



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination
Mathematics
Paper 2
Ordinary Level
2 hours 30 minutes
220 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

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Instructions

There are **two** sections in this examination paper.

Section A	Concepts and Skills	120 marks	6 questions
Section B	Contexts and Applications	100 marks	4 questions

Answer questions as follows:

- any four questions from Section A - Concepts and Skills
- any two questions from Section B - Contexts and Applications

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.

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

You may lose marks if you do not include 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:

Answer **any four** questions from this section.

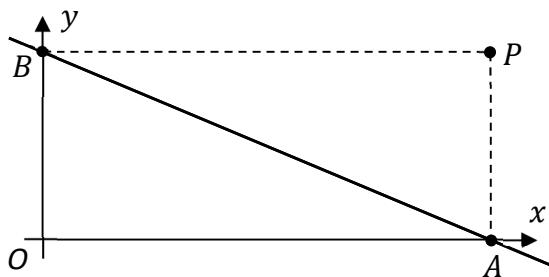
Question 1

(30 marks)

In the co-ordinate diagram below, the point P has co-ordinates $(12, 5)$.

A is the point on the x -axis vertically below P .

B is the point on the y -axis horizontally across from P .

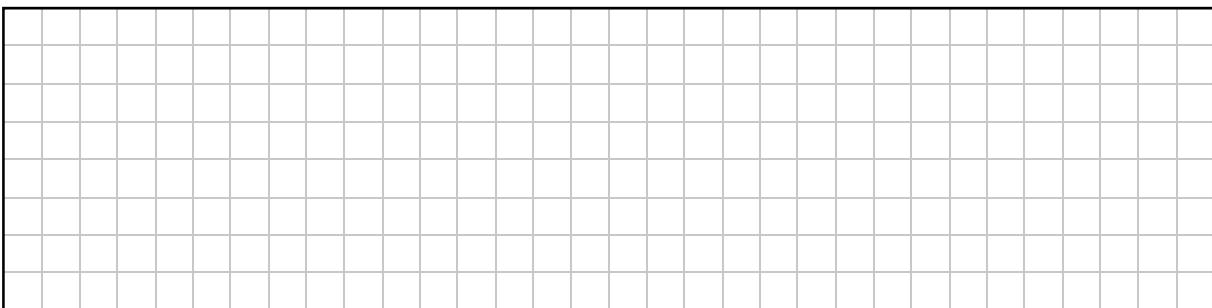


- (a)** Write down the co-ordinates of A and of B .

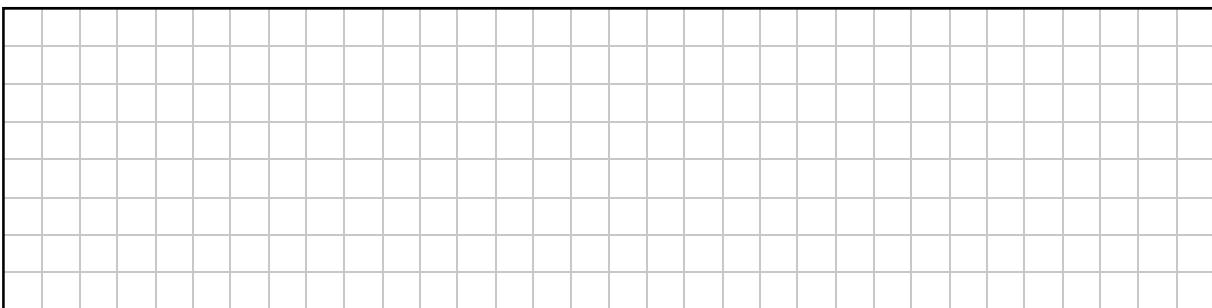
$$A = (\quad , \quad)$$

$$B = (\quad , \quad)$$

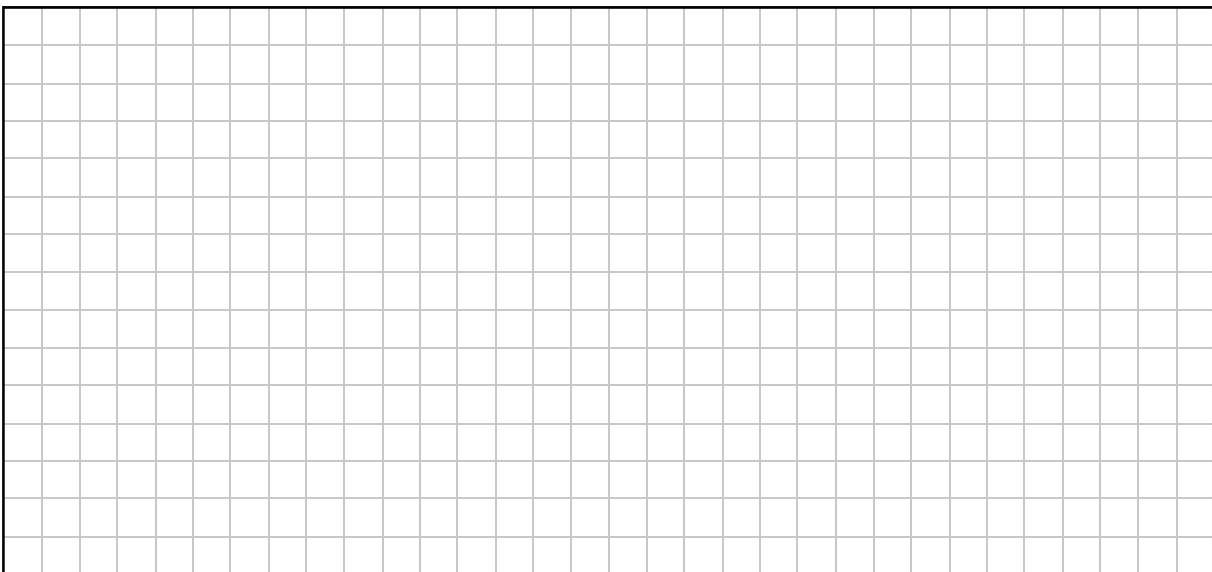
- (b)** Find the area of the triangle APB .



- (c)** Find the length $|AB|$.



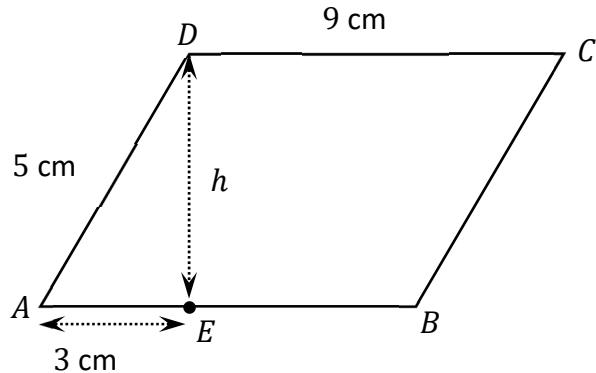
- (d) Using your answers to **part (b)** and **part (c)**, find the length of the shortest line segment from P to the line AB . Give your answer correct to 2 decimal places



Question 2**(30 marks)**

- (a) The diagram below shows a parallelogram $ABCD$. It has sides of length 9 cm and 5 cm, and a perpendicular height of h (taking the base to be 9 cm), where $h \in \mathbb{R}$.

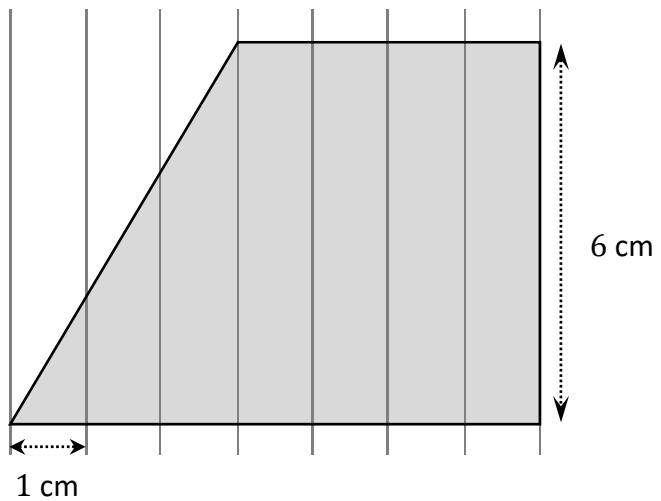
The point E lies on the side $[AB]$, so that $\angle AED$ is a right angle. $|AE| = 3$ cm, as shown.



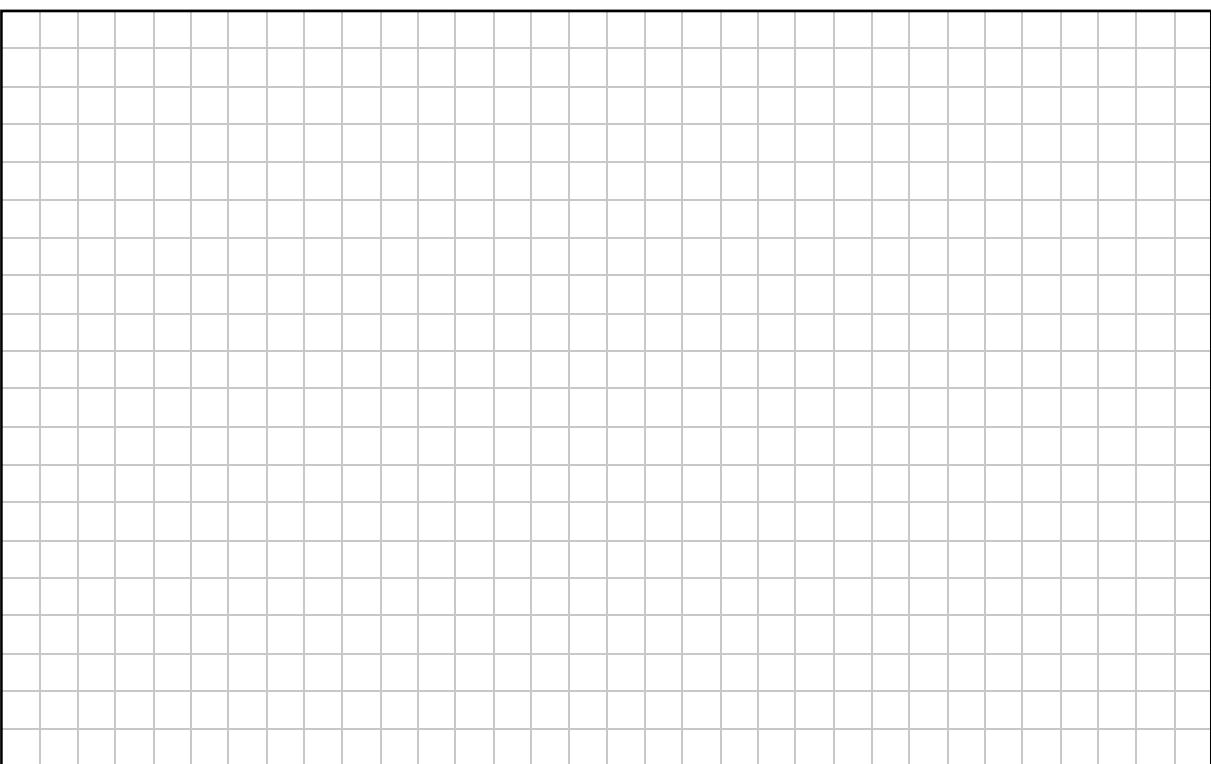
Find the value of h , and hence find area of the parallelogram.

$h =$ _____	Area of parallelogram = _____

- (b)** The diagram below shows a different quadrilateral (not to scale). Two of the sides are parallel. The other two sides are not parallel. The vertical lines on the diagram are a distance of **1 cm apart**.



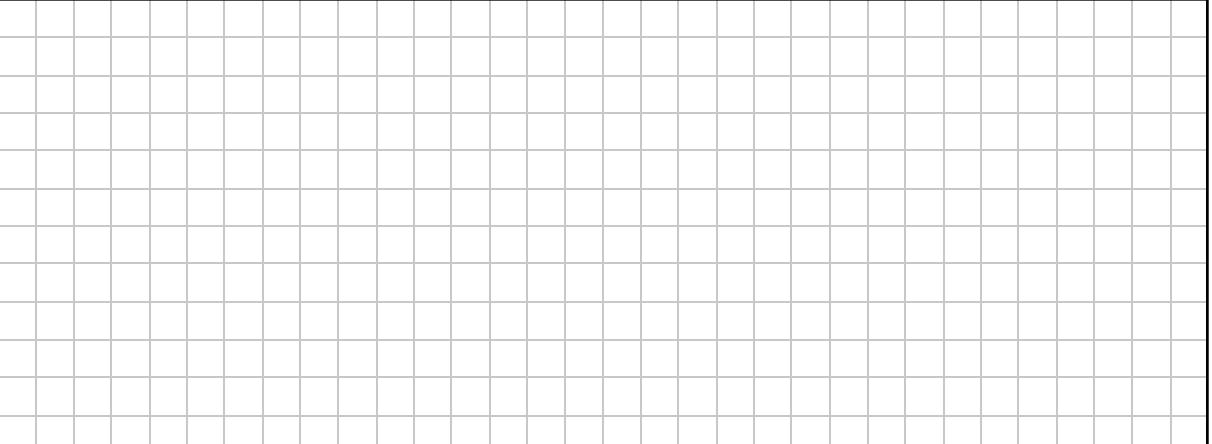
Use the **Trapezoidal Rule** to find the area of this quadrilateral.
Show all of your working out.



Question 3**(30 marks)**

- (a) A circle has equation $x^2 + y^2 = 10$, where $x, y \in \mathbb{R}$.

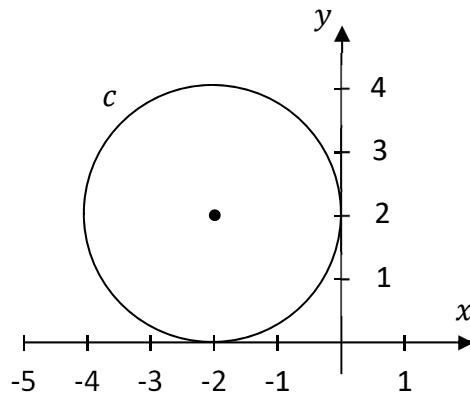
- (i) Verify that the point $(3, -1)$ is on the circle.



- (ii) Find the slope of the tangent to the circle at the point $(3, -1)$.



- (b) A circle c touches the x -axis at $(-2, 0)$ and touches the y -axis at $(0, 2)$, as shown.



- (i) Find the equation of the circle c .

- (ii) Find the equation of the circle which has the same centre as the circle c , and which passes through the point $(0, 0)$.

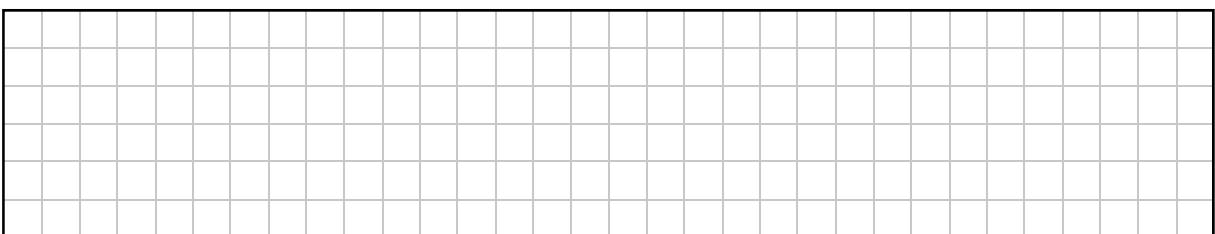
Question 4**(30 marks)**

Below is a stem-and-leaf plot of the heights of a group of students, in centimetres.

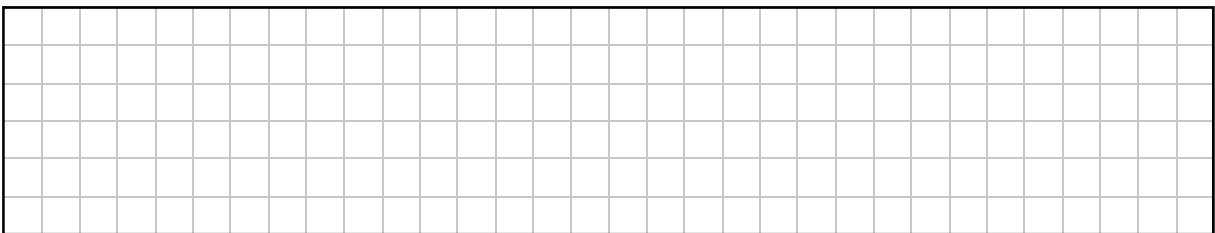
13	5	7			
14	0	1	3		
14	6	7	7	9	
15	0	1	2	3	3
15	5	6	6	8	
16	0	1			

Key: 13 | 5 means 135 cm.

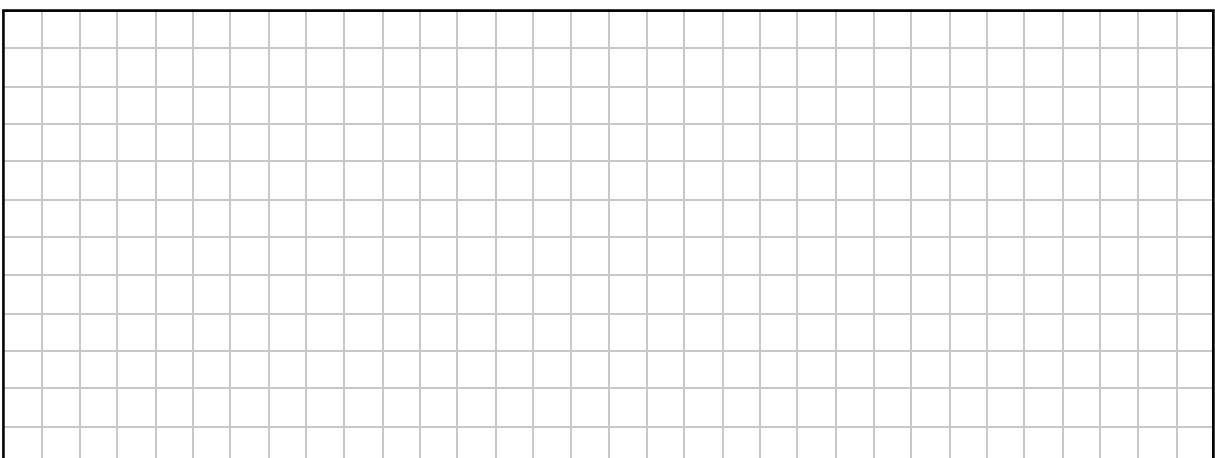
- (a) How many students are in the group?



- (b) Find the range of the heights of this group of students.

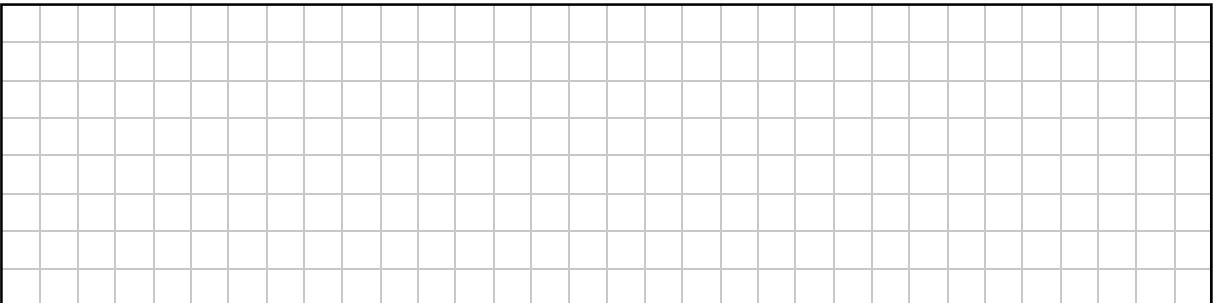


- (c) Find the interquartile range of the heights of this group of students.

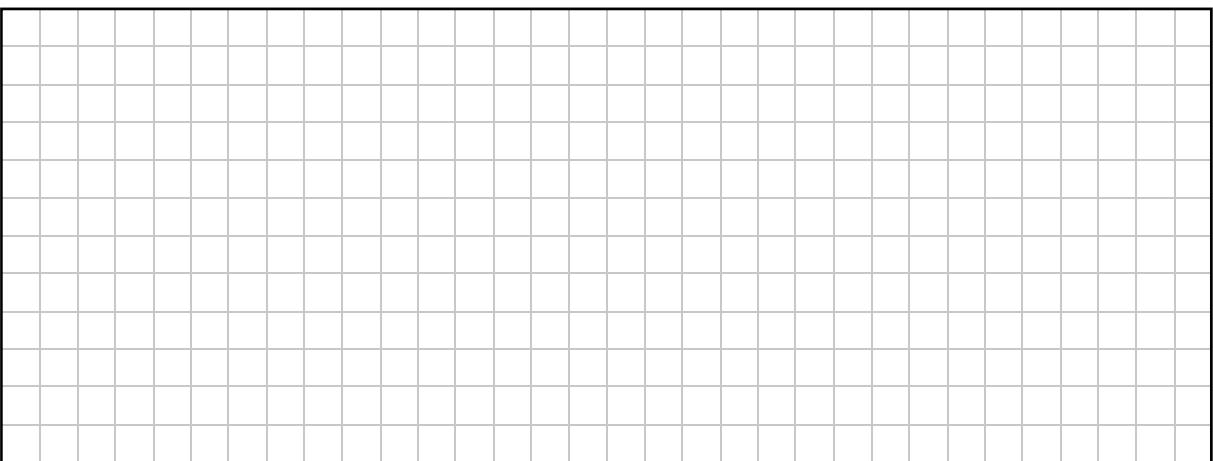


The mean height of the students in the group is 149·5 cm.

- (d) Use the mean height to work out the **sum** of the heights of all the students in the group.
Show your working out.

A large rectangular grid consisting of 10 columns and 10 rows of small squares, intended for working out the sum of student heights.

- (e) The standard deviation of the heights of the students is 7·3 cm, correct to 1 decimal place.
Find the percentage of the students whose height is within 1 standard deviation of the mean height of the group.

A large rectangular grid consisting of 10 columns and 10 rows of small squares, intended for calculating the percentage of students within one standard deviation of the mean height.

Question 5**(30 marks)**

A game is played using three straws: two identical long straws (L and L) and one short straw (S). In the game, a player picks one of the three straws at random. The player wins the game if they pick the short straw.

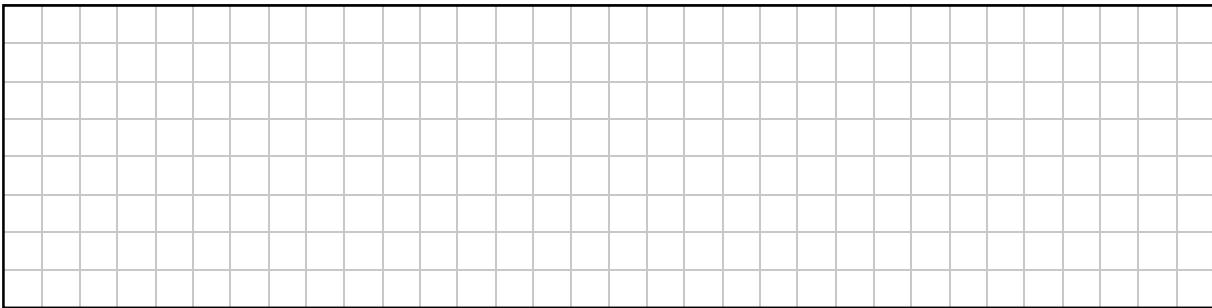
- (a)** Noel plays one game. Write down the probability that he wins the game.

- (b)** Noel plays the game three times. In this set of three games:

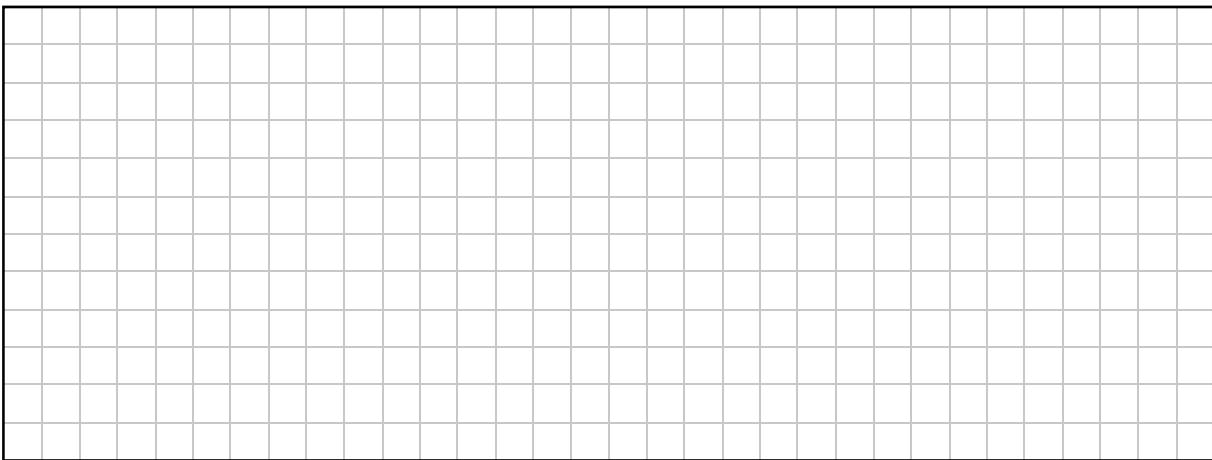
- (i)** what is the probability that Noel does **not** draw the short straw (that is, he loses all three games)?

- (ii)** what is the probability that Noel wins the first two games and loses the third game?

- (c) Noel decides to continue playing the game until he wins for the first time.
What is the probability that Noel wins for the first time on the fifth game he plays?

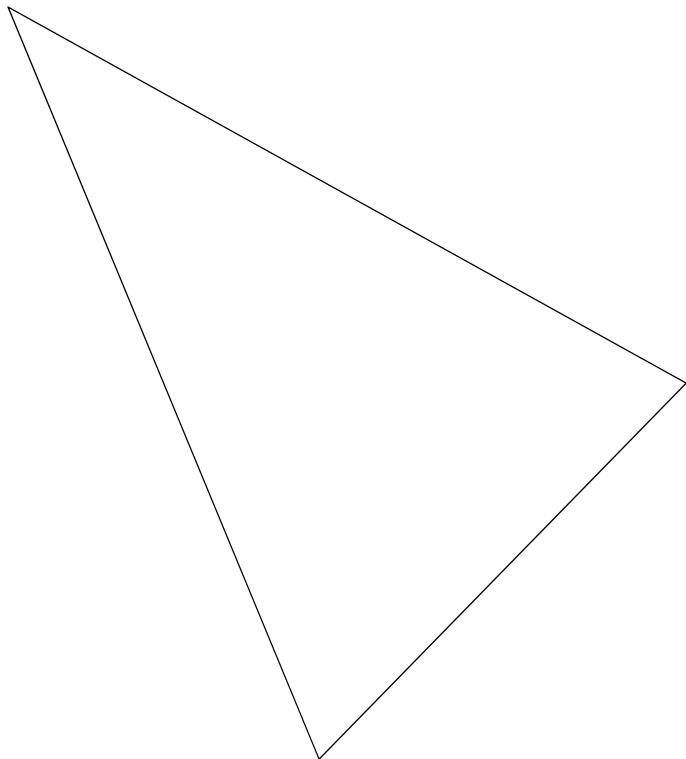
A large rectangular grid consisting of 20 columns and 10 rows of small squares, intended for students to show their working for part (c).

- (d) Noel bets €2 on each game.
If he loses the game, he loses the €2.
If he wins the game, he gets his €2 back, and also another €3.
Noel starts with €7.
How much money will he have if he plays 3 games and wins **exactly 1** of them?

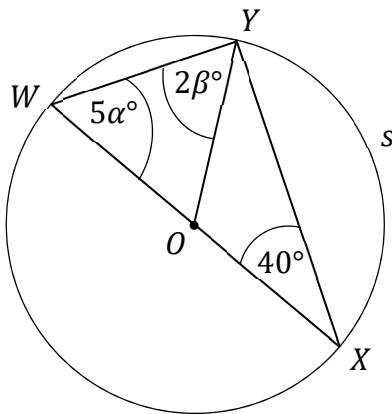
A large rectangular grid consisting of 20 columns and 10 rows of small squares, intended for students to show their working for part (d).

Question 6**(30 marks)**

- (a) Construct the **centroid** of the triangle below. Show clearly any construction lines.
(Note: all instruments are permitted. If you are using measurements, show your measurements and calculations.)



- (b) In the diagram below, O is the centre of the circle s .
The points W , X , and Y lie on s , and $\alpha, \beta \in \mathbb{R}$.



- (i) Give a reason why $|\angle XYW| = 90^\circ$.

- (ii) Find the value of α and the value of β .

$\alpha = \underline{\hspace{2cm}}$ $\beta = \underline{\hspace{2cm}}$

- (iii) Which point in the diagram is the **circumcentre** of the triangle WXY ?

Answer **any two** questions from this section.

Question 7

(50 marks)

- (a)** A teacher sets two tasks for a class.

Task 1 is to solve a maths problem. Task 2 is to complete a physics experiment.

The class works on Task 1 until one student (the winner) completes the task.

The class works on Task 2 until one student

The winner of each task gets a prize.

Based on past performance, the probabilities that Ann and Billy win each prize are given in

	Ann	Billy	Neither Ann nor Billy win the prize
Task 1	0·5	0·2	
Task 2	0·1	0·25	

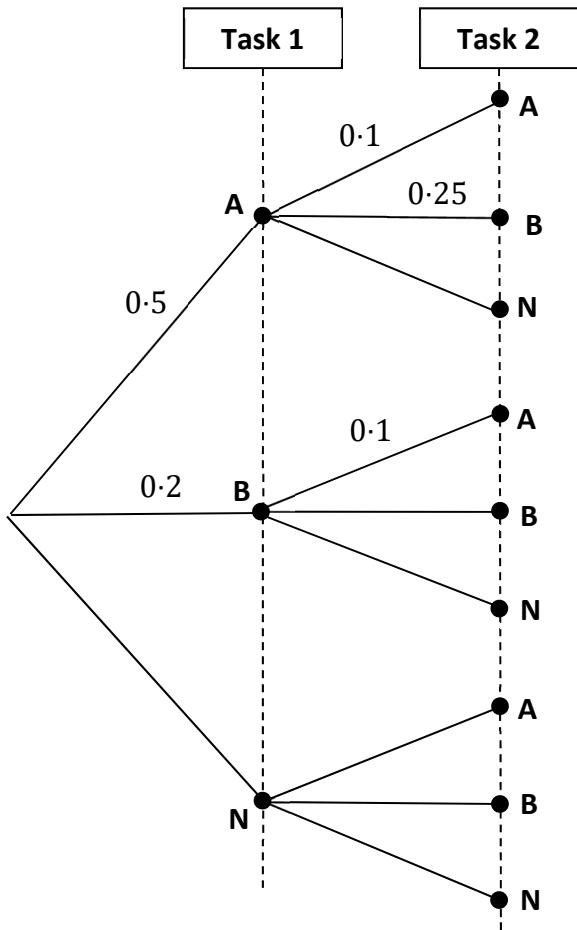
- (i) Write down the probability that Billy will **not** win the prize for Task 1.

- (ii) Complete the table above by writing in the probability neither Ann nor Billy will win the prize for each task.

The diagram on the next page is a tree diagram showing the possible winners of the two tasks. Each outcome is written as the winner of Task 1, followed by the winner of Task 2.

A stands for Ann, **B** stands for Billy, and **N** stands for neither Ann nor Billy.

For example, the outcome that Ann wins Task 1 and that neither Ann nor Billy win Task 2 is written **(A, N)**.



(iii) Outcome	(iv) Probability
(A, A)	
(A, B)	0·125
	0·325
	0·02
(B, N)	

(iii) Complete the list of **outcomes** in the table above.

(iv) Write the **probability** of each outcome in the space beside it in the table above.

(v) Work out the probability that Ann wins one prize and that Billy wins the other prize.

This question continues on the next page.

- (b)** Eric and Chidalu play a game involving **multiplying** numbers.

Eric picks a number at random from $\{1, 2, 3, 4\}$.

Chidalu also picks a number at random from $\{1, 2, 3, 4\}$.

The two numbers are multiplied and this product is recorded as the result of the game.

Eric wins if the result is less than 8.

Chidalu wins if the result is greater than or equal to 8.

- (i) Fill in the two-way table below to show the result (the product) for each possible pair of numbers. One is already done for you.

	1	2	3	4
1				
2				
3		6		
4				

- (ii) Use the two-way table to decide whether or not this game is fair (that is, if Eric and Chidalu are equally likely to win). Justify your answer.

Answer:	
Justification:	

- (iii) Eric and Chidalu play the game a number of times.

Find the probability that the first three results of the game are 4, 3, and 16, in that order. Give your answer correct to 4 decimal places.

Question 8

(50 marks)

- (a)** A polling company carried out a survey on 625 people, selected at random from those who bought tickets for a music festival.

- (i) Work out the margin of error $\left(\frac{1}{\sqrt{n}}\right)$ for this sample. Give your answer as a percentage.

- (ii) In the survey, 230 people said that they would buy a souvenir t-shirt at the festival. Using the margin of error from **part (a)(i)**, create a 95% confidence interval for the percentage of people who will buy a t-shirt at the festival.

- (iii) A music journalist claims that 34% of people who will attend the festival will buy a t-shirt. Use your answer to part (a)(ii) to conduct a hypothesis test, at the 5% level of significance, to test the journalist's claim.

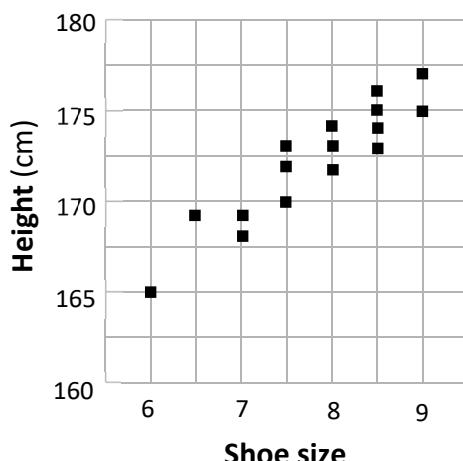
Give your conclusion, and a reason for this conclusion.

Conclusion:	
Reason:	

This question continues on the next page.

- (b)** A student asks 20 boys on a hurling panel to state their shoe size and their height (to the nearest centimetre). The data are shown in the table below. Each boy's height is recorded in the column under his shoe size. A partially completed scatter plot is also shown.

Shoe size	6	6 ½	7	7 ½	8	8 ½	9
Height (cm)	161	167	168	172	174	176	175
	163	164	169	173	172	173	177
	165	169		170	173	174	
						175	



- (i) The four shaded heights in the table above have **not** been included on the scatter plot. Draw four points on the scatter plot to show these.

- (ii) Describe the relationship between shoe size and height, based on the scatter plot.

- (iii) Which of the following values is closest to the correlation coefficient between shoe size and height, based on the data in the table and the graph? Tick **one** box only.

-1

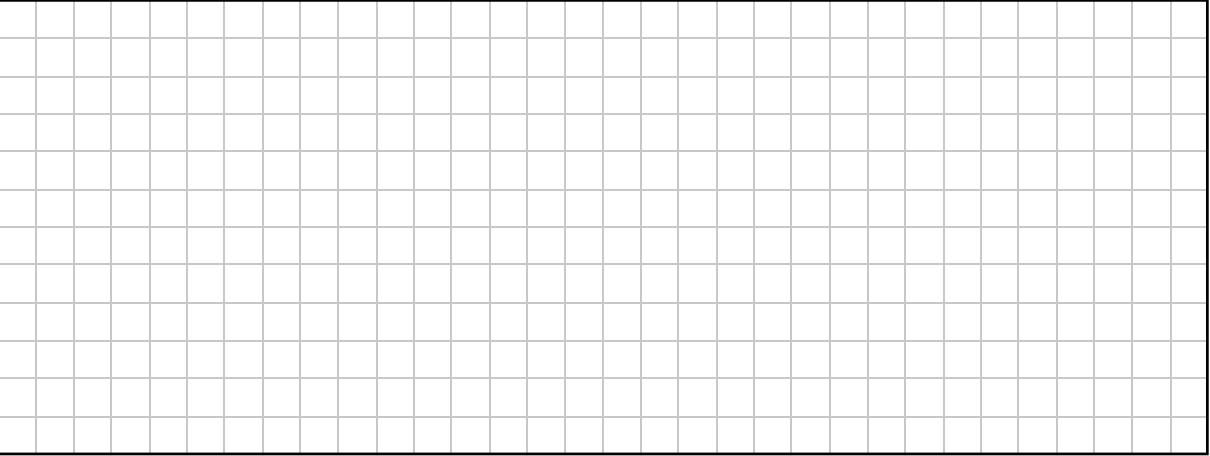
-0.5

0

0·5

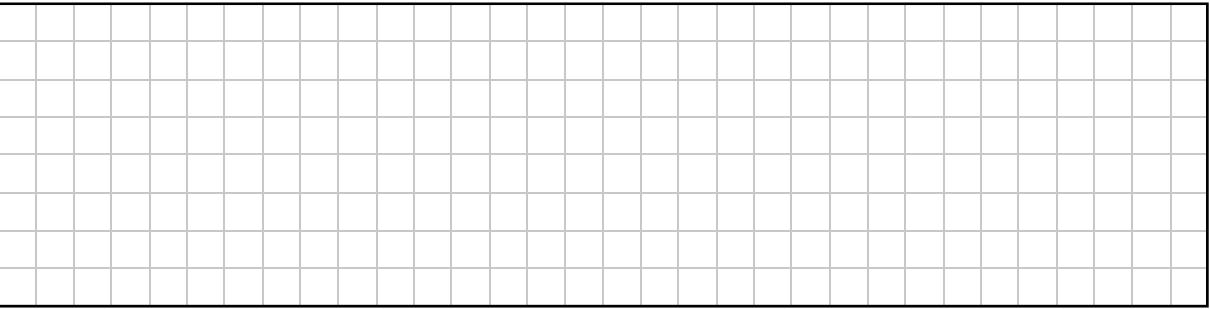
1

- (iv) Calculate the **mean** height of the 20 boys.



A new player joins the hurling panel. He has height of 178 cm.

- (v) Use the information in the scatter plot to estimate this boy's shoe size.
Show your work on the diagram.



- (vi) Which will have a **bigger increase**, the mean or the median, if we include the new player in the data? Justify your answer.

Answer (mean or median):

Justification:

Question 9**(50 marks)**

Jane and Alan visited the round tower at Kilmacduagh, Co. Galway.

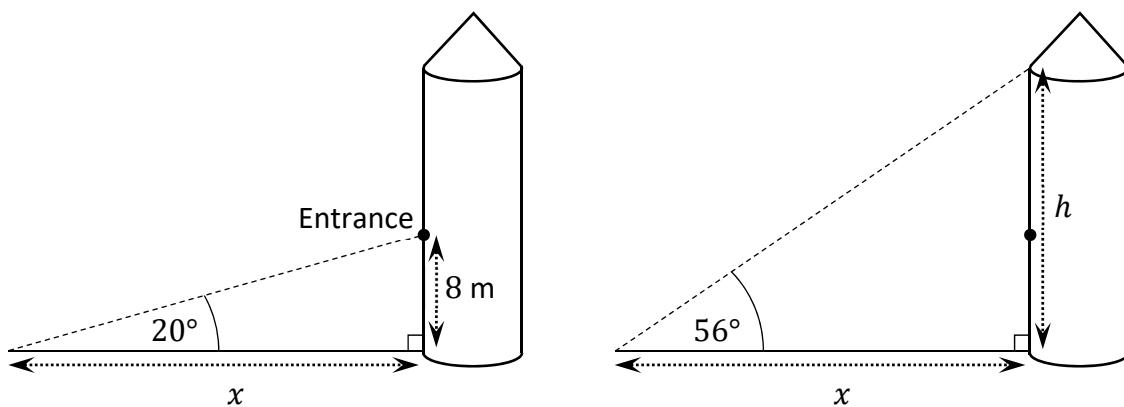
The tower is roughly in the shape of a cylinder, with a conical roof on top.

The entrance to the tower was high up on the wall of the tower.

They knew that the entrance was 8 m above the ground, but didn't know how high the tower was.

Jane suggested that they could measure the angle from the ground to the bottom of the entrance, and the angle to the top of the cylindrical part of the tower, and they could then estimate the height of the tower.

Standing at a distance of x m from the base of the tower, on level ground, they measured the angle of elevation to the bottom of the entrance as 20° , and the angle of elevation to the top of the cylindrical part of the tower as 56° . They then drew the two diagrams below (not to scale) to show these measurements.

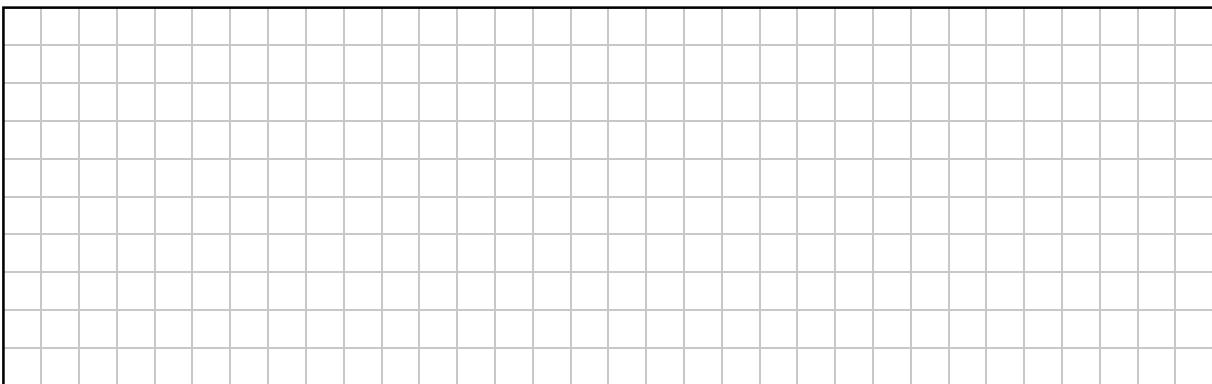


- (a) Work out the value of x , and hence work out the value of h , the height of the cylindrical part of the tower. Give each distance in metres, correct to 1 decimal place.

$x =$ _____	$h =$ _____
-------------	-------------

- (b) Later, Jane and Alan read on the internet that the actual height of the cylindrical part of the tower is approximately 34 m.

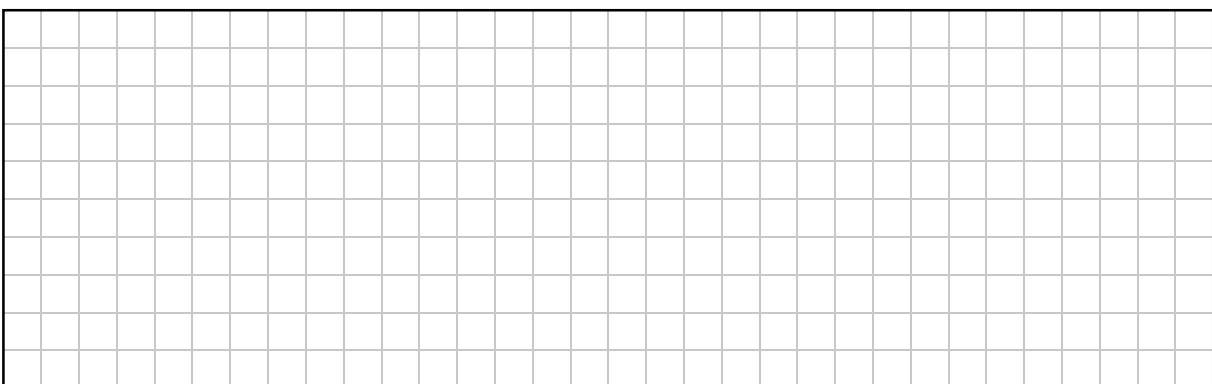
Using 34 m as the actual height of the cylindrical part of the tower, find the percentage error in the answer from **part (a)**. Give your answer correct to the nearest percent.

A large rectangular grid consisting of 20 columns and 10 rows of small squares, intended for考生 to work out their calculations for part (b).

After the visit, Alan wants to make a scale model of the round tower in Kilmacduagh.

- (c) Excluding the roof, Alan's scale model will be in the shape of a cylinder, with a diameter of 28 **centimetres** and a height of 1.7 **metres**.

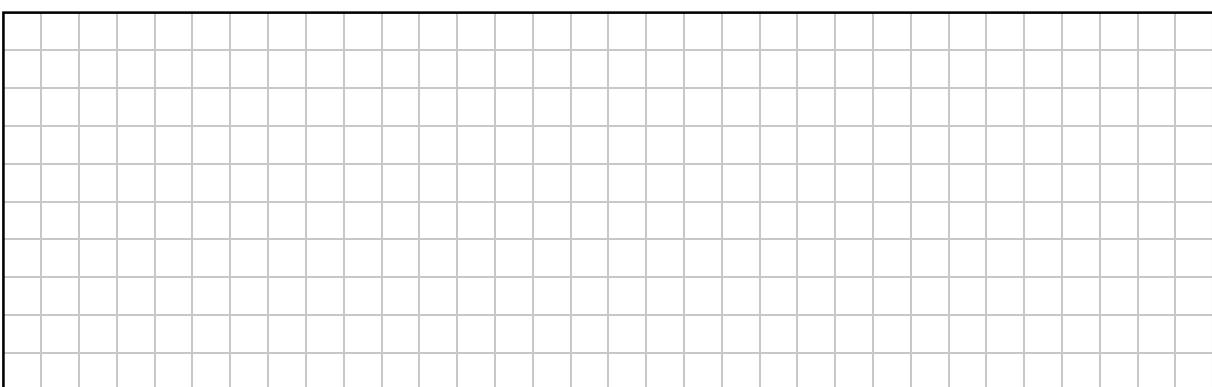
- (i) Use the fact that this is a scale model to work out the actual diameter of the round tower at Kilmacduagh. Use the approximate actual height given in **part (b)**. Give your answer in metres.

A large rectangular grid consisting of 20 columns and 10 rows of small squares, intended for考生 to work out their calculations for part (c)(i).

This question continues on the next page.

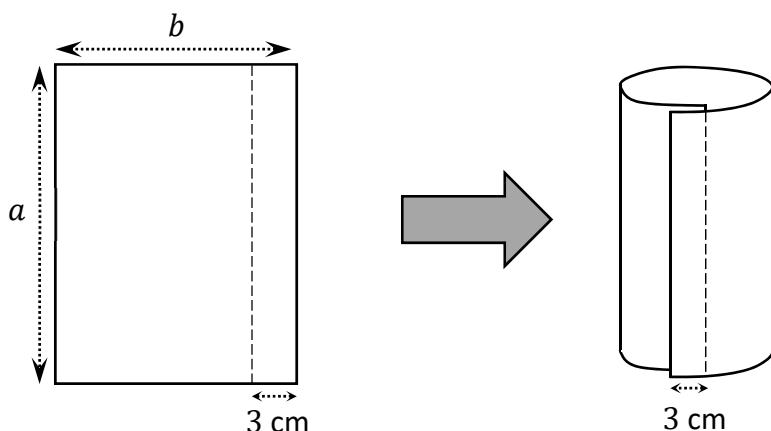
- (ii) Work out the curved surface area of Alan's model, excluding the roof.
Give your answer correct to the nearest **cm²**.

Remember that it will be in the shape of a cylinder, with a diameter of 28 **centimetres** and a height of 1.7 **metres**.

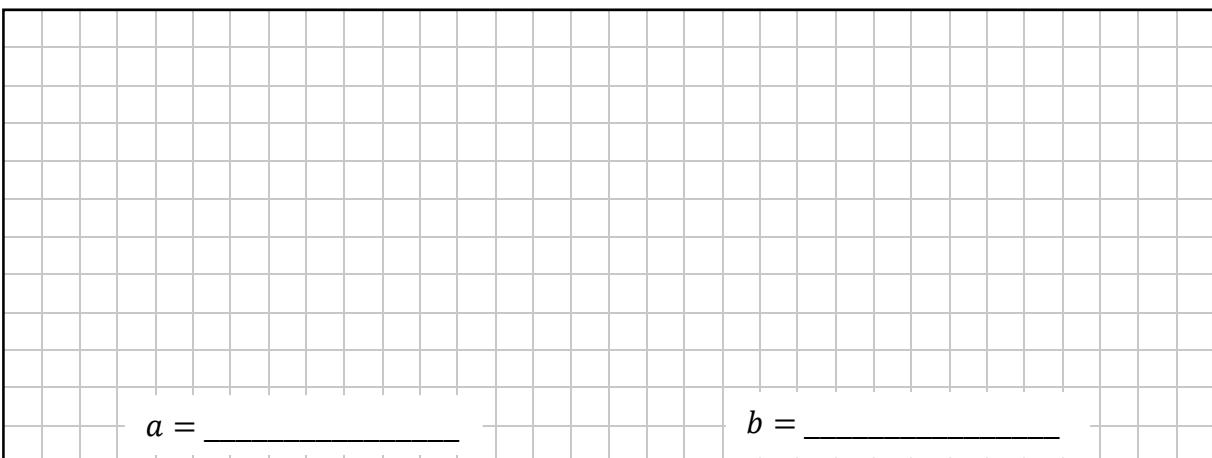


Alan is going to make this part of the model from a rectangular sheet of card of length a cm and width b cm, as shown in the diagram below (not to scale).

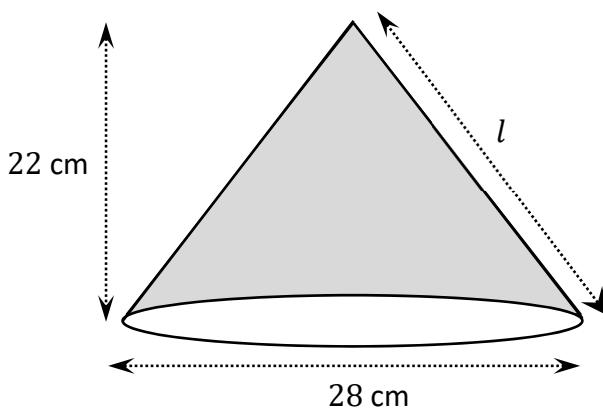
There will be an extra 3 cm of card along one edge of the sheet, which will overlap with the other edge when Alan makes the cylinder, as shown.



- (iii) Find the value of a and the value of b . Give b correct to the nearest cm.



- (d) The roof of Alan's model will be in the shape of a cone.
The diameter of the cone will be 28 cm, and the vertical height of the cone will be 22 cm.

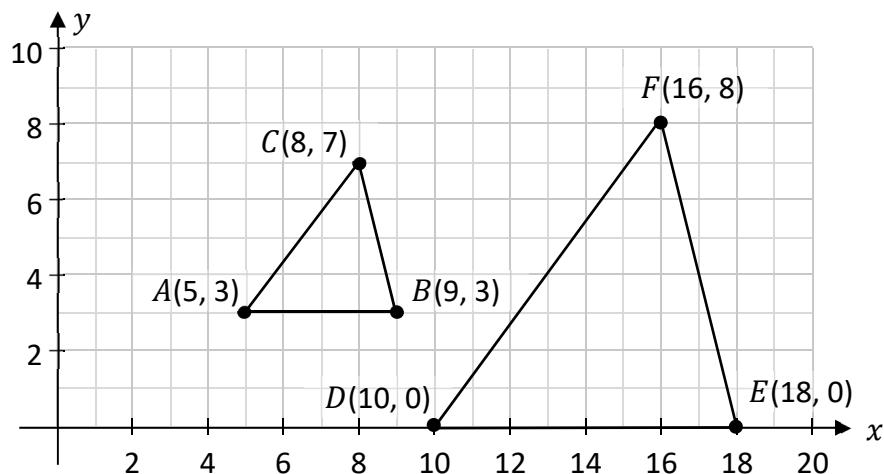


Find l , the slant height of the cone, **and** hence find the curved surface area of the cone.
Give each answer correct to 1 decimal place.

$l =$ _____	Curved surface area = _____

Question 10**(50 marks)**

The co-ordinate diagram below shows two triangles: ABC and DEF .



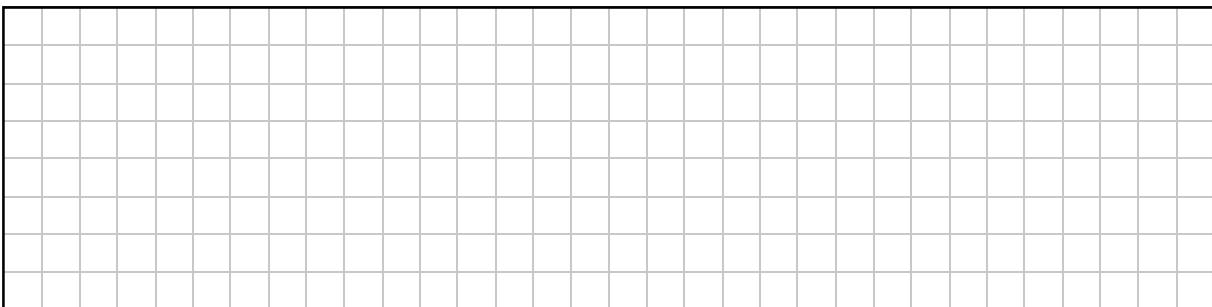
- (a) (i)** Show that the slope of AC is equal to the slope of DF .

- (ii)** What does this tell you about the lines AC and DF ?

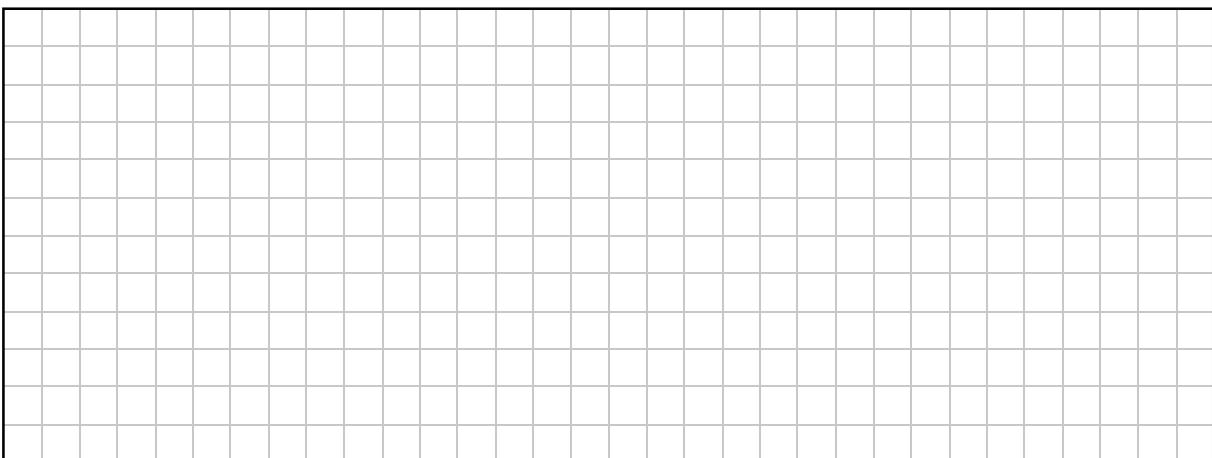
The triangle DEF is the image of ABC under an enlargement with a scale factor of k .

- (b)** Find the value of k , the scale factor of this enlargement.

- (c) The area of the triangle ABC is 8 square units.
Hence, or otherwise, find the area of the triangle DEF .

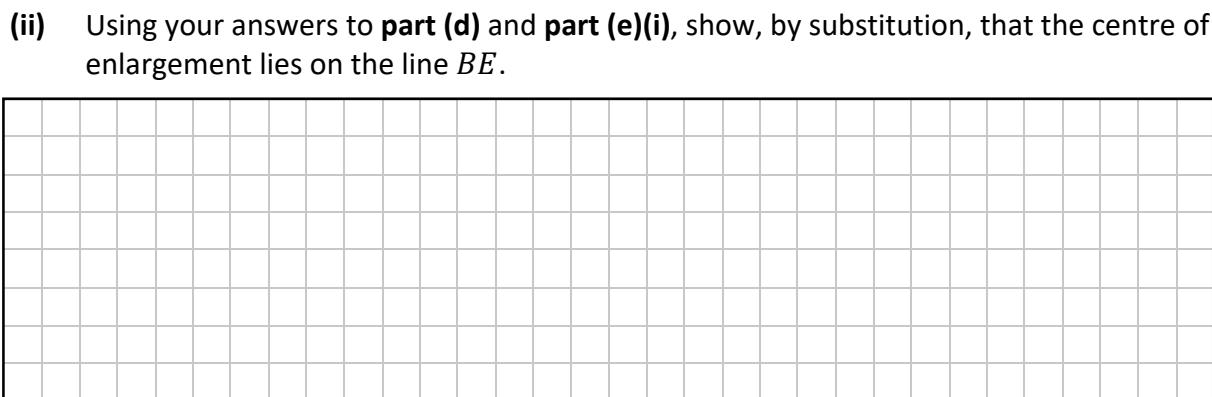


- (d) Find the equation of the line BE .
Give your answer in the form $y = mx + c$, where $m, c \in \mathbb{R}$.



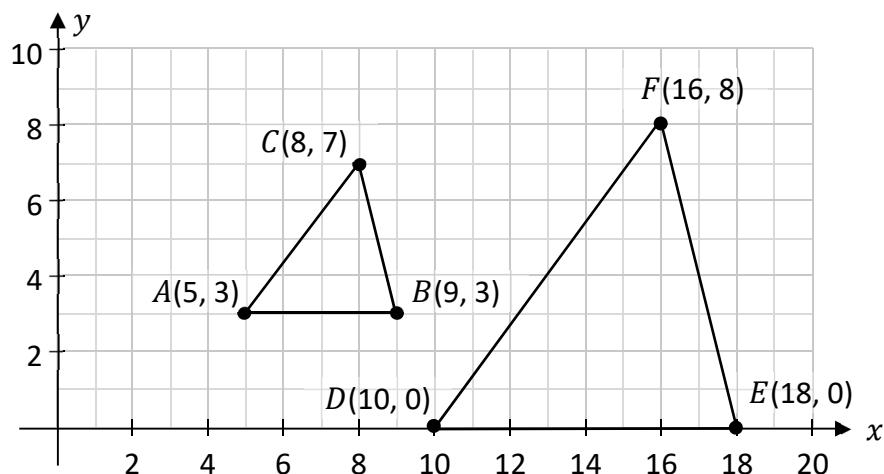
- (e) (i) By drawing suitable lines on the diagram, construct the **centre** of this enlargement,
and write down the co-ordinates of this centre.

Centre of enlargement = (,)



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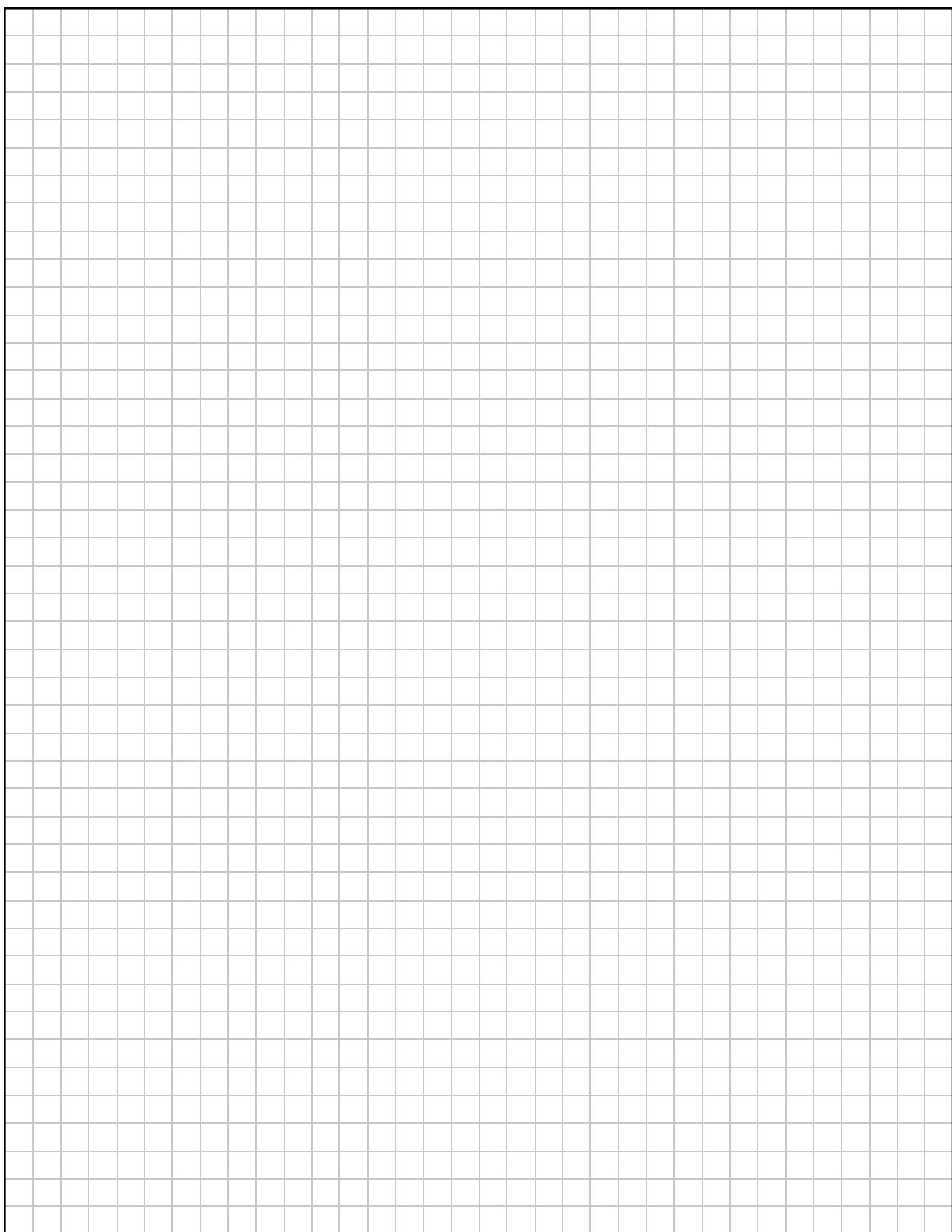
The co-ordinate diagram below shows the same two triangles, ABC and DEF .



- (f) Use trigonometry to find the size of $\angle DFE$.
Give your answer correct to 1 decimal place.

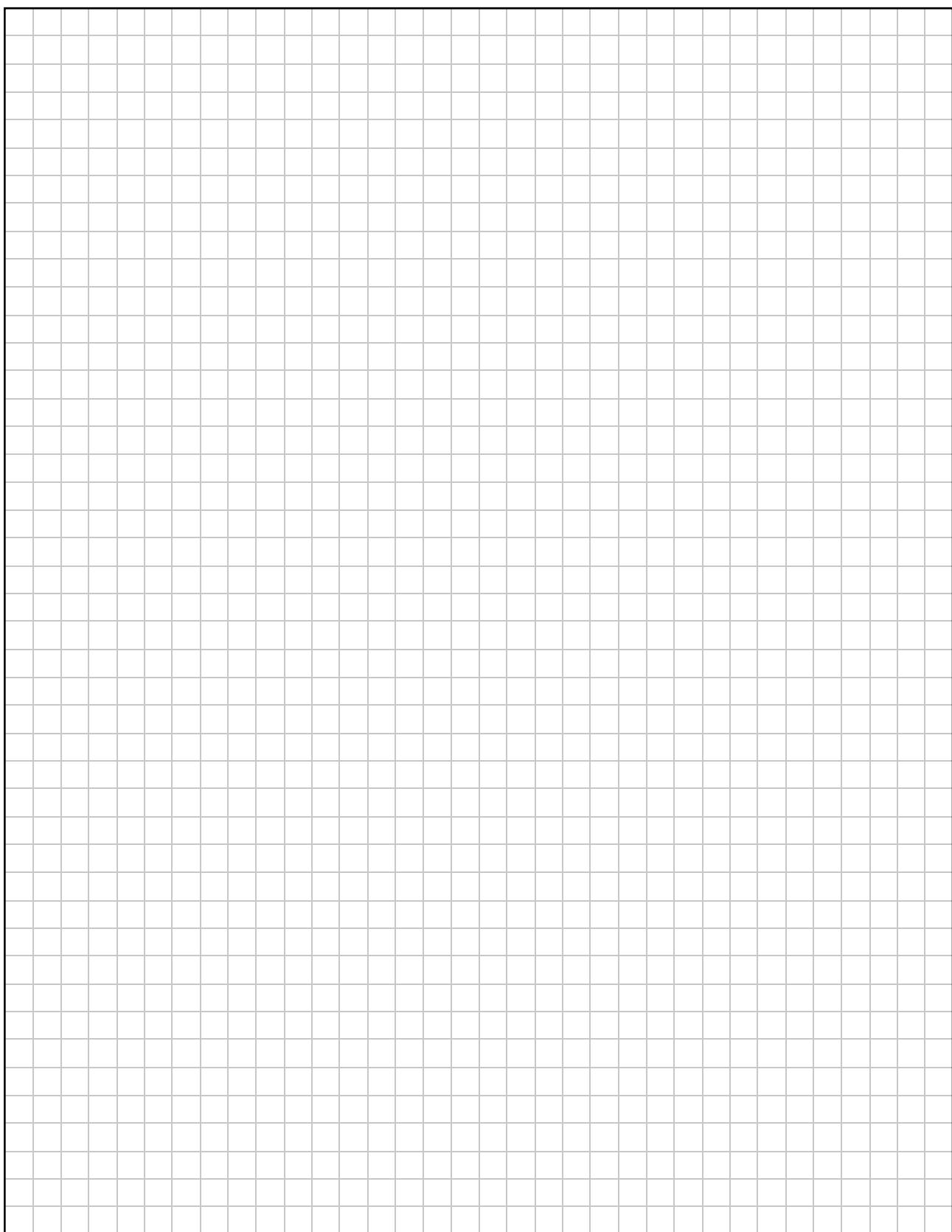
Page for extra work.

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



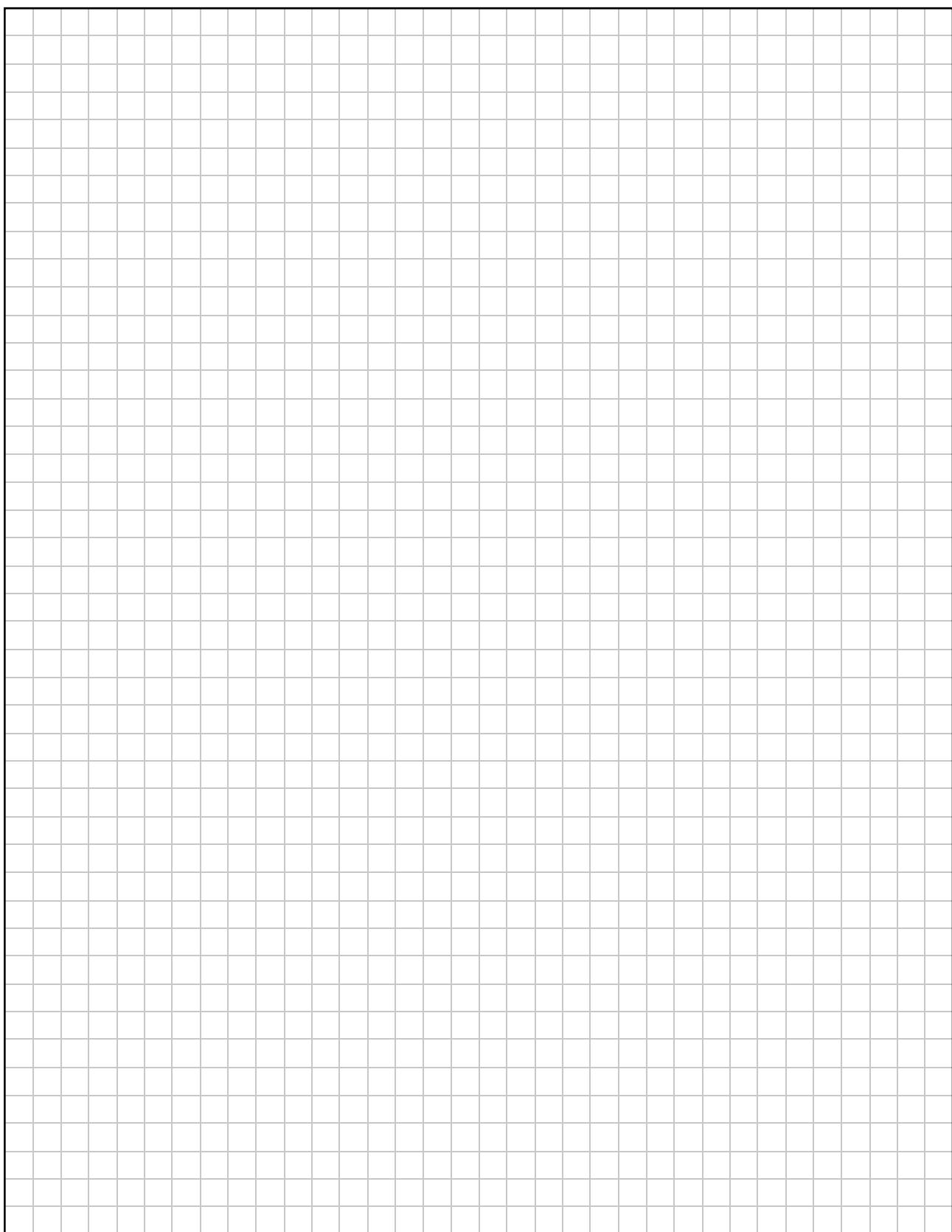
Page for extra work.

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



Page for extra work.

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



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Leaving Certificate – Ordinary Level

Mathematics Paper 2

2 hours 30 minutes