

9MA0-02 A Level Pure Mathematics 2 - June 2024

June 2024 exam series

QUESTION PAPER

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Please check the examination details below before entering your candidate information

Candidate surname

Other names

Centre Number

Candidate Number

Pearson Edexcel Level 3 GCE

Tuesday 11 June 2024

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.

$$y = 4x^3 - 7x^2 + 5x - 10$$

(a) Find in simplest form

(i) $\frac{dy}{dx}$

(ii) $\frac{d^2y}{dx^2}$

(3)

(b) Hence find the exact value of x when $\frac{d^2y}{dx^2} = 0$

(2)



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Question 1 continued

Lined area for writing the answer to Question 1.

(Total for Question 1 is 5 marks)



2. Jamie takes out an interest-free loan of £8100

Jamie makes a payment every month to pay back the loan.

Jamie repays £400 in month 1, £390 in month 2, £380 in month 3, and so on, so that the amounts repaid each month form an arithmetic sequence.

(a) Show that Jamie repays £290 in month 12 (1)

After Jamie's N th payment, the loan is completely paid back.

(b) Show that $N^2 - 81N + 1620 = 0$ (2)

(c) Hence find the value of N . (2)



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Question 2 continued

Lined area for writing the answer to Question 2.

(Total for Question 2 is 5 marks)



3. The point $P(3, -2)$ lies on the curve with equation $y = f(x)$, $x \in \mathbb{R}$

Find the coordinates of the point to which P is mapped when the curve with equation $y = f(x)$ is transformed to the curve with equation

(i) $y = f(x - 2)$

(ii) $y = f(2x)$

(iii) $y = 3f(-x) + 5$

(4)



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Question 3 continued

Lined area for writing answers.

(Total for Question 3 is 4 marks)



4. A sequence $u_1, u_2, u_3, \dots$ is defined by

$$u_{n+1} = ku_n - 5$$

$$u_1 = 6$$

where k is a positive constant.

Given that $u_3 = -1$

- (a) show that

$$6k^2 - 5k - 4 = 0 \quad (2)$$

- (b) Hence

- (i) find the value of k ,

- (ii) find the value of $\sum_{r=1}^3 u_r$ (3)



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Question 4 continued

Lined area for writing answers.

(Total for Question 4 is 5 marks)



5. Given that θ is small and in radians, use the small angle approximations to find an approximate numerical value of

$$\frac{\theta \tan 2\theta}{1 - \cos 3\theta}$$

(3)



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Question 5 continued

Lined area for writing the answer to Question 5.

(Total for Question 5 is 3 marks)



6.

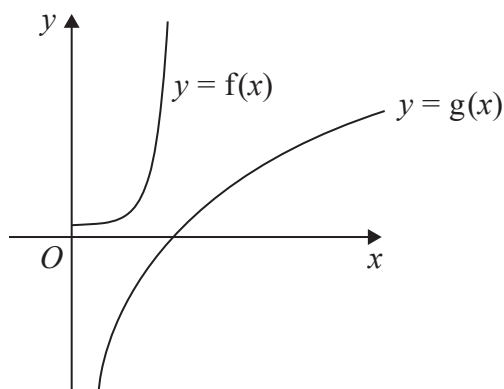


Figure 1

Figure 1 shows a sketch of the curves with equations $y = f(x)$ and $y = g(x)$ where

$$f(x) = e^{4x^2 - 1} \quad x > 0$$

$$g(x) = 8 \ln x \quad x > 0$$

(a) Find

(i) $f'(x)$

(ii) $g'(x)$

(2)

Given that $f'(x) = g'(x)$ at $x = \alpha$

(b) show that α satisfies the equation

$$4x^2 + 2 \ln x - 1 = 0$$

(2)

The iterative formula

$$x_{n+1} = \sqrt{\frac{1 - 2 \ln x_n}{4}}$$

is used with $x_1 = 0.6$ to find an approximate value for α

(c) Calculate, giving each answer to 4 decimal places,

(i) the value of x_2

(ii) the value of α

(3)



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Question 6 continued

Lined area for writing the answer to Question 6.



Question 6 continued

Lined area for writing answers.

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Question 6 continued

Lined area for writing answers.

(Total for Question 6 is 7 marks)



7.

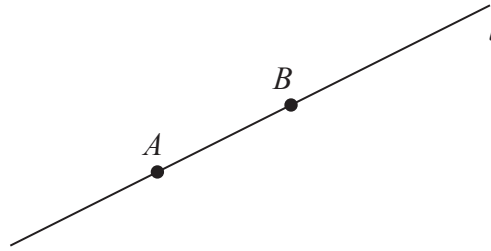


Figure 2

Figure 2 shows a sketch of the straight line l .

Line l passes through the points A and B .

Relative to a fixed origin O

- the point A has position vector $2\mathbf{i} - 3\mathbf{j} + 5\mathbf{k}$
- the point B has position vector $5\mathbf{i} + 6\mathbf{j} + 8\mathbf{k}$

(a) Find $\overrightarrow{AB}$

(1)

Given that a point P lies on l such that

$$|\vec{AP}| = 2|\vec{BP}|$$

(b) find the possible position vectors of P .

(4)



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Question 7 continued

Lined area for writing the answer to Question 7.

(Total for Question 7 is 5 marks)



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Question 8 continued

Lined area for writing the answer to Question 8.



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Question 8 continued

Lined area for writing the answer to Question 8.

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Question 8 continued

Lined area for writing the answer to Question 8.

(Total for Question 8 is 7 marks)



P 7 5 6 9 4 A 0 2 1 4 8

9.

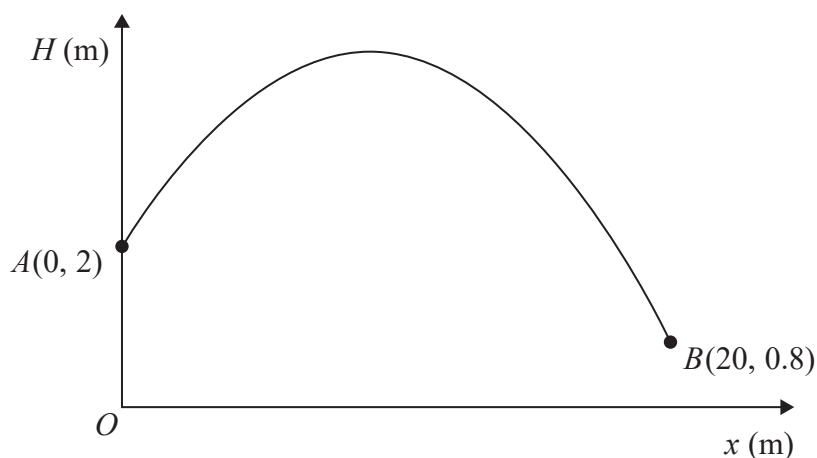


Figure 3

The graph in Figure 3 shows the path of a small ball.

The ball travels in a vertical plane above horizontal ground.

The ball is thrown from the point represented by A and caught at the point represented by B .

The height, H metres, of the ball above the ground has been plotted against the horizontal distance, x metres, measured from the point where the ball was thrown.

With respect to a fixed origin O , the point A has coordinates $(0, 2)$ and the point B has coordinates $(20, 0.8)$, as shown in Figure 3.

The ball reaches its maximum height when $x = 9$

A quadratic function, linking H with x , is used to model the path of the ball.

- (a) Find H in terms of x . (4)
- (b) Give one limitation of the model. (1)

Chandra is standing directly under the path of the ball at a point 16 m horizontally from O .

Chandra can catch the ball if the ball is less than 2.5 m above the ground.

- (c) Use the model to determine if Chandra can catch the ball. (2)



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Question 9 continued

Lined area for writing the answer to Question 9.



P 7 5 6 9 4 A 0 2 3 4 8

Question 9 continued

Lined area for writing the answer to Question 9.

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Question 9 continued

Lined area for writing the answer to Question 9.

(Total for Question 9 is 7 marks)



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Question 10 continued

Lined area for writing the answer to Question 10.

(Total for Question 10 is 6 marks)



11.

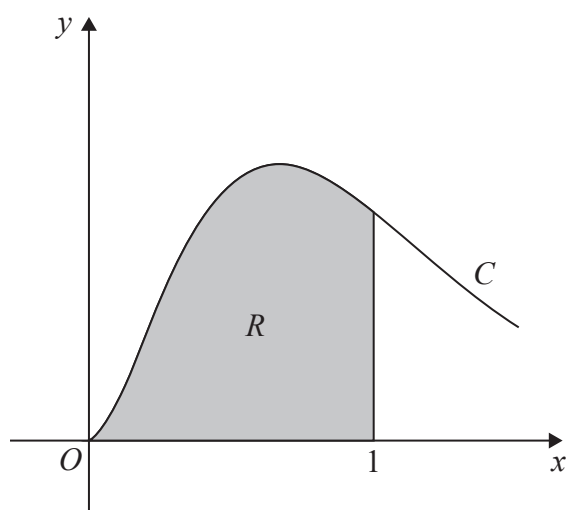


Figure 5

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

Solutions relying entirely on calculator technology are not acceptable.

Figure 5 shows a sketch of part of the curve C with equation

$$y = 8x^2e^{-3x} \quad x \geq 0$$

The finite region R , shown shaded in Figure 5, is bounded by

- the curve C
- the line with equation $x = 1$
- the x -axis

Find the exact area of R , giving your answer in the form

$$A + Be^{-3}$$

where A and B are rational numbers to be found.

(5)



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Question 11 continued

Lined area for writing the answer to Question 11.



P 7 5 6 9 4 A 0 2 9 4 8

Question 11 continued

Lined area for writing the answer to Question 11.

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Question 11 continued

Lined area for writing the answer to Question 11.

(Total for Question 11 is 5 marks)



P 7 5 6 9 4 A 0 3 1 4 8

- (d) Find the value of L , giving a reason for your answer. (2)

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Question 12 continued

Lined area for writing the answer to Question 12.



P 7 5 6 9 4 A 0 3 3 4 8

Question 12 continued

Lined area for writing the answer to Question 12.

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Question 12 continued

Lined area for writing answers.

(Total for Question 12 is 12 marks)



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Question 13 continued

Lined area for writing the answer to Question 13.



P 7 5 6 9 4 A 0 3 7 4 8

Question 13 continued

Lined area for writing the answer to Question 13.

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Question 13 continued

Lined area for writing the answer to Question 13.

(Total for Question 13 is 9 marks)



14. The circle C_1 has equation

$$x^2 + y^2 - 6x + 14y + 33 = 0$$

(a) Find

- (i) the coordinates of the centre of C_1
- (ii) the radius of C_1

(3)

A different circle C_2

- has centre with coordinates $(-6, -8)$
- has radius k , where k is a constant

Given that C_1 and C_2 intersect at 2 distinct points,

(b) find the range of values of k , writing your answer in set notation.

(5)



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Question 14 continued

Lined area for writing the answer to Question 14.



P 7 5 6 9 4 A 0 4 1 4 8

Question 14 continued

Lined area for writing the answer to Question 14.

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Question 14 continued

Lined area for writing the answer to Question 14.

(Total for Question 14 is 8 marks)



15. The curve C has equation

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

- (a) Find an expression for $\frac{dy}{dx}$ in terms of x and y .

The point $P(1, 0)$ lies on C .

- (b) Show that the normal to C at P has equation
- $$y = -2x + 2 \quad (2)$$

- (c) Prove that the normal to C at P does **not** meet C again.
- You should use algebra for your proof and make your reasoning clear.
- (5)

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Question 15 continued

Lined area for writing the answer to Question 15.



P 7 5 6 9 4 A 0 4 5 4 8

Question 15 continued

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Question 15 continued

Lined area for writing the answer to Question 15.



P 7 5 6 9 4 A 0 4 7 4 8

Question 15 continued

Lined area for writing answers.

(Total for Question 15 is 12 marks)

TOTAL FOR PAPER IS 100 MARKS

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