



**Surname** \_\_\_\_\_

**Forename(s)** \_\_\_\_\_

**Centre Number** \_\_\_\_\_

**Candidate Number** \_\_\_\_\_

**Candidate Signature** \_\_\_\_\_

**I declare this is my own work.**

**A-level**

**FURTHER MATHEMATICS**

**Paper 2**

**7367/2**

**Monday 3 June 2024 Afternoon**

**Time allowed: 2 hours**

**At the top of the page, write your surname and forename(s), your centre number, your candidate number and add your signature.**

**[Turn over]**



J U N 2 4 7 3 6 7 2 0 1

## **MATERIALS**

**For this paper you must have:**

- **the AQA Formulae and statistical tables booklet for A-level Mathematics and A-level Further Mathematics.**
- **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.**
- **Answer ALL questions.**
- **You must answer each question in the space provided. Do NOT write on blank pages.**
- **If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).**
- **Show all necessary working; otherwise marks for method may be lost.**
- **Do all rough work in this book. Cross through any work you do not want to be marked.**



## **INFORMATION**

- **The marks for questions are shown in brackets.**
- **The maximum mark for this paper is 100.**

## **ADVICE**

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

**DO NOT TURN OVER UNTIL TOLD TO DO SO**



Answer ALL questions in the spaces provided.

1 It is given that

$$\begin{bmatrix} 2 \\ 1 \\ 3 \end{bmatrix} \cdot \begin{bmatrix} 5 \\ \lambda \\ -6 \end{bmatrix} = 0$$

where  $\lambda$  is a constant.

Find the value of  $\lambda$

Circle your answer. [1 mark]

-28

-8

8

28



- 2 The movement of a particle is described by the simple harmonic equation

$$\ddot{x} = -25x$$

where  $x$  metres is the displacement of the particle at time  $t$  seconds, and  $\ddot{x}$  m s<sup>-2</sup> is the acceleration of the particle.

The maximum displacement of the particle is 9 metres.

Find the maximum speed of the particle.

Circle your answer. [1 mark]

15 m s<sup>-1</sup>

45 m s<sup>-1</sup>

75 m s<sup>-1</sup>

135 m s<sup>-1</sup>

[Turn over]



3 The function  $g$  is defined by

$$g(x) = \operatorname{sech} x \quad (x \in \mathbb{R})$$

Which one of the following is the range of  $g$ ?

Tick (✓) ONE box. [1 mark]

$-\infty < g(x) \leq -1$

$-1 \leq g(x) < 0$

$0 < g(x) \leq 1$

$1 \leq g(x) \leq \infty$



4 The function  $f$  is a quartic function with real coefficients.

The complex number  $5i$  is a root of the equation  $f(x) = 0$

Which ONE of the following MUST be a factor of  $f(x)$ ?

Circle your answer. [1 mark]

$(x^2 - 25)$

$(x^2 - 5)$

$(x^2 + 5)$

$(x^2 + 25)$

[Turn over]



- 5 The first four terms of the series  $S$  can be written as

$$S = (1 \times 2) + (2 \times 3) + (3 \times 4) + (4 \times 5) + \dots$$

- 5(a) Write an expression, using  $\sum$  notation, for the sum of the first  $n$  terms of  $S$  [1 mark]

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- 5(b) Show that the sum of the first  $n$  terms of  $S$  is equal to

$$\frac{1}{3}n(n+1)(n+2) \text{ [2 marks]}$$

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**6 The cubic equation**

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

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

**Find a cubic equation, with integer coefficients, whose roots are  $3\alpha$ ,  $3\beta$  and  $3\gamma$**   
**[3 marks]**

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12 The transformation  $S$  is represented by the

$$\text{matrix } M = \begin{bmatrix} 1 & -6 \\ 2 & 7 \end{bmatrix}$$

The transformation  $T$  is a reflection in the line  $y = x\sqrt{3}$  and is represented by the matrix  $N$

The point  $P(x, y)$  is transformed first by  $S$ , then by  $T$

The result of these transformations is the point  $Q(3, 8)$

Find the coordinates of  $P$

Give your answers to three decimal places.  
[5 marks]

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- 14 (b) State any restrictions on the value of  $k$   
[1 mark]

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- 14 (c) Using your answer to part (a), show that the solution to the set of simultaneous equations below is independent of the value of  $k$

$$5x + 2y + z = 1$$

$$6x + 3y + (2k + 3)z = 4k + 3$$

$$2x + y + 5z = 9$$

[4 marks]

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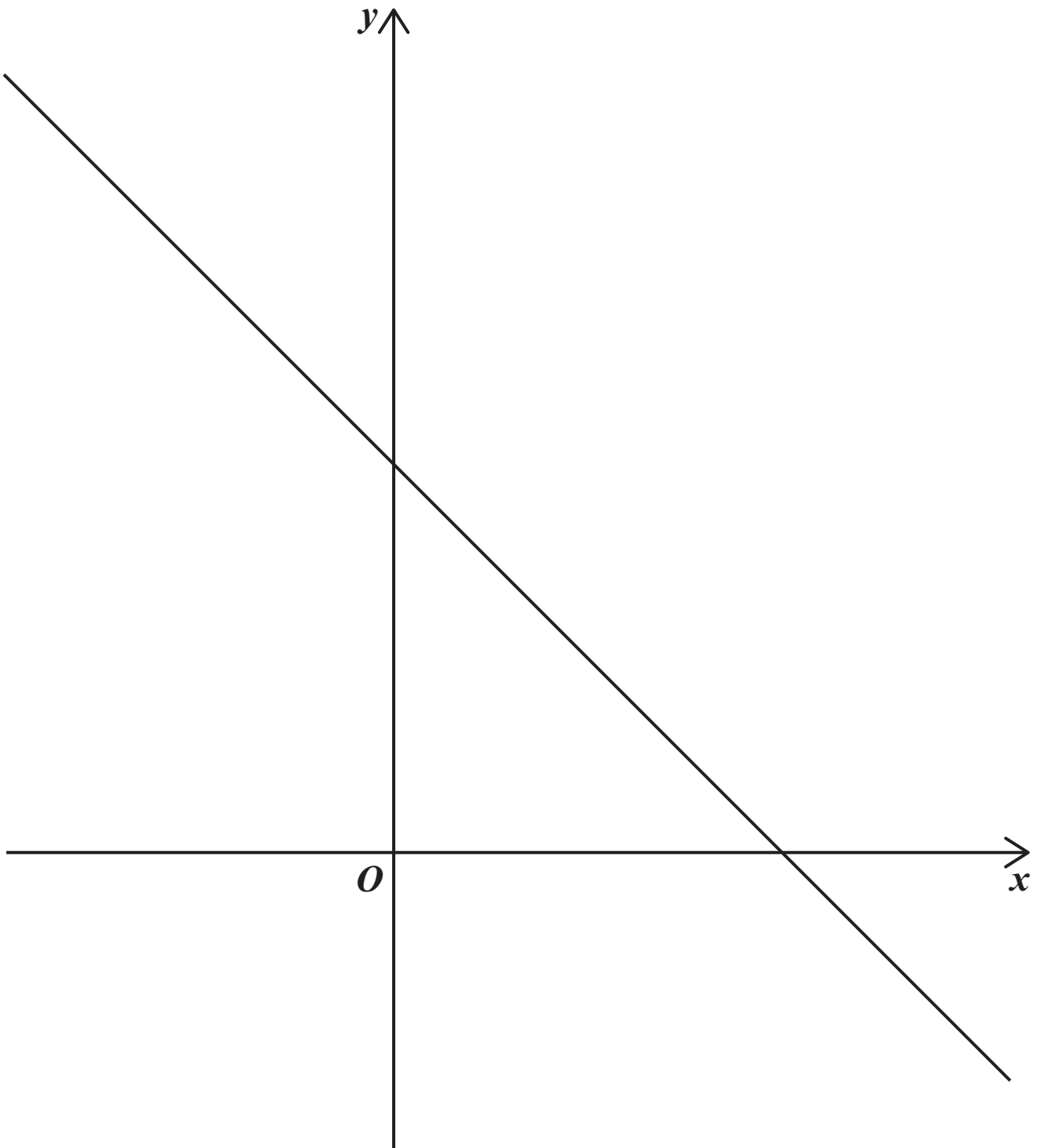
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15

The diagram shows the line  $y = 5 - x$ 

- 15(a)** On the diagram, on the opposite page, sketch the graph of  $y = |x^2 - 4x|$ , including all parts of the graph where it intersects the line  $y = 5 - x$

(You do not need to show the coordinates of the points of intersection.) [3 marks]

[Turn over]







16 The function  $f$  is defined by

$$f(x) = \frac{ax + 5}{x + b}$$

where  $a$  and  $b$  are constants.

The graph of  $y = f(x)$  has asymptotes  
 $x = -2$  and  $y = 3$

16 (a) Write down the value of  $a$  and the value of  $b$   
[2 marks]

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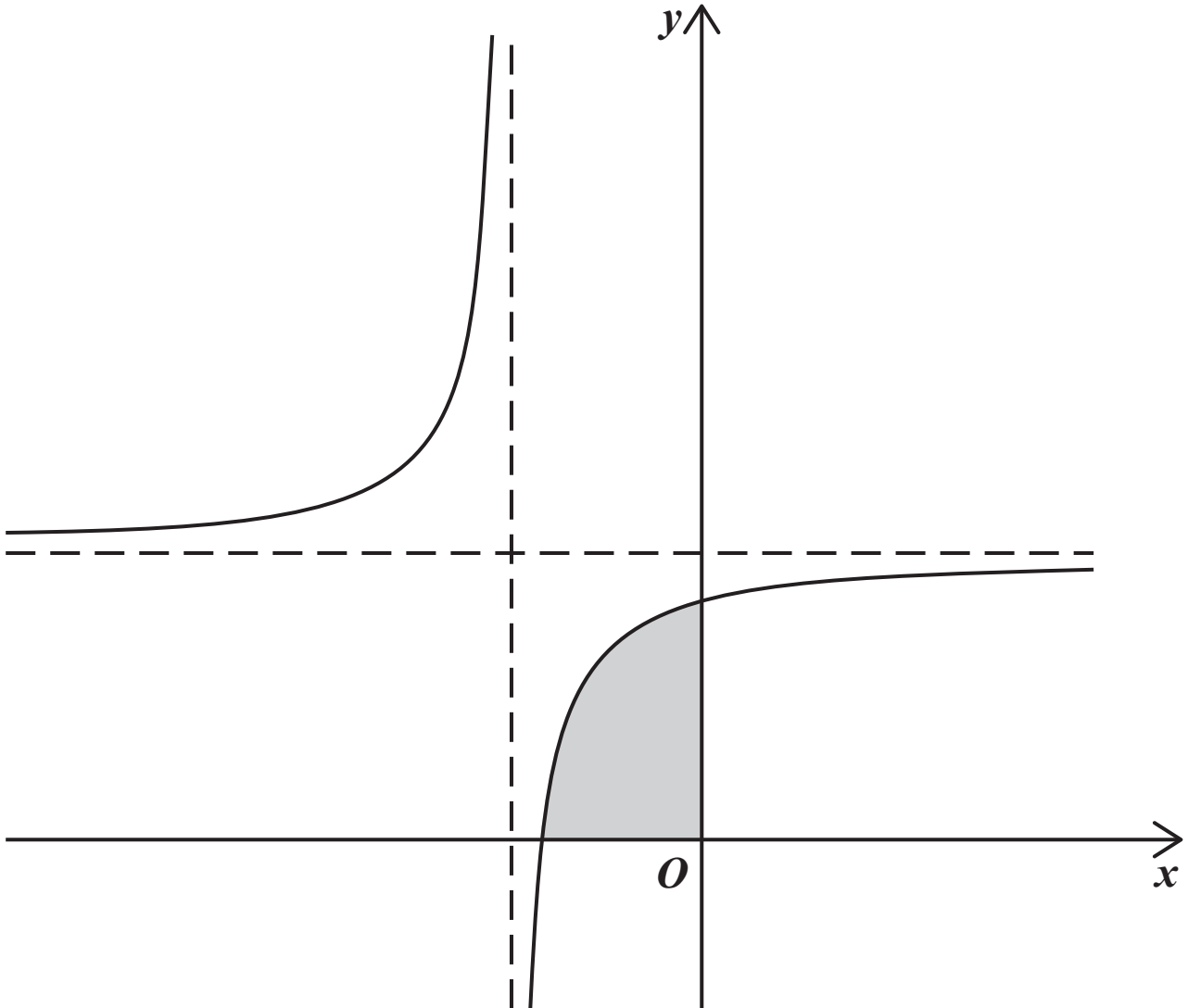
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- 16(b) The diagram shows the graph of  $y = f(x)$  and its asymptotes.

The shaded region  $R$  is enclosed by the graph of  $y = f(x)$ , the  $x$ -axis and the  $y$ -axis.



[Turn over]



**16(b) (i)** The shaded region  $R$  is rotated through  $360^\circ$  about the  $x$ -axis to form a solid.

**Find the volume of this solid.**

**Give your answer to three significant figures.  
[3 marks]**

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16(b) (ii) The shaded region  $R$  is rotated through  $360^\circ$  about the  $y$ -AXIS to form a solid.

Find the volume of this solid.

Give your answer to three significant figures.  
[4 marks]

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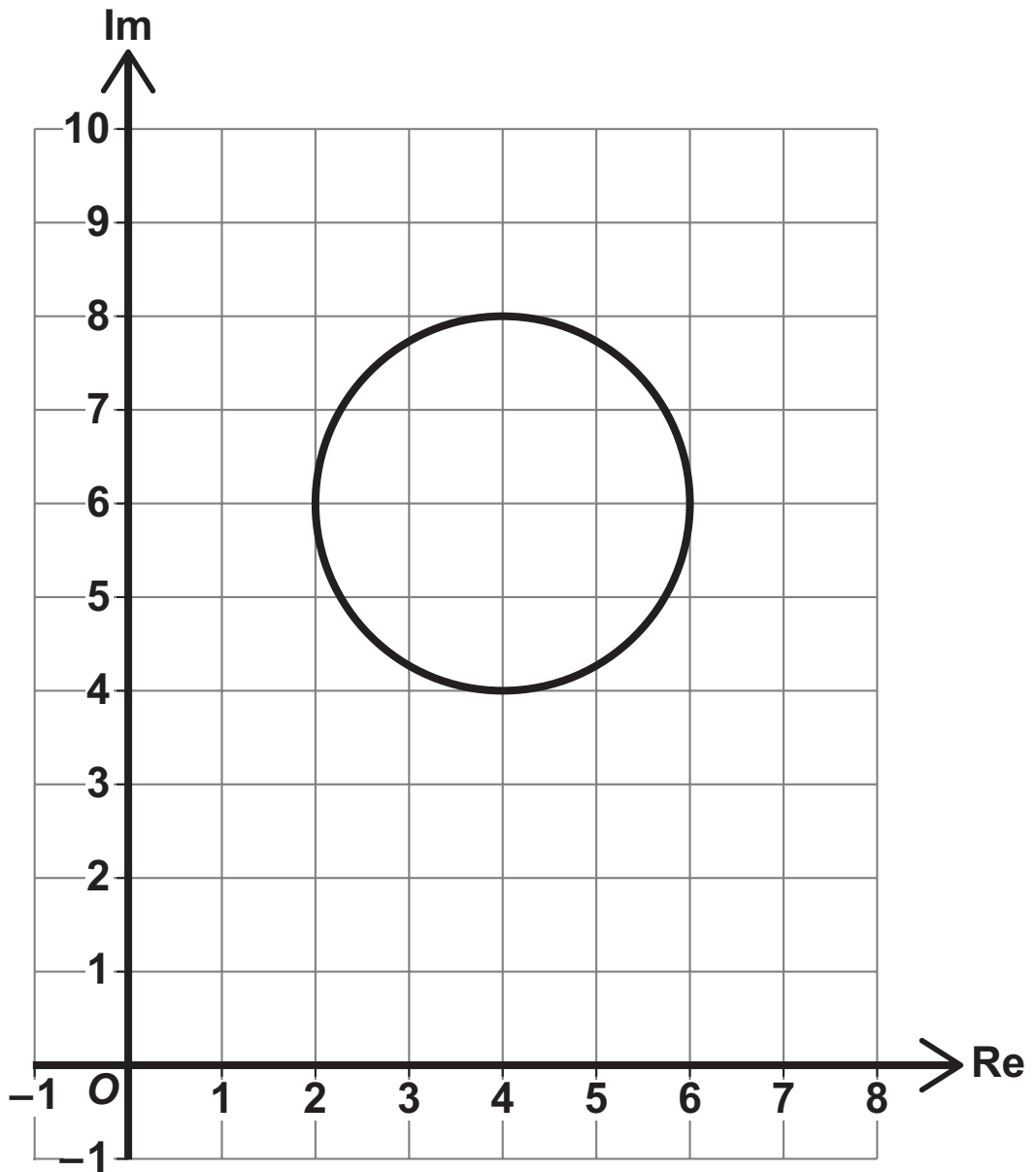
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17

The Argand diagram below shows a circle  $C$ 



17 (b) It is given that  $z_1$  is a complex number representing a point on  $C$ . Of all the complex numbers which represent points on  $C$ ,  $z_1$  has the least argument.

17 (b) (i) Find  $|z_1|$

Give your answer in an exact form. [3 marks]

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17(b)(ii) Show that  $\arg z_1 = \arcsin\left(\frac{6\sqrt{3}-2}{13}\right)$  [4 marks]

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**END OF QUESTIONS**







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For Examiner's Use	
Question	Mark
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