AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

A-level MATHEMATICS

Paper 1

Wednesday 4 June 2025 Afternoon Time allowed: 2 hours

Materials
- You must have the AQA Formulae for A-level Mathematics booklet.
- You should have a graphical or scientific calculator that meets the requirements of the specification.

Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer each question in the space provided for that question.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do **not** write outside the box around each page or on blank pages.
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work that you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 100.

Advice
- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- You do not necessarily need to use all the space provided.

For Examiner's Use	
Question	Mark
1	
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TOTAL	

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Answer **all** questions in the spaces provided.

1 The equation of a curve is given by

$$y = 3e^{x}$$

Find an expression for $\frac{dy}{dx}$

Circle your answer.

[1 mark]

$3e^{-x}$ $3e^{1}$ $3e^{x}$ $3xe^{x-1}$

2 A sequence is defined by

$$x_{n+1} = -\frac{1}{4}x_n \quad \text{with} \quad x_1 = 32$$

The first four terms of the sequence are

$$32, \quad -8, \quad 2, \quad -0.5$$

Which **one** of the following can be used to describe this sequence?

Circle your answer.

[1 mark]

Convergent Decreasing Increasing Periodic

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3 Express

$$\log_3 2x - \log_3 x$$

as a single logarithm.

Circle your answer.

[1 mark]

$\log_3 \frac{1}{2}$ $\log_3 2$ $\log_3 x$ $\log_3 2x^2$

Turn over for the next question

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4 The first three terms, in ascending powers of x, of the binomial expansion of $(1 - 8x)^{\frac{1}{2}}$ are

$$1 + nx - 8x^2$$

where n is a constant.

4 (a) State the range of values of x for which the expansion is valid.

Circle your answer.

[1 mark]

$|x| > -8$ $\quad$ $|x| > -\frac{1}{8}$ $\quad$ $|x| < \frac{1}{8}$ $\quad$ $|x| < 8$

4 (b) State the value of the constant n

Circle your answer.

[1 mark]

-16 $\quad$ -4 $\quad$ $\frac{1}{2}$ $\quad$ 4

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5 Find $\int \left(4x - 3 + x^{-\frac{1}{2}}\right) \mathrm{d}x$

[3 marks]

6 An arithmetic series has first term 3 and common difference -0.5

Find the sum of the first 250 terms.

[2 marks]

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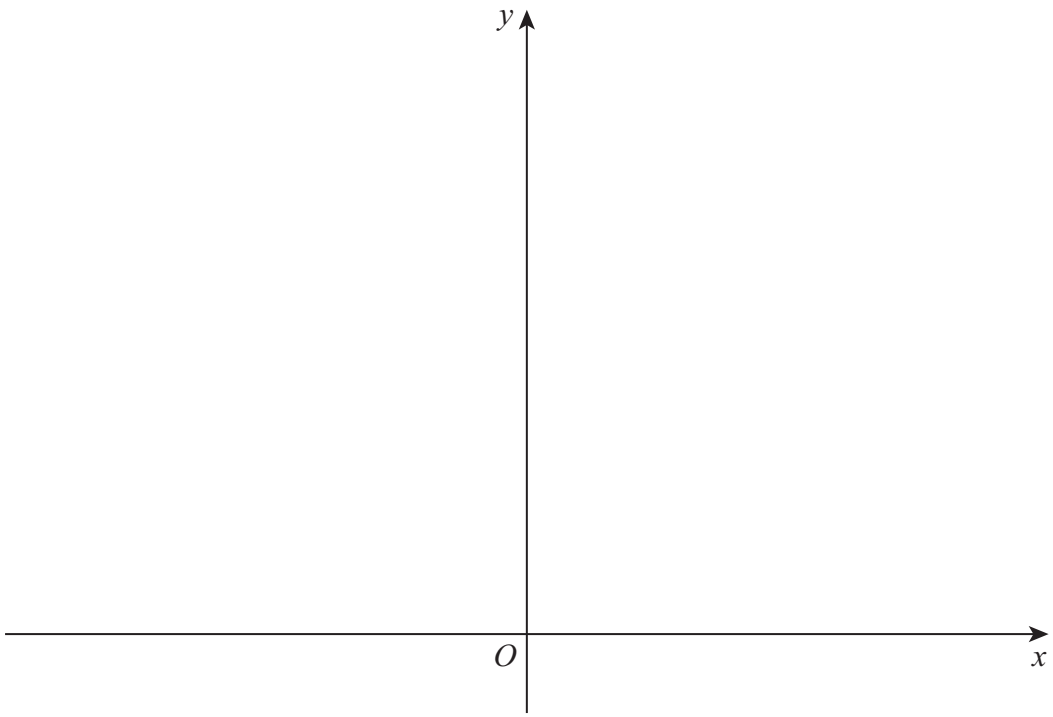
7 It is given that $0 < a < 1$

Sketch the graph with equation

$$y = a^x$$

on the axes below.

[2 marks]



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8 Show that, **for small values of x**, the graph with equation

$$y = \frac{4 + \sin 5x - 3\cos 2x}{1 + 2\tan x}$$

can be approximated by the straight line with equation of the form

$$y = ax + 1$$

where a is a constant to be found.

[5 marks]

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9 (a) A geometric series, S, has **second** term 60

The common ratio of S is 0.2

Find the exact value of the sum of the first five terms of S

[4 marks]

9 (b) A different geometric series, T, has **second** term 60 and positive common ratio r

The sum to infinity of T is T_∞

9 (b) (i) Show that

$$T_\infty = \frac{60}{r - r^2}$$

[2 marks]

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9 (b) (ii) Find the maximum value of $r - r^2$

[2 marks]

9 (b) (iii) Hence find the range of possible values of T_∞

Fully justify your answer.

[2 marks]

Turn over ▶



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10 A researcher working for a frozen-food manufacturer uses the formula

$$\theta = 21 - A\mathrm{e}^{-kt}$$

to model the temperature of a dessert once it is taken out of a freezer.

In this model:

- θ is the temperature of the dessert in °C
- t is the time in hours since the dessert was removed from the freezer
- A and k are positive constants.

10 (a) Show how

$$\theta = 21 - A\mathrm{e}^{-kt}$$

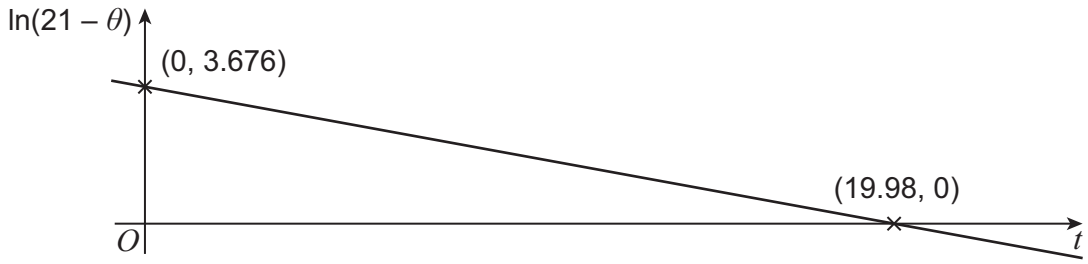
can be rearranged to obtain

$$\ln(21 - \theta) = -kt + \ln A$$

[3 marks]

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10 (b) The researcher uses measurements they have recorded to plot the graph of $\ln(21 - \theta)$ against t as shown in the diagram below.



10 (b) (i) Use the information on the graph to find the value of A

Give your answer to **three** significant figures.

[2 marks]

10 (b) (ii) Use the information on the graph to find the value of k

Give your answer to **three** significant figures.

[2 marks]

Do not write outside the box

10 (b) (iii) Find the temperature of the dessert when it is initially removed from the freezer.

Give your answer to **three** significant figures.

[2 marks]

10 (c) The dessert is ready to be eaten when its temperature reaches 4 °C

Use the model to determine the time, after being removed from the freezer, for the dessert to reach this temperature.

Give your answer to the nearest 10 minutes.

[3 marks]

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11 The equation of a curve is

$$x^2y + 4y^3 = 8x$$

The curve has two stationary points.

11 (a) Use implicit differentiation to show that at the stationary points $y = \frac{4}{x}$

[4 marks]

11 (b) Hence show that the x-coordinates of the stationary points can be written in the form $\pm\sqrt{n}$ where n is an integer to be found.

[3 marks]

Turn over ▶

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12 Functions f and g are defined by

$$\mathrm{f}(x) = x^2 + 5 \qquad x \in \mathbb{R}$$
$$\mathrm{g}(x) = \sqrt{x} \qquad x \geq 0$$

12 (a) Using set notation, state the range of f

[2 marks]

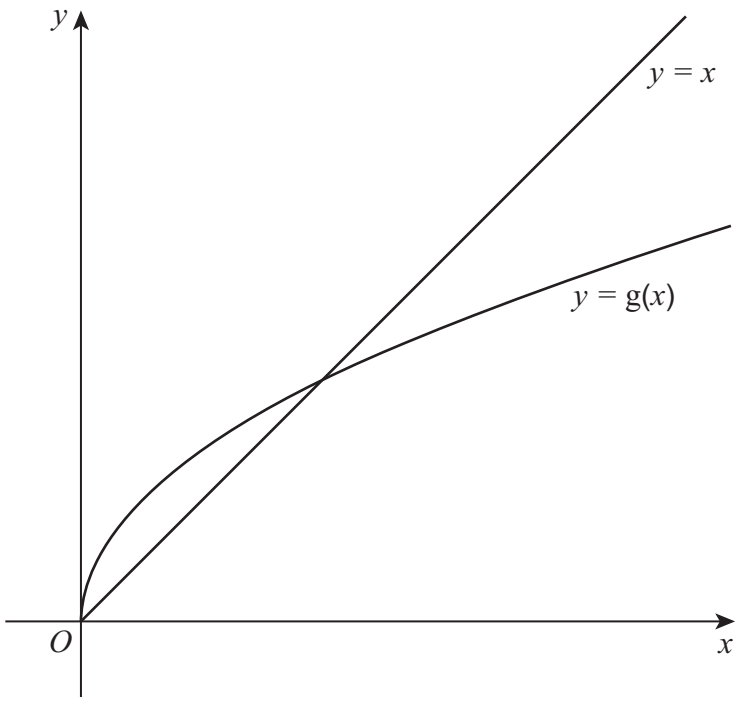
12 (b) Determine whether f has an inverse.

Fully justify your answer.

[2 marks]

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12 (c) The graph of $y = g(x)$, and the line with equation $y = x$, are shown on the diagram below.



Sketch the graph of $y = g^{-1}(x)$ on the diagram.

[2 marks]

12 (d) The composite function gf is denoted by h

12 (d) (i) Write down an expression for $h(x)$

[1 mark]

12 (d) (ii) State the range of h

[1 mark]

Turn over ▶

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13 A curve C has parametric equations

$$x = 4(4t + 1)^2$$
$$y = e^{-4t}$$

for $-\frac{1}{4} \leq t \leq 0$

13 (a) Find $\frac{dy}{dx}$ in terms of t

[3 marks]

13 (b) Find an equation of the tangent to C at the point where $t = 0$

[3 marks]

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13 (c) Find a Cartesian equation for C in the form $y = f(x)$

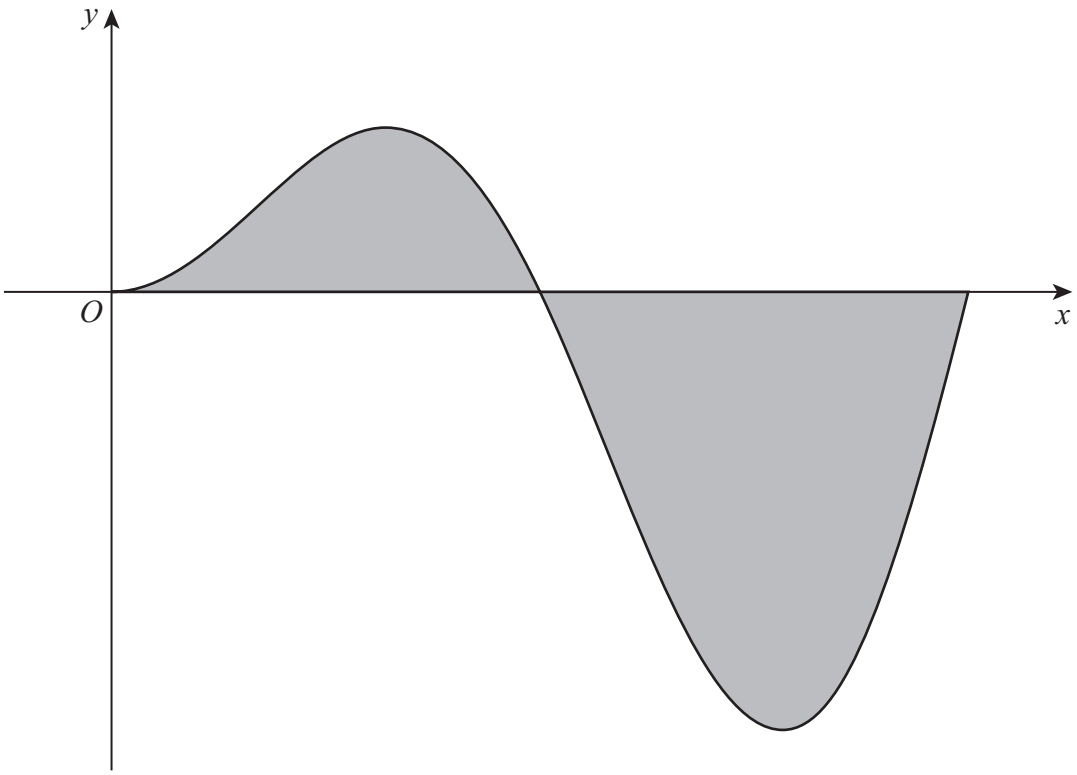
Fully justify your answer.

[3 marks]

Turn over for the next question

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14 The graph of $y = 4x \sin 2x$ for $0 \leq x \leq \pi$ is shown below.



Show that the shaded area enclosed by the x-axis and the curve is $k\pi$, where k is an integer to be found.

Fully justify your answer.

[8 marks]

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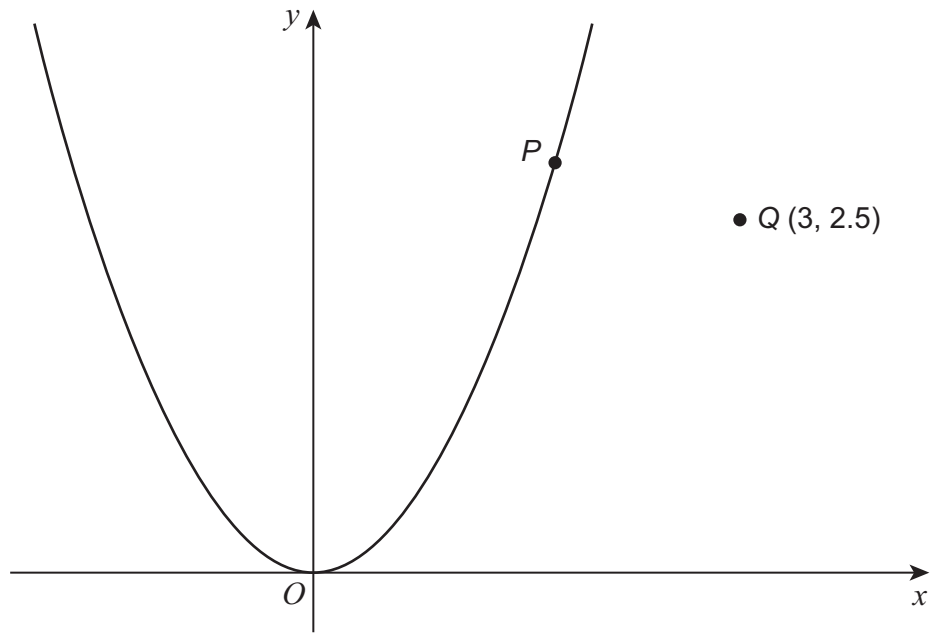
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15 A curve has equation

$$y = x^2$$

The point Q has coordinates (3, 2.5)

The point P on the curve which is closest to the point Q is shown on the diagram below.



15 (a) Show that the x-coordinate of P satisfies the equation

$$2x^3 - 4x - 3 = 0$$

[4 marks]

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15 (b) The Newton–Raphson method is to be used to find an approximate solution to the equation

$$2x^3 - 4x - 3 = 0$$

Show that the Newton–Raphson method generates the iterative formula

$$x_{n+1} = \frac{4x_n^3 + 3}{6x_n^2 - 4}$$

[4 marks]

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15 (c) Starting with $x_0 = 3$, use the iterative formula given in part **(b)** to find the value of x_3

Give your answer to **three** decimal places.

[2 marks]

15 (d) Hence find the distance *PQ*

Give your answer to **two** decimal places.

[2 marks]

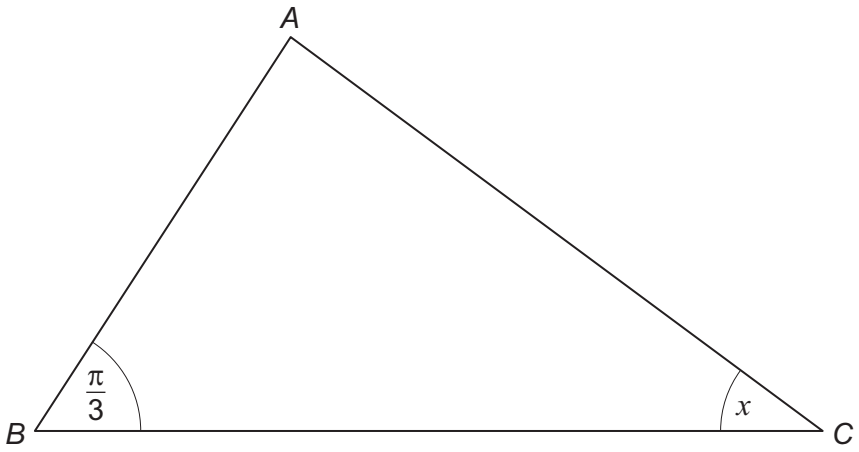
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16 The triangle *ABC* is shown in the diagram below.

The angle *ABC* is $\frac{\pi}{3}$ radians.

The angle *BCA* is x radians.



16 (a) Explain why angle $BAC = \frac{2\pi}{3} - x$

[1 mark]

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16 (b) (i) Use the sine rule to show that

$$\frac{BC}{AB} = \frac{\sqrt{3}\cot x + p}{q}$$

where p and q are integers.

[5 marks]

16 (b) (ii) Hence state the exact value of x when

$$\frac{BC}{AB} = \frac{\sqrt{3}+1}{2}$$

[1 mark]

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17 (a) Use the substitution $u = e^x + 1$ to show that

$$\int \frac{e^{2x}}{e^x + 1}\, dx = e^x - \ln(e^x + 1) + k$$

[5 marks]

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17 (b) Solve the differential equation

$$\left(\frac{e^x + 1}{e^{2x}}\right)\frac{dy}{dx} = \cos^2 y$$

given that $y = \pi$ when $x = 0$

Write your answer in the form

$$\tan y = e^x + \ln\left(\frac{A}{e^x + 1}\right) + B$$

where A and B are constants to be found.

[5 marks]

END OF QUESTIONS

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