Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Friday 23 January 2026

Morning (Time: 1 hour 30 minutes)

Paper reference **WFM03/01**

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Mathematics

International Advanced Subsidiary/Advanced Level
Further Pure Mathematics F3

You must have:
Mathematical Formulae and Statistical Tables (Yellow), calculator

Total Marks

Candidates may use any calculator permitted 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 9 questions in this question paper. The total mark for this paper is 75.
- 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.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

Turn over ▶

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1. The hyperbola H is defined by the equation

$$\frac{x^2}{48} - \frac{y^2}{b^2} = 1$$

where b is a positive constant.

Given that H has a focus at the point $(8, 0)$, determine

(i) the value of b,

(ii) the exact value of the eccentricity of H.

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Question 1 continued

(Total for Question 1 is 5 marks)

2. **In this question you must show all stages of your working.**
Solutions relying entirely on calculator technology are not acceptable.

$$\mathbf{A} = \begin{pmatrix} k & 0 & 0 \\ 4 & 2 & 3 \\ 1 & 3 & 4 \end{pmatrix}$$

where k is a constant.

(a) Find, in terms of k, the determinant of $\mathbf{A}$

(1)

(b) Hence determine, in terms of k, the matrix $\mathbf{A}^{-1}$

(3)

Given that

- $k = 1$
- the matrix $\mathbf{B}$ satisfies $\mathbf{AB} = \mathbf{A}^{\mathrm{T}}$

(c) determine the matrix $\mathbf{B}$

(3)

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Question 2 continued

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Question 2 continued

(Total for Question 2 is 7 marks)

3. (a) Using the appropriate definitions of hyperbolic functions in terms of exponentials, show that

$$\sinh x + \operatorname{sech} x = \frac{e^{4x} + 4e^{2x} - 1}{2e^{3x} + 2e^{x}}$$

(4)

(b) Hence solve the equation

$$\sinh x + \operatorname{sech} x = \frac{1}{2}e^{x}$$

Give the answer in the form $a \ln b$ where a is a rational number and b is an integer.

(*Solutions relying on calculator technology are not acceptable.*)

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Question 3 continued

(Total for Question 3 is 8 marks)

4.

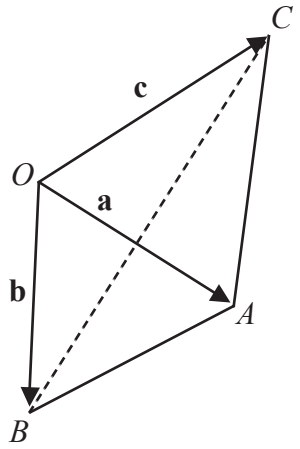


Figure 1

The points A, B and C have position vectors $\mathbf{a}$, $\mathbf{b}$ and $\mathbf{c}$ respectively, relative to a fixed origin O, as shown in Figure 1, where

$$\mathbf{a} = 2\mathbf{i} - \mathbf{k} \qquad \mathbf{b} = \mathbf{i} + 2\mathbf{j} - 2\mathbf{k} \qquad \text{and} \qquad \mathbf{c} = 3\mathbf{i} + \mathbf{j} + \mathbf{k}$$

Determine

(a) $\mathbf{b} \times \mathbf{c}$

(2)

(b) $\mathbf{a} \bullet (\mathbf{b} \times \mathbf{c})$

(2)

(c) the volume of the tetrahedron $OABC$

(1)

(d) the shortest distance from A to the plane containing O, B and C, giving the answer as a simplified surd.

(3)

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Question 4 continued

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Question 4 continued

(Total for Question 4 is 8 marks)

5.

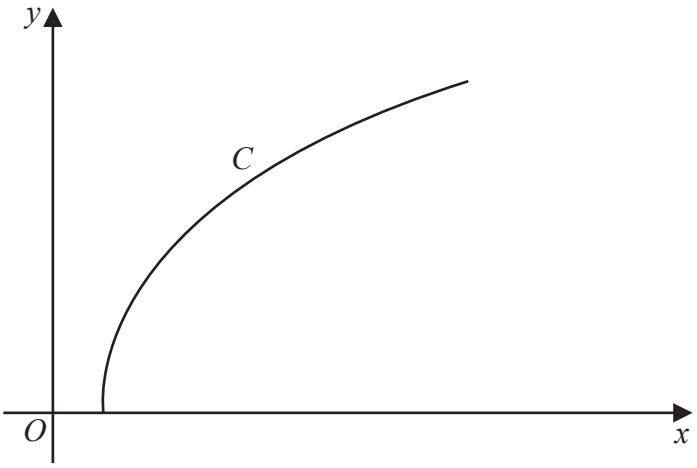


Figure 2

In this question you must show all stages of your working.
Solutions relying on calculator technology are not acceptable.

Figure 2 shows a sketch of the curve C defined by the parametric equations

$$x = \cosh 2t \qquad y = 4\sinh t \qquad 0 \leqslant t \leqslant \frac{3}{2}$$

(a) Show that

$$\left(\frac{\mathrm{d}x}{\mathrm{d}t}\right)^2 + \left(\frac{\mathrm{d}y}{\mathrm{d}t}\right)^2 = m\cosh^n t$$

where m and n are integers to be determined.

(5)

(b) Use algebraic integration to determine the exact length of C.

Give the answer in the form $a + \sinh b$ where a and b are integers to be found.

(3)

(c) Use algebraic integration to determine the exact area of the surface formed when C is rotated through $360°$ about the x-axis.

Give the answer in simplest form in terms of hyperbolic functions.

(4)

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Question 5 continued

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Question 5 continued

(Total for Question 5 is 12 marks)

6. **In this question you must show all stages of your working.**
Solutions relying on calculator technology are not acceptable.

The matrix **M** is given by

$$\begin{pmatrix} -2 & 2 & 2 \\ -3 & -7 & -3 \\ 1 & 1 & -3 \end{pmatrix}$$

(a) Show that $\begin{pmatrix} 1 \\ 0 \\ -1 \end{pmatrix}$ is an eigenvector of **M**, stating the corresponding eigenvalue.

(3)

(b) Show that the eigenvalue from part (a) is the only eigenvalue of **M**.

(4)

The transformation $M : \mathbb{R}^3 \to \mathbb{R}^3$ is represented by the matrix **M**.

(c) Determine a Cartesian equation for the image under M of the line with equation

$$x - 1 = \frac{y+1}{2} = \frac{z}{-3}$$

(4)

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Question 6 continued

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Question 6 continued

(Total for Question 6 is 11 marks)

7. **In this question you must show all stages of your working.**
Solutions relying entirely on calculator technology are not acceptable.

$$I_n = \int_0^{\frac{\pi}{4}} e^{4x} \tan^n x \, dx$$

(a) Use integration to prove that, for $n \geqslant 1$

$$I_{n+1} = \frac{e^{\pi}}{n} - \frac{k}{n} I_n - I_{n-1}$$

where k is a constant to be determined.

(4)

(b) Determine the exact value of I_0

(2)

Given that $I_1 = 3.7002$ to 5 significant figures,

(c) use the answer to part (a) to determine the value of I_4 to 3 significant figures.

(3)

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Question 7 continued

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Question 7 continued

(Total for Question 7 is 9 marks)

8 The ellipse E has equation

$$\frac{x^2}{16}+\frac{y^2}{9}=1$$

The point $P\left(4\cos\theta, 3\sin\theta\right)$ lies on E where $0 < \theta < \frac{\pi}{2}$

(a) Use calculus to show that an equation for the normal to E at P is given by

$$4x\sin\theta - 3y\cos\theta = 7\sin\theta\cos\theta$$

(4)

The normal to E at P meets the x-axis at the point A.

(b) Show that the area of triangle OAP, where O is the origin, is $k\sin 2\theta$, where k is a rational number to be determined.

(4)

(c) Hence state the value of the maximum area for triangle OAP.

(1)

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Question 8 continued

Question 8 continued

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Question 8 continued

(Total for Question 8 is 9 marks)

9. $$y = \text{artanh}\left(\frac{x}{\sqrt{1+x^2}}\right)$$

(a) Show that

$$\frac{dy}{dx} = \frac{1}{\sqrt{1+x^2}}$$

(4)

(b) Hence, by integrating the result in part (a), prove that

$$\text{artanh}\left(\frac{x}{\sqrt{1+x^2}}\right) = \text{arsinh}\, x$$

(2)

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Question 9 continued

Question 9 continued

(Total for Question 9 is 6 marks)

TOTAL FOR PAPER IS 75 MARKS

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