Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Wednesday 4 June 2025

Afternoon (Time: 2 hours)

Paper reference **9MA0/01**

Mathematics

Advanced

PAPER 1: Pure Mathematics 1

You must have:
Mathematical Formulae and Statistical Tables (Green), calculator

Total Marks

Candidates may use any calculator allowed 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 16 questions in this question paper. The total mark for this paper is 100.
- 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.

Turn over

1. The point $P(6, -4)$ lies on the curve with equation $y = \text{f}(x)$, $x \in \mathbb{R}$

Find the point to which P is mapped when the curve with equation $y = \text{f}(x)$ is transformed to the curve with equation

(a) $y = \text{f}(x + 2)$

(1)

(b) $y = \text{f}^{-1}(x)$

(1)

(c) $y = 2|\text{f}(x)| - 3$

(2)

Question 1 continued

(Total for Question 1 is 4 marks)

2. The circle C has equation

$$(x + 3)^2 + (y - 4)^2 = 24$$

(a) (i) State the coordinates of the centre of C.

(ii) Find the radius of C writing your answer as a fully simplified surd.

(3)

(b) Determine, giving a reason, whether or not the origin lies inside the circle C.

(2)

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Question 2 continued

(Total for Question 2 is 5 marks)

3. The first three terms of an arithmetic sequence are

$$6k, 10 \text{ and } 2k$$

where k is a constant.

(a) Find the value of k.

(2)

(b) Hence find the value of the sum of the first 50 terms of this sequence.

(3)

Question 3 continued

(Total for Question 3 is 5 marks)

4. Given that

- $f(x) = 2x^3 + 3x^2 - 16x + 16$
- $f(-4) = 0$

(a) write $f(x)$ in the form

$$(x + a)\,Q(x)$$

where a is a constant and $Q(x)$ is a quadratic expression.

(3)

(b) Hence prove that –4 is the only real root of the equation

$$f(x) = 0$$

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

(2)

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Question 4 continued

(Total for Question 4 is 5 marks)

5. (a) Express $\lim_{\delta x \to 0} \sum_{x=1.44}^{2.89} \frac{2}{\sqrt{x}} \delta x$ as an integral.

(1)

(b) Hence show that

$$\lim_{\delta x \to 0} \sum_{x=1.44}^{2.89} \frac{2}{\sqrt{x}} \delta x = k$$

where k is an integer to be found.

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

(2)

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Question 5 continued

(Total for Question 5 is 3 marks)

6. A scientist is monitoring the flight of sea birds after they leave their nests on a cliff.

The height above the sea, h metres, of one of the birds is modelled by the equation

$$h = A - B\,t^{1.5} \qquad h \geqslant 0 \qquad 0 \leqslant t \leqslant T$$

where t seconds is the time after the bird leaves its nest and A, B and T are positive constants.

Given that

- the bird was 17.6 m above the sea exactly 4 seconds after leaving its nest
- the bird was 11.9 m above the sea exactly 9 seconds after leaving its nest

(a) find a complete equation for the model.

(4)

Find, according to the model,

(b) the height of the bird's nest above the sea,

(1)

(c) the limitation on the value of T.

(2)

Question 6 continued

Question 6 continued

Question 6 continued

(Total for Question 6 is 7 marks)

7.

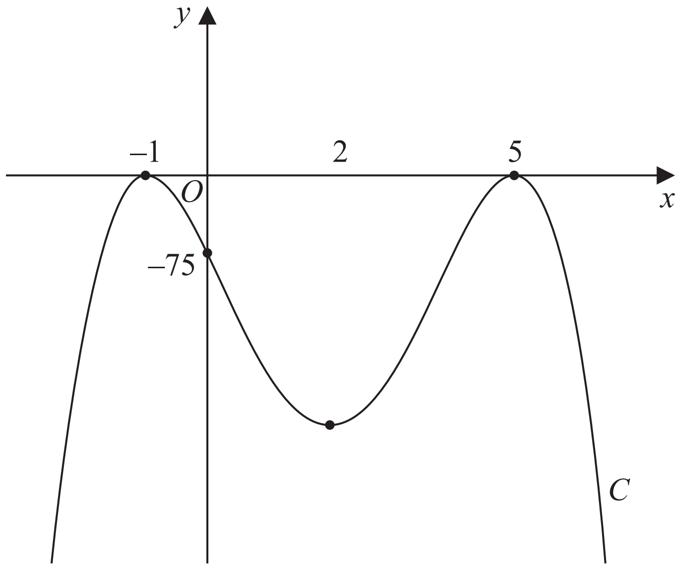

Figure 1

Figure 1 shows a sketch of a curve C with equation $y = f(x)$, where $f(x)$ is a quartic expression in x.

The curve

- has maximum turning points at (–1, 0) and (5, 0)
- crosses the y-axis at (0, –75)
- has a minimum turning point at $x = 2$

(a) Find the set of values of x for which

$$f'(x) \geqslant 0$$

writing your answer in set notation.

(2)

(b) Find the equation of C. You may leave your answer in factorised form.

(3)

The curve C_1 has equation $y = f(x) + k$, where k is a constant.

Given that the graph of C_1 intersects the x-axis at exactly four places,

(c) find the range of possible values for k.

(2)

Question 7 continued

Question 7 continued

Question 7 continued

(Total for Question 7 is 7 marks)

8. A student was asked to prove that the square of any number can be expressed in the form $5n$ or $5n \pm 1$ where $n \in \mathbb{N}$

The start of the student's proof is shown in the box below.

Let $m = 5k$

Consider $m^2 = (5k)^2 = 25k^2 = 5 \times 5k^2 = 5n$ where $n = 5k^2$ ✓

Let $m = 5k + 1$

Consider $m^2 = (5k + 1)^2$

$= 25k^2 + 10k + 1 = 5(5k^2 + 2k) + 1 = 5n + 1$ where $n = 5k^2 + 2k$ ✓

Let $m = 5k + 2$

Consider $m^2 = (5k + 2)^2$

$= 25k^2 + 10k + 4 = 5(5k^2 + 2k + 1) - 1 = 5n - 1$ where $n = 5k^2 + 2k + 1$ ✓

(a) Identify and correct an algebraic error in the box above.

(1)

(b) Show the calculations and statements that are required to complete the proof.

(4)

Question 8 continued

(Total for Question 8 is 5 marks)

9.

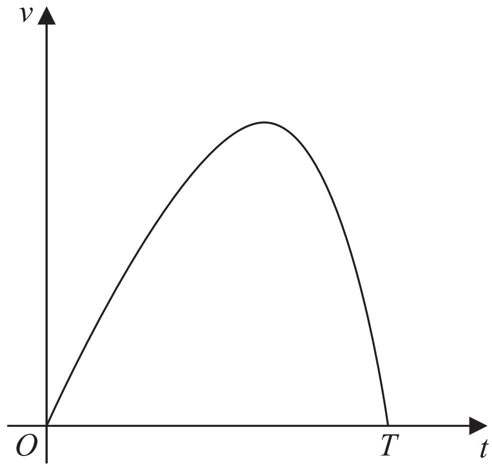

Figure 2

A racing car is driven along a straight road.

Figure 2 shows a graph of the speed of the car as it travels along the road.

The car starts from rest and is driven for T seconds before stopping.

The speed of the car is modelled by the equation

$$v = 15t - t\mathrm{e}^{0.2t} \qquad 0 \leqslant t \leqslant T$$

where t seconds is the time after the car starts to move.

According to the model,

(a) find the value of T, giving your answer to one decimal place,

(2)

(b) show that the maximum speed of the car occurs when

$$t = 5\ln\left(\frac{75}{t+5}\right)$$

(4)

Using the iteration formula

$$t_{n+1} = 5\ln\left(\frac{75}{t_n+5}\right) \qquad \text{with } t_1 = 8$$

(c) (i) find the value of t_3 to 3 decimal places,

(ii) find, by repeated iteration, the time taken for the car to reach maximum speed.

(3)

Question 9 continued

Question 9 continued

Question 9 continued

(Total for Question 9 is 9 marks)

10. Given that

- $\overrightarrow{PQ} = 2\mathbf{i} + 8\mathbf{j} - 2\mathbf{k}$
- $\overrightarrow{QR} = 6\mathbf{i} + 6\mathbf{k}$

(a) find $\overrightarrow{PR}$.

(2)

(b) Hence show that triangle PQR is both right-angled and isosceles.

(4)

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Question 10 continued

(Total for Question 10 is 6 marks)

11. **In this question you must show all stages of your working.**

Solutions relying entirely on calculator technology are not acceptable.

The value of a car, £V, is modelled by the equation

$$V = 1500 + A\mathrm{e}^{-kt}$$

where A and k are positive constants and t is the age of the car in years.

Given that

- the initial value of the car was £20 000
- the value of the car was £12 000 when it was 2.5 years old

(a) find a complete equation for the model, giving the exact value of A and the value of k to 3 significant figures. **(4)**

(b) Show that the rate of change in the value of the car can be expressed in the form

$$-k(V - 1500)$$

(3)

(c) State a limitation of this model. **(1)**

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Question 11 continued

Question 11 continued

Question 11 continued

(Total for Question 11 is 8 marks)

12.

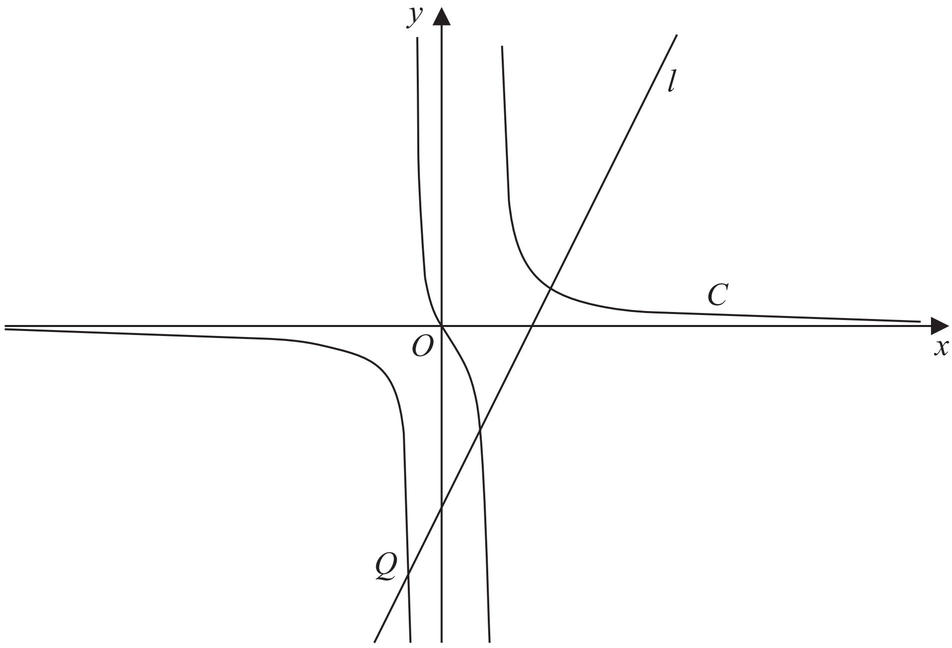

Figure 3

Figure 3 shows a sketch of the curve C with equation

$$y = \frac{15x}{(2x+3)(x-3)} \qquad x \neq -\frac{3}{2} \quad x \neq 3$$

and the straight line l with equation

$$y = 2x - 10$$

(a) Verify that C and l intersect where $x = 6$

(2)

The curve and line also intersect at the point Q shown in Figure 3.

(b) Show that the x coordinate of Q is a solution of

$$4x^3 - 26x^2 - 3x + 90 = 0$$

(2)

(c) Using algebra and showing all stages of working, find the exact x coordinate of Q.

(4)

Question 12 continued

Question 12 continued

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Question 12 continued

(Total for Question 12 is 8 marks)

13. **In this question you must show all stages of your working.**

Solutions relying on calculator technology are not acceptable.

Show that

$$\int_0^2 \frac{x}{(2x+1)^3}\,dx = \frac{2}{25}$$

(5)

Question 13 continued

(Total for Question 13 is 5 marks)

14. **In this question you must show all stages of your working.**

Solutions relying on calculator technology are not acceptable.

(a) Show that

$$\sin(x + 30°) + \sqrt{3}\cos(x + 30°) \equiv 2\cos x$$

(3)

(b) Hence solve, for $0 \leqslant \theta < 180°$

$$\sin(\theta + 30°) + \sqrt{3}\cos(\theta + 30°) = 3\sin 2\theta$$

giving your answers to one decimal place, where appropriate.

(4)

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Question 14 continued

Question 14 continued

Question 14 continued

(Total for Question 14 is 7 marks)

15.

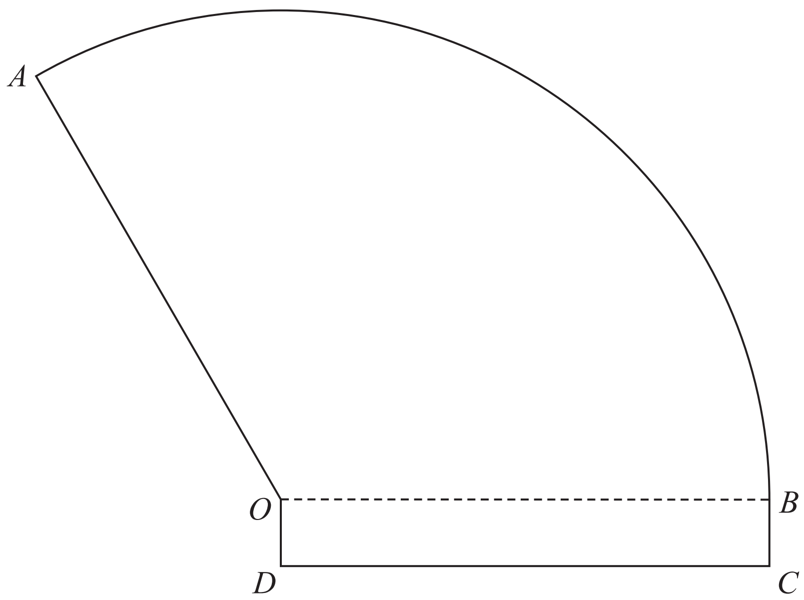

Figure 4

Figure 4 shows the plan view for the design of a stage.

The shape of this design consists of a sector of a circle *AOB* joined to a rectangle *OBCD*.

Given that

- the radius of the sector is r metres and angle *AOB* is θ radians
- the length and width of the rectangle are r metres and $\frac{1}{10}r$ metres respectively
- the total area of the stage is $240\,\text{m}^2$

(a) show that the perimeter of the stage, P metres, is given by

$$P = 2r + \frac{480}{r}$$

You must make your method clear.

(4)

Using algebraic differentiation,

(b) find the value of r for which P has a stationary value.

(3)

(c) Prove, by further differentiation, that this value of r gives the minimum perimeter of the stage.

(2)

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Question 15 continued

Question 15 continued

Question 15 continued

(Total for Question 15 is 9 marks)

16.

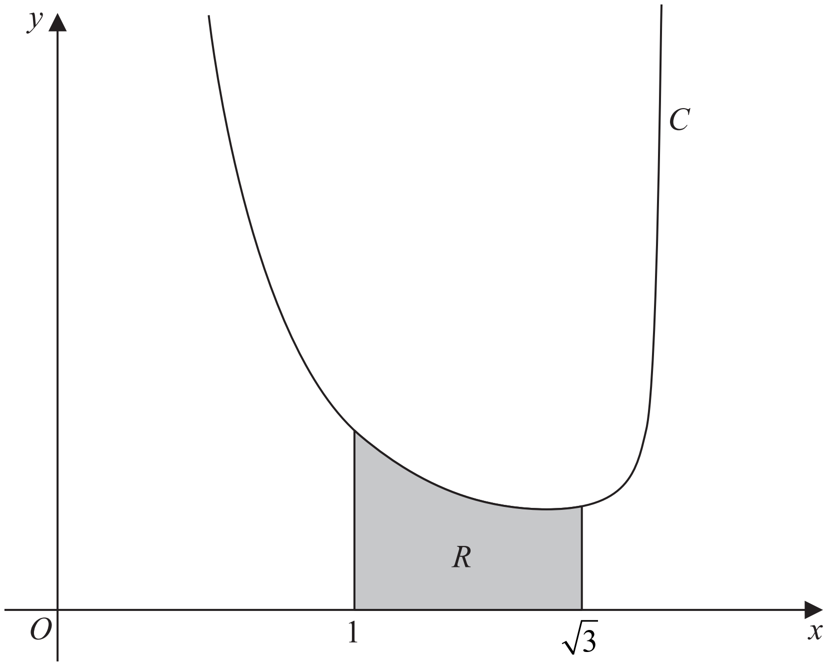

Figure 5

Figure 5 shows a sketch of the curve C with equation

$$y = \frac{1}{x^2\sqrt{4-x^2}} \qquad 0 < x < 2$$

The region R, shown shaded in Figure 5, is bounded by C, the line with equation $x = 1$, the x-axis and the line with equation $x = \sqrt{3}$

(a) Use the substitution $x = 2\sin u$ to show that the area of R is given by

$$\int_a^b k\operatorname{cosec}^2 u \, du$$

where a, b and k are constants to be found.

(4)

(b) Hence, using algebraic integration, find the exact area of R.
Give your answer in simplest form.

(3)

Question 16 continued

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Question 16 continued

(Total for Question 16 is 7 marks)

TOTAL FOR PAPER IS 100 MARKS