

Please check the examination details below before entering your candidate information

Candidate surname

Other names

**Pearson Edexcel  
Level 3 GCE**

Centre Number

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Candidate Number

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**Monday 11 May 2020**

Afternoon (Time: 1 hour 40 minutes)

Paper Reference **8FM0/01**

**Further Mathematics**

**Advanced Subsidiary**

**Paper 1: Core Pure Mathematics**

**You must have:**

Mathematical Formulae and Statistical Tables (Green), calculator

Total Marks

**Candidates may use any calculator allowed by Pearson regulations. 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.
- Inexact answers should be given to three significant figures unless otherwise stated.

### Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 10 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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**Question 4 continued**

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5.

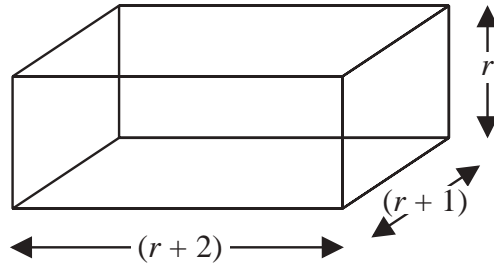


Figure 2

A block has length  $(r + 2)$  cm, width  $(r + 1)$  cm and height  $r$  cm, as shown in Figure 2.

In a set of  $n$  such blocks, the first block has a height of 1 cm, the second block has a height of 2 cm, the third block has a height of 3 cm and so on.

- (a) Use the standard results for  $\sum_{r=1}^n r^3$ ,  $\sum_{r=1}^n r^2$  and  $\sum_{r=1}^n r$  to show that the **total** volume,  $V$ , of all  $n$  blocks in the set is given by

$$V = \frac{n}{4}(n + 1)(n + 2)(n + 3) \quad n \geq 1 \quad (5)$$

Given that the total volume of all  $n$  blocks is

$$(n^4 + 6n^3 - 11710) \text{ cm}^3$$

- (b) determine how many blocks make up the set. (2)









6. (i)

$$\mathbf{A} = \begin{pmatrix} 2 & a \\ a - 4 & b \end{pmatrix}$$

where  $a$  and  $b$  are non-zero constants.

Given that the matrix  $\mathbf{A}$  is self-inverse,

- (a) determine the value of  $b$  and the possible values for  $a$ . (5)

The matrix  $\mathbf{A}$  represents a linear transformation  $M$ .

Using the smaller value of  $a$  from part (a),

- (b) show that the invariant points of the linear transformation  $M$  form a line, stating the equation of this line. (3)

(ii)

$$\mathbf{P} = \begin{pmatrix} p & 2p \\ -1 & 3p \end{pmatrix}$$

where  $p$  is a positive constant.

The matrix  $\mathbf{P}$  represents a linear transformation  $U$ .

The triangle  $T$  has vertices at the points with coordinates  $(1, 2)$ ,  $(3, 2)$  and  $(2, 5)$ .

The area of the image of  $T$  under the linear transformation  $U$  is 15

- (a) Determine the value of  $p$ . (4)

The transformation  $V$  consists of a stretch scale factor 3 parallel to the  $x$ -axis with the  $y$ -axis invariant followed by a stretch scale factor  $-2$  parallel to the  $y$ -axis with the  $x$ -axis invariant. The transformation  $V$  is represented by the matrix  $\mathbf{Q}$ .

- (b) Write down the matrix  $\mathbf{Q}$ . (2)

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

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

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7.

$$f(z) = z^4 + az^3 + bz^2 + cz + d$$

where  $a, b, c$  and  $d$  are real constants.

The equation  $f(z) = 0$  has complex roots  $z_1, z_2, z_3$  and  $z_4$

When plotted on an Argand diagram, the points representing  $z_1, z_2, z_3$  and  $z_4$  form the vertices of a square, with one vertex in each quadrant.

Given that  $z_1 = 2 + 3i$ , determine the values of  $a, b, c$  and  $d$ .

(6)

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

$$f(n) = 2^{n+2} + 3^{2n+1}$$

is divisible by 7

(6)

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9. The cubic equation

$$3x^3 + x^2 - 4x + 1 = 0$$

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

Without solving the cubic equation,

(a) determine the value of  $\frac{1}{\alpha} + \frac{1}{\beta} + \frac{1}{\gamma}$  (3)

(b) find a cubic equation that has roots  $\frac{1}{\alpha}$ ,  $\frac{1}{\beta}$  and  $\frac{1}{\gamma}$ , giving your answer in the form

$x^3 + ax^2 + bx + c = 0$ , where  $a$ ,  $b$  and  $c$  are integers to be determined. (3)







10. Given that there are two distinct complex numbers  $z$  that satisfy

$$\{z: |z - 3 - 5i| = 2r\} \cap \left\{z: \arg(z - 2) = \frac{3\pi}{4}\right\}$$

determine the exact range of values for the real constant  $r$ .

(7)





