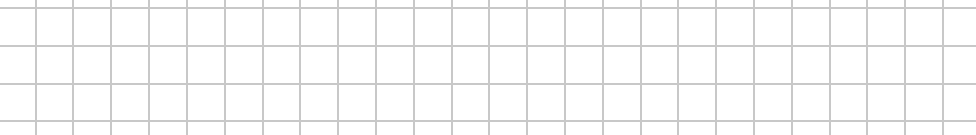
- $p =$ $q =$ $r =$

[illegible]

- $p =$ $q =$ $r =$

[illegible]

- $$\frac{b^m \times b^{-2}}{b} = b^{10}$$



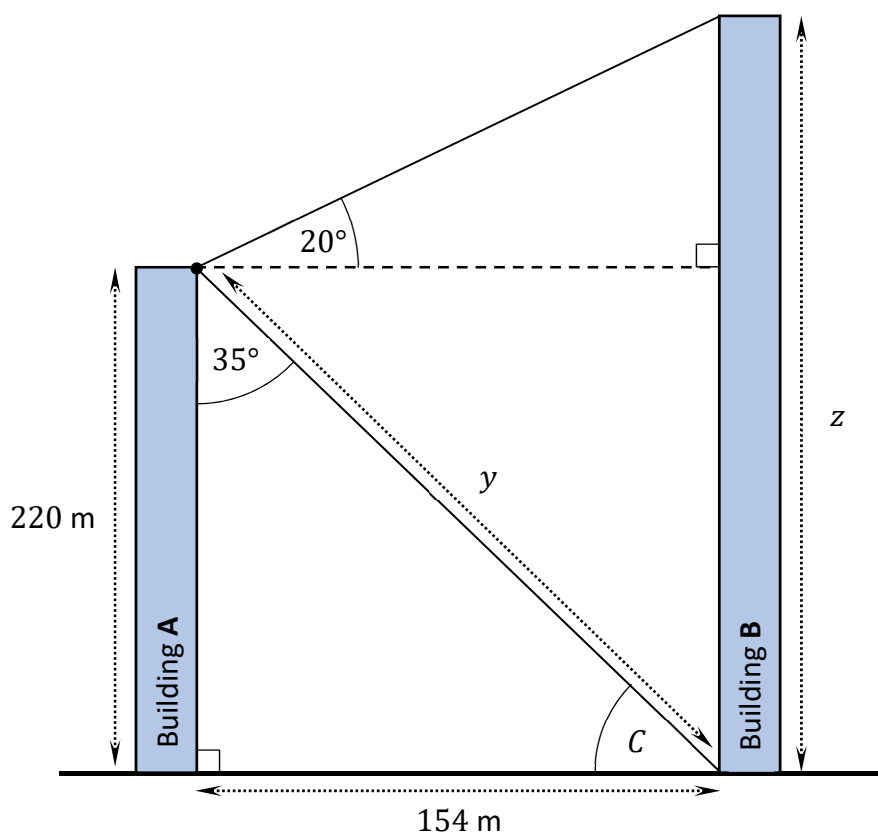
Question 8**(Suggested maximum time: 10 minutes)**

The diagram below shows two vertical buildings, **A** and **B** (diagram not to scale).

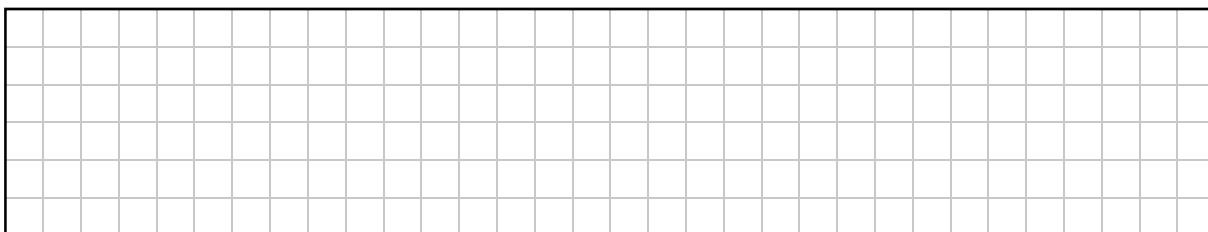
Mary stands at the top of Building **A**. She is 220 m above the ground.

She wants to work out the distances marked y and z in the diagram – that is, the distance from the top of Building **A** to the bottom of Building **B**, and the height of Building **B**, respectively.

Mary measures the two angles that are marked 35° and 20° in the diagram, to the bottom of Building **B** and the top of Building **B**, respectively. The broken line is horizontal.

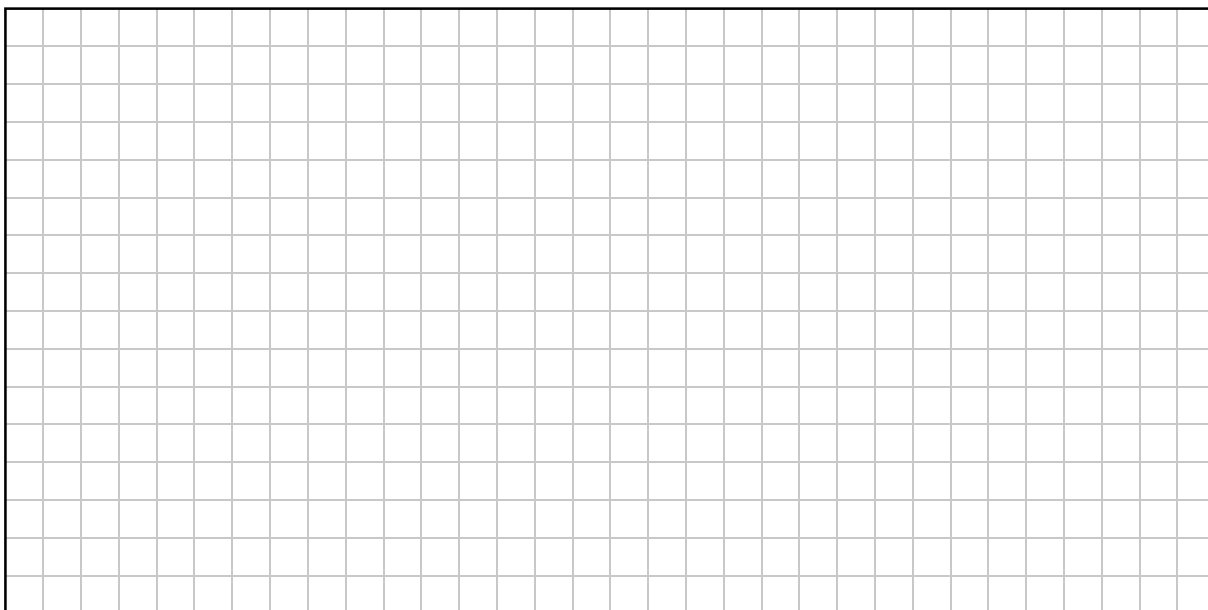


- (a) Work out the size of the angle C .

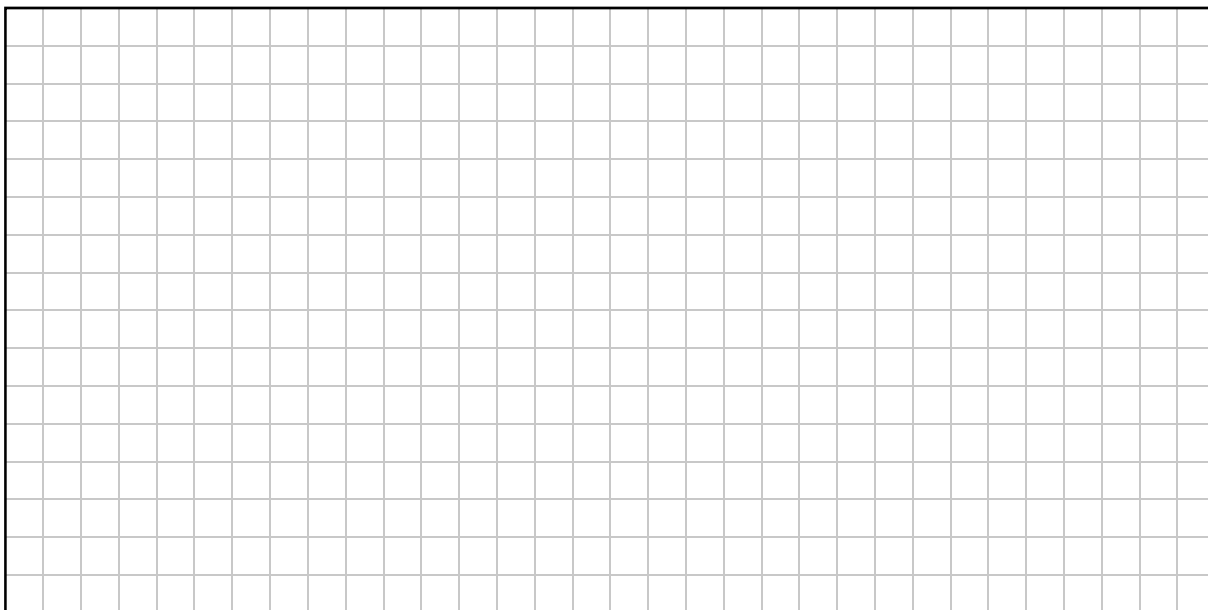


- (b) Mary works out that the horizontal distance between the two buildings is 154 m, correct to the nearest metre, as shown.

Use the **Theorem of Pythagoras** to work out the distance marked y on the diagram.
Give your answer correct to the nearest metre.



- (c) Use **trigonometry** to work out the value of z , the height of Building B.
Give your answer correct to the nearest metre.



Question 9**(Suggested maximum time: 10 minutes)**

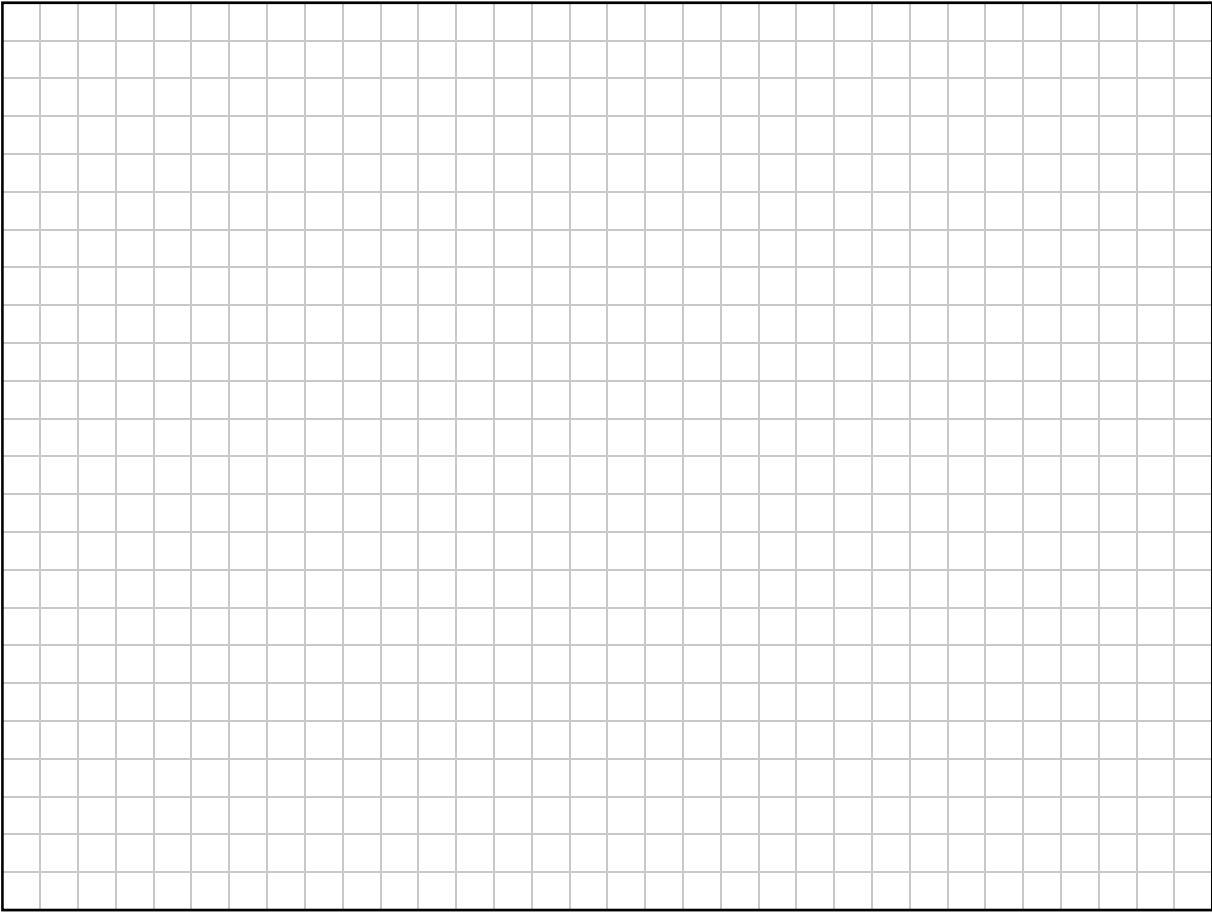
- (a)** $k = 7$ and $m - k = 4$. Work out the value of $9k - 6m$.

- (b)** Factorise fully $8ax - 14bx + 4ay - 7by$.

- (c)** Write the following as a single fraction in its simplest form:

$$\frac{2}{2x+1} - \frac{3}{3x+5}$$

(d) Solve the equation $2x^2 - 7x - 3 = 0$.
Give each answer correct to 2 decimal places.



Question 10

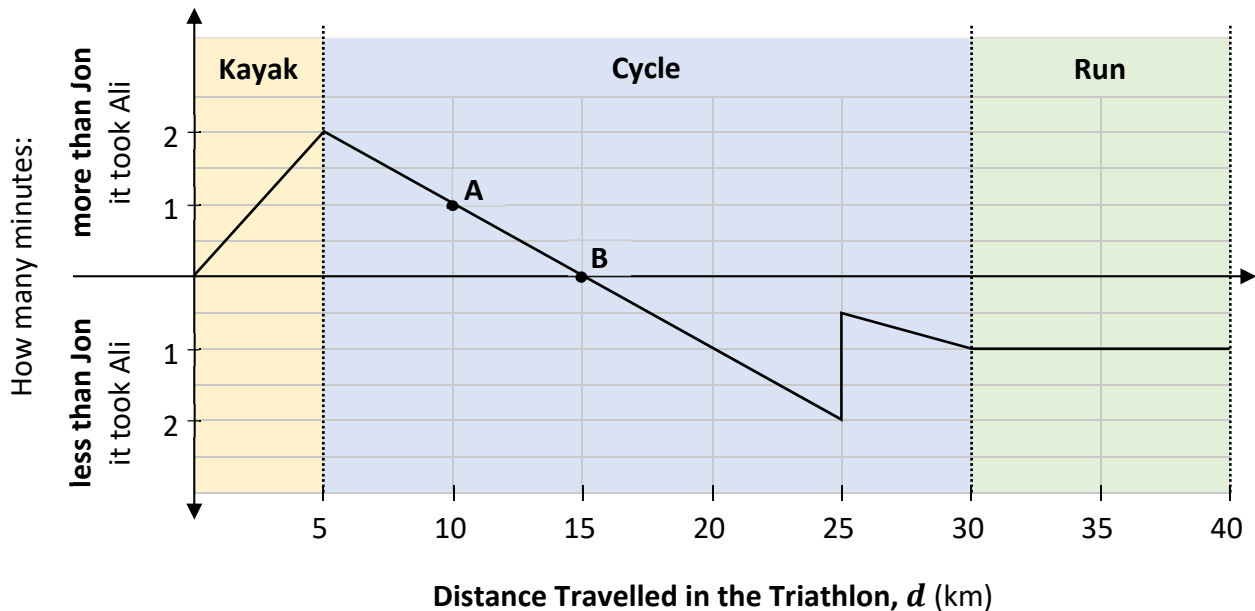
(Suggested maximum time: 15 minutes)

Ali and Jon took part in a triathlon.

In the triathlon they had to complete a 5 km kayak, then a 25 km cycle, and then a 10 km run.

The diagram below was drawn after both of them had finished the race.

It shows how many minutes more than Jon (or less than Jon) it took Ali to travel d km in the triathlon, for $0 \leq d \leq 40$. For example, the point **A** shows that it took Ali 1 minute more than Jon to travel the first 10 km. In total, it took Ali 1 minute less than Jon to finish the triathlon.



- (a) Did Ali finish the **kayak** section ahead of Jon, behind Jon, or at the same time as Jon?
(Tick **one** (✓) box only.)

Ali finished the kayak section: ahead of Jon behind Jon at the same time as Jon

☐ ☐ ☐

- (b) Ali had to stop briefly during the triathlon. Jon did not stop.

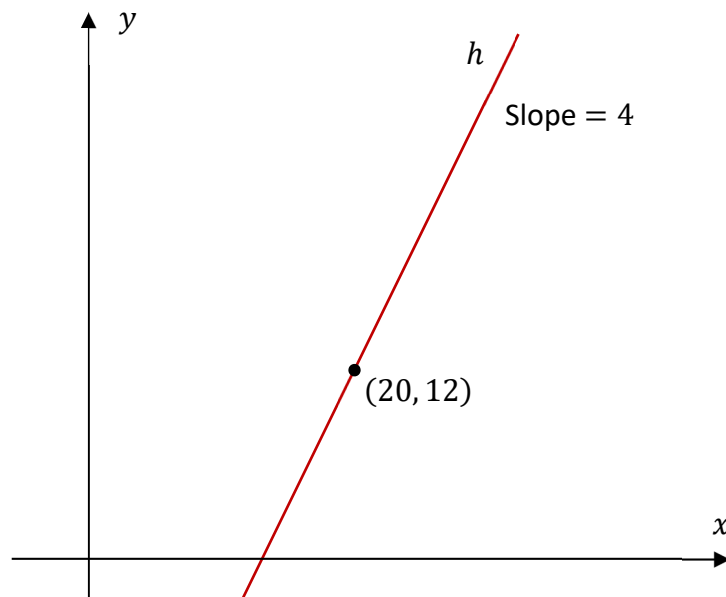
State what distance Ali had travelled when he stopped, **and** for how long he was stopped.

Distance Ali had travelled (in km):

Length of time Ali was stopped (in minutes):

Question 11**(Suggested maximum time: 5 minutes)**

The line h has a **slope of 4** and passes through the point $(20, 12)$.

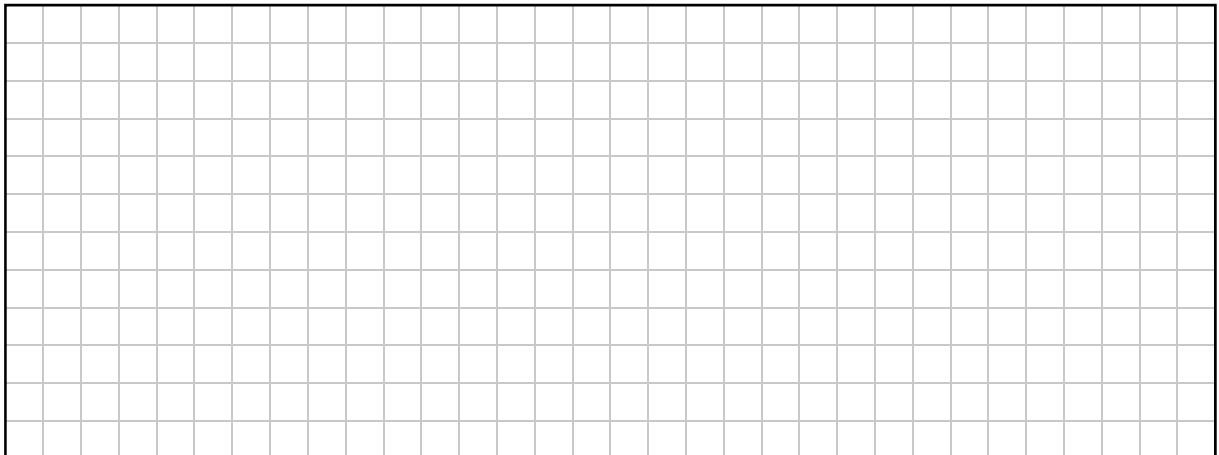


Find the co-ordinates of another point on the line h , **other than** the point $(20, 12)$.

Show your working out.

Answer =

(,)
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Question 12**(Suggested maximum time: 5 minutes)**

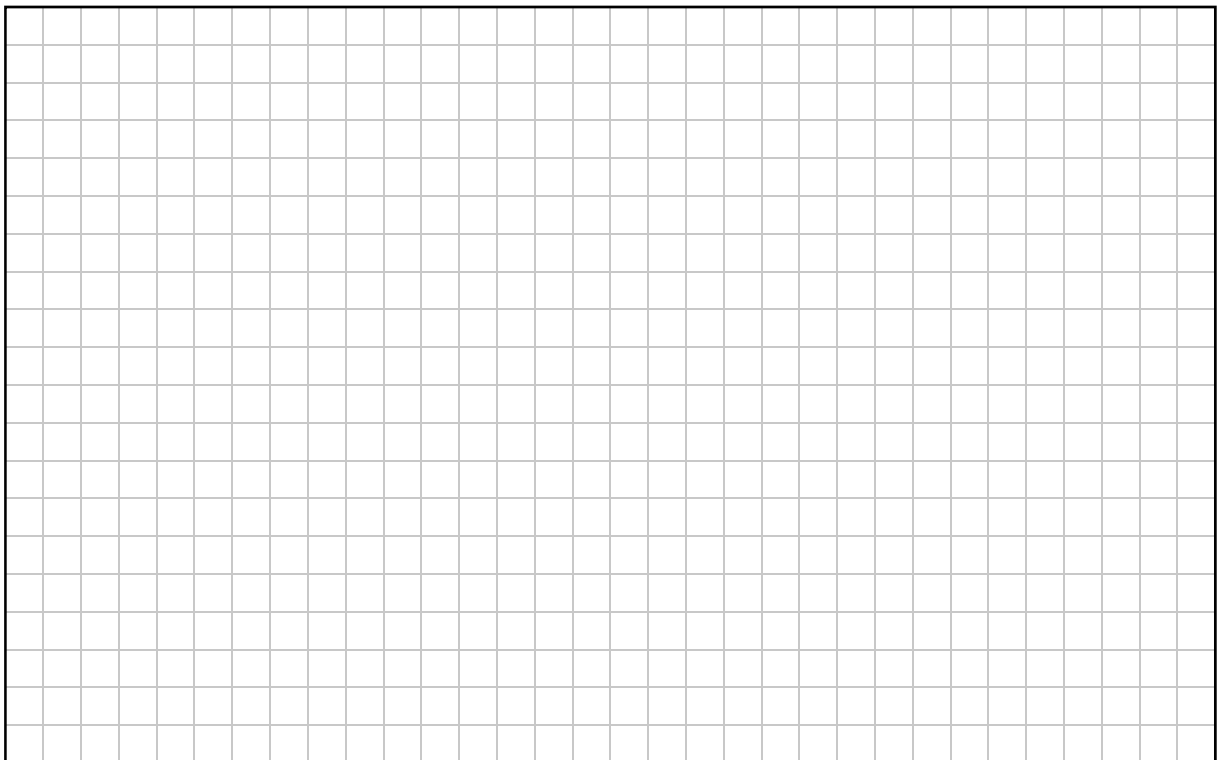
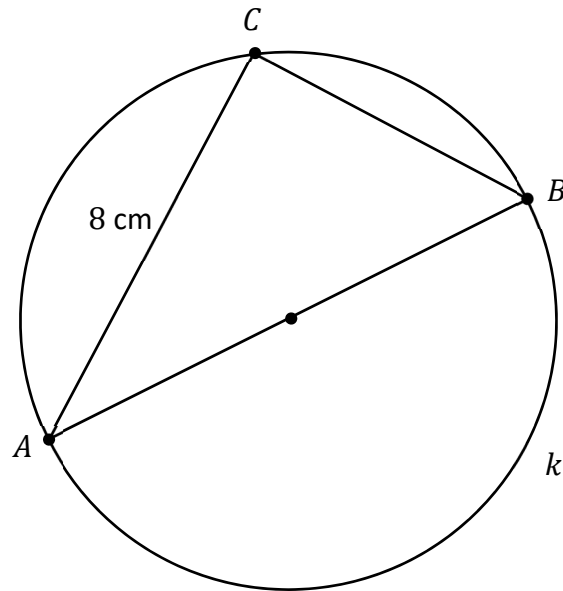
The diagram below shows the circle k (not to scale).

The points A , B , and C lie on the circle.

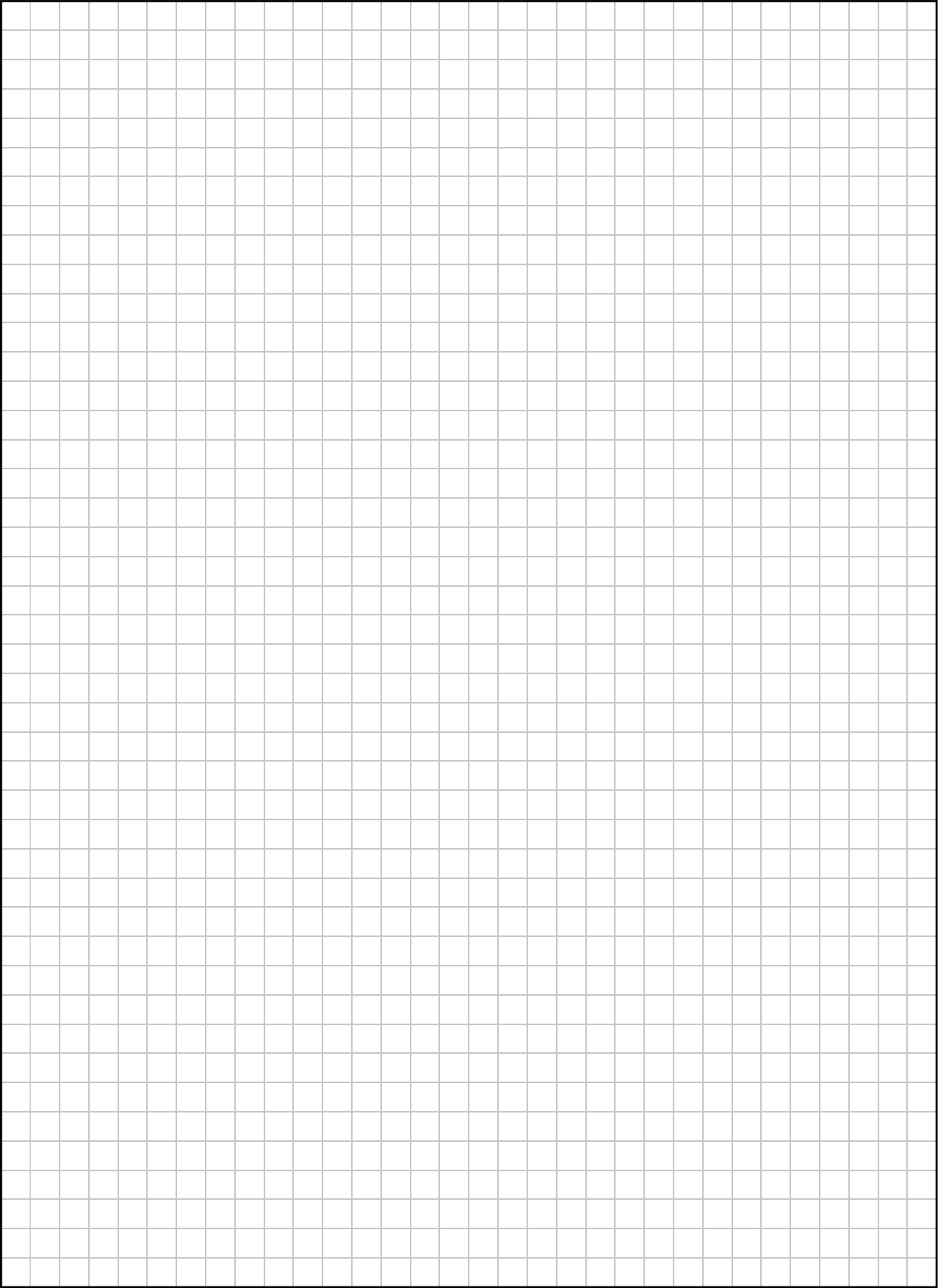
$[AB]$ is a diameter of the circle, and $|AC| = 8$ cm.

The **area** of the circle k is 25π cm².

Work out the size of the **smallest** angle in the triangle ABC .

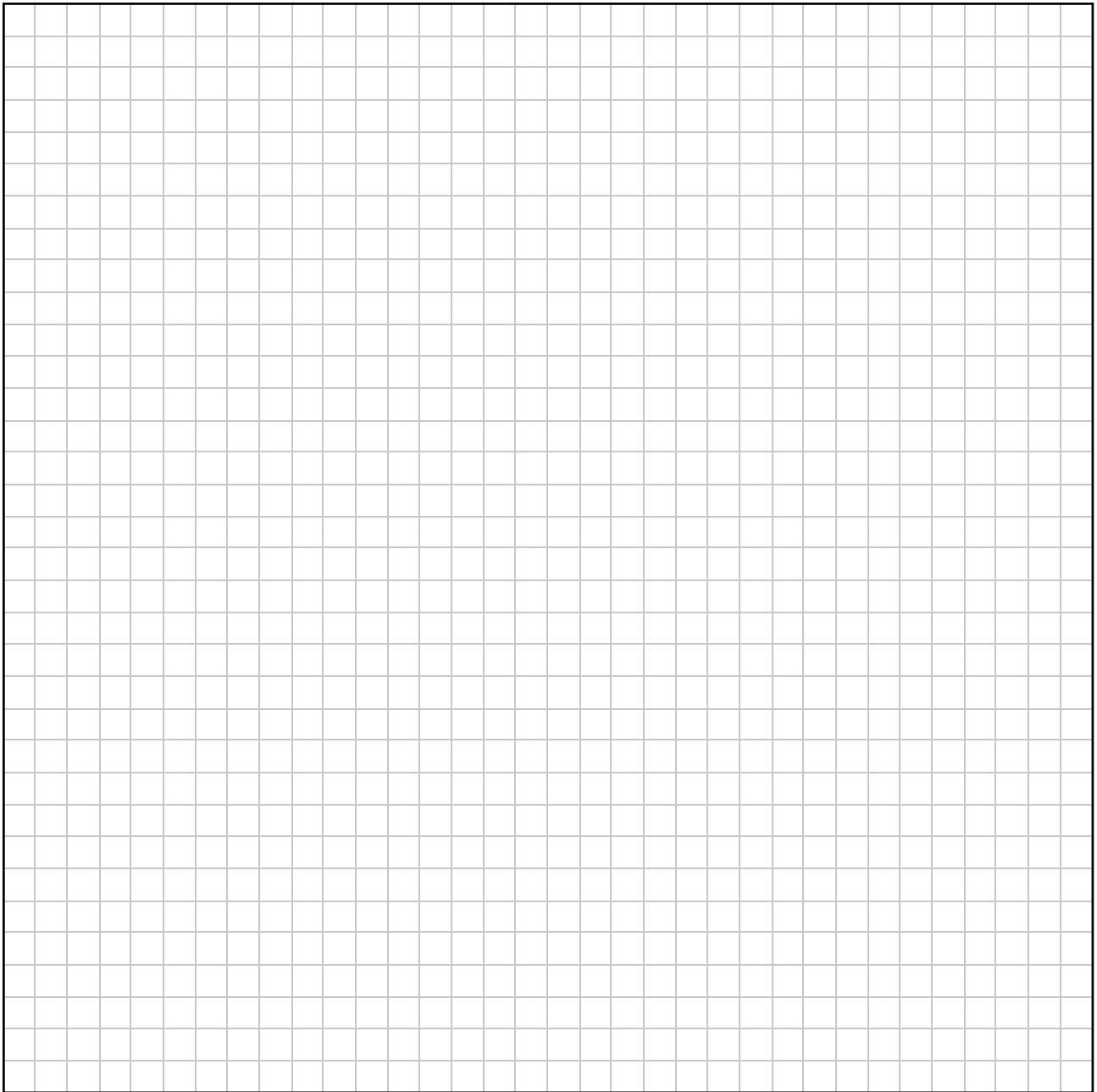


Page for extra work.
Label any extra work clearly with the question number and part.



Page for extra work.

Label any extra work clearly with the question number and part.



Acknowledgements

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Junior Cycle Final Examination – Higher Level

Mathematics

Friday 10 June

Afternoon 1:30 - 3:30