

Cambridge Assessment
International Education

Cambridge International AS & A Level

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FURTHER MATHEMATICS**9231/22**

Paper 2 Further Pure Mathematics 2

October/November 2024**2 hours**

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- 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.

INFORMATION

- 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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[4]

[illegible]



(a) Show that, at the point $\left(2, \frac{1}{2}\right)$ on C , $\frac{dy}{dx} = -\frac{1}{6}$. [3]

$$4y^2 + 4 \ln(xy) = 1.$$

(a) Show that, at the point $(2, \frac{1}{2})$ on C , $\frac{dy}{dx} = -\frac{1}{6}$. [3]

[illegible]



[4]





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$$x = \frac{1}{2}e^{2t} - \frac{1}{3}t^3 - \frac{1}{2}, \quad y = 2e^t(t-1), \quad \text{for } 0 \leq t \leq 1.$$

Find the exact length of C .

[7]

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7



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9231/22/O/N/24

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4 (a) Use de Moivre's theorem to show that

$$\cot 6\theta = \frac{\cot^6 \theta - 15 \cot^4 \theta + 15 \cot^2 \theta - 1}{6 \cot^5 \theta - 20 \cot^3 \theta + 6 \cot \theta}. \quad [6]$$

[illegible]





5 Find the particular solution of the differential equation

$$3\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + y = x^2,$$

given that, when $x = 0$, $y = \frac{dy}{dx} = 0$.

[10]

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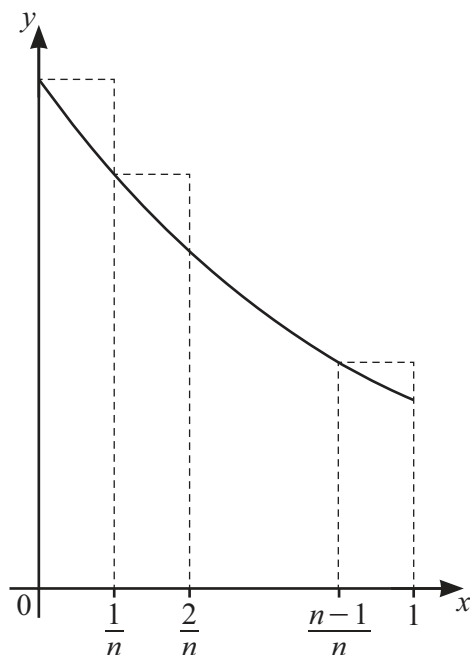


This image shows a full page of a worksheet designed for handwriting practice. It features approximately 20 horizontal dashed lines spaced evenly across the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.





6



The diagram shows the curve with equation $y = e^{1-x}$ for $0 \leq x \leq 1$, together with a set of n rectangles of width $\frac{1}{n}$.

- (a) By considering the sum of the areas of these rectangles, show that $\int_0^1 e^{1-x} dx < U_n$, where

$$U_n = \frac{e-1}{n(1-e^{-\frac{1}{n}})}. \quad [4]$$

[illegible]



(b) Use a similar method to find, in terms of n , a lower bound L_n for $\int_0^1 e^{1-x} dx$. [4]

(c) Show that $\lim_{n \rightarrow \infty} (U_n - L_n) = 0$. [2]





(d) Use the Maclaurin’s series for e^x given in the list of formulae (MF19) to find the first three terms of the series expansion of $z(1 - e^{-\frac{1}{z}})$, in ascending powers of $\frac{1}{z}$, and deduce the value of $\lim_{n \rightarrow \infty} (U_n)$. [3]

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7 (a) Show that $\frac{d}{dx}(\ln(\tanh x)) = 2 \operatorname{cosech} 2x$. [3]

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[4]

[illegible]



(c) Find a matrix $\mathbf{P}$ and a diagonal matrix $\mathbf{D}$ such that $(\mathbf{A} - 3\mathbf{I})^4 = \mathbf{PDP}^{-1}$. [6]

[illegible]



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[illegible]



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