2021.M28

2021L003G2EL

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination 2021

Mathematics

Paper 2

Ordinary Level

Monday 14 June Morning 9:30 – 12:00

220 marks

Examination Number

Day and Month of Birth

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.

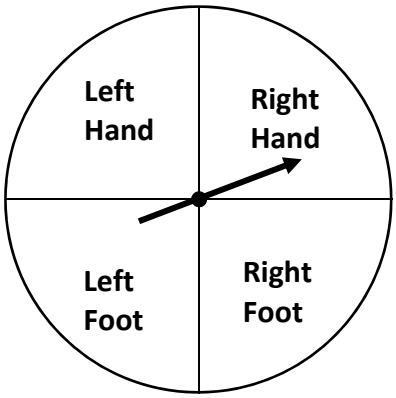
Write the make and model of your calculator(s) here:

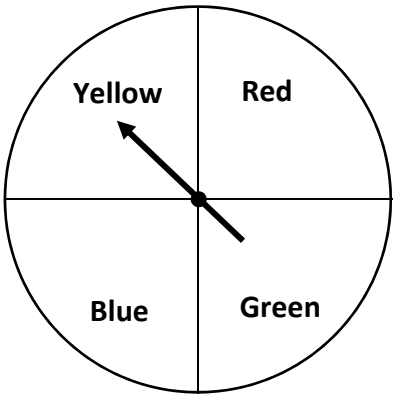
Section A — Concepts and Skills — 120 marks

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

Question 1 **(30 marks)**

The game "Twister" is played using two spinners and a mat with coloured spots.
The two spinners needed for the game are shown below. Both consist of four equal sections.
A player spins both spinners and must then place their selected hand/foot on the selected coloured spot on the game mat.
The spinners below show the outcome **Right Hand** on a **Yellow Spot**.





(a) How many different possible outcomes are there in the game?

(b) Kate spins each spinner once. What is the probability that she must use:

(i) her **left foot**?

(ii) a **red or yellow** coloured spot?

(c) Jack spins each spinner once. What is the probability that the outcome is:

(i) his right hand **and** a blue spot?

(ii) his right hand **or** a blue spot?

Question 2 **(30 marks)**

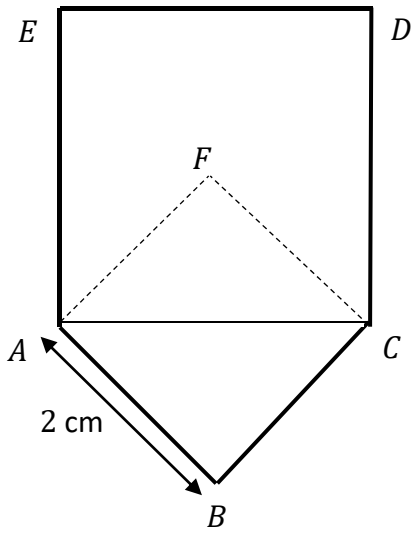
(a) At a stall in a fun fair, the probability of knocking a coconut off its support is $0{\cdot}34$.

(i) What is the probability of **not** knocking a coconut off its support?

(ii) David is given three attempts to knock the coconut off its support.
What is the probability that he knocks the coconut for the first time, on his **third attempt**? Give your answer correct to three decimal places.

(b) The figure $ABCDE$ shown in the diagram consists of a large square $ACDE$ standing on the diagonal $[AC]$ of a smaller square $ABCF$.
The smaller square has a side length of 2 cm.

Find the area **and** perimeter of the figure $ABCDE$.
Give your answer for the perimeter correct to two decimal places.



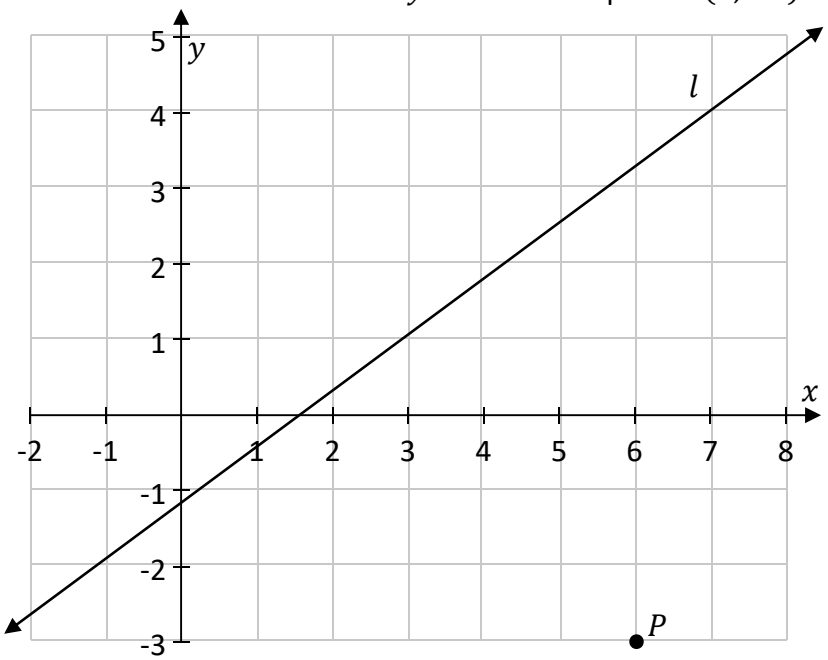
Area:

Perimeter:

Question 3 **(30 marks)**

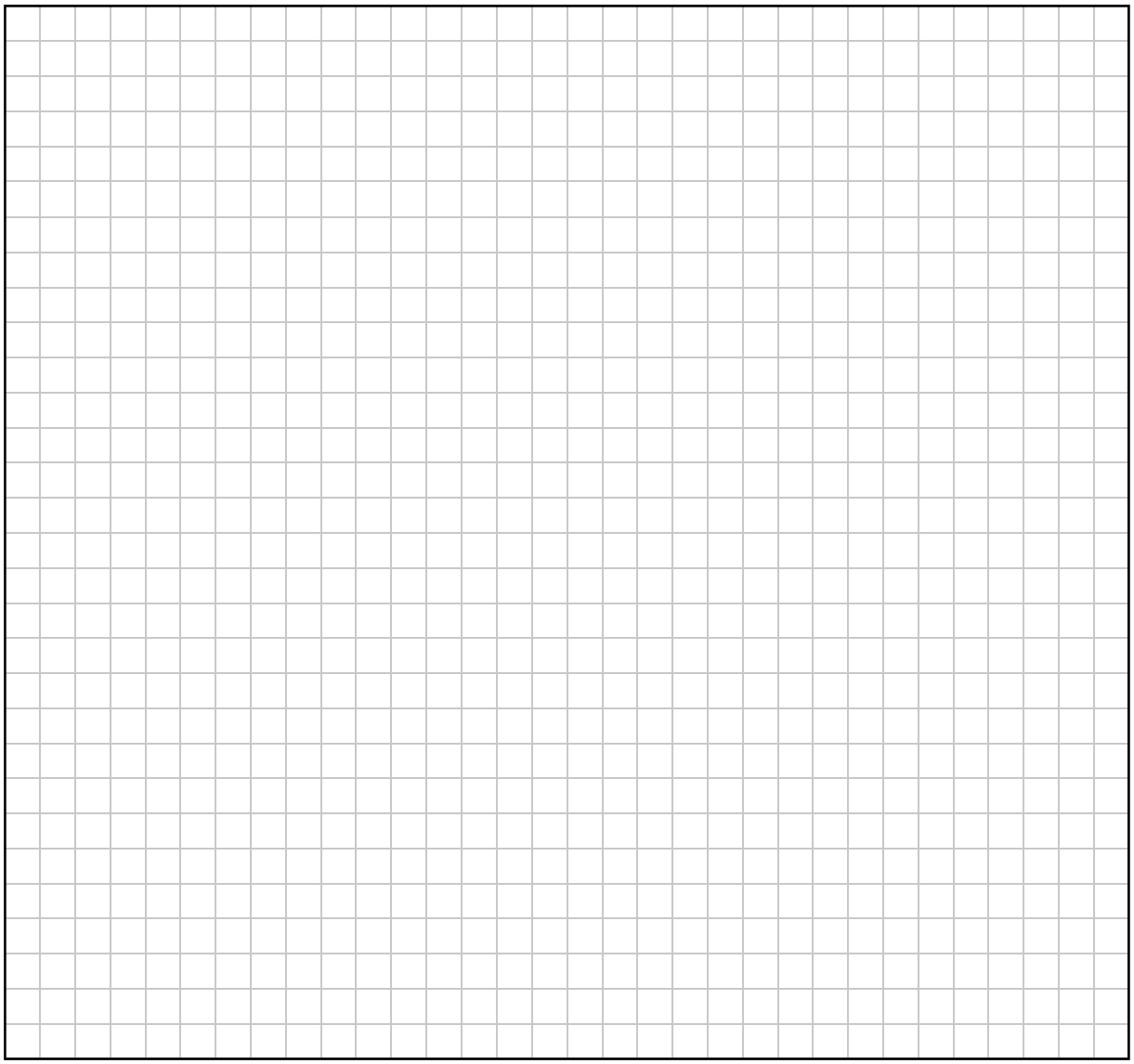
(a) A line n passes through the points $A(-1, 2)$ and $B(0, -2)$.
Write the equation of n in the form $y = mx + c$, where $m, c \in \mathbb{Z}$.

(b) The diagram below shows the line $l: 3x - 4y = 5$ and the point $P(6, -3)$.



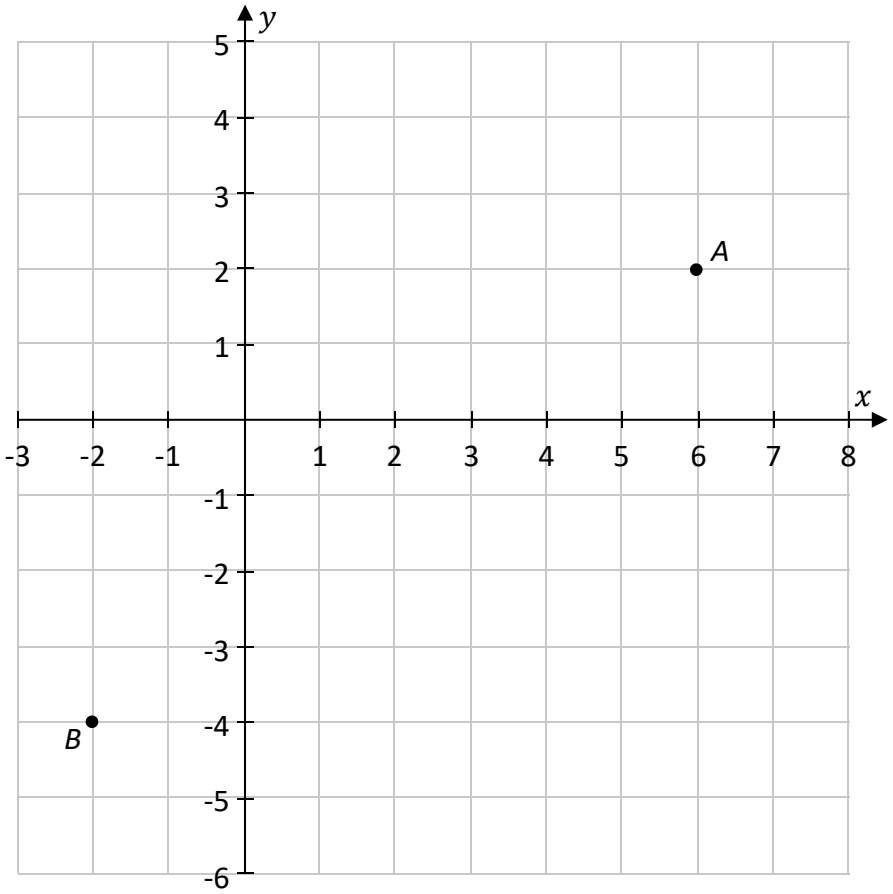
(i) Find the equation of the line k through the point P that is perpendicular to the line l.
Write your answer in the form $ax + by + c = 0$, where $a, b, c \in \mathbb{Z}$.

(ii) Find the point of intersection of the lines $l: 3x - 4y = 5$ and $h: 2x - y = 10$.



Question 4 **(30 marks)**

The co-ordinate diagram below shows two points *A* and *B*.



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

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

(ii) Find the co-ordinates of the midpoint of [*AB*].

(iii) Use a compass to **construct** the circle *c*, which has *AB* as its diameter on the diagram above.

(iv) Find the length of the radius of the circle c, and hence write down the equation of c.

Radius:

Equation:

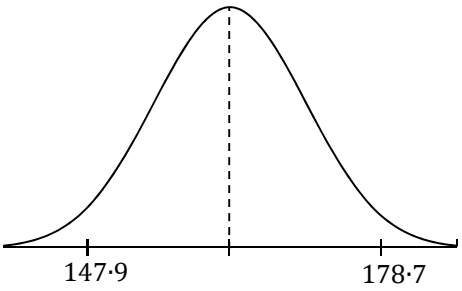
(b) The point $P(2, k)$ is in the first quadrant and is on c.
Use algebra to find the value of k and **plot the point P** on the diagram on the previous page.

$k =$

Question 5 **(30 marks)**

(a) The heights of a given population are normally distributed. 95% of the population fall within the height range [147·9 cm ↔ 178·7 cm].

Using the empirical rule, find the mean and the standard deviation of the distribution of heights in the population.



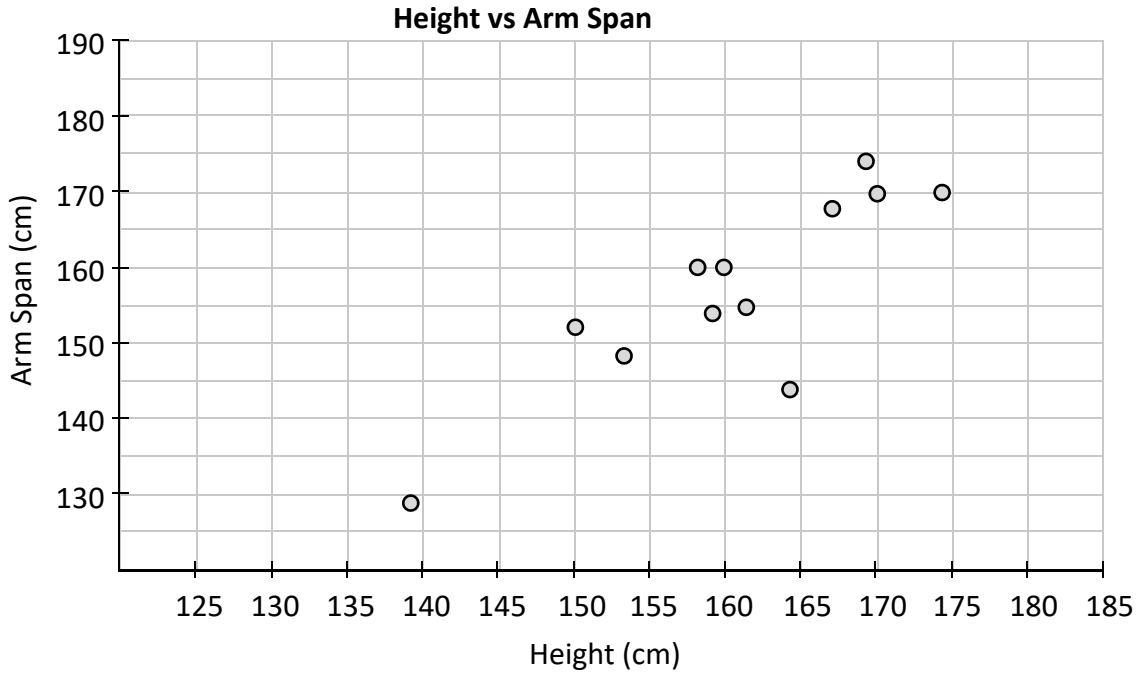
Mean =

Standard Deviation =

(b) The following table shows data on the height and arm span of twenty teenagers.

	Gender	Height (cm)	Arm Span (cm)
1	F	162	155
2	F	169	174
3	F	164	144
4	F	157	160
5	F	160	160
6	F	170	170
7	F	174	170
8	F	159	154
9	F	153	148
10	F	167	167
11	F	150	152
12	F	139	129
13	M	168	169
14	M	147	150
15	M	134	121
16	M	177	176
17	M	172	170
18	M	160	163
19	M	152	151
20	M	153	151

(i) Complete the scatter plot below by adding in the data for the males (the data in the shaded section of the table).



(ii) The table on the right shows three numbers.
One of the numbers is the correlation coefficient of the data shown in the table above.
Tick (✔) the one which you think best represents the correlation coefficient between height and arm span for this data set.

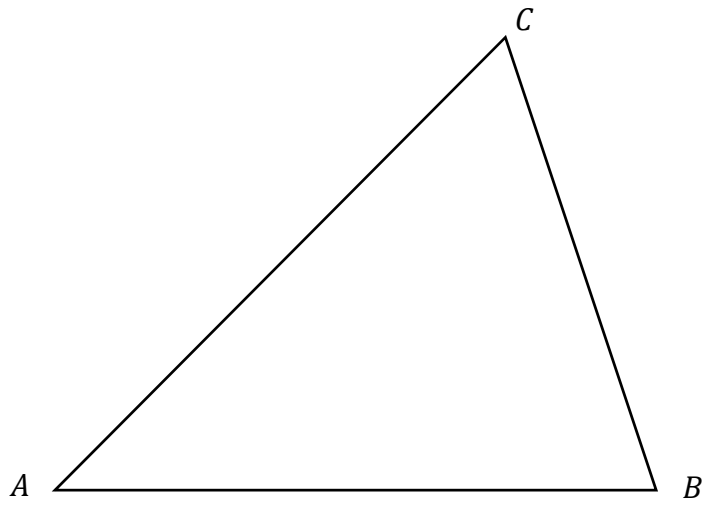
0·2	
0·9	
−0·6	

(iii) Explain what this correlation coefficient tells us about the relationship between height and arm span for this data set.

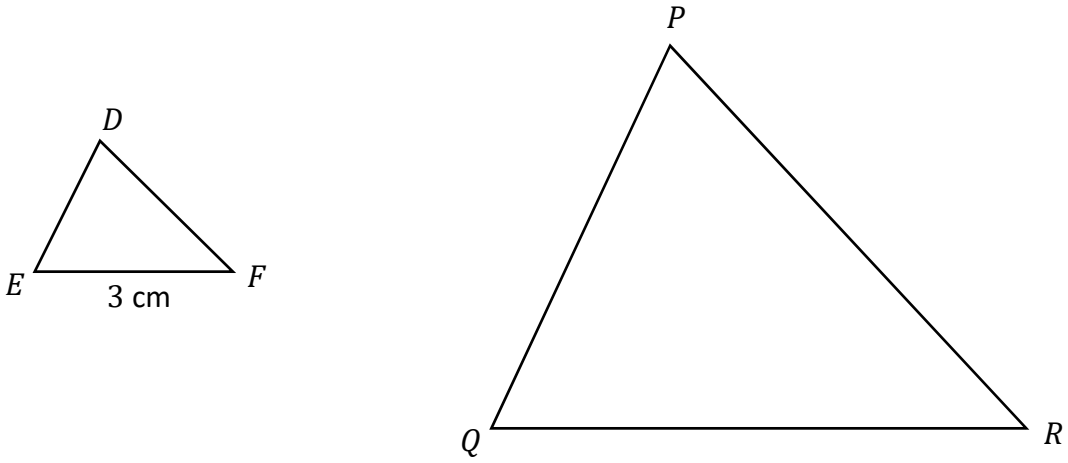
Question 6 **(30 marks)**

(a) **(i)** On the diagram below showing the triangle ABC, construct the perpendicular bisector of the side $[AC]$. Show all your construction lines and arcs clearly.

(ii) Construct the **circumcircle** of the given triangle ABC.
Show all your construction lines and arcs clearly.



(b) The triangle PQR is the image of the triangle DEF under an enlargement.
(The diagram is not drawn to scale.)
The scale factor of the enlargement, k, is 2·5.
$|EF| = 3$ cm.



(i) Use the scale factor to find $|QR|$.

(ii) The area of the triangle PQR is $18{\cdot}75$ cm^2.
Find the area of triangle DEF.

Section B — Contexts and Applications — 100 marks

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

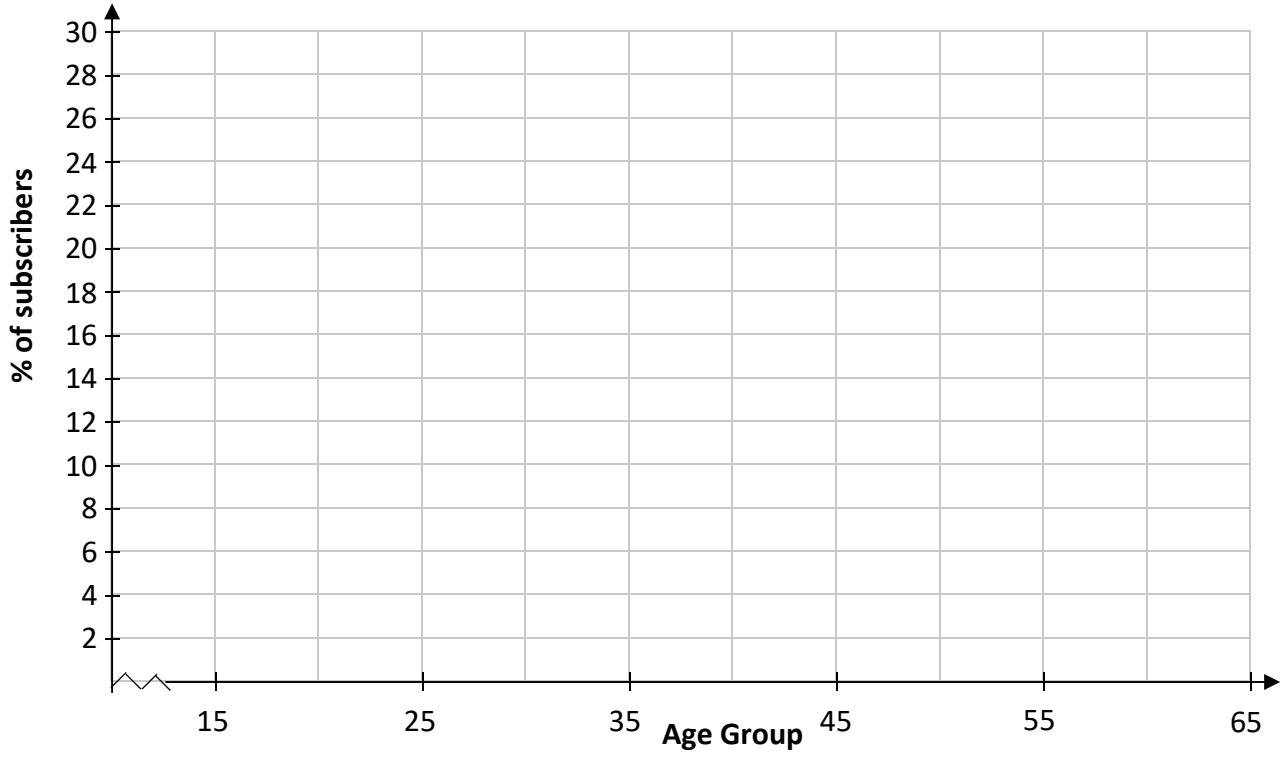
Question 7 **(50 marks)**

(a) The following table shows the age profiles of all of the people in Ireland, aged between 15 and 65, who subscribed to an online streaming platform.

Age Group	$15-25$	$25-35$	$35-45$	$45-55$	$55-65$
Percentage (%) of Subscribers	24	27	25	16	8

Note: $25-35$ means 25 years and over but less than 35 years. Source: https://www.statista.com

(i) Draw a **Histogram** to represent the data.



(ii) In a survey of 1000 subscribers, aged between 15 and 65, how many people would you expect to be between 25 years and 55 years?

(iii) Use the table or the histogram to write down the age group which contains the median age.

Age Group:

(iv) Use the mid-interval values of the groups in the table to estimate the mean age of the subscribers. Give your answer correct to one decimal place.

This question continues on the next page.

(b) Prior to the COVID-19 pandemic, *Netflix* held the largest share of the online streaming market with 65% of all streaming subscribers in the 15 to 65 age group. Aiden thought that this percentage might have changed during the pandemic and surveyed a sample of subscribers in this age group to get data.
He then carried out a Hypothesis Test to test his theory.

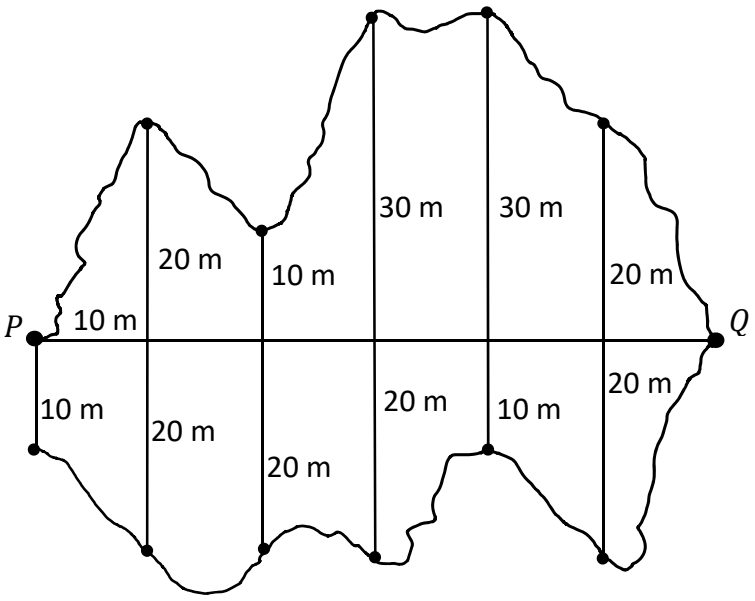
(i) If 540 people responded to his survey, calculate the margin of error of his survey. Give your answer as a percentage, correct to one decimal place.

(ii) His survey revealed that 372 of the responders said they now have a *Netflix* account. Use your answer to **Part (b)(i)** above to create a 95% confidence interval for the percentage of the population that have a *Netflix* account.

(iii) Use your answer to **Part (b)(ii)** above to conduct the Hypothesis Test, at the 5% level of significance to test Aiden's claim that the percentage of subscribers to *Netflix* had changed. State clearly your null hypothesis, your alternative hypothesis and give your conclusion in the context of the question.

Question 8 **(50 marks)**

The diagram on the right shows the plan of a lake.
The line segment $[PQ]$ represents the distance from the pier, P, to the far side of the lake.
At equal intervals of 10 m along this line, perpendicular measures are made to the sides of the lake as shown.

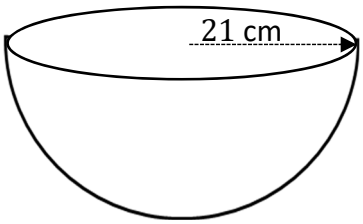


(a) **(i)** Use the Trapezoidal Rule to estimate the **surface area** of the lake.

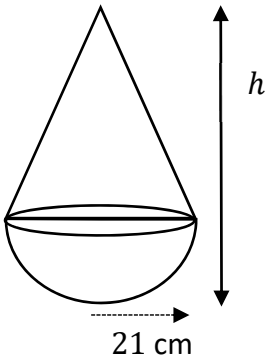
(ii) If the lake is on average 8 m deep, estimate the **volume** of water in the lake.

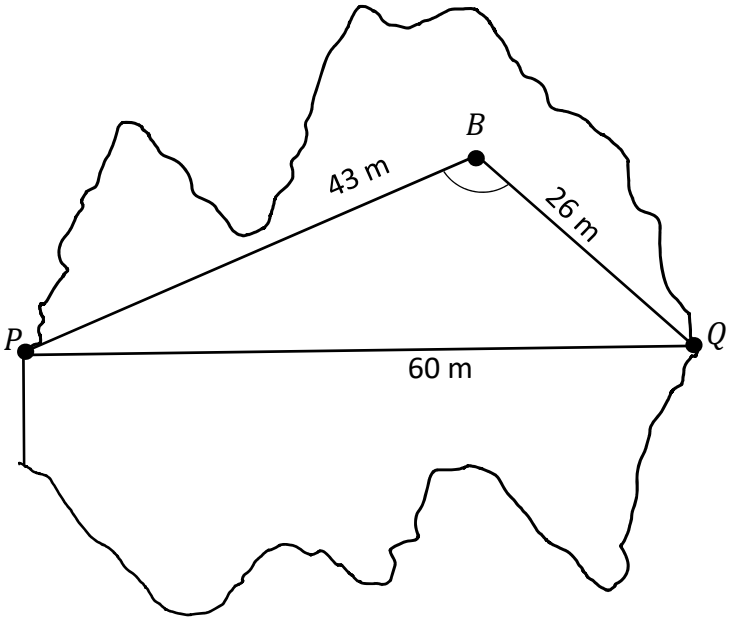
This question continues on the next page.

(b) **(i)** Calculate the **volume** , in cm^3, of a hemisphere of radius 21 cm.
Give your answer terms of π.



(ii) A buoy on the lake is in the shape of a hemisphere of radius 21 cm surmounted by a cone.
The volume of the cone is equal to the volume of the hemisphere.
Find h, the **total height** of the buoy.

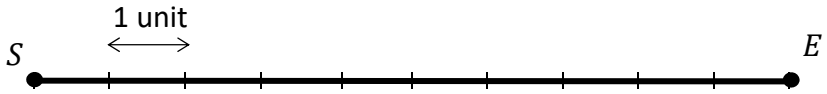




(c) The buoy is situated at B, 43 m from the pier P and 26 m from the point Q, as shown in the diagram above.
Find $|\angle QBP|$, the angle at the buoy shown on the diagram.
Give your answer correct to two decimal places.

Question 9 **(50 marks)**

The line segment [*SE*], shown below, represents an airport runway.
The point *S* and the point *E* represent the start and end points of the runway respectively.
The diagram is drawn to a scale of 1 unit $=$ 250 metres.

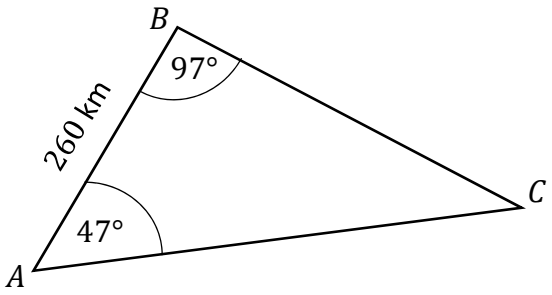


(a) **(i)** Find the length of the runway. Give your answer in km.

(ii) An aircraft starts at the point *S* and travels 1 250 m to a point L where it lifts off.
From the point L, the aircraft makes an angle of $14°$ with the ground, $[LE]$.
The aeroplane travels along this path until it is directly above E.
Plot **and** label the lift-off point L, and **draw** the aircraft's flight path for this part of its journey, on the diagram above.

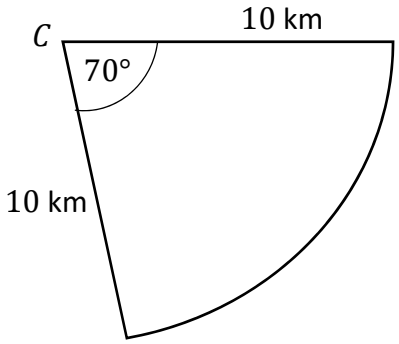
(iii) Find the total distance the aeroplane has travelled when it is directly above E.
Give your answer, in metres, correct to the nearest metre.

(b) The aircraft flies from airport A to airport B, and then on to airport C, at the same altitude. The pilot records the flight summary on the given diagram.



(i) Find the distance from airport B to airport C. Give your answer correct to the nearest km.

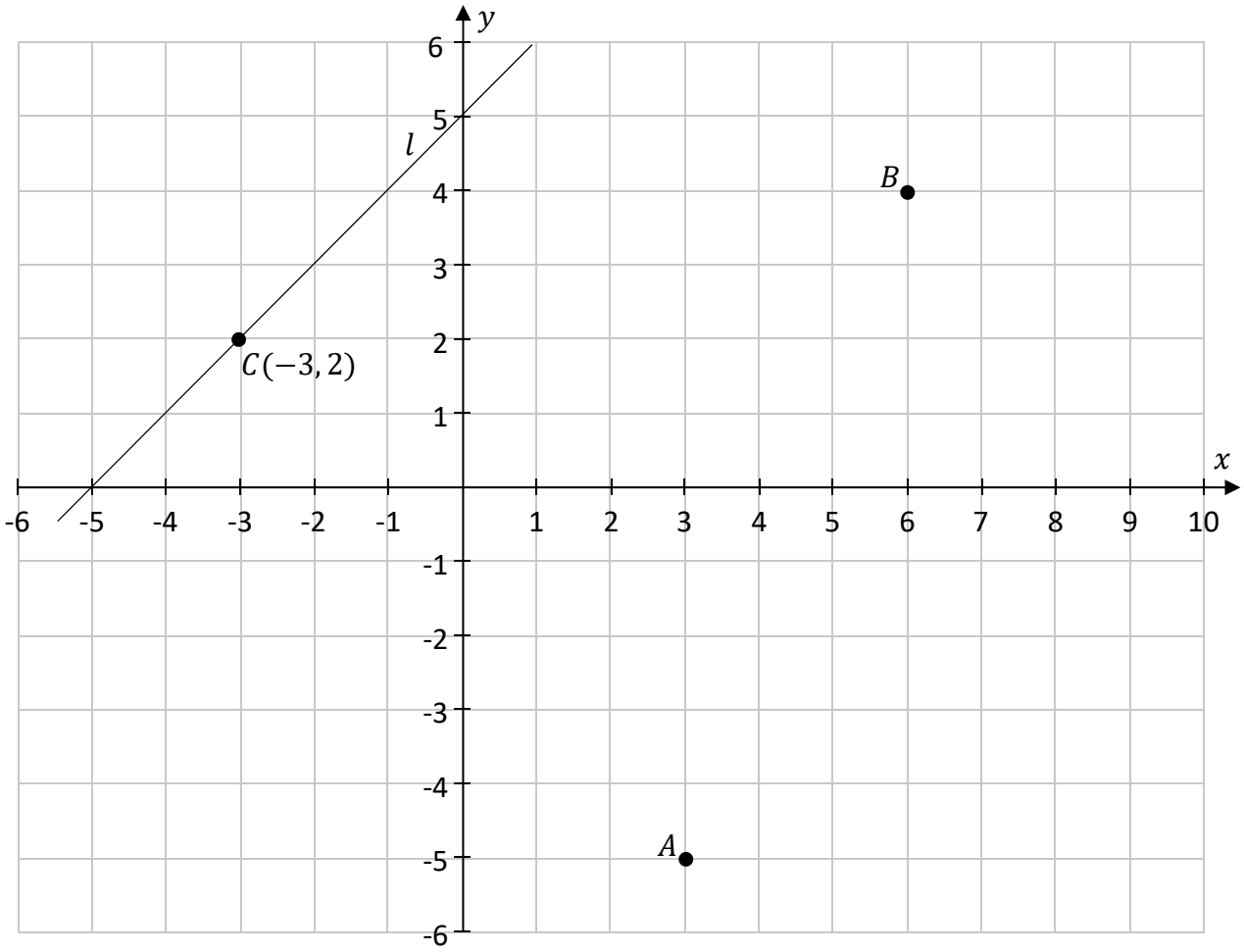
(ii) When the plane was directly over airport C, the pilot was instructed to "circle" until a runway was available. She therefore flew 10 km away from C before turning and flying along a circular arc of $70°$ and then returning to the airport.
This path was all flown at the same altitude.



Find the total distance travelled.
Give your answer, in km, correct to two decimal places.

Question 10 **(50 marks)**

A TY maths class has created a game involving a co-ordinate treasure map, as shown below.
The game consists of tasks that involve directions, distances, and locations.
The tasks in the game are based on the map.



(a) **(i)** Treasure is hidden at location $T(-2, -5)$.
Mark T on the map where this treasure can be found.

(ii) Food is located at a point F on the map.
The point F is on a line which contains the point $A(3, -5)$ and has a slope of -1.
The point F is also on a line which contains $B(6, 4)$ and has a slope of 0.
By drawing appropriate lines on the map above, or otherwise, find the co-ordinates of F.

(b) **(i)** A clue to another treasure is hidden in a locked box at point $B(6, 4)$.
The 4-digit code to open the box is d^4, where d is the distance from B to $C(-3, 2)$, and $d \in \mathbb{N}$.
Find the 4-digit code (d^4).

(ii) A meeting point $P(2, m)$ is below the x-axis.
P is a distance of $\sqrt{41}$ from point $B(6, 4)$.
Find the value of m **and** plot P on the map above.

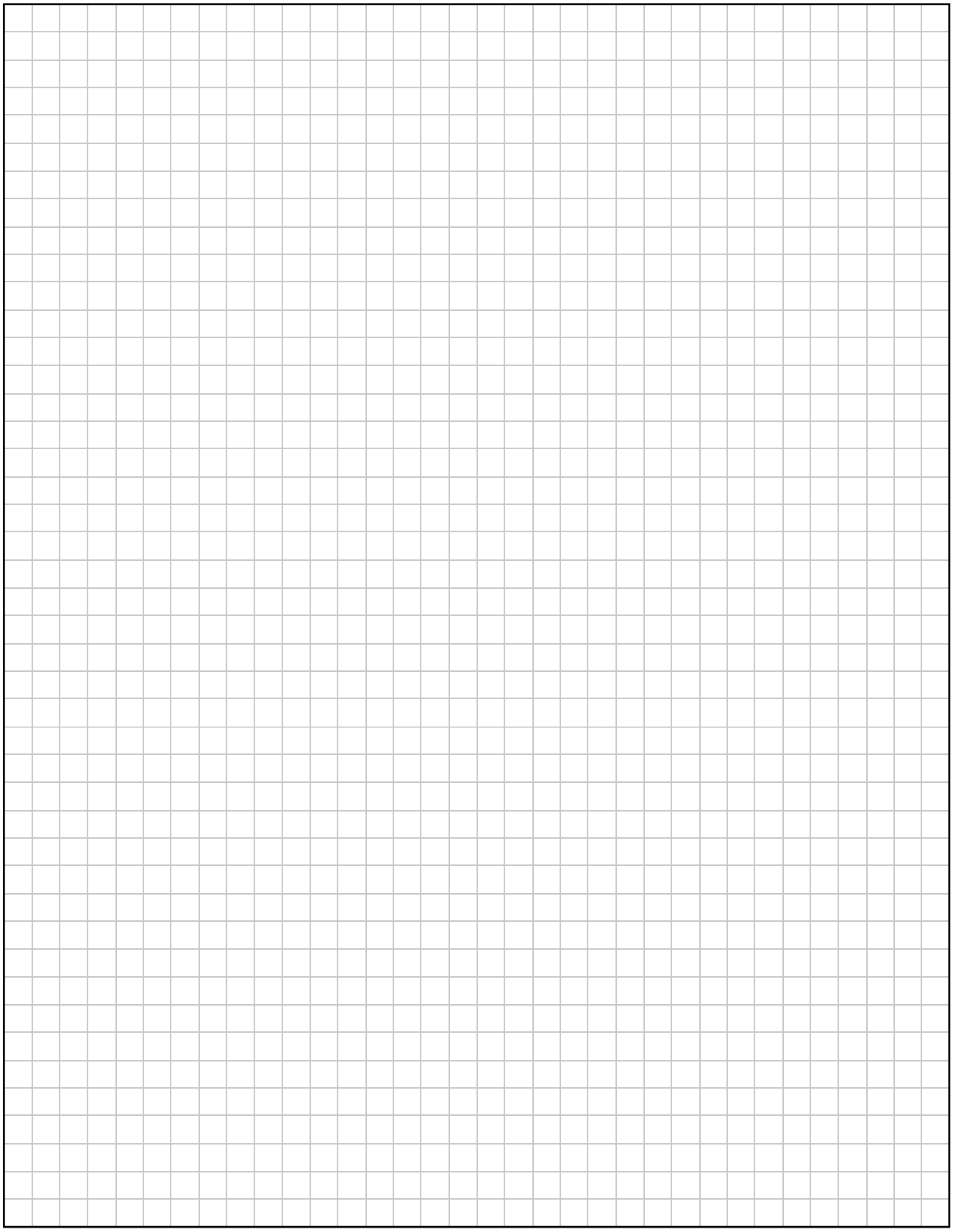
This question continues on the next page.

(c) **(i)** The line k has equation $x - y - 3 = 0$.
Verify, using substitution, that the point $T(-2, -5)$ is on k.

(ii) Another treasure also needs be somewhere on the line k.
You must pick a spot along k to contain this treasure.
Use algebra to find another point on k, other than T.

(iii) A spade for digging is hidden on line l which is parallel to k.
The line l contains the point $C(-3, 2)$.
Find the equation of line l.

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

Monday 14 June

Morning 9:30 – 12:00