AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

Level 3 Certificate
MATHEMATICAL STUDIES

Paper 2C Graphical Techniques

Wednesday 24 May 2023 Afternoon Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:
- a clean copy of the Preliminary Material and the Formulae Sheet (enclosed)
- a scientific calculator or a graphics calculator
- a ruler.

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 the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- 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 you do not want to be marked.
- The **final** answer to questions should be given to an appropriate degree of accuracy.
- You may **not** refer to the copy of the Preliminary Material that was available prior to this examination. A clean copy is enclosed for your use.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.
- You may ask for more answer paper or graph paper, which must be tagged securely to this answer booklet.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

Do not write outside the box

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

1 The table shows information about the top four teams in the 2020 Olympic Games.

		Number of medals			Number of competitors
Rank	**Team**	**Gold**	**Silver**	**Bronze**	
1	United States	39	41	33	613
2	China	38	32	18	406
3	Japan	27	14	17	556
4	Great Britain	22	20	22	376

1 (a) Work out the ratio of gold medals to bronze medals for the **United States**.

Circle your answer.

[1 mark]

11 : 13 13 : 11 24 : 11 13 : 24

1 (b) A British newspaper made the following claim.

> Great Britain won more medals per competitor than the United States.

Does the data support this claim?

Show working to support your answer.

[3 marks]

4

Do not write outside the box

2 Use **Online Nation** from the Preliminary Material.

2 (a) Suggest **two** improvements that could be made to the **graphs** in the Preliminary Material.

[2 marks]

Improvement 1 _____

_____

_____

Improvement 2 _____

_____

_____

2 (b) **Graph 1** in the Preliminary Material is based on the results of a survey.

35 children aged 7 said they use **messaging or social media**.

Estimate the number of children aged 7 that took part in the survey.

[3 marks]

_____

_____

_____

_____

_____

_____

Answer _____

Question 2 continues on the next page

Do not write outside the box

2 (c) Mark works for a children's charity.

The charity is concerned by the amount of time that children spend online.

He calculates the percentage increase in time that children aged 15–16 spend online compared to children aged 7–8

Here is his calculation, which uses information from the last sentence in the Preliminary Material.

$$\frac{4.54 - 2.54}{2.54} = 0.787$$

$$0.787 \times 100 = 78.7$$

So, children aged 15–16 spend 78.7% longer online than those aged 7–8

Identify **one** mistake in Mark's calculation and work out the correct percentage increase.

[3 marks]

Mistake _____

_____

Correct calculation and answer _____

_____

_____

_____

_____

Do not write outside the box

2 (d) Ayesha, a radio journalist, produces a report based on the **Online Nation** extract in the Preliminary Material.

The report used **Graph 1** to make the claim,

"There are more 13-year-olds using messaging or social media than 12-year-olds."

Give **one** reason why this might **not** be true.

[1 mark]

_____

_____

_____

2 (e) Ayesha commented that the **Online Nation** extract was difficult to follow in places.

Give **two** reasons why she might have said this.

You should **not** comment on the graphs.

[2 marks]

Reason 1 _____

_____

_____

Reason 2 _____

_____

_____

Question 2 continues on the next page

Do not write outside the box

2 (f) Ayesha wants to comment on how much money social media companies make from children in the UK

She finds the following information for 2020

- There were approximately 3.2 million children aged 12–15 in the UK
- Instagram made $24 billion from their 1.41 billion users around the world.
- The average exchange rate was £1 = $1.28

Use this information, together with the data from the Preliminary Material, to estimate how much Instagram made from children aged 12–15 in the UK

Give your answer to the **nearest million** pounds.

[5 marks]

Answer £ _____ million

16

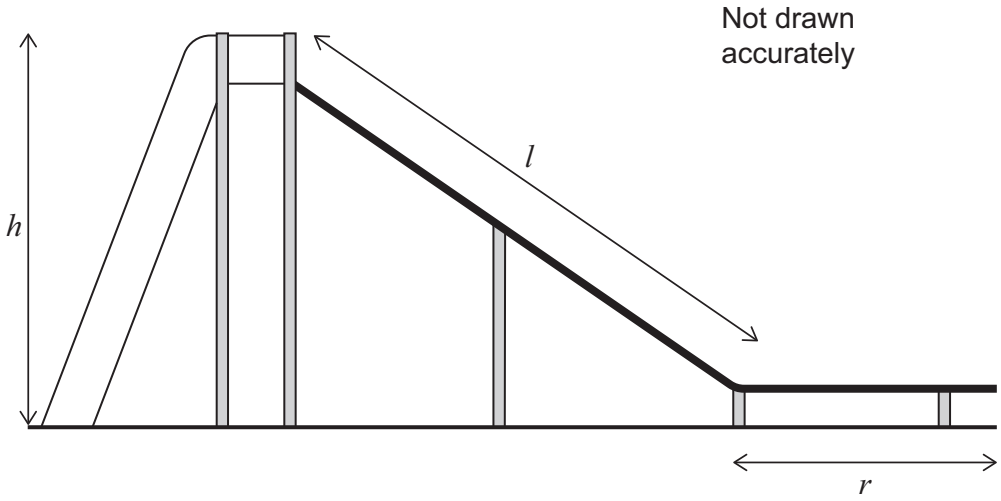
3 Playground slides are designed so that children slow down safely at the end of the slide on a horizontal run-out.

The diagram shows the dimensions important in slide design.

h is the height of the slide.

l is the slope length of the slide.

r is the run-out.



3 (a) A slide is designed with slope length $l = 3\,\text{m}$

On this slide a child has an average speed of $2.04\,\text{ms}^{-1}$ down the slope.

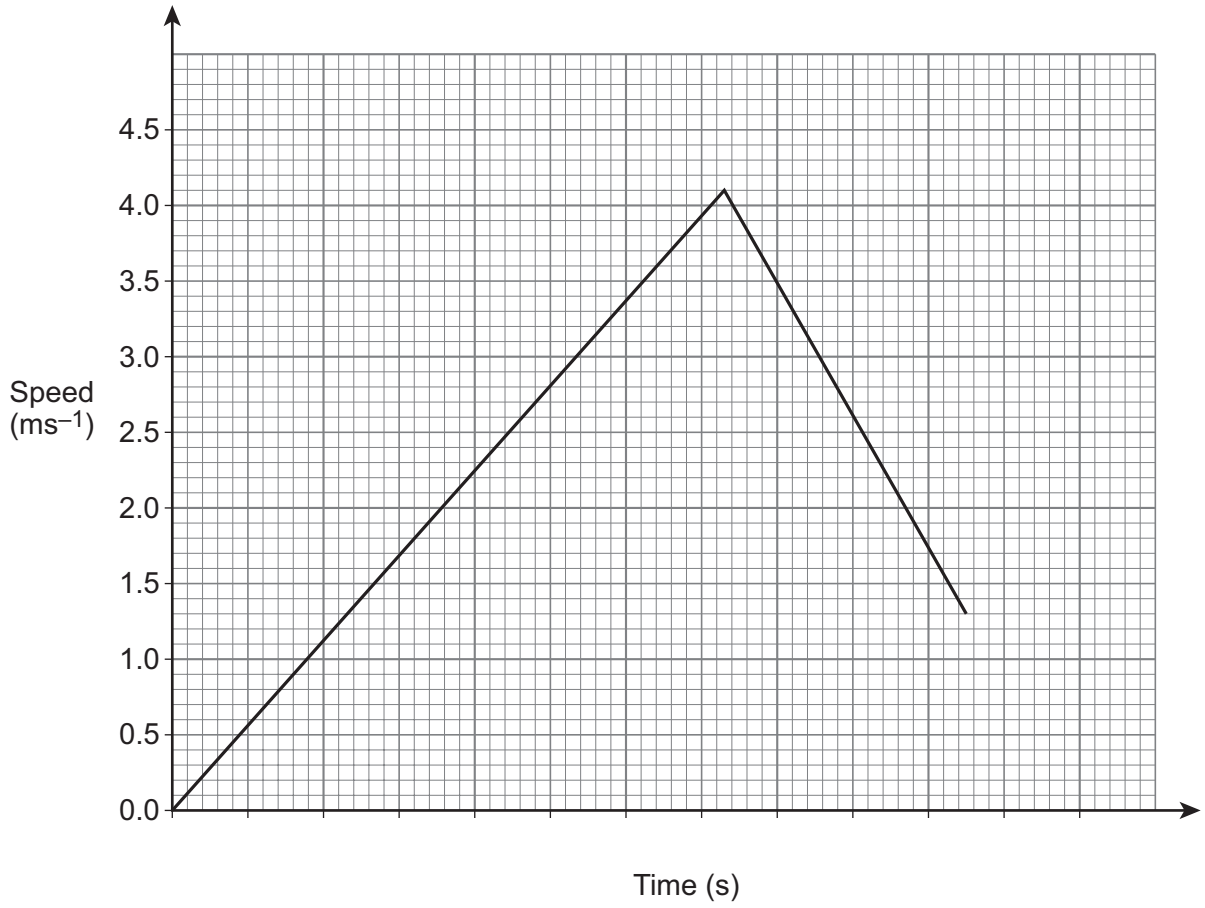
Work out the time it takes the child to travel down the slope.

[1 mark]

Answer _____ seconds

Question 3 continues on the next page

3 (b) The graph below shows the speed of the child in ms^{-1} over time as they travel down the slope and along the run-out.



3 (b) (i) Use the graph and your answer to **Question 3(a)** to estimate the amount of time that the child is travelling at **more than** $2\,ms^{-1}$

[5 marks]

Answer _____ seconds

Do not write outside the box

3 (b) (ii) Describe the acceleration of the child on the slope and on the run-out.

[2 marks]

Slope _____

_____

Run-out _____

_____

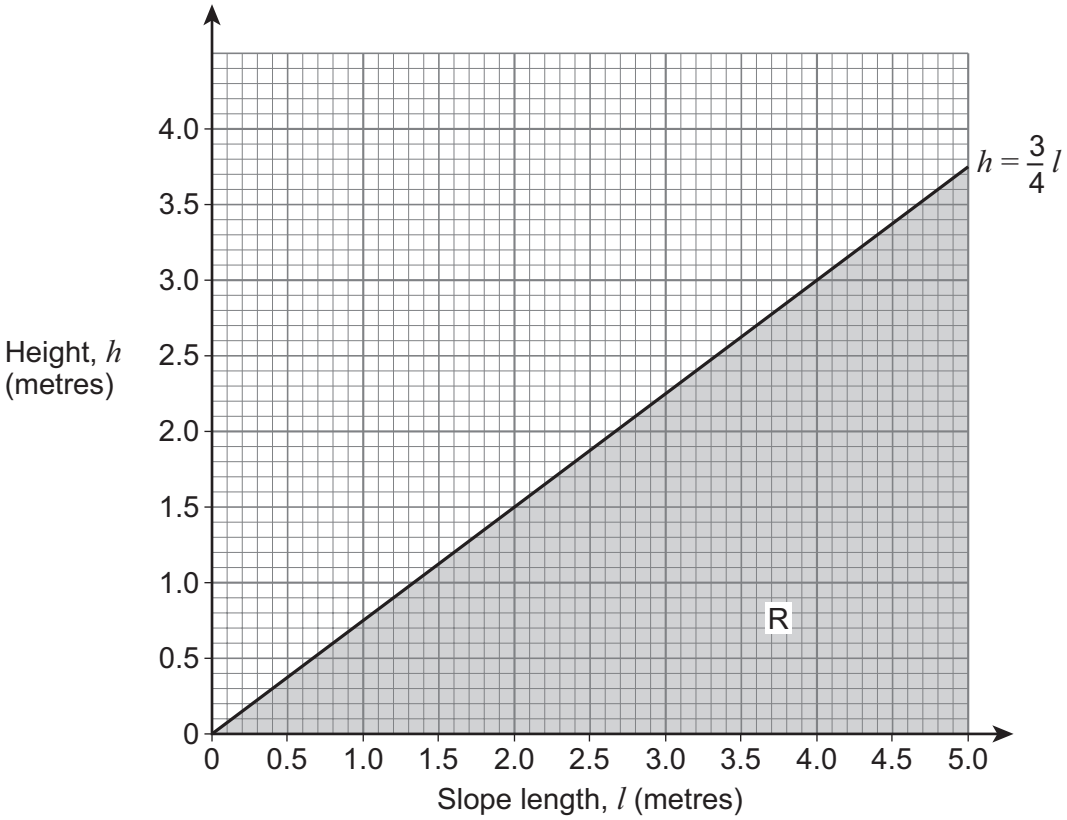
Question 3 continues on the next page

Do not write outside the box

3 (c) When designing playground slides, certain safety conditions must be met.

The length of the slope determines the maximum height permitted.

This condition is represented by the shaded region (R) on the graph.



Which **one** of the following designs will **not** meet the safety conditions?

Tick (✓) **one** box.

[1 mark]

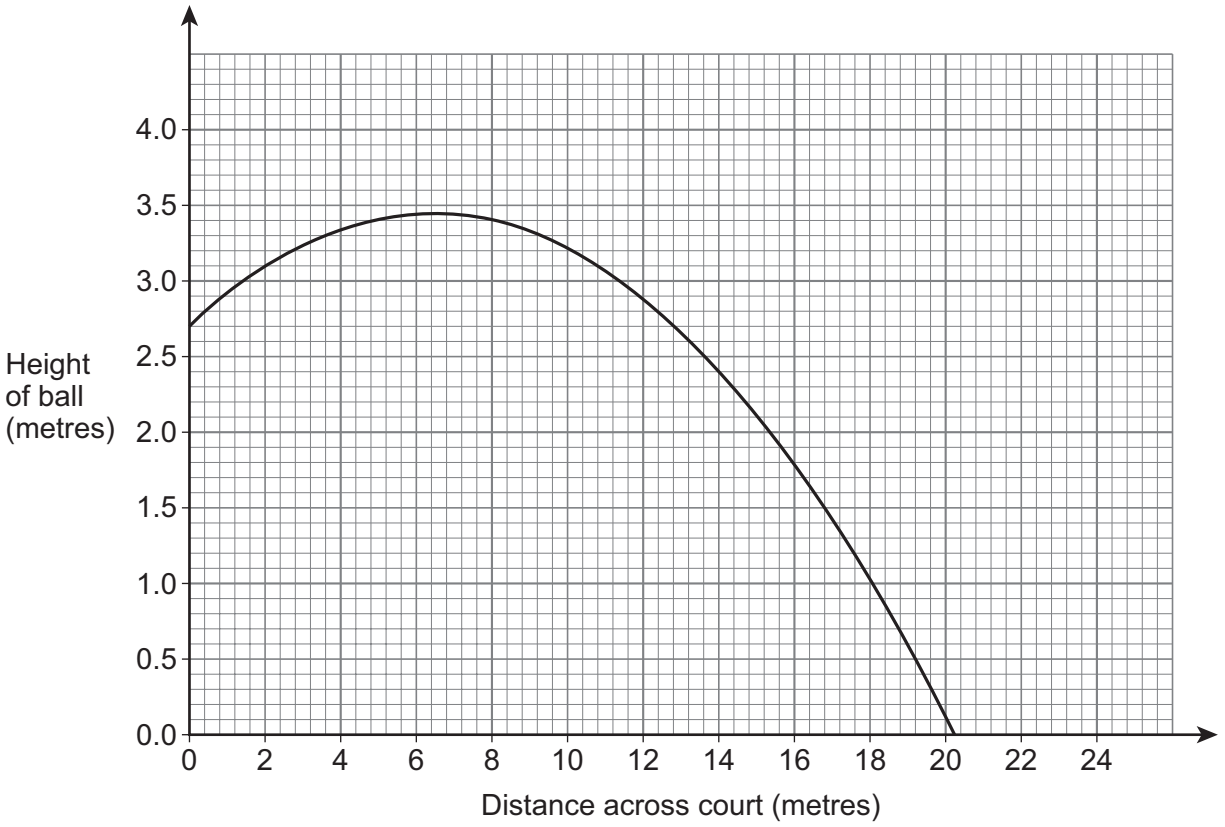
$l = 3\,\text{m}$	$h = 1.7\,\text{m}$	☐
$l = 2.2\,\text{m}$	$h = 1.6\,\text{m}$	☐
$l = 2\,\text{m}$	$h = 1.5\,\text{m}$	☐
$l = 1.7\,\text{m}$	$h = 1.4\,\text{m}$	☐

9

Do not write outside the box

4 A tennis ball is hit across a tennis court.

The graph shows the height of the ball as it travels across the court.



4 (a) Circle the type of function that the graph represents.

[1 mark]

Linear Quadratic Exponential

4 (b) A second ball is hit so that

- it has an initial height 10 cm **below** the initial height of the first ball
- it descends constantly by 10 cm for every metre travelled across the court.

By plotting the graph of the second ball, work out the distance across the court when both balls are at the same height.

[3 marks]

Answer _____ metres

4

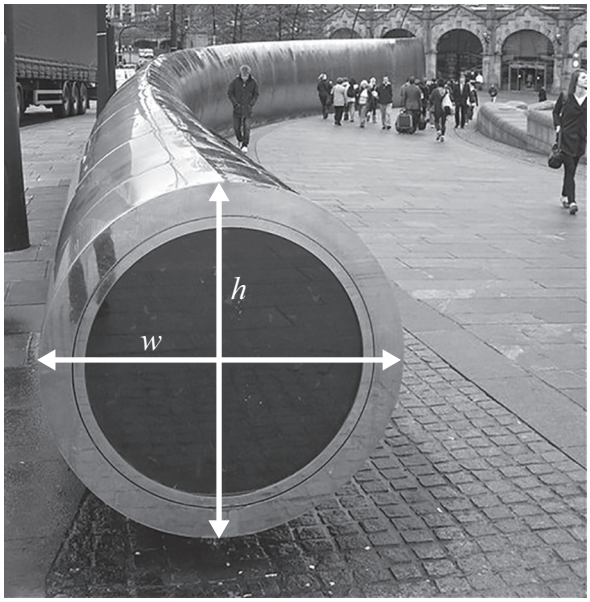
Turn over ▶

Do not write outside the box

5 In front of Sheffield train station is a curved sculpture that has a circular cross section at the front end and an oval cross section at the back end.

Over the length, l metres, of the sculpture its height, h metres, increases and its width, w metres, decreases.

The rate of change of both height and width is constant along the full length of the sculpture.



Front end

The table shows information about the sculpture.

	At front	At back
Distance from front end, l (m)	0	89
Height, h (m)	1	4
Width, w (m)	1	0.4

5 (a) Work out the height and width halfway along the sculpture.

[2 marks]

height = _____ m

width = _____ m

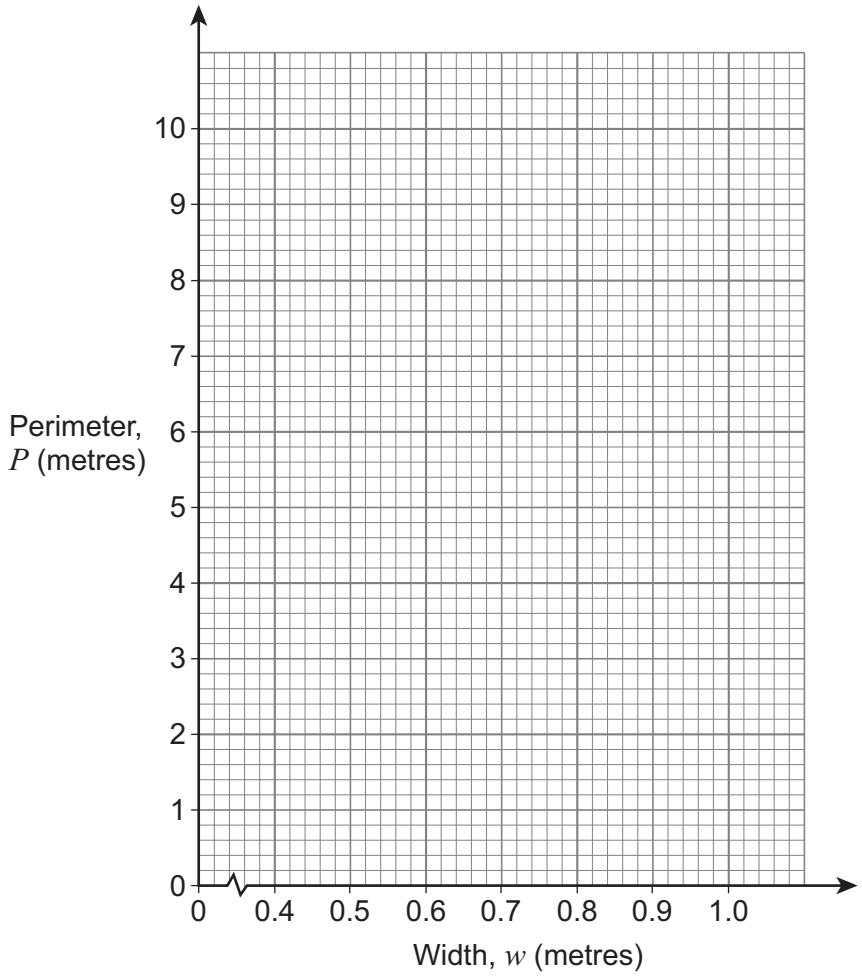
5 (b) (i) The following function can be used to model the perimeter, P metres, of the cross section.

$$P = 8w^3 - 5w^2 - 15w + 15 \qquad 0.4 \leqslant w \leqslant 1$$

Complete the table and plot the graph that represents this model.

[4 marks]

w (m)	0.4	0.5	0.6	0.7	0.8	0.9	1.0
P (m)	8.71	7.25	5.93				



5 (b) (ii) Use your graph to describe how the perimeter of the cross section changes from the front end to the back end.

[1 mark]

7

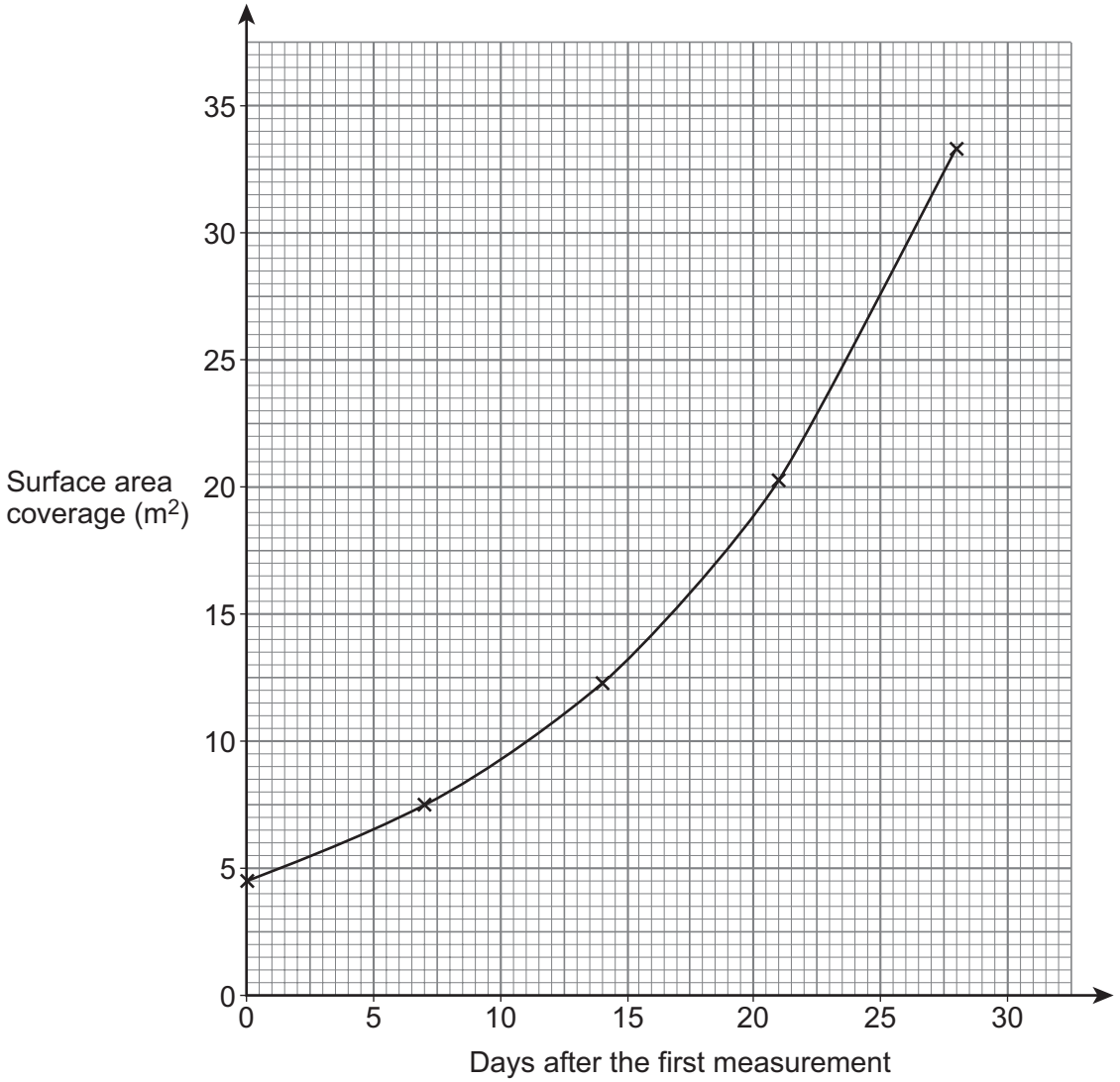
6 Water hyacinths are plants that grow in lakes and cover the water's surface.

When uncontrolled, the plants grow at an exponential rate.

The growth in one lake is recorded by measuring the surface area of water covered by the plants.

Initially the plants cover a surface area of $4.5\,m^2$

Measurements are taken weekly and a graph is plotted to model the data.



6 (a) Estimate how many days after the first measurement the plants are growing at a rate of $1\,m^2$ per day.

[1 mark]

Answer _____ days

Do not write outside the box

6 (b) The data can also be modelled by an equation of the form $S = A\mathrm{e}^{kd}$

S is the surface area covered in m^2

d is the days after the first measurement.

A and k are constants.

Work out the values of A and k.

[5 marks]

$A =$ _____

$k =$ _____

6 (c) State **two** reasons why the model might not be suitable for predicting the surface area of water covered by the plants one year after the first measurement.

[2 marks]

Reason 1 _____

Reason 2 _____

8

Do not write outside the box

7 The temperature of a computer processor increases from the moment it is turned on.
The temperature is exponential and modelled by the equation

$$T = 17 + e^{t}$$

T is the temperature of the processor (°C)

t is the time in minutes after the computer is turned on.

7 (a) Work out the temperature of the processor 30 seconds after being turned on.

[1 mark]

Answer _____ °C

7 (b) When the processor reaches 45 °C, cooling fans start.

7 (b) (i) Work out the time it takes for the cooling fans to start.
Give your answer in minutes and seconds.

[4 marks]

Answer _____ minutes _____ seconds

Do not write outside the box

7 (b) (ii) Work out the rate at which the temperature is increasing just as the fans start.

State the units of your answer.

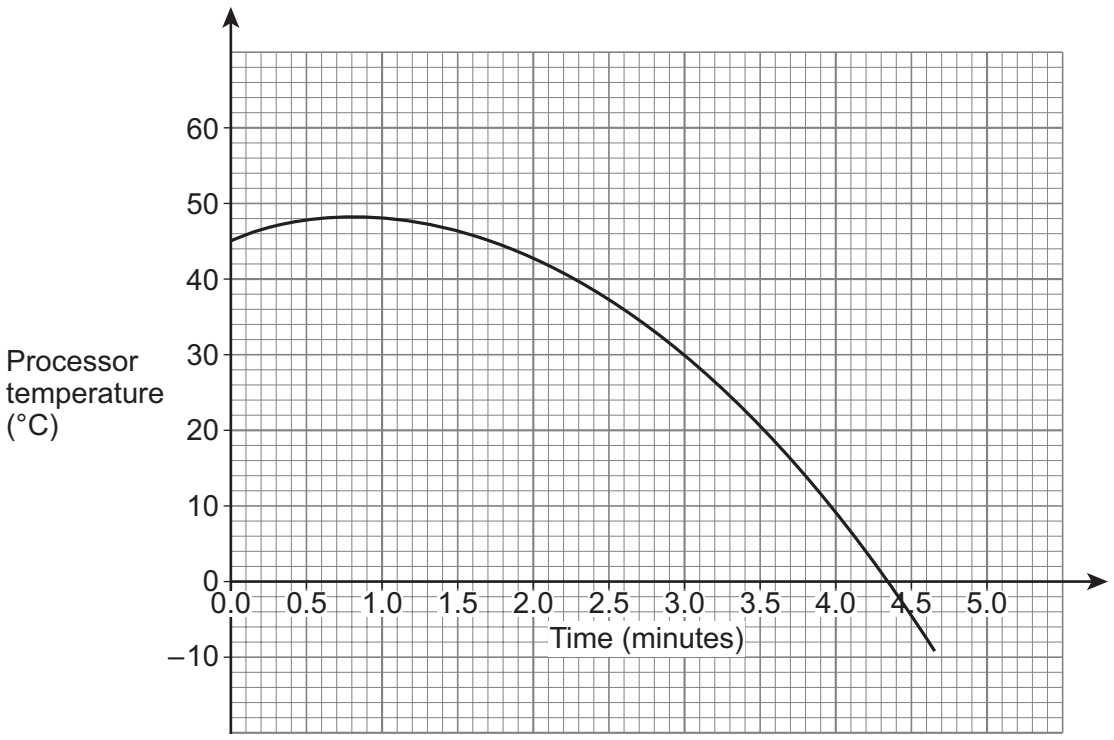
[3 marks]

Answer _____

Question 7 continues on the next page

Do not write outside the box

7 (c) The graph below models the processor temperature in °C from time t minutes after the fans start.



Use the graph to estimate the rate of cooling when the processor returns to 18 °C

Give your answer in degrees Celsius per **second**.

[4 marks]

Answer _____ °C per second

12

END OF QUESTIONS

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

Do not write outside the box

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

Do not write outside the box

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

Do not write outside the box

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**