

Thursday 9 June 2016 – Morning

GCSE APPLICATIONS OF MATHEMATICS

A382/02 Applications of Mathematics 2 (Higher Tier)

Candidates answer on the Question Paper.

OCR supplied materials:

None

Other materials required:

- Scientific or graphical calculator
- Geometrical instruments
- Tracing paper (optional)

Duration: 2 hours



Candidate forename		Candidate surname	
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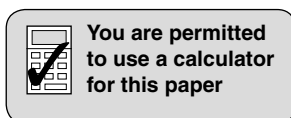
Centre number						Candidate number				
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INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Your answers should be supported with appropriate working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

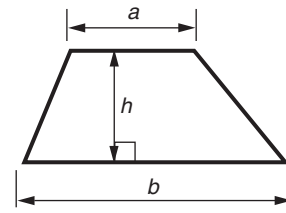
INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- Your quality of written communication is assessed in questions marked with an asterisk (*).
- The total number of marks for this paper is **90**.
- This document consists of **20** pages. Any blank pages are indicated.

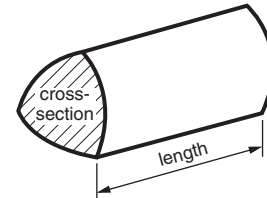


Formulae Sheet: Higher Tier

Area of trapezium = $\frac{1}{2}(a + b)h$



Volume of prism = (area of cross-section) \times length

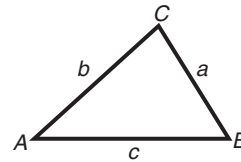


In any triangle ABC

Sine rule $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

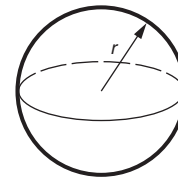
Cosine rule $a^2 = b^2 + c^2 - 2bc \cos A$

Area of triangle = $\frac{1}{2}ab \sin C$



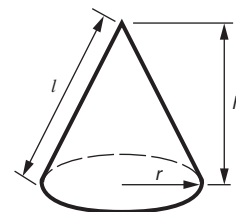
Volume of sphere = $\frac{4}{3}\pi r^3$

Surface area of sphere = $4\pi r^2$



Volume of cone = $\frac{1}{3}\pi r^2 h$

Curved surface area of cone = $\pi r l$



The Quadratic Equation

The solutions of $ax^2 + bx + c = 0$,
where $a \neq 0$, are given by

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

PLEASE DO NOT WRITE ON THIS PAGE

Answer **all** the questions.

- 1 The minimum wage is the minimum hourly rate a worker should be paid. It is determined by the government. A survey was conducted to find out people’s opinions about increasing the minimum wage. The survey results are shown in the table below.

Age \ Opinion	For	Against	No opinion	Total
21–40	28	25	10	63
41–60	26	32	14	72
Over 60	33	23	8	64
Total	87	80	32	199

- (a) What percentage of people in the **over 60** age group have **no opinion** about increasing the minimum wage?

(a) % [2]

- (b) Sami says, ‘The proportion of people aged **21–40** years who are **for** increasing the minimum wage is **less than** the proportion of people aged **41–60** who are **against** increasing the minimum wage.’

Is Sami correct?

Support your answer with calculations, using information from the table.

.....

 [3]

- (c) The table below shows the annual rate of inflation and the minimum wage for people aged over 21 at the end of that year.

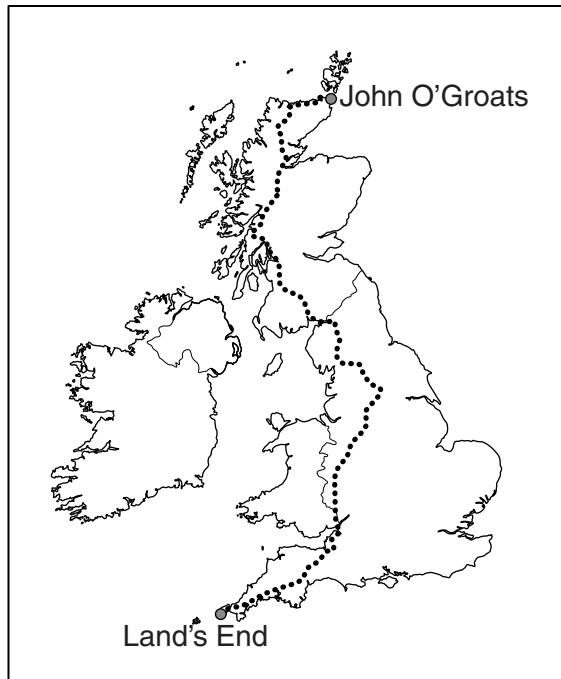
Year	2010	2011	2012
Rate of inflation, %	3.3	4.5	2.8
Minimum wage, £	5.93	6.08	6.19

Use a calculation to show that the annual rate of increase of the minimum wage was not the same as the annual rate of inflation.

.....

 [3]

2 This map shows a 969-mile cycle route from Land's End to John O'Groats.



In 2013, Sean Conway swam from Land's End to John O'Groats up the west coast of Great Britain. Sean swam 1440 kilometres in 90 days.

(a) Which distance is further, the cycle route or the swimming route, and by how much? Use the conversion 8 kilometres = 5 miles.

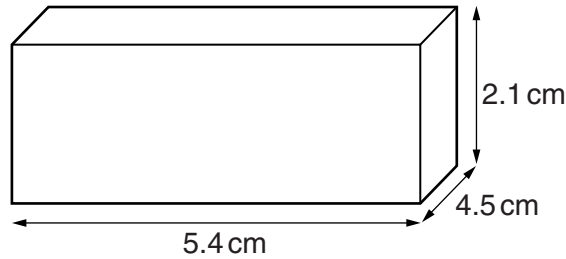
(a) [4]

(b) The number of swimming strokes made by Sean was reported as 3 million.

Why is 3 million **unlikely** to be the **exact** number of strokes Sean made?

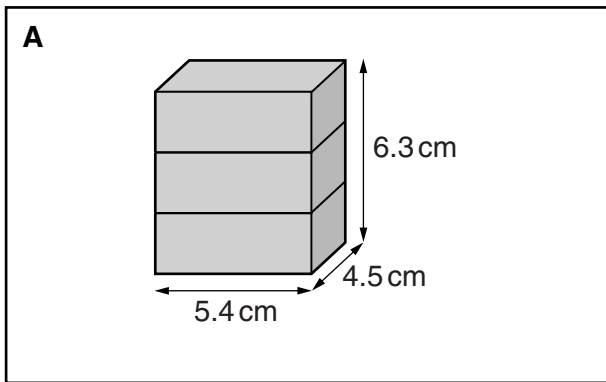
.....
..... [1]

- 3 Jayne decides to post three identical portable chargers to her three nieces for Christmas. The box for each charger is a cuboid with dimensions as shown in the diagram below.

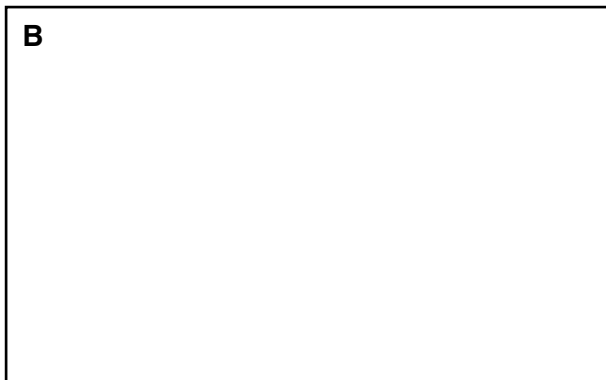


All three boxes were packed as a single parcel to post. The parcel was also a cuboid.

- (a) There are three possible ways in which the boxes can be arranged so that there is no wasted space inside the parcel. One has been drawn for you.



- (i) Sketch the other two ways in which the boxes can be arranged. Include the dimensions of the parcel on each sketch.



[4]

- (ii) The parcel of three boxes will be wrapped in paper.

Give a reason why the arrangement shown in **A** would need the least amount of paper.

..... [1]

- (b) The table below shows the maximum length, width and depth for types of package posted with Royal Mail.

Type of package	Maximum length, cm	Maximum width, cm	Maximum depth, cm
Letter	24	16.5	0.5
Large letter	35.3	25	2.5
Small parcel	45	35	16
Medium parcel	61	46	46

What is the greatest number of chargers that can be packaged as a cuboid and fit the **large letter** format?

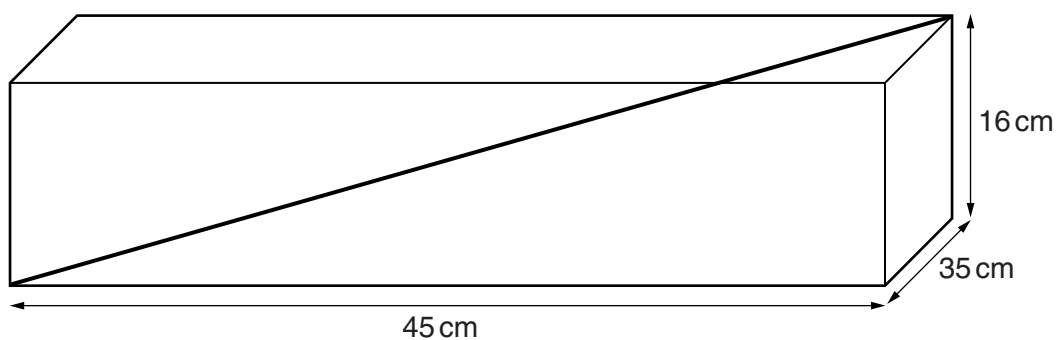
Give the dimensions of the cuboid.

Number

Dimensions of cuboid [3]

- (c) Jayne also has a long thin rod to post.

Work out the greatest length of a long thin rod that can be parcelled in a cuboid box and posted as a **small parcel**.

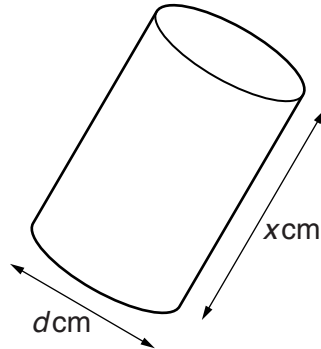


(c)cm [3]

(d) To post a cylindrical package with Royal Mail its dimensions must follow this rule:

- the length plus twice the diameter must not exceed 104 cm
- the greater dimension must be no more than 90 cm.

Jayne investigates sizes of different cylindrical packages she could post with Royal Mail. She draws this cylinder with length, x cm, and diameter, d cm.



(i) Use the first bullet point to write down an inequality connecting x and d .

(d)(i) [2]

(ii) If the length of the cylinder is 90 cm, what is the greatest possible diameter?

(ii) cm [2]

(iii) Jayne says it is not possible for the diameter to be 90 cm.

Show why Jayne is correct.

.....
 [1]

(iv) Write down an inequality for the range of values for d .

(iv) [2]

- 4 The stem and leaf diagram shows the populations of 55 US cities in 1998. All these cities had a population between 200 000 and 500 000. Each population was rounded to the nearest 10 000.

4 | 899
 4 | 6
 4 | 4455
 4 | 333
 4 | 01
 3 | 99
 3 | 677777
 3 | 55
 3 | 223
 3 | 1 1 1
 2 | 8899
 2 | 666667
 2 | 444455
 2 | 22333
 2 | 00000

Key:
 3 | 5 represents
 350 000

- (a) What does 2 | 6 represent?

(a) [1]

- (b) Complete the inequality for the population of the city represented on the diagram as 4 | 6.

..... \leq population \leq [2]

- (c) From the diagram find

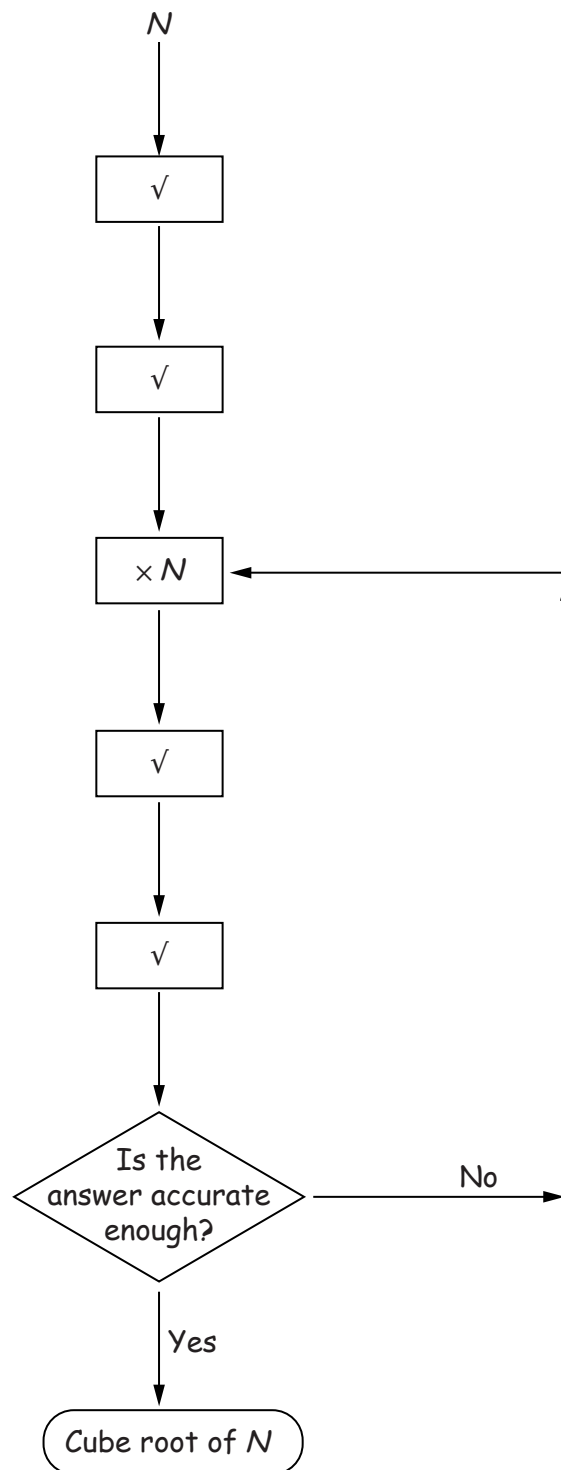
- (i) the median population,

(c)(i) [1]

- (ii) the interquartile range.

(ii) [3]

- 5 On a basic calculator you can work out square roots of numbers, but not cube roots of numbers. This flow chart can be used to find an approximation of the cube root of a number, N .



- (a) Use the flow chart for $N = 120$. Stop when you first reach the decision box 'Is the answer accurate enough?'.
 Write down the first four figures of your calculator display.

(a) [2]

- (b) The value you obtained in part (a) is not accurate enough.

Use the flow chart to obtain the cube root of 120 that is correct to one decimal place.
 Write down the value you obtain each time you reach the decision box.

Stop when you have found sufficient values; you may not need all the rows in the table.

Number of times decision box reached	Value obtained
1	
2	
3	
4	
5	
6	
7	

Write your answer to part (a) here.

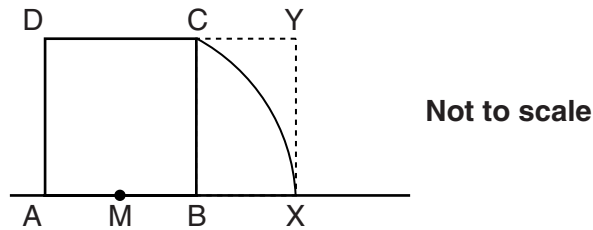
[2]

Turn over

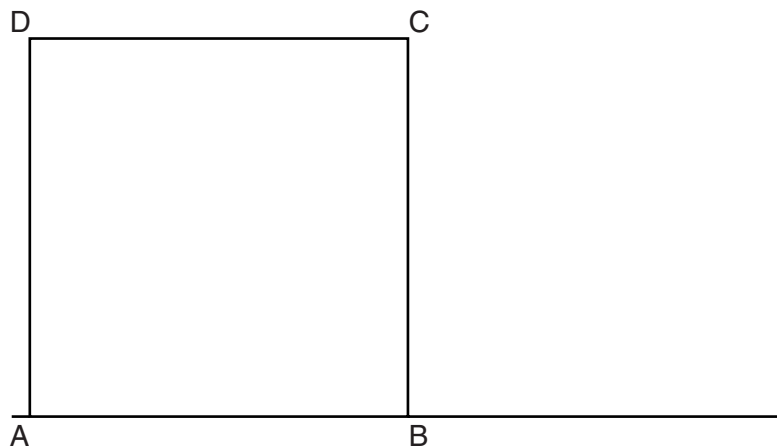
- 6 The golden ratio is commonly used in everyday design, such as postcards. Below are instructions to construct a golden rectangle, a rectangle with sides in the same proportion as the golden ratio.

- o Draw a square, ABCD.
- o Find the mid-point of AB, label it M.
- o Draw an arc with centre M, radius MC, from C to the line AB extended.
- o Label the point, X, where the arc meets AB extended.
- o Construct a perpendicular line from X.
- o DA and AX are two sides of the golden rectangle. Complete the rectangle.

This is a sketch of the rectangle.



- (a) On the diagram below, using a ruler and a pair of compasses, construct the golden rectangle AXYD. Show clearly the points M, X and Y. A square, ABCD, has been drawn for you. Leave any construction arcs on the diagram.



[3]

- (b) From your diagram use measurements, correct to the nearest mm, to write down the golden ratio, $AD : AX$.
Do not simplify your ratio.

(b) : [1]

- (c) Betty wanted to find a more accurate value for the golden ratio.

- (i) **Calculate** the length MC .
 Give your answer correct to **3 decimal places**.

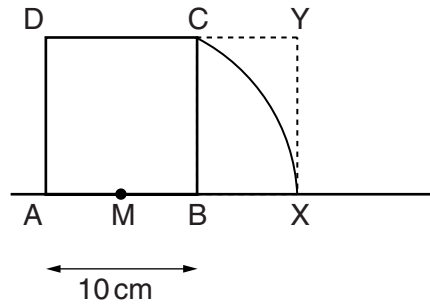
(c)(i) [3]

- (ii) Using your answer to part (c)(i) find the golden ratio, $AD : AX$, in the form $1 : n$.
 Show **all** your working and give n correct to **3 decimal places**.

(ii) 1 : [2]

(d) When Betty drew a golden rectangle, she began by drawing line $AB = 10\text{ cm}$.

This is a sketch of the rectangle.



Not to scale

Calculate the length of the arc CX on Betty's drawing.
Do not make an accurate drawing.

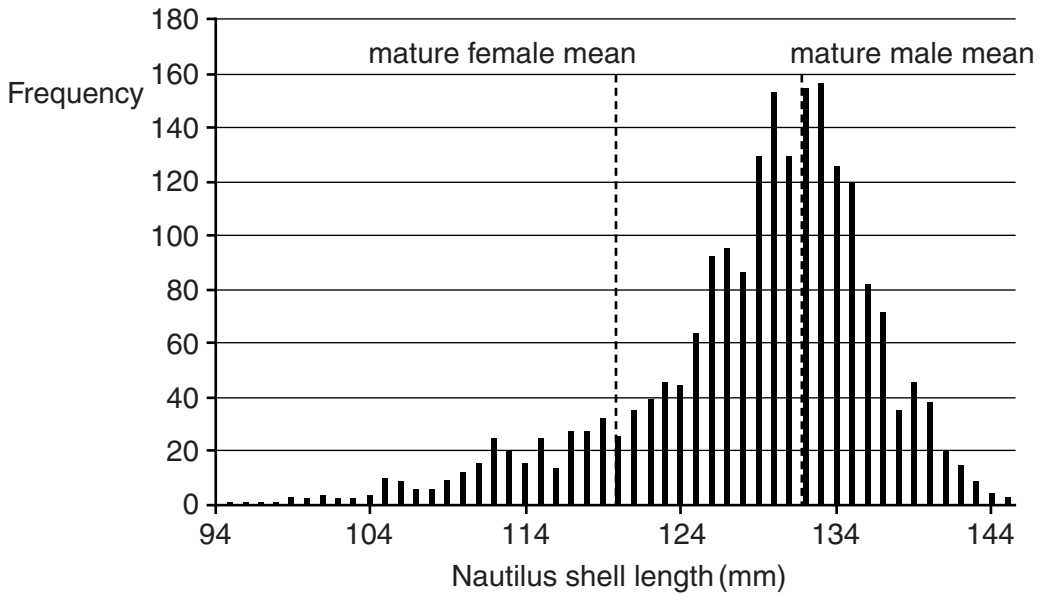
(d) cm [6]

(e) A spiral can be made using arcs drawn within a golden rectangle.

One of these spirals is found in the shell of a nautilus.



The graph shows the frequency distribution of shell lengths of over 2000 mature nautiluses collected at an island during one week. The dotted lines show the mean shell lengths for mature female and mature male nautiluses.



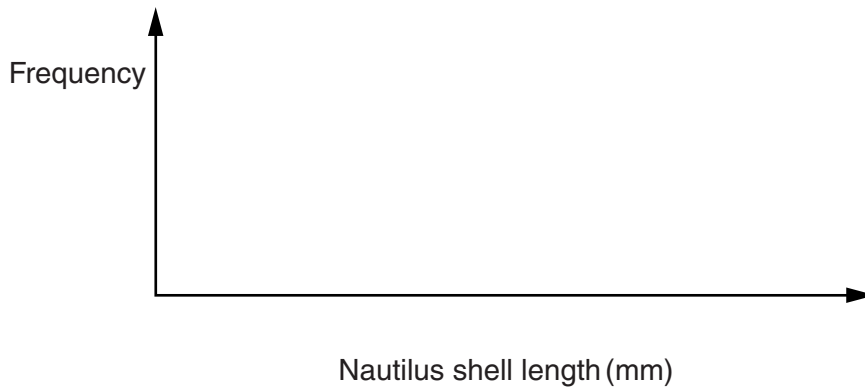
(i) Write down the mean shell length for mature female nautiluses.

(e)(i) mm [1]

(ii) Use the diagram to write down an estimate for the mean shell length of all these nautiluses.

(ii) mm [1]

(iii) Sketch a possible frequency distribution for just the mature female nautiluses collected. Include any relevant values on the horizontal axis.



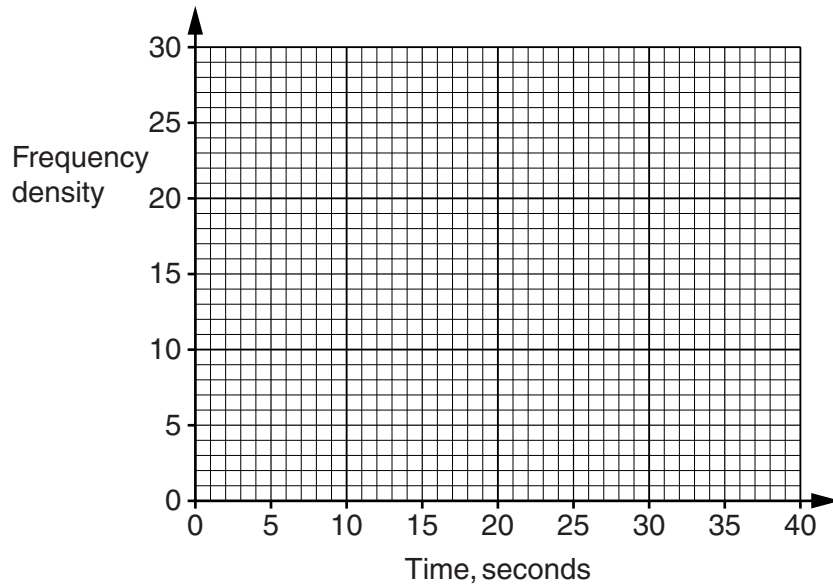
[2]

(b) Karl recorded the times taken by 300 cars to successfully climb Brooklands Hill test track. Here are his results.

Time, t seconds	Frequency	Frequency density
$12 < t \leq 14$	28	
$14 < t \leq 17$	75	
$17 < t \leq 20$	57	
$20 < t \leq 25$	65	
$25 < t \leq 40$	75	

(i) Complete the frequency density column. [3]

(ii) Draw a histogram to represent these data. [3]

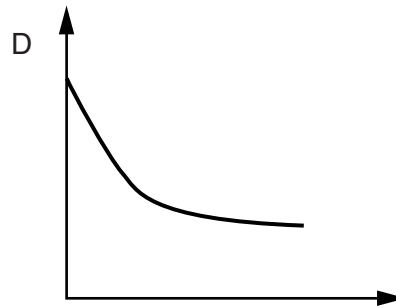
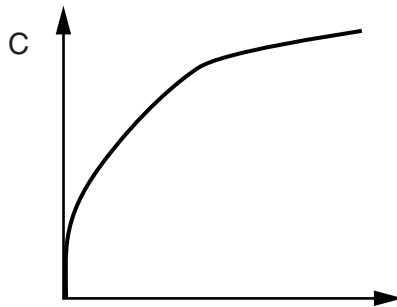
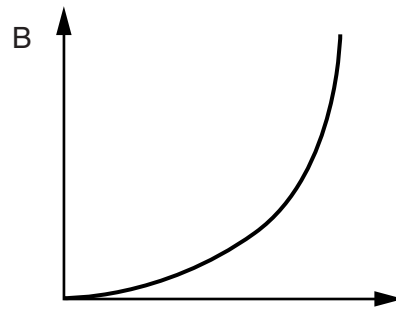
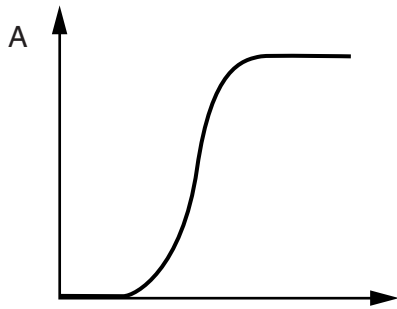


(iii) The first successful climb in 1909 took 15.04 seconds.

Calculate an estimate of the number of cars in Karl's data that were faster than 15.04 seconds.

(b)(iii) [3]

8 Here are sketches of four graphs.



Maud wrote statements describing what two of the graphs showed.
For each description

- (i) choose the most suitable graph and,
- (ii) write down labels for the horizontal axis and for the vertical axis.

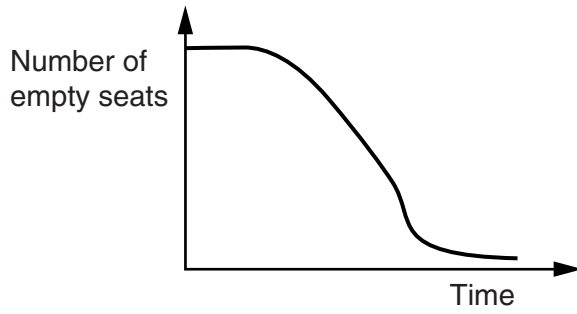
(a) There was silence at the end of the performance.
One person began to applaud, more people joined in and finally everyone was applauding.

- (i) Graph
- (ii) Horizontal axis
- Vertical axis [2]

(b) Ticket prices are now rising more slowly than at any time during the last 10 years.

- (i) Graph
- (ii) Horizontal axis
- Vertical axis [2]

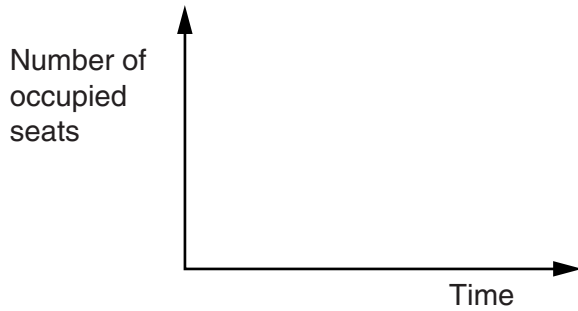
(c) Maud drew this graph to show what happened before a theatre performance.



(i) Write a statement to describe what the graph shows.

.....
..... [1]

(ii) On the axes below, draw a sketch for the same theatre performance.



[1]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

A large rectangular area with a solid vertical line on the left side and horizontal dotted lines across the rest of the page, providing space for writing answers.



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