

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Monday 12 May 2025 – Afternoon

AS Level Further Mathematics B (MEI)

Y410/01 Core Pure

**Time allowed: 1 hour 15 minutes
plus your additional time allowance**

YOU MUST HAVE:

**the Printed Answer Booklet or any suitable paper
provided by the centre. The Printed Answer Booklet may
be enlarged by the centre**

the Formulae Booklet for Further Mathematics B (MEI)

a scientific or graphical calculator

Insert for Question 7a

READ INSTRUCTIONS OVERLEAF



INSTRUCTIONS

Use black ink. You can use an HB pencil, but only for graphs and diagrams.

If you use the Printed Answer Booklet write your answer to each question in the space provided in the PRINTED ANSWER BOOKLET. If you need extra space use the lined pages at the end of the Printed Answer Booklet. The question numbers must be clearly shown.

If you use the Printed Answer Booklet fill in the boxes on the front of the Printed Answer Booklet.

Answer ALL the questions.

Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

Give your final answers to a degree of accuracy that is appropriate to the context.

Do NOT send this Question Paper for marking. Keep it in the centre or recycle it.

INFORMATION

The total mark for this paper is 60.

The marks for each question are shown in brackets [].

ADVICE

Read each question carefully before you start your answer.

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1 The matrices A and B are given by

$$\mathbf{A} = \begin{pmatrix} 1 & 3 \\ 0 & 1 \end{pmatrix} \text{ and } \mathbf{B} = \begin{pmatrix} 2 & 1 \\ 0 & 1 \end{pmatrix}.$$

(a) Use A and B to show that matrix multiplication is NOT, in general, commutative. [2]

(b) Verify that A and B satisfy $(\mathbf{AB})^{-1} = \mathbf{B}^{-1}\mathbf{A}^{-1}$. [3]

2 In this question you must show detailed reasoning.

Find the acute angle between the vector $3\mathbf{i} + 2\mathbf{j} - \mathbf{k}$ and the normal vector to the plane $2x + 3y + z = 6$. [4]

3 The matrices M and N are given by

$\mathbf{M} = \begin{pmatrix} a & -b \\ b & a \end{pmatrix}$ and $\mathbf{N} = \begin{pmatrix} b & -a \\ a & b \end{pmatrix}$ where a and b are positive constants.

(a) Given that $\mathbf{M}^2 = \mathbf{N}$, determine the exact values of a and b . [4]

(b) Hence state the transformations of the plane associated with matrices M and N. [3]

- 4 (a) The transformation T is represented by the matrix

$$\mathbf{M} = \begin{pmatrix} 1 & -2 & 2 \\ 2 & 1 & 0 \\ 1 & 2 & -1 \end{pmatrix}.$$

A shape S_1 is mapped to a shape S_2 by the transformation T.

Show that volume of S_1 is the same as the volume of S_2 . [2]

- (b) Three planes have equations

$$\begin{aligned} x - 2y + 2z &= \lambda, \\ 2x + y &= 2, \\ x + 2y - z &= 0, \end{aligned}$$

where λ is a constant.

- (i) Explain why the three planes intersect at a point for any value of λ . [2]
- (ii) Use a matrix method to determine, in terms of λ , the coordinates of this point. [4]

5 In this question you must show detailed reasoning.

The complex number w is given by

$$w = -4\sqrt{2} + (4\sqrt{2})i.$$

(a) (i) Find $|w|$. [2]

(ii) Find $\arg(w)$. [2]

The complex numbers z_1 and z_2 are given by $z_1 = a + i$ and $z_2 = 4(\cos \theta + i \sin \theta)$, where a is a positive real constant and $-\pi < \theta \leq \pi$.

(b) You are given that $z_1 z_2 = w$.

(i) Find the exact value of a . [3]

(ii) Find the value of θ . Give your answer as an exact multiple of π . [3]

6 (a) Express $\frac{1}{(r-1)^2} - \frac{1}{(r+1)^2}$ as a single simplified fraction. [2]

(b) Hence determine the limit which

$\sum_{r=2}^n \frac{r}{(r-1)^2(r+1)^2}$ converges to as $n \rightarrow \infty$. [5]

- 7 The region R of the Argand diagram consists of the set of points representing complex numbers z which satisfy the following inequalities.**

$$\operatorname{Im}(z) \geq 0 \quad \arg(z+2) \leq \frac{1}{4}\pi \quad |z| \leq |z-4-2i|$$

- (a) Sketch and clearly label the region R on an Argand diagram or on the insert. [4]**
- (b) In this question you must show detailed reasoning.**

Find the largest value of $\operatorname{Im}(z)$ in the region R. [7]

- 8 The three distinct roots of the equation $z^3 - 4z^2 + pz + q = 0$, where p and q are real, are drawn on an Argand diagram. The three points which represent these roots do not lie on a straight line but instead form a triangle T.**

- (a) Show that T is isosceles. [3]**
- (b) In this question you must show detailed reasoning.**

You are given the following information.

**The area of T is 10 square units.
One of the roots of the equation $z^3 - 4z^2 + pz + q = 0$ is $z = -2$.**

Find the other roots of the equation. [5]

END OF QUESTION PAPER



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