Surname	Centre Number	Candidate Number
Other Names		0

GCSE LINKED PAIR PILOT

4361/02

APPLICATIONS OF MATHEMATICS

UNIT 1: Applications 1
HIGHER TIER

A.M. WEDNESDAY, 15 January 2014

2 hours

ADDITIONAL MATERIALS

A calculator will be required for this paper.

A ruler, a protractor and a pair of compasses may be required.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

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

Take π as 3·14 or use the π button on your calculator.

INFORMATION FOR CANDIDATES

You should give details of your method of solution when appropriate.

Unless stated, diagrams are not drawn to scale.

Scale drawing solutions will not be acceptable where you are asked to calculate.

The number of marks is given in brackets at the end of each question or part-question.

You are reminded that assessment will take into account the quality of written communication (including mathematical communication) used in your answer to question **6**.

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**5**	
2.	**6**	
3.	**10**	
4.	**2**	
5.	**8**	
6.	**8**	
7.	**4**	
8.	**10**	
9.	**13**	
10.	**6**	
11.	**5**	
12.	**9**	
13.	**14**	
Total	**100**	

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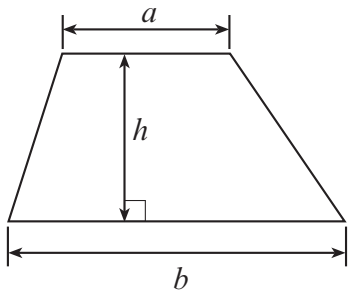
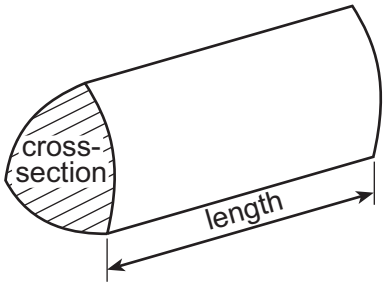
Formula List

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

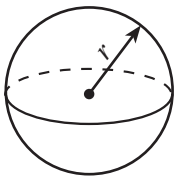


Volume of prism = area of cross-section × length



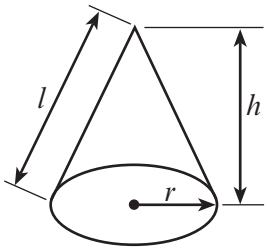
Volume of sphere = $\frac{4}{3}\pi r^3$

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



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

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

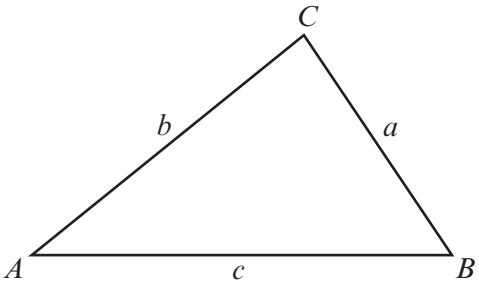


In any triangle ABC

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 = $\frac{1}{2}ab \sin C$



The Quadratic Equation

The solutions of $ax^2 + bx + c = 0$

where $a \neq 0$ are given by

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

Examiner only

1. A survey is carried out by asking people questions as they come out of a juice bar.

A section of the questionnaire is shown below.

> In questions 1 and 2 put a tick (✓) in a box
>
> 1. How old are you?
>
> 15 to 20 ☐ 21 to 30 ☐ 30 to 40 ☐ 41+ ☐
>
> 2. Do you ever go to the juice bar to buy a fruit drink?
>
> Yes ☐ No ☐
>
> 3. What method of payment do you use? .....

(a) Explain why this is a biased survey. [1]

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(b) State two criticisms of the design of question 1.
First criticism of question 1: [1]

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Second criticism of question 1: [1]

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(c) (i) What is wrong with the design of question 3? [1]

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(ii) Show how question 3 could be improved. [1]

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Examiner only

2. *MacReardon Construction* is contracted to work on a warehouse site where there are a number of liquid storage tanks.

A sketch of the base of one of the liquid storage tanks is shown below.

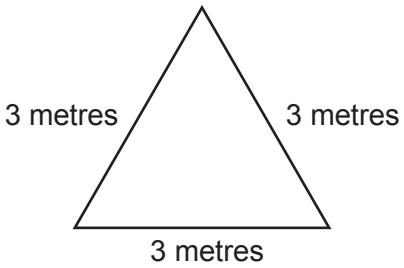


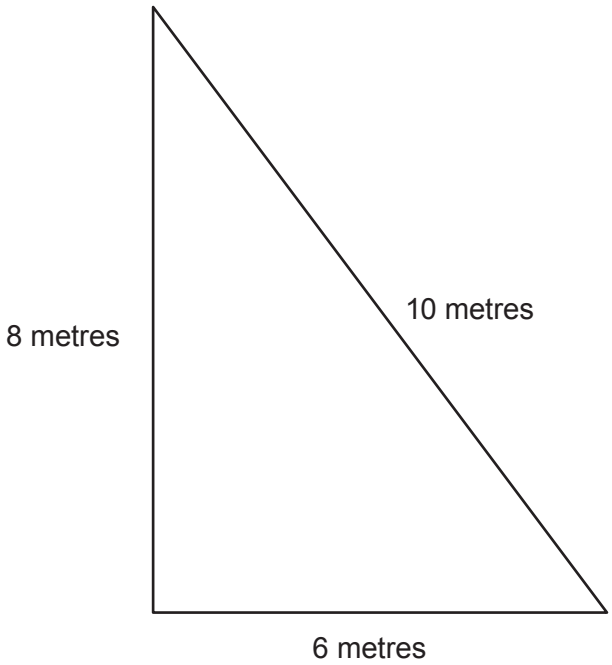
Diagram not drawn to scale

(a) Use a pair of compasses and a ruler to make an accurate scale drawing of the base shown above.
Use a scale of **2 cm to represent 1 metre**. [3]

Examiner only

(b) *MacReardon Construction* has been asked to lay a drain surrounding a different liquid storage tank. The drain must be exactly **2 metres** away from the perimeter of the base of the tank.

An accurate scale drawing of the base of this tank is shown below.
A scale of **1 cm to represent 1 metre** has been used.
On the scale drawing below, draw accurately the position of the drain surrounding the tank. [3]



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3. A machine is used to pack boxes of pasta shapes.

Each box of pasta shapes should weigh between 200 g and 205 g.
To check the machine, 10 boxes of pasta shapes are selected every half hour.
At each of these times, the number of boxes weighing between 200 g and 205 g is recorded.
The results are shown in the table below.

Time	00:00	00:30	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30
Number of the 10 boxes weighing between 200 g and 205 g	1	0	2	1	3	2	0	0	1	2

(a) Michelle has weighed all the boxes of pasta selected between 00:00 and 04:30.
For all these boxes, she finds that the following statement is true.

"Each box of pasta weighs at least 200g."

Explain, looking at the results in the table above, how this statement could be **true**. [1]

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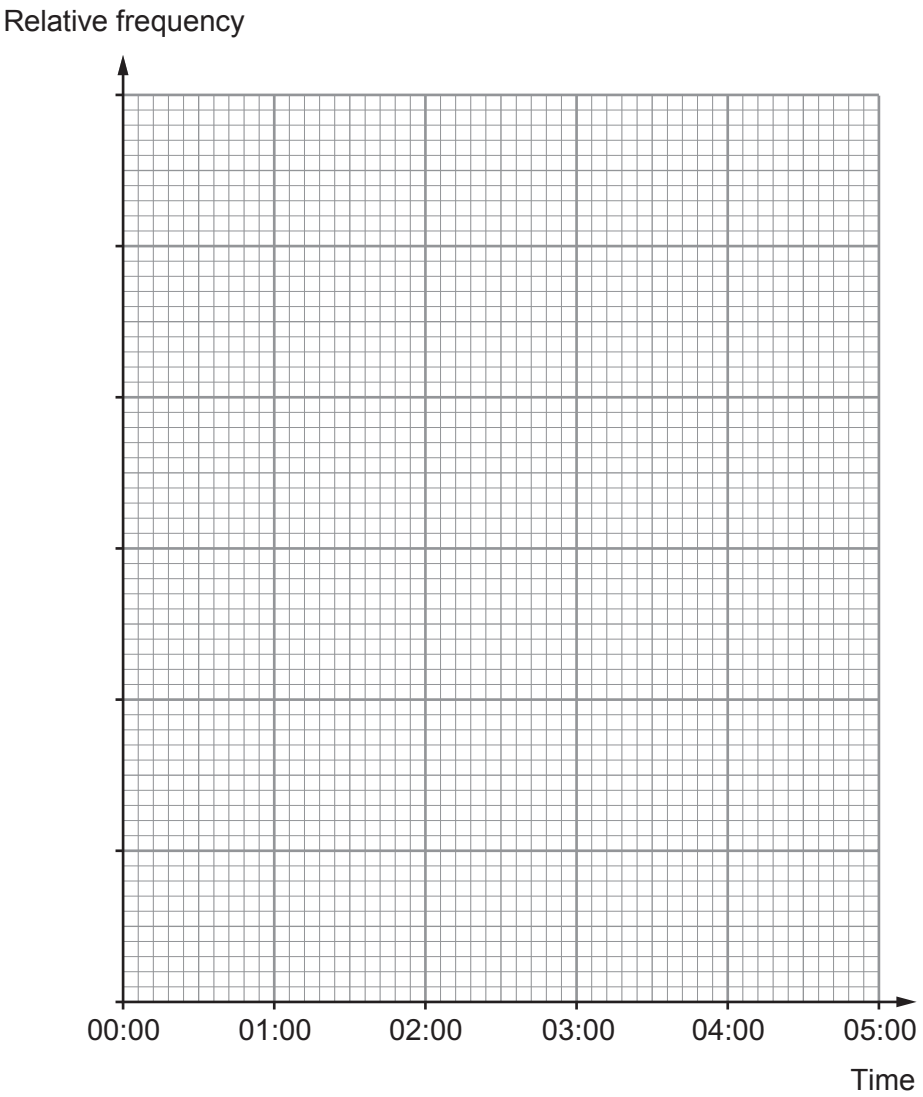
(b) Michelle decides to record and plot the relative frequencies for the information shown in the previous table.

(i) Complete the table below. [4]

Time, up to	00:00	00:30	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30
Total number of the 10 boxes weighing between 200 g and 205 g	1	1	3	4						
Total number of boxes checked	10	20	30	40						
Relative frequency	0·1	0·05								

Examiner only

(ii) Use the graph paper below to plot the relative frequencies. [3]



(iii) Write down the best estimate for the probability that a box selected at random will weigh between 200 g and 205 g. Give a reason for your answer. [2]

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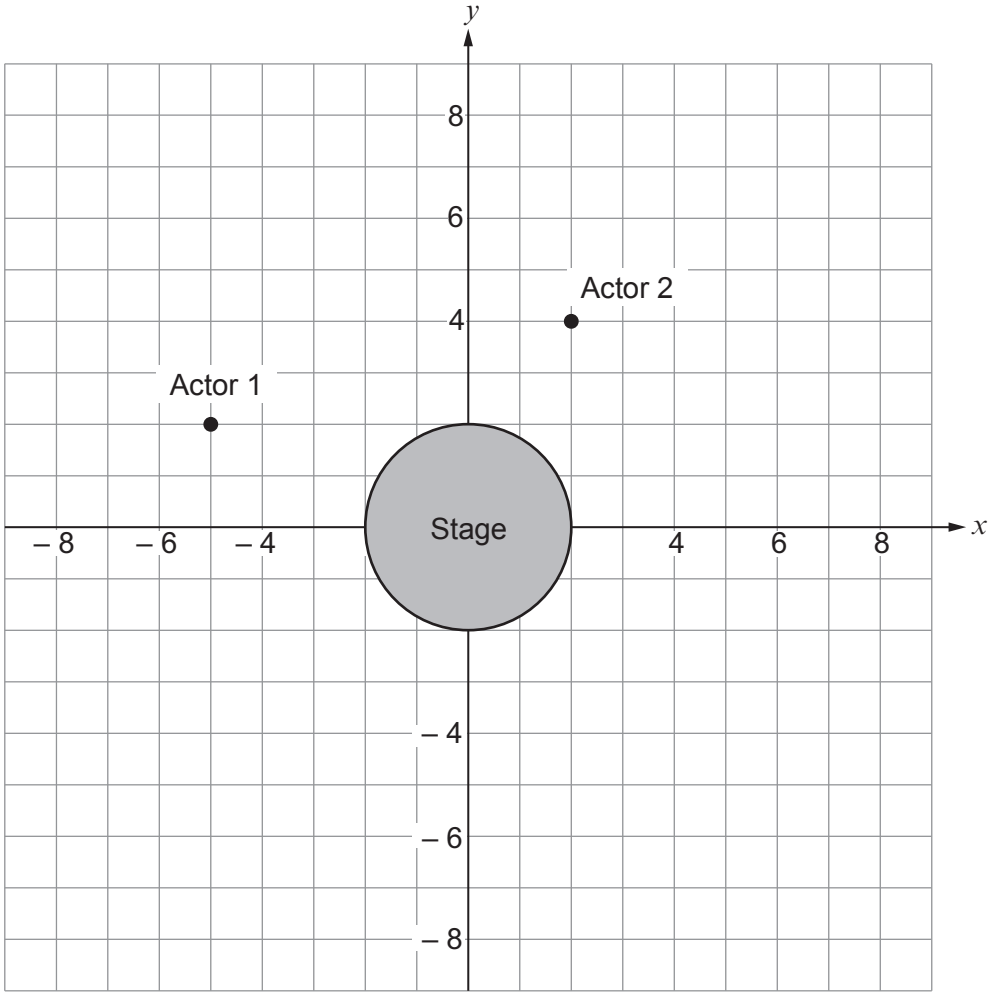
Examiner only

4. The circular stage in *Theatr Seren* is in the centre of the theatre.
It is decided to seat four actors amongst the audience to hold the ends of four ribbons.
A plan of the theatre is represented by the coordinate grid shown below.
The actors are to be seated so that ribbons held by the four of them will form a square.



Mark where the other two actors should be seated, and write down the coordinates of their positions. [2]

(..... , ...) (..... , ...)

Examiner only

5. One of the services offered by *Maid4U* is cleaning ovens.
Maid4U calculates the cost for this service using the following method.

- START with a standard charge of £18
- ADD a fee of £12 for every complete hour worked AND an additional fee of 25p for every additional minute worked
- MULTIPLY the total charge so far by 1·2
- This equals the final charge

(a) Calculate the cost of cleaning an oven that takes

(i) $2\frac{1}{2}$ hours [2]

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(ii) 45 minutes [1]

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(b) Write a formula for working out the final charge, £F for cleaning an oven taking h hours and m minutes. [4]

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(c) Doris notices that there is a problem with the method for calculating the cost of cleaning an oven.
Her oven took 2 hours to clean, and her neighbour's oven took 1 hour 50 minutes.
Doris's bill for cleaning her oven was cheaper, yet took a longer time.
Explain why this happens. [1]

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Examiner only

6. *You will be assessed on the quality of your written communication in this question.*

Tom is making a patio using paving slabs like the one shown below.
Each paving slab is in the shape of a trapezium.

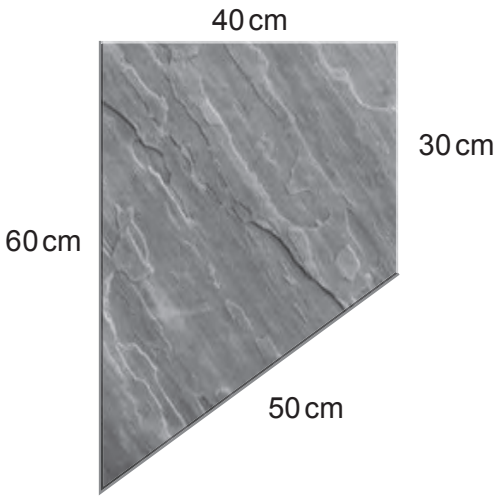

Diagram not drawn to scale

Tom used 25 of these paving slabs to make his patio.
He decides to paint the patio with a sealant to prevent staining.
Each tin of sealant that he buys covers an area of $0{\cdot}8\,\text{m}^2$.

Each tin of sealant costs £14.49.
Each paving slab costs £8.25.

Tom buys just enough tins of sealant to paint his patio.
Calculate the total cost of buying the paving slabs and sealant.
You must show all your working. [8]

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Examiner only

7. A replacement part for a machine is made using one spring, one washer and one rod.

Packs containing one spring, one washer and one rod are to be made for selling in a spare parts shop.

To make up these packs, boxes of springs, washers and rods are bought.
Boxes contain 40 springs or 24 washers or 16 rods.

All of the contents of the boxes bought must be used in making up the packs.
There must be no springs or washers or rods left over after making up the packs of one spring, one washer and one rod.

Complete the table below by calculating a suitable number of boxes each of springs, washers and rods that are needed to make up the packs.
You must show all your working. [4]

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	Number of boxes needed
Springs (40 in each box)	..... boxes
Washers (24 in each box)	..... boxes
Rods (16 in each box)	..... boxes

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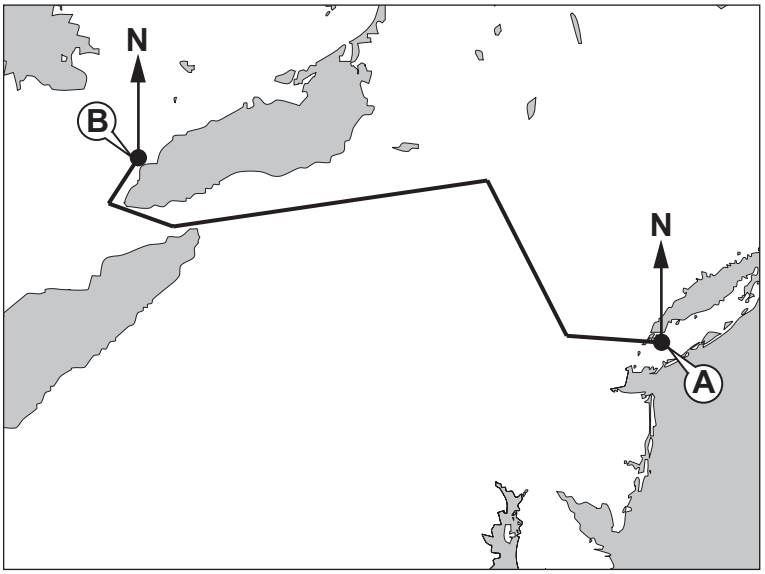
8. The image below shows the location of New York and Toronto on a map.

Jack is setting out from New York (A) to drive to Toronto (B).
He uses the map to plan his journey in 5 stages.
These stages are shown by the straight lines he has drawn on the map below.



Examiner only

(a) Jack's driving distance from New York to Toronto is approximately 500 miles.
Given that 5 miles is approximately 8 km, complete the following sentence. [4]

'Looking at the map, I think that every **1 cm** represents a

journey distance of ..... kilometres.'

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(b) Use the straight lines Jack has drawn on his map to complete the following statements for Jack's journey. [2]

For the first stage of his journey, Jack will leave New York travelling

on a bearing of ..... °.

For the last stage of his journey, Jack will arrive in Toronto travelling

on a bearing of ..... °.

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(c) Jack finds a different map.
The new map has a scale with 1 cm representing 25 000 cm.
Express 25 000 cm in km, giving your answer in standard form. [2]

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Examiner only

(d) Jack wants to derive a formula he could use to calculate his total journey time.

He decides to use

- T to represent total time, in hours
- t to represent the time he spends actually driving, in hours
- b to represent the time for breaks and rests during his journey, in hours
- d to represent the total distance travelled, in miles
- s to represent the average speed in miles per hour, whilst driving, for the whole journey

He knows that t is equal to d, the total distance in miles, divided by s, the average speed whilst driving, for his journey.

Derive a formula to calculate T in terms of b, d and s. [2]

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Examiner only

9. *(a)* A number of adults were asked how much they would be willing to pay to visit an ancient monument.

The results are summarised in the table.

Amount of money, £x	Number of adults
$1 \leqslant x < 4$	32
$4 \leqslant x < 7$	26
$7 \leqslant x < 10$	14
$10 \leqslant x < 13$	2

(i) Calculate an estimate for the mean amount of money the adults would be willing to pay. [4]

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(ii) Find the greatest possible value of the range. [1]

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Examiner only

(b) The number of adults visiting the monument during the different seasons was recorded.

Season	Winter 2012	Spring 2012	Summer 2012	Autumn 2012	Winter 2013	Spring 2013	Summer 2013
Number of adult visitors	24	86	122	8	28	94	146

(i) Calculate 4-point moving averages and complete the table below. [3]

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4-point period:	Winter 2012 to Autumn 2012	Spring 2012 to Winter 2013	Summer 2012 to Spring 2013	Autumn 2012 to Summer 2013
4-point moving average:				

(ii) The time series graph for the number of adults visiting the monument during the different seasons has been plotted on the graph paper opposite.
On this graph paper, plot the 4-point moving averages and draw a trend line. [3]

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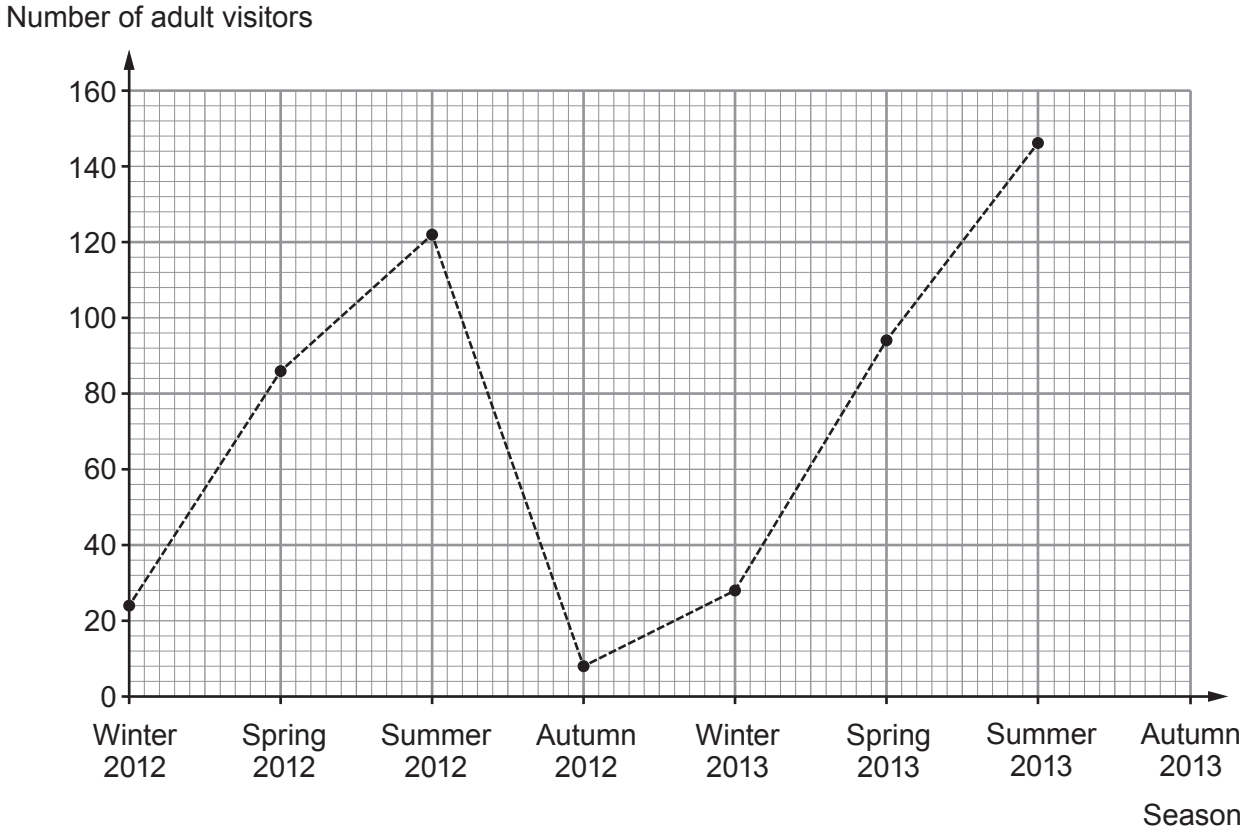

(iii) Use your graph to make two different comments about the **trend** in the number of adult visitors.
One comment should refer to the time series and one comment to the trend line.
[2]

Comment 1:

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Comment 2:

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Examiner only

10. Metric prefixes are used to describe large or small numbers.
The metric prefix 'milli', in millimetres or milligrams, is used to describe small numbers.
For example, 1 millimetre is 1000^{-1} metres which can also be written as 10^{-3} metres.

Complete the table below. [6]

Metric prefix	**1000^{x}**	**10^{y}**	**Standard form**
hecto	$1000^{\frac{2}{3}}$	.....	.....
tera	.....	10^{12}	.....
deci	$1000^{-\frac{1}{3}}$	.....	.....
yocto	.....	10^{-24}	.....

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11. A jewellery maker is manufacturing silver charms.

A diagram of the cutting pattern he uses is shown below.
Two of these charms can be made using this cutting pattern, from regions *A* and *C*.

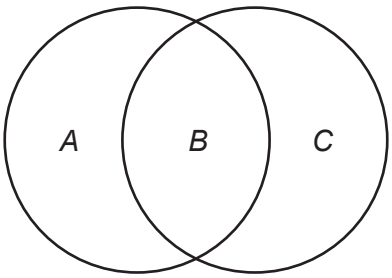

Diagram not drawn to scale

Regions *A*, *B* and *C* are indicated on the diagram, which shows two intersecting circles of equal radius.

The ratio of the areas of the regions, *A*, *B* and *C* is 2 : 3 : 2 respectively.
The radius of each circle is 1·5 cm.

Calculate the area of the region *A*.
Give your answer in cm^2. [5]

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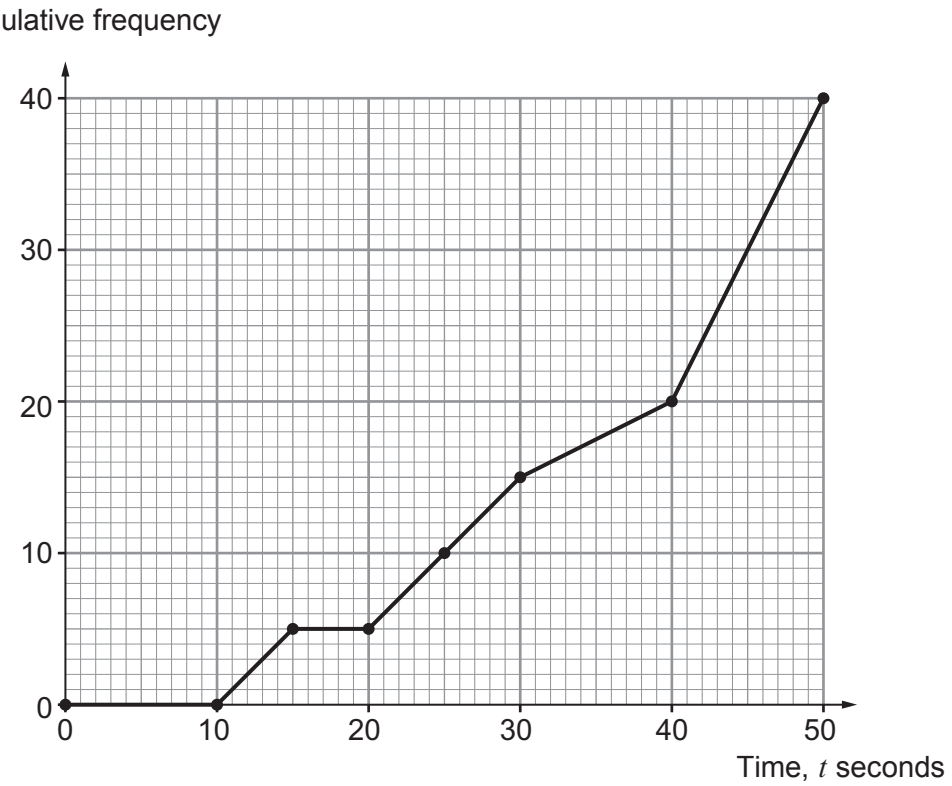
Examiner only

12. The cumulative frequency diagram shows the time taken by 40 athletes to complete a trial.



(a) Athletes completing the trial within 20 seconds are considered to be 'outstanding'.
How many athletes are 'outstanding'? [1]

.....

(b) Athletes completing the trial between 20 seconds and 40 seconds are considered to be 'excellent'.
How many athletes are 'excellent'? [1]

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(c) Write down an estimate for the interquartile range of the times.
You must show your working. [2]

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Examiner only

(d) Using the same class intervals as used in the cumulative frequency diagram, draw a histogram to illustrate the time taken by the 40 athletes to complete the trial. [5]

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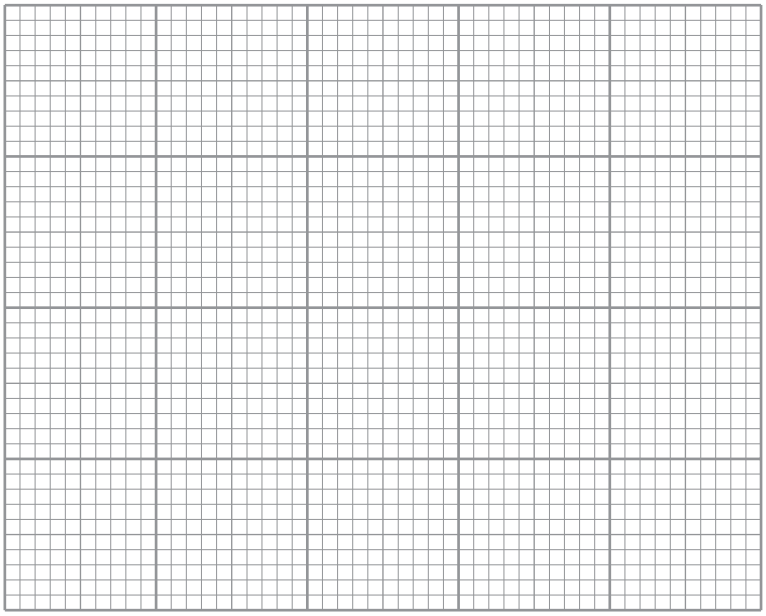
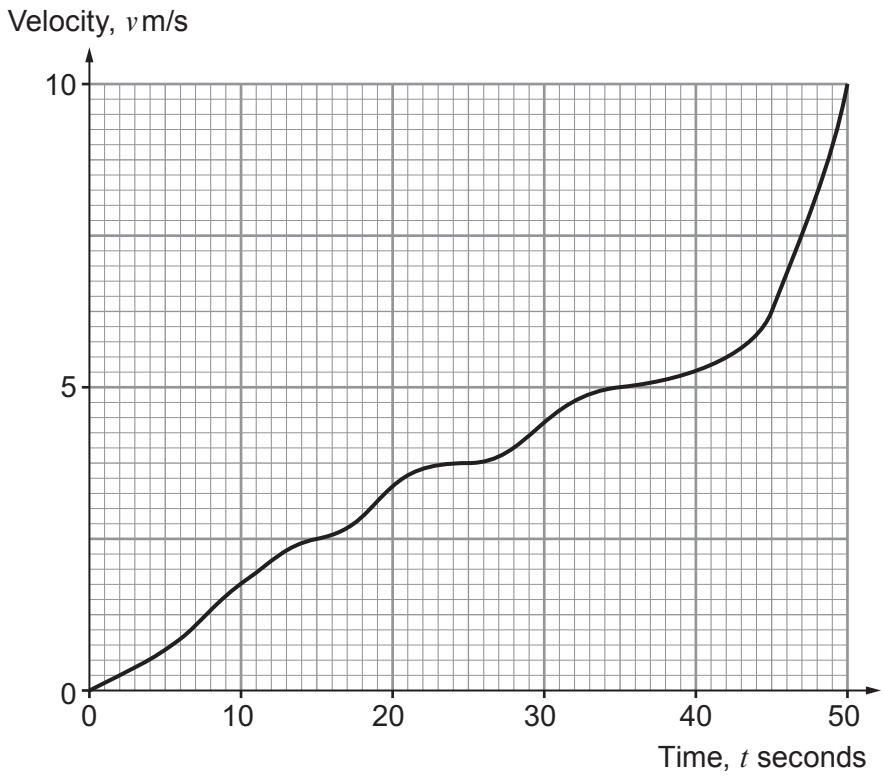


Examiner only

13. A velocity-time graph, representing a 50 second journey of a car accelerating from 0 m/s, is shown below.



(a) Calculate the velocity of the car in km/h at time t = 50 seconds. [3]

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Velocity: ..... km/h

(b) Calculate an estimate for the acceleration at time t = 30 seconds.
You must give the units for your answer. [4]

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Acceleration: .....

Examiner only

(c) Calculate an estimate for the distance travelled by the car in the first 30 seconds. [3]

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Distance travelled .....

(d) Over the same period, the velocity of another car is given by the equation $v = 0{\cdot}004t^2$. Other than at t = 0 seconds and t = 50 seconds, find the value of t for which the velocities of the two cars are the same.
Give your answer correct to the nearest second. [4]

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Time t: ..... seconds

END OF PAPER