2024.M28K
(Deferred exam)

2024L003G2EK

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination 2024

Mathematics

Paper 2

Ordinary Level

2 hours 30 minutes

300 marks

Examination number					

Centre stamp

For the Examiner only					
		Section	Question	Mark
Disallowed		A	1	
A			2	
B			3	
Total Disall.			4	
			5	
			6	
		B	7	
Cumulative Check			8	
Running Total			9	
− Total Disall.			10	
= Total		↔	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	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.

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:

Section A	Concepts and Skills	150 marks

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

Question 1 **(30 marks)**

(a) A line k has the following equation, where $x, y \in \mathbb{R}$:

$$2x + y - 4 = 0$$

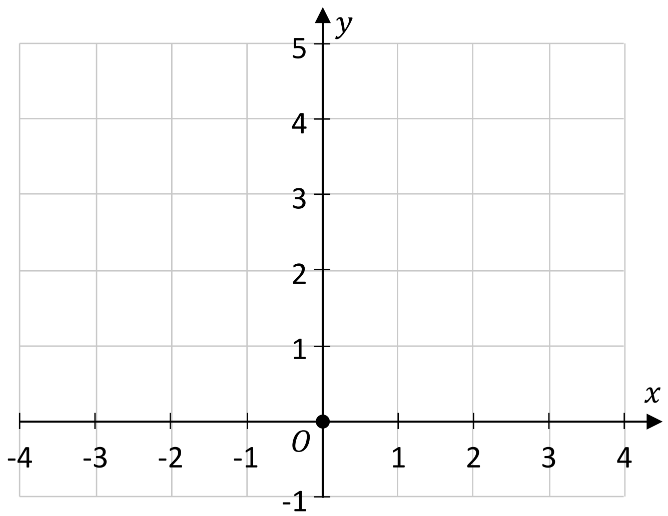
The line k intersects the y-axis at point Q, where $x = 0$.

(i) Use the equation to find the co-ordinates of point Q.

$Q = (\quad , \quad)$

The line k intersects the x-axis at point $P\ (2, 0)$.

(ii) **Plot** and **label** the points P and Q on the co-ordinate diagram below.
Hence, draw the line k.



O is the point $(0,0)$.
R is the point that makes $OPQR$ a parallelogram.

(iii) Draw the parallelogram $OPQR$ on the diagram on the previous page **and** write down the co-ordinates of the point R.

$R = (\quad , \quad)$

(b) Find the area of the triangle with vertices at the following points A, B and C:

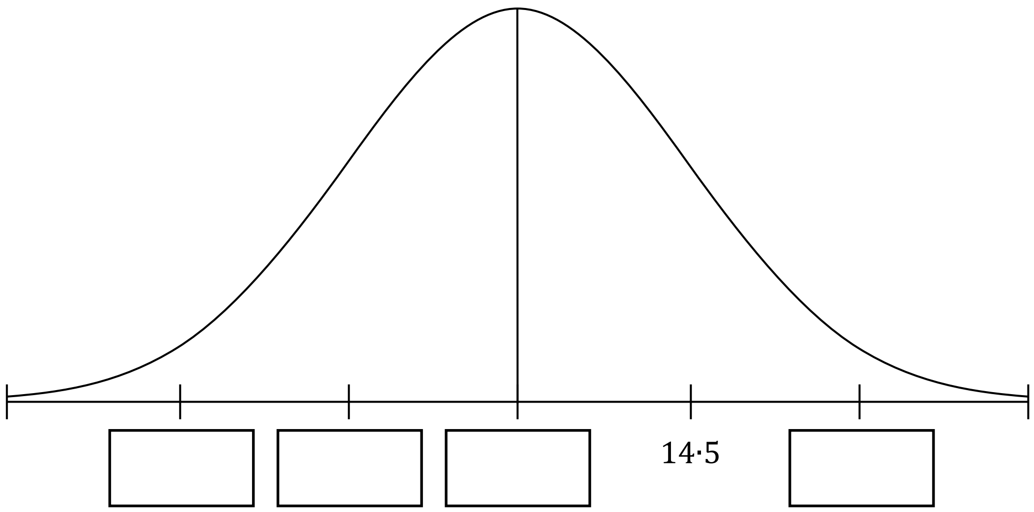
$$A\ (2,0) \qquad B\ (2,4) \qquad C\ (-3,3)$$

Question 2 **(30 marks)**

(a) The finishing times for a cross country race were normally distributed with a mean time of 13 minutes and a standard deviation of $1\cdot5$ minutes.

The diagram below shows the distribution of the finishing times.

Use the empirical rule to answer **parts (a)(i)**, **(a)(ii)** and **(a)(iii)**.



(i) Use the mean and standard deviation to fill in the missing numbers along the horizontal axis above.

(ii) What percentage of the runners who finished the race had a finishing time between $11\cdot5$ and $14\cdot5$ minutes?

120 runners finished the race.

(iii) Find the number of runners who finished the race in less than 10 minutes.

(b) In a sprint final there are 8 finalists.
There are 8 lanes, each finalist is put in a different lane.

(i) Find the number of possible ways the finalists could be arranged at the start line of the race.

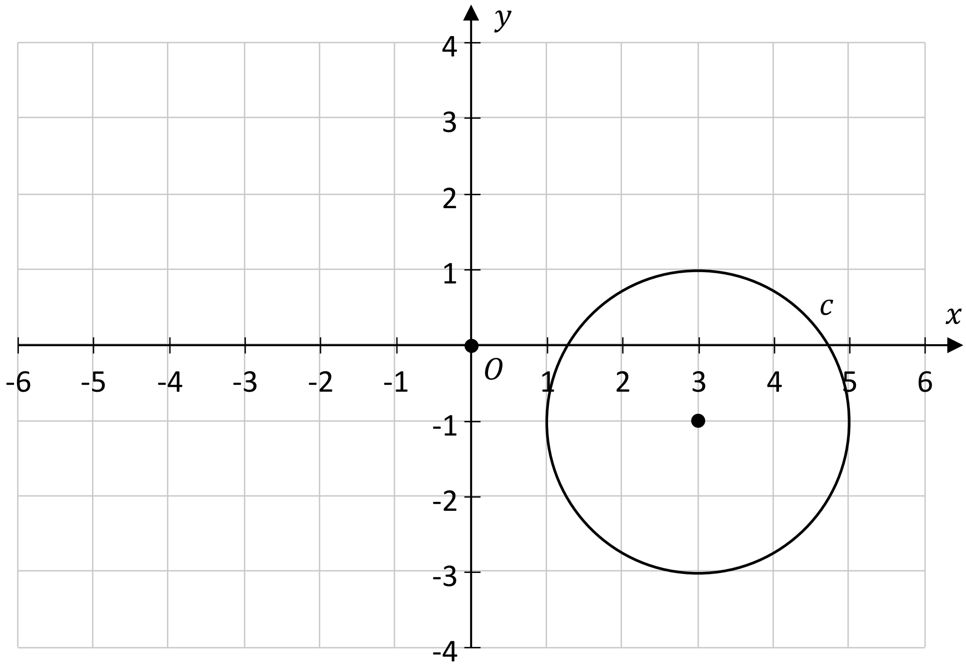
(ii) Find the number of possible ways that the top three places can be filled if only one person can finish first, one person can finish second, and one person can finish third.

Question 3 **(30 marks)**

(a) A circle c has centre $(3, -1)$ and radius 2.

(i) Write down the equation of c.

The circle c is shown on the co-ordinate diagram below.
The point $(0, 0)$ is also shown and labelled O.



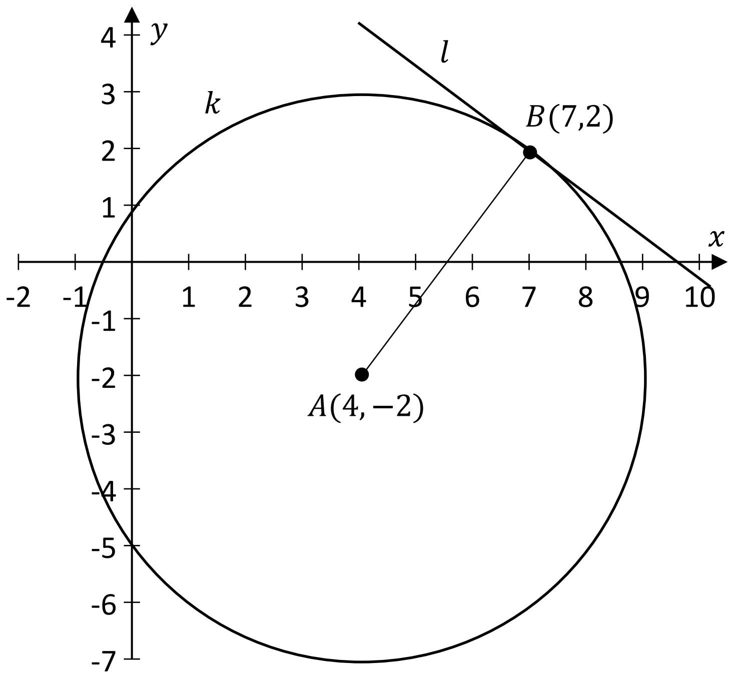
(ii) Circle s is the image of circle c by central symmetry through the point $O(0, 0)$.
Work out the centre and the radius of circle s and fill them into the table below.

Centre	(,)
Radius	

(iii) Hence, **construct** the circle s on the co-ordinate diagram above.

(b) The circle k has centre $A(4, -2)$.
The point $B(7, 2)$ is also on the circle and is the point of contact for the tangent line l.

This information is shown on the diagram below.



Find the slope of $[AB]$, and hence, work out the slope of the tangent line l.

Question 4 **(30 marks)**

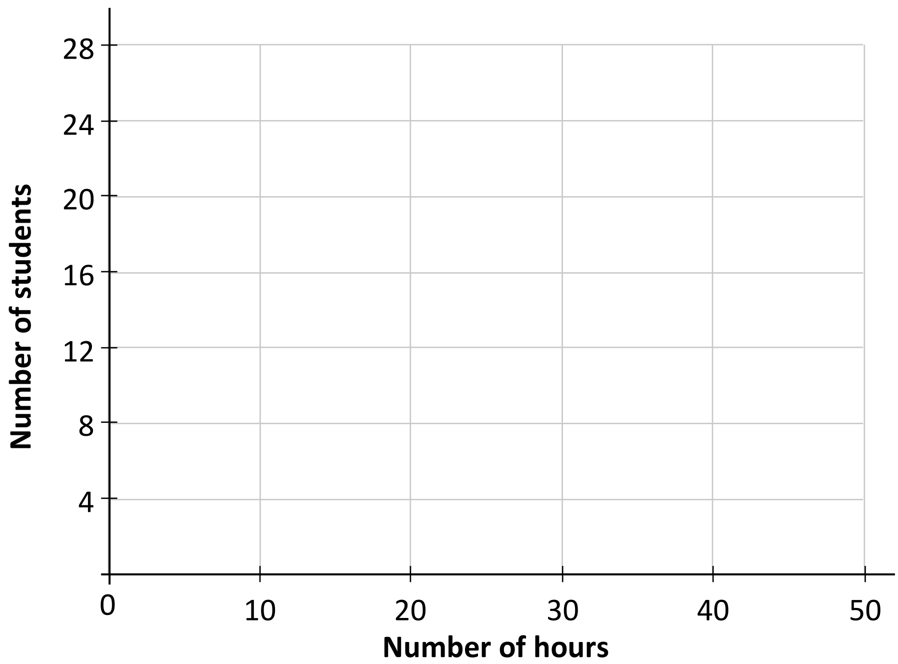
Aoife surveyed 80 students from her year group.

(a) She wrote down the number of hours each student spent on their phone in the last week. The results are shown in the table below.

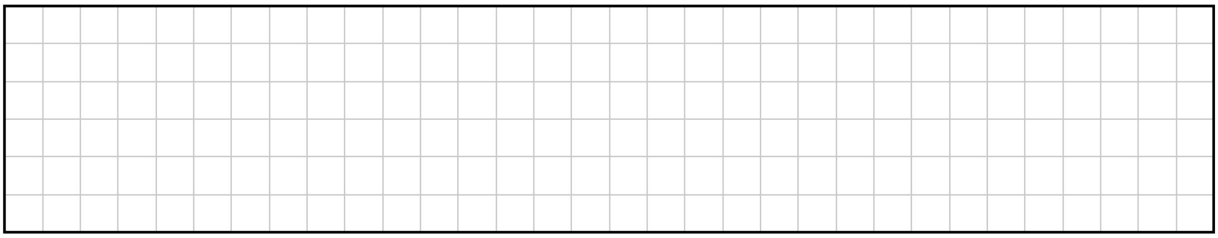
Number of hours	$0-10$	$10-20$	$20-30$	$30-40$	$40-50$
Number of students	12	14	26	12	16

(Note: $10-20$ means 10 hours or more, but less than 20 hours, and so on.)

(i) Draw a histogram to represent the data.



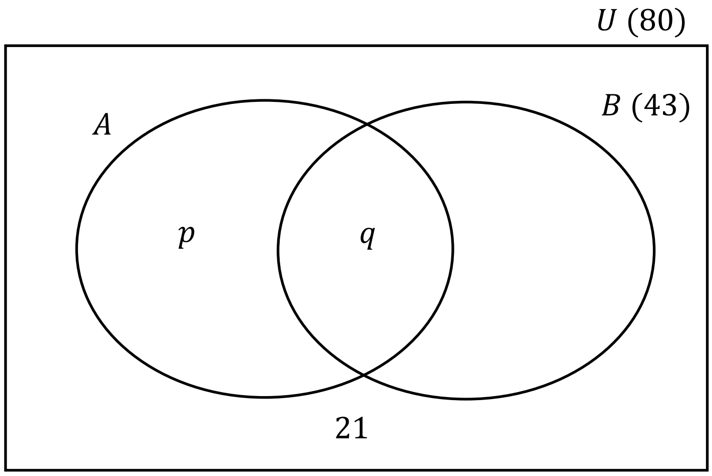
(ii) What is the **greatest** number of students that could have spent **less** than 15 hours on their phone in the last week?



(b) Aoife asked the 80 students she surveyed about their use of two social media accounts, A and B. She wrote down following information:

- 21 do not have a social media account on A or B
- 43 have an account on B.

This information is shown in the Venn diagram below, where p and $q \in \mathbb{N}$, are constants.



(i) Work out the value of p, the number of students who have an account on A only.

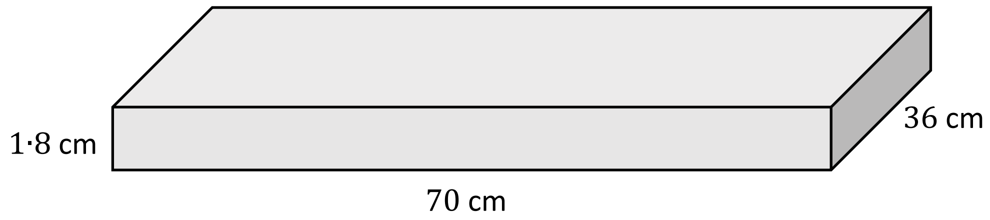
(ii) 30 of the students have an account on A or B **only**.
Hence, or otherwise, find the number of students who have an account on **both** A and B, that is, find value of q.

(iii) A student is chosen at random.
What is the probability that the student has neither an account on A nor B?

Question 5 **(30 marks)**

A person who makes chocolate (a chocolatier) uses large rectangular blocks of chocolate to make smaller chocolates.

The dimensions of one large block are 70 cm, 36 cm, and $1{\cdot}8$ cm, as shown in the diagram below.

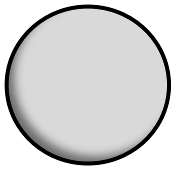


(a) **(i)** Show that the **volume** of the rectangular block of chocolate is 4536 cm^3.

The weight of the block of chocolate is 5 kg.

(ii) Find the weight, in **grams**, of 1 cm^3 of chocolate, correct to 1 decimal place.

(b) The chocolatier makes chocolate spheres.
The radius of one such sphere is $1{\cdot}6$ cm.



(i) Find the **volume** of one chocolate sphere.
Give your answer correct to 1 decimal place.

(ii) Work out the number of **complete** chocolate spheres that can be made from the large rectangular block of chocolate.

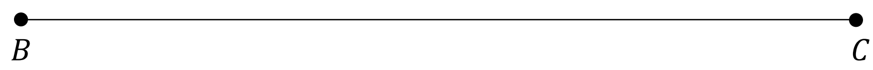
Remember that the volume of the large rectangular block of chocolate is 4536 cm^3.

(iii) Edible paint is put on some of the chocolate spheres, covering the total surface area of each sphere.
Work out the **surface area** of one such sphere with radius $1{\cdot}6$ cm.
Give your answer correct to 1 decimal place.

Question 6 **(30 marks)**

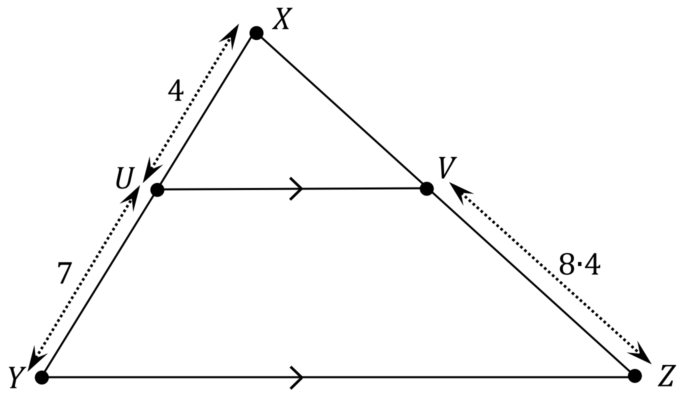
(a) **Construct** the triangle ABC, where $|BC| = 11$ cm, $|AB| = 7$ cm, and $|AC| = 9$ cm.

$[BC]$ is given.



(b) The triangle XYZ is shown in the diagram below.
$[UV]$ is **parallel** to $[YZ]$.

$|XU| = 4$, $|UY| = 7$, and $|VZ| = 8{\cdot}4$.



(i) Find $|XV|$, the distance from X to V.

(ii) Show that the triangles XYZ and XUV are **similar**.
Give a reason for each statement you make.

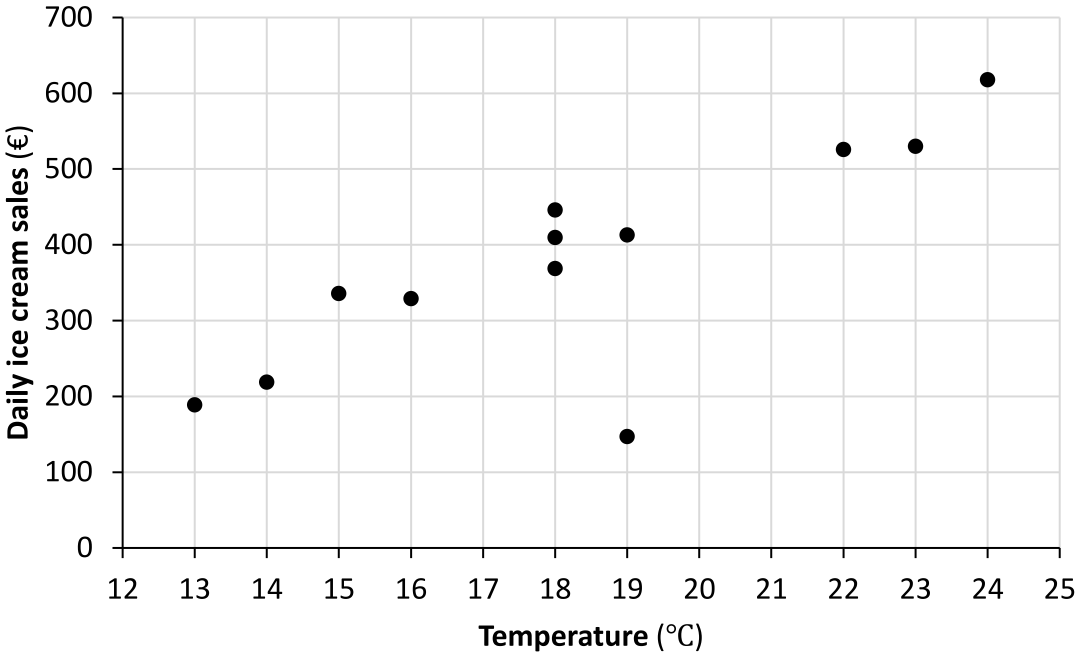
Section B Contexts and Applications 150 marks

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

Question 7 **(50 marks)**

Liam and Ava sell ice cream.

(a) Ava is investigating the relationship between daily temperatures, in degrees Celsius, and daily ice cream sales, in euro. She writes down daily temperatures and ice cream sales for 14 days.
The daily temperatures and the daily ice cream sales for 12 of these days are shown in the scatter plot below.



Use the scatter plot above to answer parts **(a)(i)** to **(a)(iv)**.

(i) Data for Day 1 and Day 2 are not plotted on the scatter plot.
Plot and label the two points from the table below on the scatter plot.

	Day 1	Day 2
Temperature (°C)	23	17
Daily Ice cream sales (€)	500	400

(ii) Describe the relationship between daily temperature and daily ice cream sales.

(iii) Estimate which of the following correlation coefficient values best describes the relationship between daily temperature and daily ice cream sales.

Answer:	$0{\cdot}2$	$-0{\cdot}8$	$0{\cdot}8$	$-0{\cdot}2$
(Tick (✓) one box **only**)	☐	☐	☐	☐

(iv) Circle the **outlier** on the scatter graph and give a possible reason for this outlier.

Reason:

This question continues on the next page.

(b) The daily ice cream sales, in euro, for 7 of the days are shown in the table below.

Day	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**	**Sun**
Daily Ice cream sales (€)	618	530	446	500	400	369	147

(i) Work out the **mean** and **standard deviation** of the daily ice cream sales for these 7 days.
Give your answer in euro, correct to 2 decimal places where necessary.

Mean = ______________ Standard deviation = _____________

(ii) What would happen the standard deviation if the value for Sunday, 147, was omitted from the calculations? Give a reason for your answer, without calculating the new standard deviation.

The standard deviation would: (Tick (✓) **one** box only)

Increase ☐ Decrease ☐ Stay the same ☐

Reason:

(c) An ice cream company surveyed 320 randomly selected customers in 2024.
74 said that their favourite ice cream flavour was vanilla.

(i) Work out the **percentage** of customers who said vanilla was their favourite flavour.
Give your answer correct to the nearest percent.

(ii) Show that, for this sample, the margin of error for a population proportion is $5 \cdot 6\%$, correct to 1 decimal place.

(iii) In 2020 vanilla was the favourite ice cream flavour of 30% of the customers.

Use your answers to parts **(c)(i)** and **(c)(ii)** to test the claim that the percentage of customers whose favourite ice cream flavour is vanilla has changed since 2020, at the 5% level of significance. Show relevant calculations, state your conclusion, and give a reason for your conclusion.

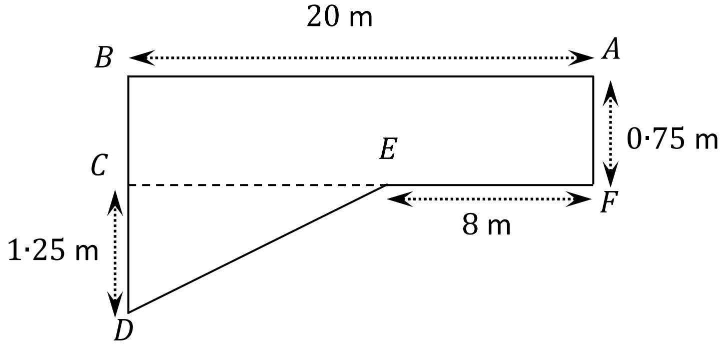
Calculations:

Conclusion:

Reason for the conclusion:

Question 8 **(50 marks)**

A swimming pool is in the shape of a prism. The diagrams below show the dimensions of the swimming pool.



Vertical side wall of the pool

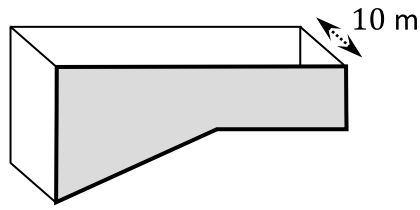


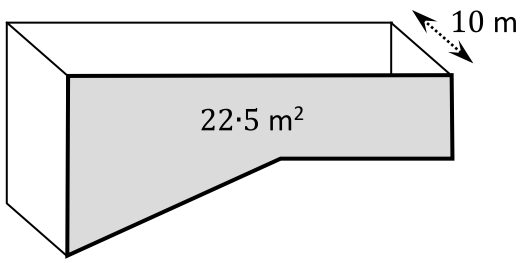
Diagram of whole pool

The vertical side wall of the swimming pool is made up of the rectangle $ABCF$ joined to the triangle CDE, with $C \in [BD]$ and $E \in [CF]$.

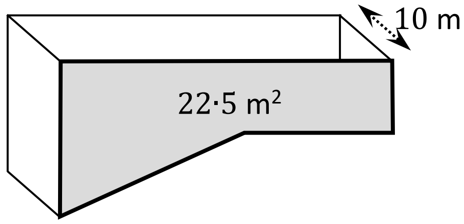
The length of the swimming pool, $|AB| = 20$ m.
The shallow end, $[EF]$, is 8 m long.
The depth of water in the swimming pool at its shallow end, $|AF| = 0{\cdot}75$ m.
The swimming pool is 1·25 m deeper at the other end, so $|CD| = 1{\cdot}25$ m.

(a) **(i)** Find $|BD|$, the **total** depth of the water at the deeper end of the pool.

(ii) Show that the area of the vertical side wall of the pool is 22·5 m^2.



The swimming pool is 10 m wide.



(iii) Use the answer to part **(a)(ii)** to find the **volume** of water in the pool.
Give your answer in litres (1 m$^3 = 1000$ litres).

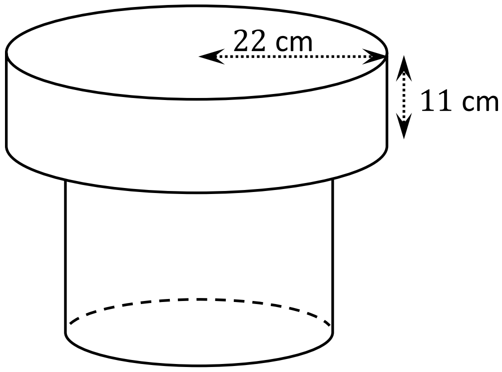
(b) The floor of the swimming pool is to be tiled.

(i) The tiles being used for tiling the floor are square with a side of length 45 cm.
Find the **area** of one of these tiles in m^2.

(ii) The area of the floor of the swimming pool is 201 m^2.
Work out the **minimum** number of tiles that are needed to tile the floor if 10% wastage is expected.

This question continues on the next page.

(c) A pump for a swimming pool is in the shape of a cylinder on top of another cylinder, as shown in the diagram below.



The top cylinder has a radius of 22 cm and a height of 11 cm.

(i) Show that the **volume** of the top cylinder is equal to 5324π cm^3.

The volume of the bottom cylinder is three times the volume of the top cylinder.
The bottom cylinder has a height of 50 cm.

(ii) Find the **radius** of the bottom cylinder, correct to 1 decimal place.

Question 9 **(50 marks)**

(a) Susan is playing a darts game called 'Hit the bull'.
In this game, a player throws 3 darts at the bullseye in the centre of the dartboard.
The probability Susan hits the bullseye with a single dart is $0{\cdot}2$.
The probability of a single dart hitting the bullseye is independent of the outcome of the previous throw.

(i) Find the probability Susan does **not** hit the bullseye on a single throw.

(ii) Find the probability that Susan hits the bullseye with her first dart and does **not** hit the bullseye with the other two darts.

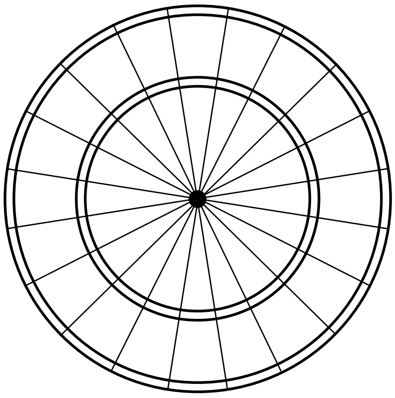
(iii) Susan plays 'Hit the bull'. She gets a score of 50 for each time she hits the bull.
Susan wants to work out her **expected** score for throwing 3 darts.
The scores and the probabilities of these scores are given in the table below.

Score	**150**	**100**	**50**	**0**
Probability of each score	$0{\cdot}008$	$0{\cdot}096$	$0{\cdot}384$	$0{\cdot}512$

Work out Susan's **expected** score for throwing 3 darts.

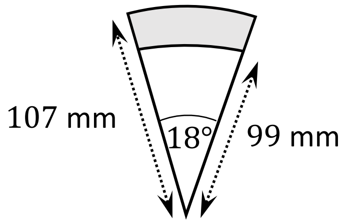
This question continues on the next page.

(b) A dartboard is in the shape of a circle.
It is divided into 20 equal sectors as shown in the modified diagram below.



(i) Show that the measure of the angle of each sector is $18°$.

The diagram on the right shows two sectors.
The radius of the smaller sector is 99 mm and the radius of the larger sector is 107 mm.



(ii) Work out the area of the shaded area correct to the nearest mm^2, that is, work out the area of the part of the larger sector that is not in the smaller sector.

(c) The integers from 1 to 20 are arranged in a circle around the dartboard, where:

$U =$ {the set of integers on the dartboard}

$P =$ {the set of prime numbers on the dartboard}, that is:

$$P = \{2, 3, 5, 7, 11, 13, 17, 19\}$$

(i) List the elements of P', that is, the set of integers on the dartboard that are **not** prime.

(ii) There are four solutions to the equation $a + b = 20$, where $a, b \in P$.
List **two** solutions.

(iii) M is the **median** of the set P.

Is $M \in P$ **or** is $M \in P'$?
Use calculations to support your answer.

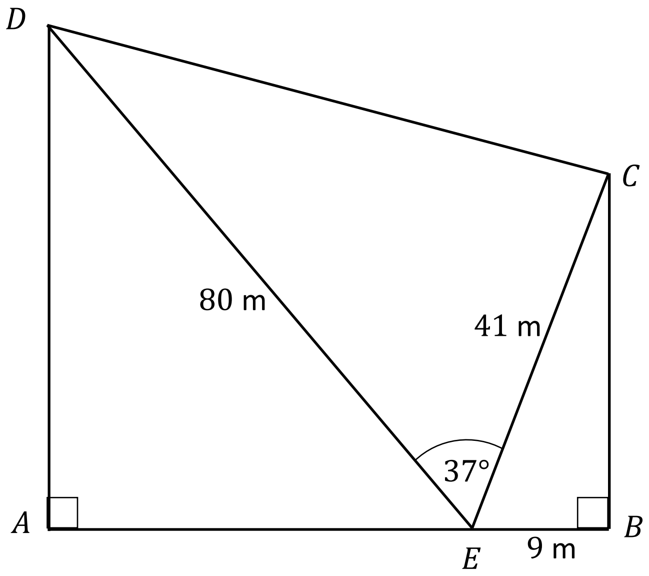
Answer: (Tick (✓) **one** box only)	$M \in P$	$M \in P'$
	☐	☐

Calculations:

Question 10 **(50 marks)**

(a) The diagram below (not to scale) shows the plan of a university campus, $ABCD$.
The points C, D, and E are main doors to buildings on the campus.

$[DE]$, $[DC]$ and $[EC]$ are pathways between the main doors.



Use the triangle CEB to answer parts **(a)(i)** and **(a)(ii)**.

(i) Use the Theorem of Pythagoras to work out $|BC|$, the distance from B to C.

(ii) Show that the size of the angle $\angle CEB = 77°$, correct to the nearest degree.

(iii) Use the size of the angle $\angle CEB = 77°$, to work out $|AD|$, the distance from A to D.
Give your answer correct to the nearest metre.

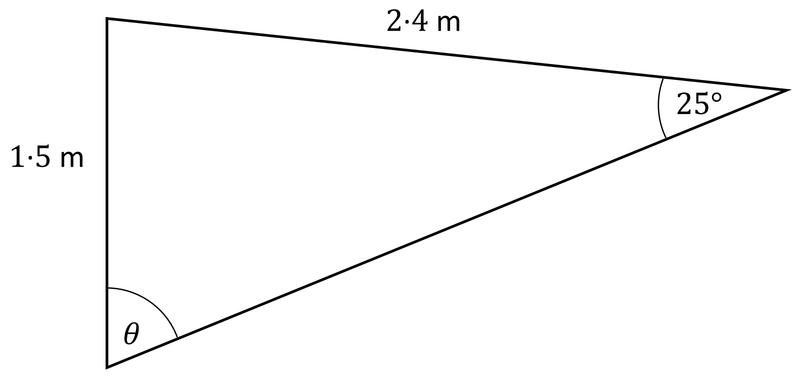
Use the triangle CDE to answer parts **(a)(iv)** and **(a)(v)**.

(iv) Calculate the **area** of the triangle CDE.
Give your answer correct to the nearest m^2.

(v) Use the **cosine rule** to work out $|DC|$, the distance from D to C.
Give your answer correct to 1 decimal place.

This question continues on the next page.

(b) A university has a triangular flag at its entrance as shown in the diagram below (not to scale).



Use the **sine rule** to find the measure of the angle θ, correct to 1 decimal place.

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