Surname	Centre Number	Candidate Number
Other Names		0

GCSE LINKED PAIR PILOT

4361/02

W15-4361-02

APPLICATIONS OF MATHEMATICS

UNIT 1: Applications 1
HIGHER TIER

A.M. WEDNESDAY, 14 January 2015

2 hours

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**6**	
2.(*a*)(*b*)	**9**	
2.(*c*)(*d*)	**5**	
3.(*a*)(*b*)	**10**	
3.(*c*)(*d*)	**12**	
3.(*e*)	**5**	
4.(*a*)	**11**	
4.(*b*)(*c*)	**12**	
4.(*d*)(*e*)	**11**	
5.	**8**	
6.	**11**	
Total	**100**	

4361
020001

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.

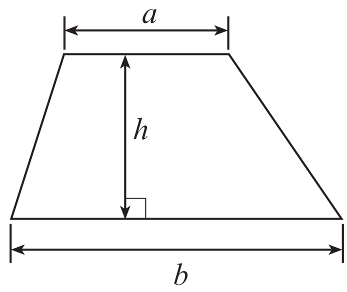
Scale drawing solutions will not be acceptable where you are asked to calculate.

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

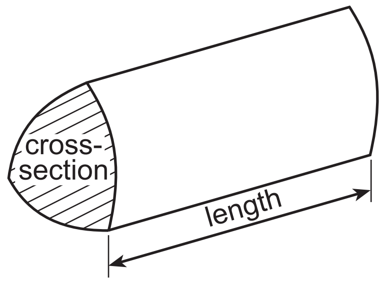
You are reminded that assessment will take into account the quality of written communication (including mathematical communication) used in your answer to question **3**(*a*).

Formula List

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

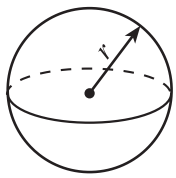


Volume of prism = area of cross-section × length



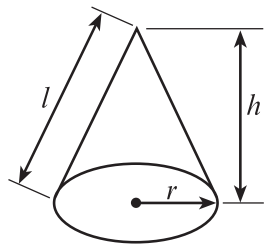
Volume of sphere = $\frac{4}{3}\pi r^3$

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



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

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

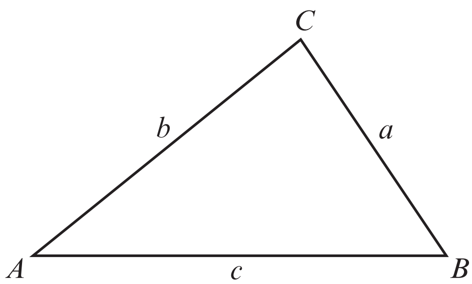


In any triangle ABC

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)*

Berlin's main railway station is known as the Hauptbahnhof.
Bellevue and Wildau are two railway stations in opposite directions from the Hauptbahnhof.

On a particular day,
- trains leave the Hauptbahnhof to Bellevue every 14 minutes
- trains leave the Hauptbahnhof to Wildau every 12 minutes.

A train to Bellevue and a train to Wildau both leave the Hauptbahnhof at 10:00.

When will a train to Bellevue and a train to Wildau next leave the Hauptbahnhof at the same time? [4]

(b) Raimund records the arrival time of the first 10 trains each hour.
A summary of his results is shown in the table below.

Time, after	Number of trains late	Number of trains on time or early
1 p.m.	2	8
2 p.m.	1	9
3 p.m.	5	5
4 p.m.	1	9
5 p.m.	3	7

Calculate the best estimate of the relative frequency of a train arriving late. [2]

4361
020003

6

Examiner only

2. *(a)* Jack is planning to build a fence across his field.
He has placed a note on the sketch of his field to show where he intends to place the fence.

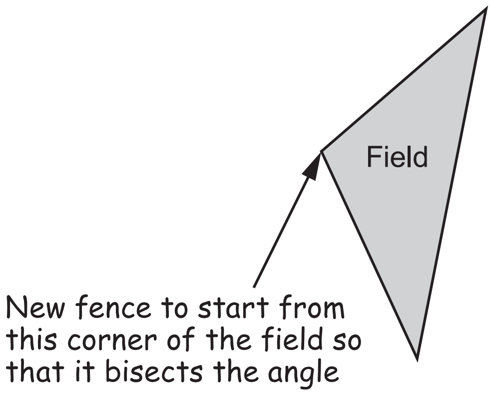
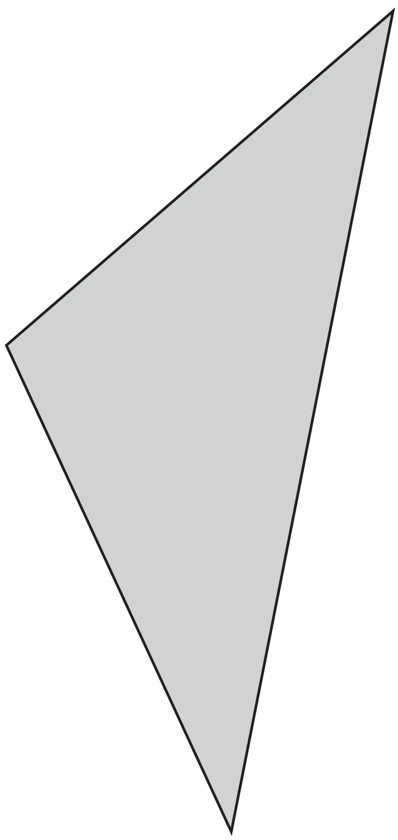


Diagram not drawn to scale

Complete the scale drawing below to show where the new fence is to be placed.
You must use a pair of compasses and a ruler to bisect the obtuse angle.
You must show all of your construction marks on the diagram. [2]



Examiner only

(b) Jack employs two workers, Siân and Dan.
He pays each of them as follows:

- £3.75 each day they work, for checking the hedges and fences on the way to work
- £16.25 per hour when working with the animals
- £18.50 per hour when working with equipment, such as fork lift trucks and tractors.

(i) Siân works 3 days a week.
Last week she spent 4 hours each day working with animals and 2 hours each day using the fork lift truck.
How much was Siân paid last week? [3]

....

....

....

....

....

....

....

....

....

4361
020005

(ii) Dan works 4 days a week.
He always spends y hours per day feeding the animals.
He always spends $2y$ hours per day driving the tractor.
Dan gets paid £P per week.
Write down a formula for P in terms of y.
Give your answer in its simplest form. [4]

....

....

....

....

....

....

....

....

9

Examiner only

(c)

There is a duck pond on Jack's farm.

The duck pond is circular, with a diameter of 12 metres.
Calculate the surface area of the duck pond. [2]

Examiner only

(d) Jack uses a trundle wheel to measure the lengths of his fields and buildings.

He counts how many times the wheel on his trundle wheel rotates so that he can calculate lengths.
The radius of Jack's trundle wheel is 0·24 m.

Complete the table below. [3]

Measured	Number of turns of the trundle wheel	Actual length in metres
Length of west field	32	
Length of the building for equipment storage	14	

....

....

....

....

....

....

....

....

4361
020007

5

Examiner only

3. Seven friends hire a boat, **The Wave**, to explore where dolphins swim.

The Wave

(a) *You will be assessed on the quality of your written communication in this part of the question.*

The cost of hiring **The Wave** for a week is £2380.
Two sponsors, *Connelly Boats* and *Water Watch*, pay part of the hire cost.

The cost of hiring **The Wave** is shared in the ratio 2 : 3 : 5 with

- *Connelly Boats* paying the **smallest** share
- *Water Watch* paying the **largest** share
- The seven friends sharing the remaining cost equally.

How much does *Connelly Boats* pay?
How much does *Water Watch* pay?
How much does each of the seven friends pay?
You must show all your working. [8]

Examiner only

(b) The charges for mooring boats are displayed in the harbour.

Mooring charges for boats for 24 hours

Mooring charges depend on the length of your boat.

Boats up to 6 m in length:	charge is £4.80 per metre
Boats 7 m in length:	charge is £4.40 per metre
Boats 8 m in length:	charge is £3.90 per metre
Boats longer than 8 m:	charge is £3.55 per metre

Charge includes fresh water, electricity and use of the showers

The friends notice that the charges were not very clear for boats between 6 m and 8 m in length.

The Wave is 7·1 m in length.
The friends were charged £30.80 for mooring **The Wave**.

Explain how the charge was calculated and suggest how the charges could be displayed more clearly. [2]

4361
020009

10

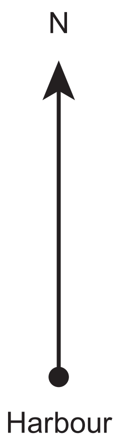
Examiner only

(c) On Monday, the friends recorded the bearings and distances sailed.

The Wave's sailing log for Monday	
Harbour to buoy 1	600 metres on a bearing of 110°
From buoy 1 to buoy 2	360 metres on a bearing of 320°
From buoy 2 to buoy 3	150 metres on a bearing of 055°

Buoys

(i) Using a scale of 1 cm to represent 60 metres, complete an accurate scale drawing of **The Wave's** route on Monday. [5]



(ii) Write down the bearing of the harbour from the position of buoy 1. [1]

.... °

(iii) Find the distance and the bearing of the harbour from the position of buoy 3. [2]

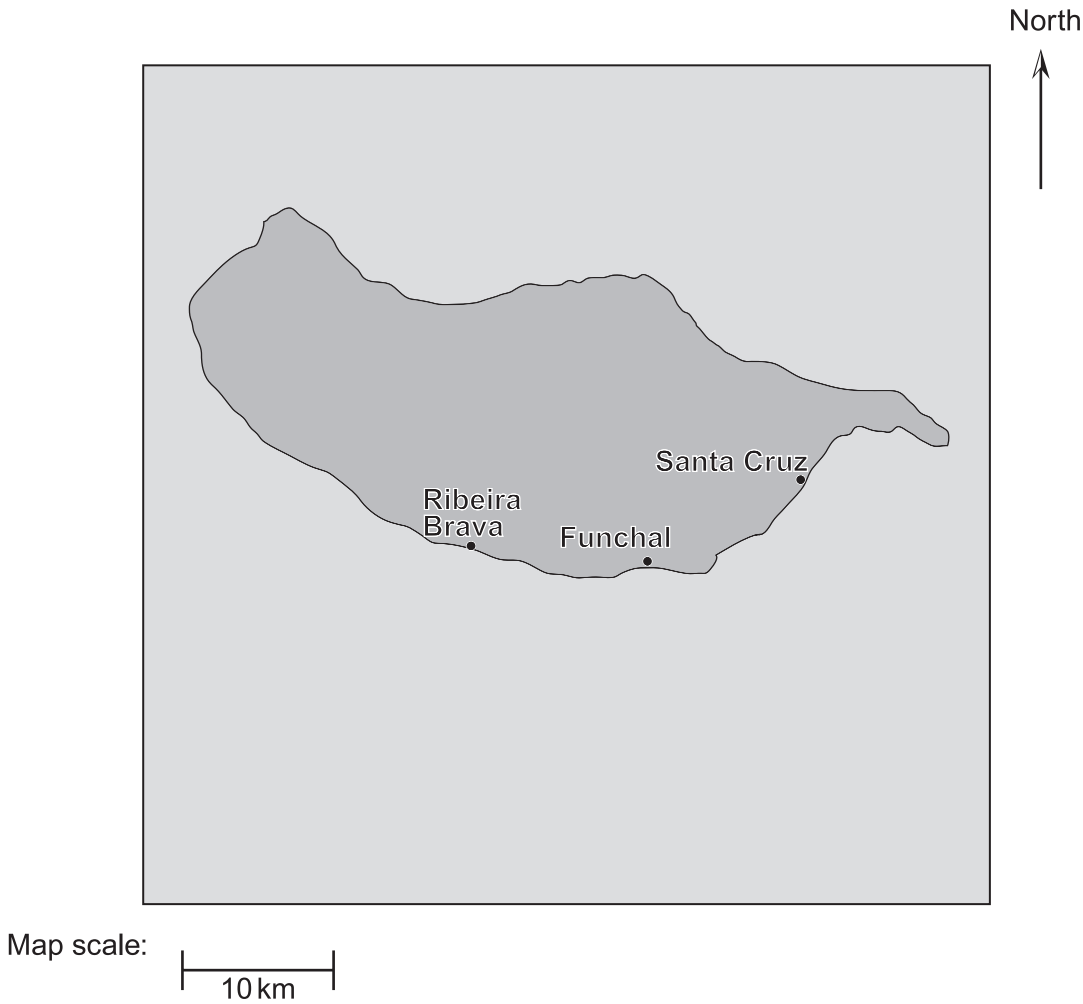
....

Distance: .... m

Bearing: .... °

Examiner only

(d) The friends want to moor **The Wave** off the coast of an island in order to watch dolphins.



Dolphins have been spotted within a 20 km radius of Funchal.
No dolphins have been spotted closer than 5 km to the coast of this island.
No dolphins have been spotted closer to Ribeira Brava than to Santa Cruz.

Indicate the approximate region on the map where dolphins have been spotted. [4]

12

4361
020011

Examiner only

(e) The height of **The Wave**'s mast is 33 feet 4 inches.

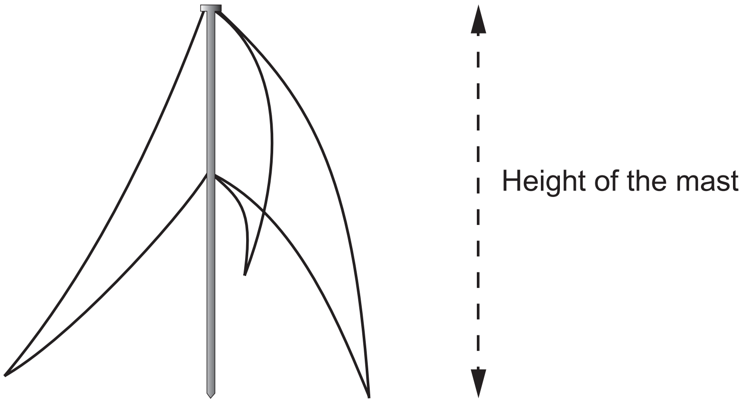


Diagram not drawn to scale

There are 12 inches in 1 foot and 1 cm is approximately 0·3937 inches.

(i) Calculate the approximate height of **The Wave**'s mast in centimetres. [3]

....

....

....

....

....

....

....

(ii) Complete the following table. [2]

The Wave		
Measure	Height **in mm**	Height **in mm** written in standard form
Height of the mast (33 feet 4 inches)	....	....

....

....

....

....

....

5

Examiner only

4. *(a)* A broadcasting company, *Stateside3*, investigated television-viewing habits.

The table below shows the number of minutes 80 people spent watching television last Wednesday.

Time (t minutes)	Frequency
$0 \leqslant t < 90$	10
$90 \leqslant t < 180$	38
$180 \leqslant t < 270$	20
$270 \leqslant t < 450$	8
$450 \leqslant t < 810$	4

(i) Did any of these people spend longer than 15 hours watching television last Wednesday?
Give a reason for your answer. [1]

....

....

....

....

(ii) Calculate an estimate for the mean time these people spent watching television last Wednesday. [4]

....

....

....

....

....

....

....

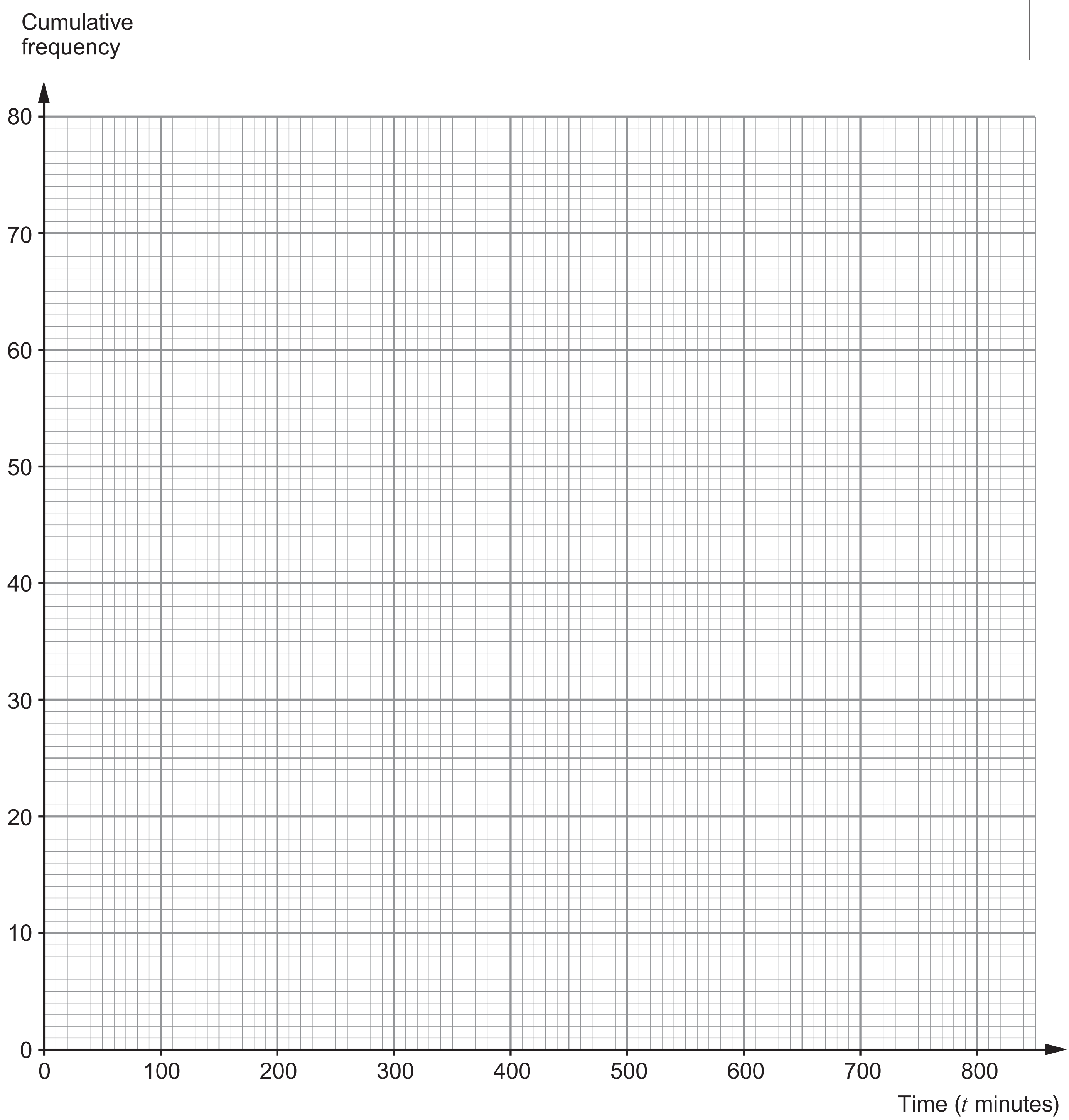
....

Examiner only

(iii) Complete the following cumulative frequency table. [1]

Time (t minutes)	$t \leqslant 0$	$t < 90$	$t < 180$	$t < 270$	$t < 450$	$t < 810$
Cumulative frequency	0					

(iv) On the graph paper below, draw a cumulative frequency diagram to show this information. [2]



Examiner only

(v) Use your cumulative frequency diagram to find an estimate for the median and the interquartile range of the times spent watching television last Wednesday.
You **must** show your working. [3]

....

....

....

....

....

Median = ... minutes

Interquartile range = ... minutes

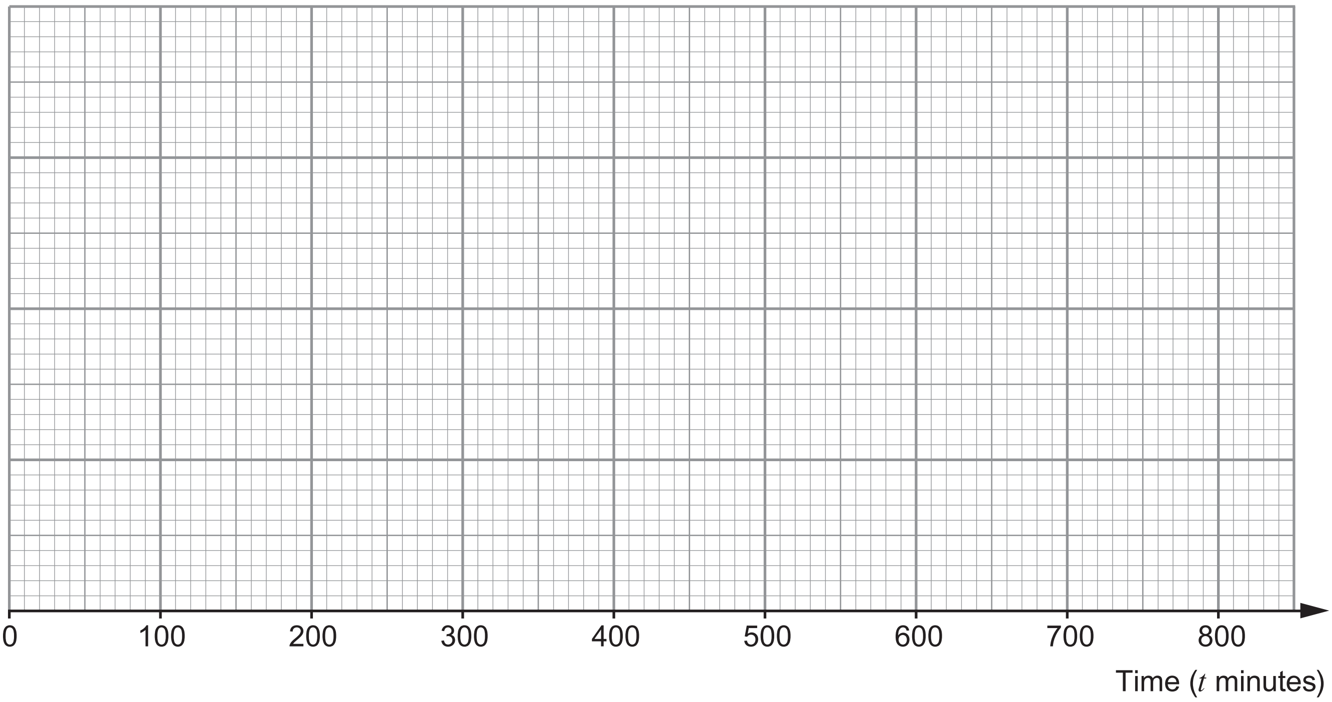
11

Examiner only

(b) (i) *Stateside3* also investigated how long this group of 80 people spent watching television last Thursday.
They published the following statement.

> Last Thursday, 80 people answered our survey on how many minutes they spent watching television.
> We now know:
> - The median time was 310 minutes.
> - The lower quartile was 200 minutes.
> - The upper quartile was 560 minutes.
> - The person who watched the least television spent 50 minutes.
> - The person who watched the most television spent 800 minutes.

Draw a box and whisker diagram to illustrate this information. [4]



(ii) *Stateside3* considers the results of the two surveys of the same 80 people.
The manager of *Stateside3* states,

> 'I think people are watching more TV on a Wednesday night than on a Thursday night.'

Do you agree with the manager of *Stateside3*?
You must explain your answer with reference to the median and the interquartile range for both days. [3]

....

....

....

....

....

Examiner only

(c) A different broadcasting company, *Metro Vision*, also analyses information about the number of people watching the programmes broadcast on their channel.
They refer to this as their 'viewing figures'.
The table below shows the viewing figures for each day of the week.

Day Week number	Mon 1	Tue 1	Wed 1	Thu 1	Fri 1	Sat 1	Sun 1	Mon 2	Tue 2	Wed 2	Thu 2
Viewing figures, to the nearest million	1·2	2·3	3·4	2·0	4·3	7·8	8·9	1·4	2·6	3·8	1·5

(i) *Metro Vision* decides to track 7-point moving averages.
Explain fully why using a 7-point moving average, as there are 7 days in the week, would be more useful than using a 5-point moving average. [1]

....

....

....

....

(ii) Calculate the five possible 7-point moving averages for the *Metro Vision* viewing figures. Give each of your answers correct to 3 significant figures. [4]

....

....

....

....

....

....

....

....

12

Examiner only

(d) The table below shows the number of minutes a different group of people spent watching programmes broadcast by *Hafod West TV* last Friday.

Time (t minutes)	Frequency
$0 \leqslant t < 100$	6
$100 \leqslant t < 200$	36
$200 \leqslant t < 300$	24
$300 \leqslant t < 500$	4
$500 \leqslant t < 800$	6

(i) Draw a histogram, on the graph paper opposite, to represent this data. [3]

....

....

....

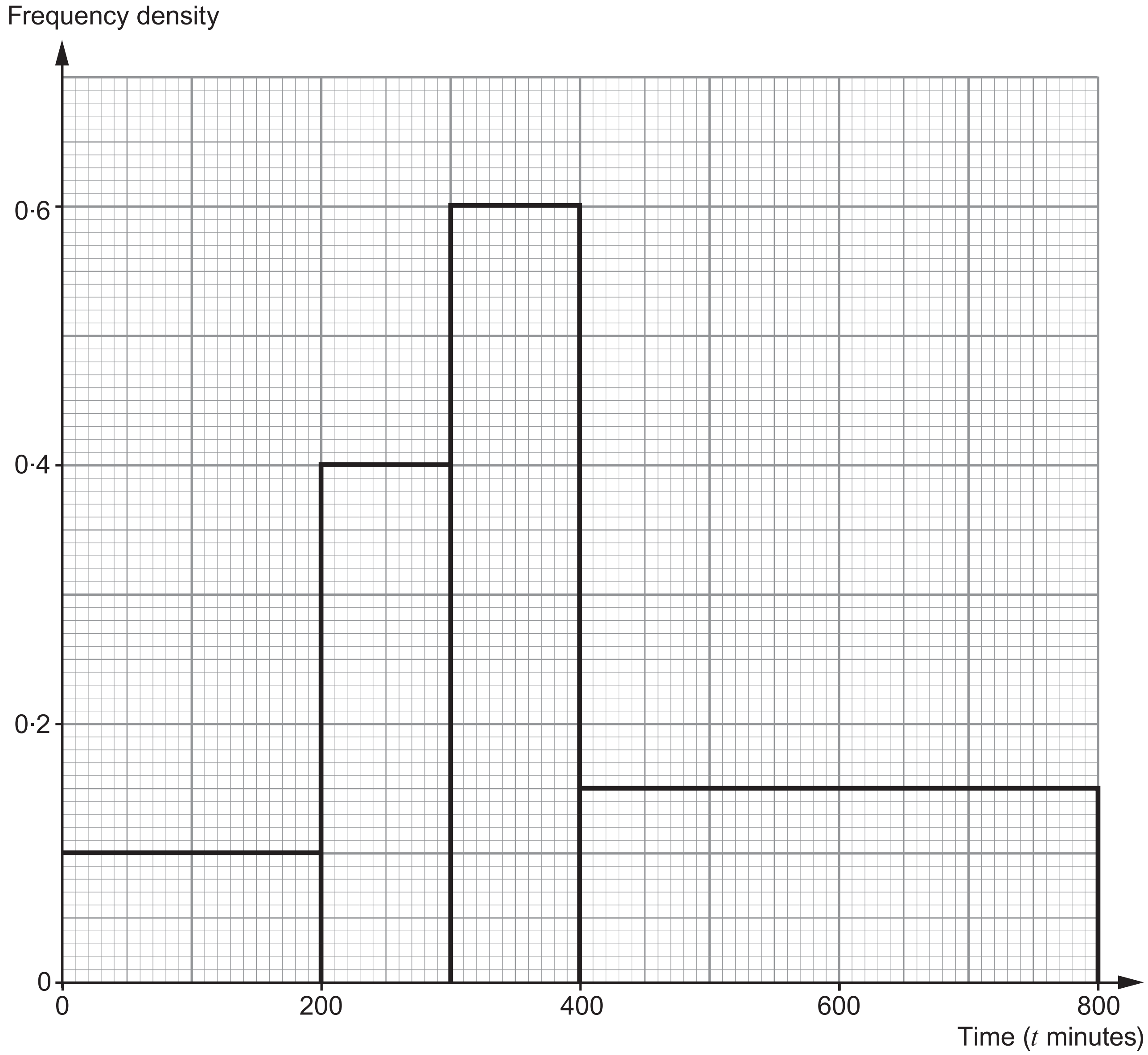
....

Examiner only

(ii) Indicate the median on your histogram.
Show how you decided where the median should be placed on the histogram. [3]

(e) After asking a number of people to complete a questionnaire, *Hafod West TV* published the histogram shown below.
It illustrates the number of minutes a group of people spent watching programmes broadcast on other television channels last Friday.

Examiner only



(i) How many people answered the questionnaire? [3]

....

....

....

(ii) How many people spent less than 250 minutes watching these other channels last Friday? [2]

....

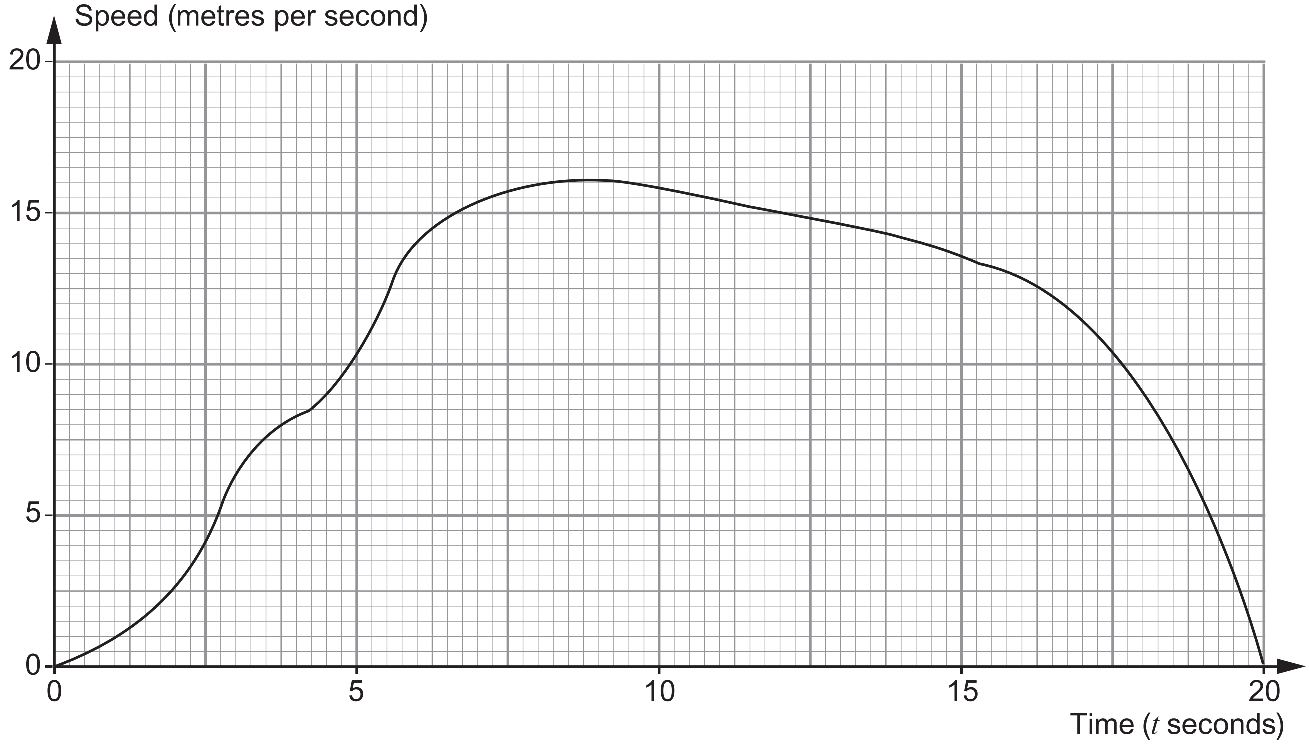
....

....

11

Examiner only

5. The graph below shows the speed of a cyclist, between two sets of traffic lights.



(a) Calculate the acceleration of the cyclist at $t = 7{\cdot}5$ seconds.
Give the units of your answer. [4]

....

....

....

(b) Calculate an estimate for the distance between the two sets of traffic lights. [4]

....

....

....

....

....

....

....

....

....

....

8

Examiner only

6.

When a stone is dropped from a bridge into the river below, the equation for calculating the height of the bridge is given as

$$H = \frac{1}{2}\, gt^2.$$

In this equation:
- H is the height of the bridge in metres
- g is the acceleration of the stone due to gravity, which is measured in m/s^2
- $g = 9{\cdot}8$
- t is the time taken in seconds for the stone to hit the surface of the water.

Glynis carries out experiments on different bridges.
The highest bridge she uses in her experiment is 200 m above the river level.

Glynis drops a stone from each bridge and times how long it takes to hit the water.
These times allow Glynis to find the heights of the bridges.

She decides that a graph would be a helpful way of finding the heights of the bridges.

(a) Use the graph paper opposite to draw a graph for Glynis to be able to read off the heights of various bridges. [5]

Examiner only

(b) **Use your graph** to complete the table. [2]

Time taken for stone to drop, in seconds	Height of bridge, in metres	Height of bridge, in kilometres written in standard form
2·5	....	....
5·2	....	....

....

....

....

....

Turn over.

Examiner only

(c) Glynis thinks there is a risk that there are some errors in her data.
State a possible error. [1]

....

....

....

....

....

(d) In 2009 the Sidu River Bridge in China became the world's highest river bridge.
Its height is 496 metres.

Calculate, using the formula $H = \frac{1}{2}gt^2$, how long it would take a stone dropped from the bridge to hit the surface of the Sidu River below.
You must show all your working. [3]

....

....

....

....

....

....

11

END OF PAPER