

Paper Reference 9MA0/02
Pearson Edexcel Level 3 GCE

Mathematics

Advanced

PAPER 2: Pure Mathematics 2

Thursday 12 June 2025 – Afternoon

Time: 2 hours

Question Paper

**THIS DOCUMENT MUST BE
RETURNED TO PEARSON AT THE END
OF THE EXAMINATION.**

In the boxes below, write your name,
centre number and candidate number.

Surname					
Other names					
Centre Number					
Candidate Number					

YOU MUST HAVE

**Mathematical Formulae and Statistical
Tables (Green), calculator**

YOU WILL BE GIVEN

Diagram Booklet

Answer Booklet

**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.**

Turn over

INSTRUCTIONS

Answer ALL questions and ensure that your answers to parts of questions are clearly labelled.

Answer the questions in the spaces provided in the Answer Booklet or in the separate Diagram Booklet – 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.

Turn over

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.

There may be spare copies of some diagrams.

Turn over

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

Solutions relying on calculator technology are not acceptable.

Factorise completely

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

(Total for Question 1 is 3 marks)

Turn over

2. Find

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

giving the answer in simplest form.

(Total for Question 2 is 4 marks)

Turn over

3. Given that

$$3^x = 7^y$$

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

(Total for Question 3 is 2 marks)

Turn over

4. Refer to the diagram for Question 4 in the Diagram Booklet.

It is NOT accurately drawn.

Shape **ABCD** consists of a triangle **ABD** containing a sector **ABC** of a circle with centre **B**

(continued on the next page)

4. continued.

Given that

- $AD = 6.4 \text{ cm}$
- $BD = 13 \text{ cm}$
- $BA = BC = 8 \text{ cm}$

(a) show that

angle $ABC = 0.394$ radians to
3 significant figures.

(2 marks)

(continued on the next page)

Turn over

4. continued.

The region **R**, shown shaded in the diagram, 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 marks)

(Total for Question 4 is 5 marks)

Turn over

5. The curve **C** has parametric equations

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

The point **P** with **x** coordinate **−3** lies on **C**

- (a) Find the **y** coordinate of **P**
(2 marks)
- (b) Find a Cartesian equation for **C**,
giving the answer in the form
y = f(x)
(2 marks)

(continued on the next page)

Turn over

5. continued.

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

(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

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

(2 marks)

(continued on the next page)

Turn over

6. continued.

(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

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

where p and q are constants to be found.

(2 marks)

(continued on the next page)

Turn over

6. continued.

(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 marks)**

(Total for Question 6 is 6 marks)

Turn over

7. Given that

$$\frac{3x^3 - 8x^2 - 6x - 11}{(x + 1)(x - 3)}$$

$$\equiv Ax + B + \frac{C}{x + 1} + \frac{D}{x - 3}$$

$$x \in \mathbb{R} \quad x \neq -1, 3$$

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

(Total for Question 7 is 4 marks)

Turn over

8.

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

where p is a constant.

Refer to the diagram for Question 8 in the Diagram Booklet.

It shows a sketch of the curve **C** with equation

$$y = f(x)$$

(continued on the next page)

Turn over

8. continued.

Given that **C** has a local maximum at

$$x = -\frac{1}{4}$$

(a) show that

$$p = -4$$

(4 marks)

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

(1 mark)

(continued on the next page)

Turn over

8. continued.

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 marks)**

(Total for Question 8 is 9 marks)

Turn over

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

Solutions relying entirely on calculator technology are not acceptable.

(continued on the next page)

9. continued.

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).

(continued on the next page)

Turn over

9. continued.

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

Given that

$N = 3000$ when

$t = T$

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

(continued on the next page)

Turn over

9. continued.

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

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 mark)**

(Total for Question 9 is 8 marks)

Turn over

- 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

(continued on the next page)

10. continued.

- 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

$$20 \frac{dV}{dt} = 9 - 6V$$

(2 marks)

(continued on the next page)

Turn over

10. continued.

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.

(5 marks)

(continued on the next page)

Turn over

10. continued.

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.

(2 marks)

(Total for Question 10 is 9 marks)

Turn over

- 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**

(continued on the next page)

Turn over

11. continued.

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 marks)**

(continued on the next page)

11. continued.

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 marks)

(continued on the next page)

Turn over

11. continued.

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 marks)

(d) Hence, or otherwise, deduce the selling price of the toy that maximises the profit.

(1 mark)

(continued on the next page)

Turn over

11. continued.

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 marks)**

(Total for Question 11 is 11 marks)

Turn over

12. Refer to the diagram for Question 12 in the Diagram Booklet.

It 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 p is a constant and

$$|p| = 1$$

**(a) find the possible values of $f(p)$
(2 marks)**

(continued on the next page)

Turn over

12. continued.

The function **g** is defined by

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

(b) Find the range of $g f(x)$
(2 marks)

The function **h** is defined by

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

where **k** is a constant.

(continued on the next page)

Turn over

12. continued.

Given that the equation

$f(x) = h(x)$ has no solutions,

**(c) find the range of values of k
(4 marks)**

(Total for Question 12 is 8 marks)

Turn over

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 mark)

(continued on the next page)

13. continued.

**(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 marks)

(Total for Question 13 is 3 marks)

Turn over

14. In this question you must show detailed reasoning.

Refer to the diagram for Question 14 in the Diagram Booklet.

It is NOT accurately drawn.

It shows a trapezium ABCD where AD is parallel to BC

(continued on the next page)

14. continued.

Given that

$$\vec{AB} = 2\underline{a} + 3\underline{b}$$

$$\vec{BC} = 15\underline{a} - 5\underline{b}$$

$$\vec{DB} = -4\underline{a} + k\underline{b} \text{ where } k \text{ is an integer}$$

(a) show that

$$k = 5$$

(3 marks)

(continued on the next page)

Turn over

14. continued.

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 marks)

(Total for Question 14 is 8 marks)

Turn over

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

Solutions relying on calculator technology are not acceptable.

Refer to the diagram for Question 15 in the Diagram Booklet.

It shows a sketch of part of the curve with equation

$y = f(x)$, where

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

(continued on the next page)

Turn over

15. continued.

The curve

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

as shown in the diagram.

- (a) Use calculus to find the exact coordinates of P**
(5 marks)

(continued on the next page)

Turn over

15. continued.

(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 marks)

(continued on the next page)

Turn over

15. continued.

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

- (c) Use algebraic integration to find the area of R
(3 marks)**

(Total for Question 15 is 13 marks)

TOTAL FOR PAPER IS 100 MARKS

END OF PAPER