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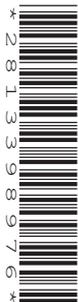
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CAMBRIDGE INTERNATIONAL MATHEMATICS

0607/61

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.

INSTRUCTIONS

- Answer both part **A** (Questions 1 to 5) and part **B** (Questions 6 to 9).
- 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 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**.

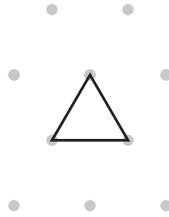
A INVESTIGATION (QUESTIONS 1 TO 5)

ISOSCELES TRAPEZIUMS (30 marks)

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

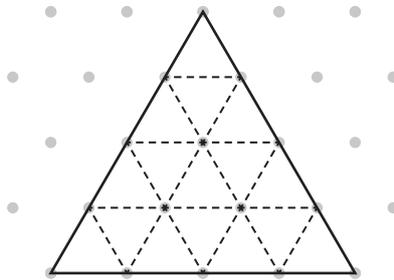
This investigation looks at equilateral triangles in isosceles trapeziums drawn on 1 cm isometric grids. There is a spare isometric grid on page 9.

A *unit triangle* is an equilateral triangle of side length 1.

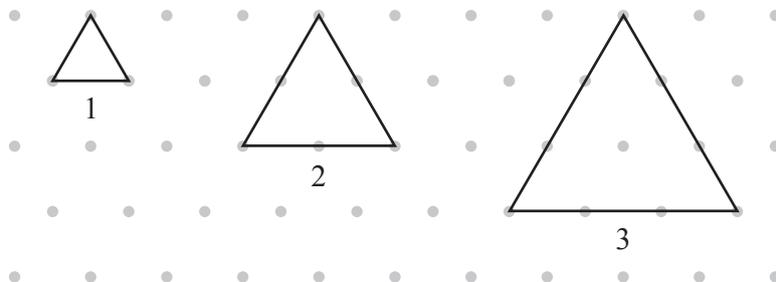


In this task, all shapes can be divided into unit triangles.

- 1 There are 16 unit triangles in the equilateral triangle with side length 4.



These are the first three equilateral triangles in a sequence.



(a) Complete the table.

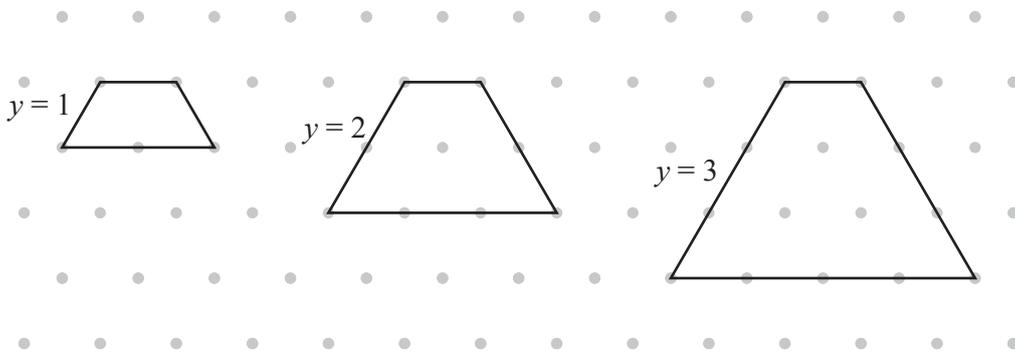
Side length (x)	1	2	3	4	5
Number of unit triangles	1			16	

[2]

(b) Write down an expression, in terms of x , for the number of unit triangles.

..... [1]

2 These are the first three isosceles trapeziums in a sequence.
The length of each sloping side is y .



(a) Complete the table.

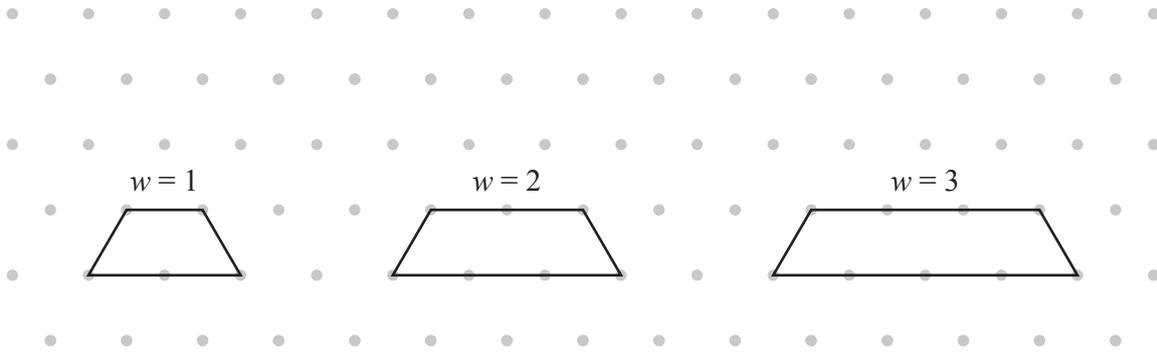
Length of sloping side (y)	1	2	3	4
Number of unit triangles	3			24

[1]

(b) Find an expression, in terms of y , for the number of unit triangles.
Give your answer in its simplest form.

..... [3]

- 3 These are the first three trapeziums in another sequence.
 The length of each sloping side is 1.
 The length of the shorter parallel side is w .



- (a) Complete the table.

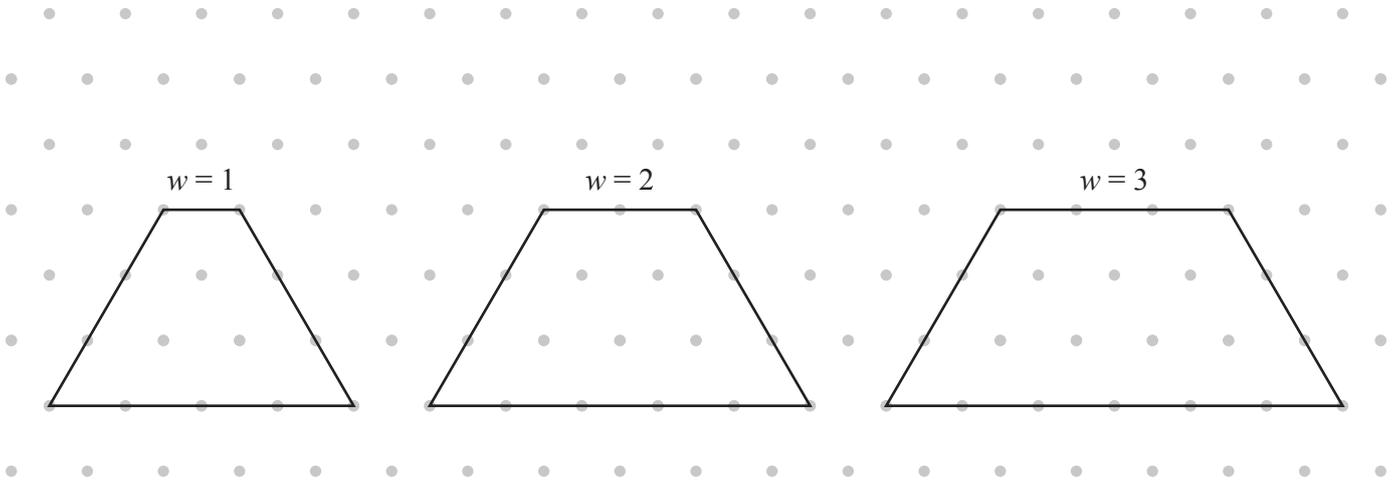
Length of shorter parallel side (w)	Number of unit triangles
1	$2^2 - \quad = 3$
2	$\quad - 2^2 =$
3	$\quad - \quad = 7$
4	$\quad - \quad =$

[2]

- (b) Find an expression, in terms of w , for the number of unit triangles.
 Give your answer in its simplest form.

..... [2]

- 4 These are the first three trapeziums in another sequence.
 The length of each sloping side is 3.
 The length of the shorter parallel side is w .



- (a) Complete the table.

Length of shorter parallel side (w)	Number of unit triangles
1	$4^2 - \quad = 15$
2	$\quad - 2^2 =$
3	$\quad - \quad = 27$
4	$\quad - \quad =$

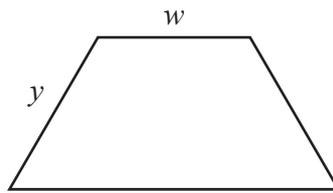
[2]

- (b) Find an expression, in terms of w , for the number of unit triangles.
 Give your answer in its simplest form.

..... [2]

- (c) Find the value of w when there are 93 unit triangles.

..... [2]



In each trapezium:

- the length of the shorter parallel side is w
- the length of each sloping side is y .

(a) Show that an expression for the number of unit triangles is $y(y + 2w)$.

[3]

(b) In a trapezium the length of the shorter parallel side is equal to the length of the sloping side.

Is it possible for the number of unit triangles to be 300?

[4]

- (c) Find the lengths of the sides for all the trapeziums with exactly 160 unit triangles.

[6]

SPARE GRID



B MODELLING (QUESTIONS 6 TO 9)**PIZZA BUSINESS (30 marks)**

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

This task is about the costs in a pizza business.

Pablo is starting a pizza business.

He collects information from pizza businesses to set up mathematical models.

He assumes that he sells all the pizzas he makes.

6 Model 1

Pablo sets the following conditions:

- He sells one type of pizza with a selling price of \$10.
- He sells n pizzas per week.
- It costs him \$2 to make one pizza.
- His running costs are \$400 per week.
- He employs 2 people each costing \$300 per week.

This is how he works out his profit.

$$\text{profit} = \text{income from selling pizzas} - \text{his costs}$$

(a) Show that a model for the weekly profit, $\$P$, in terms of n , is

$$P = 8n - 1000.$$

[1]

(b) Pablo wants a profit of at least \$500 per week.

Use the model to find the minimum number of pizzas he must sell per week.

..... [3]

- (c) Pablo expects sales to vary.
He sets the following conditions.

The pizza business:

- opens 4 days per week
- opens 6 hours per day
- makes 16 pizzas per hour for half of the time
- makes 8 pizzas per hour for the rest of the time.

Can Pablo make a weekly profit of \$500?

Use the conditions above and your answer to **part (b)** to show how you decide.

[3]

7 Pablo makes changes to the conditions.

These are the conditions now:

- He sells one type of pizza with a selling price of $\$x$.
- He sells n pizzas per week.
- It costs him $\$2$ to make one pizza.
- His running costs of $\$400$ increase by 50% .
- He employs 3 people each costing $\$300$ per week.

(a) Use these conditions to show that the model for the weekly profit, $\$P$, is

$$P = (x - 2)n - 1500.$$

[3]

(b) The pizza business is now open for 6 hours per day and 6 days per week. It continues to make 16 pizzas per hour for half of the time and 8 pizzas per hour for the rest of the time.

Work out the number of pizzas the business can make per week.

..... [2]

- (c) Pablo wants a weekly profit of at least \$500.

Use the model in **part (a)** and your answer to **part (b)** to work out the minimum selling price of a pizza.

..... [3]

8 Model 2

Pablo makes a model for the relationship between the price of a pizza and the number of pizzas he sells.

He uses the following information:

- He sells 480 pizzas per week when the selling price is \$5 per pizza.
- He sells 60 pizzas per week when the selling price is \$20 per pizza.

Pablo assumes this relationship between the selling price of a pizza, \$ x , and the number of pizzas he sells per week, n .

$$n = ax + b$$

Write down and solve a pair of simultaneous equations to show that $a = -28$ and $b = 620$.

[4]

9 Model 3

Pablo wants a model for the weekly profit, \$ P , in terms of the selling price, \$ x , of the pizzas.

(a) Use **Question 7(a)** and **Question 8** to show that a model for the weekly profit, in terms of x , is

$$P = -28x^2 + 676x - 2740.$$

[3]

(b) Sketch the graph of the model on the axes.



[3]

(c) Find the maximum weekly profit and the selling price that gives this.

Maximum weekly profit

Selling price [2]

(d) Write an inequality for the values of x that give a weekly profit, $\$P$, of at least $\$500$.

..... [3]

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