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CAMBRIDGE INTERNATIONAL MATHEMATICS

0607/51

Paper 5 Investigation (Core)

May/June 2023

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.



Answer **all** the questions.

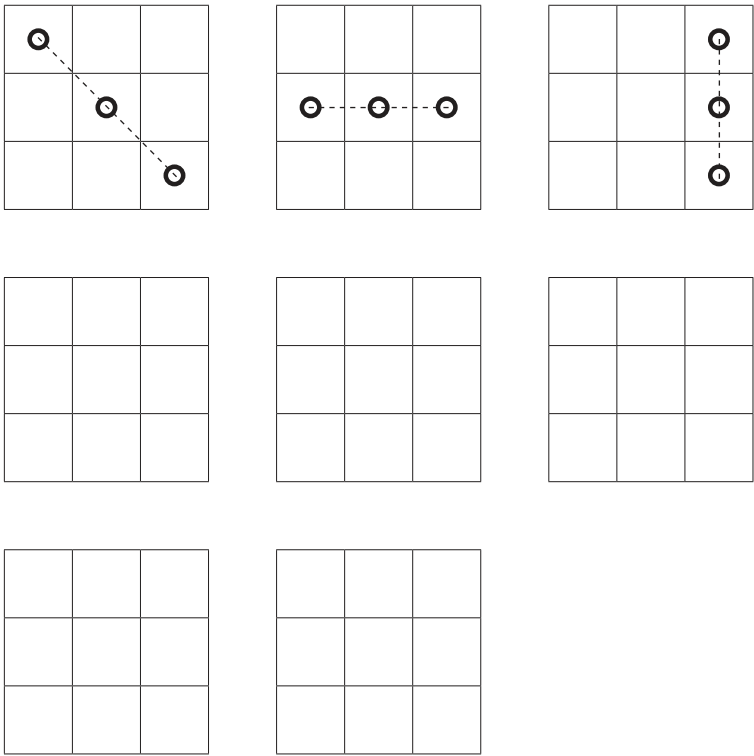
INVESTIGATION

WINNING LINES

This investigation looks at the number of winning lines on a grid.

- 1 In a game you win by making a straight line of three **○**s on a 3 by 3 grid.
There are 8 winning lines of three **○**s on a 3 by 3 grid.

Show each winning line of three **○**s on the grids.
Three of the winning lines have been shown for you.

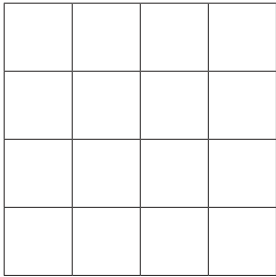
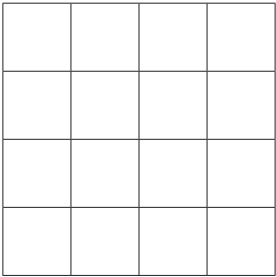
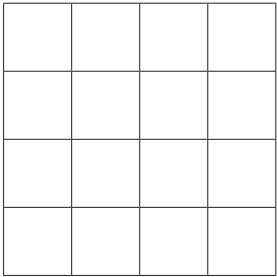


[2]

3

- 2 (a) Another grid is 4 by 4.
You now need four ●s in a line to win.

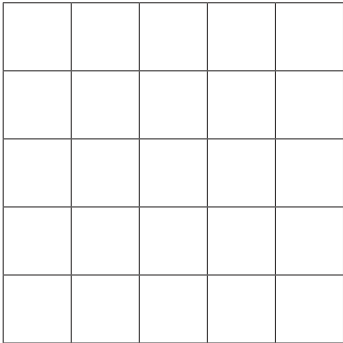
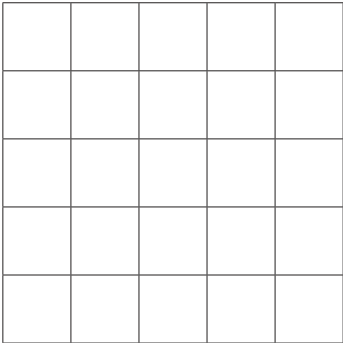
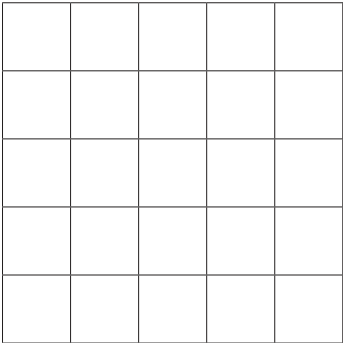
Find the number of winning lines on a 4 by 4 grid.
You may use the grids to help you.



..... [2]

- (b) Another grid is 5 by 5.
You now need five ●s in a line to win.

Find the number of winning lines on a 5 by 5 grid.
You may use the grids to help you.



..... [2]

- (c) Another grid is 6 by 6.
You now need six ●s in a line to win.

Write down the number of winning lines on a 6 by 6 grid.

..... [1]

3 (a) Complete this table using your answers to **Question 1** and **Question 2** and any patterns you notice.

Size of grid	Number of winning lines			
	Horizontal	Vertical	Diagonal	Total
3 by 3				8
4 by 4				
5 by 5				
6 by 6				
7 by 7				
20 by 20				

[3]

(b) A grid is n by n .
You need n ●s in a line to win.

Find an expression, in terms of n , for the number of winning lines.

..... [2]

(c) Jibreel draws a very large square grid.
He thinks there will be 583 winning lines of ●s on his grid.

Give a reason why he is wrong.

..... [1]

5

(d) Harriet draws a square grid with 324 squares.

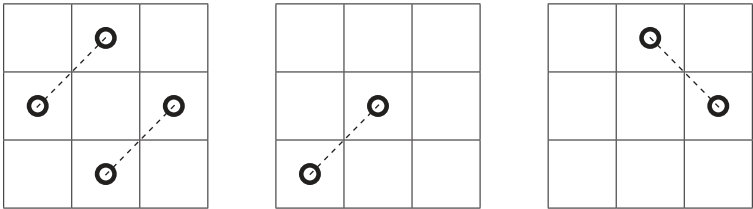
Find the number of winning lines of **O**s on this grid.

..... [3]

- 4 A grid is n by n .
In a different game a winning line is one $\bigcirc$ less than n .
To make a line, the $\bigcirc$ s must be in squares that are next to each other.

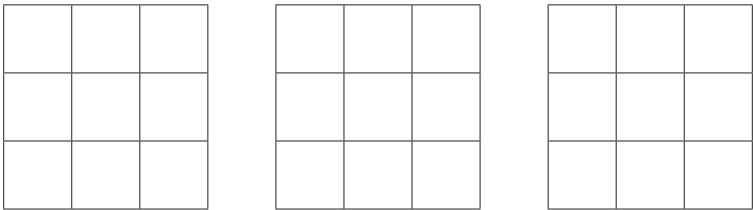
(a) In a 3 by 3 grid you need two $\bigcirc$ s in a line to win.

These diagrams show some of the diagonal winning lines.



Complete the table to find the number of winning lines with two $\bigcirc$ s.
You may use the grids below the table to help you.

Size of grid	Number of winning lines			
	Horizontal	Vertical	Diagonal	Total
3 by 3				20

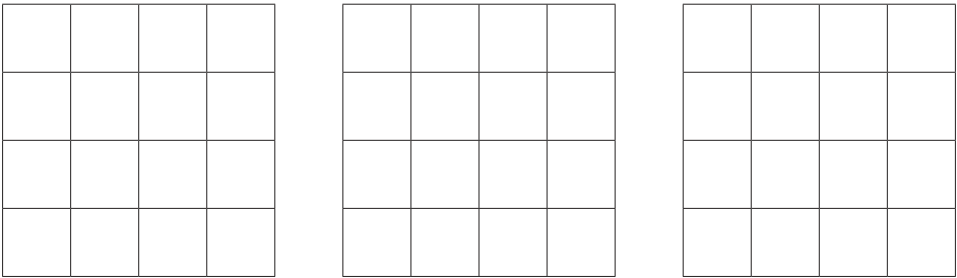


[2]

(b) In a 4 by 4 grid you need three $\bigcirc$ s in a line to win.

Complete the table to find the number of winning lines with three $\bigcirc$ s.
You may use the grids below the table to help you.

Size of grid	Number of winning lines			
	Horizontal	Vertical	Diagonal	Total
4 by 4				



[2]

- (c) Copy your results from **part (a)** and **part (b)** into this table.
Complete the table.
You may use the grids below the table to help you.

Size of grid	Number of winning lines			
	Horizontal	Vertical	Diagonal	Total
3 by 3				
4 by 4				
5 by 5				
n by n				

[4]

- (d) In an n by n grid you need $(n - 1)$ ●s in a line to win.
 n must be at least 3.

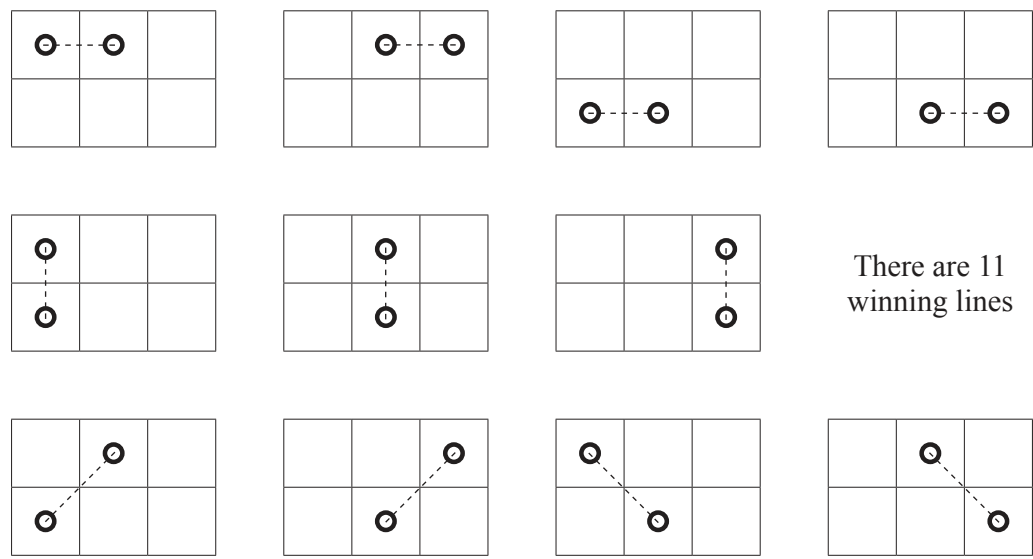
In one grid the total number of winning lines is a square number less than 50.

Find the grid size.

..... [4]

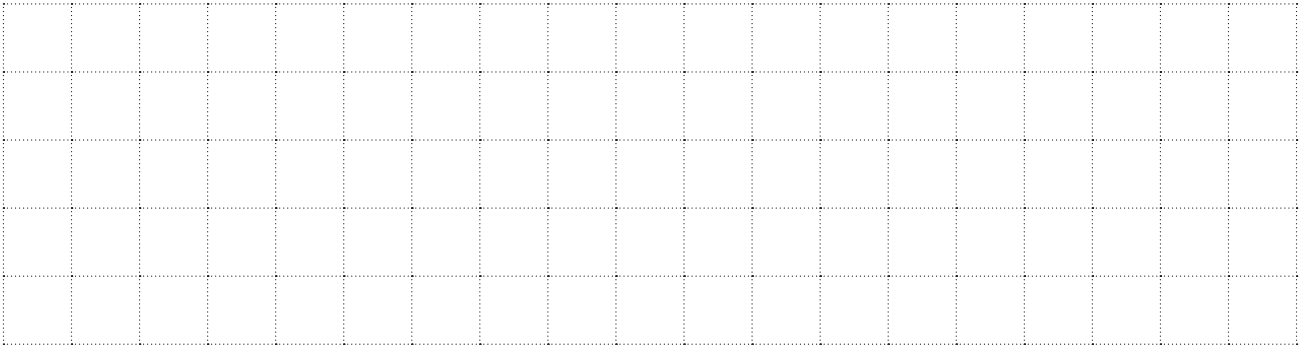
- 5 A rectangular grid has height 2 and width at least 2.
You need two **O**s in a line to win.

These diagrams show all the winning lines with two **O**s on a 2 by 3 grid.



- (a) Complete the table for the number of winning lines with two **O**s.
You may use the grid below the table to help you.

Size of grid	Number of winning lines			
	Horizontal	Vertical	Diagonal	Total
2 by 2	2	2	2	6
2 by 3	4	3	4	11
2 by 4				
2 by 5				
2 by w				



9

(b) A 2 by w grid has 111 winning lines with two **O**s.

Find the width of the grid.

..... [3]

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