



Cambridge International AS & A Level

CANDIDATE
NAME

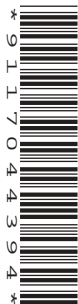
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FURTHER MATHEMATICS

9231/12

Paper 1 Further Pure Mathematics 1

October/November 2020

2 hours

You must answer on the question paper.

You will need: List of formulae (MF19)

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.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **16** pages. Blank pages are indicated.

1 The cubic equation $x^3 + bx^2 + cx + d = 0$, where b , c and d are constants, has roots α , β , γ . It is given that $\alpha\beta\gamma = -1$.

(a) State the value of d . [1]

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(b) Find a cubic equation, with coefficients in terms of b and c , whose roots are $\alpha + 1$, $\beta + 1$, $\gamma + 1$. [3]

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(c) Given also that $\gamma + 1 = -\alpha - 1$, deduce that $(c - 2b + 3)(b - 3) = b - c$. [4]

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- 3 (a) By simplifying $(x^n - \sqrt{x^{2n} + 1})(x^n + \sqrt{x^{2n} + 1})$, show that $\frac{1}{x^n - \sqrt{x^{2n} + 1}} = -x^n - \sqrt{x^{2n} + 1}$. [1]

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$$\text{Let } u_n = x^{n+1} + \sqrt{x^{2n+2} + 1} + \frac{1}{x^n - \sqrt{x^{2n} + 1}}.$$

- (b) Use the method of differences to find $\sum_{n=1}^N u_n$ in terms of N and x . [3]

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- (c) Deduce the set of values of x for which the infinite series

$$u_1 + u_2 + u_3 + \dots$$

- is convergent and give the sum to infinity when this exists. [3]

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4 The matrices **A** and **B** are given by

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

- (a) Give full details of the geometrical transformation in the x - y plane represented by **A**. [1]

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- (b) Give full details of the geometrical transformation in the x - y plane represented by **B**. [2]

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The triangle DEF in the x - y plane is transformed by **AB** onto triangle PQR .

- (c) Show that the triangles DEF and PQR have the same area. [3]

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7 The points A, B, C have position vectors

$$-2\mathbf{i} + 2\mathbf{j} - \mathbf{k}, \quad -2\mathbf{i} + \mathbf{j} + 2\mathbf{k}, \quad -2\mathbf{j} + \mathbf{k},$$

respectively, relative to the origin O .

(a) Find the equation of the plane ABC , giving your answer in the form $ax + by + cz = d$. [5]

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(b) Find the acute angle between the planes OBC and ABC . [4]

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