

CANDIDATE  
NAME

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CENTRE  
NUMBER

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CANDIDATE  
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**FURTHER MATHEMATICS**

**9231/12**

Paper 1

**October/November 2018**

**3 hours**

Candidates answer on the Question Paper.

Additional Materials: List of Formulae (MF10)

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

**DO NOT WRITE IN ANY BARCODES.**

Answer **all** the questions in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.

Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

The use of a calculator is expected, where appropriate.

Results obtained solely from a graphic calculator, without supporting working or reasoning, will not receive credit.

You are reminded of the need for clear presentation in your answers.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **26** printed pages and **2** blank pages.



1 The roots of the cubic equation

$$x^3 - 5x^2 + 13x - 4 = 0$$

are  $\alpha, \beta, \gamma$ .

(i) Find the value of  $\alpha^2 + \beta^2 + \gamma^2$ . [3]

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(ii) Find the value of  $\alpha^3 + \beta^3 + \gamma^3$ . [2]

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3 The curve  $C$  has polar equation  $r = a \cos 3\theta$ , for  $-\frac{1}{6}\pi \leq \theta \leq \frac{1}{6}\pi$ , where  $a$  is a positive constant.

(i) Sketch  $C$ .

[2]

(ii) Find the area of the region enclosed by  $C$ , showing full working.

[3]

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(iii) Find the general solution of

$$\mathbf{M}\mathbf{x} = \begin{pmatrix} 2 \\ 5 \\ 8 \\ -2 \end{pmatrix}. \quad [3]$$

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(iii) Deduce that  $\frac{S_N}{T_N}$  is an integer. [2]

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(iv) Find  $\lim_{N \rightarrow \infty} \frac{S_N}{N^3 T_N}$ . [2]

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(iii) Find the coordinates of any stationary points of  $C$ . [2]

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(iv) Sketch  $C$ , stating the coordinates of any intersections with the  $y$ -axis. [2]



















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