

Paper Reference 9FM0/02

Pearson Edexcel

Level 3 GCE

Further Mathematics

Advanced

PAPER 2: Core Pure Mathematics 2

Thursday 22 May 2025 – Afternoon

Time: 1 hour 30 minutes

Question Paper

**THIS DOCUMENT MUST BE
RETURNED TO PEARSON AT THE END
OF THE EXAMINATION.**

In the boxes below, write your name,
centre number and candidate number.

Surname					
Other names					
Centre Number					
Candidate Number					

YOU MUST HAVE

Mathematical Formulae and Statistics

Tables (Green), calculator

YOU WILL BE GIVEN

Diagram Booklet

Answer Booklet

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

Turn over

INSTRUCTIONS

Answer ALL questions and ensure that your answers to parts of questions are clearly labelled.

Answer the questions in the Answer Booklet or in the separate Diagram Booklet – 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.

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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.

There may be spare copies of some diagrams.

Turn over

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.

1. In this question you must show all stages of your working.
Solutions relying entirely on calculator technology are not acceptable.

Given that

$$z = 2 - 2\sqrt{3}i \text{ and } w = -1 + \sqrt{3}i$$

show that

$$(a) \left| \frac{z}{w} \right| = \frac{|z|}{|w|}$$

(3 marks)

(continued on the next page)

Turn over

1. continued.

(b) $\arg(zw) = \arg(z) + \arg(w)$
(3 marks)

(Total for Question 1 is 6 marks)

2. An archer shoots an arrow towards a target.

In a model

- **the arrow is a particle**
- **the flight path of the arrow is a straight line**
- **the target is part of a plane**

Relative to a fixed origin O

- **the arrow is fired from the point with position vector $3\mathbf{i} - 5\mathbf{j} + 2\mathbf{k}$**
- **the plane containing the target has equation $2x + 4y - z = 3$**

(continued on the next page)

Turn over

2. continued.

Use the model to answer parts (a) to (d).

(a) Determine the shortest distance that the arrow must travel to reach the plane.

(2 marks)

The arrow hits the target at the point with position vector $6\mathbf{i} - 2\mathbf{j} + \mathbf{k}$

(b) Determine a vector equation of the flight path of the arrow.

(2 marks)

(continued on the next page)

Turn over

2. continued.

(c) Determine the acute angle that the flight path of the arrow makes with the target.

Give your answer to the nearest degree.

(2 marks)

(d) Determine the distance travelled by the arrow.

(1 mark)

(continued on the next page)

2. continued.

(e) Comment on whether the actual distance travelled by the arrow is likely to match the answer to part (d), giving a reason for your answer.

(1 mark)

(Total for Question 2 is 8 marks)

Turn over

3. Given

$$A = \begin{pmatrix} 1 & 5 \\ 0 & 2 \end{pmatrix}$$

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

$$A^n = \begin{pmatrix} 1 & 5(2^n - 1) \\ 0 & 2^n \end{pmatrix}$$

(6 marks)

(continued on the next page)

3. continued.

Given

$$\mathbf{B} = \begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$$

**(b) describe fully the single
geometrical transformation $\mathbf{P}$
represented by the matrix $\mathbf{B}$
(2 marks)**

(continued on the next page)

3. continued.

The transformation Q is represented by the matrix A^n

The transformation P followed by the transformation Q is the transformation R , which is represented by the matrix C

**(c) Determine C in terms of n
(1 mark)**

(continued on the next page)

3. continued.

Given that, for a particular value of n , the transformation R maps the point with coordinates $(27, 1)$ to the point with coordinates (a, a) , where a is a constant,

(d) determine the matrix that represents the transformation Q (3 marks)

(Total for Question 3 is 12 marks)

4. (i) $z_1 = a + bi$ and $z_2 = c + di$

where a , b , c and d are real constants.

(continued on the next page)

4. (i) continued.

Given that

- $b > d$
- $z_1 + z_2$ is real
- $|z_1| = \sqrt{13}$
- $|z_2| = 5$
- $\operatorname{Re}(z_2 - z_1) = 2$

show that $a = 2$ and determine
the value of each of b , c and d
(5 marks)

(continued on the next page)

Turn over

4. continued.

(ii) (a) On the same Argand diagram

- sketch the locus of points z which satisfy $|z - 12| = 7$**
- sketch the locus of points w which satisfy $|w - 5i| = 4$**

showing the coordinates of any points of intersection with the axes.

There are blank axes on pages 49 – 60 in the Answer Booklet if you wish to use them.

(2 marks)

(continued on the next page)

Turn over

4. (ii) continued.

(b) Determine the range of possible values of

$$|z - w|$$

(3 marks)

(Total for Question 4 is 10 marks)

Turn over

5. Three planes are defined by the following equations

$$2x - y + z = 3$$

$$x + py - 3z = q$$

$$3x + y - 2z = 4$$

where p and q are constants.

Given that the planes form a sheaf, determine

(i) the value of p

(ii) the value of q

(Total for Question 5 is 4 marks)

6. The quartic equation

$$2x^4 + Ax^3 - Ax^2 - 5x + 6 = 0$$

where **A** is a real constant, has roots α , β , γ and δ

(a) Determine the value of

$$\frac{3}{\alpha} + \frac{3}{\beta} + \frac{3}{\gamma} + \frac{3}{\delta}$$

(3 marks)

(continued on the next page)

6. continued.

Given that

$$\alpha^2 + \beta^2 + \gamma^2 + \delta^2 = -\frac{3}{4}$$

**(b) determine the possible values
of A**

(5 marks)

(Total for Question 6 is 8 marks)

7. Refer to the diagram for Question 7 in the Diagram Booklet.

The curve **C** shown in the diagram has polar equation

$$r = a(1 + \sin \theta) \qquad -\pi < \theta \leq \pi$$

where **a** is a constant.

The tangents to **C** at the points **A** and **B** are perpendicular to the initial line.

- (a) Use calculus to determine the polar coordinates of **A** and **B**
(6 marks)

(continued on the next page)

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7. continued.

The curve C models the perimeter of the surface of a swimming pool.

Given that, according to the model, the distance across the pool from A to B is 10 metres,

(b) show that

$$a = \frac{20\sqrt{3}}{9}$$

(2 marks)

(continued on the next page)

7. continued.

(c) Use algebraic integration to determine the surface area of the swimming pool, according to the model.

(4 marks)

(Total for Question 7 is 12 marks)

8. Given that

$$y = \cos x \sinh x \quad x \in \mathbb{R}$$

(a) show that

$$\frac{d^4 y}{dx^4} = ky$$

where k is a constant to be determined.

(5 marks)

(continued on the next page)

8. continued.

- (b) Hence determine the first three non-zero terms of the Maclaurin series for y , giving each coefficient in simplest form.
(3 marks)**

(Total for Question 8 is 8 marks)

9. Given that

$$y = \arcsin 3x \quad -\frac{1}{3} \leq x \leq \frac{1}{3}$$

(a) determine $\frac{dy}{dx}$ in terms of x
(2 marks)

The curve **C** has equation

$$y = \cos(\arcsin 3x) \quad -\frac{1}{3} \leq x \leq \frac{1}{3}$$

(b) Determine $\frac{dy}{dx}$ giving your
answer in simplest form.
(2 marks)

(continued on the next page)

Turn over

9. continued.

- (c) Hence determine the x coordinate of the point on C at which the gradient is 4**
(3 marks)

(Total for Question 9 is 7 marks)

TOTAL FOR PAPER IS 75 MARKS

END OF PAPER