

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

I declare this is my own work.

GCSE MATHEMATICS

H

Higher Tier Paper 3 Calculator

Wednesday 14 June 2023

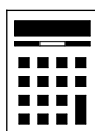
Morning

Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

- a calculator
- mathematical instruments
- the Formulae Sheet (enclosed).



Instructions

- Use black ink or black ball-point pen. Draw diagrams in pencil.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.
- You may ask for more answer paper, graph paper and tracing paper. These must be tagged securely to this answer book.

For Examiner's Use

Pages	Mark
2–3	
4–5	
6–7	
8–9	
10–11	
12–13	
14–15	
16–17	
18–19	
20–21	
22–23	
24–25	
TOTAL	

Advice

In all calculations, show clearly how you work out your answer.



Please note that these worked solutions have neither been provided nor approved by AQA and may not necessarily constitute the only possible solutions. Please refer to the original mark schemes for full guidance.

Any writing in blue indicates what must be written in order to answer the questions and get the marks. The worked solutions have been designed to show the smallest amount of work which needs to be done to answer the question.

Anything written in green in a cloud doesn't have to be written in the exam.

Anything written in orange in a rectangle doesn't have to be written in the exam and is there to show what should be put into a calculator or measured using a ruler or protractor.

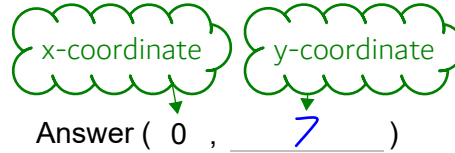
If you find any mistakes or have any requests or suggestions, please send an email to curtis@cgmaths.co.uk

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

- 1 The line with equation $y = 2x + 7$ intersects the y -axis at A.

Complete the coordinates of A.

[1 mark]



When $x = 0$ (which is given), $y = 2(0) + 7 = 7$

- 2 Write down a fraction equivalent to 1.875

[1 mark]

Answer $\frac{15}{8}$

Typing the decimal into the calculator then pressing = (or EXE) should convert it into a fraction

- 3 Solve $5x + 11 = 3x + 19$

[2 marks]

$2x + 11 = 19$ ← Subtracting $3x$ from both sides of the equation gets all the x on the same side

$2x = 8$ ← Subtracting 11 from both sides gets the x term on its own

Dividing both sides by 2 gets x on its own

$x =$ 4



- 4 A map has a scale of 1 : 5000

How many **metres** are represented by a length of 4.5 cm on the map?

[2 marks]

$$\frac{4.5 \times 5000}{100}$$

The actual distance is 5000 times what the distance is on the map. So multiplying the 4.5 cm by 5000 expresses how many centimetres this is in real life. There are 100 cm in 1 m so dividing this by 100 converts it into metres

Answer 225 m

- 5 The number of hedgehogs in England is expected to **reduce** by 4% each year. Assume there are now 1 000 000 hedgehogs in England.

Work out the expected number of hedgehogs in England after **five** years.

You **must** show your working.

[3 marks]

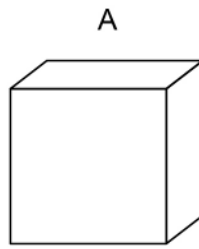
$$1000000 \times \left(\frac{100-4}{100}\right)^5$$

Using the compound interest formula. 100% is the original amount. Subtracting 4% expresses the percentage it decreases to each year. Putting this over 100 converts the percentage to a fraction, which when multiplied by reduces by 4%. Raising the fraction to the power of 5 as it needs to be decreased by 4% 5 times

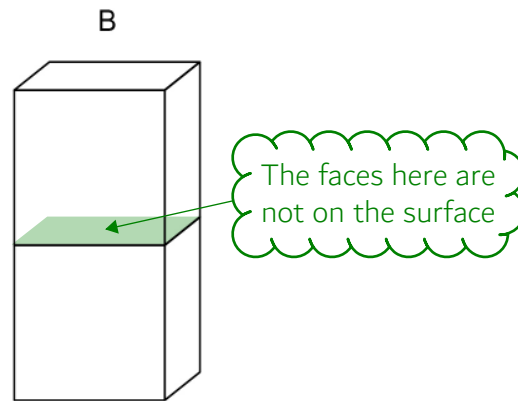
Answer 815373



6 Here is cuboid A.



Cuboid B is made from **two** of cuboid A.



volume of A : volume of B = 1 : 2

Matthew says,

“surface area of A : surface area of B must be 1 : 2 because B is made of 2 of A.”

Is Matthew correct?

Tick **one** box.

Yes

No

Cannot tell

Give a reason for your answer.

[2 marks]

Not all the faces of both cubes are on the surface in B so the surface area of B is not double the surface area of A



- 7 (a) Complete the table of values for $y = x^2 + 2x$

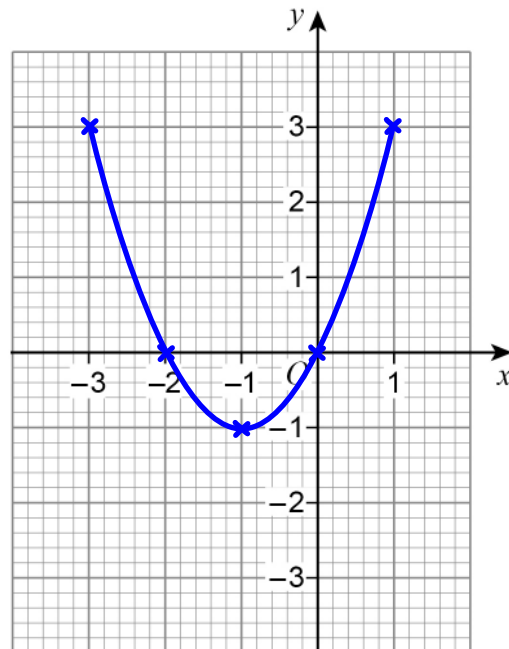
[2 marks]

x	-3	-2	-1	0	1
y	3	0	-1	0	3

Using table mode, enter $f(x) = x^2 + 2x$. Start: -3. End: 1. Step: 1

- 7 (b) Draw the graph of $y = x^2 + 2x$ for values of x from -3 to 1

[2 marks]



Plotting the points from the table of values then joining them up with a curve

Turn over for the next question

Turn over ►



8

Jing has £2450

She saves some and gives the rest to her four brothers.

money saved : money given to brothers = 2 : 5

She gives each of her **four** brothers the **same** amount.

Does each brother receive more than £430 ?

You **must** show your working.**[4 marks]**

$2+5$

We are given the total amount of money so it is helpful to work out that the total number of parts in the ratio is 7

$2450 \div 7$

The £2450 is represented by 7 parts in the ratio. Dividing the £2450 by the 7 parts works out that 1 part of the ratio is worth £350

350×5

Multiplying the value of 1 part of the ratio by the 5 parts which represent the money given to the brothers works out that £1750 was given to her brothers

$1750 \div 4 = 437.50$

Dividing the £1750 by the 4 brothers works out that each brother receives £437.50

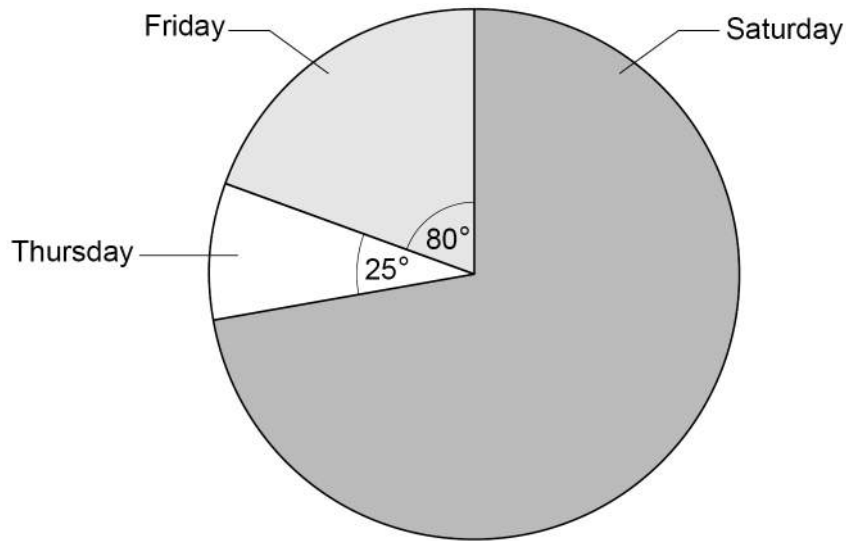
Yes

£437.50 is more than £430



9

The pie chart shows information about people at a fair during three days.



Not drawn
accurately

There were 132 **more** people on Friday than on Thursday.

Work out the number of people on Saturday.

[3 marks]

$$80 - 25$$

This works out that there are 55° more for Friday than Thursday

$$132 \div 55 = 2.4$$

The 55° represents the 132 people. So dividing the 132 people by the 55° works out that 1° represents 2.4 people

$$360 - 25 - 80$$

Subtracting the number of degrees for Thursday and Friday from the total 360° in the pie chart works out that Saturday was 255°

$$255 \times 2.4$$

Multiplying the 255° for Saturday by the 2.4 people which each degree represents works out the number of people on Saturday

Answer _____

612

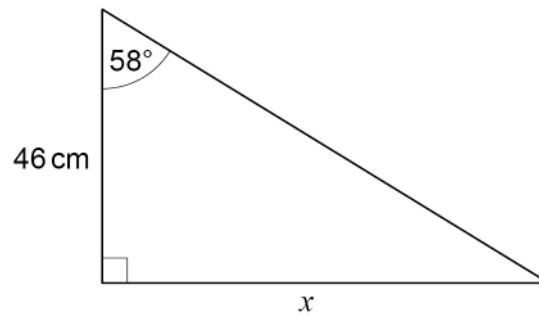
Turn over for the next question

Turn over ►



10 Use trigonometry to work out the value of x .

Not drawn
accurately



[3 marks]

SOHCAHTOA

Right-angled trigonometry can be used so writing SOH CAH TOA as formula triangles. Ticking A as 46 cm is the adjacent and O as x is the opposite

$\tan 58x = 46$

From the formula triangle, opposite = tan of the angle \times adjacent

$$x = \underline{\quad 73.6 \quad} \text{ cm}$$



11 Millie is estimating the value of $\frac{1}{(\sqrt[3]{8.34})^2} \times 10.21$

She rounds each decimal number to 1 significant figure.

- 11 (a) Work out Millie's estimate.
You **must** show your working.

[2 marks]

$$\frac{1}{(\sqrt[3]{8})^2} \times 10$$

8.34 is 8 to 1 significant figure as the first significant figure is 8 and the 3 after it causes it to round down then everything after the 8 is set to 0 and the decimal places are ignored.
10.21 to 1 significant figure is 10 as the first significant figure is 1 and the 0 after it causes it to round down then everything after the 1 is set to 0 and the decimal places are ignored

Answer $\frac{1}{40}$

- 11 (b) Millie says,
"My estimate must be more than the exact value."

Without working out the exact value, give a reason how she can know this.

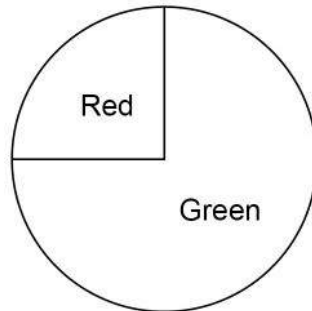
[1 mark]

8.34 and 10.21 were rounded down

Because they are the denominator of the fraction and both are positive, this makes the estimate greater



12 Here is a **biased** spinner.



12 (a) Ali, Ben and Cary want to know the probability of spinning red on the biased spinner. They each spin it and count how many times it lands on red and divide by the total number of spins.

Ali says

I spun red the most times

Ben says

I spun the spinner the most times

Cary says

My relative frequency of red is 0.25

Who had the best estimate for the probability of spinning red?

Give a reason for your answer.

[1 mark]

Ben, as he spun it the most times

Getting red more times does not make the estimate better. Stating the relative frequency does not make the estimate better. Spinning it more times makes the estimate better as the relative frequency of red is more likely to be closer to the true probability



12 (b) Dev spins the spinner 80 times.

He says,

“My relative frequency of red is 0.185”

Give a reason why his relative frequency must be wrong.

[1 mark]

0.185×80 is not a whole number

Multiplying the relative frequency of red by the number of spins should give the frequency of red, which does not work in this case as it gives 14.8, which is not a whole number

12 (c) Elena spins the spinner 125 times.

The relative frequency of red is 0.32

Work out how many times the spinner landed on **green**.

[2 marks]

0.32×125

Multiplying the relative frequency of red by the number of spins works out that it landed on red 40 times

$125 - 40$

The spinner can either land on red or green, so subtracting the number of times it landed on red from the total number of spins leaves the number of times the spinner landed on green

Answer _____ 85 _____

Turn over for the next question



13 Charlie is driving 293 miles home.

He

- leaves at 9.00 am
- travels the first 176 miles at an average speed of 48 mph
- drives the rest of the way at an average speed of 65 mph

Will he be home by 2.30 pm?

You **must** show your working.

[4 marks]

$s^d t$

This is a distance, speed, time problem so writing the formula triangle

$293 - 176$

Subtracting the 176 miles done in the first part of the journey from the total 293 miles works out that the rest of the distance is 117 miles

$9^\circ + \frac{176}{48} + \frac{117}{65} = 14^\circ 28' 0''$

Entering 9 am as a sexagesimal on the calculator. Time = distance/speed so dividing the 176 miles by the 48 mph expresses the time in hours for the first part of the journey. Dividing the 117 miles by the 65 mph expresses the time in hours for the rest of the journey. Adding these two times to the 9° gives the time he arrives home as a sexagesimal. $14^\circ 28' 0''$ means 14.28, which is 2.28 pm

Yes

2.28 pm is before 2.30 pm



14 Kiran paid Income Tax and National Insurance on her annual salary.

Income Tax

0% of the first £12570 of her annual salary
20% of the rest of her annual salary

National Insurance

0% of the first £9880 of her annual salary
13.25% of the rest of her annual salary

Kiran paid £5186 Income Tax.

How much National Insurance did she pay?

[4 marks]

$$5186 \div 20$$

Dividing the £5186 Income Tax by the 20% works out that 1% of the rest of her annual salary is £259.30

$$259.3 \times 100$$

Multiplying the 1% of the rest of her annual salary by 100 works out that 100% of the rest of her annual salary is £25930

$$25930 + 12570$$

Adding the first £12570 to the rest of her annual salary works out that her annual salary is £38500

$$38500 - 9880$$

Subtracting the £9880 which 0% is paid for National Insurance leaves £28620 which is the rest of her annual salary for the National Insurance

$$28620 \times \frac{13.25}{100}$$

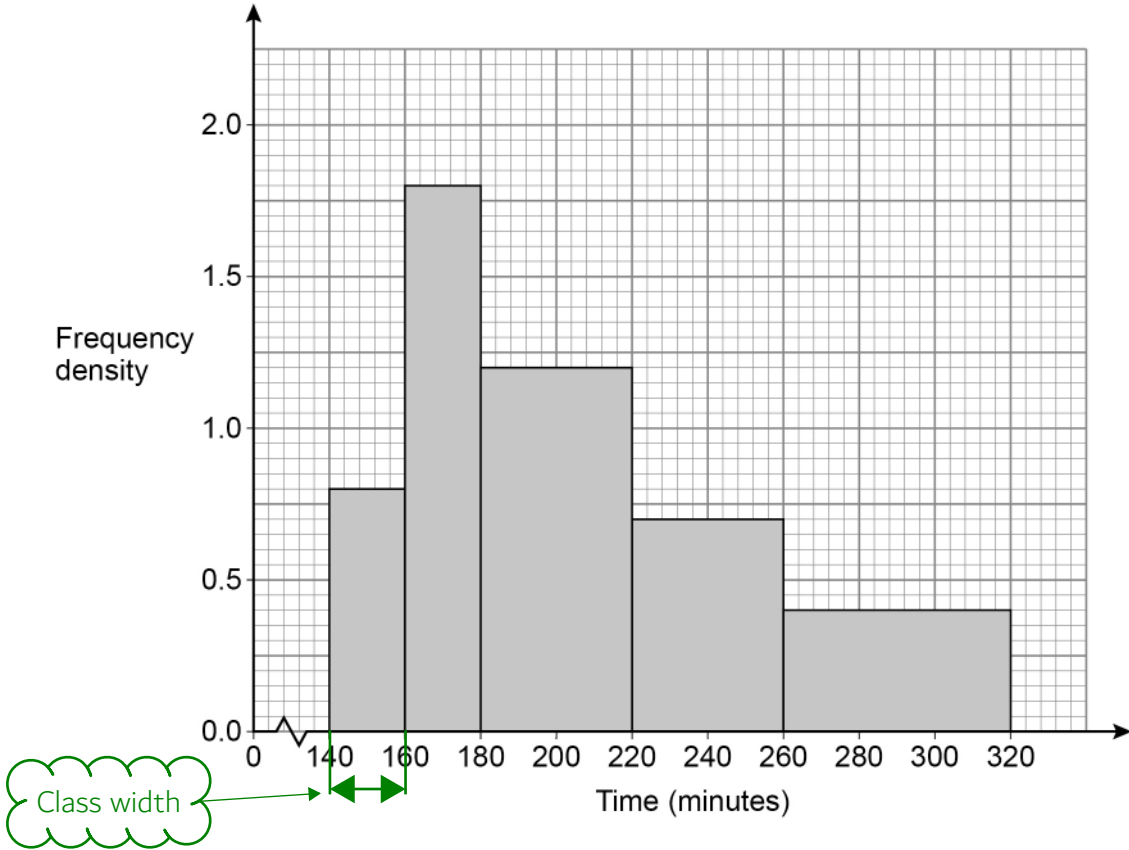
Putting 13.25% over 100 converts it into a fraction, which when multiplied by the rest of the salary for the National Insurance works out that 13.25% of it is £3792.15

Answer £ 3792.15



15 180 runners **started** a marathon.
Some of the runners did not complete it.

15 (a) The histogram represents the times of the runners who did complete the marathon.



How many runners did **not** complete the marathon?

[3 marks]

The vertical scale goes up 0.5 over 10 small boxes. $0.5 \div 10 = 0.05$ so each small box is worth 0.05 and every 2 small boxes is 0.1

- $20 \times 0.8 = 16$
- $20 \times 1.8 = 36$
- $40 \times 1.2 = 48$
- $40 \times 0.7 = 28$
- $60 \times 0.4 = 24$

Frequency is the area of each bar on a histogram. Multiplying all the class widths by the frequency densities for each bar works out the frequency represented by each bar

$180 - 16 - 36 - 48 - 28 - 24$ ← Subtracting all the frequencies of runners who completed the race from the 180 runners who started leaves the number of runners who did not complete it

Answer 28

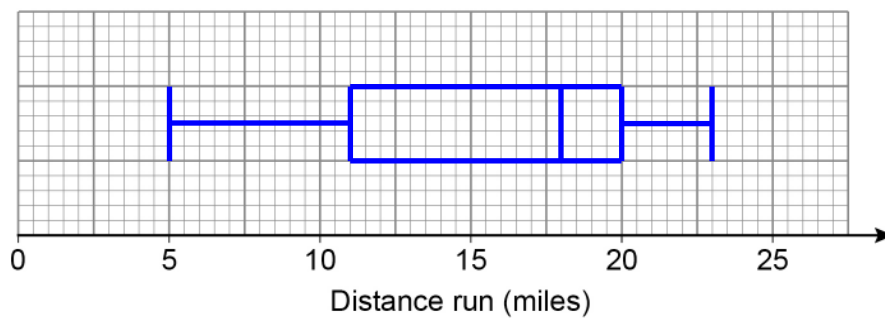


- 15 (b) The table shows information about the runners who did **not** complete the marathon.

	Distance run (miles)
Least distance	5
Greatest distance	23
Lower quartile	11
Median	18
Interquartile range	9

Draw a box plot to represent the information.

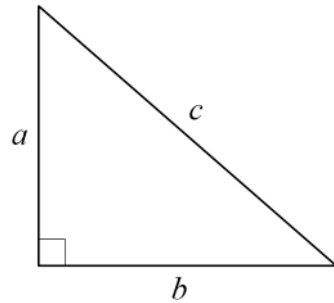
[3 marks]



Drawing vertical lines for the least, greatest, lower quartile, upper quartile and median.
Then drawing a box around the quartiles and connecting it to the least and greatest values. The upper quartile is found by adding the interquartile range to the lower quartile



16

Not drawn
accurately

In this right-angled triangle,

$$a = 16 \text{ cm}$$

$$a : c = 4 : 5$$

Work out the area of the triangle.

[4 marks]

$$16 \div 4$$

4 parts of the ratio represent length a, which is 16 cm. So dividing the 16 cm by 4 works out that 1 part of the ratio is worth 4 cm

$$4 \times 5 = 20$$

Multiplying the value of 1 part of the ratio by the 5 parts which represent c works out that c is 20 cm

$$a^2 + b^2 = c^2$$

Writing down Pythagoras' Theorem as this can be used to find the missing side of a right-angled triangle

$$16^2 + b^2 = 20^2$$

a and b are the shorter sides and c is the longest side. Substituting 16 cm for a and 20 cm for c

$$b = \sqrt{20^2 - 16^2}$$

Rearranged to find b by subtracting 16^2 from both sides then square rooting both sides. b is 12 cm

$$\frac{1}{2} \times 12 \times 16$$

Area of triangle = $\frac{1}{2} \times \text{base} \times \text{height}$. The base is 12 cm and the height is 16 cm

Answer 96 cm^2 

17 Solve $\frac{x+8}{2} + \frac{9-x}{5} = 4$

[4 marks]

$$x+8+\frac{18-2x}{5}=8$$

Multiplying all terms on both sides by 2 to eliminate the 2 as the denominator

$$5x+40+18-2x=40$$

Multiplying all terms on both sides by 5 to eliminate the 5 as the denominator

$$3x+18=0$$

Collecting like terms and subtracting 40 from both sides

$$x=-18\div 3$$

Subtracting 18 from both sides then dividing both sides by 3

$$x = \underline{\quad -6 \quad}$$

Turn over for the next question

Turn over ►



$$18 \quad f(x) = x^2 + 6x$$

$$g(x) = 2x + 4$$

$$18 \text{ (a)} \quad \text{Show that } fg(x) = 4x^2 + 28x + 40$$

[3 marks]

$$fg(x) = (2x + 4)^2 + 6(2x + 4) \leftarrow \text{Substituting } g(x) \text{ for } x \text{ in } f(x)$$

$$= 4x^2 + 16x + 16 + 12x + 24 \leftarrow \text{Expanding the brackets. For the square bracket: squaring the first term, doubling the product of the two terms, squaring the last term}$$

$$= 4x^2 + 28x + 40 \leftarrow \text{Collecting like terms}$$

$$18 \text{ (b)} \quad \text{Solve } fg(x) = -5$$

[3 marks]

$$4x^2 + 28x + 40 = -5 \leftarrow \text{Setting } fg(x) \text{ equal to } -5$$

$$4x^2 + 28x + 45 = 0 \leftarrow \text{Adding 5 to both sides to put it into the quadratic form}$$

$$x = \frac{-28 \pm \sqrt{28^2 - 4 \times 4 \times 45}}{2 \times 4}$$

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

Solving using the quadratic formula

Answer $x = -2.5$ and $x = -4.5$



19 Two integers have a difference of 6

The integers are multiplied together.

9 is then added.

Prove algebraically that the result is always a square number.

[3 marks]

$$n(n+6)+9$$

n represents any integer. n + 6 represents an integer 6 greater than n. Expressing the two integers multiplied and adding 9

$$n^2+6n+9$$

Expanding the bracket

$$(n+3)^2$$

Factorising shows that it is a square number. To factorise: two numbers which multiply to the 9 and add to the 6 are 3 and 3. Putting these in brackets with x. As both brackets are the same, one of the bracket can be squared

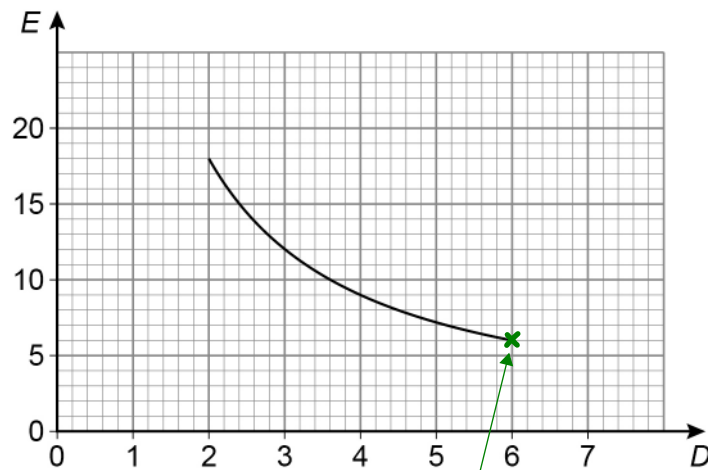
Turn over for the next question

Turn over ►



20 (a) Sunil thinks that E and D are linked by the equation $E = \frac{36}{D}$

The graph shows the values of D and E for $2 \leq D \leq 6$



Choosing this point as it is on grid lines and is easy to read

Choose **one** point on the graph and state if Sunil's equation is correct for that point.

[1 mark]

(6,6)

The point chosen

$$\frac{36}{6} = 6$$

Substituting 6 for D in the equation gives the correct value of E

correct

The point chosen satisfies the equation



20 (b) G is directly proportional to the square root of H .

$$G : H = 3 : 2 \text{ when } H = 16$$

Work out $G : H$ when $H = 100$

[4 marks]

$$G \propto \sqrt{H}$$

Writing the proportion

$$16 \div 2$$

2 parts of the first ratio represent H , which is 16. So dividing 16 by 2 works out that 1 part of the ratio is worth 8

$$8 \times 3$$

Multiplying the value of 1 part by the 3 parts which represent G works out that G is 24 when $H = 16$

$$24 \times \sqrt{\frac{100}{16}}$$

Putting 100 over 16 expresses what H has been multiplied by from 16 to 100. G must be multiplied by the square root of this

Answer 60 : 100

The value of G is 60 when H is 100

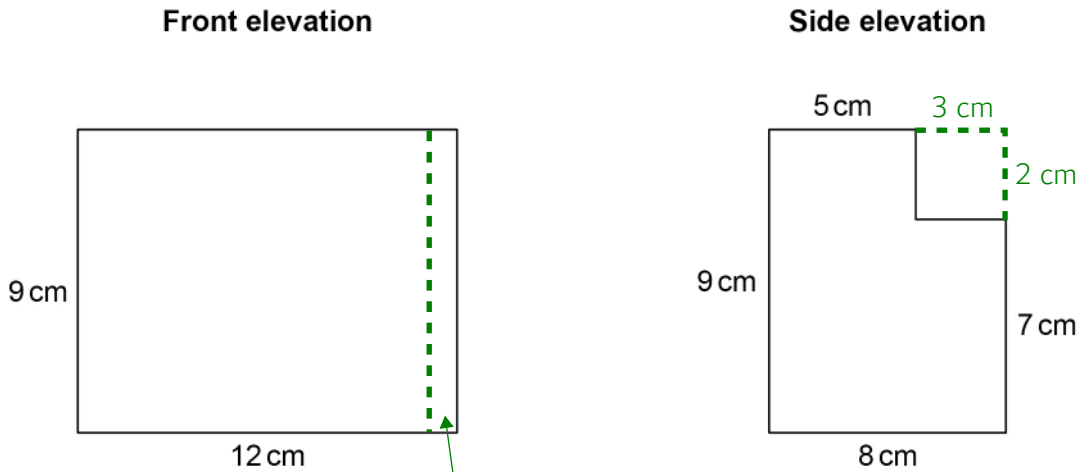
Turn over for the next question



21

A solid shape is made from centimetre cubes.
The front elevation and side elevation of the shape are shown.

Not drawn accurately



Work out

For the 1 cube thick 'wall' described for the minimum, we must take 1 off the 12 cm length as the cubes for the side elevation are already counted

the **maximum** possible number of cubes in the shape
and
the **minimum** possible number of cubes in the shape.

[3 marks]

$9 \times 8 - 3 \times 2$

This works out that the area of the side elevation is 66 cm^2 by working out the area of the whole rectangle then subtracting the small rectangle which is missing at the top right. Area of rectangle = length \times width

66×12

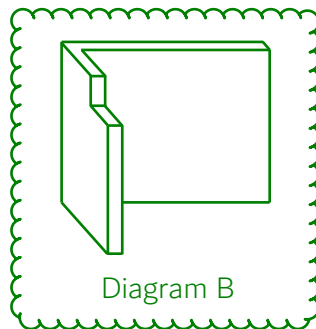
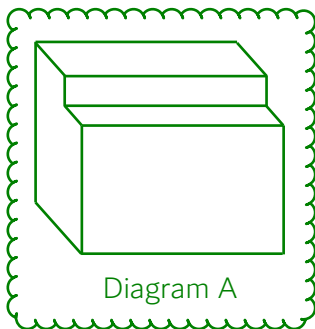
This works out the maximum possible number of cubes by assuming that the side elevation is a continuous cross section throughout the shape. See diagram A. Volume of prism = area of cross section \times length. The length is 12 cm

$66 + 11 \times 9$

This works out the minimum possible number of cubes by assuming that the side elevation is not a continuous cross section throughout the shape. See diagram B. Adding a 1 cube thick 'wall' for the front elevation to the area of the cross section

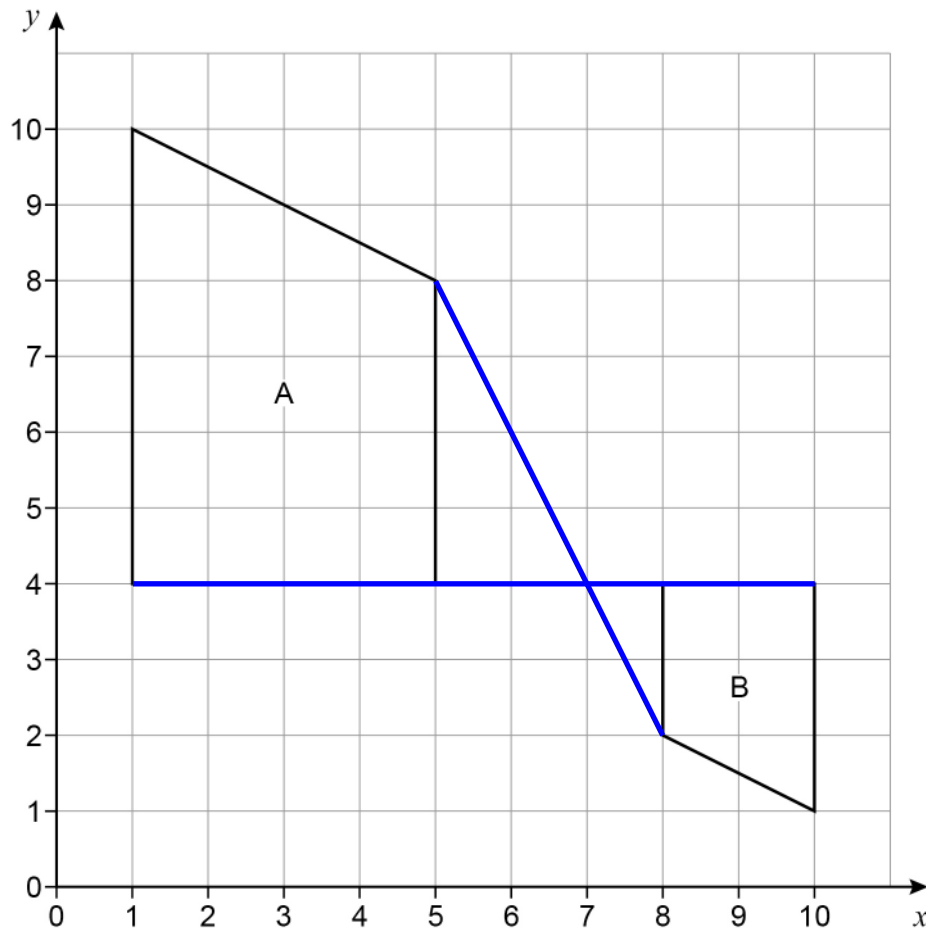
Maximum 792

Minimum 165



22

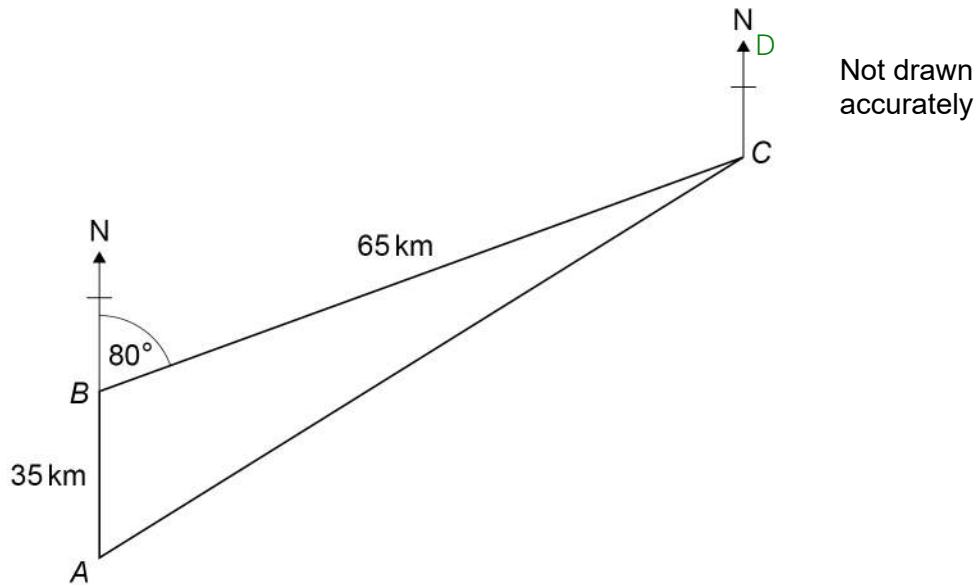
Shape A and shape B are shown on the grid.

Describe the **single** transformation that maps shape A to shape B.**[3 marks]**Enlargement, scale factor $-1/2$, centre $(7, 4)$

It must be an enlargement as it has changed size. The scale factor is $-1/2$ as it has inverted (so must be negative) and is half the size. Drawing straight lines through the same corners on both shapes works out that the centre is $(7, 4)$ as this is where the lines cross



23



A boat sails 35 km North from A to B .

From B the boat sails to C and then back to A .

23 (a) Show that the distance the boat sails from C to A is 79 km to the nearest km

You **must** show your working.

[2 marks]

$$180 - 80 = 100$$

Angles around a point on a straight line add up to 180° . So subtracting the 80° from 180° works out that angle ABC is 100°

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

There are not opposite pairs of sides and angles in triangle ABC when trying to find CA . Therefore the cosine rule has to be used as the sine rule cannot be used

$$CA = \sqrt{35^2 + 65^2 - 2 \times 35 \times 65 \times \cos 100}$$

Substituting in the values and square rooting both sides to make length CA the subject. CA is a , 35 is b , 65 is c and 100 is A

$$= 79$$

$78.994\dots$ rounds to 79 to the nearest km. Store the exact value on the calculator as A as it is needed for the next question



23 (b) Work out the bearing of A from C.

[4 marks]

$$180 - 80 = 100$$

Co-interior angles add up to 180° so subtracting the 80° from 180° works out that angle BCD is 100°

$$\frac{\sin A}{a} = \frac{\sin B}{b}$$

There are opposite pairs of sides and angles in triangle ABC so the sine rule can be used to work out angle ACB

$$ACB = \sin^{-1}\left(\frac{35 \sin 100}{78.9\dots}\right)$$

Substituting in the values and rearranging to find angle ACB by multiplying by side a and doing the inverse sin of both sides of the equation. a is opposite A and b is opposite B so side a is 35, angle A is ACB, side b is 78.9... (use the exact stored value on the calculator) and angle B is 100°

$$= 25.8\dots$$

Storing the exact value of 25.87... as B on the calculator

$$360 - 100 - 25.8\dots$$

There are 360° around a point so subtracting angles BCD and ACB from 360° works out the bearing of A from C. Using the exact value stored on the calculator as 25.8...

Answer 234.1 °

END OF QUESTIONS

