

# Cambridge IGCSE<sup>™</sup>

	CANDIDATE NAME		
	CENTRE NUMBER		CANDIDATE NUMBER
* N 5 6 1 5 0	CAMBRIDGE	INTERNATIONAL MATHEMATICS	0607/52
6 H	Paper 5 Investig	gation (Core)	October/November 2021
σ ω			1 hour 10 minutes
1 8 1 4		er on the question paper.	
4	No additional m	naterials are needed	

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 [].

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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.

		Horizontal	Vertical	Up diagonal	Down diagonal	Total
of ram y n)	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

Numbers	of connectors	that join 2 dots

Size of diagram (*n* by *n*)

[5]

- (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
[2]	 Down diagonal

(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.

		Horizontal	Vertical	Up diagonal	Down diagonal	Total
	2 by 2	0	0	0	0	0
Size of	3 by 3	3	3	1	1	8
diagram	4 by 4					
( <i>n</i> by <i>n</i> )	5 by 5	15				
	6 by 6					80
	<u> </u>					[4]

Numbers of connectors that join 3 dots

(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.

(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.

				5		
		Horizontal	Vertical	Up diagonal	Down diagonal	Total
	3 by 3	0	0	0	0	0
Size of	4 by 4					10
diagram ( <i>n</i> by <i>n</i> )	5 by 5	10				
	6 by 6	18	18	9	9	54
					11	[2]

Numbers of connectors that join 4 dots

(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.

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