



Coimisiún na Scrúduithe Stáit  
State Examinations Commission

Leaving Certificate Examination 2026  
**Mathematics**  
Paper 2  
Higher Level  
Monday 8 June Morning 9:30 - 12:00  
300 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

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## 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	4 questions

Answer questions as follows:

- **any five** questions from Section A – Concepts and Skills
- **any three** 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.

In general, diagrams are not to scale.

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

You may lose marks if the appropriate units of measurement are not included, where relevant.

You may lose marks if your answers are not given in simplest form, where relevant.

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

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

**Question 1** **(30 marks)**

A shop records the number of sales that it makes each hour over a period of time. Some of the results are shown in the stem-and-leaf graph below.

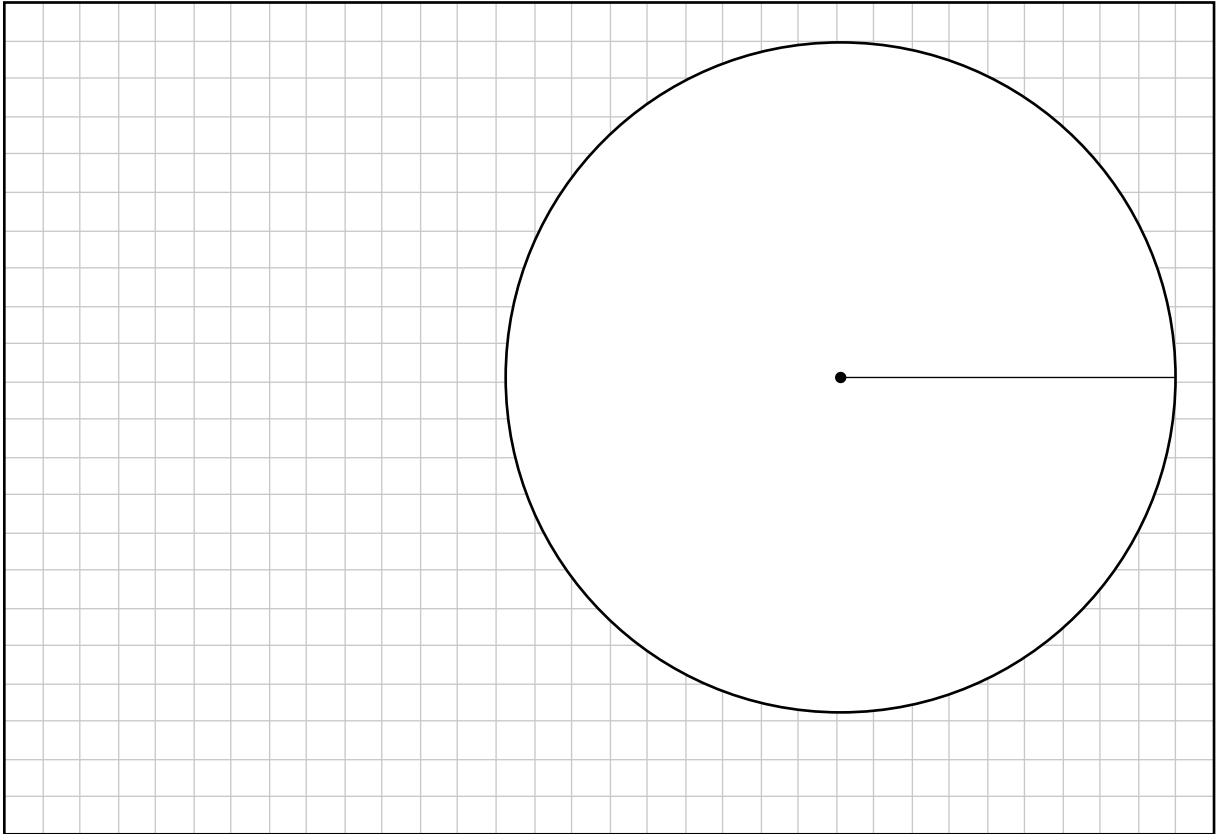
5	4	4	5	5	7	7	8		
6	2	3	3	4	5	7	9	9	
7	0	3	7						
8	0	5							

Key: 5|7 = 57 sales

(a) Work out the following statistics for the data above.

Statistic	Value
<b><i>n</i>, the number of observations</b>	20
<b>Median</b>	
<b>Range</b>	
<b>Interquartile range</b>	

- (b) Draw a **pie chart** to represent this data.  
 Use the classes 50 – 59, 60 – 69, 70 – 79, and 80 – 89.  
 Label each sector **and** the size of each angle clearly. Show all of your calculations.



- (c) The shop records the number of sales each hour for a further  $k$  hours.  
**Each** of these  $k$  hours had sales in the range 70 – 79.  
 When the sales for these  $k$  hours were combined with the sales in the stem-and-leaf graph on the previous page, 32% of the **total** number of hours had sales in the range 70 – 79.  
 Work out the value of  $k$ .

$k =$  \_\_\_\_\_

**Question 2**

**(30 marks)**

A company makes mobile phones.

- (a)** The company carries out a survey on a random sample of  $n$  of their customers, where  $n \in \mathbb{N}$ .

Based on this survey, the margin of error for the population proportion,  $\frac{1}{\sqrt{n}}$ , is 3.4%, correct to 1 decimal place.

Find one possible value of  $n$ .

$n =$ _____
-------------

- (b)** The company makes two types of mobile phones: an old model and a new model.

A random sample of 80 of the company's **new** mobile phones is tested, to see how long it takes to charge them from empty to fully charged.

The mean time for this sample is 45.4 minutes, with a standard deviation of 3.1 minutes.

- (i)** Use this information to find a 95% confidence interval for the population mean time. Give each value in your answer in minutes, correct to 1 decimal place.

Confidence interval = ( _____ , _____ )
---

- (ii) The mean time taken to charge the **old** model mobile phone from empty to fully charged is 44 minutes. The company says that the mean time taken to charge the **new** model mobile phone is the same as this.

Using your answer to part (b)(i), or otherwise, carry out a hypothesis test at the 5% level of significance to test the company's claim.

The null hypothesis is given. State clearly the alternative hypothesis, your conclusion, and the reason for your conclusion. If necessary, provide calculations.

Null hypothesis: <b>The mean time taken to fully charge the new model mobile phone is 44 minutes.</b>
Alternative hypothesis:
Conclusion:
Reason:

- (c) In a different survey, two hypothesis tests were carried out at the 5% level of significance. The  $p$ -value for the first test was 0.046. The  $p$ -value for the second test was 0.0002.

Write a sentence to explain what the difference in the sizes of these  $p$ -values means about the conclusions to these two tests. You do **not** need to carry out any calculations.

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**Question 3**

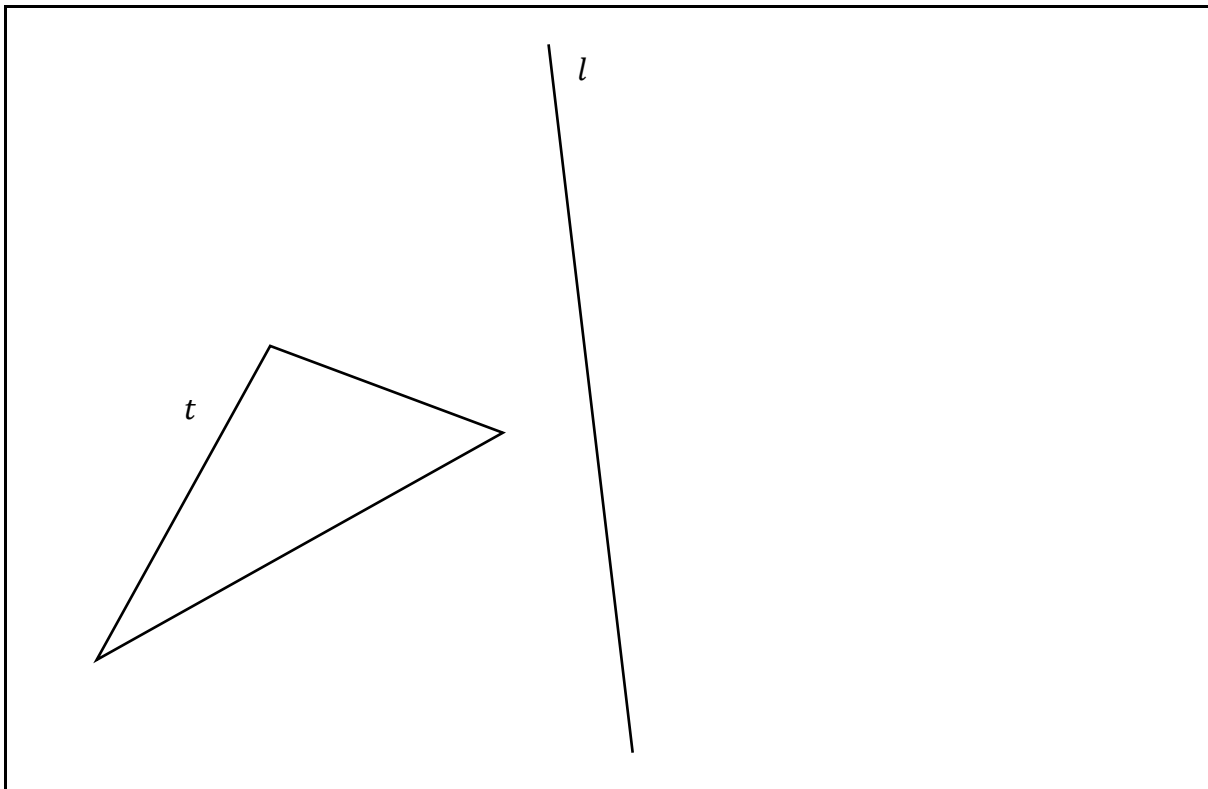
**(30 marks)**

- (a)** The diagram below shows the triangle  $t$  and the line  $l$ .

**Construct** the image of the triangle  $t$  under axial symmetry in  $l$ .

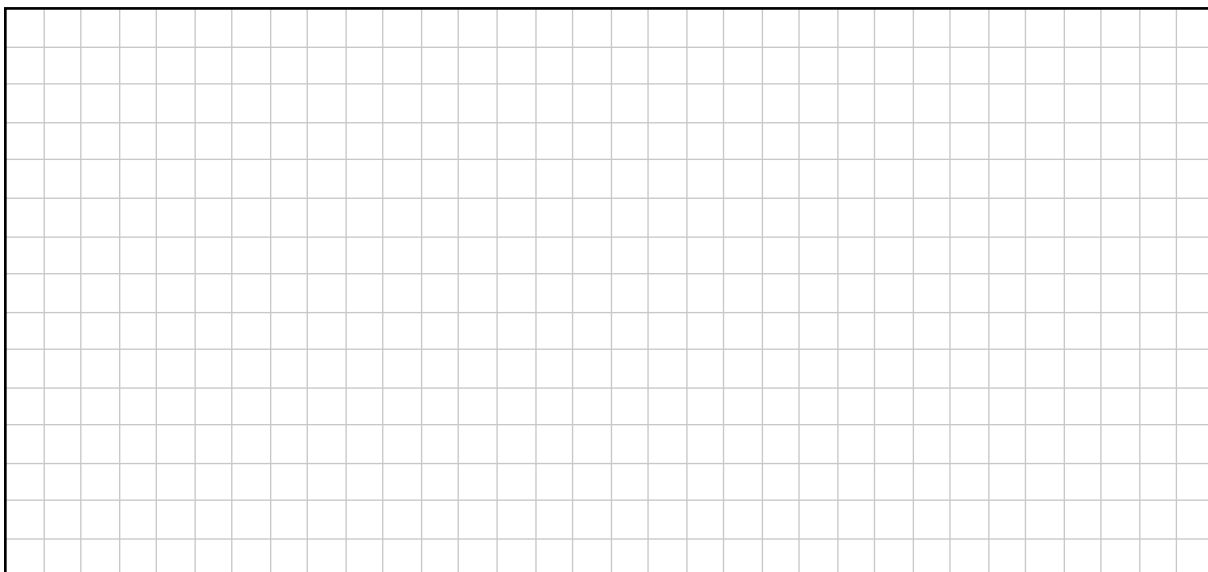
Show all construction lines clearly.

If you use measurements, write them in an appropriate place on your solution.



- (b)** A right circular cone has a height of  $h$  cm and a radius of  $\frac{h}{4}$  cm, where  $h \in \mathbb{N}$  is a constant. The volume of the cone is  $36\,000\pi$  cm<sup>3</sup>.

Work out the value of  $h$ .



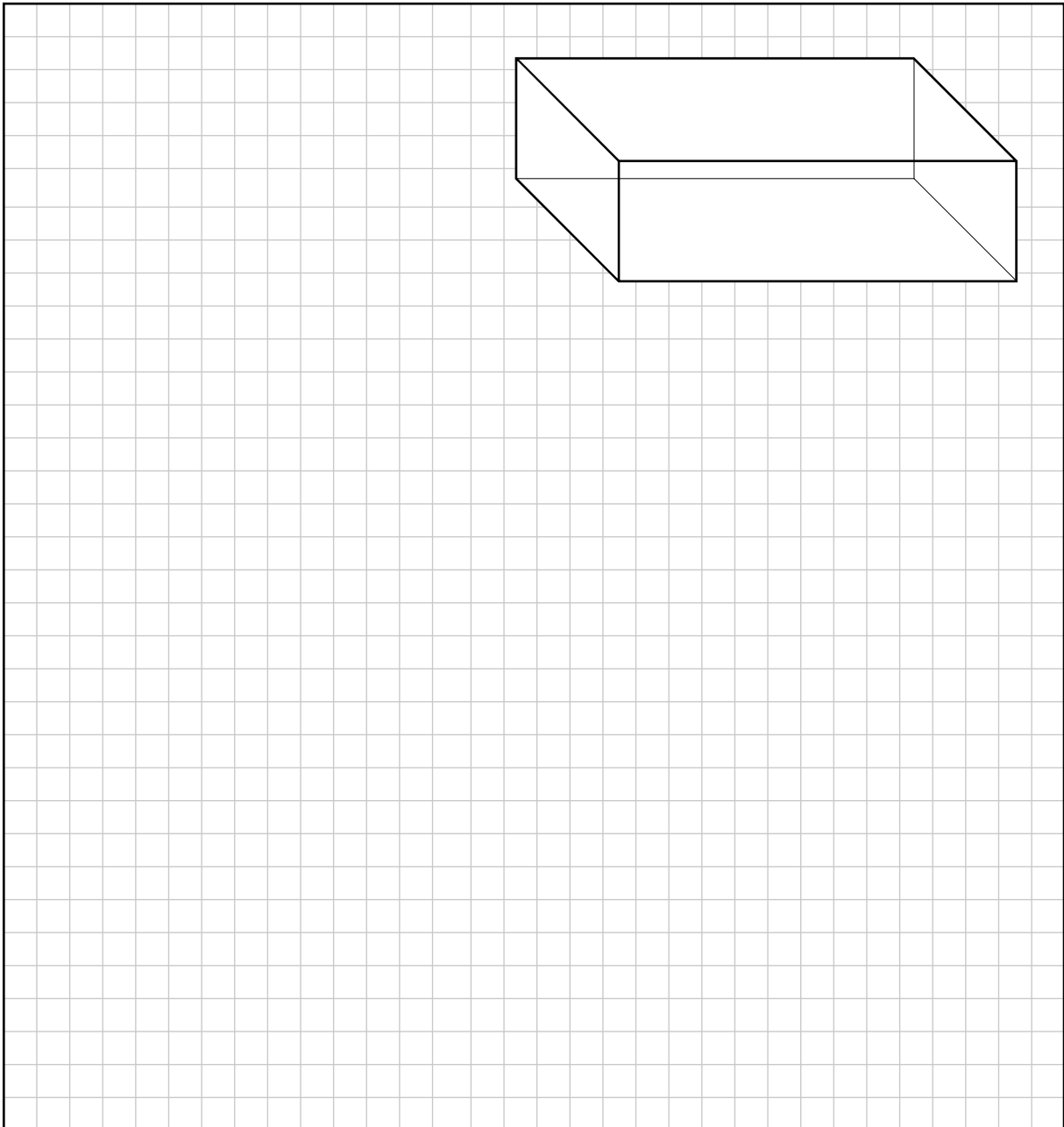
(c) A cuboid has sides of length 24 cm, 36 cm, and 60 cm.

This cuboid lies inside a sphere, so that the eight vertices (corners) of the cuboid lie on the surface of the sphere.

Work out the **volume** of the sphere.

Give your answer in the form  $a\sqrt{38}\pi \text{ cm}^3$ , where  $a \in \mathbb{N}$ .

It might be helpful to find the length of the internal diagonal of the cuboid.



Question 4

(30 marks)

(a) The lines  $l$  and  $k$  have the following equations:

$$l: \quad 3x - 2y = 0$$

$$k: \quad y = -\frac{3}{2}x + 7$$

Are the lines  $l$  and  $k$  **perpendicular**?  
Justify your answer using calculations.

Answer:
Justification:

(b) A line has equation  $y = mx + 8$ , where  $m \in \mathbb{R}$  is a constant.

Find the **ranges** of values of  $m$  for which this line does **not** intersect the line segment from  $(3, 7)$  to  $(3, 11)$ .

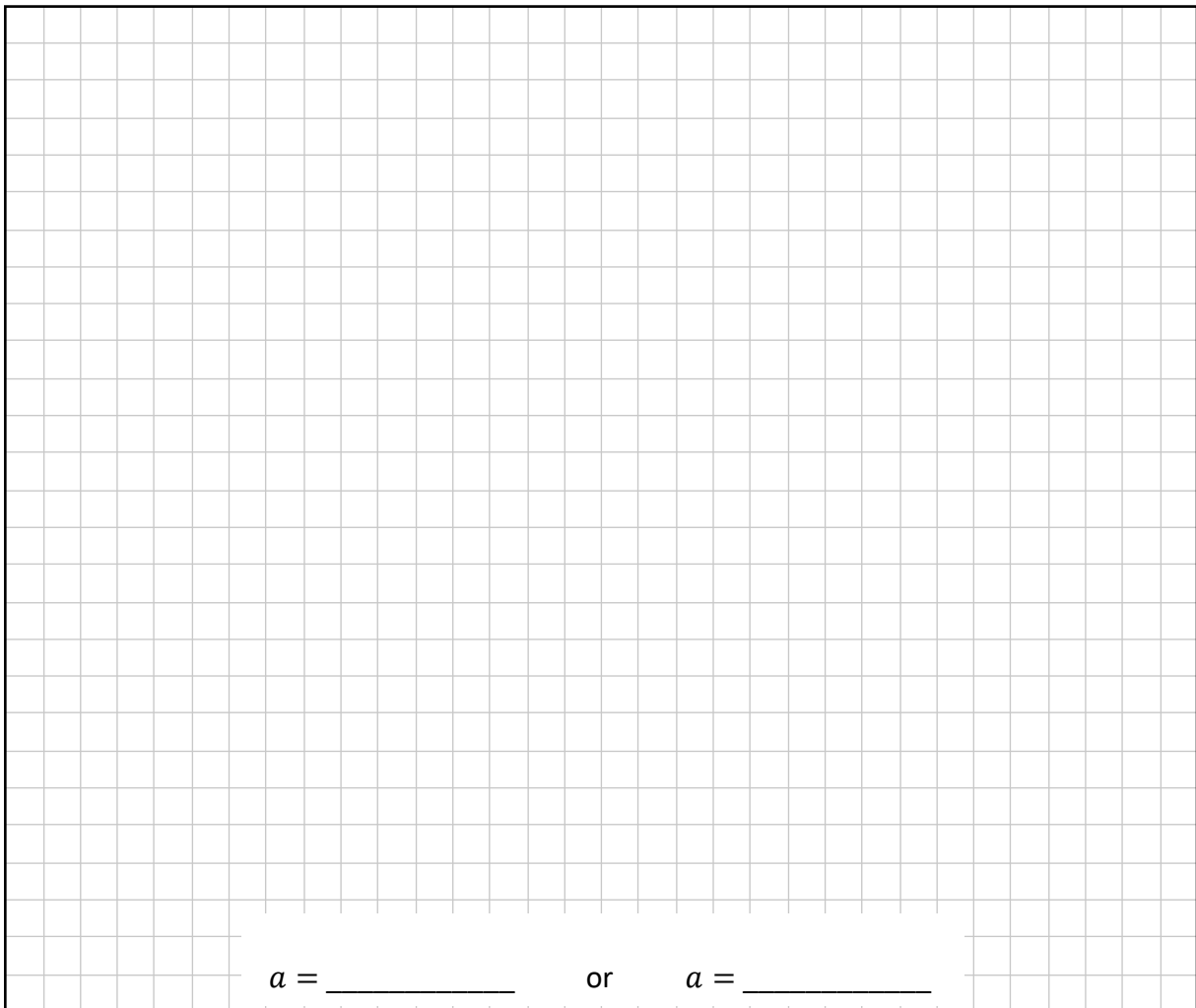
It may be helpful to draw a diagram.

Answer: _____ or _____
------------------------

(c)  $P$  is the point  $(1, 0)$ .

The perpendicular distance from  $P$  to the line  $ax + y - 5 = 0$  is 5,  
where  $a \in \mathbb{R}$  is a constant.

Find the **two** possible values of  $a$ .



$a = \underline{\hspace{2cm}}$  or  $a = \underline{\hspace{2cm}}$

Question 5

(30 marks)

(a) The circle  $c$  has equation:

$$x^2 + y^2 + 4x - 10y - 52 = 0$$

Write down the centre and radius of the circle  $c$ .

Centre = (      ,      )      Radius = _____
--

(b) Three standard unbiased 6-sided dice are labelled  $h$ ,  $k$ , and  $r$ .

Gino rolls the three dice and uses the numbers shown to form the equation of a circle in the form:

$$(x - h)^2 + (y - k)^2 = r^2$$

where  $h$ ,  $k$ , and  $r$  are the numbers shown on each of the dice.  
Each different set of values for  $h$ ,  $k$ , and  $r$  gives a different circle.

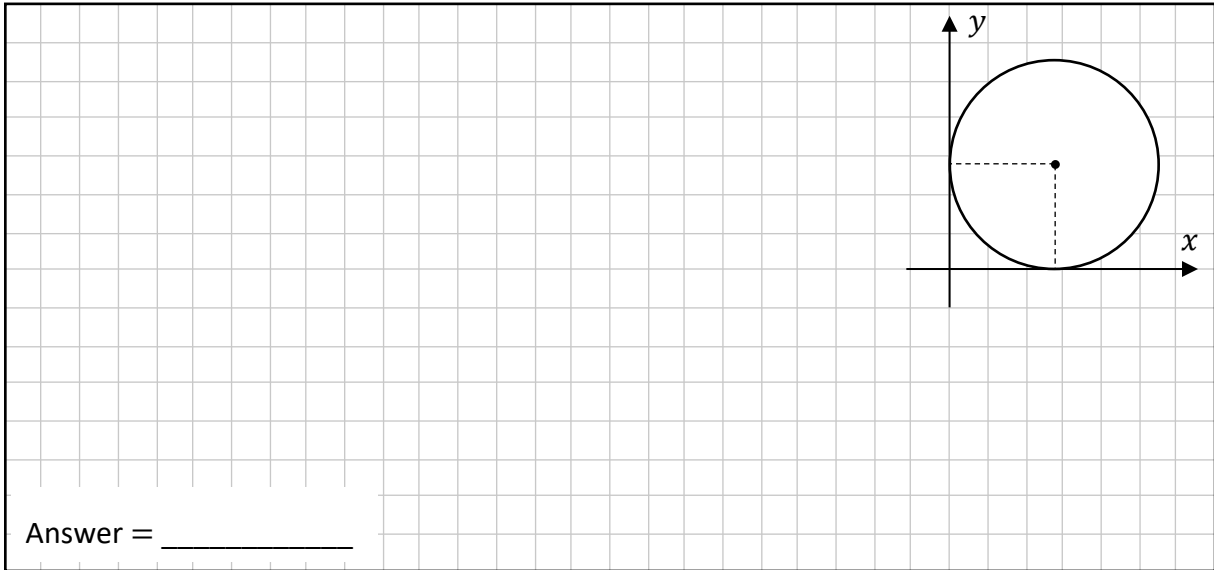
(i) Write down an example of **one** set of numbers  $h$ ,  $k$ , and  $r$  that Gino could throw, **and** write down the equation of the circle formed using these numbers.

$h =$ _____ $k =$ _____ $r =$ _____  Equation of circle: _____
--

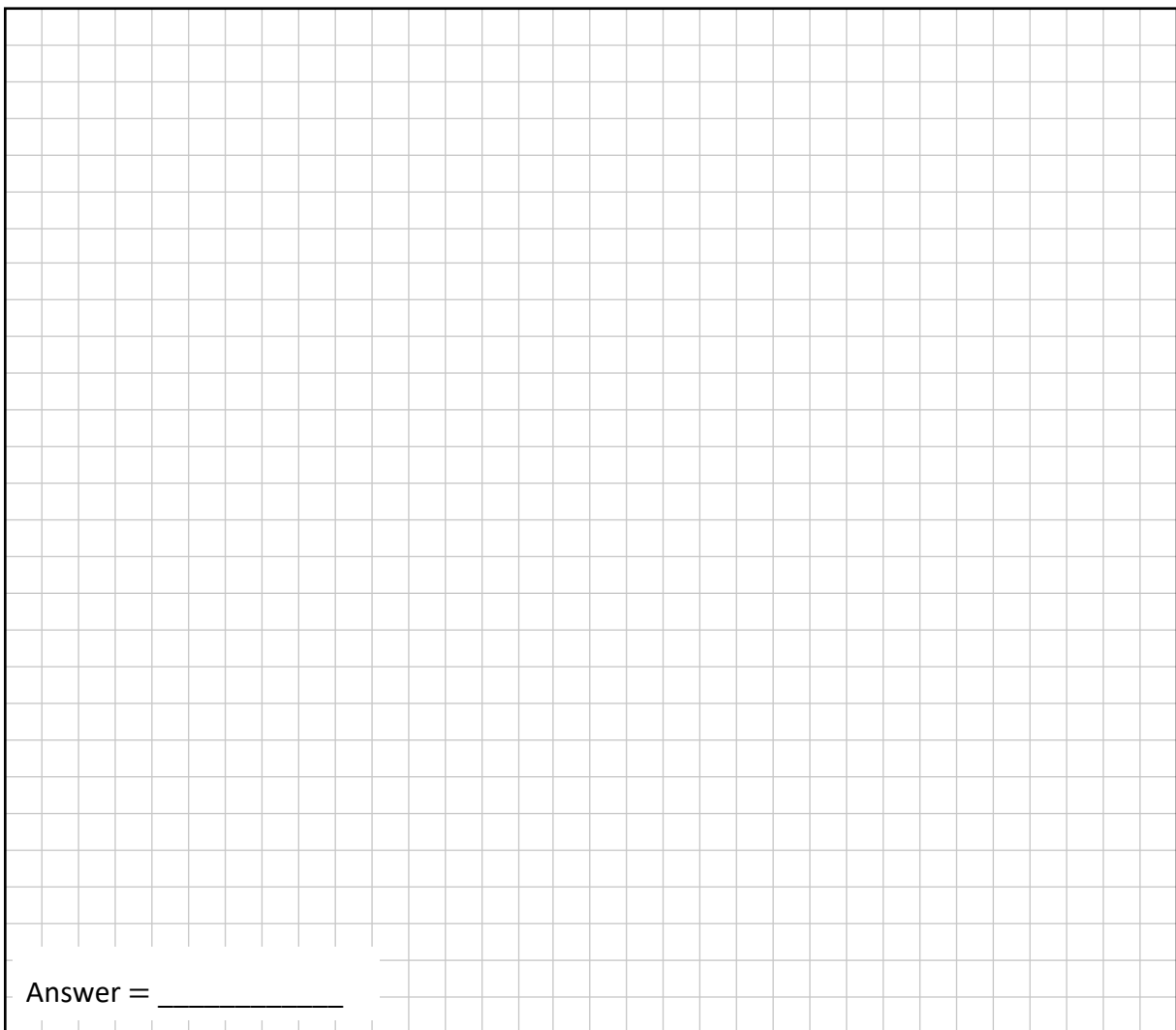
(ii) In **total**, how many different circles can Gino make in this way?

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(iii) How many of these circles have **both** the  $x$ -axis and the  $y$ -axis as a tangent?



(iv) How many of these circles lie entirely inside the first quadrant?  
(That is, how many neither touch nor cross the  $x$ -axis nor the  $y$ -axis?)



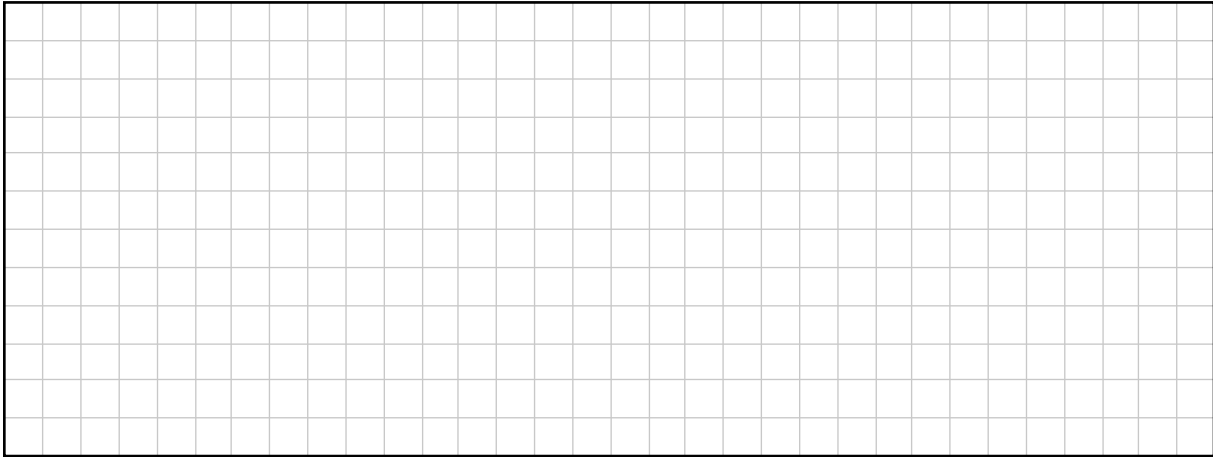
Question 6

(30 marks)

- (a)  $\theta$  is an acute angle, with  $\sin \theta = \frac{1}{4}$ .

Find the value of  $\cos \theta$ , without using a calculator.

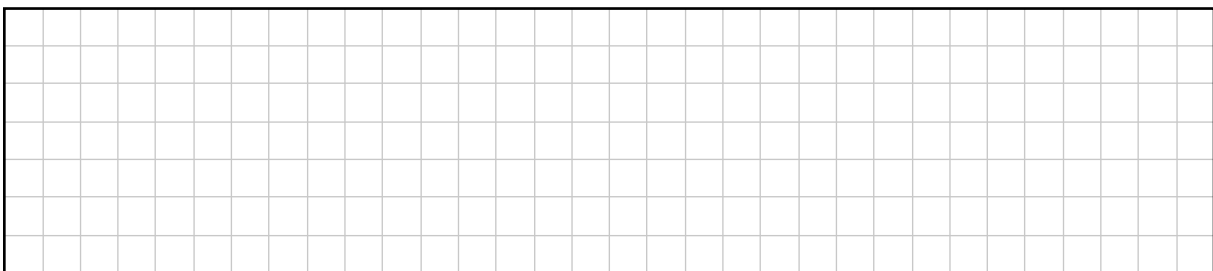
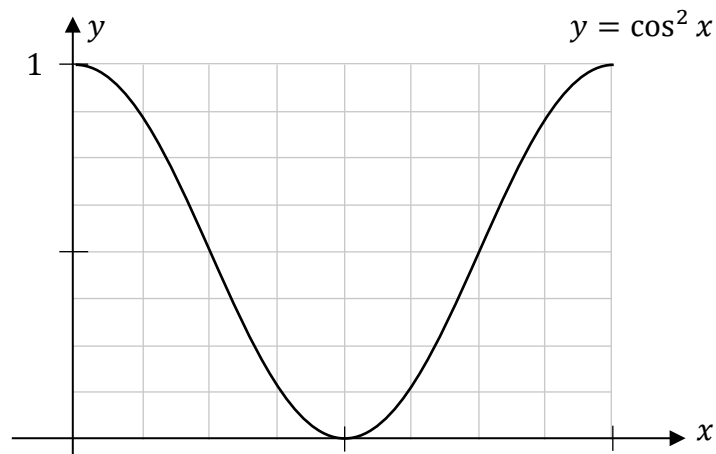
Give your answer in surd form. Show your working out.



- (b) The diagram below shows the graph of  $y = \cos^2 x$  for a limited domain.

On the diagram, **draw and label** the graph of  $y = \sin^2 x$ , using the same axes and scales.

Use the fact that  $\cos^2 A + \sin^2 A = 1$ .

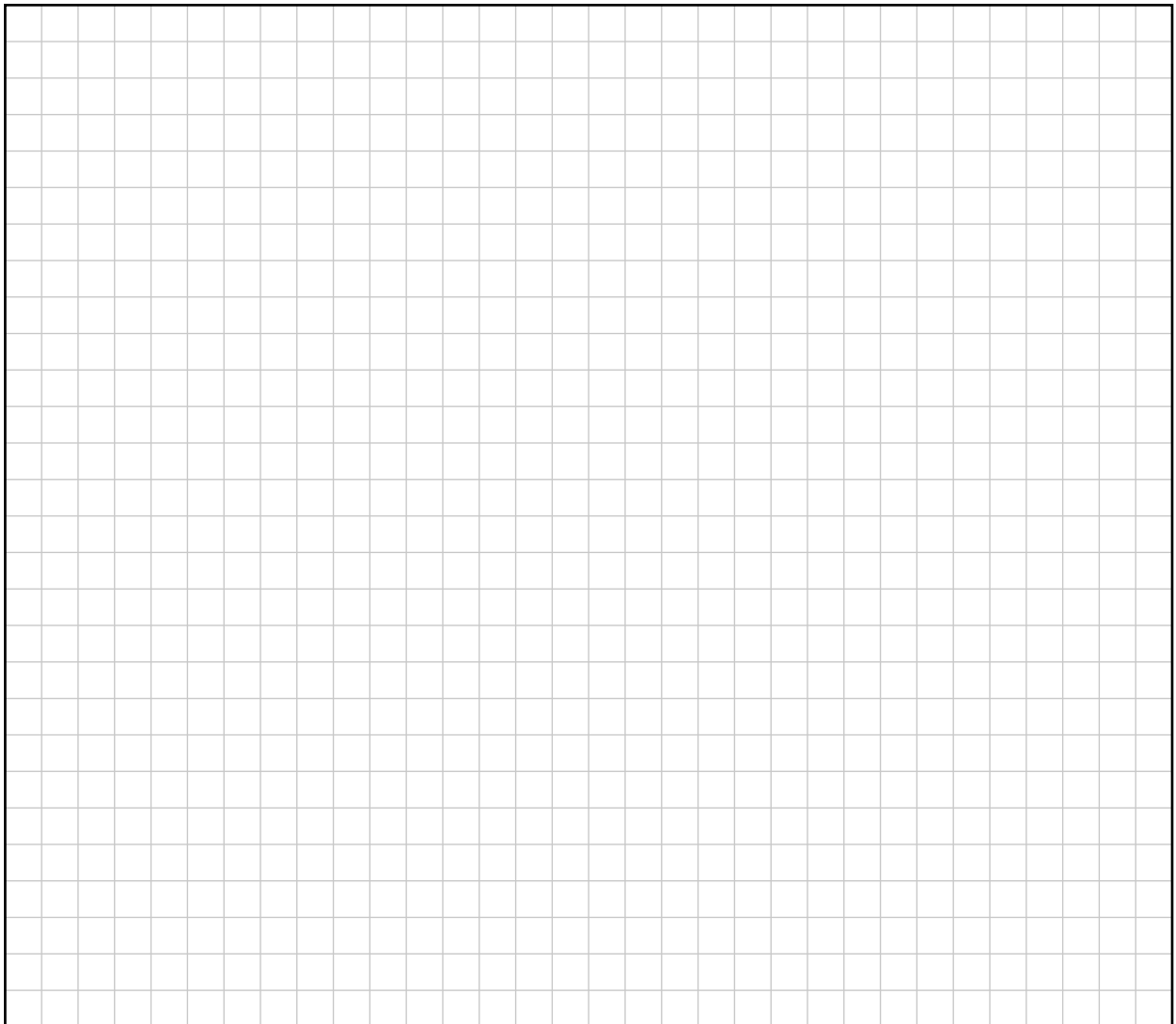
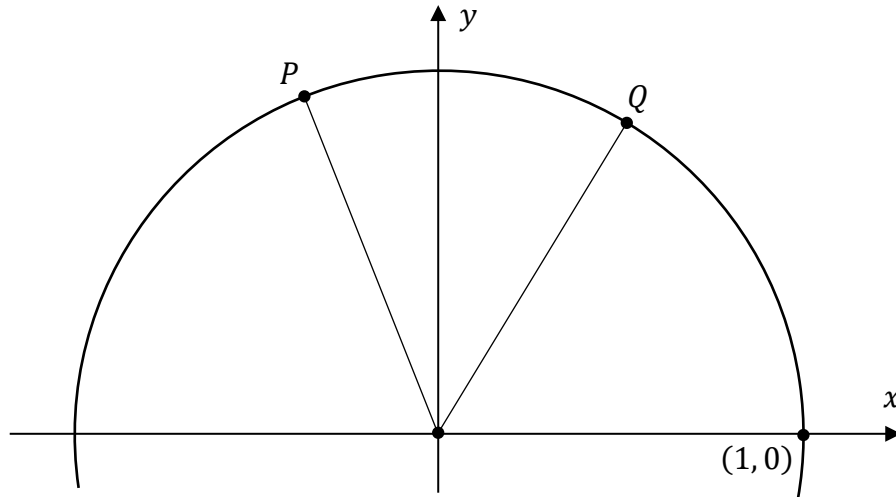


(c) Prove that:

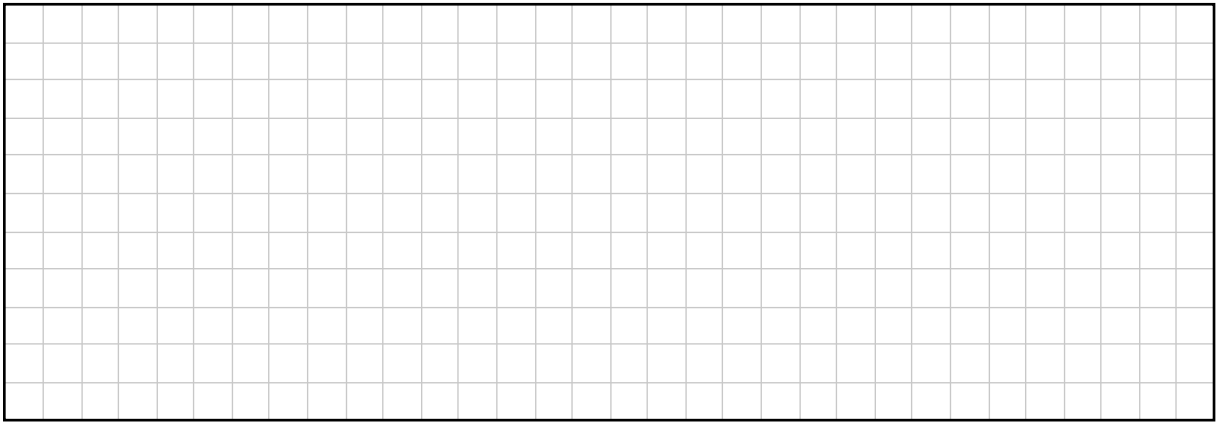
$$\cos(A - B) = \cos A \cos B + \sin A \sin B$$

where  $A$  and  $B$  are angles, with  $A > B$ .

It might be helpful to use two points,  $P$  and  $Q$ , on the unit circle.





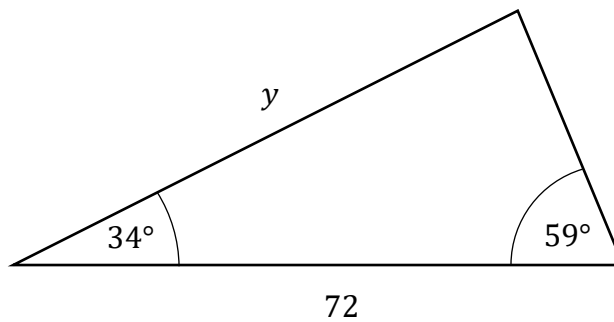


(b) Áine also makes the triangle shown below.

One side has a length of 72 and another has a length of  $y$ , where  $y \in \mathbb{N}$ .

The sizes of two of the angles are  $34^\circ$  and  $59^\circ$ , each correct to the nearest degree, as shown.

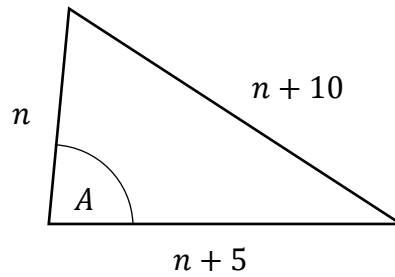
Find the value of  $y \in \mathbb{N}$ .



*This question continues on the next page.*

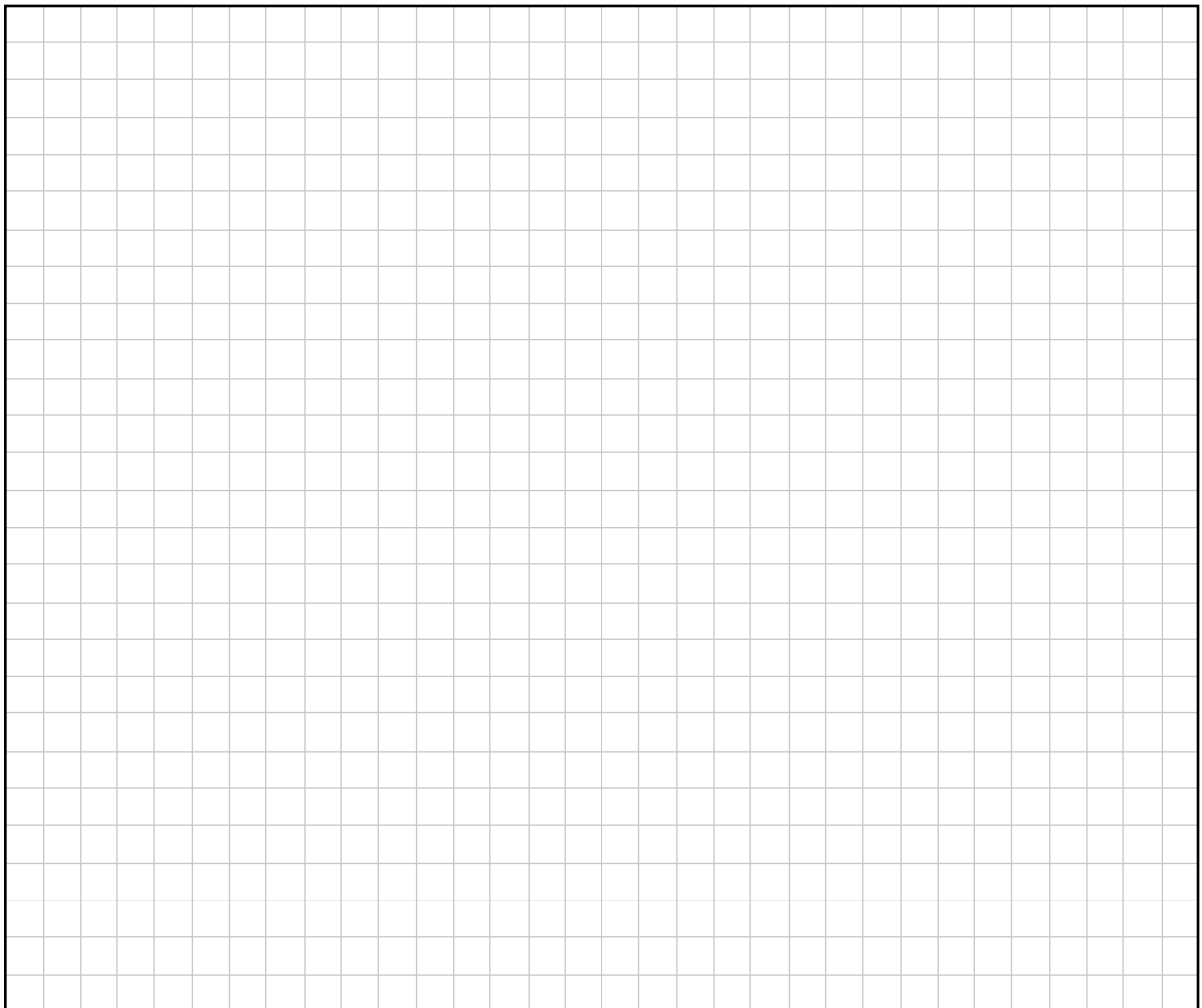
- (c) Áine makes a number of different triangles with sides of length  $n$ ,  $n + 5$ , and  $n + 10$ , where  $n \in \mathbb{N}$ .

The angle between the sides of length  $n$  and  $n + 5$  is  $A$ , as shown in the diagram below. When Áine changes the value of  $n$ , this changes the shape of the triangle and the size of the angle  $A$ .



- (i)  $A = 90^\circ$  for one value of  $n \in \mathbb{N}$ .

Find this value of  $n$ .



- (ii) Estimate the limit of the size of the angle  $A$ , as  $n$  tends to infinity.  
Write a sentence to justify your answer.

For this part only, assume that  $n$  can get extremely big (beyond 100).

Answer:
Justification:

- (d) Áine makes another triangle with three of her sticks, with sides of length 12, 24, and 30.  
Find how many **different** (non-congruent) triangles Áine could make that would be **similar** to this triangle. Show your working out.

Remember that Áine only uses three sticks for each triangle, and that the length of each stick is a different **whole number from 1 to 100**, inclusive.

Answer: _____
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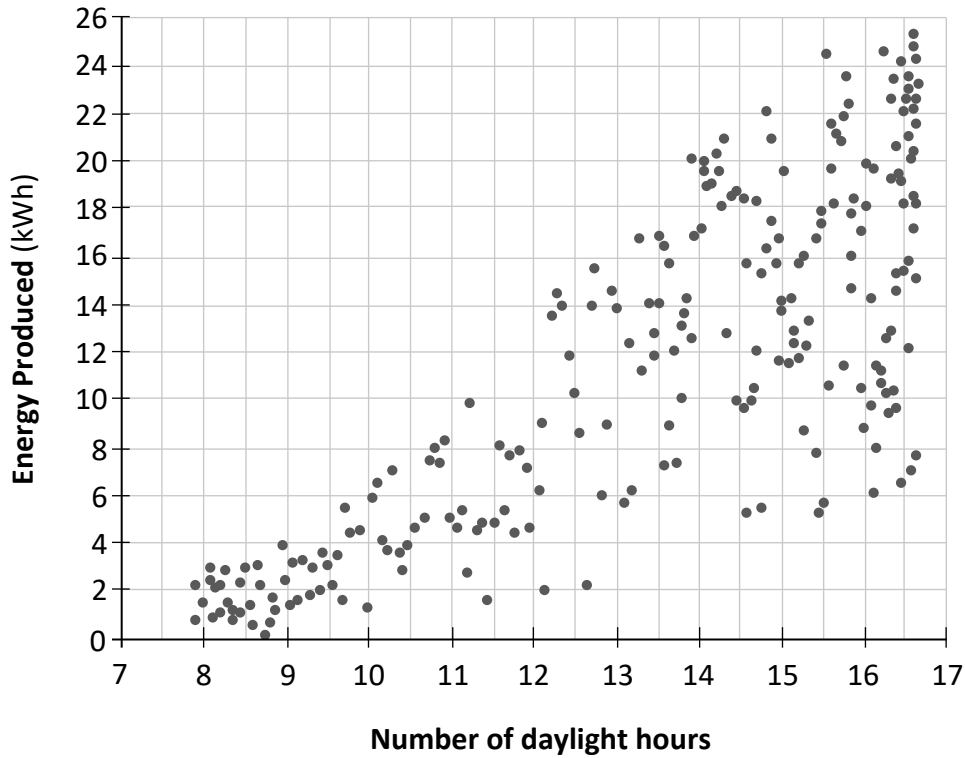
**Question 8**

**(50 marks)**

This question is about solar panels.

The graph below shows the energy produced each day by a number of solar panels, depending on the number of daylight hours. The axes do **not** meet at (0, 0).

The energy produced is measured in kWh.



- (a) Which of the following is closest to the value of  $r$ , the correlation coefficient, for this data? Justify your answer, **based on the information in the graph**.

-0.95	-0.80	-0.25	0.25	0.80	0.95
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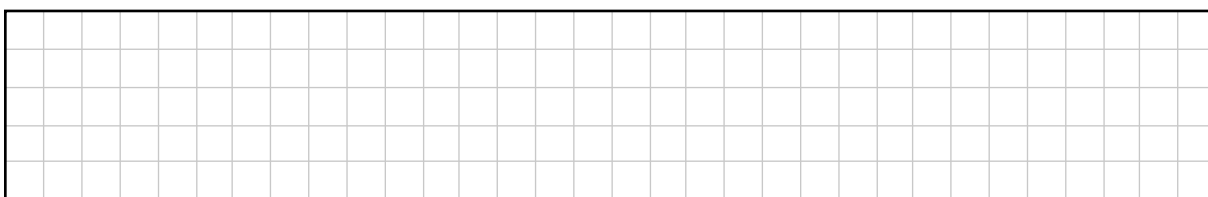
Answer:
Justification:

**(b)** According to the line of best fit, a day with 13 daylight hours corresponds to 10.7 kWh of energy being produced.

**(i)** **Plot** a point on the diagram on the previous page to represent this information. Label this point *P*.

**(ii)** **Draw** the line of best fit, by eye, on the diagram on the previous page. Your line of best fit should go through the point *P*.

**(iii)** Use the line of best fit that you have drawn to estimate the amount of energy that would be produced for a day with 11 daylight hours. Show your work on the diagram.



**(iv)** Find the equation of the line of best fit that you drew in part **(b)(ii)**. Use the point *P* you plotted in part **(b)(i)** and your answer from part **(b)(iii)**.

Give your answer in the form  $y = ax + b$ , where  $x \in \mathbb{R}$  is the number of daylight hours,  $y$  is the energy produced (in kWh), and  $a$  and  $b$  are constants.



*This question continues on the next page.*

Lee has a solar farm.

- (c) There are 128 solar panels in Lee's solar farm.  
Each week, he chooses 2 of the 128 solar panels at random to test.

Find the probability that, in a given week, he chooses **at least one** of the same solar panels as he chose the week before. Give your answer correct to 3 decimal places.

- (d) The number of daylight hours per day in the solar farm over the course of one year can be modelled by the following function,  $H(t)$ , for  $0 \leq t \leq 365$ ,  $t \in \mathbb{Z}$ :

$$H(t) = 4.5 \sin\left(\frac{2\pi}{365} t\right) + 12$$

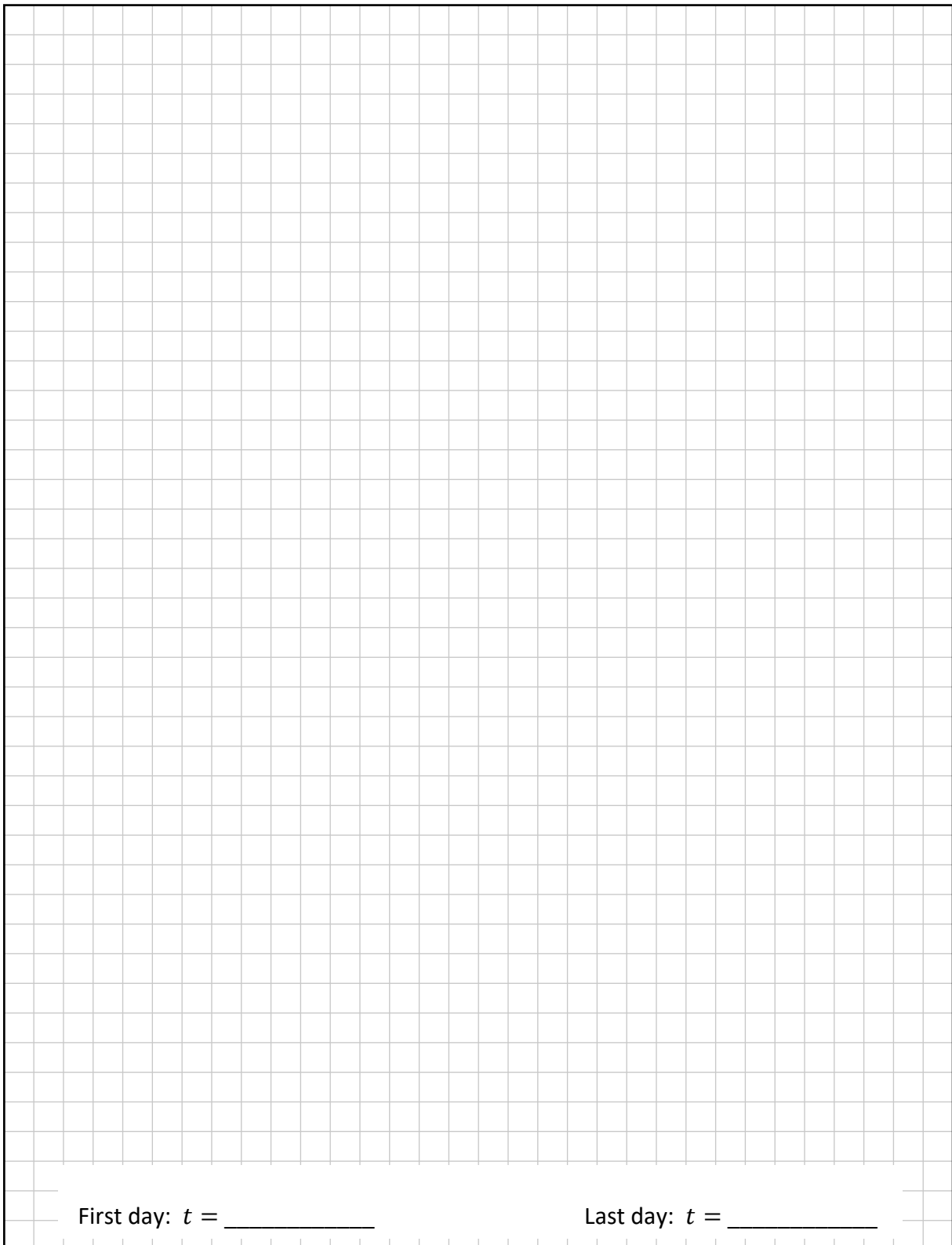
Here,  $H$  is in hours,  $t$  is the number of days after 21st March, and  $\frac{2\pi}{365}t$  is in **radians**.

- (i) Use  $H(t)$  to find the number of daylight hours on 28th March.  
Give your answer correct to 2 decimal places.

- (ii) Using  $H(t)$ , solve an equation to find the first day (value of  $t$ ) **and** the last day (value of  $t$ ), after 21st March, for which the number of daylight hours is **less than 8**.

Give each answer as a value of  $t \in \mathbb{Z}$ , with  $0 \leq t \leq 365$ .

You do **not** need to find the actual date for each day.



First day:  $t =$  \_\_\_\_\_

Last day:  $t =$  \_\_\_\_\_

**Question 9**

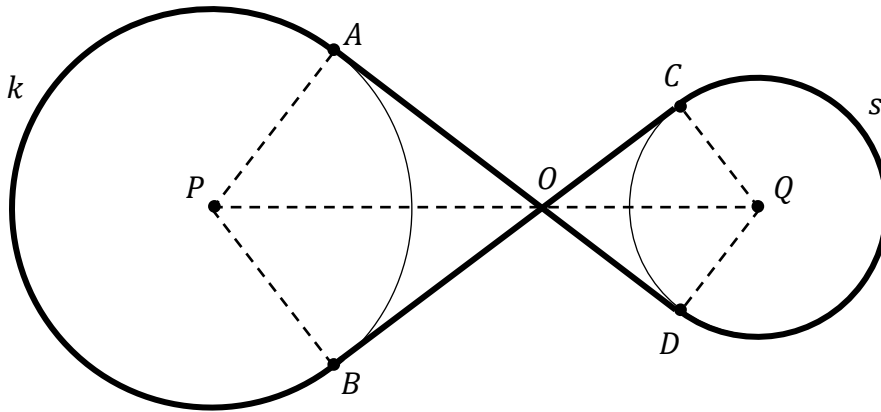
**(50 marks)**

The diagram below shows a belt drive system. In the diagram, the **belt** is the path from  $A$  to  $D$  to  $C$  to  $B$  and back to  $A$ , made up of two line segments and two major arcs of circles.

The circles  $k$  and  $s$  have centres  $P$  and  $Q$ , respectively.

$A$  and  $B$  are points on  $k$ , and  $C$  and  $D$  are points on  $s$ .

$AD$  and  $BC$  are tangents to both circles, as shown, and intersect at the point  $O$ , which lies on  $PQ$ .

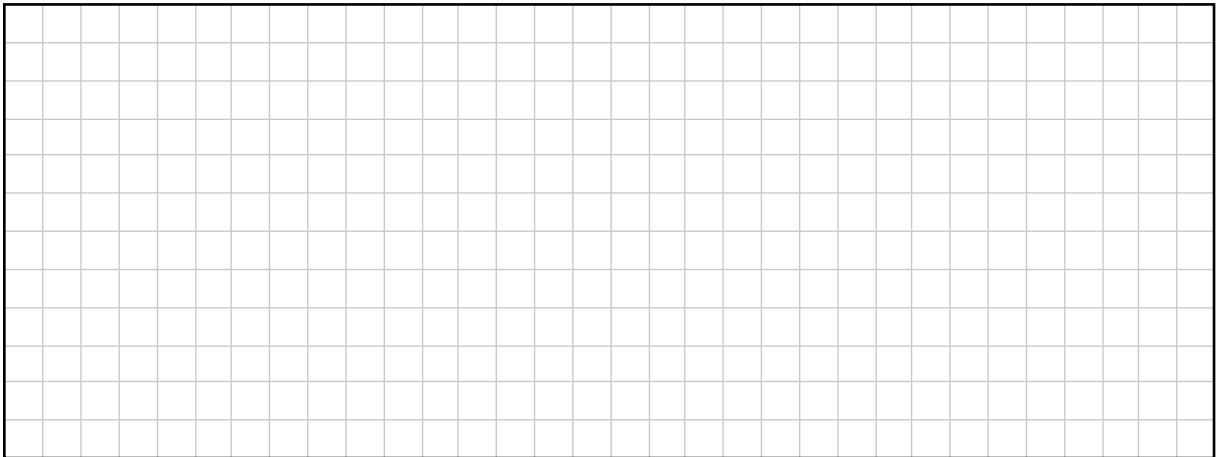


- (a) Fill in the two missing statements and four missing reasons in the table below to prove that the triangles  $POA$  and  $POB$  are **congruent**.

	Statement	Reason
Statement 1	$ PA  =  PB $	
Statement 2		
Statement 3		
Conclusion	Therefore, $\Delta POA$ and $\Delta POB$ are congruent	

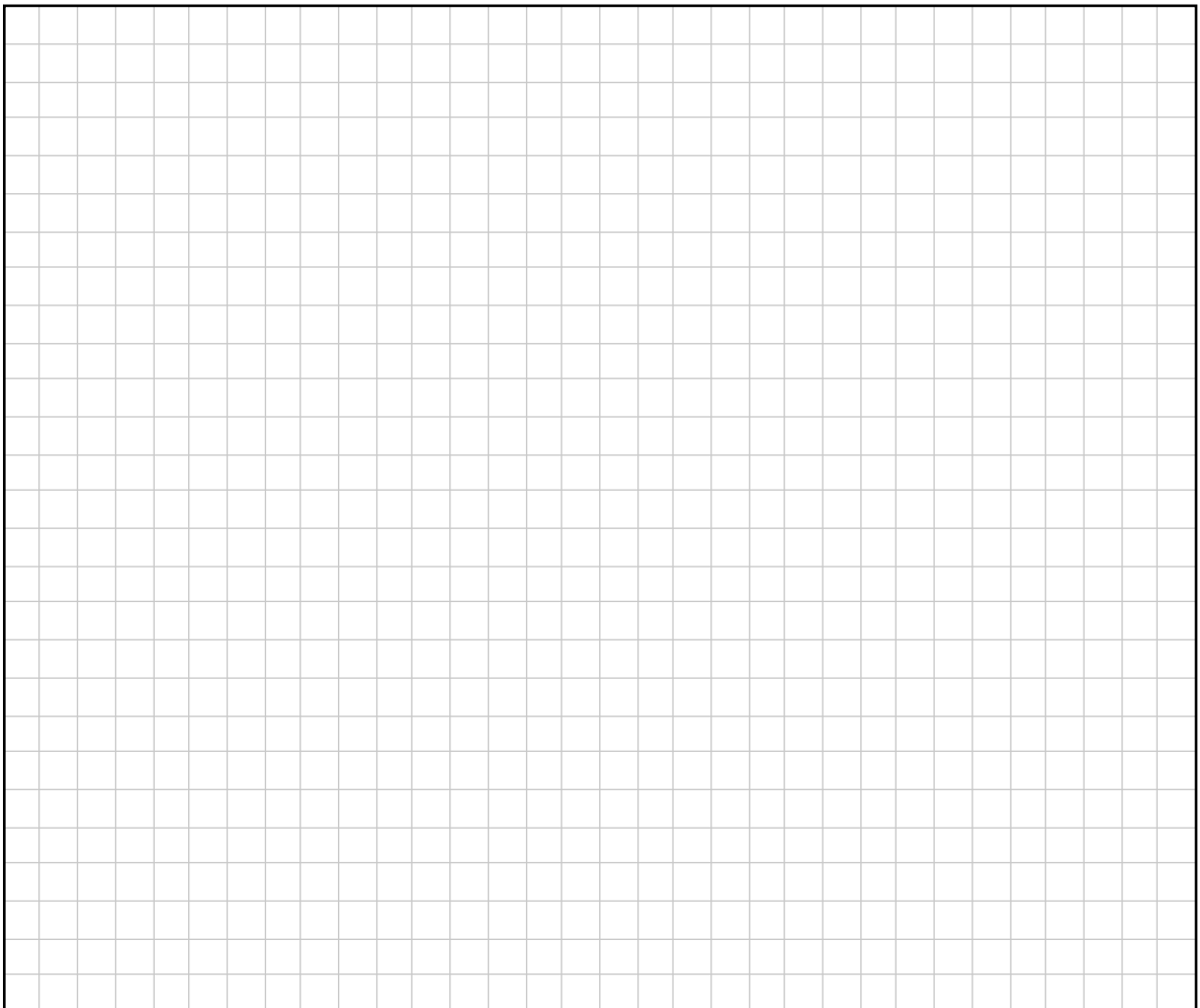
(b) The radius of the circle  $k$  is  $|PA| = 12$  cm. The size of the angle  $\angle APO$  is  $70^\circ$ .

(i) Find the distance  $|AO|$ , correct to 1 decimal place.



The triangles  $POA$  and  $QOC$  are similar. The radius of circle  $s$  is  $|QC| = 8$  cm.

(ii) Find the total length of the **belt**, that is, the path from  $A$  to  $D$  to  $C$  to  $B$  and back to  $A$ .  
Give your answer correct to the nearest cm.

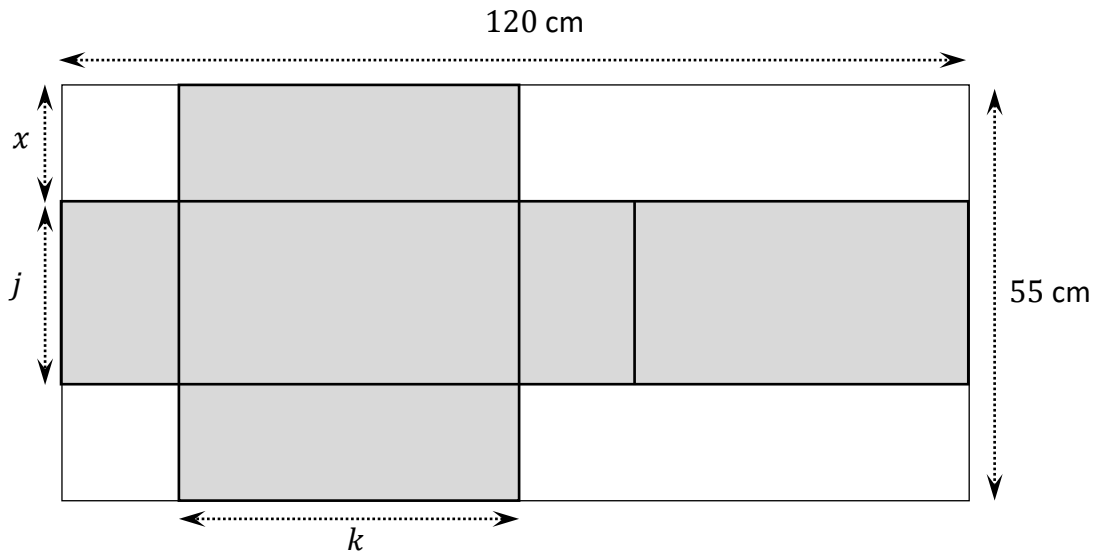


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(c) The gear belt is packed in a closed box.

The net of the box is the shaded part in the diagram below.  
It can be cut from a sheet of cardboard of size 55 cm by 120 cm.

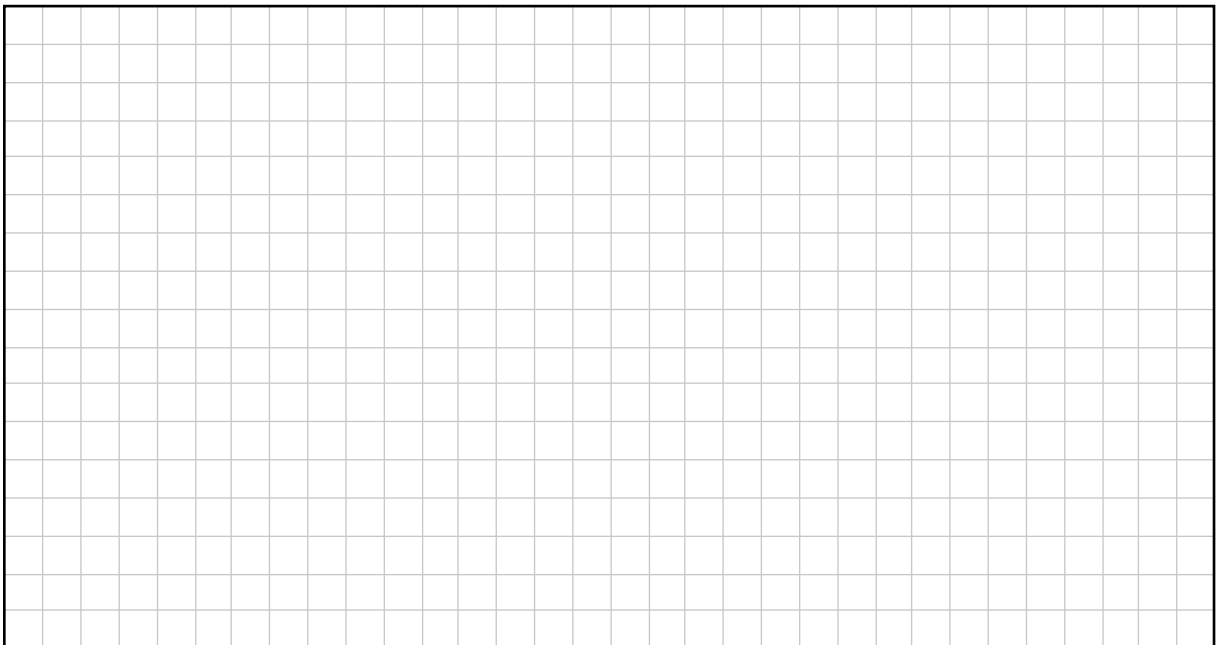
The height of the box, when assembled, is  $x$  cm, as shown.  
Two other lengths are marked  $j$  and  $k$  in the diagram.



Find the **volume** of the box in  $\text{cm}^3$ , when assembled.

Give your answer in the form  $ax^3 + bx^2 + cx$ , where  $a, b, c \in \mathbb{R}$  are constants.

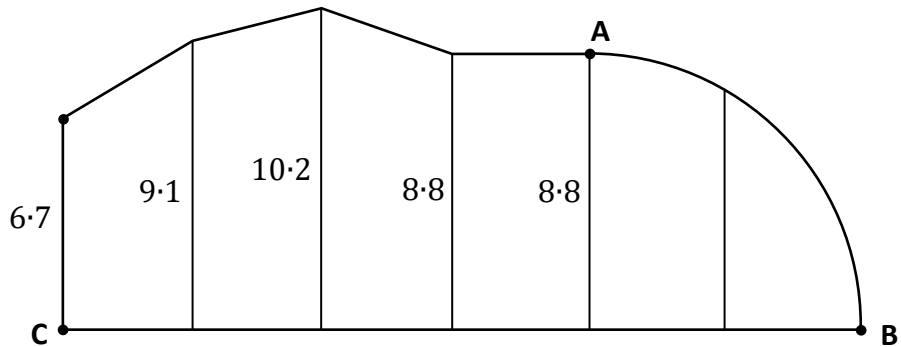
As part of your solution, express the lengths marked  $j$  and  $k$  in terms of  $x$ .



- (d) The gear belt is part of a robot lawnmower. It is used to cut the grass in the region shown in the diagram below. The perimeter of this region is made up of a number of line segments, plus the arc of one quarter of a circle from **A** to **B** with its centre on the side **BC**.

**BC** is divided into six segments of equal length.

The length, in metres, of five line segments are shown in the diagram. Each of these line segments is perpendicular to **BC**.



Liam uses the **trapezoidal rule** to estimate the total area of this region.

By finding the actual total area, or otherwise, work out the **error** in Liam's estimate for the total area of this region. Give your answer correct to the nearest  $\text{m}^2$ .

Error = \_\_\_\_\_  $\text{m}^2$

**Question 10**

**(50 marks)**

(a) The amount of money spent on entertainment per month by the adult population in a particular city is roughly **normally distributed**, with a mean of €46.02 and a standard deviation of €11.72.

(i) Work out the percentage of the adult population who spend **more than** €50 on entertainment per month. Give your answer correct to the nearest percent.

(ii) 90% of the adult population spend less than € $X$  on entertainment per month. Work out the value of  $X$ , correct to the nearest whole number.



- (c) The rules of the game are changed.  
Each time a player takes their turn, if they roll a 1, 2, 3, or 4, they still get nothing.

If a player rolls a 5 or a 6, they have a choice. They can either:

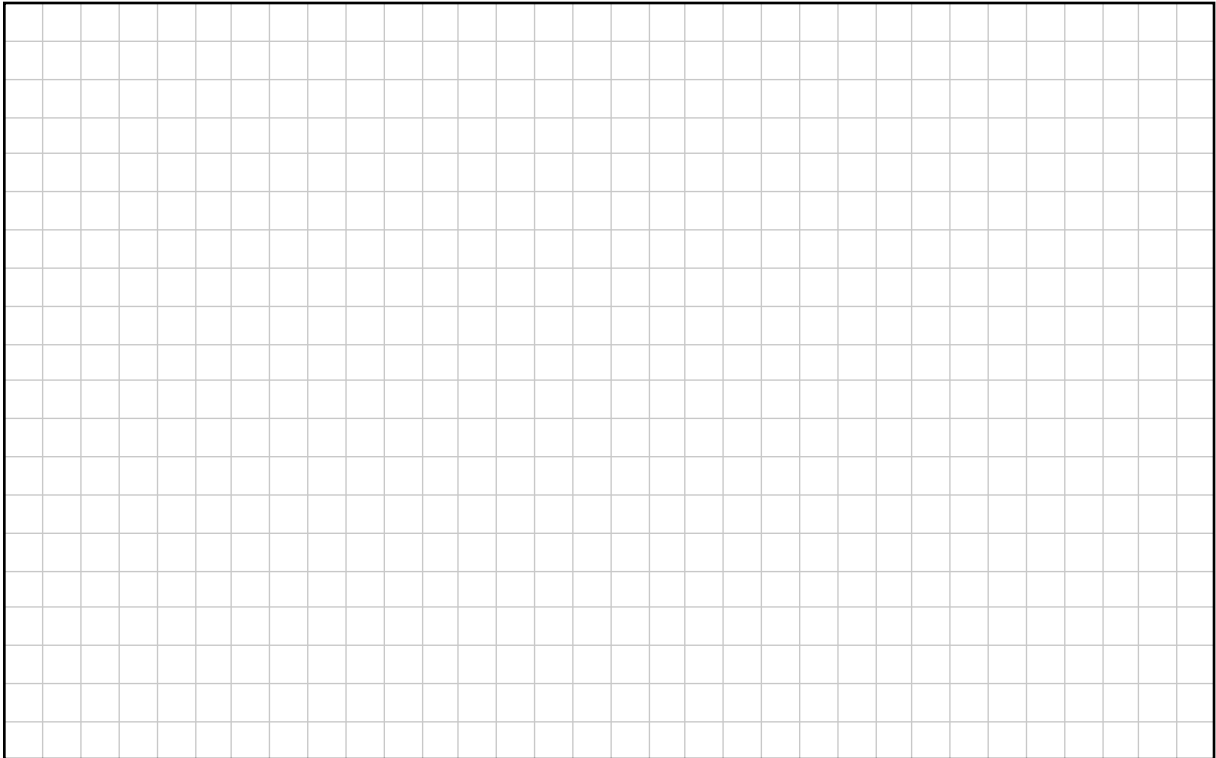
- take 1 token and finish their turn
- or: • roll the die again, as part of the same turn.  
If they roll a 1, 2, 3, or 4 this time, they get nothing at all for this turn.  
If they roll a 5 or a 6, they get a total of 4 tokens for this turn.

$p$  is the probability that a player who gets a 5 or a 6 when they roll the die the first time will take 1 token and finish their turn, where  $0 \leq p \leq 1$ .

- (i) Work out the **expected value** (in tokens) of taking one turn using these rules.  
Remember that a turn can involve one or two rolls of the die.

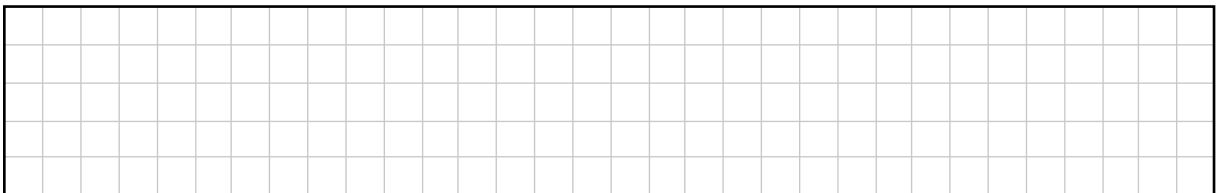
Give your answer in the form  $\frac{a+bp}{9}$  where  $a, b$  are constants.

It may be helpful to draw a tree diagram.

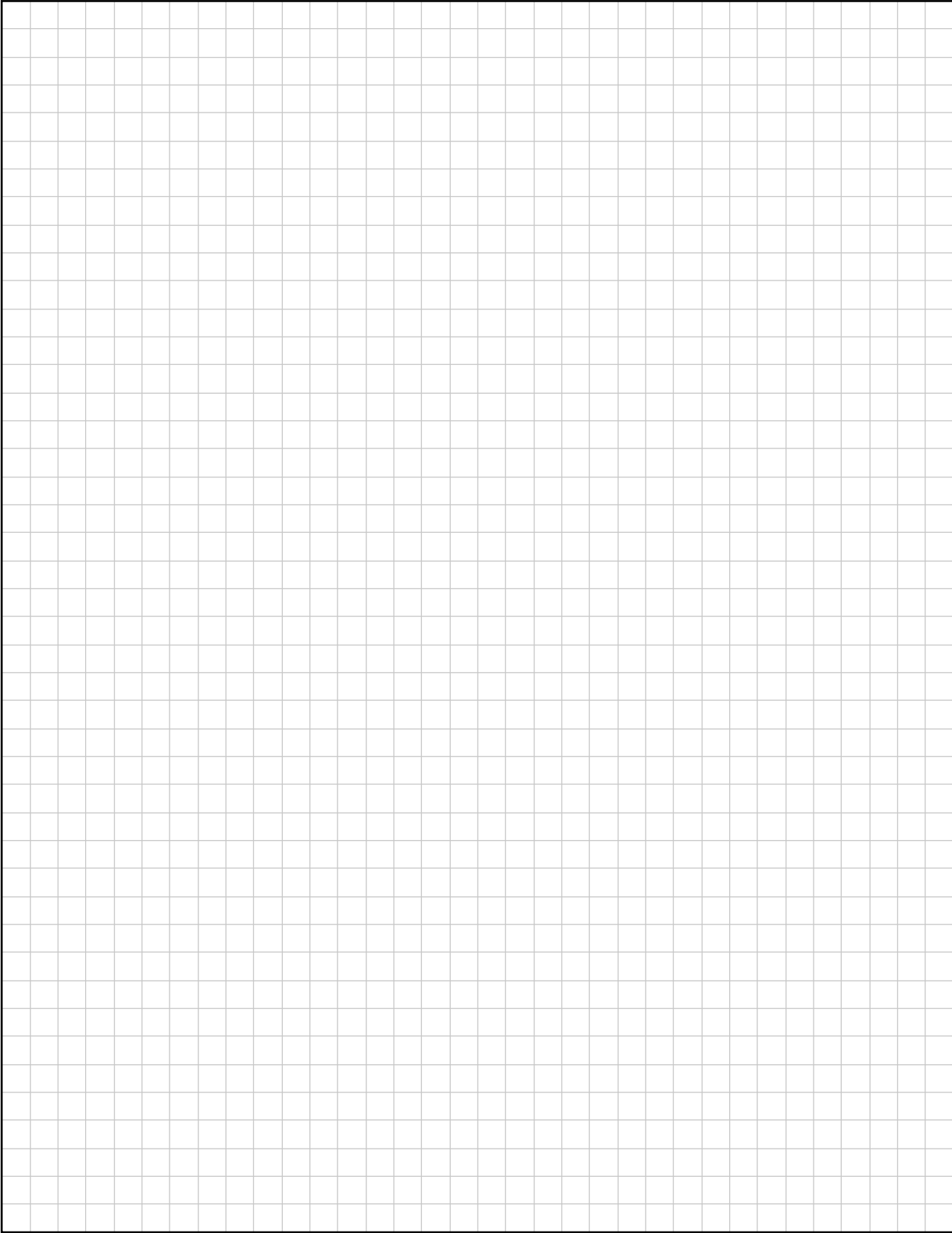


- (ii) The expected value from part (c)(i) is biggest when  $p = 0$ .

Explain what this means each player should do, in order to maximise the expected value (in tokens) of each turn.



You may use this page for extra work.  
Label any extra work clearly with the question number and part.



Do not write on this page

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Leaving Certificate – Higher Level

## Mathematics - Paper 2

Monday 8 June

Morning 9:30 - 12:00