

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

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Forename(s)

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Candidate signature

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I declare this is my own work.

INTERNATIONAL A-LEVEL MATHEMATICS

(9660/MA03) Unit P2 Pure Mathematics

Tuesday 10 January 2023 07:00 GMT Time allowed: 2 hours 30 minutes

Materials

- For this paper you must have the Oxford International AQA Booklet of Formulae and Statistical Tables (enclosed).
- You may use a graphical calculator.

Instructions

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or 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).
- 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 120.

Advice

- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- Show all necessary working; otherwise marks may be lost.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
TOTAL	



J A N 2 3 M A 0 3 0 1

1 (a) The function f is defined by $f(x) = 3^x$ for all real values of x

$$f(x+1)-f(x-2)=kf(x)$$

[3 marks]

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are approximately 20 lines visible. The paper has a slight shadow on its right side, suggesting it's resting on a surface.

$$g(x) = \frac{3-x}{5+2x} \quad \text{for all real values of } x, \quad x \neq -2.5$$

1 (b) (i) Find $g^{-1}(x)$

[illegible]

Answer _____

1 (b) (ii) State the range of g^{-1}

Answer

7



- 2 (a)** Express $8\cos\theta + 15\sin\theta$ in the form $R\cos(\theta - \alpha)$, where $R > 0$ and $0^\circ < \alpha < 90^\circ$, giving the value of α to the nearest degree.

[3 marks]

Answer _____

- 2 (b) (i)** Hence write down the minimum value of

$$|8\cos\theta + 15\sin\theta|$$

[1 mark]

Answer _____

- 2 (b) (ii)** Hence find a value of θ at which the minimum value in **part (b)(i)** occurs, giving your answer to the nearest degree.

[1 mark]

Answer _____



$$8\operatorname{cosec}(2y+10^\circ)+15\sec(2y+10^\circ)=8.5\tan(2y+10^\circ)+8.5\cot(2y+10^\circ)$$

[5 marks]

[illegible]

10



3

$$f(x) = 16x^3 + bx^2 + cx$$

where b and c are constants.

When $f(x)$ is divided by $(2x+3)$ the remainder is -45

When $f(x)$ is divided by $(4x-5)$ the remainder is 10

3 (a) (i) Find the value of b and the value of c

[4 marks]

[illegible]

$$b = \underline{\hspace{2cm}} \qquad c = \underline{\hspace{2cm}}$$



[2 marks]

Answer _____

$$px + q + \frac{r}{mx + n}$$

[3 marks]

[illegible]

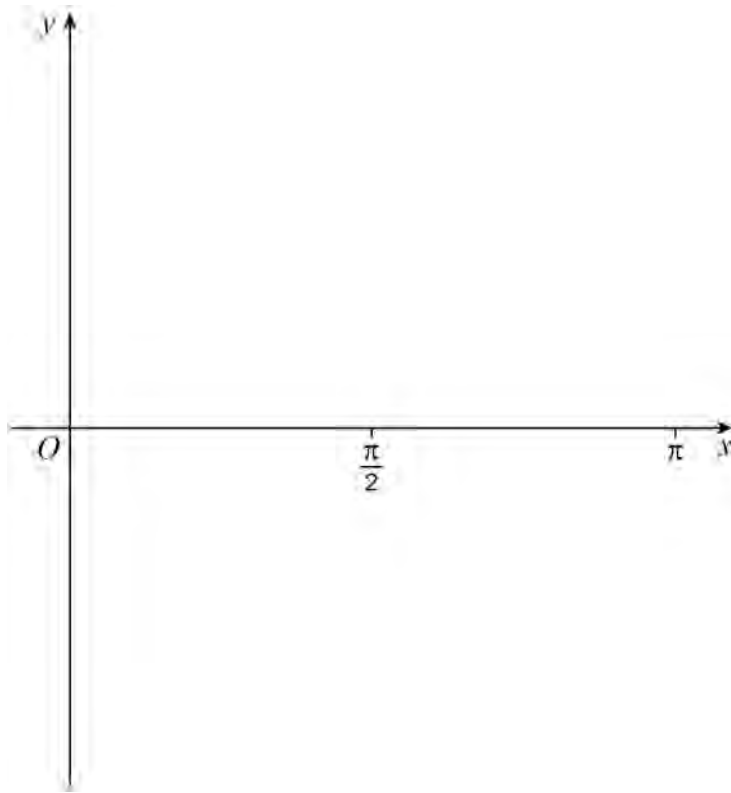
Answer



- 4 (a)** Sketch on the axes below the graph of the curve that has equation

$$y = \sec x \text{ for } 0 \leq x \leq \pi$$

[2 marks]



- 4 (b)** A curve has equation $y = \sec x$ where $0 \leq x \leq \frac{\pi}{4}$

This curve intersects the line $y = 10x - 5$ at a single point where $x = \alpha$

- 4 (b) (i)** Show that α lies between 0.6 and 0.7

[2 marks]



4 (c) Use the mid-ordinate rule with five strips to find an estimate for

$$x_{n+1} = 0.1 \sec x_n + 0.5$$

with $x_1 = 0.6$ to find the values of x_2 and x_3

[2 marks]

$$x_2 = \underline{\hspace{2cm}} \quad x_3 = \underline{\hspace{2cm}}$$

4 (c) Use the mid-ordinate rule with five strips to find an estimate for

$$\int_{0.6}^{0.7} \sec x \, dx$$

[4 marks]

[illegible]

Answer



- 5 (a)** Show that the binomial expansion of $(1 - px)^{-\frac{1}{2}}$ up to and including the term in x^3 where p is a constant is

$$1 + \frac{1}{2}px + \frac{3}{8}p^2x^2 + \frac{5}{16}p^3x^3$$

[2 marks]

- 5 (b)** Find the binomial expansion of $\sqrt{4 + px}$ up to and including the term in x^3 .
Give all numerical coefficients as simplified fractions.

[3 marks]

Answer _____



- $$\frac{3}{4}px + \sqrt{(4+px)} - 2(1-px)^{-\frac{1}{2}} = -x^2 + qx^3$$

5 (c) (i) Show that $p = \pm \frac{8}{7}$

[illegible]

- [2 marks]**

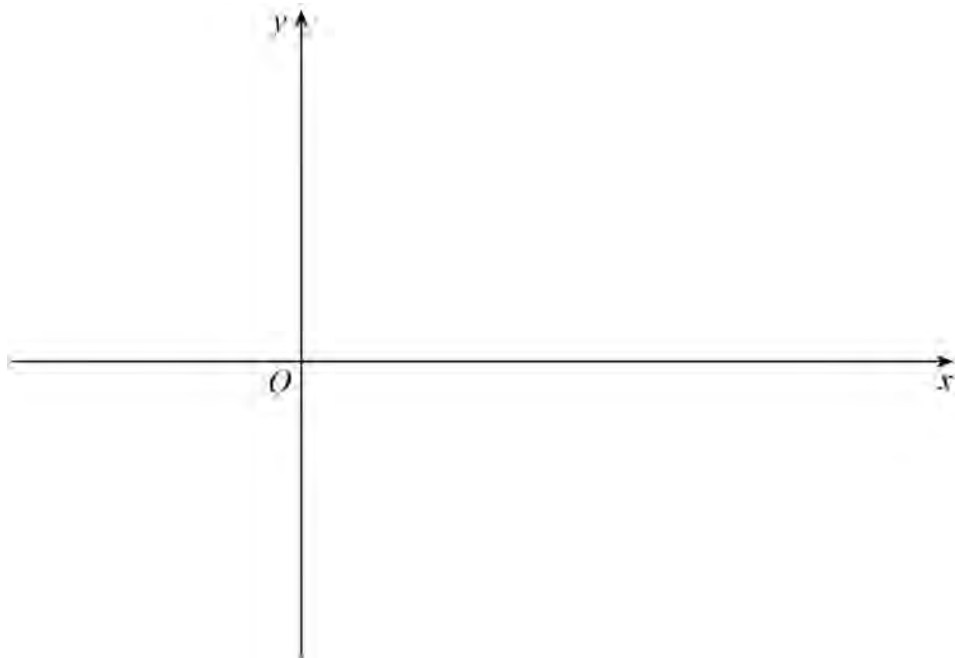
Answer



6 A curve C has equation $y = |e^{0.5x} - 4|$

- 6 (a) Sketch on the axes below the graph of C indicating the coordinates of any points where the curve meets or cuts the axes.

[3 marks]



- 6 (b) Find an equation of the normal to C at the point P where $x = \ln 25$

Give your answer in the form $ax + by = k$ where a , b and k are constants.

[5 marks]



11

- 7** The coordinates of the points A and B are $(1, 5, -3)$ and $(-2, 3, 4)$ respectively.

The line l has equation $\mathbf{r} = \begin{bmatrix} 4 \\ -1 \\ c \end{bmatrix} + \lambda \begin{bmatrix} 1 \\ -2 \\ -3 \end{bmatrix}$ where c is a constant.

- 7 (a) (i)** Find the vector \vec{AB}

[1 mark]

Answer _____

- 7 (a) (ii)** Find $|\vec{AB}|$

[2 marks]

Answer _____

- 7 (a) (iii)** Calculate the acute angle between \vec{AB} and the line l , giving your answer to the nearest 0.1°

[3 marks]

Answer _____



7 (a) (iv) The line AB intersects the line l

Find the value of c

[3 marks]

Answer _____

7 (b) (i) Find the shortest distance from l to the origin.

[4 marks]

Answer _____

7 (b) (ii) Explain which of the line l or the line AB , is nearest to the origin.

[2 marks]



[6 marks]

[illegible]

Answer

- 9 (a)** Describe a single geometrical transformation that maps the graph of $y = \ln x$ onto the graph of $y = \ln(2x)$

[2 marks]

- 9 (b)** The region bounded by the curve $y = \ln(2x)$, the line $x = 4$ and the x -axis from $x = 0.5$ to $x = 4$ is rotated through 2π radians about the x -axis to form a solid.

Find the value of the volume of the solid generated, giving your answer in an exact form.

[9 marks]

Answer _____



$$\frac{dy}{dx} = b(3a - 2y)(a - y)$$

Give your answer in the form $y = f(x)$

[illegible]

[illegible]

Answer

10

[2 marks]

[illegible]

11 (b) Use the substitution $t = \sin x$ to find

$$\int_0^{\frac{\pi}{6}} \frac{\sin 2x}{3 + \cos^2 x} dx$$

giving your answer in the form $\ln\left(\frac{a}{b}\right)$ where a and b are integers.

[7 marks]



Answer _____

12 A curve C is defined by the parametric equations

$$x = 2\cos\theta \quad \text{and} \quad y = 3\sin\theta \quad \text{for } 0 \leq \theta \leq 2\pi$$

12 (a) Find a Cartesian equation of C

[2 marks]

Answer _____

12 (b) Find the equation of the tangent to the curve at the point where $\theta = \frac{\pi}{6}$
Give your answer in the form $y + ax + b = 0$ where a and b are constants.

$$\left[\text{You are given } \sin\left(\frac{\pi}{6}\right) = \frac{1}{2} \text{ and } \cos\left(\frac{\pi}{6}\right) = \frac{\sqrt{3}}{2} \right]$$

[4 marks]

Answer _____



[5 marks]

[illegible]

11



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