Cambridge Assessment International Education

# Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

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**CAMBRIDGE INTERNATIONAL MATHEMATICS** **0607/61**

Paper 6 Investigation and Modelling (Extended) **October/November 2025**

**1 hour 30 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 50.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages.




**[Turn over**

## Section A

## INVESTIGATION SQUARE RINGS

You are advised to spend no more than 45 minutes on this section.

In this investigation, you will work with the numbers along the inside edges of two squares drawn on a number grid of width 10.

The diagram shows part of this number grid.
On the grid, a 4 by 4 square surrounds a 2 by 2 square.
The shaded area forms a 4 by 4 *square ring*.
A square ring is always one square thick.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
| 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 |
| 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |

The *ring value* is worked out in this way.

Step 1 Add the numbers along the inside edges of the large square to get $L$.
Step 2 Add the numbers along the inside edges of the small square to get $S$.
Step 3 Calculate $L - S$. This is the ring value.

Example

Step 1 $L = 3 + 4 + 5 + 6 + 16 + 26 + 36 + 35 + 34 + 33 + 23 + 13$
Step 2 $S = 14 + 15 + 25 + 24$
Step 3 Ring value $= L - S$

**1** 4 by 4 square rings

The example shows square ring 3.
This is because 3 is the top left number in the ring.

**(a)** Work out the ring value for the square ring in the example.

..... [2]

**(b)** Complete this table using **part (a)** and any patterns you notice.

| Square ring ($n$) | $L$ | $S$ | Ring value $L - S$ |
|---|---|---|---|
| 1 | | | |
| 2 | 222 | 74 | 148 |
| 3 | | | |
| 4 | 246 | 82 | 164 |
| 5 | | 86 | |

[2]

**(c)** Find an expression, in terms of $n$, for the ring value.

..... [3]

**(d)** Find the ring value for square ring 731.

..... [2]

**2** 6 by 6 square rings

On the grid, a 6 by 6 square surrounds a 4 by 4 square.
The square ring has width 6.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
| 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 |
| 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
| 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |

**(a)** Complete the working to find the ring value for square ring 1.

$L = 1+2+3+4+5+6+16+26+36+46+56+55+54+53+52+51+41+31+21+11$

$= 570$

$S = 12+13+14+15+25+35+45+44+43+42+32+22$

$= .....$

Ring value $= .....$

[1]

**(b)** Complete the table.

| Square ring ($n$) | $L$ | $S$ | Ring value $L - S$ |
|---|---|---|---|
| 1 | 570 | | |
| 2 | 590 | | 236 |
| 3 | 610 | 366 | |
| 4 | 630 | 378 | |
| 5 | 650 | 390 | 260 |

[2]

**(c)** Find an expression, in terms of $n$, for the ring value.

..... [2]

**(d)** A square ring has a ring value of 1028.

Find the number in the bottom right square of this square ring.

..... [3]

**3** *w* by *w* square rings

The width of a square ring is $w$.
For the square ring in **Question 1**, $w = 4$.
For the square ring in **Question 2**, $w = 6$.

For a $w$ by $w$ square ring, an expression for the ring value is $8n + kw - k$.
For an 8 by 8 square ring, an expression for the ring value is $8n + 308$.

Find the value of $k$.
Write down an expression, in terms of $n$ and $w$, for the ring value of a $w$ by $w$ square ring.

$k =$ .....

expression for the ring value .....

[3]


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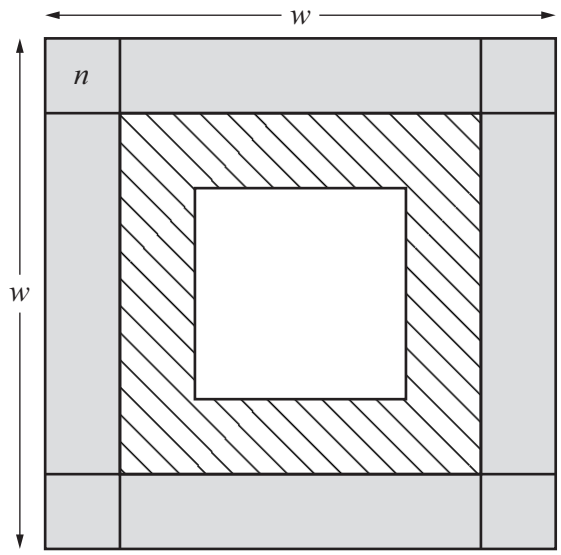
**4** The diagram shows two square rings, shaded ▭ and ▨ .

The larger square ring has width $w$.
The number in the top left square is $n$.




Use algebra to find what is always true about the difference between the two ring values.

..... [5]

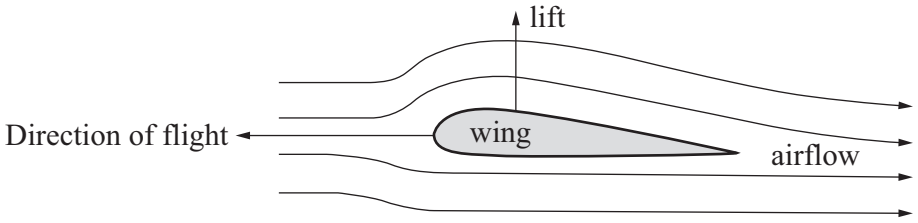
## Section B

## MODELLING LIFT

You are advised to spend no more than 45 minutes on this section.

In this task, you will model the upward force, *lift*, that an aircraft wing makes when it flies through the air.

Different wing shapes make different amounts of lift.
This task is about one wing shape and the lift that it makes.

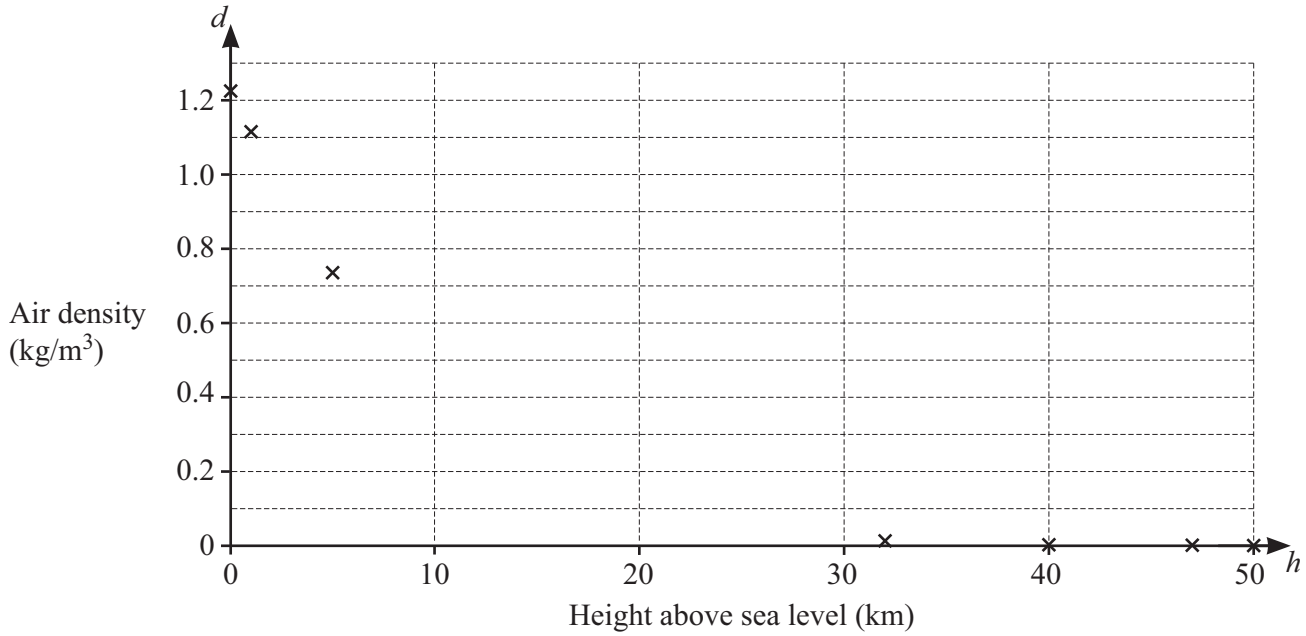



**5** We need to know the *air density* (the mass of 1 cubic metre of air) to calculate the lift.

This table shows the air density at different heights above sea level.

| Height above sea level ($h$ km) | 0 | 1 | 5 | 10 | 20 | 32 | 40 | 47 | 50 |
|---|---|---|---|---|---|---|---|---|---|
| Air density ($d$ kg/m$^3$) | 1.2250 | 1.1160 | 0.7361 | 0.4127 | 0.0880 | 0.0132 | 0.0039 | 0.0014 | 0.0010 |

The values in the shaded cells are plotted on the grid.



**(a)** Plot the remaining two points on the grid. [1]

**(b) Model A**

A possible model for air density is $d = \frac{195}{39h + 160}$ for $0 \leqslant h \leqslant 50$.

**(i)** Sketch this model on the grid.
Label the sketch A. [2]

**(ii)** Estimate the range of values for $h$ when the model will give

**(a)** a value below the actual air density

..... [1]

**(b)** a value above the actual air density.

..... [1]

**(c) Model B**

Another possible model is $d = \frac{1}{\log(2h + 3)} - 0.5$ for $0 \leqslant h \leqslant 50$.

**(i)** Sketch this model on the grid.
Label the sketch B. [2]

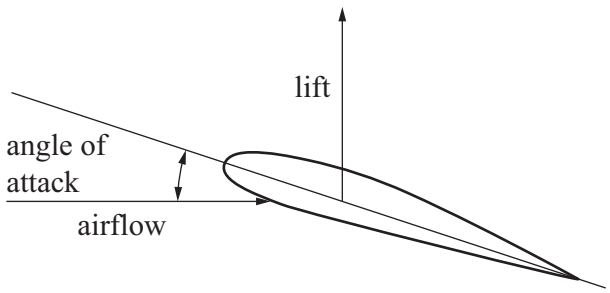
**(ii)** **(a)** Estimate the range of values for $h$ when the model is valid.

..... [1]

**(b)** Comment on the model when $h = 50$.

..... [1]

**6** To make lift, an aircraft wing is angled to the airflow.
This is called the *angle of attack*.




As the speed of the aircraft decreases, the angle of attack, $a°$, increases to get more lift.
The amount of lift depends on a quantity known as the *lift coefficient*, $C$.

This table shows how $C$ changes for different values of the angle of attack.

| Angle of attack ($a°$) | $-5$ | 0 | 5 | 10 | 15 | 20 | 25 |
|---|---|---|---|---|---|---|---|
| Lift coefficient ($C$) | 0.00 | 0.55 | 1.05 | 1.46 | 1.70 | 1.66 | 1.44 |

A possible model for $C$ is $C = m + n(a-17)^2$ where $m$ and $n$ are constants.

**(a)** Use $a = 0$ and $a = 20$ to find two equations each in terms of $m$ and $n$.
Give each equation in its simplest form.

.....

.....

[3]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**(b)** Find the value of $m$ and the value of $n$, and write the model for $C$.
Give each value correct to 2 significant figures.

$m =$ .....

$n =$ .....

$C =$ .....
[4]

**(c)** Use your model to find the maximum lift coefficient for this wing.

..... [2]

**Question 7 is printed on the next page.**

**7** A model for the lift, $L$ newtons, that an aircraft makes is $L = \frac{dv^2AC}{2}$.

$d$ = air density (kg/m$^3$)
$v$ = speed (m/s)
$A$ = wing area (m$^2$)
$C$ = lift coefficient

An aircraft has a wing area of 125 m$^2$.
It flies

- at a height of 12 km above sea level
- at a speed of 210 m/s
- with angle of attack 3°.

Use **Question 6(b)** and Model A in **Question 5(b)** to calculate the lift for this aircraft.
Give your answer correct to 2 significant figures.

..... [7]