OCR
RECOGNISING ACHIEVEMENT

H

Friday 8 November 2013 – Morning

GCSE APPLICATIONS OF MATHEMATICS

A382/02 Applications of Mathematics 2 (Higher Tier)

A393703133

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

A382202

Candidate forename		Candidate surname	

Centre number						Candidate number				

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. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

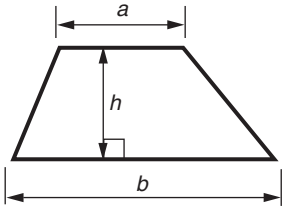
INFORMATION FOR CANDIDATES

- 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.

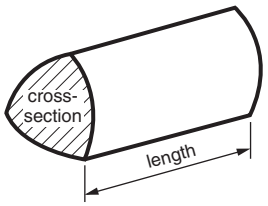
You are permitted to use a calculator for this paper

Formulae Sheet: Higher Tier

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



Volume of prism = (area of cross-section) × length

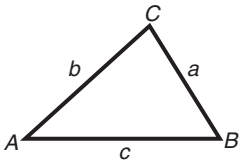


In any triangle *ABC*

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

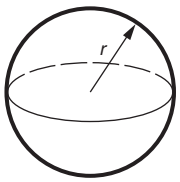
Cosine rule $a^2 = b^2 + c^2 - 2bc\cos A$

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



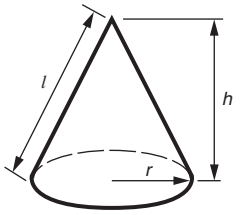
Volume of sphere $= \frac{4}{3}\pi r^3$

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



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

Curved surface area of cone $= \pi rl$



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 Supertankers are filled by special high speed pumps.

The volume of oil, V barrels, pumped into a supertanker is given by this formula.

$$V = 75\,000\,nt$$

n is the number of pumps working,
t is the time in hours they have been pumping.

(a) A supertanker needs to be filled with two million barrels of oil in less than 12 hours.

What is the smallest number of pumps needed?
You **must** show how you got your answer.

(a) _____ **[3]**

(b) The statement "A supertanker may have 1, 2 or 3 pumps" can be written as an inequality.

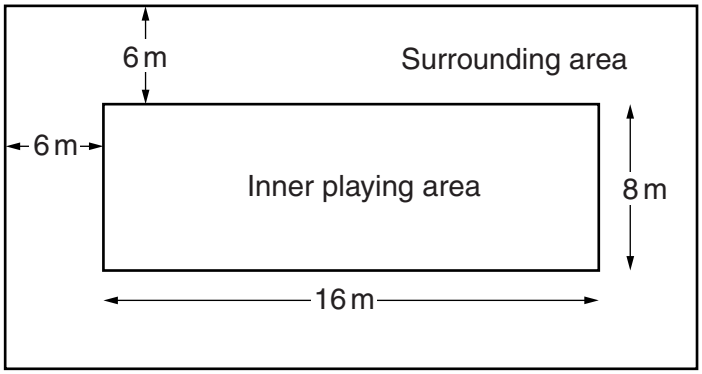
Tick (✓) the inequalities below which express this statement.
n is the number of pumps a supertanker has.

$1 < n < 3$	☐
$1 \leqslant n \leqslant 3$	☐
$1 \leqslant n < 3$	☐
$1 < n \leqslant 3$	☐
$1 \leqslant n < 4$	☐
$1 < n \leqslant 4$	☐

[2]

2 A beach volleyball court has an inner playing area and a surrounding area.

The diagram shows a beach volleyball court.
The inner playing area is a rectangle 16 m by 8 m.
The surrounding area is a border 6 m wide around the inner playing area.



Not to scale

The **whole** beach volleyball court is filled with sand to a depth of 0.5 m.

(a) How much sand is needed for the whole beach volleyball court?

(a) _____ m^3 **[3]**

(b) Below the sand is a layer of gravel 20 cm in depth.

Write down the ratio volume of gravel : volume of sand.

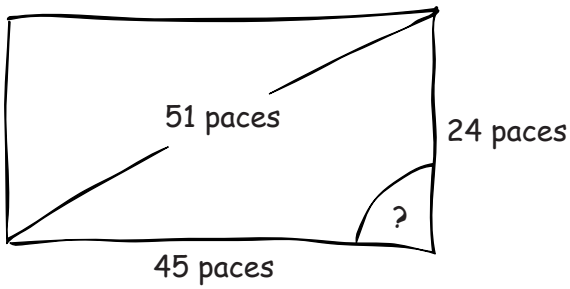
(b) _____ : _____ **[1]**

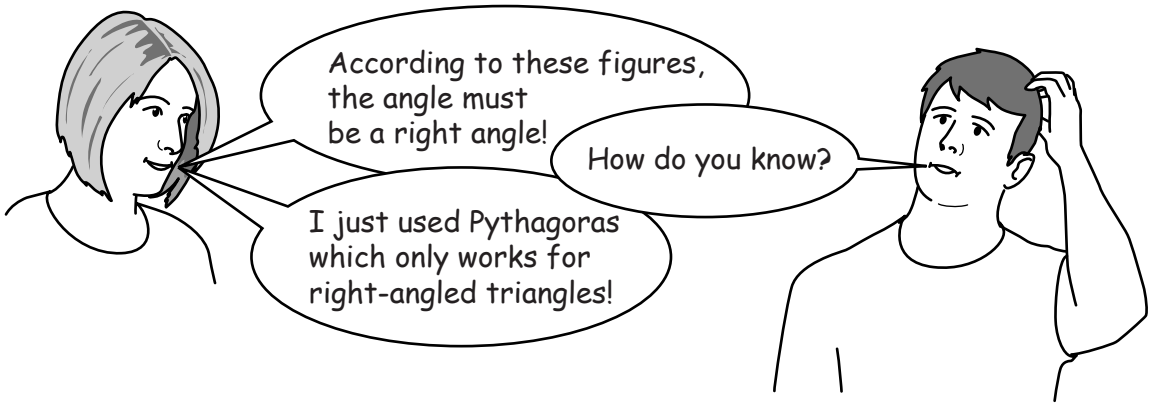
(c) A local community group wants to build a beach volleyball court in a car park.
The group wants to check the site to make sure
that it is a rectangle and the right size.

One of the members suggests finding the
length and breadth of the site by pacing it out.

She says she could check that the angle marked
is a right angle by pacing the diagonal of the site.

Here is a sketch of her results.





Use Pythagoras' theorem to show that the angle must be a right angle.

_____

_____ **[2]**

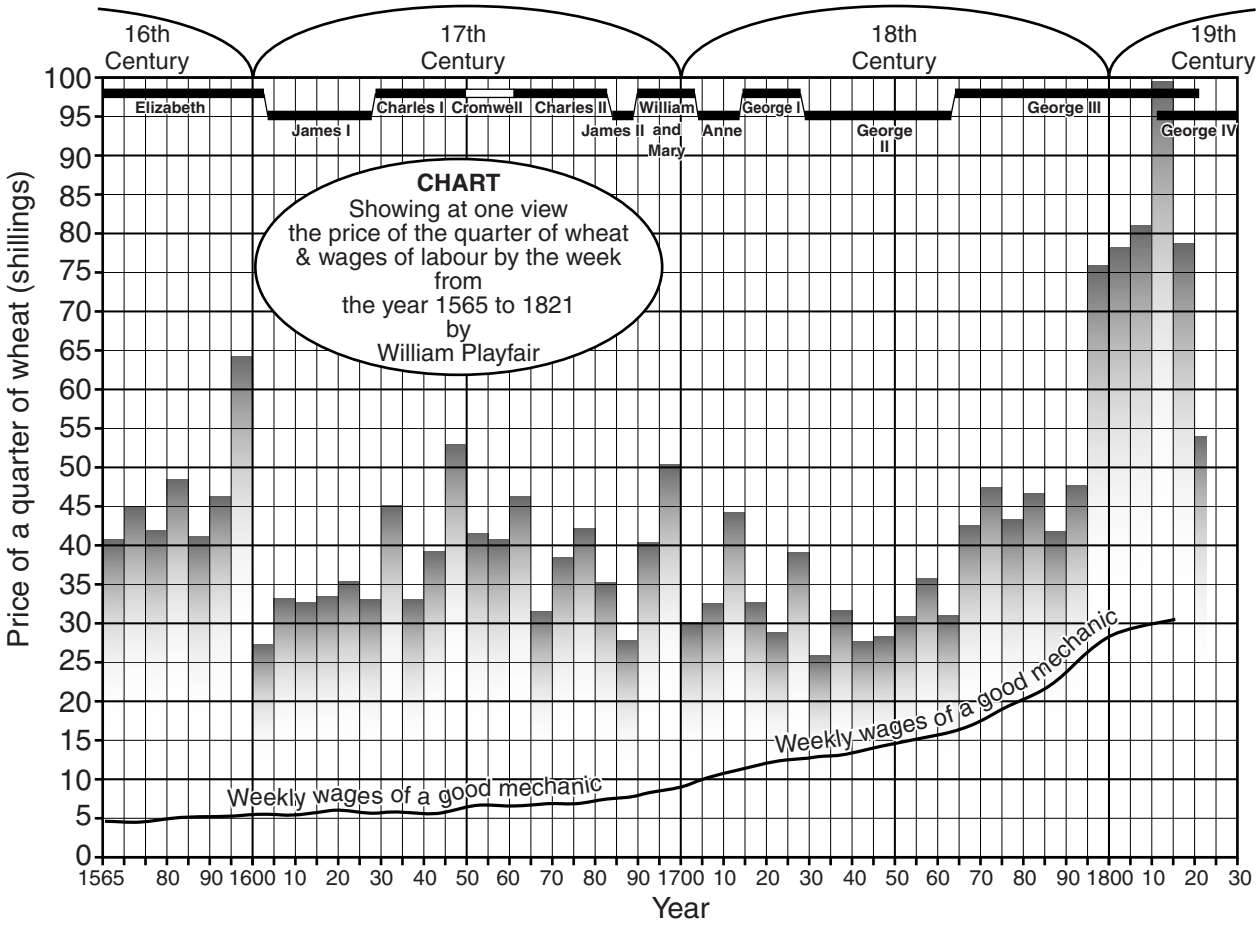
(d) A beach volleyball weighs between 260 g and 280 g, to the nearest gram.

What is the minimum and maximum possible weight of a beach volleyball?

(d) Minimum _____ g

Maximum _____ g
[2]

3 In 1821, William Playfair published a chart to show on one graph the price of a quarter of wheat and the weekly wage of a good mechanic from 1565.



The vertical axis is in shillings and goes up in 5s from 0 to 100.
The horizontal axis begins with the year 1565 with divisions marked every 5 years.
The bar graph gives a five year average price of a quarter of wheat in shillings.
The weekly wage of a good mechanic in shillings is shown by the line graph.
The chart also gives the reigns of the English monarchs across the top.

(a) (i) Estimate from the graph the median average price of a quarter of wheat during the reign of Queen Elizabeth I, from 1565 to 1600.

(a)(i) _____ shillings **[1]**

(ii) Explain why the mean may not be a good average to use for the average price of a quarter of wheat during the reign of Queen Elizabeth I.

_____

_____ **[1]**

(b) (i) What was the weekly wage for a good mechanic in 1702?

(b)(i) _____ shillings **[1]**

(ii) What was the average price of a quarter of wheat in the years 1700 to 1705?

(ii) _____ shillings **[1]**

(iii) How many weeks' wages were needed to buy a quarter of wheat in 1702?

(iii) _____ **[2]**

(c) This chart was the first to be drawn with more than one set of information on the same axes.

(i) Explain why it can be useful to present two or more sets of information on the same axes.

_____

_____ **[1]**

(ii) During the reign of which monarch was the price of wheat cheapest in proportion to the weekly wage of a good mechanic?

(c)(ii) _____ **[1]**

(d)* Wheat is used to make bread.
In the 1820s, a labourer would eat a two pound loaf of bread a day.
A two pound loaf of bread contains between 60% and 75% wheat.
A quarter of wheat is 480 pounds.

Show that a quarter of wheat **could** provide enough bread for a labourer for one year.

_____

_____

_____

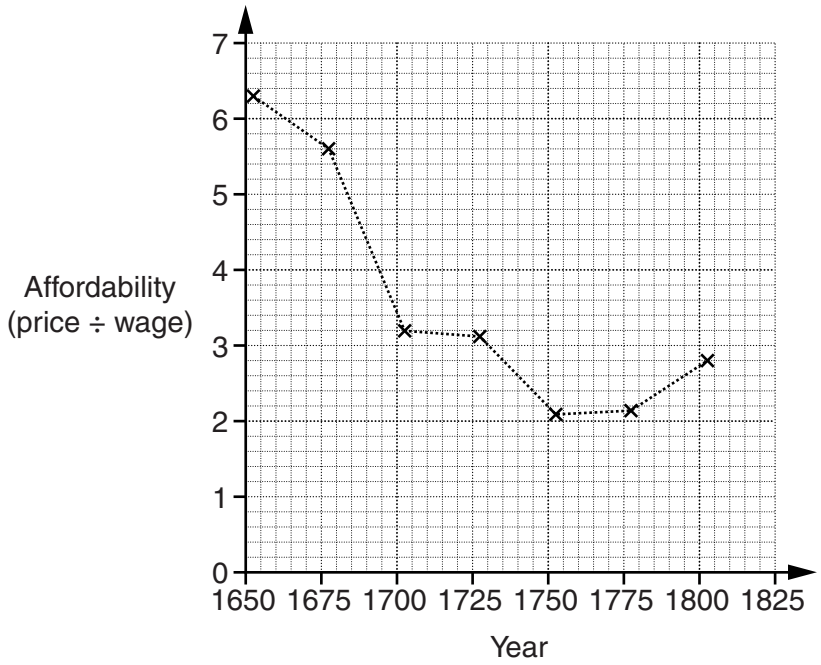
_____

_____ **[4]**

(e) Zoe and Yasmin used the information from the original chart and calculated the affordability of wheat (price ÷ wage) for some years.
The **lower** the number, the more affordable wheat was.

(i) Zoe drew this table and time series graph.

Years	1650 – 1655	1675 – 1680	1700 – 1705	1725 – 1730	1750 – 1755	1775 – 1780	1800 – 1805
Affordability (price ÷ wage)	6.3	5.6	3.2	3.12	2.1	2.15	2.8



Describe the trend in affordability of wheat in Zoe's graph.

_____

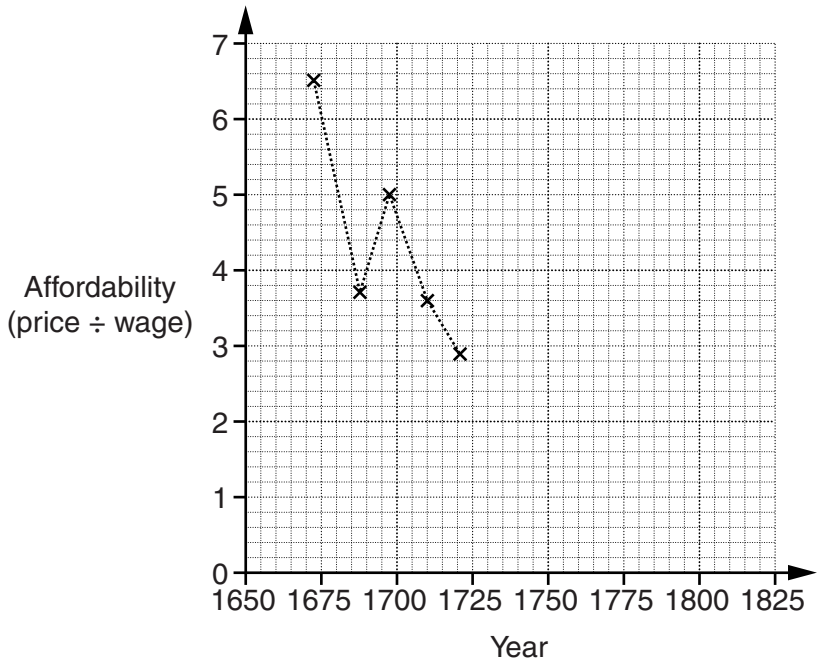
_____ **[1]**

Yasmin calculated the affordability of wheat for the reigns of the monarchs from 1660.

Monarch	Charles II	James II	William & Mary	Anne	George I	George II	George III
Years	1660 – 1685	1685 – 1688	1689 – 1702	1702 – 1714	1714 – 1727	1727 – 1760	1760 – 1820
Average price of a quarter of wheat, shillings	39	28	40	36	35	31	59
Average weekly wage, shillings	6	7.5	8	10	12	14	22.5
Affordability (price ÷ wage)	6.5	3.7	5.0	3.6	2.9		

(ii) Complete the two missing values in the table. **[2]**

(iii) Complete the time series graph for Yasmin.



[2]

(iv) Compare the trend shown in Yasmin's graph to the trend shown in Zoe's graph.

_____

_____ **[1]**

(v) How could you improve Zoe's and Yasmin's investigations?

_____

_____ **[1]**

4 Kerry, a dentist, wants to find out if a new mouthwash can protect teeth.
She chooses 100 patients.
50 are given the new mouthwash and the other 50 are asked to use their usual mouthwash.
After six months Kerry checks their teeth.

(a) Give two reasons why she may not get reliable results.

1 _____

_____

2 _____

_____ **[2]**

(b) Kerry gives the 100 patients a questionnaire to complete.
This is one of the questions.

How often did you use mouthwash? (tick one response only)

Twice a day	☐
Once a day	☐
Once a week	☐
Once a month	☐
Less often	☐

(i) One of the patients, Henry, knows how often he used the mouthwash but is unable to answer the question using just the responses given.

How often could Henry have used mouthwash?

_____ **[1]**

(ii) Write down a set of responses that cover all possibilities.
Include three or more responses.

[1]

5 The thickness of a sheet of printer paper is 0.09 mm.
Each time a sheet of paper is folded in half, the total thickness doubles.

T is the total thickness, in mm, when a piece of printer paper is folded in half n times.

$$T = 0.09 \times 2^n$$

(a) (i) Work out T for printer paper that has been folded in half 7 times.

(a)(i) _____ mm **[2]**

(ii) Find how many times the printer paper would need to be folded in half before its total thickness is greater than 0.3 cm.

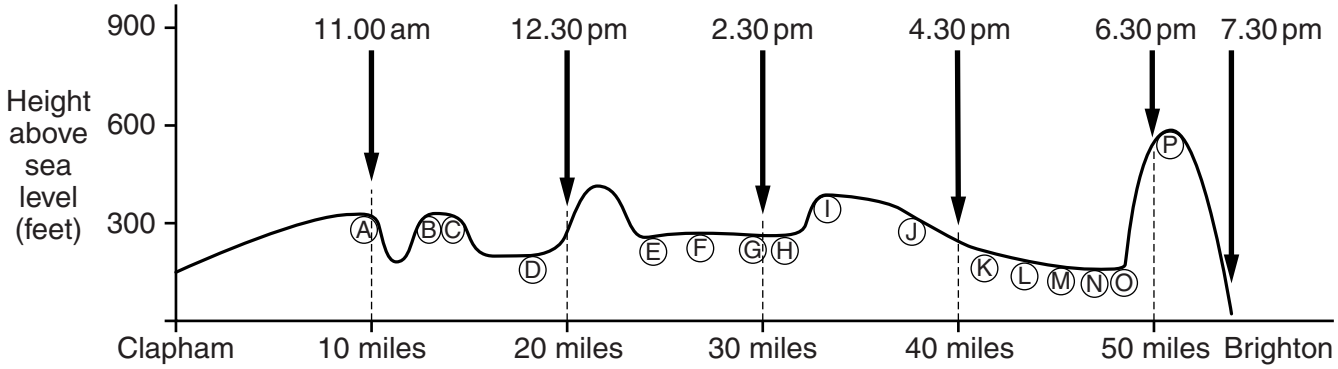
(ii) _____ **[3]**

(b) A sheet of art paper is 1.3 mm thick.

Write a formula for the total thickness of art paper that has been folded in half n times.

_____ **[1]**

6 The annual London to Brighton bike ride is 54 miles.
The starting point in London is at Clapham and the ride ends at the seafront in Brighton.
This route graph shows the distance from the start and the height above sea level at different points along the route.



A. Woodmansterne Village Hall
B. Chipstead Rugby Club
C. Fanny's Farm Shop
D. Nutfield Marsh
E. The Dog & Duck
F. Burstow Scouts
G. The Dukes Head
H. Crawley Down
I. Turners Hill
J. Ardingly Showground
K. Lindfield Village Green
L. Fox & Hounds Pub
M. Royal Oak Pub
N. Ditchling Common
O. Ditchling Village
P. Ditchling Beacon

The points A to P are support stops along the route.

(a) Which is the highest support stop and what is its height above sea level?

(a) _____ at _____ feet **[2]**

(b) The hardest part of the ride is cycling up Ditchling Beacon. Claire says,

'The gradient from Ditchling Village to Ditchling Beacon is 400 ft per mile.'

Use the graph to work out an estimate of the gradient and decide if Claire is correct.
Show all the values you use.

_____

_____

_____

_____

_____

_____ **[4]**

(c) Claire completed the bike ride.

(i) Claire was not able to ride at a constant speed between points A and B or between points D and E.

Give a reason why Claire's speed was not constant between these points.

_____

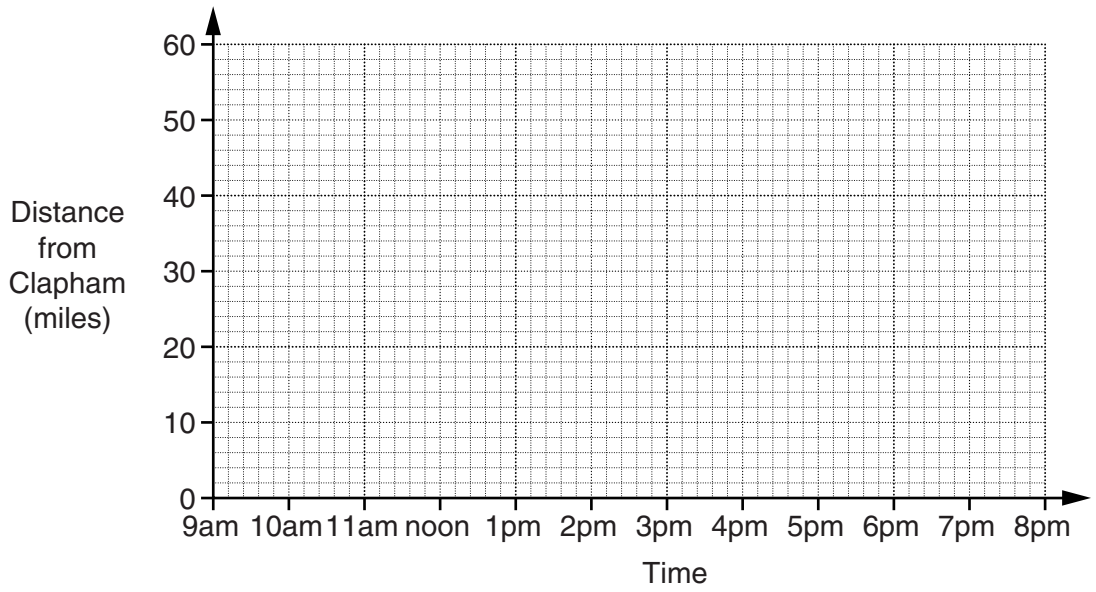
_____ **[1]**

(ii) The arrowed times shown on the graph are the latest possible times cyclists should reach these points along the route.

This is a description of Claire's bike ride.

- Claire started the ride at 9.30 am
- She reached the arrowed points at the latest possible times
- Claire completed the 54 mile ride at exactly 7.30 pm
- She stopped for a rest at The Dukes Head (G) for 30 minutes
- Claire took $1\frac{1}{2}$ hours to ride from O to P.

Draw a distance time graph for Claire's ride.



[5]

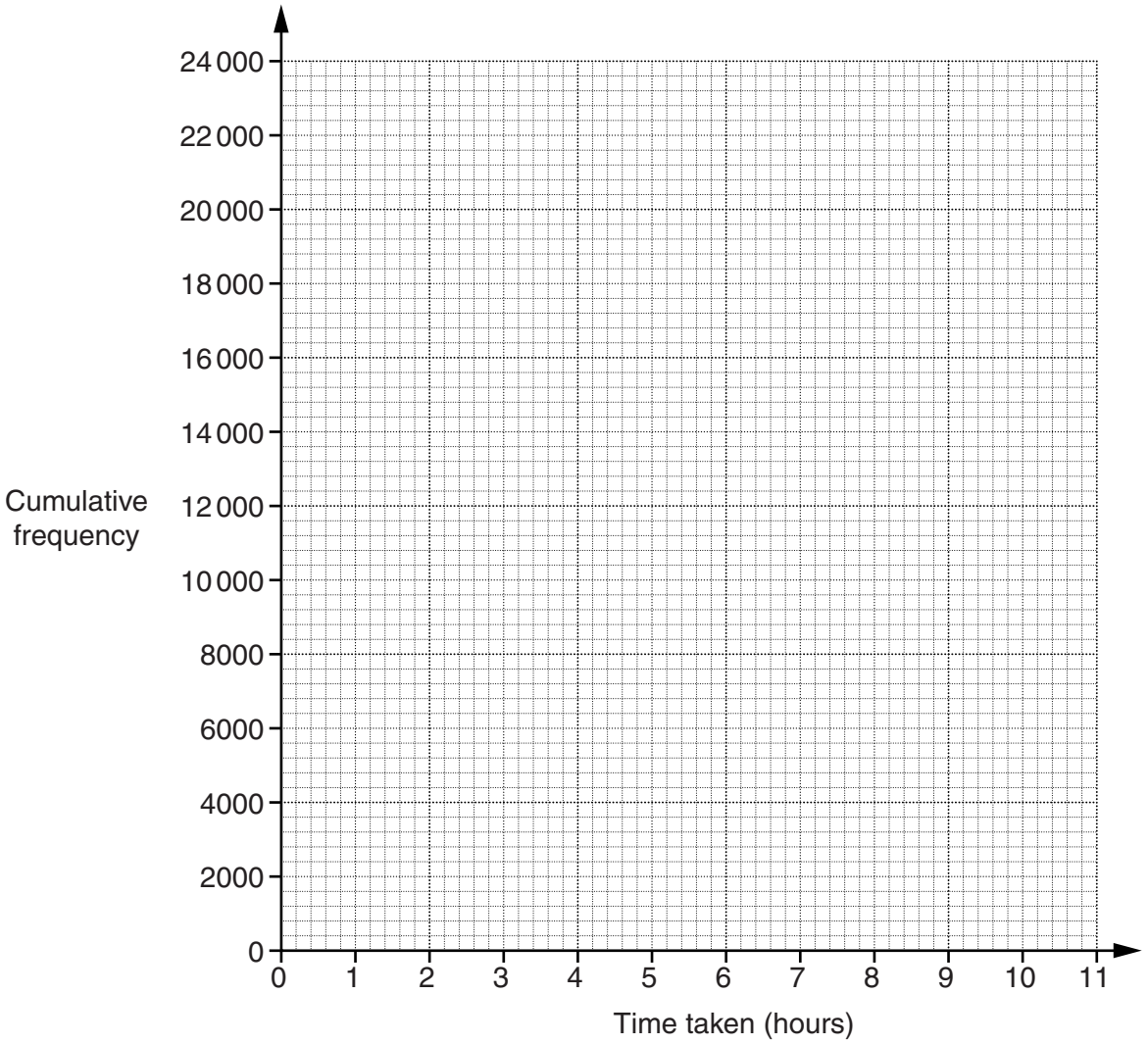
(iii) Use your graph to estimate Claire's distance from **Brighton** at 3.30 pm.

(c)(iii) _____ miles **[2]**

(d) One year 24 000 cyclists completed the ride.
Here is some information about the times taken by the cyclists.

- The quickest cyclist completed the ride in 3 hours 1 minute
- 2000 cyclists completed the ride within 4 hours
- The **next** 18 000 cyclists had completed the ride within 7 hours 30 minutes
- After 9 hours, 23 000 cyclists had completed the ride
- The slowest cyclist completed the ride in 10 hours 59 minutes

(i) Draw a cumulative frequency graph to represent this information.



[4]

(ii) Use the graph to estimate how long it took for half the cyclists to complete the ride.

(d)(ii) _____ hours _____ minutes **[2]**

(iii) Use the graph to estimate the interquartile range of the times.
Show clearly how you get your answer.

(iii) _____ hours _____ minutes **[3]**

(iv) The ride organisers say that most cyclists complete the ride in six hours.

Are the ride organisers correct?
Explain how you decide.

_____

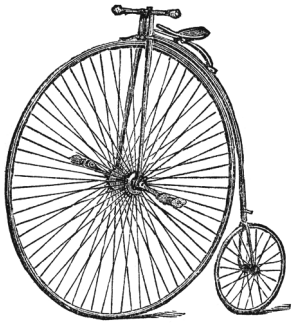
_____ **[1]**

(v) The 24 000 riders raised £3.5 million for charity.
How much on average did each rider raise per mile of the 54 mile ride?

(v) £ _____ **[3]**

(e) In this part of the question use $\pi = 3.142$ or use the π button on your calculator.

Here is a picture of a penny-farthing bicycle.

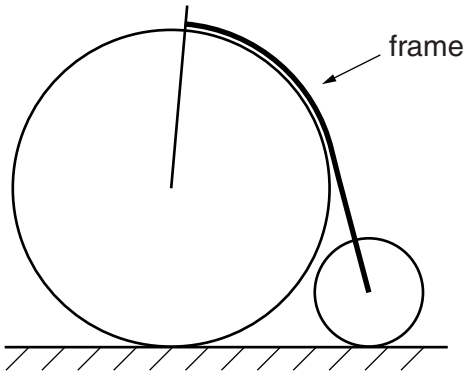


The larger wheel has radius 26 inches.

(i) Calculate the circumference of the larger wheel.

(e)(i) _____ inches **[2]**

(ii) The penny-farthing bicycle frame is an arc plus a straight section.
The length of the arc is $\frac{1}{5}$ of the circumference of a circle which has radius 1 inch greater than the radius of the larger wheel.
The straight section is 10 inches long.



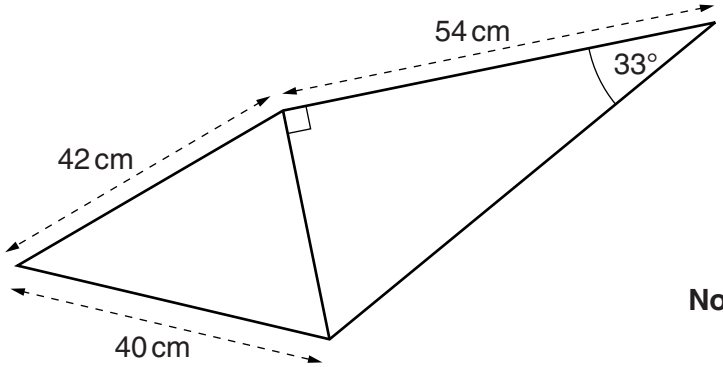
Not to scale

Work out the length of the frame.

(ii) _____ inches **[3]**

(f) Here is a picture of a modern bicycle.

This is the shape of a modern bicycle frame which is made of metal tubes.



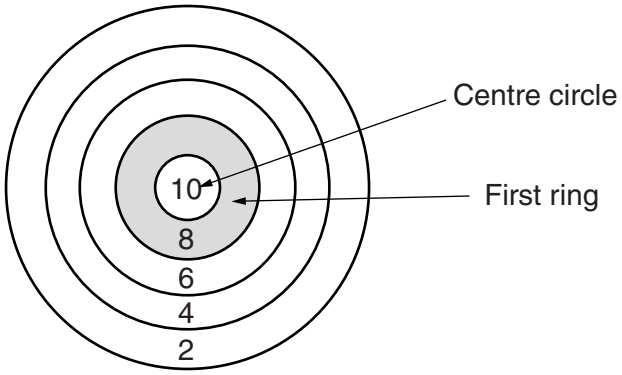
Not to scale

This bicycle frame is made up of two triangles.

Work out the total length of metal tube used to make this frame.

(f) _____ cm **[6]**

7 An archer shoots arrows at a target marked with concentric circles.
This target has five circles.



The circle at the centre has radius 12 cm.
The radius of each further circle is 12 cm more than the radius of the previous circle.

(a) (i) Work out the area of the first ring.
Leave π in your answer.

(a)(i) _____ cm^2 **[3]**

(ii) Show that the ratio of areas centre circle : first ring is 1:3.

_____

_____

_____ **[2]**

(b) Here is some information about the target.

Region	Centre circle	First ring	Second ring	Third ring	Outer ring
Ratio of areas centre circle : region	1:1	1:3	1:5	1:7	1:9
Score	10	8	6	4	2

Freya does not think the scoring system is fair.

Give one reason why Freya may think the scoring system is unfair.

_____

_____ **[1]**

(c)* The radius of the whole target is 60 cm. The target is vertical.
An archer stands 70 m from the target.
When the archer aims an arrow to hit the centre of the target, the tip of the arrow is the same height above the ground as the centre of the target.

Show that if the archer's aim is $\frac{1}{2}°$ off, either to the left or to the right of the centre of the target, then the arrow will miss the target completely.

[4]

END OF QUESTION PAPER

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