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Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination

Mathematics

Paper 2

Ordinary Level

2 hours 30 minutes

300 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	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: [ ]

Section A — Concepts and Skills — 150 marks

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

Question 1 **(30 marks)**

In a game, two fair standard six-sided dice are thrown.
The numbers are multiplied and this product of the two numbers is recorded.
Some of the possible outcomes are shown in the table below.

×	1	2	3	4	5	6
1						6
2						12
3						18
4	4					
5						
6			18	24	30	36

(a) **(i)** Complete the table.

(ii) The game is won if the product of the numbers is a multiple of 3.
What is the probability of winning the game on one throw of the two dice?
Give your answer in the form $\frac{p}{q}$, where $p, q \in \mathbb{N}$.

(iii) The rule for winning the game is changed.
The game is now won if the product of the numbers, recorded in the table, from one throw of the two dice is n, where $n \in \mathbb{N}$.
The probability of winning the game is now $\frac{1}{36}$.
List the possible values of n.

(b) There are 25 students in a class. There are 15 male students of which 3 wear glasses. In total 7 students in this class wear glasses. If a student is selected at random from this class find the probability that the student is a female who does **not** wear glasses.

Question 2 **(30 marks)**

(a) **(i)** In how many ways can the letters of the word ACTION be arranged, using all 6 letters?

(ii) In how many of these arrangements are the three vowels (A, I, and O) together?

(b) In 2020, in Ireland, according to the Central Statistics Office, a total of 55 959 live births were registered. Of those 27 057 were female.
The 5 most popular male first names and 5 most popular female first names were listed as:

Male Name	Number Registered	Female Name	Number Registered
Jack	597	Grace	410
James	495	Fiadh	366
Noah	447	Emily	329
Daniel	359	Sophie	328
Conor	345	Ava	297

If a baby name was selected at random from the register for that year, what is the probability that the name selected is:

(i) the most popular male name or the most popular female name?
Give your answer as a percentage correct to 1 decimal place.

(ii) one of the 5 female names that appears in the table above?
Give your answer as a percentage correct to 1 decimal place.

Question 3 **(30 marks)**

(a) The equation of line t is: $2x - 3y + 7 = 0$.

(i) Write down the slope of t.

(ii) The equation of line v is: $ax - 6y + 1 = 0$, where $a \in \mathbb{R}$.
Line t is parallel to line v.

Find the value of a.

(iii) The equation of line w is: $3x + 2y - 9 = 0$.
Solve simultaneous equations to find the point of intersection of t and w.

(b) $A(-2, 3), B(2, 4)$, and $C(0, 0)$ are the 3 vertices of a triangle.

Find, in square units, the area of triangle ACB.

Question 4 **(30 marks)**

(a) $A(-4, 3)$ and $B(4, -3)$ are the two end points of a diameter of a circle, s.

(i) Find the centre **and** the radius of s.

Centre: Radius:

(ii) Write down the equation of the circle s.

(iii) Show, by calculation, that the point $p(-1, -3)$ lies inside the circle s.

(b) **(i)** Write down the centre **and** the radius of each of the following circles:

k: $x^2 + y^2 = 49$ Radius of k: Centre of k:	p: $(x - 8)^2 + (y + 6)^2 = 9$ Radius of p: Centre of p:

(ii) Hence, or otherwise, write down the co-ordinates of two points on the circle k **and** two points on the circle p.

Points on k:

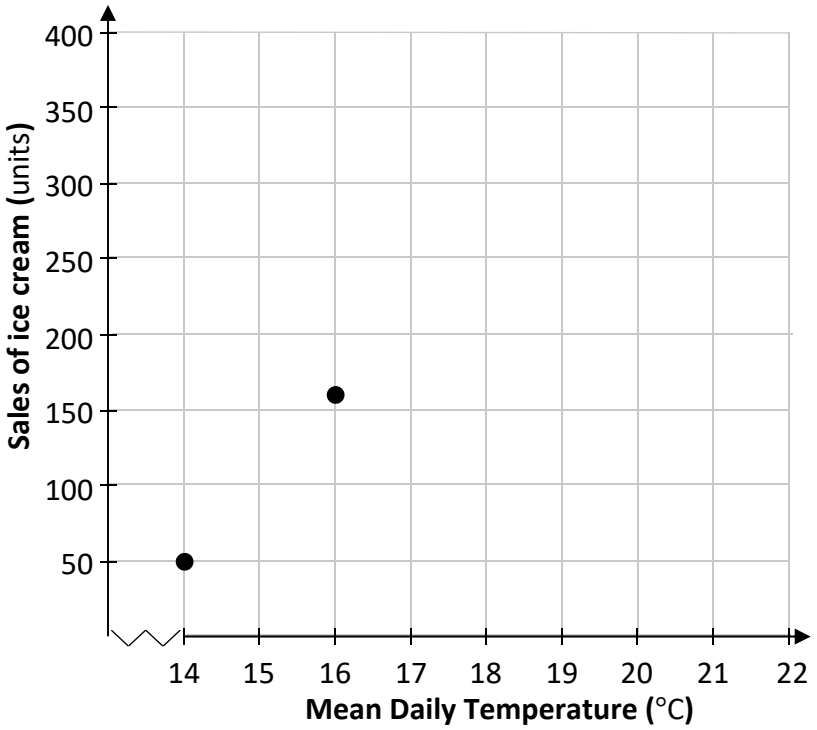
Points on p:

Question 5 **(30 marks)**

The table below shows data on the mean daily temperature (°C) during nine days in the month of July and the sales of units of ice-cream on those days, in a local shop.

Temperature (°C)	14	15	16	17	18	19	20	21	22
Sales (units)	50	90	160	240	260	320	340	380	140

(a) Complete the scatter plot of the data on the grid below.



(b) The sales at 22° seems out of line with the other data.
State what name is given to a point that seems out of line with other data **and** suggest a reason why this might have happened in the case of the data in the table.

Name:

Reason:

(c) **Ignoring the point (22, 140),** draw the line of best fit on the scatter plot, by eye.

(d) Use your line of best fit to estimate the sales of units of ice cream on a day with a mean daily temperature of 18·5 degrees. Show your work clearly on the grid in **part (a)**.

(e) **You may ignore the point (22, 140) in answering this part.**
From the list of values below, select the one which you believe best represents the correlation coefficient of the first 8 data points in the table **and** give a reason for your choice.

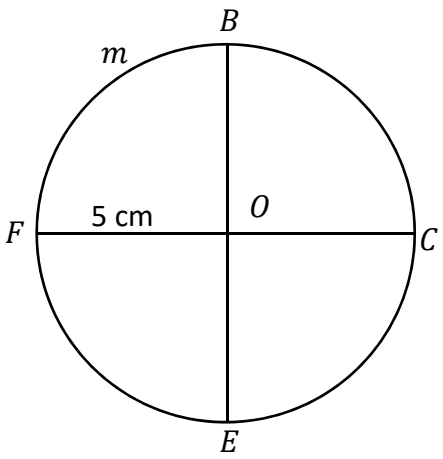
0·25, −0·9, 0·7, 0·95, 0·1, −0·55

Answer:

Reason:

Question 6 **(30 marks)**

(a) The circle m, shown below, has centre O and a radius of 5 cm.
Two diameters labelled $[BE]$ and $[FC]$ divide the circle into 4 equal sectors.



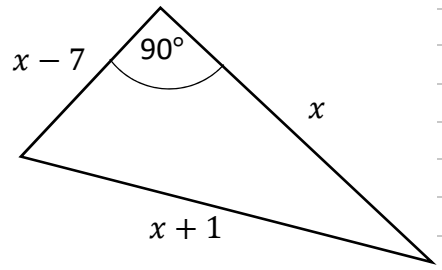
(i) What is $|\angle BOC|$?

(ii) Hence, or otherwise, find $|FE|$.
Give your answer, in cm, in surd form.

(b) Construct a triangle PQR where $|PQ| = 8$ cm, $|QR| = 8$ cm, and $|PR| = 6$ cm.
Show all construction lines clearly.
The point P is given below.

P •

(c) The right-angled triangle shown below has sides: $x - 7$, x, and $x + 1$.
Find the value of x.

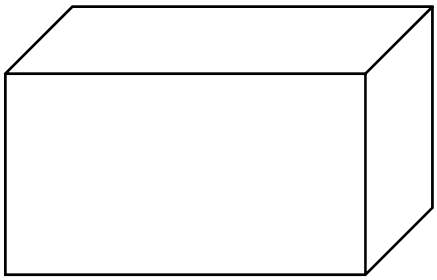


Section B — Contexts and Applications — 150 marks

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

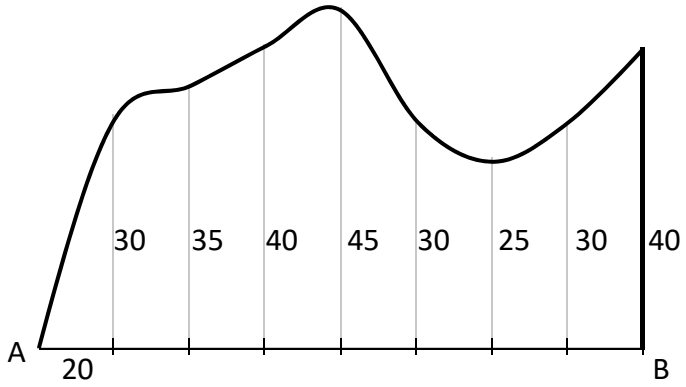
Question 7 **(50 marks)**

Kobe got a new puppy. The puppy must be kept indoors at night.
Kobe bought a six-sided cage in the shape of a cuboid for his puppy.
The cage has a length of 1·2 metres, a width of 80 cm, and a height of 70 cm.



(a) Find the volume of the space that the cage will occupy. Give your answer in cm^3.

(b) The diagram below shows the plan of a field behind Kobe's house where the puppy can play. The horizontal line AB represents a wooden fence. At equal intervals of 20 m along this fence perpendicular measurements (in metres) are taken to the opposite side of the field.

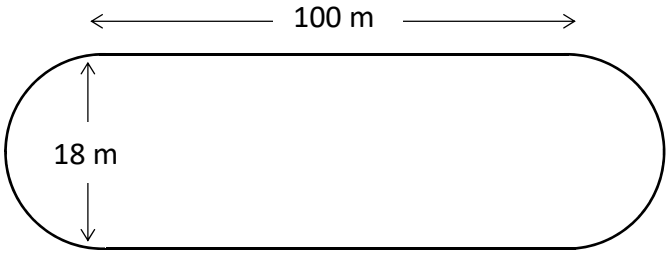


Use the **Trapezoidal Rule** to estimate the area of this field in m^2.

This question continues on the next page.

(c) Kobe decides to mark out a path to walk his puppy in this field.
His path contains two straight sides and two semi-circular ends, as shown in the diagram.
The length of each straight side is 100 m and the distance between the sides is 18 m.

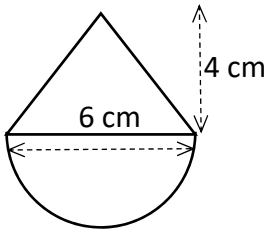
Find the distance they will walk in one full lap of this path.
Give your answer in metres, correct to two decimal places.



(d) Kobe would like to walk his puppy at least 5 km each day.
How many complete laps of the path will he need to finish each day?

(e) Kobe bought his puppy a toy.

This toy is in the shape of a cone on top of a hemisphere.
The vertical height of the conical part is 4 cm.
The diameter of the hemisphere is 6 cm, as shown.



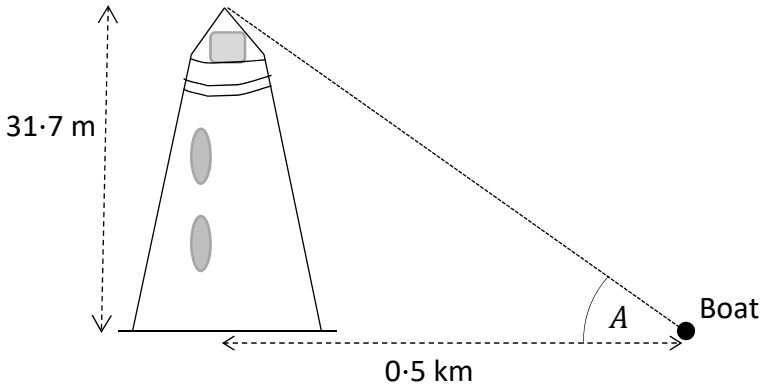
(i) Find the volume of this toy (in cm^3) in terms of π.

(ii) The inside of this toy is filled with spherical foam beads each of radius 2 mm.
Find the volume of one bead. Give your answer (in cm^3) in terms of π.

(iii) 1500 of the beads are used to stuff the toy.
Find the percentage of empty space inside the toy.

Question 8 **(50 marks)**

A lighthouse is situated, with its base at sea level, on a small island.
A boat is anchored at sea.
The boat is 0·5 km from the centre of the base of the lighthouse.
The height of the lighthouse is 31·7 m from its base to its top.
The angle of elevation from the boat to the top of the lighthouse is A.
The diagram below, showing this information, is not drawn to scale.



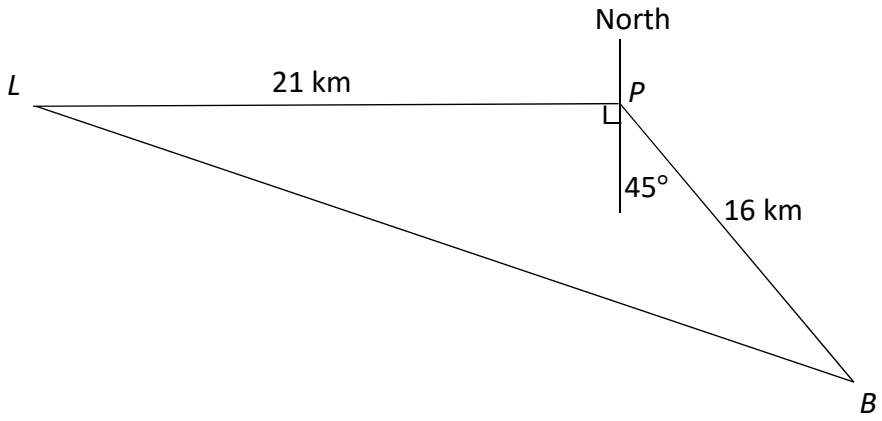
(a) **(i)** Find the distance between the boat and the top of the lighthouse.
Give your answer correct to the nearest metre.

(ii) Find the size of the angle A, the angle of elevation of the top of the lighthouse from the boat. Give your answer, in degrees, correct to 2 decimal places.

(iii) The boat moves x metres closer to the lighthouse, so that the angle of elevation doubles in size ($2A$). Find the value of x, correct to the nearest whole number.

This question continues on the next page.

(b) The diagram below shows the path of another boat which starts from the point *L* and sails due east for 21 km to the point *P*. The boat then changes course.
From *P*, it sails South East and travels a further 16 km to *B* as shown in the diagram below.



(i) Write down the size of the angle *BPL* **and** hence find the area of the triangle *BPL*.
Give your answer for the area correct to 2 decimal places.

Size of the angle *BPL*:

Area of the triangle *BPL*:

(ii) Use the Cosine Rule to find how far the point *B* is from L.
Give your answer correct to one decimal place.

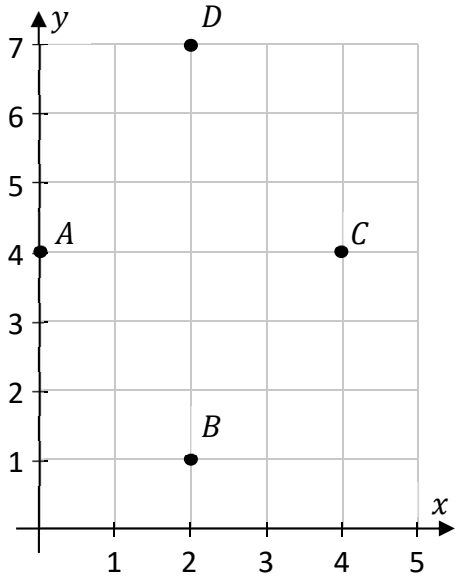
(iii) Use the Sine Rule to find l $\angle PLB$ l.
Give your answer, in degrees, correct to one decimal place.

Question 9 **(50 marks)**

Alice, Brian, Ciara, and Dave all live in the same town.
Alice draws the co-ordinate diagram on the right to show the positions of each of their houses.
The diagram is to scale.

There are paths that connect each of the houses to each other by the shortest line segment.

The side of each small square on her grid represents 1 km.



(a) Write down the co-ordinates of the position of each person's house. One is already given.

Alice, A (0 , 4)

Brian, B (,)

Ciara, C (,)

Dave, D (,)

(b) Ciara says that the distance from her house to Brian's house is the same as the distance from her house to Dave's house.
Show that $|CB| = |CD|$.

(c) Dave says that the path from his house to Brian's house is perpendicular to the path from Alice to Ciara's. Based on Alice's co-ordinate diagram, explain why this is true.

(d) Is the path from Brian's house to Ciara's house perpendicular to the path from Dave's house to Ciara's house? Justify your answer, using slopes or distances.

Answer:

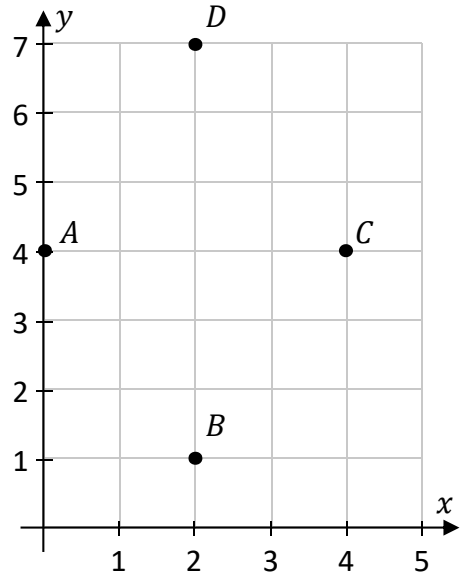
Justification:

(e) Alice and Ciara both leave their houses and walk towards each other.
Brian and Dave do the same.

Write down the co-ordinates of the points where Brian and Dave will be when Alice and Ciara meet.
(*Assume they all leave their houses at the same time and walk at the same pace.*)

Brian: (,) Dave: (,)

This question continues on the next page.



(f) Is $ABCD$ a square? Justify your answer.

Answer:

Justification:

(g) **(i)** The local shop is situated at $O(0, 0)$.
Find the distance from Ciara's house to the shop.
Give your answer, in km, in surd form.

(ii) Find the angle between Dave's house, the shop, and Ciara's house (i.e. $|\angle DOC|$). Give your answer correct to the nearest degree.

(h) Find, in km^2, the area enclosed between the four houses (i.e the area of $ABCD$).

Question 10 **(50 marks)**

(a) The table below shows the average monthly price of diesel and petrol (per litre) in Ireland during the period between September 2021 and August 2022 (*source*: *AA Ireland*).

Date	Petrol (cent)	Diesel (cent)
Sept 21	156	145
Oct 21	165	157
Nov 21	173	163
Dec 21	173	162
Jan 22	176	166
Feb 22	177	168
March 22	182	191
April 22	181	191
May 22	192	195
June 22	213	205
July 22	200	202
Aug 22	187	190

(i) Write down the range for the price of both petrol and diesel.

Range of petrol prices:

Range of diesel prices:

(ii) Find the mean and the standard deviation of the price of **diesel** during the period. Give each answer correct to the nearest cent.

Mean:

Standard deviation:

(iii) List the months in which the price of diesel was within one standard deviation of the mean price for **diesel**.

(iv) Sean drives a diesel car, Jenny drives a petrol car.
At the start of one week in April 2022, both Sean and Jenny had a full tank of fuel.
Both drove 340 km, and then filled their tank to capacity again.
The details for each car are as follows:

Sean's car	**Jenny's car**
Diesel 191 cent per litre Uses an average of 5·4 litres per 100 km driven	Petrol 181 cent per litre Uses an average of 6·2 litres per 100 km driven

Which car was cheaper to fill after the 340 km of driving, **and** by how much?
Give your second answer correct to the nearest cent.

Cheaper car: How much cheaper:

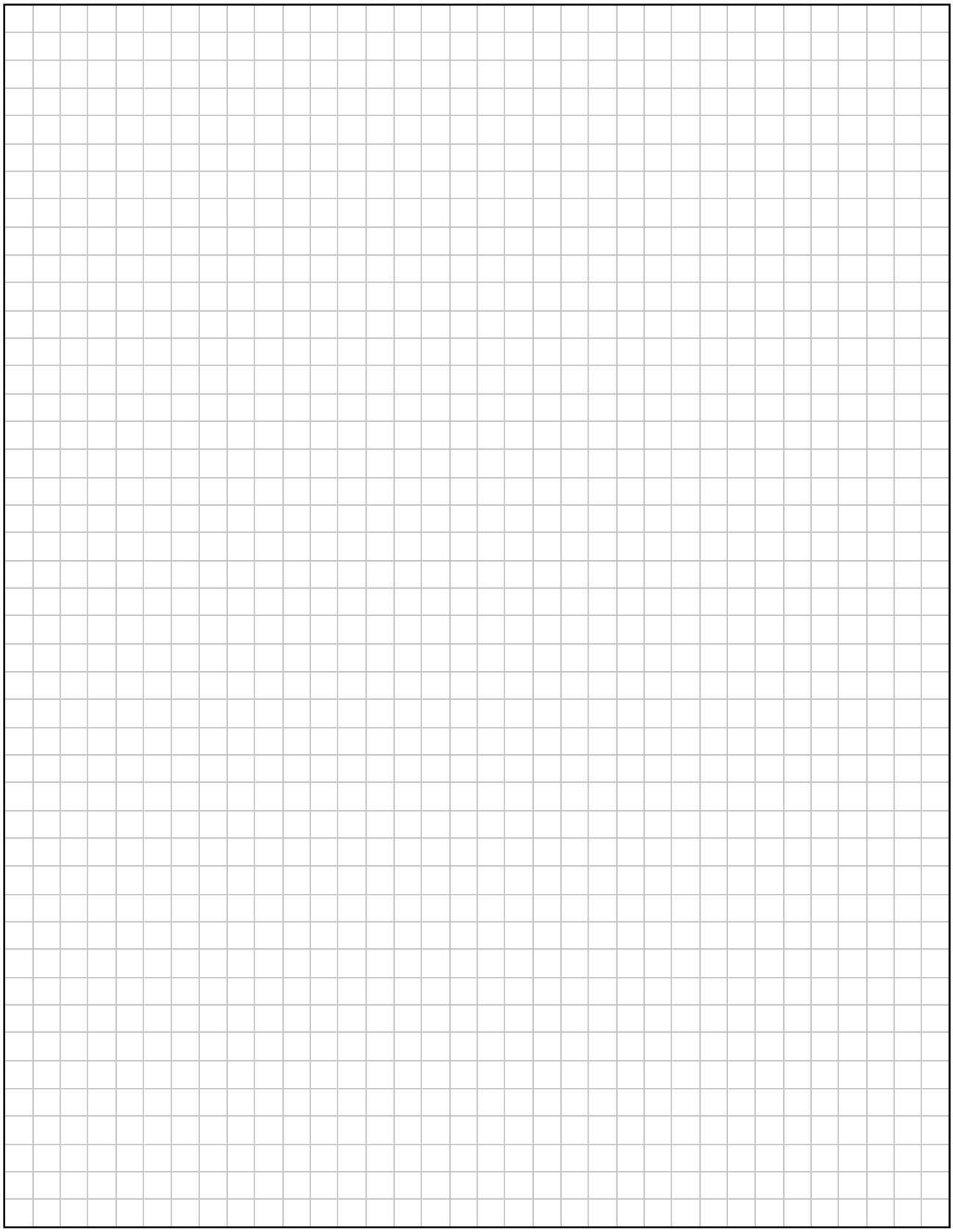
This question continues on the next page.

(b) **(i)** Find the margin of error associated with a survey of 1276 people.
Give your answer correct to 3 decimal places.

(ii) In a particular survey, 1276 people were selected at random in a particular area.
Of those surveyed, 740 of them said they were satisfied with the level of public transport in their area.
Create a 95% confidence interval for the level of satisfaction amongst the population in this area.
Give your answer correct to 3 decimal places.

(iii) What change could be made to decrease the margin of error in this survey?

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



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