Cambridge Assessment International Education

# Cambridge IGCSE™

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| CANDIDATE NAME | | | | | | | | | |
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*6553228563*

**CAMBRIDGE INTERNATIONAL MATHEMATICS** **0607/52**

Paper 5 Investigation (Core) **May/June 2021**

**1 hour 10 minutes**

You must answer on the question paper.

No additional materials are needed.

**INSTRUCTIONS**

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a graphic display calculator where appropriate.
- You may use tracing paper.
- You must show all necessary working clearly, including sketches, to gain full marks for correct methods.
- In this paper you will be awarded marks for providing full reasons, examples and steps in your working to communicate your mathematics clearly and precisely.

**INFORMATION**

- The total mark for this paper is 36.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages. Any blank pages are indicated.

DC (RW/FC) 207546/2


**[Turn over**

Answer **all** the questions.

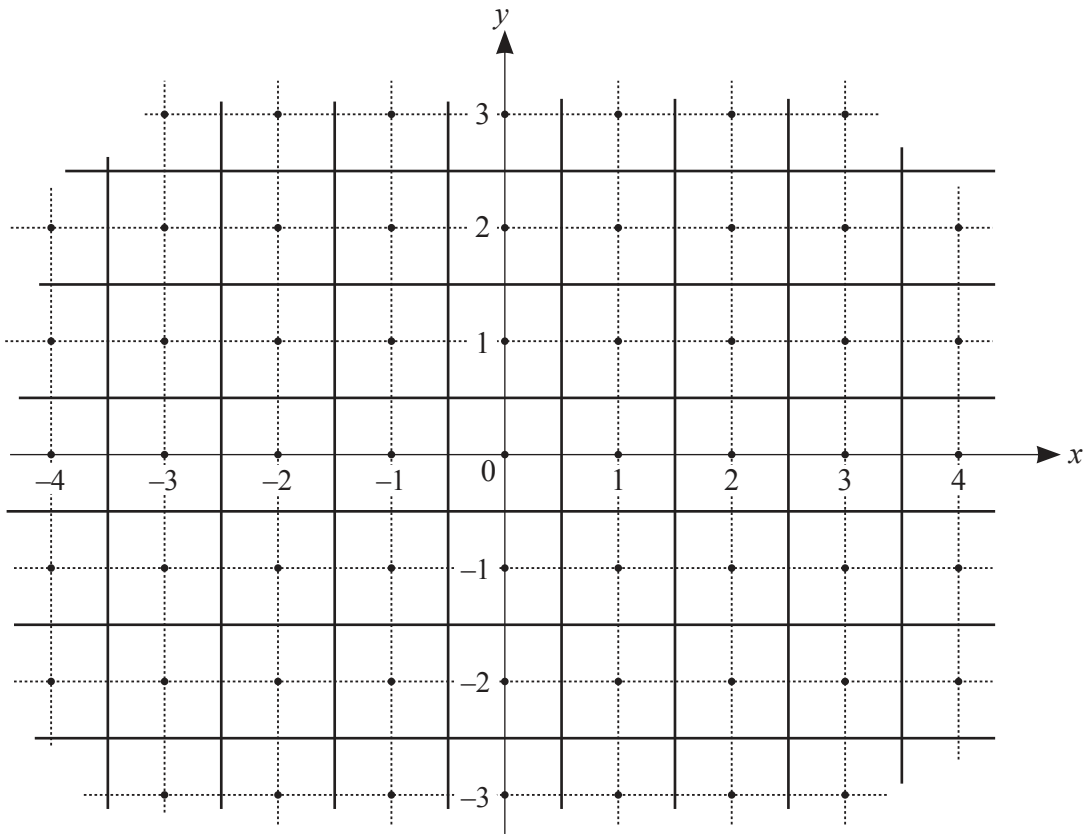
**INVESTIGATION NEAREST NEIGHBOURS**

This investigation looks at the distances from the origin (0, 0) to the centres of squares and hexagons that form a pattern.

The diagram shows a pattern of congruent squares.

A dot marks the centre of each square.

The coordinates of some of the centres are (0, 0), $(-3, -2)$ and (3, 1).



**1** **(a)** Complete this table, using a tick in each row, to show whether a point is

- at the centre of a square
- inside a square, but not at its centre
- on the side of two squares
- where four squares meet.

The first three have been done for you.

| Point | At the centre of a square | Inside a square, not at its centre | On the side of two squares | Where four squares meet |
|---|---|---|---|---|
| (0, 0) | ✓ | | | |
| (−1, 0.5) | | | ✓ | |
| (0.5, 0.5) | | | | ✓ |
| (1.5, 1.5) | | | | |
| (0, 1.5) | | | | |
| (0.25, 0) | | | | |
| (100.5, 99.5) | | | | |

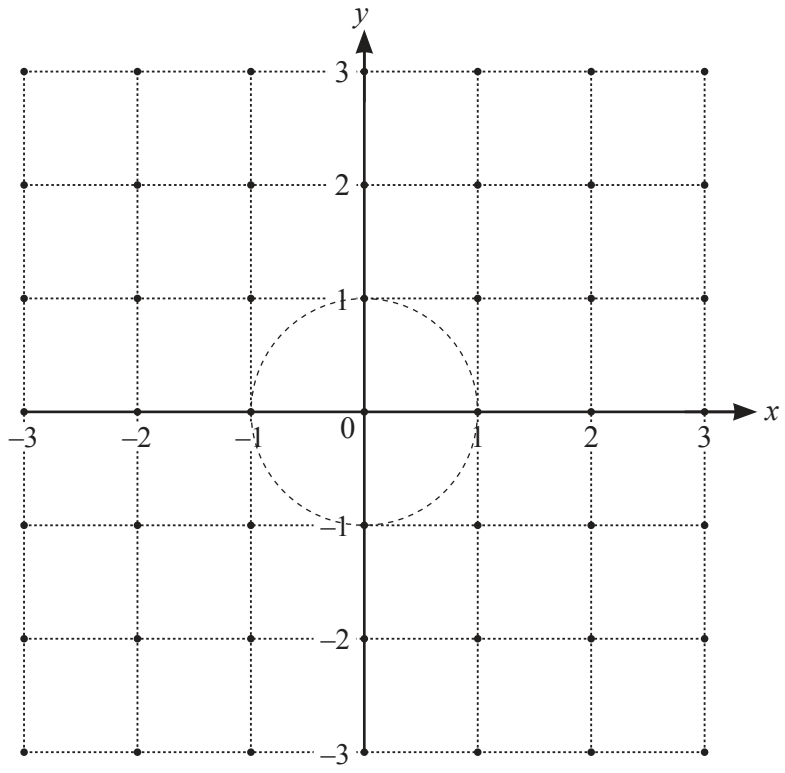
[4]

**(b)** Give a reason for your answer for (100.5, 99.5).

.....

..... [1]

**2** Each dot on the grid marks the centre of a square.




The nearest dots to (0, 0) are (−1, 0), (0, 1), (1, 0) and (0, −1).
These four dots are the **1st nearest neighbours**.

The **2nd nearest neighbours** to (0, 0) are (1, 1), (1, −1), (−1, −1) and (−1, 1).

All nearest neighbours have integer coordinates.

**(a)** One of the 3rd nearest neighbours to (0, 0) is (2, 0).

Find the other 3rd nearest neighbours and write down their coordinates.

..... [3]

**(b)** Find the coordinates of all the 4th nearest neighbours to (0, 0).

.....

..... [3]

**3** You can find the distance, $d$, from (0, 0) to the point ($a$, $b$) using Pythagoras' Theorem.

$$d^2 = a^2 + b^2$$

**(a)** Show that the distance of a 4th nearest neighbour from (0, 0) is $\sqrt{5}$.

[2]

**(b)** Here are four points and their coordinates.

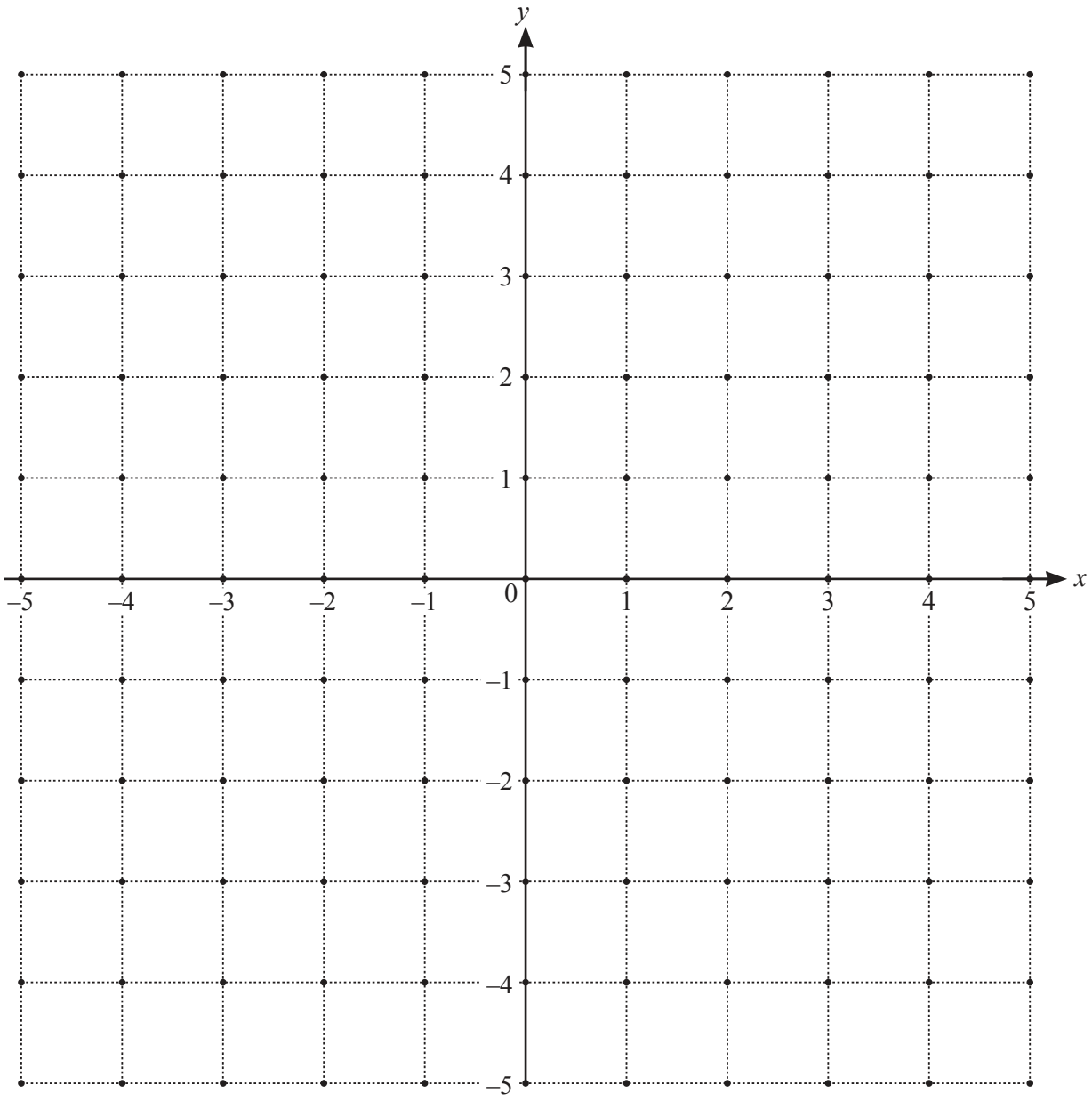
$A(20, 5)$ $B(7, 24)$ $C(-7, 24)$ $D(0, 25)$

Which of these points are a distance of 25 units from (0, 0)?

..... [3]

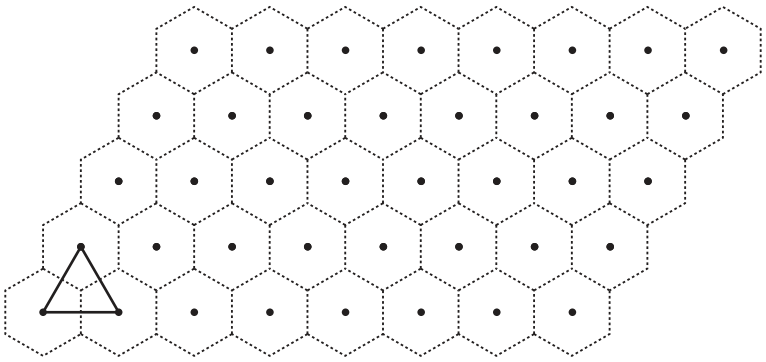
**(c)** There are more than 10 nearest neighbours to (0, 0) with $d = 5$.
Four of them are (0, 5), (5, 0), (−5, 0) and (0, −5).

On the grid, mark with a cross **all** the nearest neighbours to (0, 0) with $d = 5$.




[4]

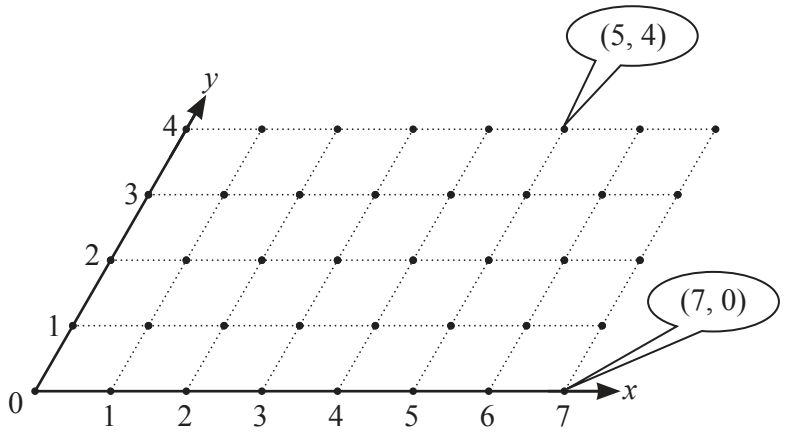
**4** Here is a pattern of congruent regular hexagons.
Each dot marks the centre of a hexagon.
The triangle shown is an equilateral triangle.



**(a) (i)** Explain why the triangle shown is an equilateral triangle.

.....  [1]

The dots at the centre of the hexagons have coordinates as shown on the grid below.




**(ii)** A line is made by joining the points (3, 0) and (4, 1).

Work out the size of the acute angle between this line and the $x$-axis.

.....  [2]

**(b)** The point at the centre of each hexagon has **six** 1st nearest neighbours.

**(i)** Complete this list of the 1st nearest neighbours to the point (1, 1).

(0, 1), (0, 2), (1, 2), ..... [2]

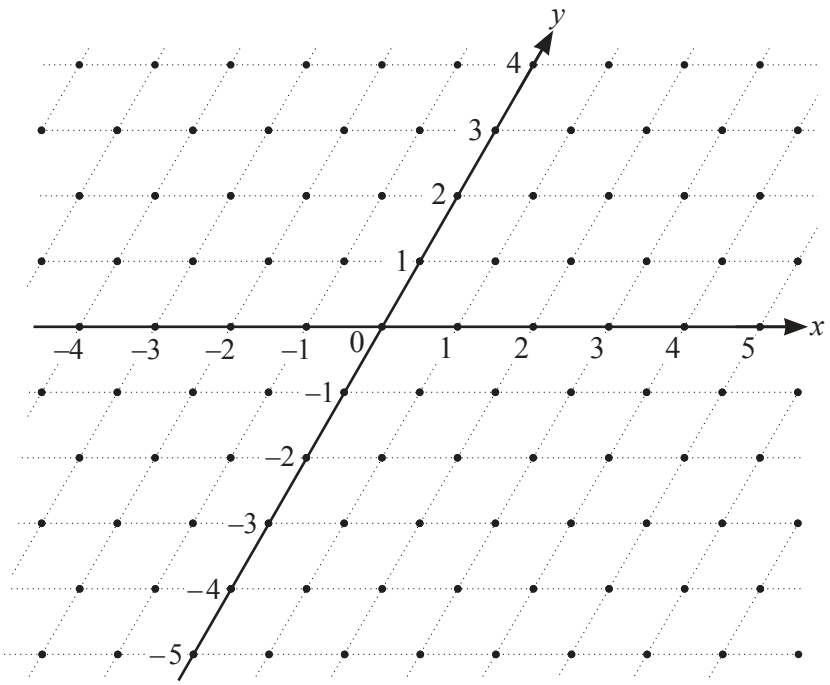
**(ii)** Find, in terms of $a$ and $b$, the coordinates of the six 1st nearest neighbours to the point $(a, b)$.

.....

..... [3]

**(c)** A student suggests that an estimate of $d$, the distance from (0, 0) to the point ($a$, $b$), is $d = \sqrt{a^2 + b^2 + ab}$ .

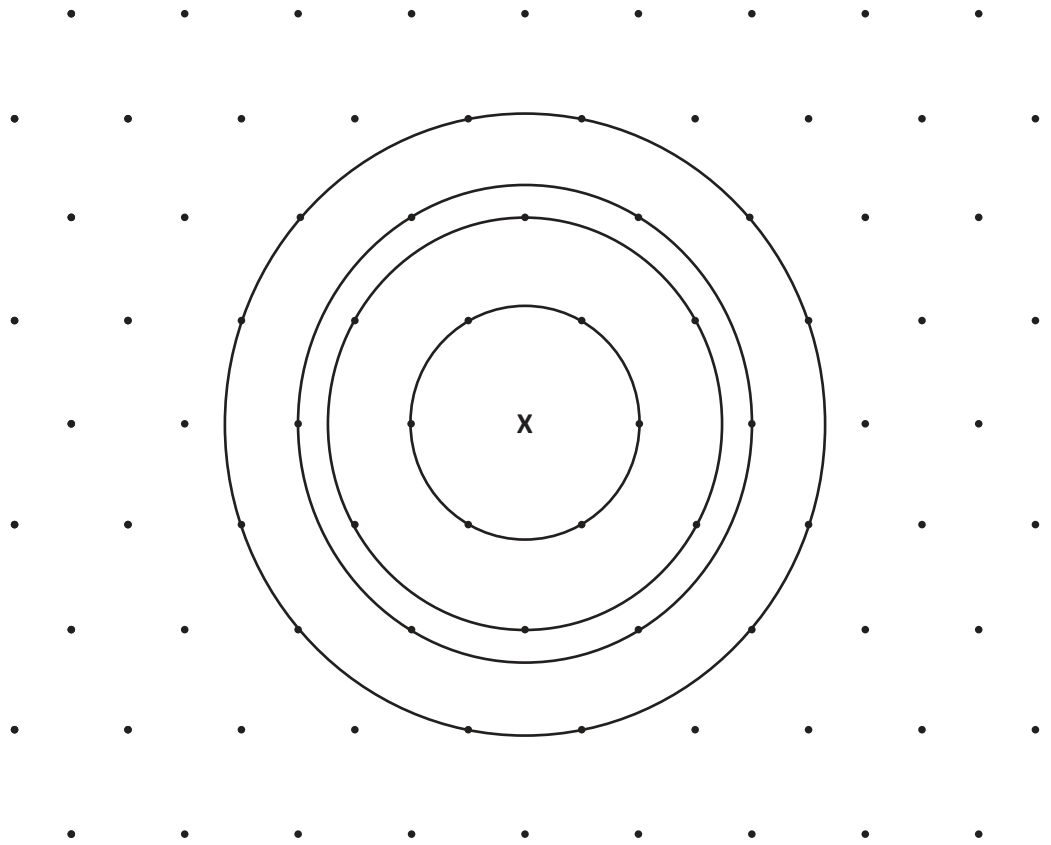
The distance between any point and its 1st nearest neighbours on this grid is 1 cm.




Does the student's formula give a good estimate for the distance from (0, 0) to (4, −3)? Show how you decide.

[5]

**5** The circles show the 1st, 2nd, 3rd, and 4th nearest neighbours to the point **X**.




**(a)** Complete this table.

| Nearest neighbour | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th |
|---|---|---|---|---|---|---|---|---|
| Number of nearest neighbours | | | | | | 6 | 12 | 6 |

[2]

**(b)** A computer calculates that there is a total of 9 points for a certain nearest neighbour distance.

Explain why the computer is probably wrong.

.....

[1]

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