



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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9709/31

May/June 2024

1 hour 50 minutes

You will need: List of formulae (MF19)

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Any blank pages are indicated.

- 1** Expand $(3+x)(1-2x)^{\frac{1}{2}}$ in ascending powers of x , up to and including the term in x^2 , simplifying the coefficients. [4]

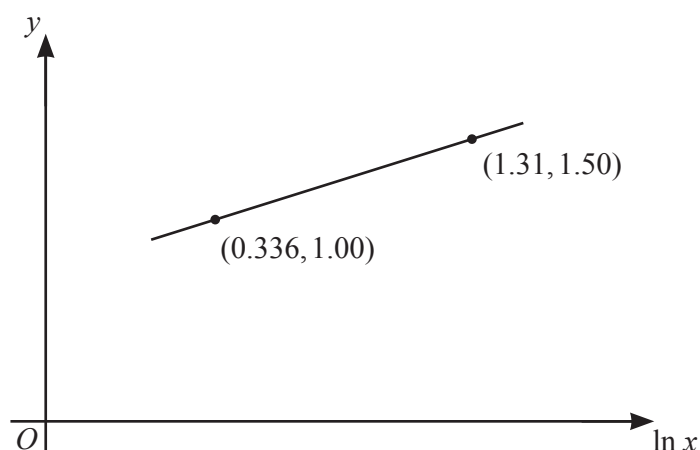
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- 2 Solve the equation $\ln(x-5) = 7 - \ln x$. Give your answer correct to 2 decimal places. [4]

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The variables x and y satisfy the equation $a^y = bx$, where a and b are constants. The graph of y against $\ln x$ is a straight line passing through the points $(0.336, 1.00)$ and $(1.31, 1.50)$, as shown in the diagram.

Find the values of a and b . Give each value correct to the nearest integer. [4]

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4 The complex number u is given by $u = -1 - i\sqrt{3}$.

- (a) Express u in the form $r(\cos \theta + i \sin \theta)$, where $r > 0$ and $-\pi < \theta \leq \pi$. Give the exact values of r and θ . [2]

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The complex number v is given by $v = 5\left(\cos \frac{1}{6}\pi + i \sin \frac{1}{6}\pi\right)$.

- (b) Express the complex number $\frac{v}{u}$ in the form $re^{i\theta}$ where $r > 0$ and $-\pi < \theta \leq \pi$. [2]

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- 5** The equation of a curve is $y = \frac{e^{\sin x}}{\cos^2 x}$ for $0 \leq x \leq 2\pi$.

Find $\frac{dy}{dx}$ and hence find the x -coordinates of the stationary points of the curve. [7]

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- 6 (a)** By sketching a suitable pair of graphs, show that the equation $\operatorname{cosec} \frac{1}{2}x = e^x - 3$ has exactly one root, denoted by α , in the interval $0 < x < \pi$. [2]

- (b) Verify by calculation that α lies between 1 and 2. [2]

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- (d) Use this iterative formula with an initial value of 1.4 to determine α correct to 2 decimal places. Give the result of each iteration to 4 decimal places. [3]

- [Turn over**

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- [4]

- [2]

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Give your answer in the form $a + b\sqrt{2}$ where a and b are rational numbers to be determined. [7]

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- 9 The equations of two straight lines l_1 and l_2 are

$$l_1: \mathbf{r} = \mathbf{i} - 2\mathbf{j} + 3\mathbf{k} + \lambda(2\mathbf{i} - \mathbf{j} + a\mathbf{k}) \quad \text{and} \quad l_2: \mathbf{r} = -\mathbf{i} - \mathbf{j} - \mathbf{k} + \mu(3\mathbf{i} - 2\mathbf{j} - 2\mathbf{k}),$$

where a is a constant.

The lines l_1 and l_2 are perpendicular.

- (a) Show that $a = 4$.

[1]

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The lines l_1 and l_2 also intersect.

- (b) Find the position vector of the point of intersection.

[4]

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The point A has position vector $-5\mathbf{i} + \mathbf{j} - 9\mathbf{k}$.

- (c) Show that A lies on l_1 . [2]

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The point B is the image of A after a reflection in the line l_2 .

- (d) Find the position vector of B . [2]

[illegible]

- 10 (a)** Given that $2x = \tan y$, show that $\frac{dy}{dx} = \frac{2}{1+4x^2}$. [3]

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- (b)** Hence find the exact value of $\int_{\frac{1}{2}}^{\frac{\sqrt{3}}{2}} x \tan^{-1}(2x) dx$. [7]

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- $$1495 \frac{dx}{dt} = x(300 - x). \quad [2]$$

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- [illegible]

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