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Surname

Other names

**Pearson Edexcel**  
**Level 3 GCE**

Centre Number

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Candidate Number

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# Further Mathematics

**Advanced Subsidiary**

**Paper 1: Core Pure Mathematics**

Monday 14 May 2018 – Afternoon

**Time: 1 hour 40 minutes**

Paper Reference

**8FM0/01**

**You must have:**

Mathematical Formulae and Statistical Tables, calculator

Total Marks

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**Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.**

## Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided  
– *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.
- Answers should be given to three significant figures unless otherwise stated.

## 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 80.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*

## 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.

Turn over ►

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**Pearson**

Answer ALL questions. Write your answers in the spaces provided.

1.

$$M = \begin{pmatrix} 2 & 1 & -3 \\ 4 & -2 & 1 \\ 3 & 5 & -2 \end{pmatrix}$$

(a) Find  $M^{-1}$  giving each element in exact form.

(2)

(b) Solve the simultaneous equations

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

$$4x - 2y + z = 9$$

$$3x + 5y - 2z = 5$$

(2)

(c) Interpret the answer to part (b) geometrically.

(1)

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**Question 1 continued**

Lined area for writing the answer to Question 1.

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**Question 1 continued**

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**Question 1 continued**

Ruled area for answering the question, consisting of numerous horizontal lines.

**(Total for Question 1 is 5 marks)**

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2. The cubic equation

$$z^3 - 3z^2 + z + 5 = 0$$

has roots  $\alpha$ ,  $\beta$  and  $\gamma$ .

Without solving the equation, find the cubic equation whose roots are  $(2\alpha + 1)$ ,  $(2\beta + 1)$  and  $(2\gamma + 1)$ , giving your answer in the form  $w^3 + pw^2 + qw + r = 0$ , where  $p$ ,  $q$  and  $r$  are integers to be found.

(5)

Handwriting practice lines consisting of multiple horizontal lines for writing the solution.

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Question 2 continued

Lined area for writing answers, consisting of 25 horizontal lines.

(Total for Question 2 is 5 marks)

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3. (a) Shade on an Argand diagram the set of points

$$\{z \in \mathbb{C} : |z - 1 - i| \leq 3\} \cap \left\{z \in \mathbb{C} : \frac{\pi}{4} \leq \arg(z - 2) \leq \frac{3\pi}{4}\right\}$$

(5)

The complex number  $w$  satisfies

$$|w - 1 - i| = 3 \text{ and } \arg(w - 2) = \frac{\pi}{4}$$

(b) Find, in simplest form, the exact value of  $|w|^2$

(4)

A series of horizontal lines provided for the student to draw an Argand diagram and show calculations.

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### Question 3 continued

Lined writing area for Question 3 continued, consisting of 27 horizontal lines.

**(Total for Question 3 is 9 marks)**

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Question 4 continued

Lined writing area for the answer to Question 4.

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Question 4 continued

Lined writing area for question response.

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5.

$$\mathbf{A} = \begin{pmatrix} -\frac{1}{2} & -\frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & -\frac{1}{2} \end{pmatrix}$$

- (a) Describe fully the single geometrical transformation  $U$  represented by the matrix  $\mathbf{A}$ . (3)

The transformation  $V$ , represented by the  $2 \times 2$  matrix  $\mathbf{B}$ , is a reflection in the line  $y = -x$ .

- (b) Write down the matrix  $\mathbf{B}$ . (1)

Given that  $U$  followed by  $V$  is the transformation  $T$ , which is represented by the matrix  $\mathbf{C}$ ,

- (c) find the matrix  $\mathbf{C}$ . (2)

- (d) Show that there is a real number  $k$  for which the point  $(1, k)$  is invariant under  $T$ . (4)

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Question 5 continued

Lined writing area for the answer.

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**Question 5 continued**

Handwriting practice lines for the answer to Question 5.

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6. (a) Use the standard results for  $\sum_{r=1}^n r^2$  and  $\sum_{r=1}^n r$  to show that

$$\sum_{r=1}^n (3r - 2)^2 = \frac{1}{2}n[6n^2 - 3n - 1]$$

for all positive integers  $n$ .

(5)

(b) Hence find any values of  $n$  for which

$$\sum_{r=5}^n (3r - 2)^2 + 103 \sum_{r=1}^{28} r \cos\left(\frac{r\pi}{2}\right) = 3n^3$$

(5)

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Question 6 continued

Lined writing area for the response to Question 6.

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Question 6 continued

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Lined writing area for the answer.

(Total for Question 6 is 10 marks)







**Question 7 continued**

Lined writing area for the answer to Question 7.

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**Question 7 continued**

Lined writing area for the answer to Question 7.

**(Total for Question 7 is 7 marks)**

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8. (i) Prove by induction that for  $n \in \mathbb{Z}^+$

$$\begin{pmatrix} 5 & -8 \\ 2 & -3 \end{pmatrix}^n = \begin{pmatrix} 4n+1 & -8n \\ 2n & 1-4n \end{pmatrix} \quad (6)$$

(ii) Prove by induction that for  $n \in \mathbb{Z}^+$

$$f(n) = 4^{n+1} + 5^{2n-1}$$

is divisible by 21

(6)

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Question 8 continued

Lined writing area for the answer to Question 8.

(Total for Question 8 is 12 marks)

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9.

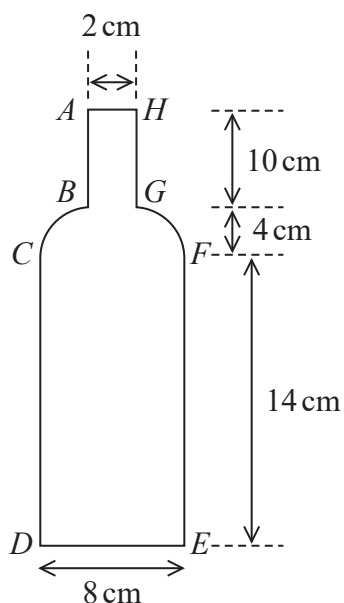


Figure 1

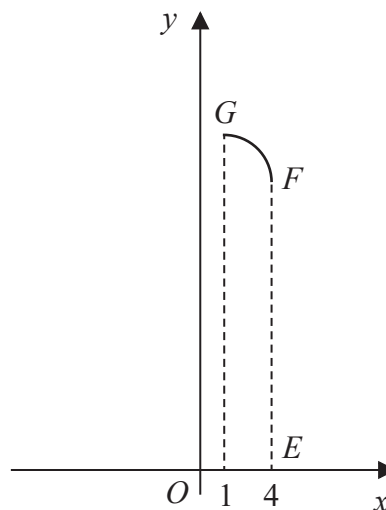


Figure 2

A mathematics student is modelling the profile of a glass bottle of water. Figure 1 shows a sketch of a central vertical cross-section  $ABCDEFGHA$  of the bottle with the measurements taken by the student.

The horizontal cross-section between  $CF$  and  $DE$  is a circle of diameter 8 cm and the horizontal cross-section between  $BG$  and  $AH$  is a circle of diameter 2 cm.

The student thinks that the curve  $GF$  could be modelled as a curve with equation

$$y = ax^2 + b \quad 1 \leq x \leq 4$$

where  $a$  and  $b$  are constants and  $O$  is the fixed origin, as shown in Figure 2.

- (a) Find the value of  $a$  and the value of  $b$  according to the model. (2)
- (b) Use the model to find the volume of water that the bottle can contain. (7)
- (c) State a limitation of the model. (1)

The label on the bottle states that the bottle holds approximately  $750 \text{ cm}^3$  of water.

- (d) Use this information and your answer to part (b) to evaluate the model, explaining your reasoning. (1)

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