Pearson Edexcel International Advanced Level

Tuesday 21 October 2025

Afternoon (Time: 1 hour 30 minutes)

Paper reference **WMA13/01A**

Mathematics

International Advanced Level
Pure Mathematics P3
Question paper

You must have:
Answer book (sent separately)
Do not return this question paper with the answer book

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1. Find

(i) (a) $\int (2x + 3)^{12} \mathrm{d}x$

(2)

(b) $\int \frac{5x}{4x^2 + 1} \mathrm{d}x$

(2)

(ii) Given that

$$\int_a^{2a} \frac{t+1}{t} \mathrm{d}t = \ln 7 \qquad a > 0$$

find the exact value of constant a.

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

(4)

(Total for Question 1 is 8 marks)

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2. $$y = (2x^2 - 3)\tan\left(\frac{1}{2}x\right) \qquad 0 < x < \pi$$

Given that $\frac{\mathrm{d}y}{\mathrm{d}x} = 0$ when $x = \alpha$

(a) show that

$$2\alpha^2 - 3 + 4\alpha \sin \alpha = 0$$

(6)

The iterative formula

$$x_{n+1} = \frac{3}{(2x_n + 4\sin x_n)}$$

can be used to find an approximation for α.

(b) Taking $x_1 = 0.7$, find the values of x_2 and x_3, giving each answer to 4 decimal places.

(2)

(c) By choosing a suitable interval and a suitable function that should be stated, show that $\alpha = 0.7283$ to 4 decimal places.

(2)

(Total for Question 2 is 10 marks)

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3. $$g(x) = \frac{x^4 + x^3 - 7x^2 + 8x - 48}{x^2 + x - 12} \qquad x > 3 \qquad x \in \mathbb{R}$$

(a) Given that

$$\frac{x^4 + x^3 - 7x^2 + 8x - 48}{x^2 + x - 12} \equiv x^2 + A + \frac{B}{x - 3}$$

find the values of the constants A and B.

(4)

(b) Hence, or otherwise, find the equation of the tangent to the curve with equation $y = g(x)$ at the point where $x = 4$. Give your answer in the form $y = mx + c$, where m and c are constants to be determined.

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

(5)

(Total for Question 3 is 9 marks)

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4. A curve has equation

$$y = \ln(1 - \cos 2x) \qquad x \in \mathbb{R} \qquad 0 < x < \pi$$

Show that

(a) $\frac{dy}{dx} = k \cot x$, where k is a constant to be found.

(4)

Hence find the exact coordinates of the point on the curve where

(b) $\frac{dy}{dx} = 2\sqrt{3}$

(4)

(Total for Question 4 is 8 marks)

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

(a) Prove that

$$2\operatorname{cosec} 2A - \cot A \equiv \tan A \qquad A \neq \frac{n\pi}{2} \qquad n \in \mathbb{Z}$$

(4)

(b) Hence solve, for $0 \leqslant \theta \leqslant \frac{\pi}{2}$

(i) $2\operatorname{cosec} 4\theta - \cot 2\theta = \sqrt{3}$

(ii) $\tan\theta + \cot\theta = 5$

Give your answers to 3 significant figures.

(5)

(Total for Question 5 is 9 marks)

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6.

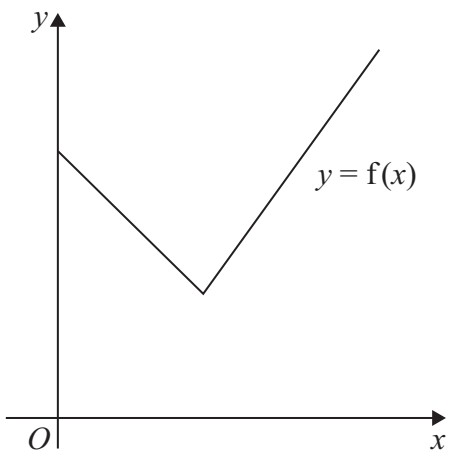


Figure 1

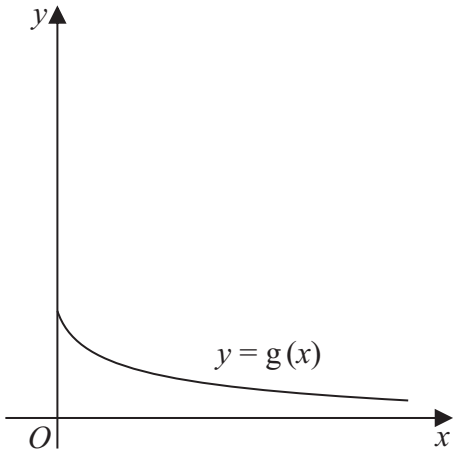


Figure 2

Figure 1 shows a sketch of part of the graph $y = f(x)$, where

$$f(x) = 2|3 - x| + 5 \qquad x \geqslant 0$$

Figure 2 shows a sketch of part of the graph $y = g(x)$, where

$$g(x) = \frac{x+9}{2x+3} \qquad x \geqslant 0$$

(a) Find the value of $fg(1)$

(2)

(b) State the range of g

(2)

(c) Find g^{-1}

(3)

Given that the equation $f(x) = k$, where k is a constant, has exactly two roots,

(d) state the range of possible values of k.

(3)

(Total for Question 6 is 10 marks)

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7.

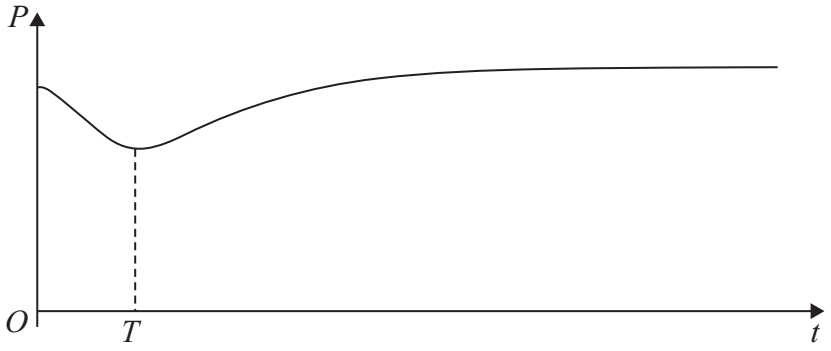


Figure 3

A colony of bees is being studied. The number of bees in the colony is modelled by the equation

$$P = 200 - \frac{160e^{0.6t}}{15 + e^{0.8t}} \qquad t \in \mathbb{R} \qquad t \geqslant 0$$

where P is the number of bees, measured in thousands, t years after the study started. A sketch of the graph of P against t is shown in Figure 3

(a) Calculate the number of bees in the colony at the start of the study.

(2)

(b) Find $\frac{dP}{dt}$

(3)

The population of bees initially decreases, reaching a minimum value after T years, as shown in Figure 3

(c) Using your answer to part (b), calculate the value of T to 2 decimal places.

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

(4)

(Total for Question 7 is 9 marks)

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

(a) Express $10\cos\theta - 3\sin\theta$ in the form $R\cos(\theta + \alpha)$, where $R > 0$ and $0 < \alpha < 90°$

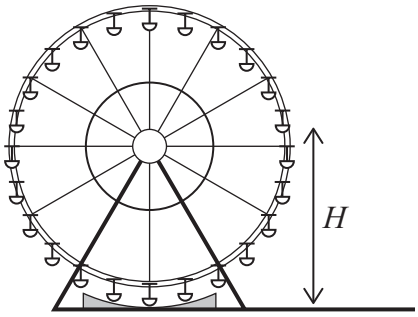
Give the exact value of R and the value of α to 2 decimal places.

(3)

Alana models the height above the ground of a passenger on a Ferris wheel by the equation

$$H = 12 - 10\cos(30t)° + 3\sin(30t)°$$

where the height of the passenger above the ground is H metres at time t minutes after the wheel starts turning.



Use part (a) and the equation of the model to answer parts (b), (c) and (d).

(b) Calculate

(i) the maximum value of H

(ii) the value of t when this maximum first occurs.

Give each answer to 2 decimal places.

(3)

(c) Calculate the value of t when the passenger is 18 m above the ground for the first time.

Give your answer to 2 decimal places.

(4)

(d) Determine the time taken for the Ferris wheel to complete two revolutions.

(2)

(Total for Question 8 is 12 marks)

TOTAL FOR PAPER IS 75 MARKS

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Please check the examination details below before entering your candidate information

Candidate surname StemUp Model Solution | Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Tuesday 21 October 2025

Afternoon (Time: 1 hour 30 minutes) | Paper reference **WMA13/01A**

Mathematics

International Advanced Level
Pure Mathematics P3
Answer Book

You must have: Question paper (sent separately), 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 8 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.

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Question 1

Write the answer to Question 1 on these 2 pages

(i)(a) $\int (2x + 3)^{12}\, dx = \frac{(2x + 3)^{13}}{13 \times 2} + c = \frac{(2x + 3)^{13}}{26} + c$

(i)(b) $\frac{d}{dx}(4x^2 + 1) = 8x$

$\int \frac{5x}{4x^2 + 1}\, dx = \frac{5}{8}\int \frac{8x}{4x^2 + 1}\, dx = \frac{5}{8}\ln(4x^2 + 1) + c$

(ii) $\int \frac{t + 1}{t}\, dt = \int \left(1 + \frac{1}{t}\right) dt = t + \ln t$

$\int_a^{2a} \frac{t + 1}{t}\, dt = \left[t + \ln t\right]_a^{2a} = 2a + \ln 2a - (a + \ln a)$

$2a + \ln 2a - a - \ln a = \ln 7$

$a + \ln\left(\frac{2a}{a}\right) = \ln 7 \Rightarrow a + \ln 2 = \ln 7$

$a = \ln 7 - \ln 2 = \ln\left(\frac{7}{2}\right)$

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Question 1 continued

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(Total for Question 1 is 8 marks)

Question 2

Write the answer to Question 2 on these 2 pages

(a) $\frac{dy}{dx} = 4x\tan\left(\frac{1}{2}x\right) + (2x^2 - 3) \times \frac{1}{2}\sec^2\left(\frac{1}{2}x\right)$ (product rule)

At $x = \alpha$, $\frac{dy}{dx} = 0$: $4\alpha\tan\left(\frac{1}{2}\alpha\right) + \frac{1}{2}(2\alpha^2 - 3)\sec^2\left(\frac{1}{2}\alpha\right) = 0$

$4\alpha\frac{\sin(\alpha/2)}{\cos(\alpha/2)} + \frac{1}{2}(2\alpha^2 - 3) \times \frac{1}{\cos^2(\alpha/2)} = 0$

$\times 2\cos^2(\alpha/2)$: $8\alpha\sin\left(\frac{1}{2}\alpha\right)\cos\left(\frac{1}{2}\alpha\right) + (2\alpha^2 - 3) = 0$

Using $2\sin\left(\frac{1}{2}\alpha\right)\cos\left(\frac{1}{2}\alpha\right) = \sin\alpha$: $4\alpha\sin\alpha + (2\alpha^2 - 3) = 0$

$\therefore$ $2\alpha^2 - 3 + 4\alpha\sin\alpha = 0$ as required

(b) $x_2 = \frac{3}{(2 \times 0.7 + 4\sin 0.7)} = 0.754361...$

$x_2 = 0.7544$, $x_3 = 0.706211... = 0.7062$

(c) Let $f(x) = 2x^2 - 3 + 4x\sin x$, interval $[0.72825, 0.72835]$

$f(0.72825) = 2(0.72825)^2 - 3 + 4(0.72825)\sin(0.72825) = -0.000514... < 0$

$f(0.72835) = 2(0.72835)^2 - 3 + 4(0.72835)\sin(0.72835) = 0.000261... > 0$

Change of sign and f is continuous, so $0.72825 < \alpha < 0.72835$

$\therefore$ $\alpha = 0.7283$ to 4 decimal places

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Question 2 continued

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(Total for Question 2 is 10 marks)

Question 3

Write the answer to Question 3 on these 2 pages

(a)

$$\begin{array}{rl} & x^2 \quad + 5 \\ x^2 + x - 12 \;\big)\; & x^4 + x^3 - 7x^2 + 8x - 48 \\ & x^4 + x^3 - 12x^2 \\ \hline & \quad 5x^2 + 8x - 48 \\ & \quad 5x^2 + 5x - 60 \\ \hline & \qquad\quad 3x + 12 \end{array}$$

Quotient $x^2 + 5$, remainder $3x + 12$

$$\frac{x^4 + x^3 - 7x^2 + 8x - 48}{x^2 + x - 12} \equiv x^2 + 5 + \frac{3x + 12}{(x + 4)(x - 3)} \equiv x^2 + 5 + \frac{3(x + 4)}{(x + 4)(x - 3)}$$

$$\equiv x^2 + 5 + \frac{3}{x - 3} \qquad A = 5, \quad B = 3$$

(b) $g(x) = x^2 + 5 + 3(x - 3)^{-1} \Rightarrow g'(x) = 2x - \frac{3}{(x - 3)^2}$

$x = 4$: $g'(4) = 2 \times 4 - \frac{3}{(4 - 3)^2} = 8 - 3 = 5$

$g(4) = 4^2 + 5 + \frac{3}{4 - 3} = 16 + 5 + 3 = 24$

$y - 24 = 5(x - 4)$

$y = 5x + 4$

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Question 3 continued

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(Total for Question 3 is 9 marks)

Question 4

Write the answer to Question 4 on these 2 pages

(a) $y = \ln(1 - \cos 2x) \Rightarrow \frac{dy}{dx} = \frac{2\sin 2x}{1 - \cos 2x}$

$= \frac{2 \times 2\sin x \cos x}{1 - (1 - 2\sin^2 x)}$ $(\sin 2x = 2\sin x \cos x,\ \cos 2x = 1 - 2\sin^2 x)$

$= \frac{4\sin x \cos x}{2\sin^2 x} = \frac{2\cos x}{\sin x} = 2\cot x$

$\therefore \frac{dy}{dx} = 2\cot x, \quad k = 2$

(b) $2\cot x = 2\sqrt{3} \Rightarrow \cot x = \sqrt{3} \Rightarrow \tan x = \frac{1}{\sqrt{3}}$

$x = \arctan\left(\frac{1}{\sqrt{3}}\right) = \frac{\pi}{6} \quad (0 < x < \pi)$

$y = \ln\left(1 - \cos\left(\frac{2\pi}{6}\right)\right) = \ln\left(1 - \frac{1}{2}\right) = \ln\left(\frac{1}{2}\right) = -\ln 2$

Point $\left(\frac{\pi}{6}, -\ln 2\right)$

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Question 4 continued

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(Total for Question 4 is 8 marks)

Question 5

Write the answer to Question 5 on these 4 pages

(a) $LHS = 2\operatorname{cosec} 2A - \cot A = \dfrac{2}{\sin 2A} - \dfrac{\cos A}{\sin A}$

$= \dfrac{2}{2\sin A \cos A} - \dfrac{\cos A}{\sin A} = \dfrac{2 - 2\cos^2 A}{2\sin A \cos A}$

$= \dfrac{2(1 - \cos^2 A)}{2\sin A \cos A} = \dfrac{2\sin^2 A}{2\sin A \cos A} = \dfrac{\sin A}{\cos A} = \tan A = RHS$

$\therefore \quad 2\operatorname{cosec} 2A - \cot A \equiv \tan A$

(b)(i) Using (a) with $A = 2\theta$: $2\operatorname{cosec} 4\theta - \cot 2\theta = \tan 2\theta$

$\tan 2\theta = \sqrt{3}, \quad 0 \leq 2\theta \leq \pi$

$2\theta = \arctan \sqrt{3} = \dfrac{\pi}{3} \quad \Rightarrow \quad \theta = \dfrac{\pi}{6} = 0.524$

$\theta = 0.524$

(ii) From (a) with $A = \theta$: $\tan \theta + \cot \theta = 2\operatorname{cosec} 2\theta$

$2\operatorname{cosec} 2\theta = 5 \quad \Rightarrow \quad \dfrac{2}{\sin 2\theta} = 5 \quad \Rightarrow \quad \sin 2\theta = \dfrac{2}{5}$

$0 \leq 2\theta \leq \pi$: $2\theta = \arcsin\left(\dfrac{2}{5}\right) = 0.411516\ldots, \quad 2\theta = \pi - 0.411516\ldots = 2.730076\ldots$

$\theta = \dfrac{1}{2}\arcsin\left(\dfrac{2}{5}\right) = 0.205758\ldots \quad \text{or} \quad \theta = 1.365037\ldots$

$\theta = 0.206, \quad \theta = 1.37$

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Question 5 continued

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Question 5 continued

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(Total for Question 5 is 9 marks)

Question 6

Write the answer to Question 6 on these 4 pages

(a) $g(1) = \frac{1+9}{2+3} = 2$

$fg(1) = f(2) = 2|3-2| + 5 = 7$

(b) $g(0) = \frac{9}{3} = 3$, as $x \to \infty$, $g(x) \to \frac{1}{2}$

$0.5 < g(x) \leq 3$

(c) $y = \frac{x+9}{2x+3} \Rightarrow 2xy + 3y = x + 9$

$2xy - x = 9 - 3y \Rightarrow x(2y-1) = 9 - 3y \Rightarrow x = \frac{9-3y}{2y-1}$

$g^{-1}(x) = \frac{9-3x}{2x-1}$, $0.5 < x \leq 3$

(d) $f(0) = 2|3-0| + 5 = 11$, minimum point $f(3) = 2|3-3| + 5 = 5$

Two roots when the line $y = k$ meets both branches:

$5 < k \leq 11$

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Question 6 continued

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(Total for Question 6 is 10 marks)

Question 7

Write the answer to Question 7 on these 4 pages

(a) $t = 0$: $P = 200 - \frac{160e^0}{15 + e^0} = 200 - \frac{160}{16} = 190$

190 000 bees

(b) $u = 160e^{0.6t}$, $\frac{du}{dt} = 96e^{0.6t}$; $v = 15 + e^{0.8t}$, $\frac{dv}{dt} = 0.8e^{0.8t}$

$$\frac{dP}{dt} = -\frac{(15 + e^{0.8t}) \times 96e^{0.6t} - 160e^{0.6t} \times 0.8e^{0.8t}}{(15 + e^{0.8t})^2}$$

(c) $\frac{dP}{dt} = 0 \Rightarrow (15 + e^{0.8t}) \times 96e^{0.6t} - 160e^{0.6t} \times 0.8e^{0.8t} = 0$

$1440e^{0.6t} + 96e^{1.4t} - 128e^{1.4t} = 0$

$1440e^{0.6t} = 32e^{1.4t} \Rightarrow e^{0.8t} = \frac{1440}{32} = 45$

$0.8T = \ln 45 \Rightarrow T = \frac{\ln 45}{0.8} = 4.758328...$

$T = 4.76$

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Question 7 continued

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(Total for Question 7 is 9 marks)

Question 8

Write the answer to Question 8 on these 3 pages

(a) $10\cos\theta - 3\sin\theta = R\cos\theta\cos\alpha - R\sin\theta\sin\alpha$

$R\cos\alpha = 10, \quad R\sin\alpha = 3$

$R = \sqrt{(10^2 + 3^2)} = \sqrt{109}$

$\tan\alpha = \frac{3}{10} \Rightarrow \alpha = 16.699...° = 16.70°$

$10\cos\theta - 3\sin\theta = \sqrt{109}\cos(\theta + 16.70°)$

(b) $H = 12 - (10\cos(30t)° - 3\sin(30t)°) = 12 - \sqrt{109}\cos(30t + 16.70)°$

(i) Maximum when $\cos(30t + 16.70)° = -1$:

$H_{max} = 12 + \sqrt{109} = 22.4403... = 22.44$ m

(ii) $30t + 16.70 = 180 \Rightarrow 30t = 163.30...$

$t = 5.44336... = 5.44$

(c) $18 = 12 - \sqrt{109}\cos(30t + 16.70)°$

$\cos(30t + 16.70)° = -\frac{6}{\sqrt{109}} = -0.5746...$

$30t + 16.70 = \arccos\left(-\frac{6}{\sqrt{109}}\right) = 125.078...°$

$30t = 108.379... \Rightarrow t = 3.6126...$

$t = 3.61$

(d) One revolution: $30t = 360 \Rightarrow t = 12$ minutes

Two revolutions: $30t = 720 \Rightarrow t = 24$ minutes

24 minutes

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Question 8 continued

Question 8 continued

(Total for Question 8 is 12 marks)

TOTAL FOR PAPER IS 75 MARKS

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