

Please check the examination details below before entering your candidate information

Candidate surname		Other names	
Centre Number		Candidate Number	

Pearson Edexcel Level 3 GCE

Monday 23 June 2025

Afternoon (Time: 1 hour 30 minutes) **Paper reference** **9FM0/4A**

Further Mathematics
Advanced
PAPER 4A: Further Pure Mathematics 2

You must have:
 Mathematical Formulae and Statistical Tables (Green), calculator

Total Marks

Candidates may use any calculator allowed by Pearson regulations. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided
– *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Inexact answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 9 questions in this question paper. The total mark for this paper is 75.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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1. The set $S = \{1, 3, 5, 9, 11, 13\}$ forms the group G , under the operation multiplication modulo 14

(a) Complete the Cayley table below for the group G

$\times_{14}$	1	3	5	9	11	13
1	1	3	5	9	11	13
3	3	9	1	13	5	11
5	5	1	11			
9	9	13		11		
11	11	5			9	
13	13	11				1

A spare table can be found on page 5 if you need to rewrite your Cayley table.

(3)

(b) Write down a subgroup of G of order 2

(1)

The group H is defined by the Cayley table below.

$*$	p	q	r	s	t	u
p	p	q	r	s	t	u
q	q	t	u	r	s	p
r	r	u	t	q	p	s
s	s	r	q	p	u	t
t	t	s	p	u	r	q
u	u	p	s	t	q	r

(c) Show that G and H are isomorphic.

(3)



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Question 1 continued

Lined area for writing the answer to Question 1.



Question 1 continued

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Question 1 continued

Only use this grid if you need to rewrite your Cayley table.

$\times_{14}$	1	3	5	9	11	13
1	1	3	5	9	11	13
3	3	9	1	13	5	11
5	5	1	11			
9	9	13		11		
11	11	5			9	
13	13	11				1

(Total for Question 1 is 7 marks)



2.

$$\mathbf{A} = \begin{pmatrix} 1 & -2 \\ -2 & 4 \end{pmatrix}$$

(a) Determine the eigenvalues of matrix $\mathbf{A}$

(3)

(b) Hence determine an orthogonal matrix $\mathbf{P}$ and a diagonal matrix $\mathbf{D}$ such that

$$\mathbf{D} = \mathbf{P}^T \mathbf{A} \mathbf{P}$$

(5)



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Question 2 continued

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Question 2 continued

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Question 2 continued

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(Total for Question 2 is 8 marks)



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3. The circle C has equation

$$|z - 5 + 4i| = 2|z - 2 + i|$$

where $z = x + iy$

(a) Show that an equation for C is

$$x^2 - 2x + y^2 - 7 = 0 \tag{3}$$

The half-line with equation

$$\arg(z-a) = -\frac{3\pi}{4}$$

where a is a real constant, is a tangent to C

(b) Determine the value of a . (6)



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Question 3 continued

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Question 3 continued

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Question 3 continued

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(Total for Question 3 is 9 marks)



4. A sequence is defined by

$$u_{n+2} = 6u_{n+1} - 8u_n \quad n \geq 1$$

$$u_1 = 399.6 \quad u_2 = 798.4$$

(a) Prove by induction that, for $n \in \mathbb{N}$

$$u_n = 200(2^n) - \frac{1}{10}(4^n) \quad (6)$$

(b) Hence determine the value of the first negative term of the sequence.

(Solutions relying entirely on calculator technology are not acceptable.)



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Question 4 continued

Lined area for writing the answer to Question 4.



Question 4 continued

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Question 4 continued

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(Total for Question 4 is 9 marks)



5. (i) A password is to be created from 5 characters using the following criteria

- one capital letter
- 3 distinct single digits
- one of the four symbols @ £ \$ &

Determine how many different passwords can be created if

- (a) the characters are in the order of the bullet points above, (2)

- (b) the characters can be in any order. (1)

- (ii) Use Fermat's Little Theorem to determine the least positive residue of 4^{50} modulo 13

- (iii) Determine the total number of different, positive **odd** numbers, less than 1000, that contain the digit 2
- (4)**

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Question 5 continued

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(Total for Question 5 is 10 marks)



6.

$$I_n = \int_0^2 (4 - x^2)^n dx$$

(a) Prove that, for $n \geq 1$

$$I_n = \frac{8n}{2n+1} I_{n-1} \quad (4)$$

(b) Using the result from part (a) and showing all stages of your working, determine the value of n for which

$$I_n = \frac{65536}{315}$$

(Solutions relying entirely on calculator technology are not acceptable.)

(4)



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Question 6 continued

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Question 6 continued

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Question 6 continued

Lined area for writing the answer to Question 6.

(Total for Question 6 is 8 marks)



7. (i) Explain why the congruence equation

$$21x \equiv 11 \pmod{36}$$

has no solutions.

(2)

- (ii) Use modular arithmetic to solve the congruence equation

$$36y \equiv 192 \pmod{40}$$

(4)



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Question 7 continued

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(Total for Question 7 is 6 marks)



8.

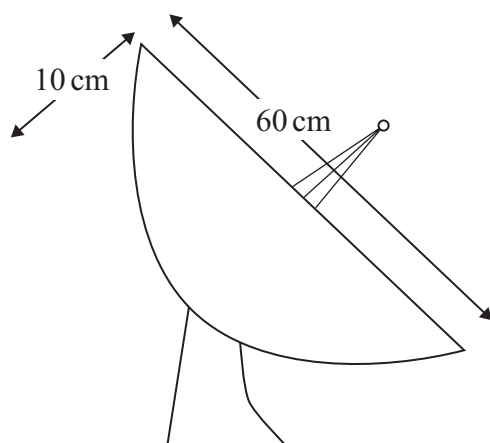


Figure 1

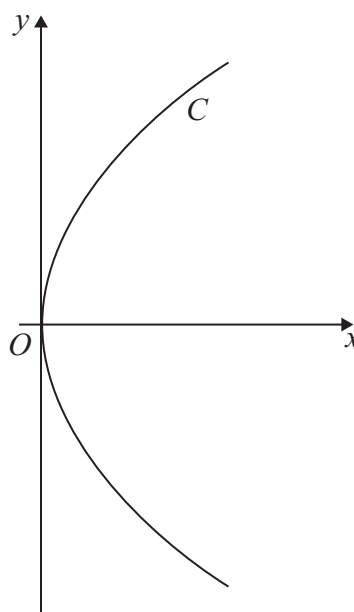


Figure 2

Figure 1 shows a satellite dish.

Figure 2 shows a sketch of the curve C with equation

$$y^2 = Ax \quad 0 \leq x \leq 10$$

where A is a positive constant.

The curved inner surface of the satellite dish is modelled by the surface of revolution formed by rotating curve C through π radians about the x -axis.

The inner surface of the satellite dish has

- a largest diameter of 60 cm
- a depth of 10 cm

as shown in Figure 1.

- Determine the value of A . (2)
- Using algebraic integration, determine, in cm^2 , the area of the curved inner surface of the satellite dish, according to the model. Give your answer to 2 significant figures. (7)
- State a limitation of the model. (1)



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Question 8 continued

Lined area for writing the answer to Question 8.



Question 8 continued

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Question 8 continued

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(Total for Question 8 is 10 marks)



9. The transformation T from the z -plane to the w -plane, where $z = x + iy$ and $w = u + iv$ is given by

$$w = \frac{z}{z + 2i} \quad z \neq -2i$$

The circle with equation $|z| = 4$ is mapped by T onto the circle C .

Determine

- (i) the coordinates of the centre of C
- (ii) the radius of C

(8)



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Question 9 continued

Lined area for writing the answer to Question 9.



Question 9 continued

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(Total for Question 9 is 8 marks)

TOTAL FOR PAPER IS 75 MARKS

