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Centre number

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Candidate signature

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I declare this is my own work.

# AS FURTHER MATHEMATICS

Paper 1

Monday 11 May 2026

Afternoon

Time allowed: 1 hour 30 minutes

## Materials

- You must have the AQA Formulae and statistical tables booklet for A-level Mathematics and A-level Further Mathematics.
- You should have a graphical or scientific calculator that meets the requirements of the specification.

## Instructions

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer each question in the space provided for that question. If you require extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do **not** write outside the box around each page or on blank pages.
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work that you do not want to be marked.

## Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.

## Advice

- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- You do not necessarily need to use all the space provided.

| For Examiner's Use |      |
|--------------------|------|
| Question           | Mark |
| 1                  |      |
| 2                  |      |
| 3                  |      |
| 4                  |      |
| 5                  |      |
| 6                  |      |
| 7                  |      |
| 8                  |      |
| 9                  |      |
| 10                 |      |
| 11                 |      |
| 12                 |      |
| 13                 |      |
| 14                 |      |
| 15                 |      |
| <b>TOTAL</b>       |      |

(JUN267366101)

Answer **all** questions in the spaces provided.

- 1** The matrices **A**, **B** and **C** are given by

$$\mathbf{A} = \begin{bmatrix} 1 & 3 & -4 \\ 2 & 0 & 5 \\ -2 & 1 & 3 \end{bmatrix}$$

$$\mathbf{B} = \begin{bmatrix} 5 & 6 & 3 \end{bmatrix}$$

$$\mathbf{C} = \begin{bmatrix} 4 \\ 2 \\ 5 \end{bmatrix}$$

Which **one** of the following products does **not** exist?

Circle your answer.

[1 mark]

**AB**

**BA**

**BC**

**CB**

- 2** The vectors **p** and **q** are such that  $|\mathbf{p}| = 3$ ,  $|\mathbf{q}| = 4$  and  $\mathbf{p} \cdot \mathbf{q} = 5$

Find the acute angle, to the nearest degree, between **p** and **q**

Circle your answer.

[1 mark]

25°

44°

46°

65°

- 3 The transformation  $T$  is represented by the matrix  $\begin{bmatrix} 2 & 1 \\ 2 & 3 \end{bmatrix}$

The point  $(1, k)$  is invariant under  $T$

Find the value of  $k$

Circle your answer.

[1 mark]

−1

1

2

3

- 4 The line  $L$  has vector equation  $\mathbf{r} = \begin{bmatrix} 3 \\ 2 \\ -1 \end{bmatrix} + \lambda \begin{bmatrix} -5 \\ 0 \\ 6 \end{bmatrix}$

The point  $A$  has coordinates  $(-7, 2, a)$  and lies on  $L$

Find the value of  $a$

Circle your answer.

[1 mark]

−13

−1

5

11

Turn over for the next question

Turn over U

**5**

$$\mathbf{M} = \begin{bmatrix} 2 & 1 & -3 \\ 0 & 3 & -1 \\ 5 & -2 & 4 \end{bmatrix}$$

**5 (a)**

$$\mathbf{M}^2 = \begin{bmatrix} -11 & p & -19 \\ q & 11 & -7 \\ 30 & -9 & r \end{bmatrix}$$

Find the value of  $p$ , the value of  $q$  and the value of  $r$

**[2 marks]**

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are approximately 20 lines visible. The paper has a slight shadow on the right side, suggesting it's resting on a surface.

$$(a, a + 2, 3 - a)$$

Find the coordinates of the image of  $A$  under  $T$

Give your answer in a simplified form in terms of  $a$

**[2 marks]**

[illegible]

Write down the  $3 \times 3$  matrix **B**

**[1 mark]**

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**Turn over** U

6

and

**[4 marks]**

[illegible]

**7**

$$f(x) = 3x^2 + x$$

The mean value of  $f$  over the interval  $[c - 1, c + 1]$  is 25, where  $c$  is a constant.

Find the possible values of  $c$

**[4 marks]**

[illegible]

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[illegible]

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**Turn over** U

- 9** The curve  $C$  has equation

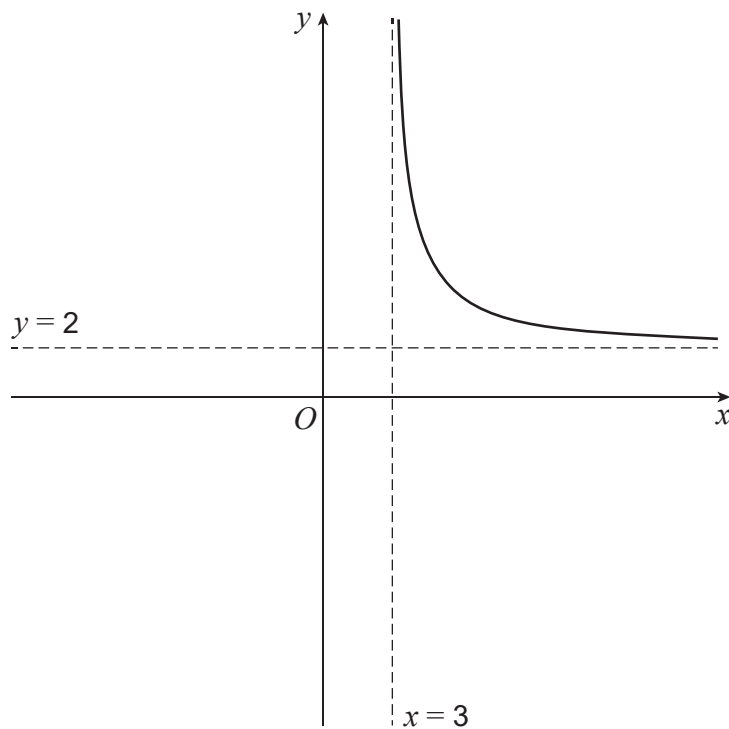
$$y = \frac{ax}{x + b}$$

where  $a$  and  $b$  are constants.

The asymptotes of  $C$  are  $x = 3$  and  $y = 2$

Part of the graph of  $C$  is shown in **Figure 1**

**Figure 1**



- 9 (a)** On **Figure 1**, sketch the graph of  $C$  for  $x < 3$

**[2 marks]**

- 9 (b)** Write down the value of  $a$

**[1 mark]**

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**[1 mark]**

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**[4 marks]**

$$\frac{ax}{x+b} \geq 2x$$

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10

and

**10 (a)**

**[3 marks]**

[illegible]

**10 (b)** Marie writes

$$(3A + B)(2A - B) = 6A^2 - 3AB + 2AB - B^2$$

Explain the error in Marie's expansion.

**[1 mark]**

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**Turn over for the next question**

**Turn over** U

11

$$\sum_{r=1}^n (2r)^3 - \sum_{r=1}^n 2(r-1)^3 = n^2(an+b)$$

where  $a$  and  $b$  are constants.

**11 (a)**

**[4 marks]**

[illegible]

- 11 (b)** Use your answer to part (a) to find the least value of the integer  $m$  which satisfies the inequality

$$13 - 2^3 + 3^3 - 4^3 + \dots + (2m-1)^3 - (2m)^3 < -250\,000$$

**[2 marks]**

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12

$$y = \frac{x^2}{x^2 + 5x - 6}$$

The line  $y = k$  intersects  $C$

**12 (a)**

No credit will be given for solutions based on differentiation.

Fully justify your answer.

**[4 marks]**

[illegible]

**[5 marks]**

[illegible]

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**13 (a)**

**[4 marks]**

[illegible]

**13 (b)** Show that

$$\frac{p}{p+1} - \frac{q}{q+1} = \frac{p-q}{(p+1)(q+1)}$$

[1 mark]

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**13 (c)** Use the results in parts **(a)** and **(b)** to find the sum of the series

$$\cancel{5000} \times \frac{1}{\cancel{5001}} + \cancel{5001} \times \frac{1}{\cancel{5002}} + \cancel{5002} \times \frac{1}{\cancel{5003}} + \dots + \cancel{10000} \times \frac{1}{\cancel{10001}}$$

Give your answer in the form  $\frac{a}{b}$  where  $a$  and  $b$  are integers.

[2 marks]

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Turn over U

14

$$r = 2 - 3 \cos \theta$$

**14 (a)**

$$\frac{(x+k)^2}{m} + \frac{y^2}{n} = 1$$

where  $k$ ,  $m$  and  $n$  are constants.

**[6 marks]**

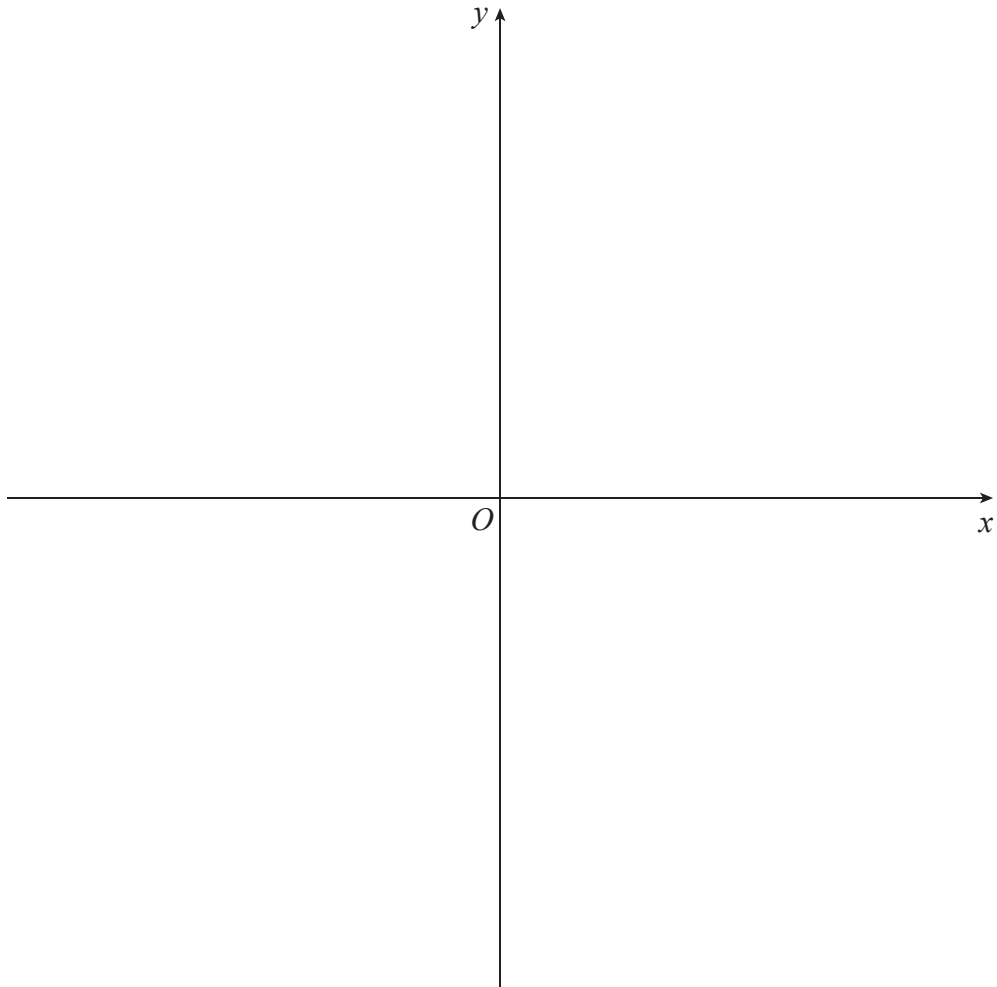
[illegible]

**14 (b)** On the axes in **Figure 2**, sketch  $E_1$

Indicate the value of any intercepts of the curve with the coordinate axes.

**[3 marks]**

**Figure 2**



**Question 14 continues on the next page**

**Turn over** U

**14 (c)** The ellipse  $E_2$  has the Cartesian equation

$$\frac{x^2}{m} + \frac{y^2}{n} = 1$$

A single geometrical transformation  $T$  maps  $E_1$  onto  $E_2$

**14(c) (i)** Describe fully the transformation  $T$

**[1 mark]**

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**14 (c) (ii)** Find the polar equation of  $E_2$  in the form

$$r = f(\theta)$$

**[2 marks]**

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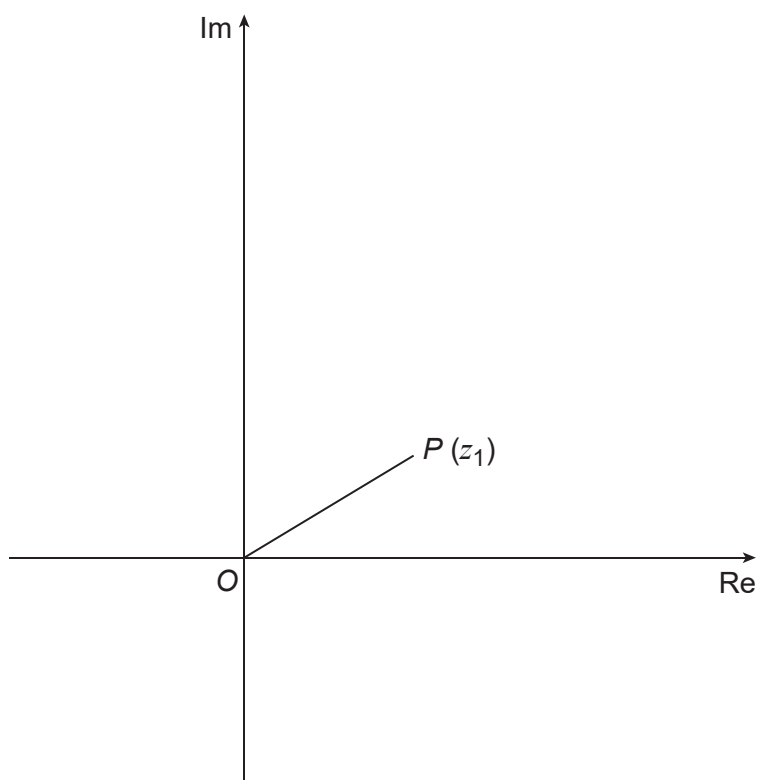
**15** The complex numbers  $z_1$  and  $z_2$  are given by

$$z_1 = \cos \frac{\pi}{6} + i \sin \frac{\pi}{6} \quad \text{and} \quad z_2 = \cos \frac{2\pi}{3} + i \sin \frac{2\pi}{3}$$

The complex numbers  $z_1$  and  $z_2$  are represented by the points  $P$  and  $Q$  respectively on an Argand diagram.

The line segment  $OP$  is shown in **Figure 3**

**Figure 3**



**15 (a)** Find the size of angle  $POQ$

**[2 marks]**

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**15 (b)** On **Figure 3**, draw the locus of points satisfying the equation

$$\arg(z - z_1) = \arg z_2$$

Indicate the value at which the locus intersects the imaginary axis.

**[3 marks]**

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**15 (c)** The complex number  $w$  is such that

$$\arg(w - z_1) = \arg z_2 \quad \text{and} \quad \arg(w - z_2) = \arg z_1$$

Find  $w$

Give the real and imaginary parts of  $w$  in surd form.

Indicate and label the position of  $w$  on **Figure 3**

**[3 marks]**

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$$|z - \alpha| = \beta$$

**15(d) (i)** Find the exact value of  $\alpha$

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**15 (d) (ii)** Find the exact value of  $\beta$

**[2 marks]**

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**END OF QUESTIONS**

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(29)

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(31)

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