

Please check the examination details below before entering your candidate information

Candidate surname		Other names	
Centre Number		Candidate Number	

Pearson Edexcel Level 3 GCE

Thursday 12 June 2025

Afternoon (Time: 2 hours)

Paper reference **9MA0/02**

Mathematics

Advanced

PAPER 2: Pure Mathematics 2

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 15 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 ►

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1.

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

Factorise completely

$$2x^3 - 24x^2 + 40x$$

(3)



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Question 1 continued

Lined area for writing the answer to Question 1.

(Total for Question 1 is 3 marks)



2. Find

$$\int \left(x^4 - 6x^{\frac{1}{2}} - 3 \right) dx$$

giving the answer in simplest form.

(4)



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Question 2 continued

Lined area for writing answers.

(Total for Question 2 is 4 marks)



3. Given that

$$3^x = 7^y$$

find the exact value of $\frac{x}{y}$

(2)



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Question 3 continued

Lined area for writing answers.

(Total for Question 3 is 2 marks)



4.

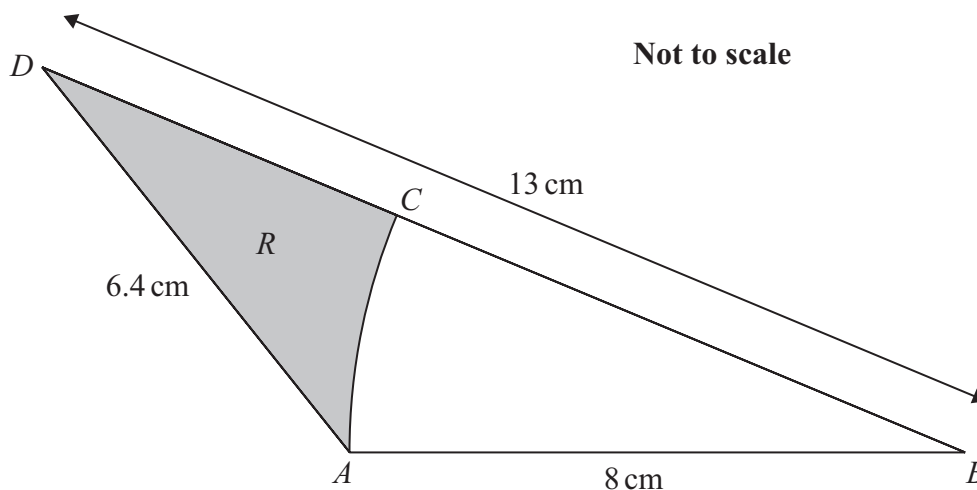


Figure 1

The shape $ABCD$, shown in Figure 1, consists of a triangle ABD containing a sector ABC of a circle with centre B .

Given that

- $AD = 6.4$ cm
- $BD = 13$ cm
- $BA = BC = 8$ cm

(a) show that angle $ABC = 0.394$ radians to 3 significant figures.

(2)

The region R , shown shaded in Figure 1, is bounded by the line CD , the line DA and the arc AC .

(b) Find the area of R , giving the answer in cm^2 to 3 significant figures.
You must make your method clear.

(3)



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Question 4 continued

Lined area for writing the answer to Question 4.



Question 4 continued

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Question 4 continued

Lined area for writing the answer to Question 4.

(Total for Question 4 is 5 marks)



- $$x = \frac{t-1}{2} \quad y = 5(t+2)^4 \quad t \in \mathbb{R}$$

(a) Find the y coordinate of P . (2)

(b) Find a Cartesian equation for C , giving the answer in the form $y = f(x)$ (2)

(c) Hence, or otherwise, find the gradient of C at the point P . (3)

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Question 5 continued

Handwriting practice area with horizontal lines.

(Total for Question 5 is 7 marks)



6.

In this question you must show detailed reasoning.

- (a) Given that x is small and in radians, use the small angle approximation for $\cos \theta$ to show that

$$1 - \cos^2(2x) \approx 4x^2 - 4x^4 \quad (2)$$

- (b) Given that x is small and in radians, use

- the answer to part (a)
- the small angle approximations for $\sin \theta$ and $\tan \theta$

to show that

$$\frac{1 - \cos^2(2x)}{\sin\left(\frac{x}{3}\right)\tan\left(\frac{x}{2}\right)} \approx a + bx^2$$

where a and b are constants to be found. (2)

- (c) Hence, given that x is **very** small, deduce an approximate value for

$$\frac{1 - \cos^2(2x)}{\sin\left(\frac{x}{3}\right)\tan\left(\frac{x}{2}\right)}$$

giving a reason for your answer. (2)

[illegible]

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Question 6 continued

Lined area for writing answers.

(Total for Question 6 is 6 marks)



7. Given that

$$\frac{3x^3 - 8x^2 - 6x - 11}{(x+1)(x-3)} \equiv Ax + B + \frac{C}{x+1} + \frac{D}{x-3} \quad x \in \mathbb{R} \quad x \neq -1, 3$$

find the value of each of the constants A , B , C and D .

(4)



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Question 7 continued

Lined area for writing the answer to Question 7.

(Total for Question 7 is 4 marks)



8.

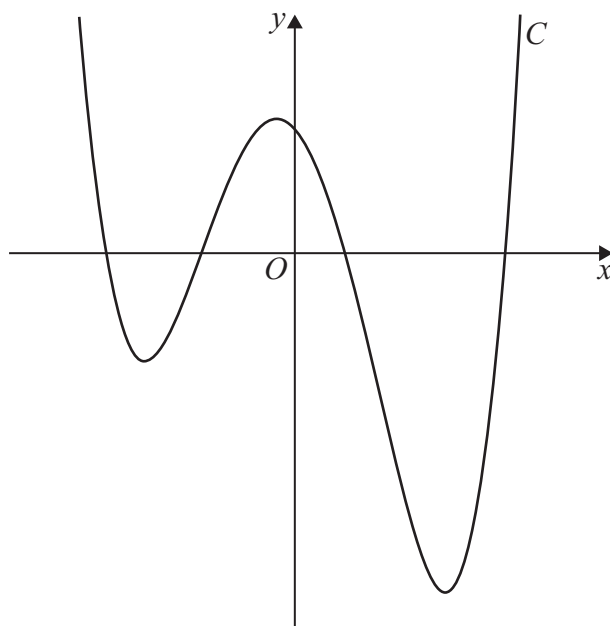


Figure 2

$$f(x) = x^4 + \frac{1}{3}x^3 - 8x^2 + ax + \frac{17}{3}$$

where a is a constant.

Figure 2 shows a sketch of the curve C with equation $y = f(x)$

Given that C has a local maximum at $x = -\frac{1}{4}$

(a) show that $a = -4$

(4)

(b) find the exact y coordinate of the local maximum.

(1)

The equation $f(x) = k$, where k is a constant, has 4 distinct solutions.

(c) Using algebra and showing all stages of your working, find the range of values of k .
Give the answer using set notation.

(Solutions relying on calculator technology are not acceptable.)

(4)



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Question 8 continued

Lined area for writing the answer to Question 8.



Question 8 continued

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Question 8 continued

Handwriting practice area with horizontal lines.

(Total for Question 8 is 9 marks)



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

A new type of car is released for sale.

The total number of this type of car sold, N , in a particular region, t months after the cars were released for sale, is modelled by the equation

$$N = 5000 - 5000e^{-0.075t} \quad t \geq 0$$

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

- (a) Find the total number of cars sold in the first 3 months. (2)

Given that $N = 3000$ when $t = T$

- (b) find the value of T giving the answer to 2 decimal places. (3)

- (c) Find the rate of increase in the total number of cars sold when $t = 3$, giving the answer to 3 significant figures. (2)

After a marketing campaign, the total number of cars sold is expected to rise and have an upper limit of 6500

- (d) Using this information, suggest **one** refinement to the model. (1)



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Question 9 continued

Lined area for writing the answer to Question 9.



Question 9 continued

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Question 9 continued

Handwriting practice area with horizontal lines.

(Total for Question 9 is 8 marks)



10. Water flows at a constant rate into a large container.

There is a tap at the bottom of the container.

At time t hours after the tap was opened

- the volume of water in the container is $V\text{m}^3$
- water is flowing into the container at a constant rate of 0.45 m^3 per hour
- water is leaving the container through the tap at a rate of $0.3V\text{m}^3$ per hour

(a) Show that

$$20 \frac{dV}{dt} = 9 - 6V \quad (2)$$

Given that when the tap was opened, there was 0.25 m^3 of water in the container,

(b) solve the differential equation to show that

$$V = P - Qe^{-kt}$$

where P , Q and k are positive constants to be found.

Given that

- the capacity of the container is 2 m^3
- the tap remains open
- the water continues to flow into the tank at the same rate

(c) determine whether the container will ever become full, giving a reason for your answer.

[illegible]

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Question 10 continued

Lined area for writing the answer to Question 10.



Question 10 continued

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Question 10 continued

Handwriting practice area with horizontal lines.

(Total for Question 10 is 9 marks)



11. A company is trying to determine the most profitable selling price for a new toy.

Given that

- if the selling price of each toy is £30, the company expects to sell 1500 toys in one year
- if the selling price of each toy is £50, the company expects to sell 300 toys in one year

Using a **linear** model, with y being the expected number of toys sold in one year and x pounds being the selling price of the toy,

- (a) find an equation for y in terms of x . (3)

Given that

- the cost of making each toy is £10
 - the company has additional costs of £8 000 per year
- (b) show that, according to the model, the yearly profit, P , in **thousands** of pounds, is given by

$$P = -0.06x^2 + 3.9x - 41$$
(3)

Use the model given in part (b) to answer parts (c), (d) and (e).

Given that the company wishes to make a profit on sales of the toy,

- (c) find the range of possible selling prices of the toy. (2)
- (d) Hence, or otherwise, deduce the selling price of the toy that maximises the profit. (1)

In one particular year, the company sold the toy for £35 and made £21 750 profit.

- (e) Use this information to evaluate the suitability of the model. (2)



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Question 11 continued

Lined area for writing the answer to Question 11.



Question 11 continued

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Question 11 continued

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(Total for Question 11 is 11 marks)



12.

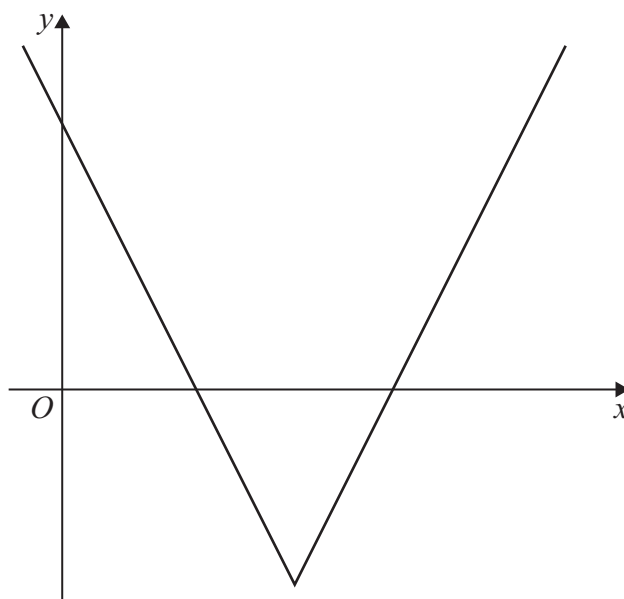


Figure 3

Figure 3 shows a sketch of the graph with equation $y = f(x)$ where

$$f(x) = 4|x - 3| - 5 \quad x \in \mathbb{R}$$

Given that a is a constant and $|a| = 1$

- (a) find the possible values of $f(a)$ (2)

The function g is defined by

$$g(x) = 2x + 17 \quad x \in \mathbb{R}$$

- (b) Find the range of $gf(x)$ (2)

The function h is defined by

$$h(x) = kx \quad x \in \mathbb{R}$$

where k is a constant.

Given that the equation $f(x) = h(x)$ has no solutions,

- (c) find the range of values of k . (4)



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Question 12 continued

Lined area for writing the answer to Question 12.



Question 12 continued

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Question 12 continued

Handwriting practice area with horizontal lines.

(Total for Question 12 is 8 marks)



13. Given that for all values of k , where $0 < |k| < 1$, the equation

$$\sin(nx) = k \quad n \in \mathbb{N}$$

has exactly 6 solutions in the interval $0 \leq x < 2\pi$

(i) deduce the value of n

(1)

(ii) deduce the number of solutions of the equation

$$\sin^2(nx) = k^2$$

in the interval $0 \leq x < 5\pi$, justifying your answer.

(2)



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Question 13 continued

Handwriting practice area with horizontal lines.

(Total for Question 13 is 3 marks)



14.

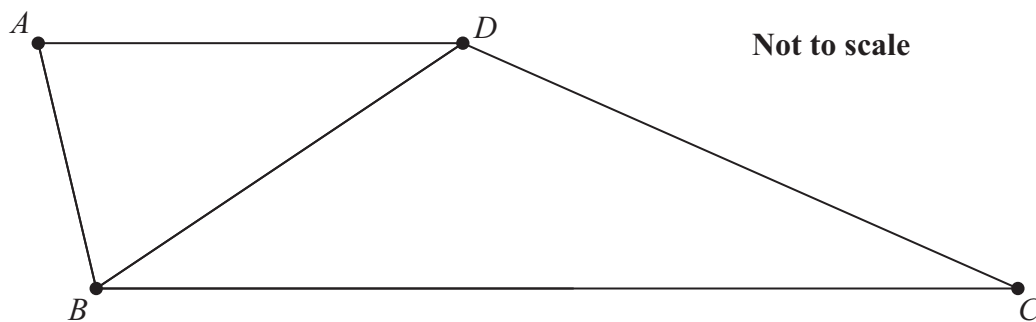


Figure 4

In this question you must show detailed reasoning.

Figure 4 shows a trapezium $ABCD$ where AD is parallel to BC

Given that

- $\vec{AB} = 2\mathbf{a} + 3\mathbf{b}$
- $\vec{BC} = 15\mathbf{a} - 5\mathbf{b}$
- $\vec{DB} = -4\mathbf{a} + k\mathbf{b}$ where k is an integer

(a) show that $k = 5$

(3)

Given also that

- the point N lies on BC such that $BN : NC = 1 : 4$
- AN intersects BD at X

(b) find $BX : XD$

(5)



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Question 14 continued

Lined area for writing the answer to Question 14.



Question 14 continued

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Question 14 continued

Handwriting practice area with horizontal lines.

(Total for Question 14 is 8 marks)



15.

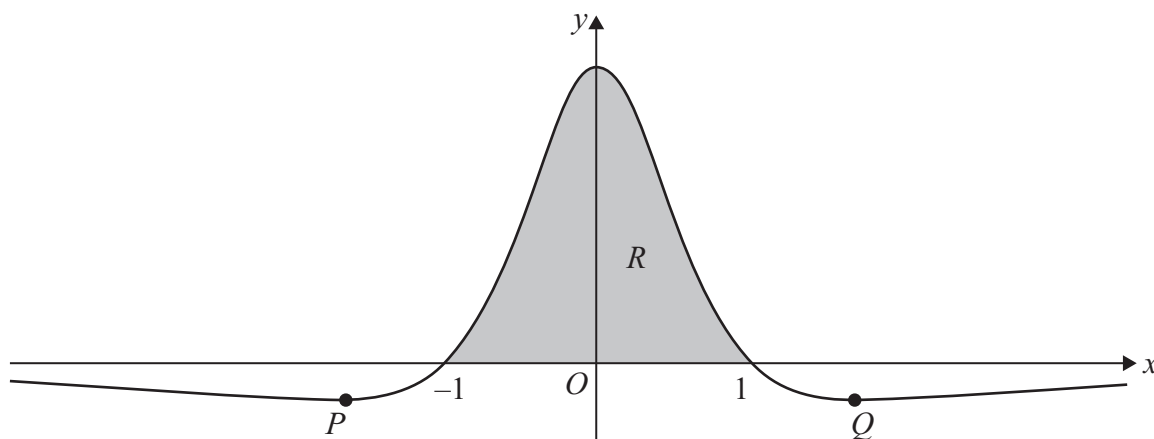


Figure 5

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

Figure 5 shows a sketch of part of the curve with equation $y = f(x)$, where

$$f(x) = \frac{1 - x^2}{(1 + x^2)^2}$$

The curve

- intersects the x -axis at -1 and 1
- has minimum turning points at P and Q

as shown in Figure 5.

(a) Use calculus to find the exact coordinates of P .

(5)

(b) Using the substitution $x = \tan \theta$ show that

$$\int_{-1}^1 f(x) dx = \int_{\alpha}^{\beta} \cos 2\theta d\theta$$

where α and β are constants to be found.

(5)

The finite region R , shown shaded in Figure 5, is bounded by the x -axis and the curve.

(c) Use algebraic integration to find the area of R .

(3)



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Question 15 continued

Lined area for writing the answer to Question 15.



Question 15 continued

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Question 15 continued

Lined area for writing the answer to Question 15.



Question 15 continued

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(Total for Question 15 is 13 marks)

TOTAL FOR PAPER IS 100 MARKS

