Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination 2016

Mathematics

Paper 2

Ordinary Level

Monday 13 June Morning 9:30 – 12:00

300 marks

Examination number

Centre stamp

Running total	

For examiner	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total	

Grade

Instructions

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

Section A	Concepts and Skills	150 marks	6 questions
Section B	Contexts and Applications	150 marks	3 questions

Answer **all nine** questions.

Write your answers in the spaces provided in this booklet. You may lose marks if you do not do so. You may also 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 will lose marks if you do not show all necessary 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:

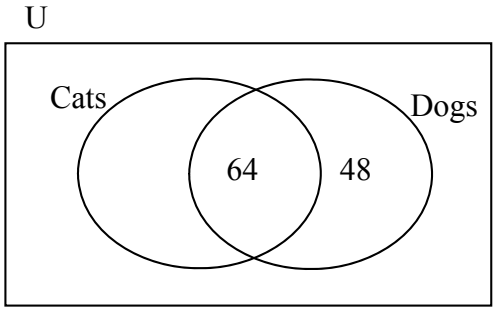
Section A — Concepts and Skills — 150 marks

Answer **all six** questions from this section.

Question 1 **(25 marks)**

(a) A survey of 168 people was carried out. Participants were asked whether they owned a cat or a dog. Some of the results are recorded in the Venn diagram below.

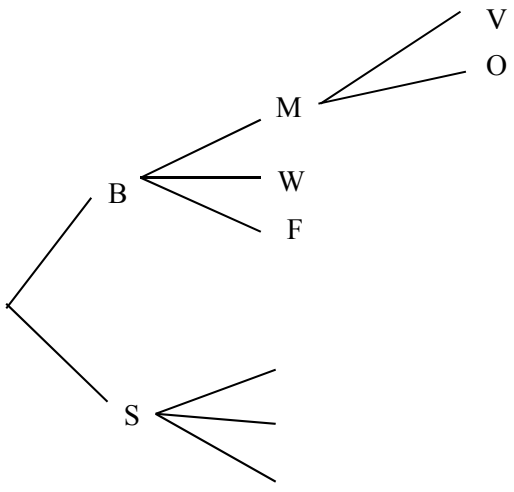
(i) Of those surveyed, 19 people did not own either a cat or a dog. Complete the diagram.



(ii) A person is chosen at random from those surveyed.
What is the probability that the person owned both a cat and a dog?

(iii) What percentage of the people surveyed owned one animal only?
Give your answer correct to one decimal place.

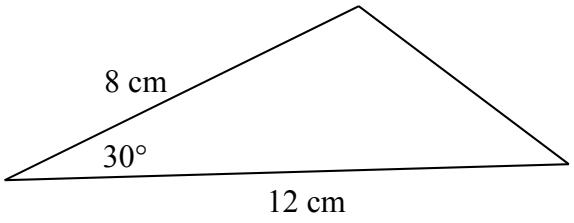
(b) Mandy wants to buy a ticket to the theatre. She can choose a ticket in the Balcony (B) or the Stalls (S). Mandy can go on Monday (M), Wednesday (W) or Friday (F). For an extra charge she can choose a VIP ticket (V) where she will meet the band or she can choose the show only (O).
Complete the tree diagram below, and hence or otherwise, find the probability that Mandy chooses a VIP ticket on a Wednesday.
You may assume that all choices are equally likely.



Probability =

Question 2 **(25 marks)**

(a) Find the area of the given triangle.

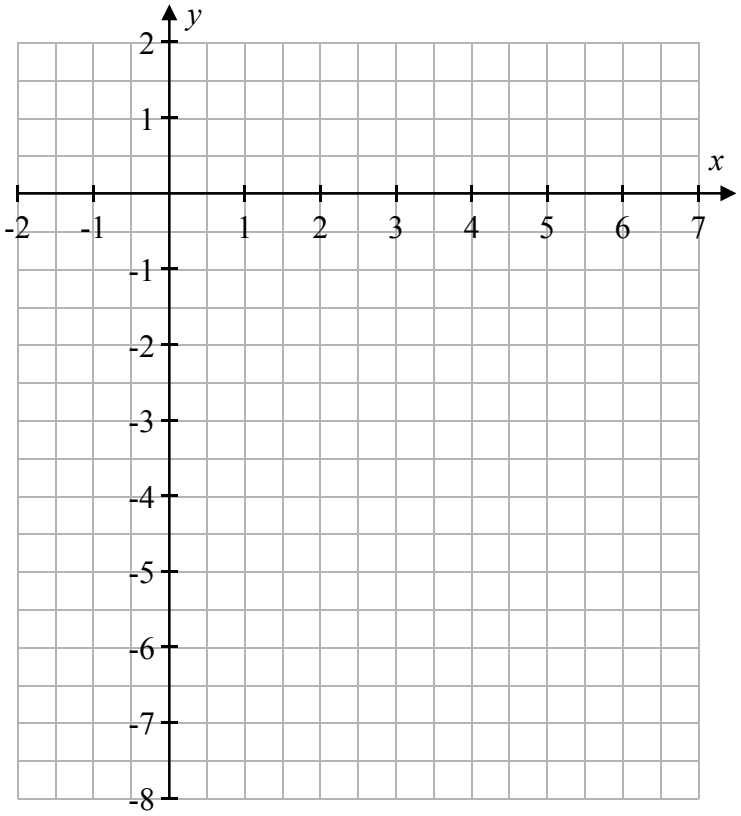


(b) A triangle has sides of length 3 cm, 5 cm, and 7 cm.
Find the size of the largest angle in the triangle.

Question 3 **(25 marks)**

(a) The circle c has centre $(2, -3)$ and a radius of 4 cm.
Write down the equation of c.

(b) Draw the circle c on the grid opposite. Each unit on the co-ordinate grid is 1 cm.



(c) Verify, using algebra, that the point $(3, 1)$ is outside of c.

(d) Find the area of the smallest four-sided figure that will fit around the circle c.

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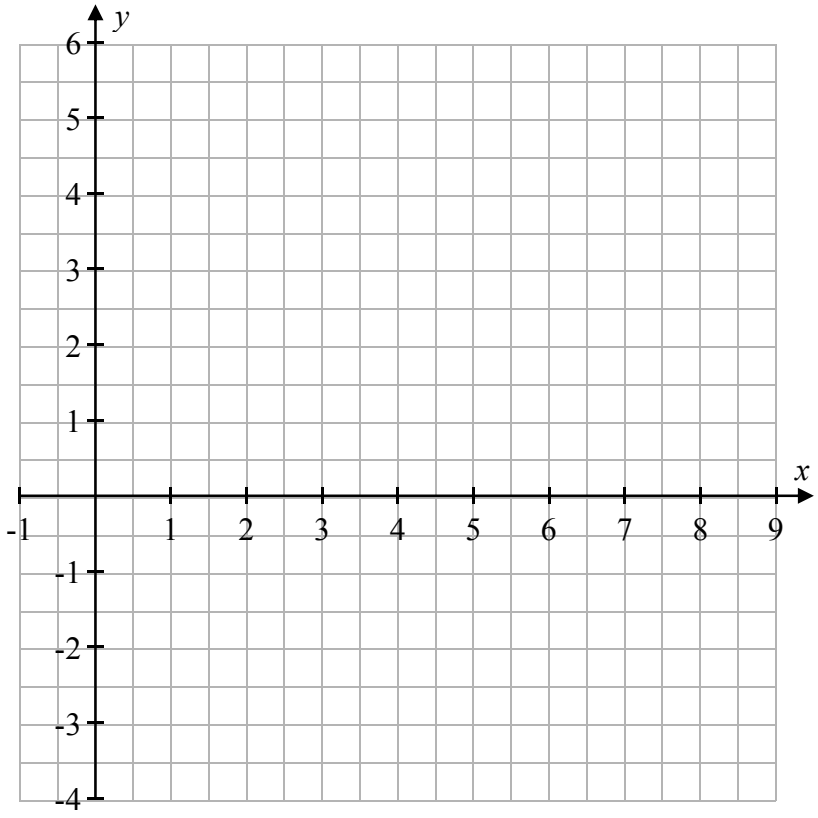
Question 4 **(25 marks)**

(a) The line l contains the points $A(4, 5)$ and $B(2, 0)$. Find the equation of l.
Give your answer in the form $ax + by + c = 0$ where a, b, and $c \in \mathbb{Z}$.

(b) Draw the line k: $x + 2y = 8$ on the axes below.



(c) Use a graphic, numeric or algebraic method to find the co-ordinates of $l \cap k$.

Question 5 **(25 marks)**

The waiting times, in minutes, for 16 patients at a dentist's surgery are recorded for a particular week (**Week 1**) on the following stem and leaf plot.

Week 2		Week 1
	0	5 8
	1	2 2 2 3
	2	0 4 5 7
	3	0 1 2 4 4
	4	4

Key: 1|3 = 13 minutes

(a) Find the mode and the median of the data.

Mode =		Median =	

(b) Find the mean waiting time for **Week 1**, correct to 1 decimal place.

(c) The waiting times were recorded again the following week. The results were:

27, 23, 6, 15, 18, 29, 16, 17, 15, 18, 40, 32, 16, 12, 28, 9.

Show these results on the plot above (under **Week 2**), creating a back-to-back stem and leaf plot to display the data.

Question 6 **(25 marks)**

(a) **(i)** Construct a triangle ABC, where $|AB| = 7$ cm, $|\angle BAC| = 50°$, and $|AC| = 4{\cdot}5$ cm.

(ii) Measure the length of $[BC]$ and hence find the sum of the lengths of the sides $[AC]$ and $[BC]$, correct to one decimal place.

$|AC| =$ 4·5 cm

$|BC| =$

Sum =

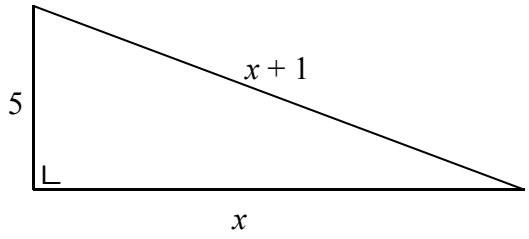
(b) State which one of the following triangles can **not** be constructed.
Give a reason to support your answer.

Triangle 1	Triangle 2
Sides of lengths (cm) 3·2, 2·9, 5·4	Sides of lengths (cm) 6, 7, 15

Answer:

Reason:

(c) The lengths of the sides of a right-angled triangle are $5, x,$ and $x + 1$ as shown.
Use the Theorem of Pythagoras to find the value of x.



Section B — Contexts and Applications — 150 marks

Answer **all three** questions from this section.

Question 7 (55 marks)

The Atomium in Brussels is one of Belgium's most famous landmarks.
It consists of 9 identical spheres joined by two types of cylindrical pipes.

Picture: Squonk11
www.flickr.com/photos/squonk

(a) The Atomium is modelled on an iron atom that has been magnified 165 billion times.
Given that a billion is a thousand million,
write 165 billion in the form $a \times 10^n$, where $n \in \mathbb{Z}$, and $1 \leq a < 10$.

(b) The diameter of each sphere in the Atomium is 18 metres.

(i) Find the radius of each sphere.

(ii) Find the volume of each sphere, correct to 2 decimal places.

(c) Find the combined surface area of all 9 spheres in the Atomium, correct to the nearest m^2.

(d) Each of the 8 cylindrical pipes extending from the centre sphere has a radius of 1·65 m and a length of 23 m.

(i) Find the sum of the curved surface areas of all 8 pipes, correct to the nearest m^2.

(ii) The other 12 cylindrical pipes connect the outer spheres to each other. Each pipe has a radius of 1·45 m. All 12 pipes are equal in length. The sum of the curved surface areas of the 12 pipes is 3170 m^2. Find the length of one pipe.
Give your answer correct to the nearest metre.

(iii) The curved surfaces of the 20 pipes and 9 spheres are covered in stainless steel. Stainless steel costs €70 per square metre. Use the areas you have calculated or have been given above to find the approximate cost of the stainless steel required to resurface the Atomium.

Question 8 **(50 marks)**

The following table shows some of the data gathered by a company on average water usage in homes.

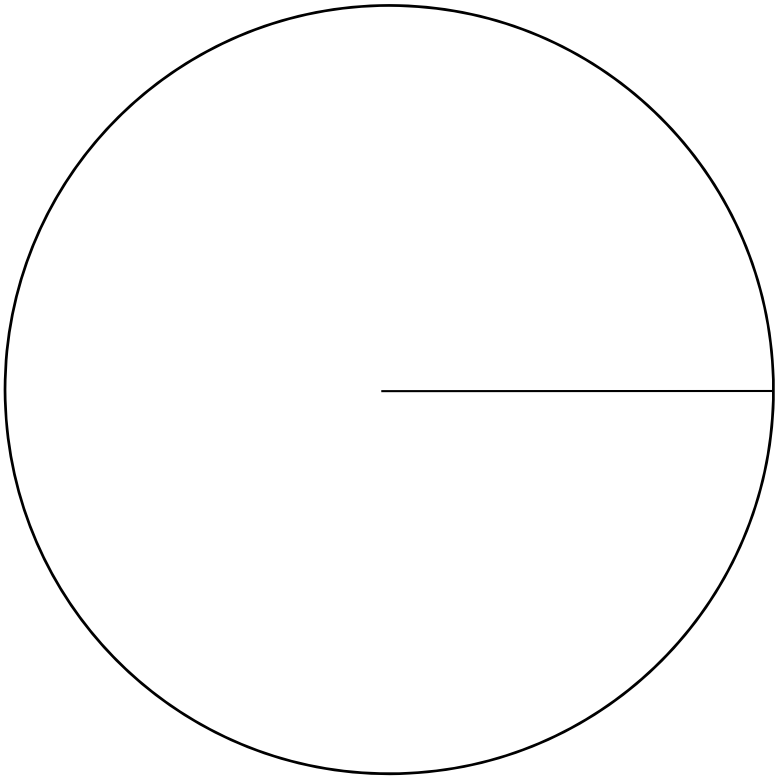
Activity	Percentage used	Angle (Degrees)
WC flushing	30%	
Personal Washing – Baths and Taps	21%	
Personal Washing – Showers	12%	
Clothes Washing	13%	46·8°
Other		

(a) Find the percentage used for the 'Other' activity, and write it in the table.

(b) A pie chart representing the data is to be drawn.

(i) The size of the angle representing 'Clothes Washing' on the pie chart is 46·8°. Complete the table above to show the remaining angles in the pie chart.

(ii) Draw a pie chart to represent the data. Label the sector corresponding to each activity and write the size of the angle in each sector.



(c) John compiled a table showing the amount of water used in his own household over the course of a week. He recorded the number of litres required for each activity and the number of times each activity was undertaken.
The data are shown in the table below.

		John's weekly household water usage	
Activity	**Water Required per activity**	**Frequency**	**Number of litres used**
One Bath	80 litres	3 baths	240
One Shower	125 litres	20 showers	
Brushing Teeth with Tap Running	6 litres per minute	32 minutes	
One WC Flush	6 litres	60 flushes	
One Use of Washing Machine	45 litres	8 uses	
One Use of Dishwasher	20 litres	7 uses	
Washing One Car with a Bucket	10 litres	1 wash	
Hosepipe	9 litres per minute	15 minutes	
		Total number of litres used	

(i) Complete the table to show the number of litres used for the various activities and the total number of litres used in the week.

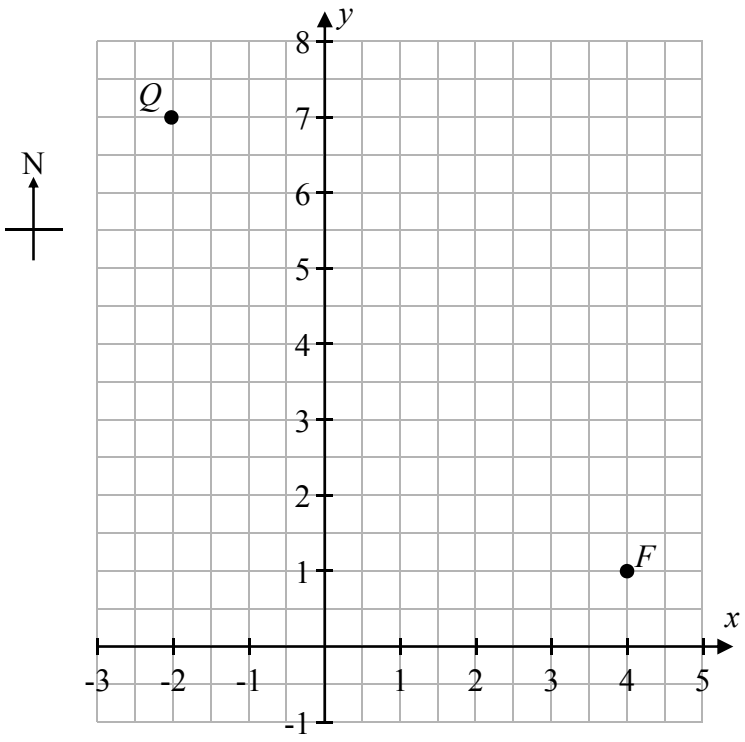
(ii) If water were charged at €1·85 per 1000 litres, find what John's household would pay for the water used **in one year** if the household uses the same amount of water each week.

(iii) Find John's total bill for this water if VAT were to be included at a rate of 13·5%.

(d) John would like to reduce his water bill to €260 per year.
If water were charged at €1·85 plus VAT at 13·5% per 1000 litres, find the number of litres of water he could purchase for €260.

Question 9 **(45 marks)**

Joe wants to draw a diagram of his farm. He uses axes and co-ordinates to plot his farmhouse at the point F on the diagram below.



(a) **(i)** Write down the co-ordinates of the point F.

$F = ($ $\quad$, $\quad$ $)$

(ii) A barn is 5 units directly North of the farmhouse. Plot the point representing the position of the barn on the diagram. Label this point B.

(b) Joe's quad bike is marked with the point Q on the diagram.
Find the distance from the barn (B) to the quad (Q).
Give your answer correct to 2 decimal places.

(c) Joe's tractor is at the point T, where $FBQT$ is a parallelogram.
Plot T on the diagram and write the co-ordinates of T in the space below.

$T = ($ $\quad$, $\quad$ $)$

(d) Joe wants to plough the land enclosed by the parallelogram *FBQT*.
Find the area of this parallelogram in square units.

(e) Given that $|\angle QFB| = 45°$, use trigonometric methods to find $|\angle BQF|$.
Give your answer in degrees correct to one decimal place.

You may use this page for extra work.

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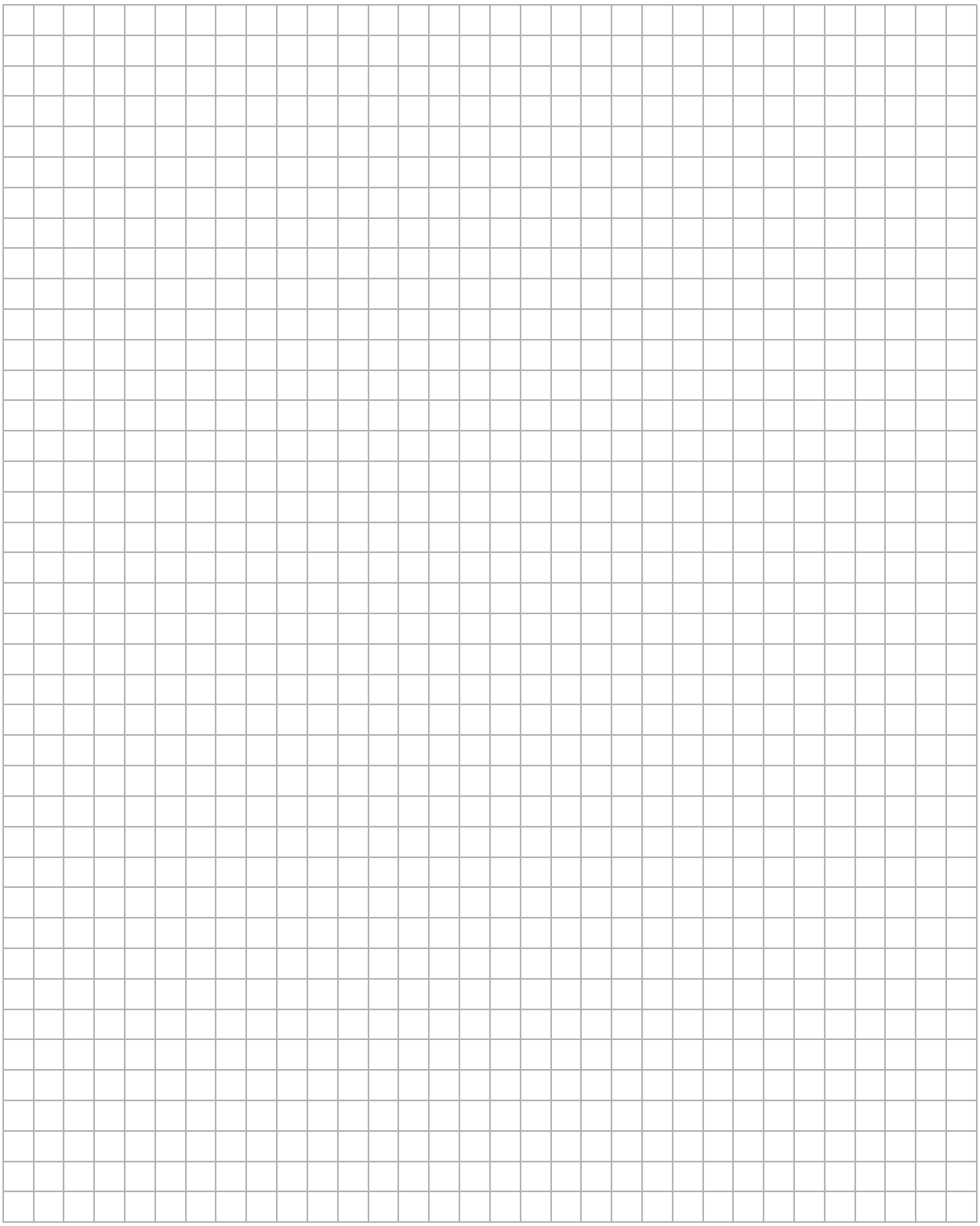

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