



CANDIDATE
NAME

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0607/63

Paper 6 Investigation and Modelling (Extended)

October/November 2022

1 hour 40 minutes

You must answer on the question paper.

No additional materials are needed.

- Answer both part **A** (Questions 1 to 4) and part **B** (Questions 5 to 7).
- 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 60.
- The number of marks for each question or part question is shown in brackets [].

This document has **16** pages. Any blank pages are indicated.

Answer **both** parts **A** and **B**.

A INVESTIGATION (QUESTIONS 1 TO 4)

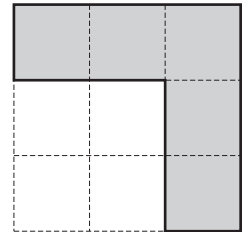
REMAINING SHAPES (30 marks)

You are advised to spend no more than 50 minutes on this part.

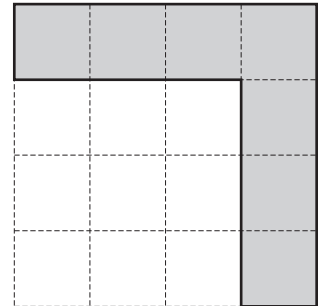
This investigation looks at the area of the remaining shape when part of a larger shape is removed.
The *side difference* is the difference between the lengths of the sides of the two shapes.
In this investigation all lengths are in centimetres.

- 1 A square is removed from a larger square.
The side difference is 1.

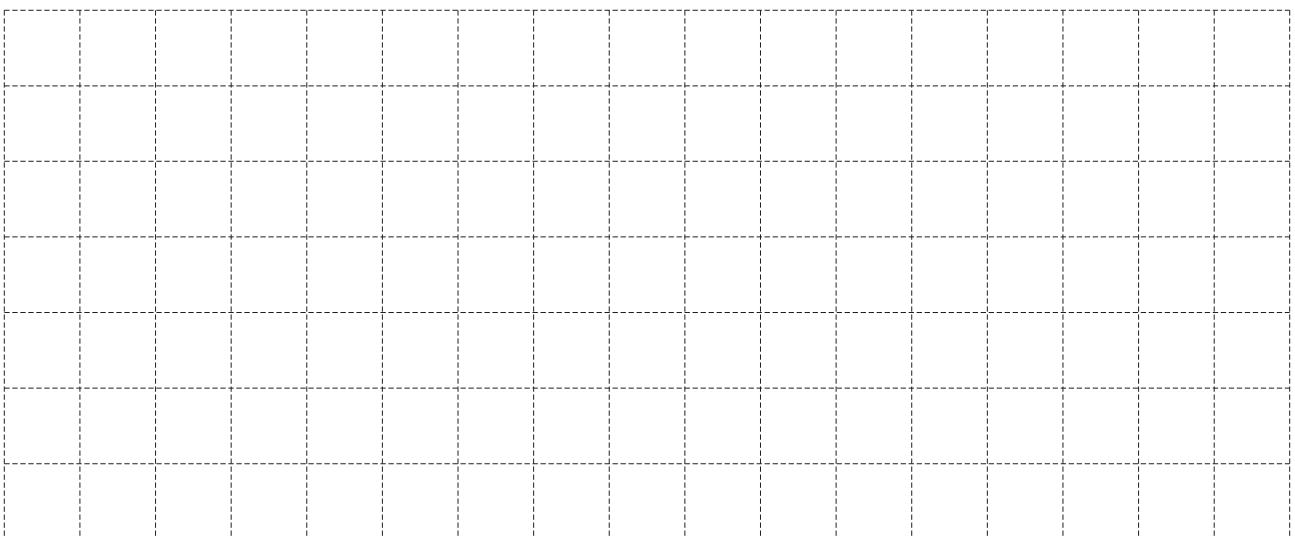
A square of side 2 is removed from a larger square of side 3.
The area of the remaining shape is 5.



A square of side 3 is removed from a larger square of side 4.
This is the remaining shape.



- (a) On this grid, draw the remaining shape for a larger square of side 5.



[1]

(b) Complete the table.

Side of larger square	Area of remaining shape
2	
3	5
4	
5	
6	

[3]

(c) Find an expression, in terms of n , for the area of the remaining shape when the larger square has side n .

..... [2]

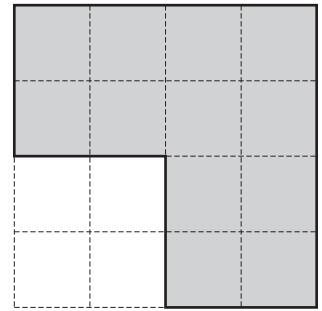
(d) The area of a remaining shape is 381.

Work out the length of the side of the larger square.

..... [2]

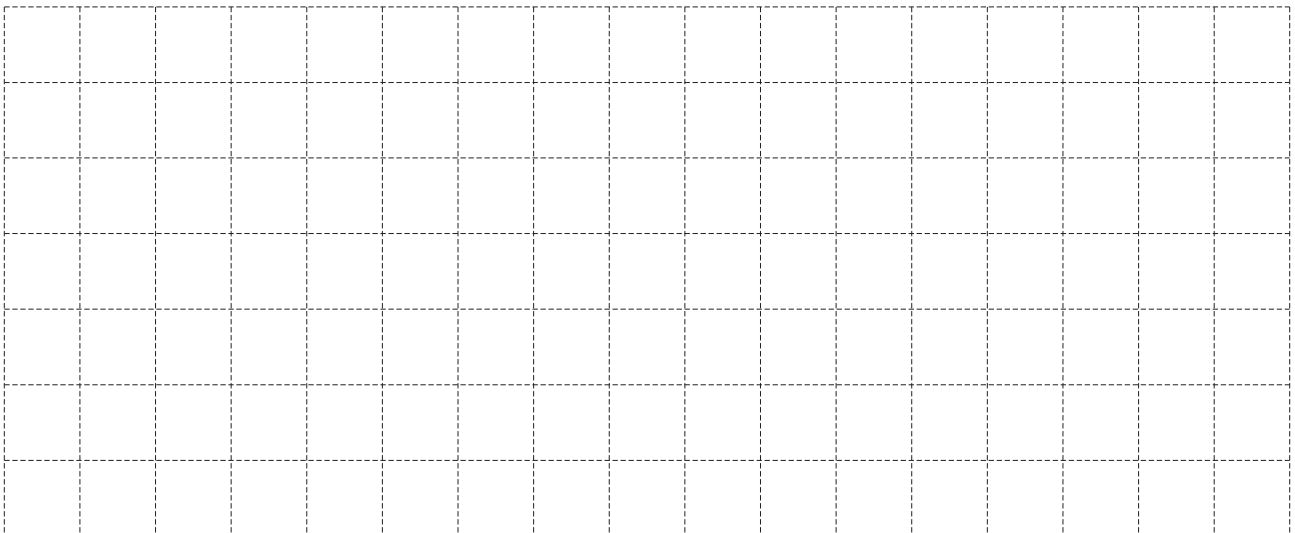
- 2 The side length of the square removed is now 2 less than the side length of the larger square.
The side difference is 2.

A square of side 2 is removed from a larger square of side 4.
The area of the remaining shape is 12.



- (a) Complete the table.
You may use the grid below to help you.

Side of larger square	Area of remaining shape
3	
4	12
5	
6	



[3]

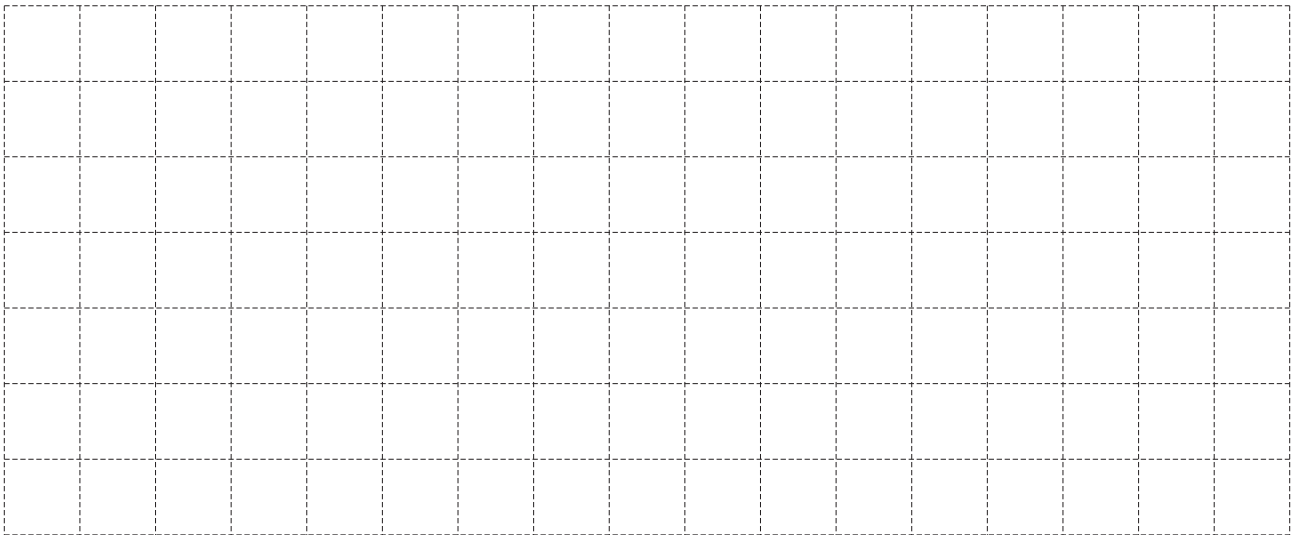
- (b) Complete the expression for the area of the remaining shape when the larger square has side n and the side difference is 2.

$4n$ [1]

- 3 (a) Complete the table using expressions in the form $an + b$, where a and b are integers.

Use your expressions from **Question 1(c)** and **Question 2(b)**.
You may use the grid below to help you.

Side difference (d)	Area of remaining shape for larger square of side n
1	
2	
3	
4	



[4]

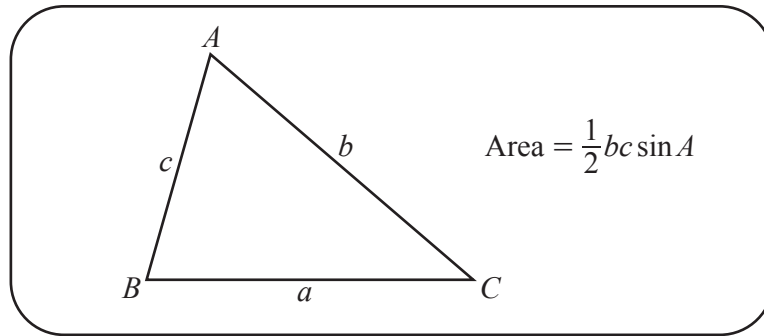
- (b) Find an expression, in terms of n and d , for the area of the remaining shape when the side difference is d .

..... [2]

- (c) The area of a remaining shape is 343.
The side difference is 7.

Find the length of the side of the larger square.

..... [2]



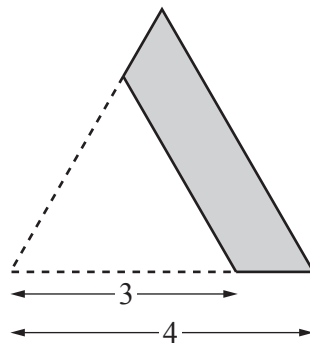
This question looks at the area of a remaining shape for an equilateral triangle.

- (a) Show that the area of an equilateral triangle with side of length n is $\frac{n^2\sqrt{3}}{4}$.

[1]

- (b) An equilateral triangle is removed from a larger equilateral triangle. The side difference is 1.

An equilateral triangle with a side of length 3 is removed from a larger equilateral triangle with a side of length 4.



Show that the area of the remaining shape is $\frac{7\sqrt{3}}{4}$.

[1]

- (c) Find the area of the remaining shape for a larger equilateral triangle with a side of length 5 and a side difference of 1.

Give your answer in the form $\frac{k\sqrt{3}}{4}$.

..... [2]

(d) Complete the table.

Side of larger triangle	Area of remaining shape
2	
3	
4	$\frac{7\sqrt{3}}{4}$
5	

[3]

(e) Find an expression, in terms of n and d , for the area of the remaining shape for a larger equilateral triangle with side of length n when the side difference is d .

Give an exact answer in its simplest form.

..... [3]

B MODELLING (QUESTIONS 5 TO 7)**ESCALATORS (30 marks)**

You are advised to spend no more than 50 minutes on this part.

This task looks at going up and down on escalators.

- 5 (a)** Every step of an escalator travels at a speed of 1.8 km/h.

Show that the distance a step moves in 1 second is 0.5 m.



[2]

- (b)** The length of the escalator is 40 m.

Find the time, in seconds, for a step to travel the length of the escalator.

..... [2]

- 6 Matt travels up a different escalator.
The length of this escalator is 24 metres.

- (a) (i) The escalator is not moving.
It takes Matt 50 seconds to walk up the length of the escalator.

Find his speed.

..... [2]

- (ii) The escalator is now moving.
When Matt stands on the escalator it takes him 30 seconds to move up the length of the escalator.

Matt now walks up the **moving** escalator at the same speed as in **part (a)(i)**.

Show that his speed walking up the moving escalator is 1.28 m/s .

[2]

- (iii) Find how long it will take him to walk up the length of the moving escalator.

..... [2]

- (b) (i) Matt walks down the escalator when it is not moving.
It takes him 24 seconds to walk down the length of the escalator.

The escalator starts moving **upwards** at the same speed as in **part (a)**.
Matt now walks down the **moving** escalator.

Show that his speed walking down the moving escalator is 0.2 m/s.

[2]

- (ii) Find how long it will take Matt to walk down the length of the escalator when it is moving **upwards** at the same speed as before.

..... [2]

- 7 Another escalator has a length of 6.2 m.
The escalator travels upwards at a speed of v metres per second.

- (a) With the escalator travelling upwards, Matt walks **up** the escalator and then immediately turns around and walks **down** the escalator.

His walking speed is 0.8 m/s.

The total time for Matt to walk up and down the moving escalator is T seconds.

- (i) Give reasons why the model for T is $T = \frac{6.2}{0.8+v} + \frac{6.2}{0.8-v}$.

.....

.....

..... [3]

- (ii) Show that the model simplifies to $T = \frac{9.92}{0.64-v^2}$.

[3]

- (iii) When the speed of the escalator is 0.4 m/s, find how long it takes Matt to walk up and down the escalator.

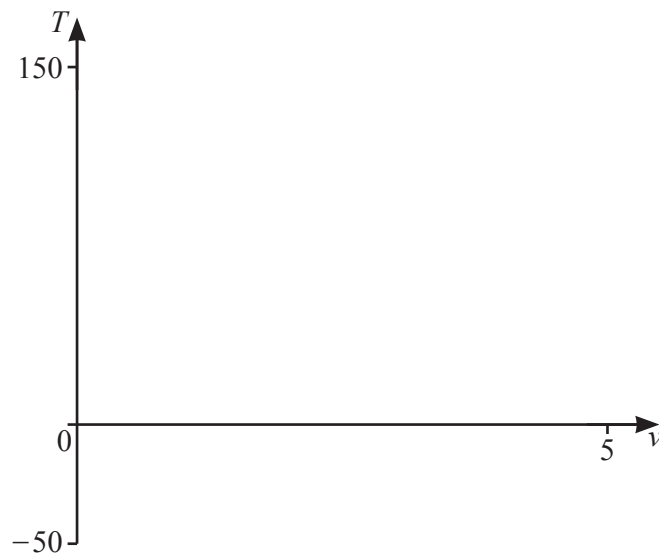
..... [1]

- (b) Matt continues to walk at 0.8 m/s.
He walks up the moving escalator, waits for 10 seconds, then walks down the escalator.

- (i) Change the model in **part (a)(ii)** to find a new model for T .
You do not need to simplify your model.

..... [1]

- (ii) Sketch the graph of T for $0 \leq v \leq 5$.



[4]

- (iii) The total time for Matt to walk up, wait, and walk down the moving escalator is 138 seconds.
Find the speed of the escalator.

..... [2]

- (iv) Give a reason why the model is not valid when $v = 5$.

..... [1]

- (v) For what range of values of v is the model valid?

..... [1]

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