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

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** | |

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

**1** Eva is a newspaper reporter.

She collected data about the degree results achieved by students at a university over 3 years.

Some students failed their course and were not awarded a degree.

Eva recorded the results in this table.

| | | Degree class awarded | | | | | |
|---|---|---|---|---|---|---|---|
| | | **First** | **Upper Second** | **Lower Second** | **Third** | **Fail** | **Total completed** |
| **Year course completed** | **2018** | 2615 | 1750 | 981 | 371 | 93 | 5810 |
| | **2019** | 3358 | 2300 | 1042 | 140 | 60 | 6900 |
| | **2020** | 5450 | 1509 | 375 | 229 | 77 | 7640 |

**1 (a)** Work out the ratio of students in **2019** awarded an Upper Second class degree to the total number of students completing their course that year.

Circle your answer.

**[1 mark]**

1 : 2 2 : 1 1 : 3 3 : 1

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**1 (b)** In an article on the data Eva made the following statements.

**Statement 1**

*'The average amount a student paid for a degree course was £27 000. This means that the university collected more than half a billion pounds from these students.'*

**Statement 2**

*'The percentage of students in the year group awarded a First class degree increased by more than half from 2018 to 2020'*

Does the data support these statements?

Show working to support your answers.

**[6 marks]**

Statement 1

Statement 2

7

**Turn over for the next question**

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**2** Use **Plastic waste** from the Preliminary Material.

**2 (a)** Suggest **two** improvements that could be made to the charts in the Preliminary Material.
**[2 marks]**

Improvement 1

Improvement 2

**2 (b)** Readers of the extract from the briefing paper commented that it was difficult to follow in places.

Give **three** reasons why they might have said this.

You should **not** comment on the charts.
**[3 marks]**

Reason 1

Reason 2

Reason 3

*Do not write outside the box*

**2 (c)** The following statements were made about the data on two online forums.

**The amount of plastic waste going to landfill fell by more than 60% from 2012 to 2016**

*Ecofriends*

**UK production of plastic waste in 2016 had increased by about 0.3 million tonnes since 2010**

*Greenusers*

Using the data given, comment on the validity of these statements.

**[6 marks]**

Ecofriends

Greenusers

**Question 2 continues on the next page**

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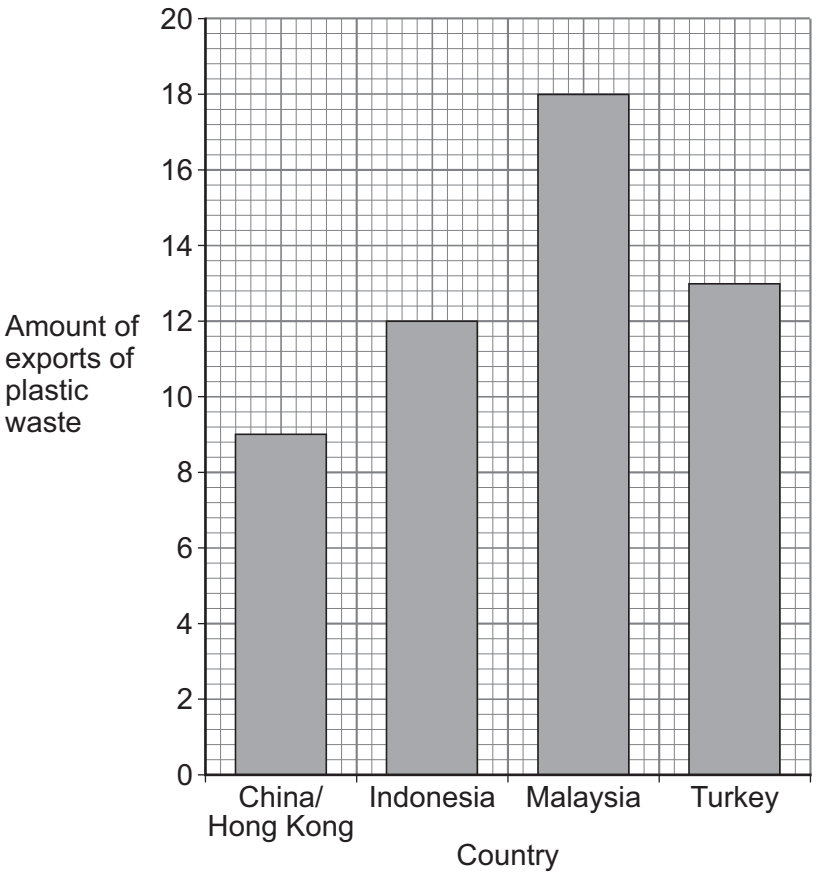
**2 (d)** The bar chart shows information about the exports of plastic waste from the UK in 2018




State **two** errors in the bar chart.

**[2 marks]**

Error 1

Error 2

13

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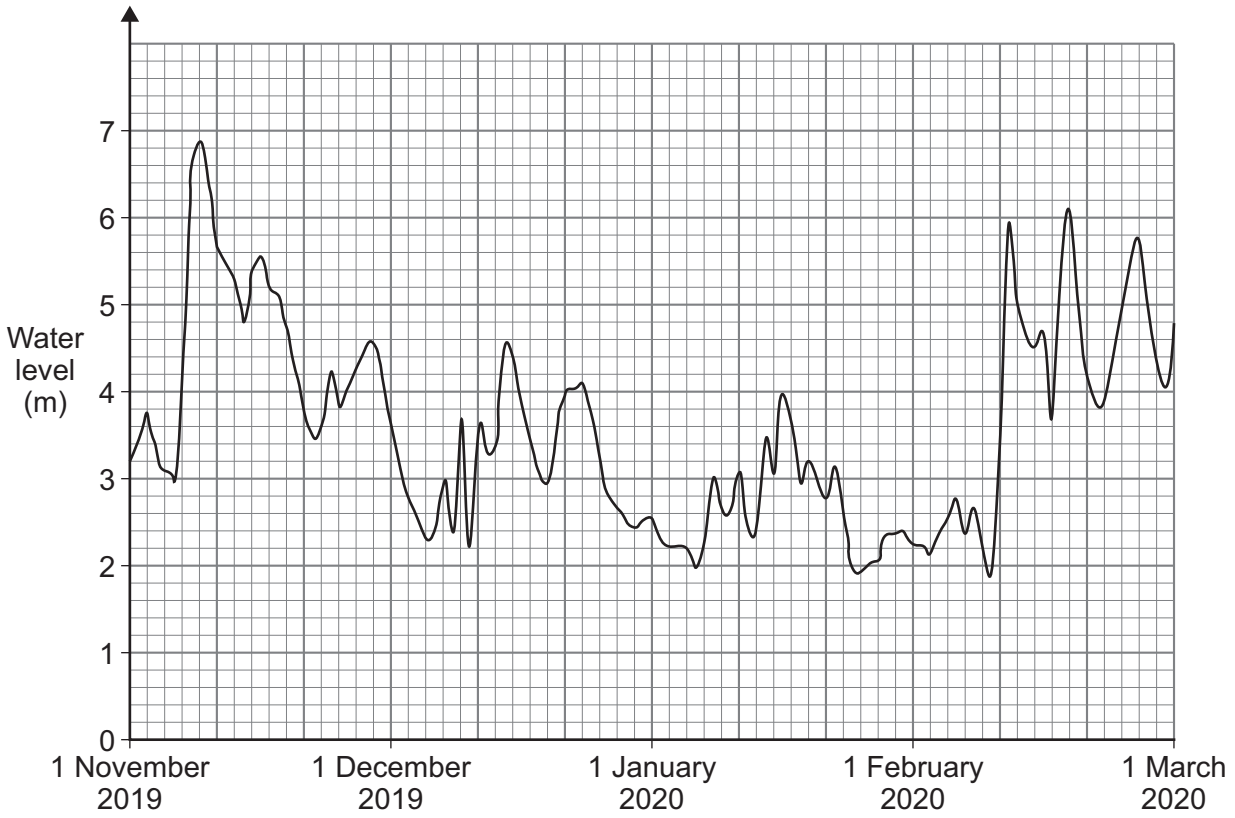
**3** River levels in the UK are measured by a network of monitoring stations.

The chart below shows the data from one station on the river Don from 1 November 2019 to 1 March 2020

This section of river floods when the water level exceeds 4.8 metres.

**Water level in the river Don**



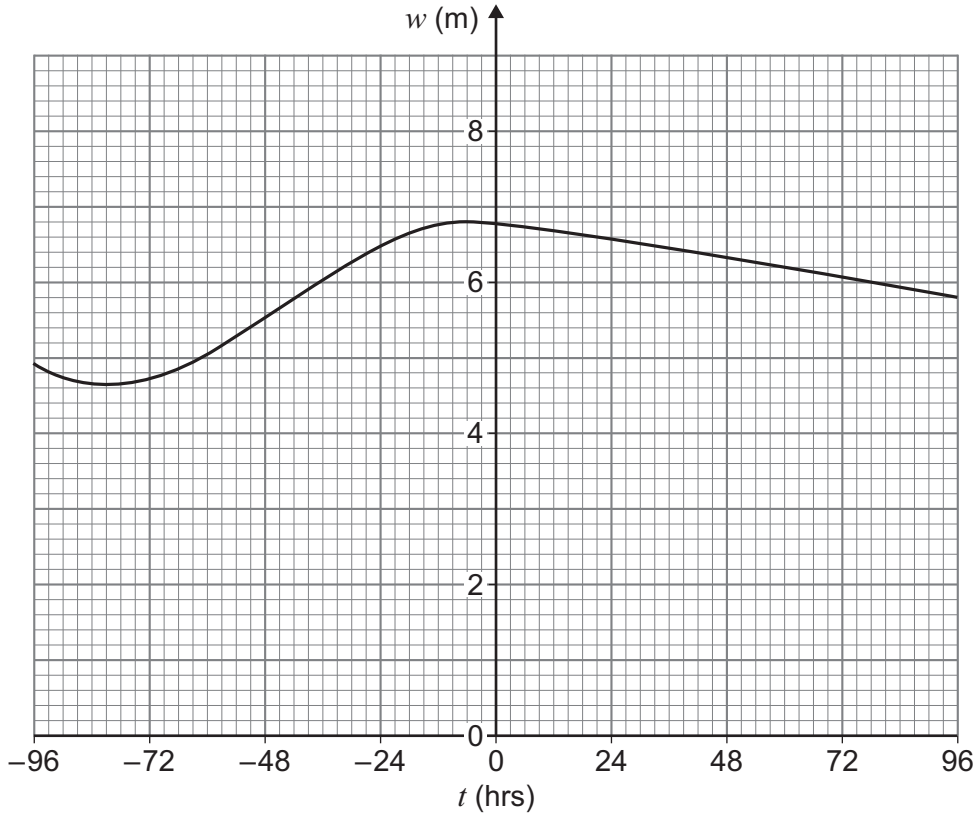

**3 (a)** Estimate the percentage of time during this 4-month period that the river flooded.

**[3 marks]**

Answer _____ %

**Question 3 continues on the next page**

The graph below models the water level, $w$ metres, for a period of time, $t$ hours, before and after 12.00 noon on 9 November 2019




**3 (b)** For $-96 \leqslant t < 0$, which of the following types of function represents the data?

Circle your answer.

**[1 mark]**

cubic exponential linear quadratic

**3 (c)** Use the graph above to work out the date and time of the maximum water level in this 192-hour period.

**[2 marks]**

Date _____ Time _____

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**3 (d)** After 12.00 noon on 9 November 2019, the water level, $w$, is modelled by the equation

$$w = At + B \qquad t \geqslant 0$$

where $A$ and $B$ are constants.

**3 (d) (i)** Use the graph to work out estimates for the values of $A$ and $B$

**[3 marks]**

$A =$ _____ $B =$ _____

**3 (d) (ii)** The water level is classed as 'normal' when below 3.18 metres.

**Use the equation** to forecast on what date after 9 November 2019 the water level would have dropped back below 3.18 metres.

You **must** show your working.

**[3 marks]**

Answer _____

**12**

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**4** One of the busiest air routes between Europe and North America is between London Heathrow and New York JFK.

**4 (a)** The flying distance between these airports is 5540 km

The flight time for a plane on this route is 8 hours.

Work out the average speed of a plane on this route.

**[1 mark]**

_____

_____

Answer _____ km/h

**4 (b)** The cruising speed of planes on this route is 900 km/h

Planes fly at cruising speed for the majority of the flight time.

Using your answer to Question **4(a)**, comment on the speed of a plane on this route when **not** at cruising speed.

**[1 mark]**

_____

_____

_____

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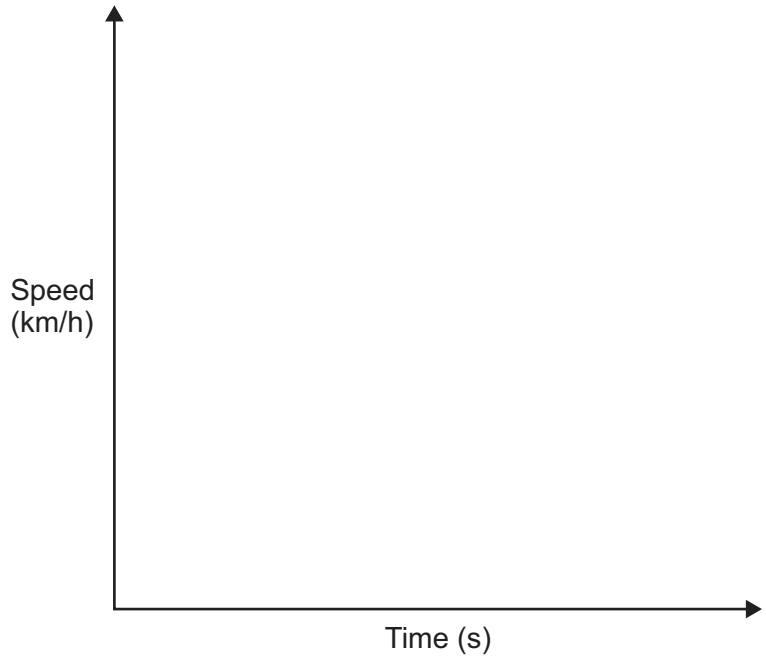
**4 (c)** When taking off, planes start from rest.

They accelerate uniformly until they reach their lift-off speed.

- Plane A has a greater lift-off speed than plane B.
- Planes A and B both take the same time to reach lift-off speed.

**4 (c) (i)** Sketch the speed–time graphs for planes A and B, from the start of their acceleration to when they reach their lift-off speed.

**[2 marks]**




**4 (c) (ii)** Plane C has

the same lift-off speed as plane A

and

the same acceleration as plane B

Compare the time for plane C to reach lift-off speed to the time for planes A and B.

**[1 mark]**

5

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**5** A social media post can very quickly receive large viewing figures.

**5 (a)** The total number of views, $v$, of one post $t$ minutes after being posted on social media is modelled by the equation

$$v = e^{0.12t}$$

The model is only a good predictor of views for certain values of $t$

**5 (a) (i)** When might this model **not** be a good predictor for the total number of views?

Suggest a reason why.

**[2 marks]**

**5 (a) (ii)** Use the model to estimate the number of minutes it would take the post to reach one million total views.

**[3 marks]**

Answer _____ minutes

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**5 (b)** Two adverts are posted on social media at the same time.

They receive $N$ total number of views, $m$ minutes after being posted.

Advert A has linear growth, with total number of views modelled by the equation

$$N_A = 1278m$$

Advert B has exponential growth, with total number of views modelled by the equation

$$N_B = 0.001\mathrm{e}^m$$

Work out the value of $m$ for which the total numbers of views of both adverts are predicted to have the same **rate of change**.

**[4 marks]**

$m =$ _____

9

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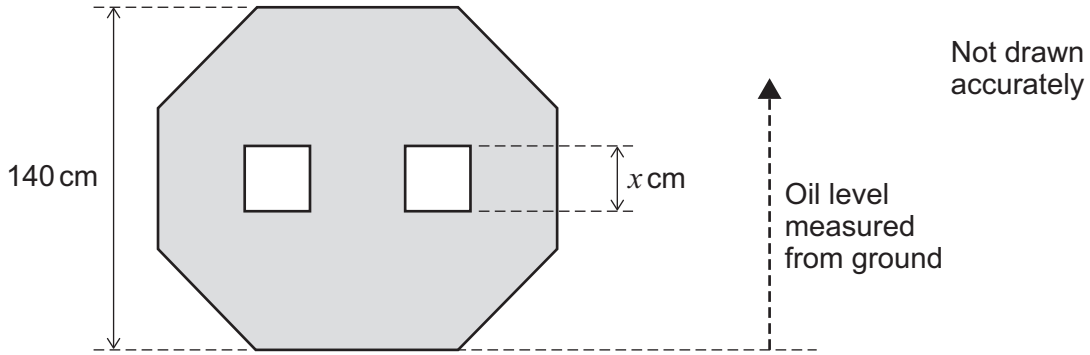
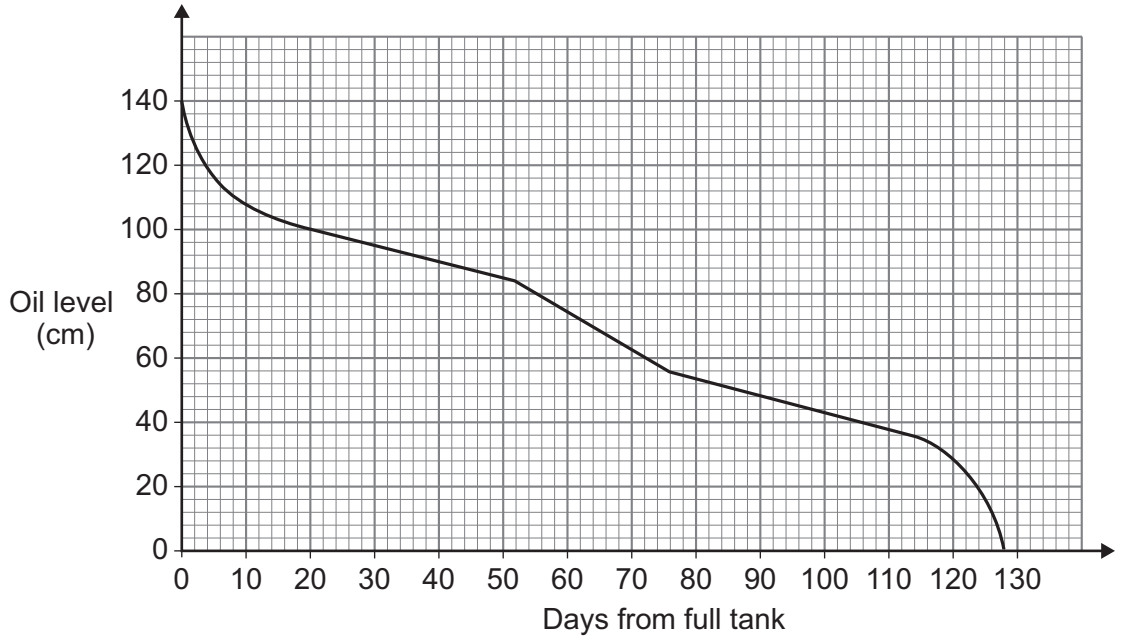
**6** A domestic oil tank of height 140 cm has an octagonal cross-section with two square hollow sections of height $x$ cm




It takes 128 days to use all the oil when it is used at a constant rate.

The graph shows the oil level for the 128 days.

**Oil level with constant use**




**6 (a)** Use the graph to work out the height of the hollow sections, marked $x$ on the diagram.

**[2 marks]**

Answer _____ cm

**Question 6 continues on the next page**

**6 (b)** A different tank is a cuboid of height 100 cm

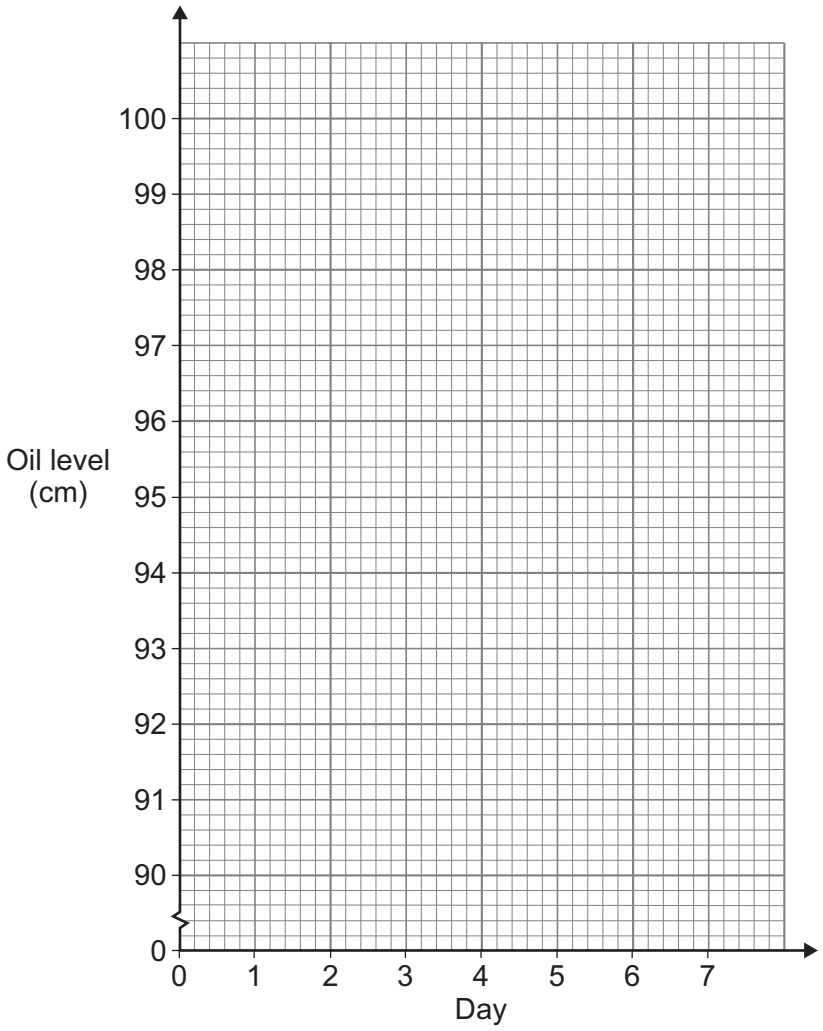
During one week the rate of oil use increases at a steady rate.

The table shows oil level readings for the week.

| **Day** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| **Oil level (cm)** | 100 | 99.5 | 98.9 | 98.1 | 97.1 | 95.9 | 94.4 | 92.5 |

**6 (b) (i)** On the grid below, plot a graph modelling this data.

**[2 marks]**



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**6 (b) (ii)** Use your graph to estimate the instantaneous rate at which the oil level is falling after 4 days.

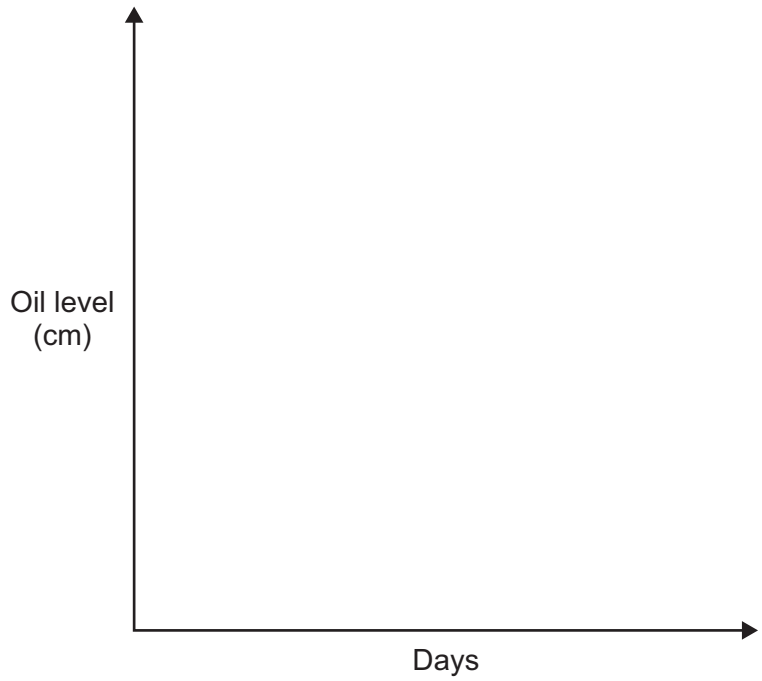
State the units of your answer.

**[3 marks]**

Answer _____

**6 (b) (iii)** Sketch a graph of the oil level in the tank if the rate at which the oil is being used **decreases** constantly over time.

**[1 mark]**




8

**Turn over for the next question**

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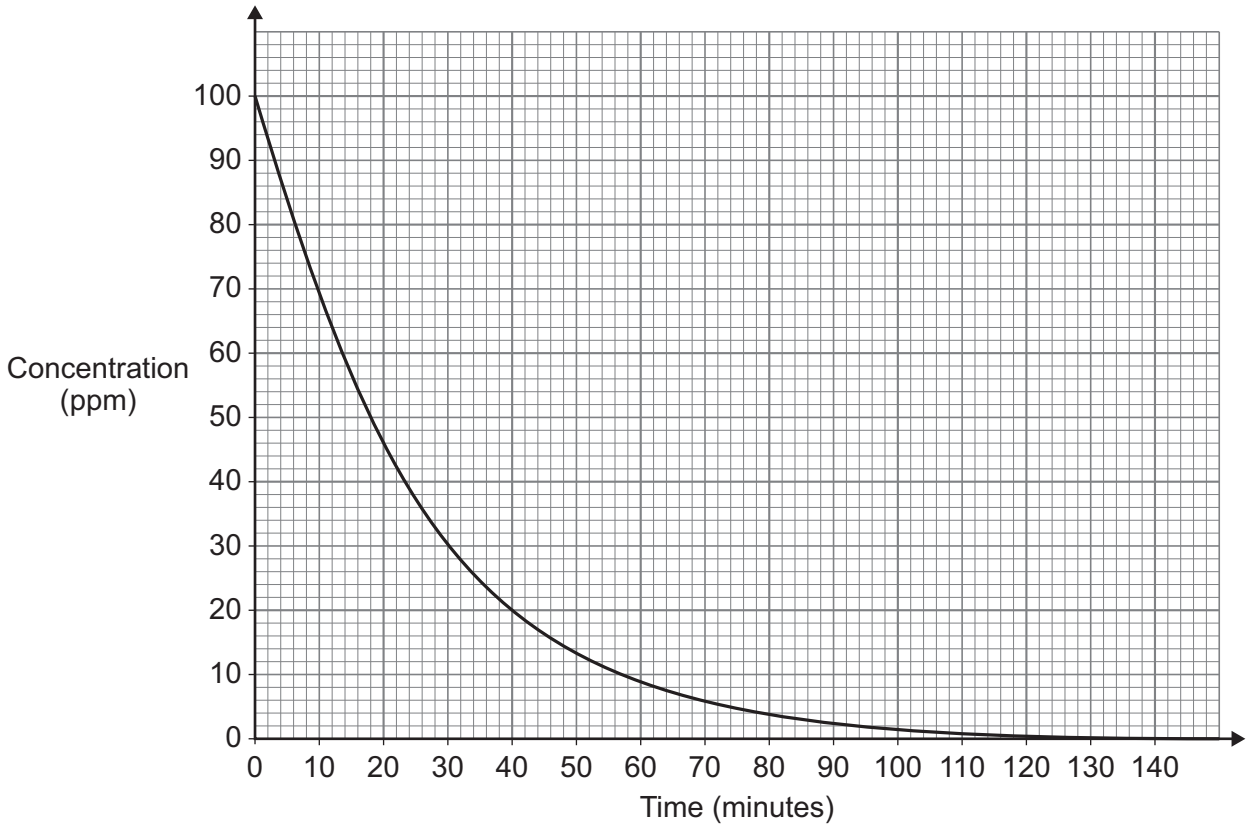
**7** An air-freshener sprays particles into the air.

The graph shows the concentration of particles in the air over time, measured in parts per million (ppm).




The concentration, $C$ ppm, at time $t$ minutes after the air-freshener is sprayed, is modelled by the equation

$$C = Ae^{kt}$$

where $A$ and $k$ are constants.

**7 (a)** Explain why $k$ must be negative.

**[1 mark]**

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**7 (b)** Use the graph to work out the values of $A$ and $k$.

**[5 marks]**

$A =$ _____ $k =$ _____

6

**END OF QUESTIONS**

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