

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
GCSE

A382/02

APPLICATIONS OF MATHEMATICS

Applications of Mathematics 2

(Higher Tier)

FRIDAY 13 JUNE 2014: Morning

DURATION: 2 hours
plus your additional time allowance

MODIFIED ENLARGED

Candidate forename		Candidate surname	
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Centre number						Candidate number				
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Candidates answer on the Question Paper.

OCR SUPPLIED MATERIALS:

Loose sheet for Question 4

OTHER MATERIALS REQUIRED:

Scientific or graphical calculator

Geometrical instruments

Tracing paper (optional)

<p>You are permitted to use a calculator for this paper</p>
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READ INSTRUCTIONS OVERLEAF

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the boxes on the first page. 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).

INFORMATION FOR CANDIDATES

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

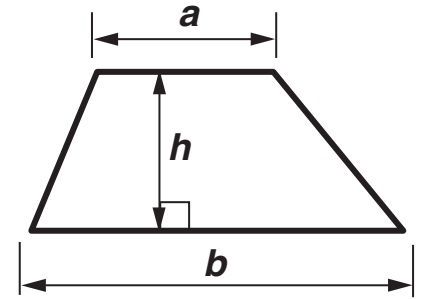
Your quality of written communication is assessed in questions marked with an asterisk (*).

The total number of marks for this paper is 90.

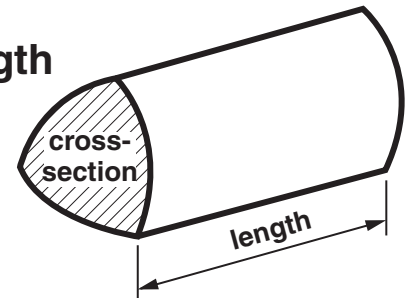
Any blank pages are indicated.

FORMULAE SHEET: HIGHER TIER

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



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

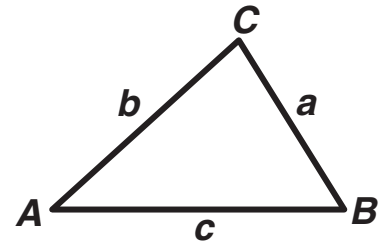


In any triangle ABC

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

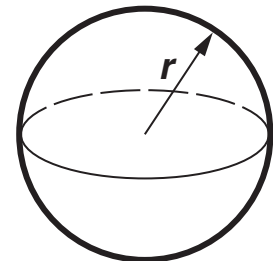
Cosine rule $a^2 = b^2 + c^2 - 2bc \cos A$

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



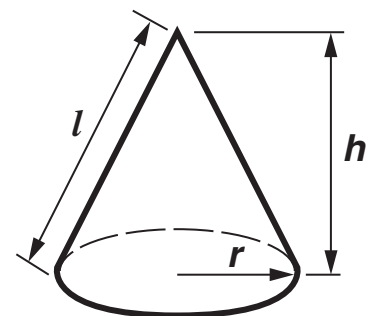
Volume of sphere = $\frac{4}{3} \pi r^3$

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

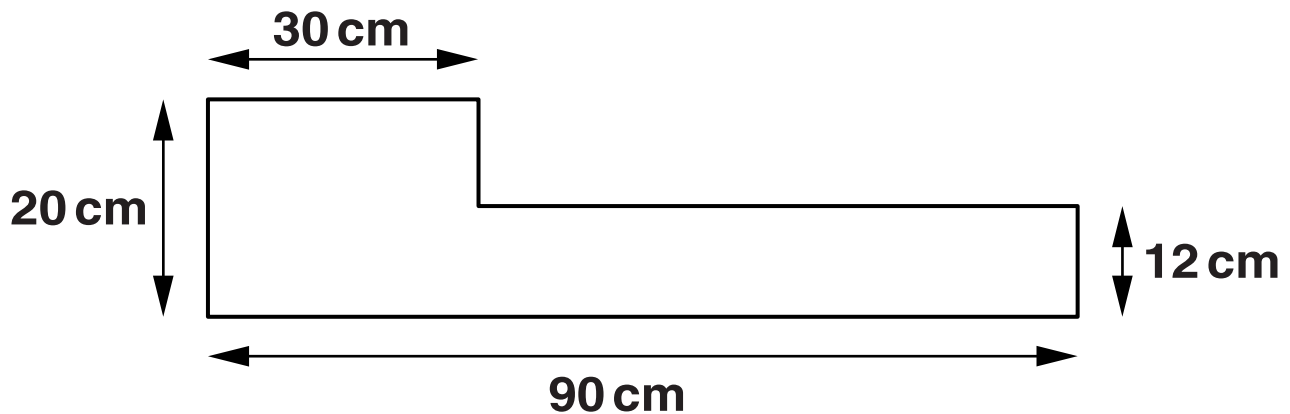
The solutions of $ax^2 + bx + c = 0$, where $a \neq 0$, are given by

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

Answer ALL the questions.

- 1 Car petrol tanks are made in different shapes and sizes.**

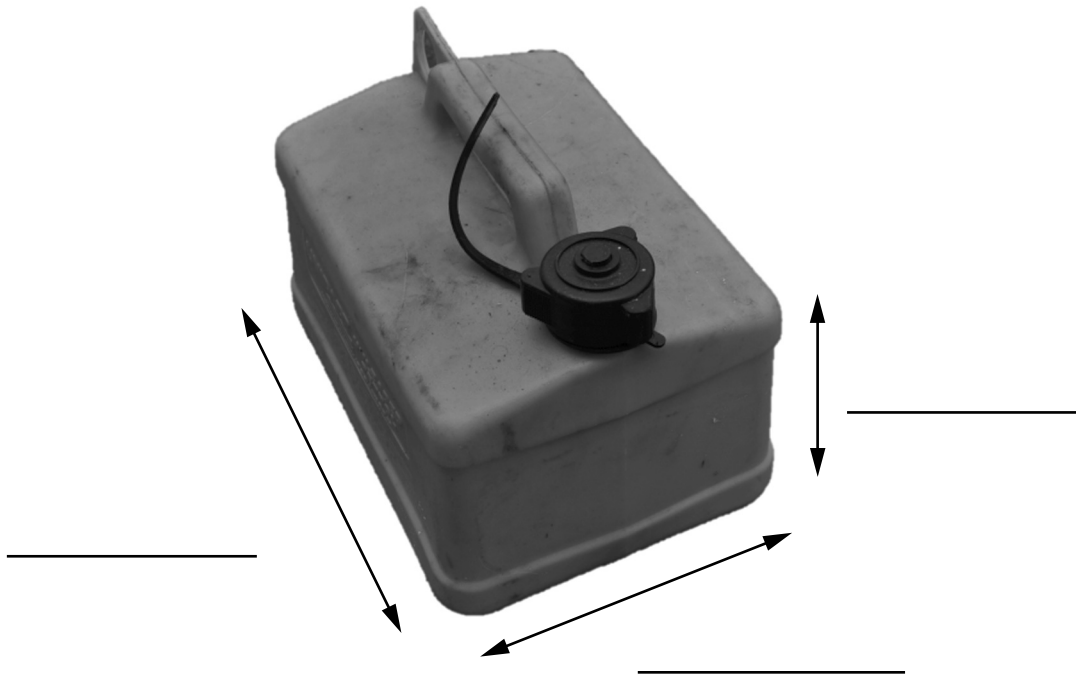
The petrol tank in Josh's car is a prism of length 40 cm. The diagram below shows the cross-section of the tank.



- (a) Work out the volume of the tank in cubic centimetres.**

(a) _____ cm³ [3]

- (b)* Josh has a portable 5-litre fuel can.
1 litre = 1000 cm³.
Josh's fuel can is roughly in the shape of a cuboid.
This is a photo of Josh's 5-litre fuel can.**



**Estimate and write down suitable values for each of the THREE arrowed lengths.
Use calculations to show why your lengths are appropriate for Josh's fuel can.**

_____ [4]

- (c) Josh investigates converting his car to use liquid petroleum gas (LPG).
He uses this information.**

A car uses 10% more LPG than petrol when driven for the same distance.

Petrol costs 140p per litre.

LPG costs 75p per litre.

In a typical week Josh uses 30 litres of petrol.

- (i) How much LPG would Josh use in a typical week?**

(c)(i) _____ litres [2]

- (ii) How much would Josh save each week if he converted his car to use LPG?**

(ii) £ _____ [4]

(d) Josh is told the total cost to convert his car to use LPG is £510.

(i) How many weeks would it take for Josh to get back the cost of the conversion?

(d)(i) _____ weeks [2]

(ii) The conversion costs are in this ratio.

tank cost : labour : safety test = 5 : 9 : 3

How much would Josh save if he does the fitting himself and does not pay the labour charge?

(ii) £ _____ [3]

(e)* Josh wants to install an LPG tank in his car's spare wheel space.

If he does, he will not have a spare wheel in his car to use in case he has a puncture.

If Josh has a puncture, the estimated car recovery cost will be up to £240.

Josh has been driving for $1\frac{1}{2}$ years and has had 1 puncture during that time.

Use the information and your answer to part (c)(ii) to explain why Josh should risk not having a spare wheel in his car.

[3]

- (f) Josh decides he will install an LPG tank in his car's spare wheel space.
The tank is shaped like the spare tyre. The radius of its cross section is r and the radius of the circle centred on the top of the tank is R .

- (i) The volume, V , of the tank is given by this formula.

$$V = 2 \times \pi^2 \times R \times r^2$$

The largest LPG tank that Josh can fit has $R = 210$ mm and $r = 87$ mm, each given correct to the nearest mm.

Work out the MINIMUM volume of this tank.
Use the π button on your calculator or use $\pi = 3.142$.

Give your answer correct to 3 significant figures.

(f)(i) _____ mm³ [4]

- (ii) It is dangerous to fill an LPG tank to more than 80% of its volume.
One litre = $1 \times 10^6 \text{ mm}^3$.

Work out the greatest number of litres of LPG that Josh should put in this tank.

(ii) _____ litres [3]

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2 A census is a record of all people and households in a country.

In the 2011 UK census there were these two new questions:

What type of central heating does this accommodation have?

How many rooms are bedrooms?

(a) Donna wanted to find out information about local households.

She asked a sample of 80 local households these two questions.

In Donna's sample there were no households with more than 6 bedrooms, and there were only three types of central heating: gas, electric and oil.

(i) Design a two-way table for Donna to use to record this information. [3]

(ii) In Donna's sample there were 14 households with 3 bedrooms and oil central heating.

Show this information in your table in part (a)(i). [1]

- (b) The census also asked for the number of people living in each household.
The government thinks that many households will have bedrooms that are not used.**

How could the census data show whether this is true?

[1]

- 3 Bashra wants to swim at her local sports centre. She is not a member of the centre. The cost is different if Bashra buys a member card or a student card. The table below shows the costs.**

	Cost of a card	Cost per swim
Non-member		£3.25
Member	£100	free
Student	£11	£2.05

**The cost, in £, of x swims for a non-member is $3.25x$.
The cost, in £, of x swims with a student card is $2.05x + 11$.**

Bashra writes this inequality to show when the cost for a student card holder will be less than the cost for a non-member.

$$2.05x + 11 < 3.25x$$

- (a) Work out the LEAST number of times Bashra must swim for it to cost less if she buys a student card instead of paying each time as a non-member.**

(a) _____ [3]

- (b) (i) Write an inequality to show when the cost for a member card holder will be less than the cost for a student card holder.**

(b)(i) _____ [2]

- (ii) Work out the LEAST number of times Bashra must swim for it to cost less if she buys a member card instead of a student card.**

(ii) _____ [3]

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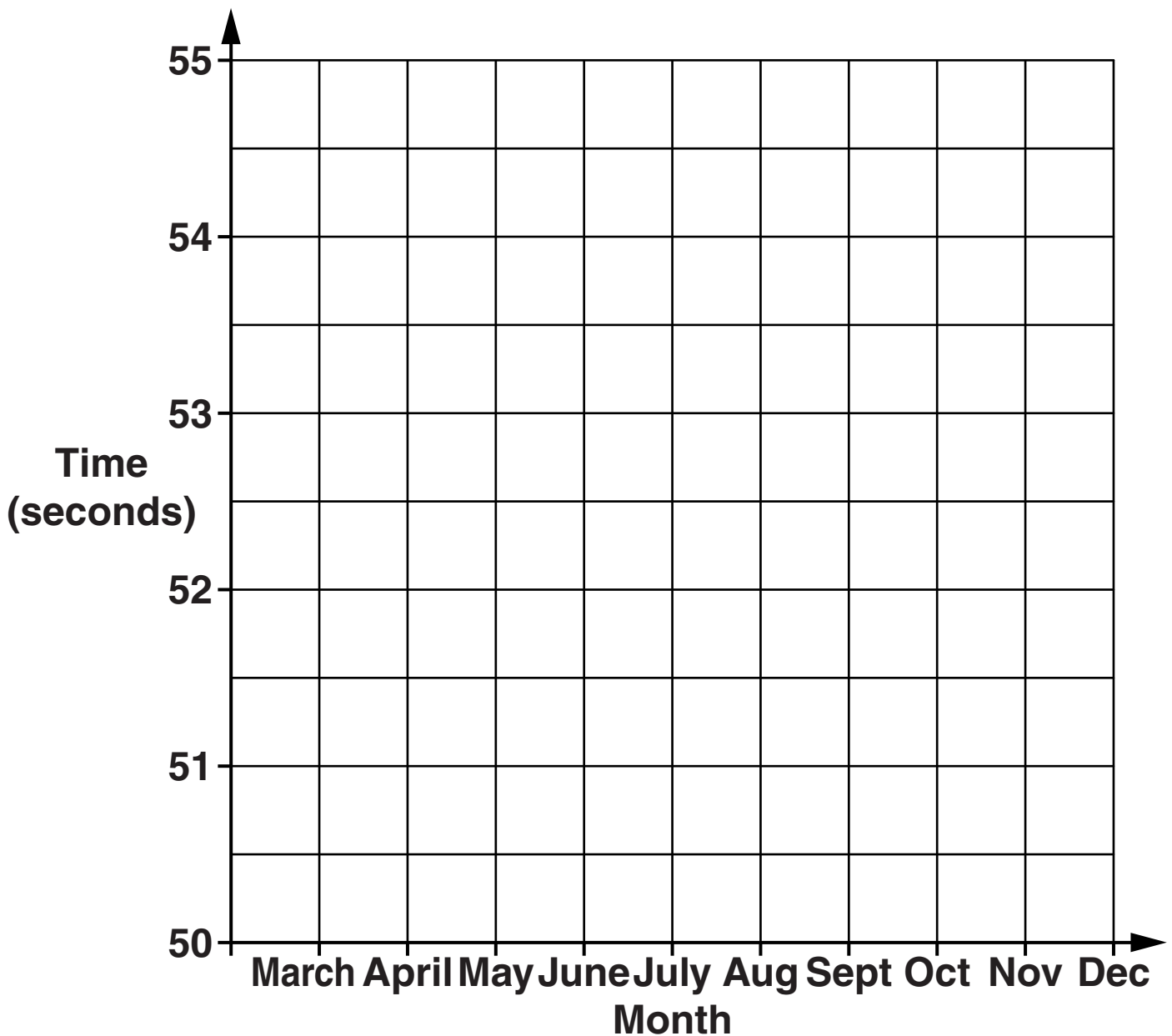
(c) The sports centre hosts a swimming time trial one day each month.

These are Bashra's times, in seconds, for swimming 50 m freestyle.

Bashra did not attend the swimming time trial in August.

Month	March	April	May	June	July	Aug	Sept	Oct
Time (seconds)	54.4	54.0	53.2	52.8	52.6		51.8	51.2

- (i) On the grid below draw a time series graph for these data.



[2]

- (ii) Use your graph to estimate what Bashra's time to swim 50m freestyle might have been if she had attended the swimming time trial in August.

(c)(ii) _____ s [1]

- (iii) Explain why it may not be sensible to use the graph to estimate Bashra's time to swim 50 m freestyle in December.**

[1]

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4 The Highway Code has a chart of typical stopping distances for cars travelling at different speeds.

The chart is provided as a separate insert. Information from the chart is shown in the following table.

Typical stopping distance			
Speed	Thinking distance	Braking distance	Total distance
20 mph (32 km/h)	6 m	6 m	12 metres (40 feet) or three car lengths
30 mph (48 km/h)	9 m	14 m	23 metres (75 feet) or six car lengths
40 mph (64 km/h)	12 m	24 m	36 metres (118 feet) or nine car lengths
50 mph (80 km/h)	15 m	38 m	53 metres (175 feet) or thirteen car lengths
60 mph (96 km/h)	18 m	55 m	73 metres (240 feet) or eighteen car lengths
70 mph (112 km/h)	21 m	75 m	96 metres (315 feet) or twenty-four car lengths

The distances shown in the table are a general guide. The distance will depend on your attention (thinking distance), the road surface, the weather conditions and the condition of your vehicle at the time.

Average car length = 4 metres (13 feet)

Stopping Distance = Thinking Distance + Braking Distance

- (a) Describe fully how thinking distance is related to speed.**

[2]

- (b) The stopping distances given in the Highway Code chart are for a DRY road.
It will take longer to stop if the road is wet.**

**Which part of the stopping distance will NOT change if the road is WET?
Give a reason for your answer.**

[1]

- (c) Ali finds the following formula for stopping distances on DRY roads.

$$d = \frac{v^2}{20} + v$$

d is the total stopping distance in feet and v is the speed in miles per hour (mph).

Ali uses this formula to draw a graph of speed and stopping distance.

- (i) Complete the following table USING THE FORMULA. There are two missing numbers to fill in.

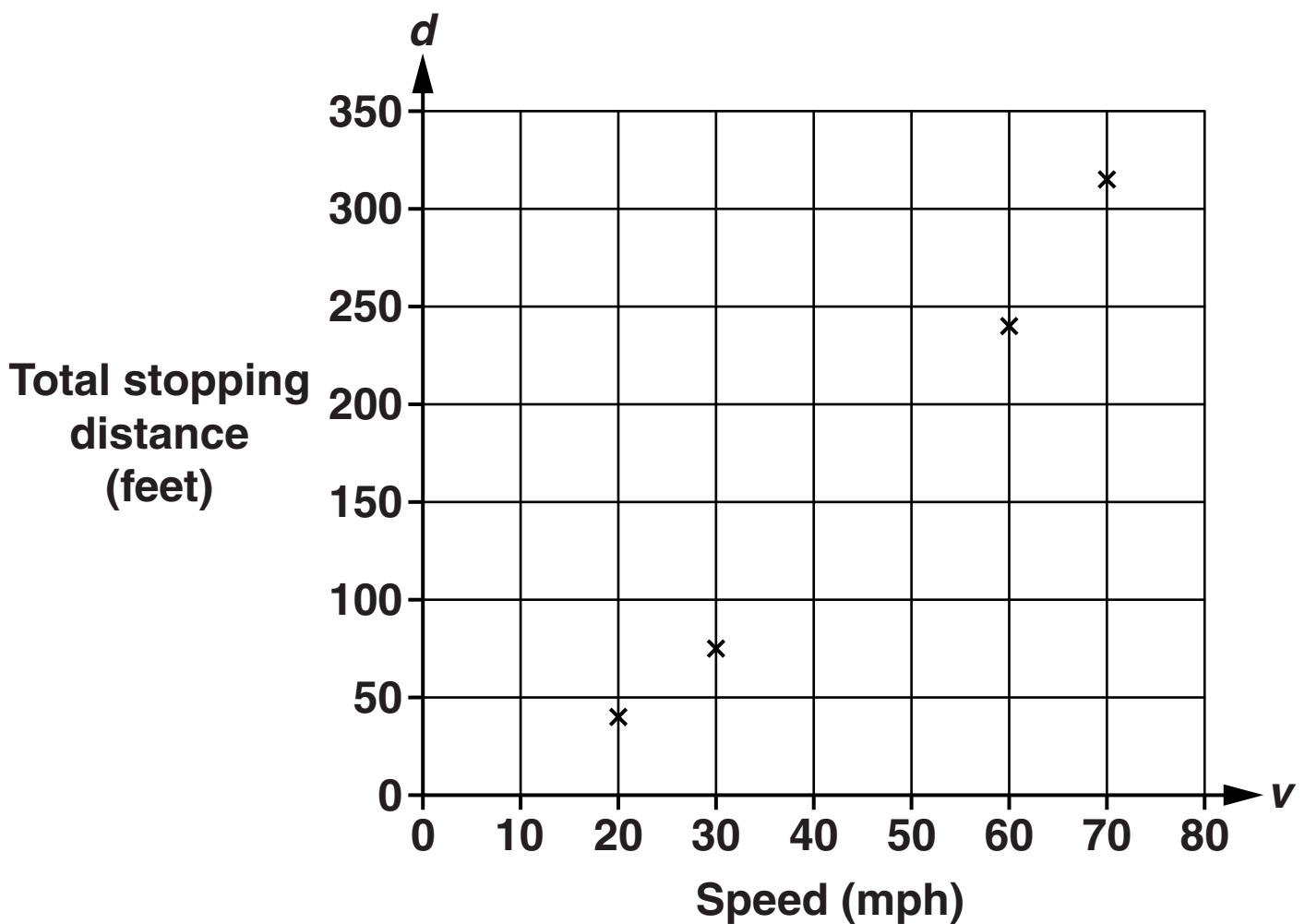
v (mph)	20	30	40	50	60	70
d (feet)	40	75			240	315

[2]

- (ii) Show that the formula is a good fit for the stopping distances given in the Highway Code chart.

[1]

- (iii) On the grid below complete the graph of $d = \frac{v^2}{20} + v$. (The four points given in the table in part(i) are already plotted.)



[2]

- (d) The following formula is for the stopping distance on WET roads.

$$d = \frac{v^2}{n} + v$$

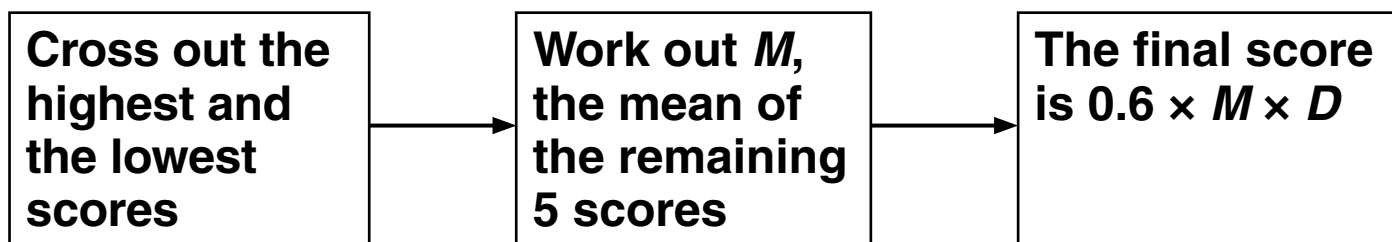
d is the total stopping distance in feet, v is the speed in mph and n is a number.

Suggest a POSSIBLE value for n .

(d) _____ [1]

- 5 In a diving competition there are 7 judges.
A dive has a difficulty rating, D , and each judge gives the dive a score out of 10.

The flow diagram below shows how the judges' scores and the difficulty rating, D , are combined to work out a competitor's final score.



The table opposite gives the difficulty rating and the judges' scores for four competitors.

(a) (i) Show that the final score for George is 12.06.

[3]

(ii) A gold medal is won by the competitor with the highest final score.

Silver and bronze medals are won by the competitors with the second and third highest final scores respectively.

George won a bronze medal.

Complete the table below to show the competitors who won the gold and silver medals and their final scores.

Medal	Competitor	Final score
Gold		
Silver		
Bronze	George	12.06

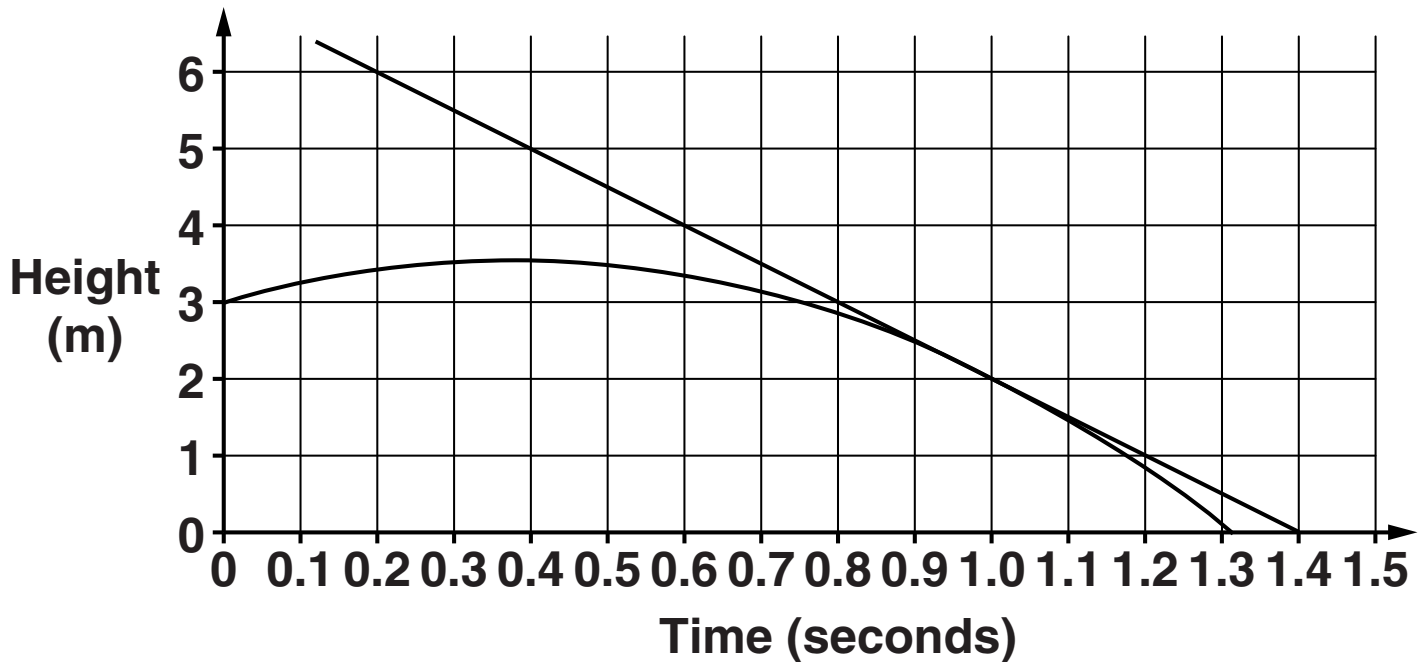
[4]

Competitor	Difficulty rating, D	Judge 1	Judge 2	Judge 3	Judge 4	Judge 5	Judge 6	Judge 7
Tapani	2.5	8.0	9.0	8.0	8.0	7.5	8.5	8.5
Chu	3.5	8.5	5.5	6.0	5.5	5.0	5.5	6.0
Lewis	3.5	6.0	6.0	6.5	6.5	6.5	6.0	6.0
George	3.0	6.5	6.0	7.0	6.5	7.0	7.0	6.5

(b) Joe dived from a diving board into a swimming pool.

The curve shows how high, in metres, Joe's feet were above the water during his dive.

The straight line is a tangent to the curve on the grid below at the point (1.0, 2).



(i) How high was the diving board?

(b)(i) _____ m [1]

(ii) After how many seconds did Joe's feet first enter the water?

(ii) _____ s [1]

(iii) Work out the gradient of the tangent.

(iii) _____ m/s [3]

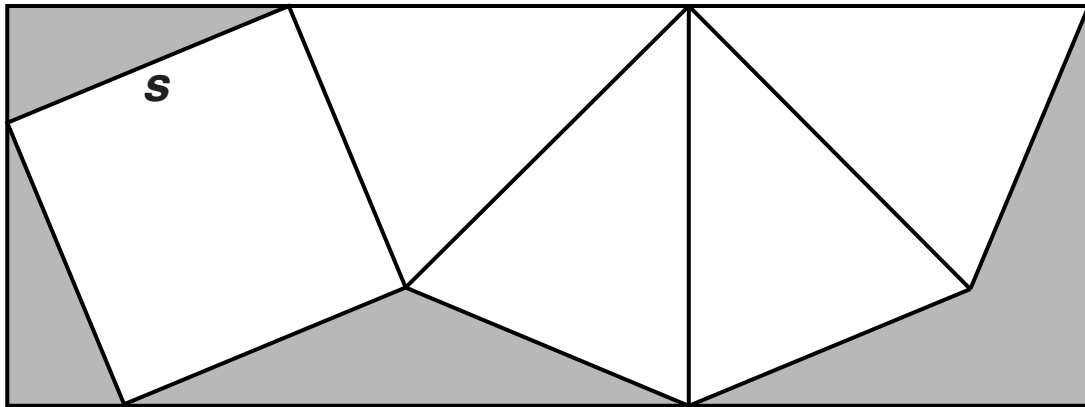
(iv) What does the gradient of the tangent represent?

_____ **[1]**

- 6 A paperweight is made in the shape of a square based pyramid.

A box for the paperweight is made from card and is the same shape as the paperweight.

A net for the box is drawn on a rectangle of card. The net is shown below on a diagram that is not to scale.

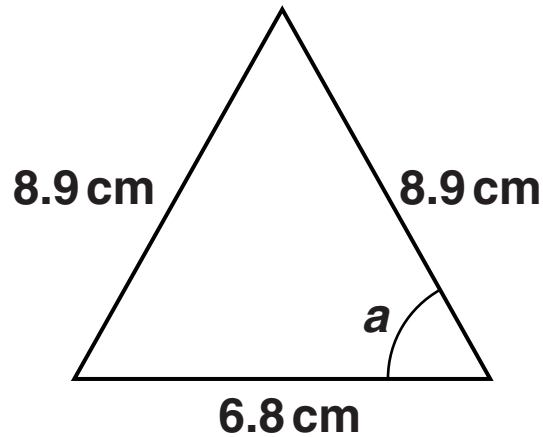


- (a) One side of the net is marked s .

Which side will join to side s when the box is made?

Label it t . [1]

The box has base length 6.8 cm.
The length of each slant edge of the box is 8.9 cm.
The top of the pyramid is above the centre of the square base.
The diagram below shows one of the triangular faces.



(b) Show that the angle, a , at the bottom of each triangular face is 67.5° .

[3]

(c) The formula for the volume of a square based pyramid is

$$\text{Volume} = \frac{1}{3}Ah$$

where A is the area of the base and h is the vertical height of the pyramid.

Work out the volume of the box.

(c) _____ cm³ [6]

(d) Calculate the dimensions of the rectangular card needed for this net.

(d) Length _____ cm

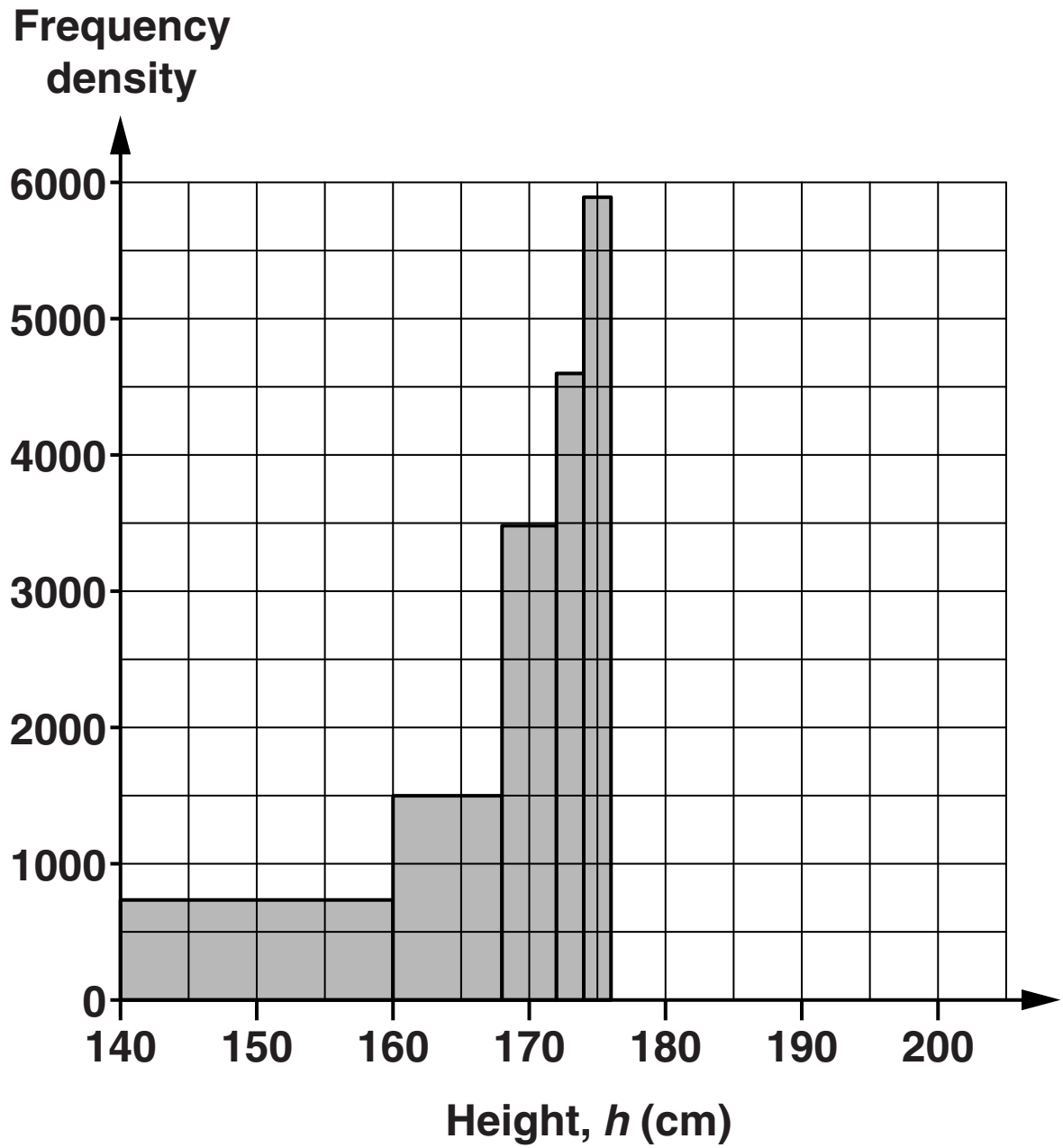
Width _____ cm [5]

- 7 Quentin collected the following information on the heights of potential recruits to the armed forces.

Height, h (cm)	Frequency	Frequency density
$140 \leq h < 160$	15 000	750
$160 \leq h < 168$	12 000	1500
$168 \leq h < 172$	14 000	3500
$172 \leq h < 174$	9200	4600
$174 \leq h < 176$	11 800	5900
$176 \leq h < 180$	11 200	
$180 \leq h < 190$	6000	
$190 \leq h < 205$	3000	

- (a) Complete the frequency density column in the table above by filling in the three missing numbers. [3]

(b) Complete the histogram below.



[2]

(c) To become an aircraft handler you need to be at least 166 cm tall.

How many of these potential recruits could become an aircraft handler?

(c) _____ [3]

END OF QUESTION PAPER

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