



## Cambridge International AS & A Level

CANDIDATE  
NAME

CENTRE  
NUMBER

--	--	--	--	--

CANDIDATE  
NUMBER

--	--	--	--



### FURTHER MATHEMATICS

9231/13

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 **20** pages. Blank pages are indicated.

**1** The matrix  $\mathbf{M}$  is given by  $\mathbf{M} = \begin{pmatrix} 1 & b \\ 0 & 1 \end{pmatrix} \begin{pmatrix} a & 0 \\ 0 & 1 \end{pmatrix}$ , where  $a$  and  $b$  are positive constants.

**(a)** The matrix  $\mathbf{M}$  represents a sequence of two geometrical transformations.

State the type of each transformation, and make clear the order in which they are applied. [2]

.....

.....

.....

.....

.....

The unit square in the  $x$ - $y$  plane is transformed by  $\mathbf{M}$  onto parallelogram  $OPQR$ .

**(b)** Find, in terms of  $a$  and  $b$ , the matrix which transforms parallelogram  $OPQR$  onto the unit square. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....







3 The cubic equation  $x^3 + cx + 1 = 0$ , where  $c$  is a constant, has roots  $\alpha, \beta, \gamma$ .

(a) Find a cubic equation whose roots are  $\alpha^3, \beta^3, \gamma^3$ . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Show that  $\alpha^6 + \beta^6 + \gamma^6 = 3 - 2c^3$ . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Find the real value of  $c$  for which the matrix  $\begin{pmatrix} 1 & \alpha^3 & \beta^3 \\ \alpha^3 & 1 & \gamma^3 \\ \beta^3 & \gamma^3 & 1 \end{pmatrix}$  is singular. [5]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....





(b) Find the perpendicular distance from  $O$  to the plane  $ABC$ . [2]

.....

.....

.....

.....

(c) Find the acute angle between the planes  $OAB$  and  $ABC$ . [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....







- (c) Find the coordinates of the intersections of  $C$  with the axes, and sketch  $C$ . [3]

.....

.....

.....

.....

.....

- (d) Sketch the curve with equation  $y = \left| \frac{x^2 + x - 1}{x - 1} \right|$ . [2]



The curve  $C$  has polar equation  $r = \sin 4\theta$ , for  $0 \leq \theta \leq \frac{1}{4}\pi$ .

(b) Sketch  $C$  and state the equation of the line of symmetry. [3]

.....  
.....

(c) Find the exact value of the area of the region enclosed by  $C$ . [4]

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....





**Additional Page**

If you use the following lined page to complete the answer(s) to any question(s), the question number(s) must be clearly shown.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....





**BLANK PAGE**

---

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at [www.cambridgeinternational.org](http://www.cambridgeinternational.org) after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.