



CANDIDATE
NAME

CENTRE
NUMBER

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CANDIDATE
NUMBER

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0607/62

February/March 2024

1 hour 40 minutes

No additional materials are needed.

- Answer both part **A** (Questions 1 to 7) and part **B** (Questions 8 to 10).
- 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 7)

MAGIC SQUARES (30 marks)

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

This investigation looks at ways to make a magic square.

A magic square is a grid with a different number in each square.

The numbers in each row, each column or each diagonal all add up to the same total.

This is the *line total*.

Example

This is a 3 by 3 magic square using the integers 1 to 9.

The line total is 15.

1	8	1	6
Row 2	3	5	7
3	4	9	2
	1	2	3
	Column		

Left diagonal Right diagonal

Line totals

Row 1 $8 + 1 + 6 = 15$

Column 1 $8 + 3 + 4 = 15$

Left diagonal $4 + 5 + 6 = 15$

Row 2 $3 + 5 + 7 = 15$

Column 2 $1 + 5 + 9 = 15$

Right diagonal $8 + 5 + 2 = 15$

Row 3 $4 + 9 + 2 = 15$

Column 3 $6 + 7 + 2 = 15$

- 1 A 3 by 3 magic square uses the integers 1 to 9.

Complete the following statements to show that the line total is 15.

The total of the integers 1 to 9 =

The total of the integers in all three rows =

The line total = $\div$ = 15 [2]

- 2 (a) This is a different 3 by 3 magic square using the integers 1 to 9.

Complete this magic square.

		4
	5	
	1	

[2]

- (b) There are 8 different 3 by 3 magic squares using the integers 1 to 9.
In all these magic squares the integer in the middle square is the same.

- (i) What is the connection between the integer in the middle square and the integers 1 to 9?

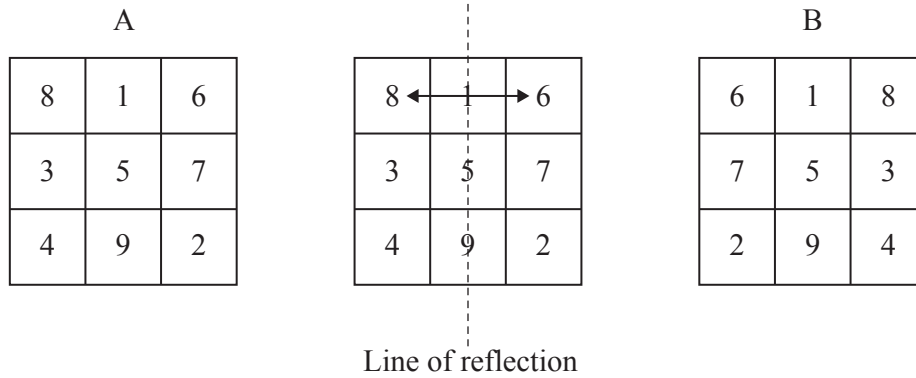
.....
..... [1]

- (ii) Explain how to use the integer in the middle square to find the line total.

..... [1]

- 3 A and B are two magic squares using the integers 1 to 9.
More magic squares can be made using reflection.

B is made by reflecting the position of each integer using a vertical line of reflection.
The line of reflection goes through the middle column of A.
The numbers move from the square in A to the reflected square in B.



- (a) Draw a horizontal line of reflection through the middle row of magic square A.

Complete the new magic square C using the horizontal line of reflection.

C

3	5	7

[1]

- (b) Two different magic squares can be made by reflection in the left and right diagonal lines drawn on A.

Complete these magic squares.

Reflection in left diagonal

		6
	5	
4		

Reflection in right diagonal

	5	

[2]

- 4 This is a method to make an n by n magic square where n is odd.

Step 1 Place the smallest integer in the middle square of the top row.

Step 2 Move **up and right** in the direction of the left diagonal to place the next integer.

- (i) If you go off the magic square, place the next integer at the opposite end of the row or column you are on.
- (ii) If the square that is up and right has an integer in it, go down one square to place the next integer.
- (iii) If you are in the top right corner, go down one square to place the next integer.

Step 3 Repeat step 2 until the magic square is complete.

Example using integers 1 to 9

- Put **1** in the middle square of the top row.

	1	
		2

- Move up and right.
This is off the square, so go to the opposite end of this column and place **2**.

- Move up and right from 2.
This is off the square, so go to the opposite end of this row and place **3**.

	1	
3		
4		2

- Move up and right from 3.
This square has 1 in it, so go down one square from 3 and place **4**.

- Move up and right and place **5** and **6**.

	1	6
3	5	7
4		2

- 6 is in the top right corner so go down one square and place **7**.

- Move up and right from 7.
This is off the square, so go to the opposite end of this row and place **8**.

8	1	6
3	5	7
4	9	2

- Move up and right from 8.
This is off the square, so go to the opposite end of this column and place **9**.

- (a) Use the method to make a 3 by 3 magic square with the integers 15 to 23.
Step 1 has been done for you.

	15	

[2]

- (b) (i) Use the method to complete the 5 by 5 magic square with the integers 1 to 25.
The first six numbers have been placed for you.

		1		
	5			
4	6			
				3
			2	

[2]

- (ii) Find the line total for this magic square.

..... [1]

- (iii) What is the connection between the line total and the integer in the middle square?

..... [1]

- (c) A 7 by 7 magic square uses the integers 1 to 49.

Find the integer in the middle square and the line total.

Integer in the middle square =

Line total = [2]

- 5 This is an expression for the line total in an n by n magic square using the integers 1 to n^2 .

$$\frac{n(n^2 + 1)}{2}$$

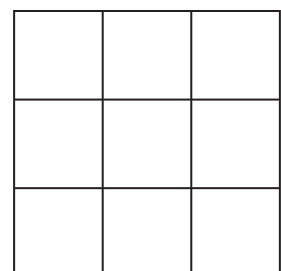
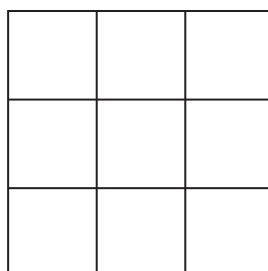
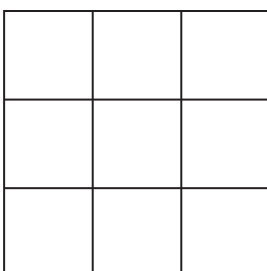
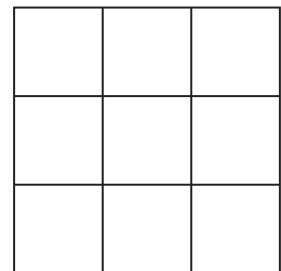
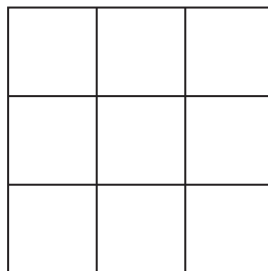
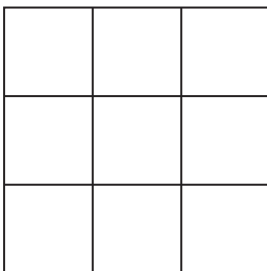
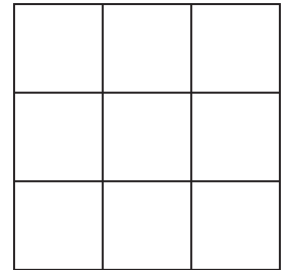
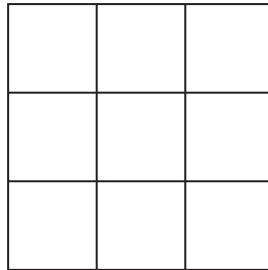
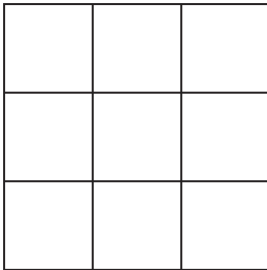
Find the line total for a magic square using the integers 1 to 81.

..... [2]

- 6 Different 3 by 3 magic squares are made using the first nine terms of a sequence.
The first term of the sequence is 2.
The n th term of the sequence is $3n - 1$.

Find six of these magic squares.

Use the method of **Question 4** and reflection to help you.



[5]

7 When n is even there is no middle square so we use a different method to make a magic square.

- Draw the two diagonals on the 4 by 4 square.
- Put the smallest integer in the top left square.
- Go from **left to right**, but only write the integers in the squares where there is part of a diagonal.

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

- Starting with the bottom row write the remaining integers, in order, from **right to left** in the empty squares.

1	15	14	4
12	6	7	9
8	10	11	5
13	3	2	16

- (a) Use this method to complete the 4 by 4 magic square with the consecutive integers k to $k+15$.
There is an extra grid for working.

[2]

- (b) (i) Find the line total in terms of k .
Give your answer in its simplest form.

..... [2]

- (ii) The line total is 254.

Find the value of the largest integer in the third row.

..... [2]

B MODELLING (QUESTIONS 8 to 10)**DELIVERIES BY SCOOTER (30 marks)**

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

This task looks at average speeds of deliveries made by scooter.

A company delivers orders from its warehouses to shops and houses.
All deliveries of small parcels are made by scooter.



- 8 (a)** Meera rides a scooter that travels 12 km in 15 minutes on quiet roads.

Show that her average speed on quiet roads is 48 km/h.

[2]

- (b)** When the roads are busy the time for the 12 km journey is 30 minutes.

Calculate her average speed on busy roads.

..... [2]

- (c)** Meera makes a delivery.

She travels for 15 minutes on quiet roads and then for 30 minutes on busy roads.

Calculate her average speed for the whole journey.

..... [2]

- (d) A warehouse is outside the town.
In her journey from the warehouse Meera always travels the first 4 km on **quiet** roads.
She then travels x km on **busy** roads to make her first delivery.

- (i) Show that a model for S , her average speed in km/h, for this whole journey is

$$S = \frac{4+x}{\frac{1}{12} + \frac{x}{24}}.$$

[2]

- (ii) Show that the model in **part (i)** simplifies to

$$S = \frac{96+24x}{2+x}.$$

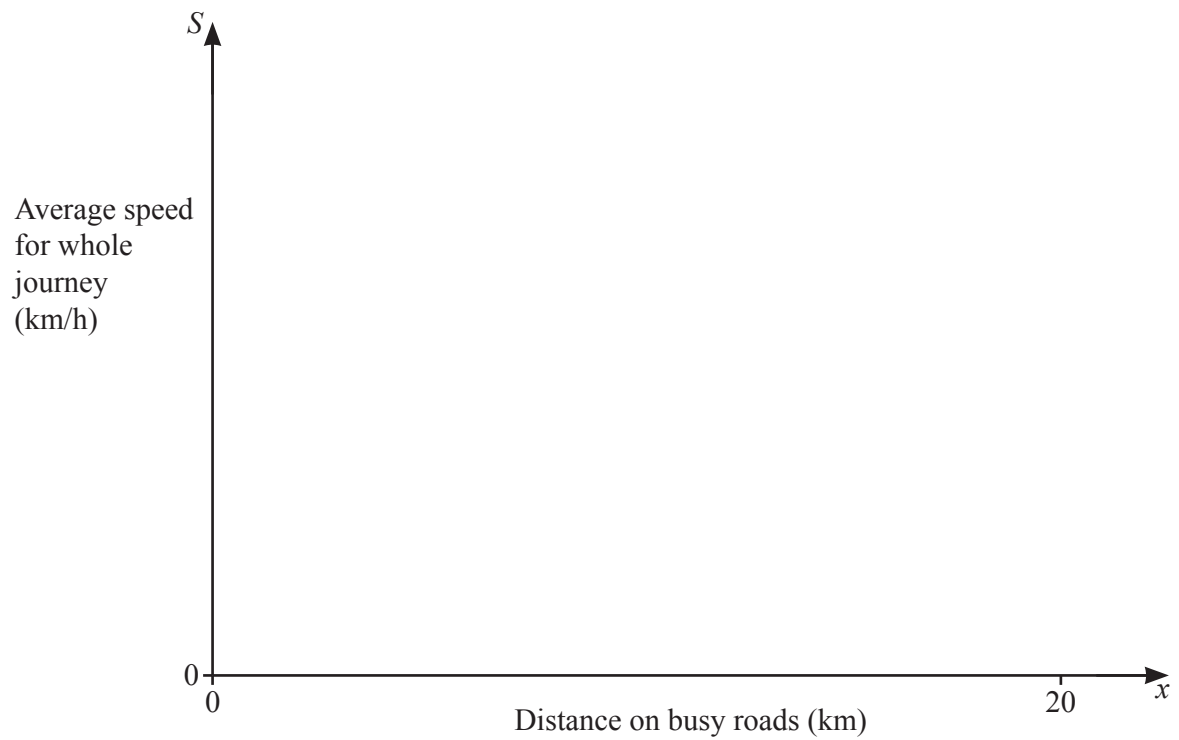
[2]

- (e) To make her first delivery Meera leaves the warehouse and travels a total of 10 km on quiet roads and busy roads.

Use the model in **part (d)(ii)** to find Meera's average speed.

..... [3]

- (f) Sketch the model for S in **part (d)(ii)** on the axes, for $0 \leq x \leq 20$.



[2]

- (g) Find the total distance of her delivery journey from the warehouse when her average speed is 27 km/h.

..... [2]

- 9 A second warehouse is in the town.
Meera travels at the same speeds on quiet roads as in **Question 8(a)** and the same speed on busy roads as in **Question 8(b)**.

In her journey from this warehouse Meera always travels the first 3 km on **busy** roads.
She then travels d km on **quiet** roads to make her first delivery.

- (a) Find a model for her average speed, Y km/h, when making a delivery from this warehouse.
Do not simplify your model.

..... [2]

- (b) Show that your model in **part (a)** simplifies to $Y = \frac{144 + 48d}{6 + d}$.

[1]

- (c) Find the average speed when $S = Y$ and $x = d$.

..... [2]

- 10 The model for one delivery from the first warehouse, $S = \frac{96+24x}{2+x}$, is the same as $S = \frac{24(4+x)}{2+x}$.

This model can be changed when there are more deliveries.

Each delivery is a distance of x km on busy roads from the previous delivery.

- (a) Rewrite this model for a total of 3 deliveries.

..... [1]

- (b) The average time that Meera stops to complete each delivery is 5 minutes.

Meera rewrites the model in **Question 8(d)(i)** to include the times stopped to make all 3 deliveries.

Show that her model is $S = \frac{24(4+3x)}{8+3x}$.

[3]

- (c) Meera needs to shorten the average time that she stops so that her average speed for the whole journey is 24 km/h.

Find the total length of time she now stops to make the 3 deliveries.

..... [4]

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