



CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

0607/52

May/June 2021

1 hour 10 minutes

You must answer on the question paper.

No additional materials are needed.

- 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.

- 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.

Answer **all** the questions.

INVESTIGATION

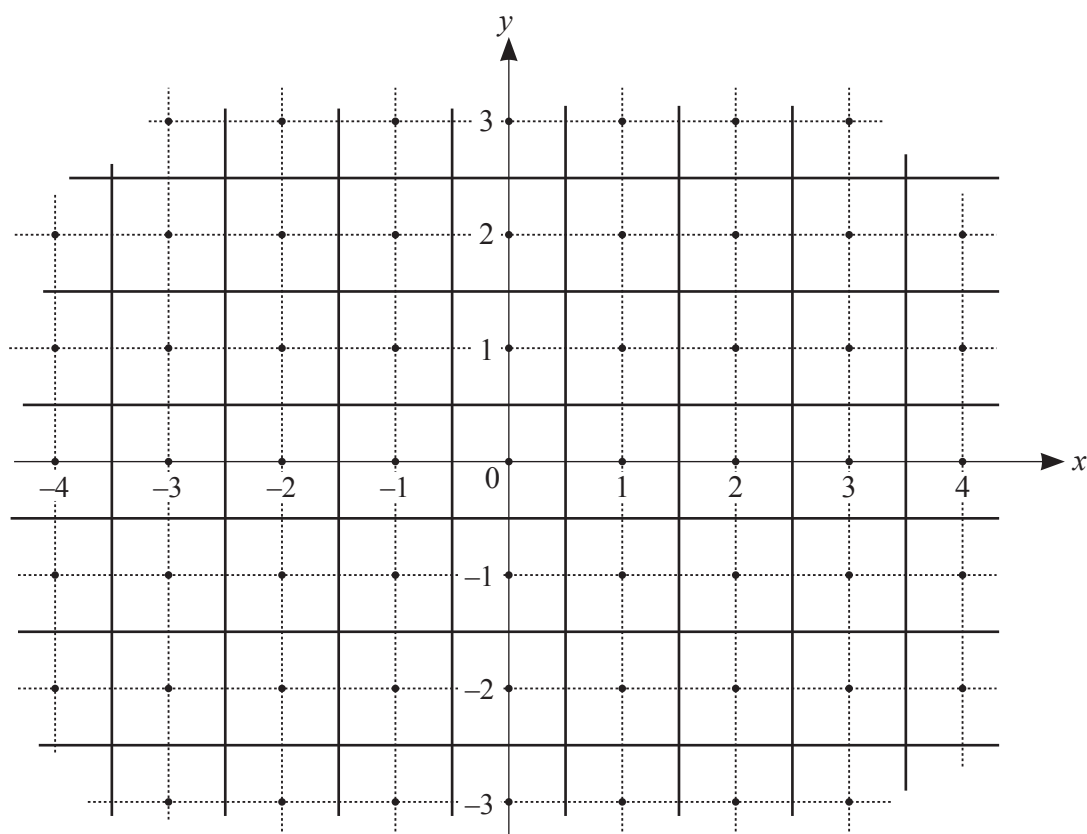
NEAREST NEIGHBOURS

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)				

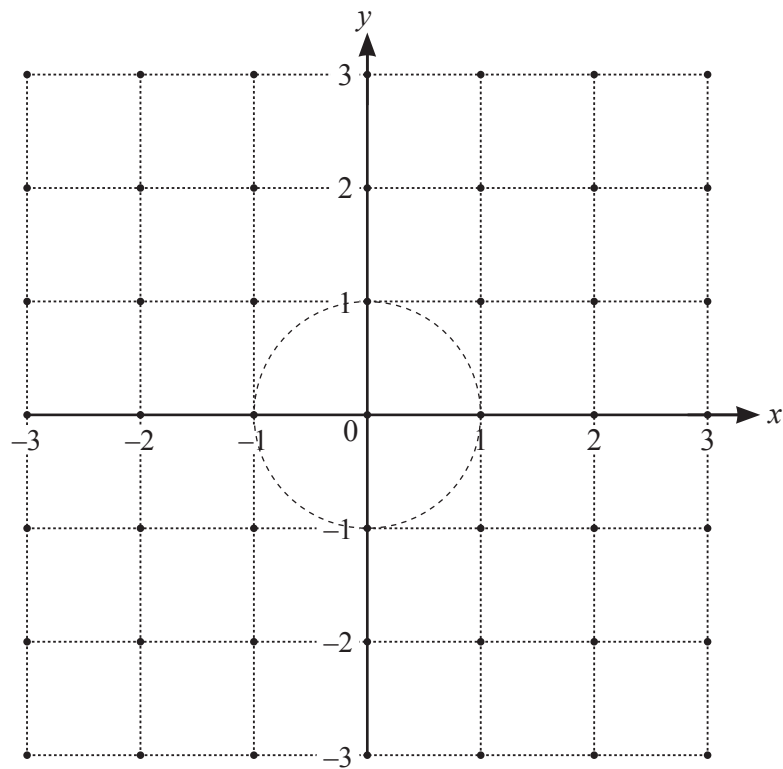
[4]

(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.

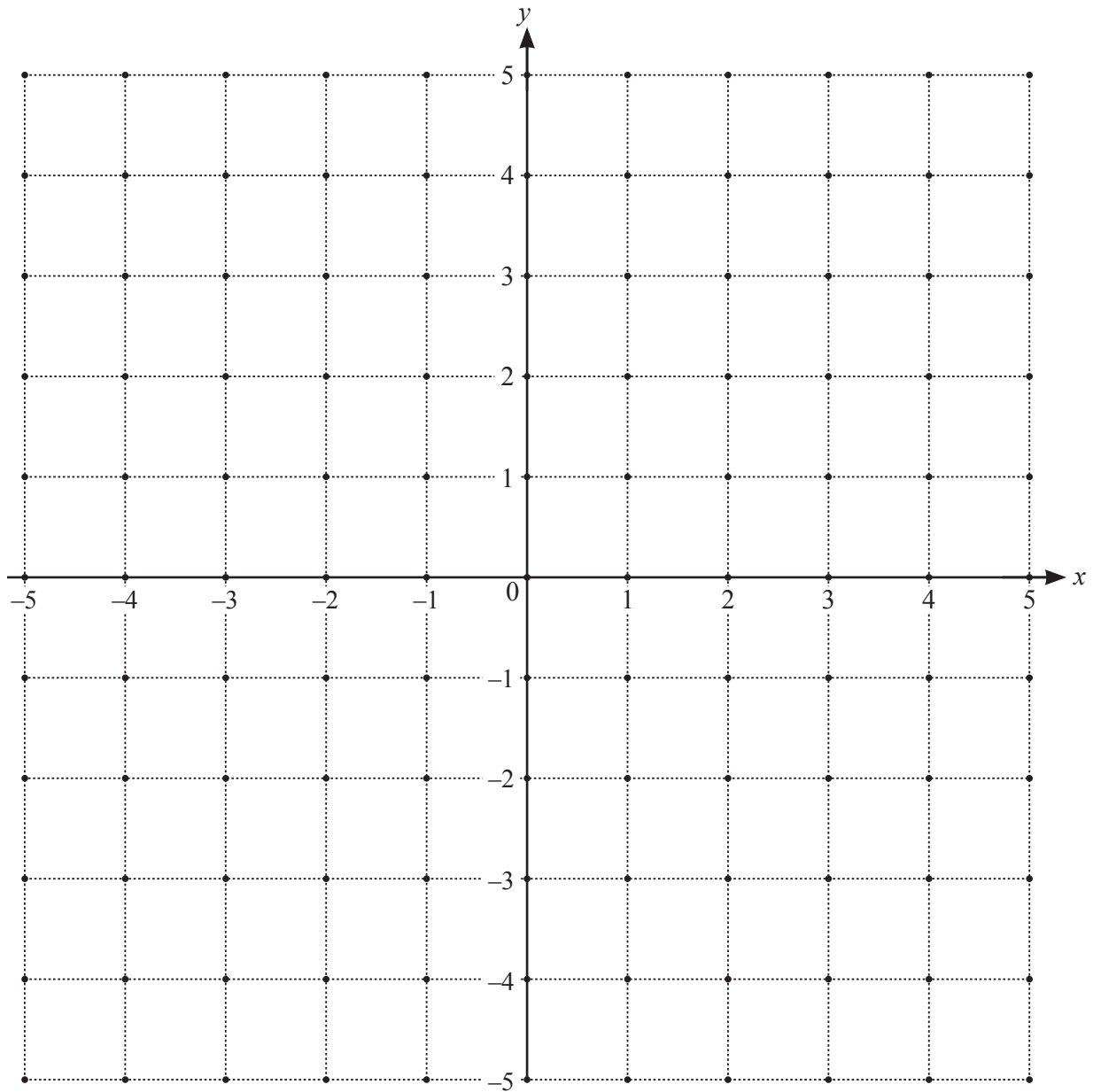
$$A(20, 5) \quad B(7, 24) \quad C(-7, 24) \quad D(0, 25)$$

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

..... [3]

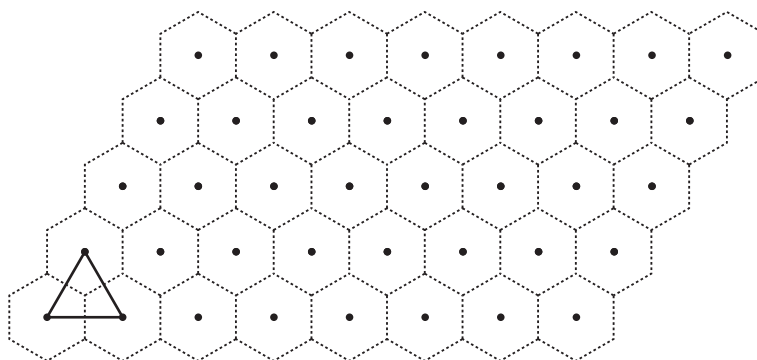
- (c) There are more than 10 nearest neighbours to $(0, 0)$ with $d = 5$.
Four of them are $(0, 5)$, $(5, 0)$, $(-5, 0)$ and $(0, -5)$.

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



[4]

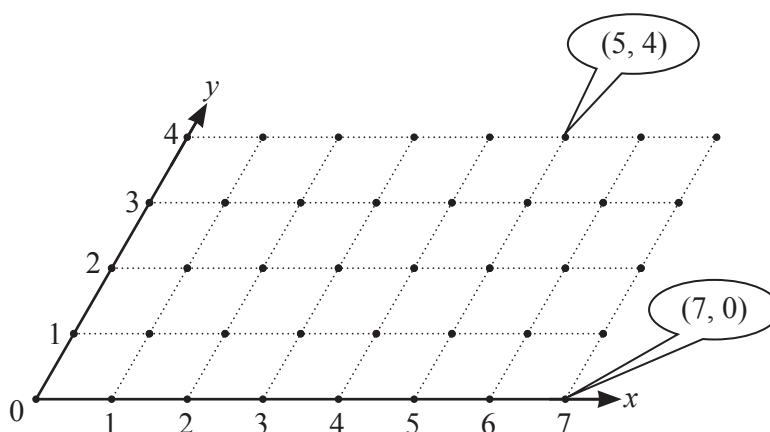
- 4 Here is a pattern of congruent regular hexagons.
Each dot marks the centre of a hexagon.
The triangle shown is an equilateral triangle.



- (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 $(1, 1)$.

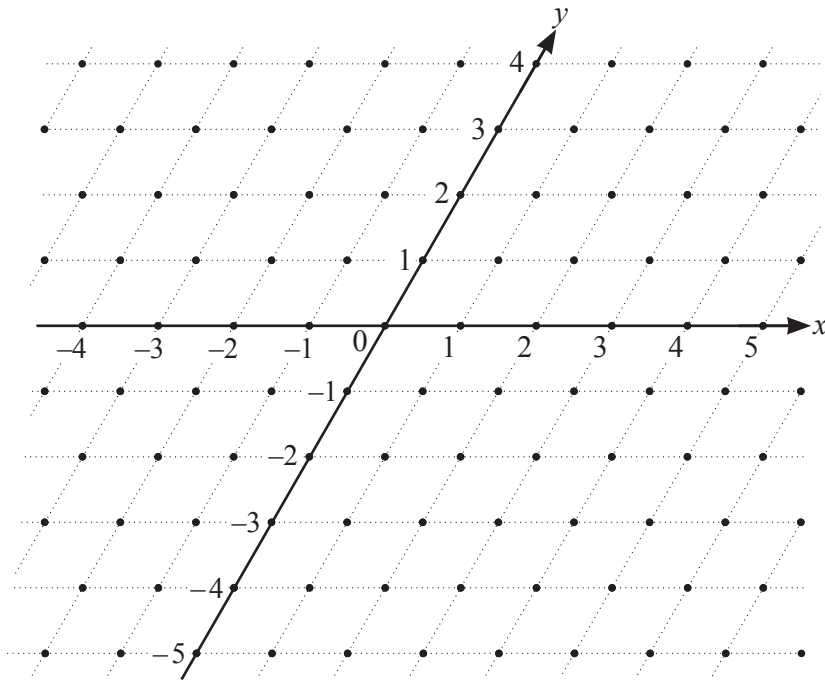
$(0, 1), (0, 2), (1, 2), \dots$ [2]

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

.....
 [3]

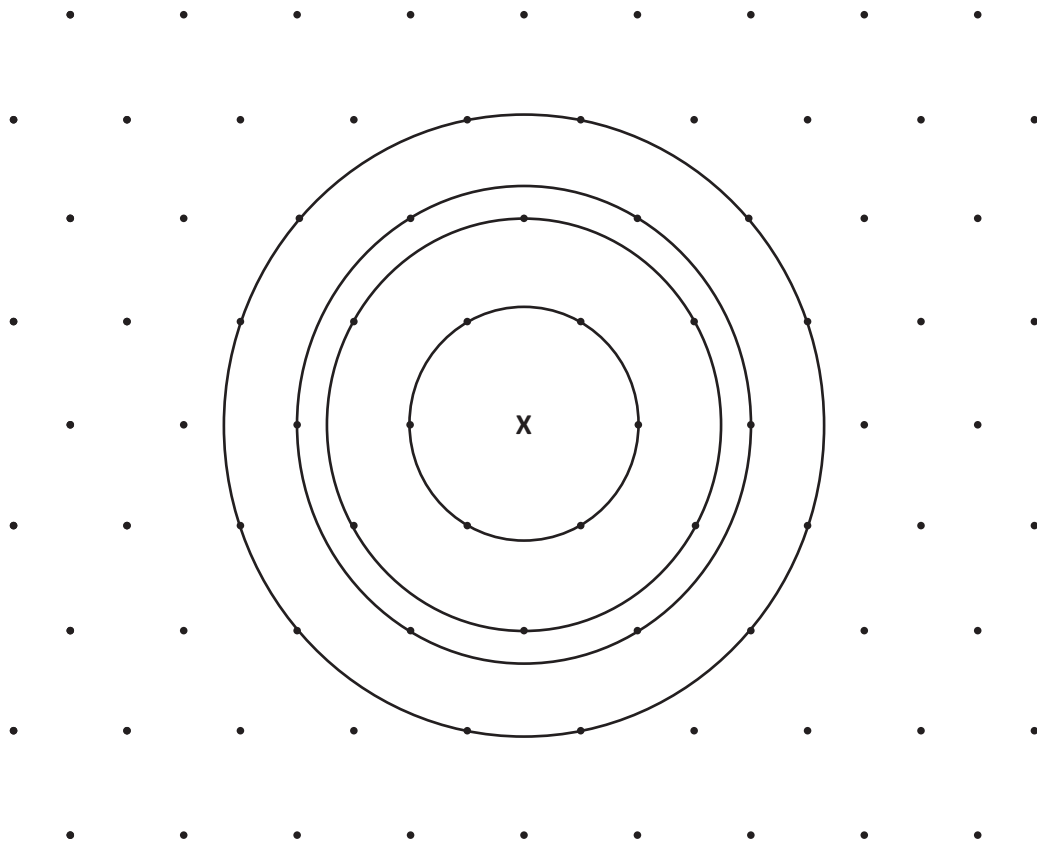
- (c) A student suggests that an estimate of d , the distance from $(0, 0)$ to the point (a, b) , is $d = \sqrt{a^2 + b^2 + ab}$.

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 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]

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.