Cambridge Assessment International Education

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2561531814

CAMBRIDGE INTERNATIONAL MATHEMATICS **0607/52**

Paper 5 Investigation (Core) **October/November 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 **8** pages.

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This square dotty paper may be used for your diagrams.



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Answer **all** the questions.

INVESTIGATION CONNECTING DOTS

This investigation looks at the number of ways of connecting dots using straight lines.

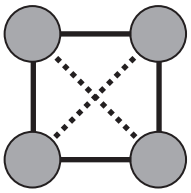
This diagram shows 1 dot.
There is 1 row and 1 column.
This is a 1 by 1 diagram.
There are no connections to other dots.



This diagram shows 4 dots.
There are 2 rows and 2 columns.
This is a 2 by 2 diagram.

There are 6 ways to join 2 dots.
These are:

- 2 vertical connectors (solid lines)
- 2 horizontal connectors (solid lines)
- 1 up diagonal connector (dashed line)
- 1 down diagonal connector (dashed line).

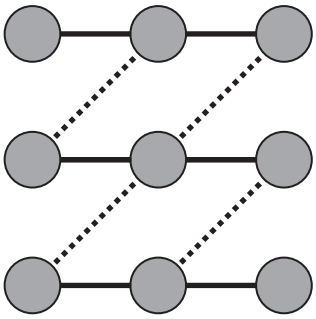


1 (a) This is a 3 by 3 diagram.

The diagram shows:

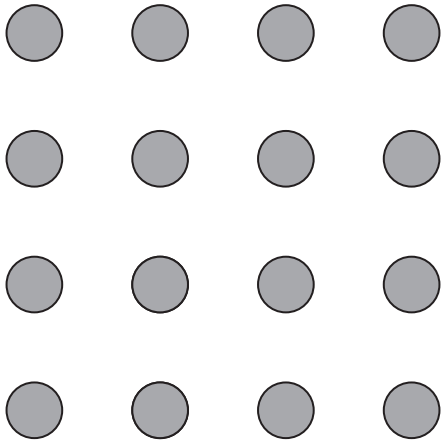
- 6 horizontal connectors
- 4 up diagonal connectors.

Each connector joins 2 dots.



Complete the diagram by drawing the 6 vertical connectors and the 4 down diagonal connectors that join 2 dots. [2]

(b) This is a 4 by 4 diagram.



On this 4 by 4 diagram,

(i) draw the horizontal connectors and the vertical connectors that join 2 dots, [1]

(ii) draw the up diagonal connectors and the down diagonal connectors that join 2 dots. [1]

(c) Complete the table for the numbers of connectors that join 2 dots.
Use **part (b)** and any patterns you notice.

You may use the square dotty paper on page 2 for diagrams.

Numbers of connectors that join 2 dots

Size of diagram (*n* by *n*)	Horizontal	Vertical	Up diagonal	Down diagonal	Total
1 by 1	0	0	0	0	0
2 by 2	2	2	1	1	6
3 by 3	6	6	4	4	20
4 by 4					
5 by 5	20		16		
6 by 6					110

[5]

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(d) In an n by n diagram there are n rows and n columns.

(i) Find an expression, in terms of n, for the number of up diagonal connectors that join 2 dots on an n by n diagram.

..... [2]

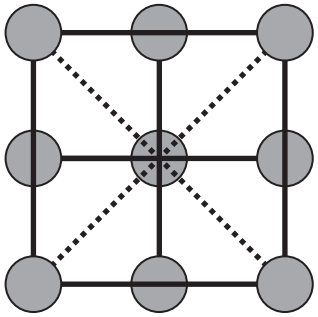
(ii) Find an expression, in terms of n, for the number of horizontal connectors that join 2 dots on an n by n diagram.

..... [3]

(e) Use your answers to **part (d)** to find the total number of connectors that join 2 dots on a 15 by 15 diagram.

..... [3]

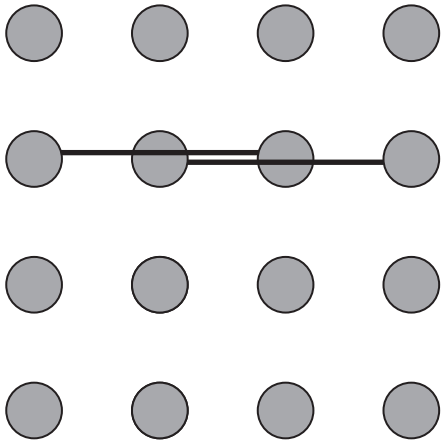
2 This is a 3 by 3 diagram.



There are 8 ways to join **3 dots**.
These are:

- 3 vertical connectors
- 3 horizontal connectors
- 1 up diagonal connector
- 1 down diagonal connector.

(a) This is a 4 by 4 diagram.



Find the number of horizontal, vertical, up diagonal and down diagonal connectors that join 3 dots.
Two horizontal connectors have been drawn for you.

Horizontal .....

Vertical .....

Up diagonal .....

Down diagonal ..... [2]

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(b) Complete the table for the numbers of connectors that join 3 dots.
Use your answers to **part (a)** and any patterns you notice.

You may use the square dotty paper on page 2 for diagrams.

Numbers of connectors that join 3 dots

Size of diagram (n by n)	Horizontal	Vertical	Up diagonal	Down diagonal	Total
2 by 2	0	0	0	0	0
3 by 3	3	3	1	1	8
4 by 4					
5 by 5	15				
6 by 6					80

[4]

(c) **(i)** This is an expression for the number of up diagonal connectors that join 3 dots on an n by n diagram.

$$(n-2)^2$$

Work out the number of up diagonal connectors that join 3 dots on a 20 by 20 diagram.

..... [1]

(ii) This is an expression for the number of horizontal connectors that join 3 dots on an n by n diagram.

$$n^2 + an$$

Find the value of a and write down the expression.

..... [3]

Question 3 is printed on the next page.

3 **(a)** Complete the table for the numbers of connectors that join 4 dots.

Numbers of connectors that join 4 dots

Size of diagram (n by n)	Horizontal	Vertical	Up diagonal	Down diagonal	Total
3 by 3	0	0	0	0	0
4 by 4					10
5 by 5	10				
6 by 6	18	18	9	9	54

[2]

(b) **(i)** Write down an expression, in terms of n, for the number of up diagonal connectors that join 4 dots on an n by n diagram.

..... [1]

(ii) Find an expression, in terms of n, for the number of horizontal connectors that join 4 dots on an n by n diagram.

..... [2]

(c) Show that the **total** number of connectors that join 4 dots on an n by n diagram is

$$4n^2 - 18n + 18.$$

[2]

(d) Find the size of the diagram which has a total of 180 connectors that join 4 dots.

..... [2]

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