

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

I declare this is my own work.

A-level MATHEMATICS

Paper 1

Wednesday 3 June 2020

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).
- 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	
2	
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11	
12	
13	
14	
15	
TOTAL	



2 A student is searching for a solution to the equation $f(x) = 0$

He correctly evaluates

$$f(-1) = -1 \text{ and } f(1) = 1$$

and concludes that there must be a root between -1 and 1 due to the change of sign.

Select the function $f(x)$ for which the conclusion is **incorrect**.

Circle your answer.

[1 mark]

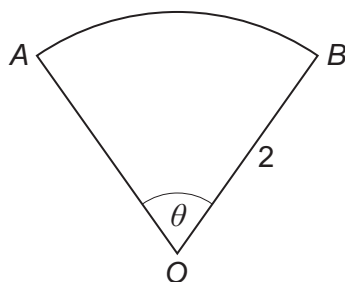
$$f(x) = \frac{1}{x}$$

$$f(x) = x$$

$$f(x) = x^3$$

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

3 The diagram shows a sector OAB of a circle with centre O and radius 2



The angle AOB is θ radians and the perimeter of the sector is 6

Find the value of θ

Circle your answer.

[1 mark]

1

$\sqrt{3}$

2

3

Turn over for the next question

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- 6** Four students, Tom, Josh, Floella and Georgia are attempting to complete the indefinite integral

$$\int \frac{1}{x} dx \quad \text{for } x > 0$$

Each of the students' solutions is shown below:

Tom $\int \frac{1}{x} dx = \ln x$

Josh $\int \frac{1}{x} dx = k \ln x$

Floella $\int \frac{1}{x} dx = \ln Ax$

Georgia $\int \frac{1}{x} dx = \ln x + c$

- 6 (a) (i)** Explain what is wrong with Tom's answer.

[1 mark]

- 6 (a) (ii)** Explain what is wrong with Josh's answer.

[1 mark]

- 6 (b)** Explain why Floella and Georgia's answers are equivalent.

[2 marks]



7 Consecutive terms of a sequence are related by

$$u_{n+1} = 3 - (u_n)^2$$

7 (a) In the case that $u_1 = 2$

7 (a) (i) Find u_3

[2 marks]

7 (a) (ii) Find u_{50}

[1 mark]

7 (b) State a different value for u_1 which gives the same value for u_{50} as found in part (a)(ii).

[1 mark]

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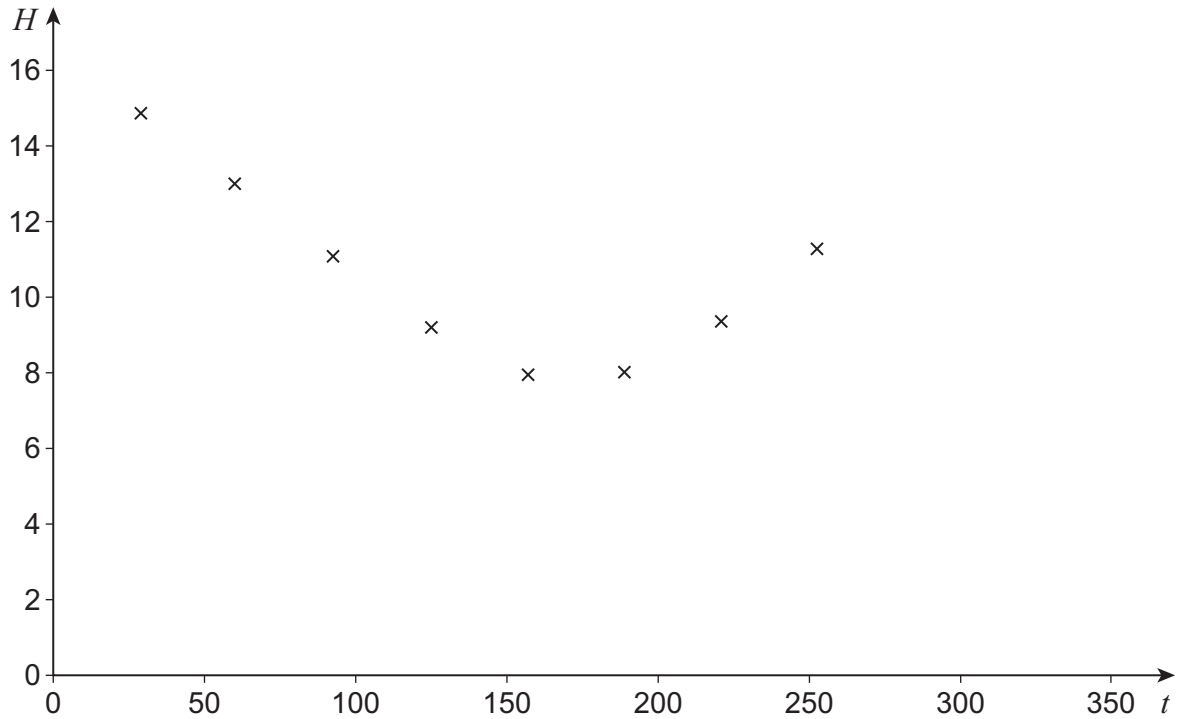


- 8** Mike, an amateur astronomer who lives in the South of England, wants to know how the number of hours of darkness changes through the year.

On various days between February and September he records the length of time, H hours, of darkness along with t , the number of days after 1 January.

His results are shown in **Figure 1** below.

Figure 1



Mike models this data using the equation

$$H = 3.87 \sin\left(\frac{2\pi(t + 101.75)}{365}\right) + 11.7$$

- 8 (a)** Find the minimum number of hours of darkness predicted by Mike's model. Give your answer to the nearest minute.

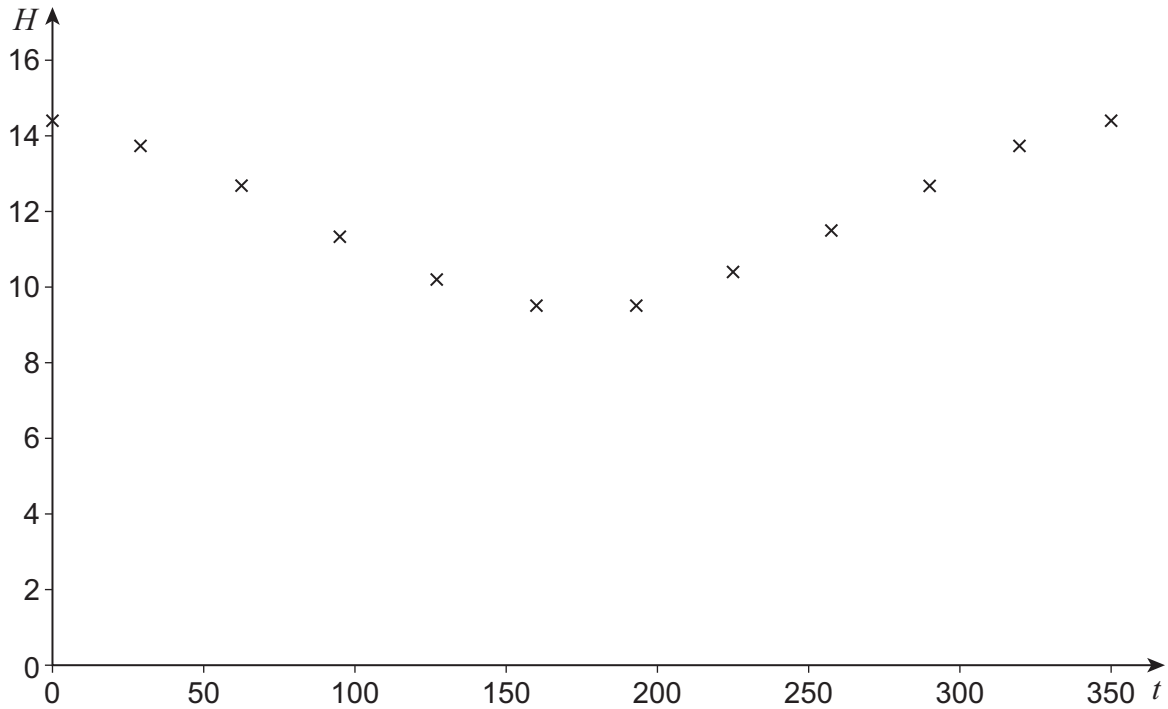
[2 marks]



- 8 (c)** Mike's friend Sofia, who lives in Spain, also records the number of hours of darkness on various days throughout the year.

Her results are shown in **Figure 2** below.

Figure 2



Sofia attempts to model her data by refining Mike's model.

She decides to increase the 3.87 value, leaving everything else unchanged.

Explain whether Sofia's refinement is appropriate.

[2 marks]



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- 9 Chloe is attempting to write $\frac{2x^2 + x}{(x + 1)(x + 2)^2}$ as partial fractions, with constant numerators.

Her incorrect attempt is shown below.

$$\text{Step 1} \quad \frac{2x^2 + x}{(x + 1)(x + 2)^2} \equiv \frac{A}{x + 1} + \frac{B}{(x + 2)^2}$$

$$\text{Step 2} \quad 2x^2 + x \equiv A(x + 2)^2 + B(x + 1)$$

$$\text{Step 3} \quad \begin{aligned} \text{Let } x = -1 &\Rightarrow A = 1 \\ \text{Let } x = -2 &\Rightarrow B = -6 \end{aligned}$$

$$\text{Answer} \quad \frac{2x^2 + x}{(x + 1)(x + 2)^2} \equiv \frac{1}{x + 1} - \frac{6}{(x + 2)^2}$$

- 9 (a) (i) By using a counter example, show that the answer obtained by Chloe cannot be correct.

[2 marks]

- 9 (a) (ii) Explain her mistake in Step 1.

[1 mark]



10 (a) An arithmetic series is given by

$$\sum_{r=5}^{20} (4r + 1)$$

10 (a) (i) Write down the first term of the series.

[1 mark]

10 (a) (ii) Write down the common difference of the series.

[1 mark]

10 (a) (iii) Find the number of terms of the series.

[1 mark]

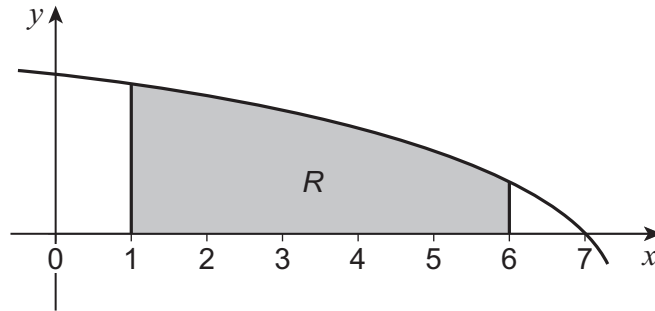


- 11** The region R enclosed by the lines $x = 1$, $x = 6$, $y = 0$ and the curve

$$y = \ln(8 - x)$$

is shown shaded in **Figure 3** below.

Figure 3



All distances are measured in centimetres.

- 11 (a)** Use a single trapezium to find an approximate value of the area of the shaded region, giving your answer in cm^2 to two decimal places.

[2 marks]

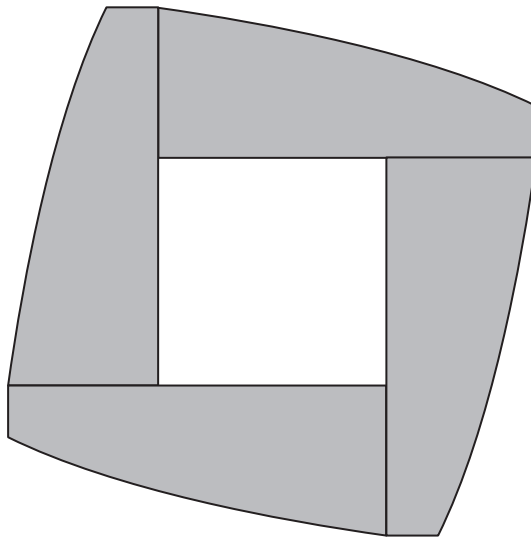
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11 (b) Shape B is made from four copies of region R as shown in **Figure 4** below.

Figure 4



Shape B is cut from metal of thickness 2 mm

The metal has a density of 10.5 g/cm^3

Use the trapezium rule with **six** ordinates to calculate an approximate value of the mass of Shape B .

Give your answer to the nearest gram.

[5 marks]



11 (c) Without further calculation, give one reason why the mass found in part **(b)** may be:

11 (c) (i) an underestimate.

[1 mark]

11 (c) (ii) an overestimate.

[1 mark]

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13 The function f is defined by

$$f(x) = \frac{2x+3}{x-2} \quad x \in \mathbb{R}, x \neq 2$$

13 (a) (i) Find f^{-1}

[3 marks]

13 (a) (ii) Write down an expression for $ff(x)$.

[1 mark]



13 (b) The function g is defined by

$$g(x) = \frac{2x^2 - 5x}{2} \quad x \in \mathbb{R}, 0 \leq x \leq 4$$

13 (b) (i) Find the range of g .

[3 marks]

13 (b) (ii) Determine whether g has an inverse.

Fully justify your answer.

[2 marks]

Turn over ►



14 The function f is defined by

$$f(x) = 3^x \sqrt{x} - 1 \quad \text{where } x \geq 0$$

14 (a) $f(x) = 0$ has a single solution at the point $x = \alpha$

By considering a suitable change of sign, show that α lies between 0 and 1

[2 marks]

14 (b) (i) Show that

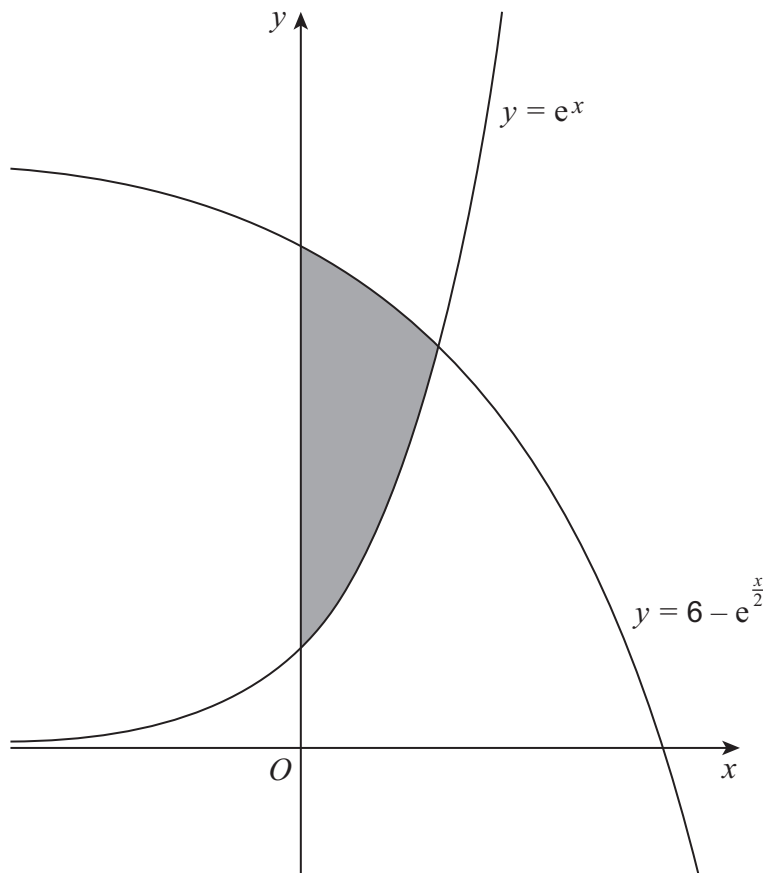
$$f'(x) = \frac{3^x(1 + x \ln 9)}{2\sqrt{x}}$$

[3 marks]



15

The region enclosed between the curves $y = e^x$, $y = 6 - e^{\frac{x}{2}}$ and the line $x = 0$ is shown shaded in the diagram below.



Show that the exact area of the shaded region is

$$6 \ln 4 - 5$$

Fully justify your answer.

[10 marks]



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