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9709/32

February/March 2024

1 hour 50 minutes

You must answer on the question paper.

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.

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- 1 Find the quotient and remainder when $x^4 - 3x^3 + 9x^2 - 12x + 27$ is divided by $x^2 + 5$. [3]

This image shows a full page of white paper with horizontal dotted lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 2 (a)** Find the coefficient of x^2 in the expansion of $(2x-5)\sqrt{4-x}$. [4]

This image shows a full page of a worksheet designed for handwriting practice. It features 18 evenly spaced, horizontal dashed lines across the entire width of the page. The background is plain white, providing a clear guide for letter height and placement. There are no margins, text, or other markings present.

- (b)** State the set of values of x for which the expansion in part **(a)** is valid. [1]

[illegible]

3 It is given that $z = -\sqrt{3} + i$.

- (a) Express z^2 in the form $re^{i\theta}$, where $r > 0$ and $-\pi < \theta \leq \pi$. [3]

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- (b) The complex number ω is such that $z^2\omega$ is real and $\left|\frac{z^2}{\omega}\right| = 12$.

Find the two possible values of ω , giving your answers in the form $Re^{i\alpha}$, where $R > 0$ and $-\pi < \alpha \leq \pi$. [3]

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- 4 The positive numbers p and q are such that

$$\ln\left(\frac{p}{q}\right) = a \quad \text{and} \quad \ln(q^2 p) = b.$$

Express $\ln(p^7q)$ in terms of a and b . [4]

[illegible]

- 5 (a)** On a sketch of an Argand diagram, shade the region whose points represent complex numbers z satisfying the inequalities $|z - 4 - 2i| \leq 3$ and $|z| \geq |10 - z|$. [4]

- (b) Find the greatest value of $\arg z$ for points in this region. [2]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the entire width of the page. There are no margins, text, or other markings present.

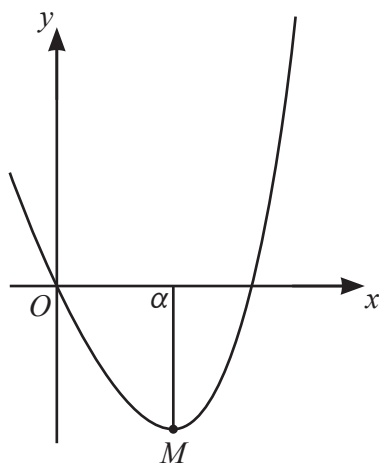
6 The equation of a curve is $2y^2 + 3xy + x = x^2$.

(a) Show that $\frac{dy}{dx} = \frac{2x-3y-1}{4y+3x}$. [4]

[illegible]

(b) Hence show that the curve does **not** have a tangent that is parallel to the x -axis. [3]

This image shows a full page of white paper with horizontal dotted lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.



(a) Show that α satisfies the equation $\alpha = \frac{1}{2} \ln\left(\frac{5}{1+2\alpha}\right)$. [3]

[illegible]

- (b) Verify by calculation that α lies between 0.4 and 0.5 .

[2]

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- (c) Use an iterative formula based on the equation in part (a) to determine α correct to 2 decimal places. Give the result of each iteration to 4 decimal places.

[3]

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- 8 (a)** Express $3 \sin x + 2\sqrt{2} \cos\left(x + \frac{1}{4}\pi\right)$ in the form $R \sin(x + \alpha)$, where $R > 0$ and $0 < \alpha < \frac{1}{2}\pi$. State the exact value of R and give α correct to 3 decimal places. [4]

[illegible]

(b) Hence solve the equation

$$6 \sin \frac{1}{2} \theta + 4 \sqrt{2} \cos \left(\frac{1}{2} \theta + \frac{1}{4} \pi \right) = 3$$

for $-4\pi < \theta < 4\pi$.

[5]

[illegible]

- 9 Relative to the origin O , the position vectors of the points A , B and C are given by

$$\overrightarrow{OA} = 5\mathbf{i} - 2\mathbf{j} + \mathbf{k}, \quad \overrightarrow{OB} = 8\mathbf{i} + 2\mathbf{j} - 6\mathbf{k} \quad \text{and} \quad \overrightarrow{OC} = 3\mathbf{i} + 4\mathbf{j} - 7\mathbf{k}.$$

- (a) Show that $OABC$ is a rectangle.

[4]

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This image shows a full page of white paper designed for handwriting practice. It features approximately 20 evenly spaced horizontal dotted lines running across the width of the page. There are no margins, text, or other markings present.

10 Let $f(x) = \frac{36a^2}{(2a+x)(2a-x)(5a-2x)}$, where a is a positive constant.

(a) Express $f(x)$ in partial fractions.

[5]

[illegible]

- (b) Hence find the exact value of $\int_{-a}^a f(x) dx$, giving your answer in the form $p \ln q + r \ln s$ where p and r are integers and q and s are prime numbers. [5]

[illegible]

- 11** The variables y and θ satisfy the differential equation

$$(1+y)(1+\cos 2\theta) \frac{dy}{d\theta} = e^{3y}.$$

It is given that $y = 0$ when $\theta = \frac{1}{4}\pi$.

Solve the differential equation and find the exact value of $\tan \theta$ when $y = 1$. [9]

This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page, typical of notebook or legal stationery. There are no margins, text, or other markings on the page.

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

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