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CAMBRIDGE INTERNATIONAL MATHEMATICS **0607/52**

Paper 5 Investigation (Core) **May/June 2026**

1 hour 15 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. Do **not** use correction fluid or tape.
- 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 40.
- The number of marks for each question or part question is shown in brackets [ ].

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

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Investigation Nim

This investigation looks at the minimum number of moves it takes to win the game of Nim.
Nim is a game for two players using a pile of sticks.

In this game, you and your friend take turns to remove sticks from the pile.
A player wins when they take the last stick.

1 In each move, a player takes 1 or 2 sticks from the pile.

(a) There are 3 sticks in the pile.
Your friend starts the game.

Your friend takes 1 stick from the pile, leaving 2.
You win by taking the remaining 2 sticks.

The table shows these moves.

move	number of sticks taken	number of sticks left in the pile	result
		3	
1	friend takes 1	2	
2	you take 2	0	you win

There is another way for you to win the game when your friend starts.
This time your friend takes 2 sticks from the pile.

Complete the table to show that you win the game.

move	number of sticks taken	number of sticks left in the pile	result
		3	
1	friend takes 2	.....	
2	you take	0	you win

[1]

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(b) There are 6 sticks in the pile.
Your friend starts the game.

You should win when there are 3 sticks left after your move.

Complete the tables to show two different ways that you win.

move	number of sticks taken	number of sticks left in the pile	result
		6	
1	friend takes 1	.....	
2	you take	3	
3	friend takes 1	.....	
4	you take	0	you win

move	number of sticks taken	number of sticks left in the pile	result
		6	
1	friend takes 2	.....	
2	you take	3	
3	friend takes 2	.....	
4	you take	0	you win

[2]

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(c) There are 9 sticks in the pile.
Your friend starts the game.

Complete the table to show how you win the game.

move	number of sticks taken	number of sticks left in the pile	result
		9	
1	friend takes 1	.....	
2	you take	6	
3	friend takes 2	.....	
4	you take	.....	
5	friend takes 2	.....	
6	you take	0	you win

[2]

(d) Your friend starts the game.
You should win when there are 3, 6 or 9 sticks in the pile.

(i) Complete the statement.

3, 6 and 9 are ..... of 3. [1]

(ii) 3, 6 and 9 are the first three terms of a sequence.

Write down the next **two** terms of this sequence.

..... , ... [1]

(iii) In a game there are 18 sticks in the pile.
It is your friend's move.

Give a reason why you should win.

..... [1]

(iv) In a game there are 20 sticks in the pile.
It is your move.

Write down the number of sticks you should take to make sure you win.

..... [1]

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(e) There are 18 sticks at the start of the game.
You always take the number of sticks so that you are sure to win.

Complete the table.
You may use **1(d)** to help you.

move	number of sticks taken	number of sticks left in the pile	result
		18	
1	friend takes 1	17	
2	you take	.....	
3	friend takes 2	.....	
4	you take	.....	
5	friend takes 2	.....	
6	you take	9	
7	friend takes 1	.....	
8	you take	.....	
9	friend takes 2	.....	
10	you take	.....	
11	friend takes 1	.....	
12	you take	0	you win

[3]

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2 In each move, a player takes 1 or 2 sticks from the pile.
Your friend starts the game.
Here is a table for the total number of moves for you to win the game.

number of sticks taken	total number of moves
3	2
6	4
9	6
18	12

(a) There are 24 sticks.

Find the total number of moves for you to win the game.

..... [2]

(b) The total number of moves for you to win the game is 40.

Find the number of sticks in the pile at the start of the game.

..... [2]

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3 In each move, a player now takes 1, 2 or 3 sticks from the pile.
Your friend starts the game.

(a) There are 4 sticks in the pile at the start of the game.

Give a reason why you will always win.

.....

..... [1]

(b) There are 8 sticks in the pile at the start of the game.

Find the total number of moves for you to win the game.

You may use the table to help you.
You may not need all the rows.

move	number of sticks taken	number of sticks left in the pile
1	friend takes	
2	you take	
	friend takes	
	you take	
	friend takes	
	you take	

..... [3]

(c) When there are 12 sticks at the start of the game you win the game.

There are **more** than 12 sticks at the start of the game.
You win the game.

Write down **two** different numbers of sticks there could be in the pile at the start of the game.

..... , ... [1]

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4 In different games of Nim, a player can take different numbers of sticks from the pile.
Your friend always starts the game.

(a) Complete the table.

number of sticks that can be taken in each move	sequence of number of sticks in the pile at the start	*n*th term of the sequence
1 or 2	3 6 9	
1, 2 or 3	4 8 12	
1, 2, 3 or 4	5	
1, 2, 3, 4, or 5	....	
1, 2, 3, ... or k		

[5]

(b) You win a game of Nim after your friend goes first.
The number of sticks in the pile at the start is 30.
In each game, the greatest number of sticks you can take in each move is k.

Find the 7 different possible values for k.
Use your answers to **4(a)** to help you.

..... [4]

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5 Now **you** always start the game.
In each move, a player takes 1 or 2 sticks from the pile.
You always take the number of sticks so that you are sure to win.

(a) There are 5 sticks in the pile at the start.

Complete the table.

move	number of sticks taken	number of sticks left in the pile	result
		5	
1	you take	.....	
2	friend takes 2	.....	
3	you take	0	you win

[1]

(b) There are 4 sticks in the pile at the start.

Write down the number of sticks you should take on your first move.

..... [1]

(c) There are 19 sticks in the pile at the start.

Give a reason why you should take 1 stick in your first move.

..... [1]

(d) After your first move there are 12 sticks in the pile.

Write down the possible numbers of sticks that were in the pile at the start.

..... [1]

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6 You always start the game.
In each move, a player now takes 1, 2 or 3 sticks from the pile.
You always take the number of sticks so that you are sure to win.

In your first move you take 1 stick so that you are sure to win.

(a) Complete the missing values in the sequence of the possible number of sticks in the pile at the start.

1 .... 29 [2]

(b) Find the *n*th term for the sequence in **6(a)**.

..... [2]

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7 You always start the game.
In each move, a player now takes 1, 2, 3 or 4 sticks from the pile.
You always take the number of sticks so that you are sure to win.

In your first move you take 3 sticks so that you are sure to win.

Find the nth term for the sequence of the possible number of sticks in the pile at the start.
Use your answers to **4(a)** and **6** to help you.

..... [2]

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